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Applications of "Embedded - Microcontrollers"

Details	
Product Status	Obsolete
Core Processor	HCS12
Core Size	16-Bit
Speed	25MHz
Connectivity	CANbus, EBI/EMI, SCI, SPI
Peripherals	POR, PWM, WDT
Number of I/O	60
Program Memory Size	32KB (32K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	2K x 8
Voltage - Supply (Vcc/Vdd)	2.35V ~ 5.5V
Data Converters	A/D 8x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 125°C (TA)
Mounting Type	Surface Mount
Package / Case	80-QFP
Supplier Device Package	80-QFP (14x14)
Purchase URL	https://www.e-xfl.com/product-detail/nxp-semiconductors/mc9s12c32mfue25r

0x001A–0x001B Miscellaneous Peripherals (Device User Guide)

Address	Name		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x001A	PARTIDH	Read:	ID15	ID14	ID13	ID12	ID11	ID10	ID9	ID8
		Write:								
0x001B	PARTIDL	Read:	ID7	ID6	ID5	ID4	ID3	ID2	ID1	ID0
		Write:								

0x001C–0x001D MMC Map 3 of 4 (HCS12 Module Mapping Control, Device User Guide)

Address	Name		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x001C	MEMSIZ0	Read:	reg_sw0	0	eep_sw1	eep_sw0	0	ram_sw2	ram_sw1	ram_sw0
		Write:								
0x001D	MEMSIZ1	Read:	rom_sw1	rom_sw0	0	0	0	0	pag_sw1	pag_sw0
		Write:								

0x001E–0x001E MEBI Map 2 of 3 (HCS12 Multiplexed External Bus Interface)

Address	Name		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x001E	INTCR	Read:	IRQE	IRQEN	0	0	0	0	0	0
		Write:								

0x001F–0x001F INT Map 2 of 2 (HCS12 Interrupt)

Address	Name		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x001F	HPRIO	Read:	PSEL7	PSEL6	PSEL5	PSEL4	PSEL3	PSEL2	PSEL1	0
		Write:								

0x0020–0x002F DBG (Including BKP) Map 1 of 1 (HCS12 Debug)

Address	Name		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x0020	DBGC1	Read:	DBGEN	ARM	TRGSEL	BEGIN	DBGBRK	0	CAPMOD	
		Write:								
0x0021	DBGSC	Read:	AF	BF	CF	0	TRG			
		Write:								
0x0022	DBGTBH	Read:	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
		Write:								
0x0023	DBGTBL	Read:	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
		Write:								
0x0024	DBGCNT	Read:	TBF	0	CNT					
		Write:								
0x0025	DBGCCX	Read:	PAGSEL		EXTCMP					
		Write:								

Table 4-1. External System Pins Associated With MEBI (continued)

Pin Name	Pin Functions	Description
PE4/ECLK	PE4	General-purpose I/O pin, see PORTE and DDRE registers.
	ECLK	Bus timing reference clock, can operate as a free-running clock at the system clock rate or to produce one low-high clock per visible access, with the high period stretched for slow accesses. ECLK is controlled by the NECLK bit in PEAR, the IVIS bit in MODE, and the ESTR bit in EBICTL.
PE3/$\overline{\text{LSTRB}}$/ $\overline{\text{TAGLO}}$	PE3	General-purpose I/O pin, see PORTE and DDRE registers.
	$\overline{\text{LSTRB}}$	Low strobe bar, 0 indicates valid data on D7–D0.
	SZ8	In special peripheral mode, this pin is an input indicating the size of the data transfer (0 = 16-bit; 1 = 8-bit).
	$\overline{\text{TAGLO}}$	In expanded wide mode or emulation narrow modes, when instruction tagging is on and low strobe is enabled, a 0 at the falling edge of E tags the low half of the instruction word being read into the instruction queue.
PE2/R/$\overline{\text{W}}$	PE2	General-purpose I/O pin, see PORTE and DDRE registers.
	R/$\overline{\text{W}}$	Read/write, indicates the direction of internal data transfers. This is an output except in special peripheral mode where it is an input.
PE1/$\overline{\text{IRQ}}$	PE1	General-purpose input-only pin, can be read even if $\overline{\text{IRQ}}$ enabled.
	$\overline{\text{IRQ}}$	Maskable interrupt request, can be level sensitive or edge sensitive.
PE0/$\overline{\text{XIRQ}}$	PE0	General-purpose input-only pin.
	$\overline{\text{XIRQ}}$	Non-maskable interrupt input.
PK7/$\overline{\text{ECS}}$	PK7	General-purpose I/O pin, see PORTK and DDRK registers.
	$\overline{\text{ECS}}$	Emulation chip select
PK6/$\overline{\text{XCS}}$	PK6	General-purpose I/O pin, see PORTK and DDRK registers.
	$\overline{\text{XCS}}$	External data chip select
PK5/X19 thru PK0/X14	PK5–PK0	General-purpose I/O pins, see PORTK and DDRK registers.
	X19–X14	Memory expansion addresses

Detailed descriptions of these pins can be found in the device overview chapter.

4.3 Memory Map and Register Definition

A summary of the registers associated with the MEBI sub-block is shown in Table 4-2. Detailed descriptions of the registers and bits are given in the subsections that follow. On most chips the registers are mappable. Therefore, the upper bits may not be all 0s as shown in the table and descriptions.

6.3.2 Register Descriptions

Register Name		Bit 7	6	5	4	3	2	1	Bit 0
0xFF00 Reserved	R	X	X	X	X	X	X	0	0
	W								
0xFF01 BDMSTS	R	ENBDM	BDMACT	ENTAG	SDV	TRACE	CLKSW	UNSEC	0
	W								
0xFF02 Reserved	R	X	X	X	X	X	X	X	X
	W								
0xFF03 Reserved	R	X	X	X	X	X	X	X	X
	W								
0xFF04 Reserved	R	X	X	X	X	X	X	X	X
	W								
0xFF05 Reserved	R	X	X	X	X	X	X	X	X
	W								
0xFF06 BDMCCR	R	CCR7	CCR6	CCR5	CCR4	CCR3	CCR2	CCR1	CCR0
	W								
0xFF07 BDMINR	R	0	REG14	REG13	REG12	REG11	0	0	0
	W								
0xFF08 Reserved	R	0	0	0	0	0	0	0	0
	W								
0xFF09 Reserved	R	0	0	0	0	0	0	0	0
	W								
0xFF0A Reserved	R	X	X	X	X	X	X	X	X
	W								
0xFF0B Reserved	R	X	X	X	X	X	X	X	X
	W								

= Unimplemented, Reserved
X = Indeterminate
= Implemented (do not alter)
0 = Always read zero

Figure 6-2. BDM Register Summary

Table 7-14. DBGC2 Field Descriptions (continued)

Field	Description
4 TAGAB	**Comparator A/B Tag Select** — This bit controls whether the breakpoint will cause a break on the next instruction boundary (force) or on a match that will be an executable opcode (tagged). Non-executed opcodes cannot cause a tagged breakpoint. 0 On match, break at the next instruction boundary (force) 1 On match, break if/when the instruction is about to be executed (tagged)
3 BKCEN	**Breakpoint Comparator C Enable Bit** — This bit enables the breakpoint capability using comparator C. 0 Comparator C disabled for breakpoint 1 Comparator C enabled for breakpoint **Note:** This bit will be cleared automatically when the DBG module is armed in loop1 mode.
2 TAGC	**Comparator C Tag Select** — This bit controls whether the breakpoint will cause a break on the next instruction boundary (force) or on a match that will be an executable opcode (tagged). Non-executed opcodes cannot cause a tagged breakpoint. 0 On match, break at the next instruction boundary (force) 1 On match, break if/when the instruction is about to be executed (tagged)
1 RWCEN	**Read/Write Comparator C Enable Bit** — The RWCEN bit controls whether read or write comparison is enabled for comparator C. RWCEN is not useful for tagged breakpoints. 0 Read/Write is not used in comparison 1 Read/Write is used in comparison
0 RWC	**Read/Write Comparator C Value Bit** — The RWC bit controls whether read or write is used in compare for comparator C. The RWC bit is not used if RWCEN = 0. 0 Write cycle will be matched 1 Read cycle will be matched

7.3.2.8 Debug Control Register 3 (DBGC3)

Module Base + 0x0029
Starting address location affected by INITRG register setting.

	7	6	5	4	3	2	1	0
R W	BKAMBH(1)	BKAMBL1	BKBMBH(2)	BKBMBL2	RWAEN	RWA	RWBEN	RWB
Reset	0	0	0	0	0	0	0	0

1. In DBG mode, BKAMBH:BKAMBL has no meaning and are forced to 0's.
2. In DBG mode, BKBMBH:BKBMBL are used in full mode to qualify data.

Figure 7-14. Debug Control Register 3 (DBGC3)

Table 8-8. Clock Prescaler Values

Prescale Value	Total Divisor Value	Maximum Bus Clock[1]	Minimum Bus Clock[2]
00000	Divide by 2	4 MHz	1 MHz
00001	Divide by 4	8 MHz	2 MHz
00010	Divide by 6	12 MHz	3 MHz
00011	Divide by 8	16 MHz	4 MHz
00100	Divide by 10	20 MHz	5 MHz
00101	Divide by 12	24 MHz	6 MHz
00110	Divide by 14	28 MHz	7 MHz
00111	Divide by 16	32 MHz	8 MHz
01000	Divide by 18	36 MHz	9 MHz
01001	Divide by 20	40 MHz	10 MHz
01010	Divide by 22	44 MHz	11 MHz
01011	Divide by 24	48 MHz	12 MHz
01100	Divide by 26	52 MHz	13 MHz
01101	Divide by 28	56 MHz	14 MHz
01110	Divide by 30	60 MHz	15 MHz
01111	Divide by 32	64 MHz	16 MHz
10000	Divide by 34	68 MHz	17 MHz
10001	Divide by 36	72 MHz	18 MHz
10010	Divide by 38	76 MHz	19 MHz
10011	Divide by 40	80 MHz	20 MHz
10100	Divide by 42	84 MHz	21 MHz
10101	Divide by 44	88 MHz	22 MHz
10110	Divide by 46	92 MHz	23 MHz
10111	Divide by 48	96 MHz	24 MHz
11000	Divide by 50	100 MHz	25 MHz
11001	Divide by 52	104 MHz	26 MHz
11010	Divide by 54	108 MHz	27 MHz
11011	Divide by 56	112 MHz	28 MHz
11100	Divide by 58	116 MHz	29 MHz
11101	Divide by 60	120 MHz	30 MHz
11110	Divide by 62	124 MHz	31 MHz
11111	Divide by 64	128 MHz	32 MHz

1. Maximum ATD conversion clock frequency is 2 MHz. The maximum allowed bus clock frequency is shown in this column.
2. Minimum ATD conversion clock frequency is 500 kHz. The minimum allowed bus clock frequency is shown in this column.

8.3.2.11 ATD Input Enable Register (ATDDIEN)

Module Base + 0x000D

	7	6	5	4	3	2	1	0
R W	IEN7	IEN6	IEN5	IEN4	IEN3	IEN2	IEN1	IEN0
Reset	0	0	0	0	0	0	0	0

Figure 8-13. ATD Input Enable Register (ATDDIEN)

Read: Anytime

Write: Anytime

Table 8-17. ATDDIEN Field Descriptions

Field	Description
7–0 IEN[7:0]	**ATD Digital Input Enable on channel x (x = 7, 6, 5, 4, 3, 2, 1, 0)** — This bit controls the digital input buffer from the analog input pin (ANx) to PTADx data register. 0 Disable digital input buffer to PTADx 1 Enable digital input buffer to PTADx. **Note:** Setting this bit will enable the corresponding digital input buffer continuously. If this bit is set while simultaneously using it as an analog port, there is potentially increased power consumption because the digital input buffer maybe in the linear region.

message in its RxBG (wrong identifier, transmission errors, etc.) the actual contents of the buffer will be over-written by the next message. The buffer will then not be shifted into the FIFO.

When the MSCAN module is transmitting, the MSCAN receives its own transmitted messages into the background receive buffer, RxBG, but does not shift it into the receiver FIFO, generate a receive interrupt, or acknowledge its own messages on the CAN bus. The exception to this rule is in loopback mode (see Section 10.3.2.2, "MSCAN Control Register 1 (CANCTL1)") where the MSCAN treats its own messages exactly like all other incoming messages. The MSCAN receives its own transmitted messages in the event that it loses arbitration. If arbitration is lost, the MSCAN must be prepared to become a receiver.

An overrun condition occurs when all receive message buffers in the FIFO are filled with correctly received messages with accepted identifiers and another message is correctly received from the CAN bus with an accepted identifier. The latter message is discarded and an error interrupt with overrun indication is generated if enabled (see Section 10.4.7.5, "Error Interrupt"). The MSCAN remains able to transmit messages while the receiver FIFO being filled, but all incoming messages are discarded. As soon as a receive buffer in the FIFO is available again, new valid messages will be accepted.

10.4.3 Identifier Acceptance Filter

The MSCAN identifier acceptance registers (see Section 10.3.2.12, "MSCAN Identifier Acceptance Control Register (CANIDAC)") define the acceptable patterns of the standard or extended identifier (ID[10:0] or ID[28:0]). Any of these bits can be marked 'don't care' in the MSCAN identifier mask registers (see Section 10.3.2.17, "MSCAN Identifier Mask Registers (CANIDMR0–CANIDMR7)").

A filter hit is indicated to the application software by a set receive buffer full flag (RXF = 1) and three bits in the CANIDAC register (see Section 10.3.2.12, "MSCAN Identifier Acceptance Control Register (CANIDAC)"). These identifier hit flags (IDHIT[2:0]) clearly identify the filter section that caused the acceptance. They simplify the application software's task to identify the cause of the receiver interrupt. If more than one hit occurs (two or more filters match), the lower hit has priority.

A very flexible programmable generic identifier acceptance filter has been introduced to reduce the CPU interrupt loading. The filter is programmable to operate in four different modes (see Bosch CAN 2.0A/B protocol specification):

- Two identifier acceptance filters, each to be applied to:
  - The full 29 bits of the extended identifier and to the following bits of the CAN 2.0B frame:
    - Remote transmission request (RTR)
    - Identifier extension (IDE)
    - Substitute remote request (SRR)
  - The 11 bits of the standard identifier plus the RTR and IDE bits of the CAN 2.0A/B messages[1]. This mode implements two filters for a full length CAN 2.0B compliant extended identifier. Figure 10-39 shows how the first 32-bit filter bank (CANIDAR0–CANIDAR3, CANIDMR0–CANIDMR3) produces a filter 0 hit. Similarly, the second filter bank (CANIDAR4–CANIDAR7, CANIDMR4–CANIDMR7) produces a filter 1 hit.
- Four identifier acceptance filters, each to be applied to

1. Although this mode can be used for standard identifiers, it is recommended to use the four or eight identifier acceptance filters for standard identifiers

Chapter 12
Pulse-Width Modulator (PWM8B6CV1) Block Description

12.1 Introduction

The pulse width modulation (PWM) definition is based on the HC12 PWM definitions. The PWM8B6CV1 module contains the basic features from the HC11 with some of the enhancements incorporated on the HC12, that is center aligned output mode and four available clock sources. The PWM8B6CV1 module has six channels with independent control of left and center aligned outputs on each channel.

Each of the six PWM channels has a programmable period and duty cycle as well as a dedicated counter. A flexible clock select scheme allows a total of four different clock sources to be used with the counters. Each of the modulators can create independent continuous waveforms with software-selectable duty rates from 0% to 100%. The PWM outputs can be programmed as left aligned outputs or center aligned outputs

12.1.1 Features

- Six independent PWM channels with programmable period and duty cycle
- Dedicated counter for each PWM channel
- Programmable PWM enable/disable for each channel
- Software selection of PWM duty pulse polarity for each channel
- Period and duty cycle are double buffered. Change takes effect when the end of the effective period is reached (PWM counter reaches 0) or when the channel is disabled.
- Programmable center or left aligned outputs on individual channels
- Six 8-bit channel or three 16-bit channel PWM resolution
- Four clock sources (A, B, SA, and SB) provide for a wide range of frequencies.
- Programmable clock select logic
- Emergency shutdown

12.1.2 Modes of Operation

There is a software programmable option for low power consumption in wait mode that disables the input clock to the prescaler.

In freeze mode there is a software programmable option to disable the input clock to the prescaler. This is useful for emulation.

12.1.3 Block Diagram

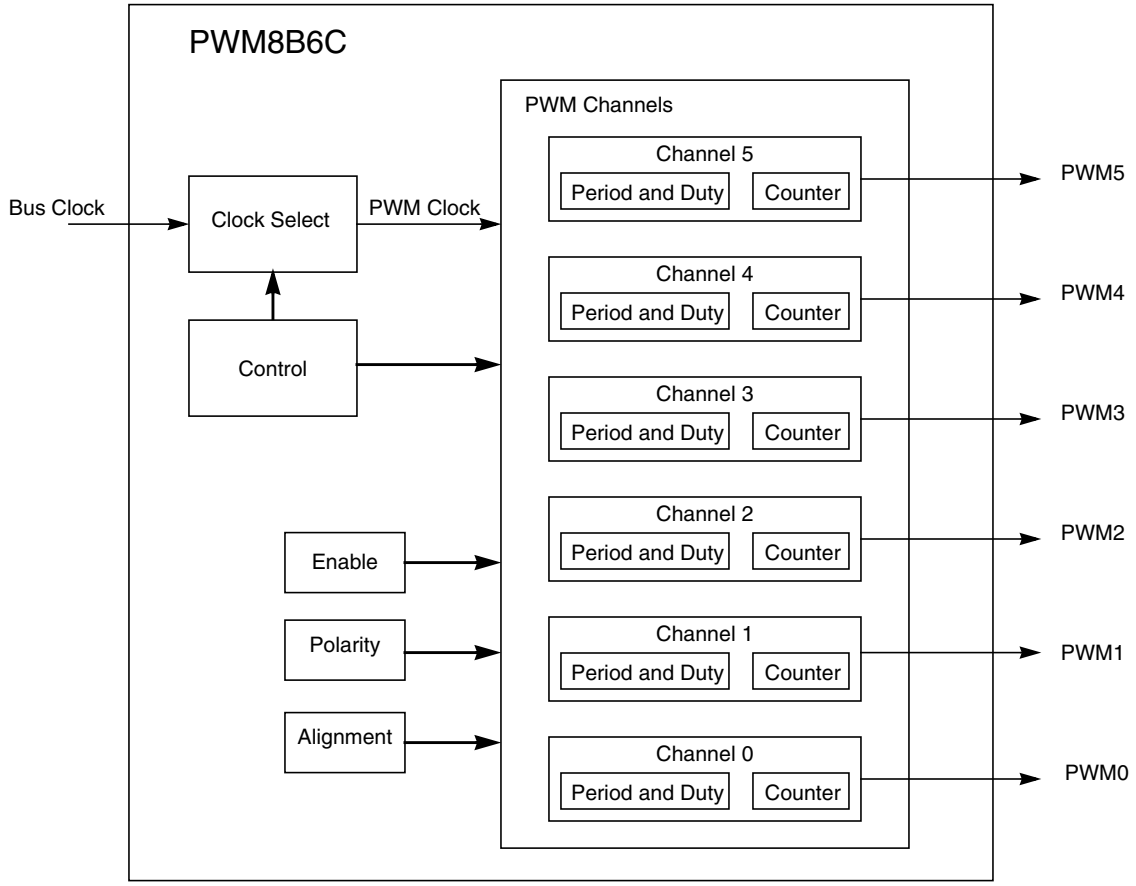

Figure 12-1. PWM8B6CV1 Block Diagram

12.2 External Signal Description

The PWM8B6CV1 module has a total of six external pins.

12.2.1 PWM5 — Pulse Width Modulator Channel 5 Pin

This pin serves as waveform output of PWM channel 5 and as an input for the emergency shutdown feature.

12.2.2 PWM4 — Pulse Width Modulator Channel 4 Pin

This pin serves as waveform output of PWM channel 4.

12.2.3 PWM3 — Pulse Width Modulator Channel 3 Pin

This pin serves as waveform output of PWM channel 3.

Module Base + 0x001B

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

Figure 12-30. PWM Channel Duty Registers (PWMDTY3)

Module Base + 0x001C

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

Figure 12-31. PWM Channel Duty Registers (PWMDTY4)

Module Base + 0x001D

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

Figure 12-32. PWM Channel Duty Registers (PWMDTY5)

Read: anytime

Write: anytime

12.3.2.15 PWM Shutdown Register (PWMSDN)

The PWMSDN register provides for the shutdown functionality of the PWM module in the emergency cases.

Module Base + 0x00E

	7	6	5	4	3	2	1	0
R	PWMIF	PWMIE	0	PWMLVL	0	PWM5IN	PWM5INL	PWM5ENA
W			PWMRSTRT					
Reset	0	0	0	0	0	0	0	0

= Unimplemented or Reserved

Figure 12-33. PWM Shutdown Register (PWMSDN)

Read: anytime

Write: anytime

Table 14-7. Example SPI Baud Rate Selection (25 MHz Bus Clock)

SPPR2	SPPR1	SPPR0	SPR2	SPR1	SPR0	Baud Rate Divisor	Baud Rate
0	0	0	0	0	0	2	12.5 MHz
0	0	0	0	0	1	4	6.25 MHz
0	0	0	0	1	0	8	3.125 MHz
0	0	0	0	1	1	16	1.5625 MHz
0	0	0	1	0	0	32	781.25 kHz
0	0	0	1	0	1	64	390.63 kHz
0	0	0	1	1	0	128	195.31 kHz
0	0	0	1	1	1	256	97.66 kHz
0	0	1	0	0	0	4	6.25 MHz
0	0	1	0	0	1	8	3.125 MHz
0	0	1	0	1	0	16	1.5625 MHz
0	0	1	0	1	1	32	781.25 kHz
0	0	1	1	0	0	64	390.63 kHz
0	0	1	1	0	1	128	195.31 kHz
0	0	1	1	1	0	256	97.66 kHz
0	0	1	1	1	1	512	48.83 kHz
0	1	0	0	0	0	6	4.16667 MHz
0	1	0	0	0	1	12	2.08333 MHz
0	1	0	0	1	0	24	1.04167 MHz
0	1	0	0	1	1	48	520.83 kHz
0	1	0	1	0	0	96	260.42 kHz
0	1	0	1	0	1	192	130.21 kHz
0	1	0	1	1	0	384	65.10 kHz
0	1	0	1	1	1	768	32.55 kHz
0	1	1	0	0	0	8	3.125 MHz
0	1	1	0	0	1	16	1.5625 MHz
0	1	1	0	1	0	32	781.25 kHz
0	1	1	0	1	1	64	390.63 kHz
0	1	1	1	0	0	128	195.31 kHz
0	1	1	1	0	1	256	97.66 kHz
0	1	1	1	1	0	512	48.83 kHz
0	1	1	1	1	1	1024	24.41 kHz
1	0	0	0	0	0	10	2.5 MHz
1	0	0	0	0	1	20	1.25 MHz
1	0	0	0	1	0	40	625 kHz
1	0	0	0	1	1	80	312.5 kHz
1	0	0	1	0	0	160	156.25 kHz
1	0	0	1	0	1	320	78.13 kHz
1	0	0	1	1	0	640	39.06 kHz

15.3.2.14 Timer Input Capture/Output Compare Registers High and Low 0–7 (TCxH and TCxL)

Module Base + 0x0010 = TC0H, 0x0012 = TC1H, 0x0014 = TC2H, 0x0016 = TC3H, 0x0018 = TC4H, 0x001A = TC5H, 0x001C = TC6H, 0x001E = TC7H

	15	14	13	12	11	10	9	0
R W	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
Reset	0	0	0	0	0	0	0	0

Figure 15-22. Timer Input Capture/Output Compare Register x High (TCxH)

Module Base + 0x0011 = TC0L, 0x0013 = TC1L, 0x0015 = TC2L, 0x0017 = TC3L, 0x0019 = TC4L, 0x001B = TC5L, 0x001D = TC6L, 0x001F = TC7L

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

Figure 15-23. Timer Input Capture/Output Compare Register x Low (TCxL)

Depending on the TIOS bit for the corresponding channel, these registers are used to latch the value of the free-running counter when a defined transition is sensed by the corresponding input capture edge detector or to trigger an output action for output compare.

Read: Anytime

Write: Anytime for output compare function.Writes to these registers have no meaning or effect during input capture. All timer input capture/output compare registers are reset to 0x0000.

NOTE

Read/Write access in byte mode for high byte should takes place before low byte otherwise it will give a different result.

Chapter 16
Dual Output Voltage Regulator (VREG3V3V2) Block Description

16.1 Introduction

The VREG3V3V2 is a dual output voltage regulator providing two separate 2.5 V (typical) supplies differing in the amount of current that can be sourced. The regulator input voltage range is from 3.3 V up to 5 V (typical).

16.1.1 Features

The block VREG3V3V2 includes these distinctive features:

- Two parallel, linear voltage regulators
  - — Bandgap reference
- Low-voltage detect (LVD) with low-voltage interrupt (LVI)
- Power-on reset (POR)
- Low-voltage reset (LVR)

16.1.2 Modes of Operation

There are three modes VREG3V3V2 can operate in:

- Full-performance mode (FPM) (MCU is not in stop mode)

  The regulator is active, providing the nominal supply voltage of 2.5 V with full current sourcing capability at both outputs. Features LVD (low-voltage detect), LVR (low-voltage reset), and POR (power-on reset) are available.
- Reduced-power mode (RPM) (MCU is in stop mode)

  The purpose is to reduce power consumption of the device. The output voltage may degrade to a lower value than in full-performance mode, additionally the current sourcing capability is substantially reduced. Only the POR is available in this mode, LVD and LVR are disabled.
- Shutdown mode

  Controlled by V_{REGEN} (see device overview chapter for connectivity of V_{REGEN}).

  This mode is characterized by minimum power consumption. The regulator outputs are in a high impedance state, only the POR feature is available, LVD and LVR are disabled.

  This mode must be used to disable the chip internal regulator VREG3V3V2, i.e., to bypass the VREG3V3V2 to use external supplies.

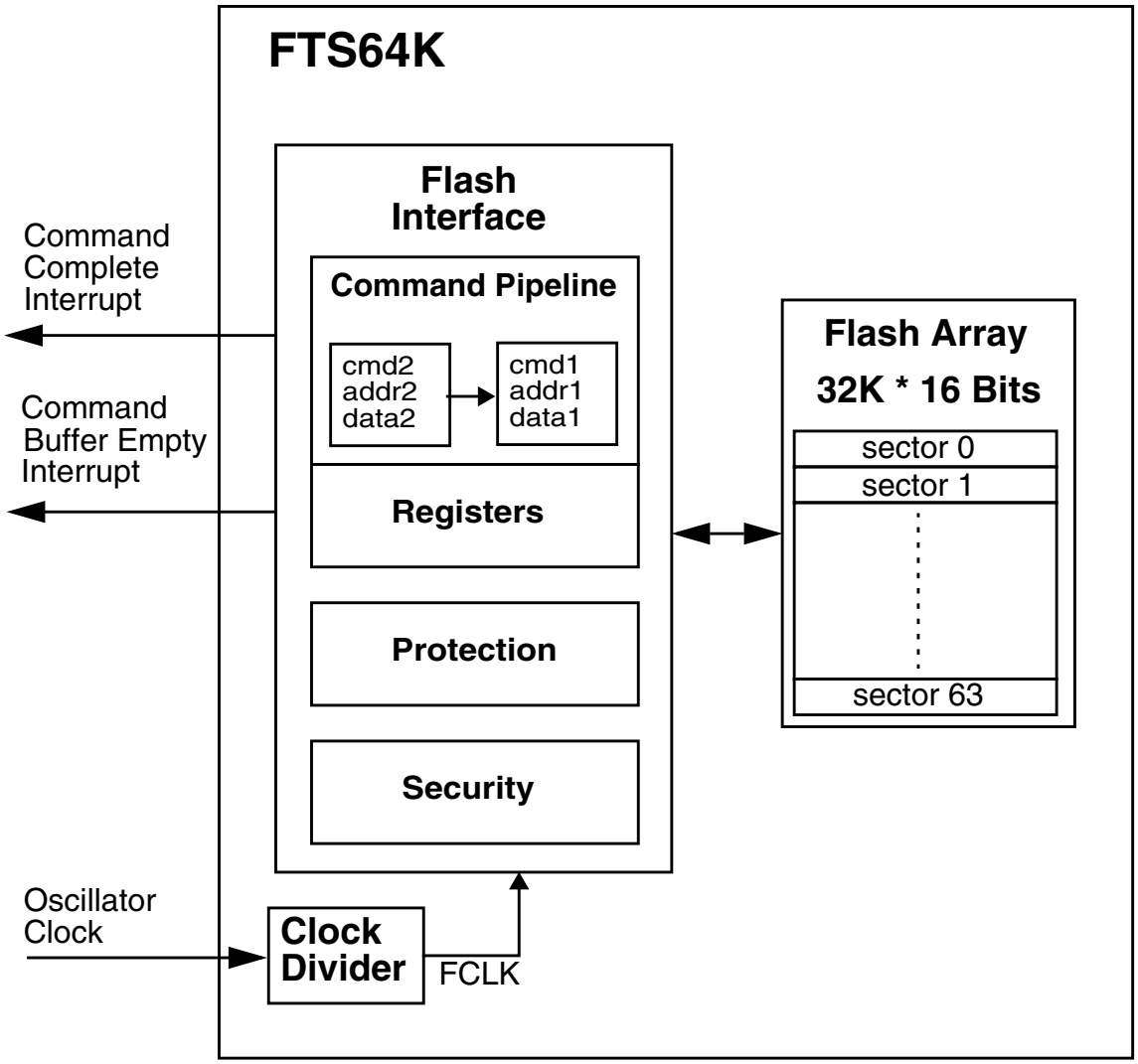

Figure 19-2. FTS64K Block Diagram

19.2 External Signal Description

The FTS128K1FTS64K module contains no signals that connect off-chip.

19.3 Memory Map and Registers

This section describes the FTS128K1FTS64K memory map and registers.

19.3.1 Module Memory Map

The FTS128K1FTS64K memory map is shown in Figure 19-3Figure 19-4. The HCS12 architecture places the Flash array addresses between 0x40000x4000 and 0xFFFF, which corresponds to three 16 Kbyte pages. The content of the HCS12 Core PPAGE register is used to map the logical middle page ranging from

19.3.2 Register Descriptions

The Flash module contains a set of 16 control and status registers located between module base + 0x0000 and 0x000F. A summary of the Flash module registers is given in Figure 19-5. Detailed descriptions of each register bit are provided.

Register Name		Bit 7	6	5	4	3	2	1	Bit 0
0x0000 FCLKDIV	R	FDIVLD	PRDIV8	FDIV5	FDIV4	FDIV3	FDIV2	FDIV1	FDIV0
	W								
0x0001 FSEC	R	KEYEN1	KEYEN0	NV5	NV4	NV3	NV2	SEC1	SEC0
	W								
0x0002 RESERVED1 (1)	R	0	0	0	0	0	0	0	0
	W								
0x0003 FCNFG	R	CBEIE	CCIE	KEYACC	0	0	0	0	0
	W								
0x0004 FPROT	R	FPOPEN	NV6	FPHDIS	FPHS1	FPHS0	FPLDIS	FPLS1	FPLS0
	W								
0x0005 FSTAT	R	CBEIF	CCIF	PVIOL	ACCERR	0	BLANK	FAIL	DONE
	W								
0x0006 FCMD	R	0	CMDB6	CMDB5	0	0	CMDB2	0	CMDB0
	W								
0x0007 RESERVED2[1]	R	0	0	0	0	0	0	0	0
	W								
0x0008 FADDRHI[1]	R	FABHI							
	W								
0x0008 FADDRHI[1]	R	0	FABHI						
	W								
0x0009 FADDRLO[1]	R	FABLO							
	W								
0x000A FDATAHI[1]	R	FDHI							
	W								
0x000B FDATALO[1]	R	FDLO							
	W								
0x000C RESERVED3[1]	R	0	0	0	0	0	0	0	0
	W								
0x000D RESERVED4[1]	R	0	0	0	0	0	0	0	0
	W								
0x000E RESERVED5[1]	R	0	0	0	0	0	0	0	0
	W								
0x000F RESERVED6[1]	R	0	0	0	0	0	0	0	0
	W								

= Unimplemented or Reserved

Figure 19-5. Flash Register Summary

1. Intended for factory test purposes only.

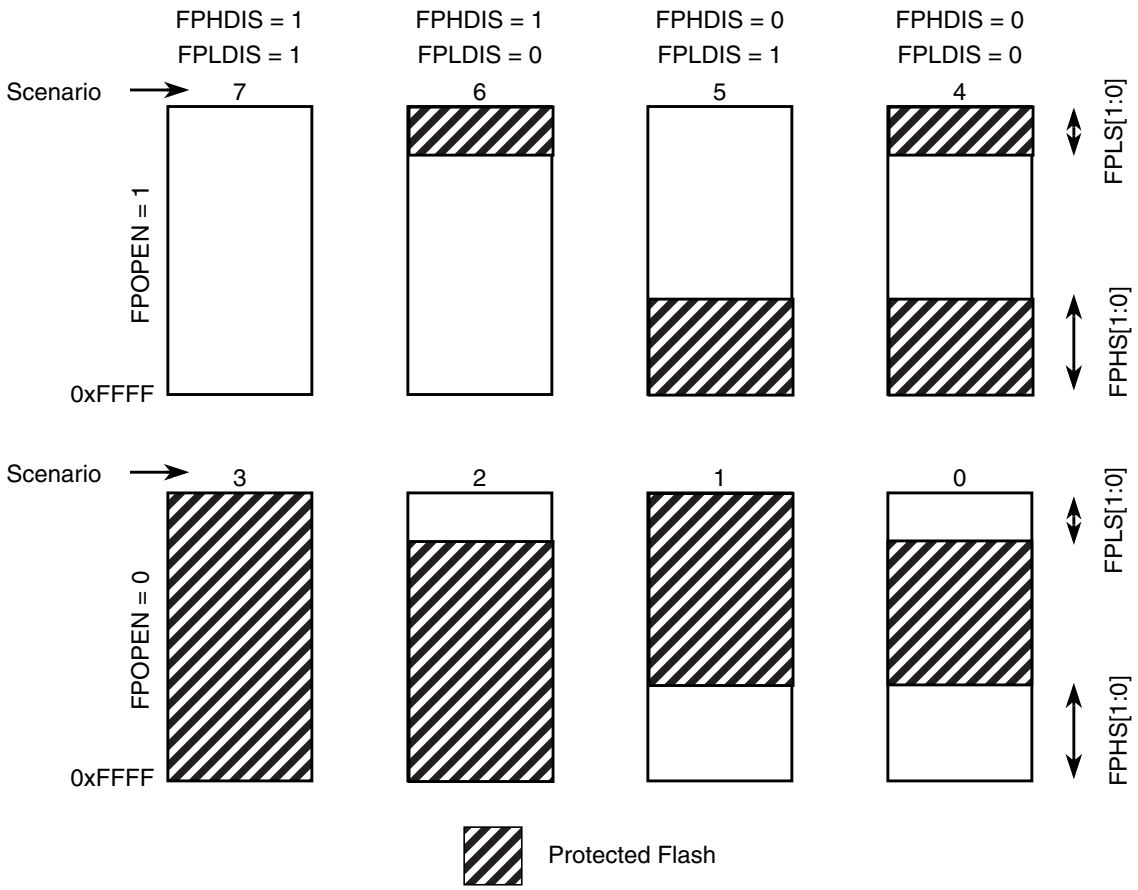

Figure 19-11. Flash Protection Scenarios

19.3.2.5.1 Flash Protection Restrictions

The general guideline is that protection can only be added, not removed. All valid transitions between Flash protection scenarios are specified in Table 19-13. Any attempt to write an invalid scenario to the FPROT register will be ignored and the FPROT register will remain unchanged. The contents of the FPROT register reflect the active protection scenario.

Table 19-13. Flash Protection Scenario Transitions

From Protection Scenario	To Protection Scenario[1]							
	0	1	2	3	4	5	6	7
0	X	X	X	X				
1		X		X				
2			X	X				
3				X				
4				X	X			
5			X	X	X	X		

Table 21-4. FSEC Field Descriptions

Field	Description
7–6 KEYEN[1:0]	**Backdoor Key Security Enable Bits** — The KEYEN[1:0] bits define the enabling of the backdoor key access to the Flash module as shown in Table 21-5.
5–2 NV[5:2]	**Nonvolatile Flag Bits** — The NV[5:2] bits are available to the user as nonvolatile flags.
1–0 SEC[1:0]	**Flash Security Bits** — The SEC[1:0] bits define the security state of the MCU as shown in Table 21-6. If the Flash module is unsecured using backdoor key access, the SEC[1:0] bits are forced to 1:0.

Table 21-5. Flash KEYEN States

KEYEN[1:0]	Status of Backdoor Key Access
00	DISABLED
01(1)	DISABLED
10	ENABLED
11	DISABLED

1. Preferred KEYEN state to disable Backdoor Key Access.

Table 21-6. Flash Security States

SEC[1:0]	Status of Security
00	Secured
01(1)	Secured
10	Unsecured
11	Secured

1. Preferred SEC state to set MCU to secured state.

The security function in the Flash module is described in Section 21.4.3, “Flash Module Security”.

21.3.2.3 RESERVED1

This register is reserved for factory testing and is not accessible to the user.

Module Base + 0x0002

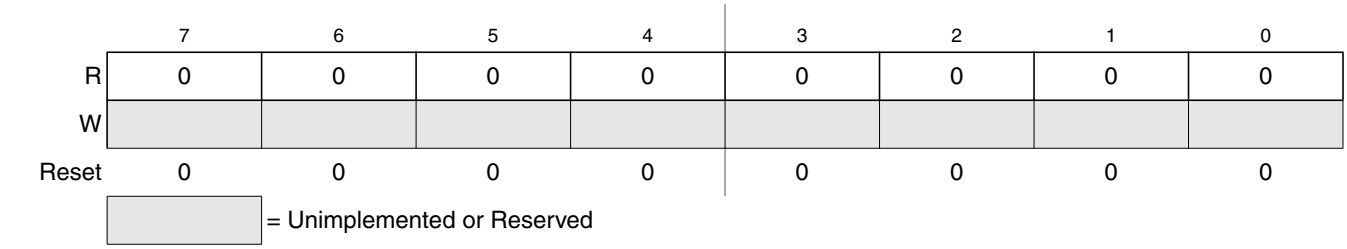

Figure 21-6. RESERVED1

All bits read 0 and are not writable.

A.2 ATD Characteristics

This section describes the characteristics of the analog-to-digital converter.

V_{RL} is not available as a separate pin in the 48- and 52-pin versions. In this case the internal V_{RL} pad is bonded to the V_{SSA} pin.

The ATD is specified and tested for both the 3.3V and 5V range. For ranges between 3.3V and 5V the ATD accuracy is generally the same as in the 3.3V range but is not tested in this range in production test.

A.2.1 ATD Operating Characteristics In 5V Range

The Table A-10 shows conditions under which the ATD operates.

The following constraints exist to obtain full-scale, full range results: $V_{SSA} \le V_{RL} \le V_{IN} \le V_{RH} \le V_{DDA}$. This constraint exists since the sample buffer amplifier can not drive beyond the power supply levels that it ties to. If the input level goes outside of this range it will effectively be clipped.

Table A-10. ATD Operating Characteristics

Conditions are shown in Table A-4 unless otherwise noted. Supply Voltage 5V-10% <= V_{DDA} <=5V+10%							
Num	**C**	**Rating**	**Symbol**	**Min**	**Typ**	**Max**	**Unit**
1	D	Reference Potential Low High	 V_{RL} V_{RH}	 V_{SSA} $V_{DDA/2}$	 — —	 $V_{DDA/2}$ V_{DDA}	 V V
2	C	Differential Reference Voltage(1)	V_{RH}-V_{RL}	4.75	5.0	5.25	V
3	D	ATD Clock Frequency	f_{ATDCLK}	0.5	—	2.0	MHz
4	D	ATD 10-Bit Conversion Period Clock Cycles(2) Conv, Time at 2.0MHz ATD Clock f_{ATDCLK}	 N_{CONV10} T_{CONV10}	 14 7	 — —	 28 14	 Cycles µs
5	D	ATD 8-Bit Conversion Period Clock Cycles2 Conv, Time at 2.0MHz ATD Clock f_{ATDCLK}	 N_{CONV10} T_{CONV10}	 12 6	 — —	 26 13	 Cycles µs
5	D	Recovery Time (V_{DDA}=5.0 Volts)	t_{REC}	—	—	20	µs
6	P	Reference Supply current	I_{REF}	—	—	0.375	mA

1. Full accuracy is not guaranteed when differential voltage is less than 4.75V
2. The minimum time assumes a final sample period of 2 ATD clocks cycles while the maximum time assumes a final sample period of 16 ATD clocks.

Table A-18. NVM Timing Characteristics

Conditions are shown in Table A-4 unless otherwise noted							
Num	**C**	**Rating**	**Symbol**	**Min**	**Typ**	**Max**	**Unit**
1	D	External Oscillator Clock	f_{NVMOSC}	0.5	—	50(1)	MHz
2	D	Bus frequency for Programming or Erase Operations	f_{NVMBUS}	1	—		MHz
3	D	Operating Frequency	f_{NVMOP}	150	—	200	kHz
4	P	Single Word Programming Time	t_{swpgm}	46(2)	—	74.5(3)	µs
5	D	Flash Burst Programming consecutive word	t_{bwpgm}	20.4[2]	—	31[3]	µs
6	D	Flash Burst Programming Time for 32 Word row	t_{brpgm}	678.4[2]	—	1035.5[3]	µs
6	D	Flash Burst Programming Time for 64 Word row	t_{brpgm}	1331.2[2]	—	2027.5[3]	µs
7	P	Sector Erase Time	t_{era}	20(4)	—	26.7[3]	ms
8	P	Mass Erase Time	t_{mass}	100[4]	—	133[3]	ms
9	D	Blank Check Time Flash per block	t_{check}	11(5)	—	32778(6)	(7)t_{cyc}
9	D	Blank Check Time Flash per block	t_{check}	11(8)	—	65546(9)	[7]t_{cyc}

1. Restrictions for oscillator in crystal mode apply!
2. Minimum Programming times are achieved under maximum NVM operating frequency f_{NVMOP} and maximum bus frequency f_{bus}.
3. Maximum Erase and Programming times are achieved under particular combinations of f_{NVMOP} and bus frequency f bus. Refer to formulae in Sections A.3.1.1 - A.3.1.4 for guidance.
4. Minimum Erase times are achieved under maximum NVM operating frequency f_{NVMOP}
5. Minimum time, if first word in the array is not blank (512 byte sector size).
6. Maximum time to complete check on an erased block (512 byte sector size)
7. Where t_{cyc} is the system bus clock period.
8. Minimum time, if first word in the array is not blank (1024 byte sector size)
9. Maximum time to complete check on an erased block (1024 byte sector size).