

Logic Diagram

## FEATURES:

### 512K x 40-bit EEPROM MCM

- RAD-PAK® radiation-hardened against natural space radiation
- Total dose hardness:
  - >100 krad (Si)
  - Dependent upon orbit
- Excellent Single event effects @ 25°C
  - SEL<sub>TH</sub> > 120 MeV cm<sup>2</sup>/mg (Device)
  - SEU<sub>TH</sub> > 90 MeV cm<sup>2</sup>/mg (Memory Cells)
  - SEU<sub>TH</sub> > 18 MeV cm<sup>2</sup>/mg (Write Mode)
  - SET<sub>TH</sub> > 40 MeV cm<sup>2</sup>/mg (Read Mode)
- High endurance
  - 10,000 cycles/byte (Page Programming Mode)
  - 10 year data retention
- Page Write Mode: 128 Dword Page
- High Speed:
  - 150 and 200 ns maximum access times
- Automatic programming
  - 10 ms automatic Page/Dword write
- Low power dissipation
  - 375 mW/MHz active current
  - 3.2 mW standby current

## DESCRIPTION:

Maxwell Technologies' 79C2040B multi-chip module (MCM) memory features a greater than 100 krad (Si) total dose tolerance, dependent upon orbit. Using Maxwell Technologies' patented radiation-hardened RAD-PAK® MCM packaging technology, the 79C2040B is the first radiation-hardened 20 megabit MCM EEPROM for space application. The 79C2040B uses twenty 1 Megabit high speed CMOS die to yield a 20 megabit product. The 79C2040B is capable of in-system electrical byte and page programmability. It has a 128 word page programming function to make the erase and write operations faster. It also features Data Polling and a Ready/Busy signal to indicate the completion of erase and programming operations. In the 79C2040B, hardware data protection is provided with the RES pin, in addition to noise protection on the WE signal and write inhibit on power on and off. Software data protection is implemented using the JEDEC optional standard algorithm.

Maxwell Technologies' patented RAD-PAK® packaging technology incorporates radiation shielding in the microcircuit package. It eliminates the need for box shielding while providing the required radiation shielding for a lifetime in orbit or space mission. In a GEO orbit, RAD-PAK® provides greater than 100 krad (Si) radiation dose tolerance. This product is available with screening up to Maxwell Technologies' self-defined Class K

PINOUT DESCRIPTION

1	VSS	VSS	100
2	VCC	VCC	99
3	D23	D31	98
4	D22	D30	97
5	D21	D29	96
6	D20	D28	95
7	D19	D27	94
8	D18	D26	93
9	D17	D25	92
10	D16	D24	91
11	VSS	VSS	90
12	VCC	VCC	89
13	CS0	D32	88
14	CS1	D33	87
15	CS2	D34	86
16	CS3	D35	85
17	NC	D36	84
18	NC	D37	83
19	NC	D38	82
20	NC	D39	81
21	VSS	VSS	80
22	VCC	VCC	79
23	A0	A8	78
24	A1	A9	77
25	A2	A10	76
26	A3	A11	75
27	A4	A12	74
28	A5	A13	73
29	VCC	VCC	72
30	VSS	VSS	71
31	A6	A14	70
32	A7	A15	69
33	RES	A16	68
34	WE0	OE	67
35	WE1	RBSY0	66
36	WE2	RBSY1	65
37	WE3	RBSY2	64
38	WE4	RBSY3	63
39	VCC	VCC	62
40	VSS	VSS	61
41	D8	D0	60
42	D9	D1	59
43	D10	D2	58
44	D11	D3	57
45	D12	D4	56
46	D13	D5	55
47	D14	D6	54
48	D15	D7	53
49	VCC	VCC	52
50	VSS	VSS	51

1, 11, 21, 30, 40, 50, 51, 61, 71, 80, 90, 100		VSS - Ground
2, 12, 22, 29, 39, 49, 52, 62, 72, 79, 89, 99		VCC - Positive Supply
60 - 53, 41 - 48, 10 - 3, 91 - 98, 88 - 81		D0 to D39 Data I/O
13, 14, 15, 16		CS0\ - CS3\ Chip Enable
23 - 28, 31, 32, 78 - 73, 70 - 68		A0 to A16 Address Inputs
33		RES\ - Reset
34 - 38		WE0 - WE4 Write Enables
66 - 63		RBSY0 - RBSY3 Ready/Busy

TABLE 1. 79C2040B ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT
Supply Voltage	$V_{CC}$	-0.6		7.0	V
Input Voltage	$V_{IN}$	-0.5 <sup>1</sup>		7.0	V
Package Weight	RSF		35		Grams
Operating Temperature Range	$T_{OPR}$	-55		125	°C
Storage Temperature Range	$T_{STG}$	-65		150	°C

1.  $V_{IN}$  min = -3.0V for pulse width  $\leq 50$ ns.

TABLE 2. 79C2040B RECOMMENDED DC OPERATING CONDITIONS

PARAMETER	SYMBOL	MIN	MAX	UNIT
Supply Voltage	$V_{CC}$	4.5	5.5	V
Input Voltage	$V_{IL}$	-0.3 <sup>1</sup>	0.8	V
	$V_{IH}$	2.2	$V_{CC} + 0.3$	V
$\overline{RES\_PIN}$	$V_H$	$V_{CC} - 0.5$	$V_{CC} + 1$	V
Operating Temperature Range	$T_{OPR}$	-55	125	°C

1.  $V_{IL}$  min = -1.0V for pulse width  $\leq 50$  ns

TABLE 3. 79C2040B DELTA LIMITS<sup>1</sup>

PARAMETER	VARIATION <sup>2</sup>
$I_{CC1A}$	+/- 10 %
$I_{CC1D}$	+/- 10 %
$I_{CC2A}$	+/- 10 %
$I_{LI}$ - ADDR, CE, OE, WE	+/- 10 %
$I_{LI}$ - D0-D39	+/- 10 %

1. Parameters are measured and recorded per MIL-STD-883 for Class K devices

2. Specified value in Table 5

TABLE 4. 79C2040B CAPACITANCE

( $T_A = 25$  °C,  $f = 1$  MHz)

PARAMETER	SYMBOL	MIN	MAX	UNIT
Input Capacitance : $V_{IN} = 0V$ <sup>1</sup>	$C_{IN\ OE}$		6	pF
	$C_{IN\ WE}$		6	
	$C_{IN\ CE_{0-30}}$		30	
	$C_{IN\ A0-A16}$		6	
	$C_{IN\ RES}$		120	

TABLE 4. 79C2040B CAPACITANCE  
( $T_A = 25^\circ\text{C}$ ,  $f = 1\text{ MHz}$ )

PARAMETER	SYMBOL	MIN	MAX	UNIT
Output Capacitance: $V_{OUT} = 0V^1$	$C_{Out}$ RDY/BSY		60	pF
	$C_{Out}$ D0-D39	--	48	

1. Guaranteed by design.

TABLE 5. 79C2040B DC ELECTRICAL CHARACTERISTICS  
( $V_{CC} = 5V \pm 10\%$ ,  $T_A = -55\text{ TO }+125^\circ\text{C}$ )

PARAMETER	TEST CONDITION	SYMBOL	SUBGROUPS	MIN	MAX	UNITS
Input Leakage Current A0-A16, WE, OE	$V_{CC}=5.5V$ , $V_{IN} = V_{CC}$ & $V_{IN}=0V$	$I_{LI}$	1, 2, 3		1 <sup>1</sup>	$\mu\text{A}$
	$V_{CC}=5.5V$ , $V_{IN}=0V$ & $V_{IN}=0V$				10	$\mu\text{A}$
	$V_{CC}=5.5V$ , $V_{IN}=V_{CC}$ & $V_{IN}=0V$				8	$\mu\text{A}$
Input Leakage Current D0-D39	$V_{CC}=5.5V$ , $V_{IN}=V_{CC}$ & $V_{IN}=0V$				8	$\mu\text{A}$
Output Leakage Current <sup>1</sup>	( $V_{CC} = 5.5V$ , $V_{OUT} = 5.5V/0.4V$ )	$I_{LO}$	1, 2, 3	--	8	$\mu\text{A}$
Standby $V_{CC}$ Current	$CE = ADDR=WE=OE = V_{CC}$	$I_{CC1A}$	1, 2, 3	--	640	$\mu\text{A}$
	$CE = V_{IH}$ , $ADDR=WE=OE = 0V$	$I_{CC1D}$		--	21	$\text{mA}$
Operating $V_{CC}$ Current <sup>1,2</sup>	$OE = 0V$ $ADDR=WE=V_{CC}$ $I_{OUT} = 0\text{mA}$ , $CE$ Duty = 100%, Cycle = 1 $\mu\text{s}$ at $V_{CC} = 5.5V$	$I_{CC2A}$	1, 2, 3		75	$\text{mA}$
	$OE = ADDR=WE=0V$ $I_{OUT} = 0\text{mA}$ , $\overline{CE}$ Duty = 100%, Cycle = 150 ns at $V_{CC} = 5.5V$	$I_{CC2D}$		1, 2, 3		250
Input Voltage  $\overline{RES\_PIN}$		$V_{IL}$ $V_{IH}$	1, 2, 3	2.2	0.8	V
		$V_H$				
Output Voltage <sup>3</sup>	Data Lines: $V_{CC}$ Min, $I_{OL} = 2.1\text{mA}$	$V_{OL}$	1, 2, 3	--	0.4	V
	Data Lines: $V_{CC}$ Min, $I_{OH} = -400\mu\text{A}$	$V_{OH}$		2.4	--	V
	All Outputs: $V_{CC}$ Min, $I_{OH} = -100\mu\text{A}$			$V_{CC} - 0.3V$	--	V

1. For  $\overline{RES}$   $I_{IL} = 2000\mu\text{A}$

2. Only one  $\overline{CE}$  active (Logic Low)

3. RBSY is an open drain output. Only  $V_{OL}$  applies to this pin.

TABLE 6. 79C2040B AC ELECTRICAL CHARACTERISTICS FOR READ OPERATION <sup>1</sup>  
( $V_{CC} = 5V \pm 10\%$ ,  $T_A = -55\text{ TO }+125^\circ\text{C}$ )

PARAMETER	SYMBOL	SUBGROUPS	MIN	MAX	UNIT	
Address Access Time -150 -200	$\overline{CE} = \overline{OE} = V_{IL}$ , $\overline{WE} = V_{IH}$	$t_{ACC}$	9, 10, 11			
				--	150	ns
				--	200	

TABLE 6. 79C2040B AC ELECTRICAL CHARACTERISTICS FOR READ OPERATION <sup>1</sup>  
 ( $V_{CC} = 5V \pm 10\%$ ,  $T_A = -55$  TO  $+125^\circ\text{C}$ )

PARAMETER	SYMBOL	SUBGROUPS	MIN	MAX	UNIT
Chip Enable Access Time $\overline{OE} = V_{IL}, \overline{WE} = V_{IH}$ -150 -200	$t_{CE}$	9, 10, 11	-- --	150 200	ns
Output Enable Access Time $\overline{CE} = V_{IL}, \overline{WE} = V_{IH}$ -150 -200	$t_{OE}$	9, 10, 11	0 0	75 100	ns
Output Hold to Address Change $\overline{CE} = \overline{OE} = V_{IL}, \overline{WE} = V_{IH}$ -150 -200	$t_{OH}$	9, 10, 11	0 0	-- --	ns
Output Disable to High-Z <sup>2</sup> $\overline{CE} = V_{IL}, \overline{WE} = V_{IH}$ -150 -200	$t_{DF}$	9, 10, 11	0 0	50 60	ns
$\overline{CE} = \overline{OE} = V_{IL}, \overline{WE} = V_{IH}$ -150 -200	$t_{DFR}$		0 0	350 450	ns
RES to Output Delay $\overline{CE} = \overline{OE} = V_{IL}, \overline{WE} = V_{IH}$ <sup>3</sup> -150 -200	$t_{RR}$	9, 10, 11	0 0	450 650	ns

1. Test conditions: input pulse levels = 0.4V to 2.4V; input rise and fall times  $\leq 20$  ns; output load = 1 TTL gate + 100 pF (including scope and fixture); reference levels for measuring timing = 0.8 V/1.8 V.
2.  $t_{DF}$  and  $t_{DFR}$  are defined as the time at which the output becomes an open circuit and data is no longer driven.
3. Guaranteed by design.

TABLE 7. 79C2040B AC ELECTRICAL CHARACTERISTICS FOR WRITE OPERATION  
 ( $V_{CC} = 5V \pm 10\%$ ,  $T_A = -55$  TO  $+125^\circ\text{C}$ )

PARAMETER	SYMBOL	SUBGROUPS	MIN <sup>1</sup>	MAX	UNITS
Address Setup Time -150 -200	$t_{AS}$	9, 10, 11	0 0	-- --	ns
Chip Enable to Write Setup Time ( $\overline{WE}$ controlled) -150 -200	$t_{CS}$	9, 10, 11	0 0	-- --	ns
Write Pulse Width $\overline{CE}$ controlled -150 -200	$t_{CW}$	9, 10, 11	250 350	-- --	ns
$\overline{WE}$ controlled -150 -200	$t_{WP}$		250 350	-- --	ns

TABLE 7. 79C2040B AC ELECTRICAL CHARACTERISTICS FOR WRITE OPERATION  
 ( $V_{CC} = 5V \pm 10\%$ ,  $T_A = -55$  TO  $+125^\circ C$ )

PARAMETER	SYMBOL	SUBGROUPS	MIN <sup>1</sup>	MAX	UNITS
Address Hold Time -150 -200	$t_{AH}$	9, 10, 11	150 200	-- --	ns
Data Setup Time -150 -200	$t_{DS}$	9, 10, 11	100 150	-- --	ns
Data Hold Time -150 -200	$t_{DH}$	9, 10, 11	10 10	-- --	ns
Chip Enable Hold Time ( $\overline{WE}$ controlled) -150 -200	$t_{CH}$	9, 10, 11	0 0	-- --	ns
Write Enable to Write Setup Time ( $\overline{CE}$ controlled) -150 -200	$t_{WS}$	9, 10, 11	0 0	-- --	ns
Write Enable Hold Time ( $\overline{CE}$ controlled) -150 -200	$t_{WH}$	9, 10, 11	0 0	-- --	ns
Output Enable to Write Setup Time -150 -200	$t_{OES}$	9, 10, 11	0 0	-- --	ns
Output Enable Hold Time -150 -200	$t_{OEHL}$	9, 10, 11	0 0	-- --	ns
Write Cycle Time <sup>2</sup> -150 -200	$t_{WC}$	9, 10, 11	-- --	10 10	ms
Data Latch Time -150 -200	$t_{DL}$	9, 10, 11	300 400	-- --	ns
Byte Load Window -150 -200	$t_{BL}$	9, 10, 11	100 200	-- --	$\mu s$
Byte Load Cycle -150 -200	$t_{BLC}$	9, 10, 11	.55 .95	30 30	$\mu s$
Time to Device Busy -150 -200	$t_{DB}$	9, 10, 11	120 170	-- --	ns
Write Start Time <sup>3</sup> -150 -200	$t_{DW}$	9, 10, 11	150 250	-- --	ns

TABLE 7. 79C2040B AC ELECTRICAL CHARACTERISTICS FOR WRITE OPERATION  
( $V_{CC} = 5V \pm 10\%$ ,  $T_A = -55$  TO  $+125^\circ C$ )

PARAMETER	SYMBOL	SUBGROUPS	MIN <sup>1</sup>	MAX	UNITS
RES to Write Setup Time -150 -200	$t_{RP}$	9, 10, 11	100 200	-- --	$\mu s$
$V_{CC}$ to RES Setup Time <sup>4</sup> -150 -200	$t_{RES}$	9, 10, 11	1 3	-- --	$\mu s$

1. Use this device in a longer cycle than this value.
2.  $t_{WC}$  must be longer than this value unless polling techniques or  $\overline{RDY}/\overline{BUSY}$  are used. This device automatically completes the internal write operation within this value.
3. Next read or write operation can be initiated after  $t_{DW}$  if polling techniques or  $\overline{RDY}/\overline{BUSY}$  are used.
4. Guaranteed by design.

TABLE 8. 79C2040B MODE SELECTION <sup>1</sup>

PARAMETER	$\overline{CE}$ <sup>2</sup>	$\overline{OE}$	$\overline{WE}$	I/O	$\overline{RES}$	$\overline{RDY}/\overline{BUSY}$
Read	$V_{IL}$	$V_{IL}$	$V_{IH}$	$D_{OUT}$	$V_H$	High-Z
Standby	$V_{IH}$	X	X	High-Z	X	High-Z
Write	$V_{IL}$	$V_{IH}$	$V_{IL}$	$D_{IN}$	$V_H$	High-Z --> $V_{OL}$
Deselect	$V_{IL}$	$V_{IH}$	$V_{IH}$	High-Z	$V_H$	High-Z
Write Inhibit	X	X	$V_{IH}$	--	X	--
	X	$V_{IL}$	X	--	X	--
Data Polling	$V_{IL}$	$V_{IL}$	$V_{IH}$	Data Out <sup>3</sup>	$V_H$	$V_{OL}$
Program Reset	X	X	X	High-Z	$V_L$	High-Z

1. Refer to the recommended DC operating conditions.
2. For  $\overline{CE}_{0-3}$  only one  $\overline{CE}$  can be used (active) at a time.
3. Bits 7, 15, 23, 31 and 39

FIGURE 1. READ TIMING WAVEFORM

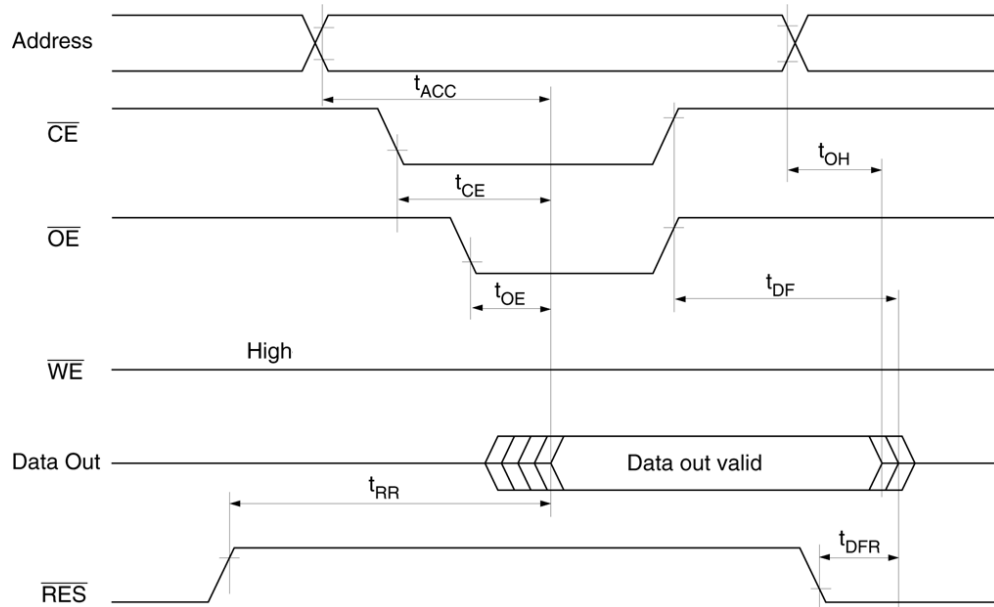


FIGURE 2. BYTE WRITE TIMING WAVEFORM (1) ( $\overline{WE}$  CONTROLLED)

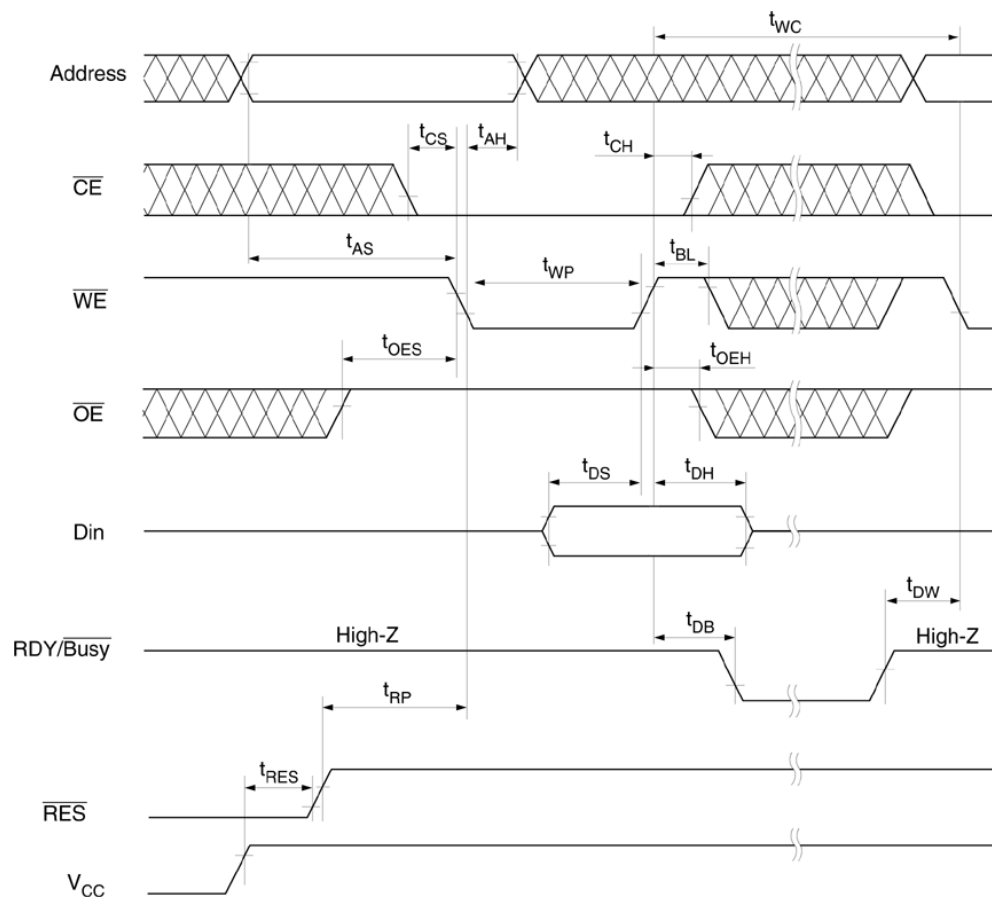


FIGURE 3. BYTE WRITE TIMING WAVEFORM (2) ( $\overline{CE}$  CONTROLLED)

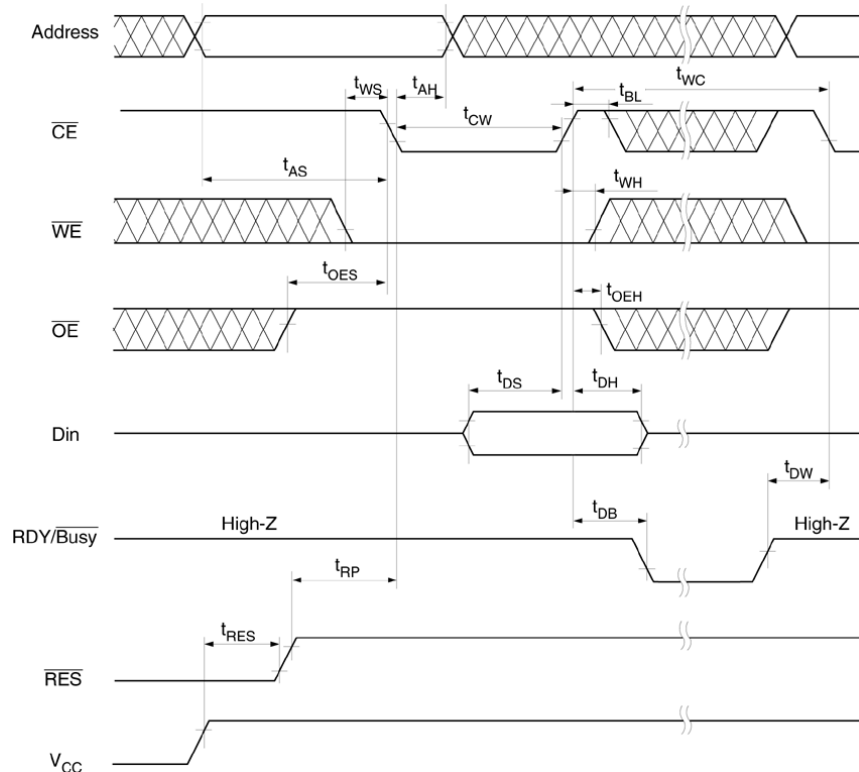
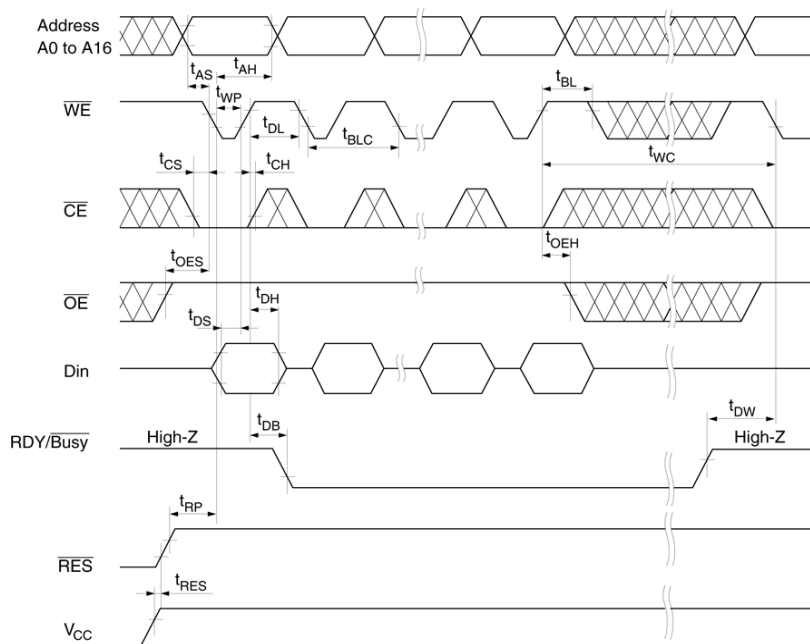
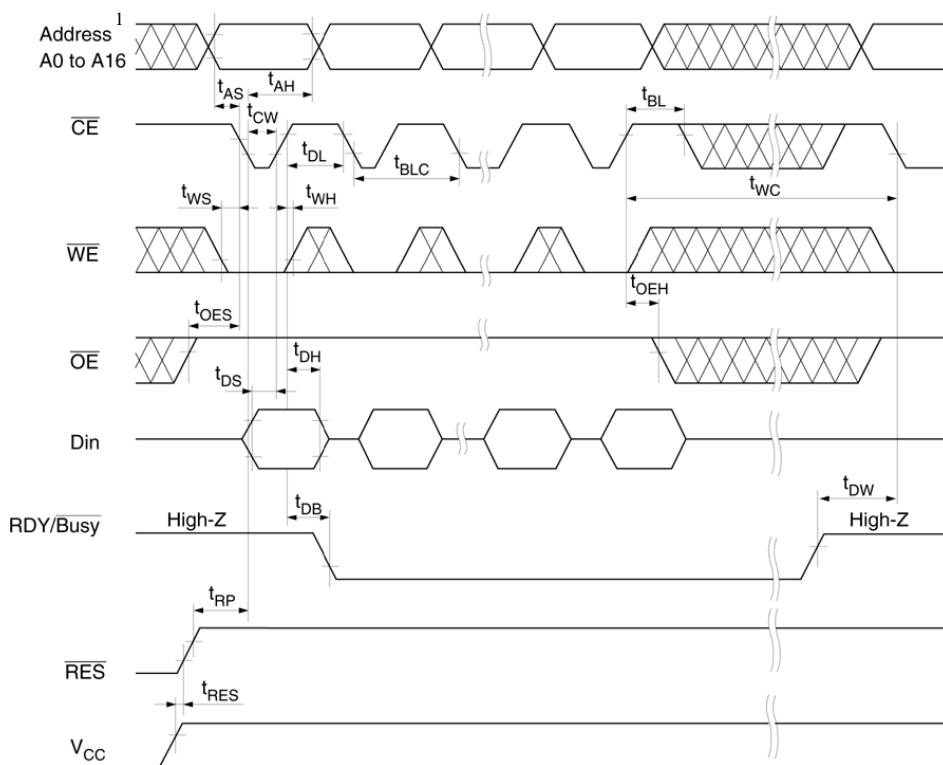


FIGURE 4. PAGE WRITE TIMING WAVEFORM (1) ( $\overline{WE}$  CONTROLLED)



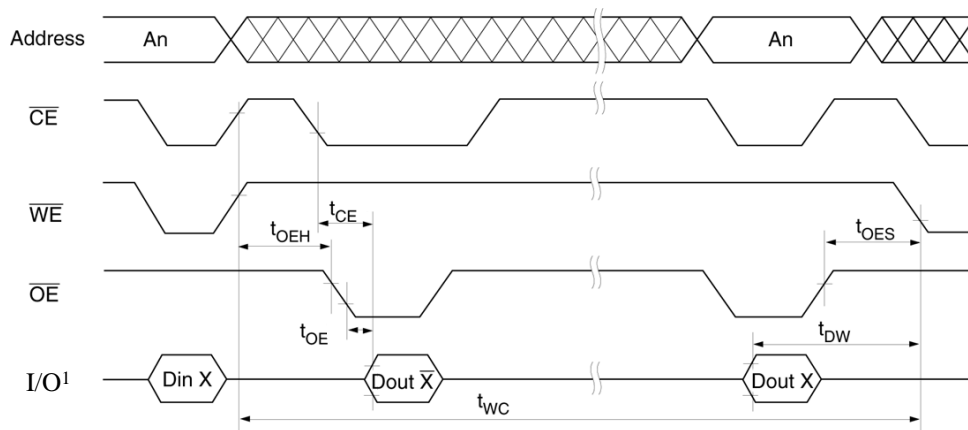
1) A7-A16 are Page Addresses and must be the same within a Page Write Operation.

FIGURE 5. PAGE WRITE TIMING WAVEFORM (2) ( $\overline{CE}$  CONTROLLED)



1) A7-A16 are Page Addresses and must be the same within a Page Write Operation.

FIGURE 6. DATA POLLING TIMING WAVEFORM



1) I/O 7, 15, 23, 31 A AND 39

FIGURE 7. SOFTWARE DATA PROTECTION TIMING WAVEFORM (1) (IN PROTECTION MODE)

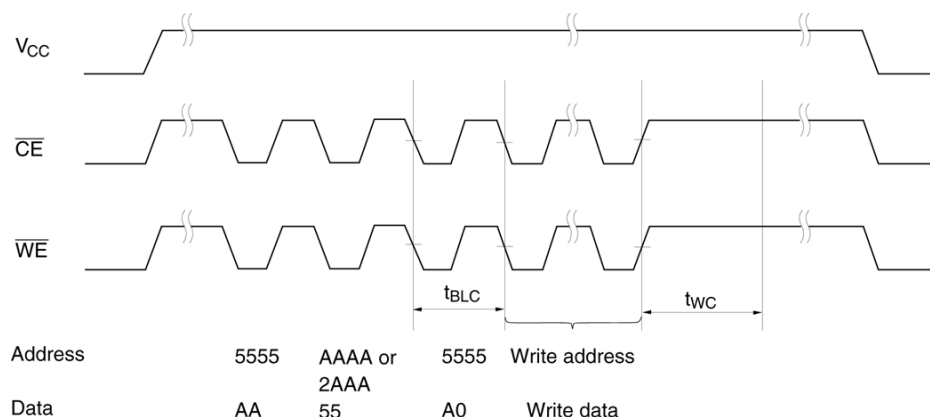
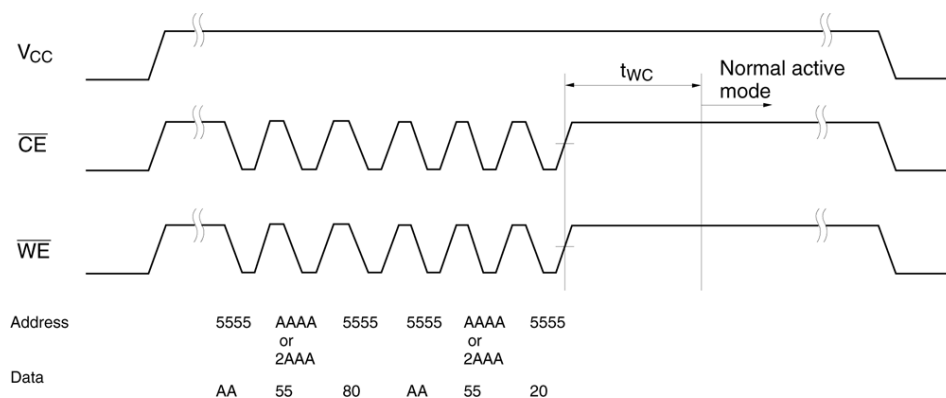


FIGURE 8. SOFTWARE DATA PROTECTION WAVEFORM (2) (IN NON-PROTECTION MODE)



## EEPROM APPLICATION NOTES

This application note describes the programming procedures for the EEPROM modules and with details of various techniques to preserve data integrity.

### Automatic Page Write

Page-mode write feature allows 1 to 128 bytes of data to be written into the EEPROM in a single write cycle. Loading the first byte of data, the data load window opens 30µs for the second byte. In the same manner each additional byte of data can be loaded within 30µs of the preceding falling edge of either WE or CE. When CE and WE are kept high for 100µs after data input, the EEPROM enters the write mode automatically and the data input is written into the EEPROM.

### WE, CE Pin Operation

During a write cycle, addresses are latched by the falling edge of WE or CE, and data is latched by the rising edge of WE or CE.

## Data Polling

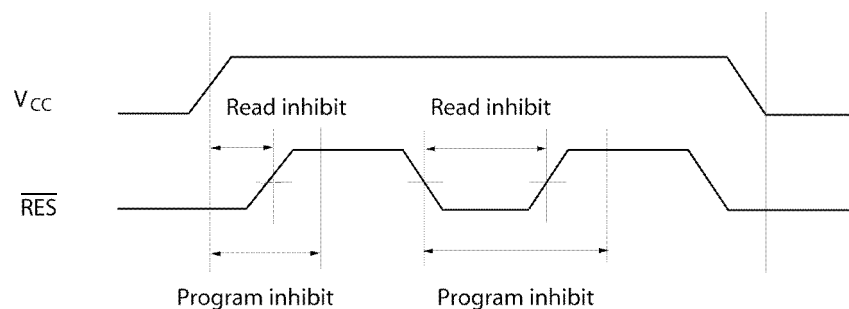
Data Polling function allows the status of the EEPROM to be determined. If EEPROM is set to read mode during a write cycle, an inversion of the last byte of data to be loaded outputs from I/O 7 to indicate that the EEPROM is performing a write operation.

## RDY/Busy Signal

RDY/Busy signal also allows a comparison operation to determine the status of the EEPROM. The RDY/Busy signal goes low ( $V_{OL}$ ) after the first write signal. At the end of the write cycle, the RDY/Busy returns to a high state.

## RES Signal

When  $\overline{RES}$  is LOW ( $V_L$ ), the EEPROM cannot be read or programmed. The EEPROM data must be protected by keeping  $\overline{RES}$  low when  $V_{CC}$  is power on and off.  $\overline{RES}$  should be high ( $V_H$ ) during read and programming operations.

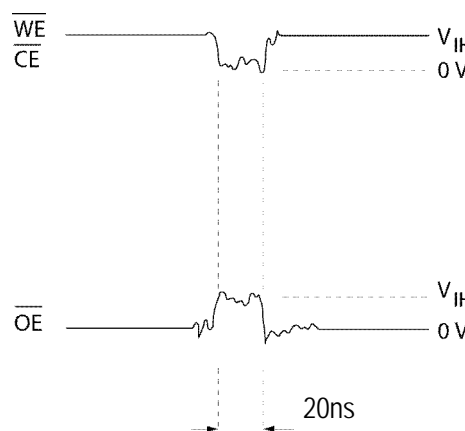


## Data Protection

To protect the data during operation and power on/off, the EEPROM has the internal functions described below.

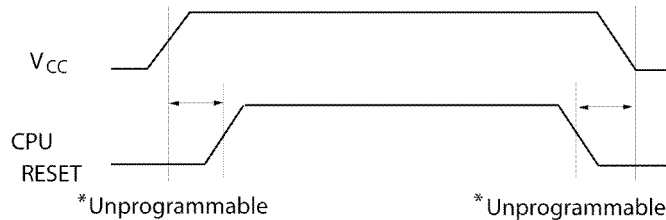
### 1. Data Protection against Noise of Control Pins ( $\overline{CE}$ , $\overline{OE}$ , $\overline{WE}$ ) during Operation.

During readout or standby, noise on the control pins may act as a trigger and turn the EEPROM to programming mode by mistake. To prevent this phenomenon, the EEPROM has a noise cancellation function that cuts noise if its width is 20ns or less in programming mode. Be careful not to allow noise of a width more than 20ns on the control pins.



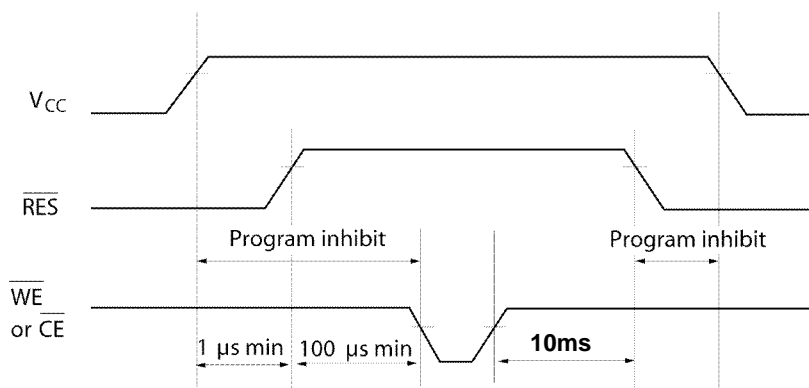
## 2. Data Protection at $V_{CC}$ on/off

When  $V_{CC}$  is turned on or off, noise on the control pins generated by external circuits, such as CPUs, may turn the EEPROM to programming mode by mistake. To prevent this unintentional programming, the EEPROM must be kept in unprogrammable state during  $V_{CC}$  on/off by using a CPU reset signal to  $\overline{RES}$  pin.



## 3. $\overline{RES}$ Signal

$\overline{RES}$  should be kept at  $V_{SS}$  level when  $V_{CC}$  is turned on or off. The EEPROM breaks off programming operation when  $\overline{RES}$  become low, programming operation doesn't finish correctly in case that  $\overline{RES}$  falls low during programming operation.  $\overline{RES}$  should be kept high for 10 ms after the last data is input



## 4. Software Data Protection Enable

The 79C2040B contains a software controlled write protection feature that allows the user to inhibit all write operations to the device. This is useful in protecting the device from unwanted write cycles due to uncontrollable circuit noise or inadvertent writes caused by minor bus contentions. Software data protection is enabled by writing the following data sequence to the EEPROM and allowing the write cycle period ( $t_{WC}$ ) of 10ms to elapse:

### Software Data Protection Enable Sequence

Address	Data
5555	AA AA AA AA AA
AAAA or 2AAA	55 55 55 55 55
5555	A0 A0 A0 A0 A0

## 5. Writing to the Memory with Software Data Protection Enabled

To write to the device once Software protection is enabled, the enable sequence must precede the data to be written. This sequence allows the write to occur while at the same time keeping the software protection enabled

Sequence for Writing Data with Software Protection Enabled.

Address	Data
5555	AA AA AA AA AA
AAAA or 2AAA	55 55 55 55 55
5555	A0 A0 A0 A0 A0
Write Address(s)	Normal Data Input

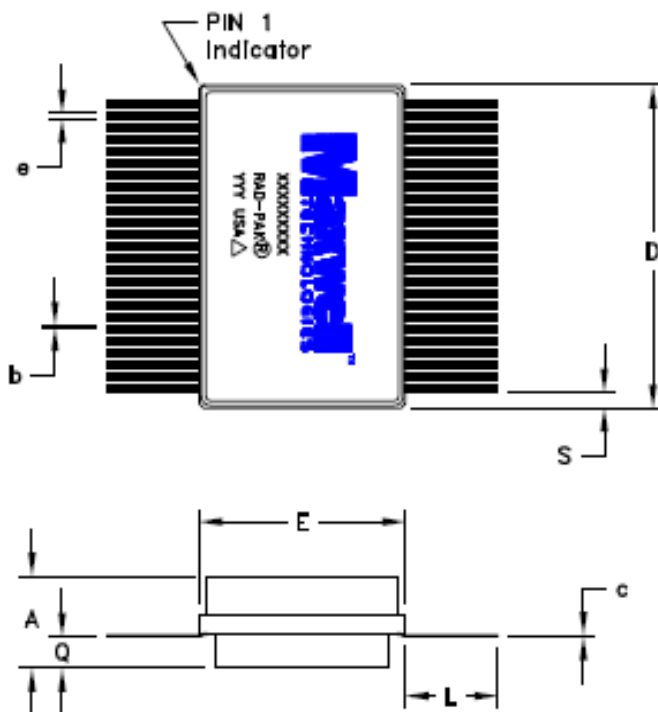
## 6. Disabling Software Protection

Software data protection mode can be disabled by inputting the following 6 bytes sequence. Once the software protection sequence has been written, no data can be written to the memory until the write cycle ( $T_{WC}$ ) has elapsed.

Software Protection Disable Sequence

Address	Data
5555	AA AA AA AA AA
AAAA or 2AAA	55 55 55 55 55
5555	80 80 80 80 80
5555	AA AA AA AA AA
AAAA or 2AAA	55 55 55 55 55
5555	20 20 20 20 20

Devices are shipped in the “unprotected” state, meaning that the contents of the memory can be changed as required by the user. After the software data protection is enabled, the device enters the Protect Mode where no further write commands have any effect on the memory contents.



100 Pin Rad-Tolerant Flat Pack

SYMBOL	DIMENSIONS		
	MIN	NOM	MAX
A	0.381	0.400	0.419
b	0.006	0.008	0.010
c	0.005	0.006	0.007
D	1.351	1.366	1.381
e	0.025 BSC		
E	0.887	0.897	0.907
L	0.390	0.400	0.410
Q	0.132	0.139	0.147
S	0.055	0.075	0.095

NOTE: ALL DIMENSIONS IN INCHES.

TOP AND BOTTOM OF THE PACKAGE ARE INTERNALLY TIED TO GROUND.

## Important Notice:

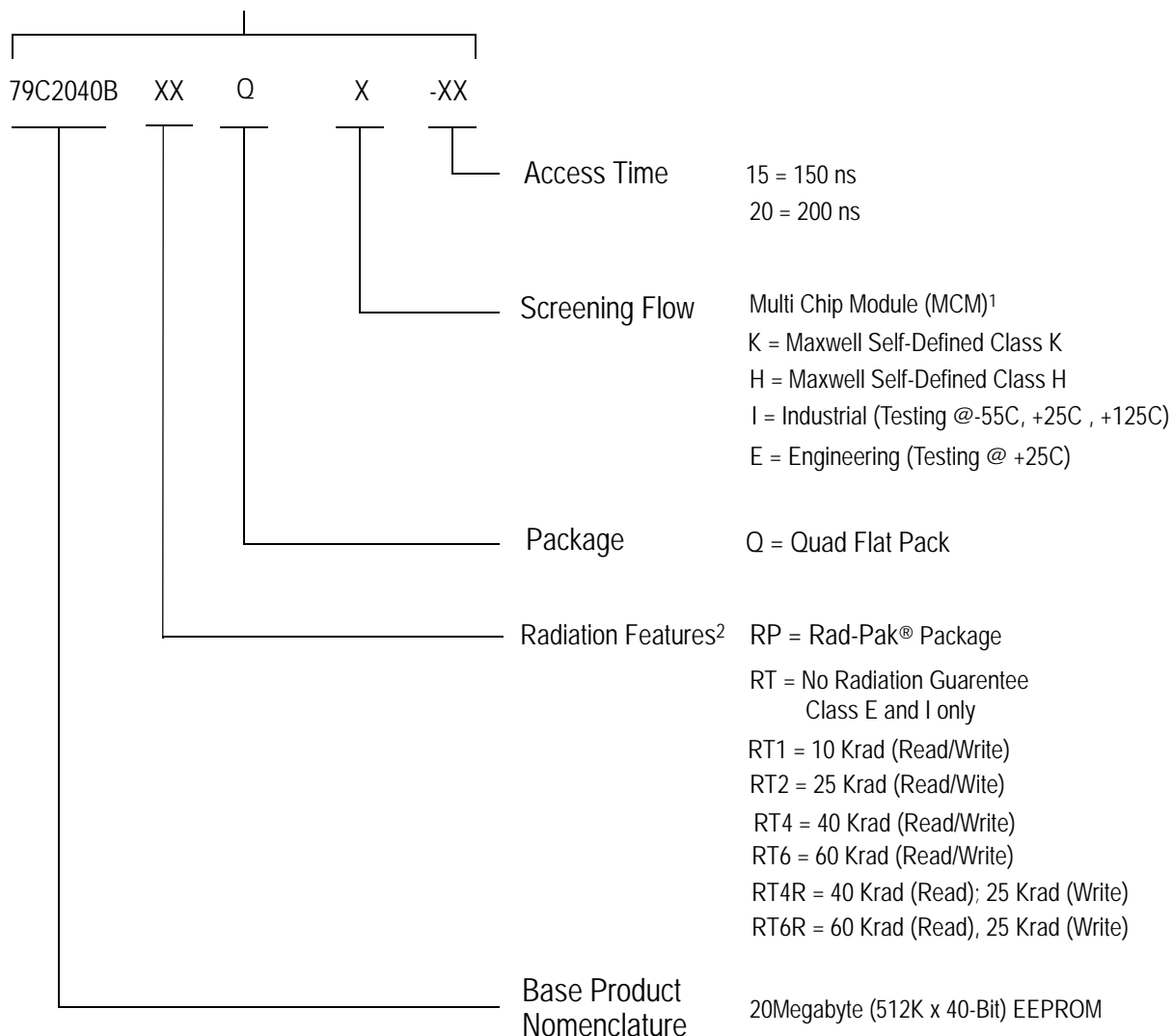
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The specifications presented within these data sheets represent the latest and most accurate information available to date. However, these specifications are subject to change without notice and Maxwell Technologies assumes no responsibility for the use of this information.

Maxwell Technologies' products are not authorized for use as critical components in life support devices or systems without express written approval from Maxwell Technologies.

Any claim against Maxwell Technologies must be made within 90 days from the date of shipment from Maxwell Technologies. Maxwell Technologies' liability shall be limited to replacement of defective parts.

## Product Ordering Options



1) Products are manufactured and screened to Maxwell Technologies' self-defined Class H and Class K.

2) The device will meet the specified read mode TID level, at the die level, if it is not written to during irradiation. Writing to the device during irradiation will reduce the device's TID tolerance to the specified write TID level. Writing to the device before irradiation does not alter the device's read mode TID level.