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# MC9S12ZVM-Family Reference Manual and Datasheet

*S12 MagniV  
Microcontrollers*

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MC9S12ZVMRM

[nxp.com](http://nxp.com)



The ZVMC256, ZVML31, ZVM32 and ZVM16 devices are targeted for safety relevant systems and have been developed using an ISO26262 compliant development system under the NXP SafeAssure program. For details of device usage in safety relevant systems refer to the MC9S12ZVMB Safety Manual.

The document revision on the Internet is the most current. To verify this is the latest revision, refer to: [nxp.com](http://nxp.com).

This document contains information for all modules except the CPU. For CPU information please refer to the CPU S12Z Reference Manual. This revision history table summarizes changes to this document. The individual module sections contain revision history tables with more detailed information.

#### **NOTE**

**This reference manual documents the S12ZVM-Family.**

**It contains a superset of features within the family.**

**Some module versions differ from one part to another within the family.**

**Section 1.2.1 MC9S12ZVM-Family Member Comparison provides support to access the correct information for a particular part within the family.**

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**Table 0-1. Revision History**

Date	Revision	Description
22 MAY2014	1.4	<p>Updated family derivative table for S12ZVML32, S12ZVM32 and S12ZVM16 devices                      Added 64KB, 32KB and 16KB derivative information to flash module chapter                      Added pin routing options for S12ZVM32 and S12ZVM16 devices                      Added HV Phy information for the S12ZVM32 and S12ZVM16 derivatives                      Updated Part ID assignment table and ordering information for S12ZVM32 and S12ZVM16                      Corrected PLL VCO maximum frequency specification                      Changed <math>V_{LVLSA}</math> maximum from 7V to 6.9V                      Added electrical parameter for HD division ratio through the phase multiplexer                      Corrected preferred VRL reference from VRL_1 to VRL_0                      Included NVM timing parameters for the S12ZVM32 and S12ZVM16 devices                      Added GDU S12ZVM32 and S12ZVM16 specific differences and electrical specifications                      Added references to <math>f_{WSTAT}</math>                      Added VDDX short circuit fall back current and temperature/input dependency specs.</p>
22 SEP 2014	1.5	<p>Removed incorrect references to PACLK in TIM chapter                      Improved clarity of routing options in PIM chapter.                      Updated S12ZVM- Family derivative table.                      Added 48LQFP thermal package parameters                      Extended LINPHY specification range minimum to 5V                      Updated BKGD pin I/O specification                      Specified ADC accuracy for a range of VDDA and VREF.</p>
20 MAR 2015	2.0	<p>Added ZVMC256 information                      Added mask set 2N95G information                      Added more detailed PTU minimum trigger spacing description                      Updated CPMU, PIM and GDU chapters for ZVMC256                      Improved CPMU specification clarity (see CPMU revision history)                      Removed electrical parameter classification                      Added reset startup timing parameter                      Updated BATS parameters                      Extended BKGD <math>V_{IL}</math> condition from 3.15V to 3.13V                      Extended GDU operating range from 26V to 26.6V                      Temperature sensor output at 150C changed from 2.25V to 2.33V.                      Added GDU VBS current parameter                      Updated package thermal information for ZVM32 and ZVM16 parts                      Added VBG temperature and voltage dependency parameters                      Added device stop current at 105C.</p>
22 APR 2015	2.1	<p>Updated Stop and Wait current parameter values (<math>I_{SUPS}</math>, <math>I_{SUPW}</math>)                      Corrected 80LQFP-EP pin name from VSS2 to VSS1                      Updated ZVMC256 VDDS regulator parameters.                      Changed PL0 ESD specification                      Minor corrections to PIM, PMF, SRAM and ADC chapters (see module revision histories)</p>
27 APR 2015	2.2	<p>Updated Stop current parameter values (<math>I_{SUPS}</math>)                      Updated LINPHY parameter range limit to 5.5V                      Added more information about VDDS1, VDDS2, SNPS1, SNPS2 to CPMU chapter.                      Reintroduced EPRES bit for GDU V4                      Added 80LQFP-EP mechanical package information</p>

**Table 0-1. Revision History**

Date	Revision	Description
20 NOV 2015	2.3	<p>Added devices to Part ID list <a href="#">Table 1-6</a>            Added explanation of GSUF dependency on xN14N mask set <a href="#">Table 1-19</a>            Minor corrections to reset source and interrupt vector tables <a href="#">Table 1-15</a>            Added device level POR information <a href="#">Figure 1-8</a>            Minor correction to PIM chapter            Added constraints to EXTCON, SCS2 and SCS1 bits in CPMU chapter            Added PMF version difference table <a href="#">Table 15-3</a>            Corrected footnotes and parameter spelling in GDU register summary            Noted GDU sense amplifier dependence on GFDE bit            Documented that flash option (FOPT) register can be written in special mode            Added pulsed absolute maximum rating for HSx pins <a href="#">Table A-2</a>            Extended VDDS1 and VDDS2 maximum ratings <a href="#">Table A-2</a>            Added thermal resistance parameter values for 80LQFP-EP package            Added VREG configuration to Run/Wait/Stop current measurement configuration <a href="#">Table A-16</a>            Removed de-saturation thresholds from electrical spec. tables            Added footnote for GDU tdelon/tdeloff electrical parameters            Added max. and min. values for GDU HD signal division through phase mux.            Removed incorrect limit from BATS electrical parameter table headers            Extended CANPHY maximum ratings to 175°C            Updated SRAM_ECC chapter to cover ZVMC256            Minor correction to PMF chapter            Updated typical Stop IDD and Pseudo Stop IDD values for ZVMC256 based on validation data            Added ZVMC256 parameter for Stop IDD with CANPHY and API enabled <a href="#">Table A-19</a>            Renamed bit GSLEWMOD to TDEL (GDU V6). Removed GSLEWMOD bit (GDU V5)            Noted temperature sensor slope is subject to further characterization</p>
14 DEC 2015	2.4	<p>Added T1IC0RR to PIM MODRR2 register            Updated temperature sensor electrical specification, <a href="#">Table B-1</a>            Added GDU current sense amp unity bandwidth parameter <a href="#">Table E-1</a>, <a href="#">Table E-2</a>            Added GDU current sense input resistance footnote <a href="#">Table E-1</a>, <a href="#">Table E-2</a></p>
14 JAN 2016	2.5	<p>Clarified non production mask sets <a href="#">Table 1-4</a>, <a href="#">Table 1-6</a>            Updated ordering information in Appendix L            Changed RESET pin input pulse passed parameter minimum specification value. <a href="#">Table A-13</a>            Replaced Freescale with NXP in logo and page footers            Added maximum value for GDU parameter VBSx current whilst high side inactive <a href="#">Table E-2</a></p>
07 MAR 2016	2.6	<p>Added 3N95G mask set information <a href="#">Table 1-19</a>, <a href="#">Table 1-4</a>, <a href="#">Table 1-6</a>            Added list of ISO26262 compliant devices            Moved GDU mask set dependent features to device overview section <a href="#">Table 1-19</a>            Added new 64LQFP-EP package diagrams <a href="#">Table K.2</a>            Added minimum value for GDU parameter VBSx current whilst high side inactive <a href="#">Table E-2</a>            Updated <math>V_{CSAoff}</math> parameter limits for GDU V5 and GDU V6 <a href="#">Table E-1</a>, <a href="#">Table E-2</a>            Added ADCCMD1[7:6] device dependencies in register listing <a href="#">Section M.13</a>, <a href="#">Section M.14</a>            Simplified GDU device dependencies in register listing <a href="#">Section M.15</a>            Corrected High Temperature Interrupt spec. (cannot wake up from STOP) <a href="#">Table 1-16</a>            Added footnote to <a href="#">Table A-14</a>            ZVMC256: added typical Run/Wait IDD values, updated 85°C Stop IDD <a href="#">Table A-18</a>, <a href="#">Table A-19</a>            Added bootstrap diode resistance parameter <a href="#">Table E-2</a>            Updated GDU boost coil current limit specification <a href="#">Table E-2</a>, <a href="#">Table E-1</a>            Reverted to original current sense amp. offset values <a href="#">Table E-2</a>, <a href="#">Table E-1</a>            Added package to mask set mapping table <a href="#">Table K-1</a></p>
08 MAR 2016	2.7	<p>Changed maximum value of <math>V_{BSTOFF}</math> <a href="#">Table E-2</a>, <a href="#">Table E-1</a>            Updated 48LQFP-EP Mechanical Information Diagram <a href="#">Section K.1</a></p>

**Table 0-1. Revision History**

Date	Revision	Description
19 APR 2016	2.8	Added PAD pin leakage specification at 125°C <a href="#">Table A-12</a> Updated $t_{HGON}$ , $t_{HGOFF}$ parameter values <a href="#">Table E-1</a> Specified VRH drop when using VDDS1 or VDDS2 as VRH on ZVMC256 <a href="#">Section C.1.1.5</a> Added min. and max. desaturation comparator filter times to electrical spec. <a href="#">Table E-1</a> Updated 64LQFP-EP thermal parameters <a href="#">Table A-9</a> , <a href="#">Table A-10</a>
06 JUN 2016	2.9	Fixed corrupted symbol fonts <a href="#">Table A-3</a> , <a href="#">Table A-5</a> Corrected wrong IFR reference <a href="#">Section 20.3.2.10</a> Clarified PAD8 leakage better <a href="#">Table A-12</a> Added $I_{SUPR}$ and $I_{SUPW}$ maximum values at $T_J = 175^\circ\text{C}$ for ZVMC256 <a href="#">Table A-18</a> Added Pseudo STOP maximum current for ZVMC256 <a href="#">Table A-20</a> Removed bandgap temperature dependency footnote, <a href="#">Table B-1</a> Changed ZVMC256 SNPS monitor threshold min/max values <a href="#">Table B-2</a> Changed VLS current limit threshold to 112mA <a href="#">Table E-1</a> , <a href="#">Table E-2</a> Removed desaturation comparator filter times from GDU chapter. Added desaturation comparator levels to <a href="#">Table E-1</a> , <a href="#">Table E-2</a> Added low side desaturation comparator functional range as footnote <a href="#">Table E-1</a> , <a href="#">Table E-2</a>
29 JUN 2016	2.10	Updated GDU VBS filter <a href="#">Figure 18-20</a> Removed incorrect reference to temperature sensor influencing GDU outputs <a href="#">Section 1.13.3.4</a> Changed Stop IDD (ISUPS) specifications for ZVMC256 <a href="#">Table A-19</a>
28 OCT 2016	2.11	Added IOC0 signal mapping to 48LQFP package <a href="#">Figure 1-6</a> Fixed corrupted symbol fonts in PIM chapter Added diode to VDDC pin <a href="#">Figure 1-18</a> Updated Stop mode current ISUPS maximum values <a href="#">Table A-19</a> Updated $t_{delon}$ , $t_{deloff}$ values <a href="#">Table E-1</a>



# Chapter 1

## Device Overview MC9S12ZVM-Family

1.1	Introduction	25
1.2	Features	26
1.2.1	MC9S12ZVM-Family Member Comparison	26
1.2.2	Module Version Differences Within The S12ZVM Family	27
1.2.3	Functional Differences Between Masksets	28
1.3	Chip-Level Features	28
1.4	Module Features	29
1.4.1	S12Z Central Processor Unit (CPU)	29
1.4.2	Embedded Memory	30
1.4.3	Clocks, Reset & Power Management Unit (CPMU)	31
1.4.4	Main External Oscillator (XOSCLCP)	32
1.4.5	Timer (TIM0)	32
1.4.6	Timer (TIM1) (ZVMC256 only)	32
1.4.7	Pulse width Modulator with Fault protection (PMF)	32
1.4.8	Programmable Trigger Unit (PTU)	32
1.4.9	LIN physical layer transceiver (ZVML devices only)	33
1.4.10	Serial Communication Interface Module (SCI)	33
1.4.11	Multi-Scalable Controller Area Network (MSCAN)	33
1.4.12	Serial Peripheral Interface Module (SPI)	34
1.4.13	Analog-to-Digital Converter Module (ADC)	34
1.4.14	Supply Voltage Sensor (BATS)	34
1.4.15	On-Chip Voltage Regulator system (VREG)	34
1.4.16	Gate Drive Unit (GDU)	35
1.4.17	Current Sense	35
1.4.18	High Voltage Physical Interface (ZVM32, ZVM16)	35
1.4.19	CAN Physical Layer Module (ZVMC256 only)	35
1.4.20	Pulse Width Modulation Module (PWM) (ZVMC256 only)	36
1.5	Block Diagram	37
1.6	Device Memory Map	38
1.6.1	Flash Module	39
1.6.2	Part ID Assignments	41
1.7	Signal Description and Device Pinouts	41
1.7.1	Pin Assignment Overview	42
1.7.2	Detailed External Signal Descriptions	42
1.7.3	Power Supply And Voltage Regulator Related Pins	50
1.7.4	Package and Pinouts	51
1.8	Internal Signal Mapping	63
1.8.1	ADC Connectivity	63
1.8.2	Motor Control Loop Signals	64
1.8.3	Device Level PMF Connectivity	65
1.8.4	BDC Clock Source Connectivity	65
1.8.5	LINPHY Connectivity	65
1.8.6	HVPHY Connectivity	65



1.8.7	FTMRZ Connectivity	66
1.8.8	CPMU Connectivity	66
1.9	Modes of Operation	66
1.9.1	Chip Configuration Modes	66
1.9.2	Debugging Modes	67
1.9.3	Low Power Modes	67
1.10	Security	68
1.10.1	Features	68
1.10.2	Securing the Microcontroller	68
1.10.3	Operation of the Secured Microcontroller	69
1.10.4	Unsecuring the Microcontroller	69
1.10.5	Reprogramming the Security Bits	70
1.10.6	Complete Memory Erase	70
1.11	Resets and Interrupts	71
1.11.1	Reset	71
1.11.2	Interrupt Vectors	71
1.11.3	Effects of Reset	74
1.12	Module device level dependencies	75
1.12.1	CPMU COP and GDU Configuration	75
1.12.2	CPMU High Temperature Trimming	76
1.12.3	CPMU VDDC enable	77
1.12.4	Flash IFR Mapping	77
1.13	Application Information	77
1.13.1	ADC Calibration	77
1.13.2	SCI Baud Rate Detection	78
1.13.3	Motor Control Application Overview	78
1.13.4	BDCM Complementary Mode Operation	86
1.13.5	BLDC Six-Step Commutation	90
1.13.6	PMSM Control	92
1.13.7	Power Domain Overview (All devices except ZVMC256)	96
1.13.8	Power Domain Overview (ZVMC256)	98

## Chapter 2

### Port Integration Module (S12ZVMPIMV3)

2.1	Introduction	104
2.1.1	Overview	104
2.1.2	Features	107
2.2	External Signal Description	108
2.3	Memory Map and Register Definition	115
2.3.1	Register Map	116
2.3.2	PIM Registers 0x0200-0x020F	122
2.3.3	PIM Generic Registers	133
2.3.4	PIM Generic Register Exceptions	140
2.4	Functional Description	147
2.4.1	General	147

2.4.2	Registers	147
2.4.3	Pin I/O Control	149
2.4.4	Pin interrupts and Key-Wakeup (KWU)	151
2.4.5	Over-Current Interrupt	152
2.4.6	High-Voltage Input	152
2.5	Initialization and Application Information	154
2.5.1	Port Data and Data Direction Register writes	154
2.5.2	Open Input Detection on HVI	154
2.5.3	Over-Current Protection on EVDD1	156

## Chapter 3 Memory Mapping Control (S12ZMMCV1)

3.1	Introduction	157
3.1.1	Glossary	158
3.1.2	Overview	158
3.1.3	Features	158
3.1.4	Modes of Operation	159
3.1.5	Block Diagram	159
3.2	External Signal Description	159
3.3	Memory Map and Register Definition	160
3.3.1	Memory Map	160
3.3.2	Register Descriptions	160
3.4	Functional Description	165
3.4.1	Global Memory Map	165
3.4.2	Illegal Accesses	167
3.4.3	Uncorrectable ECC Faults	168

## Chapter 4 Interrupt (S12ZINTV0)

4.1	Introduction	169
4.1.1	Glossary	170
4.1.2	Features	170
4.1.3	Modes of Operation	171
4.1.4	Block Diagram	171
4.2	External Signal Description	172
4.3	Memory Map and Register Definition	172
4.3.1	Module Memory Map	172
4.3.2	Register Descriptions	173
4.4	Functional Description	178
4.4.1	S12Z Exception Requests	178
4.4.2	Interrupt Prioritization	178
4.4.3	Priority Decoder	179
4.4.4	Reset Exception Requests	179
4.4.5	Exception Priority	180

4.4.6	Interrupt Vector Table Layout	180
4.5	Initialization/Application Information	180
4.5.1	Initialization	180
4.5.2	Interrupt Nesting	181
4.5.3	Wake Up from Stop or Wait Mode	182

## Chapter 5 Background Debug Controller (S12ZBDCV2)

5.1	Introduction	183
5.1.1	Glossary	183
5.1.2	Features	184
5.1.3	Modes of Operation	184
5.1.4	Block Diagram	186
5.2	External Signal Description	187
5.3	Memory Map and Register Definition	187
5.3.1	Module Memory Map	187
5.3.2	Register Descriptions	188
5.4	Functional Description	192
5.4.1	Security	192
5.4.2	Enabling BDC And Entering Active BDM	192
5.4.3	Clock Source	193
5.4.4	BDC Commands	193
5.4.5	BDC Access Of Internal Resources	210
5.4.6	BDC Serial Interface	213
5.4.7	Serial Interface Hardware Handshake (ACK Pulse) Protocol	216
5.4.8	Hardware Handshake Abort Procedure	218
5.4.9	Hardware Handshake Disabled (ACK Pulse Disabled)	219
5.4.10	Single Stepping	220
5.4.11	Serial Communication Timeout	220
5.5	Application Information	221
5.5.1	Clock Frequency Considerations	221

## Chapter 6 S12Z Debug (S12ZDBG) Module

6.1	Introduction	223
6.1.1	Glossary	224
6.1.2	Overview	224
6.1.3	Features	224
6.1.4	Modes of Operation	225
6.1.5	Block Diagram	226
6.2	External Signal Description	226
6.2.1	External Event Input	226
6.2.2	Profiling Output	227
6.3	Memory Map and Registers	227

6.3.1	Module Memory Map	227
6.3.2	Register Descriptions	230
6.4	Functional Description	251
6.4.1	DBG Operation	251
6.4.2	Comparator Modes	251
6.4.3	Events	255
6.4.4	State Sequence Control	257
6.4.5	Trace Buffer Operation	258
6.4.6	Code Profiling	267
6.4.7	Breakpoints	271
6.5	Application Information	272
6.5.1	Avoiding Unintended Breakpoint Re-triggering	272
6.5.2	Debugging Through Reset	272
6.5.3	Breakpoints from other S12Z sources	273
6.5.4	Code Profiling	273

## Chapter 7

### ECC Generation Module (SRAM\_ECCV1)

7.1	Introduction	275
7.1.1	Features	275
7.2	Memory Map and Register Definition	276
7.2.1	Register Summary	276
7.2.2	Register Descriptions	278
7.3	Functional Description	282
7.3.1	Non-aligned Memory Write Access	283
7.3.2	Aligned 2 and 4 Byte Memory Write Access	284
7.3.3	Memory Read Access	284
7.3.4	Memory Initialization	284
7.3.5	Interrupt Handling	285
7.3.6	ECC Algorithm	285
7.3.7	ECC Debug Behavior	285

## Chapter 8

### S12 Clock, Reset and Power Management Unit (V10 and V6)

8.1	Introduction	288
8.1.1	Differences between S12CPMU_UHV_V10 and S12CPMU_UHV_V6	289
8.1.2	Features	290
8.1.3	Modes of Operation	292
8.1.4	S12CPMU_UHV_V10_V6 Block Diagram	295
8.2	Signal Description	297
8.2.1	$\overline{\text{RESET}}$	297
8.2.2	EXTAL and XTAL	297
8.2.3	VSUP — Regulator Power Input Pin	297
8.2.4	VDDA, VSSA — Regulator Reference Supply Pins	297

8.2.5	VDDX, VSSX— Pad Supply Pins	297
8.2.6	VDDC— CAN Supply Pin	298
8.2.7	VDDS1— Sensor Supply1 Pin	298
8.2.8	VDDS2— Sensor Supply2 Pin	298
8.2.9	BCTL— Base Control Pin for external PNP	298
8.2.10	BCTLC — Base Control Pin for external PNP for VDDC power domain	299
8.2.11	BCTLS1 — Base Control Pin for external PNP for VDDS1 power domain	299
8.2.12	BCTLS2 — Base Control Pin for external PNP for VDDS2 power domain	300
8.2.13	SNPS1 — Sense Pin for VDDS1 power domain	300
8.2.14	SNPS2 — Sense Pin for VDDS2 power domain	300
8.2.15	VSS1,2 — Core Ground Pins	300
8.2.16	VDD— Core Logic Supply Pin	301
8.2.17	VDDF— NVM Logic Supply Pin	301
8.2.18	API_EXTCLK — API external clock output pin	301
8.2.19	TEMPSENSE — Internal Temperature Sensor Output Voltage	301
8.3	Memory Map and Registers	302
8.3.1	Module Memory Map	302
8.3.2	Register Descriptions	304
8.4	Functional Description	345
8.4.1	Phase Locked Loop with Internal Filter (PLL)	345
8.4.2	Startup from Reset	347
8.4.3	Stop Mode using PLLCLK as source of the Bus Clock	348
8.4.4	Full Stop Mode using Oscillator Clock as source of the Bus Clock	348
8.4.5	External Oscillator	350
8.4.6	System Clock Configurations	351
8.5	Resets	352
8.5.1	General	352
8.5.2	Description of Reset Operation	353
8.5.3	Oscillator Clock Monitor Reset	353
8.5.4	PLL Clock Monitor Reset	354
8.5.5	Computer Operating Properly Watchdog (COP) Reset	354
8.5.6	Power-On Reset (POR)	355
8.5.7	Low-Voltage Reset (LVR)	355
8.6	Interrupts	356
8.6.1	Description of Interrupt Operation	356
8.7	Initialization/Application Information	358
8.7.1	General Initialization Information	358
8.7.2	Application information for COP and API usage	358
8.7.3	Application Information for PLL and Oscillator Startup	359

## Chapter 9

### Analog-to-Digital Converter (ADC12B\_LBA)

9.1	Differences ADC12B_LBA V1 vs V2 vs V3	361
9.2	Introduction	362

9.3	Key Features	363
9.3.1	Modes of Operation	364
9.3.2	Block Diagram	367
9.4	Signal Description	368
9.4.1	Detailed Signal Descriptions	368
9.5	Memory Map and Register Definition	369
9.5.1	Module Memory Map	369
9.5.2	Register Descriptions	372
9.6	Functional Description	406
9.6.1	Overview	406
9.6.2	Analog Sub-Block	406
9.6.3	Digital Sub-Block	407
9.7	Resets	420
9.8	Interrupts	420
9.8.1	ADC Conversion Interrupt	420
9.8.2	ADC Sequence Abort Done Interrupt	420
9.8.3	ADC Error and Conversion Flow Control Issue Interrupt	421
9.9	Use Cases and Application Information	422
9.9.1	List Usage — CSL single buffer mode and RVL single buffer mode	422
9.9.2	List Usage — CSL single buffer mode and RVL double buffer mode	422
9.9.3	List Usage — CSL double buffer mode and RVL double buffer mode	423
9.9.4	List Usage — CSL double buffer mode and RVL single buffer mode	423
9.9.5	List Usage — CSL double buffer mode and RVL double buffer mode	424
9.9.6	RVL swapping in RVL double buffer mode and related registers ADCIMDRI and ADCEOLRI	424
9.9.7	Conversion flow control application information	426
9.9.8	Continuous Conversion	428
9.9.9	Triggered Conversion — Single CSL	429
9.9.10	Fully Timing Controlled Conversion	430

## Chapter 10

### Supply Voltage Sensor - (BATSV3)

10.1	Introduction	431
10.1.1	Features	431
10.1.2	Modes of Operation	431
10.1.3	Block Diagram	432
10.2	External Signal Description	432
10.2.1	VSUP — Voltage Supply Pin	432
10.3	Memory Map and Register Definition	433
10.3.1	Register Summary	433
10.3.2	Register Descriptions	433
10.4	Functional Description	437
10.4.1	General	437
10.4.2	Interrupts	437

## Chapter 11

### Timer Module (TIM16B4CV3) Block Description

11.1	Introduction	441
11.1.1	Features	441
11.1.2	Modes of Operation	441
11.1.3	Block Diagrams	442
11.2	External Signal Description	443
11.2.1	IOC3 - IOC0 — Input Capture and Output Compare Channel 3-0	443
11.3	Memory Map and Register Definition	443
11.3.1	Module Memory Map	443
11.3.2	Register Descriptions	443
11.4	Functional Description	455
11.4.1	Prescaler	456
11.4.2	Input Capture	457
11.4.3	Output Compare	457
11.5	Resets	458
11.6	Interrupts	458
11.6.1	Channel [3:0] Interrupt (C[3:0]F)	458
11.6.2	Timer Overflow Interrupt (TOF)	458

## Chapter 12

### Timer Module (TIM16B2CV3) Block Description

12.1	Introduction	459
12.1.1	Features	459
12.1.2	Modes of Operation	459
12.1.3	Block Diagrams	460
12.2	External Signal Description	460
12.2.1	IOC1 - IOC0 — Input Capture and Output Compare Channel 1-0	461
12.3	Memory Map and Register Definition	461
12.3.1	Module Memory Map	461
12.3.2	Register Descriptions	461
12.4	Functional Description	473
12.4.1	Prescaler	474
12.4.2	Input Capture	475
12.4.3	Output Compare	475
12.5	Resets	476
12.6	Interrupts	476
12.6.1	Channel [1:0] Interrupt (C[1:0]F)	476
12.6.2	Timer Overflow Interrupt (TOF)	476

## Chapter 13

### Scalable Controller Area Network (S12MSCANV3)

13.1	Introduction	477
13.1.1	Glossary	478

13.1.2	Block Diagram	478
13.1.3	Features	479
13.1.4	Modes of Operation	479
13.2	External Signal Description	480
13.2.1	RXCAN — CAN Receiver Input Pin	480
13.2.2	TXCAN — CAN Transmitter Output Pin	480
13.2.3	CAN System	480
13.3	Memory Map and Register Definition	481
13.3.1	Module Memory Map	481
13.3.2	Register Descriptions	483
13.3.3	Programmer's Model of Message Storage	502
13.4	Functional Description	513
13.4.1	General	513
13.4.2	Message Storage	513
13.4.3	Identifier Acceptance Filter	516
13.4.4	Modes of Operation	522
13.4.5	Low-Power Options	524
13.4.6	Reset Initialization	528
13.4.7	Interrupts	528
13.5	Initialization/Application Information	530
13.5.1	MSCAN initialization	530
13.5.2	Bus-Off Recovery	530

## Chapter 14 Programmable Trigger Unit (PTUV3)

14.1	Introduction	531
14.1.1	Features	531
14.1.2	Modes of Operation	532
14.1.3	Block Diagram	533
14.2	External Signal Description	533
14.2.1	PTUT0 — PTU Trigger 0	533
14.2.2	PTUT1 — PTU Trigger 1	533
14.2.3	PTURE — PTUE Reload Event	534
14.3	Memory Map and Register Definition	534
14.3.1	Register Summary	534
14.3.2	Register Descriptions	536
14.4	Functional Description	552
14.4.1	General	552
14.4.2	Memory based trigger event list	554
14.4.3	Reload mechanism	555
14.4.4	Async reload event	555
14.4.5	Interrupts and error handling	556
14.4.6	Debugging	557



## Chapter 15

### Pulse Width Modulator with Fault Protection (PMF15B6CV4)

15.1	Introduction	560
15.1.1	Features	561
15.1.2	Modes of Operation	561
15.1.3	Block Diagram	563
15.2	Signal Descriptions	564
15.2.1	PWM0–PWM5 Pins	564
15.2.2	FAULT0–FAULT5 Pins	564
15.2.3	IS0–IS2 Pins	564
15.2.4	Global Load OK Signal — glb_ldok	564
15.2.5	Commutation Event Signal — async_event	564
15.2.6	Commutation Event Edge Select Signal — async_event_edge_sel[1:0]	565
15.2.7	PWM Reload Event Signals — pmf_reloada,b,c	565
15.2.8	PWM Reload-Is-Asynchronous Signal — pmf_reload_is_async	565
15.3	Memory Map and Registers	566
15.3.1	Module Memory Map	566
15.3.2	Register Descriptions	571
15.4	Functional Description	599
15.4.1	Block Diagram	599
15.4.2	Prescaler	600
15.4.3	PWM Generator	600
15.4.4	Independent or Complementary Channel Operation	604
15.4.5	Deadtime Generators	605
15.4.6	Top/Bottom Correction	607
15.4.7	Asymmetric PWM Output	613
15.4.8	Variable Edge Placement PWM Output	614
15.4.9	Double Switching PWM Output	615
15.4.10	Output Polarity	617
15.4.11	Software Output Control	617
15.4.12	PWM Generator Loading	620
15.4.13	Fault Protection	625
15.5	Resets	627
15.6	Clocks	627
15.7	Interrupts	628
15.8	Initialization and Application Information	628
15.8.1	Initialization	628
15.8.2	BLDC 6-Step Commutation	629

## Chapter 16

### Serial Communication Interface (S12SCIV6)

16.1	Introduction	633
16.1.1	Glossary	633
16.1.2	Features	634

16.1.3	Modes of Operation .....	635
16.1.4	Block Diagram .....	635
16.2	External Signal Description .....	636
16.2.1	TXD — Transmit Pin .....	636
16.2.2	RXD — Receive Pin .....	636
16.3	Memory Map and Register Definition .....	636
16.3.1	Module Memory Map and Register Definition .....	636
16.3.2	Register Descriptions .....	637
16.4	Functional Description .....	650
16.4.1	Infrared Interface Submodule .....	651
16.4.2	LIN Support .....	651
16.4.3	Data Format .....	652
16.4.4	Baud Rate Generation .....	653
16.4.5	Transmitter .....	654
16.4.6	Receiver .....	659
16.4.7	Single-Wire Operation .....	667
16.4.8	Loop Operation .....	668
16.5	Initialization/Application Information .....	668
16.5.1	Reset Initialization .....	668
16.5.2	Modes of Operation .....	669
16.5.3	Interrupt Operation .....	669
16.5.4	Recovery from Wait Mode .....	672
16.5.5	Recovery from Stop Mode .....	672

## Chapter 17

### Serial Peripheral Interface (S12SPIV5)

17.1	Introduction .....	673
17.1.1	Glossary of Terms .....	673
17.1.2	Features .....	673
17.1.3	Modes of Operation .....	673
17.1.4	Block Diagram .....	674
17.2	External Signal Description .....	675
17.2.1	MOSI — Master Out/Slave In Pin .....	675
17.2.2	MISO — Master In/Slave Out Pin .....	676
17.2.3	$\overline{SS}$ — Slave Select Pin .....	676
17.2.4	SCK — Serial Clock Pin .....	676
17.3	Memory Map and Register Definition .....	676
17.3.1	Module Memory Map .....	676
17.3.2	Register Descriptions .....	677
17.4	Functional Description .....	685
17.4.1	Master Mode .....	686
17.4.2	Slave Mode .....	687
17.4.3	Transmission Formats .....	688
17.4.4	SPI Baud Rate Generation .....	693
17.4.5	Special Features .....	694

17.4.6 Error Conditions .....	695
17.4.7 Low Power Mode Options .....	696

## Chapter 18

### Gate Drive Unit (GDU)

18.1 Differences GDUV4 vs GDUV5 vs GDUV6 .....	699
18.1.1 Features .....	700
18.1.2 Modes of Operation .....	701
18.1.3 Block Diagram .....	702
18.2 External Signal Description .....	703
18.2.1 HD — High-Side Drain Connection .....	703
18.2.2 VBS[2:0] — Bootstrap Capacitor Connection Pins .....	703
18.2.3 HG[2:0] — High-Side Gate Pins .....	703
18.2.4 HS[2:0] — High-Side Source Pins .....	703
18.2.5 VLS[2:0] — Voltage Supply for Low-Side Pre-Drivers .....	703
18.2.6 LG[2:0] — Low-Side Gate Pins .....	703
18.2.7 LD[2:0] — Low-Side Gate Pins (only on GDUV6) .....	703
18.3 Memory Map and Register Definition .....	705
18.3.1 Register Summary .....	705
18.3.2 Register Descriptions .....	706
18.4 Functional Description .....	726
18.4.1 General .....	726
18.4.2 Low-Side FET Pre-Drivers .....	726
18.4.3 High-Side FET Pre-Driver .....	726
18.4.4 Charge Pump .....	729
18.4.5 Desaturation Error .....	731
18.4.6 Phase Comparators .....	733
18.4.7 Fault Protection Features .....	734
18.4.8 Current Sense Amplifier and Overcurrent Comparator .....	738
18.4.9 GDU DC Link Voltage Monitor .....	738
18.4.10 Boost Converter .....	739
18.4.11 Interrupts .....	740
18.5 Application Information .....	741
18.5.1 FET Pre-Driver Details .....	741
18.5.2 GDU Intrinsic Dead Time .....	742
18.5.3 Calculation of Bootstrap Capacitor .....	744
18.5.4 On Chip GDU tdelon and tdeloff Measurement .....	744

## Chapter 19

### LIN/HV Physical Layer (S12LINPHYV3)

19.1 Introduction .....	747
19.1.1 Features .....	748
19.1.2 Modes of Operation .....	748
19.1.3 Block Diagram .....	749

19.2	External Signal Description	751
19.2.1	LIN — LIN Bus Pin	751
19.2.2	LGND — LIN Ground Pin	751
19.2.3	VLINSUP — Positive Power Supply	751
19.2.4	LPTxD — LIN Transmit Pin	751
19.2.5	LPRxD — LIN Receive Pin	751
19.3	Memory Map and Register Definition	751
19.3.1	Module Memory Map	751
19.3.2	Register Descriptions	753
19.4	Functional Description	760
19.4.1	General	760
19.4.2	Slew Rate and LIN Mode Selection	760
19.4.3	Modes	761
19.4.4	Interrupts	764
19.5	Application Information	767
19.5.1	Module Initialization	767
19.5.2	Interrupt handling in Interrupt Service Routine (ISR)	767

## Chapter 20

### Flash Module (S12ZFTMRZ)

20.1	Introduction	769
20.1.1	Glossary	770
20.1.2	Features	770
20.1.3	Block Diagram	771
20.2	External Signal Description	773
20.3	Memory Map and Registers	774
20.3.1	Module Memory Map	774
20.3.2	Register Descriptions	778
20.4	Functional Description	798
20.4.1	Modes of Operation	798
20.4.2	IFR Version ID Word	798
20.4.3	Flash Block Read Access	798
20.4.4	Internal NVM resource	799
20.4.5	Flash Command Operations	800
20.4.6	Allowed Simultaneous P-Flash and EEPROM Operations	804
20.4.7	Flash Command Description	805
20.4.8	Interrupts	821
20.4.9	Wait Mode	822
20.4.10	Stop Mode	822
20.5	Security	822
20.5.1	Unsecuring the MCU using Backdoor Key Access	823
20.5.2	Unsecuring the MCU in Special Single Chip Mode using BDM	823
20.5.3	Mode and Security Effects on Flash Command Availability	823
20.6	Initialization	824

## Chapter 21

### CAN Physical Layer (S12CANPHYV3)

21.1	Introduction	825
21.1.1	Features	825
21.1.2	Modes of Operation	826
21.1.3	Block Diagram	826
21.2	External Signal Description	827
21.2.1	CANH — CAN Bus High Pin	828
21.2.2	CANL — CAN Bus Low Pin	828
21.2.3	SPLIT — CAN Bus Termination Pin	828
21.2.4	VDDC — Supply Pin for CAN Physical Layer	828
21.2.5	VSSC — Ground Pin for CAN Physical Layer	828
21.3	Internal Signal Description	828
21.3.1	CPTXD — TXD Input to CAN Physical Layer	828
21.3.2	CPRXD — RXD Output of CAN Physical Layer	828
21.4	Memory Map and Register Definition	829
21.4.1	Module Memory Map	829
21.4.2	Register Descriptions	830
21.5	Functional Description	837
21.5.1	General	837
21.5.2	Modes	837
21.5.3	Configurable Wake-Up	839
21.5.4	Interrupts	840
21.6	Initialization/Application Information	841
21.6.1	Initialization Sequence	841
21.6.2	Wake-up Mechanism	842
21.6.3	Bus Error Handling	842
21.6.4	CPTXD-Dominant Timeout Recovery	843

## Chapter 22

### Pulse-Width Modulator (S12PWM8B8CV2)

22.1	Introduction	845
22.1.1	Features	845
22.1.2	Modes of Operation	845
22.1.3	Block Diagram	846
22.2	External Signal Description	846
22.2.1	PWM7 - PWM0 — PWM Channel 7 - 0	847
22.3	Memory Map and Register Definition	847
22.3.1	Module Memory Map	847
22.3.2	Register Descriptions	847
22.4	Functional Description	862
22.4.1	PWM Clock Select	862
22.4.2	PWM Channel Timers	865
22.5	Resets	872

22.6 Interrupts .....	873
-----------------------	-----

## **Appendix A MCU Electrical Specifications**

A.1 General .....	875
A.2 General Purpose I/O Characteristics .....	888
A.3 Supply Currents .....	890
A.4 ADC Calibration Configuration .....	893

## **Appendix B CPMU Electrical Specifications (VREG, OSC, IRC, PLL)**

B.1 VREG Electrical Specifications .....	895
B.2 Reset and Stop Timing Characteristics .....	897
B.3 IRC and OSC Electrical Specifications .....	898
B.4 Phase Locked Loop .....	898

## **Appendix C ADC Electrical Specifications**

C.1 ADC Operating Characteristics .....	901
---	-----

## **Appendix D LIN/HV PHY Electrical Specifications**

D.1 Static Electrical Characteristics .....	907
D.2 Dynamic Electrical Characteristics .....	908

## **Appendix E GDU Electrical Specifications**

E.1 GDU specifications for devices featuring GDU V4 or V6 .....	911
E.2 Preliminary GDU specifications for devices featuring GDU V5 .....	914

## **Appendix F NVM Electrical Parameters**

F.1 NVM Timing Parameters .....	919
F.2 NVM Reliability Parameters .....	926
F.3 NVM Factory Shipping Condition .....	926

## **Appendix G BATS Electrical Specifications**

G.1 Static Electrical Characteristics .....	927
G.2 Dynamic Electrical Characteristics .....	928

## Appendix H S12CANPHY Electrical Specifications

H.1	Maximum Ratings	929
H.2	Static Electrical Characteristics	929
H.3	Dynamic Electrical Characteristics	932

## Appendix I SPI Electrical Specifications

I.1	Master Mode	935
-----	-------------	-----

## Appendix J MSCAN Electrical Specifications

J.1	MSCAN Wake-up Pulse Timing	939
-----	----------------------------	-----

## Appendix K Package Information

K.1	48LQFP-EP Mechanical Information	942
K.2	64LQFP-EP Mechanical Info (all mask sets except 1N95G, 2N95G)	945
K.3	64LQFP-EP Mechanical Information (mask sets 1N95G, 2N95G)	949
K.4	80LQFP-EP Mechanical Information	952

## Appendix L Ordering Information

## Appendix M Detailed Register Address Map

M.1	0x0000–0x0003 Part ID	957
M.2	0x0010–0x001F S12ZINT	957
M.3	0x0070–0x00FF S12ZMMC	959
M.4	0x0100–0x017F S12ZDBG	959
M.5	0x0200–0x02FF PIM (See footnotes for part specific information)	963
M.6	0x0380–0x039F FTMRZ128K512	969
M.7	0x03C0–0x03CF SRAM_ECC_32D7P	971
M.8	0x0400–0x042F TIM1	972
M.9	0x0480–0x04AF PWM0	973
M.10	0x0500–x053F PMF15B6C	975
M.11	0x0580–0x059F PTU	979
M.12	0x05C0–0x05FF TIM0	981
M.13	0x0600–0x063F ADC0	983
M.14	0x0640–0x067F ADC1	985
M.15	0x06A0–0x06BF GDU	987
M.16	0x06C0–0x06DF CPMU	988
M.17	0x06F0–0x06F7 BATS	990

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M.18 0x0700-0x0707 SCI0 .....	990
M.19 0x0710-0x0717 SCI1 .....	991
M.20 0x0780-0x0787 SPI0.....	992
M.21 0x0800-0x083F CAN0.....	992
M.22 0x0980-0x0987 LINPHY0 .....	994
M.23 0x0990-0x0997 CANPHY .....	994





# Chapter 1

## Device Overview MC9S12ZVM-Family

Table 1-1. Revision History

Version Number	Revision Date	Sections Affected	Description of Changes
1.8	04.Sep.2014	<a href="#">Section 1.2.1</a>	<ul style="list-style-type: none"> <li>Added S12ZVML31 information to derivative table</li> </ul>
2.0	10.Oct.2014	General	<ul style="list-style-type: none"> <li>Added ZVMC256 information</li> </ul>
2.01	06.Feb.2015	General	<ul style="list-style-type: none"> <li>Added 2N95G maskset information.</li> <li>Added TIM1 for ZVMC256</li> </ul>
2.02	25.Aug.2016	<a href="#">Figure 1-6</a> , <a href="#">Table 1-8</a> <a href="#">Section 1.13.3.6</a>	<ul style="list-style-type: none"> <li>Clarified IOC0 device pin mapping dependencies</li> <li>Clarified IOC0 device pin mapping dependencies</li> <li>Removed Temperature Sensor from list of Dynamic motor control fault inputs</li> </ul>

### 1.1 Introduction

The MC9S12ZVM-Family is an automotive 16-bit microcontroller family using the NVM + UHV technology that offers the capability to integrate 40 V analog components. This family reuses many features from the existing S12/S12X portfolio. The particular differentiating features of this family are the enhanced S12Z core, the combination of dual-ADC synchronized with PWM generation and the integration of “high-voltage” analog modules, including the voltage regulator (VREG), Gate Drive Unit (GDU), and either Local Interconnect Network (LIN) physical layer or CAN Physical layer. These features enable a fully integrated single chip solution to drive up to 6 external power MOSFETs for BLDC or PMSM motor drive applications.

The MC9S12ZVM-Family includes error correction code (ECC) on RAM and flash memory, EEPROM for diagnostic or data storage, a fast analog-to-digital converter (ADC) and a frequency modulated phase locked loop (IPLL) that improves the EMC performance. The MC9S12ZVM-Family allows the integration of several key system components into a single device, optimizing system architecture and achieving significant space savings. The MC9S12ZVM-Family delivers all the advantages and efficiencies of a 16-bit MCU while retaining the low cost, power consumption, EMC, and code-size efficiency advantages currently enjoyed by users of existing S12(X) families. The MC9S12ZVM-Family is available in different pin-out options, using 80-pin, 64-pin and 48-pin LQFP-EP packages to accommodate LIN, CAN and external PWM based application interfaces. In addition to the I/O ports available in each module, further I/O ports are available with interrupt capability allowing wake-up from stop or wait modes.

The MC9S12ZVM-Family is a general-purpose family of devices suitable for a range of applications, including:

- 3-phase sensorless BLDC motor control for
  - Fuel pump