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	100MHz
Co-Processors/DSP	Communications; CPM
RAM Controllers	DRAM
Graphics Acceleration	No
Display & Interface Controllers	-
Ethernet	10Mbps (4), 10/100Mbps (1)
SATA	-
USB	-
Voltage - I/O	3.3V
Operating Temperature	0°C ~ 105°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/mpc862pzq100b

1 Overview

The MPC862/857T/857DSL is a derivative of Freescale's MPC860 PowerQUICC™ family of devices. It is a versatile single-chip integrated microprocessor and peripheral combination that can be used in a variety of controller applications and communications and networking systems. The MPC862/857T/857DSL provides enhanced ATM functionality over that of other ATM-enabled members of the MPC860 family.

Table 1 shows the functionality supported by the members of the MPC862/857T/857DSL family.

Table 1. MPC862 Family Functionality

Part	Cache		Ethernet		SCC	SMC
	Instruction Cache	Data Cache	10T	10/100		
MPC862P	16 Kbyte	8 Kbyte	Up to 4	1	4	2
MPC862T	4 Kbyte	4 Kbyte	Up to 4	1	4	2
MPC857T	4 Kbyte	4 Kbyte	1	1	1	2
MPC857DSL	4 Kbyte	4 Kbyte	1	1	1 [1]	1 [2]

[1] On the MPC857DSL, the SCC (SCC1) is for ethernet only. Also, the MPC857DSL does not support the Time Slot Assigner (TSA).

[2] On the MPC857DSL, the SMC (SMC1) is for UART only.

2 Features

The following list summarizes the key MPC862/857T/857DSL features:

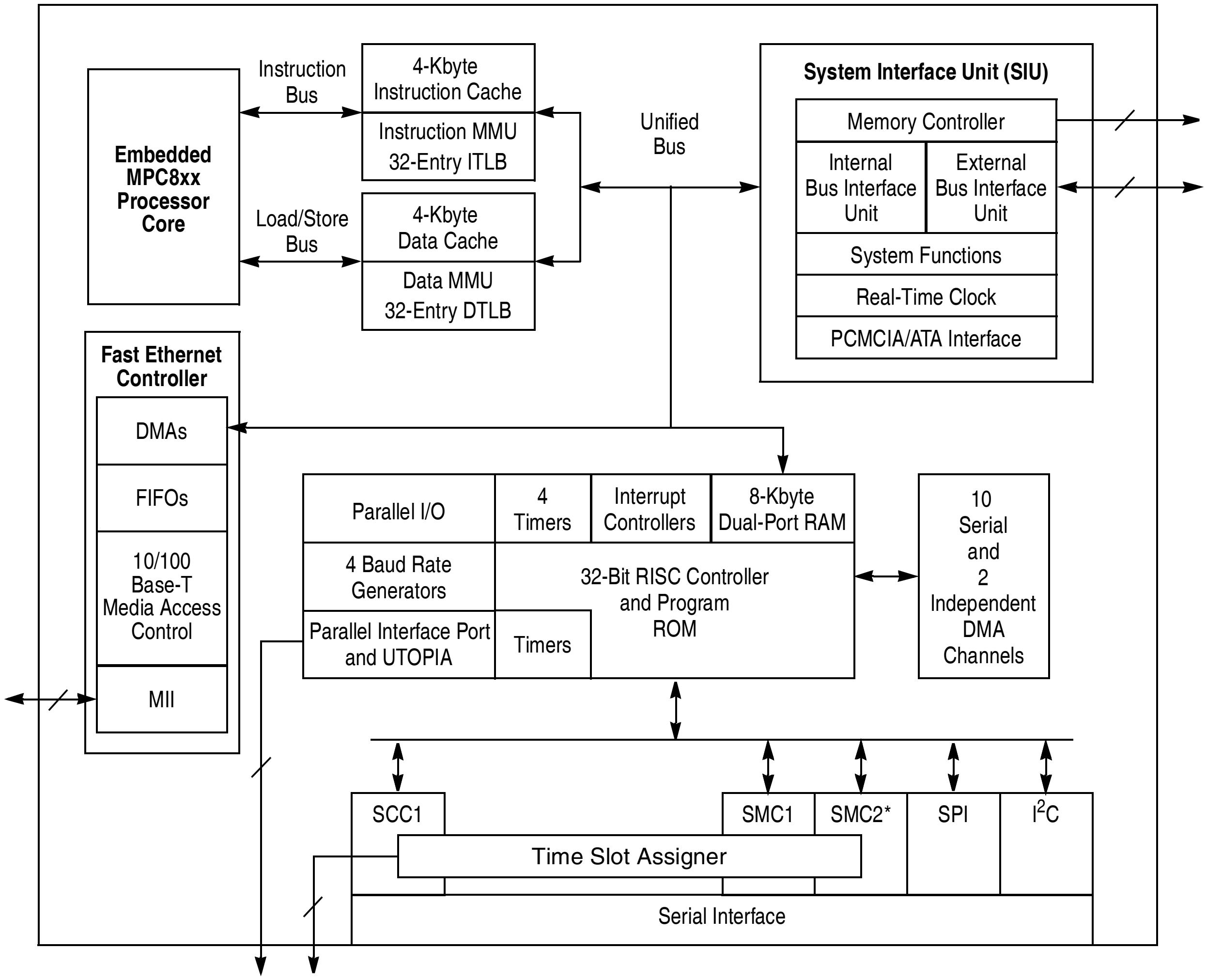
- Embedded single-issue, 32-bit MPC8xx core (implementing the PowerPC architecture) with thirty-two 32-bit general-purpose registers (GPRs)
  — The core performs branch prediction with conditional prefetch, without conditional execution
  — 4- or 8-Kbyte data cache and 4- or 16-Kbyte instruction cache (see Table 1).
    – 16-Kbyte instruction cache (MPC862P) is four-way, set-associative with 256 sets; 4-Kbyte instruction cache (MPC862T, MPC857T, and MPC857DSL) is two-way, set-associative with 128 sets.
    – 8-Kbyte data cache (MPC862P) is two-way, set-associative with 256 sets; 4-Kbyte data cache (MPC862T, MPC857T, and MPC857DSL) is 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

- System integration unit (SIU)
  - Bus monitor
  - Software watchdog
  - Periodic interrupt timer (PIT)
  - Low-power stop mode
  - Clock synthesizer
  - Decrementer, time base, and real-time clock (RTC) from the PowerPC architecture
  - Reset controller
  - IEEE 1149.1 test access port (JTAG)
- Interrupts
  - Seven external interrupt request (IRQ) lines
  - 12 port pins with interrupt capability
  - The MPC862P and MPC862T have 23 internal interrupt sources; the MPC857T and MPC857DSL have 20 internal interrupt sources
  - Programmable priority between SCCs (MPC862P and MPC862T)
  - Programmable highest priority request
- Communications processor module (CPM)
  - RISC controller
  - Communication-specific commands (for example, GRACEFUL STOP TRANSMIT, ENTER HUNT MODE, and RESTART TRANSMIT)
  - Supports continuous mode transmission and reception on all serial channels
  - Up to 8-Kbytes of dual-port RAM
  - The MPC862P and MPC862T have 16 serial DMA (SDMA) channels; the MPC857T and MPC857DSL have 10 serial DMA (SDMA) channels
  - Three parallel I/O registers with open-drain capability
- Four baud rate generators
  - Independent (can be connected to any SCC or SMC)
  - Allow changes during operation
  - Autobaud support option
- The MPC862P and MPC862T have four SCCs (serial communication controller) The MPC857T and MPC857DSL have one SCC, SCC1; the MPC857DSL supports ethernet only
  - Serial ATM capability on all SCCs
  - Optional UTOPIA port on SCC4
  - Ethernet/IEEE 802.3 optional on SCC1–4, supporting full 10-Mbps operation
  - HDLC/SDLC
  - HDLC bus (implements an HDLC-based local area network (LAN))
  - Asynchronous HDLC to support PPP (point-to-point protocol)
  - AppleTalk

— Sleep—All units disabled except RTC, PIT, time base, and decrementer with PLL active for fast wake up
— Deep sleep—All units disabled including PLL except RTC, PIT, time base, and decrementer.
— 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: = ≠ < >
  — Each watchpoint can generate a break point internally
- 3.3 V operation with 5-V TTL compatibility except EXTAL and EXTCLK
- 357-pin plastic ball grid array (PBGA) package
- Operation up to 100MHz

The MPC862/857T/857DSL is comprised of three modules that each use the 32-bit internal bus: the MPC8xx core, the system integration unit (SIU), and the communication processor module (CPM). The MPC862P/862T block diagram is shown in Figure 1. The MPC857T/857DSL block diagram is shown in Figure 2.



*The MPC857DSL does not contain SMC2 nor the Time Slot Assigner, and provides eight SDMA controllers.

Figure 2. MPC857T/MPC857DSL Block Diagram

3 Maximum Tolerated Ratings

This section provides the maximum tolerated voltage and temperature ranges for the MPC862/857T/857DSL. Table 2 provides the maximum ratings.

Table 2. Maximum Tolerated Ratings

(GND = 0 V)

Rating	Symbol	Value	Unit	Max Freq (MHz)
Supply voltage [1]	VDDH	-0.3 to 4.0	V	-
	VDDL	-0.3 to 4.0	V	-
	KAPWR	-0.3 to 4.0	V	-
	VDDSYN	-0.3 to 4.0	V	-

If the board temperature is known, an estimate of the junction temperature in the environment can be made using the following equation:

$$T_J = T_B + (R_{\theta JB} \times P_D)$$

where:

$R_{\theta JB}$ = junction-to-board thermal resistance (ºC/W)

T_B = board temperature (ºC)

P_D = power dissipation in package

If the board temperature is known and the heat loss from the package case to the air can be ignored, acceptable predictions of junction temperature can be made. For this method to work, the board and board mounting must be similar to the test board used to determine the junction-to-board thermal resistance, namely a 2s2p (board with a power and a ground plane) and vias attaching the thermal balls to the ground plane.

7.4 Estimation Using Simulation

When the board temperature is not known, a thermal simulation of the application is needed. The simple two resistor model can be used with the thermal simulation of the application [2], or a more accurate and complex model of the package can be used in the thermal simulation.

7.5 Experimental Determination

To determine the junction temperature of the device in the application after prototypes are available, the thermal characterization parameter (Ψ_{JT}) can be used to determine the junction temperature with a measurement of the temperature at the top center of the package case using the following equation:

$$T_J = T_T + (\Psi_{JT} \times P_D)$$

where:

Ψ_{JT} = thermal characterization parameter

T_T = thermocouple temperature on top of package

P_D = power dissipation in package

The thermal characterization parameter is measured per JESD51-2 specification published by JEDEC using a 40-gauge type T thermocouple epoxied to the top center of the package case. The thermocouple should be positioned so that the thermocouple junction rests on the package. A small amount of epoxy is placed over the thermocouple junction and over about 1 mm of wire extending from the junction. The thermocouple wire is placed flat against the package case to avoid measurement errors caused by cooling effects of the thermocouple wire.

7.6 References

Semiconductor Equipment and Materials International (415) 964-5111
805 East Middlefield Rd.
Mountain View, CA 94043

MIL-SPEC and EIA/JESD (JEDEC) Specifications 800-854-7179 or
(Available from Global Engineering Documents) 303-397-7956

JEDEC Specifications http://www.jedec.org

1. C.E. Triplett and B. Joiner, “An Experimental Characterization of a 272 PBGA Within an Automotive Engine Controller Module,” Proceedings of SemiTherm, San Diego, 1998, pp. 47-54.

2. B. Joiner and V. Adams, “Measurement and Simulation of Junction to Board Thermal Resistance and Its Application in Thermal Modeling,” Proceedings of SemiTherm, San Diego, 1999, pp. 212-220.

8 Layout Practices

Each V_{CC} pin on the MPC862/857T/857DSL should be provided with a low-impedance path to the board’s supply. Each GND pin should likewise be provided with a low-impedance path to ground. The power supply pins drive distinct groups of logic on chip. The V_{CC} power supply should be bypassed to ground using at least four 0.1 µF by-pass capacitors located as close as possible to the four sides of the package. The capacitor leads and associated printed circuit traces connecting to chip V_{CC} and GND should be kept to less than half an inch per capacitor lead. A four-layer board is recommended, employing two inner layers as V_{CC} and GND planes.

All output pins on the MPC862/857T/857DSL have fast rise and fall times. Printed circuit (PC) trace interconnection length should be minimized in order to minimize undershoot and reflections caused by these fast output switching times. This recommendation particularly applies to the address and data busses. Maximum PC trace lengths of six inches are recommended. Capacitance calculations should consider all device loads as well as parasitic capacitances due to the PC traces. Attention to proper PCB layout and bypassing becomes especially critical in systems with higher capacitive loads because these loads create higher transient currents in the V_{CC} and GND circuits. Pull up all unused inputs or signals that will be inputs during reset. Special care should be taken to minimize the noise levels on the PLL supply pins.

9 Bus Signal Timing

The maximum bus speed supported by the MPC862/857T/857DSL is 66 MHz. Higher-speed parts must be operated in half-speed bus mode (for example, an MPC862/857T/857DSL used at 80MHz must be configured for a 40 MHz bus). Table 6 shows the period ranges for standard part frequencies.

Table 6. Period Range for Standard Part Frequencies

Freq	50 MHz		66 MHz		80 MHz		100 MHz	
	Min	Max	Min	Max	Min	Max	Min	Max
Period	20.00	30.30	15.15	30.30	25.00	30.30	20.00	30.30

Table 7. Bus Operation Timings (continued)

Num	Characteristic	33 MHz		40 MHz		50 MHz		66 MHz		Unit
		Min	Max	Min	Max	Min	Max	Min	Max	
B29d	$\overline{WE}$(0:3) negated to D(0:31), DP(0:3) High-Z GPCM write access, TRLX = 1, CSNT = 1, EBDF = 0 (MIN = 1.50 x B1 - 2.00)	43.50	—	35.50	—	28.00	—	20.70	—	ns
B29e	$\overline{CS}$ negated to D(0:31), DP(0:3) High-Z GPCM write access, TRLX = 1, CSNT = 1, ACS = 10, or ACS = 11 EBDF = 0 (MIN = 1.50 x B1 - 2.00)	43.50	—	35.50	—	28.00	—	20.70	—	ns
B29f	$\overline{WE}$(0:3) negated to D(0:31), DP(0:3) High Z GPCM write access, TRLX = 0, CSNT = 1, EBDF = 1 (MIN = 0.375 x B1 - 6.30)	5.00	—	3.00	—	1.10	—	0.00	—	ns
B29g	$\overline{CS}$ negated to D(0:31), DP(0:3) High-Z GPCM write access, TRLX = 0, CSNT = 1 ACS = 10 or ACS = 11, EBDF = 1 (MIN = 0.375 x B1 - 6.30)	5.00	—	3.00	—	1.10	—	0.00	—	ns
B29h	$\overline{WE}$(0:3) negated to D(0:31), DP(0:3) High Z GPCM write access, TRLX = 1, CSNT = 1, EBDF = 1 (MIN = 0.375 x B1 - 3.30)	38.40	—	31.10	—	24.20	—	17.50	—	ns
B29i	$\overline{CS}$ negated to D(0:31), DP(0:3) High-Z GPCM write access, TRLX = 1, CSNT = 1, ACS = 10 or ACS = 11, EBDF = 1 (MIN = 0.375 x B1 - 3.30)	38.40	—	31.10	—	24.20	—	17.50	—	ns
B30	$\overline{CS}$, $\overline{WE}$(0:3) negated to A(0:31), BADDR(28:30) Invalid GPCM write access [11] (MIN = 0.25 x B1 - 2.00)	5.60	—	4.30	—	3.00	—	1.80	—	ns
B30a	$\overline{WE}$(0:3) negated to A(0:31), BADDR(28:30) Invalid GPCM, write access, TRLX = 0, CSNT = 1, $\overline{CS}$ negated to A(0:31) invalid GPCM write access TRLX = 0, CSNT =1 ACS = 10, or ACS == 11, EBDF = 0 (MIN = 0.50 x B1 - 2.00)	13.20	—	10.50	—	8.00	—	5.60	—	ns
B30b	$\overline{WE}$(0:3) negated to A(0:31) Invalid GPCM BADDR(28:30) invalid GPCM write access, TRLX = 1, CSNT = 1. $\overline{CS}$ negated to A(0:31) Invalid GPCM write access TRLX = 1, CSNT = 1, ACS = 10, or ACS == 11 EBDF = 0 (MIN = 1.50 x B1 - 2.00)	43.50	—	35.50	—	28.00	—	20.70	—	ns

Figure 4 is the control timing diagram.

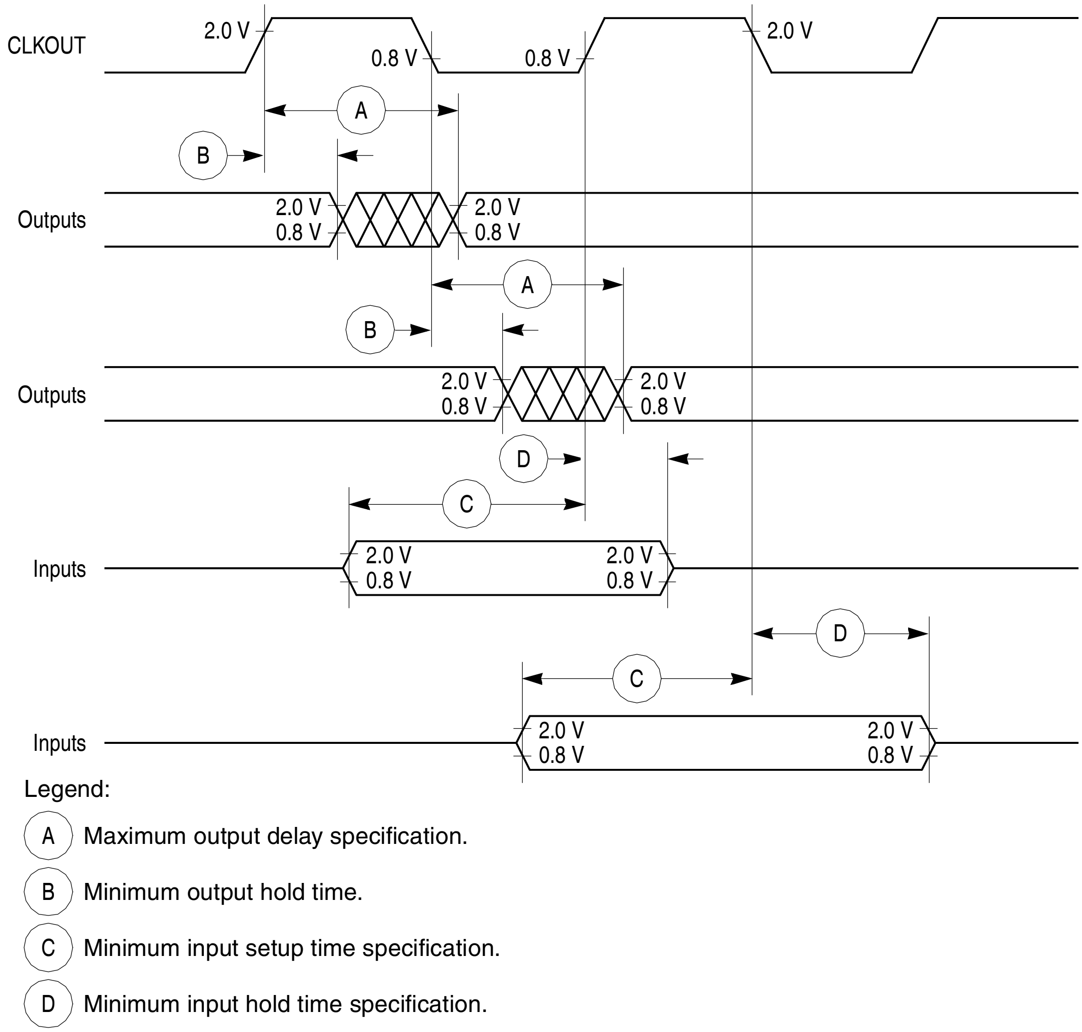


Figure 4. Control Timing

Figure 5 provides the timing for the external clock.

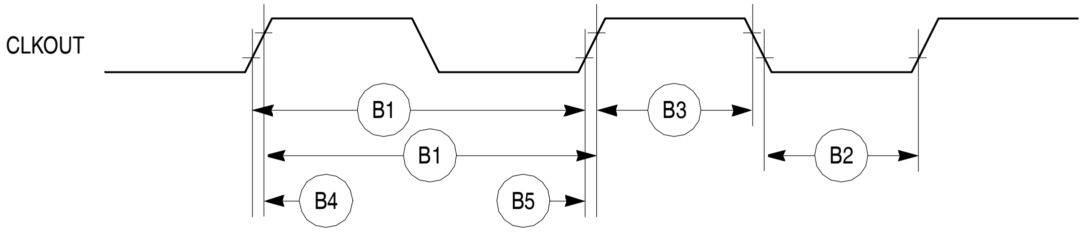


Figure 5. External Clock Timing

Figure 6 provides the timing for the synchronous output signals.

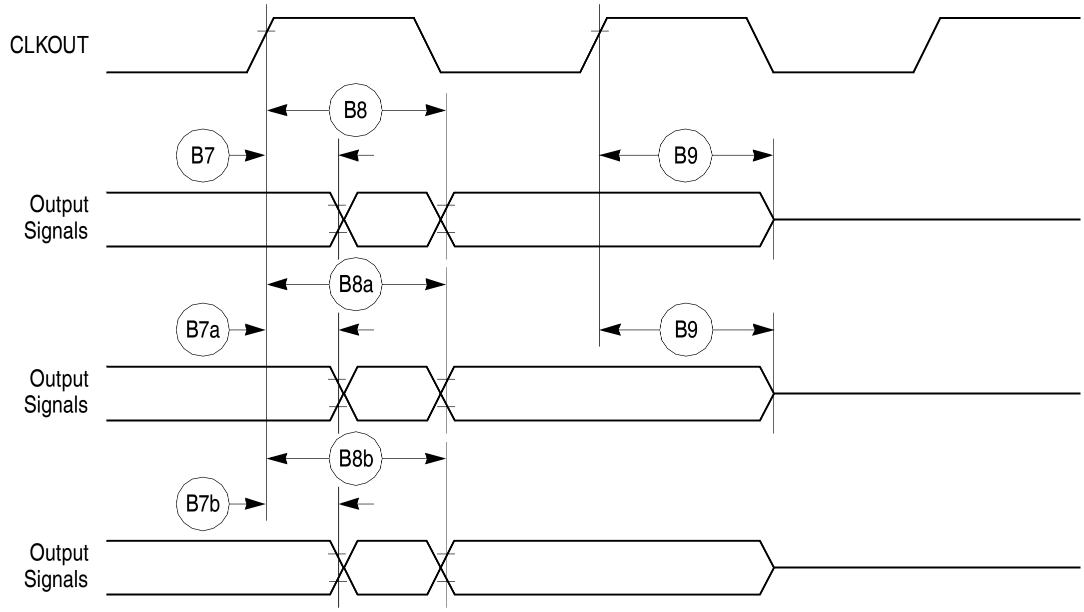


Figure 6. Synchronous Output Signals Timing

Figure 7 provides the timing for the synchronous active pull-up and open-drain output signals.

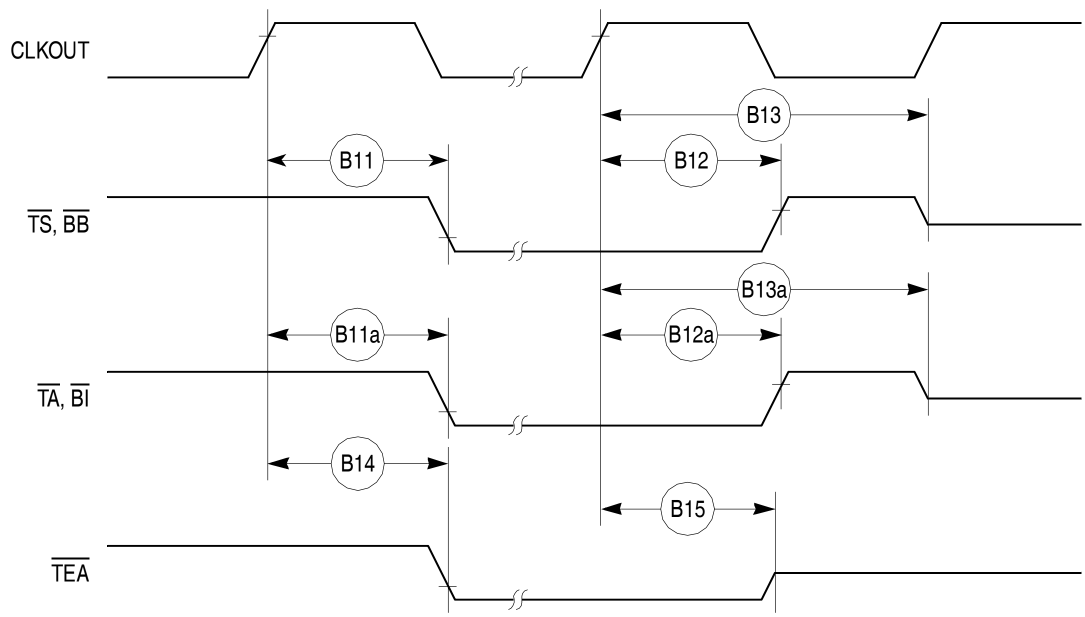


Figure 7. Synchronous Active Pull-Up Resistor and Open-Drain Outputs Signals Timing

Figure 8 provides the timing for the synchronous input signals.

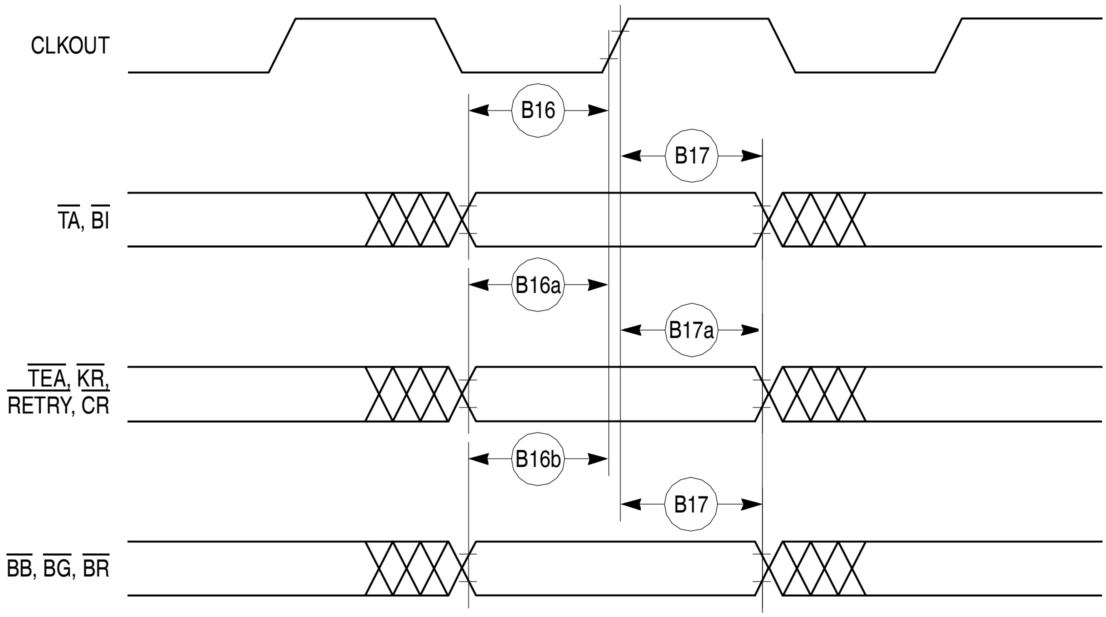


Figure 8. Synchronous Input Signals Timing

Figure 9 provides normal case timing for input data. It also applies to normal read accesses under the control of the UPM in the memory controller.

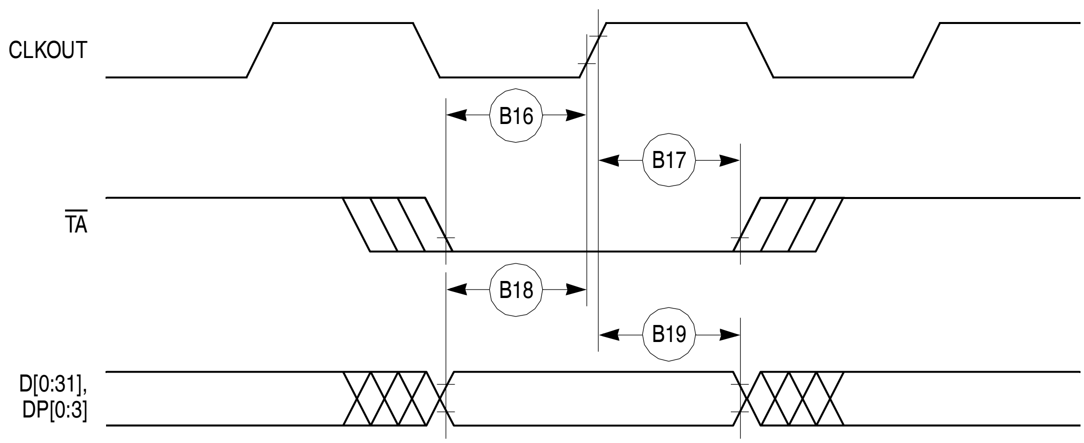


Figure 9. Input Data Timing in Normal Case

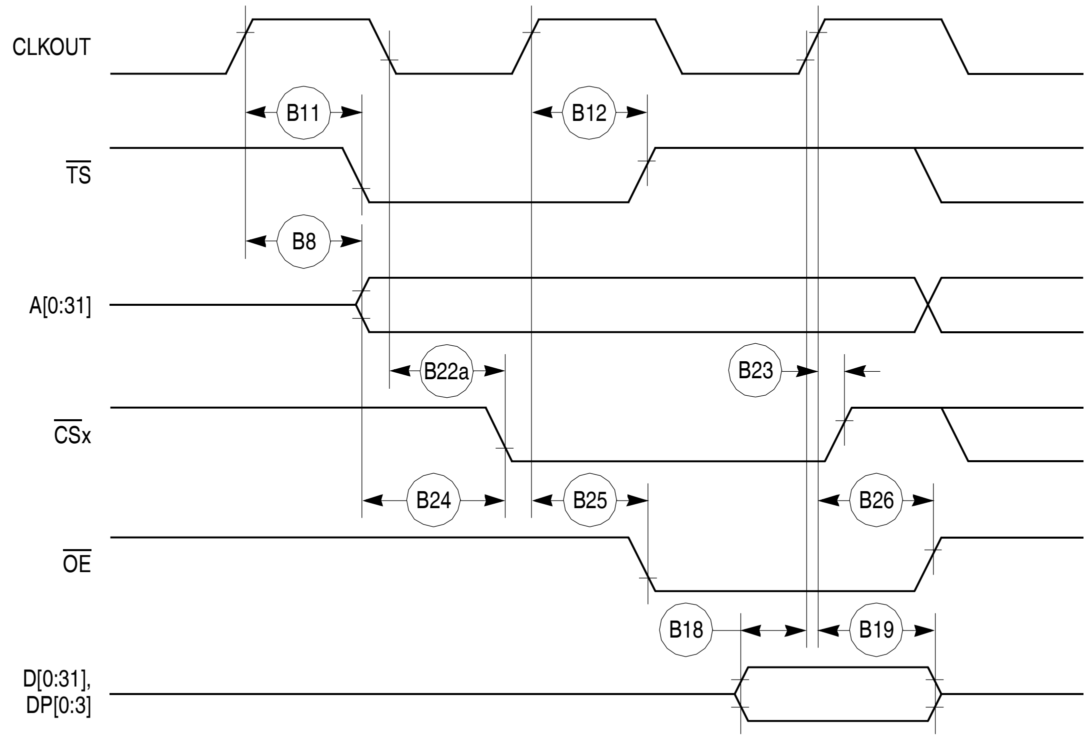


Figure 12. External Bus Read Timing (GPCM Controlled—TRLX = 0, ACS = 10)

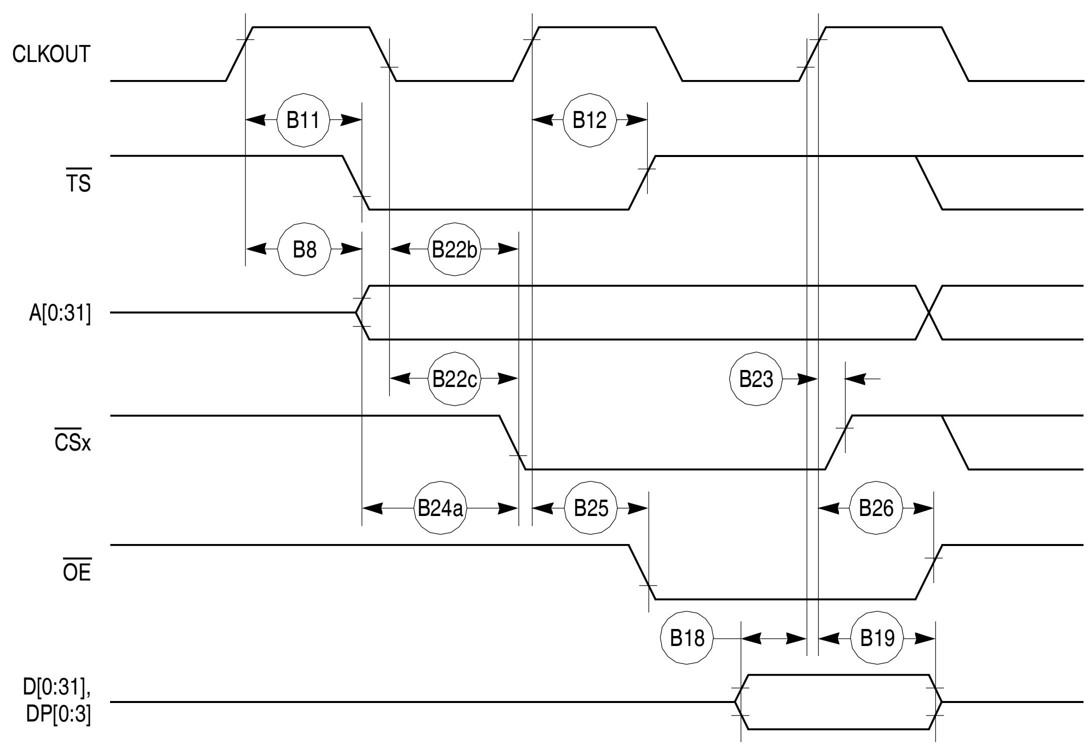


Figure 13. External Bus Read Timing (GPCM Controlled—TRLX = 0, ACS = 11)

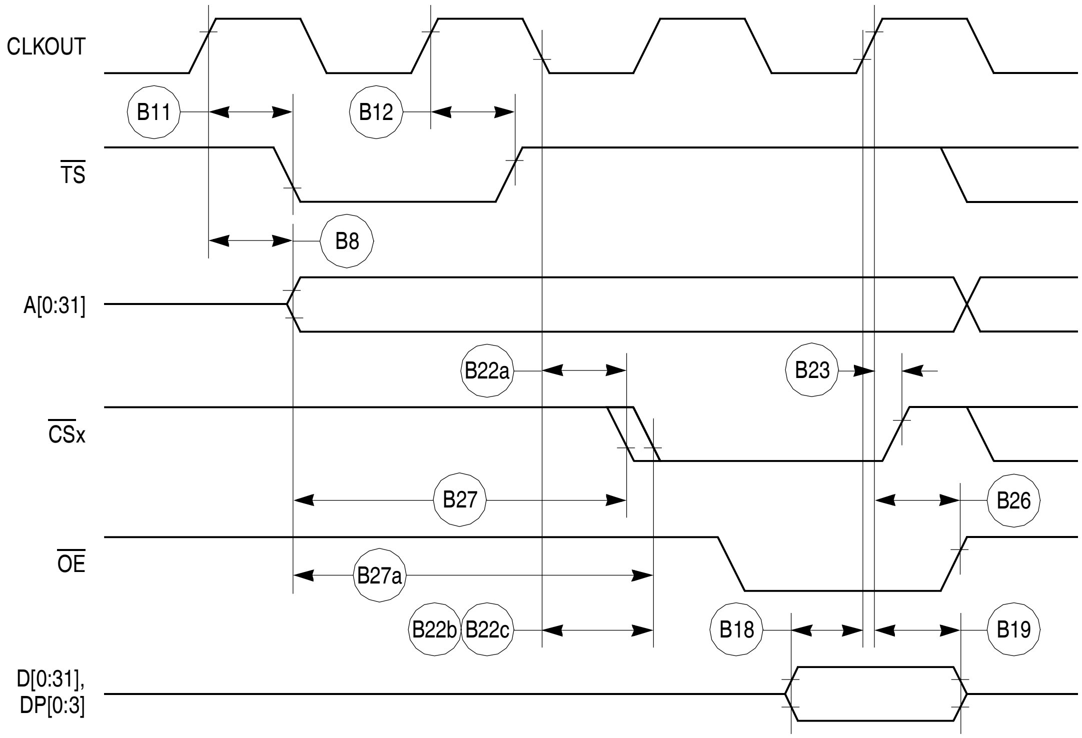


Figure 14. External Bus Read Timing (GPCM Controlled—TRLX = 1, ACS = 10, ACS = 11)

Figure 15 through Figure 17 provide the timing for the external bus write controlled by various GPCM factors.

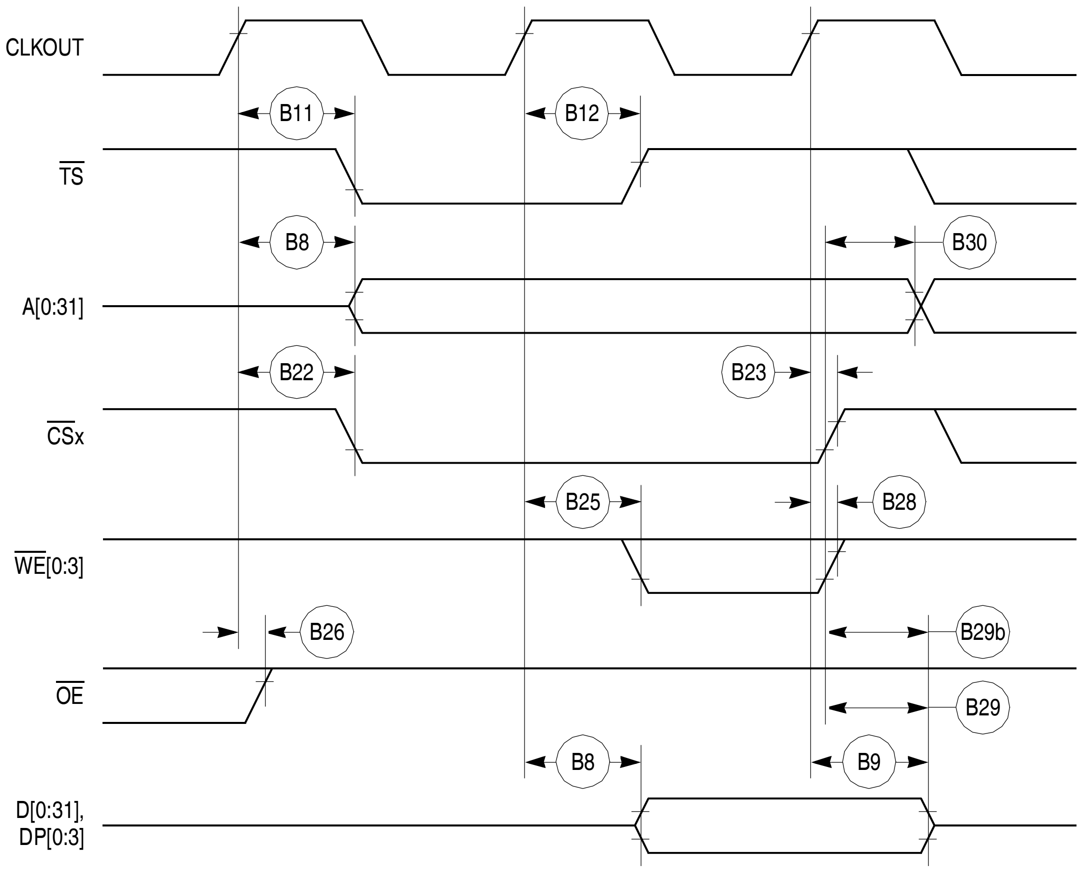


Figure 15. External Bus Write Timing (GPCM Controlled—TRLX = 0,1 CSNT = 0)

11 CPM Electrical Characteristics

This section provides the AC and DC electrical specifications for the communications processor module (CPM) of the MPC862/857T/857DSL.

11.1 PIP/PIO AC Electrical Specifications

Table 14 provides the PIP/PIO AC timings as shown in Figure 40 though Figure 44.

Table 14. PIP/PIO Timing

Num	Characteristic	All Frequencies		Unit
		Min	Max	
21	Data-in setup time to STBI low	0	—	ns
22	Data-in hold time to STBI high	2.5 – t3 [1]	—	clk
23	STBI pulse width	1.5	—	clk
24	STBO pulse width	1 clk – 5 ns	—	ns
25	Data-out setup time to STBO low	2	—	clk
26	Data-out hold time from STBO high	5	—	clk
27	STBI low to STBO low (Rx interlock)	—	2	clk
28	STBI low to STBO high (Tx interlock)	2	—	clk
29	Data-in setup time to clock high	15	—	ns
30	Data-in hold time from clock high	7.5	—	ns
31	Clock low to data-out valid (CPU writes data, control, or direction)	—	25	ns

[1] t3 = Specification 23

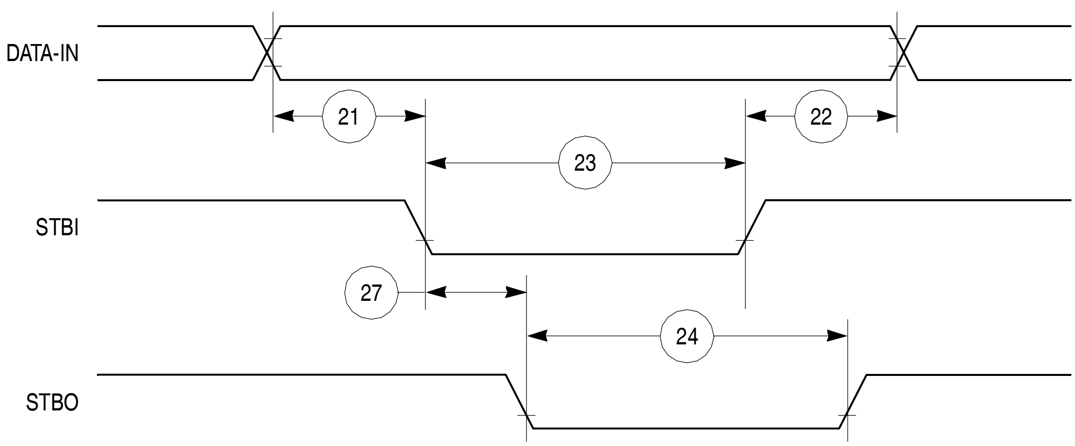


Figure 40. PIP Rx (Interlock Mode) Timing Diagram

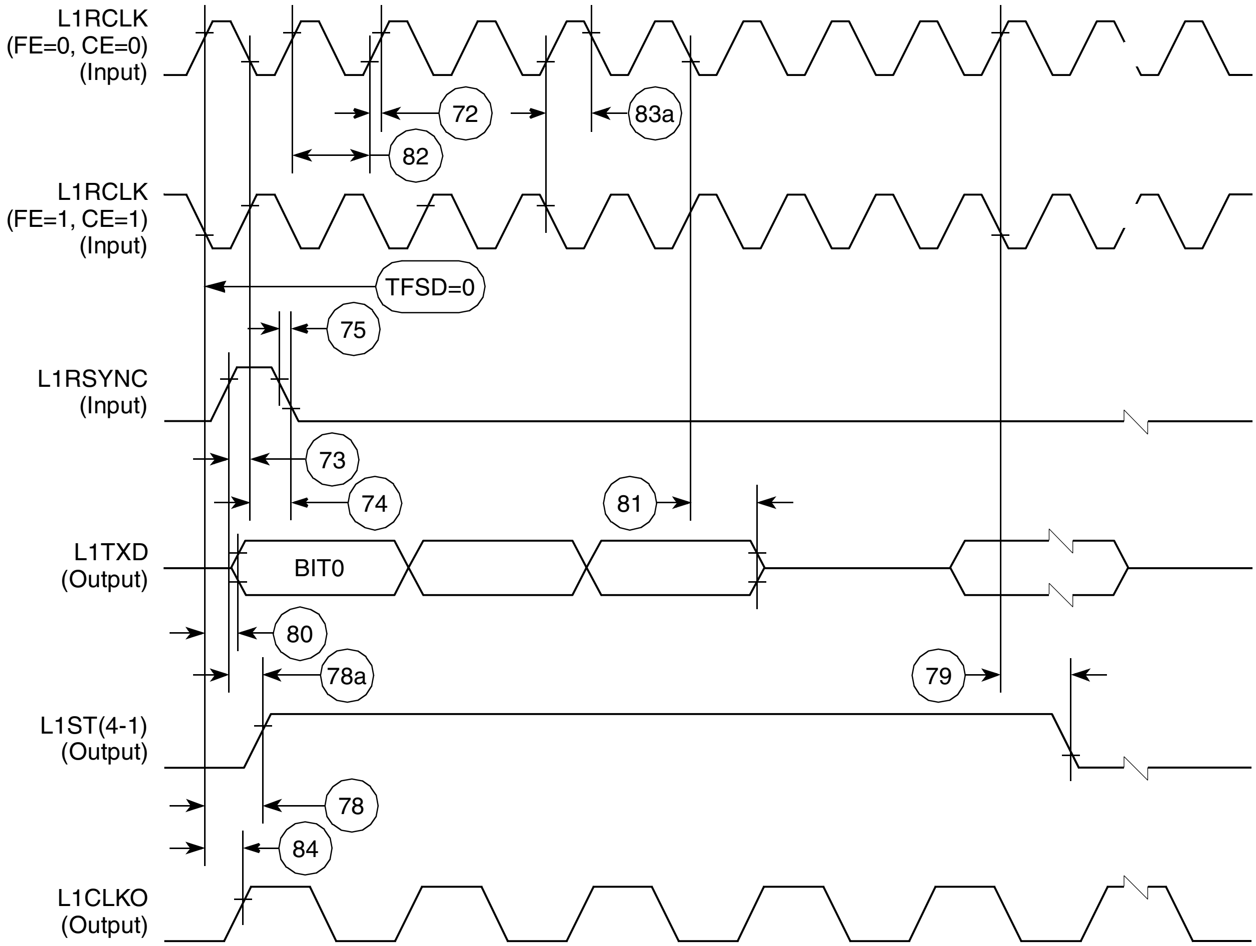


Figure 55. SI Transmit Timing with Double Speed Clocking (DSC = 1)

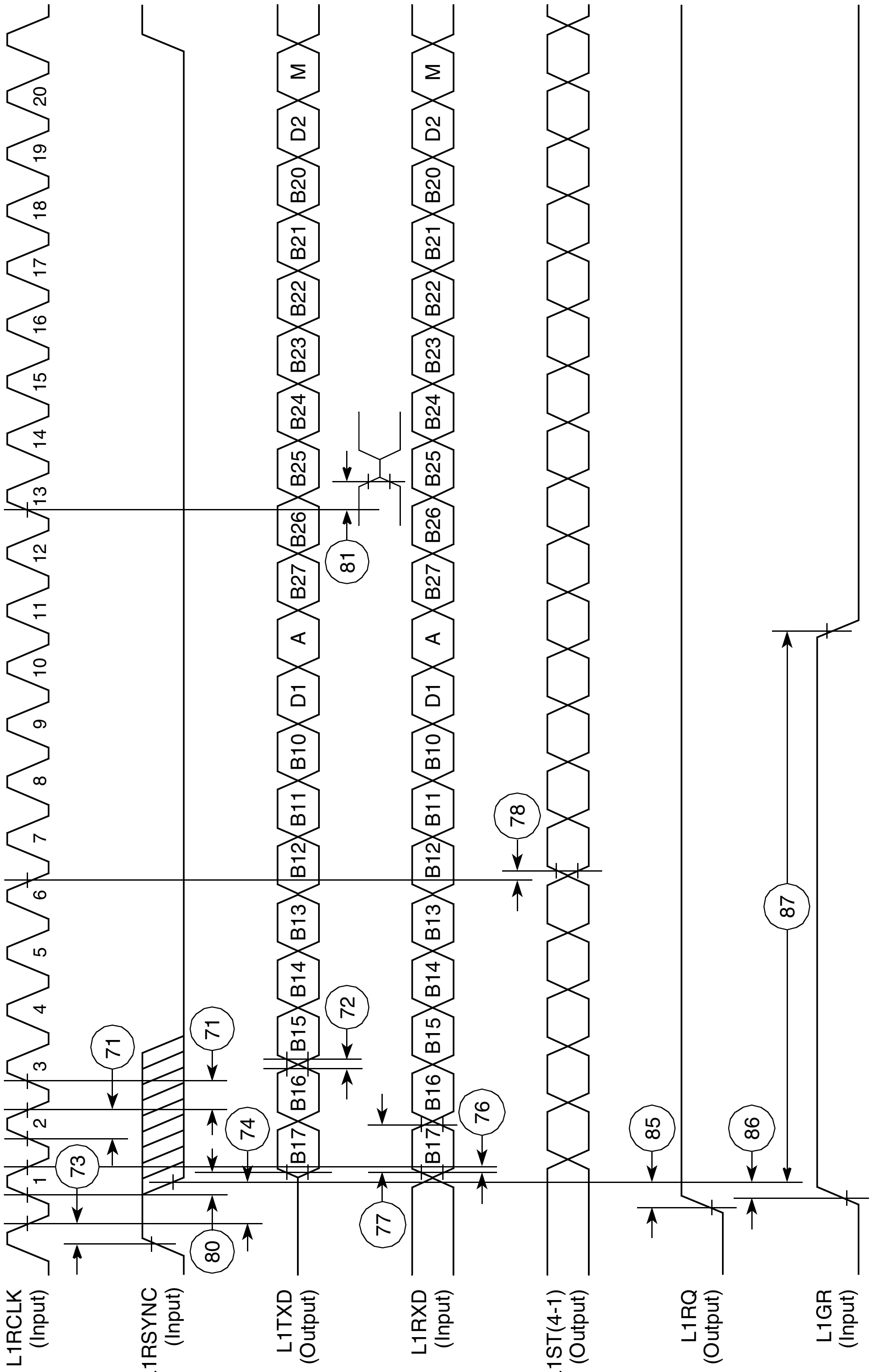


Figure 56. IDL Timing

11.7 SCC in NMSI Mode Electrical Specifications

Table 20 provides the NMSI external clock timing.

Table 20. NMSI External Clock Timing

Num	Characteristic	All Frequencies		Unit
		Min	Max	
100	RCLK1 and TCLK1 width high [1]	1/SYNCCLK	—	ns
101	RCLK1 and TCLK1 width low	1/SYNCCLK +5	—	ns
102	RCLK1 and TCLK1 rise/fall time	—	15.00	ns
103	TXD1 active delay (from TCLK1 falling edge)	0.00	50.00	ns
104	$\overline{\text{RTS1}}$ active/inactive delay (from TCLK1 falling edge)	0.00	50.00	ns
105	$\overline{\text{CTS1}}$ setup time to TCLK1 rising edge	5.00	—	ns
106	RXD1 setup time to RCLK1 rising edge	5.00	—	ns
107	RXD1 hold time from RCLK1 rising edge [2]	5.00	—	ns
108	$\overline{\text{CD1}}$ setup Time to RCLK1 rising edge	5.00	—	ns

[1] The ratios SyncCLK/RCLK1 and SyncCLK/TCLK1 must be greater than or equal to 2.25/1.

[2] Also applies to $\overline{\text{CD}}$ and $\overline{\text{CTS}}$ hold time when they are used as an external sync signal.

Table 21 provides the NMSI internal clock timing.

Table 21. NMSI Internal Clock Timing

Num	Characteristic	All Frequencies		Unit
		Min	Max	
100	RCLK1 and TCLK1 frequency [1]	0.00	SYNCCLK/3	MHz
102	RCLK1 and TCLK1 rise/fall time	—	—	ns
103	TXD1 active delay (from TCLK1 falling edge)	0.00	30.00	ns
104	$\overline{\text{RTS1}}$ active/inactive delay (from TCLK1 falling edge)	0.00	30.00	ns
105	$\overline{\text{CTS1}}$ setup time to TCLK1 rising edge	40.00	—	ns
106	RXD1 setup time to RCLK1 rising edge	40.00	—	ns
107	RXD1 hold time from RCLK1 rising edge [2]	0.00	—	ns
108	$\overline{\text{CD1}}$ setup time to RCLK1 rising edge	40.00	—	ns

[1] The ratios SyncCLK/RCLK1 and SyncCLK/TCLK1 must be greater or equal to 3/1.

[2] Also applies to $\overline{\text{CD}}$ and $\overline{\text{CTS}}$ hold time when they are used as an external sync signals.

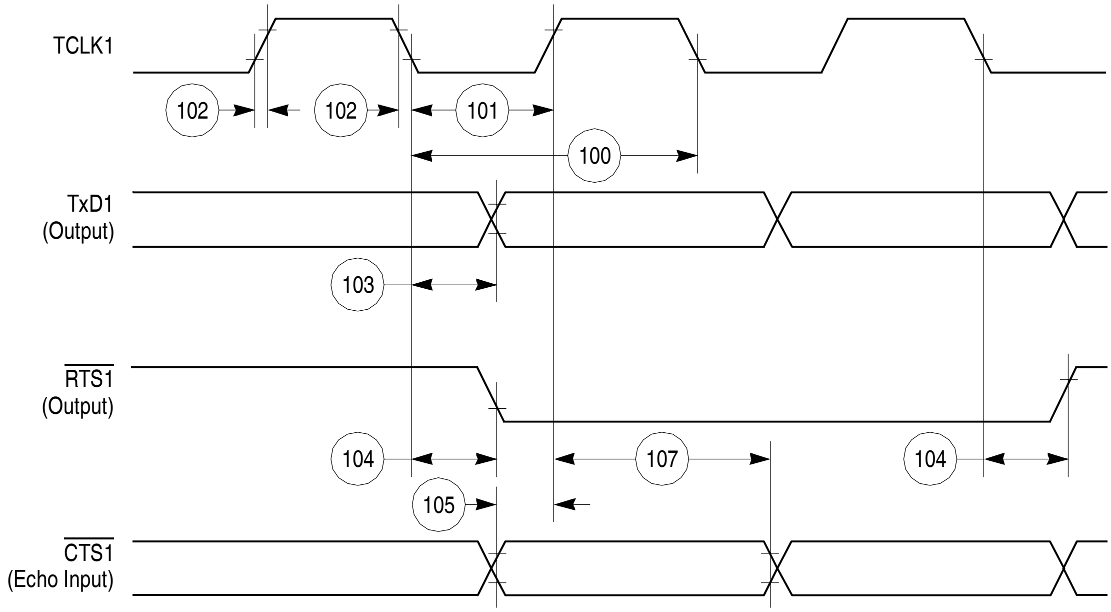


Figure 59. HDLC Bus Timing Diagram

11.8 Ethernet Electrical Specifications

Table 22 provides the Ethernet timings as shown in Figure 60 though Figure 64.

Table 22. Ethernet Timing

Num	Characteristic	All Frequencies		Unit
		Min	Max	
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

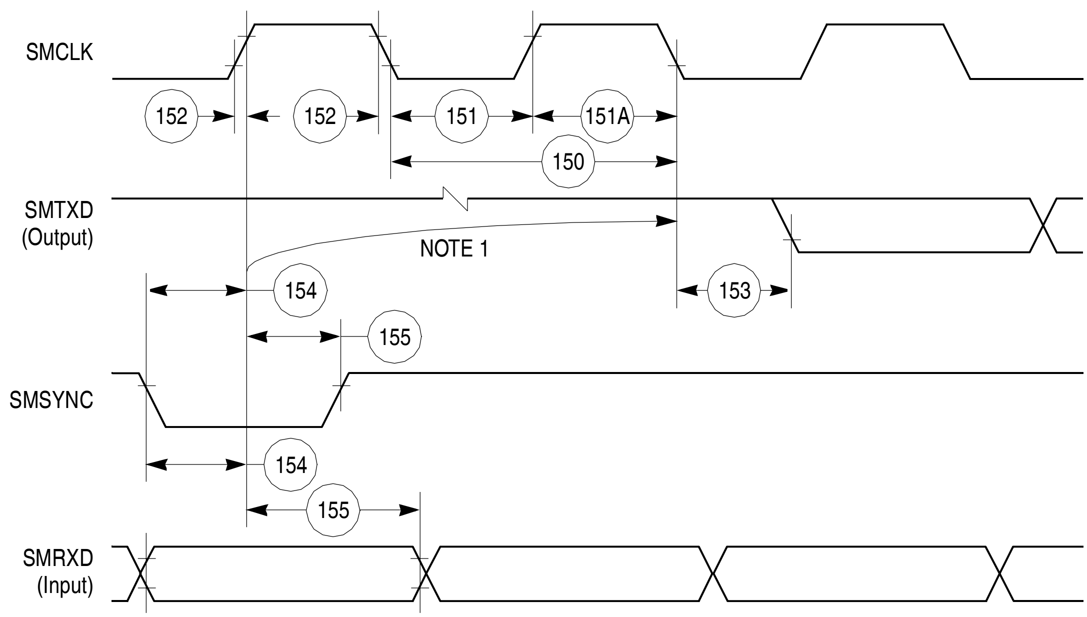
11.9 SMC Transparent AC Electrical Specifications

Table 23 provides the SMC transparent timings as shown in Figure 65.

Table 23. SMC Transparent Timing

Num	Characteristic	All Frequencies		Unit
		Min	Max	
150	SMCLK clock period [1]	100	—	ns
151	SMCLK width low	50	—	ns
151A	SMCLK width high	50	—	ns
152	SMCLK rise/fall time	—	15	ns
153	SMTXD active delay (from SMCLK falling edge)	10	50	ns
154	SMRXD/SMSYNC setup time	20	—	ns
155	RXD1/SMSYNC hold time	5	—	ns

[1] SyncCLK must be at least twice as fast as SMCLK.



NOTE:
1. This delay is equal to an integer number of character-length clocks.

Figure 65. SMC Transparent Timing Diagram

Figure 71 shows signal timings during UTOPIA receive operations.

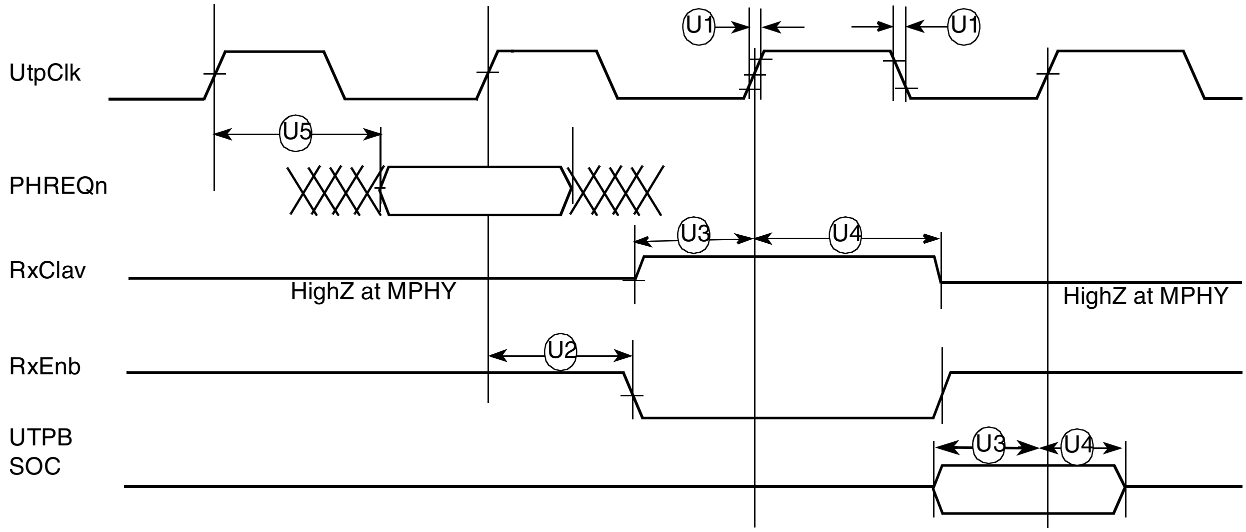


Figure 71. UTOPIA Receive Timing

Figure 72 shows signal timings during UTOPIA transmit operations.

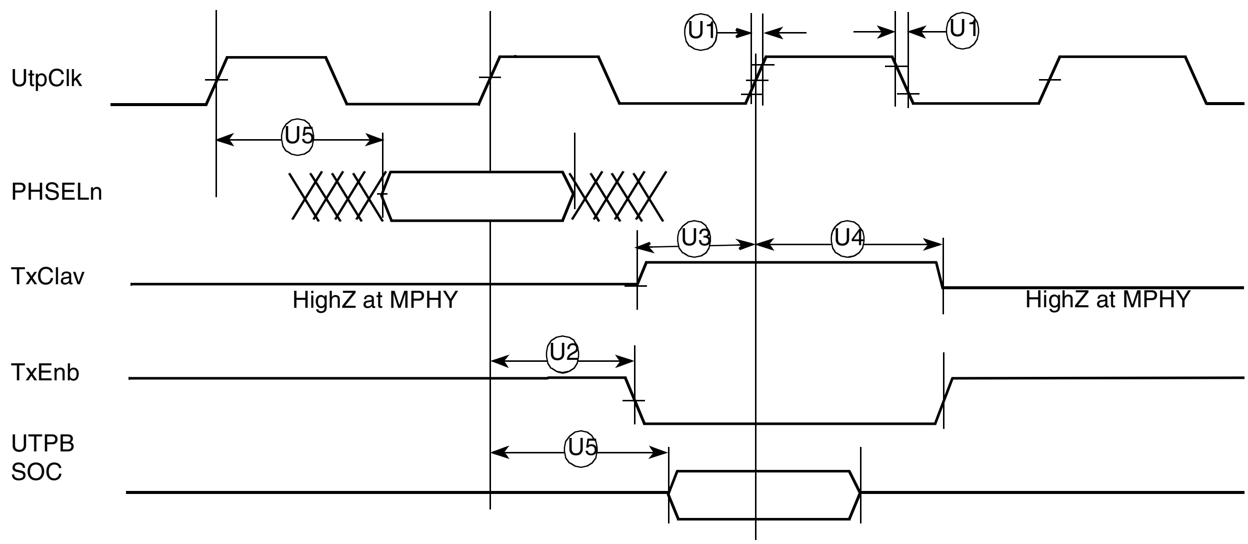


Figure 72. UTOPIA Transmit Timing

13 FEC Electrical Characteristics

This section provides the AC electrical specifications for the Fast Ethernet controller (FEC). Note that the timing specifications for the MII signals are independent of system clock frequency (part speed designation). Furthermore, MII signals use TTL signal levels compatible with devices operating at either 5.0 or 3.3 V.