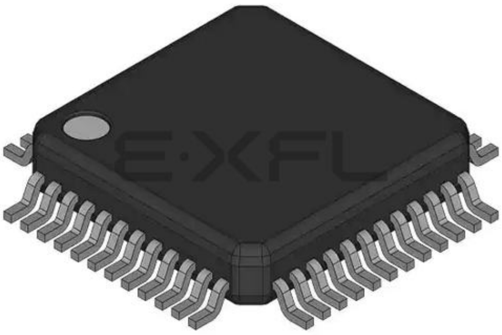

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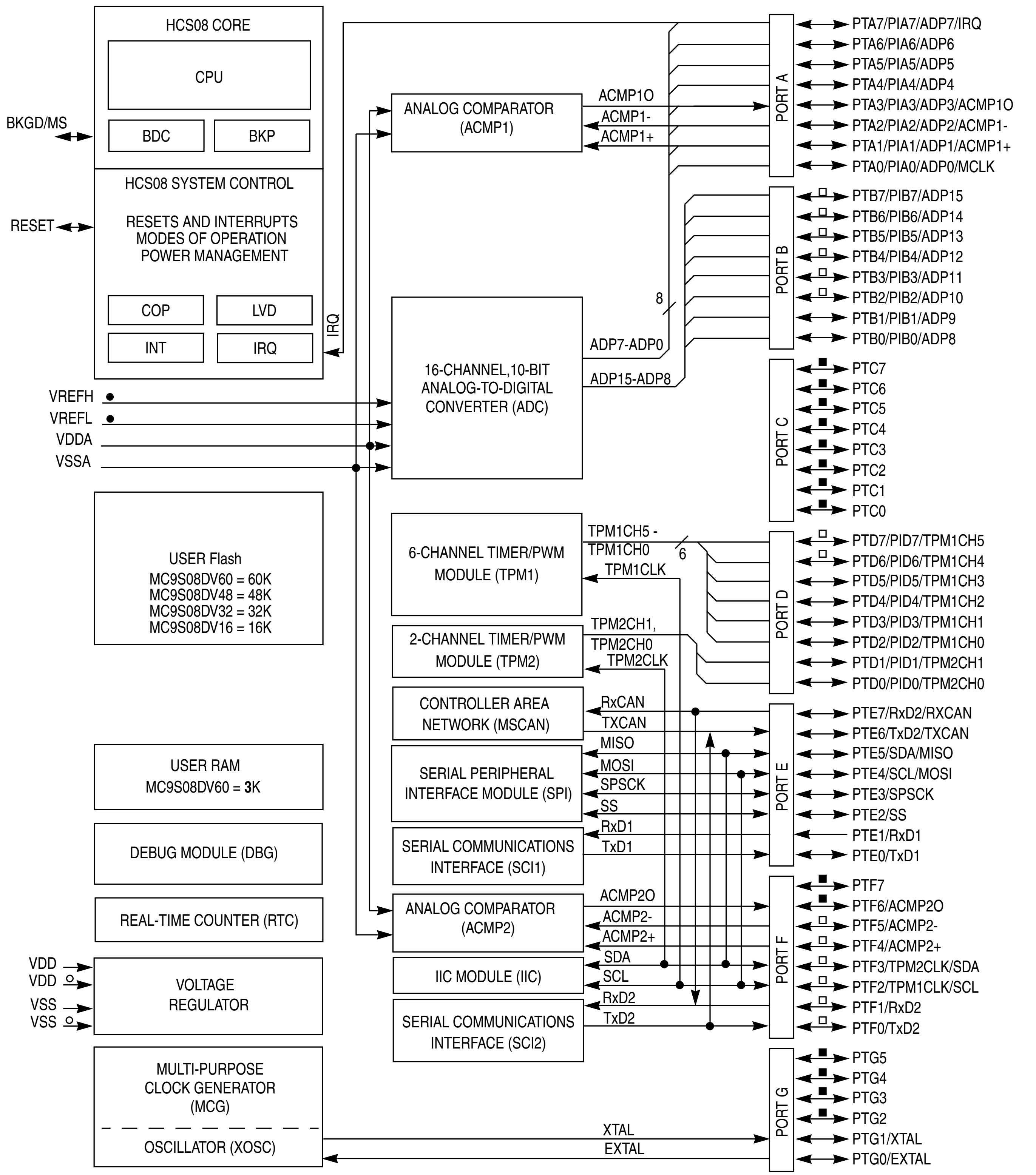
Applications of "Embedded - Microcontrollers"

Details	
Product Status	Obsolete
Core Processor	S08
Core Size	8-Bit
Speed	40MHz
Connectivity	CANbus, I²C, LINbus, SCI, SPI
Peripherals	LVD, POR, PWM, WDT
Number of I/O	39
Program Memory Size	48KB (48K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	2K x 8
Voltage - Supply (Vcc/Vdd)	2.7V ~ 5.5V
Data Converters	A/D 16x12b
Oscillator Type	External
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	48-LQFP
Supplier Device Package	48-LQFP (7x7)
Purchase URL	https://www.e-xfl.com/pro/item?MUrl=&PartUrl=mc9s08dv48aclf



● - VREFH/VREFL internally connected to VDDA/VSSA in 48-pin and 32-pin packages
○ - VDD and VSS pins are each internally connected to two pads in 32-pin package
■ - Pin not connected in 48-pin and 32-pin packages
□ - Pin not connected in 32-pin package

Figure 1-1. MC9S08DV60 Block Diagram

Table 4-3. High-Page Register Summary (Sheet 3 of 3)

Address	Register Name	Bit 7	6	5	4	3	2	1	Bit 0
0x1883	CANBTR1	SAMP	TSEG22	TSEG21	TSEG20	TSEG13	TSEG12	TSEG11	TSEG10
0x1884	CANRFLG	WUPIF	CSCIF	RSTAT1	RSTAT0	TSTAT1	TSTAT0	OVRIF	RXF
0x1885	CANRIER	WUPIE	CSCIE	RSTATE1	RSTATE0	TSTATE1	TSTATE0	OVRIE	RXFIE
0x1886	CANTFLG	0	0	0	0	0	TXE2	TXE1	TXE0
0x1887	CANTIER	0	0	0	0	0	TXEIE2	TXEIE1	TXEIE0
0x1888	CANTARQ	0	0	0	0	0	ABTRQ2	ABTRQ1	ABTRQ0
0x1889	CANTAAK	0	0	0	0	0	ABTAK2	ABTAK1	ABTAK0
0x188A	CANTBSEL	0	0	0	0	0	TX2	TX1	TX0
0x188B	CANIDAC	0	0	IDAM1	IDAM0	0	IDHIT2	IDHIT1	IDHIT0
0x188C	Reserved	0	0	0	0	0	0	0	0
0x188D	CANMISC	0	0	0	0	0	0	0	BOHOLD
0x188E	CANRXERR	RXERR7	RXERR6	RXERR5	RXERR4	RXERR3	RXERR2	RXERR1	RXERR0
0x188F	CANTXERR	TXERR7	TXERR6	TXERR5	TXERR4	TXERR3	TXERR2	TXERR1	TXERR0
0x1890 – 0x1893	CANIDAR0 – CANIDAR3	AC7	AC6	AC5	AC4	AC3	AC2	AC1	AC0
0x1894 – 0x1897	CANIDMR0 – CANIDMR3	AM7	AM6	AM5	AM4	AM3	AM2	AM1	AM0
0x1898 – 0x189B	CANIDAR4 – CANIDAR7	AC7	AC6	AC5	AC4	AC3	AC2	AC1	AC0
0x189C– 0x189F	CANIDMR4 – CANIDMR7	AM7	AM6	AM5	AM4	AM3	AM2	AM1	AM0
0x18BE	CANTTSRH	TSR15	TSR14	TSR13	TSR12	TSR11	TSR10	TSR9	TSR8
0x18BF	CANTTSRL	TSR7	TSR6	TSR5	TSR4	TSR3	TSR2	TSR1	TSR0
0x18C0– 0x18FF	Reserved	— —	— —	— —	— —	— —	— —	— —	— —

[1] This bit is reserved. User must write a 1 to this bit. Failing to do so may result in unexpected behavior.

Figure 4-4 shows the structure of receive and transmit buffers for extended identifier mapping. These registers vary depending on whether standard or extended mapping is selected. See Chapter 12, “Freescale Controller Area Network (S08MSCANV1),” for details on extended and standard identifier mapping.

Table 4-4. MSCAN Foreground Receive and Transmit Buffer Layouts — Extended Mapping Shown

0x18A0	CANRIDR0	ID28	ID27	ID26	ID25	ID24	ID23	ID22	ID21
0x18A1	CANRIDR1	ID20	ID19	ID18	SRR[1]	IDE[1]	ID17	ID16	ID15
0x18A2	CANRIDR2	ID14	ID13	ID12	ID11	ID10	ID9	ID8	ID7
0x18A3	CANRIDR3	ID6	ID5	ID4	ID3	ID2	ID1	ID0	RTR[2]
0x18A4 – 0x18AB	CANRDSR0 – CANRDSR7	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0x18AC	CANRDLR	—	—	—	—	DLC3	DLC2	DLC1	DLC0
0x18AD	Reserved	—	—	—	—	—	—	—	—
0x18AE	CANRTSRH	TSR15	TSR14	TSR13	TSR12	TSR11	TSR10	TSR9	TSR8

Table 4-14. FSTAT Register Field Descriptions (continued)

Field	Description
4 FACCERR	**Access Error Flag** — FACCERR is set automatically when the proper command sequence is not obeyed exactly (the erroneous command is ignored), if a program or erase operation is attempted before the FCDIV register has been initialized, or if the MCU enters stop while a command was in progress. For a more detailed discussion of the exact actions that are considered access errors, see Section 4.5.6, "Access Errors." FACCERR is cleared by writing a 1 to FACCERR. Writing a 0 to FACCERR has no meaning or effect. 0 No access error. 1 An access error has occurred.
2 FBLANK	**Verified as All Blank (erased) Flag** — FBLANK is set automatically at the conclusion of a blank check command if the entire Flash array was verified to be erased. FBLANK is cleared by clearing FCBEF to write a new valid command. Writing to FBLANK has no meaning or effect. 0 After a blank check command is completed and FCCF = 1, FBLANK = 0 indicates the Flash array is not completely erased. 1 After a blank check command is completed and FCCF = 1, FBLANK = 1 indicates the Flash array is completely erased (all 0xFFFF).

4.5.10.6 Flash Command Register (FCMD)

Only six command codes are recognized in normal user modes, as shown in Table 4-15. All other command codes are illegal and generate an access error. Refer to Section 4.5.3, "Program and Erase Command Execution," for a detailed discussion of Flash programming and erase operations.

	7	6	5	4	3	2	1	0
R	0	0	0	0	0	0	0	0
W	FCMD							
Reset	0	0	0	0	0	0	0	0

Figure 4-10. Flash Command Register (FCMD)

Table 4-15. Flash Commands

Command	FCMD	Equate File Label
Blank check	0x05	mBlank
Byte program	0x20	mByteProg
Burst program	0x25	mBurstProg
Sector erase	0x40	mSectorErase
Mass erase	0x41	mMassErase
Sector erase abort	0x47	mEraseAbort

It is not necessary to perform a blank check command after a mass erase operation. Only blank check is required as part of the security unlocking mechanism.

5.8 Reset, Interrupt, and System Control Registers and Control Bits

One 8-bit register in the direct page register space and eight 8-bit registers in the high-page register space are related to reset and interrupt systems.

Refer to Table 4-2 and Table 4-3 in Chapter 4, “Memory,” of this data sheet for the absolute address assignments for all registers. This section refers to registers and control bits only by their names. A Freescale-provided equate or header file is used to translate these names into the appropriate absolute addresses.

Some control bits in the SOPT1 and SPMSC2 registers are related to modes of operation. Although brief descriptions of these bits are provided here, the related functions are discussed in greater detail in Chapter 3, “Modes of Operation.”

5.8.2 System Reset Status Register (SRS)

This high page register includes read-only status flags to indicate the source of the most recent reset. When a debug host forces reset by writing 1 to BDFR in the SBDFR register, none of the status bits in SRS will be set. Writing any value to this register address causes a COP reset when the COP is enabled except the values 0x55 and 0xAA. Writing a 0x55-0xAA sequence to this address clears the COP watchdog timer without affecting the contents of this register. The reset state of these bits depends on what caused the MCU to reset.

	7	6	5	4	3	2	1	0
R	POR	PIN	COP	ILOP	ILAD	LOC	LVD	0
W	Writing 0x55, 0xAA to SRS address clears COP watchdog timer.							
POR:	1	0	0	0	0	0	1	0
LVD:	u	0	0	0	0	0	1	0
Any other reset:	0	Note(1)	Note(1)	Note(1)	Note(1)	0	0	0

1 Any of these reset sources that are active at the time of reset entry will cause the corresponding bit(s) to be set; bits corresponding to sources that are not active at the time of reset entry will be cleared.

Figure 5-3. System Reset Status (SRS)

Table 5-3. SRS Register Field Descriptions

Field	Description
7 POR	**Power-On Reset** — Reset was caused by the power-on detection logic. Because the internal supply voltage was ramping up at the time, the low-voltage reset (LVD) status bit is also set to indicate that the reset occurred while the internal supply was below the LVD threshold. 0 Reset not caused by POR. 1 POR caused reset.
6 PIN	**External Reset Pin** — Reset was caused by an active-low level on the external reset pin. 0 Reset not caused by external reset pin. 1 Reset came from external reset pin.
5 COP	**Computer Operating Properly (COP) Watchdog** — Reset was caused by the COP watchdog timer timing out. This reset source can be blocked by COPE = 0. 0 Reset not caused by COP timeout. 1 Reset caused by COP timeout.
4 ILOP	**Illegal Opcode** — Reset was caused by an attempt to execute an unimplemented or illegal opcode. The STOP instruction is considered illegal if stop is disabled by STOPE = 0 in the SOPT register. The BGND instruction is considered illegal if active background mode is disabled by ENBDM = 0 in the BDCSC register. 0 Reset not caused by an illegal opcode. 1 Reset caused by an illegal opcode.
3 ILAD	**Illegal Address** — Reset was caused by an attempt to access either data or an instruction at an unimplemented memory address. 0 Reset not caused by an illegal address. 1 Reset caused by an illegal address.

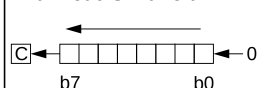
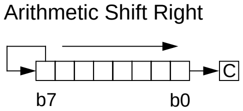
7.5 HCS08 Instruction Set Summary

Table 7-2 provides a summary of the HCS08 instruction set in all possible addressing modes. The table shows operand construction, execution time in internal bus clock cycles, and cycle-by-cycle details for each addressing mode variation of each instruction.

Table 7-2. Instruction Set Summary (Sheet 1 of 9)

Source Form	Operation	Address Mode	Object Code	Cycles	Cyc-by-Cyc Details	Affect on CCR V 1 1 H	Affect on CCR I N Z C
ADC *#opr8i* ADC *opr8a* ADC *opr16a* ADC *oprx16*,X ADC *oprx8*,X ADC ,X ADC *oprx16*,SP ADC *oprx8*,SP	Add with Carry A ← (A) + (M) + (C)	IMM DIR EXT IX2 IX1 IX SP2 SP1	A9 ii B9 dd C9 hh ll D9 ee ff E9 ff F9 9E D9 ee ff 9E E9 ff	2 3 4 4 3 3 5 4	pp rpp prpp prpp rpp rfp pprpp prpp	↕ 1 1 ↕	– ↕ ↕ ↕

ADD *#opr8i*
ADD *opr8a*
ADD *opr16a*
ADD *oprx16*,X
ADD *oprx8*,X
ADD ,X
ADD *oprx16*,SP
ADD *oprx8*,SP
	Add without Carry
	A ← (A) + (M)
		IMM
		DIR
		EXT
		IX2
		IX1
		IX
		SP2
		SP1
			AB ii
			BB dd
			CB hh ll
			DB ee ff
			EB ff
			FB
			9E DB ee ff
			9E EB ff
				2
				3
				4
				4
				3
				3
				5
				4
					pp
					rpp
					prpp
					prpp
					rpp
					rfp
					pprpp
					prpp
						↕ 1 1 ↕	– ↕ ↕ ↕

AIS *#opr8i*	Add Immediate Value (Signed) to Stack Pointer SP ← (SP) + (M)	IMM	A7 ii	2	pp	– 1 1 –	– – – –
AIX *#opr8i*	Add Immediate Value (Signed) to Index Register (H:X) H:X ← (H:X) + (M)	IMM	AF ii	2	pp	– 1 1 –	– – – –
AND *#opr8i* AND *opr8a* AND *opr16a* AND *oprx16*,X AND *oprx8*,X AND ,X AND *oprx16*,SP AND *oprx8*,SP	Logical AND A ← (A) & (M)	IMM DIR EXT IX2 IX1 IX SP2 SP1	A4 ii B4 dd C4 hh ll D4 ee ff E4 ff F4 9E D4 ee ff 9E E4 ff	2 3 4 4 3 3 5 4	pp rpp prpp prpp rpp rfp pprpp prpp	0 1 1 –	– ↕ ↕ –
ASL *opr8a* ASLA ASLX ASL *oprx8*,X ASL ,X ASL *oprx8*,SP	Arithmetic Shift Left  (Same as LSL)	DIR INH INH IX1 IX SP1	38 dd 48 58 68 ff 78 9E 68 ff	5 1 1 5 4 6	rfwpp p p rfwpp rfwp prfwpp	↕ 1 1 –	– ↕ ↕ ↕
ASR *opr8a* ASRA ASRX ASR *oprx8*,X ASR ,X ASR *oprx8*,SP	Arithmetic Shift Right 	DIR INH INH IX1 IX SP1	37 dd 47 57 67 ff 77 9E 67 ff	5 1 1 5 4 6	rfwpp p p rfwpp rfwp prfwpp	↕ 1 1 –	– ↕ ↕ ↕

- LP bit is written to 0

In FLL bypassed internal mode, the MCGOUT clock is derived from the internal reference clock. The FLL clock is controlled by the internal reference clock, and the FLL clock frequency locks to 1024 times the reference frequency, as selected by the RDIV bits. The MCGLCLK is derived from the FLL and the PLL is disabled in a low power state.

8.4.1.4 FLL Bypassed External (FBE)

In FLL bypassed external (FBE) mode, the MCGOUT clock is derived from the external reference clock and the FLL is operational but its output clock is not used. This mode is useful to allow the FLL to acquire its target frequency while the MCGOUT clock is driven from the external reference clock.

The FLL bypassed external mode is entered when all the following conditions occur:

- CLKS bits are written to 10
- IREFS bit is written to 0
- PLLS bit is written to 0
- RDIV bits are written to divide reference clock to be within the range of 31.25 kHz to 39.0625 kHz
- LP bit is written to 0

In FLL bypassed external mode, the MCGOUT clock is derived from the external reference clock. The external reference clock which is enabled can be an external crystal/resonator or it can be another external clock source.The FLL clock is controlled by the external reference clock, and the FLL clock frequency locks to 1024 times the reference frequency, as selected by the RDIV bits. The MCGLCLK is derived from the FLL and the PLL is disabled in a low power state.

NOTE

It is possible to briefly operate in FBE mode with an FLL reference clock frequency that is greater than the specified maximum frequency. This can be necessary in applications that operate in PEE mode using an external crystal with a frequency above 5 MHz. Please see 8.5.2.4, “Example # 4: Moving from FEI to PEE Mode: External Crystal = 8 MHz, Bus Frequency = 8 MHz for a detailed example.

8.4.1.5 PLL Engaged External (PEE)

The PLL engaged external (PEE) mode is entered when all the following conditions occur:

- CLKS bits are written to 00
- IREFS bit is written to 0
- PLLS bit is written to 1
- RDIV bits are written to divide reference clock to be within the range of 1 MHz to 2 MHz

In PLL engaged external mode, the MCGOUT clock is derived from the PLL clock which is controlled by the external reference clock. The external reference clock which is enabled can be an external crystal/resonator or it can be another external clock source The PLL clock frequency locks to a

Table 9-3. ACMPxSC Field Descriptions (continued)

Field	Description
3 ACO	Analog Comparator Output. Reading ACO returns the current value of the analog comparator output. ACO is reset to a 0 and reads as a 0 when the ACMP is disabled (ACME = 0).
2 ACOPE	Analog Comparator Output Pin Enable. Enables the comparator output to be placed onto the external pin, ACMPxO. 0 Analog comparator output not available on ACMPxO 1 Analog comparator output is driven out on ACMPxO
1:0 ACMOD	Analog Comparator Mode. ACMOD selects the type of compare event which sets ACF. 00 Encoding 0 — Comparator output falling edge 01 Encoding 1 — Comparator output rising edge 10 Encoding 2 — Comparator output falling edge 11 Encoding 3 — Comparator output rising or falling edge

9.4 Functional Description

The analog comparator can compare two analog input voltages applied to ACMPx+ and ACMPx–, or it can compare an analog input voltage applied to ACMPx– with an internal bandgap reference voltage. ACBGS selects between the bandgap reference voltage or the ACMPx+ pin as the input to the non-inverting input of the analog comparator. The comparator output is high when the non-inverting input is greater than the inverting input, and is low when the non-inverting input is less than the inverting input. ACMOD selects the condition that causes ACF to be set. ACF can be set on a rising edge of the comparator output, a falling edge of the comparator output, or a rising or a falling edge (toggle). The comparator output can be read directly through ACO. The comparator output can be driven onto the ACMPxO pin using ACOPE.

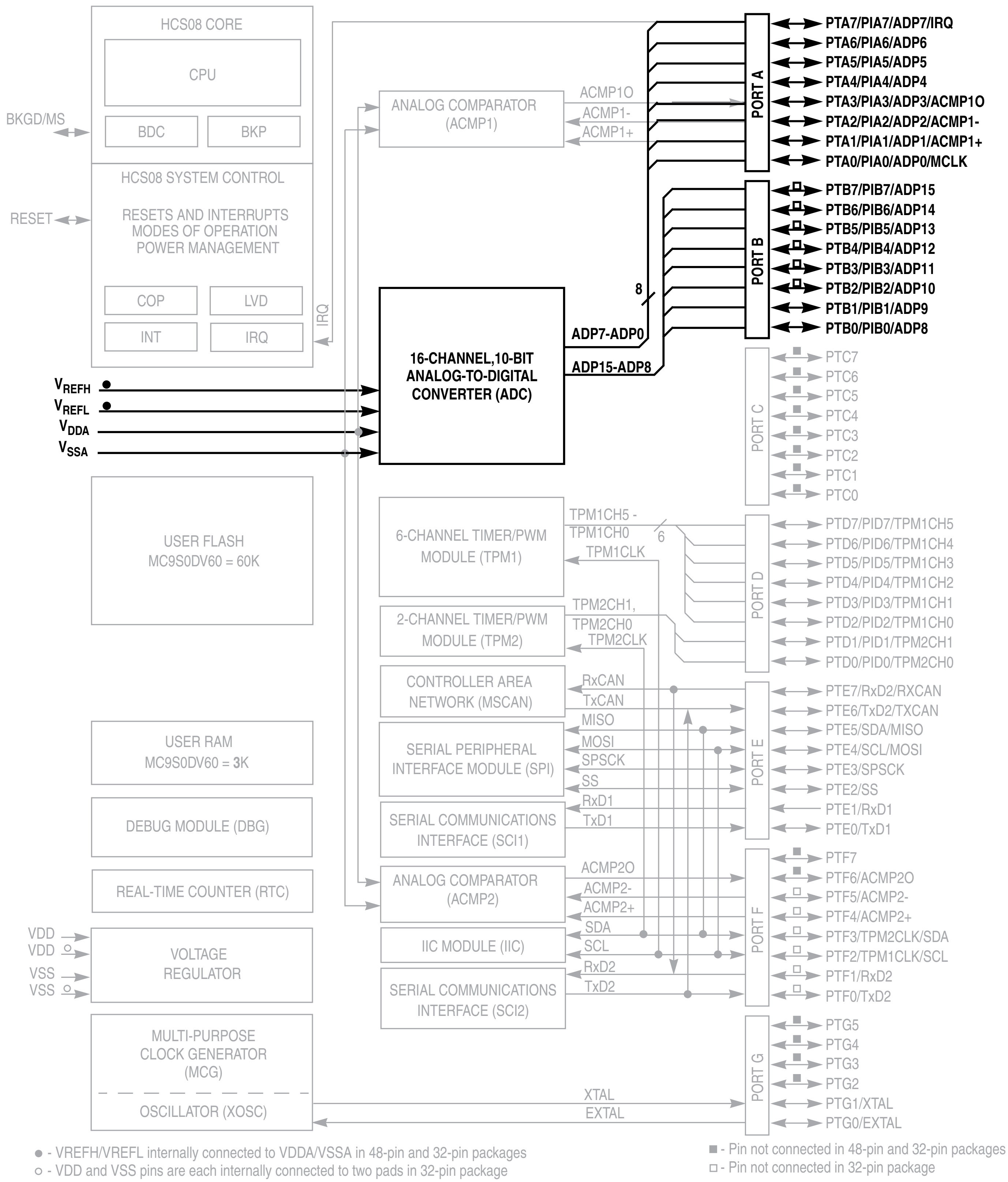


Figure 10-1. MC9S08DV60 Block Diagram Emphasizing the ADC Module and Pins

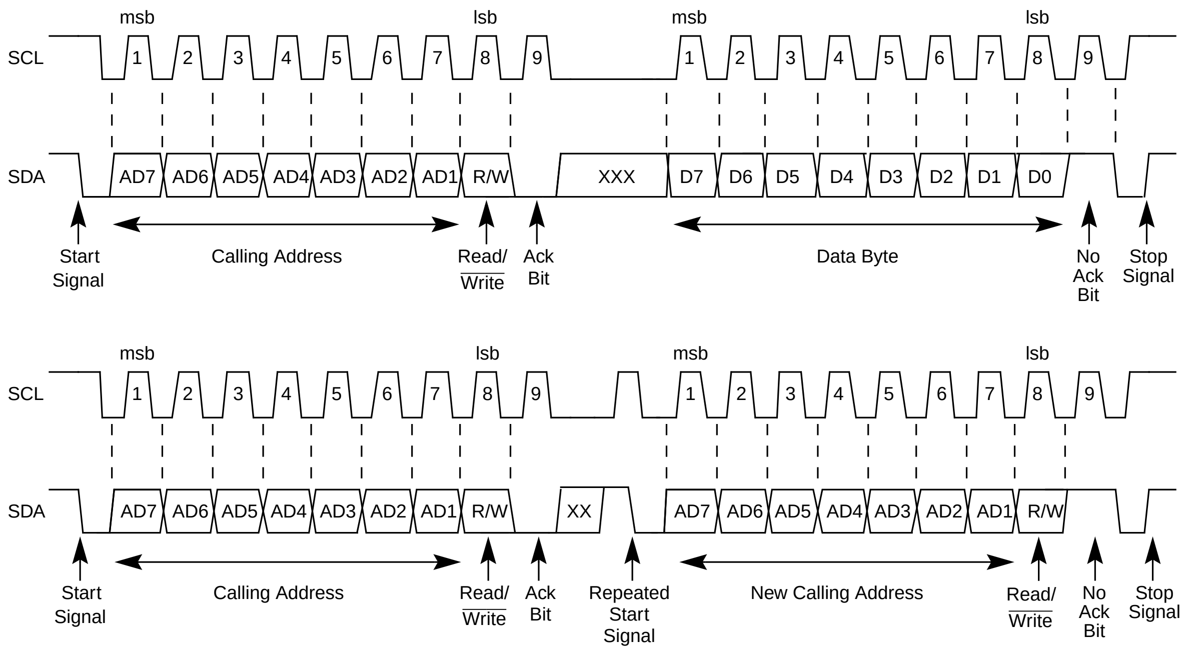


Figure 11-9. IIC Bus Transmission Signals

11.4.1.1 Start Signal

When the bus is free, no master device is engaging the bus (SCL and SDA lines are at logical high), a master may initiate communication by sending a start signal. As shown in Figure 11-9, a start signal is defined as a high-to-low transition of SDA while SCL is high. This signal denotes the beginning of a new data transfer (each data transfer may contain several bytes of data) and brings all slaves out of their idle states.

11.4.1.2 Slave Address Transmission

The first byte of data transferred immediately after the start signal is the slave address transmitted by the master. This is a seven-bit calling address followed by a R/$\overline{\text{W}}$ bit. The R/$\overline{\text{W}}$ bit tells the slave the desired direction of data transfer.

1 = Read transfer, the slave transmits data to the master.
0 = Write transfer, the master transmits data to the slave.

Only the slave with a calling address that matches the one transmitted by the master responds by sending back an acknowledge bit. This is done by pulling the SDA low at the ninth clock (see Figure 11-9).

No two slaves in the system may have the same address. If the IIC module is the master, it must not transmit an address equal to its own slave address. The IIC cannot be master and slave at the same time. However, if arbitration is lost during an address cycle, the IIC reverts to slave mode and operates correctly even if it is being addressed by another master.

Table 12-1. CANCTL0 Register Field Descriptions (continued)

Field	Description
1 SLPRQ[5]	**Sleep Mode Request** — This bit requests the MSCAN to enter sleep mode, which is an internal power saving mode (see Section 12.5.5.4, "MSCAN Sleep Mode"). The sleep mode request is serviced when the CAN bus is idle, i.e., the module is not receiving a message and all transmit buffers are empty. The module indicates entry to sleep mode by setting SLPAK = 1 (see Section 12.3.2, "MSCAN Control Register 1 (CANCTL1)"). SLPRQ cannot be set while the WUPIF flag is set (see Section 12.3.4.1, "MSCAN Receiver Flag Register (CANRFLG)"). Sleep mode will be active until SLPRQ is cleared by the CPU or, depending on the setting of WUPE, the MSCAN detects activity on the CAN bus and clears SLPRQ itself. 0 Running — The MSCAN functions normally 1 Sleep mode request — The MSCAN enters sleep mode when CAN bus idle
0 INITRQ[6,7]	**Initialization Mode Request** — When this bit is set by the CPU, the MSCAN skips to initialization mode (see Section 12.5.5.5, "MSCAN Initialization Mode"). Any ongoing transmission or reception is aborted and synchronization to the CAN bus is lost. The module indicates entry to initialization mode by setting INITAK = 1 (Section 12.3.2, "MSCAN Control Register 1 (CANCTL1)"). The following registers enter their hard reset state and restore their default values: CANCTL0[8], CANRFLG[9], CANRIER[10], CANTFLG, CANTIER, CANTARQ, CANTAAK, and CANTBSEL. The registers CANCTL1, CANBTR0, CANBTR1, CANIDAC, CANIDAR0-7, and CANIDMR0-7 can only be written by the CPU when the MSCAN is in initialization mode (INITRQ = 1 and INITAK = 1). The values of the error counters are not affected by initialization mode. When this bit is cleared by the CPU, the MSCAN restarts and then tries to synchronize to the CAN bus. If the MSCAN is not in bus-off state, it synchronizes after 11 consecutive recessive bits on the CAN bus; if the MSCAN is in bus-off state, it continues to wait for 128 occurrences of 11 consecutive recessive bits. Writing to other bits in CANCTL0, CANRFLG, CANRIER, CANTFLG, or CANTIER must be done only after initialization mode is exited, which is INITRQ = 0 and INITAK = 0. 0 Normal operation 1 MSCAN in initialization mode

1 The MSCAN must be in normal mode for this bit to become set.

2 See the Bosch CAN 2.0A/B specification for a detailed definition of transmitter and receiver states.

3 In order to protect from accidentally violating the CAN protocol, the TXCAN pin is immediately forced to a recessive state when the CPU enters wait (CSWAI = 1) or stop mode (see Section 12.5.5.2, "Operation in Wait Mode" and Section 12.5.5.3, "Operation in Stop Mode").

4 The CPU has to make sure that the WUPE bit and the WUPIE wake-up interrupt enable bit (see Section 12.3.5, "MSCAN Receiver Interrupt Enable Register (CANRIER)) is enabled, if the recovery mechanism from stop or wait is required.

5 The CPU cannot clear SLPRQ before the MSCAN has entered sleep mode (SLPRQ = 1 and SLPAK = 1).

6 The CPU cannot clear INITRQ before the MSCAN has entered initialization mode (INITRQ = 1 and INITAK = 1).

7 In order to protect from accidentally violating the CAN protocol, the TXCAN pin is immediately forced to a recessive state when the initialization mode is requested by the CPU. Thus, the recommended procedure is to bring the MSCAN into sleep mode (SLPRQ = 1 and SLPAK = 1) before requesting initialization mode.

8 Not including WUPE, INITRQ, and SLPRQ.

9 TSTAT1 and TSTAT0 are not affected by initialization mode.

10 RSTAT1 and RSTAT0 are not affected by initialization mode.

Table 12-2. CANCTL1 Register Field Descriptions (continued)

Field	Description
1 SLPAK	**Sleep Mode Acknowledge** — This flag indicates whether the MSCAN module has entered sleep mode (see Section 12.5.5.4, "MSCAN Sleep Mode"). It is used as a handshake flag for the SLPRQ sleep mode request. Sleep mode is active when SLPRQ = 1 and SLPAK = 1. Depending on the setting of WUPE, the MSCAN will clear the flag if it detects activity on the CAN bus while in sleep mode.CPU clearing the SLPRQ bit will also reset the SLPAK bit. 0 Running — The MSCAN operates normally 1 Sleep mode active — The MSCAN has entered sleep mode
0 INITAK	**Initialization Mode Acknowledge** — This flag indicates whether the MSCAN module is in initialization mode (see Section 12.5.5.5, "MSCAN Initialization Mode"). It is used as a handshake flag for the INITRQ initialization mode request. Initialization mode is active when INITRQ = 1 and INITAK = 1. The registers CANCTL1, CANBTR0, CANBTR1, CANIDAC, CANIDAR0–CANIDAR7, and CANIDMR0–CANIDMR7 can be written only by the CPU when the MSCAN is in initialization mode. 0 Running — The MSCAN operates normally 1 Initialization mode active — The MSCAN is in initialization mode

12.3.3 MSCAN Bus Timing Register 0 (CANBTR0)

The CANBTR0 register configures various CAN bus timing parameters of the MSCAN module.

	7	6	5	4	3	2	1	0
R W	SJW1	SJW0	BRP5	BRP4	BRP3	BRP2	BRP1	BRP0
Reset:	0	0	0	0	0	0	0	0

Figure 12-6. MSCAN Bus Timing Register 0 (CANBTR0)

Read: Anytime
Write: Anytime in initialization mode (INITRQ = 1 and INITAK = 1)

Table 12-3. CANBTR0 Register Field Descriptions

Field	Description
7:6 SJW[1:0]	**Synchronization Jump Width** — The synchronization jump width defines the maximum number of time quanta (Tq) clock cycles a bit can be shortened or lengthened to achieve resynchronization to data transitions on the CAN bus (see Table 12-4).
5:0 BRP[5:0]	**Baud Rate Prescaler** — These bits determine the time quanta (Tq) clock which is used to build up the bit timing (see Table 12-5).

Table 12-4. Synchronization Jump Width

SJW1	SJW0	Synchronization Jump Width
0	0	1 Tq clock cycle
0	1	2 Tq clock cycles
1	0	3 Tq clock cycles
1	1	4 Tq clock cycles

Table 12-5. Baud Rate Prescaler

BRP5	BRP4	BRP3	BRP2	BRP1	BRP0	Prescaler value (P)
0	0	0	0	0	0	1
0	0	0	0	0	1	2
0	0	0	0	1	0	3
0	0	0	0	1	1	4
:	:	:	:	:	:	:
1	1	1	1	1	1	64

12.3.4 MSCAN Bus Timing Register 1 (CANBTR1)

The CANBTR1 register configures various CAN bus timing parameters of the MSCAN module.

	7	6	5	4	3	2	1	0
R W	SAMP	TSEG22	TSEG21	TSEG20	TSEG13	TSEG12	TSEG11	TSEG10
Reset:	0	0	0	0	0	0	0	0

Figure 12-7. MSCAN Bus Timing Register 1 (CANBTR1)

Read: Anytime
Write: Anytime in initialization mode (INITRQ = 1 and INITAK = 1)

Table 12-6. CANBTR1 Register Field Descriptions

Field	Description
7 SAMP	**Sampling** — This bit determines the number of CAN bus samples taken per bit time. 0 One sample per bit. 1 Three samples per bit[1]. If SAMP = 0, the resulting bit value is equal to the value of the single bit positioned at the sample point. If SAMP = 1, the resulting bit value is determined by using majority rule on the three total samples. For higher bit rates, it is recommended that only one sample is taken per bit time (SAMP = 0).
6:4 TSEG2[2:0]	**Time Segment 2** — Time segments within the bit time fix the number of clock cycles per bit time and the location of the sample point (see Figure 12-43). Time segment 2 (TSEG2) values are programmable as shown in Table 12-7.
3:0 TSEG1[3:0]	**Time Segment 1** — Time segments within the bit time fix the number of clock cycles per bit time and the location of the sample point (see Figure 12-43). Time segment 1 (TSEG1) values are programmable as shown in Table 12-8.

[1] In this case, PHASE_SEG1 must be at least 2 time quanta (Tq).

Table 12-25. IDR0 Register Field Descriptions — Extended

Field	Description
7:0 ID[28:21]	**Extended Format Identifier —** The identifiers consist of 29 bits (ID[28:0]) for the extended format. ID28 is the most significant bit and is transmitted first on the CAN bus during the arbitration procedure. The priority of an identifier is defined to be highest for the smallest binary number.

	7	6	5	4	3	2	1	0
R W	ID20	ID19	ID18	SRR[1]	IDE[1]	ID17	ID16	ID15
Reset:	x	x	x	x	x	x	x	x

Figure 12-26. Identifier Register 1 (IDR1) — Extended Identifier Mapping

1 SRR and IDE are both 1s.

Table 12-26. IDR1 Register Field Descriptions — Extended

Field	Description
7:5 ID[20:18]	**Extended Format Identifier —** The identifiers consist of 29 bits (ID[28:0]) for the extended format. ID28 is the most significant bit and is transmitted first on the CAN bus during the arbitration procedure. The priority of an identifier is defined to be highest for the smallest binary number.
4 SRR	**Substitute Remote Request** — This fixed recessive bit is used only in extended format. It must be set to 1 by the user for transmission buffers and is stored as received on the CAN bus for receive buffers.
3 IDE	**ID Extended** — This flag indicates whether the extended or standard identifier format is applied in this buffer. In the case of a receive buffer, the flag is set as received and indicates to the CPU how to process the buffer identifier registers. In the case of a transmit buffer, the flag indicates to the MSCAN what type of identifier to send. 0 Standard format (11 bit) 1 Extended format (29 bit)
2:0 ID[17:15]	**Extended Format Identifier —** The identifiers consist of 29 bits (ID[28:0]) for the extended format. ID28 is the most significant bit and is transmitted first on the CAN bus during the arbitration procedure. The priority of an identifier is defined to be highest for the smallest binary number.

	7	6	5	4	3	2	1	0
R W	ID14	ID13	ID12	ID11	ID10	ID9	ID8	ID7
Reset:	x	x	x	x	x	x	x	x

Figure 12-27. Identifier Register 2 (IDR2) — Extended Identifier Mapping

Table 12-27. IDR2 Register Field Descriptions — Extended

Field	Description
7:0 ID[14:7]	**Extended Format Identifier —** The identifiers consist of 29 bits (ID[28:0]) for the extended format. ID28 is the most significant bit and is transmitted first on the CAN bus during the arbitration procedure. The priority of an identifier is defined to be highest for the smallest binary number.

Table 14-8. SCIxC3 Field Descriptions (continued)

Field	Description
4 TXINV[1]	**Transmit Data Inversion** — Setting this bit reverses the polarity of the transmitted data output. 0 Transmit data not inverted 1 Transmit data inverted
3 ORIE	**Overrun Interrupt Enable** — This bit enables the overrun flag (OR) to generate hardware interrupt requests. 0 OR interrupts disabled (use polling). 1 Hardware interrupt requested when OR = 1.
2 NEIE	**Noise Error Interrupt Enable** — This bit enables the noise flag (NF) to generate hardware interrupt requests. 0 NF interrupts disabled (use polling). 1 Hardware interrupt requested when NF = 1.
1 FEIE	**Framing Error Interrupt Enable** — This bit enables the framing error flag (FE) to generate hardware interrupt requests. 0 FE interrupts disabled (use polling). 1 Hardware interrupt requested when FE = 1.
0 PEIE	**Parity Error Interrupt Enable** — This bit enables the parity error flag (PF) to generate hardware interrupt requests. 0 PF interrupts disabled (use polling). 1 Hardware interrupt requested when PF = 1.

[1] Setting TXINV inverts the TxD output for all cases: data bits, start and stop bits, break, and idle.

14.2.7 SCI Data Register (SCIxD)

This register is actually two separate registers. Reads return the contents of the read-only receive data buffer and writes go to the write-only transmit data buffer. Reads and writes of this register are also involved in the automatic flag clearing mechanisms for the SCI status flags.

	7	6	5	4	3	2	1	0
R	R7	R6	R5	R4	R3	R2	R1	R0
W	T7	T6	T5	T4	T3	T2	T1	T0
Reset	0	0	0	0	0	0	0	0

Figure 14-11. SCI Data Register (SCIxD)

14.3 Functional Description

The SCI allows full-duplex, asynchronous, NRZ serial communication among the MCU and remote devices, including other MCUs. The SCI comprises a baud rate generator, transmitter, and receiver block. The transmitter and receiver operate independently, although they use the same baud rate generator. During normal operation, the MCU monitors the status of the SCI, writes the data to be transmitted, and processes received data. The following describes each of the blocks of the SCI.

14.3.1 Baud Rate Generation

As shown in Figure 14-12, the clock source for the SCI baud rate generator is the bus-rate clock.

16.6.2.1.2 Center-Aligned PWM Case

When CPWMS=1, TOF gets set when the timer counter changes direction from up-counting to down-counting at the end of the terminal count (the value in the modulo register). In this case the TOF corresponds to the end of a PWM period.

16.6.2.2 Channel Event Interrupt Description

The meaning of channel interrupts depends on the channel's current mode (input-capture, output-compare, edge-aligned PWM, or center-aligned PWM).

16.6.2.2.1 Input Capture Events

When a channel is configured as an input capture channel, the ELSnB:ELSnA control bits select no edge (off), rising edges, falling edges or any edge as the edge which triggers an input capture event. When the selected edge is detected, the interrupt flag is set. The flag is cleared by the two-step sequence described in Section 16.6.2, "Description of Interrupt Operation."

16.6.2.2.2 Output Compare Events

When a channel is configured as an output compare channel, the interrupt flag is set each time the main timer counter matches the 16-bit value in the channel value register. The flag is cleared by the two-step sequence described Section 16.6.2, "Description of Interrupt Operation."

16.6.2.2.3 PWM End-of-Duty-Cycle Events

For channels configured for PWM operation there are two possibilities. When the channel is configured for edge-aligned PWM, the channel flag gets set when the timer counter matches the channel value register which marks the end of the active duty cycle period. When the channel is configured for center-aligned PWM, the timer count matches the channel value register twice during each PWM cycle. In this CPWM case, the channel flag is set at the start and at the end of the active duty cycle period which are the times when the timer counter matches the channel value register. The flag is cleared by the two-step sequence described Section 16.6.2, "Description of Interrupt Operation."

16.7 The Differences from TPM v2 to TPM v3

1. Write to TPMxCNTH:L registers (Section 16.3.2, "TPM-Counter Registers (TPMxCNTH:TPMxCNTL)) [SE110-TPM case 7]

   Any write to TPMxCNTH or TPMxCNTL registers in TPM v3 clears the TPM counter (TPMxCNTH:L) and the prescaler counter. Instead, in the TPM v2 only the TPM counter is cleared in this case.
2. Read of TPMxCNTH:L registers (Section 16.3.2, "TPM-Counter Registers (TPMxCNTH:TPMxCNTL))

   — In TPM v3, any read of TPMxCNTH:L registers during BDM mode returns the value of the TPM counter that is frozen. In TPM v2, if only one byte of the TPMxCNTH:L registers was read before the BDM mode became active, then any read of TPMxCNTH:L registers during

A.13 Flash

This section provides details about program/erase times and program-erase endurance for the Flash memory.

Program and erase operations do not require any special power sources other than the normal V_{DD} supply. For more detailed information about program/erase operations, see Chapter 4, "Memory."

Table A-17. Flash Characteristics

Num	C	Rating	Symbol	Min	Typical	Max	Unit
1	—	Supply voltage for program/erase	$V_{prog/erase}$	2.7		5.5	V
2	—	Supply voltage for read operation $0 < f_{Bus} < 8$ MHz $0 < f_{Bus} < 20$ MHz	V_{Read}	2.7		5.5	V
3	—	Internal FCLK frequency[1]	f_{FCLK}	150		200	kHz
4	—	Internal FCLK period (1/FCLK)	t_{Fcyc}	5		6.67	μs
5	—	Byte program time (random location)[(2)]	t_{prog}		9		t_{Fcyc}
6	—	Byte program time (burst mode)[(2)]	t_{Burst}		4		t_{Fcyc}
7	—	Page erase time[2]	t_{Page}		4000		t_{Fcyc}
8	—	Mass erase time[(2)]	t_{Mass}		20,000		t_{Fcyc}
9	C	Flash Program/erase endurance[3] T_L to T_H = –40°C to + 125°C T = 25°C	n_{FLPE}	10,000 —	— 100,000	— —	cycles
10	C	Data retention[4]	t_{D_ret}	15	100	—	years

1 The frequency of this clock is controlled by a software setting.

2 These values are hardware state machine controlled. User code does not need to count cycles. This information supplied for calculating approximate time to program and erase.

3 **Typical endurance** for Flash is based on the intrinsic bit cell performance. For additional information on how Freescale Semiconductor defines typical endurance, please refer to Engineering Bulletin EB619, *Typical Endurance for Nonvolatile Memory.*

4 **Typical data retention** values are based on intrinsic capability of the technology measured at high temperature and de-rated to 25°C using the Arrhenius equation. For additional information on how Freescale Semiconductor defines typical data retention, please refer to Engineering Bulletin EB618, *Typical Data Retention for Nonvolatile Memory.*

A.14 EMC Performance

Electromagnetic compatibility (EMC) performance is highly dependant on the environment in which the MCU resides. Board design and layout, circuit topology choices, location and characteristics of external components as well as MCU software operation all play a significant role in EMC performance. The system designer should consult Freescale applications notes such as AN2321, AN1050, AN1263, AN2764, and AN1259 for advice and guidance specifically targeted at optimizing EMC performance.

Because the HCS08 is a family of 8-bit MCUs, the settings in the timer channel registers are buffered to ensure coherent 16-bit updates and to avoid unexpected PWM pulse widths. Writes to any of the registers, TPMxMODH, TPMxMODL, TPMxCnVH, and TPMxCnVL, actually write to buffer registers. Values are transferred to the corresponding timer channel registers only after both 8-bit bytes of a 16-bit register have been written and the timer counter overflows (reverses direction from up-counting to down-counting at the end of the terminal count in the modulus register). This TPMxCNT overflow requirement only applies to PWM channels, not output compares.

Optionally, when TPMxCNTH:TPMxCNTL = TPMxMODH:TPMxMODL, the TPM can generate a TOF interrupt at the end of this count. The user can choose to reload any number of the PWM buffers, and they will all update simultaneously at the start of a new period.

Writing to TPMxSC cancels any values written to TPMxMODH and/or TPMxMODL and resets the coherency mechanism for the modulo registers. Writing to TPMxCnSC cancels any values written to the channel value registers and resets the coherency mechanism for TPMxCnVH:TPMxCnVL.

B.4 TPM Interrupts

The TPM generates an optional interrupt for the main counter overflow and an interrupt for each channel. The meaning of channel interrupts depends on the mode of operation for each channel. If the channel is configured for input capture, the interrupt flag is set each time the selected input capture edge is recognized. If the channel is configured for output compare or PWM modes, the interrupt flag is set each time the main timer counter matches the value in the 16-bit channel value register. See the Resets, Interrupts, and System Configuration chapter for absolute interrupt vector addresses, priority, and local interrupt mask control bits.

For each interrupt source in the TPM, a flag bit is set on recognition of the interrupt condition such as timer overflow, channel input capture, or output compare events. This flag may be read (polled) by software to verify that the action has occurred, or an associated enable bit (TOIE or CHnIE) can be set to enable hardware interrupt generation. While the interrupt enable bit is set, a static interrupt will be generated whenever the associated interrupt flag equals 1. It is the responsibility of user software to perform a sequence of steps to clear the interrupt flag before returning from the interrupt service routine.

B.4.1 Clearing Timer Interrupt Flags

TPM interrupt flags are cleared by a 2-step process that includes a read of the flag bit while it is set (1) followed by a write of 0 to the bit. If a new event is detected between these two steps, the sequence is reset and the interrupt flag remains set after the second step to avoid the possibility of missing the new event.

B.4.2 Timer Overflow Interrupt Description

The conditions that cause TOF to become set depend on the counting mode (up or up/down). In up-counting mode, the 16-bit timer counter counts from 0x0000 through 0xFFFF and overflows to 0x0000 on the next counting clock. TOF becomes set at the transition from 0xFFFF to 0x0000. When a modulus limit is set, TOF becomes set at the transition from the value set in the modulus register to 0x0000. When the counter is operating in up-/down-counting mode, the TOF flag gets set as the counter changes direction

NOTES:

1. DIMENSIONS AND TOLERANCING PER ASME Y14.5M–1994.

2. CONTROLLING DIMENSION: MILLIMETER.

3. DATUM PLANE AB IS LOCATED AT BOTTOM OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE BOTTOM OF THE PARTING LINE.

4. DATUMS T, U, AND Z TO BE DETERMINED AT DATUM PLANE AB.

5. DIMENSIONS TO BE DETERMINED AT SEATING PLANE AC.

6. DIMENSIONS DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS 0.250 PER SIDE. DIMENSIONS DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE AB.

7. THIS DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. DAMBAR PROTRUSION SHALL NOT CAUSE THE LEAD WIDTH TO EXCEED 0.350.

8. MINIMUM SOLDER PLATE THICKNESS SHALL BE 0.0076.

9. EXACT SHAPE OF EACH CORNER IS OPTIONAL.

	MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE
TITLE: LQFP, 48 LEAD, 0.50 PITCH (7.0 X 7.0 X 1.4)	DOCUMENT NO: 98ASH00962A	REV: G
	CASE NUMBER: 932–03	14 APR 2005
	STANDARD: JEDEC MS–026–BBC	