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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, I²C, SCI, SPI
Peripherals	LVD, POR, PWM, WDT
Number of I/O	91
Program Memory Size	256KB (256K x 8)
Program Memory Type	FLASH
EEPROM Size	4K x 8
RAM Size	12K x 8
Voltage - Supply (Vcc/Vdd)	2.35V ~ 5.5V
Data Converters	A/D 16x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 125°C (TA)
Mounting Type	Surface Mount
Package / Case	112-LQFP
Supplier Device Package	112-LQFP (20x20)
Purchase URL	https://www.e-xfl.com/product-detail/nxp-semiconductors/mcs12kg256mpve

0x0010–0x0014 MMC Map 1 of 4 (HCS12 Module Mapping Control)

Address	Name		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x0010	INITRM	R	RAM15	RAM14	RAM13	RAM12	RAM11	0	0	RAMHAL
		W								
0x0011	INITRG	R	0	REG14	REG13	REG12	REG11	0	0	0
		W								
0x0012	INITEE	R	EE15	EE14	EE13	EE12	EE11	0	0	EEON
		W								
0x0013	MISC	R	0	0	0	0	EXSTR1	EXSTR0	ROMHM	ROMON
		W								
0x0014	Reserved	R	0	0	0	0	0	0	0	0
		W								

0x0015–0x0016 INT Map 1 of 2 (HCS12 Interrupt)

Address	Name		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x0015	ITCR	R	0	0	0	WRINT	ADR3	ADR2	ADR1	ADR0
		W								
0x0016	ITEST	R	INTE	INTC	INTA	INT8	INT6	INT4	INT2	INT0
		W								

0x0017–0x0017 MMC Map 2 of 4 (HCS12 Module Mapping Control)

Address	Name		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x0017	Reserved	R	0	0	0	0	0	0	0	0
		W								

0x0018–0x0018 Miscellaneous Peripherals (Device Guide)

Address	Name		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x0018	Reserved	R	0	0	0	0	0	0	0	0
		W								

0x0019–0x0019 VREG3V3 (Voltage Regulator)

Address	Name		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x0019	VREGCTRL	R	0	0	0	0	0	LVDS	LVIE	LVIF
		W								

0x001A–0x001B Miscellaneous Peripherals (Device Guide)

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

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

Address	Name		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x002C	DBGCAL BKP0L	R W	Bit 7	6	5	4	3	2	1	Bit 0
0x002D	DBGCBX BKP1X	R W	PAGSEL		EXTCMP					
0x002E	DBGCBH BKP1H	R W	Bit 15	14	13	12	11	10	9	Bit 8
0x002F	DBGCBL BKP1L	R W	Bit 7	6	5	4	3	2	1	Bit 0

0x0030–0x0031 MMC Map 4 of 4 (HCS12 Module Mapping Control)

Address	Name		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x0030	PPAGE	R W	0	0	PIX5	PIX4	PIX3	PIX2	PIX1	PIX0
0x0031	Reserved	R W	0	0	0	0	0	0	0	0

0x0032–0x0033 MEBI Map 3 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
0x0032	PORTK	R W	Bit 7	6	5	4	3	2	1	Bit 0
0x0033	DDRK	R W	Bit 7	6	5	4	3	2	1	Bit 0

0x0034–0x003F CRG (Clock and Reset Generator)

Address	Name		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x0034	SYNR	R W	0	0	SYN5	SYN4	SYN3	SYN2	SYN1	SYN0
0x0035	REFDV	R W	0	0	0	0	REFDV3	REFDV2	REFDV1	REFDV0
0x0036	CTFLG TEST ONLY	R W	TOUT7	TOUT6	TOUT5	TOUT4	TOUT3	TOUT2	TOUT1	TOUT0
0x0037	CRGFLG	R W	RTIF	PROF	0	LOCKIF	LOCK	TRACK	SCMIF	SCM
0x0038	CRGINT	R W	RTIE	0	0	LOCKIE	0	0	SCMIE	0
0x0039	CLKSEL	R W	PLLSEL	PSTP	SYSWAI	ROAWAI	PLLWAI	CWAI	RTIWAI	COPWAI
0x003A	PLLCTL	R W	CME	PLLON	AUTO	ACQ	0	PRE	PCE	SCME
0x003B	RTICTL	R W	0	RTR6	RTR5	RTR4	RTR3	RTR2	RTR1	RTR0

part goes through a reset before the security bits are reprogrammed to the unsecure state, the part will be secured again.

1.5.3 Low Power Modes

The microcontroller features three main low power modes. Consult the respective Block Guide for information on the module behavior in Stop, Pseudo Stop, and Wait Mode. An important source of information about the clock system is the Clock and Reset Generator Guide (CRG).

1.5.3.1 Stop

Executing the CPU STOP instruction stops all clocks and the oscillator thus putting the chip in fully static mode. Wake up from this mode can be done via reset or external interrupts.

1.5.3.2 Pseudo Stop

This mode is entered by executing the CPU STOP instruction. In this mode the oscillator is still running and the Real Time Interrupt (RTI) or Watchdog (COP) sub module can stay active. Other peripherals are turned off. This mode consumes more current than the full STOP mode, but the wake up time from this mode is significantly shorter.

1.5.3.3 Wait

This mode is entered by executing the CPU WAI instruction. In this mode the CPU will not execute instructions. The internal CPU signals (address and data bus) will be fully static. All peripherals stay active. For further power consumption the peripherals can individually turn off their local clocks.

1.5.3.4 Run

Although this is not a low power mode, unused peripheral modules should not be enabled in order to save power.

1.6 Resets and Interrupts

Consult the Exception Processing section of the CPU12 Reference Manual for information on resets and interrupts. Both local masking and CCR masking are included as listed in Table 1-12. System resets can be generated through external control of the $\overline{\text{RESET}}$ pin, through the clock and reset generator module CRG or through the low voltage reset (LVR) generator of the voltage regulator module. Refer to the CRG and VREG block description chapters for detailed information on reset generation.

1.6.1 Vectors

1.6.1.1 Vector Table

Table 1-12 lists interrupt sources and vectors in default order of priority.

CBEIF, PVIOL, ACCERR and DFDIF are readable and writable, CCIF and BLANK are readable and not writable, remaining bits read 0 and are not writable in normal mode. FAIL is readable and writable in special mode. FAIL must be clear when starting a command write sequence.

Table 2-17. FSTAT Field Descriptions

Field	Description
7 CBEIF	**Command Buffer Empty Interrupt Flag** — The CBEIF flag indicates that the address, data and command buffers are empty so that a new command write sequence can be started. The CBEIF flag is cleared by writing a 1 to CBEIF. Writing a 0 to the CBEIF flag has no effect on CBEIF. Writing a 0 to CBEIF after writing an aligned word to the Flash address space but before CBEIF is cleared will abort a command write sequence and cause the ACCERR flag to be set. Writing a 0 to CBEIF outside of a command write sequence will not set the ACCERR flag. The CBEIF flag is used together with the CBEIE bit in the FCNFG register to generate an interrupt request (see Figure 2-31). 0 Buffers are full. 1 Buffers are ready to accept a new command.
6 CCIF	**Command Complete Interrupt Flag** — The CCIF flag indicates that there are no more commands pending. The CCIF flag is cleared when CBEIF is clear and sets automatically upon completion of all active and pending commands. The CCIF flag does not set when an active commands completes and a pending command is fetched from the command buffer. Writing to the CCIF flag has no effect on CCIF. The CCIF flag is used together with the CCIE bit in the FCNFG register to generate an interrupt request (see Figure 2-31). 0 Command in progress. 1 All commands are completed.
5 PVIOL	**Protection Violation Flag** — The PVIOL flag indicates an attempt was made to program or erase an address in a protected area of the Flash block during a command write sequence. The PVIOL flag is cleared by writing a 1 to PVIOL. Writing a 0 to the PVIOL flag has no effect on PVIOL. While PVIOL is set, it is not possible to launch a command or start a command write sequence. 0 No failure. 1 A protection violation has occurred.
4 ACCERR	**Access Error Flag** — The ACCERR flag indicates an illegal access to the Flash array caused by either a violation of the command write sequence, issuing an illegal command (illegal combination of the CMDBx bits in the FCMD register), launching the sector erase abort command terminating a sector erase operation early, detection of a double fault or the execution of a CPU STOP instruction while a command is executing (CCIF = 0). The ACCERR flag is cleared by writing a 1 to ACCERR. Writing a 0 to the ACCERR flag has no effect on ACCERR. While ACCERR is set, it is not possible to launch a command or start a command write sequence. If ACCERR is set by the detection of a double fault, an erase verify operation or a data compress operation, any buffered command will not launch. 0 No access error detected. 1 Access error has occurred.

All bits read 0 and are not writable.

3.3.2.15 RESERVED4

This register is reserved for factory testing and is not accessible.

Module Base + 0x000F

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

= Unimplemented or Reserved

Figure 3-22. RESERVED4

All bits read 0 and are not writable.

3.4 Functional Description

3.4.1 Flash Command Operations (NVM User Mode)

Write and read operations are both used for the program, erase, erase verify, and data compress algorithms described in this subsection. The program and erase algorithms are time controlled by a state machine whose timebase, FCLK, is derived from the oscillator clock via a programmable divider. The command register as well as the associated address and data registers operate as a buffer and a register (2-stage FIFO) so that a second command along with the necessary data and address can be stored to the buffer while the first command remains in progress. This pipelined operation allows a time optimization when programming more than one word on a specific row in the Flash block as the high voltage generation can be kept active in between two programming commands. The pipelined operation also allows a simplification of command launching. Buffer empty as well as command completion are signalled by flags in the Flash status register with interrupts generated, if enabled.

The next paragraphs describe:

1. How to write the FCLKDIV register.
2. Command write sequences used to program, erase, and verify the Flash memory.
3. Valid Flash commands.
4. Effects resulting from illegal Flash command write sequences or aborting Flash operations.

3.4.1.1 Writing the FCLKDIV Register

Prior to issuing any program, erase, erase verify, or data compress command, it is first necessary to write the FCLKDIV register to divide the oscillator clock down to within the 150 kHz to 200 kHz range. Because the program and erase timings are also a function of the bus clock, the FCLKDIV determination must take this information into account.

4.3.2 Register Descriptions

Register Name		Bit 7	6	5	4	3	2	1	Bit 0
0x0000 ECLKDIV	R	EDIVLD	PRDIV8	EDIV5	EDIV4	EDIV3	EDIV2	EDIV1	EDIV0
	W								
0x0001 RESERVED1	R	0	0	0	0	0	0	0	0
	W								
0x0002 RESERVED2	R	0	0	0	0	0	0	0	0
	W								
0x0003 ECNFG	R	CBEIE	CCIE	0	0	0	0	0	0
	W								
0x0004 EPROT	R	EPOPEN	NV6	NV5	NV4	EPDIS	EP2	EP1	EPO
	W								
0x0005 ESTAT	R	CBEIF	CCIF	PVIOL	ACCERR	0	BLANK	0	0
	W								
0x0006 ECMD	R	0	CMDB6	CMDB5	0	0	CMDB2	0	CMDB0
	W								
0x0007 RESERVED3	R	0	0	0	0	0	0	0	0
	W								
0x0008 EADDRHI	R	0	0	0	0	0	EABHI		
	W								
0x0009 EADDRLO	R	EABLO							
	W								
0x000A EDATAHI	R	EDHI							
	W								
0x000B EDATALO	R	EDLO							
	W								

= Unimplemented or Reserved

Figure 4-3. EETS4K Register Summary

4.3.2.1 EEPROM Clock Divider Register (ECLKDIV)

The ECLKDIV register is used to control timed events in program and erase algorithms.

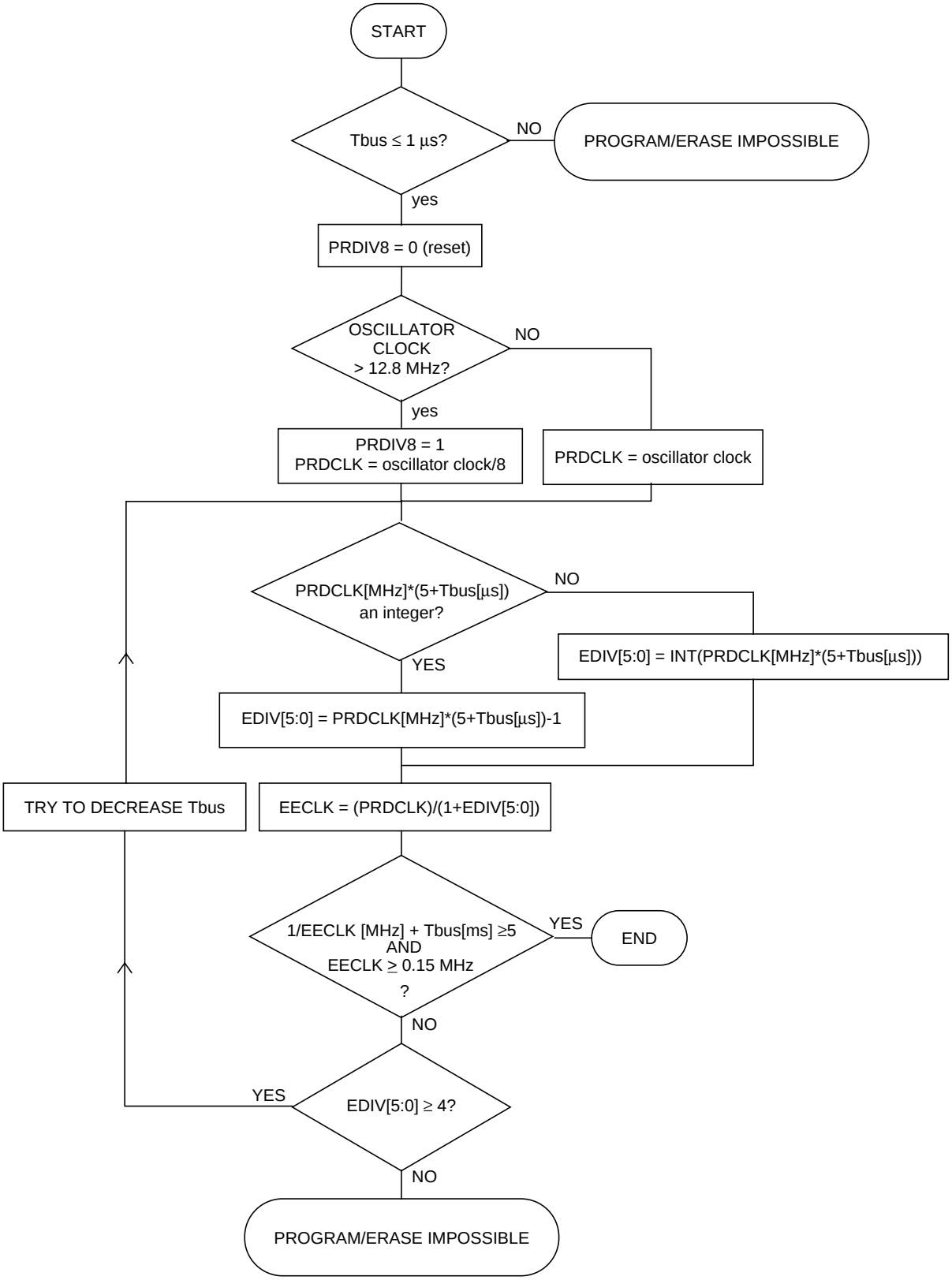

Figure 4-17. PRDIV8 and EDIV Bits Determination Procedure

Table 6-11. Outcome of Clock Loss in Wait Mode (continued)

CME	SCME	SCMIE	CRG Actions
1	1	1	Clock failure --> – VREG enabled, – PLL enabled, – SCM activated, – Start Clock Quality Check, – SCMIF set. SCMIF generates Self-Clock Mode wakeup interrupt. – Exit Wait Mode in SCM using PLL clock (f_{SCM}) as system clock, – Continue to perform a additional Clock Quality Checks until OSCCLK is o.k. again.

6.4.10 Low-Power Operation in Stop Mode

All clocks are stopped in STOP mode, dependent of the setting of the PCE, PRE and PSTP bit. The oscillator is disabled in STOP mode unless the PSTP bit is set. All counters and dividers remain frozen but do not initialize. If the PRE or PCE bits are set, the RTI or COP continues to run in pseudo-stop mode. In addition to disabling system and core clocks the CRG requests other functional units of the MCU (e.g. voltage-regulator) to enter their individual power-saving modes (if available). This is the main difference between pseudo-stop mode and wait mode.

After executing the STOP instruction the core requests the CRG to switch the MCU into stop mode. If the PLLSEL bit remains set when entering stop mode, the CRG will switch the system and core clocks to OSCCLK by clearing the PLLSEL bit. Then the CRG disables the PLL, disables the core clock and finally disables the remaining system clocks. As soon as all clocks are switched off, stop mode is active.

If pseudo-stop mode (PSTP = 1) is entered from self-clock mode the CRG will continue to check the clock quality until clock check is successful. The PLL and the voltage regulator (VREG) will remain enabled. If full stop mode (PSTP = 0) is entered from self-clock mode an ongoing clock quality check will be stopped. A complete timeout window check will be started when stop mode is exited again.

Wake-up from stop mode also depends on the setting of the PSTP bit.

6.6 Interrupts

The interrupts/reset vectors requested by the CRG are listed in Table 6-15. Refer to the device overview chapter for related vector addresses and priorities.

Table 6-15. CRG Interrupt Vectors

Interrupt Source	CCR Mask	Local Enable
Real-time interrupt	I bit	CRGINT (RTIE)
LOCK interrupt	I bit	CRGINT (LOCKIE)
SCM interrupt	I bit	CRGINT (SCMIE)

6.6.1 Real-Time Interrupt

The CRGV4 generates a real-time interrupt when the selected interrupt time period elapses. RTI interrupts are locally disabled by setting the RTIE bit to 0. The real-time interrupt flag (RTIF) is set to 1 when a timeout occurs, and is cleared to 0 by writing a 1 to the RTIF bit.

The RTI continues to run during pseudo-stop mode if the PRE bit is set to 1. This feature can be used for periodic wakeup from pseudo-stop if the RTI interrupt is enabled.

6.6.2 PLL Lock Interrupt

The CRGV4 generates a PLL lock interrupt when the LOCK condition of the PLL has changed, either from a locked state to an unlocked state or vice versa. Lock interrupts are locally disabled by setting the LOCKIE bit to 0. The PLL Lock interrupt flag (LOCKIF) is set to1 when the LOCK condition has changed, and is cleared to 0 by writing a 1 to the LOCKIF bit.

6.6.3 Self-Clock Mode Interrupt

The CRGV4 generates a self-clock mode interrupt when the SCM condition of the system has changed, either entered or exited self-clock mode. SCM conditions can only change if the self-clock mode enable bit (SCME) is set to 1. SCM conditions are caused by a failing clock quality check after power-on reset (POR) or low voltage reset (LVR) or recovery from full stop mode (PSTP = 0) or clock monitor failure. For details on the clock quality check refer to Section 6.4.4, “Clock Quality Checker.” If the clock monitor is enabled (CME = 1) a loss of external clock will also cause a SCM condition (SCME = 1).

SCM interrupts are locally disabled by setting the SCMIE bit to 0. The SCM interrupt flag (SCMIF) is set to 1 when the SCM condition has changed, and is cleared to 0 by writing a 1 to the SCMIF bit.

8.4.1.2 Analog Input Multiplexer

The analog input multiplexer connects one of the 8 external analog input channels to the sample and hold machine.

8.4.1.3 Sample Buffer Amplifier

The sample amplifier is used to buffer the input analog signal so that the storage node can be quickly charged to the sample potential.

8.4.1.4 Analog-to-Digital (A/D) Machine

The A/D Machine performs analog to digital conversions. The resolution is program selectable at either 8 or 10 bits. The A/D machine uses a successive approximation architecture. It functions by comparing the stored analog sample potential with a series of digitally generated analog potentials. By following a binary search algorithm, the A/D machine locates the approximating potential that is nearest to the sampled potential.

When not converting the A/D machine disables its own clocks. The analog electronics still draws quiescent current. The power down (ADPU) bit must be set to disable both the digital clocks and the analog power consumption.

Only analog input signals within the potential range of V_{RL} to V_{RH} (A/D reference potentials) will result in a non-railed digital output codes.

8.4.2 Digital Sub-Block

This subsection explains some of the digital features in more detail. See register descriptions for all details.

8.4.2.1 External Trigger Input

The external trigger feature allows the user to synchronize ATD conversions to the external environment events rather than relying on software to signal the ATD module when ATD conversions are to take place. The external trigger signal (out of reset ATD channel 7, configurable in ATDCTL1) is programmable to be edge or level sensitive with polarity control. Table 8-23 gives a brief description of the different combinations of control bits and their effect on the external trigger function.

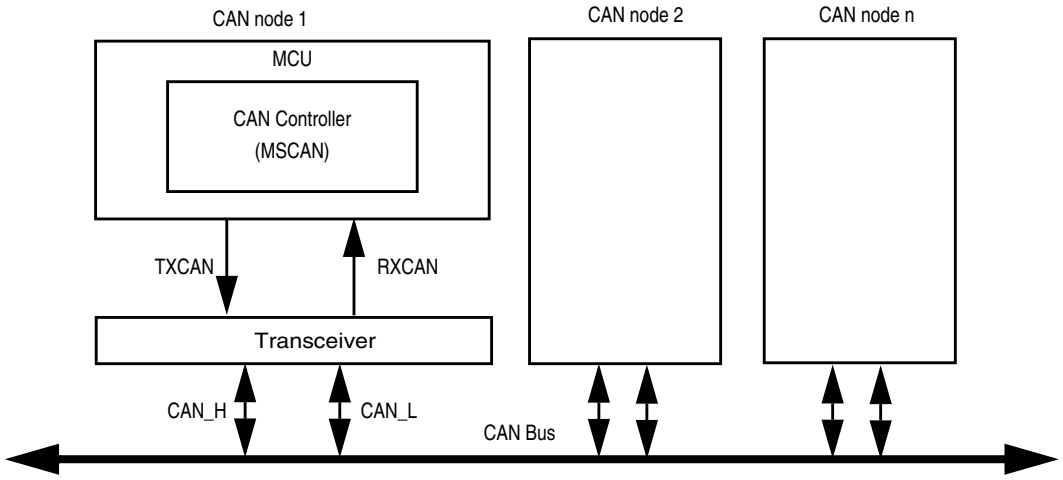

Figure 10-2. CAN System

10.3 Memory Map and Register Definition

This section provides a detailed description of all registers accessible in the MSCAN.

10.3.1 Module Memory Map

Figure 10-3 gives an overview on all registers and their individual bits in the MSCAN memory map. The *register address* results from the addition of *base address* and *address offset*. The *base address* is determined at the MCU level and can be found in the MCU memory map description. The *address offset* is defined at the module level.

The MSCAN occupies 64 bytes in the memory space. The base address of the MSCAN module is determined at the MCU level when the MCU is defined. The register decode map is fixed and begins at the first address of the module address offset.

The detailed register descriptions follow in the order they appear in the register map.

10.3.2.3 MSCAN Bus Timing Register 0 (CANBTR0)

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

Module Base + 0x0002

	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 10-6. MSCAN Bus Timing Register 0 (CANBTR0)

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

Table 10-3. 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 10-4).
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 10-5).

Table 10-4. 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 10-5. 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

15.2 External Signal Description

Due to the nature of VREG3V3V2 being a voltage regulator providing the chip internal power supply voltages most signals are power supply signals connected to pads.

Table 15-1 shows all signals of VREG3V3V2 associated with pins.

Table 15-1. VREG3V3V2 — Signal Properties

Name	Port	Function	Reset State	Pull Up
V_{DDR}	—	VREG3V3V2 power input (positive supply)	—	—
V_{DDA}	—	VREG3V3V2 quiet input (positive supply)	—	—
V_{SSA}	—	VREG3V3V2 quiet input (ground)	—	—
V_{DD}	—	VREG3V3V2 primary output (positive supply)	—	—
V_{SS}	—	VREG3V3V2 primary output (ground)	—	—
V_{DDPLL}	—	VREG3V3V2 secondary output (positive supply)	—	—
V_{SSPLL}	—	VREG3V3V2 secondary output (ground)	—	—
V_{REGEN} (optional)	—	VREG3V3V2 (Optional) Regulator Enable	—	—

NOTE

Check device overview chapter for connectivity of the signals.

15.2.1 V_{DDR} — Regulator Power Input

Signal V_{DDR} is the power input of VREG3V3V2. All currents sourced into the regulator loads flow through this pin. A chip external decoupling capacitor (100 nF...220 nF, X7R ceramic) between V_{DDR} and V_{SSR} can smoothen ripple on V_{DDR}.

For entering shutdown mode, pin V_{DDR} should also be tied to ground on devices without a V_{REGEN} pin.

15.2.2 V_{DDA}, V_{SSA} — Regulator Reference Supply

Signals V_{DDA}/V_{SSA} which are supposed to be relatively quiet are used to supply the analog parts of the regulator. Internal precision reference circuits are supplied from these signals. A chip external decoupling capacitor (100 nF...220 nF, X7R ceramic) between V_{DDA} and V_{SSA} can further improve the quality of this supply.

Table 16-2. BDMSTS Field Descriptions

Field	Description
7 ENBDM	**Enable BDM** — This bit controls whether the BDM is enabled or disabled. When enabled, BDM can be made active to allow firmware commands to be executed. When disabled, BDM cannot be made active but BDM hardware commands are allowed. 0 BDM disabled 1 BDM enabled **Note:** ENBDM is set by the firmware immediately out of reset in special single-chip mode. In secure mode, this bit will not be set by the firmware until after the EEPROM and FLASH erase verify tests are complete.
6 BDMACT	**BDM Active Status** — This bit becomes set upon entering BDM. The standard BDM firmware lookup table is then enabled and put into the memory map. BDMACT is cleared by a carefully timed store instruction in the standard BDM firmware as part of the exit sequence to return to user code and remove the BDM memory from the map. 0 BDM not active 1 BDM active
5 ENTAG	**Tagging Enable** — This bit indicates whether instruction tagging in enabled or disabled. It is set when the TAGGO command is executed and cleared when BDM is entered. The serial system is disabled and the tag function enabled 16 cycles after this bit is written. BDM cannot process serial commands while tagging is active. 0 Tagging not enabled or BDM active 1 Tagging enabled
4 SDV	**Shift Data Valid** — This bit is set and cleared by the BDM hardware. It is set after data has been transmitted as part of a firmware read command or after data has been received as part of a firmware write command. It is cleared when the next BDM command has been received or BDM is exited. SDV is used by the standard BDM firmware to control program flow execution. 0 Data phase of command not complete 1 Data phase of command is complete
3 TRACE	**TRACE1 BDM Firmware Command is Being Executed** — This bit gets set when a BDM TRACE1 firmware command is first recognized. It will stay set as long as continuous back-to-back TRACE1 commands are executed. This bit will get cleared when the next command that is not a TRACE1 command is recognized. 0 TRACE1 command is not being executed 1 TRACE1 command is being executed

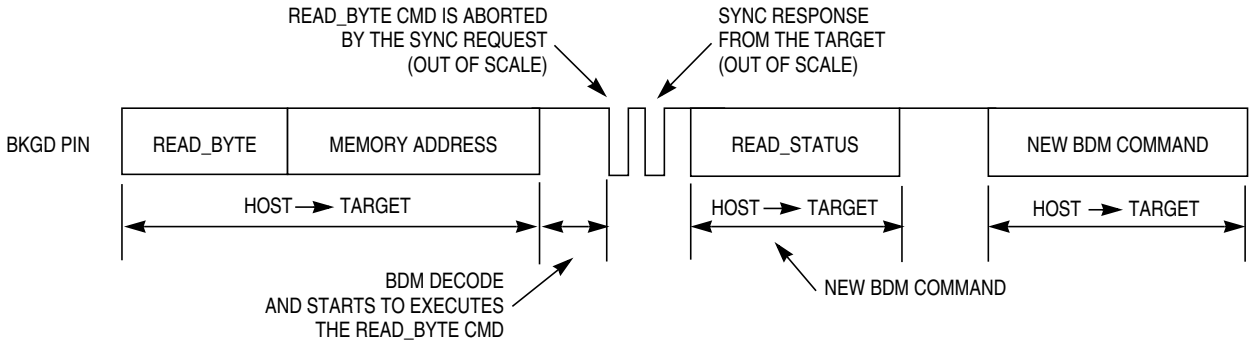

Figure 16-12. ACK Abort Procedure at the Command Level

Figure 16-13 shows a conflict between the ACK pulse and the SYNC request pulse. This conflict could occur if a POD device is connected to the target BKGD pin and the target is already in debug active mode. Consider that the target CPU is executing a pending BDM command at the exact moment the POD is being connected to the BKGD pin. In this case, an ACK pulse is issued along with the SYNC command. In this case, there is an electrical conflict between the ACK speedup pulse and the SYNC pulse. Because this is not a probable situation, the protocol does not prevent this conflict from happening.

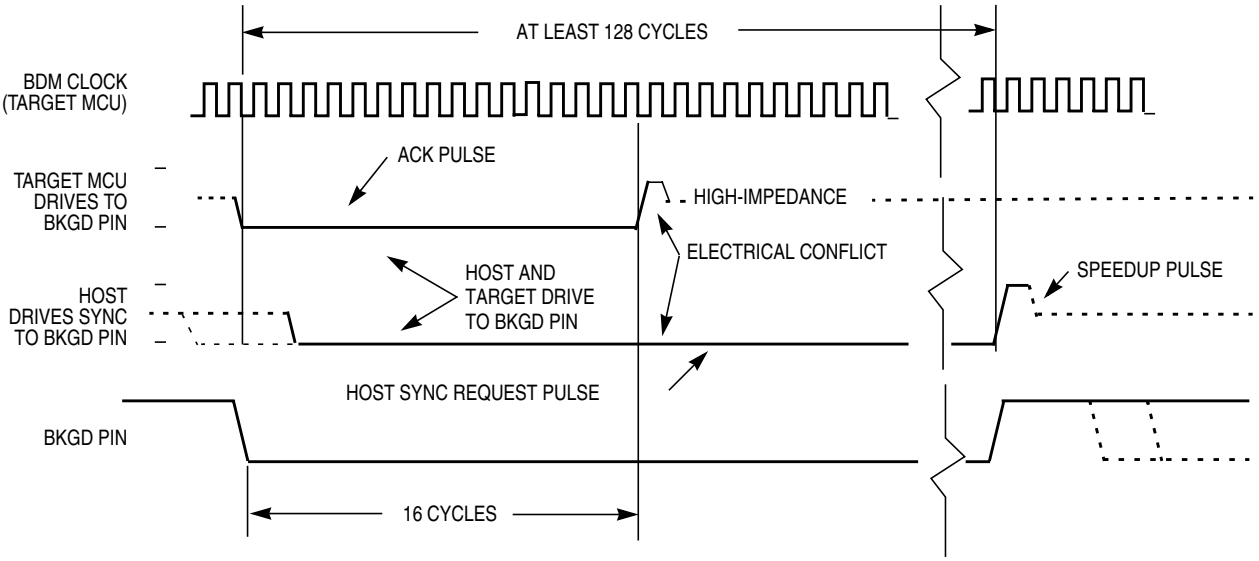

Figure 16-13. ACK Pulse and SYNC Request Conflict

NOTE

This information is being provided so that the MCU integrator will be aware that such a conflict could eventually occur.

The hardware handshake protocol is enabled by the ACK_ENABLE and disabled by the ACK_DISABLE BDM commands. This provides backwards compatibility with the existing POD devices which are not able to execute the hardware handshake protocol. It also allows for new POD devices, that support the hardware handshake protocol, to freely communicate with the target device. If desired, without the need for waiting for the ACK pulse.

The DBG in DBG mode includes these distinctive features:

- Three comparators (A, B, and C)
  - Dual mode, comparators A and B used to compare addresses
  - Full mode, comparator A compares address and comparator B compares data
  - Can be used as trigger and/or breakpoint
  - Comparator C used in LOOP1 capture mode or as additional breakpoint
- Four capture modes
  - Normal mode, change-of-flow information is captured based on trigger specification
  - Loop1 mode, comparator C is dynamically updated to prevent redundant change-of-flow storage.
  - Detail mode, address and data for all cycles except program fetch (P) and free (f) cycles are stored in trace buffer
  - Profile mode, last instruction address executed by CPU is returned when trace buffer address is read
- Two types of breakpoint or debug triggers
  - Break just before a specific instruction will begin execution (tag)
  - Break on the first instruction boundary after a match occurs (force)
- BDM or SWI breakpoint
  - Enter BDM on breakpoint (BDM)
  - Execute SWI on breakpoint (SWI)
- Nine trigger modes for comparators A and B
  - A
  - A or B
  - A then B
  - A and B, where B is data (full mode)
  - A and not B, where B is data (full mode)
  - Event only B, store data
  - A then event only B, store data
  - Inside range, $A \leq address \leq B$
  - Outside range, address $< A$ or address $> B$
- Comparator C provides an additional tag or force breakpoint when capture mode is not configured in LOOP1 mode.
- Sixty-four word (16 bits wide) trace buffer for storing change-of-flow information, event only data and other bus information.
  - Source address of taken conditional branches (long, short, bit-conditional, and loop constructs)
  - Destination address of indexed JMP, JSR, and CALL instruction.
  - Destination address of RTI, RTS, and RTC instructions
  - Vector address of interrupts, except for SWI and BDM vectors

Table 19-1. External System Pins Associated With MEBI

Pin Name	Pin Functions	Description
BKGD/MODC/ $\overline{\text{TAGHI}}$	MODC	At the rising edge on $\overline{\text{RESET}}$, the state of this pin is registered into the MODC bit to set the mode. (This pin always has an internal pullup.)
	BKGD	Pseudo open-drain communication pin for the single-wire background debug mode. There is an internal pull-up resistor on this pin.
	$\overline{\text{TAGHI}}$	When instruction tagging is on, a 0 at the falling edge of E tags the high half of the instruction word being read into the instruction queue.
PA7/A15/D15/D7 thru PA0/A8/D8/D0	PA7–PA0	General-purpose I/O pins, see PORTA and DDRA registers.
	A15–A8	High-order address lines multiplexed during ECLK low. Outputs except in special peripheral mode where they are inputs from an external tester system.
	D15–D8	High-order bidirectional data lines multiplexed during ECLK high in expanded wide modes, special peripheral mode, and visible internal accesses (IVIS = 1) in emulation expanded narrow mode. Direction of data transfer is generally indicated by R/$\overline{\text{W}}$.
	D15/D7 thru D8/D0	Alternate high-order and low-order bytes of the bidirectional data lines multiplexed during ECLK high in expanded narrow modes and narrow accesses in wide modes. Direction of data transfer is generally indicated by R/$\overline{\text{W}}$.
PB7/A7/D7 thru PB0/A0/D0	PB7–PB0	General-purpose I/O pins, see PORTB and DDRB registers.
	A7–A0	Low-order address lines multiplexed during ECLK low. Outputs except in special peripheral mode where they are inputs from an external tester system.
	D7–D0	Low-order bidirectional data lines multiplexed during ECLK high in expanded wide modes, special peripheral mode, and visible internal accesses (with IVIS = 1) in emulation expanded narrow mode. Direction of data transfer is generally indicated by R/$\overline{\text{W}}$.
PE7/NOACC	PE7	General-purpose I/O pin, see PORTE and DDRE registers.
	NOACC	CPU No Access output. Indicates whether the current cycle is a free cycle. Only available in expanded modes.
PE6/IPIPE1/ MODB/CLKTO	MODB	At the rising edge of $\overline{\text{RESET}}$, the state of this pin is registered into the MODB bit to set the mode.
	PE6	General-purpose I/O pin, see PORTE and DDRE registers.
	IPIPE1	Instruction pipe status bit 1, enabled by PIPOE bit in PEAR.
	CLKTO	System clock test output. Only available in special modes. PIPOE = 1 overrides this function. The enable for this function is in the clock module.
PE5/IPIPE0/MODA	MODA	At the rising edge on $\overline{\text{RESET}}$, the state of this pin is registered into the MODA bit to set the mode.
	PE5	General-purpose I/O pin, see PORTE and DDRE registers.
	IPIPE0	Instruction pipe status bit 0, enabled by PIPOE bit in PEAR.

19.3.2.3 Data Direction Register A (DDRA)

Module Base + 0x0002
Starting address location affected by INITRG register setting.

	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 19-4. Data Direction Register A (DDRA)

Read: Anytime when register is in the map

Write: Anytime when register is in the map

This register controls the data direction for port A. When port A is operating as a general-purpose I/O port, DDRA determines the primary direction for each port A pin. A 1 causes the associated port pin to be an output and a 0 causes the associated pin to be a high-impedance input. The value in a DDR bit also affects the source of data for reads of the corresponding PORTA register. If the DDR bit is 0 (input) the buffered pin input state is read. If the DDR bit is 1 (output) the associated port data register bit state is read.

This register is not in the on-chip memory map in expanded and special peripheral modes. Therefore, these accesses will be echoed externally. It is reset to 0x00 so the DDR does not override the three-state control signals.

Table 19-3. DDRA Field Descriptions

Field	Description
7:0 DDRA	**Data Direction Port A** 0 Configure the corresponding I/O pin as an input 1 Configure the corresponding I/O pin as an output

Defining the jitter as:

$$J(N) = \max\left(\left|1 - \frac{t_{max}(N)}{N \cdot t_{nom}}\right|, \left|1 - \frac{t_{min}(N)}{N \cdot t_{nom}}\right|\right)$$

NOTE

From the evaluation data a formula for t_{max}= f(N), resp. t_{min} = f(N) should be derived.

Assuming no long term drift of the reference clock, the following will hold

$$\lim_{N \to \infty} J(N) = 0$$

This is very important to notice with respect to timers, serial modules where a pre-scaler will eliminate the effect of the jitter to a large extent.

Table A-20. PLL Characteristics

Conditions are shown in Table A-4 unless otherwise noted							
Num	C	**Rating**	**Symbol**	**Min**	**Typ**	**Max**	**Unit**
1	P	Self Clock Mode frequency	f_{SCM}	1	—	5.5	MHz
2	D	VCO locking range	f_{VCO}	8	—	50	MHz
3	D	Lock Detector transition from Acquisition to Tracking mode	Δ_{trk}	3%	—	4%[1]	—
4	D	Lock Detection	Δ_{Lock}	0%	—	1.5%[1]	—
5	D	Un-Lock Detection	Δ_{unl}	0.5%	—	2.5%[1]	—
6	D	Lock Detector transition from Tracking to Acquisition mode	Δ_{unt}	6%	—	8%[1]	—
7	C	PLLON Total Stabilization delay[2]	t_{stab}	—	0.5	—	ms
8	D	PLLON Acquisition mode stabilization delay[2]	t_{acq}	—	0.3	—	ms
9	D	PLLON Tracking mode stabilization delay[2]	t_{al}	—	0.2	—	ms
10	D	Fitting parameter VCO loop gain	K_1	—	–100	—	MHz/V
11	D	Fitting parameter VCO loop frequency	f_1	—	60	—	MHz
12	D	Charge pump current acquisition mode	i_{ch}	—	–38.5	—	µA
13	D	Charge pump current tracking mode	i_{ch}	—	–I3.5	—	µA
14	C	Jitter fit parameter 1[2]	j_1	—	—	1.1	%
15	C	Jitter fit parameter 2[2]	j_2	—	—	0.13	%

1 % deviation from target frequency

2 f_{OSC} = 4MHz, f_{BUS} = 25MHz equivalent f_{VCO} = 50MHz: REFDV = #$03, SYNR = #$018, Cs = 4.7nF, Cp = 470pF, Rs = 10KΩ.