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Understanding Embedded - Microprocessors

Embedded microprocessors are specialized computing chips designed to perform specific tasks within an embedded system. Unlike general-purpose microprocessors found in personal computers, embedded microprocessors are tailored for dedicated functions within larger systems, offering optimized performance, efficiency, and reliability. These microprocessors are integral to the operation of countless electronic devices, providing the computational power necessary for controlling processes, handling data, and managing communications.

Applications of **Embedded - Microprocessors**

Embedded microprocessors are utilized across a broad spectrum of applications, making them indispensable in

Details

Product Status	Obsolete
Core Processor	MPC8xx
Number of Cores/Bus Width	1 Core, 32-Bit
Speed	50MHz
Co-Processors/DSP	Communications; CPM
RAM Controllers	DRAM
Graphics Acceleration	No
Display & Interface Controllers	-
Ethernet	10Mbps (2), 10/100Mbps (1)
SATA	-
USB	-
Voltage - I/O	3.3V
Operating Temperature	-40°C ~ 95°C (TA)
Security Features	-
Package / Case	357-BBGA
Supplier Device Package	357-PBGA (25x25)
Purchase URL	https://www.e-xfl.com/product-detail/nxp-semiconductors/mpc860dpcvr50d4

Email: info@E-XFL.COM

Address: Room A, 16/F, Full Win Commercial Centre, 573 Nathan Road, Mongkok, Hong Kong



2 Features

The following list summarizes the key MPC860 features:

- Embedded single-issue, 32-bit core (implementing the Power Architecture technology) with thirty-two 32-bit general-purpose registers (GPRs)
 - The core performs branch prediction with conditional prefetch without conditional execution.
 - 4- or 8-Kbyte data cache and 4- or 16-Kbyte instruction cache (see Table 1)
 - 16-Kbyte instruction caches are four-way, set-associative with 256 sets; 4-Kbyte instruction caches are two-way, set-associative with 128 sets.
 - 8-Kbyte data caches are two-way, set-associative with 256 sets; 4-Kbyte data caches are two-way, set-associative with 128 sets.
 - Cache coherency for both instruction and data caches is maintained on 128-bit (4-word) cache blocks.
 - Caches are physically addressed, implement a least recently used (LRU) replacement algorithm, and are lockable on a cache block basis.
 - MMUs with 32-entry TLB, fully-associative instruction, and data TLBs
 - MMUs support multiple page sizes of 4-, 16-, and 512-Kbytes, and 8-Mbytes; 16 virtual address spaces and 16 protection groups
 - Advanced on-chip-emulation debug mode
- Up to 32-bit data bus (dynamic bus sizing for 8, 16, and 32 bits)
- 32 address lines
- Operates at up to 80 MHz
- Memory controller (eight banks)
 - Contains complete dynamic RAM (DRAM) controller
 - Each bank can be a chip select or \overline{RAS} to support a DRAM bank.
 - Up to 15 wait states programmable per memory bank
 - Glueless interface to DRAM, SIMMS, SRAM, EPROM, Flash EPROM, and other memory devices
 - DRAM controller programmable to support most size and speed memory interfaces
 - Four $\overline{\text{CAS}}$ lines, four $\overline{\text{WE}}$ lines, and one $\overline{\text{OE}}$ line
 - Boot chip-select available at reset (options for 8-, 16-, or 32-bit memory)
 - Variable block sizes (32 Kbytes to 256 Mbytes)
 - Selectable write protection
 - On-chip bus arbitration logic
- General-purpose timers
 - Four 16-bit timers or two 32-bit timers
 - Gate mode can enable/disable counting
 - Interrupt can be masked on reference match and event capture.



- Up to 8 Kbytes of dual-port RAM
- 16 serial DMA (SDMA) channels
- Three parallel I/O registers with open-drain capability
- Four baud-rate generators (BRGs)
 - Independent (can be tied to any SCC or SMC)
 - Allows changes during operation
 - Autobaud support option
- Four serial communications controllers (SCCs)
 - Ethernet/IEEE 802.3[®] standard optional on SCC1–4, supporting full 10-Mbps operation (available only on specially programmed devices)
 - HDLC/SDLC (all channels supported at 2 Mbps)
 - HDLC bus (implements an HDLC-based local area network (LAN))
 - Asynchronous HDLC to support point-to-point protocol (PPP)
 - AppleTalk
 - Universal asynchronous receiver transmitter (UART)
 - Synchronous UART
 - Serial infrared (IrDA)
 - Binary synchronous communication (BISYNC)
 - Totally transparent (bit streams)
 - Totally transparent (frame-based with optional cyclic redundancy check (CRC))
- Two SMCs (serial management channels)
 - UART
 - Transparent
 - General circuit interface (GCI) controller
 - Can be connected to the time-division multiplexed (TDM) channels
- One SPI (serial peripheral interface)
 - Supports master and slave modes
 - Supports multimaster operation on the same bus
- One I²C (inter-integrated circuit) port
 - Supports master and slave modes
 - Multiple-master environment support
- Time-slot assigner (TSA)
 - Allows SCCs and SMCs to run in multiplexed and/or non-multiplexed operation
 - Supports T1, CEPT, PCM highway, ISDN basic rate, ISDN primary rate, user defined
 - 1- or 8-bit resolution
 - Allows independent transmit and receive routing, frame synchronization, and clocking



Features

- Allows dynamic changes
- Can be internally connected to six serial channels (four SCCs and two SMCs)
- Parallel interface port (PIP)
 - Centronics interface support
 - Supports fast connection between compatible ports on the MPC860 or the MC68360
- PCMCIA interface
 - Master (socket) interface, release 2.1 compliant
 - Supports two independent PCMCIA sockets
 - Supports eight memory or I/O windows
- Low power support
 - Full on-all units fully powered
 - Doze—core functional units disabled except time base decrementer, PLL, memory controller, RTC, and CPM in low-power standby
 - Sleep-all units disabled except RTC and PIT, PLL active for fast wake up
 - Deep sleep—all units disabled including PLL except RTC and PIT
 - Power down mode—all units powered down except PLL, RTC, PIT, time base, and decrementer
- Debug interface
 - Eight comparators: four operate on instruction address, two operate on data address, and two
 operate on data
 - Supports conditions: = $\neq < >$
 - Each watchpoint can generate a break-point internally.
- 3.3-V operation with 5-V TTL compatibility except EXTAL and EXTCLK
- 357-pin ball grid array (BGA) package



3 Maximum Tolerated Ratings

This section provides the maximum tolerated voltage and temperature ranges for the MPC860. Table 2 provides the maximum ratings.

This device contains circuitry protecting against damage due to high-static voltage or electrical fields; however, it is advised that normal precautions be taken to avoid application of any voltages higher than maximum-rated voltages to this high-impedance circuit. Reliability of operation is enhanced if unused inputs are tied to an appropriate logic voltage level (for example, either GND or V_{DD}).

(GND = 0 V)

Table 2. Maximum Tolerated Ratings

Rating	Symbol	Value	Unit
Supply voltage ¹	V _{DDH}	-0.3 to 4.0	V
	V _{DDL}	-0.3 to 4.0	V
	KAPWR	-0.3 to 4.0	V
	V _{DDSYN}	-0.3 to 4.0	V
Input voltage ²	V _{in}	GND – 0.3 to V _{DDH}	V
Temperature ³ (standard)	T _{A(min)}	0	°C
	T _{j(max)}	95	°C
Temperature ³ (extended)	T _{A(min)}	-40	°C
	T _{j(max)}	95	°C
Storage temperature range	T _{stg}	-55 to 150	°C

¹ The power supply of the device must start its ramp from 0.0 V.

² Functional operating conditions are provided with the DC electrical specifications in Table 6. Absolute maximum ratings are stress ratings only; functional operation at the maxima is not guaranteed. Stress beyond those listed may affect device reliability or cause permanent damage to the device.

Caution: All inputs that tolerate 5 V cannot be more than 2.5 V greater than the supply voltage. This restriction applies to power-up and normal operation (that is, if the MPC860 is unpowered, voltage greater than 2.5 V must not be applied to its inputs).

³ Minimum temperatures are guaranteed as ambient temperature, T_A. Maximum temperatures are guaranteed as junction temperature, T_j.



Thermal Characteristics

Figure 1 shows the undershoot and overshoot voltages at the interface of the MPC860.



1. t_{interface} refers to the clock period associated with the bus clock interface.

Figure 1. Undershoot/Overshoot Voltage for V_{DDH} and V_{DDL}

4 Thermal Characteristics

Table 3. Package Description

Package Designator	Package Code (Case No.)	Package Description
ZP	5050 (1103-01)	PBGA 357 25*25*0.9P1.27
ZQ/VR	5058 (1103D-02)	PBGA 357 25*25*1.2P1.27



Table 4 shows the thermal characteristics for the MPC860.

Table 4. MPC860 Thermal Resistance Data

Rating	Environment		Symbol	ZP MPC860P	ZQ / VR MPC860P	Unit
Mold Compound Thickness				0.85	1.15	mm
Junction-to-ambient ¹	Natural convection	Single-layer board (1s)	$R_{\theta JA}^2$	34	34	°C/W
		Four-layer board (2s2p)	$R_{\theta JMA}^{3}$	22	22	
	Airflow (200 ft/min)	Single-layer board (1s)	$R_{\theta JMA}^{3}$	27	27	
		Four-layer board (2s2p)	$R_{\theta JMA}^{3}$	18	18	
Junction-to-board ⁴			$R_{\theta JB}$	14	13	
Junction-to-case ⁵			R_{\thetaJC}	6	8	
Junction-to-package top ⁶	Natural convection		Ψ_{JT}	2	2	

¹ Junction temperature is a function of on-chip power dissipation, package thermal resistance, mounting site (board) temperature, ambient temperature, airflow, power dissipation of other components on the board, and board thermal resistance.

² Per SEMI G38-87 and JEDEC JESD51-2 with the single-layer board horizontal.

³ Per JEDEC JESD51-6 with the board horizontal.

⁴ Thermal resistance between the die and the printed-circuit board per JEDEC JESD51-8. Board temperature is measured on the top surface of the board near the package.

- ⁵ Indicates the average thermal resistance between the die and the case top surface as measured by the cold plate method (MIL SPEC-883 Method 1012.1) with the cold plate temperature used for the case temperature. For exposed pad packages where the pad would be expected to be soldered, junction-to-case thermal resistance is a simulated value from the junction to the exposed pad without contact resistance.
- ⁶ Thermal characterization parameter indicating the temperature difference between the package top and the junction temperature per JEDEC JESD51-2.



Power Dissipation

5 **Power Dissipation**

Table 5 provides power dissipation information. The modes are 1:1, where CPU and bus speeds are equal, and 2:1, where CPU frequency is twice the bus speed.

Die Revision	Frequency (MHz)	Typical ¹	Maximum ²	Unit
D.4	50	656	735	mW
(1:1 mode)	66	TBD	TBD	mW
D.4	66	722	762	mW
(2:1 mode)	80	851	909	mW

Table 5. Power Dissipation (PD)

¹ Typical power dissipation is measured at 3.3 V.

² Maximum power dissipation is measured at 3.5 V.

NOTE

Values in Table 5 represent V_{DDL} -based power dissipation and do not include I/O power dissipation over V_{DDH} . I/O power dissipation varies widely by application due to buffer current, depending on external circuitry.

6 DC Characteristics

Table 6 provides the DC electrical characteristics for the MPC860.

 Table 6. DC Electrical Specifications

Characteristic	Symbol	Min	Мах	Unit
Operating voltage at 40 MHz or less	V _{DDH} , V _{DDL} , V _{DDSYN}	3.0	3.6	V
	KAPWR (power-down mode)	2.0	3.6	V
	KAPWR (all other operating modes)	V _{DDH} – 0.4	V _{DDH}	V
Operating voltage greater than 40 MHz	V _{DDH} , V _{DDL} , KAPWR, V _{DDSYN}	3.135	3.465	V
	KAPWR (power-down mode)	2.0	3.6	V
	KAPWR (all other operating modes)	V _{DDH} – 0.4	V _{DDH}	V
Input high voltage (all inputs except EXTAL and EXTCLK)	V _{IH}	2.0	5.5	V
Input low voltage ¹	V _{IL}	GND	0.8	V
EXTAL, EXTCLK input high voltage	V _{IHC}	$0.7 imes (V_{DDH})$	V _{DDH} + 0.3	V
Input leakage current, $V_{in} = 5.5 \text{ V}$ (except TMS, TRST, DSCK, and DSDI pins)	l _{in}	—	100	μA









Figure 12. External Bus Read Timing (GPCM Controlled—TRLX = 0, ACS = 11)



Bus Signal Timing



Figure 13. External Bus Read Timing (GPCM Controlled—TRLX = 0 or 1, ACS = 10, ACS = 11)



Bus Signal Timing



Figure 15. External Bus Write Timing (GPCM Controlled—TRLX = 0 or 1, CSNT = 1)



Figure 18 provides the timing for the asynchronous asserted UPWAIT signal controlled by the UPM.



Figure 18. Asynchronous UPWAIT Asserted Detection in UPM Handled Cycles Timing

Figure 19 provides the timing for the asynchronous negated UPWAIT signal controlled by the UPM.



Figure 19. Asynchronous UPWAIT Negated Detection in UPM Handled Cycles Timing



IEEE 1149.1 Electrical Specifications



Figure 35. JTAG Test Clock Input Timing



Figure 36. JTAG Test Access Port Timing Diagram



Figure 37. JTAG TRST Timing Diagram











Figure 56 through Figure 58 show the NMSI timings.









Figure 58. HDLC Bus Timing Diagram

11.8 Ethernet Electrical Specifications

Table 22 provides the Ethernet timings as shown in Figure 59 through Figure 63.

	Oh ave staviatio	All Frequencies		11
NUM	Characteristic	Min	Мах	Unit
120	CLSN width high	40		ns
121	RCLK1 rise/fall time	—	15	ns
122	RCLK1 width low	40	—	ns
123	RCLK1 clock period ¹	80	120	ns
124	RXD1 setup time	20	—	ns
125	RXD1 hold time	5	—	ns
126	RENA active delay (from RCLK1 rising edge of the last data bit)	10	—	ns
127	RENA width low	100	—	ns
128	TCLK1 rise/fall time	—	15	ns
129	TCLK1 width low	40	—	ns
130	TCLK1 clock period ¹	99	101	ns
131	TXD1 active delay (from TCLK1 rising edge)	10	50	ns
132	TXD1 inactive delay (from TCLK1 rising edge)	10	50	ns
133	TENA active delay (from TCLK1 rising edge)	10	50	ns
134	TENA inactive delay (from TCLK1 rising edge)	10	50	ns



Num	Characteristic	All Frequencies		Unit
		Min	Мах	Unit
135	RSTRT active delay (from TCLK1 falling edge)	10	50	ns
136	RSTRT inactive delay (from TCLK1 falling edge)	10	50	ns
137	REJECT width low	1	—	CLK
138	CLKO1 low to SDACK asserted ²		20	ns
139	CLKO1 low to SDACK negated ²	_	20	ns

Table 22. Ethernet Timing (continued)

¹ The ratios SYNCCLK/RCLK1 and SYNCCLK/TCLK1 must be greater than or equal to 2/1.

² SDACK is asserted whenever the SDMA writes the incoming frame DA into memory.



Figure 59. Ethernet Collision Timing Diagram



Figure 60. Ethernet Receive Timing Diagram



11.10 SPI Master AC Electrical Specifications

Table 24 provides the SPI master timings as shown in Figure 65 and Figure 66.

Table 24. SPI Master Timing

Num	Characteristic	All Frequencies		Unit
		Min	Мах	Om
160	MASTER cycle time	4	1024	t _{cyc}
161	MASTER clock (SCK) high or low time	2	512	t _{cyc}
162	MASTER data setup time (inputs)	50	_	ns
163	Master data hold time (inputs)	0	—	ns
164	Master data valid (after SCK edge)	—	20	ns
165	Master data hold time (outputs)	0	—	ns
166	Rise time output	—	15	ns
167	Fall time output	—	15	ns





11.12 I²C AC Electrical Specifications

Table 26 provides the I^2C (SCL < 100 kHz) timings.

Table 26. I²C Timing (SCL < 100 kHz)

Num Characteristic	Characteristic	All Frequencies		Unit
		Min	Мах	Unit
200	SCL clock frequency (slave)	0	100	kHz
200	SCL clock frequency (master) ¹	1.5	100	kHz
202	Bus free time between transmissions	4.7	—	μS
203	Low period of SCL	4.7	—	μS
204	High period of SCL	4.0	—	μS
205	Start condition setup time	4.7	—	μS
206	Start condition hold time	4.0	—	μS
207	Data hold time	0	—	μS
208	Data setup time	250	—	ns
209	SDL/SCL rise time	—	1	μS
210	SDL/SCL fall time	—	300	ns
211	Stop condition setup time	4.7	—	μS

SCL frequency is given by SCL = BRGCLK_frequency / ((BRG register + 3 × pre_scaler × 2). The ratio SYNCCLK/(BRGCLK/pre_scaler) must be greater than or equal to 4/1.

Table 27 provides the I^2C (SCL > 100 kHz) timings.

Table 27. . I²C Timing (SCL > 100 kHz)

Num	Characteristic	Expression	All Freq	Unit	
Num	Characteristic	Expression	Min Max		Unit
200	SCL clock frequency (slave)	fSCL	0	BRGCLK/48	Hz
200	SCL clock frequency (master) ¹	fSCL	BRGCLK/16512	BRGCLK/48	Hz
202	Bus free time between transmissions		1/(2.2 * fSCL)	—	S
203	Low period of SCL		1/(2.2 * fSCL)	—	S
204	High period of SCL		1/(2.2 * fSCL)	_	S
205	Start condition setup time		1/(2.2 * fSCL)	—	S
206	Start condition hold time		1/(2.2 * fSCL)	—	S
207	Data hold time		0	_	S
208	Data setup time		1/(40 * fSCL)	_	S
209	SDL/SCL rise time		—	1/(10 * fSCL)	S
210	SDL/SCL fall time		—	1/(33 * fSCL)	S
211	Stop condition setup time		1/2(2.2 * fSCL)	—	s

SCL frequency is given by SCL = BRGCLK_frequency / ((BRG register + 3) × pre_scaler × 2). The ratio SYNCCLK/(BRGCLK / pre_scaler) must be greater than or equal to 4/1.



Mechanical Data and Ordering Information

Package Type	Freq. (MHz) / Temp. (Tj)	Package	Order Number
Ball grid array <i>(continued)</i> ZP suffix—leaded ZQ suffix—leaded VR suffix—lead-free	80 0° to 95°C	ZP/ZQ ¹	MPC855TZQ80D4 MPC860DEZQ80D4 MPC860DTZQ80D4 MPC860ENZQ80D4 MPC860SRZQ80D4 MPC860TZQ80D4 MPC860DPZQ80D4 MPC860PZQ80D4
		Tape and Reel	MPC860PZQ80D4R2 MPC860PVR80D4R2
		VR	MPC855TVR80D4 MPC860DEVR80D4 MPC860DPVR80D4 MPC860ENVR80D4 MPC860PVR80D4 MPC860SRVR80D4 MPC860SRVR80D4
Ball grid array (CZP suffix) CZP suffix—leaded CZQ suffix—lead-free	50 –40° to 95°C	ZP/ZQ ¹	MPC855TCZQ50D4 MPC855TCVR50D4 MPC860DECZQ50D4 MPC860DTCZQ50D4 MPC860ENCZQ50D4 MPC860SRCZQ50D4 MPC860TCZQ50D4 MPC860DPCZQ50D4 MPC860PCZQ50D4
		Tape and Reel	MPC855TCZQ50D4R2 MC860ENCVR50D4R2
		CVR	MPC860DECVR50D4 MPC860DTCVR50D4 MPC860ENCVR50D4 MPC860PCVR50D4 MPC860SRCVR50D4 MPC860TCVR50D4
	66 –40° to 95°C	ZP/ZQ ¹	MPC855TCZQ66D4 MPC855TCVR66D4 MPC860ENCZQ66D4 MPC860SRCZQ66D4 MPC860TCZQ66D4 MPC860DPCZQ66D4 MPC860PCZQ66D4
		CVR	MPC860DTCVR66D4 MPC860ENCVR66D4 MPC860PCVR66D4 MPC860SRCVR66D4 MPC860TCVR66D4

Table 34. MPC860 Family Package/Frequency Availability (continued)

¹ The ZP package is no longer recommended for use. The ZQ package replaces the ZP package.



Mechanical Data and Ordering Information

14.3 Mechanical Dimensions of the PBGA Package

Figure 77 shows the mechanical dimensions of the ZP PBGA package.



- 1. Dimensions and tolerance per ASME Y14.5M, 1994.
- 2. Dimensions in millimeters.
- 3. Dimension b is the maximum solder ball diameter measured parallel to data C.



22.40

E2

22.60