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MC9S12ZVL Family Reference Manual and Datasheet

***S12 MagniV
Microcontrollers***

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MC9S12ZVLRM

nxp.com



The MC9S12ZVL family of microcontrollers is targeted at use in safety relevant systems and has been developed using an ISO26262 compliant development system under the NXP Safe Assure program.

For more details of how to use the device in safety relevant systems refer to the MC9S12ZVL Safety Manual at :

<http://nxp.com/S12ZVL>

To provide the most up-to-date information, the revision of our documents on the World Wide Web will be the most current. Your printed copy may be an earlier revision. To verify you have the latest information available, refer to:

<http://nxp.com>

A full list of family members and options is included in the device overview section.

This document contains information for all constituent modules, with the exception of the S12Z CPU. For S12ZCPU information please refer to the CPU S12Z Reference Manual.

NOTE

This reference manual documents the entire S12ZVL-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 MC9S12ZVL-Family Member Comparison provides support to access the correct information for a particular part within the family.

Revision History

Date	Revision Level	Description
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Revision History

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Chapter 1

Device Overview MC9S12ZVL-Family

1.1	Introduction	21
1.2	Features	22
1.2.1	MC9S12ZVL-Family Member Comparison	22
1.3	Chip-Level Features	23
1.4	Module Features	24
1.4.1	S12Z Central Processor Unit (CPU)	24
1.4.2	Embedded Memory	25
1.4.3	Clocks, Reset & Power Management Unit (CPMU)	26
1.4.4	Main External Oscillator (XOSCLCP)	27
1.4.5	Timer (TIM0 and TIM1)	27
1.4.6	Pulse Width Modulation Module (PWM0 and PMW1)	27
1.4.7	Inter-IC Module (IIC)	27
1.4.8	LIN physical layer transceiver	28
1.4.9	Serial Communication Interface Module (SCI)	28
1.4.10	Serial Peripheral Interface Module (SPI)	28
1.4.11	Multi-Scalable Controller Area Network (MSCAN)	28
1.4.12	Analog-to-Digital Converter Module (ADC)	29
1.4.13	Digital-to-Analog Converter Module (DAC)	29
1.4.14	Analog Comparator Module (ACMP)	29
1.4.15	Programmable Gain Amplifier (PGA)	29
1.4.16	Supply Voltage Sensor (BATS)	30
1.4.17	On-Chip Voltage Regulator system (VREG)	30
1.5	Block Diagram	31
1.6	Device Memory Map	32
1.6.1	Part ID Assignments	35
1.7	Signal Description and Device Pinouts	35
1.7.1	Pin Assignment Overview	35
1.7.2	Detailed External Signal Descriptions	36
1.7.3	Power Supply Pins	41
1.8	Device Pinouts	41
1.9	Internal Signal Mapping	47
1.9.1	ADC Connectivity	47
1.9.2	BDC Clock Source Connectivity	48
1.9.3	FTMRZ Connectivity	48
1.9.4	CPMU Connectivity	48
1.9.5	LINPHY Connectivity	48
1.9.6	MC9S12ZVLA analog module Connectivity	48
1.9.7	PWM channel mapping	50
1.10	Modes of Operation	51
1.10.1	3.3V - 5V VDDX behavior on MC9S12ZVL(A)128/96/64 devices	51
1.10.2	Chip Configuration Modes	51
1.10.3	Debugging Modes	52
1.10.4	Low Power Modes	52

1.11	Security	53
1.11.1	Features	53
1.11.2	Securing the Microcontroller	53
1.11.3	Operation of the Secured Microcontroller	54
1.11.4	Unsecuring the Microcontroller	54
1.11.5	Reprogramming the Security Bits	55
1.11.6	Complete Memory Erase	55
1.12	Resets and Interrupts	56
1.12.1	Resets	56
1.12.2	Interrupt Vectors	56
1.12.3	Effects of Reset	59
1.13	Module device level dependencies	60
1.13.1	COP Configuration	60
1.13.2	BDC Command Restriction	60
1.13.3	Flash IFR Mapping	61
1.14	Application Information	61
1.14.1	ADC Calibration	61
1.14.2	SCI Baud Rate Detection	62
1.14.3	Voltage Domain Monitoring	62

Chapter 2

Port Integration Module (S12ZVLPIMV2)

2.1	Introduction	63
2.1.1	Overview	63
2.1.2	Features	64
2.2	External Signal Description	65
2.3	Memory Map and Register Definition	70
2.3.1	Register Map	71
2.3.2	PIM Registers 0x0200-0x020F	77
2.3.3	PIM Generic Registers	85
2.3.4	PIM Generic Register Exceptions	92
2.4	Functional Description	97
2.4.1	General	97
2.4.2	Registers	97
2.4.3	Pin I/O Control	98
2.4.4	Interrupts	100
2.4.5	High-Voltage Input	101
2.5	Initialization and Application Information	104
2.5.1	Port Data and Data Direction Register writes	104
2.5.2	SCI Baud Rate Detection	104
2.5.3	Over-Current Protection on EVDD1	104
2.5.4	Over-Current Protection on PP[5,3,1]	104
2.5.5	Open Input Detection on HVI	105

Chapter 3

5V Analog Comparator (ACMPV2)

3.1	Introduction	107
3.2	Features	107
3.3	Block Diagram	108
3.4	External Signals	108
3.4.1	Internal Signals	108
3.5	Modes of Operation	108
3.6	Memory Map and Register Definition	109
3.6.1	Register Map	109
3.6.2	Register Descriptions	110
3.7	Functional Description	113
3.8	Interrupts	114

Chapter 4

Memory Mapping Control (S12ZMMCV1)

4.1	Introduction	115
4.1.1	Glossary	116
4.1.2	Overview	116
4.1.3	Features	116
4.1.4	Modes of Operation	116
4.1.5	Block Diagram	117
4.2	External Signal Description	117
4.3	Memory Map and Register Definition	117
4.3.1	Memory Map	117
4.3.2	Register Descriptions	118
4.4	Functional Description	123
4.4.1	Global Memory Map	123
4.4.2	Illegal Accesses	125
4.4.3	Uncorrectable ECC Faults	126

Chapter 5

Background Debug Controller (S12ZBDCV2)

5.1	Introduction	127
5.1.1	Glossary	128
5.1.2	Features	128
5.1.3	Modes of Operation	128
5.1.4	Block Diagram	131
5.2	External Signal Description	131
5.3	Memory Map and Register Definition	132
5.3.1	Module Memory Map	132
5.3.2	Register Descriptions	132
5.4	Functional Description	136
5.4.1	Security	136

5.4.2	Enabling BDC And Entering Active BDM	136
5.4.3	Clock Source	137
5.4.4	BDC Commands	137
5.4.5	BDC Access Of Internal Resources	153
5.4.6	BDC Serial Interface	156
5.4.7	Serial Interface Hardware Handshake (ACK Pulse) Protocol	159
5.4.8	Hardware Handshake Abort Procedure	161
5.4.9	Hardware Handshake Disabled (ACK Pulse Disabled)	162
5.4.10	Single Stepping	163
5.4.11	Serial Communication Timeout	164
5.5	Application Information	164
5.5.1	Clock Frequency Considerations	164

Chapter 6 Interrupt (S12ZINTV0)

6.1	Introduction	165
6.1.1	Glossary	165
6.1.2	Features	166
6.1.3	Modes of Operation	166
6.1.4	Block Diagram	167
6.2	External Signal Description	167
6.3	Memory Map and Register Definition	167
6.3.1	Module Memory Map	167
6.3.2	Register Descriptions	168
6.4	Functional Description	173
6.4.1	S12Z Exception Requests	173
6.4.2	Interrupt Prioritization	173
6.4.3	Priority Decoder	174
6.4.4	Reset Exception Requests	175
6.4.5	Exception Priority	175
6.4.6	Interrupt Vector Table Layout	176
6.5	Initialization/Application Information	176
6.5.1	Initialization	176
6.5.2	Interrupt Nesting	176
6.5.3	Wake Up from Stop or Wait Mode	177

Chapter 7 S12Z DebugLite (S12ZDBGV3)

7.1	Introduction	179
7.1.1	Glossary	179
7.1.2	Overview	180
7.1.3	Features	180
7.1.4	Modes of Operation	181
7.1.5	Block Diagram	181

7.2	External Signal Description	181
7.2.1	External Event Input	181
7.3	Memory Map and Registers	182
7.3.1	Module Memory Map	182
7.3.2	Register Descriptions	184
7.4	Functional Description	196
7.4.1	DBG Operation	196
7.4.2	Comparator Modes	197
7.4.3	Events	200
7.4.4	State Sequence Control	202
7.4.5	Breakpoints	202
7.5	Application Information	204
7.5.1	Avoiding Unintended Breakpoint Re-triggering	204
7.5.2	Breakpoints from other S12Z sources	204

Chapter 8

ECC Generation Module (SRAM_ECCV2)

8.1	Introduction	205
8.1.1	Features	205
8.2	Memory Map and Register Definition	206
8.2.1	Register Summary	206
8.2.2	Register Descriptions	208
8.3	Functional Description	212
8.3.1	Aligned Memory Write Access	213
8.3.2	Non-aligned Memory Write Access	213
8.3.3	Memory Read Access	214
8.3.4	Memory Initialization	214
8.3.5	Interrupt Handling	214
8.3.6	ECC Algorithm	215
8.3.7	ECC Debug Behavior	215

Chapter 9

S12 Clock, Reset and Power Management Unit (S12CPMU_UHV)

9.1	Introduction	217
9.1.1	Features	218
9.1.2	Modes of Operation	220
9.1.3	S12CPMU_UHV Block Diagram	224
9.2	Signal Description	226
9.2.1	RESET	226
9.2.2	EXTAL and XTAL	226
9.2.3	VSUP — Regulator Power Input Pin	226
9.2.4	VDDA, VSSA — Regulator Reference Supply Pins	226
9.2.5	VDDX, VSSX — Pad Supply Pins	226
9.2.6	BCTL — Base Control Pin for external PNP	227

9.2.7	VSS — Core Logic Ground Pin	227
9.2.8	VDD — Internal Regulator Output Supply (Core Logic)	227
9.2.9	VDDF — Internal Regulator Output Supply (NVM Logic)	227
9.2.10	API_EXTCLK — API external clock output pin	227
9.2.11	TEMPSENSE — Internal Temperature Sensor Output Voltage	227
9.3	Memory Map and Registers	228
9.3.1	Module Memory Map	228
9.3.2	Register Descriptions	230
9.4	Functional Description	269
9.4.1	Phase Locked Loop with Internal Filter (PLL)	269
9.4.2	Startup from Reset	271
9.4.3	Stop Mode using PLLCLK as source of the Bus Clock	272
9.4.4	Full Stop Mode using Oscillator Clock as source of the Bus Clock	272
9.4.5	External Oscillator	274
9.4.6	System Clock Configurations	275
9.5	Resets	276
9.5.1	General	276
9.5.2	Description of Reset Operation	277
9.5.3	Oscillator Clock Monitor Reset	277
9.5.4	PLL Clock Monitor Reset	278
9.5.5	Computer Operating Properly Watchdog (COP) Reset	278
9.5.6	Power-On Reset (POR)	279
9.5.7	Low-Voltage Reset (LVR)	279
9.6	Interrupts	280
9.6.1	Description of Interrupt Operation	280
9.7	Initialization/Application Information	282
9.7.1	General Initialization Information	282
9.7.2	Application information for COP and API usage	282
9.7.3	Application Information for PLL and Oscillator Startup	282

Chapter 10

Analog-to-Digital Converter (ADC12B_LBA)

10.1	Differences ADC12B_LBA V1 vs V2 vs V3	285
10.2	Introduction	286
10.3	Key Features	287
10.3.1	Modes of Operation	288
10.3.2	Block Diagram	291
10.4	Signal Description	292
10.4.1	Detailed Signal Descriptions	292
10.5	Memory Map and Register Definition	293
10.5.1	Module Memory Map	293
10.5.2	Register Descriptions	296
10.6	Functional Description	330
10.6.1	Overview	330

10.6.2	Analog Sub-Block	330
10.6.3	Digital Sub-Block	331
10.7	Resets	344
10.8	Interrupts	344
10.8.1	ADC Conversion Interrupt	344
10.8.2	ADC Sequence Abort Done Interrupt	344
10.8.3	ADC Error and Conversion Flow Control Issue Interrupt	345
10.9	Use Cases and Application Information	346
10.9.1	List Usage — CSL single buffer mode and RVL single buffer mode	346
10.9.2	List Usage — CSL single buffer mode and RVL double buffer mode	346
10.9.3	List Usage — CSL double buffer mode and RVL double buffer mode	347
10.9.4	List Usage — CSL double buffer mode and RVL single buffer mode	347
10.9.5	List Usage — CSL double buffer mode and RVL double buffer mode	348
10.9.6	RVL swapping in RVL double buffer mode and related registers ADCIMDRI and ADCEOLRI	348
10.9.7	Conversion flow control application information	350
10.9.8	Continuous Conversion	352
10.9.9	Triggered Conversion — Single CSL	353
10.9.10	Fully Timing Controlled Conversion	354

Chapter 11

Digital Analog Converter (DAC_8B5V_V2)

11.1	Revision History	355
11.2	Introduction	355
11.2.1	Features	356
11.2.2	Modes of Operation	356
11.2.3	Block Diagram	357
11.3	External Signal Description	357
11.3.1	DACU Output Pin	357
11.3.2	AMP Output Pin	357
11.3.3	AMPP Input Pin	357
11.3.4	AMPM Input Pin	358
11.4	Memory Map and Register Definition	358
11.4.1	Register Summary	358
11.4.2	Register Descriptions	358
11.5	Functional Description	361
11.5.1	Functional Overview	361
11.5.2	Mode “Off”	362
11.5.3	Mode “Operational Amplifier”	362
11.5.4	Mode “Internal DAC only”	362
11.5.5	Mode “Unbuffered DAC”	362
11.5.6	Mode “Unbuffered DAC with Operational Amplifier”	362
11.5.7	Mode “Buffered DAC”	363
11.5.8	Analog output voltage calculation	363

Chapter 12

Programmable Gain Amplifier (PGAV1)

12.1	Revision History	365
12.2	Introduction	365
12.2.1	Features	365
12.2.2	Modes of Operation	365
12.2.3	Block Diagram	366
12.2.4	External Signal Description	366
12.2.5	Amplifier Inputs	366
12.2.6	PGA_OUT Pin	367
12.3	Memory Map and Register Definition	367
12.3.1	Register Summary	367
12.3.2	Register Descriptions	368
12.4	Functional Description	372
12.4.1	Functional Overview	372
12.4.2	Offset Compensation	372
12.4.3	Application Example for differential voltage measurement	373

Chapter 13

Scalable Controller Area Network (S12MSCANV2)

13.1	Introduction	375
13.1.1	Glossary	376
13.1.2	Block Diagram	376
13.1.3	Features	377
13.1.4	Modes of Operation	377
13.2	External Signal Description	378
13.2.1	RXCAN — CAN Receiver Input Pin	378
13.2.2	TXCAN — CAN Transmitter Output Pin	378
13.2.3	CAN System	378
13.3	Memory Map and Register Definition	379
13.3.1	Module Memory Map	379
13.3.2	Register Descriptions	381
13.3.3	Programmer's Model of Message Storage	399
13.4	Functional Description	410
13.4.1	General	410
13.4.2	Message Storage	410
13.4.3	Identifier Acceptance Filter	413
13.4.4	Modes of Operation	419
13.4.5	Low-Power Options	421
13.4.6	Reset Initialization	425
13.4.7	Interrupts	425
13.5	Initialization/Application Information	427
13.5.1	MSCAN initialization	427

Chapter 14

Supply Voltage Sensor (BATSV3)

14.1	Introduction	429
14.1.1	Features	429
14.1.2	Modes of Operation	429
14.1.3	Block Diagram	430
14.2	External Signal Description	430
14.2.1	VSUP — Voltage Supply Pin	430
14.3	Memory Map and Register Definition	431
14.3.1	Register Summary	431
14.3.2	Register Descriptions	431
14.4	Functional Description	435
14.4.1	General	435
14.4.2	Interrupts	435

Chapter 15

Timer Module (TIM16B6CV3)

15.1	Introduction	439
15.1.1	Features	439
15.1.2	Modes of Operation	440
15.1.3	Block Diagrams	440
15.2	External Signal Description	441
15.2.1	IOC5 - IOC0 — Input Capture and Output Compare Channel 5-0	441
15.3	Memory Map and Register Definition	441
15.3.1	Module Memory Map	441
15.3.2	Register Descriptions	441
15.4	Functional Description	453
15.4.1	Prescaler	454
15.4.2	Input Capture	455
15.4.3	Output Compare	455
15.5	Resets	456
15.6	Interrupts	456
15.6.1	Channel [5:0] Interrupt (C[5:0]F)	456
15.6.2	Timer Overflow Interrupt (TOF)	456

Chapter 16

Timer Module (TIM16B2CV3)

16.1	Introduction	457
16.1.1	Features	457
16.1.2	Modes of Operation	458
16.1.3	Block Diagrams	458
16.2	External Signal Description	459
16.2.1	IOC1 - IOC0 — Input Capture and Output Compare Channel 1-0	459
16.3	Memory Map and Register Definition	459

16.3.1	Module Memory Map	459
16.3.2	Register Descriptions	459
16.4	Functional Description	471
16.4.1	Prescaler	472
16.4.2	Input Capture	473
16.4.3	Output Compare	473
16.5	Resets	474
16.6	Interrupts	474
16.6.1	Channel [1:0] Interrupt (C[1:0]F)	474
16.6.2	Timer Overflow Interrupt (TOF)	474

Chapter 17

Pulse-Width Modulator (S12PWM8B8CV2)

17.1	Introduction	475
17.1.1	Features	475
17.1.2	Modes of Operation	475
17.1.3	Block Diagram	476
17.2	External Signal Description	476
17.2.1	PWM7 - PWM0 — PWM Channel 7 - 0	477
17.3	Memory Map and Register Definition	477
17.3.1	Module Memory Map	477
17.3.2	Register Descriptions	477
17.4	Functional Description	492
17.4.1	PWM Clock Select	492
17.4.2	PWM Channel Timers	495
17.5	Resets	502
17.6	Interrupts	503

Chapter 18

Serial Communication Interface (S12SCIV6)

18.1	Introduction	505
18.1.1	Glossary	505
18.1.2	Features	506
18.1.3	Modes of Operation	506
18.1.4	Block Diagram	507
18.2	External Signal Description	507
18.2.1	TXD — Transmit Pin	507
18.2.2	RXD — Receive Pin	507
18.3	Memory Map and Register Definition	507
18.3.1	Module Memory Map and Register Definition	508
18.3.2	Register Descriptions	508
18.4	Functional Description	519
18.4.1	Infrared Interface Submodule	520
18.4.2	LIN Support	521

18.4.3	Data Format	521
18.4.4	Baud Rate Generation	523
18.4.5	Transmitter	524
18.4.6	Receiver	529
18.4.7	Single-Wire Operation	537
18.4.8	Loop Operation	538
18.5	Initialization/Application Information	538
18.5.1	Reset Initialization	538
18.5.2	Modes of Operation	539
18.5.3	Interrupt Operation	539
18.5.4	Recovery from Wait Mode	541
18.5.5	Recovery from Stop Mode	541

Chapter 19

Serial Peripheral Interface (S12SPIV5)

19.1	Introduction	543
19.1.1	Glossary of Terms	543
19.1.2	Features	543
19.1.3	Modes of Operation	543
19.1.4	Block Diagram	544
19.2	External Signal Description	545
19.2.1	MOSI — Master Out/Slave In Pin	545
19.2.2	MISO — Master In/Slave Out Pin	546
19.2.3	\overline{SS} — Slave Select Pin	546
19.2.4	SCK — Serial Clock Pin	546
19.3	Memory Map and Register Definition	546
19.3.1	Module Memory Map	546
19.3.2	Register Descriptions	547
19.4	Functional Description	555
19.4.1	Master Mode	556
19.4.2	Slave Mode	557
19.4.3	Transmission Formats	558
19.4.4	SPI Baud Rate Generation	563
19.4.5	Special Features	564
19.4.6	Error Conditions	565
19.4.7	Low Power Mode Options	566

Chapter 20

Inter-Integrated Circuit (IICV3)

20.1	Introduction	569
20.1.1	Features	569
20.1.2	Modes of Operation	570
20.1.3	Block Diagram	570
20.2	External Signal Description	570

20.2.1	IIC_SCL — Serial Clock Line Pin	570
20.2.2	IIC_SDA — Serial Data Line Pin	571
20.3	Memory Map and Register Definition	571
20.3.1	Register Descriptions	571
20.4	Functional Description	583
20.4.1	I-Bus Protocol	583
20.4.2	Operation in Run Mode	588
20.4.3	Operation in Wait Mode	588
20.4.4	Operation in Stop Mode	588
20.5	Resets	588
20.6	Interrupts	588
20.7	Application Information	589
20.7.1	IIC Programming Examples	589

Chapter 21

LIN Physical Layer (S12LINPHYV2)

21.1	Introduction	595
21.1.1	Features	595
21.1.2	Modes of Operation	596
21.1.3	Block Diagram	596
21.2	External Signal Description	597
21.2.1	LIN — LIN Bus Pin	597
21.2.2	LGND — LIN Ground Pin	598
21.2.3	VLINSUP — Positive Power Supply	598
21.2.4	LPTxD — LIN Transmit Pin	598
21.2.5	LPRxD — LIN Receive Pin	598
21.3	Memory Map and Register Definition	598
21.3.1	Module Memory Map	598
21.3.2	Register Descriptions	599
21.4	Functional Description	605
21.4.1	General	605
21.4.2	Slew Rate and LIN Mode Selection	605
21.4.3	Modes	606
21.4.4	Interrupts	609
21.5	Application Information	612
21.5.1	Module Initialization	612
21.5.2	Interrupt handling in Interrupt Service Routine (ISR)	612

Chapter 22

Flash Module (S12ZFTMRZ)

22.1	Introduction	615
22.1.1	Glossary	616
22.1.2	Features	616
22.1.3	Block Diagram	617

22.2	External Signal Description	618
22.3	Memory Map and Registers	618
22.3.1	Module Memory Map	619
22.3.2	Register Descriptions	623
22.4	Functional Description	643
22.4.1	Modes of Operation	643
22.4.2	IFR Version ID Word	643
22.4.3	Flash Block Read Access	643
22.4.4	Internal NVM resource	644
22.4.5	Flash Command Operations	644
22.4.6	Allowed Simultaneous P-Flash and EEPROM Operations	649
22.4.7	Flash Command Description	650
22.4.8	Interrupts	666
22.4.9	Wait Mode	666
22.4.10	Stop Mode	667
22.5	Security	667
22.5.1	Unsecuring the MCU using Backdoor Key Access	667
22.5.2	Unsecuring the MCU in Special Single Chip Mode using BDM	668
22.5.3	Mode and Security Effects on Flash Command Availability	668
22.6	Initialization	668

Appendix A MCU Electrical Specifications

A.1	General	670
A.1.1	Pins	671
A.1.2	Current Injection	671
A.1.3	Absolute Maximum Ratings	672
A.1.4	ESD Protection and Latch-up Immunity	673
A.1.5	Operating Conditions	674
A.1.6	Power Dissipation and Thermal Characteristics	676
A.1.7	I/O Characteristics	680
A.1.8	Supply Currents	683
A.1.9	ADC Calibration Configuration	686

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

B.1	VREG Electrical Specifications	689
B.2	IRC and OSC Electrical Specifications	692
B.3	Phase Locked Loop	692
B.3.1	Jitter Information	692

Appendix C ADC Specifications

C.1	ADC Operating Characteristics	695
-----	-------------------------------	-----

C.1.1	Factors Influencing Accuracy	695
C.1.2	ADC Accuracy	698

Appendix D LINPHY Electrical Specifications

D.1	Maximum Ratings	703
D.2	Static Electrical Characteristics	703
D.3	Dynamic Electrical Characteristics	704

Appendix E NVM Electrical Parameters

E.1	NVM Timing Parameters	707
E.2	NVM Reliability Parameters	709

Appendix F BATS Electrical Specifications

F.1	Dynamic Electrical Characteristics	714
-----	------------------------------------	-----

Appendix G DAC_8B5V Electrical Specifications

G.1	Static Electrical Characteristics	716
-----	-----------------------------------	-----

Appendix H PGA Electrical Specifications

H.1	Static Electrical Characteristics	719
-----	-----------------------------------	-----

Appendix I ACMP Electrical Specifications

I.1	Maximum Ratings	721
I.2	Static Electrical Characteristics	721
I.3	Dynamic Electrical Characteristics	723

Appendix J PIM Electrical Specifications

J.1	High-Voltage Inputs (HVI) Electrical Characteristics	725
-----	--	-----

Appendix K SPI Electrical Specifications

K.1	Master Mode	728
K.2	Slave Mode	729

Appendix L MSCAN Electrical Specifications

L.1	MSCAN Wake-up Pulse Timing	732
-----	----------------------------	-----

Appendix M Package Information

M.1	48 LQFP	733
M.2	32 LQFP	735
M.3	32 QFN, MC9S12ZVLS device only	737

Appendix N Ordering Information

Appendix O Detailed Register Address Map

O.1	0x0000–0x0003 Part ID	745
O.2	0x0010–0x001F S12ZINT	745
O.3	0x0070–0x00FF S12ZMMC	747
O.4	0x0100–0x017F S12ZDBG	747
O.5	0x0200–0x037F PIM	750
O.6	0x0380–0x039F FTMRZ	755
O.7	0x03C0–0x03CF SRAM_ECC_32D7P	757
O.8	0x0400–0x042F TIM1	758
O.9	0x0480–x04AF PWM0	759
O.10	0x0500–x052F PWM1	761
O.11	0x05C0–0x05FF TIM0	763
O.12	0x0600–0x063F ADC0	765
O.13	0x0680–0x0687 DAC	767
O.14	0x0690–0x0697 ACMP	768
O.15	0x06C0–0x06DF CPMU	768
O.16	0x06F0–0x06F7 BATS	771
O.17	0x0700–0x0707 SCI0	771
O.18	0x0710–0x0717 SCI1	772
O.19	0x0780–0x0787 SPI0	773
O.20	0x07C0–0x07C7 IIC0	774
O.21	0x0800–0x083F CAN0	775
O.22	0x0980–0x0987 LINPHY0	776
O.23	0x0B40–0x0B47 PGA	776



Chapter 1

Device Overview MC9S12ZVL-Family

Table 1-1. Revision History

Version Number	Revision Date	Description of Changes
1.0	28. May 2013	<ul style="list-style-type: none">• added feedback from shared review• changed IFR mapping table conditional text to make the ADC reference conversion visible for the customer
1.1	26. Aug.2013	<ul style="list-style-type: none">• added feedback from shared review
1.2	29. Aug.2013	<ul style="list-style-type: none">• update table 1-12, replaced for SCI0/1 EX with RX
1.3	19.Sep. 2013	<ul style="list-style-type: none">• added chapter 1.13.2, “BDC Command Restriction”
1.4	2 April 2014	<ul style="list-style-type: none">• fix findings from the shared review
1.5	5 Aug. 2014	<ul style="list-style-type: none">• fix typo PMW -> PWM
1.6	24 Sep. 2014	<ul style="list-style-type: none">• added the VL128 device
1.7	21 Oct. 2014	<ul style="list-style-type: none">• added PWM channel muxing• added PGA - DAC - ACMP - ADC analog connections
1.8	03 Jun. 2015	<ul style="list-style-type: none">• correct alignment in table 1-15
1.9	27 Oct. 2015	<ul style="list-style-type: none">• correct table 1-3
2.0	08 Aug. 2017	<ul style="list-style-type: none">• correct CTRL register name for PAD6-PAD9, table 1-6• correct 32-pin QFN-EP availability, table 1-2

1.1 Introduction

The MC9S12ZVL-Family is an automotive 16-bit microcontroller family using the 180nm NVM + UHV technology that offers the capability to integrate 40V analog components. This family reuses many features from the existing S12 portfolio. The particular differentiating features of this family are the enhanced S12Z core and the integration of “high-voltage” analog modules, including the voltage regulator (VREG) and a Local Interconnect Network (LIN) physical layer.

The MC9S12ZVL-Family includes error correction code (ECC) on RAM, FLASH and 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 MC9S12ZVL-Family delivers an optimized solution with the integration of several key system components into a single device, optimizing system architecture and achieving significant space savings. The MC9S12ZVL-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 families. The MC9S12ZVL-Family is available in 48-pin, 32-pin LQFP and 32-pin QFN-EP. 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 MC9S12ZVL-Family is a general-purpose family of devices suitable for a wide range of applications. The MC9S12ZVL-Family is targeted at generic automotive applications requiring LIN connectivity. Typical examples of these applications include switch panels and body endpoints for sensors.

1.2 Features

This section describes the key features of the MC9S12ZVL-Family.

1.2.1 MC9S12ZVL-Family Member Comparison

Table 1-2 provides a summary of main features within the MC9S12ZVL-Family.

Table 1-2. MC9S12ZVL-Family Comparison

Feature	MC9S12ZVL128 MC9S12ZVLA128	MC9S12ZVL96 MC9S12ZVLA96	MC9S12ZVL64 MC9S12ZVLA64	MC9S12ZVL32	MC9S12ZVL16	MC9S12ZVL8	MC9S12ZVLS32	MC9S12ZVLS16
Flash memory (ECC) [KB]	128	96	64	32	16	8	32	16
EEPROM (ECC) [Byte]	2048		1024	128			128	
RAM (ECC) [Byte]	8192		4096	1024	1024	512	1024	
max bus clock	32 MHz			32 MHz			32 MHz	
HVI	1			1			1	
LIN Physical layer	1			1			1	
Vreg current capability ⁽¹⁾ - 70 mA (VDDX) - 170 mA ballast option (BCTL) - tolerance - 3.3V VDDX support, see also: 9.3.2.27, "Voltage Regulator Control Register (CPMUVREGCTL)	yes yes 3% / 2% ⁽²⁾ yes			yes yes 3% no			yes yes 3% no	
ASIL SEooC target	A			A			A	
Package	48-pin / 32-pin LQFP / 32-pin QFN-EP			48-pin / 32-pin LQFP			32-pin QFN-EP	
ADC channels -10-bit -12-bit	10 ⁽³⁾ / 6 10 ⁽³⁾⁽²⁾ / 6 ⁽²⁾			10 ⁽³⁾ / 6 -			6 -	
PWM	8 16 bit Channels			8 Channel (up to 4 16 bit)			8 Channel (up to 4 16 bit)	
DAC	1 ⁽⁴⁾⁽²⁾			-			-	
PGA ⁵	1 ⁽²⁾			-			-	
ACMP	1 ⁽²⁾			-			-	
Timer	6 + 2 channel			6 + 2 channel			6 + 2 channel	

Table 1-2. MC9S12ZVL-Family Comparison

Feature	MC9S12ZVL128 MC9S12ZVLA128	MC9S12ZVL96 MC9S12ZVLA96	MC9S12ZVL64 MC9S12ZVLA64	MC9S12ZVL32	MC9S12ZVL16	MC9S12ZVL8	MC9S12ZVLS32	MC9S12ZVLS16
SCI ⁶	2			2			2	
SPI	1			1			1	
IIC	1			1			1	
MSCAN	1			-			-	
max SRAM_ECC access width	4 Byte			2 Byte			2 Byte	
Supported ADC option bits	yes			no			no	
General purpose I/O - pin to support 25 mA driver strength to VSSX - pin to support 20 mA driver strength from VDDX (EVDD)	34 ⁽³⁾ / 19 3 ⁽³⁾ / 1 1			34 ⁽³⁾ / 19 3 ⁽³⁾ / 1 1			18 3 1	
Interrupt capable pins ⁷ 5V / 12V	22 ⁽³⁾ / 16 / 1			22 ⁽³⁾ / 16 / 1			14 / 1	

¹ total current capability for MCU and MCU - external loads (on same PCB - board)

² MC9S12ZVLA device only

³ available in 48-pin packages only

⁴ to internally feed the ACMP or bonded out in 48-LQFP

⁵ only 5V operation mode supported

⁶ one SCI routed to the LINPHY

⁷ \overline{IRQ} / \overline{XIRQ} and KWx pins

NOTE

After power up, the MC9S12ZVL(A)128/96/64 devices starts in 3.3V VDDX mode. Then is possible to switch to the 5.0V VDDX behavior. For more details see the “Clock, Reset and Power Management Unit” section, 9.3.2.27, “Voltage Regulator Control Register (CPMUVREGCTL)

1.3 Chip-Level Features

On-chip modules available within the family include the following features:

- S12Z CPU core
- 128, 96, 64, 32, 16 or 8 KB on-chip flash with ECC
- 2048, 1024, 128 byte EEPROM with ECC
- 8192, 4096, 1024 or 512 byte on-chip SRAM with ECC
- Phase locked loop (IPLL) frequency multiplier with internal filter
- 1 MHz internal RC oscillator with +/-1.3% accuracy over rated temperature range
- 4-20 MHz amplitude controlled pierce oscillator

- Internal COP (watchdog) module
- analog-to-digital converter (ADC) with 10 -bit or 12 -bit resolution and up to 10 channels available on external pins and V_{bg} (bandgap) result reference
- PGA module with two input channels
- One 8-bit 5V digital-to-analog converter (DAC)
- One analog comparators (ACMP) with rail-to-rail inputs
- MSCAN (1 Mbit/s, CAN 2.0 A, B software compatible) module
- One serial peripheral interface (SPI) module
- One serial communication interface (SCI) module with interface to internal LIN physical layer transceiver (with RX connected to a timer channel for frequency calibration purposes, if desired)
- Up to one additional SCI (not connected to LIN physical layer)
- One on-chip LIN physical layer transceiver fully compliant with the LIN 2.2 standard
- 6-channel timer module (TIM0) with input capture/output compare
- 2-channel timer module (TIM1) with input capture/output compare
- Inter-IC (IIC) module
- 8-channel Pulse Width Modulation module (PWM)
- On-chip voltage regulator (VREG) for regulation of input supply and all internal voltages
- Autonomous periodic interrupt (API), supports cyclic wakeup from Stop mode
- Pins to support 25 mA drive strength to VSSX
- Pin to support 20 mA drive strength from VDDX (EVDD)
- High Voltage Input (HVI)
- Supply voltage sense with low battery warning
- On-chip temperature sensor, temperature value can be measured with ADC or can generate a high temperature warning
- Up to 23 pins can be used as keyboard wake-up interrupt (KWI)

1.4 Module Features

The following sections provide more details of the integrated modules.

1.4.1 S12Z Central Processor Unit (CPU)

The S12Z CPU is a revolutionary high-speed core, with code size and execution efficiencies over the S12X CPU. The S12Z CPU also provides a linear memory map eliminating the inconvenience and performance impact of page swapping.

- Harvard Architecture - parallel data and code access
- 3 stage pipeline
- 32-Bit wide instruction and databus
- 32-Bit ALU
- 24-bit addressing (16 MByte linear address space)

- Instructions and Addressing modes optimized for C-Programming & Compiler
 - MAC unit 32bit += 32bit*32bit
 - Hardware divider
 - Single cycle multi-bit shifts (Barrel shifter)
 - Special instructions for fixed point math
- Unimplemented opcode traps
- Unprogrammed byte value (0xFF) defaults to SWI instruction

1.4.1.1 Background Debug Controller (BDC)

- Background debug controller (BDC) with single-wire interface
 - Non-intrusive memory access commands
 - Supports in-circuit programming of on-chip nonvolatile memory

1.4.1.2 Debugger (DBG)

- Three comparators (A, B and D)
 - Comparator A compares the full address bus and full 32-bit data bus
 - Comparators B and D compare the full address bus only
 - Each comparator can be configured to monitor PC addresses or addresses of data accesses
 - Each comparator can select either read or write access cycles
 - Comparator matches can force state sequencer state transitions
- Three comparator modes
 - Simple address/data comparator match mode
 - Inside address range mode, $Addmin \leq Address \leq Addmax$
 - Outside address range match mode, $Address < Addmin$ or $Address > Addmax$
- State sequencer control
 - State transitions forced by comparator matches
 - State transitions forced by software write to TRIG
 - State transitions forced by an external event
- The following types of breakpoints
 - CPU breakpoint entering active BDM on breakpoint (BDM)
 - CPU breakpoint executing SWI on breakpoint (SWI)

1.4.2 Embedded Memory

1.4.2.1 Memory Access Integrity

- Illegal address detection
- ECC support on embedded NVM and system RAM