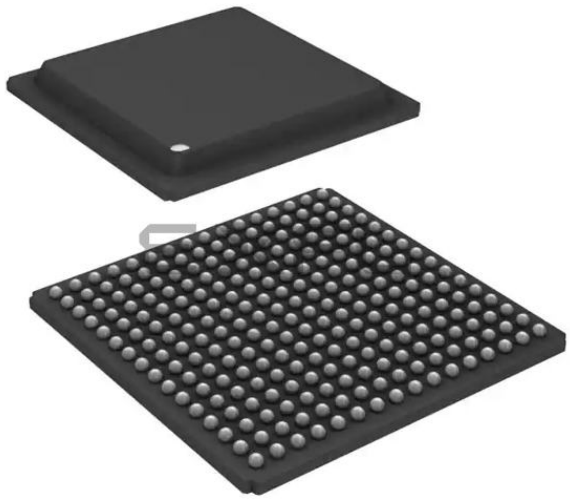

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Understanding Embedded - Microprocessors

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	133MHz
Co-Processors/DSP	Communications; CPM
RAM Controllers	DRAM
Graphics Acceleration	No
Display & Interface Controllers	-
Ethernet	10/100Mbps (2)
SATA	-
USB	USB 2.0 (1)
Voltage - I/O	3.3V
Operating Temperature	0°C ~ 95°C (TA)
Security Features	-
Package / Case	256-BBGA
Supplier Device Package	256-PBGA (23x23)
Purchase URL	https://www.e-xfl.com/product-detail/nxp-semiconductors/kmpc870vr133

Email: info@E-XFL.COM Address: Room A, 16/F, Full Win Commercial Centre, 573 Nathan Road, Mongkok, Hong Kong

- Thirty-two address lines
- Memory controller (eight banks)
  — Contains complete dynamic RAM (DRAM) controller
  — Each bank can be a chip select or $\overline{\text{RAS}}$ to support a DRAM bank
  — Up to 30 wait states programmable per memory bank
  — Glueless interface to DRAM, SIMMS, SRAM, EPROMs, Flash EPROMs, 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–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
- Two Fast Ethernet controllers (FEC)—Two 10/100 Mbps Ethernet/IEEE Std. 802.3® CDMA/CS that interface through MII and/or RMII interfaces
- System integration unit (SIU)
  — Bus monitor
  — Software watchdog
  — Periodic interrupt timer (PIT)
  — Clock synthesizer
  — Decrementer and time base
  — Reset controller
  — IEEE 1149.1™ Std. test access port (JTAG)
- Security engine is optimized to handle all the algorithms associated with IPsec, SSL/TLS, SRTP, IEEE 802.11i® standard, and iSCSI processing. Available on the MPC875, the security engine contains a crypto-channel, a controller, and a set of crypto hardware accelerators (CHAs). The CHAs are:
  — Data encryption standard execution unit (DEU)
    – DES, 3DES
    – Two key (K1, K2, K1) or three key (K1, K2, K3)
    – ECB and CBC modes for both DES and 3DES
  — Advanced encryption standard unit (AESU)
    – Implements the Rijndael symmetric key cipher

The MPC870 block diagram is shown in Figure 2.

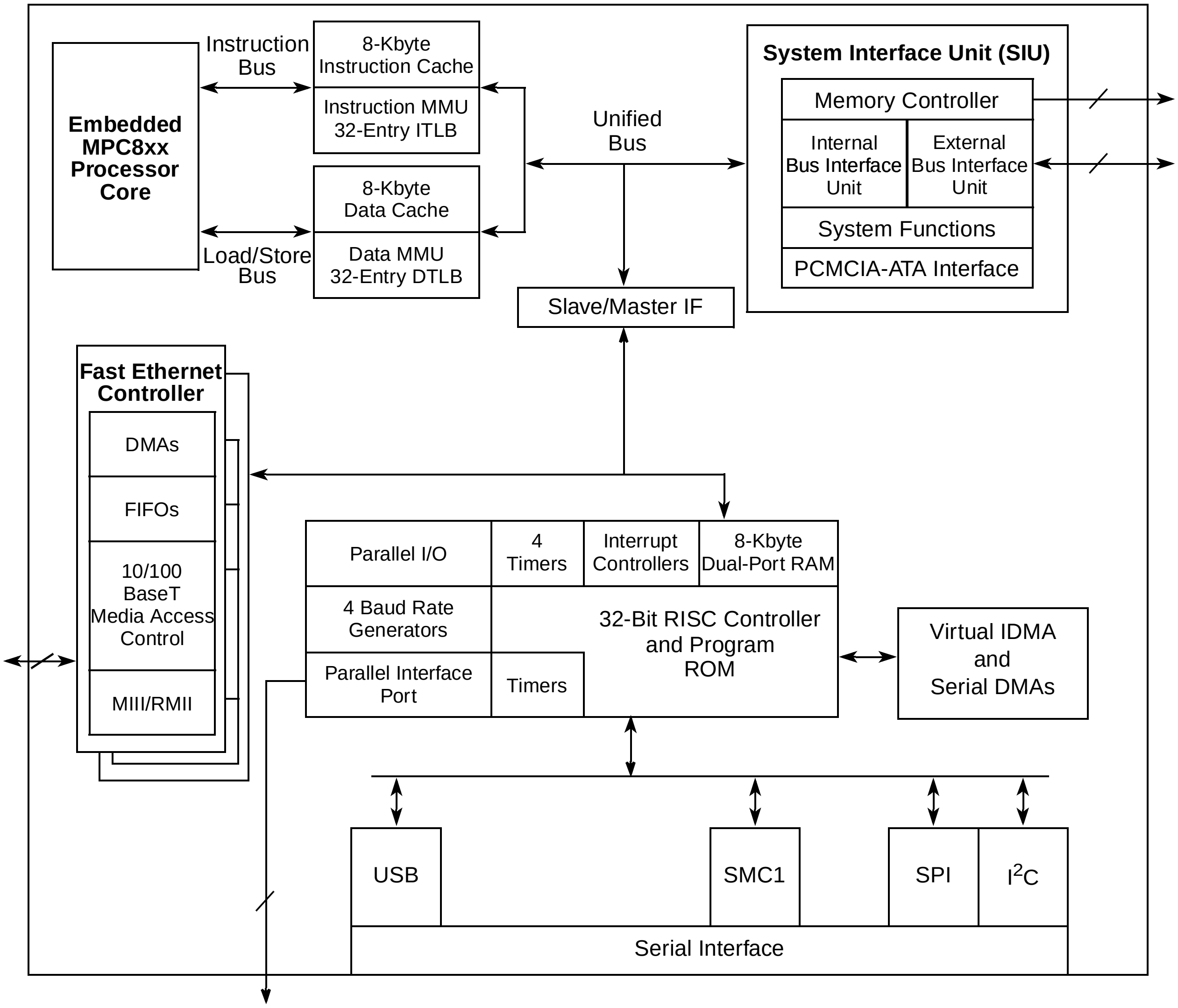

Figure 2. MPC870 Block Diagram

Table 6. DC Electrical Specifications (continued)

Characteristic	Symbol	Min	Max	Unit
Output high voltage, I_{OH} = –2.0 mA, V_{DDH} = 3.0 V (except XTAL and open-drain pins)	V_{OH}	2.4	—	V
Output low voltage I_{OL} = 2.0 mA (CLKOUT) I_{OL} = 3.2 mA[5] I_{OL} = 5.3 mA[6] I_{OL} = 7.0 mA (TXD1/PA14, TXD2/PA12) I_{OL} = 8.9 mA ($\overline{\text{TS}}$, $\overline{\text{TA}}$, $\overline{\text{TEA}}$, $\overline{\text{BI}}$, $\overline{\text{BB}}$, $\overline{\text{HRESET}}$, $\overline{\text{SRESET}}$)	V_{OL}	—	0.5	V

1 The difference between V_{DDL} and V_{DDSYN} cannot be more than 100 mV.

2 The signals PA[0:15], PB[14:31], PC[4:15], PD[3:15], PE(14:31), TDI, TDO, TCK, $\overline{\text{TRST}}$, TMS, MII1_TXEN, and MII_MDIO are 5-V tolerant. The minimum voltage is still 2.0 V.

3 V_{IL}(max) for the I^2C interface is 0.8 V rather than the 1.5 V as specified in the I^2C standard.

4 Input capacitance is periodically sampled.

5 A(0:31), TSIZ0/$\overline{\text{REG}}$, TSIZ1, D(0:31), $\overline{\text{IRQ}}$(2:4), $\overline{\text{IRQ6}}$, RD/$\overline{\text{WR}}$, $\overline{\text{BURST}}$, IP_B(0:1), PA(0:4), PA(6:7), PA(10:11), PA15, PB19, PB(23:31), PC(6:7), PC(10:13), PC15, PD8, PE(14:31), MII1_CRS, MII_MDIO, MII1_TXEN, and MII1_COL.

6 $\overline{\text{BDIP}}$/$\overline{\text{GPL\_B}}$(5), $\overline{\text{BR}}$, $\overline{\text{BG}}$, FRZ/$\overline{\text{IRQ6}}$, $\overline{\text{CS}}$(0:7), $\overline{\text{WE}}$(0:3), $\overline{\text{BS\_A}}$(0:3), $\overline{\text{GPL\_A0}}$/$\overline{\text{GPL\_B0}}$, $\overline{\text{OE}}$/$\overline{\text{GPL\_A1}}$/$\overline{\text{GPL\_B1}}$, $\overline{\text{GPL\_A}}$(2:3)/$\overline{\text{GPL\_B}}$(2:3)/$\overline{\text{CS}}$(2:3), UPWAITA/$\overline{\text{GPL\_A4}}$, UPWAITB/$\overline{\text{GPL\_B4}}$, $\overline{\text{GPL\_A5}}$, ALE_A, $\overline{\text{CE1\_A}}$, $\overline{\text{CE2\_A}}$, OP(0:3), and BADDR(28:30).

7 Thermal Calculation and Measurement

For the following discussions, $P_D = (V_{DDL} \times I_{DDL}) + P_{I/O}$, where $P_{I/O}$ is the power dissipation of the I/O drivers.

NOTE

The V_{DDSYN} power dissipation is negligible.

7.1 Estimation with Junction-to-Ambient Thermal Resistance

An estimation of the chip junction temperature, T_J, in °C can be obtained from the following equation:

$$T_J = T_A + (R_{\theta JA} \times P_D)$$

where:

T_A = ambient temperature (°C)

$R_{\theta JA}$ = package junction-to-ambient thermal resistance (°C/W)

P_D = power dissipation in package

The junction-to-ambient thermal resistance is an industry standard value that provides a quick and easy estimation of thermal performance. However, the answer is only an estimate; test cases have demonstrated that errors of a factor of two (in the quantity $T_J – T_A$) are possible.

One consequence of multiple power supplies is that when power is initially applied, the voltage rails ramp up at different rates. The rates depend on the nature of the power supply, the type of load on each power supply, and the manner in which different voltages are derived. The following restrictions apply:

- V_{DDL} must not exceed V_{DDH} during power up and power down
- V_{DDL} must not exceed 1.9 V, and V_{DDH} must not exceed 3.465 V

These cautions are necessary for the long-term reliability of the part. If they are violated, the electrostatic discharge (ESD) protection diodes are forward-biased, and excessive current can flow through these diodes. If the system power supply design does not control the voltage sequencing, the circuit shown in Figure 4 can be added to meet these requirements. The MUR420 Schottky diodes control the maximum potential difference between the external bus and core power supplies on power up, and the 1N5820 diodes regulate the maximum potential difference on power down.

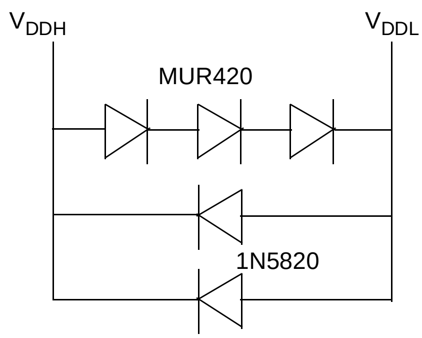

Figure 4. Example Voltage Sequencing Circuit

9 Mandatory Reset Configurations

The MPC875/MPC870 requires a mandatory configuration during reset.

If hardware reset configuration word (HRCW) is enabled, the HRCW[DBGC] value needs to be set to binary X1 in the HRCW and the SIUMCR[DBGC] should be programmed with the same value in the boot code after reset. This can be done by asserting the $\overline{\text{RSTCONF}}$ during $\overline{\text{HRESET}}$ assertion.

If HRCW is disabled, the SIUMCR[DBGC] should be programmed with binary X1 in the boot code after reset by negating the $\overline{\text{RSTCONF}}$ during the $\overline{\text{HRESET}}$ assertion.

The MBMR[GPLB4DIS], PAPAR, PADIR, PBPAR, PBDIR, PCPAR, and PCDIR need to be configured with the mandatory values in Table 7 in the boot code after the reset is negated.

Table 7. Mandatory Reset Configuration of MPC875/MPC870

Register/Configuration	Field	Value (Binary)
HRCW (Hardware reset configuration word)	HRCW[DBGC]	X1
SIUMCR (SIU module configuration register)	SIUMCR[DBGC]	X1
MBMR (Machine B mode register)	MBMR[GPLB4DIS}	0
PAPAR (Port A pin assignment register)	PAPAR[5:9] PAPAR[12:13]	0

Table 7. Mandatory Reset Configuration of MPC875/MPC870 (continued)

Register/Configuration	Field	Value (Binary)
PADIR (Port A data direction register)	PADIR[5:9] PADIR[12:13]	0
PBPAR (Port B pin assignment register)	PBPAR[14:18] PBPAR[20:22]	0
PBDIR (Port B data direction register)	PBDIR[14:8] PBDIR[20:22]	0
PCPAR (Port C pin assignment register)	PCPAR[4:5] PCPAR[8:9] PCPAR[14]	0
PCDIR (Port C data direction register)	PCDIR[4:5] PCDIR[8:9] PCDIR[14]	0
PDPAR (Port D pin assignment register)	PDPAR[3:7] PDPAR[9:5]	0
PDDIR (Port D data direction register)	PDDIR[3:7] PDDIR[9:15]	0

10 Layout Practices

Each V_{DD} pin on the MPC875/MPC870 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_{DD} power supply should be bypassed to ground using at least four 0.1-µF bypass capacitors located as close as possible to the four sides of the package. Each board designed should be characterized and additional appropriate decoupling capacitors should be used if required. The capacitor leads and associated printed-circuit traces connecting to chip V_{DD} and GND should be kept to less than half an inch per capacitor lead. At a minimum, a four-layer board employing two inner layers as V_{DD} and GND planes should be used.

All output pins on the MPC875/MPC870 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 buses. Maximum PC trace lengths of 6 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_{DD} 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. For more information, refer to Section 14.4.3, "Clock Synthesizer Power (V_{DDSYN}, V_{SSSYN}, V_{SSSYN1})," in the *MPC885 PowerQUICC™ Family Reference Manual*.

Table 10. Bus Operation Timings (continued)

Num	Characteristic	33 MHz		40 MHz		66 MHz		80 MHz		Unit
		Min	Max	Min	Max	Min	Max	Min	Max	
B30d	$\overline{WE}$(0:3)/BS_B[0:3] negated to A(0:31), 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 11, EBDF = 1	38.67	—	31.38	—	17.83	—	14.19	—	ns
B31	CLKOUT falling edge to $\overline{CS}$ valid as requested by control bit CST4 in the corresponding word in the UPM (MAX = 0.00 × B1 + 6.00)	1.50	6.00	1.50	6.00	1.50	6.00	1.50	6.00	ns
B31a	CLKOUT falling edge to $\overline{CS}$ valid as requested by control bit CST1 in the corresponding word in the UPM (MAX = 0.25 × B1 + 6.80)	7.60	14.30	6.30	13.00	3.80	10.50	3.13	10.00	ns
B31b	CLKOUT rising edge to $\overline{CS}$ valid, as requested by control bit CST2 in the corresponding word in the UPM (MAX = 0.00 × B1 + 8.00)	1.50	8.00	1.50	8.00	1.50	8.00	1.50	8.00	ns
B31c	CLKOUT rising edge to $\overline{CS}$ valid, as requested by control bit CST3 in the corresponding word in the UPM (MAX = 0.25 × B1 + 6.30)	7.60	13.80	6.30	12.50	3.80	10.00	3.13	9.40	ns
B31d	CLKOUT falling edge to $\overline{CS}$ valid as requested by control bit CST1 in the corresponding word in the UPM EBDF = 1 (MAX = 0.375 × B1 + 6.6)	13.30	18.00	11.30	16.00	7.60	12.30	4.69	11.30	ns
B32	CLKOUT falling edge to $\overline{BS}$ valid as requested by control bit BST4 in the corresponding word in the UPM (MAX = 0.00 × B1 + 6.00)	1.50	6.00	1.50	6.00	1.50	6.00	1.50	6.00	ns
B32a	CLKOUT falling edge to $\overline{BS}$ valid as requested by control bit BST1 in the corresponding word in the UPM, EBDF = 0 (MAX = 0.25 × B1 + 6.80)	7.60	14.30	6.30	13.00	3.80	10.50	3.13	10.00	ns
B32b	CLKOUT rising edge to $\overline{BS}$ valid, as requested by control bit BST2 in the corresponding word in the UPM (MAX = 0.00 × B1 + 8.00)	1.50	8.00	1.50	8.00	1.50	8.00	1.50	8.00	ns
B32c	CLKOUT rising edge to $\overline{BS}$ valid, as requested by control bit BST3 in the corresponding word in the UPM (MAX = 0.25 × B1 + 6.80)	7.60	14.30	6.30	13.00	3.80	10.50	3.13	10.00	ns
B32d	CLKOUT falling edge to $\overline{BS}$ valid as requested by control bit BST1 in the corresponding word in the UPM, EBDF = 1 (MAX = 0.375 × B1 + 6.60)	13.30	18.00	11.30	16.00	7.60	12.30	4.49	11.30	ns
B33	CLKOUT falling edge to $\overline{GPL}$ valid as requested by control bit GxT4 in the corresponding word in the UPM (MAX = 0.00 × B1 + 6.00)	1.50	6.00	1.50	6.00	1.50	6.00	1.50	6.00	ns

Table 10. Bus Operation Timings (continued)

Num	Characteristic	33 MHz		40 MHz		66 MHz		80 MHz		Unit
		Min	Max	Min	Max	Min	Max	Min	Max	
B33a	CLKOUT rising edge to $\overline{\text{GPL}}$ valid as requested by control bit GxT3 in the corresponding word in the UPM (MAX = 0.25 × B1 + 6.80)	7.60	14.30	6.30	13.00	3.80	10.50	3.13	10.00	ns
B34	A(0:31), BADDR(28:30), and D(0:31) to $\overline{\text{CS}}$ valid, as requested by control bit CST4 in the corresponding word in the UPM (MIN = 0.25 × B1 – 2.00)	5.60	—	4.30	—	1.80	—	1.13	—	ns
B34a	A(0:31), BADDR(28:30), and D(0:31) to $\overline{\text{CS}}$ valid, as requested by control bit CST1 in the corresponding word in the UPM (MIN = 0.50 × B1 – 2.00)	13.20	—	10.50	—	5.60	—	4.25	—	ns
B34b	A(0:31), BADDR(28:30), and D(0:31) to $\overline{\text{CS}}$ valid, as requested by CST2 in the corresponding word in UPM (MIN = 0.75 × B1 – 2.00)	20.70	—	16.70	—	9.40	—	6.80	—	ns
B35	A(0:31), BADDR(28:30) to $\overline{\text{CS}}$ valid as requested by control bit BST4 in the corresponding word in the UPM (MIN = 0.25 × B1 – 2.00)	5.60	—	4.30	—	1.80	—	1.13	—	ns
B35a	A(0:31), BADDR(28:30), and D(0:31) to $\overline{\text{BS}}$ valid as requested by BST1 in the corresponding word in the UPM (MIN = 0.50 × B1 – 2.00)	13.20	—	10.50	—	5.60	—	4.25	—	ns
B35b	A(0:31), BADDR(28:30), and D(0:31) to $\overline{\text{BS}}$ valid as requested by control bit BST2 in the corresponding word in the UPM (MIN = 0.75 × B1 – 2.00)	20.70	—	16.70	—	9.40	—	7.40	—	ns
B36	A(0:31), BADDR(28:30), and D(0:31) to $\overline{\text{GPL}}$ valid as requested by control bit GxT4 in the corresponding word in the UPM (MIN = 0.25 × B1 – 2.00)	5.60	—	4.30	—	1.80	—	1.13	—	ns
B37	UPWAIT valid to CLKOUT falling edge[9] (MIN = 0.00 × B1 + 6.00)	6.00	—	6.00	—	6.00	—	6.00	—	ns
B38	CLKOUT falling edge to UPWAIT valid[9] (MIN = 0.00 × B1 + 1.00)	1.00	—	1.00	—	1.00	—	1.00	—	ns
B39	$\overline{\text{AS}}$ valid to CLKOUT rising edge[10] (MIN = 0.00 × B1 + 7.00)	7.00	—	7.00	—	7.00	—	7.00	—	ns
B40	A(0:31), TSIZ(0:1), RD/$\overline{\text{WR}}$, $\overline{\text{BURST}}$ valid to CLKOUT rising edge (MIN = 0.00 × B1 + 7.00)	7.00	—	7.00	—	7.00	—	7.00	—	ns
B41	$\overline{\text{TS}}$ valid to CLKOUT rising edge (setup time) (MIN = 0.00 × B1 + 7.00)	7.00	—	7.00	—	7.00	—	7.00	—	ns

Table 10. Bus Operation Timings (continued)

Num	Characteristic	33 MHz		40 MHz		66 MHz		80 MHz		Unit
		Min	Max	Min	Max	Min	Max	Min	Max	
B42	CLKOUT rising edge to $\overline{\text{TS}}$ valid (hold time) (MIN = 0.00 × B1 + 2.00)	2.00	—	2.00	—	2.00	—	2.00	—	ns
B43	$\overline{\text{AS}}$ negation to memory controller signals negation (MAX = TBD)	—	TBD	—	TBD	—	TBD	—	TBD	ns

1 For part speeds above 50 MHz, use 9.80 ns for B11a.

2 The timing required for $\overline{\text{BR}}$ input is relevant when the MPC875/MPC870 is selected to work with the internal bus arbiter. The timing for $\overline{\text{BG}}$ input is relevant when the MPC875/MPC870 is selected to work with the external bus arbiter.

3 For part speeds above 50 MHz, use 2 ns for B17.

4 The D(0:31) input timings B18 and B19 refer to the rising edge of the CLKOUT in which the $\overline{\text{TA}}$ input signal is asserted.

5 For part speeds above 50 MHz, use 2 ns for B19.

6 The D(0:31) input timings B20 and B21 refer to the falling edge of the CLKOUT. This timing is valid only for read accesses controlled by chip-selects under control of the user-programmable machine (UPM) in the memory controller, for data beats where DLT3 = 1 in the RAM words. (This is only the case where data is latched on the falling edge of CLKOUT.)

7 This formula applies to bus operation up to 50 MHz.

8 The timing B30 refers to $\overline{\text{CS}}$ when ACS = 00 and to $\overline{\text{WE}}$(0:3) when CSNT = 0.

9 The signal UPWAIT is considered asynchronous to the CLKOUT and synchronized internally. The timings specified in B37 and B38 are specified to enable the freeze of the UPM output signals as described in Figure 20.

10 The $\overline{\text{AS}}$ signal is considered asynchronous to the CLKOUT. The timing B39 is specified in order to allow the behavior specified in Figure 23.

Figure 11 provides the timing for the input data controlled by the UPM for data beats where DLT3 = 1 in the UPM RAM words. (This is only the case where data is latched on the falling edge of CLKOUT.)

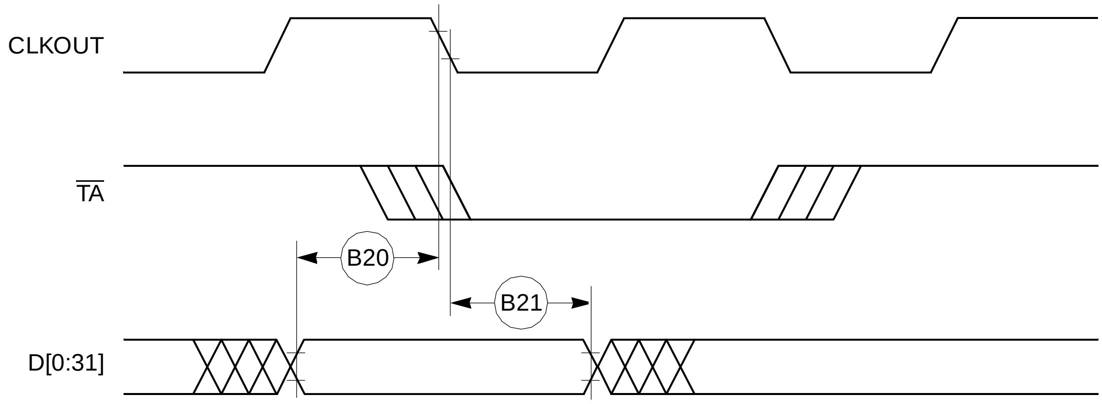

Figure 11. Input Data Timing when Controlled by UPM in the Memory Controller and DLT3 = 1

Figure 12 through Figure 15 provide the timing for the external bus read controlled by various GPCM factors.

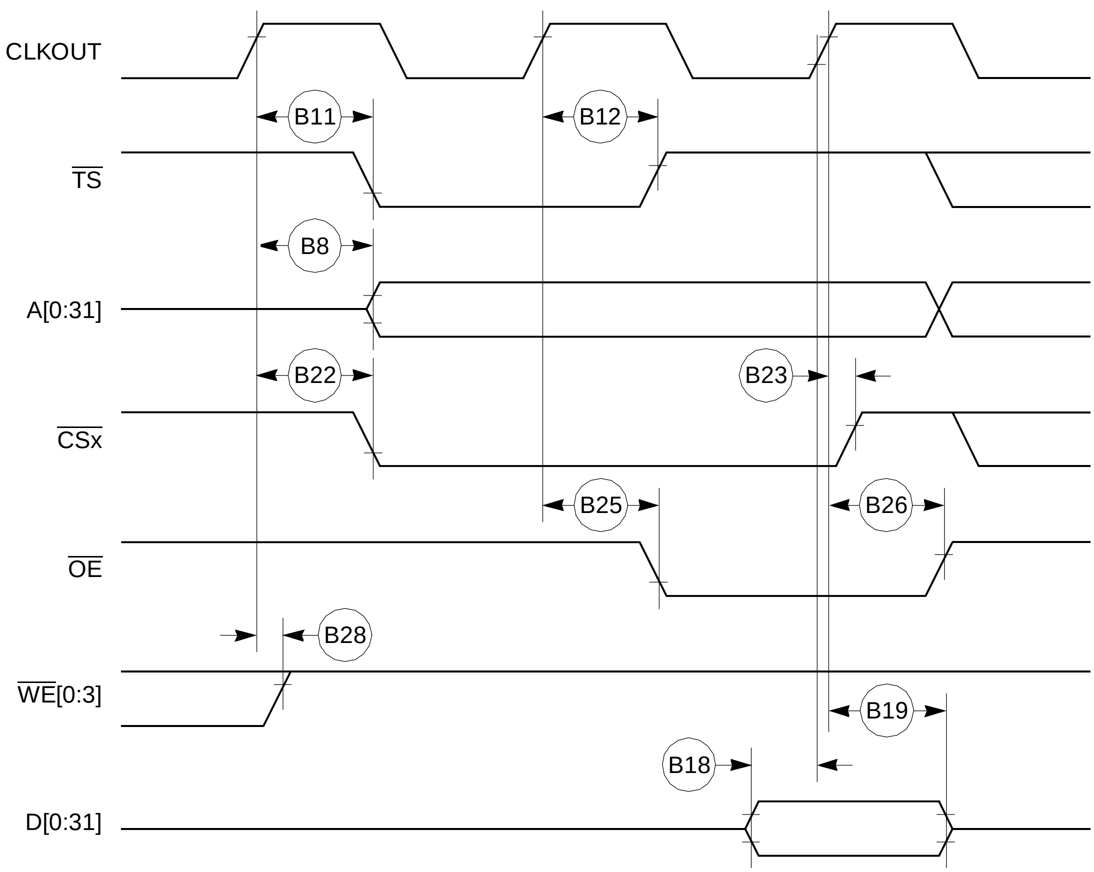

Figure 12. External Bus Read Timing (GPCM Controlled—ACS = 00)

Figure 28 provides the PCMCIA access cycle timing for the external bus write.

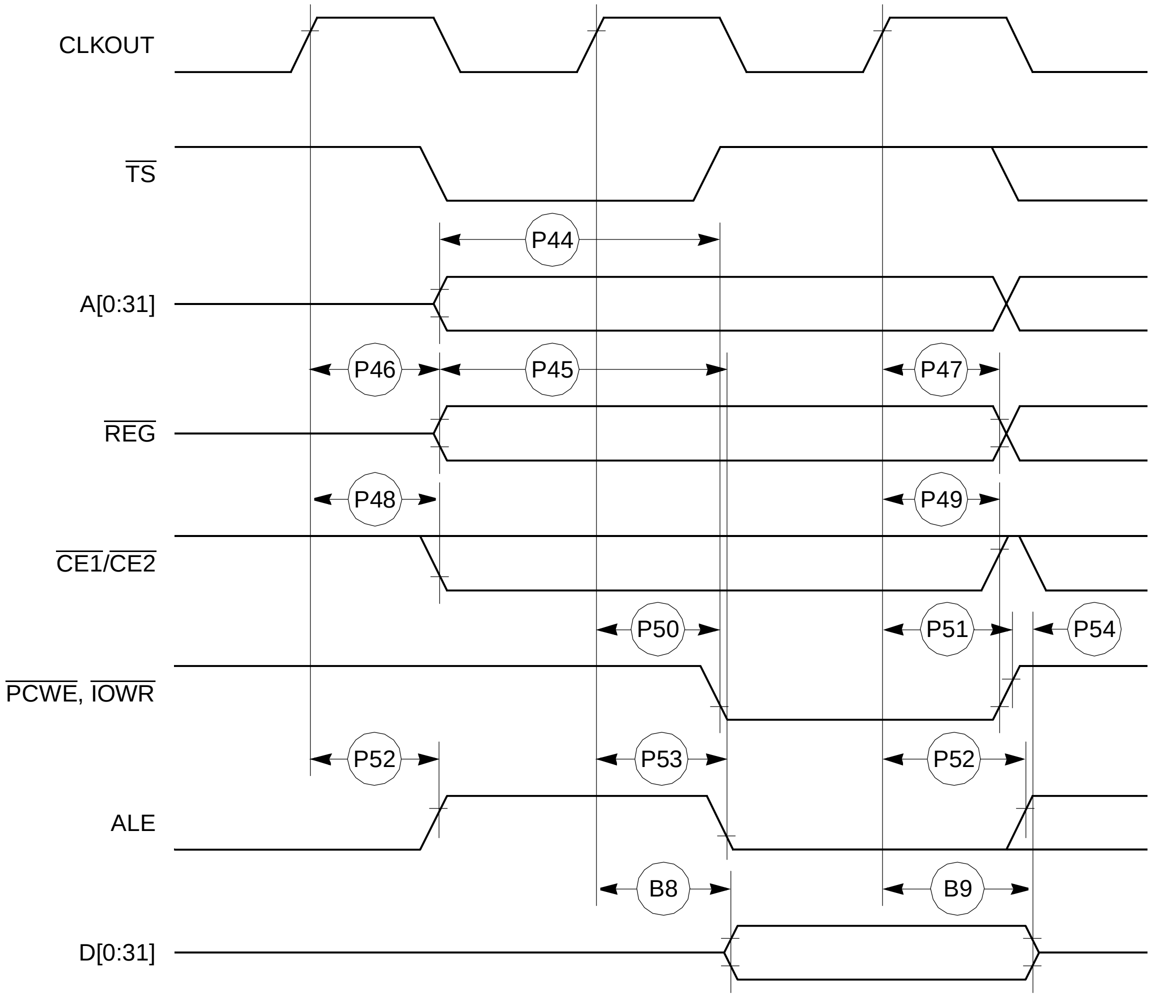

Figure 28. PCMCIA Access Cycles Timing External Bus Write

Figure 29 provides the PCMCIA $\overline{\text{WAIT}}$ signals detection timing.

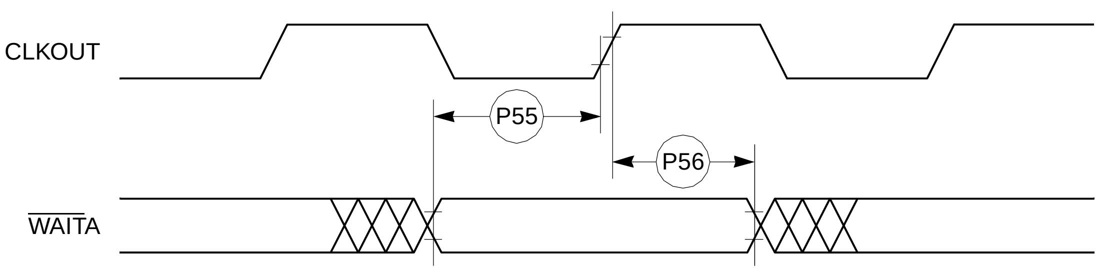

Figure 29. PCMCIA $\overline{\text{WAIT}}$ Signals Detection Timing

Table 14 shows the debug port timing for the MPC875/MPC870.

Table 14. Debug Port Timing

Num	Characteristic	All Frequencies		Unit
		Min	Max	
D61	DSCK cycle time	$3 \times T_{CLOCKOUT}$		—
D62	DSCK clock pulse width	$1.25 \times T_{CLOCKOUT}$		—
D63	DSCK rise and fall times	0.00	3.00	ns
D64	DSDI input data setup time	8.00		ns
D65	DSDI data hold time	5.00		ns
D66	DSCK low to DSDO data valid	0.00	15.00	ns
D67	DSCK low to DSDO invalid	0.00	2.00	ns

Figure 32 provides the input timing for the debug port clock.

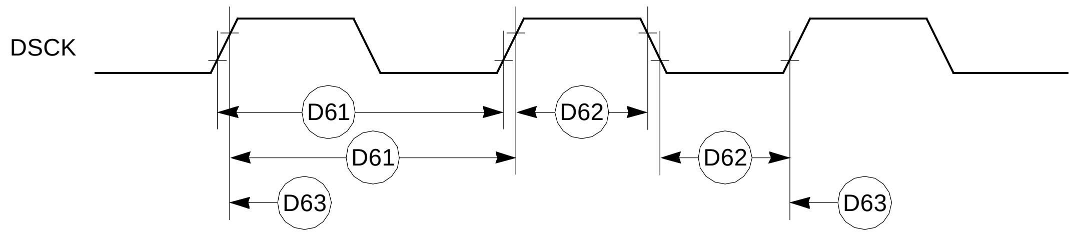

Figure 32. Debug Port Clock Input Timing

Figure 33 provides the timing for the debug port.

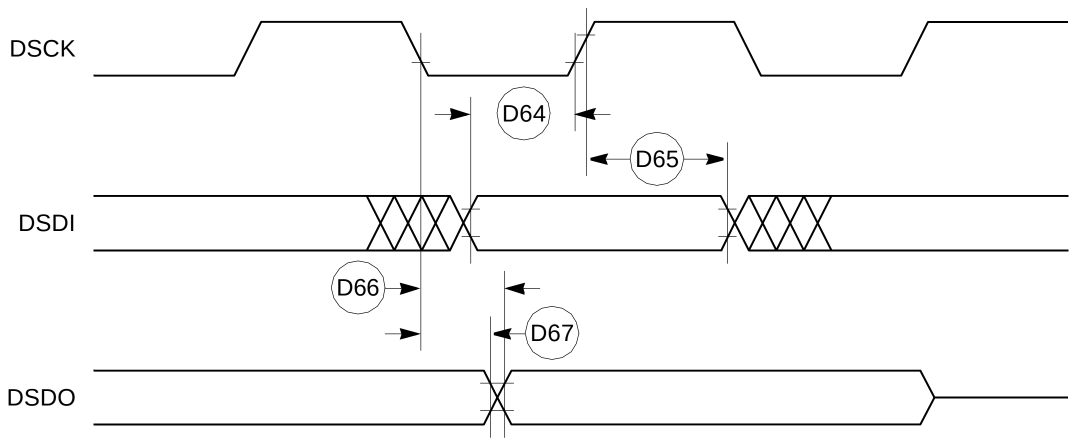

Figure 33. Debug Port Timings

Table 15 shows the reset timing for the MPC875/MPC870.

Table 15. Reset Timing

Num	Characteristic	33 MHz		40 MHz		66 MHz		80 MHz		Unit
		Min	Max	Min	Max	Min	Max	Min	Max	
R69	CLKOUT to $\overline{\text{HRESET}}$ high impedance (MAX = 0.00 × B1 + 20.00)	—	20.00	—	20.00	—	20.00	—	20.00	ns
R70	CLKOUT to $\overline{\text{SRESET}}$ high impedance (MAX = 0.00 × B1 + 20.00)	—	20.00	—	20.00	—	20.00	—	20.00	ns
R71	$\overline{\text{RSTCONF}}$ pulse width (MIN = 17.00 × B1)	515.20	—	425.00	—	257.60	—	212.50	—	ns
R72	—	—	—	—	—	—	—	—	—	—
R73	Configuration data to $\overline{\text{HRESET}}$ rising edge setup time (MIN = 15.00 × B1 + 50.00)	504.50	—	425.00	—	277.30	—	237.50	—	ns
R74	Configuration data to $\overline{\text{RSTCONF}}$ rising edge setup time (MIN = 0.00 × B1 + 350.00)	350.00	—	350.00	—	350.00	—	350.00	—	ns
R75	Configuration data hold time after $\overline{\text{RSTCONF}}$ negation (MIN = 0.00 × B1 + 0.00)	0.00	—	0.00	—	0.00	—	0.00	—	ns
R76	Configuration data hold time after $\overline{\text{HRESET}}$ negation (MIN = 0.00 × B1 + 0.00)	0.00	—	0.00	—	0.00	—	0.00	—	ns
R77	$\overline{\text{HRESET}}$ and $\overline{\text{RSTCONF}}$ asserted to data out drive (MAX = 0.00 × B1 + 25.00)	—	25.00	—	25.00	—	25.00	—	25.00	ns
R78	$\overline{\text{RSTCONF}}$ negated to data out high impedance (MAX = 0.00 × B1 + 25.00)	—	25.00	—	25.00	—	25.00	—	25.00	ns
R79	CLKOUT of last rising edge before chip three-states $\overline{\text{HRESET}}$ to data out high impedance (MAX = 0.00 × B1 + 25.00)	—	25.00	—	25.00	—	25.00	—	25.00	ns
R80	DSDI, DSCK setup (MIN = 3.00 × B1)	90.90	—	75.00	—	45.50	—	37.50	—	ns
R81	DSDI, DSCK hold time (MIN = 0.00 × B1 + 0.00)	0.00	—	0.00	—	0.00	—	0.00	—	ns
R82	$\overline{\text{SRESET}}$ negated to CLKOUT rising edge for DSDI and DSCK sample (MIN = 8.00 × B1)	242.40	—	200.00	—	121.20	—	100.00	—	ns

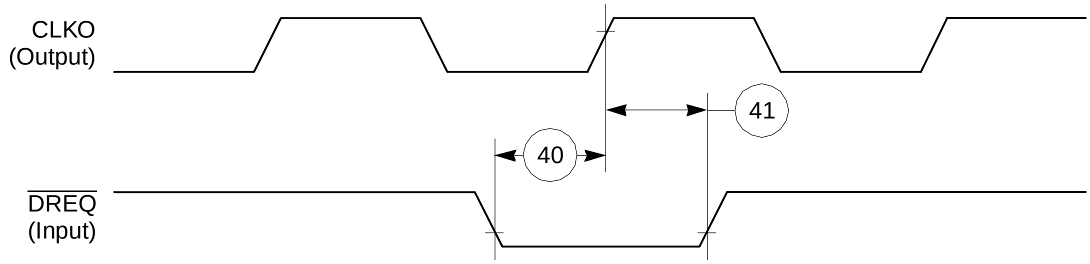

Figure 42. IDMA External Requests Timing Diagram

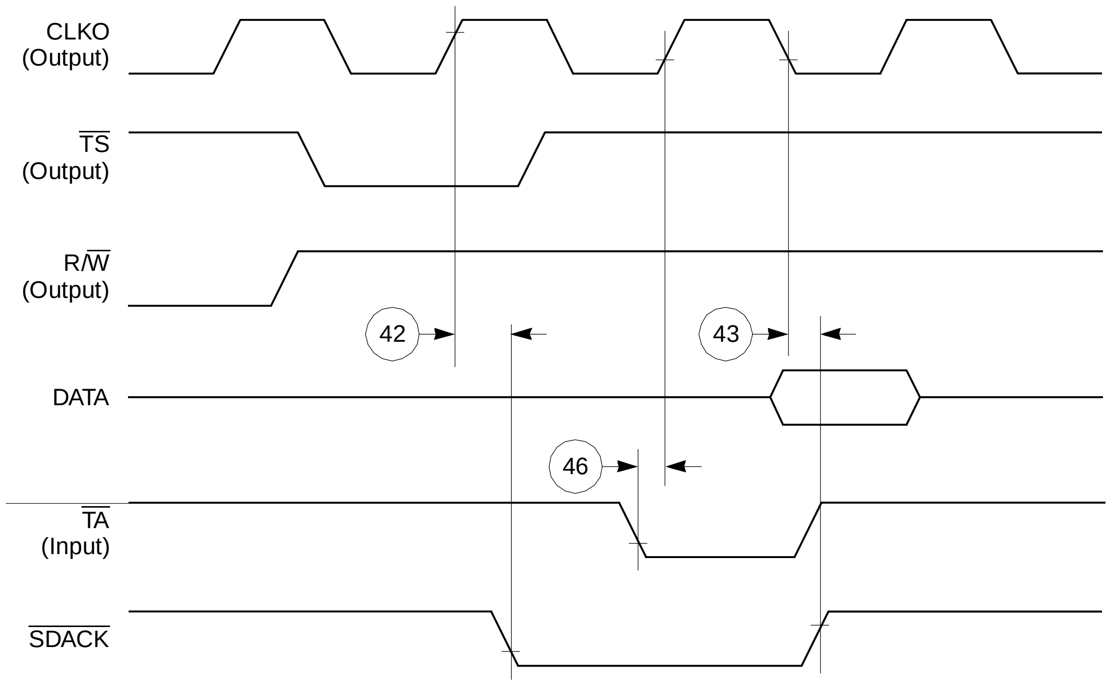

Figure 43. SDACK Timing Diagram—Peripheral Write, Externally-Generated TA

13.3 Baud Rate Generator AC Electrical Specifications

Table 19 provides the baud rate generator timings as shown in Figure 46.

Table 19. Baud Rate Generator Timing

Num	Characteristic	All Frequencies		Unit
		Min	Max	
50	BRGO rise and fall time	—	10	ns
51	BRGO duty cycle	40	60	%
52	BRGO cycle	40	—	ns

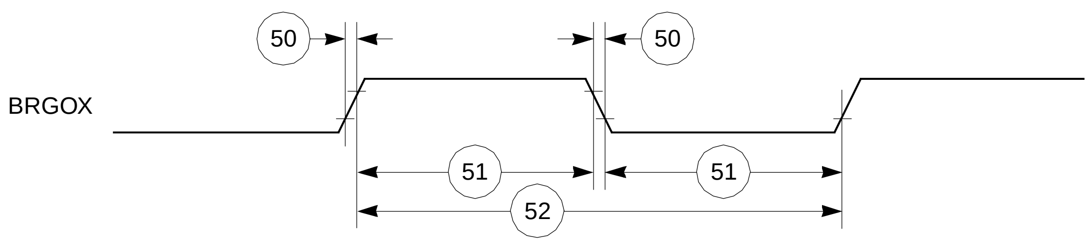

Figure 46. Baud Rate Generator Timing Diagram

13.4 Timer AC Electrical Specifications

Table 20 provides the general-purpose timer timings as shown in Figure 47.

Table 20. Timer Timing

Num	Characteristic	All Frequencies		Unit
		Min	Max	
61	TIN/$\overline{\text{TGATE}}$ rise and fall time	10	—	ns
62	TIN/$\overline{\text{TGATE}}$ low time	1	—	clk
63	TIN/$\overline{\text{TGATE}}$ high time	2	—	clk
64	TIN/$\overline{\text{TGATE}}$ cycle time	3	—	clk
65	CLKO low to $\overline{\text{TOUT}}$ valid	3	25	ns

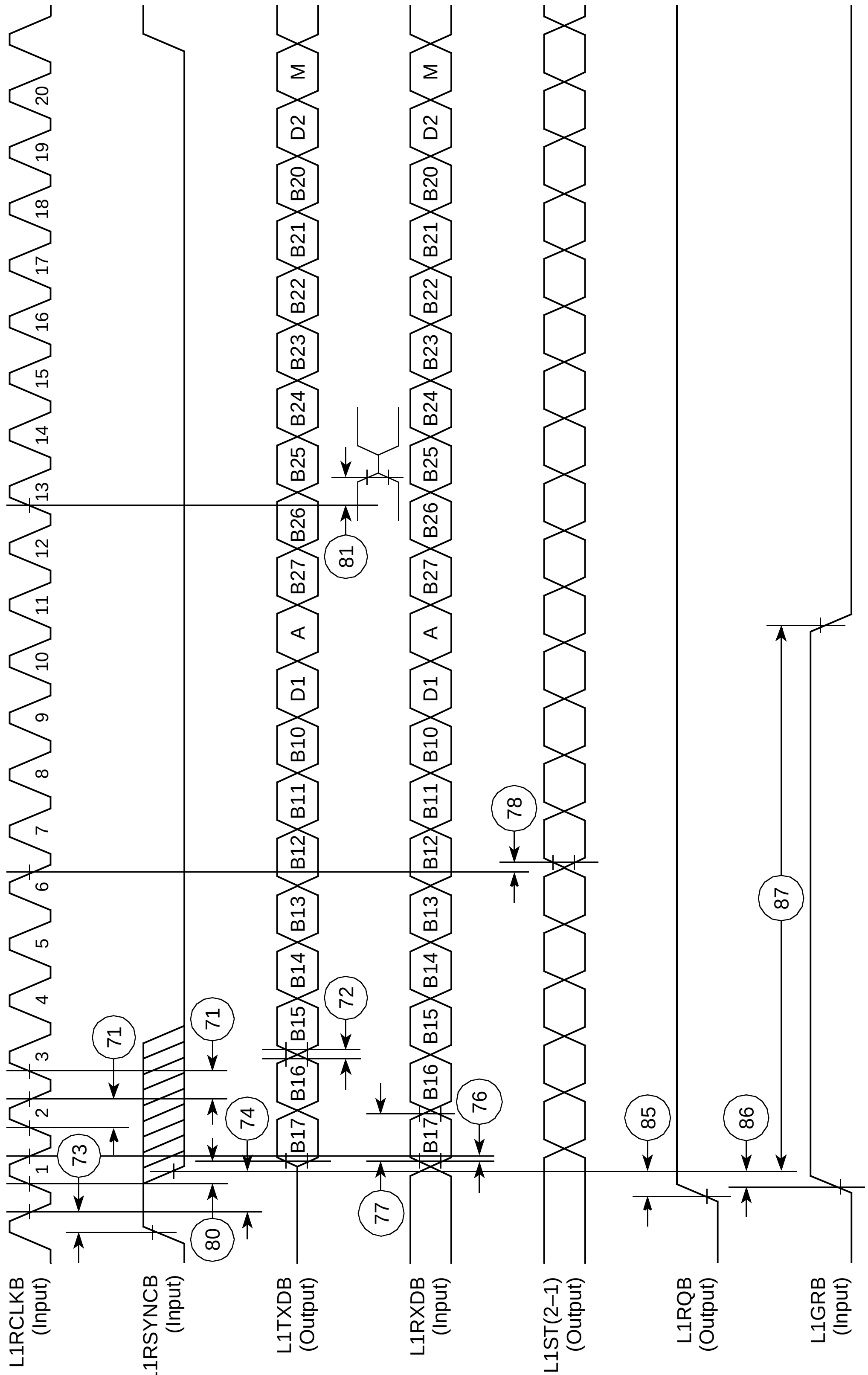

Figure 52. IDL Timing

13.6 SCC in NMSI Mode Electrical Specifications

Table 22 provides the NMSI external clock timing.

Table 22. NMSI External Clock Timing

Num	Characteristic	All Frequencies		Unit
		Min	Max	
100	RCLK3 and TCLK3 width high[1]	1/SYNCCLK	—	ns
101	RCLK3 and TCLK3 width low	1/SYNCCLK + 5	—	ns
102	RCLK3 and TCLK3 rise/fall time	—	15.00	ns
103	TXD3 active delay (from TCLK3 falling edge)	0.00	50.00	ns
104	$\overline{\text{RTS3}}$ active/inactive delay (from TCLK3 falling edge)	0.00	50.00	ns
105	$\overline{\text{CTS3}}$ setup time to TCLK3 rising edge	5.00	—	ns
106	RXD3 setup time to RCLK3 rising edge	5.00	—	ns
107	RXD3 hold time from RCLK3 rising edge[2]	5.00	—	ns
108	$\overline{\text{CD3}}$ setup time to RCLK3 rising edge	5.00	—	ns

1 The ratios SYNCCLK/RCLK3 and SYNCCLK/TCLK3 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 external SYNC signals.

Table 23 provides the NMSI internal clock timing.

Table 23. NMSI Internal Clock Timing

Num	Characteristic	All Frequencies		Unit
		Min	Max	
100	RCLK3 and TCLK3 frequency[1]	0.00	SYNCCLK/3	MHz
102	RCLK3 and TCLK3 rise/fall time	—	—	ns
103	TXD3 active delay (from TCLK3 falling edge)	0.00	30.00	ns
104	$\overline{\text{RTS3}}$ active/inactive delay (from TCLK3 falling edge)	0.00	30.00	ns
105	$\overline{\text{CTS3}}$ setup time to TCLK3 rising edge	40.00	—	ns
106	RXD3 setup time to RCLK3 rising edge	40.00	—	ns
107	RXD3 hold time from RCLK3 rising edge[2]	0.00	—	ns
108	$\overline{\text{CD3}}$ setup time to RCLK3 rising edge	40.00	—	ns

1 The ratios SYNCCLK/RCLK3 and SYNCCLK/TCLK3 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 external SYNC signals.

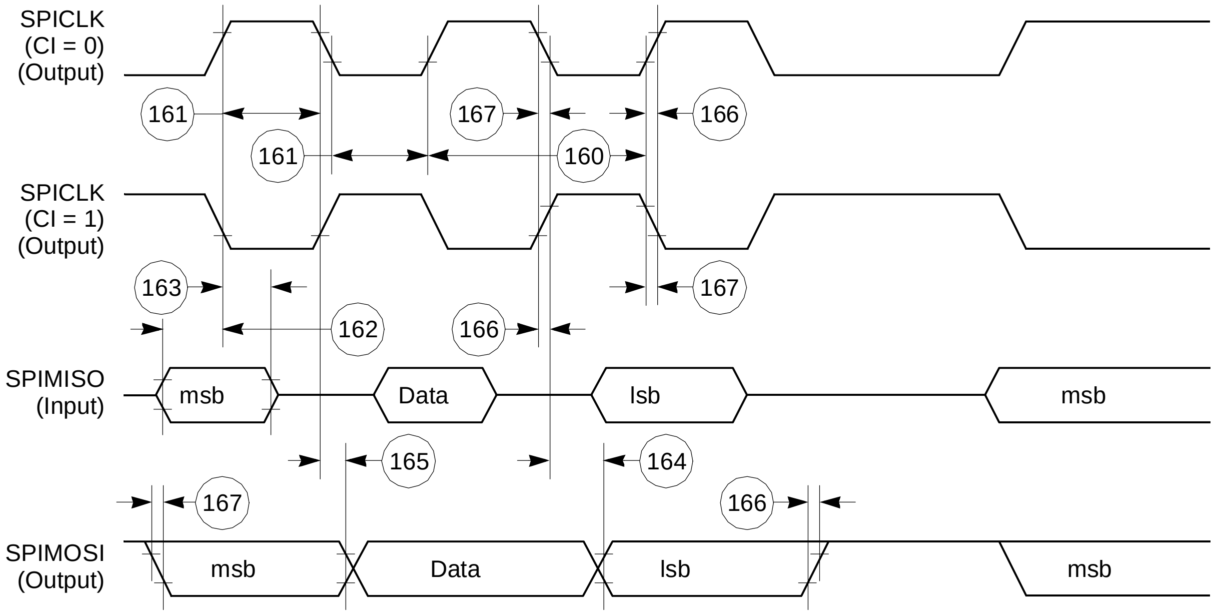

Figure 60. SPI Master (CP = 0) Timing Diagram

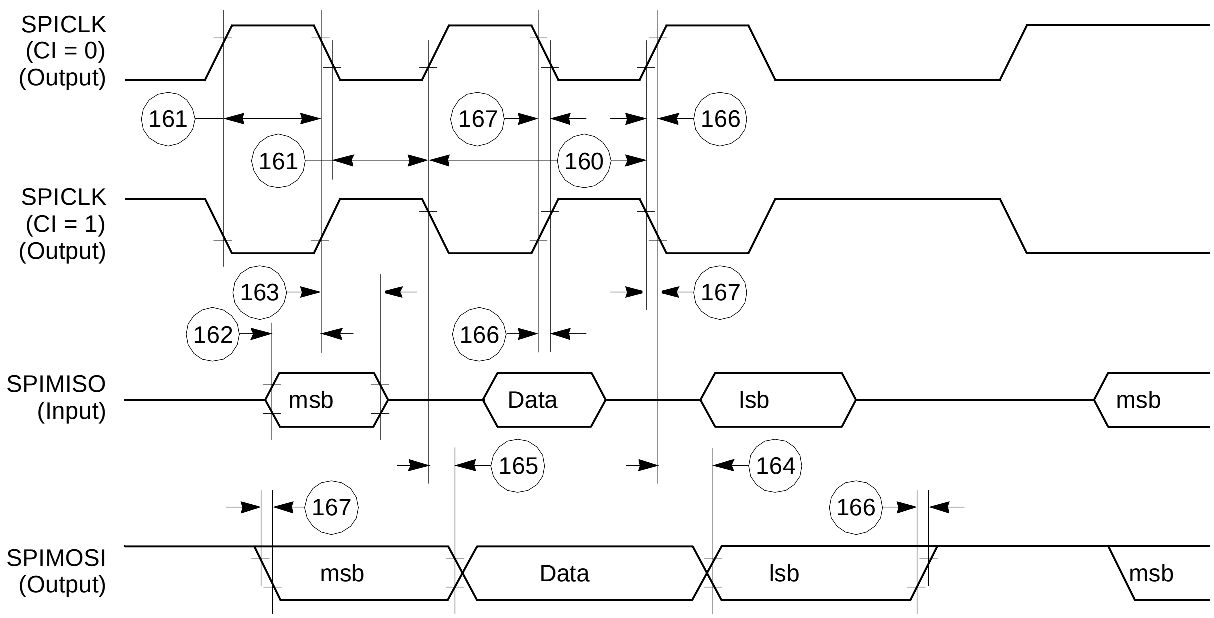

Figure 61. SPI Master (CP = 1) Timing Diagram

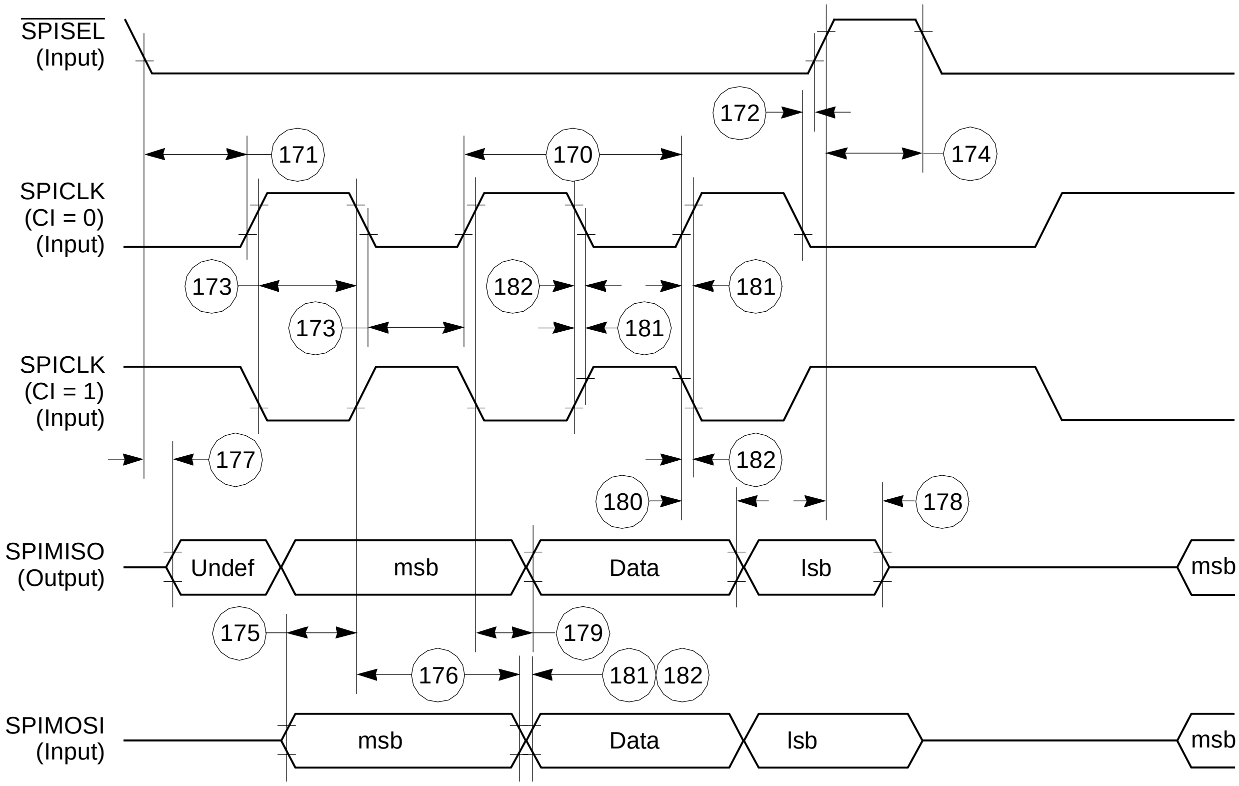

Figure 63. SPI Slave (CP = 1) Timing Diagram

13.11 I²C AC Electrical Specifications

Table 28 provides the I²C (SCL < 100 kHz) timings.

Table 28. I²C Timing (SCL < 100 kHz)

Num	Characteristic	All Frequencies		Unit
		Min	Max	
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

Table 36. Pin Assignments—JEDEC Standard (continued)

Name	Pin Number	Type
PB30, SPICLK	T17	Bidirectional (Optional: open-drain) (5-V tolerant)
PB29, SPIMOSI	R17	Bidirectional (Optional: open-drain) (5-V tolerant)
PB28, SPIMISO, BRGO4	R14	Bidirectional (Optional: open-drain) (5-V tolerant)
PB27, I2CSDA, BRGO1	N13	Bidirectional (Optional: open-drain)
PB26, I2CSCL, BRGO2	N12	Bidirectional (Optional: open-drain)
PB25, SMTXD1	U13	Bidirectional (Optional: open-drain) (5-V tolerant)
PB24, SMRXD1	T12	Bidirectional (Optional: open-drain) (5-V tolerant)
PB23, $\overline{\text{SDACK1}}$, $\overline{\text{SMSYN1}}$	U12	Bidirectional (Optional: open-drain)
PB19, MII1-RXD3, RTS4	T11	Bidirectional (Optional: open-drain)
PC15, $\overline{\text{DREQ0}}$, L1ST1	R15	Bidirectional (5-V tolerant)
PC13, MII1-TXD3, SDACK1	U9	Bidirectional (5-V tolerant)
PC12, MII1-TXD2, TOUT1	T15	Bidirectional (5-V tolerant)
PC11, USBRXP	P12	Bidirectional
PC10, USBRXN, $\overline{\text{TGATE1}}$	U11	Bidirectional
PC7, $\overline{\text{CTS4}}$, L1TSYNCB, USBTXP	T10	Bidirectional (5-V tolerant)
PC6, $\overline{\text{CD4}}$, L1RSYNCB, USBTXN	P10	Bidirectional (5-V tolerant)
PD8, RXD4, MII-MDC, RMII-MDC	T3	Bidirectional (5-V tolerant)
PE31, CLK8, L1TCLKB, MII1-RXCLK	P9	Bidirectional (Optional: open-drain)
PE30, L1RXDB, MII1-RXD2	R8	Bidirectional (Optional: open-drain)

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