

**A Thesis in the partial fulfillment of the degree of
Masters of Science in
Electrical and Electronic Engineering**

on

**High Performance Non-Volatile
Ternary Content Addressable Memory Design
Using Memristor-MOSFET Hybrid Architecture.**

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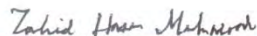
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Abstract

Content Addressable Memory (CAM) accesses a stored data word based on its contents, compares it with a search word and returns the address of the matched word. This comparison and search operations are done within the memory cell, without the assistance of Arithmetic Logic Unit (ALU). Due to this in-memory search facility, CAM can be a crucial circuit element in high-speed search engine, data base engine, artificial neural network for neuromorphic computing and other applications for Internet of Things (IoT). Ternary Content Addressable Memory (TCAM) can store and compare two bits of data in a single cell. Thus it can be used to represent three states- High, Low and Don't Care. This third state can provide Masking, which allows to search a portion of the word, instead of the whole word. Thus TCAM adds more flexibility in the search operation, and hence, has huge demand in IoT applications. In this work, we have proposed a non-volatile memristor-MOSFET hybrid architecture of TCAM cell. The memristor model used in this work is calibrated to match the physical characterization data of practical Ta-O based memristor. Furthermore, two match-line segmentation schemes- selective charging and pipelining are implemented in order to make the proposed TCAM cell work more reliably and efficiently in larger memory arrays. Finally, corner simulations are done to verify the robustness of the proposed design against process, voltage and temperature variation. The results obtained from the simulation are compared with that of conventional transistor based TCAM design and other memristor-MOSFET hybrid TCAM designs. The comparison shows significant performance improvement based on the following criteria- search time, search energy (per bit) and voltage margin. This reduces the overall search time up to 83%, energy per bit up to 77.81% during match and 99.45% during mismatch; and increases voltage margin up to 81.19% than the conventional TCAM design with MOSFETs. In other words, the proposed design shows significant performance improvement with respect to conventional TCAM designs and more practical applicability than other memristor-MOSFET hybrid TCAM designs. Therefore, this design can be a better alternative for future memory, computing and IoT applications.

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To my Parents

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Chapter-1 Introduction

1.1. Introduction

With the advent and growth of the Internet of Things (IoT), the need and usage of efficient search engines is increasing. Due to the thousands of millions of active online users per second, the data traffic is drastically increasing. In order to efficiently handle this intricate intertwined data routing and scheduling, researchers are looking for ways „to do more with less“. This instigates the quest for simultaneous storage efficiency as well as better look-up facility for faster, cheaper, reliable and power efficient search engines. Hence competent memory designs are yet to come for ensuring better usability to meet the demands for modern high-speed search engine, data base engine, artificial neural network for neuromorphic computing etc.

Memory is any form of electronic storage. If the computer's CPU needed to continuously access the hard-drive to retrieve any piece of information, it would operate very slowly. This is why information is stored in the memory for quick and easy access for processing. Most of the computer systems use temporary memory for this purpose. RAM is such a memory which temporarily stores the process data and information. Additional RAM allows a computer to work with more information. A particular type of RAM, DRAM (Dynamic Random Access Memory) needs constant refreshing as otherwise it loses its contents. This periodic refreshing demands large power consumption. Another type of RAM, SRAM (Static Random Access Memory) doesn't need periodic refreshing as it holds its content unless a content with opposite nature is stored in it. Thus, SRAM provides better memory operation without any need for refreshing, but at the price of greater cost and area requirement. Hence, despite SRAM's faster and more reliable operations, majority of the computer's memory system is constituted with DRAM as it is lot cheaper than the SRAM. However, both SRAM and DRAM are volatile in nature and provides poor look up function. The need of better look-up function becomes more prominent in case of modern internet system.

Content Addressable Memory (CAM) is a type of memory that can compare data at bit positions [1]. It is also known as „associative storage“ or „associative memory“ or „associative array“. In regular DRAM and SRAM chips the contents are addressed by bit location and then transferred to the Arithmetic Logic Unit (ALU) in the CPU for comparison. On the other hand, in CAM chips the content is compared in each bit cell, thus allowing very fast table look-up facility. A type of CAM is TCAM, which deals with 3 states using 2 bits by creating a provision for masking. This adds flexibility in the look-up operation. However, the need for storing and retrieval of 2 bits doubles the area and power consumption requirements, as two SRAM cells are needed to store each bit. The area and power constraint can be improved significantly by introducing a fourth fundamental passive circuit element- Memristor, which is a non-volatile memory element.

Several TCAM designs have been previously proposed in literature [2-4]. Conventional TCAM design with transistors require 16 transistors in each memory cell [2], thus has large cell area and consequently, large power consumption. Moreover, transistor based designs do not provide non-volatility. Hence, they need to be re-written each time the cell is turned ON. For this reason, conventional TCAM designs are not much suitable for modern internet based applications in data search engines or neuromorphic computing. To improve the performance and for getting more efficient TCAM designs for the IoT, beyond CMOS devices are incorporated with transistors to design hybrid cell structure. This reduces the cell area and power consumption to a significant extent. Furthermore these designs offer added benefits over conventional designs as- non-volatility. Hence data once written to the cell do not get lost easily even if the power supply is disconnected from the cell, thus increasing power efficiency. Several TCAM designs have been proposed with memristor-CMOS hybrid structure [3-4].

Leon Chua predicted the existence of fourth basic circuit element-memristor in 1971 [5]. Memristor changes its resistance depending on the amount and direction of current flow through it. It can remember its most recent resistance value after the supply voltage is turned OFF. Thus the inclusion of Memristor in the TCAM design has made the design non-volatile. However, the memristor model [6] used in [3-4] are not matched with any practical memristor device. Significant progress has been made in device performance using Ta-O based memristors along with switching in less than 2 ns [7]. A memristor device model is developed in [8] that can accurately match the results of several physical characterization data [9-14].

1.2. Motivation for this work

Researchers quest for sustainable, cheaper, smaller, power efficient memory system for IoT applications has led to the decision that none of the DRAM or SRAM memory systems is compatible enough for internet systems because none of them can provide the table look-up facility and search operations. In case of table look up operation SRAMs work in association with the ALU to match the words, which is awfully time-consuming. Thus the need for faster internet operation can be met efficiently by neither SRAM nor DRAM. So apart from their race between time and expense, their incapability to offer better table look-up facility makes both to be somewhat unworthy for modern computer and networking systems.

Content addressable memory can be a better alternative to RAMs due to its more convenient applicability in internet systems. In memory table look-up facility provided by CAMs make them suitable for IoT and neuromorphic computing. TCAMs can offer additional flexibility in the table look-up operation which increases the efficiency of the search operation significantly. However conventional TCAM designs require large number of transistors and huge power consumption. Again, some of the previously proposed hybrid TCAM designs did not incorporate practical device (memristor) behaviour. Hence to obtain a practically implementable more efficient TCAM design we have modified the hybrid TCAM structure and matched the device parameters to mimic practically implementable device (memristor) characteristics.

1.3. Thesis Organisation

This thesis paper describes our complete work along with the comparison with the conventional design. This paper is organized in the following manner:

Chapter 2: This chapter describes the memristor basics and characteristics. The SPICE model used for the memristor is also described with necessary equations. The PSPICE netlist used in simulation and typical simulation results for a single memristor using this code are provided at the end of this chapter.

Chapter 3: This chapter gives acquaintance of CAM designs. It then explains the structure and working principle of different conventional and hybrid TCAM designs. Various important aspects of each design are also discussed in this chapter.

Chapter 4: This chapter explains the array structure of TCAM cells. The structure and working principle of different peripheral circuitry such as- resetting circuitry, charging circuitry and sensing circuitry for each row in the array are explained. A brief introduction to matchline segmentation schemes is also included at the end of this chapter.

Chapter 5: This chapter introduces the matchline segmentation scheme- selective charging. It describes the structure and working principle of the array with this segmentation scheme. Then the simulation results for write and search operations and result analysis for this scheme are shown.

Chapter 6: This chapter introduces the matchline segmentation scheme- pipelining. It describes the structure and working principle of the array with this segmentation scheme. Then the simulation results for write and search operations and result analysis for this scheme are shown.

Chapter 7: This chapter presents the corner simulation results for both of the matchline segmentation schemes. It explains the comparative analysis among the conventional designs and the hybrid designs with our design. Comparison in terms of speed, energy per bit and voltage margin are described in detail in this chapter. It also includes the comparison between the corner results of the two matchline segmentation schemes implemented arrays.

Chapter 8: This chapter concludes the work and mentions some possible future works.

Chapter-2 Memristor

There are three fundamental passive circuit elements: the resistor, the capacitor and the inductor. We assume that the real-world circuits can be modeled using only these three ideal elements and an ideal voltage source. An ideal capacitor is defined by the single-valued relationship between the charge $q(t)$ and the voltage $v(t)$ via $dq = C dv$. Similarly, an ideal resistor is defined by a single valued relationship between the current $i(t)$ and the voltage $v(t)$ via $dv = R di$, and an ideal inductor is defined by a single-valued relationship between the magnetic flux $\phi(t)$ and the current $i(t)$ via $d\phi = L di$. These three definitions provide three relations between the four fundamental constituents of the circuit theory, namely the charge q , current i , voltage v , and magnetic flux ϕ . The definition of current, $i = \frac{dq}{dt}$, and the Lenz's law, $v = + \frac{d\phi}{dt}$, give two more relations between the four constituents. (We define the flux such that the sign in the Lenz's law is positive). This five relationships are shown in Figure 2.1. In this figure we can see that a relation between the charge $q(t)$ and magnetic flux $\phi(t)$ missing. That means, if a relation between charge $q(t)$ and magnetic flux $\phi(t)$ existed, then we could get a symmetrical configuration of this relationship diagram. So, keeping an eye to this symmetry consideration, Leon Chua in 1971 postulated that a new ideal element defined by the single-valued relationship $d\phi = M dq$ must exist. He called this element memristor M , a short for memory-resistor [5].

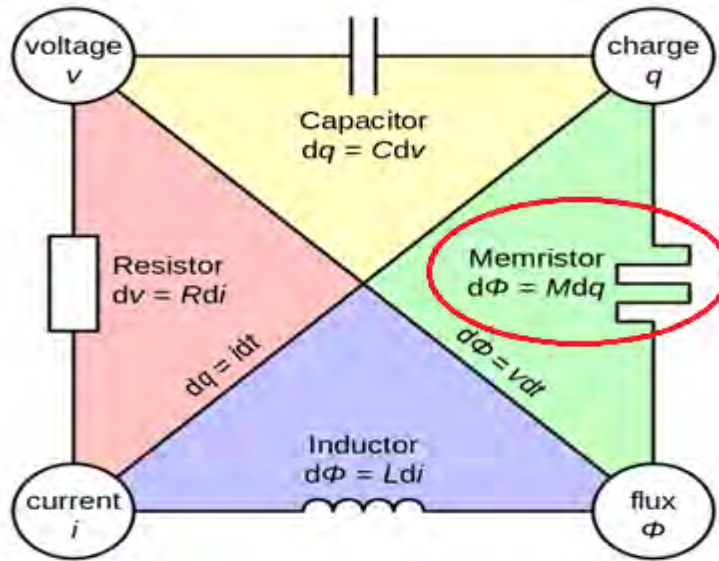


Figure 2.1 Relations between four variables of basic electrical circuit theory

Thus Leon Chua predicted the existence of the fourth fundamental circuit element- Memristor [15]. This ground-breaking hypothesis lead to a complete inter-relationship among the four variables of basic electrical circuit theory- charge q , current i , voltage v and the magnetic flux ϕ as shown in Figure 2.2.

	charge q	current i	voltage v	magnetic flux ϕ
charge q		$q = \int i dt$	capacitance $q = Cv$ ⎓	memristance $q = \frac{\phi}{M}$ ⎓
current i	$i = \frac{dq}{dt}$		resistance $i = \frac{v}{R}$ ⎓	inductance $i = \frac{\phi}{L}$ ⎓
voltage v	capacitance $v = \frac{q}{C}$ ⎓	resistance $v = Ri$ ⎓		$v = \frac{d\phi}{dt}$
magnetic flux ϕ	memristance $\phi = Mq$ ⎓	inductance $\phi = Li$ ⎓	$\phi = \int v dt$	

Figure 2.2 Interrelation among the four variables of basic electrical circuit theory

A significant feature of memristor is when the voltage is turned OFF, the memristor remembers its most recent resistance until the next time it is turned ON. Because memristor has long-term memory and is built with nanoscale imprint lithography, the technology can be used to make large amounts of non-volatile memory for future semiconductor memory chips.

HP Labs realized the memristor [16-17] as a thin semiconductor film sandwiched between two metal contacts. The film consists of one layer of insulating TiO_2 and one layer of oxygen deficient TiO_{2-x} . The doped layer of TiO_{2-x} has significantly lower resistance compared to the un-doped layer of TiO_2 . The change in resistance occurs due to ionic motion of oxygen vacancies. The device can be characterized by an equivalent time dependent resistor whose value at a particular time is dependent on the relative length of the doped and un-doped regions. Hence, memristance can have a continuous variation and, thus, a memristor can be used as an analog device. However, in this work, the memristor is used as a digital device because only the two extreme values of the memristance- lowest and highest, are taken into consideration. The memristor is turned ON (resistance decreased) by channelling current through the memristor with a forward bias that displaces oxygen vacancies (major charge carrier) drifting them into bulk layer line-up to create a conducting channel with resistivity that is lower than the bulk layer. On the other hand, the memristor is turned OFF (resistance increased) by flowing current in the opposite direction with a reverse bias. The movement of oxygen vacancies in the opposite direction would cause disruption in the conduction channel converting the bulk layer again into a high resistance substance. Thus memristance can be altered between high and low by using alternate current direction, hence alternate voltage polarity. The memristor functionalism is shown in Figure 2.3

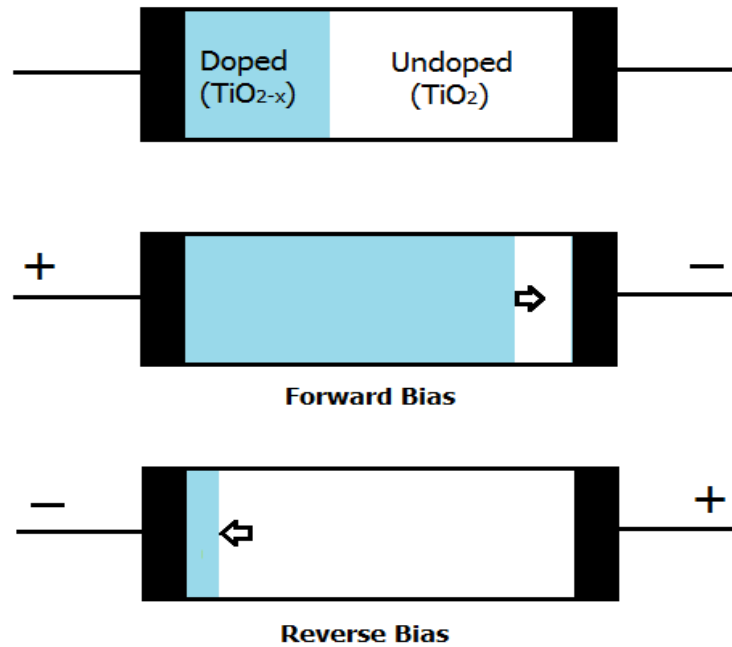


Figure 2.3A single memristor's functionalism

Significant progress has been made in device performance using Tantalum-Oxide based memristors. A recent demonstration shows over 10^{10} open-loop switching cycles [18] in Tantalum-Oxide based devices, with the device remaining switchable after 15 billion cycles without any feedback or power-limiting circuits [18-19]. This endurance record was surpassed within a year to 10^{12} by Lee et al. [19], also using a Tantalum-Oxide system. In addition, switching in less than 2 ns is demonstrated in Figure 2.4 using a relatively low voltage (less than 2 V) for switching in both direction [7,20].

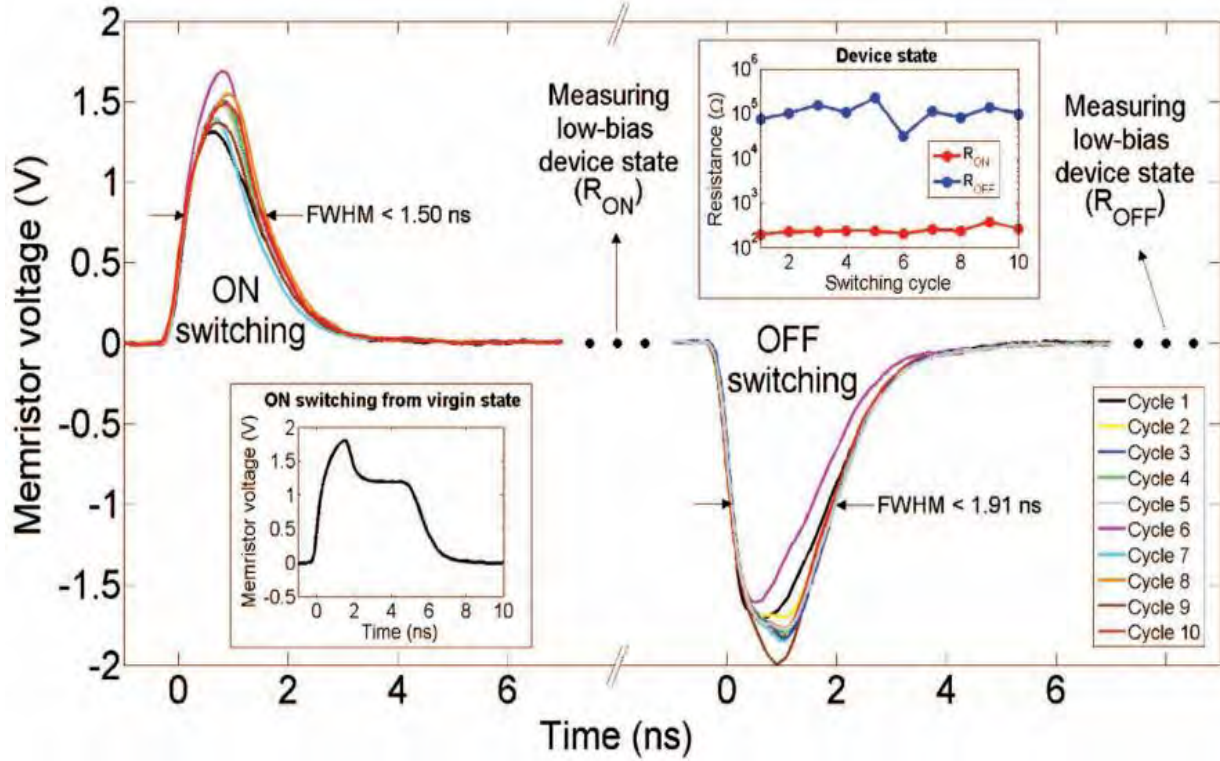


Figure 2.4 Electrical performance of tantalum oxide based memristors. Repeatable high speed switching under 2 ns measured in real-time for ON and OFF switching with a less than 2 V pulse (showing ten voltage–time curves for each) Upper right inset shows the reproducibility of the resistance values for the first ten ON and OFF pulses [7].

Modelling of memristor devices is essential for memristor based circuit and system design. It is of great benefit to circuit designers to be able to model the memristor in SPICE simulators. A memristor device model was developed in [8] that can accurately match the I-V characteristic of several published memristor devices. The equations were developed based on a more general understanding of memristor dynamics, and fitting parameters were used to match the results to physical characterization data [9-14]. In the development of this model, it was determined that a single parameter b , could be used independent of voltage polarity. The hyperbolic sinusoid shape is due to the MIM structure [21] of memristors, which causes the device to have an increase in conductivity beyond a certain voltage threshold. The parameters a_1 , a_2 , and b are used to fit equation (2.1) to the different device structures of the memristors. The fitting parameter b was used to control the intensity of the threshold function relating conductivity to input voltage magnitude. The I-V relationship also depends on the state variable $x(t)$, which provides the change in resistance based on the physical dynamics in each device.

$$I(t) = \begin{cases} a_1 x(t) \sinh(bV(t)) & , V(t) \geq 0 \\ a_2 x(t) \sinh(bV(t)) & , V(t) \leq 0 \end{cases} \quad (2.1)$$

In this model, the state variable is a value between 0 and 1 that directly impacts the conductivity of the device. The change in the state variable is based on two different functions, namely, $g(V(t))$ and $f(x(t))$. The function $g(V(t))$ imposes a programming threshold on the memristor model. The threshold is viewed as the minimum energy required to alter the physical structure of the device. Each of the published memristor devices [9-14] show that there is no state change in the memristor unless a certain voltage threshold is exceeded. The programming threshold was implemented using equation (2.2). In addition to the positive and negative thresholds (V_p and V_n), the magnitude of the exponentials (A_p and A_n) can be adjusted. The magnitude of the exponential represents how quickly the state changes once the threshold is surpassed.

$$g(V(t)) = \begin{cases} A_p(e^{V(t)} - e^{V_p}) & , V(t) > V_p \\ -A_n(e^{-V(t)} - e^{V_n}) & , V(t) < -V_n \\ 0 & , -V_n \leq V(t) \leq V_p \end{cases} \quad (2.2)$$

The second function used to model the state variable $f(x(t))$, can be seen in (3) and (4). This function was added based on the assumption that it becomes harder to change the state of the devices as the state variable approaches the boundaries. This is a necessary addition as it has been experimentally verified that the state variable motion is not equivalent in both directions [22]. The term η was introduced to represent the direction of the motion of the state variable relative to the voltage polarity. The function $f(x(t))$ was developed by assuming the state variable motion was constant up until the point x_p or x_n . At this point the motion of the state variable was limited by a decaying exponential function. Since the motion of the state variable appears to be different across the different types of devices studied, this function used fitting parameters to accommodate the variety. The constants in this equation represent the point where the state variable motion becomes limited (x_p and x_n), and the rate at which the exponential decays (α_n and α_p).

$$f(x(t)) = \begin{cases} e^{-\alpha_p(x(t)-x_p)} w_p(x(t), x_p) & , x(t) \geq x_p \\ 1 & , x(t) < x_p \end{cases} \quad (2.3)$$

$$f(x(t)) = \begin{cases} e^{\alpha_n(x(t)+x_n-1)} w_n(x(t), x_n) & , x(t) \leq 1 - x_n \\ 1 & , x(t) > 1 - x_n \end{cases} \quad (2.4)$$

In equation (2.5), $w_p(x, x_p)$ is a windowing function that ensures $f(x)$ equals zero when $x(t)=1$. In equation (2.6), $w_n(x, x_n)$ keeps $x(t)$ from becoming less than 0 when the current flow is reversed.

$$w_p(x, x_p) = \frac{x_p - x}{1 - x_p} + 1 \quad (2.5)$$

$$w_n(x, x_n) = \frac{x}{1 - x_p} \quad (2.6)$$

Equation (2.7) is used to model the state variable motion in each of the memristor devices. The term η is also used in equation (2.7) to determine the direction of the dynamic state variable motion.

$$\frac{dx}{dt} = \eta g(V(t))f(x(t)) \quad (2.7)$$

The circuit layout for a SPICE model based on equations (2.1) through (2.7) is shown in Figure 2.5. The two terminals TE and BE represent the top and bottom electrodes of the memristor. The current source G_m generates a current based on equation (2.1). The value of the state variable is determined using a current source and an integrating capacitor. The output of the current source is set equal to the right hand side of equation (2.7), and the value $x(t)$ is determined using the integrating capacitor C_x .

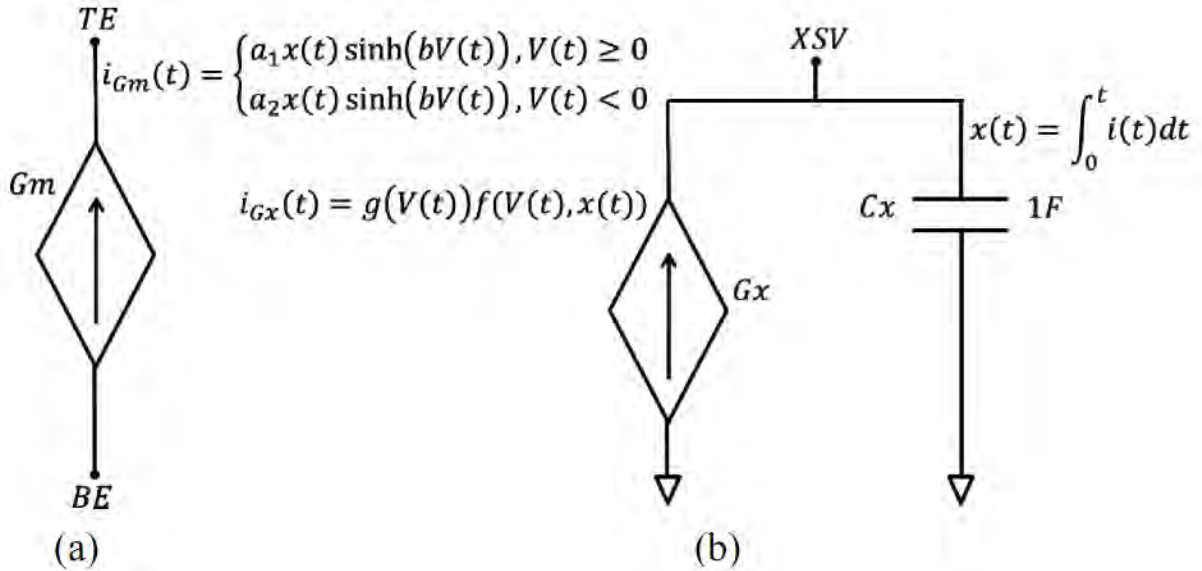


Figure 2.5 Diagrams that describe the functionality of the SPICE model where the circuit in (a) determines the I-V relationship of the memristor model and (b) shows how the value of the state variable is determined.

The SPICE netlist for this memristor model can be seen in Figure 2.6.

```

* Memristor model for many devices

* Connections:
* TE - top electrode
* BE - bottom electrode
* XSV - External connection to plot state variable
*that is not used otherwise

.subckt MEM_YAKOPCIC TE BE XSV PARAMS:

* Fitting parameters to model different devices
* a1, a2, b: Parameters for IV relationship
* Vp, Vn: Pos. and neg. voltage thresholds
* Ap, An: Multiplier for SV motion intensity
* xp, xn: Points where SV motion is reduced
* alphap, alphan: Rate at which SV motion decays
* xo: Initial value of SV
* eta: SV direction relative to voltage

+a1=0.17 a2=0.17 b=0.05 Vp=0.16 Vn=0.15 Ap=4000
+An=4000 xp=0.3 xn=0.5 alphap=1 alphan=5 xo=0.11 eta=1

* Multiplicative functions to ensure zero state
*variable motion at memristor boundaries
.func wp(V) {(xp-V)/(1-xp)+1}
.func wn(V) {V/(1-xn)}

* Function G(V(t)) - Describes the device threshold
.func G(V) { IF(V<=Vp, IF(V>=-Vn, 0, -An*(exp(-
+V)-exp(Vn))), Ap*(exp(V)-exp(Vp))) }

* Function F(V(t),x(t)) - Describes the SV motion
.func F(V1,V2) {IF(eta*V1 >= 0, IF(V2 >= xp, exp(-
+alphap*(V2-xp))*wp(V2) ,1), IF(V2 <= (1-xn),
+exp(alphan*(V2+xn-1))*wn(V2) ,1))}

* IV Response - Hyperbolic sine due to MIM structure
.func IVRel(V1,V2) {IF(V1 >= 0, a1*V2*sinh(b*V1),
+a2*V2*sinh(b*V1) )}

* Circuit to determine state variable
* dx/dt = F(V(t),x(t))*G(V(t))
Cx XSV 0 1 IC= {xo}
Gx 0 XSV value={eta*F(V(TE,BE),V(XSV,0))*G(V(TE,BE))}

* Current source for memristor IV response
Gm TE BE value = {IVRel(V(TE,BE),V(XSV,0))}

.ends MEM_YAKOPCIC

```

Figure 2.6PSpice subcircuit for the generalized memristor device model proposed in [8]

The memristor model is simulated to verify the functionality of this model. The circuit schematic that was used for simulation is shown in Figure 2.7. The simulation was done in PSpice and the simulation results are shown in Figures 2.8- 10. (The PSpice netlist is provided in Appendix A.1.)

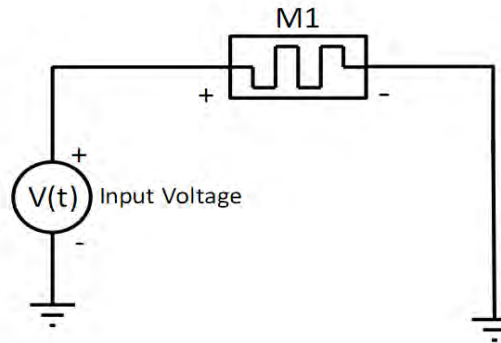


Figure 2.7 Circuit used for PSpice simulations

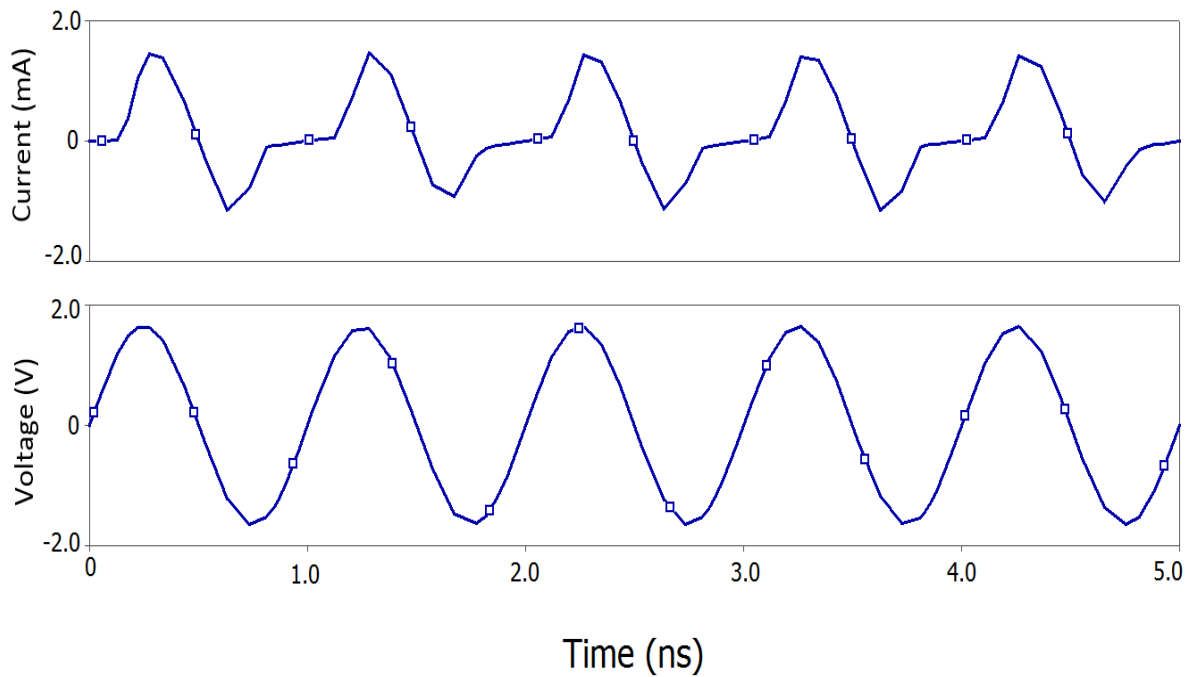


Figure 2.8 PSpice simulation results for a single memristor connected to a sinusoidal voltage source

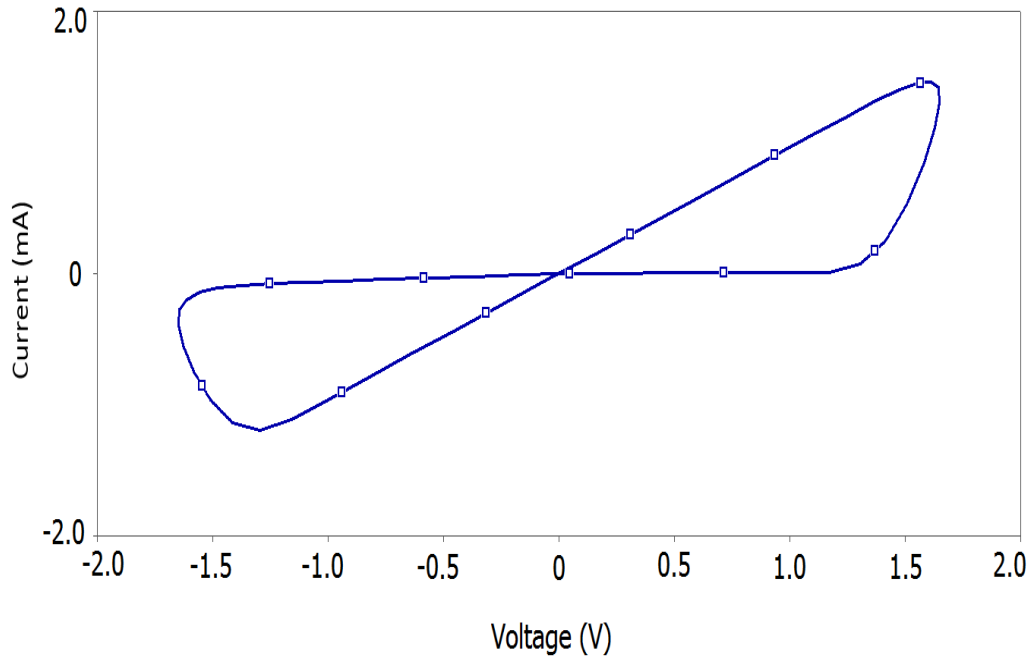


Figure 2.9 Hysteresis in a single memristor for a complete input cycle

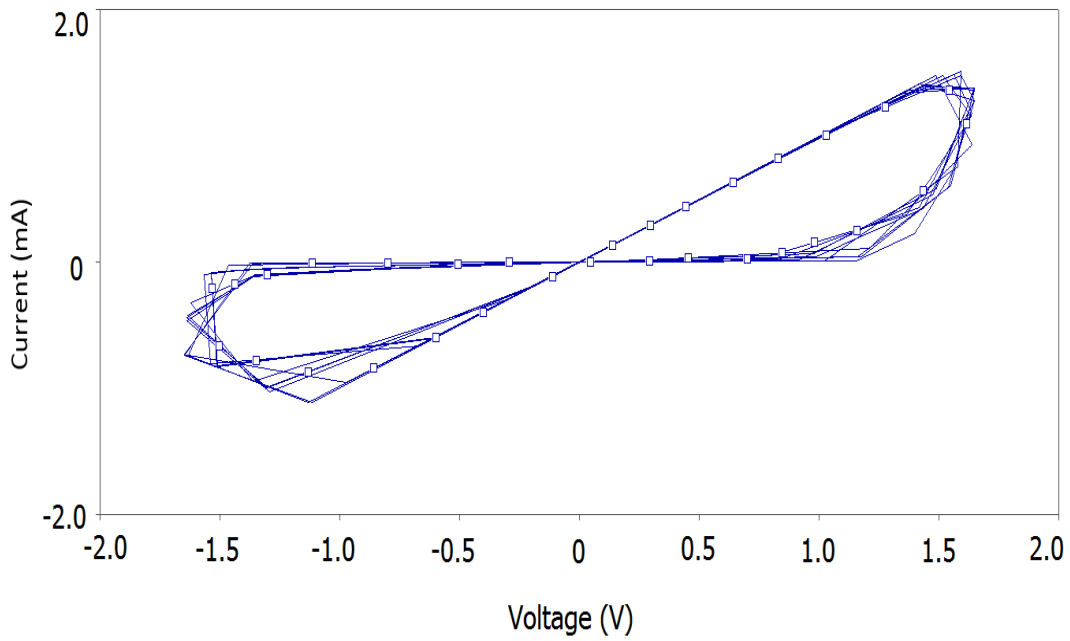


Figure 2.10 Hysteresis in a single memristor for 10 consecutive input cycles

Chapter-3 Advancement in TCAM Design

3.1. Content Addressable Memory (CAM)

Content addressable memory, abbreviated as CAM, is a storage device that searches for the matching data against a table of stored data and returns the address at which the matching data was found. It is used in certain very high speed searching applications.

In Content Addressable Memory, each bit position can be compared. In dynamic RAM (DRAM) and static RAM (SRAM) chips, the contents are addressed by bit location and then these contents are transferred to the arithmetic logic unit (ALU) in the CPU for comparison. In other words, contents are compared in the ALU. Whereas, in CAM chips, the content is compared in each bit cell, hence results in very fast table lookups.

CAMs can be divided into two categories: Binary CAM (BCAM) and Ternary CAM (TCAM).

BCAMs are capable of dealing with only 2 states (high: „1“ and low: „0“). Whereas, TCAMs handle three states („1“, „0“, „X“), where „X“ denotes mask state or don’t care. TCAMs have several advantages over BCAMs due to the existence of the third state. In this chapter, the chronological development of TCAM cell design has been discussed.

3.2. Ternary Content Addressable Memory (TCAM)

TCAM cells deal with three states – high: „1“, low: „0“, and don’t care: „X“. The third state is used as mask state. Masking allows finding out partial matches. It acts as a wild card entry, allowing a part of the entire word to be compared or searched for match. Masking can be done either locally or globally called „local masking“ and „global masking“ respectively.

In local masking, mask bits are entered in the table entry. This allows a portion of the stored data word to be searched for match or mismatch. In the global masking, mask bits are entered in the search key. This allows a portion of the search word to be compared for match or mismatch.

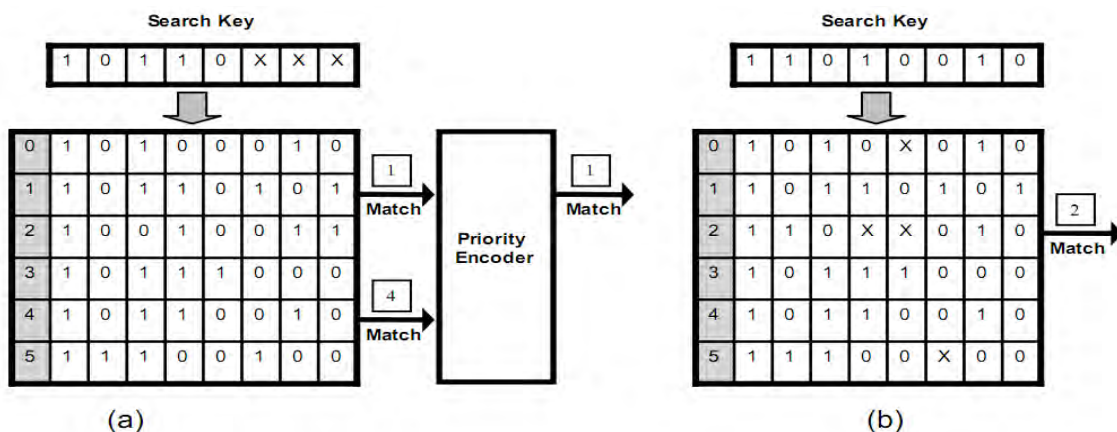


Figure 3.1(a) Global Masking (b) Local Masking [2]

With the advent of technology, researchers are thriving for getting better and more efficient TCAM cell. This constant effort of different researchers has led to gradual advancement in the basic cell design for TCAM. Here the development of TCAM cells with time is portrayed with short description of each of the TCAM cell variations and their aspects.

3.2.1. Conventional 16T TCAM cell

As TCAM cell deals with three states, it needs two bits for representing one state. Consequently, it needs two 6T SRAM cells for storing these two bits. Hence a single TCAM cell contains two SRAM storage units, each stores a single bit and its complement. A Conventional 16T NOR cell is shown in Figure 3.2.

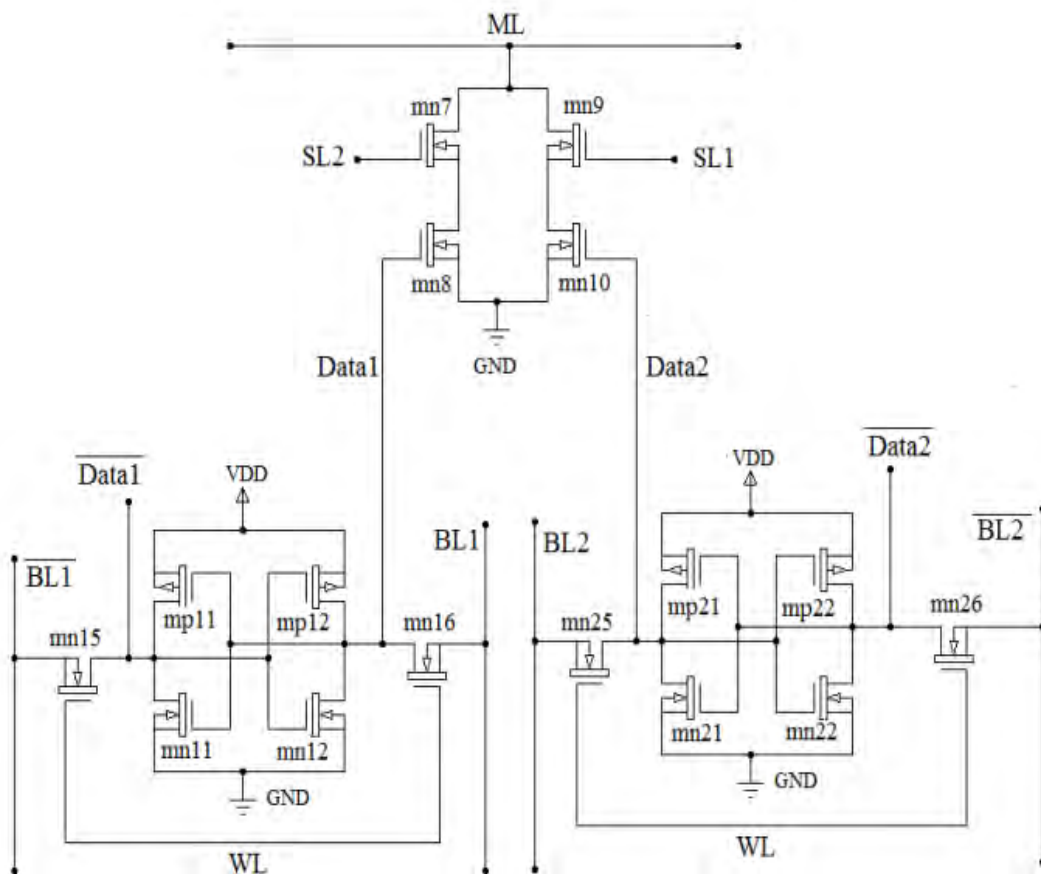


Figure 3.2 Conventional 16T NOR type TCAM cell [2]

Transistor Sizes (W/L)	
mn11, mn12, mn21, mn22 :	0.4u/0.2u
mp11, mp12, mp21, mp22 :	0.4u/0.2u

Two bits representing three states are stored in the Data1 and Data2 nodes.

Low: Data1Data2=01
High: Data1Data2 =10
Local Mask: Data1Data2=00
Global Mask: SL1SL2=00

Data1Data2=11 is not allowed.

Write Operation:

The write operation is similar to that described previously for BCAM cell. Desired data to be stored is provided via the BL1 and BL2 lines and their complements when the word line is activated. Due to the cross-coupled inverter action this data remains stored in the cell.

Search Operation:

Before the search operation, Match line is reset to zero. During search operation a charging circuitry (pre-charge) is activated through which the match line is charged high. During this time, if the path to ground is active (ON), then ML finds a path to discharge through and hence cannot pre-charge to high. If the pull-down path is disconnected from ground, then ML is pre-charged to high.

ML doesn't discharge if -

- A match between data bits and search bits is found, i.e. Data1Data2 = SL1SL2
- Local mask exists, i.e. Data1Data2=00
- Global mask exists, i.e. SL1SL2=00

ML discharges if –

- A mismatch between data bits and search bits is found, i.e. Data1Data2=SL2SL1
- No masking exists, i.e. Data1Data2≠00 and SL1SL2≠00

Aspects:

The conventional 16T TCAM cell was the first proposed TCAM design in literature. This cell has several drawbacks-

- Due to having many transistors in only a single cell the cell area is very large
- The more transistors, the more is the power consumption. Hence this cell requires a huge amount of power consumption
- Since 4 transistors are connected in the comparison circuitry, it causes a huge total capacitance in the Match Line. Specially, in case of larger arrays the Match Line capacitance increases to a very high value. Which causes the search operation to be much slower and more power consuming.
- The voltage margin is also very low

- The cell cannot retain the stored data once the power supply is turned OFF. Hence the cell is volatile.

3.2.2. 12 Transistor 2 Memristor TCAM Cell

In order to get over the non-volatility problem of conventional TCAM designs, a few literatures [3-4] have proposed Hybrid architecture of TCAM with transistors and memristors. The 12T2M hybrid structure of TCAM cell [3] is discussed here in brief.

The 12T2M TCAM cell contains two SRAM cells. The high, low and mask states are denoted by DATA1 DATA2= 10, DATA1 DATA2= 01 and DATA1 DATA2= 00 respectively. DATA1 DATA2=00 is called the Local Mask state because when this value is written in the TCAM cell, the matchline will be discharged irrespective of the value in search line. DATA1 DATA2 =11 is the forbidden state because if this value is written, the matchline will never discharge and we will not be able to distinguish this state from DATA1 DATA2=01 and DATA1 DATA2=10 states.

Similar encoding is used for search lines also. SL1 SL2=10, 01 or 11. SL1 SL2=11 is Global Mask condition. When this mask condition occurs, the matchline is discharged irrespective of data values written.

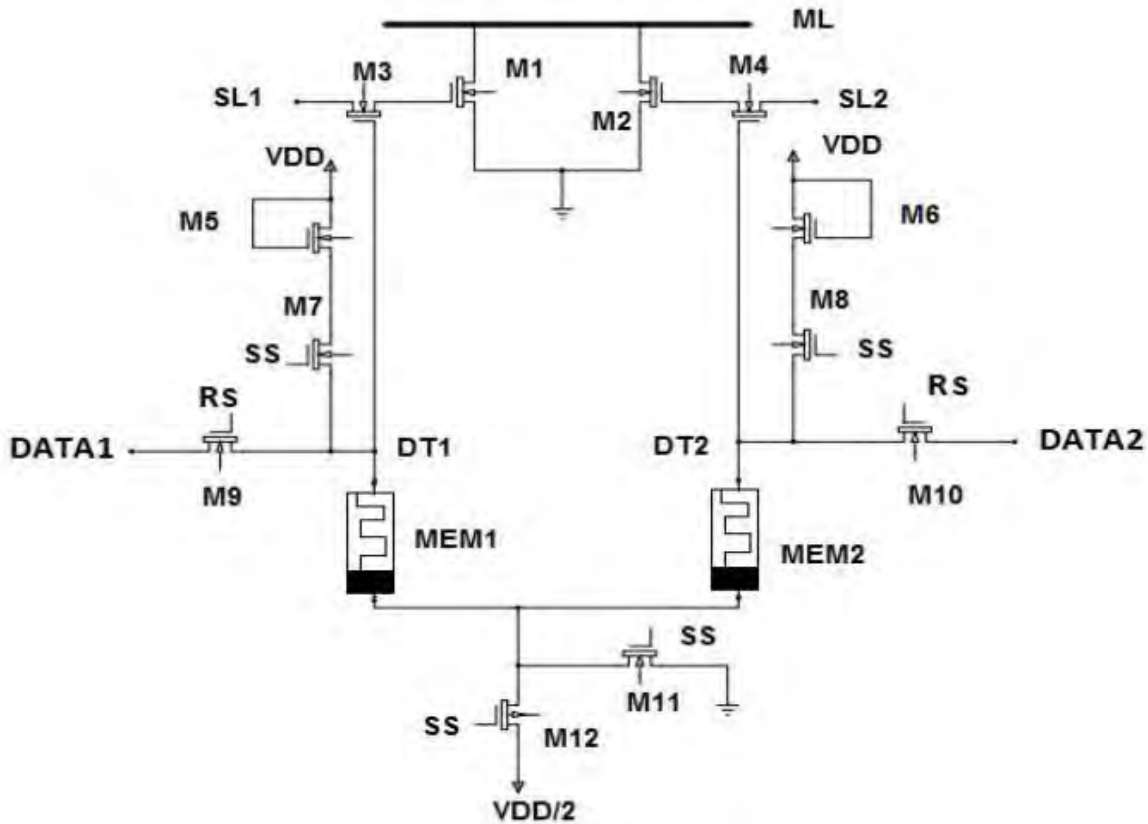


Figure 3.312T2M Hybrid structure of TCAM cell [3]

Transistor Sizes (W/L)	
mn1, mn2	: 10u/0.2u
mn3, mn4	: 16u/0.2u
mn5, mn6, mn7, mn8	: 0.4u/0.2u

Write Operation:

During write operation, Search Select (SS) signal is set to low state while RS is set to high state. Since M12 is a PMOS (Figure 3.3), it is turned ON and the circuit in Figure 3.4(a) results. When the data signal is at a HI state, the memristance goes low and voltage across it is low. On the contrary, when the data signal is at a LO state, current flows in opposite direction through the memristor as compared to the current that flows when data is HI. Hence, the memristance goes high and voltage drop across it also goes high. Thus a 2 bit data is stored in the memristor.

When for example, DATA1 DATA2=10, the memristance 1 and memristance 2 will be low and high respectively. Hence DT1=0 and DT2=1. When DATA1 DATA2=01, the memristance 1 and memristance 2 will be high and low respectively. Hence DT1=1 and DT2=0.

Search Operation:

Search operation is started by setting the Search Select (SS) signal (Figure 3.3) to HI state and RS is set to low. Hence the write signals DATA1 and DATA2 are cut off from the rest of the circuit and only search occurs. Since M11 is an NMOS (Figure 3.3), it is turned ON while M12 is turned off and the circuit in Figure 3.4(b) results. The two NMOSFET's M5 and M6 (Figure 3.3) are connected in saturation. As a consequence, they operate as resistors.

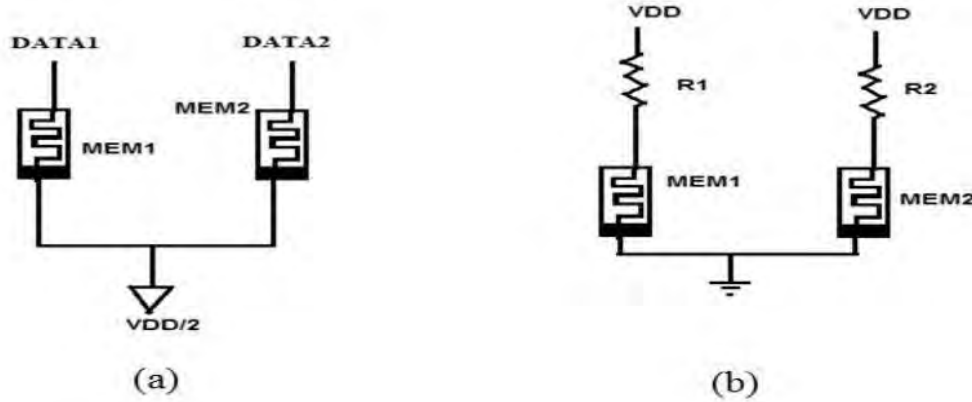


Figure 3.4(a) Circuit when SS=0, RS=1 (b) Circuit when SS=1, RS=0.

Therefore, MOSFET M5 together with memristor1 forms a voltage divider network.

Voltage at DT1 is:

$$V_{DT1} = \left(\frac{R_{mem1}}{R_{mem1} + R_1} \right) V_{DD}$$

Where, R_{mem1} and R_1 are the resistance of memristor1 and M5 respectively.

Similarly, voltage at DT2 is:

$$V_{DT2} = \left(\frac{R_{mem2}}{R_{mem2} + R_2} \right) V_{DD}$$

Where, R_{mem2} and R_2 are the resistance of memristor2 and M6 respectively.

The data to be searched is sent through the two search lines marked SL1 and SL2 (Figure 3.3). A match occurs when DT1 DT2= SL1 SL2. When DATA1 DATA2= 10, DT1 DT2 = 01. As a result, MOSFET M3 is off while M4 is turned on. If SL1 SL2= 10 both M1 and M2 remain off and the match line ML does not discharge at all (Figure 3.3). A mismatch is characterized by the discharge of match line. When a match occurs, there is a transition from high to low of the sense amplifier output. On the contrary, during a mismatch, the sense amplifier output goes from low to high. The duration of these transitions represents the time required to complete a search operation. SL1 SL2=11 is forbidden state.

3.2.3. 8 Transistor 4 Memristor TCAM cell

After further study the 12T2M TCAM cell [3] was modified by replacing the two transistors M5 and M6 (Figure 3.3) with two new memristors. The two transistors M11 and M12 were also eliminated. Instead a pulse form of $V_{DD}/2$ was used, which remains low at ground voltage during search operation and remains high at 1.65V during write operation.

The modified cell consists of 8 Transistors and 4 Memristors [4]. The cell is shown in Figure 3.4. The two Memristors MEM3 and MEM4 are connected in such a way that their memristance is high when current flows through them. For simulation purpose we have used $R_{OFF}=100k$ for MEM3 and MEM4; $R_{ON}=100$ and $R_{OFF}=100k$ for MEM1 and MEM2. Let us consider the case when $DATA1\ DATA2 = 01$, then $DT1\ DT2 = 10$. Here logic value „1“ corresponds to 3.3V and logic value „0“ corresponds to 0V. Since, $DATA1\ DATA2 = 01$ is written, resistance of MEM1 goes high e.g. $R_{OFF}=100k$ and resistance of MEM2 goes low e.g. $R_{ON}=100$.

During search cycle, $R_{mem3}=100k$ and $R_{mem4}=100k$, $R_{mem1}=100k$ and $R_{mem2}=100$

Voltage at DT1 will be,

$$V_{DT1} = \left(\frac{R_{mem\ 1}}{R_{mem\ 1} + R_{mem\ 3}} \right) V_{DD}$$
$$V_{DT1} = \left(\frac{100k}{100k + 100k} \right) 3.3\ V$$
$$= 1.65\ V\ (High)$$

Voltage at DT2 will be,

$$V_{DT2} = \left(\frac{R_{mem\ 2}}{R_{mem\ 2} + R_{mem\ 4}} \right) V_{DD}$$
$$V_{DT2} = \left(\frac{100}{100 + 100k} \right) 3.3\ V$$
$$= 0.00329\ V\ (Low)$$

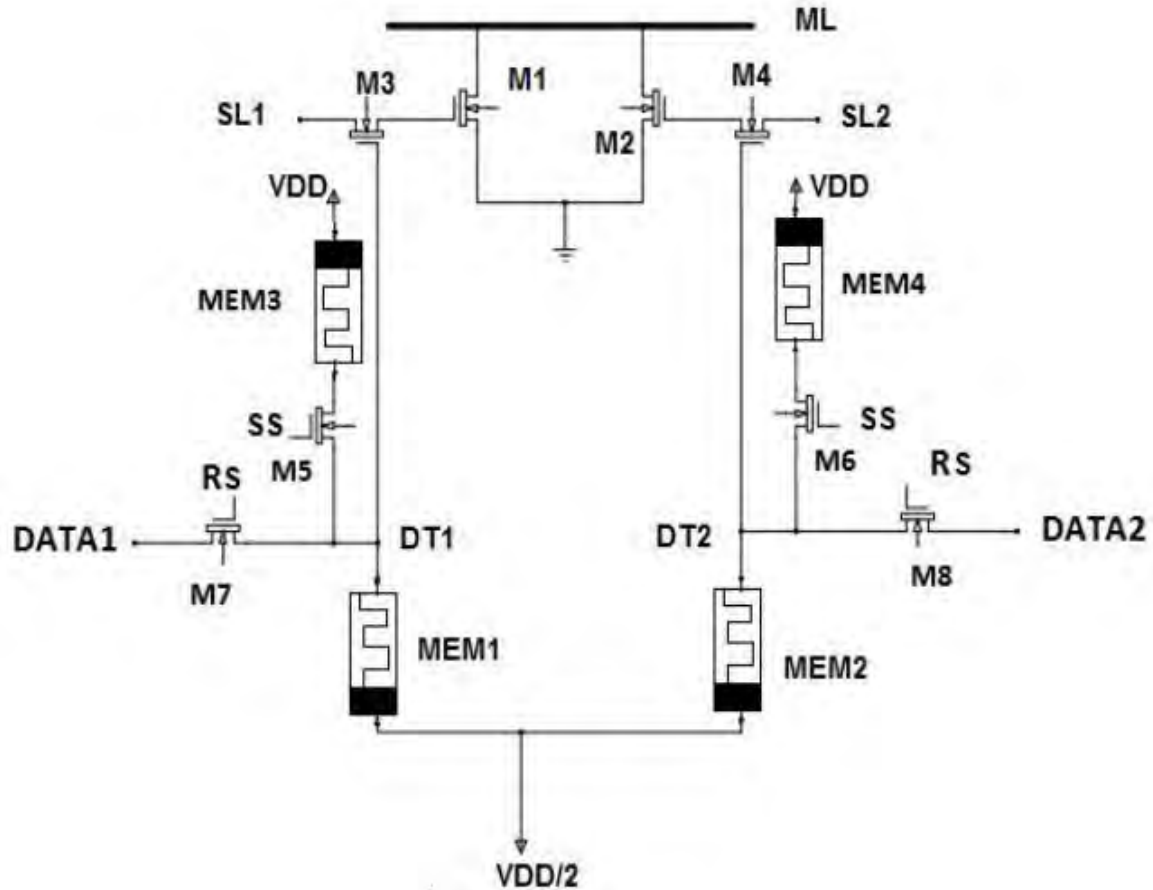


Figure 3.58T4M Hybrid structure of TCAM cell [4]

Transistor Sizes (W/L)	
mn1, mn2	: 10u/0.2u
mn3, mn4	: 16u/0.2u

The write and Search operations are almost similar to those discussed in 12T2M structure.

3.2.4. Proposed modifications in 8 Transistor 4 Memristor Structure

The efficiency of TCAM depends mostly on the search operation. Hence, in order to achieve higher search efficiency, further modifications have been made on the 8T4M TCAM structure. The modified structure is shown in Figure 3.6.

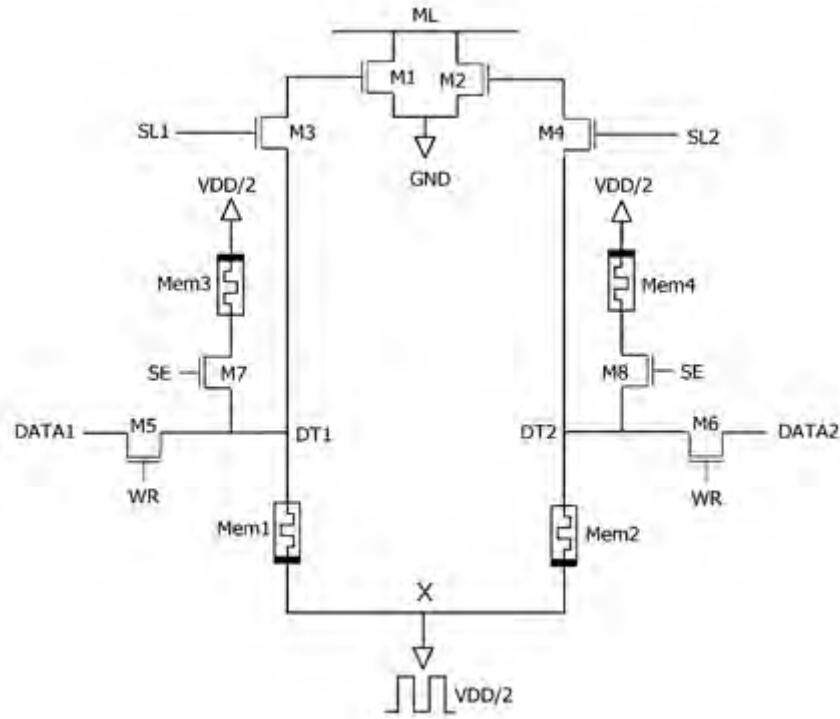


Figure 3.6 Modified 8T4M hybrid structure of TCAM cell

Transistor Sizes (W/L)	
mn1, mn2	: 0.2u/0.2u
mn3, mn4	: 4u/0.2u

The TCAM cell during search operation can be divided into two parts depending on the operation- comparison part and the voltage division part. These are shown in Figure 3.7. Two modifications have been made in these two parts for offering better search operation.

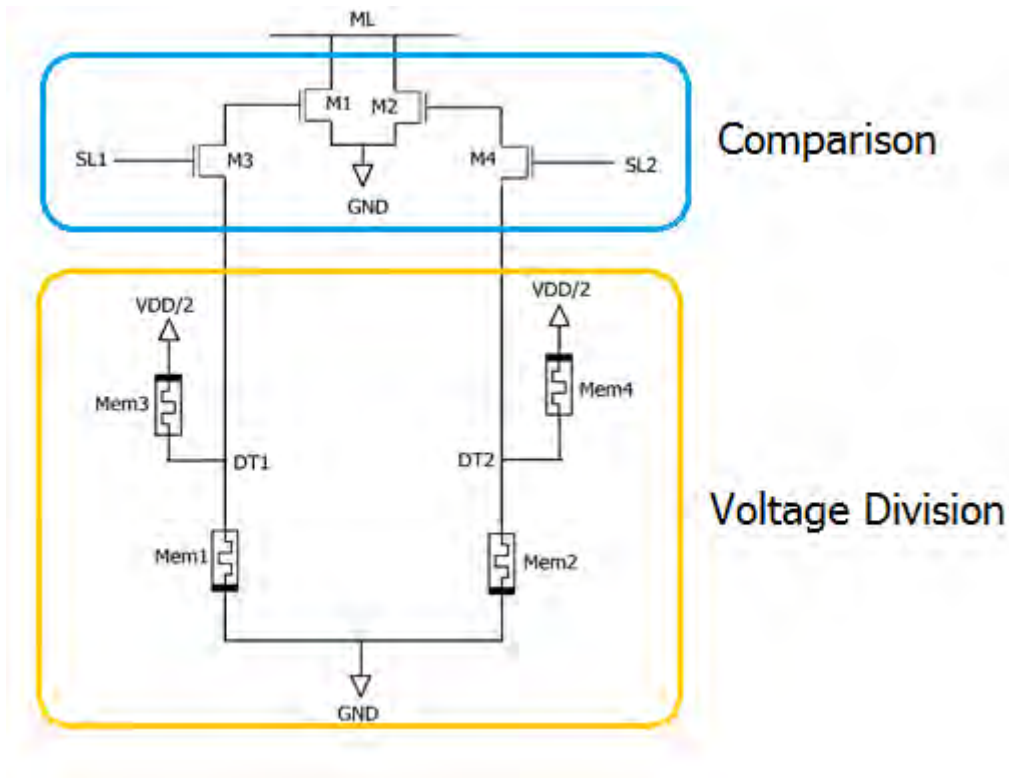


Figure 3.78T4M Cell during Search Operation

Firstly, in the comparison part of the cell the two data lines were connected to the gates of two MOSFETs. In the modified design the search lines are connected to the gates instead. This has increased the robustness of the search operation to a great extent. This is due to the fact that the voltage levels on the data lines do not get to full rail-to-rail voltage level. However, full voltage levels are applied directly on the search lines. Hence, smaller transistors can be used in the comparison part, which offers a greatly reduced capacitance. Thus the decision taking task becomes much easier and more efficient with this configuration. As the transistor sizes are reduced, the match line requires much less time to discharge. Thus the search speed increases significantly. Besides, smaller transistors consume less power. So ultimately this configuration offers greater energy efficiency. Moreover, reduced transistor size makes the cell smaller, and thus reduces the total cell area.

Secondly, the voltage division part previously were fed by full VDD power supply. In the proposed cell, the supply voltage is reduced to VDD/2. Simulation results show that, this reduction doesn't disturb the logic level to be detected on the data lines during search operation. Though the voltage level for is reduced, the logic level remains unchanged. Hence, reducing the voltage level creates no disturbance in the decision making. However, the reduced voltage level requires lower power consumption during the search operation. Thus the power consumption of the search operation is greatly reduced. Again, the lower voltage level across the memristors used in this part causes less alteration of the memristances during the search operation. In the previous designs, the search operation was destructive, i.e. the memristances were changed during the search operation, than what was stored during the write operation. However, in the

proposed modification the memristances do not alter that severely, since the voltage levels across them are now below the „threshold“, beyond which the memristances get altered. Thus this adds an additional qualification to the design.

3.2.4.1. Cell Description

Since the design is for TCAM (Ternary CAM), each cell needs to deal with three states- High, Low and Mask (Don't Care). In order to represent the three states, we need two bits. DATA1 and DATA2 are the two bits which are used to write and read those two bits. The representation of three states with these two bits are given in Table 3.1. Detailed discussion about masking is presented in Section 3.2.4.2

Table 3.1 Representation of three states using two bits

DATA1	DATA2	State
0	1	Low
1	0	High
1	1	Local Mask
0	0	Forbidden/ Not Allowed

The two memristors Mem1 and Mem2 are used to store these two bits of data. The other two memristors Mem3 and Mem4 are used to work as a voltage divider along with Mem1 and Mem2 during search operation.

The search key is provided in the SL1 and SL2 search lines. The search operation is carried on based on pattern matching between the Data Word and Search Key. The search result is categorized as either Match or Mismatch. The Match and Mismatch conditions are shown in Table 3.2. The four nMOS transistors- M1, M2, M3 and M4 altogether forms the comparison circuitry. This comparison circuitry is designed to be of NOR type instead of NAND type. This is due to the fact that, in NAND type comparison circuitry match-line voltage drops in case of long data words. Furthermore, the comparison circuitry is designed in such a way that the match-line charges during the Match condition and discharges during the Mismatch condition. Since, Mismatch is more frequent than Match, this arrangement helps reduce the overall power consumption of the search operation to a great extent.

Table 3.2 Match and Mismatch conditions during search operation

Condition	Decision	Match-line
SL1 SL2 = DATA1 DATA2	Match	Charge
SL1 SL2 ≠ DATA1 DATA2	Mismatch	Discharge

3.2.4.2. Masking

In TCAM, more flexibility in the search operation can be introduced by allowing partial search. That means instead of searching the whole word/ data line, one can search only a portion of the line. This is done with the help of masking. Masking can be done either in Data word or in Search word. If masking is done in Data word through the cell then it is called local mask. The definition of local mask is shown in Table 3.1. Again if masking is done in Search word through the search key then it is called global mask. The masking conditions are shown in Table 3.3. If any of the masking condition is held in any portion of the data word or search word, then the match-line doesn't react (charge or discharge) for that portion of the word according to Table 3.2. That means, the result of the search operation does not depend on that portion of the word.

Table 3.3 Masking Conditions

Masking	Condition
Local	DATA1 DATA2 = 1 1
Global	SL1 SL2 = 0 0

3.2.4.3. Forbidden States

The forbidden state for Data line is shown in Table 3.1. There is also forbidden state for search lines. In Table 3.4 the forbidden states for both data and search lines are mentioned separately. These two states are declared to be forbidden because the presence of these data or search bit pairs in a cell causes the search operation to behave incorrectly. The match-line will

get discharged even if there is a matching condition. Thus it will produce an ambiguous result in these cases. This is why, these states are declared to be forbidden or not allowed.

Table 3.4 Forbidden States

Lines	Bit values
DATA1 DATA2	0 0
SL1 SL2	1 1

3.2.4.4. Cell Operation

There are two types of operations that can be performed on each cell- Write operation and Search operation. Below these two operations are described separately.

Write Operation:

During Write operation the desired data to be written are provided into the DATA lines (i.e. DATA1 and DATA2). A $V_{DD}/2$ signal pulse is given to the $V_{DD}/2$ line. WR (Write enable) line of Figure 3.6 is put to logic „1“. Thus the data to be written comes to the points DT1 and DT2, creating a $V_{DT1} - V_{DD}/2$ and $V_{DT2} - V_{DD}/2$ voltage difference across Mem1 and Mem2 respectively. SE (Search Enable) line is put to logic „0“, thus disconnecting Mem3 and Mem4 from Mem1 and Mem2, respectively.

Now if any of the DATA lines is provided with logic „1“ (VDD), then current flows through the corresponding memristor in the forward direction. Thus the memristance is lowered for that memristor. Again if any of the DATA lines is provided with logic „0“ (0 volt), then current flows through the corresponding memristor in the reverse direction. Thus the memristance is increased for that memristor.

Thus logic „1“ and logic „0“ are stored as „lower“ and „higher“ memristance, respectively.

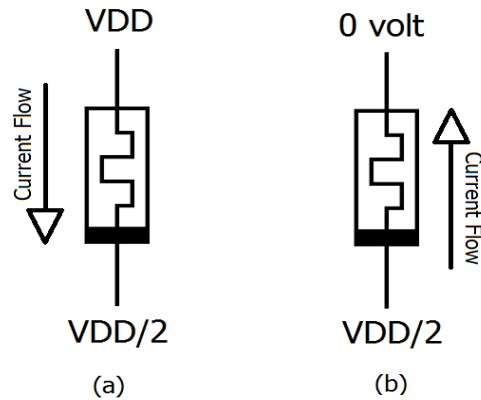


Figure 3.8 Direction of Current Flow for Writing (a) Logic '1', (b) Logic '0'

Search Operation:

During search operation WR (Write enable) line is put to logic „0“, thus disconnecting the DATA lines from Mem1 and Mem2. SE (Search Enable) line is put to logic „1“, thus connecting Mem3 and Mem4 in series with Mem1 and Mem2, respectively. The $VDD/2$ pulse is not present at the bottom of Mem1 and Mem2, since the pulse was put during the write operation only. So here a constant 0 volt is applied for rest of the time. Initially the memristors Mem3 and Mem4 are made to be completely un-doped by flowing current in the reverse direction for a prolonged time. This can be done even before connecting these memristors to the cell. This initialization of Mem3 and Mem4 is not needed to be done more than once, because current only flows in the reverse direction during the search operation. Thus keeping the memristances at the maximum value for each time these memristors are connected to the cell (by putting $SE=1$). Hence, these two memristors (Mem3 and Mem4) act as a constant high memristance in the circuit.

Now if logic „1“ was written to DATA1 (or DATA2), then the corresponding memristance Mem1 (or Mem2) was made „low“. Since Mem3 (or Mem4) is at constant „high“ memristance during search operation, the point DT1 (or DT2) will have a „low“ voltage. Similarly, if logic „0“ was written to DATA1 (or DATA2), then DT1 (or DT2) will have a „high“ voltage during search operation. Thus Mem3 and Mem1 (or Mem4 and Mem2) act as a voltage divider during search operation.

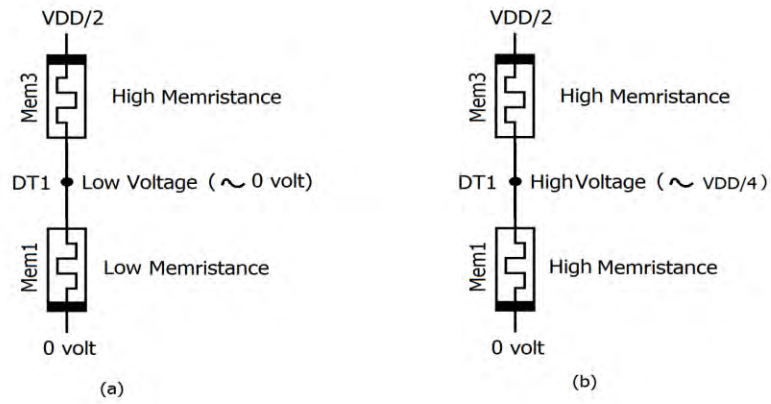


Figure 3.9 Search Operation: (a) 'Low' voltage level is produced at DT1 (or DT2) in case logic '1' was written in Mem1 (or Mem2), (b) 'High' voltage level is produced at DT1 (or DT2) in case logic '0' was written in Mem1 (or Mem2)

Now, depending on the match and mismatch condition of the data lines and search key, the match-line either charges or discharges through the path created by the comparison circuitry consisting of transistors M1 to M4.

Chapter-4 TCAM Array

4.1. Memory Array

A TCAM array is formed with a number of Words. A Word is formed by connecting a number of TCAM cells side-by-side. All the cells in a row are connected to the same write enable (WR) line and same match line (ML). All the cells in a column are connected to the same DATA line and same Search line. In Figure 4.1 a TCAM array with n-word, each word consisting of n-bit is shown.

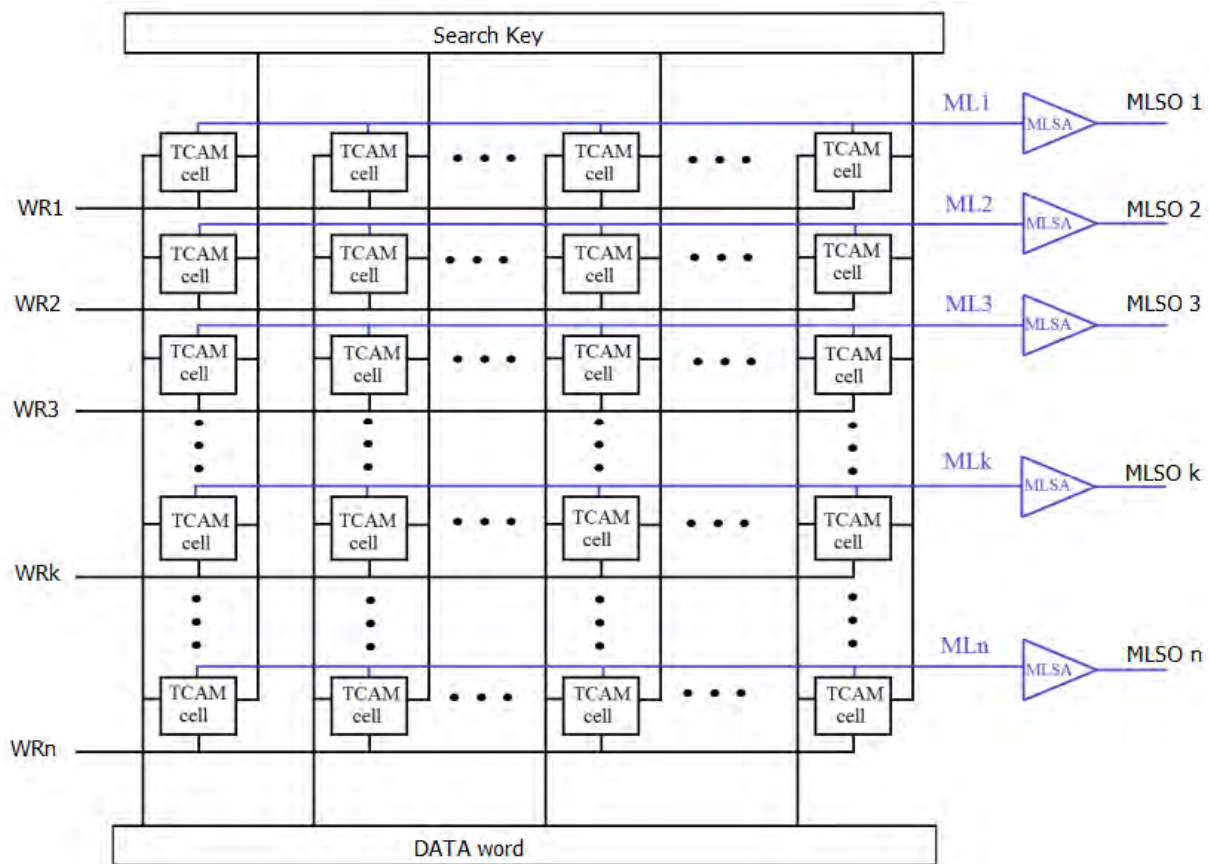


Figure 4.1. An N x N TCAM Array

4.2. Sense Amplifier

A sense amplifier (SA) is connected at the match-line of each row. This sense amplifier holds the value of ML after the search operation. Though ML does change between two consecutive

search operations, the sense amplifier output, MLSO doesn't change between two consecutive search operations. The sense amplifier consists of two back-back inverters and two transistors allowing to copy the ML value to MLSO during search operation, since SE=1 during search and to hold the value after the search operation by disconnecting the ML from the MLSO and connecting the inverters in back-to-back manner. The sense amplifier circuitry is shown in Figure 4.2.

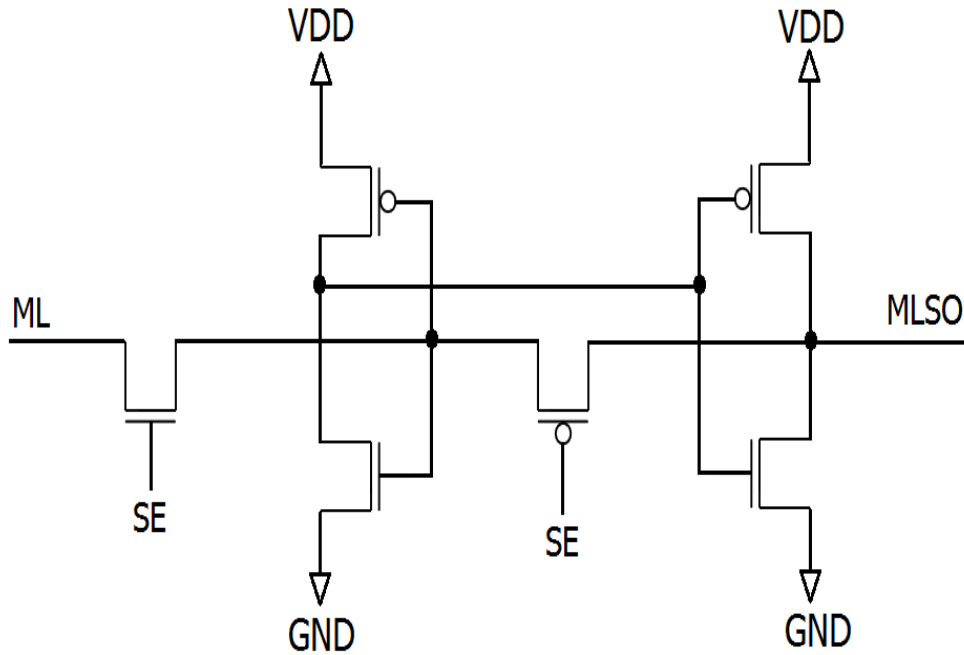


Figure 4.2. Sense Amplifier

4.3. Charging

As mentioned in Table 3.2, if match occurs between data lines and search lines, i.e. $SL1SL2=DATA1DATA2$, then the comparison circuitry doesn't create a path connecting the Match-line (ML) to the Ground (GND). For example: if $DATA1 DATA2 = 1 0$ during write operation, then $DT1 DT2 = 0 1$ during search operation. So if $SL1 SL2 = 1 0$ during search operation then no path is created from ML to GND. It is to be noted that this is a match condition, since there is match between DATA lines and SL lines.

A Charging circuitry is connected to the Match-line for charging up the ML during search operation. There are two alternatives of this charging circuitry. These are shown in Figure 4.3. In both circuits, there is a diode connected nMOS connected in series with a pMOS. During search

operation the signal CH is turned „low“ (put at logic „0“). Then the circuit starts charging the ML to VDD. The diode connected nMOS prevents the power supply source (VDD) and the ground (GND) from being shorted-out when the discharging path is ON. Thus it prevents excessive current flow during mismatch in search operation. Thus it reduces search power consumption. For the configuration as shown in Figure 4.3(a), there is a voltage drop across the nMOS. Thus the ML doesn't get the full VDD for charging. For the configuration as shown in Figure 4.3(b), the ML gets higher voltage for getting charged. So charging is more efficient in case of configuration (b) compared to configuration (a). Hence, the configuration of Figure 4.3(b) is used as the charging circuitry in this work.

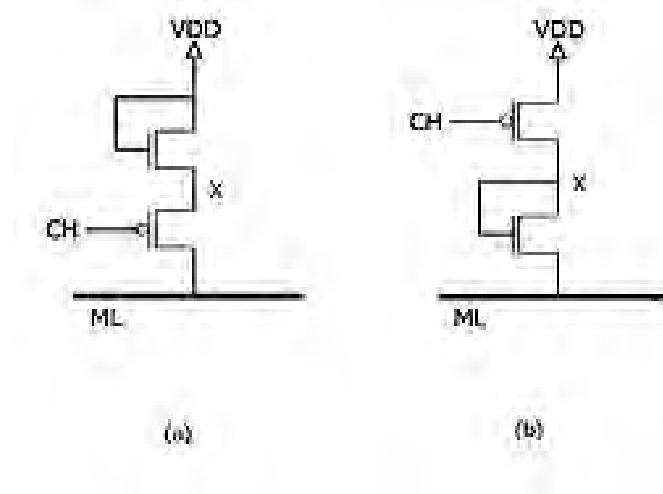


Figure 4.3 Charging Circuitry: (a) Inefficient charging, (b) Efficient charging, but requires ML reset

4.4. Resetting

However, there is a minor problem associated with the configuration of Figure 4.3(b). Even after the pMOS is turned OFF by setting CH=1 after search operation, a very low remanent voltage remains in node X due to the gate capacitance of the nMOS transistor. This voltage affects the next search operation. To avoid this problem, the ML is reset to zero by applying a short reset pulse to a transistor connected with ML to GND each time before a search operation begins. This ensures an efficient search operation without any ambiguity due to residual charge. The resetting circuitry is shown in Figure 4.4.

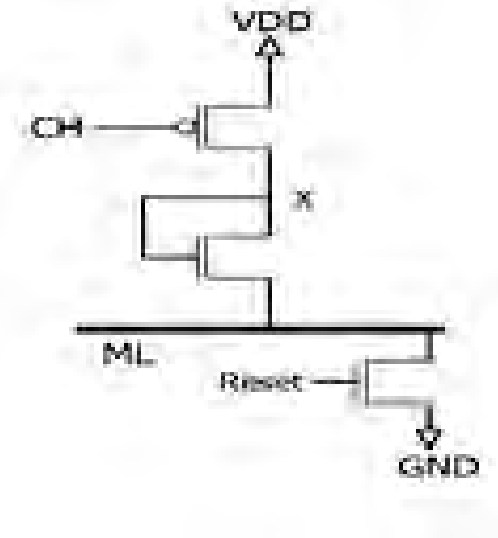


Figure 4.4 Resetting Circuitry

4.5. Entire Row

Hence, ultimately each row of the array contains a Match-line connected to a charging circuitry, a reset transistor and a sense amplifier. For example a row with 64 cells is shown in Figure 4.5.

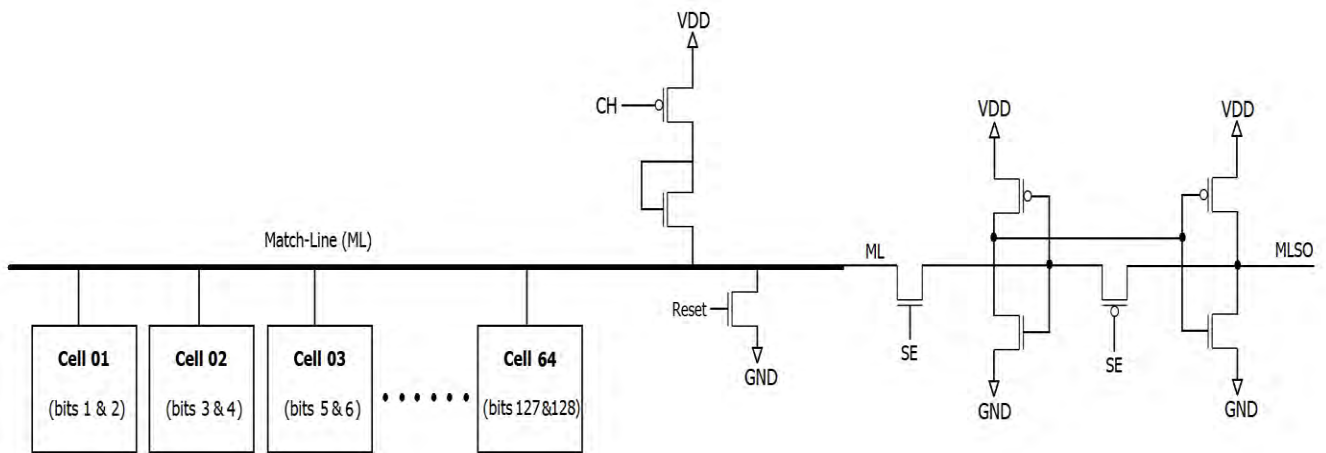


Figure 4.5 An entire row with 64 TCAM cells (128 bits)

4.6. Match-line Segmentation

In order to make the TCAM cell design more suitable for working in larger memory arrays, different match-line segmentation schemes have been implemented with the design. The schemes

make the match-line work in segments, rather than working as a whole word-line during the search operation. This improves the overall performance of the entire search operation. The two schemes that are used to segment the match-line are pipelining and selective charge. In each of these schemes the entire match-line is divided into four segments each having 16 cells or 32 bits.

Chapter-5

Match-line Segmentation: Selective Charging

In the Selective Charging scheme the entire match-line is divided into four segments. The search operation goes by one after another segment. A match in a given segment results in a search operation in the next segment but a miss terminates the match operation for that word. The arrangement of the four segments are shown in Figures 5.1 and 5.2. The array operation is described below.

5.1. Array Operation

Each Match-line (ML) segment is connected to a charging circuitry, a reset transistor and a NOT gate. All the segments are reset to zero prior to the search operation. Then during the search operation, at first the charging circuitry of the 1st segment is activated. If the 1st segment gets charged (hence, match occurs in first segment), then the NOT Gate output of the 1st segment goes „low“, which in turn activates the charging circuitry of the 2nd segment. This process continues till the last segment if a match occurs in the entire word. However, If any of the segments gets discharged (due to mismatch), then the NOT gate output of that segment goes „high“, and the charging circuitry of the next segment doesn't get activated. Thus the search operation is halted immediately a mismatch is found in any segment.

Now if a mismatch is found at any of the 4 segments, the sense amplifier immediately gives the result. To do this, all the four outputs from the NOT gates of all segments are connected to a NOR gate, as shown in Figure 5.3. If any of the NOT gate's output goes „high“, then the NOR gate output (MLNOR) goes „low“. The NOR gate output goes „high“ only if all the NOT gates' outputs are „low“. The sense amplifier gets the output of the NOR gate and holds it until the next operation is executed.

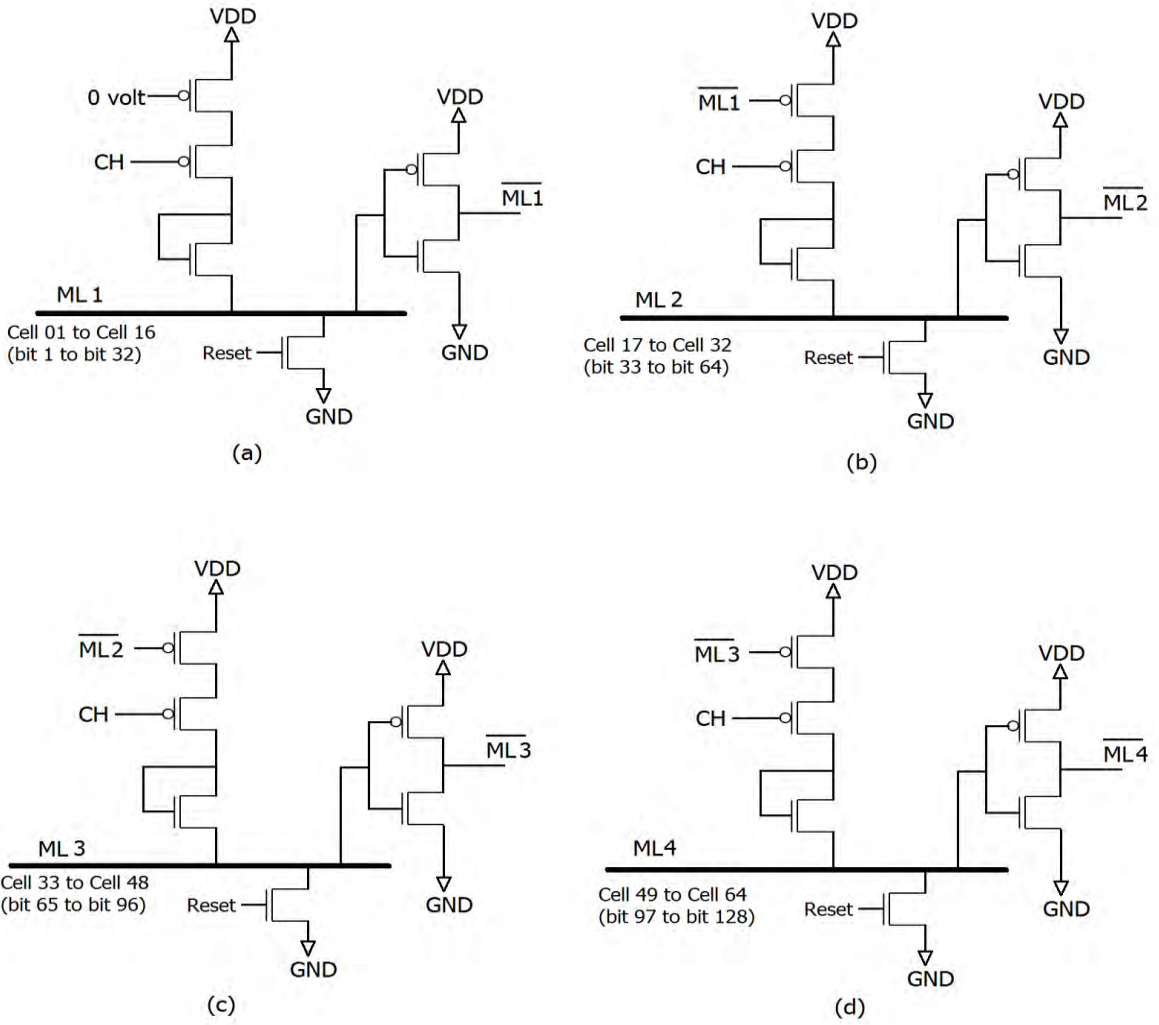


Figure 5.1 Match-line segmentation: Selective Charging- (a) 1st segment (b) 2nd segment (c) 3rd segment (d) 4th segment

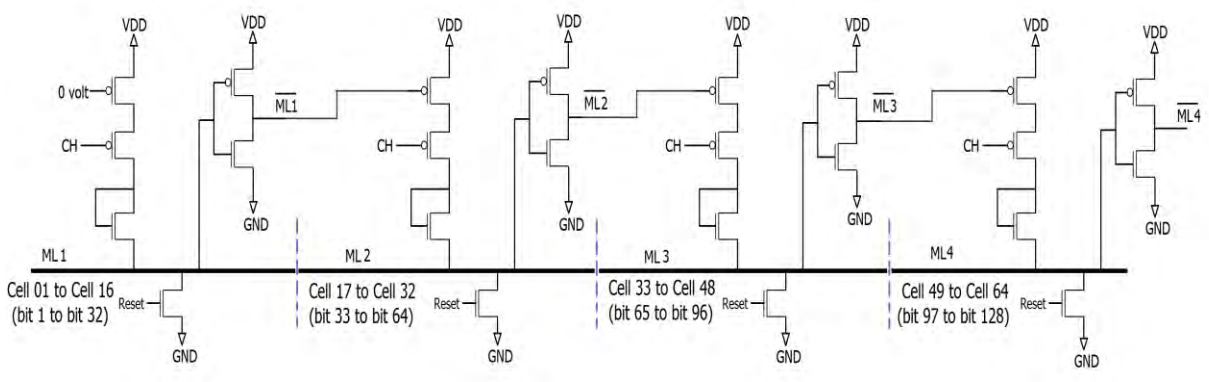


Figure 5.2 An entire row of the Selective Charging scheme

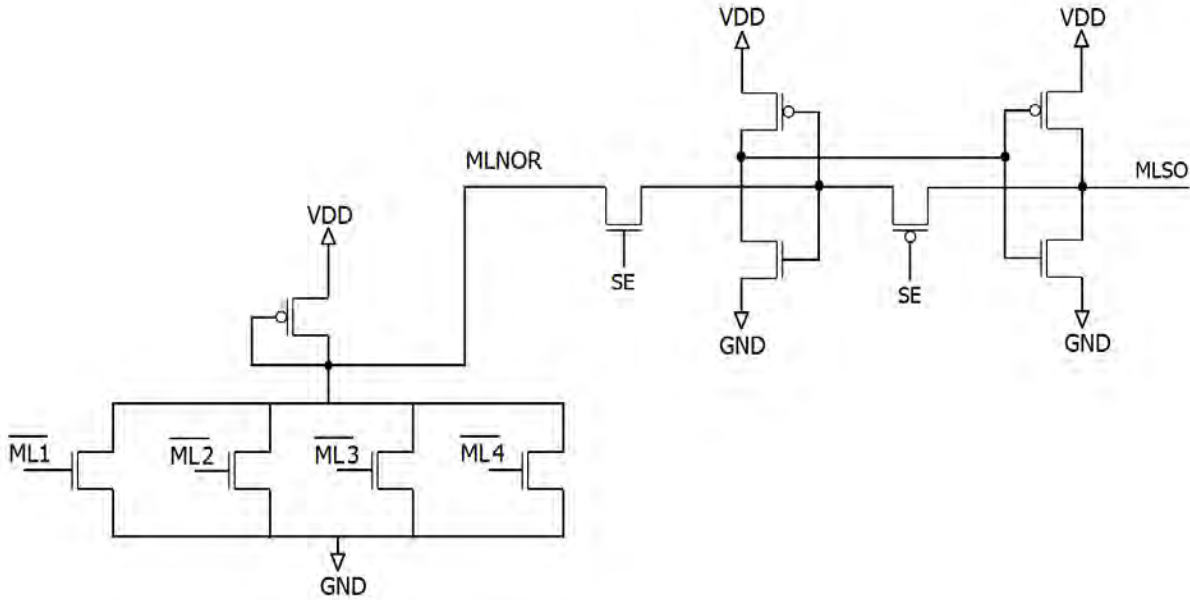


Figure 5.3NOR Gate driving the Sense amplifier

5.2. Simulation Results

A 3 word \times 64 cell (128 bit) TCAM array is simulated along with the Selective Charging match-line segmentation scheme using PSPICE software. TSMC 180nm process parameters are used for modelling the transistors. Yacopkik model [8] is used for modelling the memristors. The model parameters are adjusted in such a way that the memristance behaviour matches as closely possible as that of the demonstration for Ta-O memristor [7] The simulation results of write and search operations are given below.

5.2.1. Write Operation

The Write operation is tested for all three allowed states of Table 3.1- Low, High and Local Mask. The ON and OFF memristance of the memristors Mem1 and Mem2 are adjusted to be 4.5k Ω and 100k Ω (approx.) by changing the model parameters of these memristors while simulation. This is almost nearly equal to the ON and OFF memristance of practical memristor fabricated with Tantalum-Oxide (Ta-O) [7]. The practical memristors do saturate at a maximum memristance when it becomes completely un-doped. In order to mimic this practical memristor behaviour, the memristances are reset to zero for simulation between two consecutive write operations. Otherwise, in case, the OFF memristance persists for two consecutive write

operations, it keeps increasing instead of saturating to a maximum value. This helps mimic the practical memristor behaviour while simulation. In order to do this, a 2.5ns write pulse is applied to each memristor. Within this 2.5ns, the first 1ns is used to reset the memristance and the last 1.5ns is used to write the desired data. The write operation is shown in Figure 5.4. (The PSpice netlist can be found in Appendix A.2.) The first cycle writes the Local mask condition (DATA1DATA2 = 1 1), the second cycle writes Low state (0 1), the fourth cycle writes High state (1 0). The third cycle shows the case of having the same data for two consecutive write operations. It is seen that the memristance does not keep increasing in this case, rather it saturates to the OFF memristance, as what a practical memristor does.

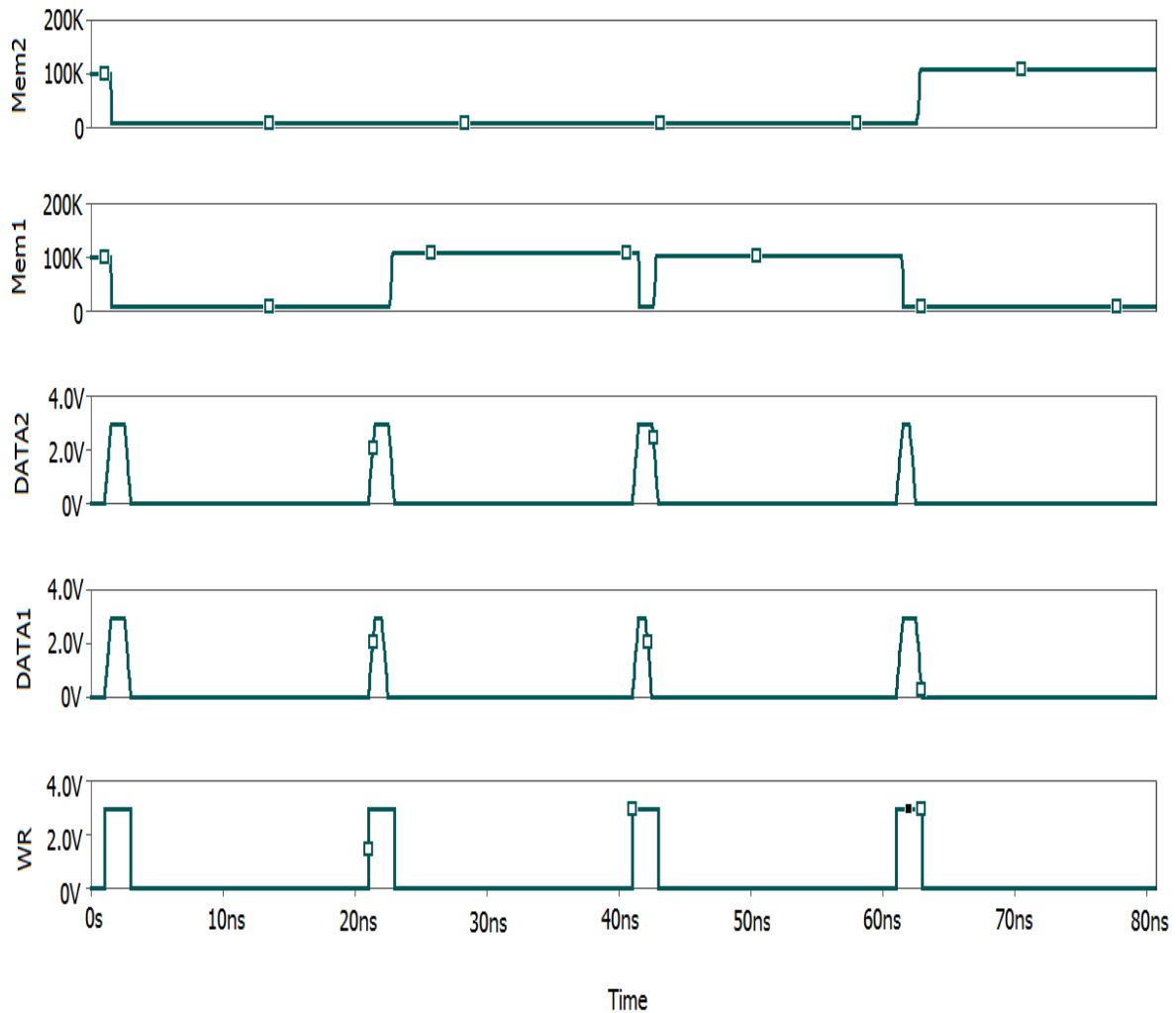


Figure 5.4 Write Operation

The write time and energy are shown in Table 5.1.

Table 5.1 Results of Write Operation

DATA1	DATA2	Time	Energy
1	1	2.5ns	290fJ
1	0	2.5ns	206.62fJ
0	1	2.5ns	282.09fJ

5.2.2. Search Operation

The search operations for both match and mismatch conditions for Selective Charging scheme are shown in Figures 5.5 and 5.6 respectively. (The PSpice netlist can be found in Appendix A.2.)

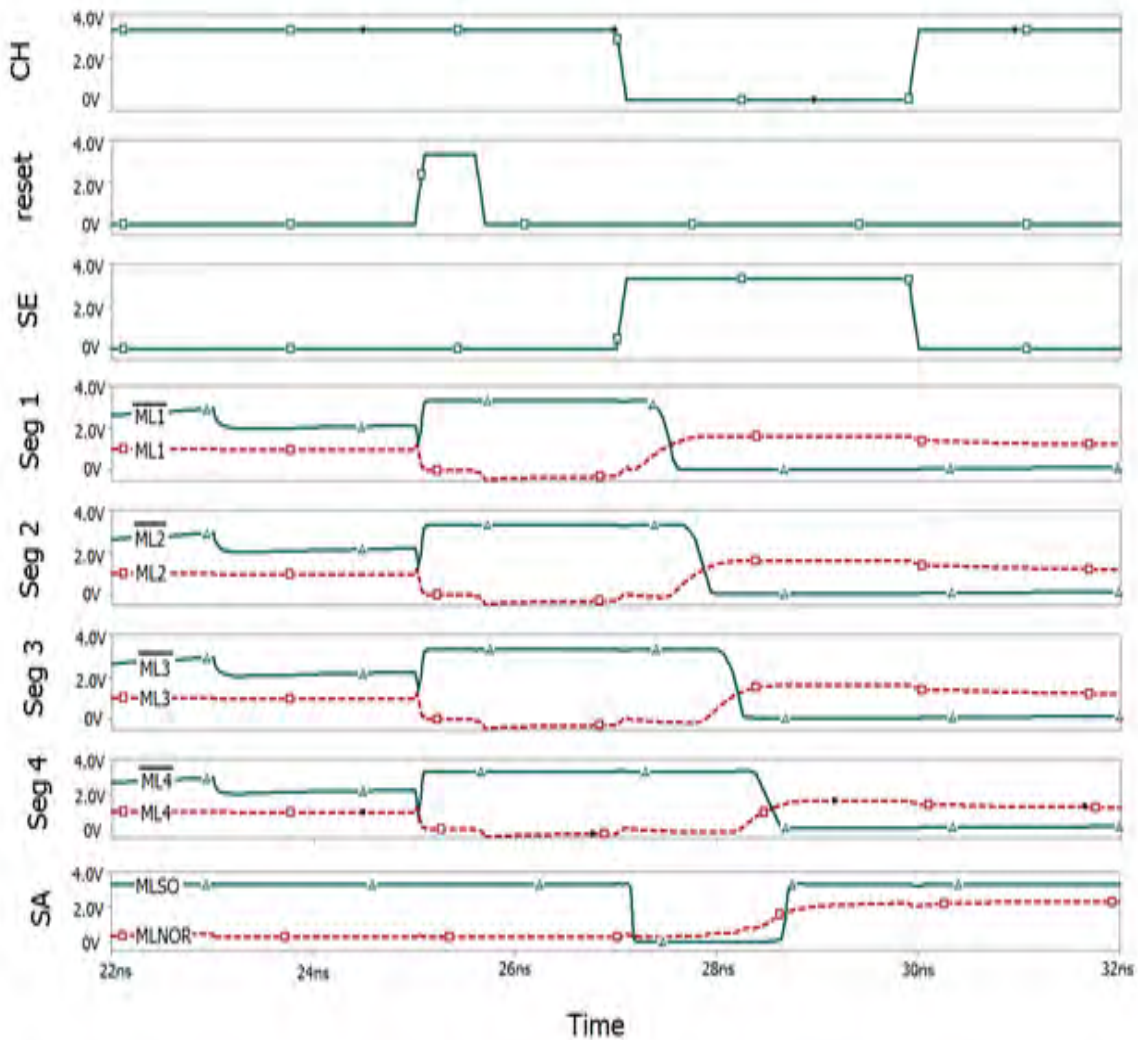


Figure 5.5 Search Operation for Matching Condition (Selective Charging Scheme)

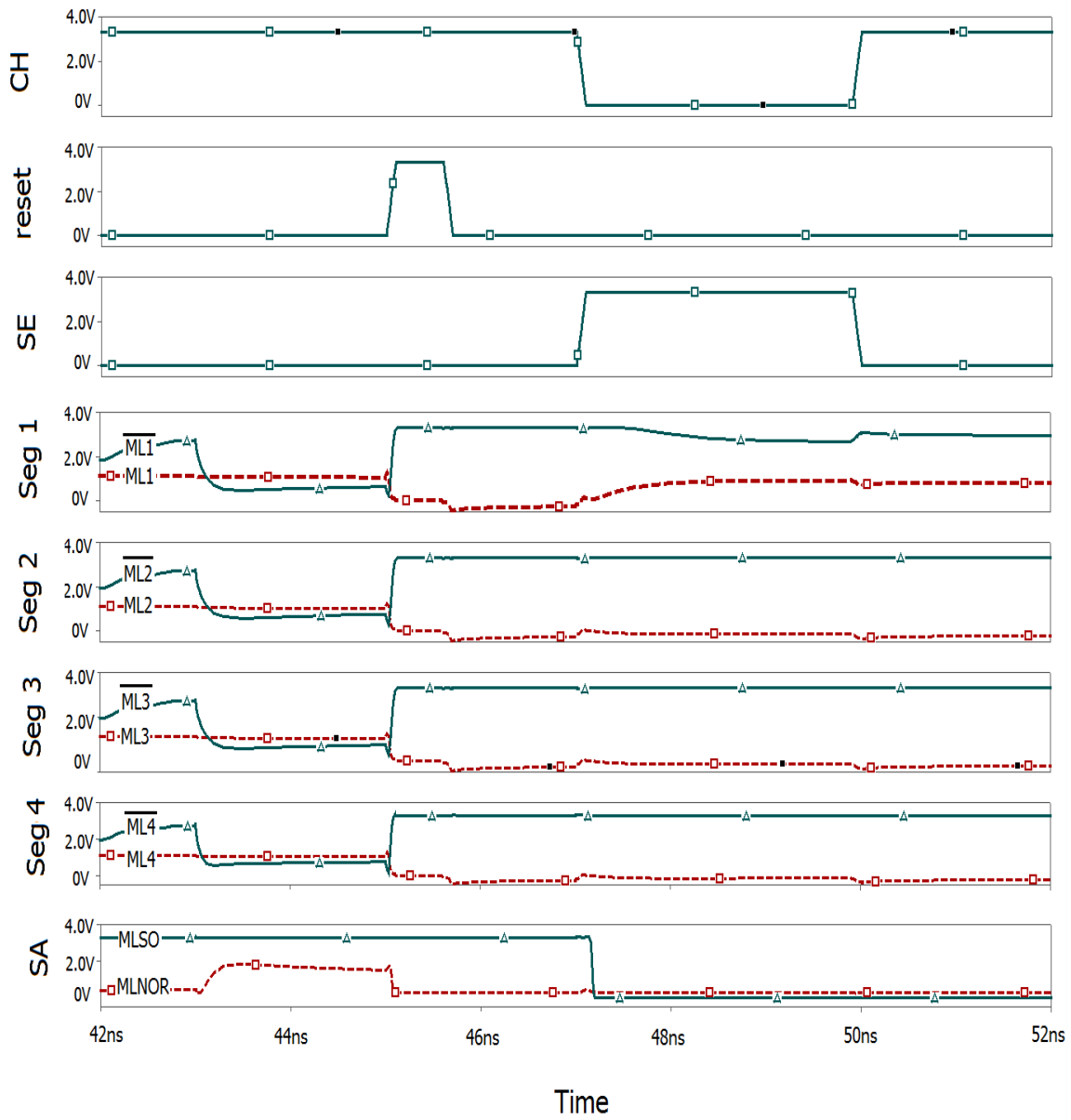


Figure 5.6 Search Operation for Mismatching Condition (Selective Charging Scheme) – 1-bit mismatch in 1st segment

The Time, Energy and Voltage Margin for Search Operation is shown in Table 5.2.

Table 5.2 Results of Search Operation with Selective Charging

Condition	Time	Energy per bit	Voltage Margin
Charging (Match)	1.32 ns	117.589 fJ	1.414 V
Discharging (1-bit Mismatch in 1 st segment)	0.191 ns	3.113 fJ	

Chapter-6

Match-line Segmentation: Pipelining

In the Pipelining scheme the entire match-line is divided into four segments. The search operations go simultaneously at all the segments. None of the segments depend on the previous segment for charging. The arrangement of the four segments are shown in Figures 6.1 and 6.2. Array Operation is described below.

6.1. Array Operation

Each Match-line (ML) segment is connected to a charging circuitry, a reset transistor and a NOT gate. All the segments are reset to zero prior to the search operation. Then during the search operation, all the segments start charging or discharging independent of each other. If any of the segments have a mismatch, then that segment discharges. Thus the NOT gate output of that segment gets „high“. If any of the segments have a match, then that segment gets charged. Thus the NOT gate output of that segment gets „low“.

All the four outputs from the NOT gates of all segments are connected to a NOR gate, as shown in Figure 6.3. If any of the NOT gate's output goes „high“, then the NOR gate output goes „low“. The NOR gate output goes „high“ only if all the NOT gates' outputs are „low“. The sense amplifier is connected to the NOR gate output. It picks and holds the result of the NOR gate output until the next search operation.

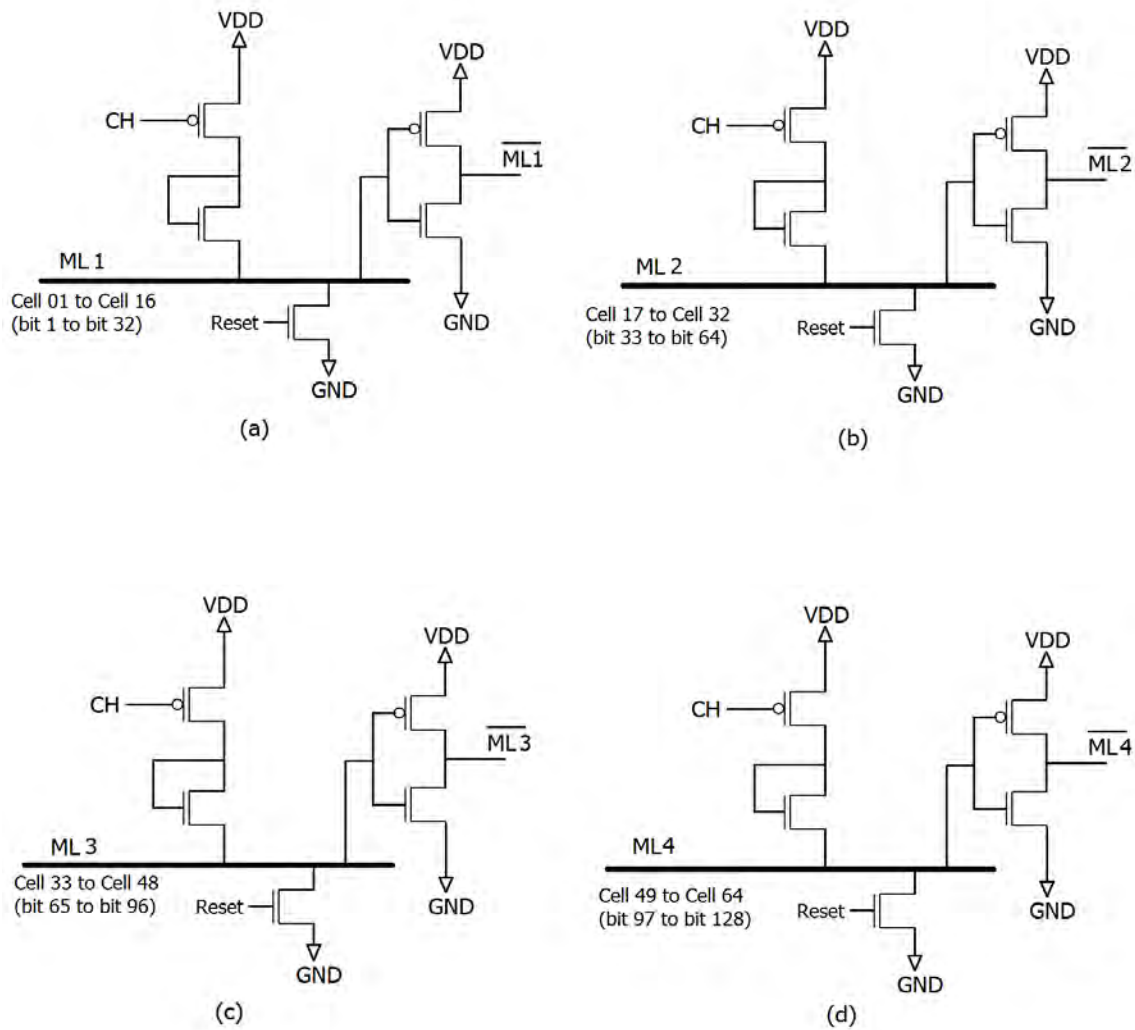


Figure 6.1 Match-line segmentation: Pipelining- (a) 1st segment (b) 2nd segment (c) 3rd segment (d) 4th segment

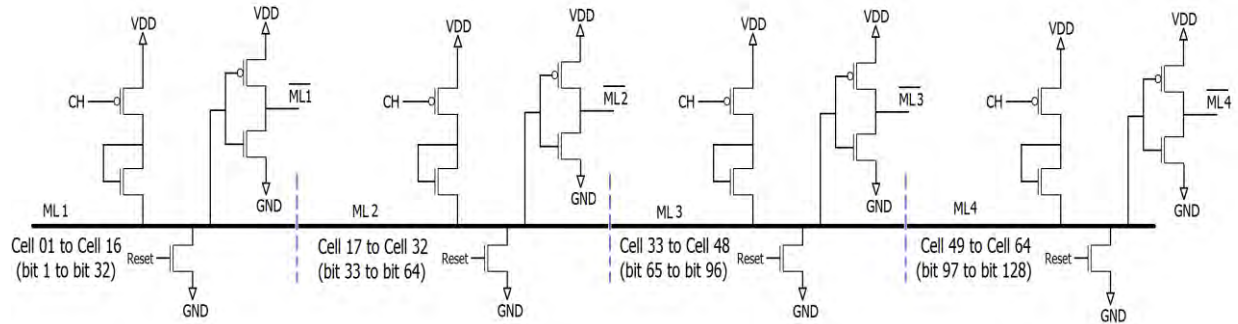


Figure 6.2 Match-line segmentation: Pipelining

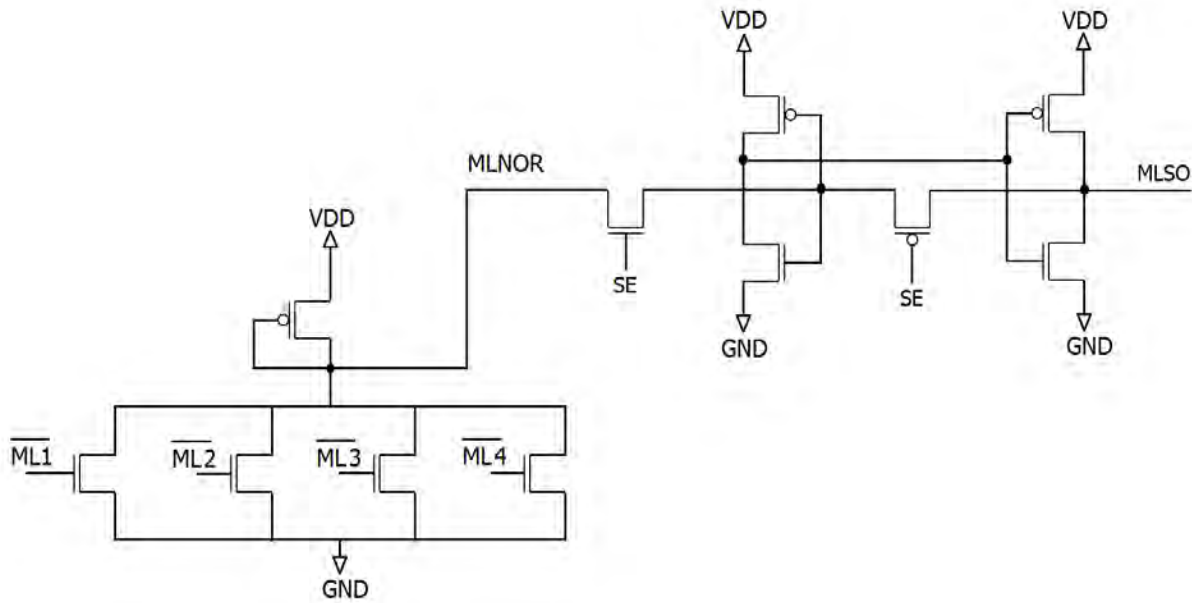


Figure 6.3NOR Gate driving the Sense amplifier

6.2. Simulation Results

A 3 word \times 64 cell (128 bit) TCAM array is simulated along with the Pipelining match-line segmentation scheme using PSPICE software. TSMC 180nm process parameters are used for modelling the transistors. Yacopkik model [8] is used for modelling the memristors. The model parameters are adjusted in such a way that the memristance behaviour matches as closely possible as that of the demonstration for Ta-O memristor [7] The simulation results of write and search operations are given below.

6.2.1. Write Operation

The Write operation is tested for all three allowed states of Table 3.1- Low, High and Local Mask. The ON and OFF memristance of the memristors Mem1 and Mem2 are adjusted to be 4.5k Ω and 100k Ω (approx.) by changing the model parameters of these memristors while simulation. This is almost nearly equal to the ON and OFF memristance of practical memristor fabricated with Tantalum-Oxide (Ta-O) [7]. The practical memristors do saturate at a maximum memristance when it becomes completely un-doped. In order to mimic this practical memristor behaviour, the memristances are reset to zero for simulation between two consecutive write operations. Otherwise, in case, the OFF memristance persists for two consecutive write operations, it keeps increasing instead of saturating to a maximum value. This helps mimic the practical memristor behaviour while simulation. In order to do this, a 2.5ns write pulse is applied

to each memristor. Within this 2.5ns, the first 1ns is used to reset the memristance and the last 1.5ns is used to write the desired data. The write operation is shown in Figure 6.4. (The PSpice netlist can be found in Appendix A.3.) The first cycle writes the Local mask condition (DATA1DATA2 = 1 1), the second cycle writes Low state (0 1), the fourth cycle writes High state (1 0). The third cycle shows the case of having the same data for two consecutive write operations. It is seen that the memristance does not keep increasing in this case, rather it saturates to the OFF memristance, as what a practical memristor does.

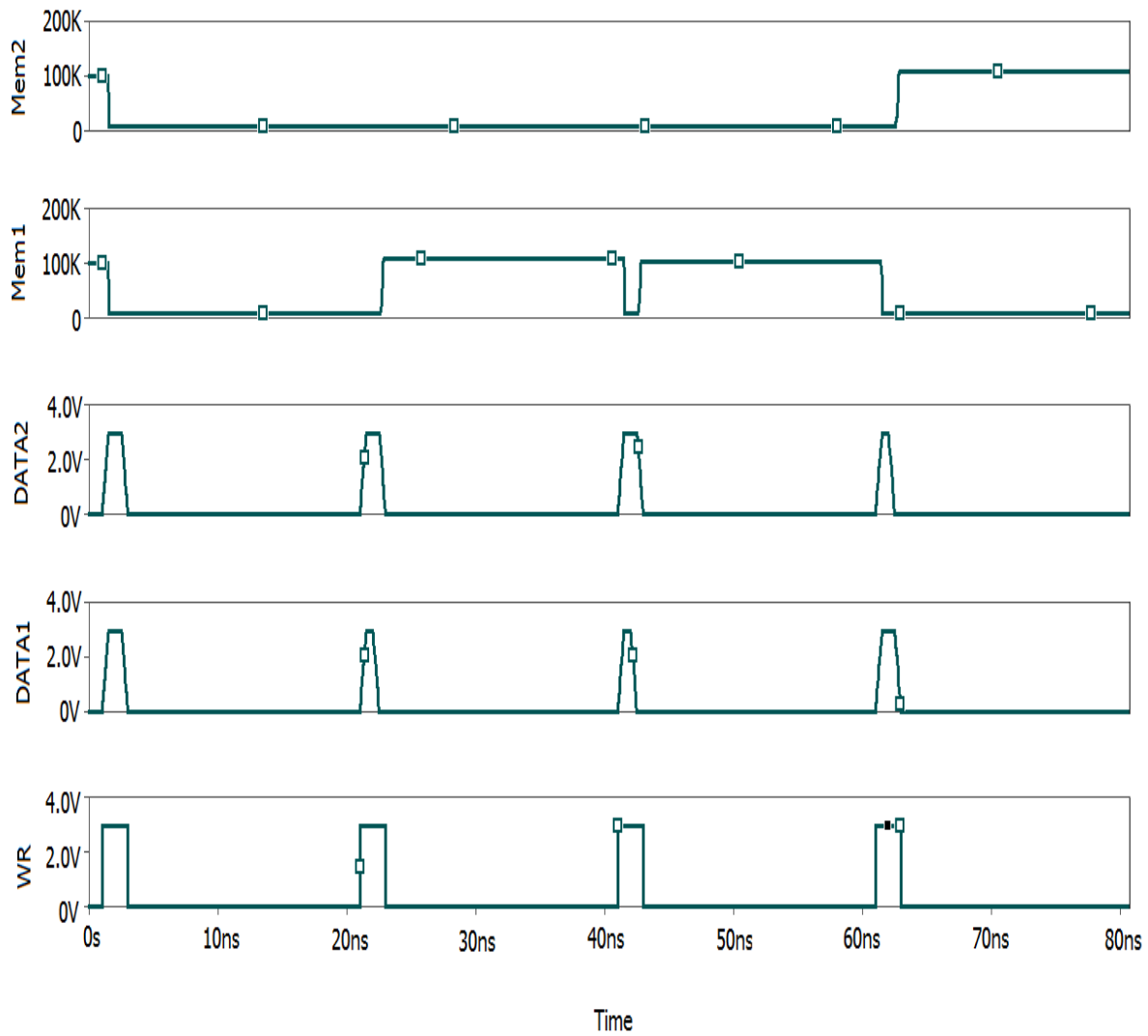


Figure 6.4 Write Operation

The write time and energy are shown in Table 6.1.

Table 6.1 Results of Write Operation

DATA1	DATA2	Time	Energy
1	1	2.5ns	290fJ
1	0	2.5ns	206.62fJ
0	1	2.5ns	282.09fJ

6.2.2. Search Operation

The search operations for both match and mismatch conditions for Selective Charging scheme are shown in Figures 6.5 and 6.6 respectively. (The PSpice netlist can be found in Appendix A.3.)

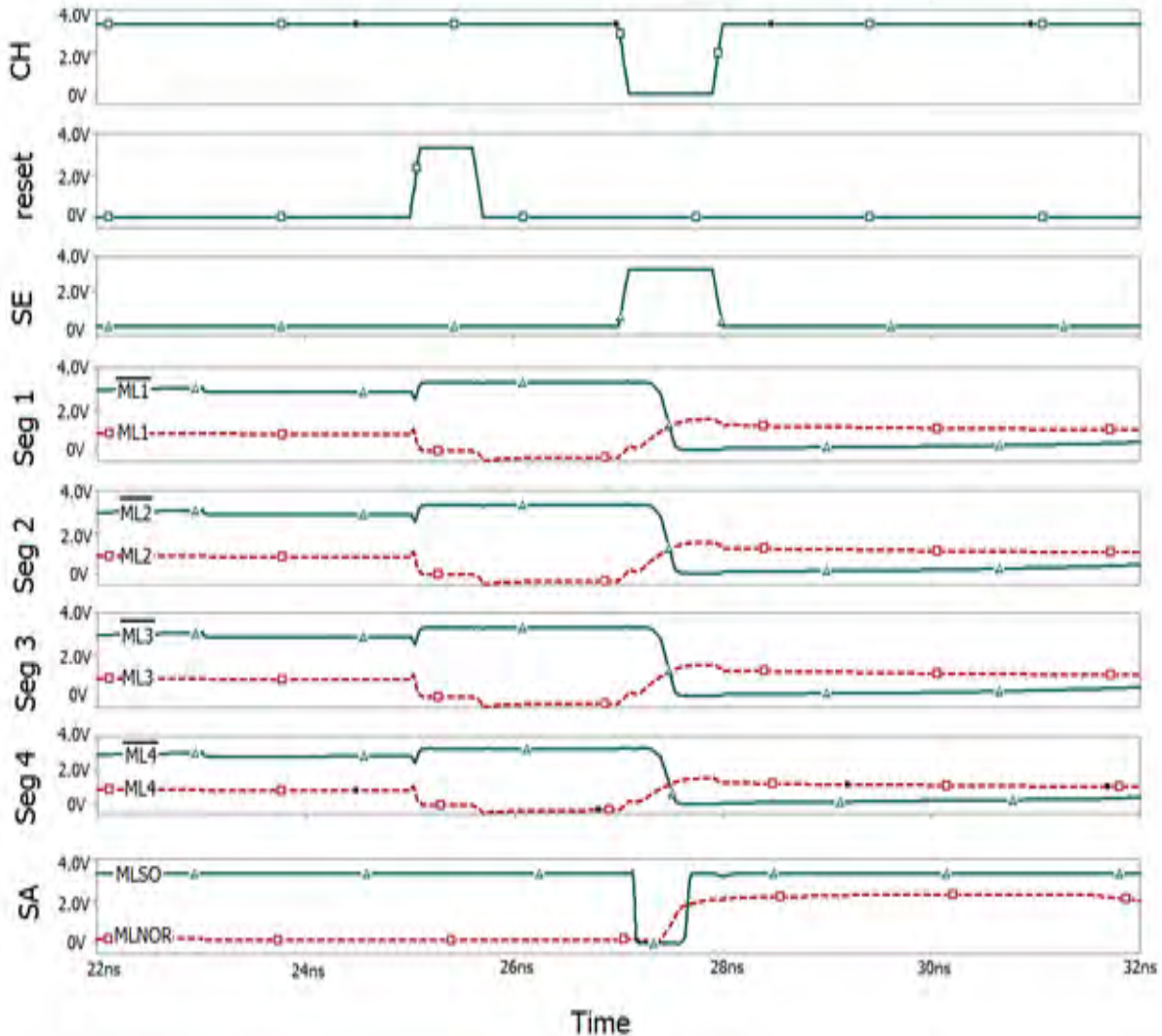


Figure 6.5 Search Operation for Matching Condition (Pipelining Scheme)

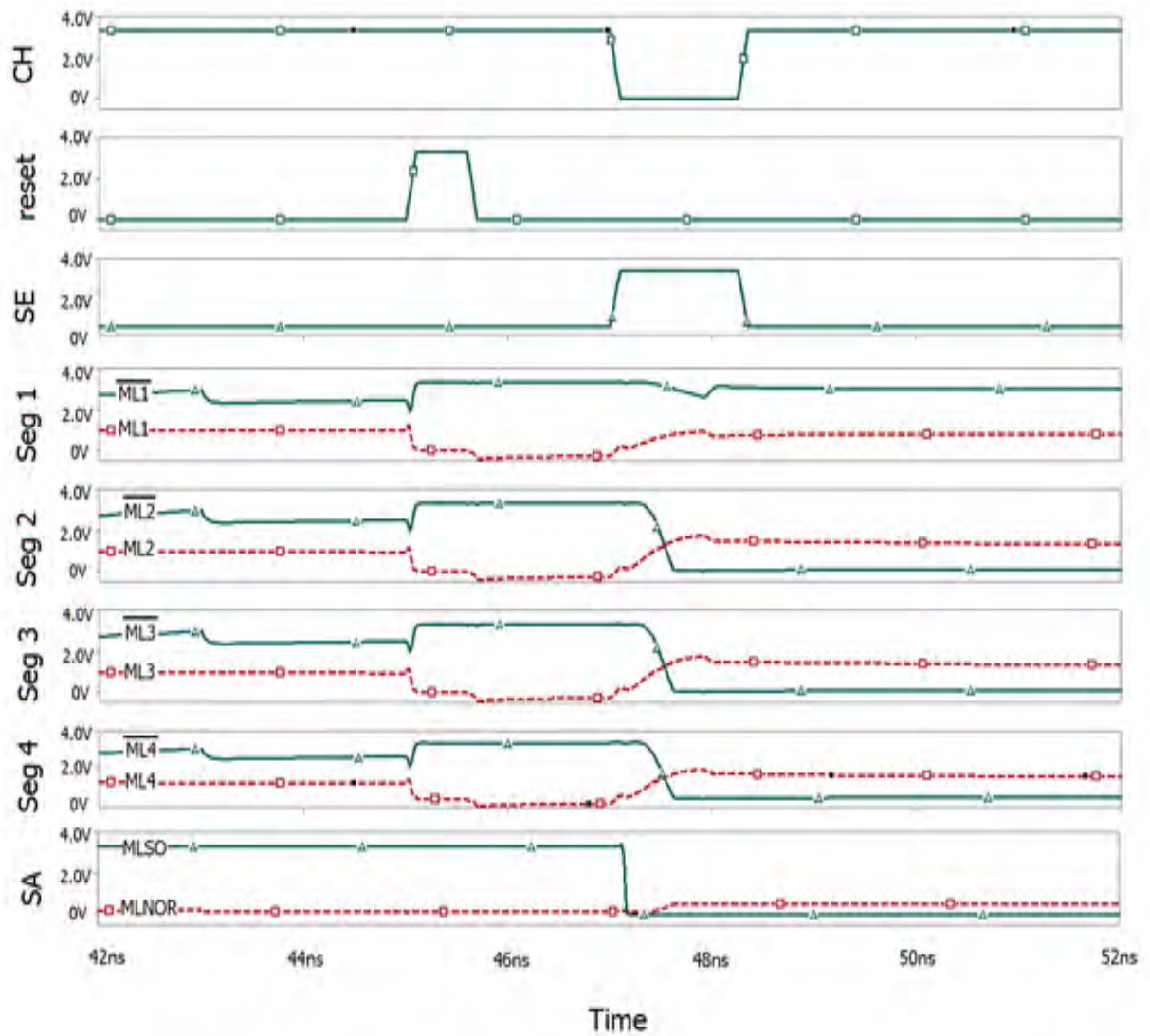


Figure 6.6 Search Operation for Mismatching Condition (Pipelining Scheme) – 1-bit mismatch in 1st segment

The Time, Energy and Voltage Margin for Search Operation is shown in Table 6.2

Table 6.2 Results of Search Operation with Pipelining

Condition	Time	Energy per bit	Voltage Margin
Charging (Match)	0.657 ns	83.162 fJ	1.6708 V
Discharging (1-bit Mismatch in 1st segment)	0.174 ns	9.171 fJ	

Chapter-7 Result Analysis

The 128 bit TCAM array with two different match-line segmentation schemes is simulated using PSpice software. The TSMC 180nm process parameters are used for modelling the transistors. Mem-Yakopcic model [8] has been used for modelling the memristors. The memristor model parameters are tuned to match with physical characterization data of practically fabricated memristor with Ta-O [7]. The effect of process, voltage and temperature (PVT) variation has been observed by carrying on corner simulation in Fast and Slow corners. The PVT specifications for corner simulation are mentioned in section 7.1. The simulation results for different schemes with PVT variation are given and analyzed in the following sections.

7.1. Corner Simulation

Corner simulations are carried out in Fast and Slow corners in order to verify the robustness of the design against process and temperature variation. The specifications for normal, fast and slow modes are given in Table 7.1.

Table 7.1 Specifications for Corner Simulation

Mode	Threshold Voltage		Temperature	Supply Voltage	
Normal	nMOS	0.3662473V	27 °C	VDD	3.3V
	pMOS	-0.3906012V		VDD/2	1.65V
Fast	nMOS	0.32962257V	0 °C	VDD	3.63V
	pMOS	-0.35154108V		VDD/2	1.815V
Slow	nMOS	0.40287203V	100 °C	VDD	2.97V
	pMOS	-0.42966132V		VDD/2	1.485V

The speed, energy and voltage margin of search operation with Selective Charging scheme and Pipelining scheme for simulation corners are shown below.

7.2. Simulation Results for Selective Charging Scheme

Normal Mode:

The search time and energy per bit for Selective Charging scheme in the Normal mode of operation is shown in Table 7.2. (The PSpice netlist can be found in Appendix A.2.)

Table 7.2 Search Time and Energy per bit for Selective Charging in Normal Mode

Condition	Time	Energy per bit
Normal Mode		
Charging (Match)	1.32 ns	117.589 fJ
Discharging (1-bit Mismatch in 1 st segment)	0.191 ns	3.113 fJ

Here, the discharging results are shown for 1 bit mismatch in the first segment. The search time and energy will be larger if the first mismatch is found in the 2nd or 3rd or 4th segments accordingly. The maximum possible search time and energy for the entire match-line of 128 bit is approximately four times for the case of 1 bit mismatch in the fourth segment.

The charging results are for the only case when there is no mismatch in any bit. However, it is seen that the time and energy for charging is larger than even the maximum time and energy for discharging. Thus discharging is faster and less power consuming than charging.

With 128 bits, 2^{128} combinations are possible for each data word, among which only 1 combination has „match“ with the search word and the other $2^{128}-1$ combinations have „mismatch“ with the search word. In other words, the probability of „match“ is $\frac{1}{2^{128}}$ and the probability of „mismatch“ is $\frac{2^{128}-1}{2^{128}}$. Hence, mismatch is more frequent than match. Since, the cell is designed to discharge the matchline during mismatch, and mismatch is seen to be faster and more energy efficient; the overall search time and energy for the array is supposed to be lower.

Fast Mode:

The search time and energy per bit for Selective Charging scheme in the Fast mode of operation is shown in Table 7.3. (The PSpice netlist can be found in Appendix A.4.)

Table 7.3 Search Time and Energy per bit for Selective Charging in Fast Mode

Condition	Time	Energy per bit
Fast Mode		
Charging (Match)	1.09 ns	125.29 fJ
Discharging (1-bit Mismatch in 1 st segment)	0.183 ns	4.2964 fJ

Here, the same observations can be seen for discharging and charging. Discharging is faster and more energy efficient than charging. Hence, discharging being the more frequent case, the overall speed and energy will be lower in the Fast mode also.

Slow Mode:

The search time and energy per bit for Selective Charging scheme in the Slow mode of operation is shown in Table 7.4. (The PSpice netlist can be found in Appendix A.5.)

Table 7.4 Search Time and Energy per bit for Selective Charging in Slow Mode

Condition	Time	Energy per bit
Slow Mode		
Charging (Match)	1.95 ns	106.3511 Fj
Discharging (1-bit Mismatch in 1 st segment)	0.204 ns	2.3319 Fj

Here, the same observations can be seen for discharging and charging. Discharging is faster and more energy efficient than charging. Hence, discharging being the more frequent case, the overall speed and energy will be lower in the Slow mode also.

Voltage Margin: The Voltage Margin in search operation for Selective Charging scheme in normal, fast and slow modes are shown in Table 7.5. (The PSpice netlist can be found in Appendix A.2, A.4 and A.5.)

Table 7.5 Voltage Margin for Selective Charging Scheme

Mode	Voltage Margin
Normal	1.414 V
Fast	1.55 V
Slow	1.2451 V

Here, the voltage margin for fast mode is larger than that of normal mode and voltage margin for slow mode is smaller than that of normal mode. This is because, the supply voltage is larger in fast mode and smaller in slow mode. So, the observed effect of PVT variation on voltage margin is reasonable.

7.3. Simulation Results for Pipelining Scheme

Normal Mode:

The search time and energy per bit for Pipelining scheme in the Normal mode of operation is shown in Table 7.6. (The PSpice netlist can be found in Appendix A.3.)

Table 7.6 Search Time and Energy per bit for Pipelining in Normal Mode

Condition	Time	Energy per bit
Normal Mode		
Charging (Match)	0.657 ns	83.162 Fj
Discharging (1-bit Mismatch)	0.174 ns	9.171 Fj

Here, the discharging results are shown for 1 bit mismatch in the first segment. The search time and energy will not vary if the mismatch is found on the 2nd or 3rd or 4th segment instead. This is because, in pipelining scheme, all the segments are charged or discharged simultaneously.

The charging results are for the only case when there is no mismatch in any bit. However, it is seen that the time and energy for charging is larger than that for discharging. Thus discharging is faster and less power consuming than charging.

With 128 bits, 2^{128} combinations are possible for each data word, among which only 1 combination has „match“ with the search word and the other $2^{128}-1$ combinations have „mismatch“ with the search word. In other words, the probability of „match“ is $\frac{1}{2^{128}}$ and the

probability of „mismatch“ is $\frac{2^{128}-1}{2^{128}}$. Hence, mismatch is more frequent than match. Since, the cell is designed to discharge the matchline during mismatch, and mismatch is seen to be faster and more energy efficient; the overall search time and energy for the array is supposed to be lower.

Fast Mode:

The search time and energy per bit for Pipelining scheme in the Fast mode of operation is shown in Table 7.7. (The PSpice netlist can be found in Appendix A.6.)

Table 7.7 Search Time and Energy per bit for Pipelining in Fast Mode

Condition	Time	Energy per bit
<i>Fast Mode</i>		
Charging (Match)	0.555 ns	116.3522 fJ
Discharging (1-bit Mismatch)	0.159 ns	16.9829 fJ

Here, the same observations can be seen for discharging and charging. Discharging is faster and more energy efficient than charging. Hence, discharging being the more frequent case, the overall speed and energy will be lower in the Fast mode also.

Slow Mode:

The search time and energy per bit for Pipelining scheme in the Slow mode of operation is shown in Table 7.8. (The PSpice netlist can be found in Appendix A.7.)

Table 7.8 Search Time and Energy per bit for Pipelining in Slow Mode

Condition	Time	Energy per bit
Slow Mode		
Charging (Match)	0.741 ns	68.8861 fJ
Discharging (1-bit Mismatch)	0.181 ns	5.82 fJ

Here, the same observations can be seen for discharging and charging. Discharging is faster and more energy efficient than charging. Hence, discharging being the more frequent case, the overall speed and energy will be lower in the Fast mode also.

Voltage Margin: The Voltage Margin in search operation for Pipelining scheme in normal, fast and slow modes are shown in Table 7.9. (The PSpice netlist can be found in Appendix A.2, A.6 and A.7.)

Table 7.9 Voltage Margin for Pipelining Scheme

Mode	Voltage Margin
Normal	1.6708V

Fast	1.8968 V
Slow	1.4867 V

Here, the voltage margin for fast mode is larger than that of normal mode and voltage margin for slow mode is smaller than that of normal mode. This is because, the supply voltage is larger in fast mode and smaller in slow mode. So, the observed effect of PVT variation on voltage margin is reasonable.

7.4. Comparison among different TCAM designs

The proposed TCAM architecture is compared with all the previous TCAM architectures mentioned in Chapter 3 in terms of search speed, energy per bit and voltage margin. The comparison is shown in Table 7.10.

Table 7.10 Comparison Among Different TCAM Designs

		16T TCAM [2]	12T 2M TCAM [3]	8T 4M TCAM [4]	Proposed TCAM with Selective Charging	Proposed TCAM with Pipelining
Normal Mode						
Charging (Match)	Time	0.626 ns	0.08 ns	0.026 ns	1.32 ns	0.657 ns
	Energy per bit	374.8 fJ	181 fJ	7.7 fJ	117.589 fJ	83.162 fJ
Discharging (1-bit Mismatch)	Time	1.06 ns	1 ns	0.94 ns	0.191 ns	0.174 ns
	Energy per bit	573.66 fJ	812 fJ	268 fJ	3.113 fJ	9.171 fJ
Voltage Margin		0.314 V	1.03 V	0.75 V	1.414 V	1.6708V
Fast Mode						
Charging (Match)	Time	0.495 ns	0.09 ns	0.024 ns	1.09 ns	0.555 ns
	Energy per bit	417 fJ	255 fJ	165 fJ	125.29 fJ	116.3522 fJ
Discharging (1-bit Mismatch)	Time	0.892 ns	1.2 ns	0.65 ns	0.183 ns	0.159 ns
	Energy per bit	615.92 fJ	1.2 pJ	1.1 pJ	4.2964 fJ	16.9829 fJ
Voltage Margin		0.276 V	1.197V	1.77V	1.55 V	1.8968 V
Slow Mode						
Charging (Match)	Time	0.776 ns	0.094 ns	0.031 ns	1.95 ns	0.741 ns
	Energy per bit	325.75 fJ	176fJ	120fJ	106.351 fJ	68.8861 fJ
Discharging (1-bit Mismatch)	Time	1.13 ns	1.268 ns	1.3 ns	0.204 ns	0.181 ns
	Energy per bit	426.32 fJ	1.4 pJ	1.1 pJ	2.3319 fJ	5.82 fJ
Voltage Margin		0.326 V	1.018V	1.194V	1.2451 V	1.4867 V

7.4.1. Comparison in terms of speed

From the Table 7.10 it can be seen that there is a good improvement in the speed of the proposed architectures compared to the conventional 16T TCAM architecture. The speed response is also better than the other previously proposed Hybrid TCAM architectures, especially in the mismatch condition. Since, mismatch is more frequent than match, the over-all speed of the search operation is supposed to be faster than other designs. However, it may seem to be somewhat ambiguous to compare the match and mismatch results with the previous results. In the previous hybrid architectures, the match-line was pre-charged each time before the beginning of the search operation. So, in other words, the search operation used to begin with a charged match-line. So mismatch (discharging) time was longer than the match (charging) time, since the ML was already charged. On the other hand, in both of the newly proposed architectures the Match-line is reset or discharged to zero before the beginning of the search operation. So, the search operation now begins with a discharged match-line. So, in the new architectures, the match (charging) time is longer than the mismatch (discharging) time, since the match-line is now already discharged.

So in the truest sense the match and mismatch times can be compared without ambiguity. And this comparison marks a good improvement in terms of speed.

7.4.2. Comparison in terms of Energy per bit

From the Table 7.10 it can be seen that there is a notable improvement in the energy requirement of the proposed architectures compared to the conventional 16T TCAM architecture. The energy requirement is also much better than the other previously proposed Hybrid TCAM architectures, especially in the mismatch condition. Since, mismatch is more frequent than match, ultimately the total search power consumption is quite lower than all the other designs. And since, the search time is lower than other designs, the energy requirement is also significantly lower than all the other previous architectures. However, it may seem to be somewhat ambiguous to compare the match and mismatch results with the previous results. In the previous hybrid architectures, the match-line was pre-charged each time before the beginning of the search operation. So, in other words, the search operation used to begin with a charged match-line. So mismatch (discharging) energy was higher than the match (charging) energy, since the ML was already charged. On the other hand, in both of the newly proposed architectures the Match-line is reset or discharged to zero before the beginning of the search operation. So, the search operation now begins with a discharged match-line. So, in the new architectures, the match (charging) energy is higher than the mismatch (discharging) energy, since the match-line is now already discharged.

So in the truest sense the match and mismatch energy per bit can be compared without ambiguity. And this comparison marks a significant improvement in terms of energy per bit.

7.4.3. Comparison in terms of Voltage Margin

Table 7.10 shows that the voltage margin is quite higher in both of the two new proposed architectures, compared to all of the previously proposed designs. This is definitely a markable improvement in terms of voltage margin.

7.4.4. Comparison Between Selective Charging and Pipelining Schemes

The Match-line configurations and functionalism of Selective Charging and Pipelining are quite similar. The only difference is in the fact that, in case of selective charging, the segments get activated one after another. Whereas, in case of pipelining, all the segments get activated at the same time. This causes the charging circuitry for the two schemes to be different. In order to include the additional condition of dependence on the previous segment's result, an additional pMOS transistor is inserted in the charging circuitry of the selective charging scheme. Due to having an additional transistor in the VDD to ML path during search operation, the selective charging scheme requires a slightly greater power consumption than the pipelining scheme during match condition (ML charging). However, in case of mismatch (ML discharging) condition, the selective charging scheme halts the search operation as soon as the mismatch is found in any segment. Whereas, in pipelining scheme all the segments keep charging or discharging even if a mismatch occurs at the very 1st segment. Thus the pipelining scheme requires a greater power consumption during mismatch condition than selective charging scheme.

There is a notable difference in the speed of search operation in these two schemes. During match condition, in case of pipelining scheme, all the segments start charging up at the same time. However, in case of selective charging, the segments get charged one after another, i.e. each segment waits for the result of the previous segment to come before starting to get charged. So, while match occurs, the pipelining scheme gives the result quite earlier to that the selective charging scheme does.

The voltage margin is found to be greater in case of pipelining scheme than in case of selective charging scheme. This is due to the presence of the additional transistor in the charging path for selective charging.

Chapter-8 Conclusion and Future Works

8.1. Conclusion

Content Addressable Memories (CAM) provide search operation in addition to write/read operations which allows table look-up facility. CAMs compare input search data against a table of stored data, and returns the address of the matching data. Ternary Content Addressable Memory (TCAM) is an extension of Content Addressable Memory, in which two bits of data are stored in a single cell which allows dealing with three states, and thus adds more flexibility in the search operation. However, in order to store an additional bit in each cell, TCAMs demand for larger cell size and higher power consumption. Hence, the need for smaller and more power efficient TCAM cell design is crucial for modern high-speed search engine, data base engine, neuromorphic computing etc.

Different CMOS based TCAM cell designs have previously been proposed. However, conventional CMOS based designs have large area and power requirement. Again, they are non-volatile, hence data needs to be written every time after the power supply is turned ON. In order to overcome these, post CMOS devices such as- memristors are incorporated with CMOS transistors to design non-volatile, compact and power efficient TCAM cells. However, some of these previously proposed designs do not assimilate the practical memristor behavior. Hence, a modification to the existing hybrid TCAM designs have been proposed to mimic practically implementable memristor behavior.

In this work, we have proposed a hybrid Ternary Content Addressable Memory design with memristors and CMOS transistors. The inclusion of memristors significantly reduces the power consumption, increases the speed and voltage margin and offers non-volatility in TCAMs; compared to conventional designs with only transistors. Different match-line segmentation schemes are also implemented to make the design more suitably applicable for working in larger memory arrays. Moreover, the memristors used in this design are modelled in such a way that they closely mimic the behaviour of practically fabricated memristors with Ta-O. In addition to these, corner simulation is done to prove the robustness of the proposed design against process, temperature and environmental variations.

The results obtained from simulation are compared with conventional TCAM designs and hybrid memristor-MOSFET TCAM designs. It is seen that, the write time is larger for the proposed hybrid design compared to the conventional transistor based design. This is because, memristor is slower device than transistors. It takes some time for memristor to change its resistance. This is why memristors cannot fully replace transistors. It can assist transistors for offering better performance and applicability. However, the comparison reveals significant performance improvement in terms of search speed, search energy per bit and voltage margin. It is seen that,

the search speed increases up to 83%; search energy per bit decreases up to 77.81% during match and 99.45% during mismatch; and voltage margin increases up to 81.19% than the conventional TCAM design with MOSFETs. Again, due to the implementation of match-line segmentation schemes, the overall performance of the designs improves noticeably compared to the other hybrid architectures. The search speed increases up to 30%; the energy consumption per bit decreases up to 69% during mismatch and 59% during match and voltage margin 19.6% than the other hybrid architectures. Hence, in terms of all the performance parameters that have been taken into consideration, the proposed TCAM design with the implementation of match-line segmentation schemes offers better results compared to other TCAM designs proposed so far. Thus, the proposed design can be a promising alternative for future memory applications.

8.2. Future Works

This thesis work can be extended for future research on hybrid TCAM design and its performance improvement. We could have explored more with the improvement of the proposed design, if we didn't have a limited time span for completion of the thesis. The following prospects can be explored for further enhancement of the work-

- Memristance variability with PVT corner could be analyzed further.
- Miss rate in TCAM search operation could be determined.
- Further optimizations could be carried out if needed, to improve the memristance variability and miss rate.
- In-memory computing e.g. XOR operation could be implemented using the proposed cell
- Secured computing methodology could be implemented using the array structure.

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Appendix A

A.1. PSpice netlist for Figures 2.8, 2.9 and 2.10

```
vd a1 0 sin(0V 1.65V 1GHz 0s 0Hz 0d)
vd2 a4 0 dc 0

xmem a1 a4 b MEM_YAKOPCIC
r1 b 0 1000000k

.tran .01ns 1ns
.probe

*****
* Memristor model for many devices

* Connections:
* TE - top electrode
* BE - bottom electrode
* XSV - External connection to plot state variable
* that is not used otherwise

.subckt MEM_YAKOPCIC TE BE XSV PARAMS:

* Fitting parameters to model different devices
* a1, a2, b: Parameters for IV relationship
* Vp, Vn: Pos. and neg. voltage thresholds
* Ap, An: Multiplier for SV motion intensity
* xp, xn: Points where SV motion is reduced
* alphap, alphan: Rate at which SV motion decays
* xo: Initial value of SV
* eta: SV direction relative to voltage

+a1=.01 a2=.01 b=0.1 Vp=1.2 Vn=1.2 Ap=1.2e10 An=1.2e10
+xp=0.1 xn=0.1 alphap=.3 alphan=.55 xo=0.01 eta=1

* Multiplicative functions to ensure zero state
* variable motion at memristor boundaries

.func wp(V) {(xp-V)/(1-xp)+1}
.func wn(V) {V/(1-xn)}

* Function G(V(t)) - Describes the device threshold

.func G(V) { IF(V<=Vp, IF(V>=-Vn, 0, -An*(exp(-V)-exp(Vn))), Ap*(exp(V)-exp(Vp))) }

* Function F(V(t),x(t)) - Describes the SV motion

.func F(V1,V2) {IF(eta*V1 >= 0, IF(V2 >= xp, exp(-
+alphap*(V2-xp))*wp(V2) ,1), IF(V2 <= (1-xn),
+exp(alphan*(V2+xn-1))*wn(V2) ,1))}

* IV Response - Hyperbolic sine due to MIM structure

.func IVRel(V1,V2) {IF(V1 >= 0, a1*V2*sinh(b*V1),
+a2*V2*sinh(b*V1) )}
```

* Circuit to determine state variable

* $dx/dt = F(V(t),x(t))*G(V(t))$

Cx XSV 0 1 IC= {xo}

Gx 0 XSV value={eta*F(V(TE,BE),V(XSV,0))*G(V(TE,BE))}

* Current source for memristor IV response

Gm TE BE value = {IVRel(V(TE,BE),V(XSV,0))}

.ends MEM_YAKOPCIC

*** model of NMOS transistor ***

```
.MODEL nenh NMOS LEVEL=7 VERSION=3.1 TNOM=27 tox=4.1E-9 XJ=1E-7 NCH=2.3549E17
+VTH0=0.3662473 K1=0.5864999 K2=1.127266E-3 K3=1E-3
+K3B=0.0294061 W0=1E-7 NLX=1.630684E-7 DVT0W=0 DVT1W=0 DVT2W=0 DVT0=1.2064649
+DVT1=0.4215486 DVT2=0.0197749 U0=273.8094484 UA=-1.40499E-9
+UB=2.408323E-18 UC=6.504826E-11 VSAT=1.355009E5 A0=2 AGS=0.4449958
+B0=1.901075E-7 B1=4.99995E-6 KETA=-0.0164863 A1=3.868769E-4 A2=0.4640272
+RDSW=123.3376355 PRWG=0.5 PRWB=-0.197728 WR=1 WINT=0 LINT=1.690044E-8
+XL=0 XW=-1E-8 DWG=-4.728719E-9 DWB=-2.452411E-9 VOFF=-0.0948017 NFACTOR=2.1860065
+CIT=0 CDSC=2.4E-4 CDSCD=0 CDSCB=0 ETA0=2.230928E-3 ETAB=6.028975E-5 DSUB=0.0145467
+PCLM=1.3822069 PDIBLC1=0.1762787 PDIBLC2 = 1.66653E-3 PDIBLCB = -0.1
+DROUT=0.7694691 PSCBE1=8.91287E9 PSCBE2=7.349607E-9 PVAG=1.685917E-3
+DELTA=0.01 RSH=6.7 MOBMOD=1 PRT=0 UTE=-1.5 KT1=-0.11 KT1L=0 KT2=0.022 UA1=4.31E-9
+UB1=-7.61E-18 UC1=-5.6E-11 AT=3.3E4 WL=0 WLN=1 WW=0 WWN=1 WWL=0 LL=0 LLN=1 LW=0
+LWN=1 LWL=0 CAPMOD=2 XPART=0.5 CGDO=8.23E-10 CGSO=8.23E-10 CGBO=1E-12
+CJ = 9.466429E-4 PB = 0.8 MJ = 0.3820266
+CJSW = 2.608154E-10 PBSW = 0.8 MJSW = 0.102322
+CJSWG = 3.3E-10 PBSWG = 0.8 MJSWG = 0.102322
+CF = 0 PVTH0 = -2.199373E-3 PRDSW = -0.9368961
+PK2 = 1.593254E-3 WKETA = -2.880976E-3 LKETA = 7.165078E-3
+PU0 = 6.777519 PUA = 5.505418E-12 PUB = 8.84133E-25
+PVSAT = 2.006286E3 PETA0 = 1.003159E-4 PKETA = -6.759277E-3
+NOIMOD=2.0E+00 NOIA=1.3182567385564E+19
+NOIB=144543.977074592 NOIC=-1.24515784572817E-12 EF=0.92 EM=41000000
```

*** model of PMOS transistor ***

```
.MODEL penh PMOS LEVEL=7 VERSION = 3.1 TNOM = 27 tox = 4.1E-9
+XJ = 1E-7 NCH = 4.1589E17 VTH0 = -0.3906012
+K1 = 0.5341312 K2 = 0.0395326 K3 = 0
+K3B = 7.4916211 W0 = 1E-6 NLX = 1.194072E-7
+DVT0W = 0 DVT1W = 0 DVT2W = 0
+DVT0 = 0.5060555 DVT1 = 0.2423835 DVT2 = 0.1
+U0 = 115.6894042 UA = 1.573746E-9 UB = 1.874308E-21
+UC = -1E-10 VSAT = 1.130982E5 A0 = 1.9976555
+AGS = 0.4186945 B0 = 1.949178E-7 B1 = 6.422908E-7
+KETA = 0.0166345 A1 = 0.4749146 A2 = 0.300003
+RDSW = 198.321294 PRWG = 0.5 PRWB = -0.4986647
+WR = 1 WINT = 0 LINT = 2.94454E-8
+XL = 0 XW = -1E-8 DWG = -2.798724E-8
+DWB = -4.83797E-10 VOFF = -0.095236 NFACTOR = 2
+CIT = 0 CDSC = 2.4E-4 CDSCD = 0
+CDSCB = 0 ETA0 = 1.035504E-3 ETAB = -4.358398E-4
```

```

+DSUB = 1.816555E-3 PCLM = 1.3299898 PDIBLC1 = 1.766563E-3
+PDIBLC2 = 7.728395E-7 PDIBLCB = -1E-3 DROUT = 1.011891E-3
+PSCBE1 = 4.872184E10 PSCBE2 = 5E-10 PVAG = 0.0209921
+DELTA = 0.01 RSH = 7.7 MOBMOD = 1
+PRT = 0 UTE = -1.5 KT1 = -0.11
+KT1L = 0 KT2 = 0.022 UA1 = 4.31E-9
+UB1 = -7.61E-18 UC1 = -5.6E-11 AT = 3.3E4
+WL = 0 WLN = 1 WW = 0
+WVN = 1 WWL = 0 LL = 0
+LLN = 1 LW = 0 LWN = 1
+LWL = 0 CAPMOD = 2 XPART = 0.5
+CGDO = 6.35E-10 CGSO = 6.35E-10 CGBO = 1E-12
+CJ = 1.144521E-3 PB = 0.8468686 MJ = 0.4099522
+CJSW = 2.490749E-10 PBSW = 0.8769118 MJSW = 0.3478565
+CJSWG = 4.22E-10 PBSWG = 0.8769118 MJSWG = 0.3478565
+CF = 0 PVTH0 = 2.302018E-3 PRDSW = 9.0575312
+PK2 = 1.821914E-3 WKETA = 0.0222457 LKETA = -1.495872E-3
+PU0 = -1.5580645 PUA = -6.36889E-11 PUB = 1E-21
+PVSAT = 49.8420442 PETA0 = 2.827793E-5 PKETA = -2.536564E-3
+NOIMOD=2.0E+00 NOIA=3.57456993317604E+18 NOIB=2500
+NOIC=2.61260020285845E-11 EF=1.1388

```

A.2. PSpice netlist for Figures 5.4, 5.5 and 5.6 and Table 7.2

* 1X64 bit TCAM array

```

.INCLUDE 'models_array64bit_SelectiveCharging.cir'
.INCLUDE 'rowcolumn_array64bit_SelectiveCharging.cir'
.INCLUDE 'sources_array64bit_SelectiveCharging.cir'
.INCLUDE 'cells_array64bit_SelectiveCharging.cir'

```

```

.SUBCKT tcam_cell d1 d2 SL1 SL2 en_row enb_row SE ML u2 I

```

```

xmem1 p I sv_mem1 MEM_YAKOPCIC_test1
xmem2 q I sv_mem2 MEM_YAKOPCIC_test1
xmem3 s u2 sv_mem3 MEM_YAKOPCIC_test2
xmem4 t u2 sv_mem4 MEM_YAKOPCIC_test2

```

```

rmem1 sv_mem1 0 10000k
rmem2 sv_mem2 0 10000k
rmem3 sv_mem3 0 10000k
rmem4 sv_mem4 0 10000k

```

```

mn1 d1 en_row p 0 nenh w=2u l=0.4u
mn2 d2 en_row q 0 nenh w=2u l=0.4u
mp1 p enb_row d1 3.3 penh w=2u l=0.4u
mp2 q enb_row d2 3.3 penh w=2u l=0.4u
mn3 s SE p 0 nenh w=4u l=0.2u
mn4 t SE q 0 nenh w=4u l=0.2u
mn5 p SL1 p1 0 nenh w=.2u l=0.2u
mn6 q SL2 q1 0 nenh w=.2u l=0.2u
mn7 ML p1 0 0 nenh w=6u l=0.2u
mn8 ML q1 0 0 nenh w=6u l=0.2u

```

```

.ENDS tcam_cell

```

```

.SUBCKT precharge pre u ML

```

```

mnpr u1 u1 ML 0 nenh w=2u l=0.2u

```



```

+a2*V2*sinh(b*V1) )}

* Circuit to determine state variable
* dx/dt = F(V(t),x(t))*G(V(t))

Cx XSV 0 1 IC= {xo}

Gx 0 XSV value={eta*F(V(TE,BE),V(XSV,0))*G(V(TE,BE))}

* Current source for memristor IV response

Gm TE BE value = {IVRel(V(TE,BE),V(XSV,0))}

.ends MEM_YAKOPCIC_test1

.subckt MEM_YAKOPCIC_test2 TE BE XSV PARAMS:

* Fitting parameters to model different devices
* a1, a2, b: Parameters for IV relationship
* Vp, Vn: Pos. and neg. voltage thresholds
* Ap, An: Multiplier for SV motion intensity
* xp, xn: Points where SV motion is reduced
* alphap, alphan: Rate at which SV motion decays
* xo: Initial value of SV
* eta: SV direction relative to voltage

+a1=.01 a2=.01 b=.011 Vp=1.7 Vn=1.7 Ap=4e3 An=4e3
+xp=0.1 xn=0.1 alphap=1 alphan=7 xo=0.1 eta=1

* Multiplicative functions to ensure zero state
* variable motion at memristor boundaries

.func wp(V) {(xp-V)/(1-xp)+1}
.func wn(V) {V/(1-xn)}

* Function G(V(t)) - Describes the device threshold

.func G(V) { IF(V<=Vp, IF(V>=-Vn, 0, -An*(exp(-V)-exp(Vn))), Ap*(exp(V)-exp(Vp))) }

* Function F(V(t),x(t)) - Describes the SV motion

.func F(V1,V2) {IF(eta*V1 >= 0, IF(V2 >= xp, exp(-
+alphap*(V2-xp))*wp(V2) ,1), IF(V2 <= (1-xn),
+exp(alphan*(V2+xn-1))*wn(V2) ,1))}

* IV Response - Hyperbolic sine due to MIM structure

.func IVRel(V1,V2) {IF(V1 >= 0, a1*V2*sinh(b*V1),
+a2*V2*sinh(b*V1) )}

* Circuit to determine state variable
* dx/dt = F(V(t),x(t))*G(V(t))

Cx XSV 0 1 IC= {xo}

Gx 0 XSV value={eta*F(V(TE,BE),V(XSV,0))*G(V(TE,BE))}

```

* Current source for memristor IV response

Gm TE BE value = {IVRel(V(TE,BE),V(XSV,0))}

.ends MEM_YAKOPCIC_test2

*** model of NMOS transistor ***

```
.MODEL nenh NMOS LEVEL=7 VERSION=3.1 TNOM=27 tox=4.1E-9 XJ=1E-7 NCH=2.3549E17
+VTH0=0.3662473 K1=0.5864999 K2=1.127266E-3 K3=1E-3
+K3B=0.0294061 W0=1E-7 NLX=1.630684E-7 DVT0W=0 DVT1W=0 DVT2W=0 DVT0=1.2064649
+DVT1=0.4215486 DVT2=0.0197749 U0=273.8094484 UA=-1.40499E-9
+UB=2.408323E-18 UC=6.504826E-11 VSAT=1.355009E5 A0=2 AGS=0.4449958
+BO=1.901075E-7 B1=4.99995E-6 KETA=-0.0164863 A1=3.868769E-4 A2=0.4640272
+RDSW=123.3376355 PRWG=0.5 PRWB=-0.197728 WR=1 WINT=0 LINT=1.690044E-8
+XL=0 XW=-1E-8 DWG=-4.728719E-9 DWB=-2.452411E-9 VOFF=-0.0948017 NFACTOR=2.1860065
+CIT=0 CDSC=2.4E-4 CDSCD=0 CDSCB=0 ETA0=2.230928E-3 ETAB=6.028975E-5 DSUB=0.0145467
+PCLM=1.3822069 PDIBLC1=0.1762787 PDIBLC2 = 1.66653E-3 PDIBLCB = -0.1
+DROUT=0.7694691 PSCBE1=8.91287E9 PSCBE2=7.349607E-9 PVAG=1.685917E-3
+DELTA=0.01 RSH=6.7 MOBMOD=1 PRT=0 UTE=-1.5 KT1=-0.11 KT1L=0 KT2=0.022 UA1=4.31E-9
+UB1=-7.61E-18 UC1=-5.6E-11 AT=3.3E4 WL=0 WLN=1 WW=0 WWN=1 WWL=0 LL=0 LLN=1 LW=0
+LWN=1 LWL=0 CAPMOD=2 XPART=0.5 CGDO=8.23E-10 CGSO=8.23E-10 CGBO=1E-12
+CJ = 9.466429E-4 PB = 0.8 MJ = 0.3820266
+CJSW = 2.608154E-10 PBSW = 0.8 MJSW = 0.102322
+CJSWG = 3.3E-10 PBSWG = 0.8 MJSWG = 0.102322
+CF = 0 PVTH0 = -2.199373E-3 PRDSW = -0.9368961
+PK2 = 1.593254E-3 WKETA = -2.880976E-3 LKETA = 7.165078E-3
+PU0 = 6.777519 PUA = 5.505418E-12 PUB = 8.84133E-25
+PVSAT = 2.006286E3 PETA0 = 1.003159E-4 PKETA = -6.759277E-3
+NOIMOD=2.0E+00 NOIA=1.3182567385564E+19
+NOIB=144543.977074592 NOIC=-1.24515784572817E-12 EF=0.92 EM=41000000
```

*** model of PMOS transistor ***

```
.MODEL nenh PMOS LEVEL=7 VERSION = 3.1 TNOM = 27 tox = 4.1E-9
+XJ = 1E-7 NCH = 4.1589E17 VTH0 = -0.3906012
+K1 = 0.5341312 K2 = 0.0395326 K3 = 0
+K3B = 7.4916211 W0 = 1E-6 NLX = 1.194072E-7
+DVT0W = 0 DVT1W = 0 DVT2W = 0
+DVT0 = 0.5060555 DVT1 = 0.2423835 DVT2 = 0.1
+U0 = 115.6894042 UA = 1.573746E-9 UB = 1.874308E-21
+UC = -1E-10 VSAT = 1.130982E5 A0 = 1.9976555
+AGS = 0.4186945 B0 = 1.949178E-7 B1 = 6.422908E-7
+KETA = 0.0166345 A1 = 0.4749146 A2 = 0.300003
+RDSW = 198.321294 PRWG = 0.5 PRWB = -0.4986647
+WR = 1 WINT = 0 LINT = 2.94454E-8
+XL = 0 XW = -1E-8 DWG = -2.798724E-8
+DWB = -4.83797E-10 VOFF = -0.095236 NFACTOR = 2
+CIT = 0 CDSC = 2.4E-4 CDSCD = 0
+CDSCB = 0 ETA0 = 1.035504E-3 ETAB = -4.358398E-4
+DSUB = 1.816555E-3 PCLM = 1.3299898 PDIBLC1 = 1.766563E-3
+PDIBLC2 = 7.728395E-7 PDIBLCB = -1E-3 DROUT = 1.011891E-3
+PSCBE1 = 4.872184E10 PSCBE2 = 5E-10 PVAG = 0.0209921
+DELTA = 0.01 RSH = 7.7 MOBMOD = 1
+PRT = 0 UTE = -1.5 KT1 = -0.11
+KT1L = 0 KT2 = 0.022 UA1 = 4.31E-9
+UB1 = -7.61E-18 UC1 = -5.6E-11 AT = 3.3E4
+WL = 0 WLN = 1 WW = 0
```



```

r_enb_row0 enb_row0 0 10000k
r1_enb_row0 enb_row0 enb1_row0 5
r_pre1_row01 pre1_row01 0 10000k
r1_pre1_row01 pre1_row01 pre_row01 5
r_pre1_row02 pre1_row02 0 10000k
r1_pre1_row02 pre1_row02 pre_row02 5
r_pre1_row03 pre1_row03 0 10000k
r1_pre1_row03 pre1_row03 pre_row03 5
r_pre1_row04 pre1_row04 0 10000k
r1_pre1_row04 pre1_row04 pre_row04 5
r_SE_row0 SE_row0 0 10000k
r1_SE_row0 SE_row0 SE1_row0 5
rML1reset_row0 ML1reset_row0 ML1reset1_row0 5
rML1reset1_row0 ML1reset1_row0 0 10000k
rML2reset_row0 ML2reset_row0 ML2reset1_row0 5
rML2reset1_row0 ML2reset1_row0 0 10000k
rML3reset_row0 ML3reset_row0 ML3reset1_row0 5
rML3reset1_row0 ML3reset1_row0 0 10000k
rML4reset_row0 ML4reset_row0 ML4reset1_row0 5
rML4reset1_row0 ML4reset1_row0 0 10000k

```

```

*****
*           columns           *
*****

```

* col0

```

mn1col0 d1_col0 en_col0 d11_col0 0 nenh w=4u l=.4u
mn2col0 d2_col0 en_col0 d22_col0 0 nenh w=4u l=.4u
mp1col0 d11_col0 enb_col0 d1_col0 3.3 penh w=8u l=0.4u
mp2col0 d22_col0 enb_col0 d2_col0 3.3 penh w=8u l=0.4u

```

```

r_en_col0 en_col0 0 10000k
r1_en_col0 en_col0 en1_col0 5
r_enb_col0 enb_col0 0 10000k
r1_enb_col0 enb_col0 enb1_col0 5

```

```

r_d11_col0 d11_col0 0 10000k
r1_d11_col0 d11_col0 d111_col0 5
r_d22_col0 d22_col0 0 10000k
r1_d22_col0 d22_col0 d222_col0 5

```

```

r_SL1col0 SL1col0 0 10000k
r1_SL1col0 SL1col0 SL11col0 5
r_SL2col0 SL2col0 0 10000k
r1_SL2col0 SL2col0 SL22col0 5

```

* col1

```

mn1col1 d1_col1 en_col1 d11_col1 0 nenh w=4u l=.4u
mn2col1 d2_col1 en_col1 d22_col1 0 nenh w=4u l=.4u
mp1col1 d11_col1 enb_col1 d1_col1 3.3 penh w=8u l=0.4u
mp2col1 d22_col1 enb_col1 d2_col1 3.3 penh w=8u l=0.4u

```

```

r_en_col1 en_col1 0 10000k
r1_en_col1 en_col1 en1_col1 5
r_enb_col1 enb_col1 0 10000k
r1_enb_col1 enb_col1 enb1_col1 5

```

```

r_d11_col1 d11_col1 0 10000k
r1_d11_col1 d11_col1 d111_col1 5

```

r_d22_col1 d22_col1 0 10000k
r1_d22_col1 d22_col1 d222_col1 5

r_SL1col1 SL1col1 0 10000k
r1_SL1col1 SL1col1 SL11col1 5
r_SL2col1 SL2col1 0 10000k
r1_SL2col1 SL2col1 SL22col1 5

* col2

mn1col2 d1_col2 en_col2 d11_col2 0 nenh w=4u l=.4u
mn2col2 d2_col2 en_col2 d22_col2 0 nenh w=4u l=.4u
mp1col2 d11_col2 enb_col2 d1_col2 3.3 penh w=8u l=0.4u
mp2col2 d22_col2 enb_col2 d2_col2 3.3 penh w=8u l=0.4u

r_en_col2 en_col2 0 10000k
r1_en_col2 en_col2 en1_col2 5
r_enb_col2 enb_col2 0 10000k
r1_enb_col2 enb_col2 enb1_col2 5

r_d11_col2 d11_col2 0 10000k
r1_d11_col2 d11_col2 d111_col2 5
r_d22_col2 d22_col2 0 10000k
r1_d22_col2 d22_col2 d222_col2 5

r_SL1col2 SL1col2 0 10000k
r1_SL1col2 SL1col2 SL11col2 5
r_SL2col2 SL2col2 0 10000k
r1_SL2col2 SL2col2 SL22col2 5

* col3

mn1col3 d1_col3 en_col3 d11_col3 0 nenh w=4u l=.4u
mn2col3 d2_col3 en_col3 d22_col3 0 nenh w=4u l=.4u
mp1col3 d11_col3 enb_col3 d1_col3 3.3 penh w=8u l=0.4u
mp2col3 d22_col3 enb_col3 d2_col3 3.3 penh w=8u l=0.4u

r_en_col3 en_col3 0 10000k
r1_en_col3 en_col3 en1_col3 5
r_enb_col3 enb_col3 0 10000k
r1_enb_col3 enb_col3 enb1_col3 5

r_d11_col3 d11_col3 0 10000k
r1_d11_col3 d11_col3 d111_col3 5
r_d22_col3 d22_col3 0 10000k
r1_d22_col3 d22_col3 d222_col3 5

r_SL1col3 SL1col3 0 10000k
r1_SL1col3 SL1col3 SL11col3 5
r_SL2col3 SL2col3 0 10000k
r1_SL2col3 SL2col3 SL22col3 5

* col4

mn1col4 d1_col4 en_col4 d11_col4 0 nenh w=4u l=.4u
mn2col4 d2_col4 en_col4 d22_col4 0 nenh w=4u l=.4u
mp1col4 d11_col4 enb_col4 d1_col4 3.3 penh w=8u l=0.4u
mp2col4 d22_col4 enb_col4 d2_col4 3.3 penh w=8u l=0.4u

r_en_col4 en_col4 0 10000k
r1_en_col4 en_col4 en1_col4 5

r_enb_col4 enb_col4 0 10000k
r1_enb_col4 enb_col4 enb1_col4 5

r_d11_col4 d11_col4 0 10000k
r1_d11_col4 d11_col4 d111_col4 5
r_d22_col4 d22_col4 0 10000k
r1_d22_col4 d22_col4 d222_col4 5

r_SL1col4 SL1col4 0 10000k
r1_SL1col4 SL1col4 SL11col4 5
r_SL2col4 SL2col4 0 10000k
r1_SL2col4 SL2col4 SL22col4 5

* col5

mn1col5 d1_col5 en_col5 d11_col5 0 nenh w=4u l=.4u
mn2col5 d2_col5 en_col5 d22_col5 0 nenh w=4u l=.4u
mp1col5 d11_col5 enb_col5 d1_col5 3.3 penh w=8u l=0.4u
mp2col5 d22_col5 enb_col5 d2_col5 3.3 penh w=8u l=0.4u

r_en_col5 en_col5 0 10000k
r1_en_col5 en_col5 en1_col5 5
r_enb_col5 enb_col5 0 10000k
r1_enb_col5 enb_col5 enb1_col5 5

r_d11_col5 d11_col5 0 10000k
r1_d11_col5 d11_col5 d111_col5 5
r_d22_col5 d22_col5 0 10000k
r1_d22_col5 d22_col5 d222_col5 5

r_SL1col5 SL1col5 0 10000k
r1_SL1col5 SL1col5 SL11col5 5
r_SL2col5 SL2col5 0 10000k
r1_SL2col5 SL2col5 SL22col5 5

* col6

mn1col6 d1_col6 en_col6 d11_col6 0 nenh w=4u l=.4u
mn2col6 d2_col6 en_col6 d22_col6 0 nenh w=4u l=.4u
mp1col6 d11_col6 enb_col6 d1_col6 3.3 penh w=8u l=0.4u
mp2col6 d22_col6 enb_col6 d2_col6 3.3 penh w=8u l=0.4u

r_en_col6 en_col6 0 10000k
r1_en_col6 en_col6 en1_col6 5
r_enb_col6 enb_col6 0 10000k
r1_enb_col6 enb_col6 enb1_col6 5

r_d11_col6 d11_col6 0 10000k
r1_d11_col6 d11_col6 d111_col6 5
r_d22_col6 d22_col6 0 10000k
r1_d22_col6 d22_col6 d222_col6 5

r_SL1col6 SL1col6 0 10000k
r1_SL1col6 SL1col6 SL11col6 5
r_SL2col6 SL2col6 0 10000k
r1_SL2col6 SL2col6 SL22col6 5

* col7

mn1col7 d1_col7 en_col7 d11_col7 0 nenh w=4u l=.4u
mn2col7 d2_col7 en_col7 d22_col7 0 nenh w=4u l=.4u
mp1col7 d11_col7 enb_col7 d1_col7 3.3 penh w=8u l=0.4u
mp2col7 d22_col7 enb_col7 d2_col7 3.3 penh w=8u l=0.4u

r_en_col7 en_col7 0 10000k
r1_en_col7 en_col7 en1_col7 5
r_enb_col7 enb_col7 0 10000k
r1_enb_col7 enb_col7 enb1_col7 5

r_d11_col7 d11_col7 0 10000k
r1_d11_col7 d11_col7 d111_col7 5
r_d22_col7 d22_col7 0 10000k
r1_d22_col7 d22_col7 d222_col7 5

r_SL1col7 SL1col7 0 10000k
r1_SL1col7 SL1col7 SL11col7 5
r_SL2col7 SL2col7 0 10000k
r1_SL2col7 SL2col7 SL22col7 5

* col8

mn1col8 d1_col8 en_col8 d11_col8 0 nenh w=4u l=.4u
mn2col8 d2_col8 en_col8 d22_col8 0 nenh w=4u l=.4u
mp1col8 d11_col8 enb_col8 d1_col8 3.3 penh w=8u l=0.4u
mp2col8 d22_col8 enb_col8 d2_col8 3.3 penh w=8u l=0.4u

r_en_col8 en_col8 0 10000k
r1_en_col8 en_col8 en1_col8 5
r_enb_col8 enb_col8 0 10000k
r1_enb_col8 enb_col8 enb1_col8 5

r_d11_col8 d11_col8 0 10000k
r1_d11_col8 d11_col8 d111_col8 5
r_d22_col8 d22_col8 0 10000k
r1_d22_col8 d22_col8 d222_col8 5

r_SL1col8 SL1col8 0 10000k
r1_SL1col8 SL1col8 SL11col8 5
r_SL2col8 SL2col8 0 10000k
r1_SL2col8 SL2col8 SL22col8 5

* col9

mn1col9 d1_col9 en_col9 d11_col9 0 nenh w=4u l=.4u
mn2col9 d2_col9 en_col9 d22_col9 0 nenh w=4u l=.4u
mp1col9 d11_col9 enb_col9 d1_col9 3.3 penh w=8u l=0.4u
mp2col9 d22_col9 enb_col9 d2_col9 3.3 penh w=8u l=0.4u

r_en_col9 en_col9 0 10000k
r1_en_col9 en_col9 en1_col9 5
r_enb_col9 enb_col9 0 10000k
r1_enb_col9 enb_col9 enb1_col9 5

r_d11_col9 d11_col9 0 10000k
r1_d11_col9 d11_col9 d111_col9 5
r_d22_col9 d22_col9 0 10000k
r1_d22_col9 d22_col9 d222_col9 5

r_SL1col9 SL1col9 0 10000k

r1_SL1col9 SL1col9 SL11col9 5
r_SL2col9 SL2col9 0 10000k
r1_SL2col9 SL2col9 SL22col9 5

* col10

mn1col10 d1_col10 en_col10 d11_col10 0 nenh w=4u l=.4u
mn2col10 d2_col10 en_col10 d22_col10 0 nenh w=4u l=.4u
mp1col10 d11_col10 enb_col10 d1_col10 3.3 penh w=8u l=0.4u
mp2col10 d22_col10 enb_col10 d2_col10 3.3 penh w=8u l=0.4u

r_en_col10 en_col10 0 10000k
r1_en_col10 en_col10 en1_col10 5
r_enb_col10 enb_col10 0 10000k
r1_enb_col10 enb_col10 enb1_col10 5

r_d11_col10 d11_col10 0 10000k
r1_d11_col10 d11_col10 d111_col10 5
r_d22_col10 d22_col10 0 10000k
r1_d22_col10 d22_col10 d222_col10 5

r_SL1col10 SL1col10 0 10000k
r1_SL1col10 SL1col10 SL11col10 5
r_SL2col10 SL2col10 0 10000k
r1_SL2col10 SL2col10 SL22col10 5

* col11

mn1col11 d1_col11 en_col11 d11_col11 0 nenh w=4u l=.4u
mn2col11 d2_col11 en_col11 d22_col11 0 nenh w=4u l=.4u
mp1col11 d11_col11 enb_col11 d1_col11 3.3 penh w=8u l=0.4u
mp2col11 d22_col11 enb_col11 d2_col11 3.3 penh w=8u l=0.4u

r_en_col11 en_col11 0 10000k
r1_en_col11 en_col11 en1_col11 5
r_enb_col11 enb_col11 0 10000k
r1_enb_col11 enb_col11 enb1_col11 5

r_d11_col11 d11_col11 0 10000k
r1_d11_col11 d11_col11 d111_col11 5
r_d22_col11 d22_col11 0 10000k
r1_d22_col11 d22_col11 d222_col11 5

r_SL1col11 SL1col11 0 10000k
r1_SL1col11 SL1col11 SL11col11 5
r_SL2col11 SL2col11 0 10000k
r1_SL2col11 SL2col11 SL22col11 5

* col12

mn1col12 d1_col12 en_col12 d11_col12 0 nenh w=4u l=.4u
mn2col12 d2_col12 en_col12 d22_col12 0 nenh w=4u l=.4u
mp1col12 d11_col12 enb_col12 d1_col12 3.3 penh w=8u l=0.4u
mp2col12 d22_col12 enb_col12 d2_col12 3.3 penh w=8u l=0.4u

r_en_col12 en_col12 0 10000k
r1_en_col12 en_col12 en1_col12 5
r_enb_col12 enb_col12 0 10000k
r1_enb_col12 enb_col12 enb1_col12 5

r_d11_col12 d11_col12 0 10000k
r1_d11_col12 d11_col12 d111_col12 5
r_d22_col12 d22_col12 0 10000k
r1_d22_col12 d22_col12 d222_col12 5

r_SL1col12 SL1col12 0 10000k
r1_SL1col12 SL1col12 SL11col12 5
r_SL2col12 SL2col12 0 10000k
r1_SL2col12 SL2col12 SL22col12 5

* col13

mn1col13 d1_col13 en_col13 d11_col13 0 nenh w=4u l=.4u
mn2col13 d2_col13 en_col13 d22_col13 0 nenh w=4u l=.4u
mp1col13 d11_col13 enb_col13 d1_col13 3.3 penh w=8u l=0.4u
mp2col13 d22_col13 enb_col13 d2_col13 3.3 penh w=8u l=0.4u

r_en_col13 en_col13 0 10000k
r1_en_col13 en_col13 en1_col13 5
r_enb_col13 enb_col13 0 10000k
r1_enb_col13 enb_col13 enb1_col13 5

r_d11_col13 d11_col13 0 10000k
r1_d11_col13 d11_col13 d111_col13 5
r_d22_col13 d22_col13 0 10000k
r1_d22_col13 d22_col13 d222_col13 5

r_SL1col13 SL1col13 0 10000k
r1_SL1col13 SL1col13 SL11col13 5
r_SL2col13 SL2col13 0 10000k
r1_SL2col13 SL2col13 SL22col13 5

* col14

mn1col14 d1_col14 en_col14 d11_col14 0 nenh w=4u l=.4u
mn2col14 d2_col14 en_col14 d22_col14 0 nenh w=4u l=.4u
mp1col14 d11_col14 enb_col14 d1_col14 3.3 penh w=8u l=0.4u
mp2col14 d22_col14 enb_col14 d2_col14 3.3 penh w=8u l=0.4u

r_en_col14 en_col14 0 10000k
r1_en_col14 en_col14 en1_col14 5
r_enb_col14 enb_col14 0 10000k
r1_enb_col14 enb_col14 enb1_col14 5

r_d11_col14 d11_col14 0 10000k
r1_d11_col14 d11_col14 d111_col14 5
r_d22_col14 d22_col14 0 10000k
r1_d22_col14 d22_col14 d222_col14 5

r_SL1col14 SL1col14 0 10000k
r1_SL1col14 SL1col14 SL11col14 5
r_SL2col14 SL2col14 0 10000k
r1_SL2col14 SL2col14 SL22col14 5

* col15

mn1col15 d1_col15 en_col15 d11_col15 0 nenh w=4u l=.4u
mn2col15 d2_col15 en_col15 d22_col15 0 nenh w=4u l=.4u
mp1col15 d11_col15 enb_col15 d1_col15 3.3 penh w=8u l=0.4u

mp2col15 d22_col15 enb_col15 d2_col15 3.3 penh w=8u l=0.4u

r_en_col15 en_col15 0 10000k
r1_en_col15 en_col15 en1_col15 5
r_enb_col15 enb_col15 0 10000k
r1_enb_col15 enb_col15 enb1_col15 5

r_d11_col15 d11_col15 0 10000k
r1_d11_col15 d11_col15 d111_col15 5
r_d22_col15 d22_col15 0 10000k
r1_d22_col15 d22_col15 d222_col15 5

r_SL1col15 SL1col15 0 10000k
r1_SL1col15 SL1col15 SL11col15 5
r_SL2col15 SL2col15 0 10000k
r1_SL2col15 SL2col15 SL22col15 5

* col16

mn1col16 d1_col16 en_col16 d11_col16 0 nenh w=4u l=.4u
mn2col16 d2_col16 en_col16 d22_col16 0 nenh w=4u l=.4u
mp1col16 d11_col16 enb_col16 d1_col16 3.3 penh w=8u l=0.4u
mp2col16 d22_col16 enb_col16 d2_col16 3.3 penh w=8u l=0.4u

r_en_col16 en_col16 0 10000k
r1_en_col16 en_col16 en1_col16 5
r_enb_col16 enb_col16 0 10000k
r1_enb_col16 enb_col16 enb1_col16 5

r_d11_col16 d11_col16 0 10000k
r1_d11_col16 d11_col16 d111_col16 5
r_d22_col16 d22_col16 0 10000k
r1_d22_col16 d22_col16 d222_col16 5

r_SL1col16 SL1col16 0 10000k
r1_SL1col16 SL1col16 SL11col16 5
r_SL2col16 SL2col16 0 10000k
r1_SL2col16 SL2col16 SL22col16 5

* col17

mn1col17 d1_col17 en_col17 d11_col17 0 nenh w=4u l=.4u
mn2col17 d2_col17 en_col17 d22_col17 0 nenh w=4u l=.4u
mp1col17 d11_col17 enb_col17 d1_col17 3.3 penh w=8u l=0.4u
mp2col17 d22_col17 enb_col17 d2_col17 3.3 penh w=8u l=0.4u

r_en_col17 en_col17 0 10000k
r1_en_col17 en_col17 en1_col17 5
r_enb_col17 enb_col17 0 10000k
r1_enb_col17 enb_col17 enb1_col17 5

r_d11_col17 d11_col17 0 10000k
r1_d11_col17 d11_col17 d111_col17 5
r_d22_col17 d22_col17 0 10000k
r1_d22_col17 d22_col17 d222_col17 5

r_SL1col17 SL1col17 0 10000k
r1_SL1col17 SL1col17 SL11col17 5
r_SL2col17 SL2col17 0 10000k
r1_SL2col17 SL2col17 SL22col17 5

* col18

mn1col18 d1_col18 en_col18 d11_col18 0 nenh w=4u l=.4u
mn2col18 d2_col18 en_col18 d22_col18 0 nenh w=4u l=.4u
mp1col18 d11_col18 enb_col18 d1_col18 3.3 penh w=8u l=0.4u
mp2col18 d22_col18 enb_col18 d2_col18 3.3 penh w=8u l=0.4u

r_en_col18 en_col18 0 10000k
r1_en_col18 en_col18 en1_col18 5
r_enb_col18 enb_col18 0 10000k
r1_enb_col18 enb_col18 enb1_col18 5

r_d11_col18 d11_col18 0 10000k
r1_d11_col18 d11_col18 d111_col18 5
r_d22_col18 d22_col18 0 10000k
r1_d22_col18 d22_col18 d222_col18 5

r_SL1col18 SL1col18 0 10000k
r1_SL1col18 SL1col18 SL11col18 5
r_SL2col18 SL2col18 0 10000k
r1_SL2col18 SL2col18 SL22col18 5

* col19

mn1col19 d1_col19 en_col19 d11_col19 0 nenh w=4u l=.4u
mn2col19 d2_col19 en_col19 d22_col19 0 nenh w=4u l=.4u
mp1col19 d11_col19 enb_col19 d1_col19 3.3 penh w=8u l=0.4u
mp2col19 d22_col19 enb_col19 d2_col19 3.3 penh w=8u l=0.4u

r_en_col19 en_col19 0 10000k
r1_en_col19 en_col19 en1_col19 5
r_enb_col19 enb_col19 0 10000k
r1_enb_col19 enb_col19 enb1_col19 5

r_d11_col19 d11_col19 0 10000k
r1_d11_col19 d11_col19 d111_col19 5
r_d22_col19 d22_col19 0 10000k
r1_d22_col19 d22_col19 d222_col19 5

r_SL1col19 SL1col19 0 10000k
r1_SL1col19 SL1col19 SL11col19 5
r_SL2col19 SL2col19 0 10000k
r1_SL2col19 SL2col19 SL22col19 5

* col20

mn1col20 d1_col20 en_col20 d11_col20 0 nenh w=4u l=.4u
mn2col20 d2_col20 en_col20 d22_col20 0 nenh w=4u l=.4u
mp1col20 d11_col20 enb_col20 d1_col20 3.3 penh w=8u l=0.4u
mp2col20 d22_col20 enb_col20 d2_col20 3.3 penh w=8u l=0.4u

r_en_col20 en_col20 0 10000k
r1_en_col20 en_col20 en1_col20 5
r_enb_col20 enb_col20 0 10000k
r1_enb_col20 enb_col20 enb1_col20 5

r_d11_col20 d11_col20 0 10000k
r1_d11_col20 d11_col20 d111_col20 5
r_d22_col20 d22_col20 0 10000k
r1_d22_col20 d22_col20 d222_col20 5

r_SL1col20 SL1col20 0 10000k
r1_SL1col20 SL1col20 SL11col20 5
r_SL2col20 SL2col20 0 10000k
r1_SL2col20 SL2col20 SL22col20 5

* col21

mn1col21 d1_col21 en_col21 d11_col21 0 nenh w=4u l=.4u
mn2col21 d2_col21 en_col21 d22_col21 0 nenh w=4u l=.4u
mp1col21 d11_col21 enb_col21 d1_col21 3.3 penh w=8u l=0.4u
mp2col21 d22_col21 enb_col21 d2_col21 3.3 penh w=8u l=0.4u

r_en_col21 en_col21 0 10000k
r1_en_col21 en_col21 en1_col21 5
r_enb_col21 enb_col21 0 10000k
r1_enb_col21 enb_col21 enb1_col21 5

r_d11_col21 d11_col21 0 10000k
r1_d11_col21 d11_col21 d111_col21 5
r_d22_col21 d22_col21 0 10000k
r1_d22_col21 d22_col21 d222_col21 5

r_SL1col21 SL1col21 0 10000k
r1_SL1col21 SL1col21 SL11col21 5
r_SL2col21 SL2col21 0 10000k
r1_SL2col21 SL2col21 SL22col21 5

* col22

mn1col22 d1_col22 en_col22 d11_col22 0 nenh w=4u l=.4u
mn2col22 d2_col22 en_col22 d22_col22 0 nenh w=4u l=.4u
mp1col22 d11_col22 enb_col22 d1_col22 3.3 penh w=8u l=0.4u
mp2col22 d22_col22 enb_col22 d2_col22 3.3 penh w=8u l=0.4u

r_en_col22 en_col22 0 10000k
r1_en_col22 en_col22 en1_col22 5
r_enb_col22 enb_col22 0 10000k
r1_enb_col22 enb_col22 enb1_col22 5

r_d11_col22 d11_col22 0 10000k
r1_d11_col22 d11_col22 d111_col22 5
r_d22_col22 d22_col22 0 10000k
r1_d22_col22 d22_col22 d222_col22 5

r_SL1col22 SL1col22 0 10000k
r1_SL1col22 SL1col22 SL11col22 5
r_SL2col22 SL2col22 0 10000k
r1_SL2col22 SL2col22 SL22col22 5

* col23

mn1col23 d1_col23 en_col23 d11_col23 0 nenh w=4u l=.4u
mn2col23 d2_col23 en_col23 d22_col23 0 nenh w=4u l=.4u
mp1col23 d11_col23 enb_col23 d1_col23 3.3 penh w=8u l=0.4u
mp2col23 d22_col23 enb_col23 d2_col23 3.3 penh w=8u l=0.4u

r_en_col23 en_col23 0 10000k
r1_en_col23 en_col23 en1_col23 5
r_enb_col23 enb_col23 0 10000k
r1_enb_col23 enb_col23 enb1_col23 5

r_d11_col23 d11_col23 0 10000k
r1_d11_col23 d11_col23 d111_col23 5
r_d22_col23 d22_col23 0 10000k
r1_d22_col23 d22_col23 d222_col23 5

r_SL1col23 SL1col23 0 10000k

r1_SL1col23 SL1col23 SL11col23 5
r_SL2col23 SL2col23 0 10000k
r1_SL2col23 SL2col23 SL22col23 5

* col24

mn1col24 d1_col24 en_col24 d11_col24 0 nenh w=4u l=.4u
mn2col24 d2_col24 en_col24 d22_col24 0 nenh w=4u l=.4u
mp1col24 d11_col24 enb_col24 d1_col24 3.3 penh w=8u l=0.4u
mp2col24 d22_col24 enb_col24 d2_col24 3.3 penh w=8u l=0.4u

r_en_col24 en_col24 0 10000k
r1_en_col24 en_col24 en1_col24 5
r_enb_col24 enb_col24 0 10000k
r1_enb_col24 enb_col24 enb1_col24 5

r_d11_col24 d11_col24 0 10000k
r1_d11_col24 d11_col24 d111_col24 5
r_d22_col24 d22_col24 0 10000k
r1_d22_col24 d22_col24 d222_col24 5

r_SL1col24 SL1col24 0 10000k
r1_SL1col24 SL1col24 SL11col24 5
r_SL2col24 SL2col24 0 10000k
r1_SL2col24 SL2col24 SL22col24 5

* col25

mn1col25 d1_col25 en_col25 d11_col25 0 nenh w=4u l=.4u
mn2col25 d2_col25 en_col25 d22_col25 0 nenh w=4u l=.4u
mp1col25 d11_col25 enb_col25 d1_col25 3.3 penh w=8u l=0.4u
mp2col25 d22_col25 enb_col25 d2_col25 3.3 penh w=8u l=0.4u

r_en_col25 en_col25 0 10000k
r1_en_col25 en_col25 en1_col25 5
r_enb_col25 enb_col25 0 10000k
r1_enb_col25 enb_col25 enb1_col25 5

r_d11_col25 d11_col25 0 10000k
r1_d11_col25 d11_col25 d111_col25 5
r_d22_col25 d22_col25 0 10000k
r1_d22_col25 d22_col25 d222_col25 5

r_SL1col25 SL1col25 0 10000k
r1_SL1col25 SL1col25 SL11col25 5
r_SL2col25 SL2col25 0 10000k
r1_SL2col25 SL2col25 SL22col25 5

* col26

mn1col26 d1_col26 en_col26 d11_col26 0 nenh w=4u l=.4u
mn2col26 d2_col26 en_col26 d22_col26 0 nenh w=4u l=.4u
mp1col26 d11_col26 enb_col26 d1_col26 3.3 penh w=8u l=0.4u
mp2col26 d22_col26 enb_col26 d2_col26 3.3 penh w=8u l=0.4u

r_en_col26 en_col26 0 10000k
r1_en_col26 en_col26 en1_col26 5
r_enb_col26 enb_col26 0 10000k
r1_enb_col26 enb_col26 enb1_col26 5

r_d11_col26 d11_col26 0 10000k
r1_d11_col26 d11_col26 d111_col26 5
r_d22_col26 d22_col26 0 10000k

r1_d22_col26 d22_col26 d222_col26 5

r_SL1col26 SL1col26 0 10000k
r1_SL1col26 SL1col26 SL11col26 5
r_SL2col26 SL2col26 0 10000k
r1_SL2col26 SL2col26 SL22col26 5

* col27

mn1col27 d1_col27 en_col27 d11_col27 0 nenh w=4u l=.4u
mn2col27 d2_col27 en_col27 d22_col27 0 nenh w=4u l=.4u
mp1col27 d11_col27 enb_col27 d1_col27 3.3 penh w=8u l=0.4u
mp2col27 d22_col27 enb_col27 d2_col27 3.3 penh w=8u l=0.4u

r_en_col27 en_col27 0 10000k
r1_en_col27 en_col27 en1_col27 5
r_enb_col27 enb_col27 0 10000k
r1_enb_col27 enb_col27 enb1_col27 5

r_d11_col27 d11_col27 0 10000k
r1_d11_col27 d11_col27 d111_col27 5
r_d22_col27 d22_col27 0 10000k
r1_d22_col27 d22_col27 d222_col27 5

r_SL1col27 SL1col27 0 10000k
r1_SL1col27 SL1col27 SL11col27 5
r_SL2col27 SL2col27 0 10000k
r1_SL2col27 SL2col27 SL22col27 5

* col28

mn1col28 d1_col28 en_col28 d11_col28 0 nenh w=4u l=.4u
mn2col28 d2_col28 en_col28 d22_col28 0 nenh w=4u l=.4u
mp1col28 d11_col28 enb_col28 d1_col28 3.3 penh w=8u l=0.4u
mp2col28 d22_col28 enb_col28 d2_col28 3.3 penh w=8u l=0.4u

r_en_col28 en_col28 0 10000k
r1_en_col28 en_col28 en1_col28 5
r_enb_col28 enb_col28 0 10000k
r1_enb_col28 enb_col28 enb1_col28 5

r_d11_col28 d11_col28 0 10000k
r1_d11_col28 d11_col28 d111_col28 5
r_d22_col28 d22_col28 0 10000k
r1_d22_col28 d22_col28 d222_col28 5

r_SL1col28 SL1col28 0 10000k
r1_SL1col28 SL1col28 SL11col28 5
r_SL2col28 SL2col28 0 10000k
r1_SL2col28 SL2col28 SL22col28 5

* col29

mn1col29 d1_col29 en_col29 d11_col29 0 nenh w=4u l=.4u
mn2col29 d2_col29 en_col29 d22_col29 0 nenh w=4u l=.4u
mp1col29 d11_col29 enb_col29 d1_col29 3.3 penh w=8u l=0.4u
mp2col29 d22_col29 enb_col29 d2_col29 3.3 penh w=8u l=0.4u

r_en_col29 en_col29 0 10000k
r1_en_col29 en_col29 en1_col29 5
r_enb_col29 enb_col29 0 10000k
r1_enb_col29 enb_col29 enb1_col29 5

r_d11_col29 d11_col29 0 10000k

r1_d11_col29 d11_col29 d111_col29 5
r_d22_col29 d22_col29 0 10000k
r1_d22_col29 d22_col29 d222_col29 5

r_SL1col29 SL1col29 0 10000k
r1_SL1col29 SL1col29 SL11col29 5
r_SL2col29 SL2col29 0 10000k
r1_SL2col29 SL2col29 SL22col29 5

* col30

mn1col30 d1_col30 en_col30 d11_col30 0 nenh w=4u l=.4u
mn2col30 d2_col30 en_col30 d22_col30 0 nenh w=4u l=.4u
mp1col30 d11_col30 enb_col30 d1_col30 3.3 penh w=8u l=0.4u
mp2col30 d22_col30 enb_col30 d2_col30 3.3 penh w=8u l=0.4u

r_en_col30 en_col30 0 10000k
r1_en_col30 en_col30 en1_col30 5
r_enb_col30 enb_col30 0 10000k
r1_enb_col30 enb_col30 enb1_col30 5

r_d11_col30 d11_col30 0 10000k
r1_d11_col30 d11_col30 d111_col30 5
r_d22_col30 d22_col30 0 10000k
r1_d22_col30 d22_col30 d222_col30 5

r_SL1col30 SL1col30 0 10000k
r1_SL1col30 SL1col30 SL11col30 5
r_SL2col30 SL2col30 0 10000k
r1_SL2col30 SL2col30 SL22col30 5

* col31

mn1col31 d1_col31 en_col31 d11_col31 0 nenh w=4u l=.4u
mn2col31 d2_col31 en_col31 d22_col31 0 nenh w=4u l=.4u
mp1col31 d11_col31 enb_col31 d1_col31 3.3 penh w=8u l=0.4u
mp2col31 d22_col31 enb_col31 d2_col31 3.3 penh w=8u l=0.4u

r_en_col31 en_col31 0 10000k
r1_en_col31 en_col31 en1_col31 5
r_enb_col31 enb_col31 0 10000k
r1_enb_col31 enb_col31 enb1_col31 5

r_d11_col31 d11_col31 0 10000k
r1_d11_col31 d11_col31 d111_col31 5
r_d22_col31 d22_col31 0 10000k
r1_d22_col31 d22_col31 d222_col31 5

r_SL1col31 SL1col31 0 10000k
r1_SL1col31 SL1col31 SL11col31 5
r_SL2col31 SL2col31 0 10000k
r1_SL2col31 SL2col31 SL22col31 5

* col32

mn1col32 d1_col32 en_col32 d11_col32 0 nenh w=4u l=.4u
mn2col32 d2_col32 en_col32 d22_col32 0 nenh w=4u l=.4u
mp1col32 d11_col32 enb_col32 d1_col32 3.3 penh w=8u l=0.4u
mp2col32 d22_col32 enb_col32 d2_col32 3.3 penh w=8u l=0.4u

r_en_col32 en_col32 0 10000k
r1_en_col32 en_col32 en1_col32 5
r_enb_col32 enb_col32 0 10000k

r1_enb_col32 enb_col32 enb1_col32 5

r_d11_col32 d11_col32 0 10000k
r1_d11_col32 d11_col32 d111_col32 5
r_d22_col32 d22_col32 0 10000k
r1_d22_col32 d22_col32 d222_col32 5

r_SL1col32 SL1col32 0 10000k
r1_SL1col32 SL1col32 SL11col32 5
r_SL2col32 SL2col32 0 10000k
r1_SL2col32 SL2col32 SL22col32 5

* col33

mn1col33 d1_col33 en_col33 d11_col33 0 nenh w=4u l=.4u
mn2col33 d2_col33 en_col33 d22_col33 0 nenh w=4u l=.4u
mp1col33 d11_col33 enb_col33 d1_col33 3.3 penh w=8u l=0.4u
mp2col33 d22_col33 enb_col33 d2_col33 3.3 penh w=8u l=0.4u

r_en_col33 en_col33 0 10000k
r1_en_col33 en_col33 en1_col33 5
r_enb_col33 enb_col33 0 10000k
r1_enb_col33 enb_col33 enb1_col33 5

r_d11_col33 d11_col33 0 10000k
r1_d11_col33 d11_col33 d111_col33 5
r_d22_col33 d22_col33 0 10000k
r1_d22_col33 d22_col33 d222_col33 5

r_SL1col33 SL1col33 0 10000k
r1_SL1col33 SL1col33 SL11col33 5
r_SL2col33 SL2col33 0 10000k
r1_SL2col33 SL2col33 SL22col33 5

* col34

mn1col34 d1_col34 en_col34 d11_col34 0 nenh w=4u l=.4u
mn2col34 d2_col34 en_col34 d22_col34 0 nenh w=4u l=.4u
mp1col34 d11_col34 enb_col34 d1_col34 3.3 penh w=8u l=0.4u
mp2col34 d22_col34 enb_col34 d2_col34 3.3 penh w=8u l=0.4u

r_en_col34 en_col34 0 10000k
r1_en_col34 en_col34 en1_col34 5
r_enb_col34 enb_col34 0 10000k
r1_enb_col34 enb_col34 enb1_col34 5

r_d11_col34 d11_col34 0 10000k
r1_d11_col34 d11_col34 d111_col34 5
r_d22_col34 d22_col34 0 10000k
r1_d22_col34 d22_col34 d222_col34 5

r_SL1col34 SL1col34 0 10000k
r1_SL1col34 SL1col34 SL11col34 5
r_SL2col34 SL2col34 0 10000k
r1_SL2col34 SL2col34 SL22col34 5

* col35

mn1col35 d1_col35 en_col35 d11_col35 0 nenh w=4u l=.4u
mn2col35 d2_col35 en_col35 d22_col35 0 nenh w=4u l=.4u
mp1col35 d11_col35 enb_col35 d1_col35 3.3 penh w=8u l=0.4u
mp2col35 d22_col35 enb_col35 d2_col35 3.3 penh w=8u l=0.4u

r_en_col35 en_col35 0 10000k

r1_en_col35 en_col35 en1_col35 5
r_enb_col35 enb_col35 0 10000k
r1_enb_col35 enb_col35 enb1_col35 5

r_d11_col35 d11_col35 0 10000k
r1_d11_col35 d11_col35 d111_col35 5
r_d22_col35 d22_col35 0 10000k
r1_d22_col35 d22_col35 d222_col35 5

r_SL1col35 SL1col35 0 10000k
r1_SL1col35 SL1col35 SL11col35 5
r_SL2col35 SL2col35 0 10000k
r1_SL2col35 SL2col35 SL22col35 5

* col36

mn1col36 d1_col36 en_col36 d11_col36 0 nenh w=4u l=.4u
mn2col36 d2_col36 en_col36 d22_col36 0 nenh w=4u l=.4u
mp1col36 d11_col36 enb_col36 d1_col36 3.3 penh w=8u l=0.4u
mp2col36 d22_col36 enb_col36 d2_col36 3.3 penh w=8u l=0.4u

r_en_col36 en_col36 0 10000k
r1_en_col36 en_col36 en1_col36 5
r_enb_col36 enb_col36 0 10000k
r1_enb_col36 enb_col36 enb1_col36 5

r_d11_col36 d11_col36 0 10000k
r1_d11_col36 d11_col36 d111_col36 5
r_d22_col36 d22_col36 0 10000k
r1_d22_col36 d22_col36 d222_col36 5

r_SL1col36 SL1col36 0 10000k
r1_SL1col36 SL1col36 SL11col36 5
r_SL2col36 SL2col36 0 10000k
r1_SL2col36 SL2col36 SL22col36 5

* col37

mn1col37 d1_col37 en_col37 d11_col37 0 nenh w=4u l=.4u
mn2col37 d2_col37 en_col37 d22_col37 0 nenh w=4u l=.4u
mp1col37 d11_col37 enb_col37 d1_col37 3.3 penh w=8u l=0.4u
mp2col37 d22_col37 enb_col37 d2_col37 3.3 penh w=8u l=0.4u

r_en_col37 en_col37 0 10000k
r1_en_col37 en_col37 en1_col37 5
r_enb_col37 enb_col37 0 10000k
r1_enb_col37 enb_col37 enb1_col37 5

r_d11_col37 d11_col37 0 10000k
r1_d11_col37 d11_col37 d111_col37 5
r_d22_col37 d22_col37 0 10000k
r1_d22_col37 d22_col37 d222_col37 5

r_SL1col37 SL1col37 0 10000k
r1_SL1col37 SL1col37 SL11col37 5
r_SL2col37 SL2col37 0 10000k
r1_SL2col37 SL2col37 SL22col37 5

* col38

mn1col38 d1_col38 en_col38 d11_col38 0 nenh w=4u l=.4u
mn2col38 d2_col38 en_col38 d22_col38 0 nenh w=4u l=.4u
mp1col38 d11_col38 enb_col38 d1_col38 3.3 penh w=8u l=0.4u
mp2col38 d22_col38 enb_col38 d2_col38 3.3 penh w=8u l=0.4u

r_en_col38 en_col38 0 10000k
r1_en_col38 en_col38 en1_col38 5
r_enb_col38 enb_col38 0 10000k
r1_enb_col38 enb_col38 enb1_col38 5

r_d11_col38 d11_col38 0 10000k
r1_d11_col38 d11_col38 d111_col38 5
r_d22_col38 d22_col38 0 10000k
r1_d22_col38 d22_col38 d222_col38 5

r_SL1col38 SL1col38 0 10000k
r1_SL1col38 SL1col38 SL11col38 5
r_SL2col38 SL2col38 0 10000k
r1_SL2col38 SL2col38 SL22col38 5

* col39

mn1col39 d1_col39 en_col39 d11_col39 0 nenh w=4u l=.4u
mn2col39 d2_col39 en_col39 d22_col39 0 nenh w=4u l=.4u
mp1col39 d11_col39 enb_col39 d1_col39 3.3 penh w=8u l=0.4u
mp2col39 d22_col39 enb_col39 d2_col39 3.3 penh w=8u l=0.4u

r_en_col39 en_col39 0 10000k
r1_en_col39 en_col39 en1_col39 5
r_enb_col39 enb_col39 0 10000k
r1_enb_col39 enb_col39 enb1_col39 5

r_d11_col39 d11_col39 0 10000k
r1_d11_col39 d11_col39 d111_col39 5
r_d22_col39 d22_col39 0 10000k
r1_d22_col39 d22_col39 d222_col39 5

r_SL1col39 SL1col39 0 10000k
r1_SL1col39 SL1col39 SL11col39 5
r_SL2col39 SL2col39 0 10000k
r1_SL2col39 SL2col39 SL22col39 5

* col40

mn1col40 d1_col40 en_col40 d11_col40 0 nenh w=4u l=.4u
mn2col40 d2_col40 en_col40 d22_col40 0 nenh w=4u l=.4u
mp1col40 d11_col40 enb_col40 d1_col40 3.3 penh w=8u l=0.4u
mp2col40 d22_col40 enb_col40 d2_col40 3.3 penh w=8u l=0.4u

r_en_col40 en_col40 0 10000k
r1_en_col40 en_col40 en1_col40 5
r_enb_col40 enb_col40 0 10000k
r1_enb_col40 enb_col40 enb1_col40 5

r_d11_col40 d11_col40 0 10000k
r1_d11_col40 d11_col40 d111_col40 5
r_d22_col40 d22_col40 0 10000k
r1_d22_col40 d22_col40 d222_col40 5

r_SL1col40 SL1col40 0 10000k
r1_SL1col40 SL1col40 SL11col40 5
r_SL2col40 SL2col40 0 10000k
r1_SL2col40 SL2col40 SL22col40 5

* col41

mn1col41 d1_col41 en_col41 d11_col41 0 nenh w=4u l=.4u
mn2col41 d2_col41 en_col41 d22_col41 0 nenh w=4u l=.4u

mp1col41 d11_col41 enb_col41 d1_col41 3.3 penh w=8u l=0.4u
mp2col41 d22_col41 enb_col41 d2_col41 3.3 penh w=8u l=0.4u

r_en_col41 en_col41 0 10000k
r1_en_col41 en_col41 en1_col41 5
r_enb_col41 enb_col41 0 10000k
r1_enb_col41 enb_col41 enb1_col41 5

r_d11_col41 d11_col41 0 10000k
r1_d11_col41 d11_col41 d111_col41 5
r_d22_col41 d22_col41 0 10000k
r1_d22_col41 d22_col41 d222_col41 5

r_SL1col41 SL1col41 0 10000k
r1_SL1col41 SL1col41 SL11col41 5
r_SL2col41 SL2col41 0 10000k
r1_SL2col41 SL2col41 SL22col41 5

* col42

mn1col42 d1_col42 en_col42 d11_col42 0 nenh w=4u l=.4u
mn2col42 d2_col42 en_col42 d22_col42 0 nenh w=4u l=.4u
mp1col42 d11_col42 enb_col42 d1_col42 3.3 penh w=8u l=0.4u
mp2col42 d22_col42 enb_col42 d2_col42 3.3 penh w=8u l=0.4u

r_en_col42 en_col42 0 10000k
r1_en_col42 en_col42 en1_col42 5
r_enb_col42 enb_col42 0 10000k
r1_enb_col42 enb_col42 enb1_col42 5

r_d11_col42 d11_col42 0 10000k
r1_d11_col42 d11_col42 d111_col42 5
r_d22_col42 d22_col42 0 10000k
r1_d22_col42 d22_col42 d222_col42 5

r_SL1col42 SL1col42 0 10000k
r1_SL1col42 SL1col42 SL11col42 5
r_SL2col42 SL2col42 0 10000k
r1_SL2col42 SL2col42 SL22col42 5

* col43

mn1col43 d1_col43 en_col43 d11_col43 0 nenh w=4u l=.4u
mn2col43 d2_col43 en_col43 d22_col43 0 nenh w=4u l=.4u
mp1col43 d11_col43 enb_col43 d1_col43 3.3 penh w=8u l=0.4u
mp2col43 d22_col43 enb_col43 d2_col43 3.3 penh w=8u l=0.4u

r_en_col43 en_col43 0 10000k
r1_en_col43 en_col43 en1_col43 5
r_enb_col43 enb_col43 0 10000k
r1_enb_col43 enb_col43 enb1_col43 5

r_d11_col43 d11_col43 0 10000k
r1_d11_col43 d11_col43 d111_col43 5
r_d22_col43 d22_col43 0 10000k
r1_d22_col43 d22_col43 d222_col43 5

r_SL1col43 SL1col43 0 10000k
r1_SL1col43 SL1col43 SL11col43 5
r_SL2col43 SL2col43 0 10000k
r1_SL2col43 SL2col43 SL22col43 5

* col44

mn1col44 d1_col44 en_col44 d11_col44 0 nenh w=4u l=.4u

mn2col44 d2_col44 en_col44 d22_col44 0 nenh w=4u l=.4u
mp1col44 d11_col44 enb_col44 d1_col44 3.3 penh w=8u l=0.4u
mp2col44 d22_col44 enb_col44 d2_col44 3.3 penh w=8u l=0.4u

r_en_col44 en_col44 0 10000k
r1_en_col44 en_col44 en1_col44 5
r_enb_col44 enb_col44 0 10000k
r1_enb_col44 enb_col44 enb1_col44 5

r_d11_col44 d11_col44 0 10000k
r1_d11_col44 d11_col44 d111_col44 5
r_d22_col44 d22_col44 0 10000k
r1_d22_col44 d22_col44 d222_col44 5

r_SL1col44 SL1col44 0 10000k
r1_SL1col44 SL1col44 SL11col44 5
r_SL2col44 SL2col44 0 10000k
r1_SL2col44 SL2col44 SL22col44 5

* col45

mn1col45 d1_col45 en_col45 d11_col45 0 nenh w=4u l=.4u
mn2col45 d2_col45 en_col45 d22_col45 0 nenh w=4u l=.4u
mp1col45 d11_col45 enb_col45 d1_col45 3.3 penh w=8u l=0.4u
mp2col45 d22_col45 enb_col45 d2_col45 3.3 penh w=8u l=0.4u

r_en_col45 en_col45 0 10000k
r1_en_col45 en_col45 en1_col45 5
r_enb_col45 enb_col45 0 10000k
r1_enb_col45 enb_col45 enb1_col45 5

r_d11_col45 d11_col45 0 10000k
r1_d11_col45 d11_col45 d111_col45 5
r_d22_col45 d22_col45 0 10000k
r1_d22_col45 d22_col45 d222_col45 5

r_SL1col45 SL1col45 0 10000k
r1_SL1col45 SL1col45 SL11col45 5
r_SL2col45 SL2col45 0 10000k
r1_SL2col45 SL2col45 SL22col45 5

* col46

mn1col46 d1_col46 en_col46 d11_col46 0 nenh w=4u l=.4u
mn2col46 d2_col46 en_col46 d22_col46 0 nenh w=4u l=.4u
mp1col46 d11_col46 enb_col46 d1_col46 3.3 penh w=8u l=0.4u
mp2col46 d22_col46 enb_col46 d2_col46 3.3 penh w=8u l=0.4u

r_en_col46 en_col46 0 10000k
r1_en_col46 en_col46 en1_col46 5
r_enb_col46 enb_col46 0 10000k
r1_enb_col46 enb_col46 enb1_col46 5

r_d11_col46 d11_col46 0 10000k
r1_d11_col46 d11_col46 d111_col46 5
r_d22_col46 d22_col46 0 10000k
r1_d22_col46 d22_col46 d222_col46 5

r_SL1col46 SL1col46 0 10000k
r1_SL1col46 SL1col46 SL11col46 5
r_SL2col46 SL2col46 0 10000k
r1_SL2col46 SL2col46 SL22col46 5

* col47

mn1col47 d1_col47 en_col47 d11_col47 0 nenh w=4u l=.4u
mn2col47 d2_col47 en_col47 d22_col47 0 nenh w=4u l=.4u
mp1col47 d11_col47 enb_col47 d1_col47 3.3 penh w=8u l=0.4u
mp2col47 d22_col47 enb_col47 d2_col47 3.3 penh w=8u l=0.4u

r_en_col47 en_col47 0 10000k
r1_en_col47 en_col47 en1_col47 5
r_enb_col47 enb_col47 0 10000k
r1_enb_col47 enb_col47 enb1_col47 5

r_d11_col47 d11_col47 0 10000k
r1_d11_col47 d11_col47 d111_col47 5
r_d22_col47 d22_col47 0 10000k
r1_d22_col47 d22_col47 d222_col47 5

r_SL1col47 SL1col47 0 10000k
r1_SL1col47 SL1col47 SL11col47 5
r_SL2col47 SL2col47 0 10000k
r1_SL2col47 SL2col47 SL22col47 5

* col48

mn1col48 d1_col48 en_col48 d11_col48 0 nenh w=4u l=.4u
mn2col48 d2_col48 en_col48 d22_col48 0 nenh w=4u l=.4u
mp1col48 d11_col48 enb_col48 d1_col48 3.3 penh w=8u l=0.4u
mp2col48 d22_col48 enb_col48 d2_col48 3.3 penh w=8u l=0.4u

r_en_col48 en_col48 0 10000k
r1_en_col48 en_col48 en1_col48 5
r_enb_col48 enb_col48 0 10000k
r1_enb_col48 enb_col48 enb1_col48 5

r_d11_col48 d11_col48 0 10000k
r1_d11_col48 d11_col48 d111_col48 5
r_d22_col48 d22_col48 0 10000k
r1_d22_col48 d22_col48 d222_col48 5

r_SL1col48 SL1col48 0 10000k
r1_SL1col48 SL1col48 SL11col48 5
r_SL2col48 SL2col48 0 10000k
r1_SL2col48 SL2col48 SL22col48 5

* col49

mn1col49 d1_col49 en_col49 d11_col49 0 nenh w=4u l=.4u
mn2col49 d2_col49 en_col49 d22_col49 0 nenh w=4u l=.4u
mp1col49 d11_col49 enb_col49 d1_col49 3.3 penh w=8u l=0.4u
mp2col49 d22_col49 enb_col49 d2_col49 3.3 penh w=8u l=0.4u

r_en_col49 en_col49 0 10000k
r1_en_col49 en_col49 en1_col49 5
r_enb_col49 enb_col49 0 10000k
r1_enb_col49 enb_col49 enb1_col49 5

r_d11_col49 d11_col49 0 10000k
r1_d11_col49 d11_col49 d111_col49 5
r_d22_col49 d22_col49 0 10000k
r1_d22_col49 d22_col49 d222_col49 5

r_SL1col49 SL1col49 0 10000k
r1_SL1col49 SL1col49 SL11col49 5
r_SL2col49 SL2col49 0 10000k
r1_SL2col49 SL2col49 SL22col49 5

* col50

mn1col50 d1_col50 en_col50 d11_col50 0 nenh w=4u l=.4u
mn2col50 d2_col50 en_col50 d22_col50 0 nenh w=4u l=.4u
mp1col50 d11_col50 enb_col50 d1_col50 3.3 penh w=8u l=0.4u
mp2col50 d22_col50 enb_col50 d2_col50 3.3 penh w=8u l=0.4u

r_en_col50 en_col50 0 10000k
r1_en_col50 en_col50 en1_col50 5
r_enb_col50 enb_col50 0 10000k
r1_enb_col50 enb_col50 enb1_col50 5

r_d11_col50 d11_col50 0 10000k
r1_d11_col50 d11_col50 d111_col50 5
r_d22_col50 d22_col50 0 10000k
r1_d22_col50 d22_col50 d222_col50 5

r_SL1col50 SL1col50 0 10000k
r1_SL1col50 SL1col50 SL11col50 5
r_SL2col50 SL2col50 0 10000k
r1_SL2col50 SL2col50 SL22col50 5

* col51

mn1col51 d1_col51 en_col51 d11_col51 0 nenh w=4u l=.4u
mn2col51 d2_col51 en_col51 d22_col51 0 nenh w=4u l=.4u
mp1col51 d11_col51 enb_col51 d1_col51 3.3 penh w=8u l=0.4u
mp2col51 d22_col51 enb_col51 d2_col51 3.3 penh w=8u l=0.4u

r_en_col51 en_col51 0 10000k
r1_en_col51 en_col51 en1_col51 5
r_enb_col51 enb_col51 0 10000k
r1_enb_col51 enb_col51 enb1_col51 5

r_d11_col51 d11_col51 0 10000k
r1_d11_col51 d11_col51 d111_col51 5
r_d22_col51 d22_col51 0 10000k
r1_d22_col51 d22_col51 d222_col51 5

r_SL1col51 SL1col51 0 10000k
r1_SL1col51 SL1col51 SL11col51 5
r_SL2col51 SL2col51 0 10000k
r1_SL2col51 SL2col51 SL22col51 5

* col52

mn1col52 d1_col52 en_col52 d11_col52 0 nenh w=4u l=.4u
mn2col52 d2_col52 en_col52 d22_col52 0 nenh w=4u l=.4u
mp1col52 d11_col52 enb_col52 d1_col52 3.3 penh w=8u l=0.4u
mp2col52 d22_col52 enb_col52 d2_col52 3.3 penh w=8u l=0.4u

r_en_col52 en_col52 0 10000k
r1_en_col52 en_col52 en1_col52 5
r_enb_col52 enb_col52 0 10000k
r1_enb_col52 enb_col52 enb1_col52 5

r_d11_col52 d11_col52 0 10000k
r1_d11_col52 d11_col52 d111_col52 5
r_d22_col52 d22_col52 0 10000k
r1_d22_col52 d22_col52 d222_col52 5

r_SL1col52 SL1col52 0 10000k
r1_SL1col52 SL1col52 SL11col52 5

r_SL2col52 SL2col52 0 10000k
r1_SL2col52 SL2col52 SL22col52 5

* col53

mn1col53 d1_col53 en_col53 d11_col53 0 nenh w=4u l=.4u
mn2col53 d2_col53 en_col53 d22_col53 0 nenh w=4u l=.4u
mp1col53 d11_col53 enb_col53 d1_col53 3.3 penh w=8u l=0.4u
mp2col53 d22_col53 enb_col53 d2_col53 3.3 penh w=8u l=0.4u

r_en_col53 en_col53 0 10000k
r1_en_col53 en_col53 en1_col53 5
r_enb_col53 enb_col53 0 10000k
r1_enb_col53 enb_col53 enb1_col53 5

r_d11_col53 d11_col53 0 10000k
r1_d11_col53 d11_col53 d111_col53 5
r_d22_col53 d22_col53 0 10000k
r1_d22_col53 d22_col53 d222_col53 5

r_SL1col53 SL1col53 0 10000k
r1_SL1col53 SL1col53 SL11col53 5
r_SL2col53 SL2col53 0 10000k
r1_SL2col53 SL2col53 SL22col53 5

* col54

mn1col54 d1_col54 en_col54 d11_col54 0 nenh w=4u l=.4u
mn2col54 d2_col54 en_col54 d22_col54 0 nenh w=4u l=.4u
mp1col54 d11_col54 enb_col54 d1_col54 3.3 penh w=8u l=0.4u
mp2col54 d22_col54 enb_col54 d2_col54 3.3 penh w=8u l=0.4u

r_en_col54 en_col54 0 10000k
r1_en_col54 en_col54 en1_col54 5
r_enb_col54 enb_col54 0 10000k
r1_enb_col54 enb_col54 enb1_col54 5

r_d11_col54 d11_col54 0 10000k
r1_d11_col54 d11_col54 d111_col54 5
r_d22_col54 d22_col54 0 10000k
r1_d22_col54 d22_col54 d222_col54 5

r_SL1col54 SL1col54 0 10000k
r1_SL1col54 SL1col54 SL11col54 5
r_SL2col54 SL2col54 0 10000k
r1_SL2col54 SL2col54 SL22col54 5

* col55

mn1col55 d1_col55 en_col55 d11_col55 0 nenh w=4u l=.4u
mn2col55 d2_col55 en_col55 d22_col55 0 nenh w=4u l=.4u
mp1col55 d11_col55 enb_col55 d1_col55 3.3 penh w=8u l=0.4u
mp2col55 d22_col55 enb_col55 d2_col55 3.3 penh w=8u l=0.4u

r_en_col55 en_col55 0 10000k
r1_en_col55 en_col55 en1_col55 5
r_enb_col55 enb_col55 0 10000k
r1_enb_col55 enb_col55 enb1_col55 5

r_d11_col55 d11_col55 0 10000k
r1_d11_col55 d11_col55 d111_col55 5
r_d22_col55 d22_col55 0 10000k
r1_d22_col55 d22_col55 d222_col55 5

r_SL1col55 SL1col55 0 10000k
r1_SL1col55 SL1col55 SL11col55 5
r_SL2col55 SL2col55 0 10000k
r1_SL2col55 SL2col55 SL22col55 5

* col56

mn1col56 d1_col56 en_col56 d11_col56 0 nenh w=4u l=.4u
mn2col56 d2_col56 en_col56 d22_col56 0 nenh w=4u l=.4u
mp1col56 d11_col56 enb_col56 d1_col56 3.3 penh w=8u l=0.4u
mp2col56 d22_col56 enb_col56 d2_col56 3.3 penh w=8u l=0.4u

r_en_col56 en_col56 0 10000k
r1_en_col56 en_col56 en1_col56 5
r_enb_col56 enb_col56 0 10000k
r1_enb_col56 enb_col56 enb1_col56 5

r_d11_col56 d11_col56 0 10000k
r1_d11_col56 d11_col56 d111_col56 5
r_d22_col56 d22_col56 0 10000k
r1_d22_col56 d22_col56 d222_col56 5

r_SL1col56 SL1col56 0 10000k
r1_SL1col56 SL1col56 SL11col56 5
r_SL2col56 SL2col56 0 10000k
r1_SL2col56 SL2col56 SL22col56 5

* col57

mn1col57 d1_col57 en_col57 d11_col57 0 nenh w=4u l=.4u
mn2col57 d2_col57 en_col57 d22_col57 0 nenh w=4u l=.4u
mp1col57 d11_col57 enb_col57 d1_col57 3.3 penh w=8u l=0.4u
mp2col57 d22_col57 enb_col57 d2_col57 3.3 penh w=8u l=0.4u

r_en_col57 en_col57 0 10000k
r1_en_col57 en_col57 en1_col57 5
r_enb_col57 enb_col57 0 10000k
r1_enb_col57 enb_col57 enb1_col57 5

r_d11_col57 d11_col57 0 10000k
r1_d11_col57 d11_col57 d111_col57 5
r_d22_col57 d22_col57 0 10000k
r1_d22_col57 d22_col57 d222_col57 5

r_SL1col57 SL1col57 0 10000k
r1_SL1col57 SL1col57 SL11col57 5
r_SL2col57 SL2col57 0 10000k
r1_SL2col57 SL2col57 SL22col57 5

* col58

mn1col58 d1_col58 en_col58 d11_col58 0 nenh w=4u l=.4u
mn2col58 d2_col58 en_col58 d22_col58 0 nenh w=4u l=.4u
mp1col58 d11_col58 enb_col58 d1_col58 3.3 penh w=8u l=0.4u
mp2col58 d22_col58 enb_col58 d2_col58 3.3 penh w=8u l=0.4u

r_en_col58 en_col58 0 10000k
r1_en_col58 en_col58 en1_col58 5
r_enb_col58 enb_col58 0 10000k
r1_enb_col58 enb_col58 enb1_col58 5

r_d11_col58 d11_col58 0 10000k
r1_d11_col58 d11_col58 d111_col58 5
r_d22_col58 d22_col58 0 10000k

r1_d22_col58 d22_col58 d222_col58 5

r_SL1col58 SL1col58 0 10000k
r1_SL1col58 SL1col58 SL11col58 5
r_SL2col58 SL2col58 0 10000k
r1_SL2col58 SL2col58 SL22col58 5

* col59

mn1col59 d1_col59 en_col59 d11_col59 0 nenh w=4u l=.4u
mn2col59 d2_col59 en_col59 d22_col59 0 nenh w=4u l=.4u
mp1col59 d11_col59 enb_col59 d1_col59 3.3 penh w=8u l=0.4u
mp2col59 d22_col59 enb_col59 d2_col59 3.3 penh w=8u l=0.4u

r_en_col59 en_col59 0 10000k
r1_en_col59 en_col59 en1_col59 5
r_enb_col59 enb_col59 0 10000k
r1_enb_col59 enb_col59 enb1_col59 5

r_d11_col59 d11_col59 0 10000k
r1_d11_col59 d11_col59 d111_col59 5
r_d22_col59 d22_col59 0 10000k
r1_d22_col59 d22_col59 d222_col59 5

r_SL1col59 SL1col59 0 10000k
r1_SL1col59 SL1col59 SL11col59 5
r_SL2col59 SL2col59 0 10000k
r1_SL2col59 SL2col59 SL22col59 5

* col60

mn1col60 d1_col60 en_col60 d11_col60 0 nenh w=4u l=.4u
mn2col60 d2_col60 en_col60 d22_col60 0 nenh w=4u l=.4u
mp1col60 d11_col60 enb_col60 d1_col60 3.3 penh w=8u l=0.4u
mp2col60 d22_col60 enb_col60 d2_col60 3.3 penh w=8u l=0.4u

r_en_col60 en_col60 0 10000k
r1_en_col60 en_col60 en1_col60 5
r_enb_col60 enb_col60 0 10000k
r1_enb_col60 enb_col60 enb1_col60 5

r_d11_col60 d11_col60 0 10000k
r1_d11_col60 d11_col60 d111_col60 5
r_d22_col60 d22_col60 0 10000k
r1_d22_col60 d22_col60 d222_col60 5

r_SL1col60 SL1col60 0 10000k
r1_SL1col60 SL1col60 SL11col60 5
r_SL2col60 SL2col60 0 10000k
r1_SL2col60 SL2col60 SL22col60 5

* col61

mn1col61 d1_col61 en_col61 d11_col61 0 nenh w=4u l=.4u
mn2col61 d2_col61 en_col61 d22_col61 0 nenh w=4u l=.4u
mp1col61 d11_col61 enb_col61 d1_col61 3.3 penh w=8u l=0.4u
mp2col61 d22_col61 enb_col61 d2_col61 3.3 penh w=8u l=0.4u

r_en_col61 en_col61 0 10000k
r1_en_col61 en_col61 en1_col61 5
r_enb_col61 enb_col61 0 10000k
r1_enb_col61 enb_col61 enb1_col61 5

r_d11_col61 d11_col61 0 10000k

r1_d11_col61 d11_col61 d111_col61 5
r_d22_col61 d22_col61 0 10000k
r1_d22_col61 d22_col61 d222_col61 5

r_SL1col61 SL1col61 0 10000k
r1_SL1col61 SL1col61 SL11col61 5
r_SL2col61 SL2col61 0 10000k
r1_SL2col61 SL2col61 SL22col61 5

* col62

mn1col62 d1_col62 en_col62 d11_col62 0 nenh w=4u l=.4u
mn2col62 d2_col62 en_col62 d22_col62 0 nenh w=4u l=.4u
mp1col62 d11_col62 enb_col62 d1_col62 3.3 penh w=8u l=0.4u
mp2col62 d22_col62 enb_col62 d2_col62 3.3 penh w=8u l=0.4u

r_en_col62 en_col62 0 10000k
r1_en_col62 en_col62 en1_col62 5
r_enb_col62 enb_col62 0 10000k
r1_enb_col62 enb_col62 enb1_col62 5

r_d11_col62 d11_col62 0 10000k
r1_d11_col62 d11_col62 d111_col62 5
r_d22_col62 d22_col62 0 10000k
r1_d22_col62 d22_col62 d222_col62 5

r_SL1col62 SL1col62 0 10000k
r1_SL1col62 SL1col62 SL11col62 5
r_SL2col62 SL2col62 0 10000k
r1_SL2col62 SL2col62 SL22col62 5

* col63

mn1col63 d1_col63 en_col63 d11_col63 0 nenh w=4u l=.4u
mn2col63 d2_col63 en_col63 d22_col63 0 nenh w=4u l=.4u
mp1col63 d11_col63 enb_col63 d1_col63 3.3 penh w=8u l=0.4u
mp2col63 d22_col63 enb_col63 d2_col63 3.3 penh w=8u l=0.4u

r_en_col63 en_col63 0 10000k
r1_en_col63 en_col63 en1_col63 5
r_enb_col63 enb_col63 0 10000k
r1_enb_col63 enb_col63 enb1_col63 5

r_d11_col63 d11_col63 0 10000k
r1_d11_col63 d11_col63 d111_col63 5
r_d22_col63 d22_col63 0 10000k
r1_d22_col63 d22_col63 d222_col63 5

r_SL1col63 SL1col63 0 10000k
r1_SL1col63 SL1col63 SL11col63 5
r_SL2col63 SL2col63 0 10000k
r1_SL2col63 SL2col63 SL22col63 5

.....
sources_array64bit_SelectiveCharging.cir
.....

* power supply *

v_dd u 0 dc 3.3
v_dd_2 u2 0 dc 1.65
v_dd2 l 0 pulse(0 1.65 1n 0.25n 0.25n 1.5n 20n)


```
*****
*           row enable           *
*****
```

```
v_en_row0 en1_row0 0 dc 3.3
v_enb_row0 enb1_row0 0 dc 0
```

```
*****
*           column enable        *
*****
```

```
v_en_col0 en1_col0 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col0 enb1_col0 0 pulse(3.3 0 1n 1p 1p 2n 20n)
```

```
v_en_col1 en1_col1 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col1 enb1_col1 0 pulse(3.3 0 1n 1p 1p 2n 20n)
```

```
v_en_col2 en1_col2 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col2 enb1_col2 0 pulse(3.3 0 1n 1p 1p 2n 20n)
```

```
v_en_col3 en1_col3 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col3 enb1_col3 0 pulse(3.3 0 1n 1p 1p 2n 20n)
```

```
v_en_col4 en1_col4 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col4 enb1_col4 0 pulse(3.3 0 1n 1p 1p 2n 20n)
```

```
v_en_col5 en1_col5 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col5 enb1_col5 0 pulse(3.3 0 1n 1p 1p 2n 20n)
```

```
v_en_col6 en1_col6 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col6 enb1_col6 0 pulse(3.3 0 1n 1p 1p 2n 20n)
```

```
v_en_col7 en1_col7 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col7 enb1_col7 0 pulse(3.3 0 1n 1p 1p 2n 20n)
```

```
v_en_col8 en1_col8 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col8 enb1_col8 0 pulse(3.3 0 1n 1p 1p 2n 20n)
```

```
v_en_col9 en1_col9 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col9 enb1_col9 0 pulse(3.3 0 1n 1p 1p 2n 20n)
```

```
v_en_col10 en1_col10 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col10 enb1_col10 0 pulse(3.3 0 1n 1p 1p 2n 20n)
```

```
v_en_col11 en1_col11 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col11 enb1_col11 0 pulse(3.3 0 1n 1p 1p 2n 20n)
```

```
v_en_col12 en1_col12 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col12 enb1_col12 0 pulse(3.3 0 1n 1p 1p 2n 20n)
```

```
v_en_col13 en1_col13 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col13 enb1_col13 0 pulse(3.3 0 1n 1p 1p 2n 20n)
```

```
v_en_col14 en1_col14 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col14 enb1_col14 0 pulse(3.3 0 1n 1p 1p 2n 20n)
```

v_en_col15 en1_col15 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col15 enb1_col15 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col16 en1_col16 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col16 enb1_col16 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col17 en1_col17 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col17 enb1_col17 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col18 en1_col18 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col18 enb1_col18 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col19 en1_col19 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col19 enb1_col19 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col20 en1_col20 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col20 enb1_col20 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col21 en1_col21 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col21 enb1_col21 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col22 en1_col22 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col22 enb1_col22 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col23 en1_col23 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col23 enb1_col23 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col24 en1_col24 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col24 enb1_col24 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col25 en1_col25 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col25 enb1_col25 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col26 en1_col26 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col26 enb1_col26 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col27 en1_col27 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col27 enb1_col27 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col28 en1_col28 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col28 enb1_col28 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col29 en1_col29 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col29 enb1_col29 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col30 en1_col30 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col30 enb1_col30 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col31 en1_col31 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col31 enb1_col31 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col32 en1_col32 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col32 enb1_col32 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col33 en1_col33 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col33 enb1_col33 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col34 en1_col34 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col34 enb1_col34 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col35 en1_col35 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col35 enb1_col35 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col36 en1_col36 0 pulse(0 3.3 1n 1p 1p 2n 20n)

v_enb_col36 enb1_col36 0 pulse(3.3 0 1n 1p 1p 2n 20n)
v_en_col37 en1_col37 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col37 enb1_col37 0 pulse(3.3 0 1n 1p 1p 2n 20n)
v_en_col38 en1_col38 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col38 enb1_col38 0 pulse(3.3 0 1n 1p 1p 2n 20n)
v_en_col39 en1_col39 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col39 enb1_col39 0 pulse(3.3 0 1n 1p 1p 2n 20n)
v_en_col40 en1_col40 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col40 enb1_col40 0 pulse(3.3 0 1n 1p 1p 2n 20n)
v_en_col41 en1_col41 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col41 enb1_col41 0 pulse(3.3 0 1n 1p 1p 2n 20n)
v_en_col42 en1_col42 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col42 enb1_col42 0 pulse(3.3 0 1n 1p 1p 2n 20n)
v_en_col43 en1_col43 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col43 enb1_col43 0 pulse(3.3 0 1n 1p 1p 2n 20n)
v_en_col44 en1_col44 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col44 enb1_col44 0 pulse(3.3 0 1n 1p 1p 2n 20n)
v_en_col45 en1_col45 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col45 enb1_col45 0 pulse(3.3 0 1n 1p 1p 2n 20n)
v_en_col46 en1_col46 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col46 enb1_col46 0 pulse(3.3 0 1n 1p 1p 2n 20n)
v_en_col47 en1_col47 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col47 enb1_col47 0 pulse(3.3 0 1n 1p 1p 2n 20n)
v_en_col48 en1_col48 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col48 enb1_col48 0 pulse(3.3 0 1n 1p 1p 2n 20n)
v_en_col49 en1_col49 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col49 enb1_col49 0 pulse(3.3 0 1n 1p 1p 2n 20n)
v_en_col50 en1_col50 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col50 enb1_col50 0 pulse(3.3 0 1n 1p 1p 2n 20n)
v_en_col51 en1_col51 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col51 enb1_col51 0 pulse(3.3 0 1n 1p 1p 2n 20n)
v_en_col52 en1_col52 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col52 enb1_col52 0 pulse(3.3 0 1n 1p 1p 2n 20n)
v_en_col53 en1_col53 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col53 enb1_col53 0 pulse(3.3 0 1n 1p 1p 2n 20n)
v_en_col54 en1_col54 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col54 enb1_col54 0 pulse(3.3 0 1n 1p 1p 2n 20n)
v_en_col55 en1_col55 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col55 enb1_col55 0 pulse(3.3 0 1n 1p 1p 2n 20n)
v_en_col56 en1_col56 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col56 enb1_col56 0 pulse(3.3 0 1n 1p 1p 2n 20n)
v_en_col57 en1_col57 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col57 enb1_col57 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col58 en1_col58 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col58 enb1_col58 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col59 en1_col59 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col59 enb1_col59 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col60 en1_col60 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col60 enb1_col60 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col61 en1_col61 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col61 enb1_col61 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col62 en1_col62 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col62 enb1_col62 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col63 en1_col63 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col63 enb1_col63 0 pulse(3.3 0 1n 1p 1p 2n 20n)

* data lines *

v_d1col0 d111_col0 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22n 3.3 22.5n 0 23n 0 41n 0 41.5n 3.3 42.5n 3.3 43n 0
+61n 0 61.5n 3.3 62n 3.3 62.5n 0 63n 0 81n 0 81.5n 3.3 82.5n 3.3 83n 0)
v_d2col0 d222_col0 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22.5n 3.3 23n 0 41n 0 41.5n 3.3 42n 3.3 42.5n 0 43n 0
+61n 0 61.5n 3.3 62.5n 3.3 63n 0 81n 0 81.5n 3.3 82n 3.3 82.5n 0 83n 0)

v_d1col1 d111_col1 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22.5n 3.3 23n 0 41n 0 41.5n 3.3 42n 3.3 42.5n 0 43n 0
+61n 0 61.5n 3.3 62.5n 3.3 63n 0 81n 0 81.5n 3.3 82n 3.3 82.5n 0 83n 0)
v_d2col1 d222_col1 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22n 3.3 22.5n 0 23n 0 41n 0 41.5n 3.3 42.5n 3.3 43n 0
+61n 0 61.5n 3.3 62n 3.3 62.5n 0 63n 0 81n 0 81.5n 3.3 82.5n 3.3 83n 0)

v_d1col2 d111_col2 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22.5n 3.3 23n 0 41n 0 41.5n 3.3 42n 3.3 42.5n 0 43n 0
+61n 0 61.5n 3.3 62.5n 3.3 63n 0 81n 0 81.5n 3.3 82n 3.3 82.5n 0 83n 0)
v_d2col2 d222_col2 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22n 3.3 22.5n 0 23n 0 41n 0 41.5n 3.3 42.5n 3.3 43n 0
+61n 0 61.5n 3.3 62n 3.3 62.5n 0 63n 0 81n 0 81.5n 3.3 82.5n 3.3 83n 0)

v_d1col3 d111_col3 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22n 3.3 22.5n 0 23n 0 41n 0 41.5n 3.3 42.5n 3.3 43n 0
+61n 0 61.5n 3.3 62n 3.3 62.5n 0 63n 0 81n 0 81.5n 3.3 82.5n 3.3 83n 0)
v_d2col3 d222_col3 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22.5n 3.3 23n 0 41n 0 41.5n 3.3 42n 3.3 42.5n 0 43n 0
+61n 0 61.5n 3.3 62.5n 3.3 63n 0 81n 0 81.5n 3.3 82.0n 3.3 82.5n 0 83n 0)

v_d1col4 d111_col4 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22.5n 3.3 23n 0 41n 0 41.5n 3.3 42n 3.3 42.5n 0 43n 0
+61n 0 61.5n 3.3 62.5n 3.3 63n 0 81n 0 81.5n 3.3 82n 3.3 82.5n 0 83n 0)
v_d2col4 d222_col4 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22n 3.3 22.5n 0 23n 0 41n 0 41.5n 3.3 42.5n 3.3 43n 0
+61n 0 61.5n 3.3 62n 3.3 62.5n 0 63n 0 81n 0 81.5n 3.3 82.5n 3.3 83n 0)

v_d1col5 d111_col5 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22.5n 3.3 23n 0 41n 0 41.5n 3.3 42n 3.3 42.5n 0 43n 0
+61n 0 61.5n 3.3 62.5n 3.3 63n 0 81n 0 81.5n 3.3 82.0n 3.3 82.5n 0 83n 0)
v_d2col5 d222_col5 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22n 3.3 22.5n 0 23n 0 41n 0 41.5n 3.3 42.5n 3.3 43n 0
+61n 0 61.5n 3.3 62n 3.3 62.5n 0 63n 0 81n 0 81.5n 3.3 82.5n 3.3 83n 0)

v_d1col6 d111_col6 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22n 3.3 22.5n 0 23n 0 41n 0 41.5n 3.3 42.5n 3.3 43n 0
+61n 0 61.5n 3.3 62n 3.3 62.5n 0 63n 0 81n 0 81.5n 3.3 82.5n 3.3 83n 0)
v_d2col6 d222_col6 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22.5n 3.3 23n 0 41n 0 41.5n 3.3 42n 3.3 42.5n 0 43n 0
+61n 0 61.5n 3.3 62.5n 3.3 63n 0 81n 0 81.5n 3.3 82.0n 3.3 82.5n 0 83n 0)

v_d1col7 d111_col7 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22n 3.3 22.5n 0 23n 0 41n 0 41.5n 3.3 42n 3.3 42.5n 0
+43n 0 61n 0 61.5n 3.3 62.5n 3.3 63n 0 81n 0 81.5n 3.3 82.5n 3.3 83n 0)
v_d2col7 d222_col7 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22.5n 3.3 23n 0 41n 0 41.5n 3.3 42.5n 3.3 43n 0
+61n 0 61.5n 3.3 62n 3.3 62.5n 0 63n 0 81n 0 81.5n 3.3 82n 3.3 82.5n 0 83n 0)
*^^^ 1st cycle = mismatch (1 bit mismatch at row=0 col=7) 2nd cycle = full match

v_d1col8 d111_col8 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22n 3.3 22.5n 0 23n 0 41n 0 41.5n 3.3 42.5n 3.3 43n 0
+61n 0 61.5n 3.3 62n 3.3 62.5n 0 63n 0 81n 0 81.5n 3.3 82.5n 3.3 83n 0)
v_d2col8 d222_col8 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22.5n 3.3 23n 0 41n 0 41.5n 3.3 42n 3.3 42.5n 0 43n 0
+61n 0 61.5n 3.3 62.5n 3.3 63n 0 81n 0 81.5n 3.3 82.0n 3.3 82n 3.3 82.5n 0 83n 0)

v_d1col9 d111_col9 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22.5n 3.3 23n 0 41n 0 41.5n 3.3 42n 3.3 42.5n 0 43n 0
+61n 0 61.5n 3.3 62.5n 3.3 63n 0 81n 0 81.5n 3.3 82.0n 3.3 82.5n 0 83n 0)
v_d2col9 d222_col9 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22n 3.3 22.5n 0 23n 0 41n 0 41.5n 3.3 42.5n 3.3 43n 0
+61n 0 61.5n 3.3 62n 3.3 62.5n 0 63n 0 81n 0 81.5n 3.3 82.5n 3.3 83n 0)

v_d1col10 d111_col10 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22.5n 3.3 23n 0 41n 0 41.5n 3.3 42n 3.3 42.5n 0 43n 0
+61n 0 61.5n 3.3 62.5n 3.3 63n 0 81n 0 81.5n 3.3 82.0n 3.3 82.5n 0 83n 0)
v_d2col10 d222_col10 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22n 3.3 22.5n 0 23n 0 41n 0 41.5n 3.3 42.5n 3.3 43n 0
+61n 0 61.5n 3.3 62n 3.3 62.5n 0 63n 0 81n 0 81.5n 3.3 82.5n 3.3 83n 0)

v_d1col11 d111_col11 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22n 3.3 22.5n 0 23n 0 41n 0 41.5n 3.3 42.5n 3.3 43n 0
+61n 0 61.5n 3.3 62n 3.3 62.5n 0 63n 0 81n 0 81.5n 3.3 82.5n 3.3 83n 0)
v_d2col11 d222_col11 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22.5n 3.3 23n 0 41n 0 41.5n 3.3 42n 3.3 42.5n 0 43n 0
+61n 0 61.5n 3.3 62.5n 3.3 63n 0 81n 0 81.5n 3.3 82.0n 3.3 82.5n 0 83n 0)

v_d1col12 d111_col12 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22n 3.3 22.5n 0 23n 0 41n 0 41.5n 3.3 42.5n 3.3 43n 0
+61n 0 61.5n 3.3 62n 3.3 62.5n 0 63n 0 81n 0 81.5n 3.3 82.5n 3.3 83n 0)
v_d2col12 d222_col12 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22.5n 3.3 23n 0 41n 0 41.5n 3.3 42n 3.3 42.5n 0 43n 0
+61n 0 61.5n 3.3 62.5n 3.3 63n 0 81n 0 81.5n 3.3 82.0n 3.3 82.5n 0 83n 0)

v_d1col13 d111_col13 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22n 3.3 22.5n 0 23n 0 41n 0 41.5n 3.3 42.5n 3.3 43n 0
+61n 0 61.5n 3.3 62n 3.3 62.5n 0 63n 0 81n 0 81.5n 3.3 82.5n 3.3 83n 0)
v_d2col13 d222_col13 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22.5n 3.3 23n 0 41n 0 41.5n 3.3 42n 3.3 42.5n 0 43n 0
+61n 0 61.5n 3.3 62.5n 3.3 63n 0 81n 0 81.5n 3.3 82.0n 3.3 82.5n 0 83n 0)

v_d1col14 d111_col14 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22.5n 3.3 23n 0 41n 0 41.5n 3.3 42n 3.3 42.5n 0 43n 0
+61n 0 61.5n 3.3 62.5n 3.3 63n 0 81n 0 81.5n 3.3 82.0n 3.3 82.5n 0 83n 0)
v_d2col14 d222_col14 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22n 3.3 22.5n 0 23n 0 41n 0 41.5n 3.3 42.5n 3.3 43n 0
+61n 0 61.5n 3.3 62n 3.3 62.5n 0 63n 0 81n 0 81.5n 3.3 82.5n 3.3 83n 0)

v_d1col15 d111_col15 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22.5n 3.3 23n 0 41n 0 41.5n 3.3 42n 3.3 42.5n 0 43n 0
+61n 0 61.5n 3.3 62.5n 3.3 63n 0 81n 0 81.5n 3.3 82.0n 3.3 82.5n 0 83n 0)

v_d2col63 d222_col63 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22.5n 3.3 23n 0 41n 0 41.5n 3.3 42n 3.3 42.5n 0 43n 0
+61n 0 61.5n 3.3 62.5n 3.3 63n 0 81n 0 81.5n 3.3 82n 3.3 82.5n 0 83n 0)

* search lines *

v_SL1_col0 SL11col0 0 pwl(0 0 47n 0 47.02n 3.3 48.0n 3.3 48.02n 0 87n 0 87.02n 3.3 88.0n 3.3 88.02n 0)
v_SL2_col0 SL22col0 0 pwl(0 0 27n 0 27.02n 3.3 28.0n 3.3 28.02n 0 67n 0 67.02n 3.3 68.0n 3.3 68.02n 0)

v_SL1_col1 SL11col1 0 pwl(0 0 27n 0 27.02n 3.3 28.0n 3.3 28.02n 0 67n 0 67.02n 3.3 68.0n 3.3 68.02n 0)
v_SL2_col1 SL22col1 0 pwl(0 0 47n 0 47.02n 3.3 48.0n 3.3 48.02n 0 87n 0 87.02n 3.3 88.0n 3.3 88.02n 0)

v_SL1_col2 SL11col2 0 pwl(0 0 27n 0 27.02n 3.3 28.0n 3.3 28.02n 0 67n 0 67.02n 3.3 68.0n 3.3 68.02n 0)
v_SL2_col2 SL22col2 0 pwl(0 0 47n 0 47.02n 3.3 48.0n 3.3 48.02n 0 87n 0 87.02n 3.3 88.0n 3.3 88.02n 0)

v_SL1_col3 SL11col3 0 pwl(0 0 47n 0 47.02n 3.3 48.0n 3.3 48.02n 0 87n 0 87.02n 3.3 88.0n 3.3 88.02n 0)
v_SL2_col3 SL22col3 0 pwl(0 0 27n 0 27.02n 3.3 28.0n 3.3 28.02n 0 67n 0 67.02n 3.3 68.0n 3.3 68.02n 0)

v_SL1_col4 SL11col4 0 pwl(0 0 27n 0 27.02n 3.3 28.0n 3.3 28.02n 0 67n 0 67.02n 3.3 68.0n 3.3 68.02n 0)
v_SL2_col4 SL22col4 0 pwl(0 0 47n 0 47.02n 3.3 48.0n 3.3 48.02n 0 87n 0 87.02n 3.3 88.0n 3.3 88.02n 0)

v_SL1_col5 SL11col5 0 pwl(0 0 27n 0 27.02n 3.3 28.0n 3.3 28.02n 0 67n 0 67.02n 3.3 68.0n 3.3 68.02n 0)
v_SL2_col5 SL22col5 0 pwl(0 0 47n 0 47.02n 3.3 48.0n 3.3 48.02n 0 87n 0 87.02n 3.3 88.0n 3.3 88.02n 0)

v_SL1_col6 SL11col6 0 pwl(0 0 47n 0 47.02n 3.3 48.0n 3.3 48.02n 0 87n 0 87.02n 3.3 88.0n 3.3 88.02n 0)
v_SL2_col6 SL22col6 0 pwl(0 0 27n 0 27.02n 3.3 28.0n 3.3 28.02n 0 67n 0 67.02n 3.3 68.0n 3.3 68.02n 0)

v_SL1_col7 SL11col7 0 pwl(0 0 7n 0 7.02n 3.3 8.5n 3.3 8.52n 0 47n 0 47.02n 3.3 48.0n 3.3 48.02n 0
+107n 0 107.02n 3.3 108.5n 3.3 108.52n 0)
v_SL2_col7 SL22col7 0 pwl(0 0 27n 0 27.02n 3.3 28.0n 3.3 28.02n 0 67n 0 67.02n 3.3 68.0n 3.3 68.02n 0)
*^^^ 1st cycle = mismatch (1 bit mismatch at row=0 col=7) 2nd cycle = full match

v_SL1_col8 SL11col8 0 pwl(0 0 47n 0 47.02n 3.3 48.0n 3.3 48.02n 0 87n 0 87.02n 3.3 88.0n 3.3 88.02n 0)
v_SL2_col8 SL22col8 0 pwl(0 0 27n 0 27.02n 3.3 28.0n 3.3 28.02n 0 67n 0 67.02n 3.3 68.0n 3.3 68.02n 0)

v_SL1_col9 SL11col9 0 pwl(0 0 27n 0 27.02n 3.3 28.0n 3.3 28.02n 0 67n 0 67.02n 3.3 68.0n 3.3 68.02n 0)
v_SL2_col9 SL22col9 0 pwl(0 0 47n 0 47.02n 3.3 48.0n 3.3 48.02n 0 87n 0 87.02n 3.3 88.0n 3.3 88.02n 0)

v_SL1_col10 SL11col10 0 pwl(0 0 27n 0 27.02n 3.3 28.0n 3.3 28.02n 0 67n 0 67.02n 3.3 68.0n 3.3 68.02n 0)
v_SL2_col10 SL22col10 0 pwl(0 0 47n 0 47.02n 3.3 48.0n 3.3 48.02n 0 87n 0 87.02n 3.3 88.0n 3.3 88.02n 0)

v_SL1_col11 SL11col11 0 pwl(0 0 47n 0 47.02n 3.3 48.0n 3.3 48.02n 0 87n 0 87.02n 3.3 88.0n 3.3 88.02n 0)
v_SL2_col11 SL22col11 0 pwl(0 0 27n 0 27.02n 3.3 28.0n 3.3 28.02n 0 67n 0 67.02n 3.3 68.0n 3.3 68.02n 0)

v_SL1_col12 SL11col12 0 pwl(0 0 47n 0 47.02n 3.3 48.0n 3.3 48.02n 0 87n 0 87.02n 3.3 88.0n 3.3 88.02n 0)
v_SL2_col12 SL22col12 0 pwl(0 0 27n 0 27.02n 3.3 28.0n 3.3 28.02n 0 67n 0 67.02n 3.3 68.0n 3.3 68.02n 0)

v_SL1_col13 SL11col13 0 pwl(0 0 47n 0 47.02n 3.3 48.0n 3.3 48.02n 0 87n 0 87.02n 3.3 88.0n 3.3 88.02n 0)
v_SL2_col13 SL22col13 0 pwl(0 0 27n 0 27.02n 3.3 28.0n 3.3 28.02n 0 67n 0 67.02n 3.3 68.0n 3.3 68.02n 0)

v_SL1_col14 SL11col14 0 pwl(0 0 27n 0 27.02n 3.3 28.0n 3.3 28.02n 0 67n 0 67.02n 3.3 68.0n 3.3 68.02n 0)
v_SL2_col14 SL22col14 0 pwl(0 0 47n 0 47.02n 3.3 48.0n 3.3 48.02n 0 87n 0 87.02n 3.3 88.0n 3.3 88.02n 0)

v_SL1_col15 SL11col15 0 pwl(0 0 27n 0 27.02n 3.3 28.0n 3.3 28.02n 0 67n 0 67.02n 3.3 68.0n 3.3 68.02n 0)
v_SL2_col15 SL22col15 0 pwl(0 0 47n 0 47.02n 3.3 48.0n 3.3 48.02n 0 87n 0 87.02n 3.3 88.0n 3.3 88.02n 0)

v_SL1_col16 SL11col16 0 pwl(0 0 47n 0 47.02n 3.3 48.0n 3.3 48.02n 0 87n 0 87.02n 3.3 88.0n 3.3 88.02n 0)
v_SL2_col16 SL22col16 0 pwl(0 0 27n 0 27.02n 3.3 28.0n 3.3 28.02n 0 67n 0 67.02n 3.3 68.0n 3.3 68.02n 0)

v_SL1_col60 SL11col60 0 pwl(0 0 47n 0 47.02n 3.3 48.0n 3.3 48.02n 0 87n 0 87.02n 3.3 88.0n 3.3 88.02n 0)
v_SL2_col60 SL22col60 0 pwl(0 0 27n 0 27.02n 3.3 28.0n 3.3 28.02n 0 67n 0 67.02n 3.3 68.0n 3.3 68.02n 0)

v_SL1_col61 SL11col61 0 pwl(0 0 27n 0 27.02n 3.3 28.0n 3.3 28.02n 0 67n 0 67.02n 3.3 68.0n 3.3 68.02n 0)
v_SL2_col61 SL22col61 0 pwl(0 0 47n 0 47.02n 3.3 48.0n 3.3 48.02n 0 87n 0 87.02n 3.3 88.0n 3.3 88.02n 0)

v_SL1_col62 SL11col62 0 pwl(0 0 27n 0 27.02n 3.3 28.0n 3.3 28.02n 0 67n 0 67.02n 3.3 68.0n 3.3 68.02n 0)
v_SL2_col62 SL22col62 0 pwl(0 0 47n 0 47.02n 3.3 48.0n 3.3 48.02n 0 87n 0 87.02n 3.3 88.0n 3.3 88.02n 0)

v_SL1_col63 SL11col63 0 pwl(0 0 47n 0 47.02n 3.3 48.0n 3.3 48.02n 0 87n 0 87.02n 3.3 88.0n 3.3 88.02n 0)
v_SL2_col63 SL22col63 0 pwl(0 0 27n 0 27.02n 3.3 28.0n 3.3 28.02n 0 67n 0 67.02n 3.3 68.0n 3.3 68.02n 0)

* search enables *

vSErow0 SE1_row0 0 pulse(0 3.3 7n .1n .1n 0.8n 20n)

* pre-charge *

vpre_row01 pre1_row01 0 pulse(3.3 0 7n 0.1n 0.1n 0.8n 20n)
vpre_row02 pre1_row02 0 pulse(3.3 0 7n 0.1n 0.1n 0.8n 20n)
vpre_row03 pre1_row03 0 pulse(3.3 0 7n 0.1n 0.1n 0.8n 20n)
vpre_row04 pre1_row04 0 pulse(3.3 0 7n 0.1n 0.1n 0.8n 20n)

* ML reset *

vML1reset_row0 ML1reset_row0 0 pulse(0 3.3 5n .1n .1n .5n 20n)
vML2reset_row0 ML2reset_row0 0 pulse(0 3.3 5n .1n .1n .5n 20n)
vML3reset_row0 ML3reset_row0 0 pulse(0 3.3 5n .1n .1n .5n 20n)
vML4reset_row0 ML4reset_row0 0 pulse(0 3.3 5n .1n .1n .5n 20n)

.....
cells_array64bit_SelectiveCharging.cir
.....

xtcam_cell_0_0 d1_col0 d2_col0 SL1col0 SL2col0 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_1 d1_col1 d2_col1 SL1col1 SL2col1 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_2 d1_col2 d2_col2 SL1col2 SL2col2 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_3 d1_col3 d2_col3 SL1col3 SL2col3 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_4 d1_col4 d2_col4 SL1col4 SL2col4 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_5 d1_col5 d2_col5 SL1col5 SL2col5 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_6 d1_col6 d2_col6 SL1col6 SL2col6 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_7 d1_col7 d2_col7 SL1col7 SL2col7 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_8 d1_col8 d2_col8 SL1col8 SL2col8 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_9 d1_col9 d2_col9 SL1col9 SL2col9 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_10 d1_col10 d2_col10 SL1col10 SL2col10 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_11 d1_col11 d2_col11 SL1col11 SL2col11 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_12 d1_col12 d2_col12 SL1col12 SL2col12 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_13 d1_col13 d2_col13 SL1col13 SL2col13 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_14 d1_col14 d2_col14 SL1col14 SL2col14 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_15 d1_col15 d2_col15 SL1col15 SL2col15 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_16 d1_col16 d2_col16 SL1col16 SL2col16 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_17 d1_col17 d2_col17 SL1col17 SL2col17 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell

```
xtcam_cell_0_18 d1_col18 d2_col18 SL1col18 SL2col18 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_19 d1_col19 d2_col19 SL1col19 SL2col19 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_20 d1_col20 d2_col20 SL1col20 SL2col20 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_21 d1_col21 d2_col21 SL1col21 SL2col21 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_22 d1_col22 d2_col22 SL1col22 SL2col22 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_23 d1_col23 d2_col23 SL1col23 SL2col23 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_24 d1_col24 d2_col24 SL1col24 SL2col24 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_25 d1_col25 d2_col25 SL1col25 SL2col25 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_26 d1_col26 d2_col26 SL1col26 SL2col26 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_27 d1_col27 d2_col27 SL1col27 SL2col27 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_28 d1_col28 d2_col28 SL1col28 SL2col28 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_29 d1_col29 d2_col29 SL1col29 SL2col29 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_30 d1_col30 d2_col30 SL1col30 SL2col30 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_31 d1_col31 d2_col31 SL1col31 SL2col31 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
```

```
xtcam_cell_0_32 d1_col32 d2_col32 SL1col32 SL2col32 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_33 d1_col33 d2_col33 SL1col33 SL2col33 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_34 d1_col34 d2_col34 SL1col34 SL2col34 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_35 d1_col35 d2_col35 SL1col35 SL2col35 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_36 d1_col36 d2_col36 SL1col36 SL2col36 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_37 d1_col37 d2_col37 SL1col37 SL2col37 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_38 d1_col38 d2_col38 SL1col38 SL2col38 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_39 d1_col39 d2_col39 SL1col39 SL2col39 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_40 d1_col40 d2_col40 SL1col40 SL2col40 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_41 d1_col41 d2_col41 SL1col41 SL2col41 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_42 d1_col42 d2_col42 SL1col42 SL2col42 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_43 d1_col43 d2_col43 SL1col43 SL2col43 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_44 d1_col44 d2_col44 SL1col44 SL2col44 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_45 d1_col45 d2_col45 SL1col45 SL2col45 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_46 d1_col46 d2_col46 SL1col46 SL2col46 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_47 d1_col47 d2_col47 SL1col47 SL2col47 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
```

```
xtcam_cell_0_48 d1_col48 d2_col48 SL1col48 SL2col48 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_49 d1_col49 d2_col49 SL1col49 SL2col49 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_50 d1_col50 d2_col50 SL1col50 SL2col50 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_51 d1_col51 d2_col51 SL1col51 SL2col51 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_52 d1_col52 d2_col52 SL1col52 SL2col52 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_53 d1_col53 d2_col53 SL1col53 SL2col53 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_54 d1_col54 d2_col54 SL1col54 SL2col54 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_55 d1_col55 d2_col55 SL1col55 SL2col55 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_56 d1_col56 d2_col56 SL1col56 SL2col56 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_57 d1_col57 d2_col57 SL1col57 SL2col57 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_58 d1_col58 d2_col58 SL1col58 SL2col58 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_59 d1_col59 d2_col59 SL1col59 SL2col59 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_60 d1_col60 d2_col60 SL1col60 SL2col60 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_61 d1_col61 d2_col61 SL1col61 SL2col61 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_62 d1_col62 d2_col62 SL1col62 SL2col62 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_63 d1_col63 d2_col63 SL1col63 SL2col63 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
```

A.3. PSpice netlist for Figures 6.4, 6.5 and 6.6

* 1X64 bit TCAM array

```
.INCLUDE 'models_array64bit_Pipelining.cir'
.INCLUDE 'rowcolumn_array64bit_Pipelining.cir'
.INCLUDE 'sources_array64bit_Pipelining.cir'
.INCLUDE 'cells_array64bit_Pipelining.cir'
```



```
.SUBCKT tcam_cell d1 d2 SL1 SL2 en_row enb_row SE ML u2 l
xmem1 p l sv_mem1 MEM_YAKOPCIC_test1
xmem2 q l sv_mem2 MEM_YAKOPCIC_test1
xmem3 s u2 sv_mem3 MEM_YAKOPCIC_test2
xmem4 t u2 sv_mem4 MEM_YAKOPCIC_test2
```

```
rmem1 sv_mem1 0 10000k
rmem2 sv_mem2 0 10000k
rmem3 sv_mem3 0 10000k
rmem4 sv_mem4 0 10000k
```

```
mn1 d1 en_row p 0 nenh w=2u l=0.4u
mn2 d2 en_row q 0 nenh w=2u l=0.4u
mp1 p enb_row d1 3.3 penh w=2u l=0.4u
mp2 q enb_row d2 3.3 penh w=2u l=0.4u
mn3 s SE p 0 nenh w=4u l=0.2u
mn4 t SE q 0 nenh w=4u l=0.2u
mn5 p SL1 p1 0 nenh w=.2u l=0.2u
mn6 q SL2 q1 0 nenh w=.2u l=0.2u
mn7 ML p1 0 0 nenh w=4u l=0.2u
mn8 ML q1 0 0 nenh w=4u l=0.2u
```

```
.ENDS tcam_cell
```

```
.SUBCKT precharge pre u ML MLb_prev
```

```
mnpr u2 u2 ML 0 nenh w=2u l=0.2u
mppr u2 pre u1 3.3 penh w=2u l=0.2u
mppr1 u1 MLb_prev u 3.3 penh w=2u l=0.2u
```

```
.ENDS precharge
```

```
.SUBCKT sense_amplifier ML SE u MLout
```

```
mnSE ML SE a 0 nenh w=.4u l=.2u
mpSE a SE MLout 3.3 penh w=.4u l=.2u
mnSE1 b a 0 0 nenh w=2u l=.2u
mpSE1 b a u 3.3 penh w=2u l=.2u
mnSE2 MLout b 0 0 nenh w=2u l=.2u
mpSE2 MLout b u 3.3 penh w=2u l=.2u
```

```
.ENDS sense_amplifier
```

```
.tran 0.1ns 110ns
.probe
```

```
.....
models_array64bit_Pipelining.cir
.....
```

```
*** model of Memristors ***
```

```
.subckt MEM_YAKOPCIC_test1 TE BE XSV PARAMS:
```

```
* Fitting parameters to model different devices
* a1, a2, b: Parameters for IV relationship
* Vp, Vn: Pos. and neg. voltage thresholds
```

```

* Ap, An: Multiplier for SV motion intensity
* xp, xn: Points where SV motion is reduced
* alphap, alphan: Rate at which SV motion decays
* xo: Initial value of SV
* eta: SV direction relative to voltage

+a1=.01 a2=.01 b=0.1 Vp=1.2 Vn=1.2 Ap=1.6e10 An=1.12e10
+xp=0.1 xn=0.1 alphap=.3 alphan=.55 xo=0.01 eta=1

* Multiplicative functions to ensure zero state
* variable motion at memristor boundaries

.func wp(V) {(xp-V)/(1-xp)+1}
.func wn(V) {V/(1-xn)}

* Function G(V(t)) - Describes the device threshold

.func G(V) { IF(V<=Vp, IF(V>=-Vn, 0, -An*(exp(-V)-exp(Vn))), Ap*(exp(V)-exp(Vp))) }

* Function F(V(t),x(t)) - Describes the SV motion

.func F(V1,V2) {IF(eta*V1 >= 0, IF(V2 >= xp, exp(-
+alphap*(V2-xp))*wp(V2) ,1), IF(V2 <= (1-xn),
+exp(alphan*(V2+xn-1))*wn(V2) ,1))}
* IV Response - Hyperbolic sine due to MIM structure

.func IVRel(V1,V2) {IF(V1 >= 0, a1*V2*sinh(b*V1),
+a2*V2*sinh(b*V1) )}

* Circuit to determine state variable
* dx/dt = F(V(t),x(t))*G(V(t))

Cx XSV 0 1 IC= {xo}

Gx 0 XSV value={eta*F(V(TE,BE),V(XSV,0))*G(V(TE,BE))}

* Current source for memristor IV response

Gm TE BE value = {IVRel(V(TE,BE),V(XSV,0))}

.ends MEM_YAKOPCIC_test1

.subckt MEM_YAKOPCIC_test2 TE BE XSV PARAMS:

* Fitting parameters to model different devices
* a1, a2, b: Parameters for IV relationship
* Vp, Vn: Pos. and neg. voltage thresholds
* Ap, An: Multiplier for SV motion intensity
* xp, xn: Points where SV motion is reduced
* alphap, alphan: Rate at which SV motion decays
* xo: Initial value of SV
* eta: SV direction relative to voltage

+a1=.01 a2=.01 b=.011 Vp=1.7 Vn=1.7 Ap=4e3 An=4e3
+xp=0.1 xn=0.1 alphap=1 alphan=7 xo=0.1 eta=1

```

* Multiplicative functions to ensure zero state
* variable motion at memristor boundaries

```
.func wp(V) {(xp-V)/(1-xp)+1}  
.func wn(V) {V/(1-xn)}
```

* Function G(V(t)) - Describes the device threshold

```
.func G(V) { IF(V<=Vp, IF(V>=-Vn, 0, -An*(exp(-V)-exp(Vn))), Ap*(exp(V)-exp(Vp))) }
```

* Function F(V(t),x(t)) - Describes the SV motion

```
.func F(V1,V2) {IF(eta*V1 >= 0, IF(V2 >= xp, exp(-  
+alphap*(V2-xp))*wp(V2),1), IF(V2 <= (1-xn),  
+exp(alphan*(V2+xn-1))*wn(V2),1))}
```

* IV Response - Hyperbolic sine due to MIM structure

```
.func IVRel(V1,V2) {IF(V1 >= 0, a1*V2*sinh(b*V1),  
+a2*V2*sinh(b*V1))}
```

* Circuit to determine state variable

* $dx/dt = F(V(t),x(t))*G(V(t))$

```
Cx XSV 0 1 IC= {xo}
```

```
Gx 0 XSV value={eta*F(V(TE,BE),V(XSV,0))*G(V(TE,BE))}
```

* Current source for memristor IV response

```
Gm TE BE value = {IVRel(V(TE,BE),V(XSV,0))}
```

```
.ends MEM_YAKOPCIC_test2
```

*** model of NMOS transistor ***

```
.MODEL nenh NMOS LEVEL=7 VERSION=3.1 TNOM=27 tox=4.1E-9 XJ=1E-7 NCH=2.3549E17  
+VTH0=0.3662473 K1=0.5864999 K2=1.127266E-3 K3=1E-3  
+K3B=0.0294061 W0=1E-7 NLX=1.630684E-7 DVT0W=0 DVT1W=0 DVT2W=0 DVT0=1.2064649  
+DVT1=0.4215486 DVT2=0.0197749 U0=273.8094484 UA=-1.40499E-9  
+UB=2.408323E-18 UC=6.504826E-11 VSAT=1.355009E5 A0=2 AGS=0.4449958  
+BO=1.901075E-7 B1=4.99995E-6 KETA=-0.0164863 A1=3.868769E-4 A2=0.4640272  
+RDSW=123.3376355 PRWG=0.5 PRWB=-0.197728 WR=1 WINT=0 LINT=1.690044E-8  
+XL=0 XW=-1E-8 DWG=-4.728719E-9 DWB=-2.452411E-9 VOFF=-0.0948017 NFACTOR=2.1860065  
+CIT=0 CDSC=2.4E-4 CDSCD=0 CDSCB=0 ETA0=2.230928E-3 ETAB=6.028975E-5 DSUB=0.0145467  
+PCLM=1.3822069 PDIBLC1=0.1762787 PDIBLC2 = 1.66653E-3 PDIBLCB = -0.1  
+DROUT=0.7694691 PSCBE1=8.91287E9 PSCBE2=7.349607E-9 PVAG=1.685917E-3  
+DELTA=0.01 RSH=6.7 MOBMOD=1 PRT=0 UTE=-1.5 KT1=-0.11 KT1L=0 KT2=0.022 UA1=4.31E-9  
+UB1=-7.61E-18 UC1=-5.6E-11 AT=3.3E4 WL=0 WLN=1 WW=0 WVN=1 WWL=0 LL=0 LLN=1 LW=0  
+LWN=1 LWL=0 CAPMOD=2 XPART=0.5 CGDO=8.23E-10 CGSO=8.23E-10 CGBO=1E-12  
+CJ = 9.466429E-4 PB = 0.8 MJ = 0.3820266  
+CJSW = 2.608154E-10 PBSW = 0.8 MJSW = 0.102322  
+CJSWG = 3.3E-10 PBSWG = 0.8 MJSWG = 0.102322  
+CF = 0 PVTH0 = -2.199373E-3 PRDSW = -0.9368961  
+PK2 = 1.593254E-3 WKETA = -2.880976E-3 LKETA = 7.165078E-3
```

```
+PUO = 6.777519   PUA = 5.505418E-12   PUB = 8.84133E-25
+PVSAT = 2.006286E3   PETAO = 1.003159E-4   PKETA = -6.759277E-3
+NOIMOD=2.0E+00      NOIA=1.3182567385564E+19
+NOIB=144543.977074592   NOIC=-1.24515784572817E-12   EF=0.92   EM=41000000
```

```
*** model of PMOS transistor ***
```

```
.MODEL penh PMOS LEVEL=7 VERSION = 3.1      TNOM = 27      tox = 4.1E-9
+XJ = 1E-7      NCH = 4.1589E17   VTH0 = -0.3906012
+K1 = 0.5341312   K2 = 0.0395326   K3 = 0
+K3B = 7.4916211   WO = 1E-6      NLX = 1.194072E-7
+DVT0W = 0      DVT1W = 0      DVT2W = 0
+DVT0 = 0.5060555   DVT1 = 0.2423835   DVT2 = 0.1
+U0 = 115.6894042   UA = 1.573746E-9   UB = 1.874308E-21
+UC = -1E-10      VSAT = 1.130982E5   A0 = 1.9976555
+AGS = 0.4186945   B0 = 1.949178E-7   B1 = 6.422908E-7
+KETA = 0.0166345   A1 = 0.4749146   A2 = 0.300003
+RDSW = 198.321294   PRWG = 0.5      PRWB = -0.4986647
+WR = 1      WINT = 0      LINT = 2.94454E-8
+XL = 0      XW = -1E-8      DWG = -2.798724E-8
+DWB = -4.83797E-10   VOFF = -0.095236   NFACTOR = 2
+CIT = 0      CDSC = 2.4E-4      CDSCD = 0
+CDSCB = 0      ETAO = 1.035504E-3   ETAB = -4.358398E-4
+DSUB = 1.816555E-3   PCLM = 1.3299898   PDIBLC1 = 1.766563E-3
+PDIBLC2 = 7.728395E-7   PDIBLCB = -1E-3   DROUT = 1.011891E-3
+PSCBE1 = 4.872184E10   PSCBE2 = 5E-10   PVAG = 0.0209921
+DELTA = 0.01      RSH = 7.7      MOBMOD = 1
+PRT = 0      UTE = -1.5      KT1 = -0.11
+KT1L = 0      KT2 = 0.022      UA1 = 4.31E-9
+UB1 = -7.61E-18   UC1 = -5.6E-11   AT = 3.3E4
+WL = 0      WLN = 1      WW = 0
+WWN = 1      WWL = 0      LL = 0
+LLN = 1      LW = 0      LWN = 1
+LWL = 0      CAPMOD = 2      XPART = 0.5
+CGDO = 6.35E-10   CGSO = 6.35E-10   CGBO = 1E-12
+CJ = 1.144521E-3   PB = 0.8468686   MJ = 0.4099522
+CJSW = 2.490749E-10   PBSW = 0.8769118   MJSW = 0.3478565
+CJSWG = 4.22E-10   PBSWG = 0.8769118   MJSWG = 0.3478565
+CF = 0      PVTH0 = 2.302018E-3   PRDSW = 9.0575312
+PK2 = 1.821914E-3   WKETA = 0.0222457   LKETA = -1.495872E-3
+PUO = -1.5580645   PUA = -6.36889E-11   PUB = 1E-21
+PVSAT = 49.8420442   PETAO = 2.827793E-5   PKETA = -2.536564E-3
+NOIMOD=2.0E+00      NOIA=3.57456993317604E+18      NOIB=2500
+NOIC=2.61260020285845E-11      EF=1.1388
```

```
.....
rowcolumn_array64bit_Pipelining.cir
.....
```

```
*      rows      *
*****
```

```
* row0
```

```
*pre-charge ckt.
```

```
xprecharge_row01 pre_row01 u ML1row0 0 precharge
xprecharge_row02 pre_row02 u ML2row0 ML1brow0 precharge
xprecharge_row03 pre_row03 u ML3row0 ML2brow0 precharge
xprecharge_row04 pre_row04 u ML4row0 ML3brow0 precharge
```

*Matchline segmentation pipelining

*NOT Gates

mnML1row0 ML1brow0 ML1row0 0 0 nenh w=2u l=.2u
mpML1row0 ML1brow0 ML1row0 u 3.3 penh w=2u l=.2u
mnML2row0 ML2brow0 ML2row0 0 0 nenh w=2u l=.2u
mpML2row0 ML2brow0 ML2row0 u 3.3 penh w=2u l=.2u
mnML3row0 ML3brow0 ML3row0 0 0 nenh w=2u l=.2u
mpML3row0 ML3brow0 ML3row0 u 3.3 penh w=2u l=.2u
mnML4row0 ML4brow0 ML4row0 0 0 nenh w=2u l=.2u
mpML4row0 ML4brow0 ML4row0 u 3.3 penh w=2u l=.2u

*NOR Gate

mn1ML1row0 MLrow0 ML1brow0 0 0 nenh w=.4u l=0.2u
mn1ML2row0 MLrow0 ML2brow0 0 0 nenh w=.4u l=0.2u
mn1ML3row0 MLrow0 ML3brow0 0 0 nenh w=.4u l=0.2u
mn1ML4row0 MLrow0 ML4brow0 0 0 nenh w=.4u l=0.2u
mpMLrow0 MLrow0 MLrow0 u 3.3 penh w=1.8u l=0.2u

* sense-amplifier

xsense_amplifier_row0 MLrow0 SE_row0 u MLout_row0 sense_amplifier

*reset

mnML1reset_row0 ML1row0 ML1reset1_row0 0 0 nenh W=40u l=0.4u
mnML2reset_row0 ML2row0 ML2reset1_row0 0 0 nenh W=40u l=0.4u
mnML3reset_row0 ML3row0 ML3reset1_row0 0 0 nenh W=40u l=0.4u
mnML4reset_row0 ML4row0 ML4reset1_row0 0 0 nenh W=40u l=0.4u

r_en_row0 en_row0 0 10000k
r1_en_row0 en_row0 en1_row0 5
r_enb_row0 enb_row0 0 10000k
r1_enb_row0 enb_row0 enb1_row0 5
r_pre1_row01 pre1_row01 0 10000k
r1_pre1_row01 pre1_row01 pre_row01 5
r_pre1_row02 pre1_row02 0 10000k
r1_pre1_row02 pre1_row02 pre_row02 5
r_pre1_row03 pre1_row03 0 10000k
r1_pre1_row03 pre1_row03 pre_row03 5
r_pre1_row04 pre1_row04 0 10000k
r1_pre1_row04 pre1_row04 pre_row04 5
r_SE_row0 SE_row0 0 10000k
r1_SE_row0 SE_row0 SE1_row0 5
rML1reset_row0 ML1reset_row0 ML1reset1_row0 5
rML1reset1_row0 ML1reset1_row0 0 10000k
rML2reset_row0 ML2reset_row0 ML2reset1_row0 5
rML2reset1_row0 ML2reset1_row0 0 10000k
rML3reset_row0 ML3reset_row0 ML3reset1_row0 5
rML3reset1_row0 ML3reset1_row0 0 10000k
rML4reset_row0 ML4reset_row0 ML4reset1_row0 5
rML4reset1_row0 ML4reset1_row0 0 10000k

* columns *

* col0

mn1col0 d1_col0 en_col0 d11_col0 0 nenh w=4u l=.4u
mn2col0 d2_col0 en_col0 d22_col0 0 nenh w=4u l=.4u
mp1col0 d11_col0 enb_col0 d1_col0 3.3 penh w=8u l=0.4u
mp2col0 d22_col0 enb_col0 d2_col0 3.3 penh w=8u l=0.4u

r_en_col0 en_col0 0 10000k
r1_en_col0 en_col0 en1_col0 5
r_enb_col0 enb_col0 0 10000k
r1_enb_col0 enb_col0 enb1_col0 5

r_d11_col0 d11_col0 0 10000k
r1_d11_col0 d11_col0 d111_col0 5
r_d22_col0 d22_col0 0 10000k
r1_d22_col0 d22_col0 d222_col0 5

r_SL1col0 SL1col0 0 10000k
r1_SL1col0 SL1col0 SL11col0 5
r_SL2col0 SL2col0 0 10000k
r1_SL2col0 SL2col0 SL22col0 5

* col1

mn1col1 d1_col1 en_col1 d11_col1 0 nenh w=4u l=.4u
mn2col1 d2_col1 en_col1 d22_col1 0 nenh w=4u l=.4u
mp1col1 d11_col1 enb_col1 d1_col1 3.3 penh w=8u l=0.4u
mp2col1 d22_col1 enb_col1 d2_col1 3.3 penh w=8u l=0.4u

r_en_col1 en_col1 0 10000k
r1_en_col1 en_col1 en1_col1 5
r_enb_col1 enb_col1 0 10000k
r1_enb_col1 enb_col1 enb1_col1 5

r_d11_col1 d11_col1 0 10000k
r1_d11_col1 d11_col1 d111_col1 5
r_d22_col1 d22_col1 0 10000k
r1_d22_col1 d22_col1 d222_col1 5

r_SL1col1 SL1col1 0 10000k
r1_SL1col1 SL1col1 SL11col1 5
r_SL2col1 SL2col1 0 10000k
r1_SL2col1 SL2col1 SL22col1 5

* col2

mn1col2 d1_col2 en_col2 d11_col2 0 nenh w=4u l=.4u
mn2col2 d2_col2 en_col2 d22_col2 0 nenh w=4u l=.4u
mp1col2 d11_col2 enb_col2 d1_col2 3.3 penh w=8u l=0.4u
mp2col2 d22_col2 enb_col2 d2_col2 3.3 penh w=8u l=0.4u

r_en_col2 en_col2 0 10000k
r1_en_col2 en_col2 en1_col2 5
r_enb_col2 enb_col2 0 10000k
r1_enb_col2 enb_col2 enb1_col2 5

r_d11_col2 d11_col2 0 10000k
r1_d11_col2 d11_col2 d111_col2 5
r_d22_col2 d22_col2 0 10000k
r1_d22_col2 d22_col2 d222_col2 5

r_SL1col2 SL1col2 0 10000k
r1_SL1col2 SL1col2 SL11col2 5
r_SL2col2 SL2col2 0 10000k

r1_SL2col2 SL2col2 SL22col2 5

* col3

mn1col3 d1_col3 en_col3 d11_col3 0 nenh w=4u l=.4u
mn2col3 d2_col3 en_col3 d22_col3 0 nenh w=4u l=.4u
mp1col3 d11_col3 enb_col3 d1_col3 3.3 penh w=8u l=0.4u
mp2col3 d22_col3 enb_col3 d2_col3 3.3 penh w=8u l=0.4u

r_en_col3 en_col3 0 10000k
r1_en_col3 en_col3 en1_col3 5
r_enb_col3 enb_col3 0 10000k
r1_enb_col3 enb_col3 enb1_col3 5

r_d11_col3 d11_col3 0 10000k
r1_d11_col3 d11_col3 d111_col3 5
r_d22_col3 d22_col3 0 10000k
r1_d22_col3 d22_col3 d222_col3 5

r_SL1col3 SL1col3 0 10000k
r1_SL1col3 SL1col3 SL11col3 5
r_SL2col3 SL2col3 0 10000k
r1_SL2col3 SL2col3 SL22col3 5

* col4

mn1col4 d1_col4 en_col4 d11_col4 0 nenh w=4u l=.4u
mn2col4 d2_col4 en_col4 d22_col4 0 nenh w=4u l=.4u
mp1col4 d11_col4 enb_col4 d1_col4 3.3 penh w=8u l=0.4u
mp2col4 d22_col4 enb_col4 d2_col4 3.3 penh w=8u l=0.4u

r_en_col4 en_col4 0 10000k
r1_en_col4 en_col4 en1_col4 5
r_enb_col4 enb_col4 0 10000k
r1_enb_col4 enb_col4 enb1_col4 5

r_d11_col4 d11_col4 0 10000k
r1_d11_col4 d11_col4 d111_col4 5
r_d22_col4 d22_col4 0 10000k
r1_d22_col4 d22_col4 d222_col4 5

r_SL1col4 SL1col4 0 10000k
r1_SL1col4 SL1col4 SL11col4 5
r_SL2col4 SL2col4 0 10000k
r1_SL2col4 SL2col4 SL22col4 5

* col5

mn1col5 d1_col5 en_col5 d11_col5 0 nenh w=4u l=.4u
mn2col5 d2_col5 en_col5 d22_col5 0 nenh w=4u l=.4u
mp1col5 d11_col5 enb_col5 d1_col5 3.3 penh w=8u l=0.4u
mp2col5 d22_col5 enb_col5 d2_col5 3.3 penh w=8u l=0.4u

r_en_col5 en_col5 0 10000k
r1_en_col5 en_col5 en1_col5 5
r_enb_col5 enb_col5 0 10000k
r1_enb_col5 enb_col5 enb1_col5 5

r_d11_col5 d11_col5 0 10000k
r1_d11_col5 d11_col5 d111_col5 5
r_d22_col5 d22_col5 0 10000k

r1_d22_col5 d22_col5 d222_col5 5

r_SL1col5 SL1col5 0 10000k
r1_SL1col5 SL1col5 SL11col5 5
r_SL2col5 SL2col5 0 10000k
r1_SL2col5 SL2col5 SL22col5 5

* col6

mn1col6 d1_col6 en_col6 d11_col6 0 nenh w=4u l=.4u
mn2col6 d2_col6 en_col6 d22_col6 0 nenh w=4u l=.4u
mp1col6 d11_col6 enb_col6 d1_col6 3.3 penh w=8u l=0.4u
mp2col6 d22_col6 enb_col6 d2_col6 3.3 penh w=8u l=0.4u

r_en_col6 en_col6 0 10000k
r1_en_col6 en_col6 en1_col6 5
r_enb_col6 enb_col6 0 10000k
r1_enb_col6 enb_col6 enb1_col6 5

r_d11_col6 d11_col6 0 10000k
r1_d11_col6 d11_col6 d111_col6 5
r_d22_col6 d22_col6 0 10000k
r1_d22_col6 d22_col6 d222_col6 5

r_SL1col6 SL1col6 0 10000k
r1_SL1col6 SL1col6 SL11col6 5
r_SL2col6 SL2col6 0 10000k
r1_SL2col6 SL2col6 SL22col6 5

* col7

mn1col7 d1_col7 en_col7 d11_col7 0 nenh w=4u l=.4u
mn2col7 d2_col7 en_col7 d22_col7 0 nenh w=4u l=.4u
mp1col7 d11_col7 enb_col7 d1_col7 3.3 penh w=8u l=0.4u
mp2col7 d22_col7 enb_col7 d2_col7 3.3 penh w=8u l=0.4u

r_en_col7 en_col7 0 10000k
r1_en_col7 en_col7 en1_col7 5
r_enb_col7 enb_col7 0 10000k
r1_enb_col7 enb_col7 enb1_col7 5

r_d11_col7 d11_col7 0 10000k
r1_d11_col7 d11_col7 d111_col7 5
r_d22_col7 d22_col7 0 10000k
r1_d22_col7 d22_col7 d222_col7 5

r_SL1col7 SL1col7 0 10000k
r1_SL1col7 SL1col7 SL11col7 5
r_SL2col7 SL2col7 0 10000k
r1_SL2col7 SL2col7 SL22col7 5

* col8

mn1col8 d1_col8 en_col8 d11_col8 0 nenh w=4u l=.4u
mn2col8 d2_col8 en_col8 d22_col8 0 nenh w=4u l=.4u
mp1col8 d11_col8 enb_col8 d1_col8 3.3 penh w=8u l=0.4u
mp2col8 d22_col8 enb_col8 d2_col8 3.3 penh w=8u l=0.4u

r_en_col8 en_col8 0 10000k
r1_en_col8 en_col8 en1_col8 5
r_enb_col8 enb_col8 0 10000k
r1_enb_col8 enb_col8 enb1_col8 5

r_d11_col8 d11_col8 0 10000k
r1_d11_col8 d11_col8 d111_col8 5
r_d22_col8 d22_col8 0 10000k
r1_d22_col8 d22_col8 d222_col8 5

r_SL1col8 SL1col8 0 10000k
r1_SL1col8 SL1col8 SL11col8 5
r_SL2col8 SL2col8 0 10000k
r1_SL2col8 SL2col8 SL22col8 5

* col9

mn1col9 d1_col9 en_col9 d11_col9 0 nenh w=4u l=.4u
mn2col9 d2_col9 en_col9 d22_col9 0 nenh w=4u l=.4u
mp1col9 d11_col9 enb_col9 d1_col9 3.3 penh w=8u l=0.4u
mp2col9 d22_col9 enb_col9 d2_col9 3.3 penh w=8u l=0.4u

r_en_col9 en_col9 0 10000k
r1_en_col9 en_col9 en1_col9 5
r_enb_col9 enb_col9 0 10000k
r1_enb_col9 enb_col9 enb1_col9 5

r_d11_col9 d11_col9 0 10000k
r1_d11_col9 d11_col9 d111_col9 5
r_d22_col9 d22_col9 0 10000k
r1_d22_col9 d22_col9 d222_col9 5

r_SL1col9 SL1col9 0 10000k
r1_SL1col9 SL1col9 SL11col9 5
r_SL2col9 SL2col9 0 10000k
r1_SL2col9 SL2col9 SL22col9 5

* col10

mn1col10 d1_col10 en_col10 d11_col10 0 nenh w=4u l=.4u
mn2col10 d2_col10 en_col10 d22_col10 0 nenh w=4u l=.4u
mp1col10 d11_col10 enb_col10 d1_col10 3.3 penh w=8u l=0.4u
mp2col10 d22_col10 enb_col10 d2_col10 3.3 penh w=8u l=0.4u

r_en_col10 en_col10 0 10000k
r1_en_col10 en_col10 en1_col10 5
r_enb_col10 enb_col10 0 10000k
r1_enb_col10 enb_col10 enb1_col10 5

r_d11_col10 d11_col10 0 10000k
r1_d11_col10 d11_col10 d111_col10 5
r_d22_col10 d22_col10 0 10000k
r1_d22_col10 d22_col10 d222_col10 5

r_SL1col10 SL1col10 0 10000k
r1_SL1col10 SL1col10 SL11col10 5
r_SL2col10 SL2col10 0 10000k
r1_SL2col10 SL2col10 SL22col10 5

* col11

mn1col11 d1_col11 en_col11 d11_col11 0 nenh w=4u l=.4u
mn2col11 d2_col11 en_col11 d22_col11 0 nenh w=4u l=.4u
mp1col11 d11_col11 enb_col11 d1_col11 3.3 penh w=8u l=0.4u
mp2col11 d22_col11 enb_col11 d2_col11 3.3 penh w=8u l=0.4u

r_en_col11 en_col11 0 10000k
r1_en_col11 en_col11 en1_col11 5
r_enb_col11 enb_col11 0 10000k
r1_enb_col11 enb_col11 enb1_col11 5

r_d11_col11 d11_col11 0 10000k
r1_d11_col11 d11_col11 d111_col11 5
r_d22_col11 d22_col11 0 10000k
r1_d22_col11 d22_col11 d222_col11 5

r_SL1col11 SL1col11 0 10000k
r1_SL1col11 SL1col11 SL11col11 5
r_SL2col11 SL2col11 0 10000k
r1_SL2col11 SL2col11 SL22col11 5

* col12

mn1col12 d1_col12 en_col12 d11_col12 0 nenh w=4u l=.4u
mn2col12 d2_col12 en_col12 d22_col12 0 nenh w=4u l=.4u
mp1col12 d11_col12 enb_col12 d1_col12 3.3 penh w=8u l=0.4u
mp2col12 d22_col12 enb_col12 d2_col12 3.3 penh w=8u l=0.4u

r_en_col12 en_col12 0 10000k
r1_en_col12 en_col12 en1_col12 5
r_enb_col12 enb_col12 0 10000k
r1_enb_col12 enb_col12 enb1_col12 5

r_d11_col12 d11_col12 0 10000k
r1_d11_col12 d11_col12 d111_col12 5
r_d22_col12 d22_col12 0 10000k
r1_d22_col12 d22_col12 d222_col12 5

r_SL1col12 SL1col12 0 10000k
r1_SL1col12 SL1col12 SL11col12 5
r_SL2col12 SL2col12 0 10000k
r1_SL2col12 SL2col12 SL22col12 5

* col13

mn1col13 d1_col13 en_col13 d11_col13 0 nenh w=4u l=.4u
mn2col13 d2_col13 en_col13 d22_col13 0 nenh w=4u l=.4u
mp1col13 d11_col13 enb_col13 d1_col13 3.3 penh w=8u l=0.4u
mp2col13 d22_col13 enb_col13 d2_col13 3.3 penh w=8u l=0.4u

r_en_col13 en_col13 0 10000k
r1_en_col13 en_col13 en1_col13 5
r_enb_col13 enb_col13 0 10000k
r1_enb_col13 enb_col13 enb1_col13 5

r_d11_col13 d11_col13 0 10000k
r1_d11_col13 d11_col13 d111_col13 5
r_d22_col13 d22_col13 0 10000k
r1_d22_col13 d22_col13 d222_col13 5

r_SL1col13 SL1col13 0 10000k
r1_SL1col13 SL1col13 SL11col13 5
r_SL2col13 SL2col13 0 10000k
r1_SL2col13 SL2col13 SL22col13 5

* col14

mn1col14 d1_col14 en_col14 d11_col14 0 nenh w=4u l=.4u
mn2col14 d2_col14 en_col14 d22_col14 0 nenh w=4u l=.4u
mp1col14 d11_col14 enb_col14 d1_col14 3.3 penh w=8u l=0.4u
mp2col14 d22_col14 enb_col14 d2_col14 3.3 penh w=8u l=0.4u

r_en_col14 en_col14 0 10000k
r1_en_col14 en_col14 en1_col14 5
r_enb_col14 enb_col14 0 10000k
r1_enb_col14 enb_col14 enb1_col14 5

r_d11_col14 d11_col14 0 10000k
r1_d11_col14 d11_col14 d111_col14 5
r_d22_col14 d22_col14 0 10000k
r1_d22_col14 d22_col14 d222_col14 5

r_SL1col14 SL1col14 0 10000k
r1_SL1col14 SL1col14 SL11col14 5
r_SL2col14 SL2col14 0 10000k
r1_SL2col14 SL2col14 SL22col14 5

* col15

mn1col15 d1_col15 en_col15 d11_col15 0 nenh w=4u l=.4u
mn2col15 d2_col15 en_col15 d22_col15 0 nenh w=4u l=.4u
mp1col15 d11_col15 enb_col15 d1_col15 3.3 penh w=8u l=0.4u
mp2col15 d22_col15 enb_col15 d2_col15 3.3 penh w=8u l=0.4u

r_en_col15 en_col15 0 10000k
r1_en_col15 en_col15 en1_col15 5
r_enb_col15 enb_col15 0 10000k
r1_enb_col15 enb_col15 enb1_col15 5

r_d11_col15 d11_col15 0 10000k
r1_d11_col15 d11_col15 d111_col15 5
r_d22_col15 d22_col15 0 10000k
r1_d22_col15 d22_col15 d222_col15 5

r_SL1col15 SL1col15 0 10000k
r1_SL1col15 SL1col15 SL11col15 5
r_SL2col15 SL2col15 0 10000k
r1_SL2col15 SL2col15 SL22col15 5

* col16

mn1col16 d1_col16 en_col16 d11_col16 0 nenh w=4u l=.4u
mn2col16 d2_col16 en_col16 d22_col16 0 nenh w=4u l=.4u
mp1col16 d11_col16 enb_col16 d1_col16 3.3 penh w=8u l=0.4u
mp2col16 d22_col16 enb_col16 d2_col16 3.3 penh w=8u l=0.4u

r_en_col16 en_col16 0 10000k
r1_en_col16 en_col16 en1_col16 5
r_enb_col16 enb_col16 0 10000k
r1_enb_col16 enb_col16 enb1_col16 5

r_d11_col16 d11_col16 0 10000k
r1_d11_col16 d11_col16 d111_col16 5
r_d22_col16 d22_col16 0 10000k
r1_d22_col16 d22_col16 d222_col16 5

r_SL1col16 SL1col16 0 10000k
r1_SL1col16 SL1col16 SL11col16 5
r_SL2col16 SL2col16 0 10000k
r1_SL2col16 SL2col16 SL22col16 5

* col17

mn1col17 d1_col17 en_col17 d11_col17 0 nenh w=4u l=.4u
mn2col17 d2_col17 en_col17 d22_col17 0 nenh w=4u l=.4u
mp1col17 d11_col17 enb_col17 d1_col17 3.3 penh w=8u l=0.4u
mp2col17 d22_col17 enb_col17 d2_col17 3.3 penh w=8u l=0.4u

r_en_col17 en_col17 0 10000k
r1_en_col17 en_col17 en1_col17 5
r_enb_col17 enb_col17 0 10000k
r1_enb_col17 enb_col17 enb1_col17 5

r_d11_col17 d11_col17 0 10000k
r1_d11_col17 d11_col17 d111_col17 5
r_d22_col17 d22_col17 0 10000k
r1_d22_col17 d22_col17 d222_col17 5

r_SL1col17 SL1col17 0 10000k
r1_SL1col17 SL1col17 SL11col17 5
r_SL2col17 SL2col17 0 10000k
r1_SL2col17 SL2col17 SL22col17 5

* col18

mn1col18 d1_col18 en_col18 d11_col18 0 nenh w=4u l=.4u
mn2col18 d2_col18 en_col18 d22_col18 0 nenh w=4u l=.4u
mp1col18 d11_col18 enb_col18 d1_col18 3.3 penh w=8u l=0.4u
mp2col18 d22_col18 enb_col18 d2_col18 3.3 penh w=8u l=0.4u

r_en_col18 en_col18 0 10000k
r1_en_col18 en_col18 en1_col18 5
r_enb_col18 enb_col18 0 10000k
r1_enb_col18 enb_col18 enb1_col18 5

r_d11_col18 d11_col18 0 10000k
r1_d11_col18 d11_col18 d111_col18 5
r_d22_col18 d22_col18 0 10000k
r1_d22_col18 d22_col18 d222_col18 5

r_SL1col18 SL1col18 0 10000k
r1_SL1col18 SL1col18 SL11col18 5
r_SL2col18 SL2col18 0 10000k
r1_SL2col18 SL2col18 SL22col18 5

* col19

mn1col19 d1_col19 en_col19 d11_col19 0 nenh w=4u l=.4u
mn2col19 d2_col19 en_col19 d22_col19 0 nenh w=4u l=.4u
mp1col19 d11_col19 enb_col19 d1_col19 3.3 penh w=8u l=0.4u
mp2col19 d22_col19 enb_col19 d2_col19 3.3 penh w=8u l=0.4u

r_en_col19 en_col19 0 10000k

r1_en_col19 en_col19 en1_col19 5
r_enb_col19 enb_col19 0 10000k
r1_enb_col19 enb_col19 enb1_col19 5

r_d11_col19 d11_col19 0 10000k
r1_d11_col19 d11_col19 d111_col19 5
r_d22_col19 d22_col19 0 10000k
r1_d22_col19 d22_col19 d222_col19 5

r_SL1col19 SL1col19 0 10000k
r1_SL1col19 SL1col19 SL11col19 5
r_SL2col19 SL2col19 0 10000k
r1_SL2col19 SL2col19 SL22col19 5

* col20

mn1col20 d1_col20 en_col20 d11_col20 0 nenh w=4u l=.4u
mn2col20 d2_col20 en_col20 d22_col20 0 nenh w=4u l=.4u
mp1col20 d11_col20 enb_col20 d1_col20 3.3 penh w=8u l=0.4u
mp2col20 d22_col20 enb_col20 d2_col20 3.3 penh w=8u l=0.4u

r_en_col20 en_col20 0 10000k
r1_en_col20 en_col20 en1_col20 5
r_enb_col20 enb_col20 0 10000k
r1_enb_col20 enb_col20 enb1_col20 5

r_d11_col20 d11_col20 0 10000k
r1_d11_col20 d11_col20 d111_col20 5
r_d22_col20 d22_col20 0 10000k
r1_d22_col20 d22_col20 d222_col20 5

r_SL1col20 SL1col20 0 10000k
r1_SL1col20 SL1col20 SL11col20 5
r_SL2col20 SL2col20 0 10000k
r1_SL2col20 SL2col20 SL22col20 5

* col21

mn1col21 d1_col21 en_col21 d11_col21 0 nenh w=4u l=.4u
mn2col21 d2_col21 en_col21 d22_col21 0 nenh w=4u l=.4u
mp1col21 d11_col21 enb_col21 d1_col21 3.3 penh w=8u l=0.4u
mp2col21 d22_col21 enb_col21 d2_col21 3.3 penh w=8u l=0.4u

r_en_col21 en_col21 0 10000k
r1_en_col21 en_col21 en1_col21 5
r_enb_col21 enb_col21 0 10000k
r1_enb_col21 enb_col21 enb1_col21 5

r_d11_col21 d11_col21 0 10000k
r1_d11_col21 d11_col21 d111_col21 5
r_d22_col21 d22_col21 0 10000k
r1_d22_col21 d22_col21 d222_col21 5

r_SL1col21 SL1col21 0 10000k
r1_SL1col21 SL1col21 SL11col21 5
r_SL2col21 SL2col21 0 10000k
r1_SL2col21 SL2col21 SL22col21 5

* col22

mn1col22 d1_col22 en_col22 d11_col22 0 nenh w=4u l=.4u
mn2col22 d2_col22 en_col22 d22_col22 0 nenh w=4u l=.4u
mp1col22 d11_col22 enb_col22 d1_col22 3.3 penh w=8u l=0.4u

mp2col22 d22_col22 enb_col22 d2_col22 3.3 penh w=8u l=0.4u

r_en_col22 en_col22 0 10000k
r1_en_col22 en_col22 en1_col22 5
r_enb_col22 enb_col22 0 10000k
r1_enb_col22 enb_col22 enb1_col22 5

r_d11_col22 d11_col22 0 10000k
r1_d11_col22 d11_col22 d111_col22 5
r_d22_col22 d22_col22 0 10000k
r1_d22_col22 d22_col22 d222_col22 5

r_SL1col22 SL1col22 0 10000k
r1_SL1col22 SL1col22 SL11col22 5
r_SL2col22 SL2col22 0 10000k
r1_SL2col22 SL2col22 SL22col22 5

* col23

mn1col23 d1_col23 en_col23 d11_col23 0 nenh w=4u l=.4u
mn2col23 d2_col23 en_col23 d22_col23 0 nenh w=4u l=.4u
mp1col23 d11_col23 enb_col23 d1_col23 3.3 penh w=8u l=0.4u
mp2col23 d22_col23 enb_col23 d2_col23 3.3 penh w=8u l=0.4u

r_en_col23 en_col23 0 10000k
r1_en_col23 en_col23 en1_col23 5
r_enb_col23 enb_col23 0 10000k
r1_enb_col23 enb_col23 enb1_col23 5

r_d11_col23 d11_col23 0 10000k
r1_d11_col23 d11_col23 d111_col23 5
r_d22_col23 d22_col23 0 10000k
r1_d22_col23 d22_col23 d222_col23 5

r_SL1col23 SL1col23 0 10000k
r1_SL1col23 SL1col23 SL11col23 5
r_SL2col23 SL2col23 0 10000k
r1_SL2col23 SL2col23 SL22col23 5

* col24

mn1col24 d1_col24 en_col24 d11_col24 0 nenh w=4u l=.4u
mn2col24 d2_col24 en_col24 d22_col24 0 nenh w=4u l=.4u
mp1col24 d11_col24 enb_col24 d1_col24 3.3 penh w=8u l=0.4u
mp2col24 d22_col24 enb_col24 d2_col24 3.3 penh w=8u l=0.4u

r_en_col24 en_col24 0 10000k
r1_en_col24 en_col24 en1_col24 5
r_enb_col24 enb_col24 0 10000k
r1_enb_col24 enb_col24 enb1_col24 5

r_d11_col24 d11_col24 0 10000k
r1_d11_col24 d11_col24 d111_col24 5
r_d22_col24 d22_col24 0 10000k
r1_d22_col24 d22_col24 d222_col24 5

r_SL1col24 SL1col24 0 10000k
r1_SL1col24 SL1col24 SL11col24 5
r_SL2col24 SL2col24 0 10000k
r1_SL2col24 SL2col24 SL22col24 5

* col25

mn1col25 d1_col25 en_col25 d11_col25 0 nenh w=4u l=.4u
mn2col25 d2_col25 en_col25 d22_col25 0 nenh w=4u l=.4u
mp1col25 d11_col25 enb_col25 d1_col25 3.3 penh w=8u l=0.4u
mp2col25 d22_col25 enb_col25 d2_col25 3.3 penh w=8u l=0.4u

r_en_col25 en_col25 0 10000k
r1_en_col25 en_col25 en1_col25 5
r_enb_col25 enb_col25 0 10000k
r1_enb_col25 enb_col25 enb1_col25 5

r_d11_col25 d11_col25 0 10000k
r1_d11_col25 d11_col25 d111_col25 5
r_d22_col25 d22_col25 0 10000k
r1_d22_col25 d22_col25 d222_col25 5

r_SL1col25 SL1col25 0 10000k
r1_SL1col25 SL1col25 SL11col25 5
r_SL2col25 SL2col25 0 10000k
r1_SL2col25 SL2col25 SL22col25 5

* col26

mn1col26 d1_col26 en_col26 d11_col26 0 nenh w=4u l=.4u
mn2col26 d2_col26 en_col26 d22_col26 0 nenh w=4u l=.4u
mp1col26 d11_col26 enb_col26 d1_col26 3.3 penh w=8u l=0.4u
mp2col26 d22_col26 enb_col26 d2_col26 3.3 penh w=8u l=0.4u

r_en_col26 en_col26 0 10000k
r1_en_col26 en_col26 en1_col26 5
r_enb_col26 enb_col26 0 10000k
r1_enb_col26 enb_col26 enb1_col26 5

r_d11_col26 d11_col26 0 10000k
r1_d11_col26 d11_col26 d111_col26 5
r_d22_col26 d22_col26 0 10000k
r1_d22_col26 d22_col26 d222_col26 5

r_SL1col26 SL1col26 0 10000k
r1_SL1col26 SL1col26 SL11col26 5
r_SL2col26 SL2col26 0 10000k
r1_SL2col26 SL2col26 SL22col26 5

* col27

mn1col27 d1_col27 en_col27 d11_col27 0 nenh w=4u l=.4u
mn2col27 d2_col27 en_col27 d22_col27 0 nenh w=4u l=.4u
mp1col27 d11_col27 enb_col27 d1_col27 3.3 penh w=8u l=0.4u
mp2col27 d22_col27 enb_col27 d2_col27 3.3 penh w=8u l=0.4u

r_en_col27 en_col27 0 10000k
r1_en_col27 en_col27 en1_col27 5
r_enb_col27 enb_col27 0 10000k
r1_enb_col27 enb_col27 enb1_col27 5

r_d11_col27 d11_col27 0 10000k
r1_d11_col27 d11_col27 d111_col27 5
r_d22_col27 d22_col27 0 10000k
r1_d22_col27 d22_col27 d222_col27 5

r_SL1col27 SL1col27 0 10000k
r1_SL1col27 SL1col27 SL11col27 5
r_SL2col27 SL2col27 0 10000k
r1_SL2col27 SL2col27 SL22col27 5

* col28

mn1col28 d1_col28 en_col28 d11_col28 0 nenh w=4u l=.4u
mn2col28 d2_col28 en_col28 d22_col28 0 nenh w=4u l=.4u
mp1col28 d11_col28 enb_col28 d1_col28 3.3 penh w=8u l=0.4u
mp2col28 d22_col28 enb_col28 d2_col28 3.3 penh w=8u l=0.4u

r_en_col28 en_col28 0 10000k
r1_en_col28 en_col28 en1_col28 5
r_enb_col28 enb_col28 0 10000k
r1_enb_col28 enb_col28 enb1_col28 5

r_d11_col28 d11_col28 0 10000k
r1_d11_col28 d11_col28 d111_col28 5
r_d22_col28 d22_col28 0 10000k
r1_d22_col28 d22_col28 d222_col28 5

r_SL1col28 SL1col28 0 10000k
r1_SL1col28 SL1col28 SL11col28 5
r_SL2col28 SL2col28 0 10000k
r1_SL2col28 SL2col28 SL22col28 5

* col29

mn1col29 d1_col29 en_col29 d11_col29 0 nenh w=4u l=.4u
mn2col29 d2_col29 en_col29 d22_col29 0 nenh w=4u l=.4u
mp1col29 d11_col29 enb_col29 d1_col29 3.3 penh w=8u l=0.4u
mp2col29 d22_col29 enb_col29 d2_col29 3.3 penh w=8u l=0.4u

r_en_col29 en_col29 0 10000k
r1_en_col29 en_col29 en1_col29 5
r_enb_col29 enb_col29 0 10000k
r1_enb_col29 enb_col29 enb1_col29 5

r_d11_col29 d11_col29 0 10000k
r1_d11_col29 d11_col29 d111_col29 5
r_d22_col29 d22_col29 0 10000k
r1_d22_col29 d22_col29 d222_col29 5

r_SL1col29 SL1col29 0 10000k
r1_SL1col29 SL1col29 SL11col29 5
r_SL2col29 SL2col29 0 10000k
r1_SL2col29 SL2col29 SL22col29 5

* col30

mn1col30 d1_col30 en_col30 d11_col30 0 nenh w=4u l=.4u
mn2col30 d2_col30 en_col30 d22_col30 0 nenh w=4u l=.4u
mp1col30 d11_col30 enb_col30 d1_col30 3.3 penh w=8u l=0.4u
mp2col30 d22_col30 enb_col30 d2_col30 3.3 penh w=8u l=0.4u

r_en_col30 en_col30 0 10000k
r1_en_col30 en_col30 en1_col30 5
r_enb_col30 enb_col30 0 10000k
r1_enb_col30 enb_col30 enb1_col30 5

r_d11_col30 d11_col30 0 10000k
r1_d11_col30 d11_col30 d111_col30 5
r_d22_col30 d22_col30 0 10000k
r1_d22_col30 d22_col30 d222_col30 5

r_SL1col30 SL1col30 0 10000k
r1_SL1col30 SL1col30 SL11col30 5
r_SL2col30 SL2col30 0 10000k

r1_SL2col30 SL2col30 SL22col30 5

* col31

mn1col31 d1_col31 en_col31 d11_col31 0 nenh w=4u l=.4u
mn2col31 d2_col31 en_col31 d22_col31 0 nenh w=4u l=.4u
mp1col31 d11_col31 enb_col31 d1_col31 3.3 penh w=8u l=0.4u
mp2col31 d22_col31 enb_col31 d2_col31 3.3 penh w=8u l=0.4u

r_en_col31 en_col31 0 10000k
r1_en_col31 en_col31 en1_col31 5
r_enb_col31 enb_col31 0 10000k
r1_enb_col31 enb_col31 enb1_col31 5

r_d11_col31 d11_col31 0 10000k
r1_d11_col31 d11_col31 d111_col31 5
r_d22_col31 d22_col31 0 10000k
r1_d22_col31 d22_col31 d222_col31 5

r_SL1col31 SL1col31 0 10000k
r1_SL1col31 SL1col31 SL11col31 5
r_SL2col31 SL2col31 0 10000k
r1_SL2col31 SL2col31 SL22col31 5

* col32

mn1col32 d1_col32 en_col32 d11_col32 0 nenh w=4u l=.4u
mn2col32 d2_col32 en_col32 d22_col32 0 nenh w=4u l=.4u
mp1col32 d11_col32 enb_col32 d1_col32 3.3 penh w=8u l=0.4u
mp2col32 d22_col32 enb_col32 d2_col32 3.3 penh w=8u l=0.4u

r_en_col32 en_col32 0 10000k
r1_en_col32 en_col32 en1_col32 5
r_enb_col32 enb_col32 0 10000k
r1_enb_col32 enb_col32 enb1_col32 5

r_d11_col32 d11_col32 0 10000k
r1_d11_col32 d11_col32 d111_col32 5
r_d22_col32 d22_col32 0 10000k
r1_d22_col32 d22_col32 d222_col32 5

r_SL1col32 SL1col32 0 10000k
r1_SL1col32 SL1col32 SL11col32 5
r_SL2col32 SL2col32 0 10000k
r1_SL2col32 SL2col32 SL22col32 5

* col33

mn1col33 d1_col33 en_col33 d11_col33 0 nenh w=4u l=.4u
mn2col33 d2_col33 en_col33 d22_col33 0 nenh w=4u l=.4u
mp1col33 d11_col33 enb_col33 d1_col33 3.3 penh w=8u l=0.4u
mp2col33 d22_col33 enb_col33 d2_col33 3.3 penh w=8u l=0.4u

r_en_col33 en_col33 0 10000k
r1_en_col33 en_col33 en1_col33 5
r_enb_col33 enb_col33 0 10000k
r1_enb_col33 enb_col33 enb1_col33 5

r_d11_col33 d11_col33 0 10000k
r1_d11_col33 d11_col33 d111_col33 5
r_d22_col33 d22_col33 0 10000k
r1_d22_col33 d22_col33 d222_col33 5

r_SL1col33 SL1col33 0 10000k
r1_SL1col33 SL1col33 SL11col33 5
r_SL2col33 SL2col33 0 10000k
r1_SL2col33 SL2col33 SL22col33 5

* col34

mn1col34 d1_col34 en_col34 d11_col34 0 nenh w=4u l=.4u
mn2col34 d2_col34 en_col34 d22_col34 0 nenh w=4u l=.4u
mp1col34 d11_col34 enb_col34 d1_col34 3.3 penh w=8u l=0.4u
mp2col34 d22_col34 enb_col34 d2_col34 3.3 penh w=8u l=0.4u

r_en_col34 en_col34 0 10000k
r1_en_col34 en_col34 en1_col34 5
r_enb_col34 enb_col34 0 10000k
r1_enb_col34 enb_col34 enb1_col34 5

r_d11_col34 d11_col34 0 10000k
r1_d11_col34 d11_col34 d111_col34 5
r_d22_col34 d22_col34 0 10000k
r1_d22_col34 d22_col34 d222_col34 5

r_SL1col34 SL1col34 0 10000k
r1_SL1col34 SL1col34 SL11col34 5
r_SL2col34 SL2col34 0 10000k
r1_SL2col34 SL2col34 SL22col34 5

* col35

mn1col35 d1_col35 en_col35 d11_col35 0 nenh w=4u l=.4u
mn2col35 d2_col35 en_col35 d22_col35 0 nenh w=4u l=.4u
mp1col35 d11_col35 enb_col35 d1_col35 3.3 penh w=8u l=0.4u
mp2col35 d22_col35 enb_col35 d2_col35 3.3 penh w=8u l=0.4u

r_en_col35 en_col35 0 10000k
r1_en_col35 en_col35 en1_col35 5
r_enb_col35 enb_col35 0 10000k
r1_enb_col35 enb_col35 enb1_col35 5

r_d11_col35 d11_col35 0 10000k
r1_d11_col35 d11_col35 d111_col35 5
r_d22_col35 d22_col35 0 10000k
r1_d22_col35 d22_col35 d222_col35 5

r_SL1col35 SL1col35 0 10000k
r1_SL1col35 SL1col35 SL11col35 5
r_SL2col35 SL2col35 0 10000k
r1_SL2col35 SL2col35 SL22col35 5

* col36

mn1col36 d1_col36 en_col36 d11_col36 0 nenh w=4u l=.4u
mn2col36 d2_col36 en_col36 d22_col36 0 nenh w=4u l=.4u
mp1col36 d11_col36 enb_col36 d1_col36 3.3 penh w=8u l=0.4u
mp2col36 d22_col36 enb_col36 d2_col36 3.3 penh w=8u l=0.4u

r_en_col36 en_col36 0 10000k
r1_en_col36 en_col36 en1_col36 5
r_enb_col36 enb_col36 0 10000k
r1_enb_col36 enb_col36 enb1_col36 5

r_d11_col36 d11_col36 0 10000k
r1_d11_col36 d11_col36 d111_col36 5
r_d22_col36 d22_col36 0 10000k

r1_d22_col36 d22_col36 d222_col36 5

r_SL1col36 SL1col36 0 10000k
r1_SL1col36 SL1col36 SL11col36 5
r_SL2col36 SL2col36 0 10000k
r1_SL2col36 SL2col36 SL22col36 5

* col37

mn1col37 d1_col37 en_col37 d11_col37 0 nenh w=4u l=.4u
mn2col37 d2_col37 en_col37 d22_col37 0 nenh w=4u l=.4u
mp1col37 d11_col37 enb_col37 d1_col37 3.3 penh w=8u l=0.4u
mp2col37 d22_col37 enb_col37 d2_col37 3.3 penh w=8u l=0.4u

r_en_col37 en_col37 0 10000k
r1_en_col37 en_col37 en1_col37 5
r_enb_col37 enb_col37 0 10000k
r1_enb_col37 enb_col37 enb1_col37 5

r_d11_col37 d11_col37 0 10000k
r1_d11_col37 d11_col37 d111_col37 5
r_d22_col37 d22_col37 0 10000k
r1_d22_col37 d22_col37 d222_col37 5

r_SL1col37 SL1col37 0 10000k
r1_SL1col37 SL1col37 SL11col37 5
r_SL2col37 SL2col37 0 10000k
r1_SL2col37 SL2col37 SL22col37 5

* col38

mn1col38 d1_col38 en_col38 d11_col38 0 nenh w=4u l=.4u
mn2col38 d2_col38 en_col38 d22_col38 0 nenh w=4u l=.4u
mp1col38 d11_col38 enb_col38 d1_col38 3.3 penh w=8u l=0.4u
mp2col38 d22_col38 enb_col38 d2_col38 3.3 penh w=8u l=0.4u

r_en_col38 en_col38 0 10000k
r1_en_col38 en_col38 en1_col38 5
r_enb_col38 enb_col38 0 10000k
r1_enb_col38 enb_col38 enb1_col38 5

r_d11_col38 d11_col38 0 10000k
r1_d11_col38 d11_col38 d111_col38 5
r_d22_col38 d22_col38 0 10000k
r1_d22_col38 d22_col38 d222_col38 5

r_SL1col38 SL1col38 0 10000k
r1_SL1col38 SL1col38 SL11col38 5
r_SL2col38 SL2col38 0 10000k
r1_SL2col38 SL2col38 SL22col38 5

* col39

mn1col39 d1_col39 en_col39 d11_col39 0 nenh w=4u l=.4u
mn2col39 d2_col39 en_col39 d22_col39 0 nenh w=4u l=.4u
mp1col39 d11_col39 enb_col39 d1_col39 3.3 penh w=8u l=0.4u
mp2col39 d22_col39 enb_col39 d2_col39 3.3 penh w=8u l=0.4u

r_en_col39 en_col39 0 10000k
r1_en_col39 en_col39 en1_col39 5
r_enb_col39 enb_col39 0 10000k
r1_enb_col39 enb_col39 enb1_col39 5

r_d11_col39 d11_col39 0 10000k

r1_d11_col39 d11_col39 d111_col39 5
r_d22_col39 d22_col39 0 10000k
r1_d22_col39 d22_col39 d222_col39 5

r_SL1col39 SL1col39 0 10000k
r1_SL1col39 SL1col39 SL11col39 5
r_SL2col39 SL2col39 0 10000k
r1_SL2col39 SL2col39 SL22col39 5

* col40

mn1col40 d1_col40 en_col40 d11_col40 0 nenh w=4u l=.4u
mn2col40 d2_col40 en_col40 d22_col40 0 nenh w=4u l=.4u
mp1col40 d11_col40 enb_col40 d1_col40 3.3 penh w=8u l=0.4u
mp2col40 d22_col40 enb_col40 d2_col40 3.3 penh w=8u l=0.4u

r_en_col40 en_col40 0 10000k
r1_en_col40 en_col40 en1_col40 5
r_enb_col40 enb_col40 0 10000k
r1_enb_col40 enb_col40 enb1_col40 5

r_d11_col40 d11_col40 0 10000k
r1_d11_col40 d11_col40 d111_col40 5
r_d22_col40 d22_col40 0 10000k
r1_d22_col40 d22_col40 d222_col40 5

r_SL1col40 SL1col40 0 10000k
r1_SL1col40 SL1col40 SL11col40 5
r_SL2col40 SL2col40 0 10000k
r1_SL2col40 SL2col40 SL22col40 5

* col41

mn1col41 d1_col41 en_col41 d11_col41 0 nenh w=4u l=.4u
mn2col41 d2_col41 en_col41 d22_col41 0 nenh w=4u l=.4u
mp1col41 d11_col41 enb_col41 d1_col41 3.3 penh w=8u l=0.4u
mp2col41 d22_col41 enb_col41 d2_col41 3.3 penh w=8u l=0.4u

r_en_col41 en_col41 0 10000k
r1_en_col41 en_col41 en1_col41 5
r_enb_col41 enb_col41 0 10000k
r1_enb_col41 enb_col41 enb1_col41 5

r_d11_col41 d11_col41 0 10000k
r1_d11_col41 d11_col41 d111_col41 5
r_d22_col41 d22_col41 0 10000k
r1_d22_col41 d22_col41 d222_col41 5

r_SL1col41 SL1col41 0 10000k
r1_SL1col41 SL1col41 SL11col41 5
r_SL2col41 SL2col41 0 10000k
r1_SL2col41 SL2col41 SL22col41 5

* col42

mn1col42 d1_col42 en_col42 d11_col42 0 nenh w=4u l=.4u
mn2col42 d2_col42 en_col42 d22_col42 0 nenh w=4u l=.4u
mp1col42 d11_col42 enb_col42 d1_col42 3.3 penh w=8u l=0.4u
mp2col42 d22_col42 enb_col42 d2_col42 3.3 penh w=8u l=0.4u

r_en_col42 en_col42 0 10000k
r1_en_col42 en_col42 en1_col42 5
r_enb_col42 enb_col42 0 10000k
r1_enb_col42 enb_col42 enb1_col42 5

r_d11_col42 d11_col42 0 10000k
r1_d11_col42 d11_col42 d111_col42 5
r_d22_col42 d22_col42 0 10000k
r1_d22_col42 d22_col42 d222_col42 5

r_SL1col42 SL1col42 0 10000k
r1_SL1col42 SL1col42 SL11col42 5
r_SL2col42 SL2col42 0 10000k
r1_SL2col42 SL2col42 SL22col42 5

* col43

mn1col43 d1_col43 en_col43 d11_col43 0 nenh w=4u l=.4u
mn2col43 d2_col43 en_col43 d22_col43 0 nenh w=4u l=.4u
mp1col43 d11_col43 enb_col43 d1_col43 3.3 penh w=8u l=0.4u
mp2col43 d22_col43 enb_col43 d2_col43 3.3 penh w=8u l=0.4u

r_en_col43 en_col43 0 10000k
r1_en_col43 en_col43 en1_col43 5
r_enb_col43 enb_col43 0 10000k
r1_enb_col43 enb_col43 enb1_col43 5

r_d11_col43 d11_col43 0 10000k
r1_d11_col43 d11_col43 d111_col43 5
r_d22_col43 d22_col43 0 10000k
r1_d22_col43 d22_col43 d222_col43 5

r_SL1col43 SL1col43 0 10000k
r1_SL1col43 SL1col43 SL11col43 5
r_SL2col43 SL2col43 0 10000k
r1_SL2col43 SL2col43 SL22col43 5

* col44

mn1col44 d1_col44 en_col44 d11_col44 0 nenh w=4u l=.4u
mn2col44 d2_col44 en_col44 d22_col44 0 nenh w=4u l=.4u
mp1col44 d11_col44 enb_col44 d1_col44 3.3 penh w=8u l=0.4u
mp2col44 d22_col44 enb_col44 d2_col44 3.3 penh w=8u l=0.4u

r_en_col44 en_col44 0 10000k
r1_en_col44 en_col44 en1_col44 5
r_enb_col44 enb_col44 0 10000k
r1_enb_col44 enb_col44 enb1_col44 5

r_d11_col44 d11_col44 0 10000k
r1_d11_col44 d11_col44 d111_col44 5
r_d22_col44 d22_col44 0 10000k
r1_d22_col44 d22_col44 d222_col44 5

r_SL1col44 SL1col44 0 10000k
r1_SL1col44 SL1col44 SL11col44 5
r_SL2col44 SL2col44 0 10000k
r1_SL2col44 SL2col44 SL22col44 5

* col45

mn1col45 d1_col45 en_col45 d11_col45 0 nenh w=4u l=.4u
mn2col45 d2_col45 en_col45 d22_col45 0 nenh w=4u l=.4u
mp1col45 d11_col45 enb_col45 d1_col45 3.3 penh w=8u l=0.4u
mp2col45 d22_col45 enb_col45 d2_col45 3.3 penh w=8u l=0.4u

r_en_col45 en_col45 0 10000k
r1_en_col45 en_col45 en1_col45 5
r_enb_col45 enb_col45 0 10000k

r1_enb_col45 enb_col45 enb1_col45 5

r_d11_col45 d11_col45 0 10000k
r1_d11_col45 d11_col45 d111_col45 5
r_d22_col45 d22_col45 0 10000k
r1_d22_col45 d22_col45 d222_col45 5

r_SL1col45 SL1col45 0 10000k
r1_SL1col45 SL1col45 SL11col45 5
r_SL2col45 SL2col45 0 10000k
r1_SL2col45 SL2col45 SL22col45 5

* col46

mn1col46 d1_col46 en_col46 d11_col46 0 nenh w=4u l=.4u
mn2col46 d2_col46 en_col46 d22_col46 0 nenh w=4u l=.4u
mp1col46 d11_col46 enb_col46 d1_col46 3.3 penh w=8u l=0.4u
mp2col46 d22_col46 enb_col46 d2_col46 3.3 penh w=8u l=0.4u

r_en_col46 en_col46 0 10000k
r1_en_col46 en_col46 en1_col46 5
r_enb_col46 enb_col46 0 10000k
r1_enb_col46 enb_col46 enb1_col46 5

r_d11_col46 d11_col46 0 10000k
r1_d11_col46 d11_col46 d111_col46 5
r_d22_col46 d22_col46 0 10000k
r1_d22_col46 d22_col46 d222_col46 5

r_SL1col46 SL1col46 0 10000k
r1_SL1col46 SL1col46 SL11col46 5
r_SL2col46 SL2col46 0 10000k
r1_SL2col46 SL2col46 SL22col46 5

* col47

mn1col47 d1_col47 en_col47 d11_col47 0 nenh w=4u l=.4u
mn2col47 d2_col47 en_col47 d22_col47 0 nenh w=4u l=.4u
mp1col47 d11_col47 enb_col47 d1_col47 3.3 penh w=8u l=0.4u
mp2col47 d22_col47 enb_col47 d2_col47 3.3 penh w=8u l=0.4u

r_en_col47 en_col47 0 10000k
r1_en_col47 en_col47 en1_col47 5
r_enb_col47 enb_col47 0 10000k
r1_enb_col47 enb_col47 enb1_col47 5

r_d11_col47 d11_col47 0 10000k
r1_d11_col47 d11_col47 d111_col47 5
r_d22_col47 d22_col47 0 10000k
r1_d22_col47 d22_col47 d222_col47 5

r_SL1col47 SL1col47 0 10000k
r1_SL1col47 SL1col47 SL11col47 5
r_SL2col47 SL2col47 0 10000k
r1_SL2col47 SL2col47 SL22col47 5

* col48

mn1col48 d1_col48 en_col48 d11_col48 0 nenh w=4u l=.4u
mn2col48 d2_col48 en_col48 d22_col48 0 nenh w=4u l=.4u
mp1col48 d11_col48 enb_col48 d1_col48 3.3 penh w=8u l=0.4u
mp2col48 d22_col48 enb_col48 d2_col48 3.3 penh w=8u l=0.4u

r_en_col48 en_col48 0 10000k

r1_en_col48 en_col48 en1_col48 5
r_enb_col48 enb_col48 0 10000k
r1_enb_col48 enb_col48 enb1_col48 5

r_d11_col48 d11_col48 0 10000k
r1_d11_col48 d11_col48 d111_col48 5
r_d22_col48 d22_col48 0 10000k
r1_d22_col48 d22_col48 d222_col48 5

r_SL1col48 SL1col48 0 10000k
r1_SL1col48 SL1col48 SL11col48 5
r_SL2col48 SL2col48 0 10000k
r1_SL2col48 SL2col48 SL22col48 5

* col49

mn1col49 d1_col49 en_col49 d11_col49 0 nenh w=4u l=.4u
mn2col49 d2_col49 en_col49 d22_col49 0 nenh w=4u l=.4u
mp1col49 d11_col49 enb_col49 d1_col49 3.3 penh w=8u l=0.4u
mp2col49 d22_col49 enb_col49 d2_col49 3.3 penh w=8u l=0.4u

r_en_col49 en_col49 0 10000k
r1_en_col49 en_col49 en1_col49 5
r_enb_col49 enb_col49 0 10000k
r1_enb_col49 enb_col49 enb1_col49 5

r_d11_col49 d11_col49 0 10000k
r1_d11_col49 d11_col49 d111_col49 5
r_d22_col49 d22_col49 0 10000k
r1_d22_col49 d22_col49 d222_col49 5

r_SL1col49 SL1col49 0 10000k
r1_SL1col49 SL1col49 SL11col49 5
r_SL2col49 SL2col49 0 10000k
r1_SL2col49 SL2col49 SL22col49 5

* col50

mn1col50 d1_col50 en_col50 d11_col50 0 nenh w=4u l=.4u
mn2col50 d2_col50 en_col50 d22_col50 0 nenh w=4u l=.4u
mp1col50 d11_col50 enb_col50 d1_col50 3.3 penh w=8u l=0.4u
mp2col50 d22_col50 enb_col50 d2_col50 3.3 penh w=8u l=0.4u

r_en_col50 en_col50 0 10000k
r1_en_col50 en_col50 en1_col50 5
r_enb_col50 enb_col50 0 10000k
r1_enb_col50 enb_col50 enb1_col50 5

r_d11_col50 d11_col50 0 10000k
r1_d11_col50 d11_col50 d111_col50 5
r_d22_col50 d22_col50 0 10000k
r1_d22_col50 d22_col50 d222_col50 5

r_SL1col50 SL1col50 0 10000k
r1_SL1col50 SL1col50 SL11col50 5
r_SL2col50 SL2col50 0 10000k
r1_SL2col50 SL2col50 SL22col50 5

* col51

mn1col51 d1_col51 en_col51 d11_col51 0 nenh w=4u l=.4u
mn2col51 d2_col51 en_col51 d22_col51 0 nenh w=4u l=.4u
mp1col51 d11_col51 enb_col51 d1_col51 3.3 penh w=8u l=0.4u
mp2col51 d22_col51 enb_col51 d2_col51 3.3 penh w=8u l=0.4u

r_en_col51 en_col51 0 10000k
r1_en_col51 en_col51 en1_col51 5
r_enb_col51 enb_col51 0 10000k
r1_enb_col51 enb_col51 enb1_col51 5

r_d11_col51 d11_col51 0 10000k
r1_d11_col51 d11_col51 d111_col51 5
r_d22_col51 d22_col51 0 10000k
r1_d22_col51 d22_col51 d222_col51 5

r_SL1col51 SL1col51 0 10000k
r1_SL1col51 SL1col51 SL11col51 5
r_SL2col51 SL2col51 0 10000k
r1_SL2col51 SL2col51 SL22col51 5

* col52

mn1col52 d1_col52 en_col52 d11_col52 0 nenh w=4u l=.4u
mn2col52 d2_col52 en_col52 d22_col52 0 nenh w=4u l=.4u
mp1col52 d11_col52 enb_col52 d1_col52 3.3 penh w=8u l=0.4u
mp2col52 d22_col52 enb_col52 d2_col52 3.3 penh w=8u l=0.4u

r_en_col52 en_col52 0 10000k
r1_en_col52 en_col52 en1_col52 5
r_enb_col52 enb_col52 0 10000k
r1_enb_col52 enb_col52 enb1_col52 5

r_d11_col52 d11_col52 0 10000k
r1_d11_col52 d11_col52 d111_col52 5
r_d22_col52 d22_col52 0 10000k
r1_d22_col52 d22_col52 d222_col52 5

r_SL1col52 SL1col52 0 10000k
r1_SL1col52 SL1col52 SL11col52 5
r_SL2col52 SL2col52 0 10000k
r1_SL2col52 SL2col52 SL22col52 5

* col53

mn1col53 d1_col53 en_col53 d11_col53 0 nenh w=4u l=.4u
mn2col53 d2_col53 en_col53 d22_col53 0 nenh w=4u l=.4u
mp1col53 d11_col53 enb_col53 d1_col53 3.3 penh w=8u l=0.4u
mp2col53 d22_col53 enb_col53 d2_col53 3.3 penh w=8u l=0.4u

r_en_col53 en_col53 0 10000k
r1_en_col53 en_col53 en1_col53 5
r_enb_col53 enb_col53 0 10000k
r1_enb_col53 enb_col53 enb1_col53 5

r_d11_col53 d11_col53 0 10000k
r1_d11_col53 d11_col53 d111_col53 5
r_d22_col53 d22_col53 0 10000k
r1_d22_col53 d22_col53 d222_col53 5

r_SL1col53 SL1col53 0 10000k
r1_SL1col53 SL1col53 SL11col53 5
r_SL2col53 SL2col53 0 10000k
r1_SL2col53 SL2col53 SL22col53 5

* col54

mn1col54 d1_col54 en_col54 d11_col54 0 nenh w=4u l=.4u
mn2col54 d2_col54 en_col54 d22_col54 0 nenh w=4u l=.4u

mp1col54 d11_col54 enb_col54 d1_col54 3.3 penh w=8u l=0.4u
mp2col54 d22_col54 enb_col54 d2_col54 3.3 penh w=8u l=0.4u

r_en_col54 en_col54 0 10000k
r1_en_col54 en_col54 en1_col54 5
r_enb_col54 enb_col54 0 10000k
r1_enb_col54 enb_col54 enb1_col54 5

r_d11_col54 d11_col54 0 10000k
r1_d11_col54 d11_col54 d111_col54 5
r_d22_col54 d22_col54 0 10000k
r1_d22_col54 d22_col54 d222_col54 5

r_SL1col54 SL1col54 0 10000k
r1_SL1col54 SL1col54 SL11col54 5
r_SL2col54 SL2col54 0 10000k
r1_SL2col54 SL2col54 SL22col54 5

* col55

mn1col55 d1_col55 en_col55 d11_col55 0 nenh w=4u l=.4u
mn2col55 d2_col55 en_col55 d22_col55 0 nenh w=4u l=.4u
mp1col55 d11_col55 enb_col55 d1_col55 3.3 penh w=8u l=0.4u
mp2col55 d22_col55 enb_col55 d2_col55 3.3 penh w=8u l=0.4u

r_en_col55 en_col55 0 10000k
r1_en_col55 en_col55 en1_col55 5
r_enb_col55 enb_col55 0 10000k
r1_enb_col55 enb_col55 enb1_col55 5

r_d11_col55 d11_col55 0 10000k
r1_d11_col55 d11_col55 d111_col55 5
r_d22_col55 d22_col55 0 10000k
r1_d22_col55 d22_col55 d222_col55 5

r_SL1col55 SL1col55 0 10000k
r1_SL1col55 SL1col55 SL11col55 5
r_SL2col55 SL2col55 0 10000k
r1_SL2col55 SL2col55 SL22col55 5

* col56

mn1col56 d1_col56 en_col56 d11_col56 0 nenh w=4u l=.4u
mn2col56 d2_col56 en_col56 d22_col56 0 nenh w=4u l=.4u
mp1col56 d11_col56 enb_col56 d1_col56 3.3 penh w=8u l=0.4u
mp2col56 d22_col56 enb_col56 d2_col56 3.3 penh w=8u l=0.4u

r_en_col56 en_col56 0 10000k
r1_en_col56 en_col56 en1_col56 5
r_enb_col56 enb_col56 0 10000k
r1_enb_col56 enb_col56 enb1_col56 5

r_d11_col56 d11_col56 0 10000k
r1_d11_col56 d11_col56 d111_col56 5
r_d22_col56 d22_col56 0 10000k
r1_d22_col56 d22_col56 d222_col56 5

r_SL1col56 SL1col56 0 10000k
r1_SL1col56 SL1col56 SL11col56 5
r_SL2col56 SL2col56 0 10000k
r1_SL2col56 SL2col56 SL22col56 5

* col57

mn1col57 d1_col57 en_col57 d11_col57 0 nenh w=4u l=.4u
mn2col57 d2_col57 en_col57 d22_col57 0 nenh w=4u l=.4u
mp1col57 d11_col57 enb_col57 d1_col57 3.3 penh w=8u l=0.4u
mp2col57 d22_col57 enb_col57 d2_col57 3.3 penh w=8u l=0.4u

r_en_col57 en_col57 0 10000k
r1_en_col57 en_col57 en1_col57 5
r_enb_col57 enb_col57 0 10000k
r1_enb_col57 enb_col57 enb1_col57 5

r_d11_col57 d11_col57 0 10000k
r1_d11_col57 d11_col57 d111_col57 5
r_d22_col57 d22_col57 0 10000k
r1_d22_col57 d22_col57 d222_col57 5

r_SL1col57 SL1col57 0 10000k
r1_SL1col57 SL1col57 SL11col57 5
r_SL2col57 SL2col57 0 10000k
r1_SL2col57 SL2col57 SL22col57 5

* col58

mn1col58 d1_col58 en_col58 d11_col58 0 nenh w=4u l=.4u
mn2col58 d2_col58 en_col58 d22_col58 0 nenh w=4u l=.4u
mp1col58 d11_col58 enb_col58 d1_col58 3.3 penh w=8u l=0.4u
mp2col58 d22_col58 enb_col58 d2_col58 3.3 penh w=8u l=0.4u

r_en_col58 en_col58 0 10000k
r1_en_col58 en_col58 en1_col58 5
r_enb_col58 enb_col58 0 10000k
r1_enb_col58 enb_col58 enb1_col58 5

r_d11_col58 d11_col58 0 10000k
r1_d11_col58 d11_col58 d111_col58 5
r_d22_col58 d22_col58 0 10000k
r1_d22_col58 d22_col58 d222_col58 5

r_SL1col58 SL1col58 0 10000k
r1_SL1col58 SL1col58 SL11col58 5
r_SL2col58 SL2col58 0 10000k
r1_SL2col58 SL2col58 SL22col58 5

* col59

mn1col59 d1_col59 en_col59 d11_col59 0 nenh w=4u l=.4u
mn2col59 d2_col59 en_col59 d22_col59 0 nenh w=4u l=.4u
mp1col59 d11_col59 enb_col59 d1_col59 3.3 penh w=8u l=0.4u
mp2col59 d22_col59 enb_col59 d2_col59 3.3 penh w=8u l=0.4u

r_en_col59 en_col59 0 10000k
r1_en_col59 en_col59 en1_col59 5
r_enb_col59 enb_col59 0 10000k
r1_enb_col59 enb_col59 enb1_col59 5

r_d11_col59 d11_col59 0 10000k
r1_d11_col59 d11_col59 d111_col59 5
r_d22_col59 d22_col59 0 10000k
r1_d22_col59 d22_col59 d222_col59 5

r_SL1col59 SL1col59 0 10000k
r1_SL1col59 SL1col59 SL11col59 5
r_SL2col59 SL2col59 0 10000k
r1_SL2col59 SL2col59 SL22col59 5

* col60

mn1col60 d1_col60 en_col60 d11_col60 0 nenh w=4u l=.4u
mn2col60 d2_col60 en_col60 d22_col60 0 nenh w=4u l=.4u
mp1col60 d11_col60 enb_col60 d1_col60 3.3 penh w=8u l=0.4u
mp2col60 d22_col60 enb_col60 d2_col60 3.3 penh w=8u l=0.4u

r_en_col60 en_col60 0 10000k
r1_en_col60 en_col60 en1_col60 5
r_enb_col60 enb_col60 0 10000k
r1_enb_col60 enb_col60 enb1_col60 5

r_d11_col60 d11_col60 0 10000k
r1_d11_col60 d11_col60 d111_col60 5
r_d22_col60 d22_col60 0 10000k
r1_d22_col60 d22_col60 d222_col60 5

r_SL1col60 SL1col60 0 10000k
r1_SL1col60 SL1col60 SL11col60 5
r_SL2col60 SL2col60 0 10000k
r1_SL2col60 SL2col60 SL22col60 5

* col61

mn1col61 d1_col61 en_col61 d11_col61 0 nenh w=4u l=.4u
mn2col61 d2_col61 en_col61 d22_col61 0 nenh w=4u l=.4u
mp1col61 d11_col61 enb_col61 d1_col61 3.3 penh w=8u l=0.4u
mp2col61 d22_col61 enb_col61 d2_col61 3.3 penh w=8u l=0.4u

r_en_col61 en_col61 0 10000k
r1_en_col61 en_col61 en1_col61 5
r_enb_col61 enb_col61 0 10000k
r1_enb_col61 enb_col61 enb1_col61 5

r_d11_col61 d11_col61 0 10000k
r1_d11_col61 d11_col61 d111_col61 5
r_d22_col61 d22_col61 0 10000k
r1_d22_col61 d22_col61 d222_col61 5

r_SL1col61 SL1col61 0 10000k
r1_SL1col61 SL1col61 SL11col61 5
r_SL2col61 SL2col61 0 10000k
r1_SL2col61 SL2col61 SL22col61 5

* col62

mn1col62 d1_col62 en_col62 d11_col62 0 nenh w=4u l=.4u
mn2col62 d2_col62 en_col62 d22_col62 0 nenh w=4u l=.4u
mp1col62 d11_col62 enb_col62 d1_col62 3.3 penh w=8u l=0.4u
mp2col62 d22_col62 enb_col62 d2_col62 3.3 penh w=8u l=0.4u

r_en_col62 en_col62 0 10000k
r1_en_col62 en_col62 en1_col62 5
r_enb_col62 enb_col62 0 10000k
r1_enb_col62 enb_col62 enb1_col62 5

r_d11_col62 d11_col62 0 10000k
r1_d11_col62 d11_col62 d111_col62 5
r_d22_col62 d22_col62 0 10000k
r1_d22_col62 d22_col62 d222_col62 5

r_SL1col62 SL1col62 0 10000k
r1_SL1col62 SL1col62 SL11col62 5
r_SL2col62 SL2col62 0 10000k

r1_SL2col62 SL2col62 SL22col62 5

* col63

mn1col63 d1_col63 en_col63 d11_col63 0 nenh w=4u l=.4u
mn2col63 d2_col63 en_col63 d22_col63 0 nenh w=4u l=.4u
mp1col63 d11_col63 enb_col63 d1_col63 3.3 penh w=8u l=0.4u
mp2col63 d22_col63 enb_col63 d2_col63 3.3 penh w=8u l=0.4u

r_en_col63 en_col63 0 10000k
r1_en_col63 en_col63 en1_col63 5
r_enb_col63 enb_col63 0 10000k
r1_enb_col63 enb_col63 enb1_col63 5

r_d11_col63 d11_col63 0 10000k
r1_d11_col63 d11_col63 d111_col63 5
r_d22_col63 d22_col63 0 10000k
r1_d22_col63 d22_col63 d222_col63 5

r_SL1col63 SL1col63 0 10000k
r1_SL1col63 SL1col63 SL11col63 5
r_SL2col63 SL2col63 0 10000k
r1_SL2col63 SL2col63 SL22col63 5

.....
sources_array64bit_Pipelining.cir
.....

* power supply *

v_dd u 0 dc 3.3
v_dd_2 u2 0 dc 1.65
v_dd2 l 0 pulse(0 1.65 1n 0.25n 0.25n 1.5n 20n)

* row enable *

v_en_row0 en1_row0 0 dc 3.3
v_enb_row0 enb1_row0 0 dc 0

* column enable *

v_en_col0 en1_col0 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col0 enb1_col0 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col1 en1_col1 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col1 enb1_col1 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col2 en1_col2 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col2 enb1_col2 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col3 en1_col3 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col3 enb1_col3 0 pulse(3.3 0 1n 1p 1p 2n 20n)
v_en_col4 en1_col4 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col4 enb1_col4 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col5 en1_col5 0 pulse(0 3.3 1n 1p 1p 2n 20n)

v_enb_col5 enb1_col5 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col6 en1_col6 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col6 enb1_col6 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col7 en1_col7 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col7 enb1_col7 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col8 en1_col8 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col8 enb1_col8 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col9 en1_col9 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col9 enb1_col9 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col10 en1_col10 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col10 enb1_col10 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col11 en1_col11 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col11 enb1_col11 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col12 en1_col12 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col12 enb1_col12 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col13 en1_col13 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col13 enb1_col13 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col14 en1_col14 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col14 enb1_col14 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col15 en1_col15 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col15 enb1_col15 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col16 en1_col16 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col16 enb1_col16 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col17 en1_col17 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col17 enb1_col17 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col18 en1_col18 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col18 enb1_col18 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col19 en1_col19 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col19 enb1_col19 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col20 en1_col20 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col20 enb1_col20 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col21 en1_col21 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col21 enb1_col21 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col22 en1_col22 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col22 enb1_col22 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col23 en1_col23 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col23 enb1_col23 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col24 en1_col24 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col24 enb1_col24 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col25 en1_col25 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col25 enb1_col25 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col26 en1_col26 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col26 enb1_col26 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col27 en1_col27 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col27 enb1_col27 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col28 en1_col28 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col28 enb1_col28 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col29 en1_col29 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col29 enb1_col29 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col30 en1_col30 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col30 enb1_col30 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col31 en1_col31 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col31 enb1_col31 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col32 en1_col32 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col32 enb1_col32 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col33 en1_col33 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col33 enb1_col33 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col34 en1_col34 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col34 enb1_col34 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col35 en1_col35 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col35 enb1_col35 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col36 en1_col36 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col36 enb1_col36 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col37 en1_col37 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col37 enb1_col37 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col38 en1_col38 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col38 enb1_col38 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col39 en1_col39 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col39 enb1_col39 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col40 en1_col40 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col40 enb1_col40 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col41 en1_col41 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col41 enb1_col41 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col42 en1_col42 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col42 enb1_col42 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col43 en1_col43 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col43 enb1_col43 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col44 en1_col44 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col44 enb1_col44 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col45 en1_col45 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col45 enb1_col45 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col46 en1_col46 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col46 enb1_col46 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col47 en1_col47 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col47 enb1_col47 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col48 en1_col48 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col48 enb1_col48 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col49 en1_col49 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col49 enb1_col49 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col50 en1_col50 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col50 enb1_col50 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col51 en1_col51 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col51 enb1_col51 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col52 en1_col52 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col52 enb1_col52 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col53 en1_col53 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col53 enb1_col53 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col54 en1_col54 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col54 enb1_col54 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col55 en1_col55 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col55 enb1_col55 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col56 en1_col56 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col56 enb1_col56 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col57 en1_col57 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col57 enb1_col57 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col58 en1_col58 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col58 enb1_col58 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col59 en1_col59 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col59 enb1_col59 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col60 en1_col60 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col60 enb1_col60 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col61 en1_col61 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col61 enb1_col61 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col62 en1_col62 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col62 enb1_col62 0 pulse(3.3 0 1n 1p 1p 2n 20n)

v_en_col63 en1_col63 0 pulse(0 3.3 1n 1p 1p 2n 20n)
v_enb_col63 enb1_col63 0 pulse(3.3 0 1n 1p 1p 2n 20n)

* data lines *

v_d1col0 d111_col0 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22n 3.3 22.5n 0 23n 0 41n 0 41.5n 3.3 42.5n 3.3 43n 0
+61n 0 61.5n 3.3 62n 3.3 62.5n 0 63n 0 81n 0 81.5n 3.3 82.5n 3.3 83n 0)
v_d2col0 d222_col0 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22.5n 3.3 23n 0 41n 0 41.5n 3.3 42n 3.3 42.5n 0 43n 0
+61n 0 61.5n 3.3 62.5n 3.3 63n 0 81n 0 81.5n 3.3 82n 3.3 82.5n 0 83n 0)

v_d1col1 d111_col1 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22.5n 3.3 23n 0 41n 0 41.5n 3.3 42n 3.3 42.5n 0 43n 0
+61n 0 61.5n 3.3 62.5n 3.3 63n 0 81n 0 81.5n 3.3 82n 3.3 82.5n 0 83n 0)
v_d2col1 d222_col1 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22n 3.3 22.5n 0 23n 0 41n 0 41.5n 3.3 42.5n 3.3 43n 0
+61n 0 61.5n 3.3 62n 3.3 62.5n 0 63n 0 81n 0 81.5n 3.3 82.5n 3.3 83n 0)

v_d1col60 d111_col60 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22n 3.3 22.5n 0 23n 0 41n 0 41.5n 3.3 42.5n 3.3 43n 0
+61n 0 61.5n 3.3 62n 3.3 62.5n 0 63n 0 81n 0 81.5n 3.3 82.5n 3.3 83n 0)
v_d2col60 d222_col60 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22.5n 3.3 23n 0 41n 0 41.5n 3.3 42n 3.3 42.5n 0 43n 0
+61n 0 61.5n 3.3 62.5n 3.3 63n 0 81n 0 81.5n 3.3 82n 3.3 82.5n 0 83n 0)

v_d1col61 d111_col61 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22.5n 3.3 23n 0 41n 0 41.5n 3.3 42n 3.3 42.5n 0 43n 0
+61n 0 61.5n 3.3 62.5n 3.3 63n 0 81n 0 81.5n 3.3 82n 3.3 82.5n 0 83n 0)
v_d2col61 d222_col61 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22n 3.3 22.5n 0 23n 0 41n 0 41.5n 3.3 42.5n 3.3 43n 0
+61n 0 61.5n 3.3 62n 3.3 62.5n 0 63n 0 81n 0 81.5n 3.3 82.5n 3.3 83n 0)

v_d1col62 d111_col62 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22.5n 3.3 23n 0 41n 0 41.5n 3.3 42n 3.3 42.5n 0 43n 0
+61n 0 61.5n 3.3 62.5n 3.3 63n 0 81n 0 81.5n 3.3 82n 3.3 82.5n 0 83n 0)
v_d2col62 d222_col62 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22n 3.3 22.5n 0 23n 0 41n 0 41.5n 3.3 42.5n 3.3 43n 0
+61n 0 61.5n 3.3 62n 3.3 62.5n 0 63n 0 81n 0 81.5n 3.3 82.5n 3.3 83n 0)

v_d1col63 d111_col63 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22n 3.3 22.5n 0 23n 0 41n 0 41.5n 3.3 42.5n 3.3 43n 0
+61n 0 61.5n 3.3 62n 3.3 62.5n 0 63n 0 81n 0 81.5n 3.3 82.5n 3.3 83n 0)
v_d2col63 d222_col63 0 pwl(0 0 1n 0 1.5n 3.3 2.5n 3.3 3n 0 21n 0 21.5n 3.3 22.5n 3.3 23n 0 41n 0 41.5n 3.3 42n 3.3 42.5n 0 43n 0
+61n 0 61.5n 3.3 62.5n 3.3 63n 0 81n 0 81.5n 3.3 82n 3.3 82.5n 0 83n 0)

* search lines *

v_SL1_col0 SL11col0 0 pwl(0 0 47n 0 47.02n 3.3 50.0n 3.3 50.02n 0 87n 0 87.02n 3.3 90.0n 3.3 90.02n 0)
v_SL2_col0 SL22col0 0 pwl(0 0 27n 0 27.02n 3.3 30.0n 3.3 30.02n 0 67n 0 67.02n 3.3 70.0n 3.3 70.02n 0)

v_SL1_col1 SL11col1 0 pwl(0 0 27n 0 27.02n 3.3 30.0n 3.3 30.02n 0 67n 0 67.02n 3.3 70.0n 3.3 70.02n 0)
v_SL2_col1 SL22col1 0 pwl(0 0 47n 0 47.02n 3.3 50.0n 3.3 50.02n 0 87n 0 87.02n 3.3 90.0n 3.3 90.02n 0)

v_SL1_col2 SL11col2 0 pwl(0 0 27n 0 27.02n 3.3 30.0n 3.3 30.02n 0 67n 0 67.02n 3.3 70.0n 3.3 70.02n 0)
v_SL2_col2 SL22col2 0 pwl(0 0 47n 0 47.02n 3.3 50.0n 3.3 50.02n 0 87n 0 87.02n 3.3 90.0n 3.3 90.02n 0)

v_SL1_col3 SL11col3 0 pwl(0 0 47n 0 47.02n 3.3 50.0n 3.3 50.02n 0 87n 0 87.02n 3.3 90.0n 3.3 90.02n 0)
v_SL2_col3 SL22col3 0 pwl(0 0 27n 0 27.02n 3.3 30.0n 3.3 30.02n 0 67n 0 67.02n 3.3 70.0n 3.3 70.02n 0)

v_SL1_col4 SL11col4 0 pwl(0 0 27n 0 27.02n 3.3 30.0n 3.3 30.02n 0 67n 0 67.02n 3.3 70.0n 3.3 70.02n 0)
v_SL2_col4 SL22col4 0 pwl(0 0 47n 0 47.02n 3.3 50.0n 3.3 50.02n 0 87n 0 87.02n 3.3 90.0n 3.3 90.02n 0)

v_SL1_col5 SL11col5 0 pwl(0 0 27n 0 27.02n 3.3 30.0n 3.3 30.02n 0 67n 0 67.02n 3.3 70.0n 3.3 70.02n 0)
v_SL2_col5 SL22col5 0 pwl(0 0 47n 0 47.02n 3.3 50.0n 3.3 50.02n 0 87n 0 87.02n 3.3 90.0n 3.3 90.02n 0)

v_SL1_col6 SL11col6 0 pwl(0 0 47n 0 47.02n 3.3 50.0n 3.3 50.02n 0 87n 0 87.02n 3.3 90.0n 3.3 90.02n 0)
v_SL2_col6 SL22col6 0 pwl(0 0 27n 0 27.02n 3.3 30.0n 3.3 30.02n 0 67n 0 67.02n 3.3 70.0n 3.3 70.02n 0)

v_SL1_col7 SL11col7 0 pwl(0 0 7n 0 7.02n 3.3 8.5n 3.3 8.52n 0 47n 0 47.02n 3.3 50.0n 3.3 50.02n 0
+107n 0 107.02n 3.3 108.5n 3.3 108.52n 0)
v_SL2_col7 SL22col7 0 pwl(0 0 27n 0 27.02n 3.3 30.0n 3.3 30.02n 0 67n 0 67.02n 3.3 70.0n 3.3 70.02n 0)


```

v_SL1_col50 SL11col50 0 pwl(0 0 47n 0 47.02n 3.3 50.0n 3.3 50.02n 0 87n 0 87.02n 3.3 90.0n 3.3 90.02n 0)
v_SL2_col50 SL22col50 0 pwl(0 0 27n 0 27.02n 3.3 30.0n 3.3 30.02n 0 67n 0 67.02n 3.3 70.0n 3.3 70.02n 0)

v_SL1_col51 SL11col51 0 pwl(0 0 27n 0 27.02n 3.3 30.0n 3.3 30.02n 0 67n 0 67.02n 3.3 70.0n 3.3 70.02n 0)
v_SL2_col51 SL22col51 0 pwl(0 0 47n 0 47.02n 3.3 50.0n 3.3 50.02n 0 87n 0 87.02n 3.3 90.0n 3.3 90.02n 0)

v_SL1_col52 SL11col52 0 pwl(0 0 27n 0 27.02n 3.3 30.0n 3.3 30.02n 0 67n 0 67.02n 3.3 70.0n 3.3 70.02n 0)
v_SL2_col52 SL22col52 0 pwl(0 0 47n 0 47.02n 3.3 50.0n 3.3 50.02n 0 87n 0 87.02n 3.3 90.0n 3.3 90.02n 0)

v_SL1_col53 SL11col53 0 pwl(0 0 47n 0 47.02n 3.3 50.0n 3.3 50.02n 0 87n 0 87.02n 3.3 90.0n 3.3 90.02n 0)
v_SL2_col53 SL22col53 0 pwl(0 0 27n 0 27.02n 3.3 30.0n 3.3 30.02n 0 67n 0 67.02n 3.3 70.0n 3.3 70.02n 0)

v_SL1_col54 SL11col54 0 pwl(0 0 27n 0 27.02n 3.3 30.0n 3.3 30.02n 0 67n 0 67.02n 3.3 70.0n 3.3 70.02n 0)
v_SL2_col54 SL22col54 0 pwl(0 0 47n 0 47.02n 3.3 50.0n 3.3 50.02n 0 87n 0 87.02n 3.3 90.0n 3.3 90.02n 0)

v_SL1_col55 SL11col55 0 pwl(0 0 27n 0 27.02n 3.3 30.0n 3.3 30.02n 0 67n 0 67.02n 3.3 70.0n 3.3 70.02n 0)
v_SL2_col55 SL22col55 0 pwl(0 0 47n 0 47.02n 3.3 50.0n 3.3 50.02n 0 87n 0 87.02n 3.3 90.0n 3.3 90.02n 0)

v_SL1_col56 SL11col56 0 pwl(0 0 47n 0 47.02n 3.3 50.0n 3.3 50.02n 0 87n 0 87.02n 3.3 90.0n 3.3 90.02n 0)
v_SL2_col56 SL22col56 0 pwl(0 0 27n 0 27.02n 3.3 30.0n 3.3 30.02n 0 67n 0 67.02n 3.3 70.0n 3.3 70.02n 0)

v_SL1_col57 SL11col57 0 pwl(0 0 47n 0 47.02n 3.3 50.0n 3.3 50.02n 0 87n 0 87.02n 3.3 90.0n 3.3 90.02n 0)
v_SL2_col57 SL22col57 0 pwl(0 0 27n 0 27.02n 3.3 30.0n 3.3 30.02n 0 67n 0 67.02n 3.3 70.0n 3.3 70.02n 0)

v_SL1_col58 SL11col58 0 pwl(0 0 47n 0 47.02n 3.3 50.0n 3.3 50.02n 0 87n 0 87.02n 3.3 90.0n 3.3 90.02n 0)
v_SL2_col58 SL22col58 0 pwl(0 0 27n 0 27.02n 3.3 30.0n 3.3 30.02n 0 67n 0 67.02n 3.3 70.0n 3.3 70.02n 0)

v_SL1_col59 SL11col59 0 pwl(0 0 27n 0 27.02n 3.3 30.0n 3.3 30.02n 0 67n 0 67.02n 3.3 70.0n 3.3 70.02n 0)
v_SL2_col59 SL22col59 0 pwl(0 0 47n 0 47.02n 3.3 50.0n 3.3 50.02n 0 87n 0 87.02n 3.3 90.0n 3.3 90.02n 0)

v_SL1_col60 SL11col60 0 pwl(0 0 47n 0 47.02n 3.3 50.0n 3.3 50.02n 0 87n 0 87.02n 3.3 90.0n 3.3 90.02n 0)
v_SL2_col60 SL22col60 0 pwl(0 0 27n 0 27.02n 3.3 30.0n 3.3 30.02n 0 67n 0 67.02n 3.3 70.0n 3.3 70.02n 0)

v_SL1_col61 SL11col61 0 pwl(0 0 27n 0 27.02n 3.3 30.0n 3.3 30.02n 0 67n 0 67.02n 3.3 70.0n 3.3 70.02n 0)
v_SL2_col61 SL22col61 0 pwl(0 0 47n 0 47.02n 3.3 50.0n 3.3 50.02n 0 87n 0 87.02n 3.3 90.0n 3.3 90.02n 0)

v_SL1_col62 SL11col62 0 pwl(0 0 27n 0 27.02n 3.3 30.0n 3.3 30.02n 0 67n 0 67.02n 3.3 70.0n 3.3 70.02n 0)
v_SL2_col62 SL22col62 0 pwl(0 0 47n 0 47.02n 3.3 50.0n 3.3 50.02n 0 87n 0 87.02n 3.3 90.0n 3.3 90.02n 0)

v_SL1_col63 SL11col63 0 pwl(0 0 47n 0 47.02n 3.3 50.0n 3.3 50.02n 0 87n 0 87.02n 3.3 90.0n 3.3 90.02n 0)
v_SL2_col63 SL22col63 0 pwl(0 0 27n 0 27.02n 3.3 30.0n 3.3 30.02n 0 67n 0 67.02n 3.3 70.0n 3.3 70.02n 0)

```

```

*****
*          search enables          *
*****

```

```
vSErow0 SE1_row0 0 pulse(0 3.3 7n .1n .1n 2.8n 20n)
```

```

*****
*          pre-charge             *
*****

```

```

vpre_row01 pre1_row01 0 pulse(3.3 0 7n 0.1n 0.1n 2.8n 20n)
vpre_row02 pre1_row02 0 pulse(3.3 0 7n 0.1n 0.1n 2.8n 20n)
vpre_row03 pre1_row03 0 pulse(3.3 0 7n 0.1n 0.1n 2.8n 20n)
vpre_row04 pre1_row04 0 pulse(3.3 0 7n 0.1n 0.1n 2.8n 20n)

```

* ML reset *

vML1reset_row0 ML1reset_row0 0 pulse(0 3.3 5n .1n .1n .5n 20n)
vML2reset_row0 ML2reset_row0 0 pulse(0 3.3 5n .1n .1n .5n 20n)
vML3reset_row0 ML3reset_row0 0 pulse(0 3.3 5n .1n .1n .5n 20n)
vML4reset_row0 ML4reset_row0 0 pulse(0 3.3 5n .1n .1n .5n 20n)

.....
cells_array64bit_Pipelining.cir
.....

xtcam_cell_0_0 d1_col0 d2_col0 SL1col0 SL2col0 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_1 d1_col1 d2_col1 SL1col1 SL2col1 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_2 d1_col2 d2_col2 SL1col2 SL2col2 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_3 d1_col3 d2_col3 SL1col3 SL2col3 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_4 d1_col4 d2_col4 SL1col4 SL2col4 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_5 d1_col5 d2_col5 SL1col5 SL2col5 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_6 d1_col6 d2_col6 SL1col6 SL2col6 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_7 d1_col7 d2_col7 SL1col7 SL2col7 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_8 d1_col8 d2_col8 SL1col8 SL2col8 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_9 d1_col9 d2_col9 SL1col9 SL2col9 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_10 d1_col10 d2_col10 SL1col10 SL2col10 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_11 d1_col11 d2_col11 SL1col11 SL2col11 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_12 d1_col12 d2_col12 SL1col12 SL2col12 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_13 d1_col13 d2_col13 SL1col13 SL2col13 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_14 d1_col14 d2_col14 SL1col14 SL2col14 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_15 d1_col15 d2_col15 SL1col15 SL2col15 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell

xtcam_cell_0_16 d1_col16 d2_col16 SL1col16 SL2col16 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_17 d1_col17 d2_col17 SL1col17 SL2col17 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_18 d1_col18 d2_col18 SL1col18 SL2col18 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_19 d1_col19 d2_col19 SL1col19 SL2col19 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_20 d1_col20 d2_col20 SL1col20 SL2col20 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_21 d1_col21 d2_col21 SL1col21 SL2col21 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_22 d1_col22 d2_col22 SL1col22 SL2col22 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_23 d1_col23 d2_col23 SL1col23 SL2col23 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_24 d1_col24 d2_col24 SL1col24 SL2col24 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_25 d1_col25 d2_col25 SL1col25 SL2col25 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_26 d1_col26 d2_col26 SL1col26 SL2col26 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_27 d1_col27 d2_col27 SL1col27 SL2col27 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_28 d1_col28 d2_col28 SL1col28 SL2col28 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_29 d1_col29 d2_col29 SL1col29 SL2col29 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_30 d1_col30 d2_col30 SL1col30 SL2col30 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_31 d1_col31 d2_col31 SL1col31 SL2col31 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell

xtcam_cell_0_32 d1_col32 d2_col32 SL1col32 SL2col32 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_33 d1_col33 d2_col33 SL1col33 SL2col33 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_34 d1_col34 d2_col34 SL1col34 SL2col34 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_35 d1_col35 d2_col35 SL1col35 SL2col35 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_36 d1_col36 d2_col36 SL1col36 SL2col36 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_37 d1_col37 d2_col37 SL1col37 SL2col37 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_38 d1_col38 d2_col38 SL1col38 SL2col38 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_39 d1_col39 d2_col39 SL1col39 SL2col39 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_40 d1_col40 d2_col40 SL1col40 SL2col40 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_41 d1_col41 d2_col41 SL1col41 SL2col41 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_42 d1_col42 d2_col42 SL1col42 SL2col42 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_43 d1_col43 d2_col43 SL1col43 SL2col43 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_44 d1_col44 d2_col44 SL1col44 SL2col44 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_45 d1_col45 d2_col45 SL1col45 SL2col45 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_46 d1_col46 d2_col46 SL1col46 SL2col46 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell

```
xtcam_cell_0_47 d1_col47 d2_col47 SL1col47 SL2col47 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
```

```
xtcam_cell_0_48 d1_col48 d2_col48 SL1col48 SL2col48 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell  
xtcam_cell_0_49 d1_col49 d2_col49 SL1col49 SL2col49 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell  
xtcam_cell_0_50 d1_col50 d2_col50 SL1col50 SL2col50 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell  
xtcam_cell_0_51 d1_col51 d2_col51 SL1col51 SL2col51 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell  
xtcam_cell_0_52 d1_col52 d2_col52 SL1col52 SL2col52 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell  
xtcam_cell_0_53 d1_col53 d2_col53 SL1col53 SL2col53 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell  
xtcam_cell_0_54 d1_col54 d2_col54 SL1col54 SL2col54 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell  
xtcam_cell_0_55 d1_col55 d2_col55 SL1col55 SL2col55 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell  
xtcam_cell_0_56 d1_col56 d2_col56 SL1col56 SL2col56 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell  
xtcam_cell_0_57 d1_col57 d2_col57 SL1col57 SL2col57 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell  
xtcam_cell_0_58 d1_col58 d2_col58 SL1col58 SL2col58 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell  
xtcam_cell_0_59 d1_col59 d2_col59 SL1col59 SL2col59 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell  
xtcam_cell_0_60 d1_col60 d2_col60 SL1col60 SL2col60 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell  
xtcam_cell_0_61 d1_col61 d2_col61 SL1col61 SL2col61 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell  
xtcam_cell_0_62 d1_col62 d2_col62 SL1col62 SL2col62 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell  
xtcam_cell_0_63 d1_col63 d2_col63 SL1col63 SL2col63 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
```

A.4. PSpice netlist for Table 7.3

* 1X64 bit TCAM array

```
.INCLUDE 'models_array64bit_SelectiveCharging_Fast.cir'  
.INCLUDE 'rowcolumn_array64bit_SelectiveCharging_Fast.cir'  
.INCLUDE 'sources_array64bit_SelectiveCharging_Fast.cir'  
.INCLUDE 'cells_array64bit_SelectiveCharging_Fast.cir'
```

```
.SUBCKT tcam_cell d1 d2 SL1 SL2 en_row enb_row SE ML u2 |
```

```
xmem1 p | sv_mem1 MEM_YAKOPCIC_test1  
xmem2 q | sv_mem2 MEM_YAKOPCIC_test1  
xmem3 s u2 sv_mem3 MEM_YAKOPCIC_test2  
xmem4 t u2 sv_mem4 MEM_YAKOPCIC_test2
```

```
rmem1 sv_mem1 0 10000k  
rmem2 sv_mem2 0 10000k  
rmem3 sv_mem3 0 10000k  
rmem4 sv_mem4 0 10000k
```

```
mn1 d1 en_row p 0 nenh w=2u l=0.4u  
mn2 d2 en_row q 0 nenh w=2u l=0.4u  
mp1 p enb_row d1 3.63 penh w=2u l=0.4u  
mp2 q enb_row d2 3.63 penh w=2u l=0.4u  
mn3 s SE p 0 nenh w=4u l=0.2u  
mn4 t SE q 0 nenh w=4u l=0.2u  
mn5 p SL1 p1 0 nenh w=.2u l=0.2u  
mn6 q SL2 q1 0 nenh w=.2u l=0.2u  
mn7 ML p1 0 0 nenh w=6u l=0.2u  
mn8 ML q1 0 0 nenh w=6u l=0.2u
```

```
.ENDS tcam_cell
```

```
.SUBCKT precharge pre u ML
```

```
mnpr u1 u1 ML 0 nenh w=2u l=0.2u  
mppr u1 pre u 3.63 penh w=2u l=0.2u
```

```
.ENDS precharge
```

```
.SUBCKT sense_amplifier ML SE u MLout
```

```
mnSE ML SE a 0 nenh w=.4u l=.2u
mpSE a SE MLout 3.63 penh w=.4u l=.2u
mnSE1 b a 0 0 nenh w=2u l=.2u
mpSE1 b a u 3.63 penh w=2u l=.2u
mnSE2 MLout b 0 0 nenh w=2u l=.2u
mpSE2 MLout b u 3.63 penh w=2u l=.2u
```

```
.ENDS sense_amplifier
```

```
.temp 0
.tran 0.1ns 110ns
.probe
```

```
.....
models_array64bit_SelectiveCharging_Fast.cir
.....
```

```
*** model of Memristors ***
```

```
.subckt MEM_YAKOPCIC_test1 TE BE XSV PARAMS:
```

```
* Fitting parameters to model different devices
* a1, a2, b: Parameters for IV relationship
* Vp, Vn: Pos. and neg. voltage thresholds
* Ap, An: Multiplier for SV motion intensity
* xp, xn: Points where SV motion is reduced
* alphap, alphan: Rate at which SV motion decays
* xo: Initial value of SV
* eta: SV direction relative to voltage
```

```
+a1=.01 a2=.01 b=0.1 Vp=1.2 Vn=1.2 Ap=1.8e10 An=8e9
+xp=0.1 xn=0.1 alphap=.3 alphan=.55 xo=0.01 eta=1
```

```
* Multiplicative functions to ensure zero state
* variable motion at memristor boundaries
```

```
.func wp(V) {(xp-V)/(1-xp)+1}
.func wn(V) {V/(1-xn)}
```

```
* Function G(V(t)) - Describes the device threshold
.func G(V) {IF(V<=Vp, IF(V>=-Vn, 0, -An*(exp(-V)-exp(Vn))), Ap*(exp(V)-exp(Vp))) }
```

```
* Function F(V(t),x(t)) - Describes the SV motion
.func F(V1,V2) {IF(eta*V1 >= 0, IF(V2 >= xp, exp(-
+alphap*(V2-xp))*wp(V2) ,1), IF(V2 <= (1-xn),
+exp(alphan*(V2+xn-1))*wn(V2) ,1))}
```

```
* IV Response - Hyperbolic sine due to MIM structure
.func IVRel(V1,V2) {IF(V1 >= 0, a1*V2*sinh(b*V1),
+a2*V2*sinh(b*V1) )}
```

```
* Circuit to determine state variable
* dx/dt = F(V(t),x(t))*G(V(t))
```

```
Cx XSV 0 1 IC= {xo}
Gx 0 XSV value={eta*F(V(TE,BE),V(XSV,0))*G(V(TE,BE))}
```

```
* Current source for memristor IV response
Gm TE BE value = {IVRel(V(TE,BE),V(XSV,0))}
```

```
.ends MEM_YAKOPCIC_test1
```

```

.subckt MEM_YAKOPCIC_test2 TE BE XSV PARAMS:

* Fitting parameters to model different devices
* a1, a2, b: Parameters for IV relationship
* Vp, Vn: Pos. and neg. voltage thresholds
* Ap, An: Multiplier for SV motion intensity
* xp, xn: Points where SV motion is reduced
* alphap, alphan: Rate at which SV motion decays
* xo: Initial value of SV
* eta: SV direction relative to voltage

+a1=.01 a2=.01 b=.011 Vp=1.7 Vn=1.7 Ap=4e3 An=4e3
+xp=0.1 xn=0.1 alphap=1 alphan=7 xo=0.1 eta=1

* Multiplicative functions to ensure zero state
* variable motion at memristor boundaries

.func wp(V) {(xp-V)/(1-xp)+1}
.func wn(V) {V/(1-xn)}

* Function G(V(t)) - Describes the device threshold

.func G(V) { IF(V<=Vp, IF(V>=-Vn, 0, -An*(exp(-V)-exp(Vn))), Ap*(exp(V)-exp(Vp))) }

* Function F(V(t),x(t)) - Describes the SV motion

.func F(V1,V2) {IF(eta*V1 >= 0, IF(V2 >= xp, exp(-
+alphap*(V2-xp))*wp(V2) ,1), IF(V2 <= (1-xn),
+exp(alphan*(V2+xn-1))*wn(V2) ,1))}

* IV Response - Hyperbolic sine due to MIM structure

.func IVRel(V1,V2) {IF(V1 >= 0, a1*V2*sinh(b*V1),
+a2*V2*sinh(b*V1) )}

* Circuit to determine state variable
* dx/dt = F(V(t),x(t))*G(V(t))

Cx XSV 0 1 IC= {xo}
Gx 0 XSV value={eta*F(V(TE,BE),V(XSV,0))*G(V(TE,BE))}

* Current source for memristor IV response
Gm TE BE value = {IVRel(V(TE,BE),V(XSV,0))}

.ends MEM_YAKOPCIC_test2

*** model of NMOS transistor ***

.MODEL nenh NMOS LEVEL=7 VERSION=3.1 TNOM=0 tox=4.1E-9 XJ=1E-7 NCH=2.3549E17
+VTH0=0.32962257 K1=0.5864999 K2=1.127266E-3 K3=1E-3
+K3B=0.0294061 W0=1E-7 NLX=1.630684E-7 DVT0W=0 DVT1W=0 DVT2W=0 DVT0=1.2064649
+DVT1=0.4215486 DVT2=0.0197749 U0=273.8094484 UA=-1.40499E-9
+UB=2.408323E-18 UC=6.504826E-11 VSAT=1.355009E5 A0=2 AGS=0.4449958
+B0=1.901075E-7 B1=4.99995E-6 KETA=-0.0164863 A1=3.868769E-4 A2=0.4640272
+RDSW=123.3376355 PRWG=0.5 PRWB=-0.197728 WR=1 WINT=0 LINT=1.690044E-8
+XL=0 XW=-1E-8 DWG=-4.728719E-9 DWB=-2.452411E-9 VOFF=-0.0948017 NFACTOR=2.1860065
+CIT=0 CDSC=2.4E-4 CDSCD=0 CDSCB=0 ETA0=2.230928E-3 ETAB=6.028975E-5 DSUB=0.0145467
+PCLM=1.3822069 PDIBLC1=0.1762787 PDIBLC2 = 1.66653E-3 PDIBLCB = -0.1
+DROUT=0.7694691 PSCBE1=8.91287E9 PSCBE2=7.349607E-9 PVAG=1.685917E-3

```

```

+DELTA=0.01 RSH=6.7 MOBMOD=1 PRT=0 UTE=-1.5 KT1=-0.11 KT1L=0 KT2=0.022 UA1=4.31E-9
+UB1=-7.61E-18 UC1=-5.6E-11 AT=3.3E4 WL=0 WLN=1 WW=0 WWN=1 WWL=0 LL=0 LLN=1 LW=0
+LWN=1 LWL=0 CAPMOD=2 XPART=0.5 CGDO=8.23E-10 CGSO=8.23E-10 CGBO=1E-12
+CJ = 9.466429E-4 PB = 0.8 MJ = 0.3820266
+CJSW = 2.608154E-10 PBSW = 0.8 MJSW = 0.102322
+CJSWG = 3.3E-10 PBSWG = 0.8 MJSWG = 0.102322
+CF = 0 PVTH0 = -2.199373E-3 PRDSW = -0.9368961
+PK2 = 1.593254E-3 WKETA = -2.880976E-3 LKETA = 7.165078E-3
+PU0 = 6.777519 PUA = 5.505418E-12 PUB = 8.84133E-25
+PVSAT = 2.006286E3 PETA0 = 1.003159E-4 PKETA = -6.759277E-3
+NOIMOD=2.0E+00 NOIA=1.3182567385564E+19
+NOIB=144543.977074592 NOIC=-1.24515784572817E-12 EF=0.92 EM=41000000

```

*** model of PMOS transistor ***

```

.MODEL penh PMOS LEVEL=7 VERSION = 3.1 TNOM = 0 tox = 4.1E-9

```

```

+XJ = 1E-7 NCH = 4.1589E17 VTH0 = -0.35154108
+K1 = 0.5341312 K2 = 0.0395326 K3 = 0
+K3B = 7.4916211 WO = 1E-6 NLX = 1.194072E-7
+DVTOW = 0 DVT1W = 0 DVT2W = 0
+DVT0 = 0.5060555 DVT1 = 0.2423835 DVT2 = 0.1
+U0 = 115.6894042 UA = 1.573746E-9 UB = 1.874308E-21
+UC = -1E-10 VSAT = 1.130982E5 A0 = 1.9976555
+AGS = 0.4186945 B0 = 1.949178E-7 B1 = 6.422908E-7
+KETA = 0.0166345 A1 = 0.4749146 A2 = 0.300003
+RDSW = 198.321294 PRWG = 0.5 PRWB = -0.4986647
+WR = 1 WINT = 0 LINT = 2.94454E-8
+XL = 0 XW = -1E-8 DWG = -2.798724E-8
+DWB = -4.83797E-10 VOFF = -0.095236 NFACTOR = 2
+CIT = 0 CDSC = 2.4E-4 CDSCD = 0
+CDSCB = 0 ETA0 = 1.035504E-3 ETAB = -4.358398E-4
+DSUB = 1.816555E-3 PCLM = 1.3299898 PDIBLC1 = 1.766563E-3
+PDIBLC2 = 7.728395E-7 PDIBLCB = -1E-3 DROUT = 1.011891E-3
+PSCBE1 = 4.872184E10 PSCBE2 = 5E-10 PVAG = 0.0209921
+DELTA = 0.01 RSH = 7.7 MOBMOD = 1
+PRT = 0 UTE = -1.5 KT1 = -0.11
+KT1L = 0 KT2 = 0.022 UA1 = 4.31E-9
+UB1 = -7.61E-18 UC1 = -5.6E-11 AT = 3.3E4
+WL = 0 WLN = 1 WW = 0
+WWN = 1 WWL = 0 LL = 0
+LLN = 1 LW = 0 LWN = 1
+LWL = 0 CAPMOD = 2 XPART = 0.5
+CGDO = 6.35E-10 CGSO = 6.35E-10 CGBO = 1E-12
+CJ = 1.144521E-3 PB = 0.8468686 MJ = 0.4099522
+CJSW = 2.490749E-10 PBSW = 0.8769118 MJSW = 0.3478565
+CJSWG = 4.22E-10 PBSWG = 0.8769118 MJSWG = 0.3478565
+CF = 0 PVTH0 = 2.302018E-3 PRDSW = 9.0575312
+PK2 = 1.821914E-3 WKETA = 0.0222457 LKETA = -1.495872E-3
+PU0 = -1.5580645 PUA = -6.36889E-11 PUB = 1E-21
+PVSAT = 49.8420442 PETA0 = 2.827793E-5 PKETA = -2.536564E-3
+NOIMOD=2.0E+00 NOIA=3.57456993317604E+18 NOIB=2500
+NOIC=2.61260020285845E-11 EF=1.1388

```

```

.....
rowcolumn_array64bit_SelectiveCharging_Fast.cir
.....

```

```

*****
*          *
*          *
*****

```

* row0

```

*pre-charge ckt.
xprecharge_row01 pre_row01 u ML1row0 precharge
xprecharge_row02 pre_row02 u ML2row0 precharge
xprecharge_row03 pre_row03 u ML3row0 precharge
xprecharge_row04 pre_row04 u ML4row0 precharge

*Matchline segmentation

*NOT Gates
mnML1row0 ML1brow0 ML1row0 0 0 nenh w=2u l=.2u
mpML1row0 ML1brow0 ML1row0 u 3.63 penh w=2u l=.2u
mnML2row0 ML2brow0 ML2row0 0 0 nenh w=2u l=.2u
mpML2row0 ML2brow0 ML2row0 u 3.63 penh w=2u l=.2u
mnML3row0 ML3brow0 ML3row0 0 0 nenh w=2u l=.2u
mpML3row0 ML3brow0 ML3row0 u 3.63 penh w=2u l=.2u
mnML4row0 ML4brow0 ML4row0 0 0 nenh w=2u l=.2u
mpML4row0 ML4brow0 ML4row0 u 3.63 penh w=2u l=.2u

*NOR Gate
mn1ML1row0 MLrow0 ML1brow0 0 0 nenh w=4u l=0.2u
mn1ML2row0 MLrow0 ML2brow0 0 0 nenh w=4u l=0.2u
mn1ML3row0 MLrow0 ML3brow0 0 0 nenh w=4u l=0.2u
mn1ML4row0 MLrow0 ML4brow0 0 0 nenh w=4u l=0.2u
mpMLrow0 MLrow0 MLrow0 u 3.63 penh w=8u l=0.2u

* sense-amplifier

xsense_amplifier_row0 MLrow0 SE_row0 u MLout_row0 sense_amplifier

*reset
mnML1reset_row0 ML1row0 ML1reset1_row0 0 0 nenh W=40u l=0.4u
mnML2reset_row0 ML2row0 ML2reset1_row0 0 0 nenh W=40u l=0.4u
mnML3reset_row0 ML3row0 ML3reset1_row0 0 0 nenh W=40u l=0.4u
mnML4reset_row0 ML4row0 ML4reset1_row0 0 0 nenh W=40u l=0.4u

r_en_row0 en_row0 0 10000k
r1_en_row0 en_row0 en1_row0 5
r_enb_row0 enb_row0 0 10000k
r1_enb_row0 enb_row0 enb1_row0 5
r_pre1_row01 pre1_row01 0 10000k
r1_pre1_row01 pre1_row01 pre_row01 5
r_pre1_row02 pre1_row02 0 10000k
r1_pre1_row02 pre1_row02 pre_row02 5
r_pre1_row03 pre1_row03 0 10000k
r1_pre1_row03 pre1_row03 pre_row03 5
r_pre1_row04 pre1_row04 0 10000k
r1_pre1_row04 pre1_row04 pre_row04 5
r_SE_row0 SE_row0 0 10000k
r1_SE_row0 SE_row0 SE1_row0 5
rML1reset_row0 ML1reset_row0 ML1reset1_row0 5
rML1reset1_row0 ML1reset1_row0 0 10000k
rML2reset_row0 ML2reset_row0 ML2reset1_row0 5
rML2reset1_row0 ML2reset1_row0 0 10000k
rML3reset_row0 ML3reset_row0 ML3reset1_row0 5
rML3reset1_row0 ML3reset1_row0 0 10000k
rML4reset_row0 ML4reset_row0 ML4reset1_row0 5
rML4reset1_row0 ML4reset1_row0 0 10000k

*****
*                columns                *
*****

```


* col0

mn1col0 d1_col0 en_col0 d11_col0 0 nenh w=4u l=.4u
mn2col0 d2_col0 en_col0 d22_col0 0 nenh w=4u l=.4u
mp1col0 d11_col0 enb_col0 d1_col0 3.63 penh w=8u l=0.4u
mp2col0 d22_col0 enb_col0 d2_col0 3.63 penh w=8u l=0.4u

r_en_col0 en_col0 0 10000k
r1_en_col0 en_col0 en1_col0 5
r_enb_col0 enb_col0 0 10000k
r1_enb_col0 enb_col0 enb1_col0 5

r_d11_col0 d11_col0 0 10000k
r1_d11_col0 d11_col0 d111_col0 5
r_d22_col0 d22_col0 0 10000k
r1_d22_col0 d22_col0 d222_col0 5

r_SL1col0 SL1col0 0 10000k
r1_SL1col0 SL1col0 SL11col0 5
r_SL2col0 SL2col0 0 10000k
r1_SL2col0 SL2col0 SL22col0 5

* col1

mn1col1 d1_col1 en_col1 d11_col1 0 nenh w=4u l=.4u
mn2col1 d2_col1 en_col1 d22_col1 0 nenh w=4u l=.4u
mp1col1 d11_col1 enb_col1 d1_col1 3.63 penh w=8u l=0.4u
mp2col1 d22_col1 enb_col1 d2_col1 3.63 penh w=8u l=0.4u

r_en_col1 en_col1 0 10000k
r1_en_col1 en_col1 en1_col1 5
r_enb_col1 enb_col1 0 10000k
r1_enb_col1 enb_col1 enb1_col1 5

r_d11_col1 d11_col1 0 10000k
r1_d11_col1 d11_col1 d111_col1 5
r_d22_col1 d22_col1 0 10000k
r1_d22_col1 d22_col1 d222_col1 5

r_SL1col1 SL1col1 0 10000k
r1_SL1col1 SL1col1 SL11col1 5
r_SL2col1 SL2col1 0 10000k
r1_SL2col1 SL2col1 SL22col1 5

* col2

mn1col2 d1_col2 en_col2 d11_col2 0 nenh w=4u l=.4u
mn2col2 d2_col2 en_col2 d22_col2 0 nenh w=4u l=.4u
mp1col2 d11_col2 enb_col2 d1_col2 3.63 penh w=8u l=0.4u
mp2col2 d22_col2 enb_col2 d2_col2 3.63 penh w=8u l=0.4u

r_en_col2 en_col2 0 10000k
r1_en_col2 en_col2 en1_col2 5
r_enb_col2 enb_col2 0 10000k
r1_enb_col2 enb_col2 enb1_col2 5

r_d11_col2 d11_col2 0 10000k
r1_d11_col2 d11_col2 d111_col2 5
r_d22_col2 d22_col2 0 10000k
r1_d22_col2 d22_col2 d222_col2 5
r_SL1col2 SL1col2 0 10000k

r1_SL1col2 SL1col2 SL11col2 5
r_SL2col2 SL2col2 0 10000k
r1_SL2col2 SL2col2 SL22col2 5

* col3

mn1col3 d1_col3 en_col3 d11_col3 0 nenh w=4u l=.4u
mn2col3 d2_col3 en_col3 d22_col3 0 nenh w=4u l=.4u
mp1col3 d11_col3 enb_col3 d1_col3 3.63 penh w=8u l=0.4u
mp2col3 d22_col3 enb_col3 d2_col3 3.63 penh w=8u l=0.4u

r_en_col3 en_col3 0 10000k
r1_en_col3 en_col3 en1_col3 5
r_enb_col3 enb_col3 0 10000k
r1_enb_col3 enb_col3 enb1_col3 5

r_d11_col3 d11_col3 0 10000k
r1_d11_col3 d11_col3 d111_col3 5
r_d22_col3 d22_col3 0 10000k
r1_d22_col3 d22_col3 d222_col3 5

r_SL1col3 SL1col3 0 10000k
r1_SL1col3 SL1col3 SL11col3 5
r_SL2col3 SL2col3 0 10000k
r1_SL2col3 SL2col3 SL22col3 5

* col4

mn1col4 d1_col4 en_col4 d11_col4 0 nenh w=4u l=.4u
mn2col4 d2_col4 en_col4 d22_col4 0 nenh w=4u l=.4u
mp1col4 d11_col4 enb_col4 d1_col4 3.63 penh w=8u l=0.4u
mp2col4 d22_col4 enb_col4 d2_col4 3.63 penh w=8u l=0.4u

r_en_col4 en_col4 0 10000k
r1_en_col4 en_col4 en1_col4 5
r_enb_col4 enb_col4 0 10000k
r1_enb_col4 enb_col4 enb1_col4 5

r_d11_col4 d11_col4 0 10000k
r1_d11_col4 d11_col4 d111_col4 5
r_d22_col4 d22_col4 0 10000k
r1_d22_col4 d22_col4 d222_col4 5

r_SL1col4 SL1col4 0 10000k
r1_SL1col4 SL1col4 SL11col4 5
r_SL2col4 SL2col4 0 10000k
r1_SL2col4 SL2col4 SL22col4 5

* col5

mn1col5 d1_col5 en_col5 d11_col5 0 nenh w=4u l=.4u
mn2col5 d2_col5 en_col5 d22_col5 0 nenh w=4u l=.4u
mp1col5 d11_col5 enb_col5 d1_col5 3.63 penh w=8u l=0.4u
mp2col5 d22_col5 enb_col5 d2_col5 3.63 penh w=8u l=0.4u

r_en_col5 en_col5 0 10000k
r1_en_col5 en_col5 en1_col5 5
r_enb_col5 enb_col5 0 10000k
r1_enb_col5 enb_col5 enb1_col5 5

r_d11_col5 d11_col5 0 10000k
r1_d11_col5 d11_col5 d111_col5 5
r_d22_col5 d22_col5 0 10000k
r1_d22_col5 d22_col5 d222_col5 5

r_SL1col5 SL1col5 0 10000k

r1_SL1col5 SL1col5 SL11col5 5
r_SL2col5 SL2col5 0 10000k
r1_SL2col5 SL2col5 SL22col5 5

* col6

mn1col6 d1_col6 en_col6 d11_col6 0 nenh w=4u l=.4u
mn2col6 d2_col6 en_col6 d22_col6 0 nenh w=4u l=.4u
mp1col6 d11_col6 enb_col6 d1_col6 3.63 penh w=8u l=0.4u
mp2col6 d22_col6 enb_col6 d2_col6 3.63 penh w=8u l=0.4u

r_en_col6 en_col6 0 10000k
r1_en_col6 en_col6 en1_col6 5
r_enb_col6 enb_col6 0 10000k
r1_enb_col6 enb_col6 enb1_col6 5

r_d11_col6 d11_col6 0 10000k
r1_d11_col6 d11_col6 d111_col6 5
r_d22_col6 d22_col6 0 10000k
r1_d22_col6 d22_col6 d222_col6 5

r_SL1col6 SL1col6 0 10000k
r1_SL1col6 SL1col6 SL11col6 5
r_SL2col6 SL2col6 0 10000k
r1_SL2col6 SL2col6 SL22col6 5

* col7

mn1col7 d1_col7 en_col7 d11_col7 0 nenh w=4u l=.4u
mn2col7 d2_col7 en_col7 d22_col7 0 nenh w=4u l=.4u
mp1col7 d11_col7 enb_col7 d1_col7 3.63 penh w=8u l=0.4u
mp2col7 d22_col7 enb_col7 d2_col7 3.63 penh w=8u l=0.4u

r_en_col7 en_col7 0 10000k
r1_en_col7 en_col7 en1_col7 5
r_enb_col7 enb_col7 0 10000k
r1_enb_col7 enb_col7 enb1_col7 5

r_d11_col7 d11_col7 0 10000k
r1_d11_col7 d11_col7 d111_col7 5
r_d22_col7 d22_col7 0 10000k
r1_d22_col7 d22_col7 d222_col7 5

r_SL1col7 SL1col7 0 10000k
r1_SL1col7 SL1col7 SL11col7 5
r_SL2col7 SL2col7 0 10000k
r1_SL2col7 SL2col7 SL22col7 5

* col8

mn1col8 d1_col8 en_col8 d11_col8 0 nenh w=4u l=.4u
mn2col8 d2_col8 en_col8 d22_col8 0 nenh w=4u l=.4u
mp1col8 d11_col8 enb_col8 d1_col8 3.63 penh w=8u l=0.4u
mp2col8 d22_col8 enb_col8 d2_col8 3.63 penh w=8u l=0.4u

r_en_col8 en_col8 0 10000k
r1_en_col8 en_col8 en1_col8 5
r_enb_col8 enb_col8 0 10000k
r1_enb_col8 enb_col8 enb1_col8 5

r_d11_col8 d11_col8 0 10000k
r1_d11_col8 d11_col8 d111_col8 5
r_d22_col8 d22_col8 0 10000k
r1_d22_col8 d22_col8 d222_col8 5

r_SL1col8 SL1col8 0 10000k
r1_SL1col8 SL1col8 SL11col8 5
r_SL2col8 SL2col8 0 10000k
r1_SL2col8 SL2col8 SL22col8 5

* col9

mn1col9 d1_col9 en_col9 d11_col9 0 nenh w=4u l=.4u
mn2col9 d2_col9 en_col9 d22_col9 0 nenh w=4u l=.4u
mp1col9 d11_col9 enb_col9 d1_col9 3.63 penh w=8u l=0.4u
mp2col9 d22_col9 enb_col9 d2_col9 3.63 penh w=8u l=0.4u

r_en_col9 en_col9 0 10000k
r1_en_col9 en_col9 en1_col9 5
r_enb_col9 enb_col9 0 10000k
r1_enb_col9 enb_col9 enb1_col9 5

r_d11_col9 d11_col9 0 10000k
r1_d11_col9 d11_col9 d111_col9 5
r_d22_col9 d22_col9 0 10000k
r1_d22_col9 d22_col9 d222_col9 5

r_SL1col9 SL1col9 0 10000k
r1_SL1col9 SL1col9 SL11col9 5
r_SL2col9 SL2col9 0 10000k
r1_SL2col9 SL2col9 SL22col9 5

* col10

mn1col10 d1_col10 en_col10 d11_col10 0 nenh w=4u l=.4u
mn2col10 d2_col10 en_col10 d22_col10 0 nenh w=4u l=.4u
mp1col10 d11_col10 enb_col10 d1_col10 3.63 penh w=8u l=0.4u
mp2col10 d22_col10 enb_col10 d2_col10 3.63 penh w=8u l=0.4u

r_en_col10 en_col10 0 10000k
r1_en_col10 en_col10 en1_col10 5
r_enb_col10 enb_col10 0 10000k
r1_enb_col10 enb_col10 enb1_col10 5

r_d11_col10 d11_col10 0 10000k
r1_d11_col10 d11_col10 d111_col10 5
r_d22_col10 d22_col10 0 10000k
r1_d22_col10 d22_col10 d222_col10 5

r_SL1col10 SL1col10 0 10000k
r1_SL1col10 SL1col10 SL11col10 5
r_SL2col10 SL2col10 0 10000k
r1_SL2col10 SL2col10 SL22col10 5

* col11

mn1col11 d1_col11 en_col11 d11_col11 0 nenh w=4u l=.4u
mn2col11 d2_col11 en_col11 d22_col11 0 nenh w=4u l=.4u
mp1col11 d11_col11 enb_col11 d1_col11 3.63 penh w=8u l=0.4u
mp2col11 d22_col11 enb_col11 d2_col11 3.63 penh w=8u l=0.4u

r_en_col11 en_col11 0 10000k
r1_en_col11 en_col11 en1_col11 5
r_enb_col11 enb_col11 0 10000k
r1_enb_col11 enb_col11 enb1_col11 5

r_d11_col11 d11_col11 0 10000k
r1_d11_col11 d11_col11 d111_col11 5
r_d22_col11 d22_col11 0 10000k

r1_d22_col11 d22_col11 d222_col11 5

r_SL1col11 SL1col11 0 10000k
r1_SL1col11 SL1col11 SL11col11 5
r_SL2col11 SL2col11 0 10000k
r1_SL2col11 SL2col11 SL22col11 5

* col12

mn1col12 d1_col12 en_col12 d11_col12 0 nenh w=4u l=.4u
mn2col12 d2_col12 en_col12 d22_col12 0 nenh w=4u l=.4u
mp1col12 d11_col12 enb_col12 d1_col12 3.63 penh w=8u l=0.4u
mp2col12 d22_col12 enb_col12 d2_col12 3.63 penh w=8u l=0.4u

r_en_col12 en_col12 0 10000k
r1_en_col12 en_col12 en1_col12 5
r_enb_col12 enb_col12 0 10000k
r1_enb_col12 enb_col12 enb1_col12 5

r_d11_col12 d11_col12 0 10000k
r1_d11_col12 d11_col12 d111_col12 5
r_d22_col12 d22_col12 0 10000k
r1_d22_col12 d22_col12 d222_col12 5

r_SL1col12 SL1col12 0 10000k
r1_SL1col12 SL1col12 SL11col12 5
r_SL2col12 SL2col12 0 10000k
r1_SL2col12 SL2col12 SL22col12 5

* col13

mn1col13 d1_col13 en_col13 d11_col13 0 nenh w=4u l=.4u
mn2col13 d2_col13 en_col13 d22_col13 0 nenh w=4u l=.4u
mp1col13 d11_col13 enb_col13 d1_col13 3.63 penh w=8u l=0.4u
mp2col13 d22_col13 enb_col13 d2_col13 3.63 penh w=8u l=0.4u

r_en_col13 en_col13 0 10000k
r1_en_col13 en_col13 en1_col13 5
r_enb_col13 enb_col13 0 10000k
r1_enb_col13 enb_col13 enb1_col13 5

r_d11_col13 d11_col13 0 10000k
r1_d11_col13 d11_col13 d111_col13 5
r_d22_col13 d22_col13 0 10000k
r1_d22_col13 d22_col13 d222_col13 5

r_SL1col13 SL1col13 0 10000k
r1_SL1col13 SL1col13 SL11col13 5
r_SL2col13 SL2col13 0 10000k
r1_SL2col13 SL2col13 SL22col13 5

* col14

mn1col14 d1_col14 en_col14 d11_col14 0 nenh w=4u l=.4u
mn2col14 d2_col14 en_col14 d22_col14 0 nenh w=4u l=.4u
mp1col14 d11_col14 enb_col14 d1_col14 3.63 penh w=8u l=0.4u
mp2col14 d22_col14 enb_col14 d2_col14 3.63 penh w=8u l=0.4u

r_en_col14 en_col14 0 10000k
r1_en_col14 en_col14 en1_col14 5
r_enb_col14 enb_col14 0 10000k
r1_enb_col14 enb_col14 enb1_col14 5

r_d11_col14 d11_col14 0 10000k
r1_d11_col14 d11_col14 d111_col14 5
r_d22_col14 d22_col14 0 10000k
r1_d22_col14 d22_col14 d222_col14 5

r_SL1col14 SL1col14 0 10000k
r1_SL1col14 SL1col14 SL11col14 5
r_SL2col14 SL2col14 0 10000k
r1_SL2col14 SL2col14 SL22col14 5

* col15

mn1col15 d1_col15 en_col15 d11_col15 0 nenh w=4u l=.4u
mn2col15 d2_col15 en_col15 d22_col15 0 nenh w=4u l=.4u
mp1col15 d11_col15 enb_col15 d1_col15 3.63 penh w=8u l=0.4u
mp2col15 d22_col15 enb_col15 d2_col15 3.63 penh w=8u l=0.4u

r_en_col15 en_col15 0 10000k
r1_en_col15 en_col15 en1_col15 5
r_enb_col15 enb_col15 0 10000k
r1_enb_col15 enb_col15 enb1_col15 5

r_d11_col15 d11_col15 0 10000k
r1_d11_col15 d11_col15 d111_col15 5
r_d22_col15 d22_col15 0 10000k
r1_d22_col15 d22_col15 d222_col15 5

r_SL1col15 SL1col15 0 10000k
r1_SL1col15 SL1col15 SL11col15 5
r_SL2col15 SL2col15 0 10000k
r1_SL2col15 SL2col15 SL22col15 5

* col16

mn1col16 d1_col16 en_col16 d11_col16 0 nenh w=4u l=.4u
mn2col16 d2_col16 en_col16 d22_col16 0 nenh w=4u l=.4u
mp1col16 d11_col16 enb_col16 d1_col16 3.63 penh w=8u l=0.4u
mp2col16 d22_col16 enb_col16 d2_col16 3.63 penh w=8u l=0.4u

r_en_col16 en_col16 0 10000k
r1_en_col16 en_col16 en1_col16 5
r_enb_col16 enb_col16 0 10000k
r1_enb_col16 enb_col16 enb1_col16 5

r_d11_col16 d11_col16 0 10000k
r1_d11_col16 d11_col16 d111_col16 5
r_d22_col16 d22_col16 0 10000k
r1_d22_col16 d22_col16 d222_col16 5

r_SL1col16 SL1col16 0 10000k
r1_SL1col16 SL1col16 SL11col16 5
r_SL2col16 SL2col16 0 10000k
r1_SL2col16 SL2col16 SL22col16 5

* col17

mn1col17 d1_col17 en_col17 d11_col17 0 nenh w=4u l=.4u
mn2col17 d2_col17 en_col17 d22_col17 0 nenh w=4u l=.4u
mp1col17 d11_col17 enb_col17 d1_col17 3.63 penh w=8u l=0.4u
mp2col17 d22_col17 enb_col17 d2_col17 3.63 penh w=8u l=0.4u

r_en_col17 en_col17 0 10000k
r1_en_col17 en_col17 en1_col17 5
r_enb_col17 enb_col17 0 10000k

r1_enb_col17 enb_col17 enb1_col17 5

r_d11_col17 d11_col17 0 10000k
r1_d11_col17 d11_col17 d111_col17 5
r_d22_col17 d22_col17 0 10000k
r1_d22_col17 d22_col17 d222_col17 5

r_SL1col17 SL1col17 0 10000k
r1_SL1col17 SL1col17 SL11col17 5
r_SL2col17 SL2col17 0 10000k
r1_SL2col17 SL2col17 SL22col17 5

* col18

mn1col18 d1_col18 en_col18 d11_col18 0 nenh w=4u l=.4u
mn2col18 d2_col18 en_col18 d22_col18 0 nenh w=4u l=.4u
mp1col18 d11_col18 enb_col18 d1_col18 3.63 penh w=8u l=0.4u
mp2col18 d22_col18 enb_col18 d2_col18 3.63 penh w=8u l=0.4u

r_en_col18 en_col18 0 10000k
r1_en_col18 en_col18 en1_col18 5
r_enb_col18 enb_col18 0 10000k
r1_enb_col18 enb_col18 enb1_col18 5

r_d11_col18 d11_col18 0 10000k
r1_d11_col18 d11_col18 d111_col18 5
r_d22_col18 d22_col18 0 10000k
r1_d22_col18 d22_col18 d222_col18 5

r_SL1col18 SL1col18 0 10000k
r1_SL1col18 SL1col18 SL11col18 5
r_SL2col18 SL2col18 0 10000k
r1_SL2col18 SL2col18 SL22col18 5

* col19

mn1col19 d1_col19 en_col19 d11_col19 0 nenh w=4u l=.4u
mn2col19 d2_col19 en_col19 d22_col19 0 nenh w=4u l=.4u
mp1col19 d11_col19 enb_col19 d1_col19 3.63 penh w=8u l=0.4u
mp2col19 d22_col19 enb_col19 d2_col19 3.63 penh w=8u l=0.4u

r_en_col19 en_col19 0 10000k
r1_en_col19 en_col19 en1_col19 5
r_enb_col19 enb_col19 0 10000k
r1_enb_col19 enb_col19 enb1_col19 5

r_d11_col19 d11_col19 0 10000k
r1_d11_col19 d11_col19 d111_col19 5
r_d22_col19 d22_col19 0 10000k
r1_d22_col19 d22_col19 d222_col19 5
r_SL1col19 SL1col19 0 10000k
r1_SL1col19 SL1col19 SL11col19 5
r_SL2col19 SL2col19 0 10000k
r1_SL2col19 SL2col19 SL22col19 5

* col20

mn1col20 d1_col20 en_col20 d11_col20 0 nenh w=4u l=.4u
mn2col20 d2_col20 en_col20 d22_col20 0 nenh w=4u l=.4u
mp1col20 d11_col20 enb_col20 d1_col20 3.63 penh w=8u l=0.4u
mp2col20 d22_col20 enb_col20 d2_col20 3.63 penh w=8u l=0.4u

r_en_col20 en_col20 0 10000k
r1_en_col20 en_col20 en1_col20 5

r_enb_col20 enb_col20 0 10000k
r1_enb_col20 enb_col20 enb1_col20 5

r_d11_col20 d11_col20 0 10000k
r1_d11_col20 d11_col20 d111_col20 5
r_d22_col20 d22_col20 0 10000k
r1_d22_col20 d22_col20 d222_col20 5

r_SL1col20 SL1col20 0 10000k
r1_SL1col20 SL1col20 SL11col20 5
r_SL2col20 SL2col20 0 10000k
r1_SL2col20 SL2col20 SL22col20 5

* col21

mn1col21 d1_col21 en_col21 d11_col21 0 nenh w=4u l=.4u
mn2col21 d2_col21 en_col21 d22_col21 0 nenh w=4u l=.4u
mp1col21 d11_col21 enb_col21 d1_col21 3.63 penh w=8u l=0.4u
mp2col21 d22_col21 enb_col21 d2_col21 3.63 penh w=8u l=0.4u

r_en_col21 en_col21 0 10000k
r1_en_col21 en_col21 en1_col21 5
r_enb_col21 enb_col21 0 10000k
r1_enb_col21 enb_col21 enb1_col21 5

r_d11_col21 d11_col21 0 10000k
r1_d11_col21 d11_col21 d111_col21 5
r_d22_col21 d22_col21 0 10000k
r1_d22_col21 d22_col21 d222_col21 5

r_SL1col21 SL1col21 0 10000k
r1_SL1col21 SL1col21 SL11col21 5
r_SL2col21 SL2col21 0 10000k
r1_SL2col21 SL2col21 SL22col21 5

* col22

mn1col22 d1_col22 en_col22 d11_col22 0 nenh w=4u l=.4u
mn2col22 d2_col22 en_col22 d22_col22 0 nenh w=4u l=.4u
mp1col22 d11_col22 enb_col22 d1_col22 3.63 penh w=8u l=0.4u
mp2col22 d22_col22 enb_col22 d2_col22 3.63 penh w=8u l=0.4u

r_en_col22 en_col22 0 10000k
r1_en_col22 en_col22 en1_col22 5
r_enb_col22 enb_col22 0 10000k
r1_enb_col22 enb_col22 enb1_col22 5

r_d11_col22 d11_col22 0 10000k
r1_d11_col22 d11_col22 d111_col22 5
r_d22_col22 d22_col22 0 10000k
r1_d22_col22 d22_col22 d222_col22 5

r_SL1col22 SL1col22 0 10000k
r1_SL1col22 SL1col22 SL11col22 5
r_SL2col22 SL2col22 0 10000k
r1_SL2col22 SL2col22 SL22col22 5

* col23

mn1col23 d1_col23 en_col23 d11_col23 0 nenh w=4u l=.4u
mn2col23 d2_col23 en_col23 d22_col23 0 nenh w=4u l=.4u
mp1col23 d11_col23 enb_col23 d1_col23 3.63 penh w=8u l=0.4u
mp2col23 d22_col23 enb_col23 d2_col23 3.63 penh w=8u l=0.4u

r_en_col23 en_col23 0 10000k
r1_en_col23 en_col23 en1_col23 5
r_enb_col23 enb_col23 0 10000k
r1_enb_col23 enb_col23 enb1_col23 5

r_d11_col23 d11_col23 0 10000k
r1_d11_col23 d11_col23 d111_col23 5
r_d22_col23 d22_col23 0 10000k
r1_d22_col23 d22_col23 d222_col23 5

r_SL1col23 SL1col23 0 10000k
r1_SL1col23 SL1col23 SL11col23 5
r_SL2col23 SL2col23 0 10000k
r1_SL2col23 SL2col23 SL22col23 5

* col24

mn1col24 d1_col24 en_col24 d11_col24 0 nenh w=4u l=.4u
mn2col24 d2_col24 en_col24 d22_col24 0 nenh w=4u l=.4u
mp1col24 d11_col24 enb_col24 d1_col24 3.63 penh w=8u l=0.4u
mp2col24 d22_col24 enb_col24 d2_col24 3.63 penh w=8u l=0.4u

r_en_col24 en_col24 0 10000k
r1_en_col24 en_col24 en1_col24 5
r_enb_col24 enb_col24 0 10000k
r1_enb_col24 enb_col24 enb1_col24 5

r_d11_col24 d11_col24 0 10000k
r1_d11_col24 d11_col24 d111_col24 5
r_d22_col24 d22_col24 0 10000k
r1_d22_col24 d22_col24 d222_col24 5

r_SL1col24 SL1col24 0 10000k
r1_SL1col24 SL1col24 SL11col24 5
r_SL2col24 SL2col24 0 10000k
r1_SL2col24 SL2col24 SL22col24 5

* col25

mn1col25 d1_col25 en_col25 d11_col25 0 nenh w=4u l=.4u
mn2col25 d2_col25 en_col25 d22_col25 0 nenh w=4u l=.4u
mp1col25 d11_col25 enb_col25 d1_col25 3.63 penh w=8u l=0.4u
mp2col25 d22_col25 enb_col25 d2_col25 3.63 penh w=8u l=0.4u

r_en_col25 en_col25 0 10000k
r1_en_col25 en_col25 en1_col25 5
r_enb_col25 enb_col25 0 10000k
r1_enb_col25 enb_col25 enb1_col25 5

r_d11_col25 d11_col25 0 10000k
r1_d11_col25 d11_col25 d111_col25 5
r_d22_col25 d22_col25 0 10000k
r1_d22_col25 d22_col25 d222_col25 5

r_SL1col25 SL1col25 0 10000k
r1_SL1col25 SL1col25 SL11col25 5
r_SL2col25 SL2col25 0 10000k
r1_SL2col25 SL2col25 SL22col25 5

* col26

mn1col26 d1_col26 en_col26 d11_col26 0 nenh w=4u l=.4u
mn2col26 d2_col26 en_col26 d22_col26 0 nenh w=4u l=.4u
mp1col26 d11_col26 enb_col26 d1_col26 3.63 penh w=8u l=0.4u

mp2col26 d22_col26 enb_col26 d2_col26 3.63 penh w=8u l=0.4u

r_en_col26 en_col26 0 10000k
r1_en_col26 en_col26 en1_col26 5
r_enb_col26 enb_col26 0 10000k
r1_enb_col26 enb_col26 enb1_col26 5

r_d11_col26 d11_col26 0 10000k
r1_d11_col26 d11_col26 d111_col26 5
r_d22_col26 d22_col26 0 10000k
r1_d22_col26 d22_col26 d222_col26 5

r_SL1col26 SL1col26 0 10000k
r1_SL1col26 SL1col26 SL11col26 5
r_SL2col26 SL2col26 0 10000k
r1_SL2col26 SL2col26 SL22col26 5

* col27

mn1col27 d1_col27 en_col27 d11_col27 0 nenh w=4u l=.4u
mn2col27 d2_col27 en_col27 d22_col27 0 nenh w=4u l=.4u
mp1col27 d11_col27 enb_col27 d1_col27 3.63 penh w=8u l=0.4u
mp2col27 d22_col27 enb_col27 d2_col27 3.63 penh w=8u l=0.4u

r_en_col27 en_col27 0 10000k
r1_en_col27 en_col27 en1_col27 5
r_enb_col27 enb_col27 0 10000k
r1_enb_col27 enb_col27 enb1_col27 5

r_d11_col27 d11_col27 0 10000k
r1_d11_col27 d11_col27 d111_col27 5
r_d22_col27 d22_col27 0 10000k
r1_d22_col27 d22_col27 d222_col27 5

r_SL1col27 SL1col27 0 10000k
r1_SL1col27 SL1col27 SL11col27 5
r_SL2col27 SL2col27 0 10000k
r1_SL2col27 SL2col27 SL22col27 5

* col28

mn1col28 d1_col28 en_col28 d11_col28 0 nenh w=4u l=.4u
mn2col28 d2_col28 en_col28 d22_col28 0 nenh w=4u l=.4u
mp1col28 d11_col28 enb_col28 d1_col28 3.63 penh w=8u l=0.4u
mp2col28 d22_col28 enb_col28 d2_col28 3.63 penh w=8u l=0.4u

r_en_col28 en_col28 0 10000k
r1_en_col28 en_col28 en1_col28 5
r_enb_col28 enb_col28 0 10000k
r1_enb_col28 enb_col28 enb1_col28 5

r_d11_col28 d11_col28 0 10000k
r1_d11_col28 d11_col28 d111_col28 5
r_d22_col28 d22_col28 0 10000k
r1_d22_col28 d22_col28 d222_col28 5

r_SL1col28 SL1col28 0 10000k
r1_SL1col28 SL1col28 SL11col28 5
r_SL2col28 SL2col28 0 10000k
r1_SL2col28 SL2col28 SL22col28 5

* col29

mn1col29 d1_col29 en_col29 d11_col29 0 nenh w=4u l=.4u

mn2col29 d2_col29 en_col29 d22_col29 0 nenh w=4u l=.4u
mp1col29 d11_col29 enb_col29 d1_col29 3.63 penh w=8u l=0.4u
mp2col29 d22_col29 enb_col29 d2_col29 3.63 penh w=8u l=0.4u

r_en_col29 en_col29 0 10000k
r1_en_col29 en_col29 en1_col29 5
r_enb_col29 enb_col29 0 10000k
r1_enb_col29 enb_col29 enb1_col29 5

r_d11_col29 d11_col29 0 10000k
r1_d11_col29 d11_col29 d111_col29 5
r_d22_col29 d22_col29 0 10000k
r1_d22_col29 d22_col29 d222_col29 5

r_SL1col29 SL1col29 0 10000k
r1_SL1col29 SL1col29 SL11col29 5
r_SL2col29 SL2col29 0 10000k
r1_SL2col29 SL2col29 SL22col29 5

* col30

mn1col30 d1_col30 en_col30 d11_col30 0 nenh w=4u l=.4u
mn2col30 d2_col30 en_col30 d22_col30 0 nenh w=4u l=.4u
mp1col30 d11_col30 enb_col30 d1_col30 3.63 penh w=8u l=0.4u
mp2col30 d22_col30 enb_col30 d2_col30 3.63 penh w=8u l=0.4u

r_en_col30 en_col30 0 10000k
r1_en_col30 en_col30 en1_col30 5
r_enb_col30 enb_col30 0 10000k
r1_enb_col30 enb_col30 enb1_col30 5

r_d11_col30 d11_col30 0 10000k
r1_d11_col30 d11_col30 d111_col30 5
r_d22_col30 d22_col30 0 10000k
r1_d22_col30 d22_col30 d222_col30 5

r_SL1col30 SL1col30 0 10000k
r1_SL1col30 SL1col30 SL11col30 5
r_SL2col30 SL2col30 0 10000k
r1_SL2col30 SL2col30 SL22col30 5

* col31

mn1col31 d1_col31 en_col31 d11_col31 0 nenh w=4u l=.4u
mn2col31 d2_col31 en_col31 d22_col31 0 nenh w=4u l=.4u
mp1col31 d11_col31 enb_col31 d1_col31 3.63 penh w=8u l=0.4u
mp2col31 d22_col31 enb_col31 d2_col31 3.63 penh w=8u l=0.4u

r_en_col31 en_col31 0 10000k
r1_en_col31 en_col31 en1_col31 5
r_enb_col31 enb_col31 0 10000k
r1_enb_col31 enb_col31 enb1_col31 5

r_d11_col31 d11_col31 0 10000k
r1_d11_col31 d11_col31 d111_col31 5
r_d22_col31 d22_col31 0 10000k
r1_d22_col31 d22_col31 d222_col31 5

r_SL1col31 SL1col31 0 10000k
r1_SL1col31 SL1col31 SL11col31 5
r_SL2col31 SL2col31 0 10000k
r1_SL2col31 SL2col31 SL22col31 5

* col32

mn1col32 d1_col32 en_col32 d11_col32 0 nenh w=4u l=.4u
mn2col32 d2_col32 en_col32 d22_col32 0 nenh w=4u l=.4u
mp1col32 d11_col32 enb_col32 d1_col32 3.63 penh w=8u l=0.4u
mp2col32 d22_col32 enb_col32 d2_col32 3.63 penh w=8u l=0.4u

r_en_col32 en_col32 0 10000k
r1_en_col32 en_col32 en1_col32 5
r_enb_col32 enb_col32 0 10000k
r1_enb_col32 enb_col32 enb1_col32 5

r_d11_col32 d11_col32 0 10000k
r1_d11_col32 d11_col32 d111_col32 5
r_d22_col32 d22_col32 0 10000k
r1_d22_col32 d22_col32 d222_col32 5

r_SL1col32 SL1col32 0 10000k
r1_SL1col32 SL1col32 SL11col32 5
r_SL2col32 SL2col32 0 10000k
r1_SL2col32 SL2col32 SL22col32 5

* col33

mn1col33 d1_col33 en_col33 d11_col33 0 nenh w=4u l=.4u
mn2col33 d2_col33 en_col33 d22_col33 0 nenh w=4u l=.4u
mp1col33 d11_col33 enb_col33 d1_col33 3.63 penh w=8u l=0.4u
mp2col33 d22_col33 enb_col33 d2_col33 3.63 penh w=8u l=0.4u

r_en_col33 en_col33 0 10000k
r1_en_col33 en_col33 en1_col33 5
r_enb_col33 enb_col33 0 10000k
r1_enb_col33 enb_col33 enb1_col33 5

r_d11_col33 d11_col33 0 10000k
r1_d11_col33 d11_col33 d111_col33 5
r_d22_col33 d22_col33 0 10000k
r1_d22_col33 d22_col33 d222_col33 5

r_SL1col33 SL1col33 0 10000k
r1_SL1col33 SL1col33 SL11col33 5
r_SL2col33 SL2col33 0 10000k
r1_SL2col33 SL2col33 SL22col33 5

* col34

mn1col34 d1_col34 en_col34 d11_col34 0 nenh w=4u l=.4u
mn2col34 d2_col34 en_col34 d22_col34 0 nenh w=4u l=.4u
mp1col34 d11_col34 enb_col34 d1_col34 3.63 penh w=8u l=0.4u
mp2col34 d22_col34 enb_col34 d2_col34 3.63 penh w=8u l=0.4u

r_en_col34 en_col34 0 10000k
r1_en_col34 en_col34 en1_col34 5
r_enb_col34 enb_col34 0 10000k
r1_enb_col34 enb_col34 enb1_col34 5

r_d11_col34 d11_col34 0 10000k
r1_d11_col34 d11_col34 d111_col34 5
r_d22_col34 d22_col34 0 10000k
r1_d22_col34 d22_col34 d222_col34 5

r_SL1col34 SL1col34 0 10000k
r1_SL1col34 SL1col34 SL11col34 5
r_SL2col34 SL2col34 0 10000k
r1_SL2col34 SL2col34 SL22col34 5

* col35

mn1col35 d1_col35 en_col35 d11_col35 0 nenh w=4u l=.4u
mn2col35 d2_col35 en_col35 d22_col35 0 nenh w=4u l=.4u
mp1col35 d11_col35 enb_col35 d1_col35 3.63 penh w=8u l=0.4u
mp2col35 d22_col35 enb_col35 d2_col35 3.63 penh w=8u l=0.4u

r_en_col35 en_col35 0 10000k
r1_en_col35 en_col35 en1_col35 5
r_enb_col35 enb_col35 0 10000k
r1_enb_col35 enb_col35 enb1_col35 5

r_d11_col35 d11_col35 0 10000k
r1_d11_col35 d11_col35 d111_col35 5
r_d22_col35 d22_col35 0 10000k
r1_d22_col35 d22_col35 d222_col35 5

r_SL1col35 SL1col35 0 10000k
r1_SL1col35 SL1col35 SL11col35 5
r_SL2col35 SL2col35 0 10000k
r1_SL2col35 SL2col35 SL22col35 5

* col36

mn1col36 d1_col36 en_col36 d11_col36 0 nenh w=4u l=.4u
mn2col36 d2_col36 en_col36 d22_col36 0 nenh w=4u l=.4u
mp1col36 d11_col36 enb_col36 d1_col36 3.63 penh w=8u l=0.4u
mp2col36 d22_col36 enb_col36 d2_col36 3.63 penh w=8u l=0.4u

r_en_col36 en_col36 0 10000k
r1_en_col36 en_col36 en1_col36 5
r_enb_col36 enb_col36 0 10000k
r1_enb_col36 enb_col36 enb1_col36 5

r_d11_col36 d11_col36 0 10000k
r1_d11_col36 d11_col36 d111_col36 5
r_d22_col36 d22_col36 0 10000k
r1_d22_col36 d22_col36 d222_col36 5

r_SL1col36 SL1col36 0 10000k
r1_SL1col36 SL1col36 SL11col36 5
r_SL2col36 SL2col36 0 10000k
r1_SL2col36 SL2col36 SL22col36 5

* col37

mn1col37 d1_col37 en_col37 d11_col37 0 nenh w=4u l=.4u
mn2col37 d2_col37 en_col37 d22_col37 0 nenh w=4u l=.4u
mp1col37 d11_col37 enb_col37 d1_col37 3.63 penh w=8u l=0.4u
mp2col37 d22_col37 enb_col37 d2_col37 3.63 penh w=8u l=0.4u

r_en_col37 en_col37 0 10000k
r1_en_col37 en_col37 en1_col37 5
r_enb_col37 enb_col37 0 10000k
r1_enb_col37 enb_col37 enb1_col37 5

r_d11_col37 d11_col37 0 10000k
r1_d11_col37 d11_col37 d111_col37 5
r_d22_col37 d22_col37 0 10000k
r1_d22_col37 d22_col37 d222_col37 5

r_SL1col37 SL1col37 0 10000k
r1_SL1col37 SL1col37 SL11col37 5

r_SL2col37 SL2col37 0 10000k
r1_SL2col37 SL2col37 SL22col37 5

* col38

mn1col38 d1_col38 en_col38 d11_col38 0 nenh w=4u l=.4u
mn2col38 d2_col38 en_col38 d22_col38 0 nenh w=4u l=.4u
mp1col38 d11_col38 enb_col38 d1_col38 3.63 penh w=8u l=0.4u
mp2col38 d22_col38 enb_col38 d2_col38 3.63 penh w=8u l=0.4u

r_en_col38 en_col38 0 10000k
r1_en_col38 en_col38 en1_col38 5
r_enb_col38 enb_col38 0 10000k
r1_enb_col38 enb_col38 enb1_col38 5

r_d11_col38 d11_col38 0 10000k
r1_d11_col38 d11_col38 d111_col38 5
r_d22_col38 d22_col38 0 10000k
r1_d22_col38 d22_col38 d222_col38 5

r_SL1col38 SL1col38 0 10000k
r1_SL1col38 SL1col38 SL11col38 5
r_SL2col38 SL2col38 0 10000k
r1_SL2col38 SL2col38 SL22col38 5

* col39

mn1col39 d1_col39 en_col39 d11_col39 0 nenh w=4u l=.4u
mn2col39 d2_col39 en_col39 d22_col39 0 nenh w=4u l=.4u
mp1col39 d11_col39 enb_col39 d1_col39 3.63 penh w=8u l=0.4u
mp2col39 d22_col39 enb_col39 d2_col39 3.63 penh w=8u l=0.4u

r_en_col39 en_col39 0 10000k
r1_en_col39 en_col39 en1_col39 5
r_enb_col39 enb_col39 0 10000k
r1_enb_col39 enb_col39 enb1_col39 5

r_d11_col39 d11_col39 0 10000k
r1_d11_col39 d11_col39 d111_col39 5
r_d22_col39 d22_col39 0 10000k
r1_d22_col39 d22_col39 d222_col39 5

r_SL1col39 SL1col39 0 10000k
r1_SL1col39 SL1col39 SL11col39 5
r_SL2col39 SL2col39 0 10000k
r1_SL2col39 SL2col39 SL22col39 5

* col40

mn1col40 d1_col40 en_col40 d11_col40 0 nenh w=4u l=.4u
mn2col40 d2_col40 en_col40 d22_col40 0 nenh w=4u l=.4u
mp1col40 d11_col40 enb_col40 d1_col40 3.63 penh w=8u l=0.4u
mp2col40 d22_col40 enb_col40 d2_col40 3.63 penh w=8u l=0.4u

r_en_col40 en_col40 0 10000k
r1_en_col40 en_col40 en1_col40 5
r_enb_col40 enb_col40 0 10000k
r1_enb_col40 enb_col40 enb1_col40 5

r_d11_col40 d11_col40 0 10000k
r1_d11_col40 d11_col40 d111_col40 5
r_d22_col40 d22_col40 0 10000k
r1_d22_col40 d22_col40 d222_col40 5

r_SL1col40 SL1col40 0 10000k
r1_SL1col40 SL1col40 SL11col40 5
r_SL2col40 SL2col40 0 10000k
r1_SL2col40 SL2col40 SL22col40 5

* col41

mn1col41 d1_col41 en_col41 d11_col41 0 nenh w=4u l=.4u
mn2col41 d2_col41 en_col41 d22_col41 0 nenh w=4u l=.4u
mp1col41 d11_col41 enb_col41 d1_col41 3.63 penh w=8u l=0.4u
mp2col41 d22_col41 enb_col41 d2_col41 3.63 penh w=8u l=0.4u

r_en_col41 en_col41 0 10000k
r1_en_col41 en_col41 en1_col41 5
r_enb_col41 enb_col41 0 10000k
r1_enb_col41 enb_col41 enb1_col41 5

r_d11_col41 d11_col41 0 10000k
r1_d11_col41 d11_col41 d111_col41 5
r_d22_col41 d22_col41 0 10000k
r1_d22_col41 d22_col41 d222_col41 5

r_SL1col41 SL1col41 0 10000k
r1_SL1col41 SL1col41 SL11col41 5
r_SL2col41 SL2col41 0 10000k
r1_SL2col41 SL2col41 SL22col41 5

* col42

mn1col42 d1_col42 en_col42 d11_col42 0 nenh w=4u l=.4u
mn2col42 d2_col42 en_col42 d22_col42 0 nenh w=4u l=.4u
mp1col42 d11_col42 enb_col42 d1_col42 3.63 penh w=8u l=0.4u
mp2col42 d22_col42 enb_col42 d2_col42 3.63 penh w=8u l=0.4u

r_en_col42 en_col42 0 10000k
r1_en_col42 en_col42 en1_col42 5
r_enb_col42 enb_col42 0 10000k
r1_enb_col42 enb_col42 enb1_col42 5

r_d11_col42 d11_col42 0 10000k
r1_d11_col42 d11_col42 d111_col42 5
r_d22_col42 d22_col42 0 10000k
r1_d22_col42 d22_col42 d222_col42 5

r_SL1col42 SL1col42 0 10000k
r1_SL1col42 SL1col42 SL11col42 5
r_SL2col42 SL2col42 0 10000k
r1_SL2col42 SL2col42 SL22col42 5

* col43

mn1col43 d1_col43 en_col43 d11_col43 0 nenh w=4u l=.4u
mn2col43 d2_col43 en_col43 d22_col43 0 nenh w=4u l=.4u
mp1col43 d11_col43 enb_col43 d1_col43 3.63 penh w=8u l=0.4u
mp2col43 d22_col43 enb_col43 d2_col43 3.63 penh w=8u l=0.4u

r_en_col43 en_col43 0 10000k
r1_en_col43 en_col43 en1_col43 5
r_enb_col43 enb_col43 0 10000k
r1_enb_col43 enb_col43 enb1_col43 5

r_d11_col43 d11_col43 0 10000k
r1_d11_col43 d11_col43 d111_col43 5
r_d22_col43 d22_col43 0 10000k

r1_d22_col43 d22_col43 d222_col43 5

r_SL1col43 SL1col43 0 10000k
r1_SL1col43 SL1col43 SL11col43 5
r_SL2col43 SL2col43 0 10000k
r1_SL2col43 SL2col43 SL22col43 5

* col44

mn1col44 d1_col44 en_col44 d11_col44 0 nenh w=4u l=.4u
mn2col44 d2_col44 en_col44 d22_col44 0 nenh w=4u l=.4u
mp1col44 d11_col44 enb_col44 d1_col44 3.63 penh w=8u l=0.4u
mp2col44 d22_col44 enb_col44 d2_col44 3.63 penh w=8u l=0.4u

r_en_col44 en_col44 0 10000k
r1_en_col44 en_col44 en1_col44 5
r_enb_col44 enb_col44 0 10000k
r1_enb_col44 enb_col44 enb1_col44 5

r_d11_col44 d11_col44 0 10000k
r1_d11_col44 d11_col44 d111_col44 5
r_d22_col44 d22_col44 0 10000k
r1_d22_col44 d22_col44 d222_col44 5

r_SL1col44 SL1col44 0 10000k
r1_SL1col44 SL1col44 SL11col44 5
r_SL2col44 SL2col44 0 10000k
r1_SL2col44 SL2col44 SL22col44 5

* col45

mn1col45 d1_col45 en_col45 d11_col45 0 nenh w=4u l=.4u
mn2col45 d2_col45 en_col45 d22_col45 0 nenh w=4u l=.4u
mp1col45 d11_col45 enb_col45 d1_col45 3.63 penh w=8u l=0.4u
mp2col45 d22_col45 enb_col45 d2_col45 3.63 penh w=8u l=0.4u

r_en_col45 en_col45 0 10000k
r1_en_col45 en_col45 en1_col45 5
r_enb_col45 enb_col45 0 10000k
r1_enb_col45 enb_col45 enb1_col45 5

r_d11_col45 d11_col45 0 10000k
r1_d11_col45 d11_col45 d111_col45 5
r_d22_col45 d22_col45 0 10000k
r1_d22_col45 d22_col45 d222_col45 5

r_SL1col45 SL1col45 0 10000k
r1_SL1col45 SL1col45 SL11col45 5
r_SL2col45 SL2col45 0 10000k
r1_SL2col45 SL2col45 SL22col45 5

* col46

mn1col46 d1_col46 en_col46 d11_col46 0 nenh w=4u l=.4u
mn2col46 d2_col46 en_col46 d22_col46 0 nenh w=4u l=.4u
mp1col46 d11_col46 enb_col46 d1_col46 3.63 penh w=8u l=0.4u
mp2col46 d22_col46 enb_col46 d2_col46 3.63 penh w=8u l=0.4u

r_en_col46 en_col46 0 10000k
r1_en_col46 en_col46 en1_col46 5
r_enb_col46 enb_col46 0 10000k
r1_enb_col46 enb_col46 enb1_col46 5

r_d11_col46 d11_col46 0 10000k
r1_d11_col46 d11_col46 d111_col46 5

r_d22_col46 d22_col46 0 10000k
r1_d22_col46 d22_col46 d222_col46 5

r_SL1col46 SL1col46 0 10000k
r1_SL1col46 SL1col46 SL11col46 5
r_SL2col46 SL2col46 0 10000k
r1_SL2col46 SL2col46 SL22col46 5

* col47

mn1col47 d1_col47 en_col47 d11_col47 0 nenh w=4u l=.4u
mn2col47 d2_col47 en_col47 d22_col47 0 nenh w=4u l=.4u
mp1col47 d11_col47 enb_col47 d1_col47 3.63 penh w=8u l=0.4u
mp2col47 d22_col47 enb_col47 d2_col47 3.63 penh w=8u l=0.4u

r_en_col47 en_col47 0 10000k
r1_en_col47 en_col47 en1_col47 5
r_enb_col47 enb_col47 0 10000k
r1_enb_col47 enb_col47 enb1_col47 5

r_d11_col47 d11_col47 0 10000k
r1_d11_col47 d11_col47 d111_col47 5
r_d22_col47 d22_col47 0 10000k
r1_d22_col47 d22_col47 d222_col47 5

r_SL1col47 SL1col47 0 10000k
r1_SL1col47 SL1col47 SL11col47 5
r_SL2col47 SL2col47 0 10000k
r1_SL2col47 SL2col47 SL22col47 5

* col48

mn1col48 d1_col48 en_col48 d11_col48 0 nenh w=4u l=.4u
mn2col48 d2_col48 en_col48 d22_col48 0 nenh w=4u l=.4u
mp1col48 d11_col48 enb_col48 d1_col48 3.63 penh w=8u l=0.4u
mp2col48 d22_col48 enb_col48 d2_col48 3.63 penh w=8u l=0.4u

r_en_col48 en_col48 0 10000k
r1_en_col48 en_col48 en1_col48 5
r_enb_col48 enb_col48 0 10000k
r1_enb_col48 enb_col48 enb1_col48 5

r_d11_col48 d11_col48 0 10000k
r1_d11_col48 d11_col48 d111_col48 5
r_d22_col48 d22_col48 0 10000k
r1_d22_col48 d22_col48 d222_col48 5
r_SL1col48 SL1col48 0 10000k
r1_SL1col48 SL1col48 SL11col48 5
r_SL2col48 SL2col48 0 10000k
r1_SL2col48 SL2col48 SL22col48 5

* col49

mn1col49 d1_col49 en_col49 d11_col49 0 nenh w=4u l=.4u
mn2col49 d2_col49 en_col49 d22_col49 0 nenh w=4u l=.4u
mp1col49 d11_col49 enb_col49 d1_col49 3.63 penh w=8u l=0.4u
mp2col49 d22_col49 enb_col49 d2_col49 3.63 penh w=8u l=0.4u

r_en_col49 en_col49 0 10000k
r1_en_col49 en_col49 en1_col49 5
r_enb_col49 enb_col49 0 10000k
r1_enb_col49 enb_col49 enb1_col49 5

r_d11_col49 d11_col49 0 10000k

r1_d11_col49 d11_col49 d111_col49 5
r_d22_col49 d22_col49 0 10000k
r1_d22_col49 d22_col49 d222_col49 5

r_SL1col49 SL1col49 0 10000k
r1_SL1col49 SL1col49 SL11col49 5
r_SL2col49 SL2col49 0 10000k
r1_SL2col49 SL2col49 SL22col49 5

* col50

mn1col50 d1_col50 en_col50 d11_col50 0 nenh w=4u l=.4u
mn2col50 d2_col50 en_col50 d22_col50 0 nenh w=4u l=.4u
mp1col50 d11_col50 enb_col50 d1_col50 3.63 penh w=8u l=0.4u
mp2col50 d22_col50 enb_col50 d2_col50 3.63 penh w=8u l=0.4u

r_en_col50 en_col50 0 10000k
r1_en_col50 en_col50 en1_col50 5
r_enb_col50 enb_col50 0 10000k
r1_enb_col50 enb_col50 enb1_col50 5

r_d11_col50 d11_col50 0 10000k
r1_d11_col50 d11_col50 d111_col50 5
r_d22_col50 d22_col50 0 10000k
r1_d22_col50 d22_col50 d222_col50 5

r_SL1col50 SL1col50 0 10000k
r1_SL1col50 SL1col50 SL11col50 5
r_SL2col50 SL2col50 0 10000k
r1_SL2col50 SL2col50 SL22col50 5

* col51

mn1col51 d1_col51 en_col51 d11_col51 0 nenh w=4u l=.4u
mn2col51 d2_col51 en_col51 d22_col51 0 nenh w=4u l=.4u
mp1col51 d11_col51 enb_col51 d1_col51 3.63 penh w=8u l=0.4u
mp2col51 d22_col51 enb_col51 d2_col51 3.63 penh w=8u l=0.4u

r_en_col51 en_col51 0 10000k
r1_en_col51 en_col51 en1_col51 5
r_enb_col51 enb_col51 0 10000k
r1_enb_col51 enb_col51 enb1_col51 5

r_d11_col51 d11_col51 0 10000k
r1_d11_col51 d11_col51 d111_col51 5
r_d22_col51 d22_col51 0 10000k
r1_d22_col51 d22_col51 d222_col51 5

r_SL1col51 SL1col51 0 10000k
r1_SL1col51 SL1col51 SL11col51 5
r_SL2col51 SL2col51 0 10000k
r1_SL2col51 SL2col51 SL22col51 5

* col52

mn1col52 d1_col52 en_col52 d11_col52 0 nenh w=4u l=.4u
mn2col52 d2_col52 en_col52 d22_col52 0 nenh w=4u l=.4u
mp1col52 d11_col52 enb_col52 d1_col52 3.63 penh w=8u l=0.4u
mp2col52 d22_col52 enb_col52 d2_col52 3.63 penh w=8u l=0.4u

r_en_col52 en_col52 0 10000k
r1_en_col52 en_col52 en1_col52 5
r_enb_col52 enb_col52 0 10000k
r1_enb_col52 enb_col52 enb1_col52 5

r_d11_col52 d11_col52 0 10000k
r1_d11_col52 d11_col52 d111_col52 5
r_d22_col52 d22_col52 0 10000k
r1_d22_col52 d22_col52 d222_col52 5

r_SL1col52 SL1col52 0 10000k
r1_SL1col52 SL1col52 SL11col52 5
r_SL2col52 SL2col52 0 10000k
r1_SL2col52 SL2col52 SL22col52 5

* col53

mn1col53 d1_col53 en_col53 d11_col53 0 nenh w=4u l=.4u
mn2col53 d2_col53 en_col53 d22_col53 0 nenh w=4u l=.4u
mp1col53 d11_col53 enb_col53 d1_col53 3.63 penh w=8u l=0.4u
mp2col53 d22_col53 enb_col53 d2_col53 3.63 penh w=8u l=0.4u

r_en_col53 en_col53 0 10000k
r1_en_col53 en_col53 en1_col53 5
r_enb_col53 enb_col53 0 10000k
r1_enb_col53 enb_col53 enb1_col53 5

r_d11_col53 d11_col53 0 10000k
r1_d11_col53 d11_col53 d111_col53 5
r_d22_col53 d22_col53 0 10000k
r1_d22_col53 d22_col53 d222_col53 5

r_SL1col53 SL1col53 0 10000k
r1_SL1col53 SL1col53 SL11col53 5
r_SL2col53 SL2col53 0 10000k
r1_SL2col53 SL2col53 SL22col53 5

* col54

mn1col54 d1_col54 en_col54 d11_col54 0 nenh w=4u l=.4u
mn2col54 d2_col54 en_col54 d22_col54 0 nenh w=4u l=.4u
mp1col54 d11_col54 enb_col54 d1_col54 3.63 penh w=8u l=0.4u
mp2col54 d22_col54 enb_col54 d2_col54 3.63 penh w=8u l=0.4u

r_en_col54 en_col54 0 10000k
r1_en_col54 en_col54 en1_col54 5
r_enb_col54 enb_col54 0 10000k
r1_enb_col54 enb_col54 enb1_col54 5

r_d11_col54 d11_col54 0 10000k
r1_d11_col54 d11_col54 d111_col54 5
r_d22_col54 d22_col54 0 10000k
r1_d22_col54 d22_col54 d222_col54 5

r_SL1col54 SL1col54 0 10000k
r1_SL1col54 SL1col54 SL11col54 5
r_SL2col54 SL2col54 0 10000k
r1_SL2col54 SL2col54 SL22col54 5

* col55

mn1col55 d1_col55 en_col55 d11_col55 0 nenh w=4u l=.4u
mn2col55 d2_col55 en_col55 d22_col55 0 nenh w=4u l=.4u
mp1col55 d11_col55 enb_col55 d1_col55 3.63 penh w=8u l=0.4u
mp2col55 d22_col55 enb_col55 d2_col55 3.63 penh w=8u l=0.4u

r_en_col55 en_col55 0 10000k
r1_en_col55 en_col55 en1_col55 5

r_enb_col55 enb_col55 0 10000k
r1_enb_col55 enb_col55 enb1_col55 5

r_d11_col55 d11_col55 0 10000k
r1_d11_col55 d11_col55 d111_col55 5
r_d22_col55 d22_col55 0 10000k
r1_d22_col55 d22_col55 d222_col55 5

r_SL1col55 SL1col55 0 10000k
r1_SL1col55 SL1col55 SL11col55 5
r_SL2col55 SL2col55 0 10000k
r1_SL2col55 SL2col55 SL22col55 5

* col56

mn1col56 d1_col56 en_col56 d11_col56 0 nenh w=4u l=.4u
mn2col56 d2_col56 en_col56 d22_col56 0 nenh w=4u l=.4u
mp1col56 d11_col56 enb_col56 d1_col56 3.63 penh w=8u l=0.4u
mp2col56 d22_col56 enb_col56 d2_col56 3.63 penh w=8u l=0.4u

r_en_col56 en_col56 0 10000k
r1_en_col56 en_col56 en1_col56 5
r_enb_col56 enb_col56 0 10000k
r1_enb_col56 enb_col56 enb1_col56 5

r_d11_col56 d11_col56 0 10000k
r1_d11_col56 d11_col56 d111_col56 5
r_d22_col56 d22_col56 0 10000k
r1_d22_col56 d22_col56 d222_col56 5

r_SL1col56 SL1col56 0 10000k
r1_SL1col56 SL1col56 SL11col56 5
r_SL2col56 SL2col56 0 10000k
r1_SL2col56 SL2col56 SL22col56 5

* col57

mn1col57 d1_col57 en_col57 d11_col57 0 nenh w=4u l=.4u
mn2col57 d2_col57 en_col57 d22_col57 0 nenh w=4u l=.4u
mp1col57 d11_col57 enb_col57 d1_col57 3.63 penh w=8u l=0.4u
mp2col57 d22_col57 enb_col57 d2_col57 3.63 penh w=8u l=0.4u

r_en_col57 en_col57 0 10000k
r1_en_col57 en_col57 en1_col57 5
r_enb_col57 enb_col57 0 10000k
r1_enb_col57 enb_col57 enb1_col57 5

r_d11_col57 d11_col57 0 10000k
r1_d11_col57 d11_col57 d111_col57 5
r_d22_col57 d22_col57 0 10000k
r1_d22_col57 d22_col57 d222_col57 5

r_SL1col57 SL1col57 0 10000k
r1_SL1col57 SL1col57 SL11col57 5
r_SL2col57 SL2col57 0 10000k
r1_SL2col57 SL2col57 SL22col57 5

* col58

mn1col58 d1_col58 en_col58 d11_col58 0 nenh w=4u l=.4u
mn2col58 d2_col58 en_col58 d22_col58 0 nenh w=4u l=.4u
mp1col58 d11_col58 enb_col58 d1_col58 3.63 penh w=8u l=0.4u
mp2col58 d22_col58 enb_col58 d2_col58 3.63 penh w=8u l=0.4u

r_en_col58 en_col58 0 10000k
r1_en_col58 en_col58 en1_col58 5
r_enb_col58 enb_col58 0 10000k
r1_enb_col58 enb_col58 enb1_col58 5

r_d11_col58 d11_col58 0 10000k
r1_d11_col58 d11_col58 d111_col58 5
r_d22_col58 d22_col58 0 10000k
r1_d22_col58 d22_col58 d222_col58 5

r_SL1col58 SL1col58 0 10000k
r1_SL1col58 SL1col58 SL11col58 5
r_SL2col58 SL2col58 0 10000k
r1_SL2col58 SL2col58 SL22col58 5

* col59

mn1col59 d1_col59 en_col59 d11_col59 0 nenh w=4u l=.4u
mn2col59 d2_col59 en_col59 d22_col59 0 nenh w=4u l=.4u
mp1col59 d11_col59 enb_col59 d1_col59 3.63 penh w=8u l=0.4u
mp2col59 d22_col59 enb_col59 d2_col59 3.63 penh w=8u l=0.4u

r_en_col59 en_col59 0 10000k
r1_en_col59 en_col59 en1_col59 5
r_enb_col59 enb_col59 0 10000k
r1_enb_col59 enb_col59 enb1_col59 5

r_d11_col59 d11_col59 0 10000k
r1_d11_col59 d11_col59 d111_col59 5
r_d22_col59 d22_col59 0 10000k
r1_d22_col59 d22_col59 d222_col59 5

r_SL1col59 SL1col59 0 10000k
r1_SL1col59 SL1col59 SL11col59 5
r_SL2col59 SL2col59 0 10000k
r1_SL2col59 SL2col59 SL22col59 5

* col60

mn1col60 d1_col60 en_col60 d11_col60 0 nenh w=4u l=.4u
mn2col60 d2_col60 en_col60 d22_col60 0 nenh w=4u l=.4u
mp1col60 d11_col60 enb_col60 d1_col60 3.63 penh w=8u l=0.4u
mp2col60 d22_col60 enb_col60 d2_col60 3.63 penh w=8u l=0.4u

r_en_col60 en_col60 0 10000k
r1_en_col60 en_col60 en1_col60 5
r_enb_col60 enb_col60 0 10000k
r1_enb_col60 enb_col60 enb1_col60 5

r_d11_col60 d11_col60 0 10000k
r1_d11_col60 d11_col60 d111_col60 5
r_d22_col60 d22_col60 0 10000k
r1_d22_col60 d22_col60 d222_col60 5

r_SL1col60 SL1col60 0 10000k
r1_SL1col60 SL1col60 SL11col60 5
r_SL2col60 SL2col60 0 10000k
r1_SL2col60 SL2col60 SL22col60 5

* col61

mn1col61 d1_col61 en_col61 d11_col61 0 nenh w=4u l=.4u
mn2col61 d2_col61 en_col61 d22_col61 0 nenh w=4u l=.4u
mp1col61 d11_col61 enb_col61 d1_col61 3.63 penh w=8u l=0.4u

mp2col61 d22_col61 enb_col61 d2_col61 3.63 penh w=8u l=0.4u

r_en_col61 en_col61 0 10000k
r1_en_col61 en_col61 en1_col61 5
r_enb_col61 enb_col61 0 10000k
r1_enb_col61 enb_col61 enb1_col61 5

r_d11_col61 d11_col61 0 10000k
r1_d11_col61 d11_col61 d111_col61 5
r_d22_col61 d22_col61 0 10000k
r1_d22_col61 d22_col61 d222_col61 5

r_SL1col61 SL1col61 0 10000k
r1_SL1col61 SL1col61 SL11col61 5
r_SL2col61 SL2col61 0 10000k
r1_SL2col61 SL2col61 SL22col61 5

* col62

mn1col62 d1_col62 en_col62 d11_col62 0 nenh w=4u l=.4u
mn2col62 d2_col62 en_col62 d22_col62 0 nenh w=4u l=.4u
mp1col62 d11_col62 enb_col62 d1_col62 3.63 penh w=8u l=0.4u
mp2col62 d22_col62 enb_col62 d2_col62 3.63 penh w=8u l=0.4u

r_en_col62 en_col62 0 10000k
r1_en_col62 en_col62 en1_col62 5
r_enb_col62 enb_col62 0 10000k
r1_enb_col62 enb_col62 enb1_col62 5

r_d11_col62 d11_col62 0 10000k
r1_d11_col62 d11_col62 d111_col62 5
r_d22_col62 d22_col62 0 10000k
r1_d22_col62 d22_col62 d222_col62 5

r_SL1col62 SL1col62 0 10000k
r1_SL1col62 SL1col62 SL11col62 5
r_SL2col62 SL2col62 0 10000k
r1_SL2col62 SL2col62 SL22col62 5

* col63

mn1col63 d1_col63 en_col63 d11_col63 0 nenh w=4u l=.4u
mn2col63 d2_col63 en_col63 d22_col63 0 nenh w=4u l=.4u
mp1col63 d11_col63 enb_col63 d1_col63 3.63 penh w=8u l=0.4u
mp2col63 d22_col63 enb_col63 d2_col63 3.63 penh w=8u l=0.4u

r_en_col63 en_col63 0 10000k
r1_en_col63 en_col63 en1_col63 5
r_enb_col63 enb_col63 0 10000k
r1_enb_col63 enb_col63 enb1_col63 5

r_d11_col63 d11_col63 0 10000k
r1_d11_col63 d11_col63 d111_col63 5
r_d22_col63 d22_col63 0 10000k
r1_d22_col63 d22_col63 d222_col63 5

r_SL1col63 SL1col63 0 10000k
r1_SL1col63 SL1col63 SL11col63 5
r_SL2col63 SL2col63 0 10000k
r1_SL2col63 SL2col63 SL22col63 5

.....
sources_array64bit_SelectiveCharging_Fast.cir
.....

```

*****
*           power supply           *
*****

v_dd u 0 dc 3.63
v_dd_2 u2 0 dc 1.815
v_dd2 l 0 pulse(0 1.815 1n 0.25n 0.25n 1.5n 20n)

*****
*           row enable             *
*****

v_en_row0 en1_row0 0 dc 3.63
v_enb_row0 enb1_row0 0 dc 0

*****
*           column enable          *
*****

v_en_col0 en1_col0 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col0 enb1_col0 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col1 en1_col1 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col1 enb1_col1 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col2 en1_col2 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col2 enb1_col2 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col3 en1_col3 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col3 enb1_col3 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col4 en1_col4 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col4 enb1_col4 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col5 en1_col5 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col5 enb1_col5 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col6 en1_col6 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col6 enb1_col6 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col7 en1_col7 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col7 enb1_col7 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col8 en1_col8 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col8 enb1_col8 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col9 en1_col9 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col9 enb1_col9 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col10 en1_col10 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col10 enb1_col10 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col11 en1_col11 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col11 enb1_col11 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col12 en1_col12 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col12 enb1_col12 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col13 en1_col13 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col13 enb1_col13 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col14 en1_col14 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col14 enb1_col14 0 pulse(3.63 0 1n 1p 1p 2n 20n)

```

v_en_col15 en1_col15 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col15 enb1_col15 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col16 en1_col16 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col16 enb1_col16 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col17 en1_col17 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col17 enb1_col17 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col18 en1_col18 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col18 enb1_col18 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col19 en1_col19 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col19 enb1_col19 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col20 en1_col20 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col20 enb1_col20 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col21 en1_col21 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col21 enb1_col21 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col22 en1_col22 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col22 enb1_col22 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col23 en1_col23 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col23 enb1_col23 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col24 en1_col24 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col24 enb1_col24 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col25 en1_col25 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col25 enb1_col25 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col26 en1_col26 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col26 enb1_col26 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col27 en1_col27 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col27 enb1_col27 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col28 en1_col28 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col28 enb1_col28 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col29 en1_col29 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col29 enb1_col29 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col30 en1_col30 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col30 enb1_col30 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col31 en1_col31 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col31 enb1_col31 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col32 en1_col32 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col32 enb1_col32 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col33 en1_col33 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col33 enb1_col33 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col34 en1_col34 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col34 enb1_col34 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col35 en1_col35 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col35 enb1_col35 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col36 en1_col36 0 pulse(0 3.63 1n 1p 1p 2n 20n)

v_enb_col36 enb1_col36 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col37 en1_col37 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col37 enb1_col37 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col38 en1_col38 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col38 enb1_col38 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col39 en1_col39 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col39 enb1_col39 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col40 en1_col40 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col40 enb1_col40 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col41 en1_col41 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col41 enb1_col41 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col42 en1_col42 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col42 enb1_col42 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col43 en1_col43 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col43 enb1_col43 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col44 en1_col44 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col44 enb1_col44 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col45 en1_col45 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col45 enb1_col45 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col46 en1_col46 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col46 enb1_col46 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col47 en1_col47 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col47 enb1_col47 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col48 en1_col48 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col48 enb1_col48 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col49 en1_col49 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col49 enb1_col49 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col50 en1_col50 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col50 enb1_col50 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col51 en1_col51 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col51 enb1_col51 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col52 en1_col52 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col52 enb1_col52 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col53 en1_col53 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col53 enb1_col53 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col54 en1_col54 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col54 enb1_col54 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col55 en1_col55 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col55 enb1_col55 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col56 en1_col56 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col56 enb1_col56 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col57 en1_col57 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col57 enb1_col57 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col58 en1_col58 0 pulse(0 3.63 1n 1p 1p 2n 20n)

v_enb_col58 enb1_col58 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col59 en1_col59 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col59 enb1_col59 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col60 en1_col60 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col60 enb1_col60 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col61 en1_col61 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col61 enb1_col61 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col62 en1_col62 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col62 enb1_col62 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col63 en1_col63 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col63 enb1_col63 0 pulse(3.63 0 1n 1p 1p 2n 20n)

* data lines *

v_d1col0 d111_col0 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)
v_d2col0 d222_col0 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82n 3.63 82.5n 0 83n 0)

v_d1col1 d111_col1 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82n 3.63 82.5n 0 83n 0)
v_d2col1 d222_col1 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)

v_d1col2 d111_col2 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82n 3.63 82.5n 0 83n 0)
v_d2col2 d222_col2 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)

v_d1col3 d111_col3 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)
v_d2col3 d222_col3 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82.0n 3.63 82.5n 0 83n 0)

v_d1col4 d111_col4 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82n 3.63 82.5n 0 83n 0)
v_d2col4 d222_col4 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)

v_d1col5 d111_col5 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82.0n 3.63 82.5n 0 83n 0)
v_d2col5 d222_col5 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)

v_d1col6 d111_col6 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0

```

+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)
v_d2col6 d222_col6 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82.0n 3.63 82.5n 0 83n 0)

v_d1col7 d111_col7 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0
+43n 0 61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0 )
v_d2col7 d222_col7 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82n 3.63 82.5n 0 83n 0 )
*^^^ 1st cycle = mismatch (1 bit mismatch at row=0 col=7) ..... 2nd cycle = full match

v_d1col8 d111_col8 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)
v_d2col8 d222_col8 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82.0n 3.63 82n 3.63 82.5n 0 83n 0)

v_d1col9 d111_col9 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82.0n 3.63 82.5n 0 83n 0)
v_d2col9 d222_col9 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)

v_d1col10 d111_col10 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82.0n 3.63 82.5n 0 83n 0)
v_d2col10 d222_col10 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)

v_d1col11 d111_col11 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)
v_d2col11 d222_col11 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82.0n 3.63 82.5n 0 83n 0)

v_d1col12 d111_col12 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)
v_d2col12 d222_col12 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82.0n 3.63 82.5n 0 83n 0)

v_d1col13 d111_col13 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)
v_d2col13 d222_col13 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82.0n 3.63 82.5n 0 83n 0)

v_d1col14 d111_col14 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82.0n 3.63 82.5n 0 83n 0)
v_d2col14 d222_col14 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)

```



```

+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82n 3.63 82.5n 0 83n 0 )

v_d1col61 d111_col61 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82n 3.63 82.5n 0 83n 0 )
v_d2col61 d222_col61 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)

v_d1col62 d111_col62 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82n 3.63 82.5n 0 83n 0 )
v_d2col62 d222_col62 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)

v_d1col63 d111_col63 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)
v_d2col63 d222_col63 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82n 3.63 82.5n 0 83n 0 )

*****
*                search lines                *
*****

v_SL1_col0 SL11col0 0 pwl(0 0 47n 0 47.02n 3.63 48.0n 3.63 48.02n 0 87n 0 87.02n 3.63 88.0n 3.63 88.02n 0)
v_SL2_col0 SL22col0 0 pwl(0 0 27n 0 27.02n 3.63 28.0n 3.63 28.02n 0 67n 0 67.02n 3.63 68.0n 3.63 68.02n 0)

v_SL1_col1 SL11col1 0 pwl(0 0 27n 0 27.02n 3.63 28.0n 3.63 28.02n 0 67n 0 67.02n 3.63 68.0n 3.63 68.02n 0)
v_SL2_col1 SL22col1 0 pwl(0 0 47n 0 47.02n 3.63 48.0n 3.63 48.02n 0 87n 0 87.02n 3.63 88.0n 3.63 88.02n 0)

v_SL1_col2 SL11col2 0 pwl(0 0 27n 0 27.02n 3.63 28.0n 3.63 28.02n 0 67n 0 67.02n 3.63 68.0n 3.63 68.02n 0)
v_SL2_col2 SL22col2 0 pwl(0 0 47n 0 47.02n 3.63 48.0n 3.63 48.02n 0 87n 0 87.02n 3.63 88.0n 3.63 88.02n 0)

v_SL1_col3 SL11col3 0 pwl(0 0 47n 0 47.02n 3.63 48.0n 3.63 48.02n 0 87n 0 87.02n 3.63 88.0n 3.63 88.02n 0)
v_SL2_col3 SL22col3 0 pwl(0 0 27n 0 27.02n 3.63 28.0n 3.63 28.02n 0 67n 0 67.02n 3.63 68.0n 3.63 68.02n 0)

v_SL1_col4 SL11col4 0 pwl(0 0 27n 0 27.02n 3.63 28.0n 3.63 28.02n 0 67n 0 67.02n 3.63 68.0n 3.63 68.02n 0)
v_SL2_col4 SL22col4 0 pwl(0 0 47n 0 47.02n 3.63 48.0n 3.63 48.02n 0 87n 0 87.02n 3.63 88.0n 3.63 88.02n 0)

v_SL1_col5 SL11col5 0 pwl(0 0 27n 0 27.02n 3.63 28.0n 3.63 28.02n 0 67n 0 67.02n 3.63 68.0n 3.63 68.02n 0)
v_SL2_col5 SL22col5 0 pwl(0 0 47n 0 47.02n 3.63 48.0n 3.63 48.02n 0 87n 0 87.02n 3.63 88.0n 3.63 88.02n 0)

v_SL1_col6 SL11col6 0 pwl(0 0 47n 0 47.02n 3.63 48.0n 3.63 48.02n 0 87n 0 87.02n 3.63 88.0n 3.63 88.02n 0)
v_SL2_col6 SL22col6 0 pwl(0 0 27n 0 27.02n 3.63 28.0n 3.63 28.02n 0 67n 0 67.02n 3.63 68.0n 3.63 68.02n 0)

v_SL1_col7 SL11col7 0 pwl(0 0 7n 0 7.02n 3.63 8.5n 3.63 8.52n 0 47n 0 47.02n 3.63 48.0n 3.63 48.02n 0
+107n 0 107.02n 3.63 108.5n 3.63 108.52n 0 )
v_SL2_col7 SL22col7 0 pwl(0 0 27n 0 27.02n 3.63 28.0n 3.63 28.02n 0 67n 0 67.02n 3.63 68.0n 3.63 68.02n 0)
*^^^ 1st cycle = mismatch (1 bit mismatch at row=0 col=7) ..... 2nd cycle = full match

v_SL1_col8 SL11col8 0 pwl(0 0 47n 0 47.02n 3.63 48.0n 3.63 48.02n 0 87n 0 87.02n 3.63 88.0n 3.63 88.02n 0)
v_SL2_col8 SL22col8 0 pwl(0 0 27n 0 27.02n 3.63 28.0n 3.63 28.02n 0 67n 0 67.02n 3.63 68.0n 3.63 68.02n 0)

v_SL1_col9 SL11col9 0 pwl(0 0 27n 0 27.02n 3.63 28.0n 3.63 28.02n 0 67n 0 67.02n 3.63 68.0n 3.63 68.02n 0)
v_SL2_col9 SL22col9 0 pwl(0 0 47n 0 47.02n 3.63 48.0n 3.63 48.02n 0 87n 0 87.02n 3.63 88.0n 3.63 88.02n 0)

v_SL1_col10 SL11col10 0 pwl(0 0 27n 0 27.02n 3.63 28.0n 3.63 28.02n 0 67n 0 67.02n 3.63 68.0n 3.63 68.02n 0)
v_SL2_col10 SL22col10 0 pwl(0 0 47n 0 47.02n 3.63 48.0n 3.63 48.02n 0 87n 0 87.02n 3.63 88.0n 3.63 88.02n 0)

v_SL1_col11 SL11col11 0 pwl(0 0 47n 0 47.02n 3.63 48.0n 3.63 48.02n 0 87n 0 87.02n 3.63 88.0n 3.63 88.02n 0)

```



```
v_SL1_col55 SL11col55 0 pwl(0 0 27n 0 27.02n 3.63 28.0n 3.63 28.02n 0 67n 0 67.02n 3.63 68.0n 3.63 68.02n 0)
v_SL2_col55 SL22col55 0 pwl(0 0 47n 0 47.02n 3.63 48.0n 3.63 48.02n 0 87n 0 87.02n 3.63 88.0n 3.63 88.02n 0)

v_SL1_col56 SL11col56 0 pwl(0 0 47n 0 47.02n 3.63 48.0n 3.63 48.02n 0 87n 0 87.02n 3.63 88.0n 3.63 88.02n 0)
v_SL2_col56 SL22col56 0 pwl(0 0 27n 0 27.02n 3.63 28.0n 3.63 28.02n 0 67n 0 67.02n 3.63 68.0n 3.63 68.02n 0)

v_SL1_col57 SL11col57 0 pwl(0 0 47n 0 47.02n 3.63 48.0n 3.63 48.02n 0 87n 0 87.02n 3.63 88.0n 3.63 88.02n 0)
v_SL2_col57 SL22col57 0 pwl(0 0 27n 0 27.02n 3.63 28.0n 3.63 28.02n 0 67n 0 67.02n 3.63 68.0n 3.63 68.02n 0)

v_SL1_col58 SL11col58 0 pwl(0 0 47n 0 47.02n 3.63 48.0n 3.63 48.02n 0 87n 0 87.02n 3.63 88.0n 3.63 88.02n 0)
v_SL2_col58 SL22col58 0 pwl(0 0 27n 0 27.02n 3.63 28.0n 3.63 28.02n 0 67n 0 67.02n 3.63 68.0n 3.63 68.02n 0)

v_SL1_col59 SL11col59 0 pwl(0 0 27n 0 27.02n 3.63 28.0n 3.63 28.02n 0 67n 0 67.02n 3.63 68.0n 3.63 68.02n 0)
v_SL2_col59 SL22col59 0 pwl(0 0 47n 0 47.02n 3.63 48.0n 3.63 48.02n 0 87n 0 87.02n 3.63 88.0n 3.63 88.02n 0)

v_SL1_col60 SL11col60 0 pwl(0 0 47n 0 47.02n 3.63 48.0n 3.63 48.02n 0 87n 0 87.02n 3.63 88.0n 3.63 88.02n 0)
v_SL2_col60 SL22col60 0 pwl(0 0 27n 0 27.02n 3.63 28.0n 3.63 28.02n 0 67n 0 67.02n 3.63 68.0n 3.63 68.02n 0)

v_SL1_col61 SL11col61 0 pwl(0 0 27n 0 27.02n 3.63 28.0n 3.63 28.02n 0 67n 0 67.02n 3.63 68.0n 3.63 68.02n 0)
v_SL2_col61 SL22col61 0 pwl(0 0 47n 0 47.02n 3.63 48.0n 3.63 48.02n 0 87n 0 87.02n 3.63 88.0n 3.63 88.02n 0)

v_SL1_col62 SL11col62 0 pwl(0 0 27n 0 27.02n 3.63 28.0n 3.63 28.02n 0 67n 0 67.02n 3.63 68.0n 3.63 68.02n 0)
v_SL2_col62 SL22col62 0 pwl(0 0 47n 0 47.02n 3.63 48.0n 3.63 48.02n 0 87n 0 87.02n 3.63 88.0n 3.63 88.02n 0)

v_SL1_col63 SL11col63 0 pwl(0 0 47n 0 47.02n 3.63 48.0n 3.63 48.02n 0 87n 0 87.02n 3.63 88.0n 3.63 88.02n 0)
v_SL2_col63 SL22col63 0 pwl(0 0 27n 0 27.02n 3.63 28.0n 3.63 28.02n 0 67n 0 67.02n 3.63 68.0n 3.63 68.02n 0)
```

```
*****
* search enables *
*****
```

```
vSErow0 SE1_row0 0 pulse(0 3.63 7n .1n .1n 0.8n 20n)
```

```
*****
* pre-charge *
*****
```

```
vpre_row01 pre1_row01 0 pulse(3.63 0 7n 0.1n 0.1n 0.8n 20n)
vpre_row02 pre1_row02 0 pulse(3.63 0 7n 0.1n 0.1n 0.8n 20n)
vpre_row03 pre1_row03 0 pulse(3.63 0 7n 0.1n 0.1n 0.8n 20n)
vpre_row04 pre1_row04 0 pulse(3.63 0 7n 0.1n 0.1n 0.8n 20n)
```

```
*****
* ML reset *
*****
```

```
vML1reset_row0 ML1reset_row0 0 pulse(0 3.63 5n .1n .1n .5n 20n)
vML2reset_row0 ML2reset_row0 0 pulse(0 3.63 5n .1n .1n .5n 20n)
vML3reset_row0 ML3reset_row0 0 pulse(0 3.63 5n .1n .1n .5n 20n)
vML4reset_row0 ML4reset_row0 0 pulse(0 3.63 5n .1n .1n .5n 20n)
```

```
*****
cells_array64bit_SelectiveCharging_Fast.cir
*****
```

```
xtcam_cell_0_0 d1_col0 d2_col0 SL1col0 SL2col0 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_1 d1_col1 d2_col1 SL1col1 SL2col1 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_2 d1_col2 d2_col2 SL1col2 SL2col2 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_3 d1_col3 d2_col3 SL1col3 SL2col3 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
```



```
xtcam_cell_0_62 d1_col62 d2_col62 SL1col62 SL2col62 en_row0 enb_row0 SE_row0 ML4row0 u2 l tcam_cell
xtcam_cell_0_63 d1_col63 d2_col63 SL1col63 SL2col63 en_row0 enb_row0 SE_row0 ML4row0 u2 l tcam_cell
```

A.5. PSpice netlist for Table 7.4

* 1X64 bit TCAM array

```
.INCLUDE 'models_array64bit_SelectiveCharging_Slow.cir'
.INCLUDE 'rowcolumn_array64bit_SelectiveCharging_Slow.cir'
.INCLUDE 'sources_array64bit_SelectiveCharging_Slow.cir'
.INCLUDE 'cells_array64bit_SelectiveCharging_Slow.cir'
```

```
.SUBCKT tcam_cell d1 d2 SL1 SL2 en_row enb_row SE ML u2 l
```

```
xmem1 p l sv_mem1 MEM_YAKOPCIC_test1
xmem2 q l sv_mem2 MEM_YAKOPCIC_test1
xmem3 s u2 sv_mem3 MEM_YAKOPCIC_test2
xmem4 t u2 sv_mem4 MEM_YAKOPCIC_test2
```

```
rmem1 sv_mem1 0 10000k
rmem2 sv_mem2 0 10000k
rmem3 sv_mem3 0 10000k
rmem4 sv_mem4 0 10000k
```

```
mn1 d1 en_row p 0 nenh w=2u l=0.4u
mn2 d2 en_row q 0 nenh w=2u l=0.4u
mp1 p enb_row d1 2.97 penh w=2u l=0.4u
mp2 q enb_row d2 2.97 penh w=2u l=0.4u
mn3 s SE p 0 nenh w=4u l=0.2u
mn4 t SE q 0 nenh w=4u l=0.2u
mn5 p SL1 p1 0 nenh w=.2u l=0.2u
mn6 q SL2 q1 0 nenh w=.2u l=0.2u
mn7 ML p1 0 0 nenh w=6u l=0.2u
mn8 ML q1 0 0 nenh w=6u l=0.2u
```

```
.ENDS tcam_cell
```

```
.SUBCKT precharge pre u ML
```

```
mnpr u1 u1 ML 0 nenh w=2u l=0.2u
mppr u1 pre u 2.97 penh w=1.4u l=0.2u
```

```
.ENDS precharge
```

```
.SUBCKT sense_amplifier ML SE u MLout
```

```
mnSE ML SE a 0 nenh w=.4u l=.2u
mpSE a SE MLout 2.97 penh w=.4u l=.2u
mnSE1 b a 0 0 nenh w=2u l=.2u
mpSE1 b a u 2.97 penh w=2u l=.2u
mnSE2 MLout b 0 0 nenh w=2u l=.2u
mpSE2 MLout b u 2.97 penh w=2u l=.2u
```

```
.ENDS sense_amplifier
```

```
.tran 0.1ns 110ns
.probe
```

```
.....
models_array64bit_SelectiveCharging_Slow.cir
.....
```

```

*** model of Memristors ***

.subckt MEM_YAKOPCIC_test1 TE BE XSV PARAMS:

* Fitting parameters to model different devices
* a1, a2, b: Parameters for IV relationship
* Vp, Vn: Pos. and neg. voltage thresholds
* Ap, An: Multiplier for SV motion intensity
* xp, xn: Points where SV motion is reduced
* alphap, alphan: Rate at which SV motion decays
* xo: Initial value of SV
* eta: SV direction relative to voltage

+a1=.01 a2=.01 b=0.1 Vp=1.2 Vn=1.2 Ap=1.8e10 An=2e10
+xp=0.1 xn=0.1 alphap=.3 alphan=.55 xo=0.01 eta=1

* Multiplicative functions to ensure zero state
* variable motion at memristor boundaries

.func wp(V) {(xp-V)/(1-xp)+1}
.func wn(V) {V/(1-xn)}

* Function G(V(t)) - Describes the device threshold

.func G(V) { IF(V<=Vp, IF(V>=-Vn, 0, -An*(exp(-V)-exp(Vn))), Ap*(exp(V)-exp(Vp))) }

* Function F(V(t),x(t)) - Describes the SV motion

.func F(V1,V2) {IF(eta*V1 >= 0, IF(V2 >= xp, exp(-
+alphap*(V2-xp))*wp(V2) ,1), IF(V2 <= (1-xn),
+exp(alphan*(V2+xn-1))*wn(V2) ,1))}

* IV Response - Hyperbolic sine due to MIM structure

.func IVRel(V1,V2) {IF(V1 >= 0, a1*V2*sinh(b*V1),
+a2*V2*sinh(b*V1) )}

* Circuit to determine state variable
* dx/dt = F(V(t),x(t))*G(V(t))

Cx XSV 0 1 IC= {xo}
Gx 0 XSV value={eta*F(V(TE,BE),V(XSV,0))*G(V(TE,BE))}

* Current source for memristor IV response

Gm TE BE value = {IVRel(V(TE,BE),V(XSV,0))}

.ends MEM_YAKOPCIC_test1

.subckt MEM_YAKOPCIC_test2 TE BE XSV PARAMS:

* Fitting parameters to model different devices
* a1, a2, b: Parameters for IV relationship
* Vp, Vn: Pos. and neg. voltage thresholds
* Ap, An: Multiplier for SV motion intensity
* xp, xn: Points where SV motion is reduced
* alphap, alphan: Rate at which SV motion decays
* xo: Initial value of SV
* eta: SV direction relative to voltage

+a1=.01 a2=.01 b=.011 Vp=1.7 Vn=1.7 Ap=4e3 An=4e3
+xp=0.1 xn=0.1 alphap=1 alphan=7 xo=0.1 eta=1

* Multiplicative functions to ensure zero state

```

* variable motion at memristor boundaries

```
.func wp(V) {(xp-V)/(1-xp)+1}
.func wn(V) {V/(1-xn)}
```

* Function G(V(t)) - Describes the device threshold

```
.func G(V) { IF(V<=Vp, IF(V>=-Vn, 0, -An*(exp(-V)-exp(Vn))), Ap*(exp(V)-exp(Vp))) }
```

* Function F(V(t),x(t)) - Describes the SV motion

```
.func F(V1,V2) {IF(eta*V1 >= 0, IF(V2 >= xp, exp(-
+alphap*(V2-xp))*wp(V2) ,1), IF(V2 <= (1-xn),
+exp(alphan*(V2+xn-1))*wn(V2) ,1))}
```

* IV Response - Hyperbolic sine due to MIM structure

```
.func IVRel(V1,V2) {IF(V1 >= 0, a1*V2*sinh(b*V1),
+a2*V2*sinh(b*V1) )}
```

* Circuit to determine state variable

```
* dx/dt = F(V(t),x(t))*G(V(t))
```

```
Cx XSV 0 1 IC= {xo}
```

```
Gx 0 XSV value={eta*F(V(TE,BE),V(XSV,0))*G(V(TE,BE))}
```

* Current source for memristor IV response

```
Gm TE BE value = {IVRel(V(TE,BE),V(XSV,0))}
```

```
.ends MEM_YAKOPCIC_test2
```

*** model of NMOS transistor ***

```
.MODEL nenh NMOS LEVEL=7 VERSION=3.1 TNOM=100 tox=4.1E-9 XJ=1E-7 NCH=2.3549E17
+VTH0=0.40287203 K1=0.5864999 K2=1.127266E-3 K3=1E-3
+K3B=0.0294061 W0=1E-7 NLX=1.630684E-7 DVT0W=0 DVT1W=0 DVT2W=0 DVT0=1.2064649
+DVT1=0.4215486 DVT2=0.0197749 U0=273.8094484 UA=-1.40499E-9
+UB=2.408323E-18 UC=6.504826E-11 VSAT=1.355009E5 A0=2 AGS=0.4449958
+BO=1.901075E-7 B1=4.99995E-6 KETA=-0.0164863 A1=3.868769E-4 A2=0.4640272
+RDSW=123.3376355 PRWG=0.5 PRWB=-0.197728 WR=1 WINT=0 LINT=1.690044E-8
+XL=0 XW=-1E-8 DWG=-4.728719E-9 DWB=-2.452411E-9 VOFF=-0.0948017 NFACTOR=2.1860065
+CIT=0 CDSC=2.4E-4 CDSCD=0 CDSCB=0 ETA0=2.230928E-3 ETAB=6.028975E-5 DSUB=0.0145467
+PCLM=1.3822069 PDIBLC1=0.1762787 PDIBLC2 = 1.66653E-3 PDIBLCB = -0.1
+DROUT=0.7694691 PSCBE1=8.91287E9 PSCBE2=7.349607E-9 PVAG=1.685917E-3
+DELTA=0.01 RSH=6.7 MOBMOD=1 PRT=0 UTE=-1.5 KT1=-0.11 KT1L=0 KT2=0.022 UA1=4.31E-9
+UB1=-7.61E-18 UC1=-5.6E-11 AT=3.3E4 WL=0 WLN=1 WW=0 WWN=1 WWL=0 LL=0 LLN=1 LW=0
+LWN=1 LWL=0 CAPMOD=2 XPART=0.5 CGDO=8.23E-10 CGSO=8.23E-10 CGBO=1E-12
+CJ = 9.466429E-4 PB = 0.8 MJ = 0.3820266
+CJSW = 2.608154E-10 PBSW = 0.8 MJSW = 0.102322
+CJSWG = 3.3E-10 PBSWG = 0.8 MJSWG = 0.102322
+CF = 0 PVTH0 = -2.199373E-3 PRDSW = -0.9368961
+PK2 = 1.593254E-3 WKETA = -2.880976E-3 LKETA = 7.165078E-3
+PU0 = 6.777519 PUA = 5.505418E-12 PUB = 8.84133E-25
+PVSAT = 2.006286E3 PETA0 = 1.003159E-4 PKETA = -6.759277E-3
+NOIMOD=2.0E+00 NOIA=1.3182567385564E+19
+NOIB=144543.977074592 NOIC=-1.24515784572817E-12 EF=0.92 EM=41000000
```

*** model of PMOS transistor ***

```
.MODEL penh PMOS LEVEL=7 VERSION = 3.1 TNOM = 100 tox = 4.1E-9
+XJ = 1E-7 NCH = 4.1589E17 VTH0 = -0.42966132
+K1 = 0.5341312 K2 = 0.0395326 K3 = 0
+K3B = 7.4916211 W0 = 1E-6 NLX = 1.194072E-7
+DVT0W = 0 DVT1W = 0 DVT2W = 0
```



```

+DVT0 = 0.5060555 DVT1 = 0.2423835 DVT2 = 0.1
+U0 = 115.6894042 UA = 1.573746E-9 UB = 1.874308E-21
+UC = -1E-10 VSAT = 1.130982E5 A0 = 1.9976555
+AGS = 0.4186945 B0 = 1.949178E-7 B1 = 6.422908E-7
+KETA = 0.0166345 A1 = 0.4749146 A2 = 0.300003
+RDSW = 198.321294 PRWG = 0.5 PRWB = -0.4986647
+WR = 1 WINT = 0 LINT = 2.94454E-8
+XL = 0 XW = -1E-8 DWG = -2.798724E-8
+DWB = -4.83797E-10 VOFF = -0.095236 NFACTOR = 2
+CIT = 0 CDSC = 2.4E-4 CDSCD = 0
+CDSCB = 0 ETAO = 1.035504E-3 ETAB = -4.358398E-4
+DSUB = 1.816555E-3 PCLM = 1.3299898 PDIBLC1 = 1.766563E-3
+PDIBLC2 = 7.728395E-7 PDIBLCB = -1E-3 DROUT = 1.011891E-3
+PSCBE1 = 4.872184E10 PSCBE2 = 5E-10 PVAG = 0.0209921
+DELTA = 0.01 RSH = 7.7 MOBMOD = 1
+PRT = 0 UTE = -1.5 KT1 = -0.11
+KT1L = 0 KT2 = 0.022 UA1 = 4.31E-9
+UB1 = -7.61E-18 UC1 = -5.6E-11 AT = 3.3E4
+WL = 0 WLN = 1 WW = 0
+WWN = 1 WWL = 0 LL = 0
+LLN = 1 LW = 0 LWN = 1
+LWL = 0 CAPMOD = 2 XPART = 0.5
+CGDO = 6.35E-10 CGSO = 6.35E-10 CGBO = 1E-12
+CJ = 1.144521E-3 PB = 0.8468686 MJ = 0.4099522
+CJSW = 2.490749E-10 PBSW = 0.8769118 MJSW = 0.3478565
+CJSWG = 4.22E-10 PBSWG = 0.8769118 MJSWG = 0.3478565
+CF = 0 PVTH0 = 2.302018E-3 PRDSW = 9.0575312
+PK2 = 1.821914E-3 WKETA = 0.0222457 LKETA = -1.495872E-3
+PUO = -1.5580645 PUA = -6.36889E-11 PUB = 1E-21
+PVSAT = 49.8420442 PETAO = 2.827793E-5 PKETA = -2.536564E-3
+NOIMOD=2.0E+00 NOIA=3.57456993317604E+18 NOIB=2500
+NOIC=2.61260020285845E-11 EF=1.1388

```

```

.....
rowcolumn_array64bit_SelectiveCharging_Slow.cir
.....

```

```

*****
*           rows           *
*****
* row0
*pre-charge ckt.
xprecharge_row01 pre_row01 u ML1row0 precharge
xprecharge_row02 pre_row02 u ML2row0 precharge
xprecharge_row03 pre_row03 u ML3row0 precharge
xprecharge_row04 pre_row04 u ML4row0 precharge

*Matchline segmentation

*NOT Gates
mnML1row0 ML1brow0 ML1row0 0 0 nenh w=2u l=.2u
mpML1row0 ML1brow0 ML1row0 u 2.97 penh w=2u l=.2u
mnML2row0 ML2brow0 ML2row0 0 0 nenh w=2u l=.2u
mpML2row0 ML2brow0 ML2row0 u 2.97 penh w=2u l=.2u
mnML3row0 ML3brow0 ML3row0 0 0 nenh w=2u l=.2u
mpML3row0 ML3brow0 ML3row0 u 2.97 penh w=2u l=.2u
mnML4row0 ML4brow0 ML4row0 0 0 nenh w=2u l=.2u
mpML4row0 ML4brow0 ML4row0 u 2.97 penh w=2u l=.2u

*NOR Gate
mn1ML1row0 MLrow0 ML1brow0 0 0 nenh w=2u l=0.2u
mn1ML2row0 MLrow0 ML2brow0 0 0 nenh w=2u l=0.2u
mn1ML3row0 MLrow0 ML3brow0 0 0 nenh w=2u l=0.2u
mn1ML4row0 MLrow0 ML4brow0 0 0 nenh w=2u l=0.2u
mpMLrow0 MLrow0 MLrow0 u 2.97 penh w=4u l=0.2u

```

* sense-amplifier

xsense_amplifier_row0 MLrow0 SE_row0 u MLout_row0 sense_amplifier

*reset

mnML1reset_row0 ML1row0 ML1reset1_row0 0 0 nenh W=40u l=0.4u
mnML2reset_row0 ML2row0 ML2reset1_row0 0 0 nenh W=40u l=0.4u
mnML3reset_row0 ML3row0 ML3reset1_row0 0 0 nenh W=40u l=0.4u
mnML4reset_row0 ML4row0 ML4reset1_row0 0 0 nenh W=40u l=0.4u

r_en_row0 en_row0 0 10000k
r1_en_row0 en_row0 en1_row0 5
r_enb_row0 enb_row0 0 10000k
r1_enb_row0 enb_row0 enb1_row0 5
r_pre1_row01 pre1_row01 0 10000k
r1_pre1_row01 pre1_row01 pre_row01 5
r_pre1_row02 pre1_row02 0 10000k
r1_pre1_row02 pre1_row02 pre_row02 5
r_pre1_row03 pre1_row03 0 10000k
r1_pre1_row03 pre1_row03 pre_row03 5
r_pre1_row04 pre1_row04 0 10000k
r1_pre1_row04 pre1_row04 pre_row04 5
r_SE_row0 SE_row0 0 10000k
r1_SE_row0 SE_row0 SE1_row0 5
rML1reset_row0 ML1reset_row0 ML1reset1_row0 5
rML1reset1_row0 ML1reset1_row0 0 10000k
rML2reset_row0 ML2reset_row0 ML2reset1_row0 5
rML2reset1_row0 ML2reset1_row0 0 10000k
rML3reset_row0 ML3reset_row0 ML3reset1_row0 5
rML3reset1_row0 ML3reset1_row0 0 10000k
rML4reset_row0 ML4reset_row0 ML4reset1_row0 5
rML4reset1_row0 ML4reset1_row0 0 10000k

* columns *

* col0

mn1col0 d1_col0 en_col0 d11_col0 0 nenh w=4u l=.4u
mn2col0 d2_col0 en_col0 d22_col0 0 nenh w=4u l=.4u
mp1col0 d11_col0 enb_col0 d1_col0 2.97 penh w=8u l=0.4u
mp2col0 d22_col0 enb_col0 d2_col0 2.97 penh w=8u l=0.4u

r_en_col0 en_col0 0 10000k
r1_en_col0 en_col0 en1_col0 5
r_enb_col0 enb_col0 0 10000k
r1_enb_col0 enb_col0 enb1_col0 5

r_d11_col0 d11_col0 0 10000k
r1_d11_col0 d11_col0 d111_col0 5
r_d22_col0 d22_col0 0 10000k
r1_d22_col0 d22_col0 d222_col0 5

r_SL1col0 SL1col0 0 10000k
r1_SL1col0 SL1col0 SL11col0 5
r_SL2col0 SL2col0 0 10000k
r1_SL2col0 SL2col0 SL22col0 5

* col1

mn1col1 d1_col1 en_col1 d11_col1 0 nenh w=4u l=.4u
mn2col1 d2_col1 en_col1 d22_col1 0 nenh w=4u l=.4u

mp1col1 d11_col1 enb_col1 d1_col1 2.97 penh w=8u l=0.4u
mp2col1 d22_col1 enb_col1 d2_col1 2.97 penh w=8u l=0.4u

r_en_col1 en_col1 0 10000k
r1_en_col1 en_col1 en1_col1 5
r_enb_col1 enb_col1 0 10000k
r1_enb_col1 enb_col1 enb1_col1 5

r_d11_col1 d11_col1 0 10000k
r1_d11_col1 d11_col1 d111_col1 5
r_d22_col1 d22_col1 0 10000k
r1_d22_col1 d22_col1 d222_col1 5

r_SL1col1 SL1col1 0 10000k
r1_SL1col1 SL1col1 SL11col1 5
r_SL2col1 SL2col1 0 10000k
r1_SL2col1 SL2col1 SL22col1 5

* col2

mn1col2 d1_col2 en_col2 d11_col2 0 nenh w=4u l=.4u
mn2col2 d2_col2 en_col2 d22_col2 0 nenh w=4u l=.4u
mp1col2 d11_col2 enb_col2 d1_col2 2.97 penh w=8u l=0.4u
mp2col2 d22_col2 enb_col2 d2_col2 2.97 penh w=8u l=0.4u

r_en_col2 en_col2 0 10000k
r1_en_col2 en_col2 en1_col2 5
r_enb_col2 enb_col2 0 10000k
r1_enb_col2 enb_col2 enb1_col2 5

r_d11_col2 d11_col2 0 10000k
r1_d11_col2 d11_col2 d111_col2 5
r_d22_col2 d22_col2 0 10000k
r1_d22_col2 d22_col2 d222_col2 5

r_SL1col2 SL1col2 0 10000k
r1_SL1col2 SL1col2 SL11col2 5
r_SL2col2 SL2col2 0 10000k
r1_SL2col2 SL2col2 SL22col2 5

* col3

mn1col3 d1_col3 en_col3 d11_col3 0 nenh w=4u l=.4u
mn2col3 d2_col3 en_col3 d22_col3 0 nenh w=4u l=.4u
mp1col3 d11_col3 enb_col3 d1_col3 2.97 penh w=8u l=0.4u
mp2col3 d22_col3 enb_col3 d2_col3 2.97 penh w=8u l=0.4u

r_en_col3 en_col3 0 10000k
r1_en_col3 en_col3 en1_col3 5
r_enb_col3 enb_col3 0 10000k
r1_enb_col3 enb_col3 enb1_col3 5

r_d11_col3 d11_col3 0 10000k
r1_d11_col3 d11_col3 d111_col3 5
r_d22_col3 d22_col3 0 10000k
r1_d22_col3 d22_col3 d222_col3 5

r_SL1col3 SL1col3 0 10000k
r1_SL1col3 SL1col3 SL11col3 5
r_SL2col3 SL2col3 0 10000k
r1_SL2col3 SL2col3 SL22col3 5

* col4

mn1col4 d1_col4 en_col4 d11_col4 0 nenh w=4u l=.4u
mn2col4 d2_col4 en_col4 d22_col4 0 nenh w=4u l=.4u
mp1col4 d11_col4 enb_col4 d1_col4 2.97 penh w=8u l=0.4u
mp2col4 d22_col4 enb_col4 d2_col4 2.97 penh w=8u l=0.4u

r_en_col4 en_col4 0 10000k
r1_en_col4 en_col4 en1_col4 5
r_enb_col4 enb_col4 0 10000k
r1_enb_col4 enb_col4 enb1_col4 5

r_d11_col4 d11_col4 0 10000k
r1_d11_col4 d11_col4 d111_col4 5
r_d22_col4 d22_col4 0 10000k
r1_d22_col4 d22_col4 d222_col4 5

r_SL1col4 SL1col4 0 10000k
r1_SL1col4 SL1col4 SL11col4 5
r_SL2col4 SL2col4 0 10000k
r1_SL2col4 SL2col4 SL22col4 5

* col5

mn1col5 d1_col5 en_col5 d11_col5 0 nenh w=4u l=.4u
mn2col5 d2_col5 en_col5 d22_col5 0 nenh w=4u l=.4u
mp1col5 d11_col5 enb_col5 d1_col5 2.97 penh w=8u l=0.4u
mp2col5 d22_col5 enb_col5 d2_col5 2.97 penh w=8u l=0.4u

r_en_col5 en_col5 0 10000k
r1_en_col5 en_col5 en1_col5 5
r_enb_col5 enb_col5 0 10000k
r1_enb_col5 enb_col5 enb1_col5 5

r_d11_col5 d11_col5 0 10000k
r1_d11_col5 d11_col5 d111_col5 5
r_d22_col5 d22_col5 0 10000k
r1_d22_col5 d22_col5 d222_col5 5

r_SL1col5 SL1col5 0 10000k
r1_SL1col5 SL1col5 SL11col5 5
r_SL2col5 SL2col5 0 10000k
r1_SL2col5 SL2col5 SL22col5 5

* col6

mn1col6 d1_col6 en_col6 d11_col6 0 nenh w=4u l=.4u
mn2col6 d2_col6 en_col6 d22_col6 0 nenh w=4u l=.4u
mp1col6 d11_col6 enb_col6 d1_col6 2.97 penh w=8u l=0.4u
mp2col6 d22_col6 enb_col6 d2_col6 2.97 penh w=8u l=0.4u

r_en_col6 en_col6 0 10000k
r1_en_col6 en_col6 en1_col6 5
r_enb_col6 enb_col6 0 10000k
r1_enb_col6 enb_col6 enb1_col6 5

r_d11_col6 d11_col6 0 10000k
r1_d11_col6 d11_col6 d111_col6 5
r_d22_col6 d22_col6 0 10000k
r1_d22_col6 d22_col6 d222_col6 5

r_SL1col6 SL1col6 0 10000k
r1_SL1col6 SL1col6 SL11col6 5
r_SL2col6 SL2col6 0 10000k
r1_SL2col6 SL2col6 SL22col6 5

* col7

mn1col7 d1_col7 en_col7 d11_col7 0 nenh w=4u l=.4u
mn2col7 d2_col7 en_col7 d22_col7 0 nenh w=4u l=.4u
mp1col7 d11_col7 enb_col7 d1_col7 2.97 penh w=8u l=0.4u
mp2col7 d22_col7 enb_col7 d2_col7 2.97 penh w=8u l=0.4u

r_en_col7 en_col7 0 10000k
r1_en_col7 en_col7 en1_col7 5
r_enb_col7 enb_col7 0 10000k
r1_enb_col7 enb_col7 enb1_col7 5

r_d11_col7 d11_col7 0 10000k
r1_d11_col7 d11_col7 d111_col7 5
r_d22_col7 d22_col7 0 10000k
r1_d22_col7 d22_col7 d222_col7 5

r_SL1col7 SL1col7 0 10000k
r1_SL1col7 SL1col7 SL11col7 5
r_SL2col7 SL2col7 0 10000k
r1_SL2col7 SL2col7 SL22col7 5

* col8

mn1col8 d1_col8 en_col8 d11_col8 0 nenh w=4u l=.4u
mn2col8 d2_col8 en_col8 d22_col8 0 nenh w=4u l=.4u
mp1col8 d11_col8 enb_col8 d1_col8 2.97 penh w=8u l=0.4u
mp2col8 d22_col8 enb_col8 d2_col8 2.97 penh w=8u l=0.4u

r_en_col8 en_col8 0 10000k
r1_en_col8 en_col8 en1_col8 5
r_enb_col8 enb_col8 0 10000k
r1_enb_col8 enb_col8 enb1_col8 5

r_d11_col8 d11_col8 0 10000k
r1_d11_col8 d11_col8 d111_col8 5
r_d22_col8 d22_col8 0 10000k
r1_d22_col8 d22_col8 d222_col8 5

r_SL1col8 SL1col8 0 10000k
r1_SL1col8 SL1col8 SL11col8 5
r_SL2col8 SL2col8 0 10000k
r1_SL2col8 SL2col8 SL22col8 5

* col9

mn1col9 d1_col9 en_col9 d11_col9 0 nenh w=4u l=.4u
mn2col9 d2_col9 en_col9 d22_col9 0 nenh w=4u l=.4u
mp1col9 d11_col9 enb_col9 d1_col9 2.97 penh w=8u l=0.4u
mp2col9 d22_col9 enb_col9 d2_col9 2.97 penh w=8u l=0.4u

r_en_col9 en_col9 0 10000k
r1_en_col9 en_col9 en1_col9 5
r_enb_col9 enb_col9 0 10000k
r1_enb_col9 enb_col9 enb1_col9 5

r_d11_col9 d11_col9 0 10000k
r1_d11_col9 d11_col9 d11_col9 5
r_d22_col9 d22_col9 0 10000k
r1_d22_col9 d22_col9 d222_col9 5

r_SL1col9 SL1col9 0 10000k
r1_SL1col9 SL1col9 SL11col9 5
r_SL2col9 SL2col9 0 10000k
r1_SL2col9 SL2col9 SL22col9 5

* col10

mn1col10 d1_col10 en_col10 d11_col10 0 nenh w=4u l=.4u
mn2col10 d2_col10 en_col10 d22_col10 0 nenh w=4u l=.4u
mp1col10 d11_col10 enb_col10 d1_col10 2.97 penh w=8u l=0.4u
mp2col10 d22_col10 enb_col10 d2_col10 2.97 penh w=8u l=0.4u

r_en_col10 en_col10 0 10000k
r1_en_col10 en_col10 en1_col10 5
r_enb_col10 enb_col10 0 10000k
r1_enb_col10 enb_col10 enb1_col10 5

r_d11_col10 d11_col10 0 10000k
r1_d11_col10 d11_col10 d111_col10 5
r_d22_col10 d22_col10 0 10000k
r1_d22_col10 d22_col10 d222_col10 5

r_SL1col10 SL1col10 0 10000k
r1_SL1col10 SL1col10 SL11col10 5
r_SL2col10 SL2col10 0 10000k
r1_SL2col10 SL2col10 SL22col10 5

* col11

mn1col11 d1_col11 en_col11 d11_col11 0 nenh w=4u l=.4u
mn2col11 d2_col11 en_col11 d22_col11 0 nenh w=4u l=.4u
mp1col11 d11_col11 enb_col11 d1_col11 2.97 penh w=8u l=0.4u
mp2col11 d22_col11 enb_col11 d2_col11 2.97 penh w=8u l=0.4u

r_en_col11 en_col11 0 10000k
r1_en_col11 en_col11 en1_col11 5
r_enb_col11 enb_col11 0 10000k
r1_enb_col11 enb_col11 enb1_col11 5

r_d11_col11 d11_col11 0 10000k
r1_d11_col11 d11_col11 d111_col11 5
r_d22_col11 d22_col11 0 10000k
r1_d22_col11 d22_col11 d222_col11 5

r_SL1col11 SL1col11 0 10000k
r1_SL1col11 SL1col11 SL11col11 5
r_SL2col11 SL2col11 0 10000k
r1_SL2col11 SL2col11 SL22col11 5

* col12

mn1col12 d1_col12 en_col12 d11_col12 0 nenh w=4u l=.4u
mn2col12 d2_col12 en_col12 d22_col12 0 nenh w=4u l=.4u
mp1col12 d11_col12 enb_col12 d1_col12 2.97 penh w=8u l=0.4u
mp2col12 d22_col12 enb_col12 d2_col12 2.97 penh w=8u l=0.4u

r_en_col12 en_col12 0 10000k
r1_en_col12 en_col12 en1_col12 5
r_enb_col12 enb_col12 0 10000k
r1_enb_col12 enb_col12 enb1_col12 5

r_d11_col12 d11_col12 0 10000k
r1_d11_col12 d11_col12 d111_col12 5
r_d22_col12 d22_col12 0 10000k
r1_d22_col12 d22_col12 d222_col12 5

r_SL1col12 SL1col12 0 10000k
r1_SL1col12 SL1col12 SL11col12 5
r_SL2col12 SL2col12 0 10000k
r1_SL2col12 SL2col12 SL22col12 5

* col13

mn1col13 d1_col13 en_col13 d11_col13 0 nenh w=4u l=.4u
mn2col13 d2_col13 en_col13 d22_col13 0 nenh w=4u l=.4u
mp1col13 d11_col13 enb_col13 d1_col13 2.97 penh w=8u l=0.4u
mp2col13 d22_col13 enb_col13 d2_col13 2.97 penh w=8u l=0.4u

r_en_col13 en_col13 0 10000k
r1_en_col13 en_col13 en1_col13 5
r_enb_col13 enb_col13 0 10000k
r1_enb_col13 enb_col13 enb1_col13 5

r_d11_col13 d11_col13 0 10000k
r1_d11_col13 d11_col13 d111_col13 5
r_d22_col13 d22_col13 0 10000k
r1_d22_col13 d22_col13 d222_col13 5

r_SL1col13 SL1col13 0 10000k
r1_SL1col13 SL1col13 SL11col13 5
r_SL2col13 SL2col13 0 10000k
r1_SL2col13 SL2col13 SL22col13 5

* col14

mn1col14 d1_col14 en_col14 d11_col14 0 nenh w=4u l=.4u
mn2col14 d2_col14 en_col14 d22_col14 0 nenh w=4u l=.4u
mp1col14 d11_col14 enb_col14 d1_col14 2.97 penh w=8u l=0.4u
mp2col14 d22_col14 enb_col14 d2_col14 2.97 penh w=8u l=0.4u

r_en_col14 en_col14 0 10000k
r1_en_col14 en_col14 en1_col14 5
r_enb_col14 enb_col14 0 10000k
r1_enb_col14 enb_col14 enb1_col14 5

r_d11_col14 d11_col14 0 10000k
r1_d11_col14 d11_col14 d111_col14 5
r_d22_col14 d22_col14 0 10000k
r1_d22_col14 d22_col14 d222_col14 5

r_SL1col14 SL1col14 0 10000k
r1_SL1col14 SL1col14 SL11col14 5
r_SL2col14 SL2col14 0 10000k
r1_SL2col14 SL2col14 SL22col14 5

* col15

mn1col15 d1_col15 en_col15 d11_col15 0 nenh w=4u l=.4u

mn2col15 d2_col15 en_col15 d22_col15 0 nenh w=4u l=.4u
mp1col15 d11_col15 enb_col15 d1_col15 2.97 penh w=8u l=0.4u
mp2col15 d22_col15 enb_col15 d2_col15 2.97 penh w=8u l=0.4u

r_en_col15 en_col15 0 10000k
r1_en_col15 en_col15 en1_col15 5
r_enb_col15 enb_col15 0 10000k
r1_enb_col15 enb_col15 enb1_col15 5

r_d11_col15 d11_col15 0 10000k
r1_d11_col15 d11_col15 d111_col15 5
r_d22_col15 d22_col15 0 10000k
r1_d22_col15 d22_col15 d222_col15 5

r_SL1col15 SL1col15 0 10000k
r1_SL1col15 SL1col15 SL11col15 5
r_SL2col15 SL2col15 0 10000k
r1_SL2col15 SL2col15 SL22col15 5

* col16

mn1col16 d1_col16 en_col16 d11_col16 0 nenh w=4u l=.4u
mn2col16 d2_col16 en_col16 d22_col16 0 nenh w=4u l=.4u
mp1col16 d11_col16 enb_col16 d1_col16 2.97 penh w=8u l=0.4u
mp2col16 d22_col16 enb_col16 d2_col16 2.97 penh w=8u l=0.4u

r_en_col16 en_col16 0 10000k
r1_en_col16 en_col16 en1_col16 5
r_enb_col16 enb_col16 0 10000k
r1_enb_col16 enb_col16 enb1_col16 5

r_d11_col16 d11_col16 0 10000k
r1_d11_col16 d11_col16 d111_col16 5
r_d22_col16 d22_col16 0 10000k
r1_d22_col16 d22_col16 d222_col16 5

r_SL1col16 SL1col16 0 10000k
r1_SL1col16 SL1col16 SL11col16 5
r_SL2col16 SL2col16 0 10000k
r1_SL2col16 SL2col16 SL22col16 5

* col17

mn1col17 d1_col17 en_col17 d11_col17 0 nenh w=4u l=.4u
mn2col17 d2_col17 en_col17 d22_col17 0 nenh w=4u l=.4u
mp1col17 d11_col17 enb_col17 d1_col17 2.97 penh w=8u l=0.4u
mp2col17 d22_col17 enb_col17 d2_col17 2.97 penh w=8u l=0.4u

r_en_col17 en_col17 0 10000k
r1_en_col17 en_col17 en1_col17 5
r_enb_col17 enb_col17 0 10000k
r1_enb_col17 enb_col17 enb1_col17 5

r_d11_col17 d11_col17 0 10000k
r1_d11_col17 d11_col17 d111_col17 5
r_d22_col17 d22_col17 0 10000k
r1_d22_col17 d22_col17 d222_col17 5

r_SL1col17 SL1col17 0 10000k
r1_SL1col17 SL1col17 SL11col17 5
r_SL2col17 SL2col17 0 10000k
r1_SL2col17 SL2col17 SL22col17 5

* col18

mn1col18 d1_col18 en_col18 d11_col18 0 nenh w=4u l=.4u
mn2col18 d2_col18 en_col18 d22_col18 0 nenh w=4u l=.4u
mp1col18 d11_col18 enb_col18 d1_col18 2.97 penh w=8u l=0.4u
mp2col18 d22_col18 enb_col18 d2_col18 2.97 penh w=8u l=0.4u
r_en_col18 en_col18 0 10000k
r1_en_col18 en_col18 en1_col18 5
r_enb_col18 enb_col18 0 10000k
r1_enb_col18 enb_col18 enb1_col18 5

r_d11_col18 d11_col18 0 10000k
r1_d11_col18 d11_col18 d111_col18 5
r_d22_col18 d22_col18 0 10000k
r1_d22_col18 d22_col18 d222_col18 5

r_SL1col18 SL1col18 0 10000k
r1_SL1col18 SL1col18 SL11col18 5
r_SL2col18 SL2col18 0 10000k
r1_SL2col18 SL2col18 SL22col18 5

* col19

mn1col19 d1_col19 en_col19 d11_col19 0 nenh w=4u l=.4u
mn2col19 d2_col19 en_col19 d22_col19 0 nenh w=4u l=.4u
mp1col19 d11_col19 enb_col19 d1_col19 2.97 penh w=8u l=0.4u
mp2col19 d22_col19 enb_col19 d2_col19 2.97 penh w=8u l=0.4u

r_en_col19 en_col19 0 10000k
r1_en_col19 en_col19 en1_col19 5
r_enb_col19 enb_col19 0 10000k
r1_enb_col19 enb_col19 enb1_col19 5

r_d11_col19 d11_col19 0 10000k
r1_d11_col19 d11_col19 d111_col19 5
r_d22_col19 d22_col19 0 10000k
r1_d22_col19 d22_col19 d222_col19 5

r_SL1col19 SL1col19 0 10000k
r1_SL1col19 SL1col19 SL11col19 5
r_SL2col19 SL2col19 0 10000k
r1_SL2col19 SL2col19 SL22col19 5

* col20

mn1col20 d1_col20 en_col20 d11_col20 0 nenh w=4u l=.4u
mn2col20 d2_col20 en_col20 d22_col20 0 nenh w=4u l=.4u
mp1col20 d11_col20 enb_col20 d1_col20 2.97 penh w=8u l=0.4u
mp2col20 d22_col20 enb_col20 d2_col20 2.97 penh w=8u l=0.4u

r_en_col20 en_col20 0 10000k
r1_en_col20 en_col20 en1_col20 5
r_enb_col20 enb_col20 0 10000k
r1_enb_col20 enb_col20 enb1_col20 5

r_d11_col20 d11_col20 0 10000k
r1_d11_col20 d11_col20 d111_col20 5
r_d22_col20 d22_col20 0 10000k
r1_d22_col20 d22_col20 d222_col20 5

r_SL1col20 SL1col20 0 10000k
r1_SL1col20 SL1col20 SL11col20 5
r_SL2col20 SL2col20 0 10000k
r1_SL2col20 SL2col20 SL22col20 5

* col21

mn1col21 d1_col21 en_col21 d11_col21 0 nenh w=4u l=.4u
mn2col21 d2_col21 en_col21 d22_col21 0 nenh w=4u l=.4u
mp1col21 d11_col21 enb_col21 d1_col21 2.97 penh w=8u l=0.4u
mp2col21 d22_col21 enb_col21 d2_col21 2.97 penh w=8u l=0.4u

r_en_col21 en_col21 0 10000k
r1_en_col21 en_col21 en1_col21 5
r_enb_col21 enb_col21 0 10000k
r1_enb_col21 enb_col21 enb1_col21 5

r_d11_col21 d11_col21 0 10000k
r1_d11_col21 d11_col21 d111_col21 5
r_d22_col21 d22_col21 0 10000k
r1_d22_col21 d22_col21 d222_col21 5

r_SL1col21 SL1col21 0 10000k
r1_SL1col21 SL1col21 SL11col21 5
r_SL2col21 SL2col21 0 10000k
r1_SL2col21 SL2col21 SL22col21 5

* col22

mn1col22 d1_col22 en_col22 d11_col22 0 nenh w=4u l=.4u
mn2col22 d2_col22 en_col22 d22_col22 0 nenh w=4u l=.4u
mp1col22 d11_col22 enb_col22 d1_col22 2.97 penh w=8u l=0.4u
mp2col22 d22_col22 enb_col22 d2_col22 2.97 penh w=8u l=0.4u

r_en_col22 en_col22 0 10000k
r1_en_col22 en_col22 en1_col22 5
r_enb_col22 enb_col22 0 10000k
r1_enb_col22 enb_col22 enb1_col22 5

r_d11_col22 d11_col22 0 10000k
r1_d11_col22 d11_col22 d111_col22 5
r_d22_col22 d22_col22 0 10000k
r1_d22_col22 d22_col22 d222_col22 5

r_SL1col22 SL1col22 0 10000k
r1_SL1col22 SL1col22 SL11col22 5
r_SL2col22 SL2col22 0 10000k
r1_SL2col22 SL2col22 SL22col22 5

* col23

mn1col23 d1_col23 en_col23 d11_col23 0 nenh w=4u l=.4u
mn2col23 d2_col23 en_col23 d22_col23 0 nenh w=4u l=.4u
mp1col23 d11_col23 enb_col23 d1_col23 2.97 penh w=8u l=0.4u
mp2col23 d22_col23 enb_col23 d2_col23 2.97 penh w=8u l=0.4u

r_en_col23 en_col23 0 10000k
r1_en_col23 en_col23 en1_col23 5
r_enb_col23 enb_col23 0 10000k
r1_enb_col23 enb_col23 enb1_col23 5

r_d11_col23 d11_col23 0 10000k
r1_d11_col23 d11_col23 d111_col23 5
r_d22_col23 d22_col23 0 10000k
r1_d22_col23 d22_col23 d222_col23 5

r_SL1col23 SL1col23 0 10000k
r1_SL1col23 SL1col23 SL11col23 5
r_SL2col23 SL2col23 0 10000k
r1_SL2col23 SL2col23 SL22col23 5

* col24

mn1col24 d1_col24 en_col24 d11_col24 0 nenh w=4u l=.4u
mn2col24 d2_col24 en_col24 d22_col24 0 nenh w=4u l=.4u
mp1col24 d11_col24 enb_col24 d1_col24 2.97 penh w=8u l=0.4u
mp2col24 d22_col24 enb_col24 d2_col24 2.97 penh w=8u l=0.4u

r_en_col24 en_col24 0 10000k
r1_en_col24 en_col24 en1_col24 5
r_enb_col24 enb_col24 0 10000k
r1_enb_col24 enb_col24 enb1_col24 5

r_d11_col24 d11_col24 0 10000k
r1_d11_col24 d11_col24 d111_col24 5
r_d22_col24 d22_col24 0 10000k
r1_d22_col24 d22_col24 d222_col24 5

r_SL1col24 SL1col24 0 10000k
r1_SL1col24 SL1col24 SL11col24 5
r_SL2col24 SL2col24 0 10000k
r1_SL2col24 SL2col24 SL22col24 5

* col25

mn1col25 d1_col25 en_col25 d11_col25 0 nenh w=4u l=.4u
mn2col25 d2_col25 en_col25 d22_col25 0 nenh w=4u l=.4u
mp1col25 d11_col25 enb_col25 d1_col25 2.97 penh w=8u l=0.4u
mp2col25 d22_col25 enb_col25 d2_col25 2.97 penh w=8u l=0.4u

r_en_col25 en_col25 0 10000k
r1_en_col25 en_col25 en1_col25 5
r_enb_col25 enb_col25 0 10000k
r1_enb_col25 enb_col25 enb1_col25 5

r_d11_col25 d11_col25 0 10000k
r1_d11_col25 d11_col25 d111_col25 5
r_d22_col25 d22_col25 0 10000k
r1_d22_col25 d22_col25 d222_col25 5

r_SL1col25 SL1col25 0 10000k
r1_SL1col25 SL1col25 SL11col25 5
r_SL2col25 SL2col25 0 10000k
r1_SL2col25 SL2col25 SL22col25 5

* col26

mn1col26 d1_col26 en_col26 d11_col26 0 nenh w=4u l=.4u
mn2col26 d2_col26 en_col26 d22_col26 0 nenh w=4u l=.4u
mp1col26 d11_col26 enb_col26 d1_col26 2.97 penh w=8u l=0.4u
mp2col26 d22_col26 enb_col26 d2_col26 2.97 penh w=8u l=0.4u

r_en_col26 en_col26 0 10000k
r1_en_col26 en_col26 en1_col26 5
r_enb_col26 enb_col26 0 10000k
r1_enb_col26 enb_col26 enb1_col26 5

r_d11_col26 d11_col26 0 10000k
r1_d11_col26 d11_col26 d111_col26 5
r_d22_col26 d22_col26 0 10000k
r1_d22_col26 d22_col26 d222_col26 5

r_SL1col26 SL1col26 0 10000k

r1_SL1col26 SL1col26 SL11col26 5
r_SL2col26 SL2col26 0 10000k
r1_SL2col26 SL2col26 SL22col26 5

* col27

mn1col27 d1_col27 en_col27 d11_col27 0 nenh w=4u l=.4u
mn2col27 d2_col27 en_col27 d22_col27 0 nenh w=4u l=.4u
mp1col27 d11_col27 enb_col27 d1_col27 2.97 penh w=8u l=0.4u
mp2col27 d22_col27 enb_col27 d2_col27 2.97 penh w=8u l=0.4u

r_en_col27 en_col27 0 10000k
r1_en_col27 en_col27 en1_col27 5
r_enb_col27 enb_col27 0 10000k
r1_enb_col27 enb_col27 enb1_col27 5

r_d11_col27 d11_col27 0 10000k
r1_d11_col27 d11_col27 d111_col27 5
r_d22_col27 d22_col27 0 10000k
r1_d22_col27 d22_col27 d222_col27 5

r_SL1col27 SL1col27 0 10000k
r1_SL1col27 SL1col27 SL11col27 5
r_SL2col27 SL2col27 0 10000k
r1_SL2col27 SL2col27 SL22col27 5
* col28

mn1col28 d1_col28 en_col28 d11_col28 0 nenh w=4u l=.4u
mn2col28 d2_col28 en_col28 d22_col28 0 nenh w=4u l=.4u
mp1col28 d11_col28 enb_col28 d1_col28 2.97 penh w=8u l=0.4u
mp2col28 d22_col28 enb_col28 d2_col28 2.97 penh w=8u l=0.4u

r_en_col28 en_col28 0 10000k
r1_en_col28 en_col28 en1_col28 5
r_enb_col28 enb_col28 0 10000k
r1_enb_col28 enb_col28 enb1_col28 5

r_d11_col28 d11_col28 0 10000k
r1_d11_col28 d11_col28 d111_col28 5
r_d22_col28 d22_col28 0 10000k
r1_d22_col28 d22_col28 d222_col28 5

r_SL1col28 SL1col28 0 10000k
r1_SL1col28 SL1col28 SL11col28 5
r_SL2col28 SL2col28 0 10000k
r1_SL2col28 SL2col28 SL22col28 5

* col29

mn1col29 d1_col29 en_col29 d11_col29 0 nenh w=4u l=.4u
mn2col29 d2_col29 en_col29 d22_col29 0 nenh w=4u l=.4u
mp1col29 d11_col29 enb_col29 d1_col29 2.97 penh w=8u l=0.4u
mp2col29 d22_col29 enb_col29 d2_col29 2.97 penh w=8u l=0.4u

r_en_col29 en_col29 0 10000k
r1_en_col29 en_col29 en1_col29 5
r_enb_col29 enb_col29 0 10000k
r1_enb_col29 enb_col29 enb1_col29 5

r_d11_col29 d11_col29 0 10000k
r1_d11_col29 d11_col29 d111_col29 5
r_d22_col29 d22_col29 0 10000k
r1_d22_col29 d22_col29 d222_col29 5

r_SL1col29 SL1col29 0 10000k
r1_SL1col29 SL1col29 SL11col29 5
r_SL2col29 SL2col29 0 10000k
r1_SL2col29 SL2col29 SL22col29 5

* col30

mn1col30 d1_col30 en_col30 d11_col30 0 nenh w=4u l=.4u
mn2col30 d2_col30 en_col30 d22_col30 0 nenh w=4u l=.4u
mp1col30 d11_col30 enb_col30 d1_col30 2.97 penh w=8u l=0.4u
mp2col30 d22_col30 enb_col30 d2_col30 2.97 penh w=8u l=0.4u

r_en_col30 en_col30 0 10000k
r1_en_col30 en_col30 en1_col30 5
r_enb_col30 enb_col30 0 10000k
r1_enb_col30 enb_col30 enb1_col30 5

r_d11_col30 d11_col30 0 10000k
r1_d11_col30 d11_col30 d111_col30 5
r_d22_col30 d22_col30 0 10000k
r1_d22_col30 d22_col30 d222_col30 5

r_SL1col30 SL1col30 0 10000k
r1_SL1col30 SL1col30 SL11col30 5
r_SL2col30 SL2col30 0 10000k
r1_SL2col30 SL2col30 SL22col30 5

* col31

mn1col31 d1_col31 en_col31 d11_col31 0 nenh w=4u l=.4u
mn2col31 d2_col31 en_col31 d22_col31 0 nenh w=4u l=.4u
mp1col31 d11_col31 enb_col31 d1_col31 2.97 penh w=8u l=0.4u
mp2col31 d22_col31 enb_col31 d2_col31 2.97 penh w=8u l=0.4u

r_en_col31 en_col31 0 10000k
r1_en_col31 en_col31 en1_col31 5
r_enb_col31 enb_col31 0 10000k
r1_enb_col31 enb_col31 enb1_col31 5

r_d11_col31 d11_col31 0 10000k
r1_d11_col31 d11_col31 d111_col31 5
r_d22_col31 d22_col31 0 10000k
r1_d22_col31 d22_col31 d222_col31 5

r_SL1col31 SL1col31 0 10000k
r1_SL1col31 SL1col31 SL11col31 5
r_SL2col31 SL2col31 0 10000k
r1_SL2col31 SL2col31 SL22col31 5

* col32

mn1col32 d1_col32 en_col32 d11_col32 0 nenh w=4u l=.4u
mn2col32 d2_col32 en_col32 d22_col32 0 nenh w=4u l=.4u
mp1col32 d11_col32 enb_col32 d1_col32 2.97 penh w=8u l=0.4u
mp2col32 d22_col32 enb_col32 d2_col32 2.97 penh w=8u l=0.4u

r_en_col32 en_col32 0 10000k
r1_en_col32 en_col32 en1_col32 5
r_enb_col32 enb_col32 0 10000k
r1_enb_col32 enb_col32 enb1_col32 5

r_d11_col32 d11_col32 0 10000k
r1_d11_col32 d11_col32 d111_col32 5

r_d22_col32 d22_col32 0 10000k
r1_d22_col32 d22_col32 d222_col32 5

r_SL1col32 SL1col32 0 10000k
r1_SL1col32 SL1col32 SL11col32 5
r_SL2col32 SL2col32 0 10000k
r1_SL2col32 SL2col32 SL22col32 5

* col33

mn1col33 d1_col33 en_col33 d11_col33 0 nenh w=4u l=.4u
mn2col33 d2_col33 en_col33 d22_col33 0 nenh w=4u l=.4u
mp1col33 d11_col33 enb_col33 d1_col33 2.97 penh w=8u l=0.4u
mp2col33 d22_col33 enb_col33 d2_col33 2.97 penh w=8u l=0.4u

r_en_col33 en_col33 0 10000k
r1_en_col33 en_col33 en1_col33 5
r_enb_col33 enb_col33 0 10000k
r1_enb_col33 enb_col33 enb1_col33 5

r_d11_col33 d11_col33 0 10000k
r1_d11_col33 d11_col33 d111_col33 5
r_d22_col33 d22_col33 0 10000k
r1_d22_col33 d22_col33 d222_col33 5

r_SL1col33 SL1col33 0 10000k
r1_SL1col33 SL1col33 SL11col33 5
r_SL2col33 SL2col33 0 10000k
r1_SL2col33 SL2col33 SL22col33 5

* col34

mn1col34 d1_col34 en_col34 d11_col34 0 nenh w=4u l=.4u
mn2col34 d2_col34 en_col34 d22_col34 0 nenh w=4u l=.4u
mp1col34 d11_col34 enb_col34 d1_col34 2.97 penh w=8u l=0.4u
mp2col34 d22_col34 enb_col34 d2_col34 2.97 penh w=8u l=0.4u

r_en_col34 en_col34 0 10000k
r1_en_col34 en_col34 en1_col34 5
r_enb_col34 enb_col34 0 10000k
r1_enb_col34 enb_col34 enb1_col34 5

r_d11_col34 d11_col34 0 10000k
r1_d11_col34 d11_col34 d111_col34 5
r_d22_col34 d22_col34 0 10000k
r1_d22_col34 d22_col34 d222_col34 5

r_SL1col34 SL1col34 0 10000k
r1_SL1col34 SL1col34 SL11col34 5
r_SL2col34 SL2col34 0 10000k
r1_SL2col34 SL2col34 SL22col34 5

* col35

mn1col35 d1_col35 en_col35 d11_col35 0 nenh w=4u l=.4u
mn2col35 d2_col35 en_col35 d22_col35 0 nenh w=4u l=.4u
mp1col35 d11_col35 enb_col35 d1_col35 2.97 penh w=8u l=0.4u
mp2col35 d22_col35 enb_col35 d2_col35 2.97 penh w=8u l=0.4u

r_en_col35 en_col35 0 10000k
r1_en_col35 en_col35 en1_col35 5
r_enb_col35 enb_col35 0 10000k
r1_enb_col35 enb_col35 enb1_col35 5

r_d11_col35 d11_col35 0 10000k
r1_d11_col35 d11_col35 d111_col35 5
r_d22_col35 d22_col35 0 10000k
r1_d22_col35 d22_col35 d222_col35 5

r_SL1col35 SL1col35 0 10000k
r1_SL1col35 SL1col35 SL11col35 5
r_SL2col35 SL2col35 0 10000k
r1_SL2col35 SL2col35 SL22col35 5

* col36

mn1col36 d1_col36 en_col36 d11_col36 0 nenh w=4u l=.4u
mn2col36 d2_col36 en_col36 d22_col36 0 nenh w=4u l=.4u
mp1col36 d11_col36 enb_col36 d1_col36 2.97 penh w=8u l=0.4u
mp2col36 d22_col36 enb_col36 d2_col36 2.97 penh w=8u l=0.4u

r_en_col36 en_col36 0 10000k
r1_en_col36 en_col36 en1_col36 5
r_enb_col36 enb_col36 0 10000k
r1_enb_col36 enb_col36 enb1_col36 5

r_d11_col36 d11_col36 0 10000k
r1_d11_col36 d11_col36 d111_col36 5
r_d22_col36 d22_col36 0 10000k
r1_d22_col36 d22_col36 d222_col36 5

r_SL1col36 SL1col36 0 10000k
r1_SL1col36 SL1col36 SL11col36 5
r_SL2col36 SL2col36 0 10000k
r1_SL2col36 SL2col36 SL22col36 5

* col37

mn1col37 d1_col37 en_col37 d11_col37 0 nenh w=4u l=.4u
mn2col37 d2_col37 en_col37 d22_col37 0 nenh w=4u l=.4u
mp1col37 d11_col37 enb_col37 d1_col37 2.97 penh w=8u l=0.4u
mp2col37 d22_col37 enb_col37 d2_col37 2.97 penh w=8u l=0.4u

r_en_col37 en_col37 0 10000k
r1_en_col37 en_col37 en1_col37 5
r_enb_col37 enb_col37 0 10000k
r1_enb_col37 enb_col37 enb1_col37 5

r_d11_col37 d11_col37 0 10000k
r1_d11_col37 d11_col37 d111_col37 5
r_d22_col37 d22_col37 0 10000k
r1_d22_col37 d22_col37 d222_col37 5

r_SL1col37 SL1col37 0 10000k
r1_SL1col37 SL1col37 SL11col37 5
r_SL2col37 SL2col37 0 10000k
r1_SL2col37 SL2col37 SL22col37 5

* col38

mn1col38 d1_col38 en_col38 d11_col38 0 nenh w=4u l=.4u
mn2col38 d2_col38 en_col38 d22_col38 0 nenh w=4u l=.4u
mp1col38 d11_col38 enb_col38 d1_col38 2.97 penh w=8u l=0.4u
mp2col38 d22_col38 enb_col38 d2_col38 2.97 penh w=8u l=0.4u

r_en_col38 en_col38 0 10000k
r1_en_col38 en_col38 en1_col38 5
r_enb_col38 enb_col38 0 10000k

r1_enb_col38 enb_col38 enb1_col38 5

r_d11_col38 d11_col38 0 10000k
r1_d11_col38 d11_col38 d111_col38 5
r_d22_col38 d22_col38 0 10000k
r1_d22_col38 d22_col38 d222_col38 5

r_SL1col38 SL1col38 0 10000k
r1_SL1col38 SL1col38 SL11col38 5
r_SL2col38 SL2col38 0 10000k
r1_SL2col38 SL2col38 SL22col38 5

* col39

mn1col39 d1_col39 en_col39 d11_col39 0 nenh w=4u l=.4u
mn2col39 d2_col39 en_col39 d22_col39 0 nenh w=4u l=.4u
mp1col39 d11_col39 enb_col39 d1_col39 2.97 penh w=8u l=0.4u
mp2col39 d22_col39 enb_col39 d2_col39 2.97 penh w=8u l=0.4u

r_en_col39 en_col39 0 10000k
r1_en_col39 en_col39 en1_col39 5
r_enb_col39 enb_col39 0 10000k
r1_enb_col39 enb_col39 enb1_col39 5

r_d11_col39 d11_col39 0 10000k
r1_d11_col39 d11_col39 d111_col39 5
r_d22_col39 d22_col39 0 10000k
r1_d22_col39 d22_col39 d222_col39 5

r_SL1col39 SL1col39 0 10000k
r1_SL1col39 SL1col39 SL11col39 5
r_SL2col39 SL2col39 0 10000k
r1_SL2col39 SL2col39 SL22col39 5

* col40

mn1col40 d1_col40 en_col40 d11_col40 0 nenh w=4u l=.4u
mn2col40 d2_col40 en_col40 d22_col40 0 nenh w=4u l=.4u
mp1col40 d11_col40 enb_col40 d1_col40 2.97 penh w=8u l=0.4u
mp2col40 d22_col40 enb_col40 d2_col40 2.97 penh w=8u l=0.4u

r_en_col40 en_col40 0 10000k
r1_en_col40 en_col40 en1_col40 5
r_enb_col40 enb_col40 0 10000k
r1_enb_col40 enb_col40 enb1_col40 5

r_d11_col40 d11_col40 0 10000k
r1_d11_col40 d11_col40 d111_col40 5
r_d22_col40 d22_col40 0 10000k
r1_d22_col40 d22_col40 d222_col40 5

r_SL1col40 SL1col40 0 10000k
r1_SL1col40 SL1col40 SL11col40 5
r_SL2col40 SL2col40 0 10000k
r1_SL2col40 SL2col40 SL22col40 5

* col41

mn1col41 d1_col41 en_col41 d11_col41 0 nenh w=4u l=.4u
mn2col41 d2_col41 en_col41 d22_col41 0 nenh w=4u l=.4u
mp1col41 d11_col41 enb_col41 d1_col41 2.97 penh w=8u l=0.4u
mp2col41 d22_col41 enb_col41 d2_col41 2.97 penh w=8u l=0.4u

r_en_col41 en_col41 0 10000k

r1_en_col41 en_col41 en1_col41 5
r_enb_col41 enb_col41 0 10000k
r1_enb_col41 enb_col41 enb1_col41 5

r_d11_col41 d11_col41 0 10000k
r1_d11_col41 d11_col41 d111_col41 5
r_d22_col41 d22_col41 0 10000k
r1_d22_col41 d22_col41 d222_col41 5

r_SL1col41 SL1col41 0 10000k
r1_SL1col41 SL1col41 SL11col41 5
r_SL2col41 SL2col41 0 10000k
r1_SL2col41 SL2col41 SL22col41 5

* col42

mn1col42 d1_col42 en_col42 d11_col42 0 nenh w=4u l=.4u
mn2col42 d2_col42 en_col42 d22_col42 0 nenh w=4u l=.4u
mp1col42 d11_col42 enb_col42 d1_col42 2.97 penh w=8u l=0.4u
mp2col42 d22_col42 enb_col42 d2_col42 2.97 penh w=8u l=0.4u

r_en_col42 en_col42 0 10000k
r1_en_col42 en_col42 en1_col42 5
r_enb_col42 enb_col42 0 10000k
r1_enb_col42 enb_col42 enb1_col42 5

r_d11_col42 d11_col42 0 10000k
r1_d11_col42 d11_col42 d111_col42 5
r_d22_col42 d22_col42 0 10000k
r1_d22_col42 d22_col42 d222_col42 5

r_SL1col42 SL1col42 0 10000k
r1_SL1col42 SL1col42 SL11col42 5
r_SL2col42 SL2col42 0 10000k
r1_SL2col42 SL2col42 SL22col42 5

* col43

mn1col43 d1_col43 en_col43 d11_col43 0 nenh w=4u l=.4u
mn2col43 d2_col43 en_col43 d22_col43 0 nenh w=4u l=.4u
mp1col43 d11_col43 enb_col43 d1_col43 2.97 penh w=8u l=0.4u
mp2col43 d22_col43 enb_col43 d2_col43 2.97 penh w=8u l=0.4u

r_en_col43 en_col43 0 10000k
r1_en_col43 en_col43 en1_col43 5
r_enb_col43 enb_col43 0 10000k
r1_enb_col43 enb_col43 enb1_col43 5

r_d11_col43 d11_col43 0 10000k
r1_d11_col43 d11_col43 d111_col43 5
r_d22_col43 d22_col43 0 10000k
r1_d22_col43 d22_col43 d222_col43 5

r_SL1col43 SL1col43 0 10000k
r1_SL1col43 SL1col43 SL11col43 5
r_SL2col43 SL2col43 0 10000k
r1_SL2col43 SL2col43 SL22col43 5

* col44

mn1col44 d1_col44 en_col44 d11_col44 0 nenh w=4u l=.4u
mn2col44 d2_col44 en_col44 d22_col44 0 nenh w=4u l=.4u
mp1col44 d11_col44 enb_col44 d1_col44 2.97 penh w=8u l=0.4u
mp2col44 d22_col44 enb_col44 d2_col44 2.97 penh w=8u l=0.4u

r_en_col44 en_col44 0 10000k
r1_en_col44 en_col44 en1_col44 5
r_enb_col44 enb_col44 0 10000k
r1_enb_col44 enb_col44 enb1_col44 5

r_d11_col44 d11_col44 0 10000k
r1_d11_col44 d11_col44 d111_col44 5
r_d22_col44 d22_col44 0 10000k
r1_d22_col44 d22_col44 d222_col44 5

r_SL1col44 SL1col44 0 10000k
r1_SL1col44 SL1col44 SL11col44 5
r_SL2col44 SL2col44 0 10000k
r1_SL2col44 SL2col44 SL22col44 5

* col45

mn1col45 d1_col45 en_col45 d11_col45 0 nenh w=4u l=.4u
mn2col45 d2_col45 en_col45 d22_col45 0 nenh w=4u l=.4u
mp1col45 d11_col45 enb_col45 d1_col45 2.97 penh w=8u l=0.4u
mp2col45 d22_col45 enb_col45 d2_col45 2.97 penh w=8u l=0.4u

r_en_col45 en_col45 0 10000k
r1_en_col45 en_col45 en1_col45 5
r_enb_col45 enb_col45 0 10000k
r1_enb_col45 enb_col45 enb1_col45 5

r_d11_col45 d11_col45 0 10000k
r1_d11_col45 d11_col45 d111_col45 5
r_d22_col45 d22_col45 0 10000k
r1_d22_col45 d22_col45 d222_col45 5

r_SL1col45 SL1col45 0 10000k
r1_SL1col45 SL1col45 SL11col45 5
r_SL2col45 SL2col45 0 10000k
r1_SL2col45 SL2col45 SL22col45 5

* col46

mn1col46 d1_col46 en_col46 d11_col46 0 nenh w=4u l=.4u
mn2col46 d2_col46 en_col46 d22_col46 0 nenh w=4u l=.4u
mp1col46 d11_col46 enb_col46 d1_col46 2.97 penh w=8u l=0.4u
mp2col46 d22_col46 enb_col46 d2_col46 2.97 penh w=8u l=0.4u

r_en_col46 en_col46 0 10000k
r1_en_col46 en_col46 en1_col46 5
r_enb_col46 enb_col46 0 10000k
r1_enb_col46 enb_col46 enb1_col46 5

r_d11_col46 d11_col46 0 10000k
r1_d11_col46 d11_col46 d111_col46 5
r_d22_col46 d22_col46 0 10000k
r1_d22_col46 d22_col46 d222_col46 5

r_SL1col46 SL1col46 0 10000k
r1_SL1col46 SL1col46 SL11col46 5
r_SL2col46 SL2col46 0 10000k
r1_SL2col46 SL2col46 SL22col46 5

* col47

mn1col47 d1_col47 en_col47 d11_col47 0 nenh w=4u l=.4u
mn2col47 d2_col47 en_col47 d22_col47 0 nenh w=4u l=.4u

mp1col47 d11_col47 enb_col47 d1_col47 2.97 penh w=8u l=0.4u
mp2col47 d22_col47 enb_col47 d2_col47 2.97 penh w=8u l=0.4u

r_en_col47 en_col47 0 10000k
r1_en_col47 en_col47 en1_col47 5
r_enb_col47 enb_col47 0 10000k
r1_enb_col47 enb_col47 enb1_col47 5

r_d11_col47 d11_col47 0 10000k
r1_d11_col47 d11_col47 d111_col47 5
r_d22_col47 d22_col47 0 10000k
r1_d22_col47 d22_col47 d222_col47 5

r_SL1col47 SL1col47 0 10000k
r1_SL1col47 SL1col47 SL11col47 5
r_SL2col47 SL2col47 0 10000k
r1_SL2col47 SL2col47 SL22col47 5

* col48

mn1col48 d1_col48 en_col48 d11_col48 0 nenh w=4u l=.4u
mn2col48 d2_col48 en_col48 d22_col48 0 nenh w=4u l=.4u
mp1col48 d11_col48 enb_col48 d1_col48 2.97 penh w=8u l=0.4u
mp2col48 d22_col48 enb_col48 d2_col48 2.97 penh w=8u l=0.4u

r_en_col48 en_col48 0 10000k
r1_en_col48 en_col48 en1_col48 5
r_enb_col48 enb_col48 0 10000k
r1_enb_col48 enb_col48 enb1_col48 5

r_d11_col48 d11_col48 0 10000k
r1_d11_col48 d11_col48 d111_col48 5
r_d22_col48 d22_col48 0 10000k
r1_d22_col48 d22_col48 d222_col48 5

r_SL1col48 SL1col48 0 10000k
r1_SL1col48 SL1col48 SL11col48 5
r_SL2col48 SL2col48 0 10000k
r1_SL2col48 SL2col48 SL22col48 5

* col49

mn1col49 d1_col49 en_col49 d11_col49 0 nenh w=4u l=.4u
mn2col49 d2_col49 en_col49 d22_col49 0 nenh w=4u l=.4u
mp1col49 d11_col49 enb_col49 d1_col49 2.97 penh w=8u l=0.4u
mp2col49 d22_col49 enb_col49 d2_col49 2.97 penh w=8u l=0.4u

r_en_col49 en_col49 0 10000k
r1_en_col49 en_col49 en1_col49 5
r_enb_col49 enb_col49 0 10000k
r1_enb_col49 enb_col49 enb1_col49 5

r_d11_col49 d11_col49 0 10000k
r1_d11_col49 d11_col49 d111_col49 5
r_d22_col49 d22_col49 0 10000k
r1_d22_col49 d22_col49 d222_col49 5

r_SL1col49 SL1col49 0 10000k
r1_SL1col49 SL1col49 SL11col49 5
r_SL2col49 SL2col49 0 10000k
r1_SL2col49 SL2col49 SL22col49 5

* col50

mn1col50 d1_col50 en_col50 d11_col50 0 nenh w=4u l=.4u
mn2col50 d2_col50 en_col50 d22_col50 0 nenh w=4u l=.4u
mp1col50 d11_col50 enb_col50 d1_col50 2.97 penh w=8u l=0.4u
mp2col50 d22_col50 enb_col50 d2_col50 2.97 penh w=8u l=0.4u

r_en_col50 en_col50 0 10000k
r1_en_col50 en_col50 en1_col50 5
r_enb_col50 enb_col50 0 10000k
r1_enb_col50 enb_col50 enb1_col50 5

r_d11_col50 d11_col50 0 10000k
r1_d11_col50 d11_col50 d111_col50 5
r_d22_col50 d22_col50 0 10000k
r1_d22_col50 d22_col50 d222_col50 5

r_SL1col50 SL1col50 0 10000k
r1_SL1col50 SL1col50 SL11col50 5
r_SL2col50 SL2col50 0 10000k
r1_SL2col50 SL2col50 SL22col50 5

* col51

mn1col51 d1_col51 en_col51 d11_col51 0 nenh w=4u l=.4u
mn2col51 d2_col51 en_col51 d22_col51 0 nenh w=4u l=.4u
mp1col51 d11_col51 enb_col51 d1_col51 2.97 penh w=8u l=0.4u
mp2col51 d22_col51 enb_col51 d2_col51 2.97 penh w=8u l=0.4u

r_en_col51 en_col51 0 10000k
r1_en_col51 en_col51 en1_col51 5
r_enb_col51 enb_col51 0 10000k
r1_enb_col51 enb_col51 enb1_col51 5

r_d11_col51 d11_col51 0 10000k
r1_d11_col51 d11_col51 d111_col51 5
r_d22_col51 d22_col51 0 10000k
r1_d22_col51 d22_col51 d222_col51 5

r_SL1col51 SL1col51 0 10000k
r1_SL1col51 SL1col51 SL11col51 5
r_SL2col51 SL2col51 0 10000k
r1_SL2col51 SL2col51 SL22col51 5

* col52

mn1col52 d1_col52 en_col52 d11_col52 0 nenh w=4u l=.4u
mn2col52 d2_col52 en_col52 d22_col52 0 nenh w=4u l=.4u
mp1col52 d11_col52 enb_col52 d1_col52 2.97 penh w=8u l=0.4u
mp2col52 d22_col52 enb_col52 d2_col52 2.97 penh w=8u l=0.4u

r_en_col52 en_col52 0 10000k
r1_en_col52 en_col52 en1_col52 5
r_enb_col52 enb_col52 0 10000k
r1_enb_col52 enb_col52 enb1_col52 5

r_d11_col52 d11_col52 0 10000k
r1_d11_col52 d11_col52 d111_col52 5
r_d22_col52 d22_col52 0 10000k
r1_d22_col52 d22_col52 d222_col52 5

r_SL1col52 SL1col52 0 10000k
r1_SL1col52 SL1col52 SL11col52 5
r_SL2col52 SL2col52 0 10000k
r1_SL2col52 SL2col52 SL22col52 5

* col53

mn1col53 d1_col53 en_col53 d11_col53 0 nenh w=4u l=.4u
mn2col53 d2_col53 en_col53 d22_col53 0 nenh w=4u l=.4u
mp1col53 d11_col53 enb_col53 d1_col53 2.97 penh w=8u l=0.4u
mp2col53 d22_col53 enb_col53 d2_col53 2.97 penh w=8u l=0.4u

r_en_col53 en_col53 0 10000k
r1_en_col53 en_col53 en1_col53 5
r_enb_col53 enb_col53 0 10000k
r1_enb_col53 enb_col53 enb1_col53 5

r_d11_col53 d11_col53 0 10000k
r1_d11_col53 d11_col53 d111_col53 5
r_d22_col53 d22_col53 0 10000k
r1_d22_col53 d22_col53 d222_col53 5

r_SL1col53 SL1col53 0 10000k
r1_SL1col53 SL1col53 SL11col53 5
r_SL2col53 SL2col53 0 10000k
r1_SL2col53 SL2col53 SL22col53 5

* col54

mn1col54 d1_col54 en_col54 d11_col54 0 nenh w=4u l=.4u
mn2col54 d2_col54 en_col54 d22_col54 0 nenh w=4u l=.4u
mp1col54 d11_col54 enb_col54 d1_col54 2.97 penh w=8u l=0.4u
mp2col54 d22_col54 enb_col54 d2_col54 2.97 penh w=8u l=0.4u

r_en_col54 en_col54 0 10000k
r1_en_col54 en_col54 en1_col54 5
r_enb_col54 enb_col54 0 10000k
r1_enb_col54 enb_col54 enb1_col54 5

r_d11_col54 d11_col54 0 10000k
r1_d11_col54 d11_col54 d111_col54 5
r_d22_col54 d22_col54 0 10000k
r1_d22_col54 d22_col54 d222_col54 5

r_SL1col54 SL1col54 0 10000k
r1_SL1col54 SL1col54 SL11col54 5
r_SL2col54 SL2col54 0 10000k
r1_SL2col54 SL2col54 SL22col54 5

* col55

mn1col55 d1_col55 en_col55 d11_col55 0 nenh w=4u l=.4u
mn2col55 d2_col55 en_col55 d22_col55 0 nenh w=4u l=.4u
mp1col55 d11_col55 enb_col55 d1_col55 2.97 penh w=8u l=0.4u
mp2col55 d22_col55 enb_col55 d2_col55 2.97 penh w=8u l=0.4u

r_en_col55 en_col55 0 10000k
r1_en_col55 en_col55 en1_col55 5
r_enb_col55 enb_col55 0 10000k
r1_enb_col55 enb_col55 enb1_col55 5

r_d11_col55 d11_col55 0 10000k
r1_d11_col55 d11_col55 d111_col55 5
r_d22_col55 d22_col55 0 10000k
r1_d22_col55 d22_col55 d222_col55 5

r_SL1col55 SL1col55 0 10000k
r1_SL1col55 SL1col55 SL11col55 5
r_SL2col55 SL2col55 0 10000k

r1_SL2col55 SL2col55 SL22col55 5

* col56

mn1col56 d1_col56 en_col56 d11_col56 0 nenh w=4u l=.4u
mn2col56 d2_col56 en_col56 d22_col56 0 nenh w=4u l=.4u
mp1col56 d11_col56 enb_col56 d1_col56 2.97 penh w=8u l=0.4u
mp2col56 d22_col56 enb_col56 d2_col56 2.97 penh w=8u l=0.4u

r_en_col56 en_col56 0 10000k
r1_en_col56 en_col56 en1_col56 5
r_enb_col56 enb_col56 0 10000k
r1_enb_col56 enb_col56 enb1_col56 5

r_d11_col56 d11_col56 0 10000k
r1_d11_col56 d11_col56 d111_col56 5
r_d22_col56 d22_col56 0 10000k
r1_d22_col56 d22_col56 d222_col56 5

r_SL1col56 SL1col56 0 10000k
r1_SL1col56 SL1col56 SL11col56 5
r_SL2col56 SL2col56 0 10000k
r1_SL2col56 SL2col56 SL22col56 5

* col57

mn1col57 d1_col57 en_col57 d11_col57 0 nenh w=4u l=.4u
mn2col57 d2_col57 en_col57 d22_col57 0 nenh w=4u l=.4u
mp1col57 d11_col57 enb_col57 d1_col57 2.97 penh w=8u l=0.4u
mp2col57 d22_col57 enb_col57 d2_col57 2.97 penh w=8u l=0.4u

r_en_col57 en_col57 0 10000k
r1_en_col57 en_col57 en1_col57 5
r_enb_col57 enb_col57 0 10000k
r1_enb_col57 enb_col57 enb1_col57 5

r_d11_col57 d11_col57 0 10000k
r1_d11_col57 d11_col57 d111_col57 5
r_d22_col57 d22_col57 0 10000k
r1_d22_col57 d22_col57 d222_col57 5

r_SL1col57 SL1col57 0 10000k
r1_SL1col57 SL1col57 SL11col57 5
r_SL2col57 SL2col57 0 10000k
r1_SL2col57 SL2col57 SL22col57 5

* col58

mn1col58 d1_col58 en_col58 d11_col58 0 nenh w=4u l=.4u
mn2col58 d2_col58 en_col58 d22_col58 0 nenh w=4u l=.4u
mp1col58 d11_col58 enb_col58 d1_col58 2.97 penh w=8u l=0.4u
mp2col58 d22_col58 enb_col58 d2_col58 2.97 penh w=8u l=0.4u

r_en_col58 en_col58 0 10000k
r1_en_col58 en_col58 en1_col58 5
r_enb_col58 enb_col58 0 10000k
r1_enb_col58 enb_col58 enb1_col58 5

r_d11_col58 d11_col58 0 10000k
r1_d11_col58 d11_col58 d111_col58 5
r_d22_col58 d22_col58 0 10000k
r1_d22_col58 d22_col58 d222_col58 5

r_SL1col58 SL1col58 0 10000k

r1_SL1col58 SL1col58 SL11col58 5
r_SL2col58 SL2col58 0 10000k
r1_SL2col58 SL2col58 SL22col58 5

* col59

mn1col59 d1_col59 en_col59 d11_col59 0 nenh w=4u l=.4u
mn2col59 d2_col59 en_col59 d22_col59 0 nenh w=4u l=.4u
mp1col59 d11_col59 enb_col59 d1_col59 2.97 penh w=8u l=0.4u
mp2col59 d22_col59 enb_col59 d2_col59 2.97 penh w=8u l=0.4u
r_en_col59 en_col59 0 10000k
r1_en_col59 en_col59 en1_col59 5
r_enb_col59 enb_col59 0 10000k
r1_enb_col59 enb_col59 enb1_col59 5

r_d11_col59 d11_col59 0 10000k
r1_d11_col59 d11_col59 d111_col59 5
r_d22_col59 d22_col59 0 10000k
r1_d22_col59 d22_col59 d222_col59 5

r_SL1col59 SL1col59 0 10000k
r1_SL1col59 SL1col59 SL11col59 5
r_SL2col59 SL2col59 0 10000k
r1_SL2col59 SL2col59 SL22col59 5

* col60

mn1col60 d1_col60 en_col60 d11_col60 0 nenh w=4u l=.4u
mn2col60 d2_col60 en_col60 d22_col60 0 nenh w=4u l=.4u
mp1col60 d11_col60 enb_col60 d1_col60 2.97 penh w=8u l=0.4u
mp2col60 d22_col60 enb_col60 d2_col60 2.97 penh w=8u l=0.4u

r_en_col60 en_col60 0 10000k
r1_en_col60 en_col60 en1_col60 5
r_enb_col60 enb_col60 0 10000k
r1_enb_col60 enb_col60 enb1_col60 5

r_d11_col60 d11_col60 0 10000k
r1_d11_col60 d11_col60 d111_col60 5
r_d22_col60 d22_col60 0 10000k
r1_d22_col60 d22_col60 d222_col60 5

r_SL1col60 SL1col60 0 10000k
r1_SL1col60 SL1col60 SL11col60 5
r_SL2col60 SL2col60 0 10000k
r1_SL2col60 SL2col60 SL22col60 5

* col61

mn1col61 d1_col61 en_col61 d11_col61 0 nenh w=4u l=.4u
mn2col61 d2_col61 en_col61 d22_col61 0 nenh w=4u l=.4u
mp1col61 d11_col61 enb_col61 d1_col61 2.97 penh w=8u l=0.4u
mp2col61 d22_col61 enb_col61 d2_col61 2.97 penh w=8u l=0.4u

r_en_col61 en_col61 0 10000k
r1_en_col61 en_col61 en1_col61 5
r_enb_col61 enb_col61 0 10000k
r1_enb_col61 enb_col61 enb1_col61 5

r_d11_col61 d11_col61 0 10000k
r1_d11_col61 d11_col61 d111_col61 5
r_d22_col61 d22_col61 0 10000k
r1_d22_col61 d22_col61 d222_col61 5
r_SL1col61 SL1col61 0 10000k

r1_SL1col61 SL1col61 SL11col61 5
r_SL2col61 SL2col61 0 10000k
r1_SL2col61 SL2col61 SL22col61 5

* col62

mn1col62 d1_col62 en_col62 d11_col62 0 nenh w=4u l=.4u
mn2col62 d2_col62 en_col62 d22_col62 0 nenh w=4u l=.4u
mp1col62 d11_col62 enb_col62 d1_col62 2.97 penh w=8u l=0.4u
mp2col62 d22_col62 enb_col62 d2_col62 2.97 penh w=8u l=0.4u

r_en_col62 en_col62 0 10000k
r1_en_col62 en_col62 en1_col62 5
r_enb_col62 enb_col62 0 10000k
r1_enb_col62 enb_col62 enb1_col62 5

r_d11_col62 d11_col62 0 10000k
r1_d11_col62 d11_col62 d111_col62 5
r_d22_col62 d22_col62 0 10000k
r1_d22_col62 d22_col62 d222_col62 5

r_SL1col62 SL1col62 0 10000k
r1_SL1col62 SL1col62 SL11col62 5
r_SL2col62 SL2col62 0 10000k
r1_SL2col62 SL2col62 SL22col62 5

* col63

mn1col63 d1_col63 en_col63 d11_col63 0 nenh w=4u l=.4u
mn2col63 d2_col63 en_col63 d22_col63 0 nenh w=4u l=.4u
mp1col63 d11_col63 enb_col63 d1_col63 2.97 penh w=8u l=0.4u
mp2col63 d22_col63 enb_col63 d2_col63 2.97 penh w=8u l=0.4u

r_en_col63 en_col63 0 10000k
r1_en_col63 en_col63 en1_col63 5
r_enb_col63 enb_col63 0 10000k
r1_enb_col63 enb_col63 enb1_col63 5

r_d11_col63 d11_col63 0 10000k
r1_d11_col63 d11_col63 d111_col63 5
r_d22_col63 d22_col63 0 10000k
r1_d22_col63 d22_col63 d222_col63 5

r_SL1col63 SL1col63 0 10000k
r1_SL1col63 SL1col63 SL11col63 5
r_SL2col63 SL2col63 0 10000k
r1_SL2col63 SL2col63 SL22col63 5

.....
sources_array64bit_SelectiveCharging_Slow.cir
.....

* power supply *

v_dd u 0 dc 2.97
v_dd_2 u2 0 dc 1.485
v_dd2 l 0 pulse(0 1.485 1n 0.25n 0.25n 1.5n 20n)

* row enable *

v_en_row0 en1_row0 0 dc 2.97

v_enb_row0 enb1_row0 0 dc 0

```
*****  
*           column enable           *  
*****
```

v_en_col0 en1_col0 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col0 enb1_col0 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col1 en1_col1 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col1 enb1_col1 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col2 en1_col2 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col2 enb1_col2 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col3 en1_col3 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col3 enb1_col3 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col4 en1_col4 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col4 enb1_col4 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col5 en1_col5 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col5 enb1_col5 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col6 en1_col6 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col6 enb1_col6 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col7 en1_col7 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col7 enb1_col7 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col8 en1_col8 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col8 enb1_col8 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col9 en1_col9 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col9 enb1_col9 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col10 en1_col10 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col10 enb1_col10 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col11 en1_col11 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col11 enb1_col11 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col12 en1_col12 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col12 enb1_col12 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col13 en1_col13 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col13 enb1_col13 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col14 en1_col14 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col14 enb1_col14 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col15 en1_col15 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col15 enb1_col15 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col16 en1_col16 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col16 enb1_col16 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col17 en1_col17 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col17 enb1_col17 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col18 en1_col18 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col18 enb1_col18 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col19 en1_col19 0 pulse(0 2.97 1n 1p 1p 2n 20n)

v_enb_col19 enb1_col19 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col20 en1_col20 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col20 enb1_col20 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col21 en1_col21 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col21 enb1_col21 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col22 en1_col22 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col22 enb1_col22 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col23 en1_col23 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col23 enb1_col23 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col24 en1_col24 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col24 enb1_col24 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col25 en1_col25 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col25 enb1_col25 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col26 en1_col26 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col26 enb1_col26 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col27 en1_col27 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col27 enb1_col27 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col28 en1_col28 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col28 enb1_col28 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col29 en1_col29 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col29 enb1_col29 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col30 en1_col30 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col30 enb1_col30 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col31 en1_col31 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col31 enb1_col31 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col32 en1_col32 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col32 enb1_col32 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col33 en1_col33 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col33 enb1_col33 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col34 en1_col34 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col34 enb1_col34 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col35 en1_col35 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col35 enb1_col35 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col36 en1_col36 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col36 enb1_col36 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col37 en1_col37 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col37 enb1_col37 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col38 en1_col38 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col38 enb1_col38 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col39 en1_col39 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col39 enb1_col39 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col40 en1_col40 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col40 enb1_col40 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col41 en1_col41 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col41 enb1_col41 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col42 en1_col42 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col42 enb1_col42 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col43 en1_col43 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col43 enb1_col43 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col44 en1_col44 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col44 enb1_col44 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col45 en1_col45 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col45 enb1_col45 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col46 en1_col46 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col46 enb1_col46 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col47 en1_col47 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col47 enb1_col47 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col48 en1_col48 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col48 enb1_col48 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col49 en1_col49 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col49 enb1_col49 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col50 en1_col50 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col50 enb1_col50 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col51 en1_col51 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col51 enb1_col51 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col52 en1_col52 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col52 enb1_col52 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col53 en1_col53 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col53 enb1_col53 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col54 en1_col54 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col54 enb1_col54 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col55 en1_col55 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col55 enb1_col55 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col56 en1_col56 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col56 enb1_col56 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col57 en1_col57 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col57 enb1_col57 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col58 en1_col58 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col58 enb1_col58 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col59 en1_col59 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col59 enb1_col59 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col60 en1_col60 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col60 enb1_col60 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col61 en1_col61 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col61 enb1_col61 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col62 en1_col62 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col62 enb1_col62 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col63 en1_col63 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col63 enb1_col63 0 pulse(2.97 0 1n 1p 1p 2n 20n)

* data lines *

v_d1col0 d111_col0 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22n 2.97 22.5n 0 23n 0
+41n 0 41.5n 2.97 42.5n 2.97 43n 0
+61n 0 61.5n 2.97 62n 2.97 62.5n 0 63n 0 81n 0 81.5n 2.97 82.5n 2.97 83n 0)
v_d2col0 d222_col0 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22.5n 2.97 23n 0
+41n 0 41.5n 2.97 42n 2.97 42.5n 0 43n 0
+61n 0 61.5n 2.97 62.5n 2.97 63n 0 81n 0 81.5n 2.97 82n 2.97 82.5n 0 83n 0)

v_d1col1 d111_col1 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22.5n 2.97 23n 0
+41n 0 41.5n 2.97 42n 2.97 42.5n 0 43n 0
+61n 0 61.5n 2.97 62.5n 2.97 63n 0 81n 0 81.5n 2.97 82n 2.97 82.5n 0 83n 0)
v_d2col1 d222_col1 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22n 2.97 22.5n 0 23n 0
+41n 0 41.5n 2.97 42.5n 2.97 43n 0
+61n 0 61.5n 2.97 62n 2.97 62.5n 0 63n 0 81n 0 81.5n 2.97 82.5n 2.97 83n 0)

v_d1col2 d111_col2 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22.5n 2.97 23n 0
+41n 0 41.5n 2.97 42n 2.97 42.5n 0 43n 0
+61n 0 61.5n 2.97 62.5n 2.97 63n 0 81n 0 81.5n 2.97 82n 2.97 82.5n 0 83n 0)
v_d2col2 d222_col2 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22n 2.97 22.5n 0 23n 0
+41n 0 41.5n 2.97 42.5n 2.97 43n 0
+61n 0 61.5n 2.97 62n 2.97 62.5n 0 63n 0 81n 0 81.5n 2.97 82.5n 2.97 83n 0)

v_d1col3 d111_col3 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22n 2.97 22.5n 0 23n 0
+41n 0 41.5n 2.97 42.5n 2.97 43n 0
+61n 0 61.5n 2.97 62n 2.97 62.5n 0 63n 0 81n 0 81.5n 2.97 82.5n 2.97 83n 0)
v_d2col3 d222_col3 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22.5n 2.97 23n 0
+41n 0 41.5n 2.97 42n 2.97 42.5n 0 43n 0
+61n 0 61.5n 2.97 62.5n 2.97 63n 0 81n 0 81.5n 2.97 82.0n 2.97 82.5n 0 83n 0)

v_d1col4 d111_col4 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22.5n 2.97 23n 0
+41n 0 41.5n 2.97 42n 2.97 42.5n 0 43n 0
+61n 0 61.5n 2.97 62.5n 2.97 63n 0 81n 0 81.5n 2.97 82n 2.97 82.5n 0 83n 0)
v_d2col4 d222_col4 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22n 2.97 22.5n 0 23n 0
+41n 0 41.5n 2.97 42.5n 2.97 43n 0
+61n 0 61.5n 2.97 62n 2.97 62.5n 0 63n 0 81n 0 81.5n 2.97 82.5n 2.97 83n 0)

v_d1col5 d111_col5 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22.5n 2.97 23n 0
+41n 0 41.5n 2.97 42n 2.97 42.5n 0 43n 0
+61n 0 61.5n 2.97 62.5n 2.97 63n 0 81n 0 81.5n 2.97 82.0n 2.97 82.5n 0 83n 0)
v_d2col5 d222_col5 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22n 2.97 22.5n 0 23n 0
+41n 0 41.5n 2.97 42.5n 2.97 43n 0
+61n 0 61.5n 2.97 62n 2.97 62.5n 0 63n 0 81n 0 81.5n 2.97 82.5n 2.97 83n 0)

v_d1col6 d111_col6 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22n 2.97 22.5n 0 23n 0
+41n 0 41.5n 2.97 42.5n 2.97 43n 0
+61n 0 61.5n 2.97 62n 2.97 62.5n 0 63n 0 81n 0 81.5n 2.97 82.5n 2.97 83n 0)
v_d2col6 d222_col6 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22.5n 2.97 23n 0
+41n 0 41.5n 2.97 42n 2.97 42.5n 0 43n 0

+61n 0 61.5n 2.97 62.5n 2.97 63n 0 81n 0 81.5n 2.97 82.0n 2.97 82.5n 0 83n 0)

v_d1col7 d111_col7 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22n 2.97 22.5n 0 23n 0
+41n 0 41.5n 2.97 42n 2.97 42.5n 0
+43n 0 61n 0 61.5n 2.97 62.5n 2.97 63n 0 81n 0 81.5n 2.97 82.5n 2.97 83n 0)
v_d2col7 d222_col7 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22.5n 2.97 23n 0
+41n 0 41.5n 2.97 42.5n 2.97 43n 0
+61n 0 61.5n 2.97 62n 2.97 62.5n 0 63n 0 81n 0 81.5n 2.97 82n 2.97 82.5n 0 83n 0)
*^^^ 1st cycle = mismatch (1 bit mismatch at row=0 col=7) 2nd cycle = full match

v_d1col8 d111_col8 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22n 2.97 22.5n 0 23n 0
+41n 0 41.5n 2.97 42.5n 2.97 43n 0
+61n 0 61.5n 2.97 62n 2.97 62.5n 0 63n 0 81n 0 81.5n 2.97 82.5n 2.97 83n 0)
v_d2col8 d222_col8 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22.5n 2.97 23n 0
+41n 0 41.5n 2.97 42n 2.97 42.5n 0 43n 0
+61n 0 61.5n 2.97 62.5n 2.97 63n 0 81n 0 81.5n 2.97 82.0n 2.97 82n 2.97 82.5n 0 83n 0)

v_d1col9 d111_col9 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22.5n 2.97 23n 0
+41n 0 41.5n 2.97 42n 2.97 42.5n 0 43n 0
+61n 0 61.5n 2.97 62.5n 2.97 63n 0 81n 0 81.5n 2.97 82.0n 2.97 82.5n 0 83n 0)
v_d2col9 d222_col9 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22n 2.97 22.5n 0 23n 0
+41n 0 41.5n 2.97 42.5n 2.97 43n 0
+61n 0 61.5n 2.97 62n 2.97 62.5n 0 63n 0 81n 0 81.5n 2.97 82.5n 2.97 83n 0)

v_d1col10 d111_col10 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22.5n 2.97 23n 0
+41n 0 41.5n 2.97 42n 2.97 42.5n 0 43n 0
+61n 0 61.5n 2.97 62.5n 2.97 63n 0 81n 0 81.5n 2.97 82.0n 2.97 82.5n 0 83n 0)
v_d2col10 d222_col10 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22n 2.97 22.5n 0 23n 0
+41n 0 41.5n 2.97 42.5n 2.97 43n 0
+61n 0 61.5n 2.97 62n 2.97 62.5n 0 63n 0 81n 0 81.5n 2.97 82.5n 2.97 83n 0)

v_d1col11 d111_col11 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22n 2.97 22.5n 0 23n 0
+41n 0 41.5n 2.97 42.5n 2.97 43n 0
+61n 0 61.5n 2.97 62n 2.97 62.5n 0 63n 0 81n 0 81.5n 2.97 82.5n 2.97 83n 0)
v_d2col11 d222_col11 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22.5n 2.97 23n 0
+41n 0 41.5n 2.97 42n 2.97 42.5n 0 43n 0
+61n 0 61.5n 2.97 62.5n 2.97 63n 0 81n 0 81.5n 2.97 82.0n 2.97 82.5n 0 83n 0)

v_d1col12 d111_col12 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22n 2.97 22.5n 0 23n 0
+41n 0 41.5n 2.97 42.5n 2.97 43n 0
+61n 0 61.5n 2.97 62n 2.97 62.5n 0 63n 0 81n 0 81.5n 2.97 82.5n 2.97 83n 0)
v_d2col12 d222_col12 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22.5n 2.97 23n 0
+41n 0 41.5n 2.97 42n 2.97 42.5n 0 43n 0
+61n 0 61.5n 2.97 62.5n 2.97 63n 0 81n 0 81.5n 2.97 82.0n 2.97 82.5n 0 83n 0)
v_d1col13 d111_col13 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22n 2.97 22.5n 0 23n 0
+41n 0 41.5n 2.97 42.5n 2.97 43n 0
+61n 0 61.5n 2.97 62n 2.97 62.5n 0 63n 0 81n 0 81.5n 2.97 82.5n 2.97 83n 0)
v_d2col13 d222_col13 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22.5n 2.97 23n 0
+41n 0 41.5n 2.97 42n 2.97 42.5n 0 43n 0
+61n 0 61.5n 2.97 62.5n 2.97 63n 0 81n 0 81.5n 2.97 82.0n 2.97 82.5n 0 83n 0)

v_d1col14 d111_col14 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22.5n 2.97 23n 0
+41n 0 41.5n 2.97 42n 2.97 42.5n 0 43n 0
+61n 0 61.5n 2.97 62.5n 2.97 63n 0 81n 0 81.5n 2.97 82.0n 2.97 82.5n 0 83n 0)
v_d2col14 d222_col14 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22n 2.97 22.5n 0 23n 0
+41n 0 41.5n 2.97 42.5n 2.97 43n 0
+61n 0 61.5n 2.97 62n 2.97 62.5n 0 63n 0 81n 0 81.5n 2.97 82.5n 2.97 83n 0)


```
xtcam_cell_0_30 d1_col30 d2_col30 SL1col30 SL2col30 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_31 d1_col31 d2_col31 SL1col31 SL2col31 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
```

```
xtcam_cell_0_32 d1_col32 d2_col32 SL1col32 SL2col32 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_33 d1_col33 d2_col33 SL1col33 SL2col33 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_34 d1_col34 d2_col34 SL1col34 SL2col34 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_35 d1_col35 d2_col35 SL1col35 SL2col35 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_36 d1_col36 d2_col36 SL1col36 SL2col36 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_37 d1_col37 d2_col37 SL1col37 SL2col37 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_38 d1_col38 d2_col38 SL1col38 SL2col38 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_39 d1_col39 d2_col39 SL1col39 SL2col39 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_40 d1_col40 d2_col40 SL1col40 SL2col40 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_41 d1_col41 d2_col41 SL1col41 SL2col41 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_42 d1_col42 d2_col42 SL1col42 SL2col42 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_43 d1_col43 d2_col43 SL1col43 SL2col43 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_44 d1_col44 d2_col44 SL1col44 SL2col44 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_45 d1_col45 d2_col45 SL1col45 SL2col45 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_46 d1_col46 d2_col46 SL1col46 SL2col46 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_47 d1_col47 d2_col47 SL1col47 SL2col47 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
```

```
xtcam_cell_0_48 d1_col48 d2_col48 SL1col48 SL2col48 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_49 d1_col49 d2_col49 SL1col49 SL2col49 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_50 d1_col50 d2_col50 SL1col50 SL2col50 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_51 d1_col51 d2_col51 SL1col51 SL2col51 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_52 d1_col52 d2_col52 SL1col52 SL2col52 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_53 d1_col53 d2_col53 SL1col53 SL2col53 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_54 d1_col54 d2_col54 SL1col54 SL2col54 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_55 d1_col55 d2_col55 SL1col55 SL2col55 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_56 d1_col56 d2_col56 SL1col56 SL2col56 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_57 d1_col57 d2_col57 SL1col57 SL2col57 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_58 d1_col58 d2_col58 SL1col58 SL2col58 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_59 d1_col59 d2_col59 SL1col59 SL2col59 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_60 d1_col60 d2_col60 SL1col60 SL2col60 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_61 d1_col61 d2_col61 SL1col61 SL2col61 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_62 d1_col62 d2_col62 SL1col62 SL2col62 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_63 d1_col63 d2_col63 SL1col63 SL2col63 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
```

A.6. PSpice netlist for Table 7.7

* 1X64 bit TCAM array

```
.INCLUDE 'models_array64bit_Pipelining_Fast.cir'
.INCLUDE 'rowcolumn_array64bit_Pipelining_Fast..cir'
.INCLUDE 'sources_array64bit_Pipelining_Fast..cir'
.INCLUDE 'cells_array64bit_Pipelining_Fast..cir'

.SUBCKT tcam_cell d1 d2 SL1 SL2 en_row enb_row SE ML u2 I

xmem1 p | sv_mem1 MEM_YAKOPCIC_test1
xmem2 q | sv_mem2 MEM_YAKOPCIC_test1
xmem3 s u2 sv_mem3 MEM_YAKOPCIC_test2
xmem4 t u2 sv_mem4 MEM_YAKOPCIC_test2

rmem1 sv_mem1 0 10000k
rmem2 sv_mem2 0 10000k
rmem3 sv_mem3 0 10000k
rmem4 sv_mem4 0 10000k

mn1 d1 en_row p 0 nenh w=2u l=0.4u
mn2 d2 en_row q 0 nenh w=2u l=0.4u
mp1 p enb_row d1 3.63 penh w=2u l=0.4u
```



```

* IV Response - Hyperbolic sine due to MIM structure

.func IVRel(V1,V2) {IF(V1 >= 0, a1*V2*sinh(b*V1),
+a2*V2*sinh(b*V1) )}

* Circuit to determine state variable
* dx/dt = F(V(t),x(t))*G(V(t))

Cx XSV 0 1 IC= {xo}
Gx 0 XSV value={eta*F(V(TE,BE),V(XSV,0))*G(V(TE,BE))}

* Current source for memristor IV response

Gm TE BE value = {IVRel(V(TE,BE),V(XSV,0))}

.ends MEM_YAKOPCIC_test1

.subckt MEM_YAKOPCIC_test2 TE BE XSV PARAMS:

* Fitting parameters to model different devices
* a1, a2, b: Parameters for IV relationship
* Vp, Vn: Pos. and neg. voltage thresholds
* Ap, An: Multiplier for SV motion intensity
* xp, xn: Points where SV motion is reduced
* alphap, alphan: Rate at which SV motion decays
* xo: Initial value of SV
* eta: SV direction relative to voltage

+a1=.01 a2=.01 b=.011 Vp=1.7 Vn=1.7 Ap=4e3 An=4e3
+xp=0.1 xn=0.1 alphap=1 alphan=7 xo=0.1 eta=1

* Multiplicative functions to ensure zero state
* variable motion at memristor boundaries

.func wp(V) {(xp-V)/(1-xp)+1}
.func wn(V) {V/(1-xn)}

* Function G(V(t)) - Describes the device threshold

.func G(V) { IF(V<=Vp, IF(V>=-Vn, 0, -An*(exp(-V)-exp(Vn))), Ap*(exp(V)-exp(Vp))) }

* Function F(V(t),x(t)) - Describes the SV motion

.func F(V1,V2) {IF(eta*V1 >= 0, IF(V2 >= xp, exp(-
+alphap*(V2-xp))*wp(V2) ,1), IF(V2 <= (1-xn),
+exp(alphan*(V2+xn-1))*wn(V2) ,1))}

* IV Response - Hyperbolic sine due to MIM structure

.func IVRel(V1,V2) {IF(V1 >= 0, a1*V2*sinh(b*V1),
+a2*V2*sinh(b*V1) )}

* Circuit to determine state variable
* dx/dt = F(V(t),x(t))*G(V(t))

Cx XSV 0 1 IC= {xo}
Gx 0 XSV value={eta*F(V(TE,BE),V(XSV,0))*G(V(TE,BE))}

* Current source for memristor IV response

Gm TE BE value = {IVRel(V(TE,BE),V(XSV,0))}

.ends MEM_YAKOPCIC_test2

```

*** model of NMOS transistor ***

```
.MODEL nenh NMOS LEVEL=7 VERSION=3.1 TNOM=0 tox=4.1E-9 XJ=1E-7 NCH=2.3549E17
+VTH0= 0.32962257 K1=0.5864999 K2=1.127266E-3 K3=1E-3
+K3B=0.0294061 W0=1E-7 NLX=1.630684E-7 DVT0W=0 DVT1W=0 DVT2W=0 DVT0=1.2064649
+DVT1=0.4215486 DVT2=0.0197749 U0=273.8094484 UA=-1.40499E-9
+UB=2.408323E-18 UC=6.504826E-11 VSAT=1.355009E5 A0=2 AGS=0.4449958
+BO=1.901075E-7 B1=4.99995E-6 KETA=-0.0164863 A1=3.868769E-4 A2=0.4640272
+RDSW=123.3376355 PRWG=0.5 PRWB=-0.197728 WR=1 WINT=0 LINT=1.690044E-8
+XL=0 XW=-1E-8 DWG=-4.728719E-9 DWB=-2.452411E-9 VOFF=-0.0948017 NFACTOR=2.1860065
+CIT=0 CDSC=2.4E-4 CDSCD=0 CDSCB=0 ETA0=2.230928E-3 ETAB=6.028975E-5 DSUB=0.0145467
+PCLM=1.3822069 PDIBLC1=0.1762787 PDIBLC2 = 1.66653E-3 PDIBLCB = -0.1
+DROUT=0.7694691 PSCBE1=8.91287E9 PSCBE2=7.349607E-9 PVAG=1.685917E-3
+DELTA=0.01 RSH=6.7 MOBMOD=1 PRT=0 UTE=-1.5 KT1=-0.11 KT1L=0 KT2=0.022 UA1=4.31E-9
+UB1=-7.61E-18 UC1=-5.6E-11 AT=3.3E4 WL=0 WLN=1 WW=0 WWN=1 WWL=0 LL=0 LLN=1 LW=0
+LWN=1 LWL=0 CAPMOD=2 XPART=0.5 CGDO=8.23E-10 CGSO=8.23E-10 CGBO=1E-12
+CJ = 9.466429E-4 PB = 0.8 MJ = 0.3820266
+CJSW = 2.608154E-10 PBSW = 0.8 MJSW = 0.102322
+CJSWG = 3.3E-10 PBSWG = 0.8 MJSWG = 0.102322
+CF = 0 PVTH0 = -2.199373E-3 PRDSW = -0.9368961
+PK2 = 1.593254E-3 WKETA = -2.880976E-3 LKETA = 7.165078E-3
+PUO = 6.777519 PUA = 5.505418E-12 PUB = 8.84133E-25
+PVSAT = 2.006286E3 PETA0 = 1.003159E-4 PKETA = -6.759277E-3
+NOIMOD=2.0E+00 NOIA=1.3182567385564E+19
+NOIB=144543.977074592 NOIC=-1.24515784572817E-12 EF=0.92 EM=41000000
```

*** model of PMOS transistor ***

```
.MODEL penh PMOS LEVEL=7 VERSION = 3.1 TNOM = 0 tox = 4.1E-9
+XJ = 1E-7 NCH = 4.1589E17 VTH0 = -0.35154108
+K1 = 0.5341312 K2 = 0.0395326 K3 = 0
+K3B = 7.4916211 W0 = 1E-6 NLX = 1.194072E-7
+DVT0W = 0 DVT1W = 0 DVT2W = 0
+DVT0 = 0.5060555 DVT1 = 0.2423835 DVT2 = 0.1
+U0 = 115.6894042 UA = 1.573746E-9 UB = 1.874308E-21
+UC = -1E-10 VSAT = 1.130982E5 A0 = 1.9976555
+AGS = 0.4186945 BO = 1.949178E-7 B1 = 6.422908E-7
+KETA = 0.0166345 A1 = 0.4749146 A2 = 0.300003
+RDSW = 198.321294 PRWG = 0.5 PRWB = -0.4986647
+WR = 1 WINT = 0 LINT = 2.94454E-8
+XL = 0 XW = -1E-8 DWG = -2.798724E-8
+DWB = -4.83797E-10 VOFF = -0.095236 NFACTOR = 2
+CIT = 0 CDSC = 2.4E-4 CDSCD = 0
+CDSCB = 0 ETA0 = 1.035504E-3 ETAB = -4.358398E-4
+DSUB = 1.816555E-3 PCLM = 1.3299898 PDIBLC1 = 1.766563E-3
+PDIBLC2 = 7.728395E-7 PDIBLCB = -1E-3 DROUT = 1.011891E-3
+PSCBE1 = 4.872184E10 PSCBE2 = 5E-10 PVAG = 0.0209921
+DELTA = 0.01 RSH = 7.7 MOBMOD = 1
+PRT = 0 UTE = -1.5 KT1 = -0.11
+KT1L = 0 KT2 = 0.022 UA1 = 4.31E-9
+UB1 = -7.61E-18 UC1 = -5.6E-11 AT = 3.3E4
+WL = 0 WLN = 1 WW = 0
+WWN = 1 WWL = 0 LL = 0
+LLN = 1 LW = 0 LWN = 1
+LWL = 0 CAPMOD = 2 XPART = 0.5
+CGDO = 6.35E-10 CGSO = 6.35E-10 CGBO = 1E-12
+CJ = 1.144521E-3 PB = 0.8468686 MJ = 0.4099522
+CJSW = 2.490749E-10 PBSW = 0.8769118 MJSW = 0.3478565
+CJSWG = 4.22E-10 PBSWG = 0.8769118 MJSWG = 0.3478565
+CF = 0 PVTH0 = 2.302018E-3 PRDSW = 9.0575312
+PK2 = 1.821914E-3 WKETA = 0.0222457 LKETA = -1.495872E-3
+PUO = -1.5580645 PUA = -6.36889E-11 PUB = 1E-21
```

+PVSAT = 49.8420442 PETA0 = 2.827793E-5 PKETA = -2.536564E-3
+NOIMOD=2.0E+00 NOIA=3.57456993317604E+18 NOIB=2500
+NOIC=2.61260020285845E-11 EF=1.1388

.....
rowcolumn_array64bit_Pipelining_Fast.cir
.....

* rows *

* row0

*pre-charge ckt.

xprecharge_row01 pre_row01 u ML1row0 0 precharge
xprecharge_row02 pre_row02 u ML2row0 ML1brow0 precharge
xprecharge_row03 pre_row03 u ML3row0 ML2brow0 precharge
xprecharge_row04 pre_row04 u ML4row0 ML3brow0 precharge

*Matchline segmentation pipelining

*NOT Gates

mnML1row0 ML1brow0 ML1row0 0 0 nenh w=2u l=.2u
mpML1row0 ML1brow0 ML1row0 u 3.63 penh w=2u l=.2u
mnML2row0 ML2brow0 ML2row0 0 0 nenh w=2u l=.2u
mpML2row0 ML2brow0 ML2row0 u 3.63 penh w=2u l=.2u
mnML3row0 ML3brow0 ML3row0 0 0 nenh w=2u l=.2u
mpML3row0 ML3brow0 ML3row0 u 3.63 penh w=2u l=.2u
mnML4row0 ML4brow0 ML4row0 0 0 nenh w=2u l=.2u
mpML4row0 ML4brow0 ML4row0 u 3.63 penh w=2u l=.2u

*NOR Gate

mn1ML1row0 MLrow0 ML1brow0 0 0 nenh w=.4u l=0.2u
mn1ML2row0 MLrow0 ML2brow0 0 0 nenh w=.4u l=0.2u
mn1ML3row0 MLrow0 ML3brow0 0 0 nenh w=.4u l=0.2u
mn1ML4row0 MLrow0 ML4brow0 0 0 nenh w=.4u l=0.2u
mpMLrow0 MLrow0 MLrow0 u 3.63 penh w=1.8u l=0.2u

* sense-amplifier

xsense_amplifier_row0 MLrow0 SE_row0 u MLout_row0 sense_amplifier

*reset

mnML1reset_row0 ML1row0 ML1reset1_row0 0 0 nenh W=40u l=0.4u
mnML2reset_row0 ML2row0 ML2reset1_row0 0 0 nenh W=40u l=0.4u
mnML3reset_row0 ML3row0 ML3reset1_row0 0 0 nenh W=40u l=0.4u
mnML4reset_row0 ML4row0 ML4reset1_row0 0 0 nenh W=40u l=0.4u

r_en_row0 en_row0 0 1000k
r1_en_row0 en_row0 en1_row0 5
r_enb_row0 enb_row0 0 1000k
r1_enb_row0 enb_row0 enb1_row0 5
r_pre1_row01 pre1_row01 0 1000k
r1_pre1_row01 pre1_row01 pre_row01 5
r_pre1_row02 pre1_row02 0 1000k
r1_pre1_row02 pre1_row02 pre_row02 5
r_pre1_row03 pre1_row03 0 1000k
r1_pre1_row03 pre1_row03 pre_row03 5
r_pre1_row04 pre1_row04 0 1000k
r1_pre1_row04 pre1_row04 pre_row04 5
r_SE_row0 SE_row0 0 1000k
r1_SE_row0 SE_row0 SE1_row0 5
rML1reset_row0 ML1reset_row0 ML1reset1_row0 5

rML1reset1_row0 ML1reset1_row0 0 10000k
rML2reset_row0 ML2reset_row0 ML2reset1_row0 5
rML2reset1_row0 ML2reset1_row0 0 10000k
rML3reset_row0 ML3reset_row0 ML3reset1_row0 5
rML3reset1_row0 ML3reset1_row0 0 10000k
rML4reset_row0 ML4reset_row0 ML4reset1_row0 5
rML4reset1_row0 ML4reset1_row0 0 10000k

* columns *

* col0

mn1col0 d1_col0 en_col0 d11_col0 0 nenh w=4u l=.4u
mn2col0 d2_col0 en_col0 d22_col0 0 nenh w=4u l=.4u
mp1col0 d11_col0 enb_col0 d1_col0 3.63 penh w=8u l=0.4u
mp2col0 d22_col0 enb_col0 d2_col0 3.63 penh w=8u l=0.4u

r_en_col0 en_col0 0 10000k
r1_en_col0 en_col0 en1_col0 5
r_enb_col0 enb_col0 0 10000k
r1_enb_col0 enb_col0 enb1_col0 5

r_d11_col0 d11_col0 0 10000k
r1_d11_col0 d11_col0 d111_col0 5
r_d22_col0 d22_col0 0 10000k
r1_d22_col0 d22_col0 d222_col0 5

r_SL1col0 SL1col0 0 10000k
r1_SL1col0 SL1col0 SL11col0 5
r_SL2col0 SL2col0 0 10000k
r1_SL2col0 SL2col0 SL22col0 5

* col1

mn1col1 d1_col1 en_col1 d11_col1 0 nenh w=4u l=.4u
mn2col1 d2_col1 en_col1 d22_col1 0 nenh w=4u l=.4u
mp1col1 d11_col1 enb_col1 d1_col1 3.63 penh w=8u l=0.4u
mp2col1 d22_col1 enb_col1 d2_col1 3.63 penh w=8u l=0.4u

r_en_col1 en_col1 0 10000k
r1_en_col1 en_col1 en1_col1 5
r_enb_col1 enb_col1 0 10000k
r1_enb_col1 enb_col1 enb1_col1 5

r_d11_col1 d11_col1 0 10000k
r1_d11_col1 d11_col1 d111_col1 5
r_d22_col1 d22_col1 0 10000k
r1_d22_col1 d22_col1 d222_col1 5

r_SL1col1 SL1col1 0 10000k
r1_SL1col1 SL1col1 SL11col1 5
r_SL2col1 SL2col1 0 10000k
r1_SL2col1 SL2col1 SL22col1 5

* col2

mn1col2 d1_col2 en_col2 d11_col2 0 nenh w=4u l=.4u
mn2col2 d2_col2 en_col2 d22_col2 0 nenh w=4u l=.4u
mp1col2 d11_col2 enb_col2 d1_col2 3.63 penh w=8u l=0.4u

mp2col2 d22_col2 enb_col2 d2_col2 3.63 penh w=8u l=0.4u

r_en_col2 en_col2 0 10000k
r1_en_col2 en_col2 en1_col2 5
r_enb_col2 enb_col2 0 10000k
r1_enb_col2 enb_col2 enb1_col2 5

r_d11_col2 d11_col2 0 10000k
r1_d11_col2 d11_col2 d111_col2 5
r_d22_col2 d22_col2 0 10000k
r1_d22_col2 d22_col2 d222_col2 5

r_SL1col2 SL1col2 0 10000k
r1_SL1col2 SL1col2 SL11col2 5
r_SL2col2 SL2col2 0 10000k
r1_SL2col2 SL2col2 SL22col2 5

* col3

mn1col3 d1_col3 en_col3 d11_col3 0 nenh w=4u l=.4u
mn2col3 d2_col3 en_col3 d22_col3 0 nenh w=4u l=.4u
mp1col3 d11_col3 enb_col3 d1_col3 3.63 penh w=8u l=0.4u
mp2col3 d22_col3 enb_col3 d2_col3 3.63 penh w=8u l=0.4u

r_en_col3 en_col3 0 10000k
r1_en_col3 en_col3 en1_col3 5
r_enb_col3 enb_col3 0 10000k
r1_enb_col3 enb_col3 enb1_col3 5

r_d11_col3 d11_col3 0 10000k
r1_d11_col3 d11_col3 d111_col3 5
r_d22_col3 d22_col3 0 10000k
r1_d22_col3 d22_col3 d222_col3 5

r_SL1col3 SL1col3 0 10000k
r1_SL1col3 SL1col3 SL11col3 5
r_SL2col3 SL2col3 0 10000k
r1_SL2col3 SL2col3 SL22col3 5

* col4

mn1col4 d1_col4 en_col4 d11_col4 0 nenh w=4u l=.4u
mn2col4 d2_col4 en_col4 d22_col4 0 nenh w=4u l=.4u
mp1col4 d11_col4 enb_col4 d1_col4 3.63 penh w=8u l=0.4u
mp2col4 d22_col4 enb_col4 d2_col4 3.63 penh w=8u l=0.4u

r_en_col4 en_col4 0 10000k
r1_en_col4 en_col4 en1_col4 5
r_enb_col4 enb_col4 0 10000k
r1_enb_col4 enb_col4 enb1_col4 5

r_d11_col4 d11_col4 0 10000k
r1_d11_col4 d11_col4 d111_col4 5
r_d22_col4 d22_col4 0 10000k
r1_d22_col4 d22_col4 d222_col4 5

r_SL1col4 SL1col4 0 10000k
r1_SL1col4 SL1col4 SL11col4 5
r_SL2col4 SL2col4 0 10000k
r1_SL2col4 SL2col4 SL22col4 5

* col5

mn1col5 d1_col5 en_col5 d11_col5 0 nenh w=4u l=.4u
mn2col5 d2_col5 en_col5 d22_col5 0 nenh w=4u l=.4u
mp1col5 d11_col5 enb_col5 d1_col5 3.63 penh w=8u l=0.4u
mp2col5 d22_col5 enb_col5 d2_col5 3.63 penh w=8u l=0.4u

r_en_col5 en_col5 0 10000k
r1_en_col5 en_col5 en1_col5 5
r_enb_col5 enb_col5 0 10000k
r1_enb_col5 enb_col5 enb1_col5 5

r_d11_col5 d11_col5 0 10000k
r1_d11_col5 d11_col5 d111_col5 5
r_d22_col5 d22_col5 0 10000k
r1_d22_col5 d22_col5 d222_col5 5

r_SL1col5 SL1col5 0 10000k
r1_SL1col5 SL1col5 SL11col5 5
r_SL2col5 SL2col5 0 10000k
r1_SL2col5 SL2col5 SL22col5 5

* col6

mn1col6 d1_col6 en_col6 d11_col6 0 nenh w=4u l=.4u
mn2col6 d2_col6 en_col6 d22_col6 0 nenh w=4u l=.4u
mp1col6 d11_col6 enb_col6 d1_col6 3.63 penh w=8u l=0.4u
mp2col6 d22_col6 enb_col6 d2_col6 3.63 penh w=8u l=0.4u

r_en_col6 en_col6 0 10000k
r1_en_col6 en_col6 en1_col6 5
r_enb_col6 enb_col6 0 10000k
r1_enb_col6 enb_col6 enb1_col6 5

r_d11_col6 d11_col6 0 10000k
r1_d11_col6 d11_col6 d111_col6 5
r_d22_col6 d22_col6 0 10000k
r1_d22_col6 d22_col6 d222_col6 5

r_SL1col6 SL1col6 0 10000k
r1_SL1col6 SL1col6 SL11col6 5
r_SL2col6 SL2col6 0 10000k
r1_SL2col6 SL2col6 SL22col6 5

* col7

mn1col7 d1_col7 en_col7 d11_col7 0 nenh w=4u l=.4u
mn2col7 d2_col7 en_col7 d22_col7 0 nenh w=4u l=.4u
mp1col7 d11_col7 enb_col7 d1_col7 3.63 penh w=8u l=0.4u
mp2col7 d22_col7 enb_col7 d2_col7 3.63 penh w=8u l=0.4u

r_en_col7 en_col7 0 10000k
r1_en_col7 en_col7 en1_col7 5
r_enb_col7 enb_col7 0 10000k
r1_enb_col7 enb_col7 enb1_col7 5

r_d11_col7 d11_col7 0 10000k
r1_d11_col7 d11_col7 d111_col7 5
r_d22_col7 d22_col7 0 10000k
r1_d22_col7 d22_col7 d222_col7 5

r_SL1col7 SL1col7 0 10000k
r1_SL1col7 SL1col7 SL11col7 5
r_SL2col7 SL2col7 0 10000k
r1_SL2col7 SL2col7 SL22col7 5

* col8

mn1col8 d1_col8 en_col8 d11_col8 0 nenh w=4u l=.4u
mn2col8 d2_col8 en_col8 d22_col8 0 nenh w=4u l=.4u
mp1col8 d11_col8 enb_col8 d1_col8 3.63 penh w=8u l=0.4u
mp2col8 d22_col8 enb_col8 d2_col8 3.63 penh w=8u l=0.4u

r_en_col8 en_col8 0 10000k
r1_en_col8 en_col8 en1_col8 5
r_enb_col8 enb_col8 0 10000k
r1_enb_col8 enb_col8 enb1_col8 5

r_d11_col8 d11_col8 0 10000k
r1_d11_col8 d11_col8 d111_col8 5
r_d22_col8 d22_col8 0 10000k
r1_d22_col8 d22_col8 d222_col8 5

r_SL1col8 SL1col8 0 10000k
r1_SL1col8 SL1col8 SL11col8 5
r_SL2col8 SL2col8 0 10000k
r1_SL2col8 SL2col8 SL22col8 5

* col9

mn1col9 d1_col9 en_col9 d11_col9 0 nenh w=4u l=.4u
mn2col9 d2_col9 en_col9 d22_col9 0 nenh w=4u l=.4u
mp1col9 d11_col9 enb_col9 d1_col9 3.63 penh w=8u l=0.4u
mp2col9 d22_col9 enb_col9 d2_col9 3.63 penh w=8u l=0.4u

r_en_col9 en_col9 0 10000k
r1_en_col9 en_col9 en1_col9 5
r_enb_col9 enb_col9 0 10000k
r1_enb_col9 enb_col9 enb1_col9 5

r_d11_col9 d11_col9 0 10000k
r1_d11_col9 d11_col9 d111_col9 5
r_d22_col9 d22_col9 0 10000k
r1_d22_col9 d22_col9 d222_col9 5

r_SL1col9 SL1col9 0 10000k
r1_SL1col9 SL1col9 SL11col9 5
r_SL2col9 SL2col9 0 10000k
r1_SL2col9 SL2col9 SL22col9 5

* col10

mn1col10 d1_col10 en_col10 d11_col10 0 nenh w=4u l=.4u
mn2col10 d2_col10 en_col10 d22_col10 0 nenh w=4u l=.4u
mp1col10 d11_col10 enb_col10 d1_col10 3.63 penh w=8u l=0.4u
mp2col10 d22_col10 enb_col10 d2_col10 3.63 penh w=8u l=0.4u

r_en_col10 en_col10 0 10000k
r1_en_col10 en_col10 en1_col10 5
r_enb_col10 enb_col10 0 10000k
r1_enb_col10 enb_col10 enb1_col10 5

r_d11_col10 d11_col10 0 10000k
r1_d11_col10 d11_col10 d111_col10 5
r_d22_col10 d22_col10 0 10000k
r1_d22_col10 d22_col10 d222_col10 5

r_SL1col10 SL1col10 0 10000k
r1_SL1col10 SL1col10 SL11col10 5
r_SL2col10 SL2col10 0 10000k
r1_SL2col10 SL2col10 SL22col10 5

* col11

mn1col11 d1_col11 en_col11 d11_col11 0 nenh w=4u l=.4u
mn2col11 d2_col11 en_col11 d22_col11 0 nenh w=4u l=.4u
mp1col11 d11_col11 enb_col11 d1_col11 3.63 penh w=8u l=0.4u
mp2col11 d22_col11 enb_col11 d2_col11 3.63 penh w=8u l=0.4u

r_en_col11 en_col11 0 10000k
r1_en_col11 en_col11 en1_col11 5
r_enb_col11 enb_col11 0 10000k
r1_enb_col11 enb_col11 enb1_col11 5

r_d11_col11 d11_col11 0 10000k
r1_d11_col11 d11_col11 d111_col11 5
r_d22_col11 d22_col11 0 10000k
r1_d22_col11 d22_col11 d222_col11 5

r_SL1col11 SL1col11 0 10000k
r1_SL1col11 SL1col11 SL11col11 5
r_SL2col11 SL2col11 0 10000k
r1_SL2col11 SL2col11 SL22col11 5

* col12

mn1col12 d1_col12 en_col12 d11_col12 0 nenh w=4u l=.4u
mn2col12 d2_col12 en_col12 d22_col12 0 nenh w=4u l=.4u
mp1col12 d11_col12 enb_col12 d1_col12 3.63 penh w=8u l=0.4u
mp2col12 d22_col12 enb_col12 d2_col12 3.63 penh w=8u l=0.4u

r_en_col12 en_col12 0 10000k
r1_en_col12 en_col12 en1_col12 5
r_enb_col12 enb_col12 0 10000k
r1_enb_col12 enb_col12 enb1_col12 5

r_d11_col12 d11_col12 0 10000k
r1_d11_col12 d11_col12 d111_col12 5
r_d22_col12 d22_col12 0 10000k
r1_d22_col12 d22_col12 d222_col12 5

r_SL1col12 SL1col12 0 10000k
r1_SL1col12 SL1col12 SL11col12 5
r_SL2col12 SL2col12 0 10000k
r1_SL2col12 SL2col12 SL22col12 5

* col13

mn1col13 d1_col13 en_col13 d11_col13 0 nenh w=4u l=.4u
mn2col13 d2_col13 en_col13 d22_col13 0 nenh w=4u l=.4u
mp1col13 d11_col13 enb_col13 d1_col13 3.63 penh w=8u l=0.4u
mp2col13 d22_col13 enb_col13 d2_col13 3.63 penh w=8u l=0.4u

r_en_col13 en_col13 0 10000k
r1_en_col13 en_col13 en1_col13 5
r_enb_col13 enb_col13 0 10000k
r1_enb_col13 enb_col13 enb1_col13 5

r_d11_col13 d11_col13 0 10000k
r1_d11_col13 d11_col13 d111_col13 5
r_d22_col13 d22_col13 0 10000k
r1_d22_col13 d22_col13 d222_col13 5

r_SL1col13 SL1col13 0 10000k
r1_SL1col13 SL1col13 SL11col13 5
r_SL2col13 SL2col13 0 10000k
r1_SL2col13 SL2col13 SL22col13 5

* col14

mn1col14 d1_col14 en_col14 d11_col14 0 nenh w=4u l=.4u
mn2col14 d2_col14 en_col14 d22_col14 0 nenh w=4u l=.4u
mp1col14 d11_col14 enb_col14 d1_col14 3.63 penh w=8u l=0.4u
mp2col14 d22_col14 enb_col14 d2_col14 3.63 penh w=8u l=0.4u

r_en_col14 en_col14 0 10000k
r1_en_col14 en_col14 en1_col14 5
r_enb_col14 enb_col14 0 10000k
r1_enb_col14 enb_col14 enb1_col14 5

r_d11_col14 d11_col14 0 10000k
r1_d11_col14 d11_col14 d111_col14 5
r_d22_col14 d22_col14 0 10000k
r1_d22_col14 d22_col14 d222_col14 5

r_SL1col14 SL1col14 0 10000k
r1_SL1col14 SL1col14 SL11col14 5
r_SL2col14 SL2col14 0 10000k
r1_SL2col14 SL2col14 SL22col14 5

* col15

mn1col15 d1_col15 en_col15 d11_col15 0 nenh w=4u l=.4u
mn2col15 d2_col15 en_col15 d22_col15 0 nenh w=4u l=.4u
mp1col15 d11_col15 enb_col15 d1_col15 3.63 penh w=8u l=0.4u
mp2col15 d22_col15 enb_col15 d2_col15 3.63 penh w=8u l=0.4u

r_en_col15 en_col15 0 10000k
r1_en_col15 en_col15 en1_col15 5
r_enb_col15 enb_col15 0 10000k
r1_enb_col15 enb_col15 enb1_col15 5

r_d11_col15 d11_col15 0 10000k
r1_d11_col15 d11_col15 d111_col15 5
r_d22_col15 d22_col15 0 10000k
r1_d22_col15 d22_col15 d222_col15 5

r_SL1col15 SL1col15 0 10000k
r1_SL1col15 SL1col15 SL11col15 5
r_SL2col15 SL2col15 0 10000k

r1_SL2col15 SL2col15 SL22col15 5

* col16

mn1col16 d1_col16 en_col16 d11_col16 0 nenh w=4u l=.4u
mn2col16 d2_col16 en_col16 d22_col16 0 nenh w=4u l=.4u
mp1col16 d11_col16 enb_col16 d1_col16 3.63 penh w=8u l=0.4u
mp2col16 d22_col16 enb_col16 d2_col16 3.63 penh w=8u l=0.4u

r_en_col16 en_col16 0 10000k
r1_en_col16 en_col16 en1_col16 5
r_enb_col16 enb_col16 0 10000k
r1_enb_col16 enb_col16 enb1_col16 5

r_d11_col16 d11_col16 0 10000k
r1_d11_col16 d11_col16 d111_col16 5
r_d22_col16 d22_col16 0 10000k
r1_d22_col16 d22_col16 d222_col16 5

r_SL1col16 SL1col16 0 10000k
r1_SL1col16 SL1col16 SL11col16 5
r_SL2col16 SL2col16 0 10000k
r1_SL2col16 SL2col16 SL22col16 5

* col17

mn1col17 d1_col17 en_col17 d11_col17 0 nenh w=4u l=.4u
mn2col17 d2_col17 en_col17 d22_col17 0 nenh w=4u l=.4u
mp1col17 d11_col17 enb_col17 d1_col17 3.63 penh w=8u l=0.4u
mp2col17 d22_col17 enb_col17 d2_col17 3.63 penh w=8u l=0.4u

r_en_col17 en_col17 0 10000k
r1_en_col17 en_col17 en1_col17 5
r_enb_col17 enb_col17 0 10000k
r1_enb_col17 enb_col17 enb1_col17 5

r_d11_col17 d11_col17 0 10000k
r1_d11_col17 d11_col17 d111_col17 5
r_d22_col17 d22_col17 0 10000k
r1_d22_col17 d22_col17 d222_col17 5

r_SL1col17 SL1col17 0 10000k
r1_SL1col17 SL1col17 SL11col17 5
r_SL2col17 SL2col17 0 10000k
r1_SL2col17 SL2col17 SL22col17 5

* col18

mn1col18 d1_col18 en_col18 d11_col18 0 nenh w=4u l=.4u
mn2col18 d2_col18 en_col18 d22_col18 0 nenh w=4u l=.4u
mp1col18 d11_col18 enb_col18 d1_col18 3.63 penh w=8u l=0.4u
mp2col18 d22_col18 enb_col18 d2_col18 3.63 penh w=8u l=0.4u

r_en_col18 en_col18 0 10000k
r1_en_col18 en_col18 en1_col18 5
r_enb_col18 enb_col18 0 10000k
r1_enb_col18 enb_col18 enb1_col18 5

r_d11_col18 d11_col18 0 10000k
r1_d11_col18 d11_col18 d111_col18 5
r_d22_col18 d22_col18 0 10000k
r1_d22_col18 d22_col18 d222_col18 5

r_SL1col18 SL1col18 0 10000k
r1_SL1col18 SL1col18 SL11col18 5
r_SL2col18 SL2col18 0 10000k
r1_SL2col18 SL2col18 SL22col18 5

* col19

mn1col19 d1_col19 en_col19 d11_col19 0 nenh w=4u l=.4u
mn2col19 d2_col19 en_col19 d22_col19 0 nenh w=4u l=.4u
mp1col19 d11_col19 enb_col19 d1_col19 3.63 penh w=8u l=0.4u
mp2col19 d22_col19 enb_col19 d2_col19 3.63 penh w=8u l=0.4u

r_en_col19 en_col19 0 10000k
r1_en_col19 en_col19 en1_col19 5
r_enb_col19 enb_col19 0 10000k
r1_enb_col19 enb_col19 enb1_col19 5

r_d11_col19 d11_col19 0 10000k
r1_d11_col19 d11_col19 d111_col19 5
r_d22_col19 d22_col19 0 10000k
r1_d22_col19 d22_col19 d222_col19 5

r_SL1col19 SL1col19 0 10000k
r1_SL1col19 SL1col19 SL11col19 5
r_SL2col19 SL2col19 0 10000k
r1_SL2col19 SL2col19 SL22col19 5

* col20

mn1col20 d1_col20 en_col20 d11_col20 0 nenh w=4u l=.4u
mn2col20 d2_col20 en_col20 d22_col20 0 nenh w=4u l=.4u
mp1col20 d11_col20 enb_col20 d1_col20 3.63 penh w=8u l=0.4u
mp2col20 d22_col20 enb_col20 d2_col20 3.63 penh w=8u l=0.4u

r_en_col20 en_col20 0 10000k
r1_en_col20 en_col20 en1_col20 5
r_enb_col20 enb_col20 0 10000k
r1_enb_col20 enb_col20 enb1_col20 5

r_d11_col20 d11_col20 0 10000k
r1_d11_col20 d11_col20 d111_col20 5
r_d22_col20 d22_col20 0 10000k
r1_d22_col20 d22_col20 d222_col20 5

r_SL1col20 SL1col20 0 10000k
r1_SL1col20 SL1col20 SL11col20 5
r_SL2col20 SL2col20 0 10000k
r1_SL2col20 SL2col20 SL22col20 5

* col21

mn1col21 d1_col21 en_col21 d11_col21 0 nenh w=4u l=.4u
mn2col21 d2_col21 en_col21 d22_col21 0 nenh w=4u l=.4u
mp1col21 d11_col21 enb_col21 d1_col21 3.63 penh w=8u l=0.4u
mp2col21 d22_col21 enb_col21 d2_col21 3.63 penh w=8u l=0.4u

r_en_col21 en_col21 0 10000k
r1_en_col21 en_col21 en1_col21 5
r_enb_col21 enb_col21 0 10000k
r1_enb_col21 enb_col21 enb1_col21 5

r_d11_col21 d11_col21 0 10000k
r1_d11_col21 d11_col21 d111_col21 5

r_d22_col21 d22_col21 0 10000k
r1_d22_col21 d22_col21 d222_col21 5

r_SL1col21 SL1col21 0 10000k
r1_SL1col21 SL1col21 SL11col21 5
r_SL2col21 SL2col21 0 10000k
r1_SL2col21 SL2col21 SL22col21 5

* col22

mn1col22 d1_col22 en_col22 d11_col22 0 nenh w=4u l=.4u
mn2col22 d2_col22 en_col22 d22_col22 0 nenh w=4u l=.4u
mp1col22 d11_col22 enb_col22 d1_col22 3.63 penh w=8u l=0.4u
mp2col22 d22_col22 enb_col22 d2_col22 3.63 penh w=8u l=0.4u

r_en_col22 en_col22 0 10000k
r1_en_col22 en_col22 en1_col22 5
r_enb_col22 enb_col22 0 10000k
r1_enb_col22 enb_col22 enb1_col22 5

r_d11_col22 d11_col22 0 10000k
r1_d11_col22 d11_col22 d111_col22 5
r_d22_col22 d22_col22 0 10000k
r1_d22_col22 d22_col22 d222_col22 5

r_SL1col22 SL1col22 0 10000k
r1_SL1col22 SL1col22 SL11col22 5
r_SL2col22 SL2col22 0 10000k
r1_SL2col22 SL2col22 SL22col22 5

* col23

mn1col23 d1_col23 en_col23 d11_col23 0 nenh w=4u l=.4u
mn2col23 d2_col23 en_col23 d22_col23 0 nenh w=4u l=.4u
mp1col23 d11_col23 enb_col23 d1_col23 3.63 penh w=8u l=0.4u
mp2col23 d22_col23 enb_col23 d2_col23 3.63 penh w=8u l=0.4u

r_en_col23 en_col23 0 10000k
r1_en_col23 en_col23 en1_col23 5
r_enb_col23 enb_col23 0 10000k
r1_enb_col23 enb_col23 enb1_col23 5

r_d11_col23 d11_col23 0 10000k
r1_d11_col23 d11_col23 d111_col23 5
r_d22_col23 d22_col23 0 10000k
r1_d22_col23 d22_col23 d222_col23 5

r_SL1col23 SL1col23 0 10000k
r1_SL1col23 SL1col23 SL11col23 5
r_SL2col23 SL2col23 0 10000k
r1_SL2col23 SL2col23 SL22col23 5

* col24

mn1col24 d1_col24 en_col24 d11_col24 0 nenh w=4u l=.4u
mn2col24 d2_col24 en_col24 d22_col24 0 nenh w=4u l=.4u
mp1col24 d11_col24 enb_col24 d1_col24 3.63 penh w=8u l=0.4u
mp2col24 d22_col24 enb_col24 d2_col24 3.63 penh w=8u l=0.4u

r_en_col24 en_col24 0 10000k
r1_en_col24 en_col24 en1_col24 5
r_enb_col24 enb_col24 0 10000k

r1_enb_col24 enb_col24 enb1_col24 5

r_d11_col24 d11_col24 0 10000k
r1_d11_col24 d11_col24 d111_col24 5
r_d22_col24 d22_col24 0 10000k
r1_d22_col24 d22_col24 d222_col24 5

r_SL1col24 SL1col24 0 10000k
r1_SL1col24 SL1col24 SL11col24 5
r_SL2col24 SL2col24 0 10000k
r1_SL2col24 SL2col24 SL22col24 5

* col25

mn1col25 d1_col25 en_col25 d11_col25 0 nenh w=4u l=.4u
mn2col25 d2_col25 en_col25 d22_col25 0 nenh w=4u l=.4u
mp1col25 d11_col25 enb_col25 d1_col25 3.63 penh w=8u l=0.4u
mp2col25 d22_col25 enb_col25 d2_col25 3.63 penh w=8u l=0.4u

r_en_col25 en_col25 0 10000k
r1_en_col25 en_col25 en1_col25 5
r_enb_col25 enb_col25 0 10000k
r1_enb_col25 enb_col25 enb1_col25 5

r_d11_col25 d11_col25 0 10000k
r1_d11_col25 d11_col25 d111_col25 5
r_d22_col25 d22_col25 0 10000k
r1_d22_col25 d22_col25 d222_col25 5

r_SL1col25 SL1col25 0 10000k
r1_SL1col25 SL1col25 SL11col25 5
r_SL2col25 SL2col25 0 10000k
r1_SL2col25 SL2col25 SL22col25 5

* col26

mn1col26 d1_col26 en_col26 d11_col26 0 nenh w=4u l=.4u
mn2col26 d2_col26 en_col26 d22_col26 0 nenh w=4u l=.4u
mp1col26 d11_col26 enb_col26 d1_col26 3.63 penh w=8u l=0.4u
mp2col26 d22_col26 enb_col26 d2_col26 3.63 penh w=8u l=0.4u

r_en_col26 en_col26 0 10000k
r1_en_col26 en_col26 en1_col26 5
r_enb_col26 enb_col26 0 10000k
r1_enb_col26 enb_col26 enb1_col26 5

r_d11_col26 d11_col26 0 10000k
r1_d11_col26 d11_col26 d111_col26 5
r_d22_col26 d22_col26 0 10000k
r1_d22_col26 d22_col26 d222_col26 5

r_SL1col26 SL1col26 0 10000k
r1_SL1col26 SL1col26 SL11col26 5
r_SL2col26 SL2col26 0 10000k
r1_SL2col26 SL2col26 SL22col26 5

* col27

mn1col27 d1_col27 en_col27 d11_col27 0 nenh w=4u l=.4u
mn2col27 d2_col27 en_col27 d22_col27 0 nenh w=4u l=.4u
mp1col27 d11_col27 enb_col27 d1_col27 3.63 penh w=8u l=0.4u
mp2col27 d22_col27 enb_col27 d2_col27 3.63 penh w=8u l=0.4u

r_en_col27 en_col27 0 10000k

r1_en_col27 en_col27 en1_col27 5
r_enb_col27 enb_col27 0 10000k
r1_enb_col27 enb_col27 enb1_col27 5

r_d11_col27 d11_col27 0 10000k
r1_d11_col27 d11_col27 d111_col27 5
r_d22_col27 d22_col27 0 10000k
r1_d22_col27 d22_col27 d222_col27 5

r_SL1col27 SL1col27 0 10000k
r1_SL1col27 SL1col27 SL11col27 5
r_SL2col27 SL2col27 0 10000k
r1_SL2col27 SL2col27 SL22col27 5

* col28

mn1col28 d1_col28 en_col28 d11_col28 0 nenh w=4u l=.4u
mn2col28 d2_col28 en_col28 d22_col28 0 nenh w=4u l=.4u
mp1col28 d11_col28 enb_col28 d1_col28 3.63 penh w=8u l=0.4u
mp2col28 d22_col28 enb_col28 d2_col28 3.63 penh w=8u l=0.4u

r_en_col28 en_col28 0 10000k
r1_en_col28 en_col28 en1_col28 5
r_enb_col28 enb_col28 0 10000k
r1_enb_col28 enb_col28 enb1_col28 5

r_d11_col28 d11_col28 0 10000k
r1_d11_col28 d11_col28 d111_col28 5
r_d22_col28 d22_col28 0 10000k
r1_d22_col28 d22_col28 d222_col28 5

r_SL1col28 SL1col28 0 10000k
r1_SL1col28 SL1col28 SL11col28 5
r_SL2col28 SL2col28 0 10000k
r1_SL2col28 SL2col28 SL22col28 5

* col29

mn1col29 d1_col29 en_col29 d11_col29 0 nenh w=4u l=.4u
mn2col29 d2_col29 en_col29 d22_col29 0 nenh w=4u l=.4u
mp1col29 d11_col29 enb_col29 d1_col29 3.63 penh w=8u l=0.4u
mp2col29 d22_col29 enb_col29 d2_col29 3.63 penh w=8u l=0.4u

r_en_col29 en_col29 0 10000k
r1_en_col29 en_col29 en1_col29 5
r_enb_col29 enb_col29 0 10000k
r1_enb_col29 enb_col29 enb1_col29 5

r_d11_col29 d11_col29 0 10000k
r1_d11_col29 d11_col29 d111_col29 5
r_d22_col29 d22_col29 0 10000k
r1_d22_col29 d22_col29 d222_col29 5

r_SL1col29 SL1col29 0 10000k
r1_SL1col29 SL1col29 SL11col29 5
r_SL2col29 SL2col29 0 10000k
r1_SL2col29 SL2col29 SL22col29 5

* col30

mn1col30 d1_col30 en_col30 d11_col30 0 nenh w=4u l=.4u
mn2col30 d2_col30 en_col30 d22_col30 0 nenh w=4u l=.4u
mp1col30 d11_col30 enb_col30 d1_col30 3.63 penh w=8u l=0.4u
mp2col30 d22_col30 enb_col30 d2_col30 3.63 penh w=8u l=0.4u

r_en_col30 en_col30 0 10000k
r1_en_col30 en_col30 en1_col30 5
r_enb_col30 enb_col30 0 10000k
r1_enb_col30 enb_col30 enb1_col30 5

r_d11_col30 d11_col30 0 10000k
r1_d11_col30 d11_col30 d111_col30 5
r_d22_col30 d22_col30 0 10000k
r1_d22_col30 d22_col30 d222_col30 5
r_SL1col30 SL1col30 0 10000k
r1_SL1col30 SL1col30 SL11col30 5
r_SL2col30 SL2col30 0 10000k
r1_SL2col30 SL2col30 SL22col30 5

* col31

mn1col31 d1_col31 en_col31 d11_col31 0 nenh w=4u l=.4u
mn2col31 d2_col31 en_col31 d22_col31 0 nenh w=4u l=.4u
mp1col31 d11_col31 enb_col31 d1_col31 3.63 penh w=8u l=0.4u
mp2col31 d22_col31 enb_col31 d2_col31 3.63 penh w=8u l=0.4u

r_en_col31 en_col31 0 10000k
r1_en_col31 en_col31 en1_col31 5
r_enb_col31 enb_col31 0 10000k
r1_enb_col31 enb_col31 enb1_col31 5

r_d11_col31 d11_col31 0 10000k
r1_d11_col31 d11_col31 d111_col31 5
r_d22_col31 d22_col31 0 10000k
r1_d22_col31 d22_col31 d222_col31 5

r_SL1col31 SL1col31 0 10000k
r1_SL1col31 SL1col31 SL11col31 5
r_SL2col31 SL2col31 0 10000k
r1_SL2col31 SL2col31 SL22col31 5

* col32

mn1col32 d1_col32 en_col32 d11_col32 0 nenh w=4u l=.4u
mn2col32 d2_col32 en_col32 d22_col32 0 nenh w=4u l=.4u
mp1col32 d11_col32 enb_col32 d1_col32 3.63 penh w=8u l=0.4u
mp2col32 d22_col32 enb_col32 d2_col32 3.63 penh w=8u l=0.4u

r_en_col32 en_col32 0 10000k
r1_en_col32 en_col32 en1_col32 5
r_enb_col32 enb_col32 0 10000k
r1_enb_col32 enb_col32 enb1_col32 5

r_d11_col32 d11_col32 0 10000k
r1_d11_col32 d11_col32 d111_col32 5
r_d22_col32 d22_col32 0 10000k
r1_d22_col32 d22_col32 d222_col32 5

r_SL1col32 SL1col32 0 10000k
r1_SL1col32 SL1col32 SL11col32 5
r_SL2col32 SL2col32 0 10000k
r1_SL2col32 SL2col32 SL22col32 5

* col33

mn1col33 d1_col33 en_col33 d11_col33 0 nenh w=4u l=.4u
mn2col33 d2_col33 en_col33 d22_col33 0 nenh w=4u l=.4u

mp1col33 d11_col33 enb_col33 d1_col33 3.63 penh w=8u l=0.4u
mp2col33 d22_col33 enb_col33 d2_col33 3.63 penh w=8u l=0.4u

r_en_col33 en_col33 0 10000k
r1_en_col33 en_col33 en1_col33 5
r_enb_col33 enb_col33 0 10000k
r1_enb_col33 enb_col33 enb1_col33 5

r_d11_col33 d11_col33 0 10000k
r1_d11_col33 d11_col33 d111_col33 5
r_d22_col33 d22_col33 0 10000k
r1_d22_col33 d22_col33 d222_col33 5

r_SL1col33 SL1col33 0 10000k
r1_SL1col33 SL1col33 SL11col33 5
r_SL2col33 SL2col33 0 10000k
r1_SL2col33 SL2col33 SL22col33 5

* col34

mn1col34 d1_col34 en_col34 d11_col34 0 nenh w=4u l=.4u
mn2col34 d2_col34 en_col34 d22_col34 0 nenh w=4u l=.4u
mp1col34 d11_col34 enb_col34 d1_col34 3.63 penh w=8u l=0.4u
mp2col34 d22_col34 enb_col34 d2_col34 3.63 penh w=8u l=0.4u

r_en_col34 en_col34 0 10000k
r1_en_col34 en_col34 en1_col34 5
r_enb_col34 enb_col34 0 10000k
r1_enb_col34 enb_col34 enb1_col34 5

r_d11_col34 d11_col34 0 10000k
r1_d11_col34 d11_col34 d111_col34 5
r_d22_col34 d22_col34 0 10000k
r1_d22_col34 d22_col34 d222_col34 5

r_SL1col34 SL1col34 0 10000k
r1_SL1col34 SL1col34 SL11col34 5
r_SL2col34 SL2col34 0 10000k
r1_SL2col34 SL2col34 SL22col34 5

* col35

mn1col35 d1_col35 en_col35 d11_col35 0 nenh w=4u l=.4u
mn2col35 d2_col35 en_col35 d22_col35 0 nenh w=4u l=.4u
mp1col35 d11_col35 enb_col35 d1_col35 3.63 penh w=8u l=0.4u
mp2col35 d22_col35 enb_col35 d2_col35 3.63 penh w=8u l=0.4u

r_en_col35 en_col35 0 10000k
r1_en_col35 en_col35 en1_col35 5
r_enb_col35 enb_col35 0 10000k
r1_enb_col35 enb_col35 enb1_col35 5

r_d11_col35 d11_col35 0 10000k
r1_d11_col35 d11_col35 d111_col35 5
r_d22_col35 d22_col35 0 10000k
r1_d22_col35 d22_col35 d222_col35 5

r_SL1col35 SL1col35 0 10000k
r1_SL1col35 SL1col35 SL11col35 5
r_SL2col35 SL2col35 0 10000k
r1_SL2col35 SL2col35 SL22col35 5

* col36

mn1col36 d1_col36 en_col36 d11_col36 0 nenh w=4u l=.4u
mn2col36 d2_col36 en_col36 d22_col36 0 nenh w=4u l=.4u
mp1col36 d11_col36 enb_col36 d1_col36 3.63 penh w=8u l=0.4u
mp2col36 d22_col36 enb_col36 d2_col36 3.63 penh w=8u l=0.4u

r_en_col36 en_col36 0 10000k
r1_en_col36 en_col36 en1_col36 5
r_enb_col36 enb_col36 0 10000k
r1_enb_col36 enb_col36 enb1_col36 5

r_d11_col36 d11_col36 0 10000k
r1_d11_col36 d11_col36 d111_col36 5
r_d22_col36 d22_col36 0 10000k
r1_d22_col36 d22_col36 d222_col36 5

r_SL1col36 SL1col36 0 10000k
r1_SL1col36 SL1col36 SL11col36 5
r_SL2col36 SL2col36 0 10000k
r1_SL2col36 SL2col36 SL22col36 5

* col37

mn1col37 d1_col37 en_col37 d11_col37 0 nenh w=4u l=.4u
mn2col37 d2_col37 en_col37 d22_col37 0 nenh w=4u l=.4u
mp1col37 d11_col37 enb_col37 d1_col37 3.63 penh w=8u l=0.4u
mp2col37 d22_col37 enb_col37 d2_col37 3.63 penh w=8u l=0.4u

r_en_col37 en_col37 0 10000k
r1_en_col37 en_col37 en1_col37 5
r_enb_col37 enb_col37 0 10000k
r1_enb_col37 enb_col37 enb1_col37 5

r_d11_col37 d11_col37 0 10000k
r1_d11_col37 d11_col37 d111_col37 5
r_d22_col37 d22_col37 0 10000k
r1_d22_col37 d22_col37 d222_col37 5

r_SL1col37 SL1col37 0 10000k
r1_SL1col37 SL1col37 SL11col37 5
r_SL2col37 SL2col37 0 10000k
r1_SL2col37 SL2col37 SL22col37 5

* col38

mn1col38 d1_col38 en_col38 d11_col38 0 nenh w=4u l=.4u
mn2col38 d2_col38 en_col38 d22_col38 0 nenh w=4u l=.4u
mp1col38 d11_col38 enb_col38 d1_col38 3.63 penh w=8u l=0.4u
mp2col38 d22_col38 enb_col38 d2_col38 3.63 penh w=8u l=0.4u

r_en_col38 en_col38 0 10000k
r1_en_col38 en_col38 en1_col38 5
r_enb_col38 enb_col38 0 10000k
r1_enb_col38 enb_col38 enb1_col38 5

r_d11_col38 d11_col38 0 10000k
r1_d11_col38 d11_col38 d111_col38 5
r_d22_col38 d22_col38 0 10000k
r1_d22_col38 d22_col38 d222_col38 5

r_SL1col38 SL1col38 0 10000k
r1_SL1col38 SL1col38 SL11col38 5
r_SL2col38 SL2col38 0 10000k
r1_SL2col38 SL2col38 SL22col38 5

* col39

mn1col39 d1_col39 en_col39 d11_col39 0 nenh w=4u l=.4u
mn2col39 d2_col39 en_col39 d22_col39 0 nenh w=4u l=.4u
mp1col39 d11_col39 enb_col39 d1_col39 3.63 penh w=8u l=0.4u
mp2col39 d22_col39 enb_col39 d2_col39 3.63 penh w=8u l=0.4u

r_en_col39 en_col39 0 10000k
r1_en_col39 en_col39 en1_col39 5
r_enb_col39 enb_col39 0 10000k
r1_enb_col39 enb_col39 enb1_col39 5

r_d11_col39 d11_col39 0 10000k
r1_d11_col39 d11_col39 d111_col39 5
r_d22_col39 d22_col39 0 10000k
r1_d22_col39 d22_col39 d222_col39 5

r_SL1col39 SL1col39 0 10000k
r1_SL1col39 SL1col39 SL11col39 5
r_SL2col39 SL2col39 0 10000k
r1_SL2col39 SL2col39 SL22col39 5

* col40

mn1col40 d1_col40 en_col40 d11_col40 0 nenh w=4u l=.4u
mn2col40 d2_col40 en_col40 d22_col40 0 nenh w=4u l=.4u
mp1col40 d11_col40 enb_col40 d1_col40 3.63 penh w=8u l=0.4u
mp2col40 d22_col40 enb_col40 d2_col40 3.63 penh w=8u l=0.4u

r_en_col40 en_col40 0 10000k
r1_en_col40 en_col40 en1_col40 5
r_enb_col40 enb_col40 0 10000k
r1_enb_col40 enb_col40 enb1_col40 5

r_d11_col40 d11_col40 0 10000k
r1_d11_col40 d11_col40 d111_col40 5
r_d22_col40 d22_col40 0 10000k
r1_d22_col40 d22_col40 d222_col40 5

r_SL1col40 SL1col40 0 10000k
r1_SL1col40 SL1col40 SL11col40 5
r_SL2col40 SL2col40 0 10000k
r1_SL2col40 SL2col40 SL22col40 5

* col41

mn1col41 d1_col41 en_col41 d11_col41 0 nenh w=4u l=.4u
mn2col41 d2_col41 en_col41 d22_col41 0 nenh w=4u l=.4u
mp1col41 d11_col41 enb_col41 d1_col41 3.63 penh w=8u l=0.4u
mp2col41 d22_col41 enb_col41 d2_col41 3.63 penh w=8u l=0.4u

r_en_col41 en_col41 0 10000k
r1_en_col41 en_col41 en1_col41 5
r_enb_col41 enb_col41 0 10000k
r1_enb_col41 enb_col41 enb1_col41 5

r_d11_col41 d11_col41 0 10000k
r1_d11_col41 d11_col41 d111_col41 5
r_d22_col41 d22_col41 0 10000k
r1_d22_col41 d22_col41 d222_col41 5

r_SL1col41 SL1col41 0 10000k
r1_SL1col41 SL1col41 SL11col41 5
r_SL2col41 SL2col41 0 10000k
r1_SL2col41 SL2col41 SL22col41 5

* col42

mn1col42 d1_col42 en_col42 d11_col42 0 nenh w=4u l=.4u
mn2col42 d2_col42 en_col42 d22_col42 0 nenh w=4u l=.4u
mp1col42 d11_col42 enb_col42 d1_col42 3.63 penh w=8u l=0.4u
mp2col42 d22_col42 enb_col42 d2_col42 3.63 penh w=8u l=0.4u

r_en_col42 en_col42 0 10000k
r1_en_col42 en_col42 en1_col42 5
r_enb_col42 enb_col42 0 10000k
r1_enb_col42 enb_col42 enb1_col42 5

r_d11_col42 d11_col42 0 10000k
r1_d11_col42 d11_col42 d111_col42 5
r_d22_col42 d22_col42 0 10000k
r1_d22_col42 d22_col42 d222_col42 5

r_SL1col42 SL1col42 0 10000k
r1_SL1col42 SL1col42 SL11col42 5
r_SL2col42 SL2col42 0 10000k
r1_SL2col42 SL2col42 SL22col42 5

* col43

mn1col43 d1_col43 en_col43 d11_col43 0 nenh w=4u l=.4u
mn2col43 d2_col43 en_col43 d22_col43 0 nenh w=4u l=.4u
mp1col43 d11_col43 enb_col43 d1_col43 3.63 penh w=8u l=0.4u
mp2col43 d22_col43 enb_col43 d2_col43 3.63 penh w=8u l=0.4u

r_en_col43 en_col43 0 10000k
r1_en_col43 en_col43 en1_col43 5
r_enb_col43 enb_col43 0 10000k
r1_enb_col43 enb_col43 enb1_col43 5

r_d11_col43 d11_col43 0 10000k
r1_d11_col43 d11_col43 d111_col43 5
r_d22_col43 d22_col43 0 10000k
r1_d22_col43 d22_col43 d222_col43 5

r_SL1col43 SL1col43 0 10000k
r1_SL1col43 SL1col43 SL11col43 5
r_SL2col43 SL2col43 0 10000k
r1_SL2col43 SL2col43 SL22col43 5

* col44

mn1col44 d1_col44 en_col44 d11_col44 0 nenh w=4u l=.4u
mn2col44 d2_col44 en_col44 d22_col44 0 nenh w=4u l=.4u
mp1col44 d11_col44 enb_col44 d1_col44 3.63 penh w=8u l=0.4u
mp2col44 d22_col44 enb_col44 d2_col44 3.63 penh w=8u l=0.4u

r_en_col44 en_col44 0 10000k
r1_en_col44 en_col44 en1_col44 5
r_enb_col44 enb_col44 0 10000k
r1_enb_col44 enb_col44 enb1_col44 5

r_d11_col44 d11_col44 0 10000k
r1_d11_col44 d11_col44 d111_col44 5
r_d22_col44 d22_col44 0 10000k
r1_d22_col44 d22_col44 d222_col44 5

r_SL1col44 SL1col44 0 10000k
r1_SL1col44 SL1col44 SL11col44 5
r_SL2col44 SL2col44 0 10000k

r1_SL2col44 SL2col44 SL22col44 5

* col45

mn1col45 d1_col45 en_col45 d11_col45 0 nenh w=4u l=.4u
mn2col45 d2_col45 en_col45 d22_col45 0 nenh w=4u l=.4u
mp1col45 d11_col45 enb_col45 d1_col45 3.63 penh w=8u l=0.4u
mp2col45 d22_col45 enb_col45 d2_col45 3.63 penh w=8u l=0.4u
r_en_col45 en_col45 0 10000k
r1_en_col45 en_col45 en1_col45 5
r_enb_col45 enb_col45 0 10000k
r1_enb_col45 enb_col45 enb1_col45 5

r_d11_col45 d11_col45 0 10000k
r1_d11_col45 d11_col45 d111_col45 5
r_d22_col45 d22_col45 0 10000k
r1_d22_col45 d22_col45 d222_col45 5

r_SL1col45 SL1col45 0 10000k
r1_SL1col45 SL1col45 SL11col45 5
r_SL2col45 SL2col45 0 10000k
r1_SL2col45 SL2col45 SL22col45 5

* col46

mn1col46 d1_col46 en_col46 d11_col46 0 nenh w=4u l=.4u
mn2col46 d2_col46 en_col46 d22_col46 0 nenh w=4u l=.4u
mp1col46 d11_col46 enb_col46 d1_col46 3.63 penh w=8u l=0.4u
mp2col46 d22_col46 enb_col46 d2_col46 3.63 penh w=8u l=0.4u

r_en_col46 en_col46 0 10000k
r1_en_col46 en_col46 en1_col46 5
r_enb_col46 enb_col46 0 10000k
r1_enb_col46 enb_col46 enb1_col46 5

r_d11_col46 d11_col46 0 10000k
r1_d11_col46 d11_col46 d111_col46 5
r_d22_col46 d22_col46 0 10000k
r1_d22_col46 d22_col46 d222_col46 5

r_SL1col46 SL1col46 0 10000k
r1_SL1col46 SL1col46 SL11col46 5
r_SL2col46 SL2col46 0 10000k
r1_SL2col46 SL2col46 SL22col46 5

* col47

mn1col47 d1_col47 en_col47 d11_col47 0 nenh w=4u l=.4u
mn2col47 d2_col47 en_col47 d22_col47 0 nenh w=4u l=.4u
mp1col47 d11_col47 enb_col47 d1_col47 3.63 penh w=8u l=0.4u
mp2col47 d22_col47 enb_col47 d2_col47 3.63 penh w=8u l=0.4u

r_en_col47 en_col47 0 10000k
r1_en_col47 en_col47 en1_col47 5
r_enb_col47 enb_col47 0 10000k
r1_enb_col47 enb_col47 enb1_col47 5

r_d11_col47 d11_col47 0 10000k
r1_d11_col47 d11_col47 d111_col47 5
r_d22_col47 d22_col47 0 10000k
r1_d22_col47 d22_col47 d222_col47 5

r_SL1col47 SL1col47 0 10000k
r1_SL1col47 SL1col47 SL11col47 5

r_SL2col47 SL2col47 0 10000k
r1_SL2col47 SL2col47 SL22col47 5

* col48

mn1col48 d1_col48 en_col48 d11_col48 0 nenh w=4u l=.4u
mn2col48 d2_col48 en_col48 d22_col48 0 nenh w=4u l=.4u
mp1col48 d11_col48 enb_col48 d1_col48 3.63 penh w=8u l=0.4u
mp2col48 d22_col48 enb_col48 d2_col48 3.63 penh w=8u l=0.4u

r_en_col48 en_col48 0 10000k
r1_en_col48 en_col48 en1_col48 5
r_enb_col48 enb_col48 0 10000k
r1_enb_col48 enb_col48 enb1_col48 5

r_d11_col48 d11_col48 0 10000k
r1_d11_col48 d11_col48 d111_col48 5
r_d22_col48 d22_col48 0 10000k
r1_d22_col48 d22_col48 d222_col48 5

r_SL1col48 SL1col48 0 10000k
r1_SL1col48 SL1col48 SL11col48 5
r_SL2col48 SL2col48 0 10000k
r1_SL2col48 SL2col48 SL22col48 5

* col49

mn1col49 d1_col49 en_col49 d11_col49 0 nenh w=4u l=.4u
mn2col49 d2_col49 en_col49 d22_col49 0 nenh w=4u l=.4u
mp1col49 d11_col49 enb_col49 d1_col49 3.63 penh w=8u l=0.4u
mp2col49 d22_col49 enb_col49 d2_col49 3.63 penh w=8u l=0.4u

r_en_col49 en_col49 0 10000k
r1_en_col49 en_col49 en1_col49 5
r_enb_col49 enb_col49 0 10000k
r1_enb_col49 enb_col49 enb1_col49 5

r_d11_col49 d11_col49 0 10000k
r1_d11_col49 d11_col49 d111_col49 5
r_d22_col49 d22_col49 0 10000k
r1_d22_col49 d22_col49 d222_col49 5

r_SL1col49 SL1col49 0 10000k
r1_SL1col49 SL1col49 SL11col49 5
r_SL2col49 SL2col49 0 10000k
r1_SL2col49 SL2col49 SL22col49 5

* col50

mn1col50 d1_col50 en_col50 d11_col50 0 nenh w=4u l=.4u
mn2col50 d2_col50 en_col50 d22_col50 0 nenh w=4u l=.4u
mp1col50 d11_col50 enb_col50 d1_col50 3.63 penh w=8u l=0.4u
mp2col50 d22_col50 enb_col50 d2_col50 3.63 penh w=8u l=0.4u

r_en_col50 en_col50 0 10000k
r1_en_col50 en_col50 en1_col50 5
r_enb_col50 enb_col50 0 10000k
r1_enb_col50 enb_col50 enb1_col50 5

r_d11_col50 d11_col50 0 10000k
r1_d11_col50 d11_col50 d111_col50 5
r_d22_col50 d22_col50 0 10000k
r1_d22_col50 d22_col50 d222_col50 5

r_SL1col50 SL1col50 0 10000k
r1_SL1col50 SL1col50 SL11col50 5
r_SL2col50 SL2col50 0 10000k
r1_SL2col50 SL2col50 SL22col50 5

* col51

mn1col51 d1_col51 en_col51 d11_col51 0 nenh w=4u l=.4u
mn2col51 d2_col51 en_col51 d22_col51 0 nenh w=4u l=.4u
mp1col51 d11_col51 enb_col51 d1_col51 3.63 penh w=8u l=0.4u
mp2col51 d22_col51 enb_col51 d2_col51 3.63 penh w=8u l=0.4u

r_en_col51 en_col51 0 10000k
r1_en_col51 en_col51 en1_col51 5
r_enb_col51 enb_col51 0 10000k
r1_enb_col51 enb_col51 enb1_col51 5

r_d11_col51 d11_col51 0 10000k
r1_d11_col51 d11_col51 d111_col51 5
r_d22_col51 d22_col51 0 10000k
r1_d22_col51 d22_col51 d222_col51 5

r_SL1col51 SL1col51 0 10000k
r1_SL1col51 SL1col51 SL11col51 5
r_SL2col51 SL2col51 0 10000k
r1_SL2col51 SL2col51 SL22col51 5

* col52

mn1col52 d1_col52 en_col52 d11_col52 0 nenh w=4u l=.4u
mn2col52 d2_col52 en_col52 d22_col52 0 nenh w=4u l=.4u
mp1col52 d11_col52 enb_col52 d1_col52 3.63 penh w=8u l=0.4u
mp2col52 d22_col52 enb_col52 d2_col52 3.63 penh w=8u l=0.4u

r_en_col52 en_col52 0 10000k
r1_en_col52 en_col52 en1_col52 5
r_enb_col52 enb_col52 0 10000k
r1_enb_col52 enb_col52 enb1_col52 5

r_d11_col52 d11_col52 0 10000k
r1_d11_col52 d11_col52 d111_col52 5
r_d22_col52 d22_col52 0 10000k
r1_d22_col52 d22_col52 d222_col52 5

r_SL1col52 SL1col52 0 10000k
r1_SL1col52 SL1col52 SL11col52 5
r_SL2col52 SL2col52 0 10000k
r1_SL2col52 SL2col52 SL22col52 5

* col53

mn1col53 d1_col53 en_col53 d11_col53 0 nenh w=4u l=.4u
mn2col53 d2_col53 en_col53 d22_col53 0 nenh w=4u l=.4u
mp1col53 d11_col53 enb_col53 d1_col53 3.63 penh w=8u l=0.4u
mp2col53 d22_col53 enb_col53 d2_col53 3.63 penh w=8u l=0.4u

r_en_col53 en_col53 0 10000k
r1_en_col53 en_col53 en1_col53 5
r_enb_col53 enb_col53 0 10000k
r1_enb_col53 enb_col53 enb1_col53 5

r_d11_col53 d11_col53 0 10000k
r1_d11_col53 d11_col53 d111_col53 5
r_d22_col53 d22_col53 0 10000k

r1_d22_col53 d22_col53 d222_col53 5

r_SL1col53 SL1col53 0 10000k
r1_SL1col53 SL1col53 SL11col53 5
r_SL2col53 SL2col53 0 10000k
r1_SL2col53 SL2col53 SL22col53 5

* col54

mn1col54 d1_col54 en_col54 d11_col54 0 nenh w=4u l=.4u
mn2col54 d2_col54 en_col54 d22_col54 0 nenh w=4u l=.4u
mp1col54 d11_col54 enb_col54 d1_col54 3.63 penh w=8u l=0.4u
mp2col54 d22_col54 enb_col54 d2_col54 3.63 penh w=8u l=0.4u

r_en_col54 en_col54 0 10000k
r1_en_col54 en_col54 en1_col54 5
r_enb_col54 enb_col54 0 10000k
r1_enb_col54 enb_col54 enb1_col54 5

r_d11_col54 d11_col54 0 10000k
r1_d11_col54 d11_col54 d111_col54 5
r_d22_col54 d22_col54 0 10000k
r1_d22_col54 d22_col54 d222_col54 5

r_SL1col54 SL1col54 0 10000k
r1_SL1col54 SL1col54 SL11col54 5
r_SL2col54 SL2col54 0 10000k
r1_SL2col54 SL2col54 SL22col54 5

* col55

mn1col55 d1_col55 en_col55 d11_col55 0 nenh w=4u l=.4u
mn2col55 d2_col55 en_col55 d22_col55 0 nenh w=4u l=.4u
mp1col55 d11_col55 enb_col55 d1_col55 3.63 penh w=8u l=0.4u
mp2col55 d22_col55 enb_col55 d2_col55 3.63 penh w=8u l=0.4u

r_en_col55 en_col55 0 10000k
r1_en_col55 en_col55 en1_col55 5
r_enb_col55 enb_col55 0 10000k
r1_enb_col55 enb_col55 enb1_col55 5

r_d11_col55 d11_col55 0 10000k
r1_d11_col55 d11_col55 d111_col55 5
r_d22_col55 d22_col55 0 10000k
r1_d22_col55 d22_col55 d222_col55 5

r_SL1col55 SL1col55 0 10000k
r1_SL1col55 SL1col55 SL11col55 5
r_SL2col55 SL2col55 0 10000k
r1_SL2col55 SL2col55 SL22col55 5

* col56

mn1col56 d1_col56 en_col56 d11_col56 0 nenh w=4u l=.4u
mn2col56 d2_col56 en_col56 d22_col56 0 nenh w=4u l=.4u
mp1col56 d11_col56 enb_col56 d1_col56 3.63 penh w=8u l=0.4u
mp2col56 d22_col56 enb_col56 d2_col56 3.63 penh w=8u l=0.4u

r_en_col56 en_col56 0 10000k
r1_en_col56 en_col56 en1_col56 5
r_enb_col56 enb_col56 0 10000k
r1_enb_col56 enb_col56 enb1_col56 5

r_d11_col56 d11_col56 0 10000k

r1_d11_col56 d11_col56 d111_col56 5
r_d22_col56 d22_col56 0 10000k
r1_d22_col56 d22_col56 d222_col56 5

r_SL1col56 SL1col56 0 10000k
r1_SL1col56 SL1col56 SL11col56 5
r_SL2col56 SL2col56 0 10000k
r1_SL2col56 SL2col56 SL22col56 5

* col57

mn1col57 d1_col57 en_col57 d11_col57 0 nenh w=4u l=.4u
mn2col57 d2_col57 en_col57 d22_col57 0 nenh w=4u l=.4u
mp1col57 d11_col57 enb_col57 d1_col57 3.63 penh w=8u l=0.4u
mp2col57 d22_col57 enb_col57 d2_col57 3.63 penh w=8u l=0.4u

r_en_col57 en_col57 0 10000k
r1_en_col57 en_col57 en1_col57 5
r_enb_col57 enb_col57 0 10000k
r1_enb_col57 enb_col57 enb1_col57 5

r_d11_col57 d11_col57 0 10000k
r1_d11_col57 d11_col57 d111_col57 5
r_d22_col57 d22_col57 0 10000k
r1_d22_col57 d22_col57 d222_col57 5

r_SL1col57 SL1col57 0 10000k
r1_SL1col57 SL1col57 SL11col57 5
r_SL2col57 SL2col57 0 10000k
r1_SL2col57 SL2col57 SL22col57 5

* col58

mn1col58 d1_col58 en_col58 d11_col58 0 nenh w=4u l=.4u
mn2col58 d2_col58 en_col58 d22_col58 0 nenh w=4u l=.4u
mp1col58 d11_col58 enb_col58 d1_col58 3.63 penh w=8u l=0.4u
mp2col58 d22_col58 enb_col58 d2_col58 3.63 penh w=8u l=0.4u

r_en_col58 en_col58 0 10000k
r1_en_col58 en_col58 en1_col58 5
r_enb_col58 enb_col58 0 10000k
r1_enb_col58 enb_col58 enb1_col58 5

r_d11_col58 d11_col58 0 10000k
r1_d11_col58 d11_col58 d111_col58 5
r_d22_col58 d22_col58 0 10000k
r1_d22_col58 d22_col58 d222_col58 5

r_SL1col58 SL1col58 0 10000k
r1_SL1col58 SL1col58 SL11col58 5
r_SL2col58 SL2col58 0 10000k
r1_SL2col58 SL2col58 SL22col58 5

* col59

mn1col59 d1_col59 en_col59 d11_col59 0 nenh w=4u l=.4u
mn2col59 d2_col59 en_col59 d22_col59 0 nenh w=4u l=.4u
mp1col59 d11_col59 enb_col59 d1_col59 3.63 penh w=8u l=0.4u
mp2col59 d22_col59 enb_col59 d2_col59 3.63 penh w=8u l=0.4u

r_en_col59 en_col59 0 10000k
r1_en_col59 en_col59 en1_col59 5
r_enb_col59 enb_col59 0 10000k
r1_enb_col59 enb_col59 enb1_col59 5

r_d11_col59 d11_col59 0 10000k
r1_d11_col59 d11_col59 d111_col59 5
r_d22_col59 d22_col59 0 10000k
r1_d22_col59 d22_col59 d222_col59 5

r_SL1col59 SL1col59 0 10000k
r1_SL1col59 SL1col59 SL11col59 5
r_SL2col59 SL2col59 0 10000k
r1_SL2col59 SL2col59 SL22col59 5

* col60

mn1col60 d1_col60 en_col60 d11_col60 0 nenh w=4u l=.4u
mn2col60 d2_col60 en_col60 d22_col60 0 nenh w=4u l=.4u
mp1col60 d11_col60 enb_col60 d1_col60 3.63 penh w=8u l=0.4u
mp2col60 d22_col60 enb_col60 d2_col60 3.63 penh w=8u l=0.4u

r_en_col60 en_col60 0 10000k
r1_en_col60 en_col60 en1_col60 5
r_enb_col60 enb_col60 0 10000k
r1_enb_col60 enb_col60 enb1_col60 5

r_d11_col60 d11_col60 0 10000k
r1_d11_col60 d11_col60 d111_col60 5
r_d22_col60 d22_col60 0 10000k
r1_d22_col60 d22_col60 d222_col60 5

r_SL1col60 SL1col60 0 10000k
r1_SL1col60 SL1col60 SL11col60 5
r_SL2col60 SL2col60 0 10000k
r1_SL2col60 SL2col60 SL22col60 5

* col61

mn1col61 d1_col61 en_col61 d11_col61 0 nenh w=4u l=.4u
mn2col61 d2_col61 en_col61 d22_col61 0 nenh w=4u l=.4u
mp1col61 d11_col61 enb_col61 d1_col61 3.63 penh w=8u l=0.4u
mp2col61 d22_col61 enb_col61 d2_col61 3.63 penh w=8u l=0.4u

r_en_col61 en_col61 0 10000k
r1_en_col61 en_col61 en1_col61 5
r_enb_col61 enb_col61 0 10000k
r1_enb_col61 enb_col61 enb1_col61 5

r_d11_col61 d11_col61 0 10000k
r1_d11_col61 d11_col61 d111_col61 5
r_d22_col61 d22_col61 0 10000k
r1_d22_col61 d22_col61 d222_col61 5

r_SL1col61 SL1col61 0 10000k
r1_SL1col61 SL1col61 SL11col61 5
r_SL2col61 SL2col61 0 10000k
r1_SL2col61 SL2col61 SL22col61 5

* col62

mn1col62 d1_col62 en_col62 d11_col62 0 nenh w=4u l=.4u
mn2col62 d2_col62 en_col62 d22_col62 0 nenh w=4u l=.4u
mp1col62 d11_col62 enb_col62 d1_col62 3.63 penh w=8u l=0.4u
mp2col62 d22_col62 enb_col62 d2_col62 3.63 penh w=8u l=0.4u

r_en_col62 en_col62 0 10000k
r1_en_col62 en_col62 en1_col62 5

v_en_col2 en1_col2 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col2 enb1_col2 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col3 en1_col3 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col3 enb1_col3 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col4 en1_col4 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col4 enb1_col4 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col5 en1_col5 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col5 enb1_col5 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col6 en1_col6 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col6 enb1_col6 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col7 en1_col7 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col7 enb1_col7 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col8 en1_col8 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col8 enb1_col8 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col9 en1_col9 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col9 enb1_col9 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col10 en1_col10 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col10 enb1_col10 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col11 en1_col11 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col11 enb1_col11 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col12 en1_col12 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col12 enb1_col12 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col13 en1_col13 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col13 enb1_col13 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col14 en1_col14 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col14 enb1_col14 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col15 en1_col15 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col15 enb1_col15 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col16 en1_col16 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col16 enb1_col16 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col17 en1_col17 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col17 enb1_col17 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col18 en1_col18 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col18 enb1_col18 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col19 en1_col19 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col19 enb1_col19 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col20 en1_col20 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col20 enb1_col20 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col21 en1_col21 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col21 enb1_col21 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col22 en1_col22 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col22 enb1_col22 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col23 en1_col23 0 pulse(0 3.63 1n 1p 1p 2n 20n)

v_enb_col23 enb1_col23 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col24 en1_col24 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col24 enb1_col24 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col25 en1_col25 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col25 enb1_col25 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col26 en1_col26 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col26 enb1_col26 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col27 en1_col27 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col27 enb1_col27 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col28 en1_col28 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col28 enb1_col28 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col29 en1_col29 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col29 enb1_col29 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col30 en1_col30 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col30 enb1_col30 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col31 en1_col31 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col31 enb1_col31 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col32 en1_col32 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col32 enb1_col32 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col33 en1_col33 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col33 enb1_col33 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col34 en1_col34 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col34 enb1_col34 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col35 en1_col35 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col35 enb1_col35 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col36 en1_col36 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col36 enb1_col36 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col37 en1_col37 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col37 enb1_col37 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col38 en1_col38 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col38 enb1_col38 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col39 en1_col39 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col39 enb1_col39 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col40 en1_col40 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col40 enb1_col40 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col41 en1_col41 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col41 enb1_col41 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col42 en1_col42 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col42 enb1_col42 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col43 en1_col43 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col43 enb1_col43 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col44 en1_col44 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col44 enb1_col44 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col45 en1_col45 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col45 enb1_col45 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col46 en1_col46 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col46 enb1_col46 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col47 en1_col47 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col47 enb1_col47 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col48 en1_col48 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col48 enb1_col48 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col49 en1_col49 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col49 enb1_col49 0 pulse(3.63 0 1n 1p 1p 2n 20n)
v_en_col50 en1_col50 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col50 enb1_col50 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col51 en1_col51 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col51 enb1_col51 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col52 en1_col52 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col52 enb1_col52 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col53 en1_col53 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col53 enb1_col53 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col54 en1_col54 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col54 enb1_col54 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col55 en1_col55 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col55 enb1_col55 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col56 en1_col56 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col56 enb1_col56 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col57 en1_col57 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col57 enb1_col57 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col58 en1_col58 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col58 enb1_col58 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col59 en1_col59 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col59 enb1_col59 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col60 en1_col60 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col60 enb1_col60 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col61 en1_col61 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col61 enb1_col61 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col62 en1_col62 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col62 enb1_col62 0 pulse(3.63 0 1n 1p 1p 2n 20n)

v_en_col63 en1_col63 0 pulse(0 3.63 1n 1p 1p 2n 20n)
v_enb_col63 enb1_col63 0 pulse(3.63 0 1n 1p 1p 2n 20n)

* data lines *

v_d1col0 d111_col0 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)

v_d2col0 d222_col0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82n 3.63 82.5n 0 83n 0)
v_d1col1 d111_col1 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82n 3.63 82.5n 0 83n 0)
v_d2col1 d222_col1 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)

v_d1col2 d111_col2 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82n 3.63 82.5n 0 83n 0)
v_d2col2 d222_col2 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)

v_d1col3 d111_col3 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)
v_d2col3 d222_col3 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82.0n 3.63 82.5n 0 83n 0)

v_d1col4 d111_col4 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82n 3.63 82.5n 0 83n 0)
v_d2col4 d222_col4 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)

v_d1col5 d111_col5 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82.0n 3.63 82.5n 0 83n 0)
v_d2col5 d222_col5 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)

v_d1col6 d111_col6 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)
v_d2col6 d222_col6 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82.0n 3.63 82.5n 0 83n 0)

v_d1col7 d111_col7 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0
+43n 0 61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)
v_d2col7 d222_col7 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82n 3.63 82.5n 0 83n 0)
*^^^ 1st cycle = mismatch (1 bit mismatch at row=0 col=7) 2nd cycle = full match

v_d1col8 d111_col8 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)
v_d2col8 d222_col8 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0

v_d1col57 d111_col57 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)
v_d2col57 d222_col57 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82n 3.63 82.5n 0 83n 0)

v_d1col58 d111_col58 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)
v_d2col58 d222_col58 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82n 3.63 82.5n 0 83n 0)

v_d1col59 d111_col59 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82n 3.63 82.5n 0 83n 0)
v_d2col59 d222_col59 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)

v_d1col60 d111_col60 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)
v_d2col60 d222_col60 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82n 3.63 82.5n 0 83n 0)

v_d1col61 d111_col61 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82n 3.63 82.5n 0 83n 0)
v_d2col61 d222_col61 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)

v_d1col62 d111_col62 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82n 3.63 82.5n 0 83n 0)
v_d2col62 d222_col62 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)

v_d1col63 d111_col63 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22n 3.63 22.5n 0 23n 0
+41n 0 41.5n 3.63 42.5n 3.63 43n 0
+61n 0 61.5n 3.63 62n 3.63 62.5n 0 63n 0 81n 0 81.5n 3.63 82.5n 3.63 83n 0)
v_d2col63 d222_col63 0 pwl(0 0 1n 0 1.5n 3.63 2.5n 3.63 3n 0 21n 0 21.5n 3.63 22.5n 3.63 23n 0
+41n 0 41.5n 3.63 42n 3.63 42.5n 0 43n 0
+61n 0 61.5n 3.63 62.5n 3.63 63n 0 81n 0 81.5n 3.63 82n 3.63 82.5n 0 83n 0)

* search lines *

v_SL1_col0 SL11col0 0 pwl(0 0 47n 0 47.02n 3.63 50.0n 3.63 50.02n 0 87n 0 87.02n 3.63 90.0n 3.63 90.02n 0)

v_SL2_col0 SL22col0 0 pwl(0 0 27n 0 27.02n 3.63 30.0n 3.63 30.02n 0 67n 0 67.02n 3.63 70.0n 3.63 70.02n 0)

v_SL1_col1 SL11col1 0 pwl(0 0 27n 0 27.02n 3.63 30.0n 3.63 30.02n 0 67n 0 67.02n 3.63 70.0n 3.63 70.02n 0)
v_SL2_col1 SL22col1 0 pwl(0 0 47n 0 47.02n 3.63 50.0n 3.63 50.02n 0 87n 0 87.02n 3.63 90.0n 3.63 90.02n 0)

v_SL1_col2 SL11col2 0 pwl(0 0 27n 0 27.02n 3.63 30.0n 3.63 30.02n 0 67n 0 67.02n 3.63 70.0n 3.63 70.02n 0)
v_SL2_col2 SL22col2 0 pwl(0 0 47n 0 47.02n 3.63 50.0n 3.63 50.02n 0 87n 0 87.02n 3.63 90.0n 3.63 90.02n 0)

v_SL1_col3 SL11col3 0 pwl(0 0 47n 0 47.02n 3.63 50.0n 3.63 50.02n 0 87n 0 87.02n 3.63 90.0n 3.63 90.02n 0)
v_SL2_col3 SL22col3 0 pwl(0 0 27n 0 27.02n 3.63 30.0n 3.63 30.02n 0 67n 0 67.02n 3.63 70.0n 3.63 70.02n 0)

v_SL1_col4 SL11col4 0 pwl(0 0 27n 0 27.02n 3.63 30.0n 3.63 30.02n 0 67n 0 67.02n 3.63 70.0n 3.63 70.02n 0)
v_SL2_col4 SL22col4 0 pwl(0 0 47n 0 47.02n 3.63 50.0n 3.63 50.02n 0 87n 0 87.02n 3.63 90.0n 3.63 90.02n 0)

v_SL1_col5 SL11col5 0 pwl(0 0 27n 0 27.02n 3.63 30.0n 3.63 30.02n 0 67n 0 67.02n 3.63 70.0n 3.63 70.02n 0)
v_SL2_col5 SL22col5 0 pwl(0 0 47n 0 47.02n 3.63 50.0n 3.63 50.02n 0 87n 0 87.02n 3.63 90.0n 3.63 90.02n 0)

v_SL1_col6 SL11col6 0 pwl(0 0 47n 0 47.02n 3.63 50.0n 3.63 50.02n 0 87n 0 87.02n 3.63 90.0n 3.63 90.02n 0)
v_SL2_col6 SL22col6 0 pwl(0 0 27n 0 27.02n 3.63 30.0n 3.63 30.02n 0 67n 0 67.02n 3.63 70.0n 3.63 70.02n 0)

v_SL1_col7 SL11col7 0 pwl(0 0 7n 0 7.02n 3.63 8.5n 3.63 8.52n 0 47n 0 47.02n 3.63 50.0n 3.63 50.02n 0
+107n 0 107.02n 3.63 108.5n 3.63 108.52n 0)
v_SL2_col7 SL22col7 0 pwl(0 0 27n 0 27.02n 3.63 30.0n 3.63 30.02n 0 87n 0 87.02n 3.63 90.0n 3.63 90.02n 0)
*^^^ 1st cycle = mismatch (1 bit mismatch at row=0 col=7) 2nd cycle = full match

v_SL1_col8 SL11col8 0 pwl(0 0 47n 0 47.02n 3.63 50.0n 3.63 50.02n 0 87n 0 87.02n 3.63 90.0n 3.63 90.02n 0)
v_SL2_col8 SL22col8 0 pwl(0 0 27n 0 27.02n 3.63 30.0n 3.63 30.02n 0 67n 0 67.02n 3.63 70.0n 3.63 70.02n 0)

v_SL1_col9 SL11col9 0 pwl(0 0 27n 0 27.02n 3.63 30.0n 3.63 30.02n 0 67n 0 67.02n 3.63 70.0n 3.63 70.02n 0)
v_SL2_col9 SL22col9 0 pwl(0 0 47n 0 47.02n 3.63 50.0n 3.63 50.02n 0 87n 0 87.02n 3.63 90.0n 3.63 90.02n 0)

v_SL1_col10 SL11col10 0 pwl(0 0 27n 0 27.02n 3.63 30.0n 3.63 30.02n 0 67n 0 67.02n 3.63 70.0n 3.63 70.02n 0)
v_SL2_col10 SL22col10 0 pwl(0 0 47n 0 47.02n 3.63 50.0n 3.63 50.02n 0 87n 0 87.02n 3.63 90.0n 3.63 90.02n 0)

v_SL1_col11 SL11col11 0 pwl(0 0 47n 0 47.02n 3.63 50.0n 3.63 50.02n 0 87n 0 87.02n 3.63 90.0n 3.63 90.02n 0)
v_SL2_col11 SL22col11 0 pwl(0 0 27n 0 27.02n 3.63 30.0n 3.63 30.02n 0 67n 0 67.02n 3.63 70.0n 3.63 70.02n 0)

v_SL1_col12 SL11col12 0 pwl(0 0 47n 0 47.02n 3.63 50.0n 3.63 50.02n 0 87n 0 87.02n 3.63 90.0n 3.63 90.02n 0)
v_SL2_col12 SL22col12 0 pwl(0 0 27n 0 27.02n 3.63 30.0n 3.63 30.02n 0 67n 0 67.02n 3.63 70.0n 3.63 70.02n 0)

v_SL1_col13 SL11col13 0 pwl(0 0 47n 0 47.02n 3.63 50.0n 3.63 50.02n 0 87n 0 87.02n 3.63 90.0n 3.63 90.02n 0)
v_SL2_col13 SL22col13 0 pwl(0 0 27n 0 27.02n 3.63 30.0n 3.63 30.02n 0 67n 0 67.02n 3.63 70.0n 3.63 70.02n 0)

v_SL1_col14 SL11col14 0 pwl(0 0 27n 0 27.02n 3.63 30.0n 3.63 30.02n 0 67n 0 67.02n 3.63 70.0n 3.63 70.02n 0)
v_SL2_col14 SL22col14 0 pwl(0 0 47n 0 47.02n 3.63 50.0n 3.63 50.02n 0 87n 0 87.02n 3.63 90.0n 3.63 90.02n 0)

v_SL1_col15 SL11col15 0 pwl(0 0 27n 0 27.02n 3.63 30.0n 3.63 30.02n 0 67n 0 67.02n 3.63 70.0n 3.63 70.02n 0)
v_SL2_col15 SL22col15 0 pwl(0 0 47n 0 47.02n 3.63 50.0n 3.63 50.02n 0 87n 0 87.02n 3.63 90.0n 3.63 90.02n 0)

v_SL1_col16 SL11col16 0 pwl(0 0 47n 0 47.02n 3.63 50.0n 3.63 50.02n 0 87n 0 87.02n 3.63 90.0n 3.63 90.02n 0)
v_SL2_col16 SL22col16 0 pwl(0 0 27n 0 27.02n 3.63 30.0n 3.63 30.02n 0 67n 0 67.02n 3.63 70.0n 3.63 70.02n 0)

v_SL1_col17 SL11col17 0 pwl(0 0 47n 0 47.02n 3.63 50.0n 3.63 50.02n 0 87n 0 87.02n 3.63 90.0n 3.63 90.02n 0)
v_SL2_col17 SL22col17 0 pwl(0 0 27n 0 27.02n 3.63 30.0n 3.63 30.02n 0 67n 0 67.02n 3.63 70.0n 3.63 70.02n 0)

v_SL1_col18 SL11col18 0 pwl(0 0 47n 0 47.02n 3.63 50.0n 3.63 50.02n 0 87n 0 87.02n 3.63 90.0n 3.63 90.02n 0)
v_SL2_col18 SL22col18 0 pwl(0 0 27n 0 27.02n 3.63 30.0n 3.63 30.02n 0 67n 0 67.02n 3.63 70.0n 3.63 70.02n 0)

v_SL1_col19 SL11col19 0 pwl(0 0 27n 0 27.02n 3.63 30.0n 3.63 30.02n 0 67n 0 67.02n 3.63 70.0n 3.63 70.02n 0)
v_SL2_col19 SL22col19 0 pwl(0 0 47n 0 47.02n 3.63 50.0n 3.63 50.02n 0 87n 0 87.02n 3.63 90.0n 3.63 90.02n 0)

v_SL1_col20 SL11col20 0 pwl(0 0 47n 0 47.02n 3.63 50.0n 3.63 50.02n 0 87n 0 87.02n 3.63 90.0n 3.63 90.02n 0)
v_SL2_col20 SL22col20 0 pwl(0 0 27n 0 27.02n 3.63 30.0n 3.63 30.02n 0 67n 0 67.02n 3.63 70.0n 3.63 70.02n 0)


```

xtcam_cell_0_32 d1_col32 d2_col32 SL1col32 SL2col32 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_33 d1_col33 d2_col33 SL1col33 SL2col33 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_34 d1_col34 d2_col34 SL1col34 SL2col34 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_35 d1_col35 d2_col35 SL1col35 SL2col35 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_36 d1_col36 d2_col36 SL1col36 SL2col36 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_37 d1_col37 d2_col37 SL1col37 SL2col37 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_38 d1_col38 d2_col38 SL1col38 SL2col38 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_39 d1_col39 d2_col39 SL1col39 SL2col39 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_40 d1_col40 d2_col40 SL1col40 SL2col40 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_41 d1_col41 d2_col41 SL1col41 SL2col41 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_42 d1_col42 d2_col42 SL1col42 SL2col42 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_43 d1_col43 d2_col43 SL1col43 SL2col43 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_44 d1_col44 d2_col44 SL1col44 SL2col44 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_45 d1_col45 d2_col45 SL1col45 SL2col45 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_46 d1_col46 d2_col46 SL1col46 SL2col46 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_47 d1_col47 d2_col47 SL1col47 SL2col47 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell

```

```

xtcam_cell_0_48 d1_col48 d2_col48 SL1col48 SL2col48 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_49 d1_col49 d2_col49 SL1col49 SL2col49 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_50 d1_col50 d2_col50 SL1col50 SL2col50 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_51 d1_col51 d2_col51 SL1col51 SL2col51 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_52 d1_col52 d2_col52 SL1col52 SL2col52 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_53 d1_col53 d2_col53 SL1col53 SL2col53 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_54 d1_col54 d2_col54 SL1col54 SL2col54 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_55 d1_col55 d2_col55 SL1col55 SL2col55 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_56 d1_col56 d2_col56 SL1col56 SL2col56 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_57 d1_col57 d2_col57 SL1col57 SL2col57 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_58 d1_col58 d2_col58 SL1col58 SL2col58 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_59 d1_col59 d2_col59 SL1col59 SL2col59 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_60 d1_col60 d2_col60 SL1col60 SL2col60 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_61 d1_col61 d2_col61 SL1col61 SL2col61 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_62 d1_col62 d2_col62 SL1col62 SL2col62 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_63 d1_col63 d2_col63 SL1col63 SL2col63 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell

```

A.7. PSpice netlist for Table 7.8

* 1X64 bit TCAM array

```

.INCLUDE 'models_array64bit_Pipelining_Slow.cir'
.INCLUDE 'rowcolumn_array64bit_Pipelining_Slow.cir '
.INCLUDE 'sources_array64bit_Pipelining_Slow.cir '
.INCLUDE 'cells_array64bit_Pipelining_Slow.cir '

.SUBCKT tcam_cell d1 d2 SL1 SL2 en_row enb_row SE ML u2 I

xmem1 p | sv_mem1 MEM_YAKOPCIC_test1
xmem2 q | sv_mem2 MEM_YAKOPCIC_test1
xmem3 s u2 sv_mem3 MEM_YAKOPCIC_test2
xmem4 t u2 sv_mem4 MEM_YAKOPCIC_test2

rmem1 sv_mem1 0 10000k
rmem2 sv_mem2 0 10000k
rmem3 sv_mem3 0 10000k
rmem4 sv_mem4 0 10000k

mn1 d1 en_row p 0 nenh w=2u l=0.4u
mn2 d2 en_row q 0 nenh w=2u l=0.4u
mp1 p enb_row d1 2.97 penh w=2u l=0.4u
mp2 q enb_row d2 2.97 penh w=2u l=0.4u
mn3 s SE p 0 nenh w=4u l=0.2u
mn4 t SE q 0 nenh w=4u l=0.2u
mn5 p SL1 p1 0 nenh w=.2u l=0.2u

```



```

+exp(alphan*(V2+xn-1))*wn(V2 ,1))}

* IV Response - Hyperbolic sine due to MIM structure

.func IVRel(V1,V2) {IF(V1 >= 0, a1*V2*sinh(b*V1),
+a2*V2*sinh(b*V1) )}

* Circuit to determine state variable
* dx/dt = F(V(t),x(t))*G(V(t))

Cx XSV 0 1 IC= {xo}

Gx 0 XSV value={eta*F(V(TE,BE),V(XSV,0))*G(V(TE,BE))}

* Current source for memristor IV response

Gm TE BE value = {IVRel(V(TE,BE),V(XSV,0))}

.ends MEM_YAKOPCIC_test1

.subckt MEM_YAKOPCIC_test2 TE BE XSV PARAMS:

* Fitting parameters to model different devices
* a1, a2, b: Parameters for IV relationship
* Vp, Vn: Pos. and neg. voltage thresholds
* Ap, An: Multiplier for SV motion intensity
* xp, xn: Points where SV motion is reduced
* alphap, alphan: Rate at which SV motion decays
* xo: Initial value of SV
* eta: SV direction relative to voltage

+a1=.01 a2=-.01 b=.011 Vp=1.7 Vn=1.7 Ap=4e3 An=4e3
+xp=0.1 xn=0.1 alphap=1 alphan=7 xo=0.1 eta=1

* Multiplicative functions to ensure zero state
* variable motion at memristor boundaries

.func wp(V) {(xp-V)/(1-xp)+1}
.func wn(V) {V/(1-xn)}

* Function G(V(t)) - Describes the device threshold

.func G(V) { IF(V<=Vp, IF(V>=-Vn, 0, -An*(exp(-V)-exp(Vn))), Ap*(exp(V)-exp(Vp))) }

* Function F(V(t),x(t)) - Describes the SV motion

.func F(V1,V2) {IF(eta*V1 >= 0, IF(V2 >= xp, exp(-
+alphap*(V2-xp))*wp(V2) ,1), IF(V2 <= (1-xn),
+exp(alphan*(V2+xn-1))*wn(V2) ,1))}

* IV Response - Hyperbolic sine due to MIM structure

.func IVRel(V1,V2) {IF(V1 >= 0, a1*V2*sinh(b*V1),
+a2*V2*sinh(b*V1) )}

* Circuit to determine state variable
* dx/dt = F(V(t),x(t))*G(V(t))

Cx XSV 0 1 IC= {xo}
Gx 0 XSV value={eta*F(V(TE,BE),V(XSV,0))*G(V(TE,BE))}

* Current source for memristor IV response

```

Gm TE BE value = {IVRel(V(TE,BE),V(XSV,0))}

.ends MEM_YAKOPCIC_test2

*** model of NMOS transistor ***

```
.MODEL nenh NMOS LEVEL=7 VERSION=3.1 TNOM=100 tox=4.1E-9 XJ=1E-7 NCH=2.3549E17
+VTH0= 0.40287203 K1=0.5864999 K2=1.127266E-3 K3=1E-3
+K3B=0.0294061 W0=1E-7 NLX=1.630684E-7 DVT0W=0 DVT1W=0 DVT2W=0 DVT0=1.2064649
+DVT1=0.4215486 DVT2=0.0197749 U0=273.8094484 UA=-1.40499E-9
+UB=2.408323E-18 UC=6.504826E-11 VSAT=1.355009E5 A0=2 AGS=0.4449958
+BO=1.901075E-7 B1=4.99995E-6 KETA=-0.0164863 A1=3.868769E-4 A2=0.4640272
+RDSW=123.3376355 PRWG=0.5 PRWB=-0.197728 WR=1 WINT=0 LINT=1.690044E-8
+XL=0 XW=-1E-8 DWG=-4.728719E-9 DWB=-2.452411E-9 VOFF=-0.0948017 NFACTOR=2.1860065
+CIT=0 CDSC=2.4E-4 CDSCD=0 CDSCB=0 ETA0=2.230928E-3 ETAB=6.028975E-5 DSUB=0.0145467
+PCLM=1.3822069 PDIBLC1=0.1762787 PDIBLC2 = 1.66653E-3 PDIBLCB = -0.1
+DROUT=0.7694691 PSCBE1=8.91287E9 PSCBE2=7.349607E-9 PVAG=1.685917E-3
+DELTA=0.01 RSH=6.7 MOBMOD=1 PRT=0 UTE=-1.5 KT1=-0.11 KT1L=0 KT2=0.022 UA1=4.31E-9
+UB1=-7.61E-18 UC1=-5.6E-11 AT=3.3E4 WL=0 WLN=1 WW=0 WWN=1 WWL=0 LL=0 LLN=1 LW=0
+LWN=1 LWL=0 CAPMOD=2 XPART=0.5 CGDO=8.23E-10 CGSO=8.23E-10 CGBO=1E-12
+CJ = 9.466429E-4 PB = 0.8 MJ = 0.3820266
+CJSW = 2.608154E-10 PBSW = 0.8 MJSW = 0.102322
+CJSWG = 3.3E-10 PBSWG = 0.8 MJSWG = 0.102322
+CF = 0 PVTH0 = -2.199373E-3 PRDSW = -0.9368961
+PK2 = 1.593254E-3 WKETA = -2.880976E-3 LKETA = 7.165078E-3
+PUO = 6.777519 PUA = 5.505418E-12 PUB = 8.84133E-25
+PVSAT = 2.006286E3 PETA0 = 1.003159E-4 PKETA = -6.759277E-3
+NOIMOD=2.0E+00 NOIA=1.3182567385564E+19
+NOIB=144543.977074592 NOIC=-1.24515784572817E-12 EF=0.92 EM=41000000
```

*** model of PMOS transistor ***

```
.MODEL penh PMOS LEVEL=7 VERSION = 3.1 TNOM = 100 tox = 4.1E-9
+XJ = 1E-7 NCH = 4.1589E17 VTH0 = -0.42966132
+K1 = 0.5341312 K2 = 0.0395326 K3 = 0
+K3B = 7.4916211 W0 = 1E-6 NLX = 1.194072E-7
+DVT0W = 0 DVT1W = 0 DVT2W = 0
+DVT0 = 0.5060555 DVT1 = 0.2423835 DVT2 = 0.1
+U0 = 115.6894042 UA = 1.573746E-9 UB = 1.874308E-21
+UC = -1E-10 VSAT = 1.130982E5 A0 = 1.9976555
+AGS = 0.4186945 B0 = 1.949178E-7 B1 = 6.422908E-7
+KETA = 0.0166345 A1 = 0.4749146 A2 = 0.300003
+RDSW = 198.321294 PRWG = 0.5 PRWB = -0.4986647
+WR = 1 WINT = 0 LINT = 2.94454E-8
+XL = 0 XW = -1E-8 DWG = -2.798724E-8
+DWB = -4.83797E-10 VOFF = -0.095236 NFACTOR = 2
+CIT = 0 CDSC = 2.4E-4 CDSCD = 0
+CDSCB = 0 ETA0 = 1.035504E-3 ETAB = -4.358398E-4
+DSUB = 1.816555E-3 PCLM = 1.3299898 PDIBLC1 = 1.766563E-3
+PDIBLC2 = 7.728395E-7 PDIBLCB = -1E-3 DROUT = 1.011891E-3
+PSCBE1 = 4.872184E10 PSCBE2 = 5E-10 PVAG = 0.0209921
+DELTA = 0.01 RSH = 7.7 MOBMOD = 1
+PRT = 0 UTE = -1.5 KT1 = -0.11
+KT1L = 0 KT2 = 0.022 UA1 = 4.31E-9
+UB1 = -7.61E-18 UC1 = -5.6E-11 AT = 3.3E4
+WL = 0 WLN = 1 WW = 0
+WWN = 1 WWL = 0 LL = 0
+LLN = 1 LW = 0 LWN = 1
+LWL = 0 CAPMOD = 2 XPART = 0.5
+CGDO = 6.35E-10 CGSO = 6.35E-10 CGBO = 1E-12
+CJ = 1.144521E-3 PB = 0.8468686 MJ = 0.4099522
```



```

r1_pre1_row03 pre1_row03 pre_row03 5
r_pre1_row04 pre1_row04 0 10000k
r1_pre1_row04 pre1_row04 pre_row04 5
r_SE_row0 SE_row0 0 10000k
r1_SE_row0 SE_row0 SE1_row0 5
rML1reset_row0 ML1reset_row0 ML1reset1_row0 5
rML1reset1_row0 ML1reset1_row0 0 10000k
rML2reset_row0 ML2reset_row0 ML2reset1_row0 5
rML2reset1_row0 ML2reset1_row0 0 10000k
rML3reset_row0 ML3reset_row0 ML3reset1_row0 5
rML3reset1_row0 ML3reset1_row0 0 10000k
rML4reset_row0 ML4reset_row0 ML4reset1_row0 5
rML4reset1_row0 ML4reset1_row0 0 10000k

```

```

*****
*           columns           *
*****

```

```
* col0
```

```

mn1col0 d1_col0 en_col0 d11_col0 0 nenh w=4u l=.4u
mn2col0 d2_col0 en_col0 d22_col0 0 nenh w=4u l=.4u
mp1col0 d11_col0 enb_col0 d1_col0 2.97 penh w=8u l=0.4u
mp2col0 d22_col0 enb_col0 d2_col0 2.97 penh w=8u l=0.4u

```

```

r_en_col0 en_col0 0 10000k
r1_en_col0 en_col0 en1_col0 5
r_enb_col0 enb_col0 0 10000k
r1_enb_col0 enb_col0 enb1_col0 5

```

```

r_d11_col0 d11_col0 0 10000k
r1_d11_col0 d11_col0 d111_col0 5
r_d22_col0 d22_col0 0 10000k
r1_d22_col0 d22_col0 d222_col0 5

```

```

r_SL1col0 SL1col0 0 10000k
r1_SL1col0 SL1col0 SL11col0 5
r_SL2col0 SL2col0 0 10000k
r1_SL2col0 SL2col0 SL22col0 5

```

```
* col1
```

```

mn1col1 d1_col1 en_col1 d11_col1 0 nenh w=4u l=.4u
mn2col1 d2_col1 en_col1 d22_col1 0 nenh w=4u l=.4u
mp1col1 d11_col1 enb_col1 d1_col1 2.97 penh w=8u l=0.4u
mp2col1 d22_col1 enb_col1 d2_col1 2.97 penh w=8u l=0.4u

```

```

r_en_col1 en_col1 0 10000k
r1_en_col1 en_col1 en1_col1 5
r_enb_col1 enb_col1 0 10000k
r1_enb_col1 enb_col1 enb1_col1 5

```

```

r_d11_col1 d11_col1 0 10000k
r1_d11_col1 d11_col1 d111_col1 5
r_d22_col1 d22_col1 0 10000k
r1_d22_col1 d22_col1 d222_col1 5

```

```

r_SL1col1 SL1col1 0 10000k
r1_SL1col1 SL1col1 SL11col1 5
r_SL2col1 SL2col1 0 10000k
r1_SL2col1 SL2col1 SL22col1 5

```


* col2

mn1col2 d1_col2 en_col2 d11_col2 0 nenh w=4u l=.4u
mn2col2 d2_col2 en_col2 d22_col2 0 nenh w=4u l=.4u
mp1col2 d11_col2 enb_col2 d1_col2 2.97 penh w=8u l=0.4u
mp2col2 d22_col2 enb_col2 d2_col2 2.97 penh w=8u l=0.4u

r_en_col2 en_col2 0 10000k
r1_en_col2 en_col2 en1_col2 5
r_enb_col2 enb_col2 0 10000k
r1_enb_col2 enb_col2 enb1_col2 5
r_d11_col2 d11_col2 0 10000k
r1_d11_col2 d11_col2 d111_col2 5
r_d22_col2 d22_col2 0 10000k
r1_d22_col2 d22_col2 d222_col2 5

r_SL1col2 SL1col2 0 10000k
r1_SL1col2 SL1col2 SL11col2 5
r_SL2col2 SL2col2 0 10000k
r1_SL2col2 SL2col2 SL22col2 5

* col3

mn1col3 d1_col3 en_col3 d11_col3 0 nenh w=4u l=.4u
mn2col3 d2_col3 en_col3 d22_col3 0 nenh w=4u l=.4u
mp1col3 d11_col3 enb_col3 d1_col3 2.97 penh w=8u l=0.4u
mp2col3 d22_col3 enb_col3 d2_col3 2.97 penh w=8u l=0.4u

r_en_col3 en_col3 0 10000k
r1_en_col3 en_col3 en1_col3 5
r_enb_col3 enb_col3 0 10000k
r1_enb_col3 enb_col3 enb1_col3 5

r_d11_col3 d11_col3 0 10000k
r1_d11_col3 d11_col3 d111_col3 5
r_d22_col3 d22_col3 0 10000k
r1_d22_col3 d22_col3 d222_col3 5

r_SL1col3 SL1col3 0 10000k
r1_SL1col3 SL1col3 SL11col3 5
r_SL2col3 SL2col3 0 10000k
r1_SL2col3 SL2col3 SL22col3 5

* col4

mn1col4 d1_col4 en_col4 d11_col4 0 nenh w=4u l=.4u
mn2col4 d2_col4 en_col4 d22_col4 0 nenh w=4u l=.4u
mp1col4 d11_col4 enb_col4 d1_col4 2.97 penh w=8u l=0.4u
mp2col4 d22_col4 enb_col4 d2_col4 2.97 penh w=8u l=0.4u

r_en_col4 en_col4 0 10000k
r1_en_col4 en_col4 en1_col4 5
r_enb_col4 enb_col4 0 10000k
r1_enb_col4 enb_col4 enb1_col4 5

r_d11_col4 d11_col4 0 10000k
r1_d11_col4 d11_col4 d111_col4 5
r_d22_col4 d22_col4 0 10000k
r1_d22_col4 d22_col4 d222_col4 5

r_SL1col4 SL1col4 0 10000k

r1_SL1col4 SL1col4 SL11col4 5
r_SL2col4 SL2col4 0 10000k
r1_SL2col4 SL2col4 SL22col4 5

* col5

mn1col5 d1_col5 en_col5 d11_col5 0 nenh w=4u l=.4u
mn2col5 d2_col5 en_col5 d22_col5 0 nenh w=4u l=.4u
mp1col5 d11_col5 enb_col5 d1_col5 2.97 penh w=8u l=0.4u
mp2col5 d22_col5 enb_col5 d2_col5 2.97 penh w=8u l=0.4u

r_en_col5 en_col5 0 10000k
r1_en_col5 en_col5 en1_col5 5
r_enb_col5 enb_col5 0 10000k
r1_enb_col5 enb_col5 enb1_col5 5

r_d11_col5 d11_col5 0 10000k
r1_d11_col5 d11_col5 d111_col5 5
r_d22_col5 d22_col5 0 10000k
r1_d22_col5 d22_col5 d222_col5 5

r_SL1col5 SL1col5 0 10000k
r1_SL1col5 SL1col5 SL11col5 5
r_SL2col5 SL2col5 0 10000k
r1_SL2col5 SL2col5 SL22col5 5

* col6

mn1col6 d1_col6 en_col6 d11_col6 0 nenh w=4u l=.4u
mn2col6 d2_col6 en_col6 d22_col6 0 nenh w=4u l=.4u
mp1col6 d11_col6 enb_col6 d1_col6 2.97 penh w=8u l=0.4u
mp2col6 d22_col6 enb_col6 d2_col6 2.97 penh w=8u l=0.4u

r_en_col6 en_col6 0 10000k
r1_en_col6 en_col6 en1_col6 5
r_enb_col6 enb_col6 0 10000k
r1_enb_col6 enb_col6 enb1_col6 5

r_d11_col6 d11_col6 0 10000k
r1_d11_col6 d11_col6 d111_col6 5
r_d22_col6 d22_col6 0 10000k
r1_d22_col6 d22_col6 d222_col6 5

r_SL1col6 SL1col6 0 10000k
r1_SL1col6 SL1col6 SL11col6 5
r_SL2col6 SL2col6 0 10000k
r1_SL2col6 SL2col6 SL22col6 5

* col7

mn1col7 d1_col7 en_col7 d11_col7 0 nenh w=4u l=.4u
mn2col7 d2_col7 en_col7 d22_col7 0 nenh w=4u l=.4u
mp1col7 d11_col7 enb_col7 d1_col7 2.97 penh w=8u l=0.4u
mp2col7 d22_col7 enb_col7 d2_col7 2.97 penh w=8u l=0.4u

r_en_col7 en_col7 0 10000k
r1_en_col7 en_col7 en1_col7 5
r_enb_col7 enb_col7 0 10000k
r1_enb_col7 enb_col7 enb1_col7 5

r_d11_col7 d11_col7 0 10000k

r1_d11_col7 d11_col7 d111_col7 5
r_d22_col7 d22_col7 0 10000k
r1_d22_col7 d22_col7 d222_col7 5

r_SL1col7 SL1col7 0 10000k
r1_SL1col7 SL1col7 SL11col7 5
r_SL2col7 SL2col7 0 10000k
r1_SL2col7 SL2col7 SL22col7 5

* col8

mn1col8 d1_col8 en_col8 d11_col8 0 nenh w=4u l=.4u
mn2col8 d2_col8 en_col8 d22_col8 0 nenh w=4u l=.4u
mp1col8 d11_col8 enb_col8 d1_col8 2.97 penh w=8u l=0.4u
mp2col8 d22_col8 enb_col8 d2_col8 2.97 penh w=8u l=0.4u

r_en_col8 en_col8 0 10000k
r1_en_col8 en_col8 en1_col8 5
r_enb_col8 enb_col8 0 10000k
r1_enb_col8 enb_col8 enb1_col8 5

r_d11_col8 d11_col8 0 10000k
r1_d11_col8 d11_col8 d111_col8 5
r_d22_col8 d22_col8 0 10000k
r1_d22_col8 d22_col8 d222_col8 5

r_SL1col8 SL1col8 0 10000k
r1_SL1col8 SL1col8 SL11col8 5
r_SL2col8 SL2col8 0 10000k
r1_SL2col8 SL2col8 SL22col8 5

* col9

mn1col9 d1_col9 en_col9 d11_col9 0 nenh w=4u l=.4u
mn2col9 d2_col9 en_col9 d22_col9 0 nenh w=4u l=.4u
mp1col9 d11_col9 enb_col9 d1_col9 2.97 penh w=8u l=0.4u
mp2col9 d22_col9 enb_col9 d2_col9 2.97 penh w=8u l=0.4u

r_en_col9 en_col9 0 10000k
r1_en_col9 en_col9 en1_col9 5
r_enb_col9 enb_col9 0 10000k
r1_enb_col9 enb_col9 enb1_col9 5

r_d11_col9 d11_col9 0 10000k
r1_d11_col9 d11_col9 d111_col9 5
r_d22_col9 d22_col9 0 10000k
r1_d22_col9 d22_col9 d222_col9 5

r_SL1col9 SL1col9 0 10000k
r1_SL1col9 SL1col9 SL11col9 5
r_SL2col9 SL2col9 0 10000k
r1_SL2col9 SL2col9 SL22col9 5

* col10

mn1col10 d1_col10 en_col10 d11_col10 0 nenh w=4u l=.4u
mn2col10 d2_col10 en_col10 d22_col10 0 nenh w=4u l=.4u
mp1col10 d11_col10 enb_col10 d1_col10 2.97 penh w=8u l=0.4u
mp2col10 d22_col10 enb_col10 d2_col10 2.97 penh w=8u l=0.4u

r_en_col10 en_col10 0 10000k
r1_en_col10 en_col10 en1_col10 5
r_enb_col10 enb_col10 0 10000k
r1_enb_col10 enb_col10 enb1_col10 5

r_d11_col10 d11_col10 0 10000k
r1_d11_col10 d11_col10 d111_col10 5
r_d22_col10 d22_col10 0 10000k
r1_d22_col10 d22_col10 d222_col10 5

r_SL1col10 SL1col10 0 10000k
r1_SL1col10 SL1col10 SL11col10 5
r_SL2col10 SL2col10 0 10000k
r1_SL2col10 SL2col10 SL22col10 5

* col11

mn1col11 d1_col11 en_col11 d11_col11 0 nenh w=4u l=.4u
mn2col11 d2_col11 en_col11 d22_col11 0 nenh w=4u l=.4u
mp1col11 d11_col11 enb_col11 d1_col11 2.97 penh w=8u l=0.4u
mp2col11 d22_col11 enb_col11 d2_col11 2.97 penh w=8u l=0.4u

r_en_col11 en_col11 0 10000k
r1_en_col11 en_col11 en1_col11 5
r_enb_col11 enb_col11 0 10000k
r1_enb_col11 enb_col11 enb1_col11 5

r_d11_col11 d11_col11 0 10000k
r1_d11_col11 d11_col11 d111_col11 5
r_d22_col11 d22_col11 0 10000k
r1_d22_col11 d22_col11 d222_col11 5
r_SL1col11 SL1col11 0 10000k
r1_SL1col11 SL1col11 SL11col11 5
r_SL2col11 SL2col11 0 10000k
r1_SL2col11 SL2col11 SL22col11 5

* col12

mn1col12 d1_col12 en_col12 d11_col12 0 nenh w=4u l=.4u
mn2col12 d2_col12 en_col12 d22_col12 0 nenh w=4u l=.4u
mp1col12 d11_col12 enb_col12 d1_col12 2.97 penh w=8u l=0.4u
mp2col12 d22_col12 enb_col12 d2_col12 2.97 penh w=8u l=0.4u

r_en_col12 en_col12 0 10000k
r1_en_col12 en_col12 en1_col12 5
r_enb_col12 enb_col12 0 10000k
r1_enb_col12 enb_col12 enb1_col12 5

r_d11_col12 d11_col12 0 10000k
r1_d11_col12 d11_col12 d111_col12 5
r_d22_col12 d22_col12 0 10000k
r1_d22_col12 d22_col12 d222_col12 5

r_SL1col12 SL1col12 0 10000k
r1_SL1col12 SL1col12 SL11col12 5
r_SL2col12 SL2col12 0 10000k
r1_SL2col12 SL2col12 SL22col12 5

* col13

mn1col13 d1_col13 en_col13 d11_col13 0 nenh w=4u l=.4u
mn2col13 d2_col13 en_col13 d22_col13 0 nenh w=4u l=.4u
mp1col13 d11_col13 enb_col13 d1_col13 2.97 penh w=8u l=0.4u
mp2col13 d22_col13 enb_col13 d2_col13 2.97 penh w=8u l=0.4u

r_en_col13 en_col13 0 10000k
r1_en_col13 en_col13 en1_col13 5
r_enb_col13 enb_col13 0 10000k
r1_enb_col13 enb_col13 enb1_col13 5

r_d11_col13 d11_col13 0 10000k
r1_d11_col13 d11_col13 d111_col13 5
r_d22_col13 d22_col13 0 10000k
r1_d22_col13 d22_col13 d222_col13 5

r_SL1col13 SL1col13 0 10000k
r1_SL1col13 SL1col13 SL11col13 5
r_SL2col13 SL2col13 0 10000k
r1_SL2col13 SL2col13 SL22col13 5

* col14

mn1col14 d1_col14 en_col14 d11_col14 0 nenh w=4u l=.4u
mn2col14 d2_col14 en_col14 d22_col14 0 nenh w=4u l=.4u
mp1col14 d11_col14 enb_col14 d1_col14 2.97 penh w=8u l=0.4u
mp2col14 d22_col14 enb_col14 d2_col14 2.97 penh w=8u l=0.4u

r_en_col14 en_col14 0 10000k
r1_en_col14 en_col14 en1_col14 5
r_enb_col14 enb_col14 0 10000k
r1_enb_col14 enb_col14 enb1_col14 5

r_d11_col14 d11_col14 0 10000k
r1_d11_col14 d11_col14 d111_col14 5
r_d22_col14 d22_col14 0 10000k
r1_d22_col14 d22_col14 d222_col14 5

r_SL1col14 SL1col14 0 10000k
r1_SL1col14 SL1col14 SL11col14 5
r_SL2col14 SL2col14 0 10000k
r1_SL2col14 SL2col14 SL22col14 5

* col15

mn1col15 d1_col15 en_col15 d11_col15 0 nenh w=4u l=.4u
mn2col15 d2_col15 en_col15 d22_col15 0 nenh w=4u l=.4u
mp1col15 d11_col15 enb_col15 d1_col15 2.97 penh w=8u l=0.4u
mp2col15 d22_col15 enb_col15 d2_col15 2.97 penh w=8u l=0.4u

r_en_col15 en_col15 0 10000k
r1_en_col15 en_col15 en1_col15 5
r_enb_col15 enb_col15 0 10000k
r1_enb_col15 enb_col15 enb1_col15 5

r_d11_col15 d11_col15 0 10000k
r1_d11_col15 d11_col15 d111_col15 5
r_d22_col15 d22_col15 0 10000k
r1_d22_col15 d22_col15 d222_col15 5

r_SL1col15 SL1col15 0 10000k
r1_SL1col15 SL1col15 SL11col15 5
r_SL2col15 SL2col15 0 10000k

r1_SL2col15 SL2col15 SL22col15 5

* col16

mn1col16 d1_col16 en_col16 d11_col16 0 nenh w=4u l=.4u
mn2col16 d2_col16 en_col16 d22_col16 0 nenh w=4u l=.4u
mp1col16 d11_col16 enb_col16 d1_col16 2.97 penh w=8u l=0.4u
mp2col16 d22_col16 enb_col16 d2_col16 2.97 penh w=8u l=0.4u

r_en_col16 en_col16 0 10000k
r1_en_col16 en_col16 en1_col16 5
r_enb_col16 enb_col16 0 10000k
r1_enb_col16 enb_col16 enb1_col16 5

r_d11_col16 d11_col16 0 10000k
r1_d11_col16 d11_col16 d111_col16 5
r_d22_col16 d22_col16 0 10000k
r1_d22_col16 d22_col16 d222_col16 5

r_SL1col16 SL1col16 0 10000k
r1_SL1col16 SL1col16 SL11col16 5
r_SL2col16 SL2col16 0 10000k
r1_SL2col16 SL2col16 SL22col16 5

* col17

mn1col17 d1_col17 en_col17 d11_col17 0 nenh w=4u l=.4u
mn2col17 d2_col17 en_col17 d22_col17 0 nenh w=4u l=.4u
mp1col17 d11_col17 enb_col17 d1_col17 2.97 penh w=8u l=0.4u
mp2col17 d22_col17 enb_col17 d2_col17 2.97 penh w=8u l=0.4u

r_en_col17 en_col17 0 10000k
r1_en_col17 en_col17 en1_col17 5
r_enb_col17 enb_col17 0 10000k
r1_enb_col17 enb_col17 enb1_col17 5

r_d11_col17 d11_col17 0 10000k
r1_d11_col17 d11_col17 d111_col17 5
r_d22_col17 d22_col17 0 10000k
r1_d22_col17 d22_col17 d222_col17 5

r_SL1col17 SL1col17 0 10000k
r1_SL1col17 SL1col17 SL11col17 5
r_SL2col17 SL2col17 0 10000k
r1_SL2col17 SL2col17 SL22col17 5

* col18

mn1col18 d1_col18 en_col18 d11_col18 0 nenh w=4u l=.4u
mn2col18 d2_col18 en_col18 d22_col18 0 nenh w=4u l=.4u
mp1col18 d11_col18 enb_col18 d1_col18 2.97 penh w=8u l=0.4u
mp2col18 d22_col18 enb_col18 d2_col18 2.97 penh w=8u l=0.4u

r_en_col18 en_col18 0 10000k
r1_en_col18 en_col18 en1_col18 5
r_enb_col18 enb_col18 0 10000k
r1_enb_col18 enb_col18 enb1_col18 5

r_d11_col18 d11_col18 0 10000k
r1_d11_col18 d11_col18 d111_col18 5
r_d22_col18 d22_col18 0 10000k
r1_d22_col18 d22_col18 d222_col18 5

r_SL1col18 SL1col18 0 10000k
r1_SL1col18 SL1col18 SL11col18 5
r_SL2col18 SL2col18 0 10000k
r1_SL2col18 SL2col18 SL22col18 5

* col19

mn1col19 d1_col19 en_col19 d11_col19 0 nenh w=4u l=.4u
mn2col19 d2_col19 en_col19 d22_col19 0 nenh w=4u l=.4u
mp1col19 d11_col19 enb_col19 d1_col19 2.97 penh w=8u l=0.4u
mp2col19 d22_col19 enb_col19 d2_col19 2.97 penh w=8u l=0.4u

r_en_col19 en_col19 0 10000k
r1_en_col19 en_col19 en1_col19 5
r_enb_col19 enb_col19 0 10000k
r1_enb_col19 enb_col19 enb1_col19 5

r_d11_col19 d11_col19 0 10000k
r1_d11_col19 d11_col19 d111_col19 5
r_d22_col19 d22_col19 0 10000k
r1_d22_col19 d22_col19 d222_col19 5

r_SL1col19 SL1col19 0 10000k
r1_SL1col19 SL1col19 SL11col19 5
r_SL2col19 SL2col19 0 10000k
r1_SL2col19 SL2col19 SL22col19 5

* col20

mn1col20 d1_col20 en_col20 d11_col20 0 nenh w=4u l=.4u
mn2col20 d2_col20 en_col20 d22_col20 0 nenh w=4u l=.4u
mp1col20 d11_col20 enb_col20 d1_col20 2.97 penh w=8u l=0.4u
mp2col20 d22_col20 enb_col20 d2_col20 2.97 penh w=8u l=0.4u

r_en_col20 en_col20 0 10000k
r1_en_col20 en_col20 en1_col20 5
r_enb_col20 enb_col20 0 10000k
r1_enb_col20 enb_col20 enb1_col20 5

r_d11_col20 d11_col20 0 10000k
r1_d11_col20 d11_col20 d111_col20 5
r_d22_col20 d22_col20 0 10000k
r1_d22_col20 d22_col20 d222_col20 5

r_SL1col20 SL1col20 0 10000k
r1_SL1col20 SL1col20 SL11col20 5
r_SL2col20 SL2col20 0 10000k
r1_SL2col20 SL2col20 SL22col20 5

* col21

mn1col21 d1_col21 en_col21 d11_col21 0 nenh w=4u l=.4u
mn2col21 d2_col21 en_col21 d22_col21 0 nenh w=4u l=.4u
mp1col21 d11_col21 enb_col21 d1_col21 2.97 penh w=8u l=0.4u
mp2col21 d22_col21 enb_col21 d2_col21 2.97 penh w=8u l=0.4u

r_en_col21 en_col21 0 10000k
r1_en_col21 en_col21 en1_col21 5
r_enb_col21 enb_col21 0 10000k
r1_enb_col21 enb_col21 enb1_col21 5

r_d11_col21 d11_col21 0 10000k
r1_d11_col21 d11_col21 d111_col21 5

r_d22_col21 d22_col21 0 10000k
r1_d22_col21 d22_col21 d222_col21 5

r_SL1col21 SL1col21 0 10000k
r1_SL1col21 SL1col21 SL11col21 5
r_SL2col21 SL2col21 0 10000k
r1_SL2col21 SL2col21 SL22col21 5

* col22

mn1col22 d1_col22 en_col22 d11_col22 0 nenh w=4u l=.4u
mn2col22 d2_col22 en_col22 d22_col22 0 nenh w=4u l=.4u
mp1col22 d11_col22 enb_col22 d1_col22 2.97 penh w=8u l=0.4u
mp2col22 d22_col22 enb_col22 d2_col22 2.97 penh w=8u l=0.4u

r_en_col22 en_col22 0 10000k
r1_en_col22 en_col22 en1_col22 5
r_enb_col22 enb_col22 0 10000k
r1_enb_col22 enb_col22 enb1_col22 5

r_d11_col22 d11_col22 0 10000k
r1_d11_col22 d11_col22 d111_col22 5
r_d22_col22 d22_col22 0 10000k
r1_d22_col22 d22_col22 d222_col22 5

r_SL1col22 SL1col22 0 10000k
r1_SL1col22 SL1col22 SL11col22 5
r_SL2col22 SL2col22 0 10000k
r1_SL2col22 SL2col22 SL22col22 5

* col23

mn1col23 d1_col23 en_col23 d11_col23 0 nenh w=4u l=.4u
mn2col23 d2_col23 en_col23 d22_col23 0 nenh w=4u l=.4u
mp1col23 d11_col23 enb_col23 d1_col23 2.97 penh w=8u l=0.4u
mp2col23 d22_col23 enb_col23 d2_col23 2.97 penh w=8u l=0.4u

r_en_col23 en_col23 0 10000k
r1_en_col23 en_col23 en1_col23 5
r_enb_col23 enb_col23 0 10000k
r1_enb_col23 enb_col23 enb1_col23 5

r_d11_col23 d11_col23 0 10000k
r1_d11_col23 d11_col23 d111_col23 5
r_d22_col23 d22_col23 0 10000k
r1_d22_col23 d22_col23 d222_col23 5

r_SL1col23 SL1col23 0 10000k
r1_SL1col23 SL1col23 SL11col23 5
r_SL2col23 SL2col23 0 10000k
r1_SL2col23 SL2col23 SL22col23 5

* col24

mn1col24 d1_col24 en_col24 d11_col24 0 nenh w=4u l=.4u
mn2col24 d2_col24 en_col24 d22_col24 0 nenh w=4u l=.4u
mp1col24 d11_col24 enb_col24 d1_col24 2.97 penh w=8u l=0.4u
mp2col24 d22_col24 enb_col24 d2_col24 2.97 penh w=8u l=0.4u

r_en_col24 en_col24 0 10000k
r1_en_col24 en_col24 en1_col24 5
r_enb_col24 enb_col24 0 10000k

r1_enb_col24 enb_col24 enb1_col24 5

r_d11_col24 d11_col24 0 10000k
r1_d11_col24 d11_col24 d111_col24 5
r_d22_col24 d22_col24 0 10000k
r1_d22_col24 d22_col24 d222_col24 5

r_SL1col24 SL1col24 0 10000k
r1_SL1col24 SL1col24 SL11col24 5
r_SL2col24 SL2col24 0 10000k
r1_SL2col24 SL2col24 SL22col24 5

* col25

mn1col25 d1_col25 en_col25 d11_col25 0 nenh w=4u l=.4u
mn2col25 d2_col25 en_col25 d22_col25 0 nenh w=4u l=.4u
mp1col25 d11_col25 enb_col25 d1_col25 2.97 penh w=8u l=0.4u
mp2col25 d22_col25 enb_col25 d2_col25 2.97 penh w=8u l=0.4u

r_en_col25 en_col25 0 10000k
r1_en_col25 en_col25 en1_col25 5
r_enb_col25 enb_col25 0 10000k
r1_enb_col25 enb_col25 enb1_col25 5

r_d11_col25 d11_col25 0 10000k
r1_d11_col25 d11_col25 d111_col25 5
r_d22_col25 d22_col25 0 10000k
r1_d22_col25 d22_col25 d222_col25 5

r_SL1col25 SL1col25 0 10000k
r1_SL1col25 SL1col25 SL11col25 5
r_SL2col25 SL2col25 0 10000k
r1_SL2col25 SL2col25 SL22col25 5

* col26

mn1col26 d1_col26 en_col26 d11_col26 0 nenh w=4u l=.4u
mn2col26 d2_col26 en_col26 d22_col26 0 nenh w=4u l=.4u
mp1col26 d11_col26 enb_col26 d1_col26 2.97 penh w=8u l=0.4u
mp2col26 d22_col26 enb_col26 d2_col26 2.97 penh w=8u l=0.4u

r_en_col26 en_col26 0 10000k
r1_en_col26 en_col26 en1_col26 5
r_enb_col26 enb_col26 0 10000k
r1_enb_col26 enb_col26 enb1_col26 5

r_d11_col26 d11_col26 0 10000k
r1_d11_col26 d11_col26 d111_col26 5
r_d22_col26 d22_col26 0 10000k
r1_d22_col26 d22_col26 d222_col26 5

r_SL1col26 SL1col26 0 10000k
r1_SL1col26 SL1col26 SL11col26 5
r_SL2col26 SL2col26 0 10000k
r1_SL2col26 SL2col26 SL22col26 5

* col27

mn1col27 d1_col27 en_col27 d11_col27 0 nenh w=4u l=.4u
mn2col27 d2_col27 en_col27 d22_col27 0 nenh w=4u l=.4u
mp1col27 d11_col27 enb_col27 d1_col27 2.97 penh w=8u l=0.4u
mp2col27 d22_col27 enb_col27 d2_col27 2.97 penh w=8u l=0.4u

r_en_col27 en_col27 0 10000k

r1_en_col27 en_col27 en1_col27 5
r_enb_col27 enb_col27 0 10000k
r1_enb_col27 enb_col27 enb1_col27 5

r_d11_col27 d11_col27 0 10000k
r1_d11_col27 d11_col27 d111_col27 5
r_d22_col27 d22_col27 0 10000k
r1_d22_col27 d22_col27 d222_col27 5

r_SL1col27 SL1col27 0 10000k
r1_SL1col27 SL1col27 SL11col27 5
r_SL2col27 SL2col27 0 10000k
r1_SL2col27 SL2col27 SL22col27 5

* col28

mn1col28 d1_col28 en_col28 d11_col28 0 nenh w=4u l=.4u
mn2col28 d2_col28 en_col28 d22_col28 0 nenh w=4u l=.4u
mp1col28 d11_col28 enb_col28 d1_col28 2.97 penh w=8u l=0.4u
mp2col28 d22_col28 enb_col28 d2_col28 2.97 penh w=8u l=0.4u

r_en_col28 en_col28 0 10000k
r1_en_col28 en_col28 en1_col28 5
r_enb_col28 enb_col28 0 10000k
r1_enb_col28 enb_col28 enb1_col28 5

r_d11_col28 d11_col28 0 10000k
r1_d11_col28 d11_col28 d111_col28 5
r_d22_col28 d22_col28 0 10000k
r1_d22_col28 d22_col28 d222_col28 5

r_SL1col28 SL1col28 0 10000k
r1_SL1col28 SL1col28 SL11col28 5
r_SL2col28 SL2col28 0 10000k
r1_SL2col28 SL2col28 SL22col28 5

* col29

mn1col29 d1_col29 en_col29 d11_col29 0 nenh w=4u l=.4u
mn2col29 d2_col29 en_col29 d22_col29 0 nenh w=4u l=.4u
mp1col29 d11_col29 enb_col29 d1_col29 2.97 penh w=8u l=0.4u
mp2col29 d22_col29 enb_col29 d2_col29 2.97 penh w=8u l=0.4u

r_en_col29 en_col29 0 10000k
r1_en_col29 en_col29 en1_col29 5
r_enb_col29 enb_col29 0 10000k
r1_enb_col29 enb_col29 enb1_col29 5

r_d11_col29 d11_col29 0 10000k
r1_d11_col29 d11_col29 d111_col29 5
r_d22_col29 d22_col29 0 10000k
r1_d22_col29 d22_col29 d222_col29 5

r_SL1col29 SL1col29 0 10000k
r1_SL1col29 SL1col29 SL11col29 5
r_SL2col29 SL2col29 0 10000k
r1_SL2col29 SL2col29 SL22col29 5

* col30

mn1col30 d1_col30 en_col30 d11_col30 0 nenh w=4u l=.4u
mn2col30 d2_col30 en_col30 d22_col30 0 nenh w=4u l=.4u
mp1col30 d11_col30 enb_col30 d1_col30 2.97 penh w=8u l=0.4u
mp2col30 d22_col30 enb_col30 d2_col30 2.97 penh w=8u l=0.4u

r_en_col30 en_col30 0 10000k
r1_en_col30 en_col30 en1_col30 5
r_enb_col30 enb_col30 0 10000k
r1_enb_col30 enb_col30 enb1_col30 5

r_d11_col30 d11_col30 0 10000k
r1_d11_col30 d11_col30 d111_col30 5
r_d22_col30 d22_col30 0 10000k
r1_d22_col30 d22_col30 d222_col30 5

r_SL1col30 SL1col30 0 10000k
r1_SL1col30 SL1col30 SL11col30 5
r_SL2col30 SL2col30 0 10000k
r1_SL2col30 SL2col30 SL22col30 5

* col31

mn1col31 d1_col31 en_col31 d11_col31 0 nenh w=4u l=.4u
mn2col31 d2_col31 en_col31 d22_col31 0 nenh w=4u l=.4u
mp1col31 d11_col31 enb_col31 d1_col31 2.97 penh w=8u l=0.4u
mp2col31 d22_col31 enb_col31 d2_col31 2.97 penh w=8u l=0.4u

r_en_col31 en_col31 0 10000k
r1_en_col31 en_col31 en1_col31 5
r_enb_col31 enb_col31 0 10000k
r1_enb_col31 enb_col31 enb1_col31 5

r_d11_col31 d11_col31 0 10000k
r1_d11_col31 d11_col31 d111_col31 5
r_d22_col31 d22_col31 0 10000k
r1_d22_col31 d22_col31 d222_col31 5

r_SL1col31 SL1col31 0 10000k
r1_SL1col31 SL1col31 SL11col31 5
r_SL2col31 SL2col31 0 10000k
r1_SL2col31 SL2col31 SL22col31 5

* col32

mn1col32 d1_col32 en_col32 d11_col32 0 nenh w=4u l=.4u
mn2col32 d2_col32 en_col32 d22_col32 0 nenh w=4u l=.4u
mp1col32 d11_col32 enb_col32 d1_col32 2.97 penh w=8u l=0.4u
mp2col32 d22_col32 enb_col32 d2_col32 2.97 penh w=8u l=0.4u

r_en_col32 en_col32 0 10000k
r1_en_col32 en_col32 en1_col32 5
r_enb_col32 enb_col32 0 10000k
r1_enb_col32 enb_col32 enb1_col32 5

r_d11_col32 d11_col32 0 10000k
r1_d11_col32 d11_col32 d111_col32 5
r_d22_col32 d22_col32 0 10000k
r1_d22_col32 d22_col32 d222_col32 5

r_SL1col32 SL1col32 0 10000k
r1_SL1col32 SL1col32 SL11col32 5
r_SL2col32 SL2col32 0 10000k
r1_SL2col32 SL2col32 SL22col32 5

* col33

mn1col33 d1_col33 en_col33 d11_col33 0 nenh w=4u l=.4u

mn2col33 d2_col33 en_col33 d22_col33 0 nenh w=4u l=.4u
mp1col33 d11_col33 enb_col33 d1_col33 2.97 penh w=8u l=0.4u
mp2col33 d22_col33 enb_col33 d2_col33 2.97 penh w=8u l=0.4u

r_en_col33 en_col33 0 10000k
r1_en_col33 en_col33 en1_col33 5
r_enb_col33 enb_col33 0 10000k
r1_enb_col33 enb_col33 enb1_col33 5

r_d11_col33 d11_col33 0 10000k
r1_d11_col33 d11_col33 d111_col33 5
r_d22_col33 d22_col33 0 10000k
r1_d22_col33 d22_col33 d222_col33 5

r_SL1col33 SL1col33 0 10000k
r1_SL1col33 SL1col33 SL11col33 5
r_SL2col33 SL2col33 0 10000k
r1_SL2col33 SL2col33 SL22col33 5

* col34

mn1col34 d1_col34 en_col34 d11_col34 0 nenh w=4u l=.4u
mn2col34 d2_col34 en_col34 d22_col34 0 nenh w=4u l=.4u
mp1col34 d11_col34 enb_col34 d1_col34 2.97 penh w=8u l=0.4u
mp2col34 d22_col34 enb_col34 d2_col34 2.97 penh w=8u l=0.4u

r_en_col34 en_col34 0 10000k
r1_en_col34 en_col34 en1_col34 5
r_enb_col34 enb_col34 0 10000k
r1_enb_col34 enb_col34 enb1_col34 5

r_d11_col34 d11_col34 0 10000k
r1_d11_col34 d11_col34 d111_col34 5
r_d22_col34 d22_col34 0 10000k
r1_d22_col34 d22_col34 d222_col34 5

r_SL1col34 SL1col34 0 10000k
r1_SL1col34 SL1col34 SL11col34 5
r_SL2col34 SL2col34 0 10000k
r1_SL2col34 SL2col34 SL22col34 5

* col35

mn1col35 d1_col35 en_col35 d11_col35 0 nenh w=4u l=.4u
mn2col35 d2_col35 en_col35 d22_col35 0 nenh w=4u l=.4u
mp1col35 d11_col35 enb_col35 d1_col35 2.97 penh w=8u l=0.4u
mp2col35 d22_col35 enb_col35 d2_col35 2.97 penh w=8u l=0.4u

r_en_col35 en_col35 0 10000k
r1_en_col35 en_col35 en1_col35 5
r_enb_col35 enb_col35 0 10000k
r1_enb_col35 enb_col35 enb1_col35 5

r_d11_col35 d11_col35 0 10000k
r1_d11_col35 d11_col35 d111_col35 5
r_d22_col35 d22_col35 0 10000k
r1_d22_col35 d22_col35 d222_col35 5

r_SL1col35 SL1col35 0 10000k
r1_SL1col35 SL1col35 SL11col35 5
r_SL2col35 SL2col35 0 10000k
r1_SL2col35 SL2col35 SL22col35 5

* col36

mn1col36 d1_col36 en_col36 d11_col36 0 nenh w=4u l=.4u
mn2col36 d2_col36 en_col36 d22_col36 0 nenh w=4u l=.4u
mp1col36 d11_col36 enb_col36 d1_col36 2.97 penh w=8u l=0.4u
mp2col36 d22_col36 enb_col36 d2_col36 2.97 penh w=8u l=0.4u

r_en_col36 en_col36 0 10000k
r1_en_col36 en_col36 en1_col36 5
r_enb_col36 enb_col36 0 10000k
r1_enb_col36 enb_col36 enb1_col36 5

r_d11_col36 d11_col36 0 10000k
r1_d11_col36 d11_col36 d111_col36 5
r_d22_col36 d22_col36 0 10000k
r1_d22_col36 d22_col36 d222_col36 5

r_SL1col36 SL1col36 0 10000k
r1_SL1col36 SL1col36 SL11col36 5
r_SL2col36 SL2col36 0 10000k
r1_SL2col36 SL2col36 SL22col36 5

* col37

mn1col37 d1_col37 en_col37 d11_col37 0 nenh w=4u l=.4u
mn2col37 d2_col37 en_col37 d22_col37 0 nenh w=4u l=.4u
mp1col37 d11_col37 enb_col37 d1_col37 2.97 penh w=8u l=0.4u
mp2col37 d22_col37 enb_col37 d2_col37 2.97 penh w=8u l=0.4u

r_en_col37 en_col37 0 10000k
r1_en_col37 en_col37 en1_col37 5
r_enb_col37 enb_col37 0 10000k
r1_enb_col37 enb_col37 enb1_col37 5

r_d11_col37 d11_col37 0 10000k
r1_d11_col37 d11_col37 d111_col37 5
r_d22_col37 d22_col37 0 10000k
r1_d22_col37 d22_col37 d222_col37 5

r_SL1col37 SL1col37 0 10000k
r1_SL1col37 SL1col37 SL11col37 5
r_SL2col37 SL2col37 0 10000k
r1_SL2col37 SL2col37 SL22col37 5

* col38

mn1col38 d1_col38 en_col38 d11_col38 0 nenh w=4u l=.4u
mn2col38 d2_col38 en_col38 d22_col38 0 nenh w=4u l=.4u
mp1col38 d11_col38 enb_col38 d1_col38 2.97 penh w=8u l=0.4u
mp2col38 d22_col38 enb_col38 d2_col38 2.97 penh w=8u l=0.4u

r_en_col38 en_col38 0 10000k
r1_en_col38 en_col38 en1_col38 5
r_enb_col38 enb_col38 0 10000k
r1_enb_col38 enb_col38 enb1_col38 5

r_d11_col38 d11_col38 0 10000k
r1_d11_col38 d11_col38 d111_col38 5
r_d22_col38 d22_col38 0 10000k
r1_d22_col38 d22_col38 d222_col38 5

r_SL1col38 SL1col38 0 10000k
r1_SL1col38 SL1col38 SL11col38 5
r_SL2col38 SL2col38 0 10000k
r1_SL2col38 SL2col38 SL22col38 5

* col39

mn1col39 d1_col39 en_col39 d11_col39 0 nenh w=4u l=.4u
mn2col39 d2_col39 en_col39 d22_col39 0 nenh w=4u l=.4u
mp1col39 d11_col39 enb_col39 d1_col39 2.97 penh w=8u l=0.4u
mp2col39 d22_col39 enb_col39 d2_col39 2.97 penh w=8u l=0.4u

r_en_col39 en_col39 0 10000k
r1_en_col39 en_col39 en1_col39 5
r_enb_col39 enb_col39 0 10000k
r1_enb_col39 enb_col39 enb1_col39 5

r_d11_col39 d11_col39 0 10000k
r1_d11_col39 d11_col39 d111_col39 5
r_d22_col39 d22_col39 0 10000k
r1_d22_col39 d22_col39 d222_col39 5

r_SL1col39 SL1col39 0 10000k
r1_SL1col39 SL1col39 SL11col39 5
r_SL2col39 SL2col39 0 10000k
r1_SL2col39 SL2col39 SL22col39 5

* col40

mn1col40 d1_col40 en_col40 d11_col40 0 nenh w=4u l=.4u
mn2col40 d2_col40 en_col40 d22_col40 0 nenh w=4u l=.4u
mp1col40 d11_col40 enb_col40 d1_col40 2.97 penh w=8u l=0.4u
mp2col40 d22_col40 enb_col40 d2_col40 2.97 penh w=8u l=0.4u

r_en_col40 en_col40 0 10000k
r1_en_col40 en_col40 en1_col40 5
r_enb_col40 enb_col40 0 10000k
r1_enb_col40 enb_col40 enb1_col40 5

r_d11_col40 d11_col40 0 10000k
r1_d11_col40 d11_col40 d111_col40 5
r_d22_col40 d22_col40 0 10000k
r1_d22_col40 d22_col40 d222_col40 5

r_SL1col40 SL1col40 0 10000k
r1_SL1col40 SL1col40 SL11col40 5
r_SL2col40 SL2col40 0 10000k
r1_SL2col40 SL2col40 SL22col40 5

* col41

mn1col41 d1_col41 en_col41 d11_col41 0 nenh w=4u l=.4u
mn2col41 d2_col41 en_col41 d22_col41 0 nenh w=4u l=.4u
mp1col41 d11_col41 enb_col41 d1_col41 2.97 penh w=8u l=0.4u
mp2col41 d22_col41 enb_col41 d2_col41 2.97 penh w=8u l=0.4u

r_en_col41 en_col41 0 10000k
r1_en_col41 en_col41 en1_col41 5
r_enb_col41 enb_col41 0 10000k
r1_enb_col41 enb_col41 enb1_col41 5

r_d11_col41 d11_col41 0 10000k
r1_d11_col41 d11_col41 d111_col41 5
r_d22_col41 d22_col41 0 10000k
r1_d22_col41 d22_col41 d222_col41 5

r_SL1col41 SL1col41 0 10000k
r1_SL1col41 SL1col41 SL11col41 5

r_SL2col41 SL2col41 0 10000k
r1_SL2col41 SL2col41 SL22col41 5

* col42

mn1col42 d1_col42 en_col42 d11_col42 0 nenh w=4u l=.4u
mn2col42 d2_col42 en_col42 d22_col42 0 nenh w=4u l=.4u
mp1col42 d11_col42 enb_col42 d1_col42 2.97 penh w=8u l=0.4u
mp2col42 d22_col42 enb_col42 d2_col42 2.97 penh w=8u l=0.4u

r_en_col42 en_col42 0 10000k
r1_en_col42 en_col42 en1_col42 5
r_enb_col42 enb_col42 0 10000k
r1_enb_col42 enb_col42 enb1_col42 5

r_d11_col42 d11_col42 0 10000k
r1_d11_col42 d11_col42 d111_col42 5
r_d22_col42 d22_col42 0 10000k
r1_d22_col42 d22_col42 d222_col42 5

r_SL1col42 SL1col42 0 10000k
r1_SL1col42 SL1col42 SL11col42 5
r_SL2col42 SL2col42 0 10000k
r1_SL2col42 SL2col42 SL22col42 5

* col43

mn1col43 d1_col43 en_col43 d11_col43 0 nenh w=4u l=.4u
mn2col43 d2_col43 en_col43 d22_col43 0 nenh w=4u l=.4u
mp1col43 d11_col43 enb_col43 d1_col43 2.97 penh w=8u l=0.4u
mp2col43 d22_col43 enb_col43 d2_col43 2.97 penh w=8u l=0.4u

r_en_col43 en_col43 0 10000k
r1_en_col43 en_col43 en1_col43 5
r_enb_col43 enb_col43 0 10000k
r1_enb_col43 enb_col43 enb1_col43 5

r_d11_col43 d11_col43 0 10000k
r1_d11_col43 d11_col43 d111_col43 5
r_d22_col43 d22_col43 0 10000k
r1_d22_col43 d22_col43 d222_col43 5

r_SL1col43 SL1col43 0 10000k
r1_SL1col43 SL1col43 SL11col43 5
r_SL2col43 SL2col43 0 10000k
r1_SL2col43 SL2col43 SL22col43 5

* col44

mn1col44 d1_col44 en_col44 d11_col44 0 nenh w=4u l=.4u
mn2col44 d2_col44 en_col44 d22_col44 0 nenh w=4u l=.4u
mp1col44 d11_col44 enb_col44 d1_col44 2.97 penh w=8u l=0.4u
mp2col44 d22_col44 enb_col44 d2_col44 2.97 penh w=8u l=0.4u

r_en_col44 en_col44 0 10000k
r1_en_col44 en_col44 en1_col44 5
r_enb_col44 enb_col44 0 10000k
r1_enb_col44 enb_col44 enb1_col44 5

r_d11_col44 d11_col44 0 10000k
r1_d11_col44 d11_col44 d111_col44 5
r_d22_col44 d22_col44 0 10000k
r1_d22_col44 d22_col44 d222_col44 5

r_SL1col44 SL1col44 0 10000k
r1_SL1col44 SL1col44 SL11col44 5
r_SL2col44 SL2col44 0 10000k
r1_SL2col44 SL2col44 SL22col44 5

* col45

mn1col45 d1_col45 en_col45 d11_col45 0 nenh w=4u l=.4u
mn2col45 d2_col45 en_col45 d22_col45 0 nenh w=4u l=.4u
mp1col45 d11_col45 enb_col45 d1_col45 2.97 penh w=8u l=0.4u
mp2col45 d22_col45 enb_col45 d2_col45 2.97 penh w=8u l=0.4u

r_en_col45 en_col45 0 10000k
r1_en_col45 en_col45 en1_col45 5
r_enb_col45 enb_col45 0 10000k
r1_enb_col45 enb_col45 enb1_col45 5

r_d11_col45 d11_col45 0 10000k
r1_d11_col45 d11_col45 d111_col45 5
r_d22_col45 d22_col45 0 10000k
r1_d22_col45 d22_col45 d222_col45 5

r_SL1col45 SL1col45 0 10000k
r1_SL1col45 SL1col45 SL11col45 5
r_SL2col45 SL2col45 0 10000k
r1_SL2col45 SL2col45 SL22col45 5

* col46

mn1col46 d1_col46 en_col46 d11_col46 0 nenh w=4u l=.4u
mn2col46 d2_col46 en_col46 d22_col46 0 nenh w=4u l=.4u
mp1col46 d11_col46 enb_col46 d1_col46 2.97 penh w=8u l=0.4u
mp2col46 d22_col46 enb_col46 d2_col46 2.97 penh w=8u l=0.4u

r_en_col46 en_col46 0 10000k
r1_en_col46 en_col46 en1_col46 5
r_enb_col46 enb_col46 0 10000k
r1_enb_col46 enb_col46 enb1_col46 5

r_d11_col46 d11_col46 0 10000k
r1_d11_col46 d11_col46 d111_col46 5
r_d22_col46 d22_col46 0 10000k
r1_d22_col46 d22_col46 d222_col46 5

r_SL1col46 SL1col46 0 10000k
r1_SL1col46 SL1col46 SL11col46 5
r_SL2col46 SL2col46 0 10000k
r1_SL2col46 SL2col46 SL22col46 5

* col47

mn1col47 d1_col47 en_col47 d11_col47 0 nenh w=4u l=.4u
mn2col47 d2_col47 en_col47 d22_col47 0 nenh w=4u l=.4u
mp1col47 d11_col47 enb_col47 d1_col47 2.97 penh w=8u l=0.4u
mp2col47 d22_col47 enb_col47 d2_col47 2.97 penh w=8u l=0.4u

r_en_col47 en_col47 0 10000k
r1_en_col47 en_col47 en1_col47 5
r_enb_col47 enb_col47 0 10000k
r1_enb_col47 enb_col47 enb1_col47 5

r_d11_col47 d11_col47 0 10000k
r1_d11_col47 d11_col47 d111_col47 5
r_d22_col47 d22_col47 0 10000k

r1_d22_col47 d22_col47 d222_col47 5

r_SL1col47 SL1col47 0 10000k
r1_SL1col47 SL1col47 SL11col47 5
r_SL2col47 SL2col47 0 10000k
r1_SL2col47 SL2col47 SL22col47 5

* col48

mn1col48 d1_col48 en_col48 d11_col48 0 nenh w=4u l=.4u
mn2col48 d2_col48 en_col48 d22_col48 0 nenh w=4u l=.4u
mp1col48 d11_col48 enb_col48 d1_col48 2.97 penh w=8u l=0.4u
mp2col48 d22_col48 enb_col48 d2_col48 2.97 penh w=8u l=0.4u

r_en_col48 en_col48 0 10000k
r1_en_col48 en_col48 en1_col48 5
r_enb_col48 enb_col48 0 10000k
r1_enb_col48 enb_col48 enb1_col48 5

r_d11_col48 d11_col48 0 10000k
r1_d11_col48 d11_col48 d111_col48 5
r_d22_col48 d22_col48 0 10000k
r1_d22_col48 d22_col48 d222_col48 5

r_SL1col48 SL1col48 0 10000k
r1_SL1col48 SL1col48 SL11col48 5
r_SL2col48 SL2col48 0 10000k
r1_SL2col48 SL2col48 SL22col48 5

* col49

mn1col49 d1_col49 en_col49 d11_col49 0 nenh w=4u l=.4u
mn2col49 d2_col49 en_col49 d22_col49 0 nenh w=4u l=.4u
mp1col49 d11_col49 enb_col49 d1_col49 2.97 penh w=8u l=0.4u
mp2col49 d22_col49 enb_col49 d2_col49 2.97 penh w=8u l=0.4u

r_en_col49 en_col49 0 10000k
r1_en_col49 en_col49 en1_col49 5
r_enb_col49 enb_col49 0 10000k
r1_enb_col49 enb_col49 enb1_col49 5

r_d11_col49 d11_col49 0 10000k
r1_d11_col49 d11_col49 d111_col49 5
r_d22_col49 d22_col49 0 10000k
r1_d22_col49 d22_col49 d222_col49 5

r_SL1col49 SL1col49 0 10000k
r1_SL1col49 SL1col49 SL11col49 5
r_SL2col49 SL2col49 0 10000k
r1_SL2col49 SL2col49 SL22col49 5

* col50

mn1col50 d1_col50 en_col50 d11_col50 0 nenh w=4u l=.4u
mn2col50 d2_col50 en_col50 d22_col50 0 nenh w=4u l=.4u
mp1col50 d11_col50 enb_col50 d1_col50 2.97 penh w=8u l=0.4u
mp2col50 d22_col50 enb_col50 d2_col50 2.97 penh w=8u l=0.4u

r_en_col50 en_col50 0 10000k
r1_en_col50 en_col50 en1_col50 5
r_enb_col50 enb_col50 0 10000k
r1_enb_col50 enb_col50 enb1_col50 5

r_d11_col50 d11_col50 0 10000k

r1_d11_col50 d11_col50 d111_col50 5
r_d22_col50 d22_col50 0 10000k
r1_d22_col50 d22_col50 d222_col50 5

r_SL1col50 SL1col50 0 10000k
r1_SL1col50 SL1col50 SL11col50 5
r_SL2col50 SL2col50 0 10000k
r1_SL2col50 SL2col50 SL22col50 5

* col51

mn1col51 d1_col51 en_col51 d11_col51 0 nenh w=4u l=.4u
mn2col51 d2_col51 en_col51 d22_col51 0 nenh w=4u l=.4u
mp1col51 d11_col51 enb_col51 d1_col51 2.97 penh w=8u l=0.4u
mp2col51 d22_col51 enb_col51 d2_col51 2.97 penh w=8u l=0.4u

r_en_col51 en_col51 0 10000k
r1_en_col51 en_col51 en1_col51 5
r_enb_col51 enb_col51 0 10000k
r1_enb_col51 enb_col51 enb1_col51 5

r_d11_col51 d11_col51 0 10000k
r1_d11_col51 d11_col51 d111_col51 5
r_d22_col51 d22_col51 0 10000k
r1_d22_col51 d22_col51 d222_col51 5

r_SL1col51 SL1col51 0 10000k
r1_SL1col51 SL1col51 SL11col51 5
r_SL2col51 SL2col51 0 10000k
r1_SL2col51 SL2col51 SL22col51 5

* col52

mn1col52 d1_col52 en_col52 d11_col52 0 nenh w=4u l=.4u
mn2col52 d2_col52 en_col52 d22_col52 0 nenh w=4u l=.4u
mp1col52 d11_col52 enb_col52 d1_col52 2.97 penh w=8u l=0.4u
mp2col52 d22_col52 enb_col52 d2_col52 2.97 penh w=8u l=0.4u

r_en_col52 en_col52 0 10000k
r1_en_col52 en_col52 en1_col52 5
r_enb_col52 enb_col52 0 10000k
r1_enb_col52 enb_col52 enb1_col52 5

r_d11_col52 d11_col52 0 10000k
r1_d11_col52 d11_col52 d111_col52 5
r_d22_col52 d22_col52 0 10000k
r1_d22_col52 d22_col52 d222_col52 5

r_SL1col52 SL1col52 0 10000k
r1_SL1col52 SL1col52 SL11col52 5
r_SL2col52 SL2col52 0 10000k
r1_SL2col52 SL2col52 SL22col52 5

* col53

mn1col53 d1_col53 en_col53 d11_col53 0 nenh w=4u l=.4u
mn2col53 d2_col53 en_col53 d22_col53 0 nenh w=4u l=.4u
mp1col53 d11_col53 enb_col53 d1_col53 2.97 penh w=8u l=0.4u
mp2col53 d22_col53 enb_col53 d2_col53 2.97 penh w=8u l=0.4u

r_en_col53 en_col53 0 10000k
r1_en_col53 en_col53 en1_col53 5
r_enb_col53 enb_col53 0 10000k
r1_enb_col53 enb_col53 enb1_col53 5

r_d11_col53 d11_col53 0 10000k
r1_d11_col53 d11_col53 d111_col53 5
r_d22_col53 d22_col53 0 10000k
r1_d22_col53 d22_col53 d222_col53 5

r_SL1col53 SL1col53 0 10000k
r1_SL1col53 SL1col53 SL11col53 5
r_SL2col53 SL2col53 0 10000k
r1_SL2col53 SL2col53 SL22col53 5

* col54

mn1col54 d1_col54 en_col54 d11_col54 0 nenh w=4u l=.4u
mn2col54 d2_col54 en_col54 d22_col54 0 nenh w=4u l=.4u
mp1col54 d11_col54 enb_col54 d1_col54 2.97 penh w=8u l=0.4u
mp2col54 d22_col54 enb_col54 d2_col54 2.97 penh w=8u l=0.4u

r_en_col54 en_col54 0 10000k
r1_en_col54 en_col54 en1_col54 5
r_enb_col54 enb_col54 0 10000k
r1_enb_col54 enb_col54 enb1_col54 5

r_d11_col54 d11_col54 0 10000k
r1_d11_col54 d11_col54 d111_col54 5
r_d22_col54 d22_col54 0 10000k
r1_d22_col54 d22_col54 d222_col54 5
r_SL1col54 SL1col54 0 10000k
r1_SL1col54 SL1col54 SL11col54 5
r_SL2col54 SL2col54 0 10000k
r1_SL2col54 SL2col54 SL22col54 5

* col55

mn1col55 d1_col55 en_col55 d11_col55 0 nenh w=4u l=.4u
mn2col55 d2_col55 en_col55 d22_col55 0 nenh w=4u l=.4u
mp1col55 d11_col55 enb_col55 d1_col55 2.97 penh w=8u l=0.4u
mp2col55 d22_col55 enb_col55 d2_col55 2.97 penh w=8u l=0.4u

r_en_col55 en_col55 0 10000k
r1_en_col55 en_col55 en1_col55 5
r_enb_col55 enb_col55 0 10000k
r1_enb_col55 enb_col55 enb1_col55 5

r_d11_col55 d11_col55 0 10000k
r1_d11_col55 d11_col55 d111_col55 5
r_d22_col55 d22_col55 0 10000k
r1_d22_col55 d22_col55 d222_col55 5

r_SL1col55 SL1col55 0 10000k
r1_SL1col55 SL1col55 SL11col55 5
r_SL2col55 SL2col55 0 10000k
r1_SL2col55 SL2col55 SL22col55 5

* col56

mn1col56 d1_col56 en_col56 d11_col56 0 nenh w=4u l=.4u
mn2col56 d2_col56 en_col56 d22_col56 0 nenh w=4u l=.4u
mp1col56 d11_col56 enb_col56 d1_col56 2.97 penh w=8u l=0.4u
mp2col56 d22_col56 enb_col56 d2_col56 2.97 penh w=8u l=0.4u

r_en_col56 en_col56 0 10000k
r1_en_col56 en_col56 en1_col56 5
r_enb_col56 enb_col56 0 10000k
r1_enb_col56 enb_col56 enb1_col56 5

r_d11_col56 d11_col56 0 10000k
r1_d11_col56 d11_col56 d111_col56 5
r_d22_col56 d22_col56 0 10000k
r1_d22_col56 d22_col56 d222_col56 5

r_SL1col56 SL1col56 0 10000k
r1_SL1col56 SL1col56 SL11col56 5
r_SL2col56 SL2col56 0 10000k
r1_SL2col56 SL2col56 SL22col56 5

* col57

mn1col57 d1_col57 en_col57 d11_col57 0 nenh w=4u l=.4u
mn2col57 d2_col57 en_col57 d22_col57 0 nenh w=4u l=.4u
mp1col57 d11_col57 enb_col57 d1_col57 2.97 penh w=8u l=0.4u
mp2col57 d22_col57 enb_col57 d2_col57 2.97 penh w=8u l=0.4u

r_en_col57 en_col57 0 10000k
r1_en_col57 en_col57 en1_col57 5
r_enb_col57 enb_col57 0 10000k
r1_enb_col57 enb_col57 enb1_col57 5

r_d11_col57 d11_col57 0 10000k
r1_d11_col57 d11_col57 d111_col57 5
r_d22_col57 d22_col57 0 10000k
r1_d22_col57 d22_col57 d222_col57 5

r_SL1col57 SL1col57 0 10000k
r1_SL1col57 SL1col57 SL11col57 5
r_SL2col57 SL2col57 0 10000k
r1_SL2col57 SL2col57 SL22col57 5

* col58

mn1col58 d1_col58 en_col58 d11_col58 0 nenh w=4u l=.4u
mn2col58 d2_col58 en_col58 d22_col58 0 nenh w=4u l=.4u
mp1col58 d11_col58 enb_col58 d1_col58 2.97 penh w=8u l=0.4u
mp2col58 d22_col58 enb_col58 d2_col58 2.97 penh w=8u l=0.4u

r_en_col58 en_col58 0 10000k
r1_en_col58 en_col58 en1_col58 5
r_enb_col58 enb_col58 0 10000k
r1_enb_col58 enb_col58 enb1_col58 5

r_d11_col58 d11_col58 0 10000k
r1_d11_col58 d11_col58 d111_col58 5
r_d22_col58 d22_col58 0 10000k
r1_d22_col58 d22_col58 d222_col58 5

r_SL1col58 SL1col58 0 10000k
r1_SL1col58 SL1col58 SL11col58 5
r_SL2col58 SL2col58 0 10000k
r1_SL2col58 SL2col58 SL22col58 5

* col59

mn1col59 d1_col59 en_col59 d11_col59 0 nenh w=4u l=.4u
mn2col59 d2_col59 en_col59 d22_col59 0 nenh w=4u l=.4u
mp1col59 d11_col59 enb_col59 d1_col59 2.97 penh w=8u l=0.4u
mp2col59 d22_col59 enb_col59 d2_col59 2.97 penh w=8u l=0.4u

r_en_col59 en_col59 0 10000k
r1_en_col59 en_col59 en1_col59 5

r_enb_col59 enb_col59 0 10000k
r1_enb_col59 enb_col59 enb1_col59 5

r_d11_col59 d11_col59 0 10000k
r1_d11_col59 d11_col59 d111_col59 5
r_d22_col59 d22_col59 0 10000k
r1_d22_col59 d22_col59 d222_col59 5

r_SL1col59 SL1col59 0 10000k
r1_SL1col59 SL1col59 SL11col59 5
r_SL2col59 SL2col59 0 10000k
r1_SL2col59 SL2col59 SL22col59 5

* col60

mn1col60 d1_col60 en_col60 d11_col60 0 nenh w=4u l=.4u
mn2col60 d2_col60 en_col60 d22_col60 0 nenh w=4u l=.4u
mp1col60 d11_col60 enb_col60 d1_col60 2.97 penh w=8u l=0.4u
mp2col60 d22_col60 enb_col60 d2_col60 2.97 penh w=8u l=0.4u

r_en_col60 en_col60 0 10000k
r1_en_col60 en_col60 en1_col60 5
r_enb_col60 enb_col60 0 10000k
r1_enb_col60 enb_col60 enb1_col60 5

r_d11_col60 d11_col60 0 10000k
r1_d11_col60 d11_col60 d111_col60 5
r_d22_col60 d22_col60 0 10000k
r1_d22_col60 d22_col60 d222_col60 5

r_SL1col60 SL1col60 0 10000k
r1_SL1col60 SL1col60 SL11col60 5
r_SL2col60 SL2col60 0 10000k
r1_SL2col60 SL2col60 SL22col60 5

* col61

mn1col61 d1_col61 en_col61 d11_col61 0 nenh w=4u l=.4u
mn2col61 d2_col61 en_col61 d22_col61 0 nenh w=4u l=.4u
mp1col61 d11_col61 enb_col61 d1_col61 2.97 penh w=8u l=0.4u
mp2col61 d22_col61 enb_col61 d2_col61 2.97 penh w=8u l=0.4u

r_en_col61 en_col61 0 10000k
r1_en_col61 en_col61 en1_col61 5
r_enb_col61 enb_col61 0 10000k
r1_enb_col61 enb_col61 enb1_col61 5

r_d11_col61 d11_col61 0 10000k
r1_d11_col61 d11_col61 d111_col61 5
r_d22_col61 d22_col61 0 10000k
r1_d22_col61 d22_col61 d222_col61 5

r_SL1col61 SL1col61 0 10000k
r1_SL1col61 SL1col61 SL11col61 5
r_SL2col61 SL2col61 0 10000k
r1_SL2col61 SL2col61 SL22col61 5

* col62

mn1col62 d1_col62 en_col62 d11_col62 0 nenh w=4u l=.4u
mn2col62 d2_col62 en_col62 d22_col62 0 nenh w=4u l=.4u
mp1col62 d11_col62 enb_col62 d1_col62 2.97 penh w=8u l=0.4u
mp2col62 d22_col62 enb_col62 d2_col62 2.97 penh w=8u l=0.4u

v_en_col1 en1_col1 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col1 enb1_col1 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col2 en1_col2 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col2 enb1_col2 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col3 en1_col3 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col3 enb1_col3 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col4 en1_col4 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col4 enb1_col4 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col5 en1_col5 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col5 enb1_col5 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col6 en1_col6 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col6 enb1_col6 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col7 en1_col7 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col7 enb1_col7 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col8 en1_col8 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col8 enb1_col8 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col9 en1_col9 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col9 enb1_col9 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col10 en1_col10 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col10 enb1_col10 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col11 en1_col11 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col11 enb1_col11 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col12 en1_col12 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col12 enb1_col12 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col13 en1_col13 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col13 enb1_col13 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col14 en1_col14 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col14 enb1_col14 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col15 en1_col15 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col15 enb1_col15 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col16 en1_col16 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col16 enb1_col16 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col17 en1_col17 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col17 enb1_col17 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col18 en1_col18 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col18 enb1_col18 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col19 en1_col19 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col19 enb1_col19 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col20 en1_col20 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col20 enb1_col20 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col21 en1_col21 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col21 enb1_col21 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col22 en1_col22 0 pulse(0 2.97 1n 1p 1p 2n 20n)

v_enb_col22 enb1_col22 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col23 en1_col23 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col23 enb1_col23 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col24 en1_col24 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col24 enb1_col24 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col25 en1_col25 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col25 enb1_col25 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col26 en1_col26 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col26 enb1_col26 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col27 en1_col27 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col27 enb1_col27 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col28 en1_col28 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col28 enb1_col28 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col29 en1_col29 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col29 enb1_col29 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col30 en1_col30 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col30 enb1_col30 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col31 en1_col31 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col31 enb1_col31 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col32 en1_col32 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col32 enb1_col32 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col33 en1_col33 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col33 enb1_col33 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col34 en1_col34 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col34 enb1_col34 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col35 en1_col35 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col35 enb1_col35 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col36 en1_col36 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col36 enb1_col36 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col37 en1_col37 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col37 enb1_col37 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col38 en1_col38 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col38 enb1_col38 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col39 en1_col39 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col39 enb1_col39 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col40 en1_col40 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col40 enb1_col40 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col41 en1_col41 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col41 enb1_col41 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col42 en1_col42 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col42 enb1_col42 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col43 en1_col43 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col43 enb1_col43 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col44 en1_col44 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col44 enb1_col44 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col45 en1_col45 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col45 enb1_col45 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col46 en1_col46 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col46 enb1_col46 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col47 en1_col47 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col47 enb1_col47 0 pulse(2.97 0 1n 1p 1p 2n 20n)
v_en_col48 en1_col48 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col48 enb1_col48 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col49 en1_col49 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col49 enb1_col49 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col50 en1_col50 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col50 enb1_col50 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col51 en1_col51 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col51 enb1_col51 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col52 en1_col52 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col52 enb1_col52 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col53 en1_col53 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col53 enb1_col53 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col54 en1_col54 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col54 enb1_col54 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col55 en1_col55 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col55 enb1_col55 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col56 en1_col56 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col56 enb1_col56 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col57 en1_col57 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col57 enb1_col57 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col58 en1_col58 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col58 enb1_col58 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col59 en1_col59 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col59 enb1_col59 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col60 en1_col60 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col60 enb1_col60 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col61 en1_col61 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col61 enb1_col61 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col62 en1_col62 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col62 enb1_col62 0 pulse(2.97 0 1n 1p 1p 2n 20n)

v_en_col63 en1_col63 0 pulse(0 2.97 1n 1p 1p 2n 20n)
v_enb_col63 enb1_col63 0 pulse(2.97 0 1n 1p 1p 2n 20n)

* data lines *

v_d1col0 d111_col0 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22n 2.97 22.5n 0 23n 0
+41n 0 41.5n 2.97 42.5n 2.97 43n 0
+61n 0 61.5n 2.97 62n 2.97 62.5n 0 63n 0 81n 0 81.5n 2.97 82.5n 2.97 83n 0)
v_d2col0 d222_col0 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22.5n 2.97 23n 0
+41n 0 41.5n 2.97 42n 2.97 42.5n 0 43n 0
+61n 0 61.5n 2.97 62.5n 2.97 63n 0 81n 0 81.5n 2.97 82n 2.97 82.5n 0 83n 0)

v_d1col1 d111_col1 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22.5n 2.97 23n 0
+41n 0 41.5n 2.97 42n 2.97 42.5n 0 43n 0
+61n 0 61.5n 2.97 62.5n 2.97 63n 0 81n 0 81.5n 2.97 82n 2.97 82.5n 0 83n 0)
v_d2col1 d222_col1 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22n 2.97 22.5n 0 23n 0
+41n 0 41.5n 2.97 42.5n 2.97 43n 0
+61n 0 61.5n 2.97 62n 2.97 62.5n 0 63n 0 81n 0 81.5n 2.97 82.5n 2.97 83n 0)

v_d1col2 d111_col2 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22.5n 2.97 23n 0
+41n 0 41.5n 2.97 42n 2.97 42.5n 0 43n 0
+61n 0 61.5n 2.97 62.5n 2.97 63n 0 81n 0 81.5n 2.97 82n 2.97 82.5n 0 83n 0)
v_d2col2 d222_col2 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22n 2.97 22.5n 0 23n 0
+41n 0 41.5n 2.97 42.5n 2.97 43n 0
+61n 0 61.5n 2.97 62n 2.97 62.5n 0 63n 0 81n 0 81.5n 2.97 82.5n 2.97 83n 0)

v_d1col3 d111_col3 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22n 2.97 22.5n 0 23n 0
+41n 0 41.5n 2.97 42.5n 2.97 43n 0
+61n 0 61.5n 2.97 62n 2.97 62.5n 0 63n 0 81n 0 81.5n 2.97 82.5n 2.97 83n 0)
v_d2col3 d222_col3 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22.5n 2.97 23n 0
+41n 0 41.5n 2.97 42n 2.97 42.5n 0 43n 0
+61n 0 61.5n 2.97 62.5n 2.97 63n 0 81n 0 81.5n 2.97 82.0n 2.97 82.5n 0 83n 0)

v_d1col4 d111_col4 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22.5n 2.97 23n 0
+41n 0 41.5n 2.97 42n 2.97 42.5n 0 43n 0
+61n 0 61.5n 2.97 62.5n 2.97 63n 0 81n 0 81.5n 2.97 82n 2.97 82.5n 0 83n 0)
v_d2col4 d222_col4 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22n 2.97 22.5n 0 23n 0
+41n 0 41.5n 2.97 42.5n 2.97 43n 0
+61n 0 61.5n 2.97 62n 2.97 62.5n 0 63n 0 81n 0 81.5n 2.97 82.5n 2.97 83n 0)

v_d1col5 d111_col5 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22.5n 2.97 23n 0
+41n 0 41.5n 2.97 42n 2.97 42.5n 0 43n 0
+61n 0 61.5n 2.97 62.5n 2.97 63n 0 81n 0 81.5n 2.97 82.0n 2.97 82.5n 0 83n 0)
v_d2col5 d222_col5 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22n 2.97 22.5n 0 23n 0
+41n 0 41.5n 2.97 42.5n 2.97 43n 0
+61n 0 61.5n 2.97 62n 2.97 62.5n 0 63n 0 81n 0 81.5n 2.97 82.5n 2.97 83n 0)

v_d1col6 d111_col6 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22n 2.97 22.5n 0 23n 0
+41n 0 41.5n 2.97 42.5n 2.97 43n 0
+61n 0 61.5n 2.97 62n 2.97 62.5n 0 63n 0 81n 0 81.5n 2.97 82.5n 2.97 83n 0)
v_d2col6 d222_col6 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22.5n 2.97 23n 0
+41n 0 41.5n 2.97 42n 2.97 42.5n 0 43n 0
+61n 0 61.5n 2.97 62.5n 2.97 63n 0 81n 0 81.5n 2.97 82.0n 2.97 82.5n 0 83n 0)

v_d1col7 d111_col7 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22n 2.97 22.5n 0 23n 0
+41n 0 41.5n 2.97 42n 2.97 42.5n 0
+43n 0 61n 0 61.5n 2.97 62.5n 2.97 63n 0 81n 0 81.5n 2.97 82.5n 2.97 83n 0)
v_d2col7 d222_col7 0 pwl(0 0 1n 0 1.5n 2.97 2.5n 2.97 3n 0 21n 0 21.5n 2.97 22.5n 2.97 23n 0
+41n 0 41.5n 2.97 42.5n 2.97 43n 0
+61n 0 61.5n 2.97 62n 2.97 62.5n 0 63n 0 81n 0 81.5n 2.97 82n 2.97 82.5n 0 83n 0)
*^^^ 1st cycle = mismatch (1 bit mismatch at row=0 col=7) 2nd cycle = full match


```
*****
*          search enables          *
*****
```

vSErow0 SE1_row0 0 pulse(0 2.97 7n .1n .1n 2.8n 20n)

```
*****
*          pre-charge              *
*****
```

vpre_row01 pre1_row01 0 pulse(2.97 0 7n 0.1n 0.1n 2.8n 20n)
vpre_row02 pre1_row02 0 pulse(2.97 0 7n 0.1n 0.1n 2.8n 20n)
vpre_row03 pre1_row03 0 pulse(2.97 0 7n 0.1n 0.1n 2.8n 20n)
vpre_row04 pre1_row04 0 pulse(2.97 0 7n 0.1n 0.1n 2.8n 20n)

```
*****
*          ML reset                *
*****
```

vML1reset_row0 ML1reset_row0 0 pulse(0 2.97 5n .1n .1n .5n 20n)
vML2reset_row0 ML2reset_row0 0 pulse(0 2.97 5n .1n .1n .5n 20n)
vML3reset_row0 ML3reset_row0 0 pulse(0 2.97 5n .1n .1n .5n 20n)
vML4reset_row0 ML4reset_row0 0 pulse(0 2.97 5n .1n .1n .5n 20n)

.....
cells_array64bit_Pipelining_Slow.cir
.....

xtcam_cell_0_0 d1_col0 d2_col0 SL1col0 SL2col0 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_1 d1_col1 d2_col1 SL1col1 SL2col1 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_2 d1_col2 d2_col2 SL1col2 SL2col2 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_3 d1_col3 d2_col3 SL1col3 SL2col3 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_4 d1_col4 d2_col4 SL1col4 SL2col4 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_5 d1_col5 d2_col5 SL1col5 SL2col5 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_6 d1_col6 d2_col6 SL1col6 SL2col6 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_7 d1_col7 d2_col7 SL1col7 SL2col7 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_8 d1_col8 d2_col8 SL1col8 SL2col8 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_9 d1_col9 d2_col9 SL1col9 SL2col9 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_10 d1_col10 d2_col10 SL1col10 SL2col10 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_11 d1_col11 d2_col11 SL1col11 SL2col11 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_12 d1_col12 d2_col12 SL1col12 SL2col12 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_13 d1_col13 d2_col13 SL1col13 SL2col13 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_14 d1_col14 d2_col14 SL1col14 SL2col14 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell
xtcam_cell_0_15 d1_col15 d2_col15 SL1col15 SL2col15 en_row0 enb_row0 SE_row0 ML1row0 u2 | tcam_cell

xtcam_cell_0_16 d1_col16 d2_col16 SL1col16 SL2col16 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_17 d1_col17 d2_col17 SL1col17 SL2col17 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_18 d1_col18 d2_col18 SL1col18 SL2col18 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_19 d1_col19 d2_col19 SL1col19 SL2col19 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_20 d1_col20 d2_col20 SL1col20 SL2col20 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_21 d1_col21 d2_col21 SL1col21 SL2col21 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_22 d1_col22 d2_col22 SL1col22 SL2col22 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_23 d1_col23 d2_col23 SL1col23 SL2col23 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_24 d1_col24 d2_col24 SL1col24 SL2col24 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_25 d1_col25 d2_col25 SL1col25 SL2col25 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_26 d1_col26 d2_col26 SL1col26 SL2col26 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_27 d1_col27 d2_col27 SL1col27 SL2col27 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_28 d1_col28 d2_col28 SL1col28 SL2col28 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_29 d1_col29 d2_col29 SL1col29 SL2col29 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell
xtcam_cell_0_30 d1_col30 d2_col30 SL1col30 SL2col30 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell

xtcam_cell_0_31 d1_col31 d2_col31 SL1col31 SL2col31 en_row0 enb_row0 SE_row0 ML2row0 u2 | tcam_cell

xtcam_cell_0_32 d1_col32 d2_col32 SL1col32 SL2col32 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_33 d1_col33 d2_col33 SL1col33 SL2col33 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_34 d1_col34 d2_col34 SL1col34 SL2col34 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_35 d1_col35 d2_col35 SL1col35 SL2col35 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_36 d1_col36 d2_col36 SL1col36 SL2col36 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_37 d1_col37 d2_col37 SL1col37 SL2col37 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_38 d1_col38 d2_col38 SL1col38 SL2col38 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_39 d1_col39 d2_col39 SL1col39 SL2col39 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_40 d1_col40 d2_col40 SL1col40 SL2col40 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_41 d1_col41 d2_col41 SL1col41 SL2col41 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_42 d1_col42 d2_col42 SL1col42 SL2col42 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_43 d1_col43 d2_col43 SL1col43 SL2col43 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_44 d1_col44 d2_col44 SL1col44 SL2col44 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_45 d1_col45 d2_col45 SL1col45 SL2col45 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_46 d1_col46 d2_col46 SL1col46 SL2col46 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell
xtcam_cell_0_47 d1_col47 d2_col47 SL1col47 SL2col47 en_row0 enb_row0 SE_row0 ML3row0 u2 | tcam_cell

xtcam_cell_0_48 d1_col48 d2_col48 SL1col48 SL2col48 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_49 d1_col49 d2_col49 SL1col49 SL2col49 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_50 d1_col50 d2_col50 SL1col50 SL2col50 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_51 d1_col51 d2_col51 SL1col51 SL2col51 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_52 d1_col52 d2_col52 SL1col52 SL2col52 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_53 d1_col53 d2_col53 SL1col53 SL2col53 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_54 d1_col54 d2_col54 SL1col54 SL2col54 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_55 d1_col55 d2_col55 SL1col55 SL2col55 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_56 d1_col56 d2_col56 SL1col56 SL2col56 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_57 d1_col57 d2_col57 SL1col57 SL2col57 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_58 d1_col58 d2_col58 SL1col58 SL2col58 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_59 d1_col59 d2_col59 SL1col59 SL2col59 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_60 d1_col60 d2_col60 SL1col60 SL2col60 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_61 d1_col61 d2_col61 SL1col61 SL2col61 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_62 d1_col62 d2_col62 SL1col62 SL2col62 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell
xtcam_cell_0_63 d1_col63 d2_col63 SL1col63 SL2col63 en_row0 enb_row0 SE_row0 ML4row0 u2 | tcam_cell