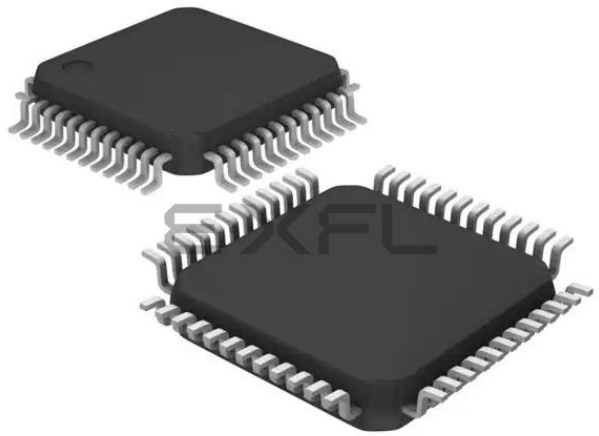

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Appendix C
Ordering Information and Mechanical Drawings

5.8.1 Interrupt Pin Request Status and Control Register (IRQSC)

This direct page register includes status and control bits which are used to configure the IRQ function, report status, and acknowledge IRQ events.

	7	6	5	4	3	2	1	0
R	0	IRQPDD	IRQEDG	IRQPE	IRQF	0	IRQIE	IRQMOD
W						IRQACK		
Reset	0	0	0	0	0	0	0	0

= Unimplemented or Reserved

Figure 5-2. Interrupt Request Status and Control Register (IRQSC)

Table 5-2. IRQSC Register Field Descriptions

Field	Description
6 IRQPDD	**Interrupt Request (IRQ) Pull Device Disable**— This read/write control bit is used to disable the internal pull-up/pull-down device when the IRQ pin is enabled (IRQPE = 1) allowing for an external device to be used. 0 IRQ pull device enabled if IRQPE = 1. 1 IRQ pull device disabled if IRQPE = 1.
5 IRQEDG	**Interrupt Request (IRQ) Edge Select** — This read/write control bit is used to select the polarity of edges or levels on the IRQ pin that cause IRQF to be set. The IRQMOD control bit determines whether the IRQ pin is sensitive to both edges and levels or only edges. When the IRQ pin is enabled as the IRQ input and is configured to detect rising edges, it has a pull-down. When the IRQ pin is enabled as the IRQ input and is configured to detect falling edges, it has a pull-up. 0 IRQ is falling edge or falling edge/low-level sensitive. 1 IRQ is rising edge or rising edge/high-level sensitive.
4 IRQPE	**IRQ Pin Enable** — This read/write control bit enables the IRQ pin function. When this bit is set the IRQ pin can be used as an interrupt request. 0 IRQ pin function is disabled. 1 IRQ pin function is enabled.
3 IRQF	**IRQ Flag** — This read-only status bit indicates when an interrupt request event has occurred. 0 No IRQ request. 1 IRQ event detected.
2 IRQACK	**IRQ Acknowledge** — This write-only bit is used to acknowledge interrupt request events (write 1 to clear IRQF). Writing 0 has no meaning or effect. Reads always return 0. If edge-and-level detection is selected (IRQMOD = 1), IRQF cannot be cleared while the IRQ pin remains at its asserted level.
1 IRQIE	**IRQ Interrupt Enable** — This read/write control bit determines whether IRQ events generate an interrupt request. 0 Interrupt request when IRQF set is disabled (use polling). 1 Interrupt requested whenever IRQF = 1.
0 IRQMOD	**IRQ Detection Mode** — This read/write control bit selects either edge-only detection or edge-and-level detection. The IRQEDG control bit determines the polarity of edges and levels that are detected as interrupt request events. See Section 5.5.2.2, “Edge and Level Sensitivity” for more details. 0 IRQ event on falling edges or rising edges only. 1 IRQ event on falling edges and low levels or on rising edges and high levels.

6.5.4.3 Port D Pull Enable Register (PTDPE)

	7	6	5	4	3	2	1	0
R W	PTDPE7	PTDPE6	PTDPE5	PTDPE4	PTDPE3	PTDPE2	PTDPE1	PTDPE0
Reset:	0	0	0	0	0	0	0	0

Figure 6-26. Internal Pull Enable for Port D Register (PTDPE)

Table 6-24. PTDPE Register Field Descriptions

Field	Description
7:0 PTDPE[7:0]	**Internal Pull Enable for Port D Bits** — Each of these control bits determines if the internal pull-up or pull-down device is enabled for the associated PTD pin. For port D pins that are configured as outputs, these bits have no effect and the internal pull devices are disabled. 0 Internal pull-up/pull-down device disabled for port D bit n. 1 Internal pull-up/pull-down device enabled for port D bit n.

NOTE

Pull-down devices only apply when using pin interrupt functions, when corresponding edge select and pin select functions are configured.

6.5.4.4 Port D Slew Rate Enable Register (PTDSE)

	7	6	5	4	3	2	1	0
R W	PTDSE7	PTDSE6	PTDSE5	PTDSE4	PTDSE3	PTDSE2	PTDSE1	PTDSE0
Reset:	0	0	0	0	0	0	0	0

Figure 6-27. Slew Rate Enable for Port D Register (PTDSE)

Table 6-25. PTDSE Register Field Descriptions

Field	Description
7:0 PTDSE[7:0]	**Output Slew Rate Enable for Port D Bits** — Each of these control bits determines if the output slew rate control is enabled for the associated PTD pin. For port D pins that are configured as inputs, these bits have no effect. 0 Output slew rate control disabled for port D bit n. 1 Output slew rate control enabled for port D bit n.

Note: Slew rate reset default values may differ between engineering samples and final production parts. Always initialize slew rate control to the desired value to ensure correct operation.

6.5.4.5 Port D Drive Strength Selection Register (PTDDS)

	7	6	5	4	3	2	1	0
R W	PTDDS7	PTDDS6	PTDDS5	PTDDS4	PTDDS3	PTDDS2	PTDDS1	PTDDS0
Reset:	0	0	0	0	0	0	0	0

Figure 6-28. Drive Strength Selection for Port D Register (PTDDS)

Table 6-26. PTDDS Register Field Descriptions

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

6.5.4.6 Port D Interrupt Status and Control Register (PTDSC)

	7	6	5	4	3	2	1	0
R	0	0	0	0	PTDIF	0	PTDIE	PTDMOD
W						PTDACK		
Reset:	0	0	0	0	0	0	0	0

= Unimplemented or Reserved

Figure 6-29. Port D Interrupt Status and Control Register (PTDSC)

Table 6-27. PTDSC Register Field Descriptions

Field	Description
3 PTDIF	**Port D Interrupt Flag** — PTDIF indicates when a port D interrupt is detected. Writes have no effect on PTDIF. 0 No port D interrupt detected. 1 Port D interrupt detected.
2 PTDACK	**Port D Interrupt Acknowledge** — Writing a 1 to PTDACK is part of the flag clearing mechanism. PTDACK always reads as 0.
1 PTDIE	**Port D Interrupt Enable** — PTDIE determines whether a port D interrupt is requested. 0 Port D interrupt request not enabled. 1 Port D interrupt request enabled.
0 PTDMOD	**Port A Detection Mode** — PTDMOD (along with the PTDES bits) controls the detection mode of the port D interrupt pins. 0 Port D pins detect edges only. 1 Port D pins detect both edges and levels.

8.3.3 MCG Trim Register (MCGTRM)

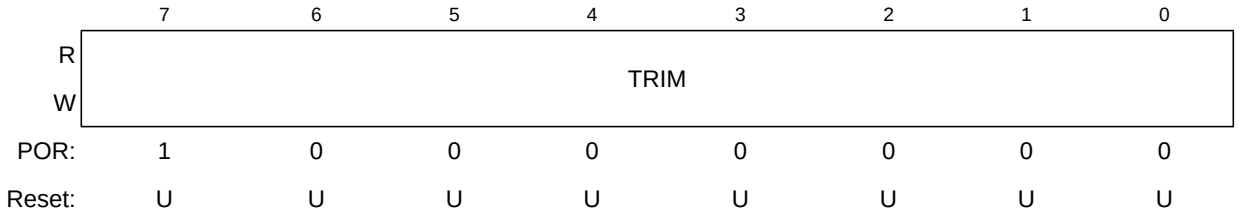


Figure 8-5. MCG Trim Register (MCGTRM)

Table 8-3. MCG Trim Register Field Descriptions

Field	Description
7:0 TRIM	MCG **Trim Setting** — Controls the internal reference clock frequency by controlling the internal reference clock period. The TRIM bits are binary weighted (i.e., bit 1 will adjust twice as much as bit 0). Increasing the binary value in TRIM will increase the period, and decreasing the value will decrease the period. An additional fine trim bit is available in MCGSC as the FTRIM bit. If a TRIM[7:0] value stored in nonvolatile memory is to be used, it's the user's responsibility to copy that value from the nonvolatile memory location to this register.

8.3.4 MCG Status and Control Register (MCGSC)

	7	6	5	4	3	2	1	0
R	LOLS	LOCK	PLLST	IREFST	CLKST		OSCINIT	FTRIM
W								
POR:	0	0	0	1	0	0	0	0
Reset:	0	0	0	1	0	0	0	U

Figure 8-6. MCG Status and Control Register (MCGSC)

Table 8-4. MCG Status and Control Register Field Descriptions

Field	Description
7 LOLS	**Loss of Lock Status** — This bit is a sticky indication of lock status for the FLL or PLL. LOLS is set when lock detection is enabled and after acquiring lock, the FLL or PLL output frequency has fallen outside the lock exit frequency tolerance, D_{unl}. LOLIE determines whether an interrupt request is made when set. LOLS is cleared by reset or by writing a logic 1 to LOLS when LOLS is set. Writing a logic 0 to LOLS has no effect. 0 FLL or PLL has not lost lock since LOLS was last cleared. 1 FLL or PLL has lost lock since LOLS was last cleared.
6 LOCK	**Lock Status** — Indicates whether the FLL or PLL has acquired lock. Lock detection is disabled when both the FLL and PLL are disabled. If the lock status bit is set then changing the value of any of the following bits IREFS, PLLS, RDIV[2:0], TRIM[7:0] (if in FEI or FBI modes), or VDIV[3:0] (if in PBE or PEE modes), will cause the lock status bit to clear and stay cleared until the FLL or PLL has reacquired lock. Stop mode entry will also cause the lock status bit to clear and stay cleared until the FLL or PLL has reacquired lock. Entry into BLPI or BLPE mode will also cause the lock status bit to clear and stay cleared until the MCG has exited these modes and the FLL or PLL has reacquired lock. 0 FLL or PLL is currently unlocked. 1 FLL or PLL is currently locked.
5 PLLST	**PLL Select Status** — The PLLST bit indicates the current source for the PLLS clock. The PLLST bit does not update immediately after a write to the PLLS bit due to internal synchronization between clock domains. 0 Source of PLLS clock is FLL clock. 1 Source of PLLS clock is PLL clock.
4 IREFST	**Internal Reference Status** — The IREFST bit indicates the current source for the reference clock. The IREFST bit does not update immediately after a write to the IREFS bit due to internal synchronization between clock domains. 0 Source of reference clock is external reference clock (oscillator or external clock source as determined by the EREFS bit in the MCGC2 register). 1 Source of reference clock is internal reference clock.
3:2 CLKST	**Clock Mode Status** — The CLKST bits indicate the current clock mode. The CLKST bits do not update immediately after a write to the CLKS bits due to internal synchronization between clock domains. 00 Encoding 0 — Output of FLL is selected. 01 Encoding 1 — Internal reference clock is selected. 10 Encoding 2 — External reference clock is selected. 11 Encoding 3 — Output of PLL is selected.

The table below shows MCGOUT frequency calculations using RDIV, BDIV, and VDIV settings for each clock mode. The bus frequency is equal to MCGOUT divided by 2.

Table 8-6. MCGOUT Frequency Calculation Options

Clock Mode	f_{MCGOUT}[1]	Note
FEI (FLL engaged internal)	(f_{int} * 1024) / B	Typical f_{MCGOUT} = 16 MHz immediately after reset. RDIV bits set to %000.
FEE (FLL engaged external)	(f_{ext} / R *1024) / B	f_{ext} / R must be in the range of 31.25 kHz to 39.0625 kHz
FBE (FLL bypassed external)	f_{ext} / B	f_{ext} / R must be in the range of 31.25 kHz to 39.0625 kHz
FBI (FLL bypassed internal)	f_{int} / B	Typical f_{int} = 32 kHz
PEE (PLL engaged external)	[(f_{ext} / R) * M] / B	f_{ext} / R must be in the range of 1 MHz to 2 MHz
PBE (PLL bypassed external)	f_{ext} / B	f_{ext} / R must be in the range of 1 MHz to 2 MHz
BLPI (Bypassed low power internal)	f_{int} / B	
BLPE (Bypassed low power external)	f_{ext} / B	

1 R is the reference divider selected by the RDIV bits, B is the bus frequency divider selected by the BDIV bits, and M is the multiplier selected by the VDIV bits.

This section will include 3 mode switching examples using a 4 MHz external crystal. If using an external clock source less than 1 MHz, the MCG should not be configured for any of the PLL modes (PEE and PBE).

8.5.2.1 Example # 1: Moving from FEI to PEE Mode: External Crystal = 4 MHz, Bus Frequency = 8 MHz

In this example, the MCG will move through the proper operational modes from FEI to PEE mode until the 4 MHz crystal reference frequency is set to achieve a bus frequency of 8 MHz. Because the MCG is in FEI mode out of reset, this example also shows how to initialize the MCG for PEE mode out of reset. First, the code sequence will be described. Then a flowchart will be included which illustrates the sequence.

1. First, FEI must transition to FBE mode:
   a) MCGC2 = 0x36 (%00110110)
      – BDIV (bits 7 and 6) set to %00, or divide-by-1
      – RANGE (bit 5) set to 1 because the frequency of 4 MHz is within the high frequency range
      – HGO (bit 4) set to 1 to configure external oscillator for high gain operation
      – EREFS (bit 2) set to 1, because a crystal is being used
      – ERCLKEN (bit 1) set to 1 to ensure the external reference clock is active
   b) Loop until OSCINIT (bit 1) in MCGSC is 1, indicating the crystal selected by the EREFS bit has been initialized.

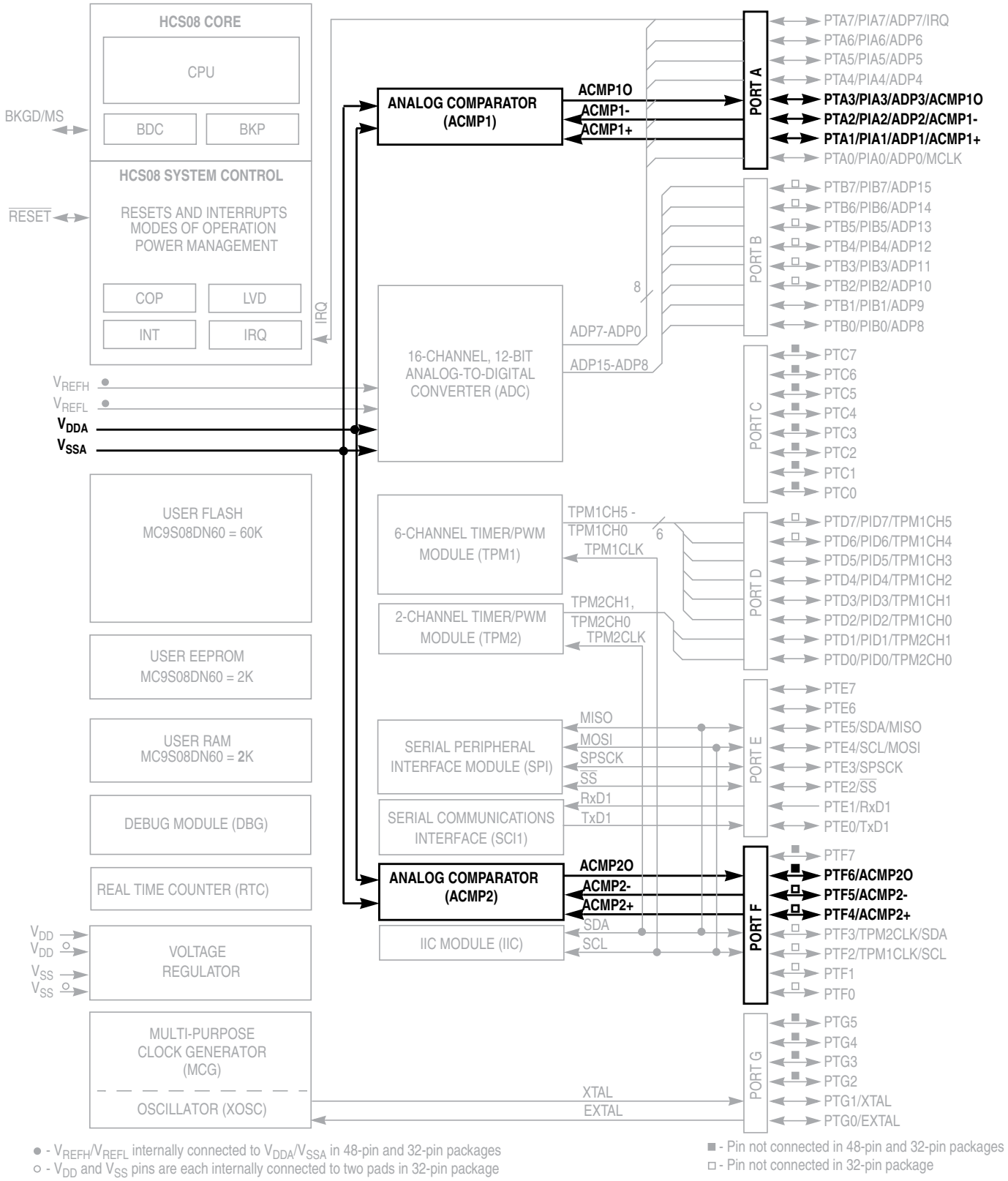


Figure 9-1. MC9S08DN60 Block Diagram

In 10-bit mode, the ADCCVH register holds the upper two bits of the 10-bit compare value (ADCV[9:8]). These bits are compared to the upper two bits of the result following a conversion in 10-bit mode when the compare function is enabled.

In 8-bit mode, ADCCVH is not used during compare.

10.3.6 Compare Value Low Register (ADCCVL)

This register holds the lower 8 bits of the 12-bit or 10-bit compare value or all 8 bits of the 8-bit compare value. When the compare function is enabled, bits ADCV[7:0] are compared to the lower 8 bits of the result following a conversion in 12-bit, 10-bit or 8-bit mode.

	7	6	5	4	3	2	1	0
R W	ADCV7	ADCV6	ADCV5	ADCV4	ADCV3	ADCV2	ADCV1	ADCV0
Reset:	0	0	0	0	0	0	0	0

Figure 10-8. Compare Value Low Register (ADCCVL)

10.3.7 Configuration Register (ADCCFG)

ADCCFG selects the mode of operation, clock source, clock divide, and configures for low power and long sample time.

	7	6	5	4	3	2	1	0
R W	ADLPC	ADIV		ADLSMP	MODE		ADICLK	
Reset:	0	0	0	0	0	0	0	0

Figure 10-9. Configuration Register (ADCCFG)

Table 10-6. ADCCFG Register Field Descriptions

Field	Description
7 ADLPC	Low-Power Configuration. ADLPC controls the speed and power configuration of the successive approximation converter. This optimizes power consumption when higher sample rates are not required. 0 High speed configuration 1 Low power configuration: The power is reduced at the expense of maximum clock speed.
6:5 ADIV	Clock Divide Select. ADIV selects the divide ratio used by the ADC to generate the internal clock ADCK. Table 10-7 shows the available clock configurations.
4 ADLSMP	Long Sample Time Configuration. ADLSMP selects between long and short sample time. This adjusts the sample period to allow higher impedance inputs to be accurately sampled or to maximize conversion speed for lower impedance inputs. Longer sample times can also be used to lower overall power consumption when continuous conversions are enabled if high conversion rates are not required. 0 Short sample time 1 Long sample time

Table 10-11. APCTL2 Register Field Descriptions

Field	Description
7 ADPC15	ADC Pin Control 15. ADPC15 controls the pin associated with channel AD15. 0 AD15 pin I/O control enabled 1 AD15 pin I/O control disabled
6 ADPC14	ADC Pin Control 14. ADPC14 controls the pin associated with channel AD14. 0 AD14 pin I/O control enabled 1 AD14 pin I/O control disabled
5 ADPC13	ADC Pin Control 13. ADPC13 controls the pin associated with channel AD13. 0 AD13 pin I/O control enabled 1 AD13 pin I/O control disabled
4 ADPC12	ADC Pin Control 12. ADPC12 controls the pin associated with channel AD12. 0 AD12 pin I/O control enabled 1 AD12 pin I/O control disabled
3 ADPC11	ADC Pin Control 11. ADPC11 controls the pin associated with channel AD11. 0 AD11 pin I/O control enabled 1 AD11 pin I/O control disabled
2 ADPC10	ADC Pin Control 10. ADPC10 controls the pin associated with channel AD10. 0 AD10 pin I/O control enabled 1 AD10 pin I/O control disabled
1 ADPC9	ADC Pin Control 9. ADPC9 controls the pin associated with channel AD9. 0 AD9 pin I/O control enabled 1 AD9 pin I/O control disabled
0 ADPC8	ADC Pin Control 8. ADPC8 controls the pin associated with channel AD8. 0 AD8 pin I/O control enabled 1 AD8 pin I/O control disabled

10.3.10 Pin Control 3 Register (APCTL3)

APCTL3 controls channels 16–23 of the ADC module.

	7	6	5	4	3	2	1	0
R W	ADPC23	ADPC22	ADPC21	ADPC20	ADPC19	ADPC18	ADPC17	ADPC16
Reset:	0	0	0	0	0	0	0	0

Figure 10-12. Pin Control 3 Register (APCTL3)

10.6.1.3 Analog Input Pins

The external analog inputs are typically shared with digital I/O pins on MCU devices. The pin I/O control is disabled by setting the appropriate control bit in one of the pin control registers. Conversions can be performed on inputs without the associated pin control register bit set. It is recommended that the pin control register bit always be set when using a pin as an analog input. This avoids problems with contention because the output buffer is in its high impedance state and the pullup is disabled. Also, the input buffer draws DC current when its input is not at V_{DD} or V_{SS}. Setting the pin control register bits for all pins used as analog inputs should be done to achieve lowest operating current.

Empirical data shows that capacitors on the analog inputs improve performance in the presence of noise or when the source impedance is high. Use of 0.01 µF capacitors with good high-frequency characteristics is sufficient. These capacitors are not necessary in all cases, but when used they must be placed as near as possible to the package pins and be referenced to V_{SSA}.

For proper conversion, the input voltage must fall between V_{REFH} and V_{REFL}. If the input is equal to or exceeds V_{REFH}, the converter circuit converts the signal to 0xFFF (full scale 12-bit representation), 0x3FF (full scale 10-bit representation) or 0xFF (full scale 8-bit representation). If the input is equal to or less than V_{REFL}, the converter circuit converts it to 0x000. Input voltages between V_{REFH} and V_{REFL} are straight-line linear conversions. There is a brief current associated with V_{REFL} when the sampling capacitor is charging. The input is sampled for 3.5 cycles of the ADCK source when ADLSMP is low, or 23.5 cycles when ADLSMP is high.

For minimal loss of accuracy due to current injection, pins adjacent to the analog input pins should not be transitioning during conversions.

10.6.2 Sources of Error

Several sources of error exist for A/D conversions. These are discussed in the following sections.

10.6.2.1 Sampling Error

For proper conversions, the input must be sampled long enough to achieve the proper accuracy. Given the maximum input resistance of approximately 7kΩ and input capacitance of approximately 5.5 pF, sampling to within 1/4LSB (at 12-bit resolution) can be achieved within the minimum sample window (3.5 cycles @ 8 MHz maximum ADCK frequency) provided the resistance of the external analog source (R_{AS}) is kept below 2 kΩ.

Higher source resistances or higher-accuracy sampling is possible by setting ADLSMP (to increase the sample window to 23.5 cycles) or decreasing ADCK frequency to increase sample time.

10.6.2.2 Pin Leakage Error

Leakage on the I/O pins can cause conversion error if the external analog source resistance (R_{AS}) is high. If this error cannot be tolerated by the application, keep R_{AS} lower than $V_{DDAD} / (2^N * I_{LEAK})$ for less than 1/4LSB leakage error (N = 8 in 8-bit, 10 in 10-bit or 12 in 12-bit mode).

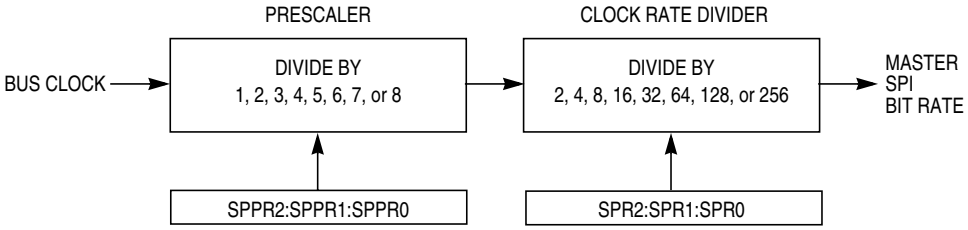


Figure 12-4. SPI Baud Rate Generation

12.2 External Signal Description

The SPI optionally shares four port pins. The function of these pins depends on the settings of SPI control bits. When the SPI is disabled (SPE = 0), these four pins revert to being general-purpose port I/O pins that are not controlled by the SPI.

12.2.1 SPSCK — SPI Serial Clock

When the SPI is enabled as a slave, this pin is the serial clock input. When the SPI is enabled as a master, this pin is the serial clock output.

12.2.2 MOSI — Master Data Out, Slave Data In

When the SPI is enabled as a master and SPI pin control zero (SPC0) is 0 (not bidirectional mode), this pin is the serial data output. When the SPI is enabled as a slave and SPC0 = 0, this pin is the serial data input. If SPC0 = 1 to select single-wire bidirectional mode, and master mode is selected, this pin becomes the bidirectional data I/O pin (MOMI). Also, the bidirectional mode output enable bit determines whether the pin acts as an input (BIDIROE = 0) or an output (BIDIROE = 1). If SPC0 = 1 and slave mode is selected, this pin is not used by the SPI and reverts to being a general-purpose port I/O pin.

12.2.3 MISO — Master Data In, Slave Data Out

When the SPI is enabled as a master and SPI pin control zero (SPC0) is 0 (not bidirectional mode), this pin is the serial data input. When the SPI is enabled as a slave and SPC0 = 0, this pin is the serial data output. If SPC0 = 1 to select single-wire bidirectional mode, and slave mode is selected, this pin becomes the bidirectional data I/O pin (SISO) and the bidirectional mode output enable bit determines whether the pin acts as an input (BIDIROE = 0) or an output (BIDIROE = 1). If SPC0 = 1 and master mode is selected, this pin is not used by the SPI and reverts to being a general-purpose port I/O pin.

12.2.4 $\overline{SS}$ — Slave Select

When the SPI is enabled as a slave, this pin is the low-true slave select input. When the SPI is enabled as a master and mode fault enable is off (MODFEN = 0), this pin is not used by the SPI and reverts to being a general-purpose port I/O pin. When the SPI is enabled as a master and MODFEN = 1, the slave select output enable bit determines whether this pin acts as the mode fault input (SSOE = 0) or as the slave select output (SSOE = 1).

Table 12-1. SPIC1 Field Descriptions (continued)

Field	Description
4 MSTR	**Master/Slave Mode Select** 0 SPI module configured as a slave SPI device 1 SPI module configured as a master SPI device
3 CPOL	**Clock Polarity** — This bit effectively places an inverter in series with the clock signal from a master SPI or to a slave SPI device. Refer to Section 12.5.1, “SPI Clock Formats” for more details. 0 Active-high SPI clock (idles low) 1 Active-low SPI clock (idles high)
2 CPHA	**Clock Phase** — This bit selects one of two clock formats for different kinds of synchronous serial peripheral devices. Refer to Section 12.5.1, “SPI Clock Formats” for more details. 0 First edge on SPSCK occurs at the middle of the first cycle of an 8-cycle data transfer 1 First edge on SPSCK occurs at the start of the first cycle of an 8-cycle data transfer
1 SSOE	**Slave Select Output Enable** — This bit is used in combination with the mode fault enable (MODFEN) bit in SPCR2 and the master/slave (MSTR) control bit to determine the function of the $\overline{SS}$ pin as shown in Table 12-2.
0 LSBFE	**LSB First (Shifter Direction)** 0 SPI serial data transfers start with most significant bit 1 SPI serial data transfers start with least significant bit

Table 12-2. $\overline{SS}$ Pin Function

MODFEN	SSOE	Master Mode	Slave Mode
0	0	General-purpose I/O (not SPI)	Slave select input
0	1	General-purpose I/O (not SPI)	Slave select input
1	0	$\overline{SS}$ input for mode fault	Slave select input
1	1	Automatic $\overline{SS}$ output	Slave select input

NOTE

Ensure that the SPI should not be disabled (SPE=0) at the same time as a bit change to the CPHA bit. These changes should be performed as separate operations or unexpected behavior may occur.

12.4.2 SPI Control Register 2 (SPIC2)

This read/write register is used to control optional features of the SPI system. Bits 7, 6, 5, and 2 are not implemented and always read 0.

	7	6	5	4	3	2	1	0
R	0	0	0	MODFEN	BIDIROE	0	SPISWAI	SPC0
W								
Reset	0	0	0	0	0	0	0	0

= Unimplemented or Reserved

Figure 12-6. SPI Control Register 2 (SPIC2)

Chapter 13
Serial Communications Interface (S08SCIV4)

13.1 Introduction

All MCUs in the MC9S08DN60 Series include SCI1.

NOTE

- MC9S08DN60 Series devices operate at a higher voltage range (2.7 V to 5.5 V) and do not include stop1 mode. Please ignore references to stop1.
- The RxD1 pin does not contain a clamp diode to V_{DD} and should not be driven above V_{DD}. The voltage measured on the internally pulled up RxD1 pin may be as low as $V_{DD} – 0.7$ V. The internal gates connected to this pin are pulled all the way to V_{DD}.

16.4.3.7 Debug Control Register (DBGC)

This register can be read or written at any time.

	7	6	5	4	3	2	1	0
R W	DBGEN	ARM	TAG	BRKEN	RWA	RWAEN	RWB	RWBEN
Reset	0	0	0	0	0	0	0	0

Figure 16-7. Debug Control Register (DBGC)

Table 16-4. DBGC Register Field Descriptions

Field	Description
7 DBGEN	**Debug Module Enable** — Used to enable the debug module. DBGEN cannot be set to 1 if the MCU is secure. 0 DBG disabled 1 DBG enabled
6 ARM	**Arm Control** — Controls whether the debugger is comparing and storing information in the FIFO. A write is used to set this bit (and ARMF) and completion of a debug run automatically clears it. Any debug run can be manually stopped by writing 0 to ARM or to DBGEN. 0 Debugger not armed 1 Debugger armed
5 TAG	**Tag/Force Select** — Controls whether break requests to the CPU will be tag or force type requests. If BRKEN = 0, this bit has no meaning or effect. 0 CPU breaks requested as force type requests 1 CPU breaks requested as tag type requests
4 BRKEN	**Break Enable** — Controls whether a trigger event will generate a break request to the CPU. Trigger events can cause information to be stored in the FIFO without generating a break request to the CPU. For an end trace, CPU break requests are issued to the CPU when the comparator(s) and R/W meet the trigger requirements. For a begin trace, CPU break requests are issued when the FIFO becomes full. TRGSEL does not affect the timing of CPU break requests. 0 CPU break requests not enabled 1 Triggers cause a break request to the CPU
3 RWA	**R/W Comparison Value for Comparator A** — When RWAEN = 1, this bit determines whether a read or a write access qualifies comparator A. When RWAEN = 0, RWA and the R/W signal do not affect comparator A. 0 Comparator A can only match on a write cycle 1 Comparator A can only match on a read cycle
2 RWAEN	**Enable R/W for Comparator A** — Controls whether the level of R/W is considered for a comparator A match. 0 R/W is not used in comparison A 1 R/W is used in comparison A
1 RWB	**R/W Comparison Value for Comparator B** — When RWBEN = 1, this bit determines whether a read or a write access qualifies comparator B. When RWBEN = 0, RWB and the R/W signal do not affect comparator B. 0 Comparator B can match only on a write cycle 1 Comparator B can match only on a read cycle
0 RWBEN	**Enable R/W for Comparator B** — Controls whether the level of R/W is considered for a comparator B match. 0 R/W is not used in comparison B 1 R/W is used in comparison B

16.4.3.8 Debug Trigger Register (DBGT)

This register can be read any time, but may be written only if ARM = 0, except bits 4 and 5 are hard-wired to 0s.

	7	6	5	4	3	2	1	0
R	TRGSEL	BEGIN	0	0	TRG3	TRG2	TRG1	TRG0
W								
Reset	0	0	0	0	0	0	0	0

= Unimplemented or Reserved

Figure 16-8. Debug Trigger Register (DBGT)

Table 16-5. DBGT Register Field Descriptions

Field	Description
7 TRGSEL	**Trigger Type** — Controls whether the match outputs from comparators A and B are qualified with the opcode tracking logic in the debug module. If TRGSEL is set, a match signal from comparator A or B must propagate through the opcode tracking logic and a trigger event is only signalled to the FIFO logic if the opcode at the match address is actually executed. 0 Trigger on access to compare address (force) 1 Trigger if opcode at compare address is executed (tag)
6 BEGIN	**Begin/End Trigger Select** — Controls whether the FIFO starts filling at a trigger or fills in a circular manner until a trigger ends the capture of information. In event-only trigger modes, this bit is ignored and all debug runs are assumed to be begin traces. 0 Data stored in FIFO until trigger (end trace) 1 Trigger initiates data storage (begin trace)
3:0 TRG[3:0]	**Select Trigger Mode** — Selects one of nine triggering modes, as described below. 0000 A-only 0001 A OR B 0010 A Then B 0011 Event-only B (store data) 0100 A then event-only B (store data) 0101 A AND B data (full mode) 0110 A AND NOT B data (full mode) 0111 Inside range: A ≤ address ≤ B 1000 Outside range: address < A or address > B 1001 – 1111 (No trigger)

A.6 DC Characteristics

This section includes information about power supply requirements, I/O pin characteristics, and power supply current in various operating modes.

Table A-6. DC Characteristics

Num	C	Characteristic	Symbol	Condition	Min	Typ[1]	Max	Unit
1	—	Operating Voltage	V_{DD}		2.7	—	5.5	V
2	P	Output high voltage — All I/O pins, low-drive strength	V_{OH}	5 V, I_{Load} = –2 mA	V_{DD} – 1.5	—	—	V
	C			3 V, I_{Load} = –0.6 mA	V_{DD} – 1.5	—	—	
	C			5 V, I_{Load} = –0.4 mA	V_{DD} – 0.8	—	—	
	C			3 V, I_{Load} = –0.24 mA	V_{DD} – 0.8	—	—	
	P	Output high voltage — All I/O pins, high-drive strength		5 V, I_{Load} = –10 mA	V_{DD} – 1.5	—	—	
	C			3 V, I_{Load} = –3 mA	V_{DD} – 1.5	—	—	
	C			5 V, I_{Load} = –2 mA	V_{DD} – 0.8	—	—	
	C			3 V, I_{Load} = –0.4 mA	V_{DD} – 0.8	—	—	
3	C	Output high current — Max total I_{OH} for all ports	I_{OHT}	5 V	0	—	-100	mA
				3 V	0	—	-60	
4	P	Output low voltage — All I/O pins, low-drive strength	V_{OL}	5 V, I_{Load} = 2 mA	—	—	1.5	V
	C			3 V, I_{Load} = 0.6 mA	—	—	1.5	
	C			5 V, I_{Load} = 0.4 mA	—	—	0.8	
	C			3 V, I_{Load} = 0.24 mA	—	—	0.8	
	P	Output low voltage — All I/O pins, high-drive strength		5 V, I_{Load} = 10 mA	—	—	1.5	
	C			3 V, I_{Load} = 3 mA	—	—	1.5	
	C			5 V, I_{Load} = 2 mA	—	—	0.8	
	C			3 V, I_{Load} = 0.4 mA	—	—	0.8	
5	C	Output low current — Max total I_{OL} for all ports	I_{OLT}	5 V	0	—	100	mA
				3 V	0	—	60	
6	C	Input high voltage; all digital inputs	V_{IH}	5V	0.65 x V_{DD}	—	—	V
7	C	Input low voltage; all digital inputs	V_{IL}	5V	—	—	0.35 x V_{DD}	
8	C	Input hysteresis	V_{hys}		0.06 x V_{DD}			mV
9	P	Input leakage current (Per pin) all input only pins	$\lvert I_{In} \rvert$	V_{In} = V_{DD} or V_{SS}	—	0.1	1	µA
10	P	Hi-Z (off-state) leakage current (per pin) all input/output	$\lvert I_{OZ} \rvert$	V_{In} = V_{DD} or V_{SS}	—	0.1	1	µA
11	P	Pullup resistors (or Pulldown[2] resistors when enabled)	R_{PU}, R_{PD}	5 V	20	45	65	kΩ
	C			3 V	20	45	65	
12	T	Input Capacitance, all pins	C_{In}		—	—	8	pF
13	D	RAM retention voltage	V_{RAM}		—	0.6	1.0	V

Table B-5. Mode, Edge, and Level Selection

CPWMS	MSnB:MSnA	ELSnB:ELSnA	Mode	Configuration
X	XX	00	Pin not used for TPM channel; use as an external clock for the TPM or revert to general-purpose I/O	
0	00	01	Input capture	Capture on rising edge only
		10		Capture on falling edge only
		11		Capture on rising or falling edge
	01	00	Output compare	Software compare only
		01		Toggle output on compare
		10		Clear output on compare
		11		Set output on compare
	1X	10	Edge-aligned PWM	High-true pulses (clear output on compare)
		X1		Low-true pulses (set output on compare)
1	XX	10	Center-aligned PWM	High-true pulses (clear output on compare-up)
		X1		Low-true pulses (set output on compare-up)

If the associated port pin is not stable for at least two bus clock cycles before changing to input capture mode, it is possible to get an unexpected indication of an edge trigger. Typically, a program would clear status flags after changing channel configuration bits and before enabling channel interrupts or using the status flags to avoid any unexpected behavior.

B.2.5 Timer Channel Value Registers (TPMxCnVH:TPMxCnVL)

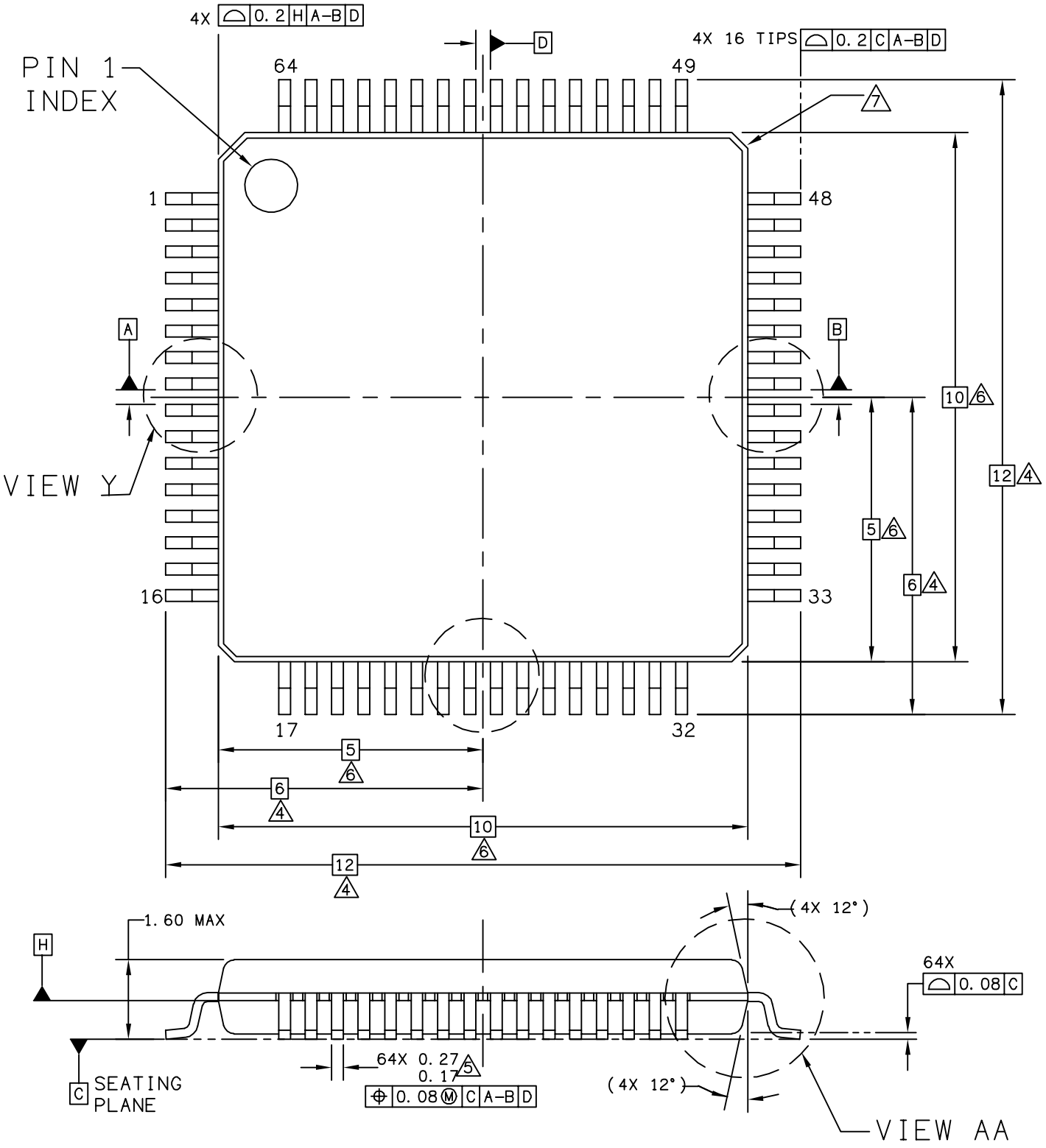
These read/write registers contain the captured TPM counter value of the input capture function or the output compare value for the output compare or PWM functions. The channel value registers are cleared by reset.

	7	6	5	4	3	2	1	0
R W	Bit 15	14	13	12	11	10	9	Bit 8
Reset	0	0	0	0	0	0	0	0

Figure B-8. Timer Channel Value Register High (TPMxCnVH)

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

Figure B-9. Timer Channel Value Register Low (TPMxCnVL)



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