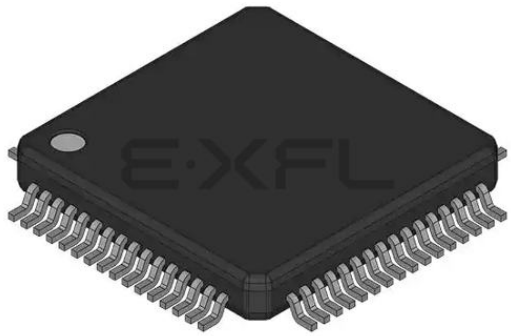

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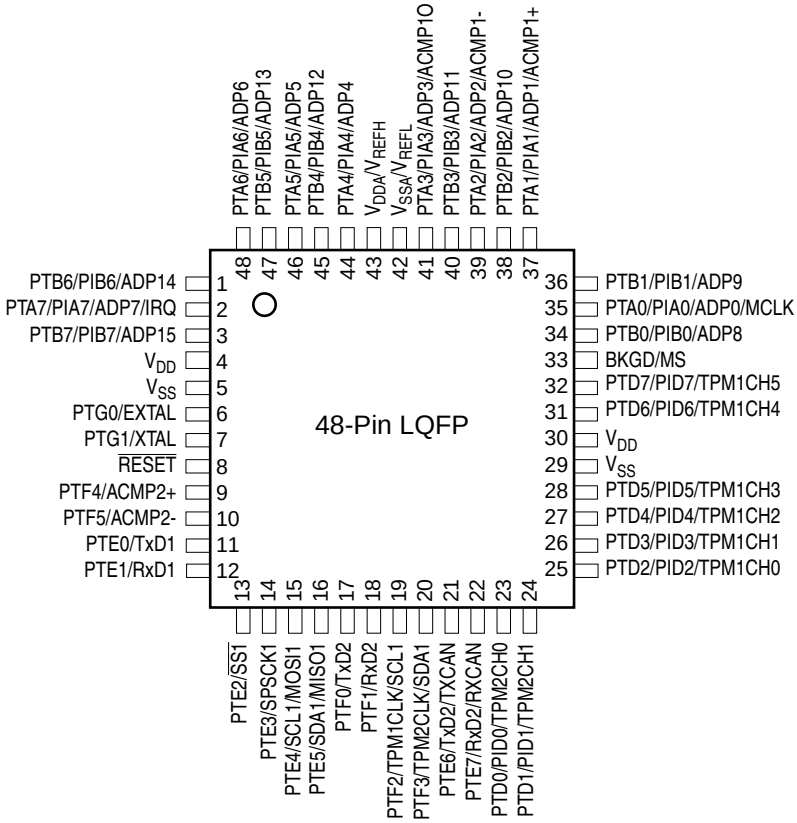
Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	S08
Core Size	8-Bit
Speed	40MHz
Connectivity	CANbus, I²C, LINbus, SCI, SPI
Peripherals	LVD, POR, PWM, WDT
Number of I/O	53
Program Memory Size	96KB (96K x 8)
Program Memory Type	FLASH
EEPROM Size	2K x 8
RAM Size	6K x 8
Voltage - Supply (Vcc/Vdd)	2.7V ~ 5.5V
Data Converters	A/D 24x12b
Oscillator Type	External
Operating Temperature	-40°C ~ 125°C (TA)
Mounting Type	Surface Mount
Package / Case	64-LQFP
Supplier Device Package	64-LQFP (10x10)
Purchase URL	https://www.e-xfl.com/pro/item?MUrl=&PartUrl=mc9s08dz96mlh

Chapter 11
Inter-Integrated Circuit (S08IICV2)

Chapter 12
Freescale's Controller Area Network (S08MSCANV1)

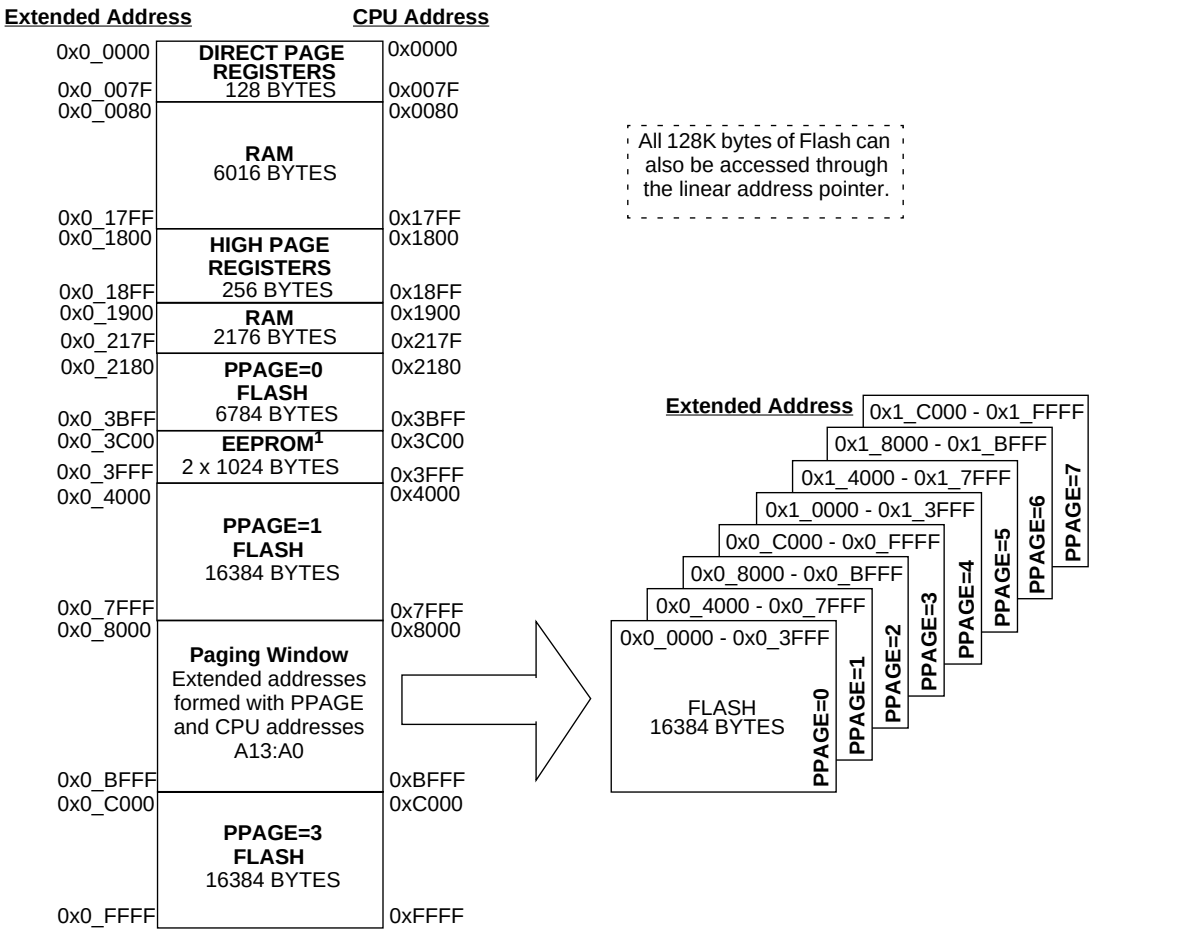


V_{REFH} and V_{REFL} are internally connected to V_{DDA} and V_{SSA}, respectively.

Figure 2-3. MC9S08DZ128 Series in 48-Pin LQFP

Table 2-1. Pin Availability by Package Pin-Count (continued)

Pin Number			<-- Lowest **Priority** --> Highest			
100	**64**	**48**	**Port Pin/Interrupt**		**Alt 1**	**Alt 2**
51	33	25	PTD2	PID2		TPM1CH0
52	34	26	PTD3	PID3		TPM1CH1
53	35	27	PTD4	PID4		TPM1CH2
54	36	28	PTD5	PID5		TPM1CH3
55	—	—	PTH0			$\overline{SS2}$
56	—	—	PTH1			SPSCK2
57	—	—	PTH2			MOSI2
58	—	—	PTH3			MISO2
59	37	—	PTF7			
60	—	—	PTL3			
61	38	29				V_{SS}
62	39	30				V_{DD}
63	40	31	PTD6	PID6		TPM1CH4
64	41	32	PTD7	PID7		TPM1CH5
65	42	33			BKGD	MS
66	—	—	PTH4			
67	—	—	PTH5			
68	—	—	PTH6			
69	—	—	PTH7			
70	43	—	PTC0		ADP16	
71	44	34	PTB0	PIB0	ADP8	
72	45	—	PTC1		ADP17	
73	46	35	PTA0	PIA0	ADP0	MCLK
74	47	—	PTC2		ADP18	
75	48	36	PTB1	PIB1	ADP9	
76	49	37	PTA1	PIA1	ADP1[4]	ACMP1+[4]
77	50	38	PTB2	PIB2	ADP10	
78	51	39	PTA2	PIA2	ADP2[4]	ACMP1-[4]
79	52	—	PTC3		ADP19	
80	53	40	PTB3	PIB3	ADP11	
81	54	41	PTA3	PIA3	ADP3	ACMP1O
82	—	—	PTL4			
83	—	—	PTK0			
84	—	—	PTK1			
85	—	—	PTK2			
86	—	—	PTK3			
87	55	42				V_{SSA}
88	56					V_{REFL}



1 EEPROM address range shows half the total EEPROM. See Section 4.6.10, “EEPROM Mapping” for more

Figure 4-1. MC9S08DZ128 Series Memory Map

A strictly monitored procedure must be obeyed or the command will not be accepted. This minimizes the possibility of any unintended changes to the memory contents. The command complete flag (FCCF) indicates when a command is complete. The command sequence must be completed by clearing FCBEF to launch the command. Figure 4-11 is a flowchart for executing all of the commands except for burst programming and sector erase abort.

4. Wait until the FCCF bit in FSTAT is set. As soon as FCCF= 1, the operation has completed successfully.

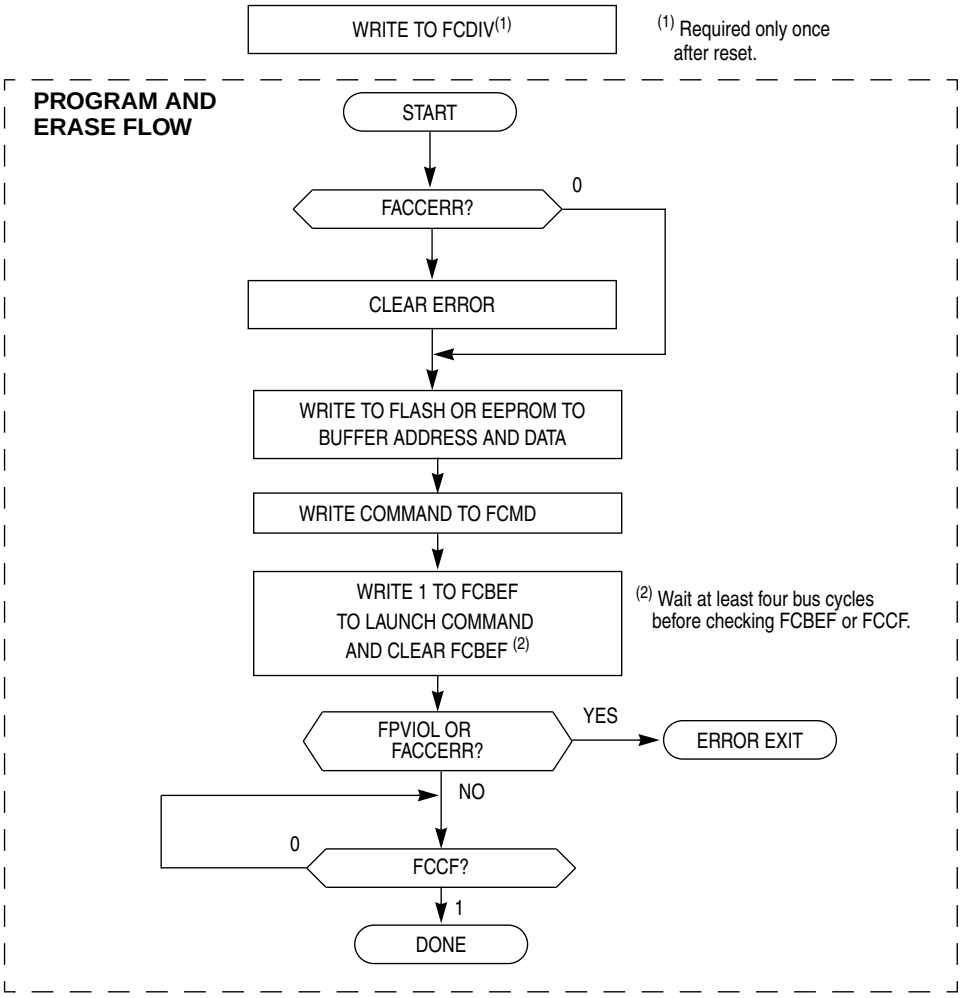


Figure 4-11. Program and Erase Flowchart

4.6.4 Burst Program Execution

The burst program command is used to program sequential bytes of data in less time than would be required using the standard program command. This is possible because the high voltage to the FLASH array does not need to be disabled between program operations. Ordinarily, when a program or erase command is issued, an internal charge pump associated with the FLASH memory must be enabled to supply high voltage to the array. Upon completion of the command, the charge pump is turned off. When

Table 4-13. FCDIV Register Field Descriptions

Field	Description
7 DIVLD	**Divisor Loaded Status Flag** — When set, this read-only status flag indicates that the FCDIV register has been written since reset. Reset clears this bit and the first write to this register causes this bit to become set regardless of the data written. 0 FCDIV has not been written since reset; erase and program operations disabled for FLASH and EEPROM. 1 FCDIV has been written since reset; erase and program operations enabled for FLASH and EEPROM.
6 PRDIV8	**Prescale (Divide) FLASH and EEPROM Clock by 8** (This bit is write once.) 0 Clock input to the FLASH and EEPROM clock divider is the bus rate clock. 1 Clock input to the FLASH and EEPROM clock divider is the bus rate clock divided by 8.
5:0 DIV	**Divisor for FLASH and EEPROM Clock Divider** — The FLASH and EEPROM clock divider divides the bus rate clock (or the bus rate clock divided by 8 if PRDIV8 = 1) by the value in the 6-bit DIV field plus one. The resulting frequency of the internal FLASH and EEPROM clock must fall within the range of 200 kHz to 150 kHz for proper FLASH and EEPROM operations. Program/Erase timing pulses are one cycle of this internal FLASH and EEPROM clock which corresponds to a range of 5 µs to 6.7 µs. The automated programming logic uses an integer number of these pulses to complete an erase or program operation. See Equation 4-1 and Equation 4-2.

6.5.8.5 Port H Drive Strength Selection Register (PTHDS)

	7	6	5	4	3	2	1	0
R W	PTHDS7	PTHDS6	PTHDS5	PTHDS4	PTHDS3	PTHDS2	PTHDS1	PTHDS0
Reset:	0	0	0	0	0	0	0	0

Figure 6-51. Drive Strength Selection for Port H Register (PTHDS)

Table 6-49. PTHDS Register Field Descriptions

Field	Description
7:0 PTHDS[7:0]	**Output Drive Strength Selection for Port H Bits** — Each of these control bits selects between low and high output drive for the associated PTH pin. For port H pins that are configured as inputs, these bits have no effect. 0 Low output drive strength selected for port H bit n. 1 High output drive strength selected for port H bit n.

Chapter 7
Central Processor Unit (S08CPUV5)

7.1 Introduction

This section provides summary information about the registers, addressing modes, and instruction set of the CPU of the HCS08 Family. For a more detailed discussion, refer to the *HCS08 Family Reference Manual, volume 1*, Freescale Semiconductor document order number HCS08RMV1/D.

The HCS08 CPU is fully source- and object-code-compatible with the M68HC08 CPU. Several instructions and enhanced addressing modes were added to improve C compiler efficiency and to support a new background debug system which replaces the monitor mode of earlier M68HC08 microcontrollers (MCU).

7.1.1 Features

Features of the HCS08 CPU include:

- Object code fully upward-compatible with M68HC05 and M68HC08 Families
- 64-KB CPU address space with banked memory management unit for greater than 64 KB
- 16-bit stack pointer (any size stack anywhere in 64-KB CPU address space)
- 16-bit index register (H:X) with powerful indexed addressing modes
- 8-bit accumulator (A)
- Many instructions treat X as a second general-purpose 8-bit register
- Seven addressing modes:
  - Inherent — Operands in internal registers
  - Relative — 8-bit signed offset to branch destination
  - Immediate — Operand in next object code byte(s)
  - Direct — Operand in memory at 0x0000–0x00FF
  - Extended — Operand anywhere in 64-Kbyte address space
  - Indexed relative to H:X — Five submodes including auto increment
  - Indexed relative to SP — Improves C efficiency dramatically
- Memory-to-memory data move instructions with four address mode combinations
- Overflow, half-carry, negative, zero, and carry condition codes support conditional branching on the results of signed, unsigned, and binary-coded decimal (BCD) operations
- Efficient bit manipulation instructions
- Fast 8-bit by 8-bit multiply and 16-bit by 8-bit divide instructions
- STOP and WAIT instructions to invoke low-power operating modes

8.1.1 Features

Key features of the MCG module are:

- Frequency-locked loop (FLL)
  - Internal or external reference can be used to control the FLL
- Phase-locked loop (PLL)
  - Voltage-controlled oscillator (VCO)
  - Modulo VCO frequency divider
  - Phase/Frequency detector
  - Integrated loop filter
  - Lock detector with interrupt capability
- Internal reference clock
  - Nine trim bits for accuracy
  - Can be selected as the clock source for the MCU
- External reference clock
  - Control for external oscillator
  - Clock monitor with reset capability
  - Can be selected as the clock source for the MCU
- Reference divider is provided
- Clock source selected can be divided down by 1, 2, 4, or 8
- BDC clock (MCGLCLK) is provided as a constant divide by 2 of the DCO output whether in an FLL or PLL mode.
- Two selectable digitally controlled oscillators (DCOs) optimized for different frequency ranges.
- Option to maximize DCO output frequency for a 32,768 Hz external reference clock source.

8.3 Register Definition

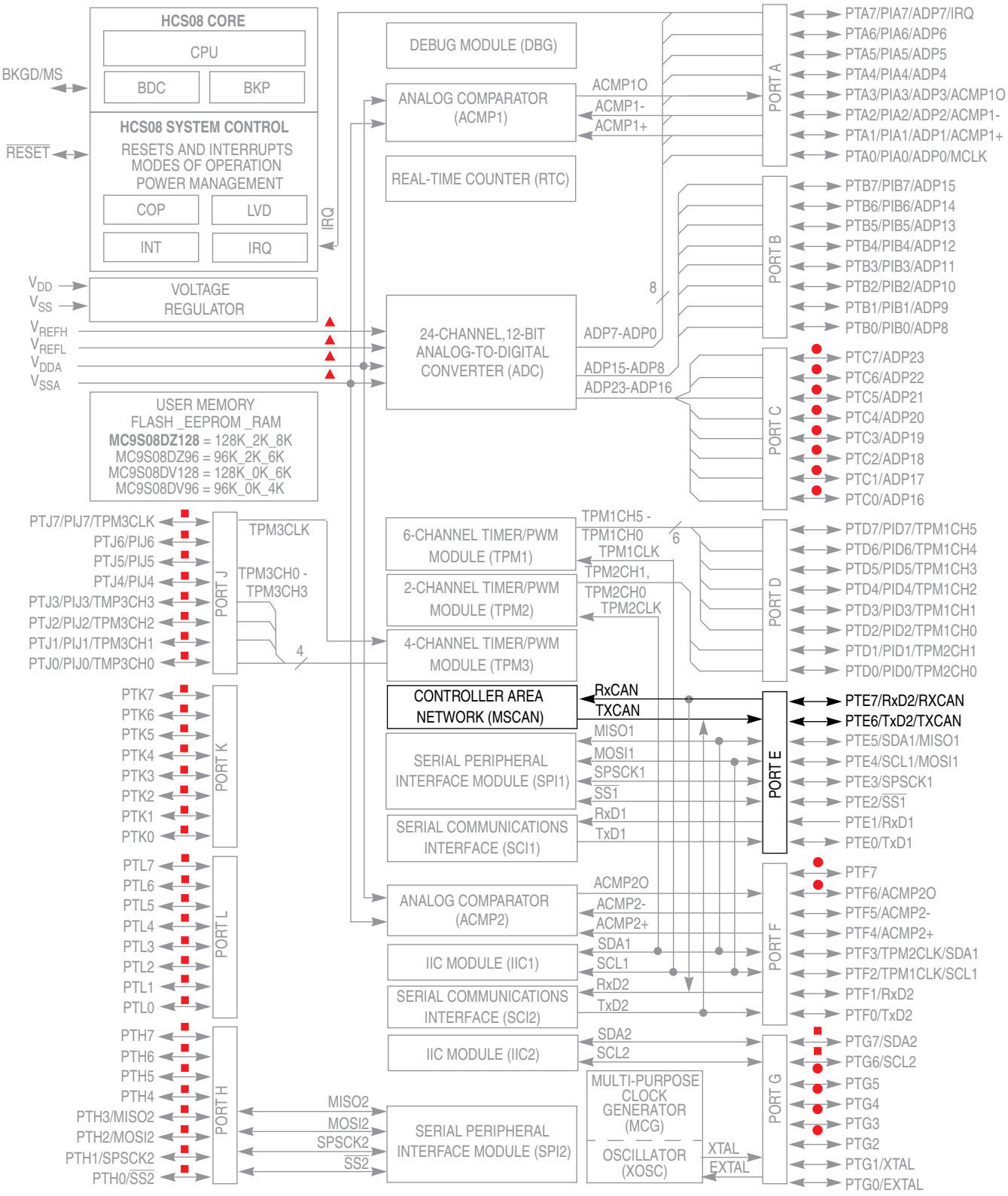
8.3.1 MCG Control Register 1 (MCGC1)

	7	6	5	4	3	2	1	0
R W	CLKS		RDIV			IREFS	IRCLKEN	IREFSTEN
Reset:	0	0	0	0	0	1	0	0

Figure 8-3. MCG Control Register 1 (MCGC1)

Table 8-1. MCG Control Register 1 Field Descriptions

Field	Description
7:6 CLKS	**Clock Source Select** — Selects the system clock source. 00 Encoding 0 — Output of FLL or PLL is selected. 01 Encoding 1 — Internal reference clock is selected. 10 Encoding 2 — External reference clock is selected. 11 Encoding 3 — Reserved, defaults to 00.
5:3 RDIV	**External Reference Divider** — Selects the amount to divide down the external reference clock. If the FLL is selected, the resulting frequency must be in the range 31.25 kHz to 39.0625 kHz. If the PLL is selected, the resulting frequency must be in the range 1 MHz to 2 MHz. See Table 8-2 and Table 8-3 for the divide-by factors.
2 IREFS	**Internal Reference Select** — Selects the reference clock source. 1 Internal reference clock selected 0 External reference clock selected
1 IRCLKEN	**Internal Reference Clock Enable** — Enables the internal reference clock for use as MCGIRCLK. 1 MCGIRCLK active 0 MCGIRCLK inactive
0 IREFSTEN	**Internal Reference Stop Enable** — Controls whether or not the internal reference clock remains enabled when the MCG enters stop mode. 1 Internal reference clock stays enabled in stop if IRCLKEN is set or if MCG is in FEI, FBI, or BLPI mode before entering stop 0 Internal reference clock is disabled in stop



■ - Pin not connected in 64-pin and 48-pin packages ● - Pin not available in the 48-pin package

▲ - In 48-pin package, VDDA and VREFH are internally connected to each other and VSSA and VREFL are internally connected to each other.

Figure 12-1. MC9S08DZ128 Block Diagram with MSCAN Highlighted

Table 12-33. Data Length Codes

Data Length Code				Data Byte Count
DLC3	DLC2	DLC1	DLC0	
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8

12.4.5 Transmit Buffer Priority Register (TBPR)

This register defines the local priority of the associated message transmit buffer. The local priority is used for the internal prioritization process of the MSCAN and is defined to be highest for the smallest binary number. The MSCAN implements the following internal prioritization mechanisms:

- All transmission buffers with a cleared TXEx flag participate in the prioritization immediately before the SOF (start of frame) is sent.
- The transmission buffer with the lowest local priority field wins the prioritization.

In cases of more than one buffer having the same lowest priority, the message buffer with the lower index number wins.

	7	6	5	4	3	2	1	0
R W	PRIO7	PRIO6	PRIO5	PRIO4	PRIO3	PRIO2	PRIO1	PRIO0
Reset:	0	0	0	0	0	0	0	0

Figure 12-35. Transmit Buffer Priority Register (TBPR)

Read: Anytime when TXEx flag is set (see Section 12.3.6, "MSCAN Transmitter Flag Register (CANTFLG)") and the corresponding transmit buffer is selected in CANTBSEL (see Section 12.3.10, "MSCAN Transmit Buffer Selection Register (CANTBSEL)").

Write: Anytime when TXEx flag is set (see Section 12.3.6, "MSCAN Transmitter Flag Register (CANTFLG)") and the corresponding transmit buffer is selected in CANTBSEL (see Section 12.3.10, "MSCAN Transmit Buffer Selection Register (CANTBSEL)").

12.4.6 Time Stamp Register (TSRH–TSRL)

If the TIME bit is enabled, the MSCAN will write a time stamp to the respective registers in the active transmit or receive buffer as soon as a message has been acknowledged on the CAN bus (see

12.5.2 Message Storage

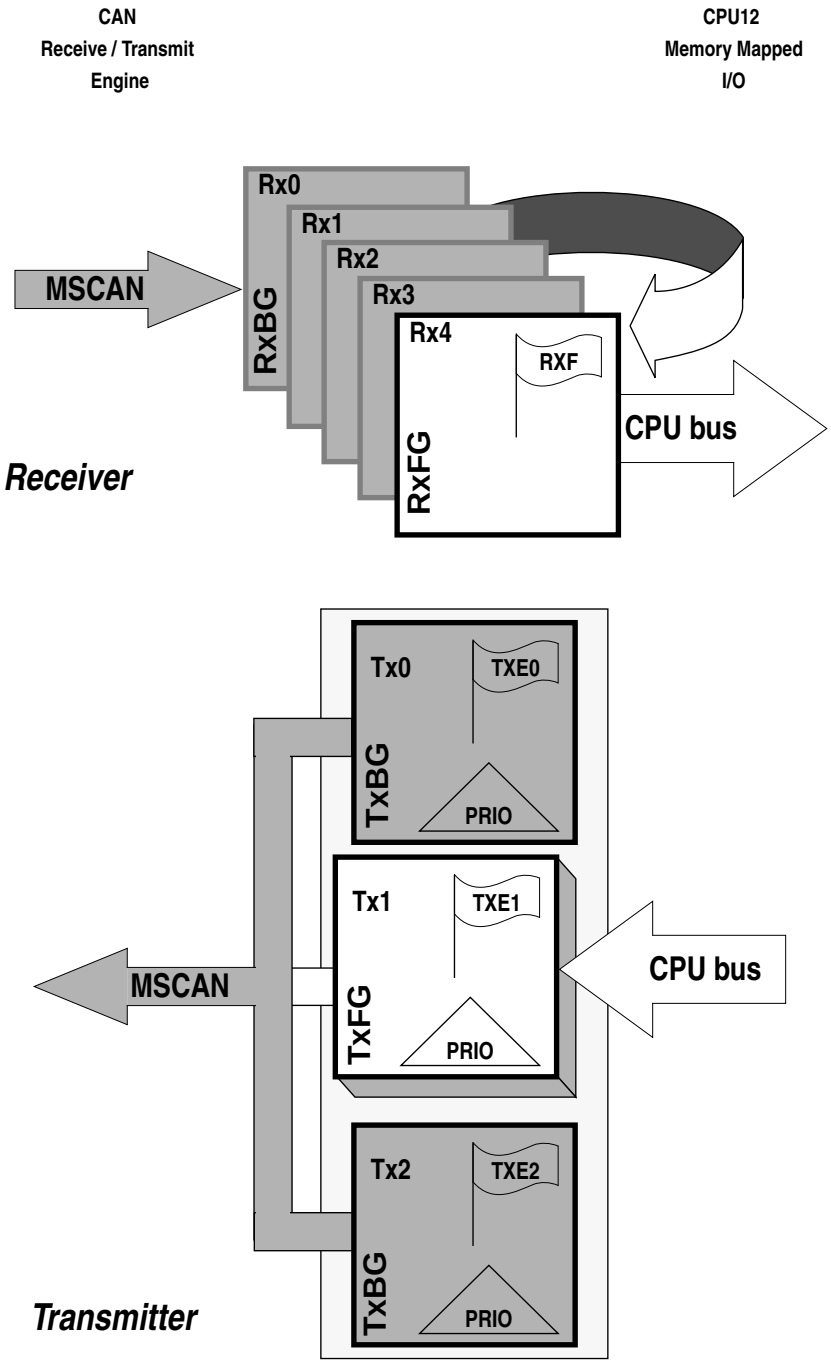


Figure 12-38. User Model for Message Buffer Organization

MSCAN facilitates a sophisticated message storage system which addresses the requirements of a broad range of network applications.

12.5.4.3 Emulation Modes

In all emulation modes, the MSCAN module behaves just like normal system operation modes as described within this specification.

12.5.4.4 Listen-Only Mode

In an optional CAN bus monitoring mode (listen-only), the CAN node is able to receive valid data frames and valid remote frames, but it sends only "recessive" bits on the CAN bus. In addition, it cannot start a transmision. If the MAC sub-layer is required to send a "dominant" bit (ACK bit, overload flag, or active error flag), the bit is rerouted internally so that the MAC sub-layer monitors this "dominant" bit, although the CAN bus may remain in recessive state externally.

12.5.4.5 Security Modes

The MSCAN module has no security features.

12.5.4.6 Loopback Self Test Mode

Loopback self test mode is sometimes used to check software, independent of connections in the external system, to help isolate system problems. In this mode, the transmitter output is internally connected to the receiver input. The RXCAN input pin is ignored and the TXCAN output goes to the recessive state (logic 1). The MSCAN behaves as it does normally when transmitting and treats its own transmitted message as a message received from a remote node. In this state, the MSCAN ignores the bit sent during the ACK slot in the CAN frame acknowledge field to ensure proper reception of its own message. Both transmit and receive interrupts are generated.

12.5.5 Low-Power Options

If the MSCAN is disabled (CANE = 0), the MSCAN clocks are stopped for power saving.

If the MSCAN is enabled (CANE = 1), the MSCAN has two additional modes with reduced power consumption, compared to normal mode: sleep and power down mode. In sleep mode, power consumption is reduced by stopping all clocks except those to access the registers from the CPU side. In power down mode, all clocks are stopped and no power is consumed.

Table 12-36 summarizes the combinations of MSCAN and CPU modes. A particular combination of modes is entered by the given settings on the CSWAI and SLPRQ/SLPAK bits.

For all modes, an MSCAN wake-up interrupt can occur only if the MSCAN is in sleep mode (SLPRQ = 1 and SLPAK = 1), wake-up functionality is enabled (WUPE = 1), and the wake-up interrupt is enabled (WUPIE = 1).

16.2.1.1 EXTCLK — External Clock Source

Control bits in the timer status and control register allow the user to select nothing (timer disable), the bus-rate clock (the normal default source), a crystal-related clock, or an external clock as the clock which drives the TPM prescaler and subsequently the 16-bit TPM counter. The external clock source is synchronized in the TPM. The bus clock clocks the synchronizer; the frequency of the external source must be no more than one-fourth the frequency of the bus-rate clock, to meet Nyquist criteria and allowing for jitter.

The external clock signal shares the same pin as a channel I/O pin, so the channel pin will not be usable for channel I/O function when selected as the external clock source. It is the user's responsibility to avoid such settings. If this pin is used as an external clock source (CLKSB:CLKSA = 1:1), the channel can still be used in output compare mode as a software timer (ELSnB:ELSnA = 0:0).

16.2.1.2 TPMxCHn — TPM Channel n I/O Pin(s)

Each TPM channel is associated with an I/O pin on the MCU. The function of this pin depends on the channel configuration. The TPM pins share with general purpose I/O pins, where each pin has a port data register bit, and a data direction control bit, and the port has optional passive pullups which may be enabled whenever a port pin is acting as an input.

The TPM channel does not control the I/O pin when (ELSnB:ELSnA = 0:0) or when (CLKSB:CLKSA = 0:0) so it normally reverts to general purpose I/O control. When CPWMS = 1 (and ELSnB:ELSnA not = 0:0), all channels within the TPM are configured for center-aligned PWM and the TPMxCHn pins are all controlled by the TPM system. When CPWMS=0, the MSnB:MSnA control bits determine whether the channel is configured for input capture, output compare, or edge-aligned PWM.

When a channel is configured for input capture (CPWMS=0, MSnB:MSnA = 0:0 and ELSnB:ELSnA not = 0:0), the TPMxCHn pin is forced to act as an edge-sensitive input to the TPM. ELSnB:ELSnA control bits determine what polarity edge or edges will trigger input-capture events. A synchronizer based on the bus clock is used to synchronize input edges to the bus clock. This implies the minimum pulse width—that can be reliably detected—on an input capture pin is four bus clock periods (with ideal clock pulses as near as two bus clocks can be detected). TPM uses this pin as an input capture input to override the port data and data direction controls for the same pin.

When a channel is configured for output compare (CPWMS=0, MSnB:MSnA = 0:1 and ELSnB:ELSnA not = 0:0), the associated data direction control is overridden, the TPMxCHn pin is considered an output controlled by the TPM, and the ELSnB:ELSnA control bits determine how the pin is controlled. The remaining three combinations of ELSnB:ELSnA determine whether the TPMxCHn pin is toggled, cleared, or set each time the 16-bit channel value register matches the timer counter.

When the output compare toggle mode is initially selected, the previous value on the pin is driven out until the next output compare event—then the pin is toggled.

When the TPM is configured for center-aligned PWM (and ELSnB:ELSnA not = 0:0), the data direction for all channels in this TPM are overridden, the TPMxCHn pins are forced to be outputs controlled by the TPM, and the ELSnA bits control the polarity of each TPMxCHn output. If ELSnB:ELSnA=1:0, the corresponding TPMxCHn pin is cleared when the timer counter is counting up, and the channel value register matches the timer counter; the TPMxCHn pin is set when the timer counter is counting down, and the channel value register matches the timer counter. If ELSnA=1, the corresponding TPMxCHn pin is set when the timer counter is counting up and the channel value register matches the timer counter; the TPMxCHn pin is cleared when the timer counter is counting down and the channel value register matches the timer counter.

TPMxMODH:TPMxMODL = 0x0008
TPMxMODH:TPMxMODL = 0x0005

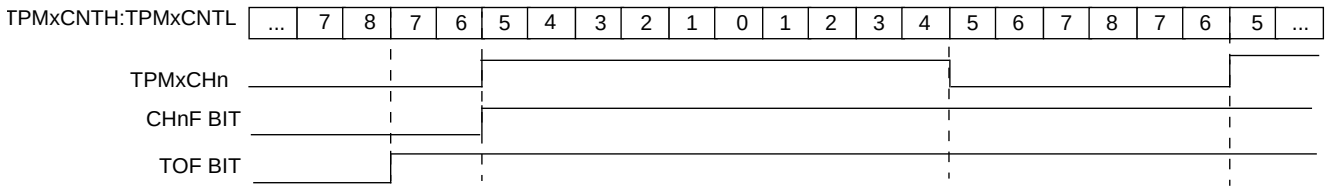


Figure 16-5. High-True Pulse of a Center-Aligned PWM

TPMxMODH:TPMxMODL = 0x0008
TPMxMODH:TPMxMODL = 0x0005

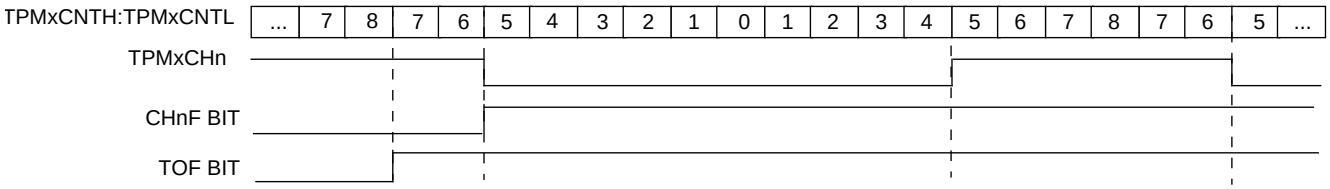


Figure 16-6. Low-True Pulse of a Center-Aligned PWM

when this timeout occurs is aborted without affecting the memory or operating mode of the target MCU system.

The custom serial protocol requires the debug pod to know the target BDC communication clock speed.

The clock switch (CLKSW) control bit in the BDC status and control register allows the user to select the BDC clock source. The BDC clock source can either be the bus or the alternate BDC clock source.

The BKGD pin can receive a high or low level or transmit a high or low level. The following diagrams show timing for each of these cases. Interface timing is synchronous to clocks in the target BDC, but asynchronous to the external host. The internal BDC clock signal is shown for reference in counting cycles.

Figure 17-2 shows an external host transmitting a logic 1 or 0 to the BKGD pin of a target HCS08 MCU. The host is asynchronous to the target so there is a 0-to-1 cycle delay from the host-generated falling edge to where the target perceives the beginning of the bit time. Ten target BDC clock cycles later, the target senses the bit level on the BKGD pin. Typically, the host actively drives the pseudo-open-drain BKGD pin during host-to-target transmissions to speed up rising edges. Because the target does not drive the BKGD pin during the host-to-target transmission period, there is no need to treat the line as an open-drain signal during this period.

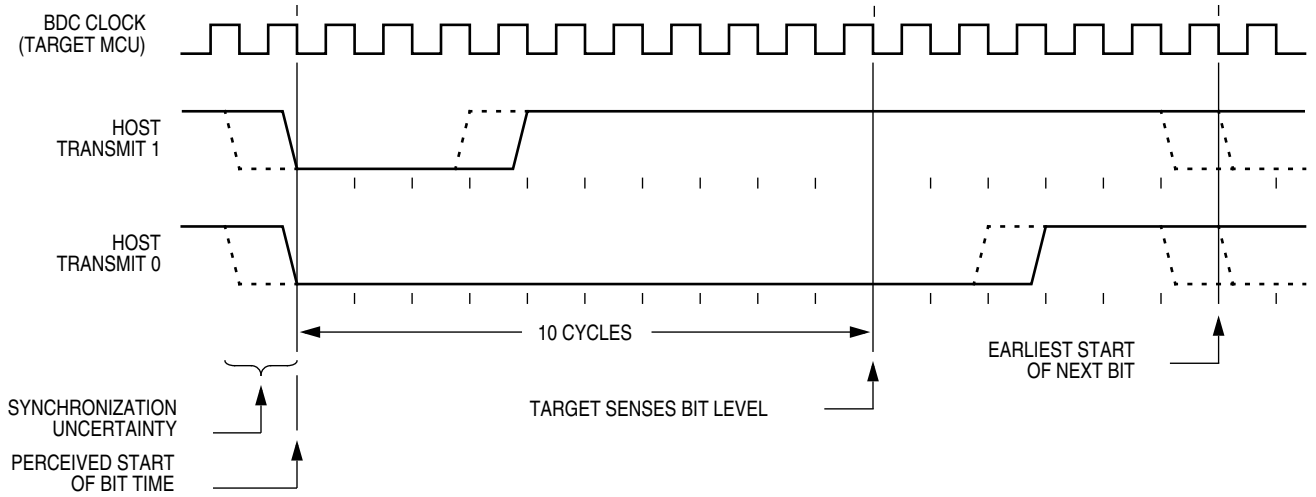


Figure 17-2. BDC Host-to-Target Serial Bit Timing

18.3.2

Table 18-2. Register Bit Summary

	7	6	5	4	3	2	1	0
DBGCAH	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
DBGCAL	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
DBGCBH	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
DBGCBL	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
DBGCCH	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
DBGCCL	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
DBGFH	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
DBGFL	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
DBGCAX	RWAEN	RWA	PAGSEL	0	0	0	0	bit-16
DBGCBX	RWBEN	RWB	PAGSEL	0	0	0	0	bit-16
DBGCCX	RWCEN	RWC	PAGSEL	0	0	0	0	bit-16
DBGFX	PPACC	0	0	0	0	0	0	bit-16
DBGC	DBGEN	ARM	TAG	BRKEN	-	-	-	LOOP1
DBGT	TRGSEL	BEGIN	0	0	TRG[3:0]			
DBGS	AF	BF	CF	0	0	0	0	ARMF
DBGCNT	0	0	0	0	CNT[3:0]			

18.3.3.12 Debug FIFO Extended Information Register (DBGFX)

Module Base + 0x000B

	7	6	5	4	3	2	1	0
R	PPACC	0	0	0	0	0	0	Bit 16
W								
POR or non-end-run	0	0	0	0	0	0	0	0
Reset end-run[1]	U	0	0	0	0	0	0	U

= Unimplemented or Reserved

Figure 18-13. Debug FIFO Extended Information Register (DBGFX)

[1] In the case of an end-trace to reset where DBGEN=1 and BEGIN=0, the bits in this register do not change after reset.

Table 18-14. DBGFX Field Descriptions

Field	Description
7 PPACC	**PPAGE Access Indicator Bit** — This bit indicates whether the captured information in the current FIFO word is associated with an extended access through the PPAGE mechanism or not. This is indicated by the internal signal mmu_ppage_sel which is 1 when the access is through the PPAGE mechanism. 0 The information in the corresponding FIFO word is event-only data or an unpaged 17-bit CPU address with bit-16 = 0 1 The information in the corresponding FIFO word is a 17-bit flash address with PPAGE[2:0] in the three most significant bits and CPU address[13:0] in the 14 least significant bits
0 Bit 16	**Extended Address Bit 16** — This bit is the most significant bit of the 17-bit core address.