Introduction to the S12ZVL

S12 MagniV

Aug.2015

Agenda

- Introduction to MagniV Technology
- Features
- Target applications
- Block diagram
- Device pinouts
- Module details
  - Core
  - Digital Components
  - Analog Components
  - High Voltage Analog
- Resets.
- Use Cases

S12ZVL Overview

S12ZVL Smallest Integrated LIN Slave MCU

- **System in a Package** - Highly integrated part which is ideal for space constrained applications such as Actuators, Sensors, LIN nodes etc.
- **Low System Cost –** Directly powered by Battery. Integrated LIN Phy, EVDD and NGPIOs reduce system, qualification and manufacturing cost.
- **High Reliability –** High immunity to EMI and ESD stresses, LIN 2.x compliant with +/- 8kV ESD capability.
- **Enablement –** Supported by comprehensive hardware and software system (free low-level drivers to enterprise 3rd party tools) which reduces development costs and time to market.

MagniV™

Directly powered by Car Battery

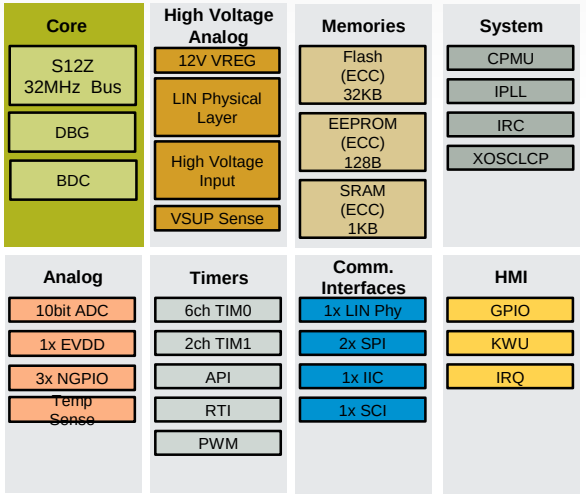
Integrated LIN Transceiver

Safe Assure™

Ultra-Reliable Industrial

15 Year Longevity

Fast ADC



S12ZVL			
Flash	8 – 32 kB	12V VREG	12V/70mA, 170mA w ext ballast
RAM	1 kB	EVDD	1ch 5V/20mA (source)
Core	S12Z	NGPIO	3ch 5V/25mA (sink)
Speed	32 MHz	Timer	6ch + 2ch 16bit
ADC	10ch 10bit	SPI/SCI/IIC	2/1/1
HVI	1	Packages	32LQFP, 32QFN, 48LQFP

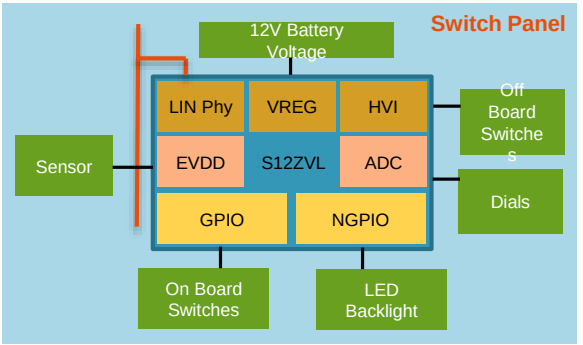
Part Numbers		
32LQFP	32QFN-EP	48LQFP
S9S12ZVL32F0MLC	S9S12ZVLS3F0MFM	S9S12ZVL32F0MLF
S9S12ZVL16F0MLC	S9S12ZVLS1F0MFM	S9S12ZVL16F0MLF
S9S12ZVL8F0MLC	S9S12ZVLS8F0MFM	S9S12ZVL8F0MLF

Targeted Applications

- LIN nodes
- LIN switch panel / user interface
- LIN actuators, sensors
- HVAC
- Lighting controls
- Ambient lighting
- Seat positioning
- Ultrasonic Sensors

Enablement Tools

- Evaluation Boards / Hardware
  - TRK-S12ZVL
- Reference Solutions
  - Ultrasonic distance measurement
  - LIN RGB LED
- CodeWarrior, Cosmic
- LIN drivers



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Sample | Data Sheet | Tools

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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.

- 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.

- It’s primarily targeted at LIN nodes, ultrasonic sensors, switchpanel and lighting.

Introduction (cont.)

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- **Low System Cost –** Directly powered by Battery. Integrated LIN Phy, EVDD and NGPIOs reduce system, qualification and manufacturing cost.

- **High Reliability –** High immunity to EMI and ESD stresses, LIN 2.x compliant with +/- 8kV ESD capability.

- **Enablement –** Supported by comprehensive hardware and software system (free low-level drivers to enterprise 3rd party tools) which reduces development costs and time to market.

Key Features

- S12Z-core (up to 32MHz bus frequency) compatible within MagniV
- On chip 12V Vreg with Supply-capability:
  - 70mA total (170mA with ext. Ballast)
- LIN-PHY, LIN2.x / J2602 compliant
- On chip RC Oscillator; trimmed to +/- 1,3% tolerance over full temperature range
- Robust 12V inputs Vsup-sense & HVI (with ADC)
- 1x E-Vdd (20mA source capability)
- 1-3x N-GPIO (25 mA sink capability)
- 5x5mm footprint 32QFN-package optional
- ASIL-A compliancy


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Integrated LIN Transceiver


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15 Year Longevity


Fast ADC

Features (cont.)

Product Name	S12ZVL		S12ZVLS
Package	48-LQFP	32-LQFP	32-QFN
Flash memory (ECC)	32 / 16 / 8 kB		32 / 16 kB
EEPROM (ECC)	128B		
RAM (ECC)	1kB		
SCI / SPI / IIC	2 / 1 / 1		
LIN-PHY	1		
HVI	1		
V reg	12V/70mA; extendable to 170mA with ext. Ballast		
Timer	6ch + 2ch (16 Bit)		
PWM	8ch 8 Bit (or 4ch 16Bit)		
ADC	10ch 10Bit	6ch 10Bit	
eVdd (5V/20mA)	1ch (source)		
N-GPIOs (5V / 25mA)	3ch (sink)	1ch (sink)	3ch (sink)
Temperature options	C / V / M		

Target Applications

LIN-Sensors

Product Function

- Hooking up sensors into automotive LIN-Network (with signal pre-conditioning

Market Requirements

- LIN-PHY, 12V-Vreg, MCU
- Small formfactor (QFN)
- ADC, SPI

LIN-switchpanels

Product Function

- Reading multiple switch-positions and feeding into LIN-network

Market Requirements

- LIN-PHY, 12V-Vreg, MCU
- Multiple GPIOs, LED drive
- ADC

LIN-Actuator

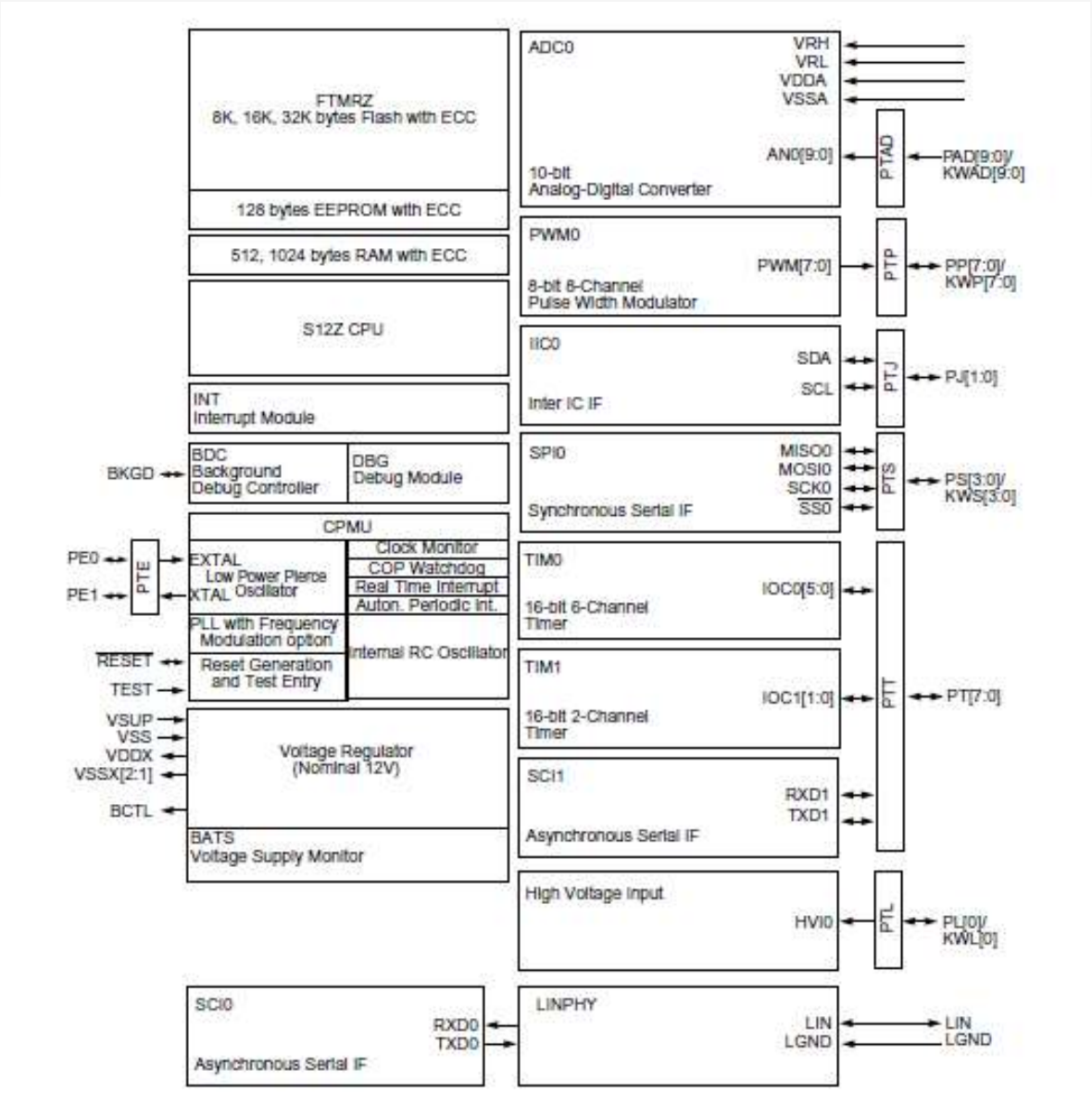
Product Function

- Converting LIN-command into an activity (eg driving LEDs)

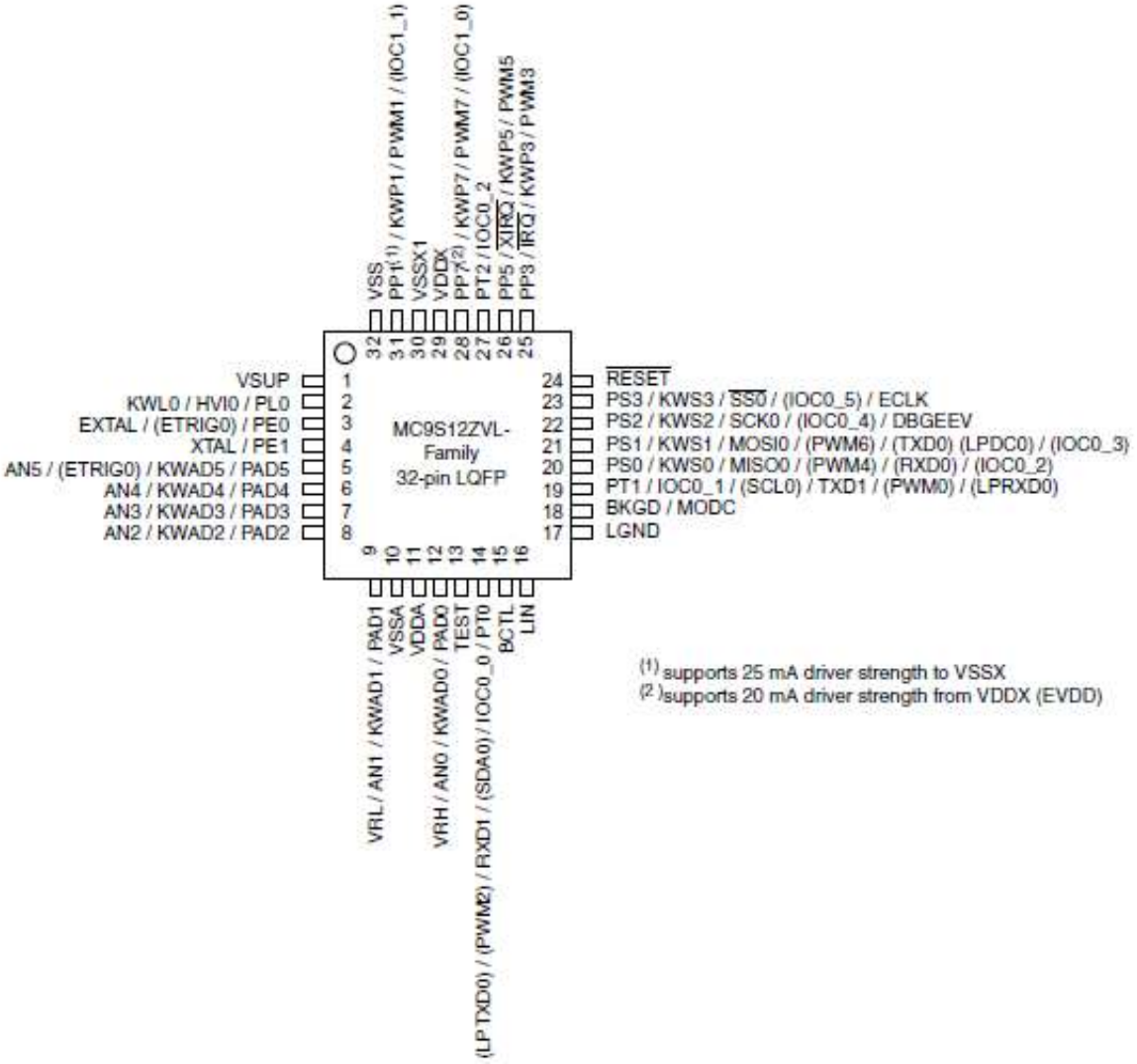
Market Requirements

- LIN-PHY, 12V-Vreg, MCU
- Drivers (3x25mA drive strength in case of RGB-LED)
- ADC

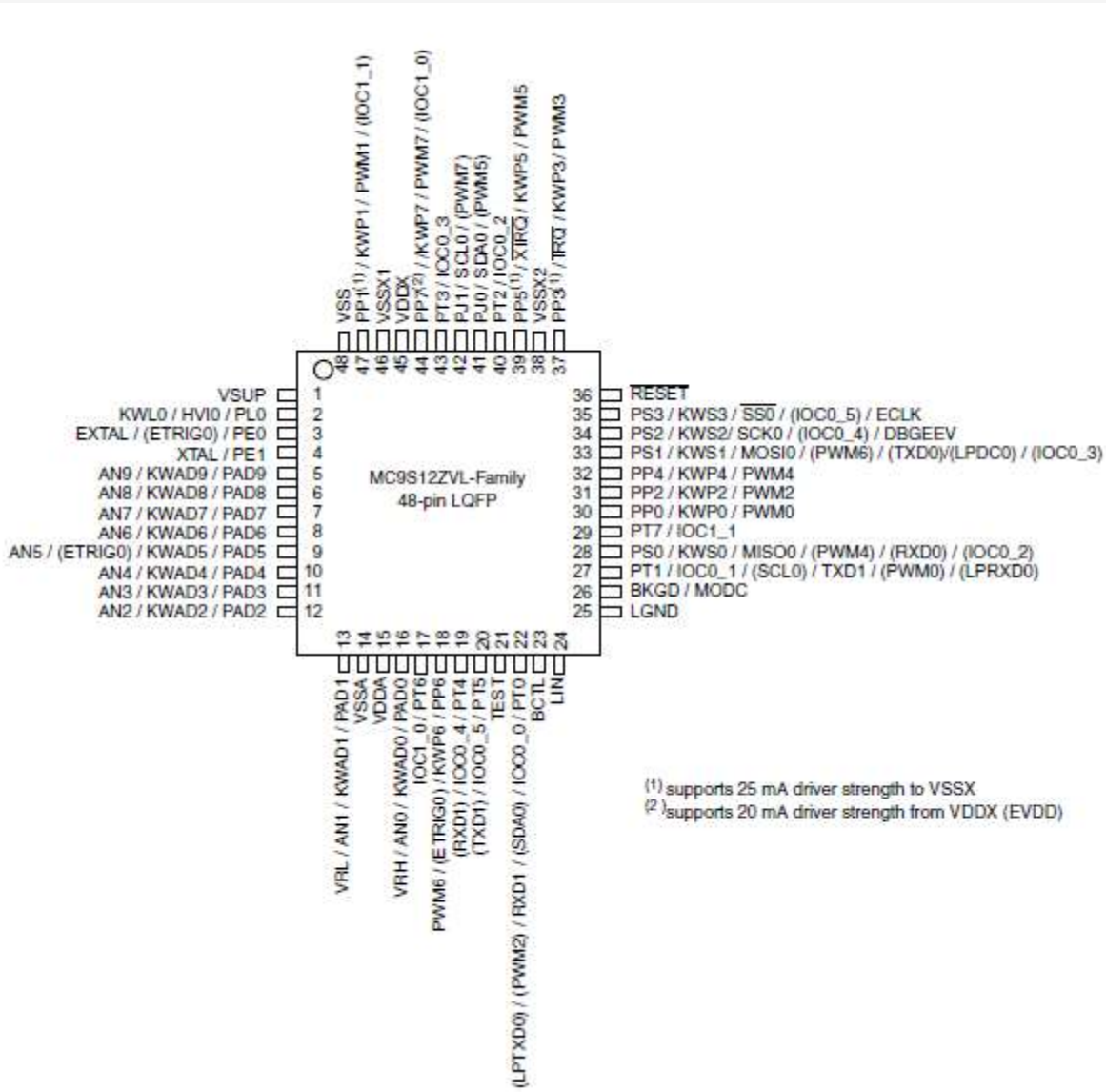
Block diagram



Device pinouts



Device pinouts (cont.)



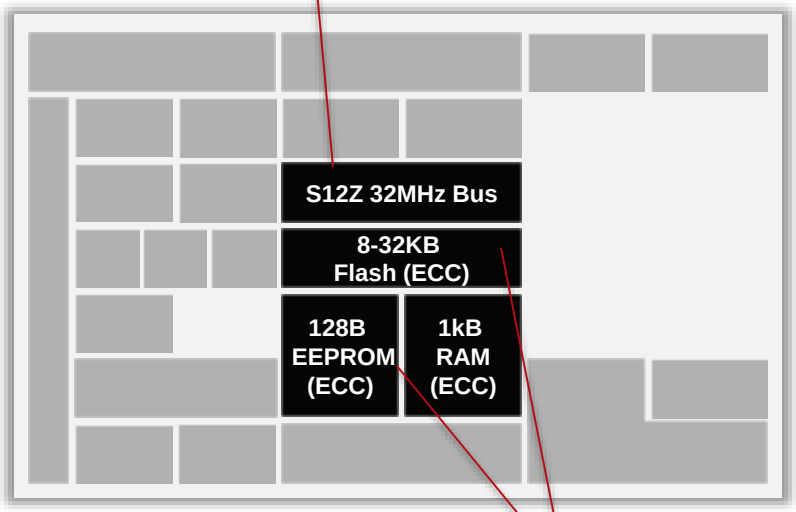
S12ZVL Module Details

S12ZVL_ Introduction

Core and Memories

MCU Core and Memories

S12Z CPU
16-bit, 32b MAC, linear addressing Harvard architec. compatible within MagniV



EEPROM
4 byte eraseable 100k program/ erase cycles

Flash (8-32kB)
512B erasable 10k p/e cycles Can be used for Data (parameter, config, calibr.)

Core and Memories

- 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
- Optimized address path so it is capable to run at 50MHz without Flash wait states

Core and Memories

Flash

- On-chip flash memory on the MC9S12ZVL-Family
- • Up to 32 KB of program flash memory
- — Automated program and erase algorithm
- — Protection scheme to prevent accidental program or erase

EEPROM

- • Up to 128 bytes EEPROM
- — 16 data bits plus 6 syndrome ECC (error correction code) bits allow single bit error correction
- and double fault detection
- — Erase sector size 4 bytes
- — Automated program and erase algorithm
- — User margin level setting for reads

SRAM

- • Up to 1 KB of general-purpose RAM with ECC
- — Single bit error correction and double bit error detection code based on 16-bit data words

Digital Components

2 UARTs
One linked to LIN Phy, 2nd as independant Test Intf.

SPI, IIC
Serial link to other Ics, e.g sensors,…
or indep. test Interface

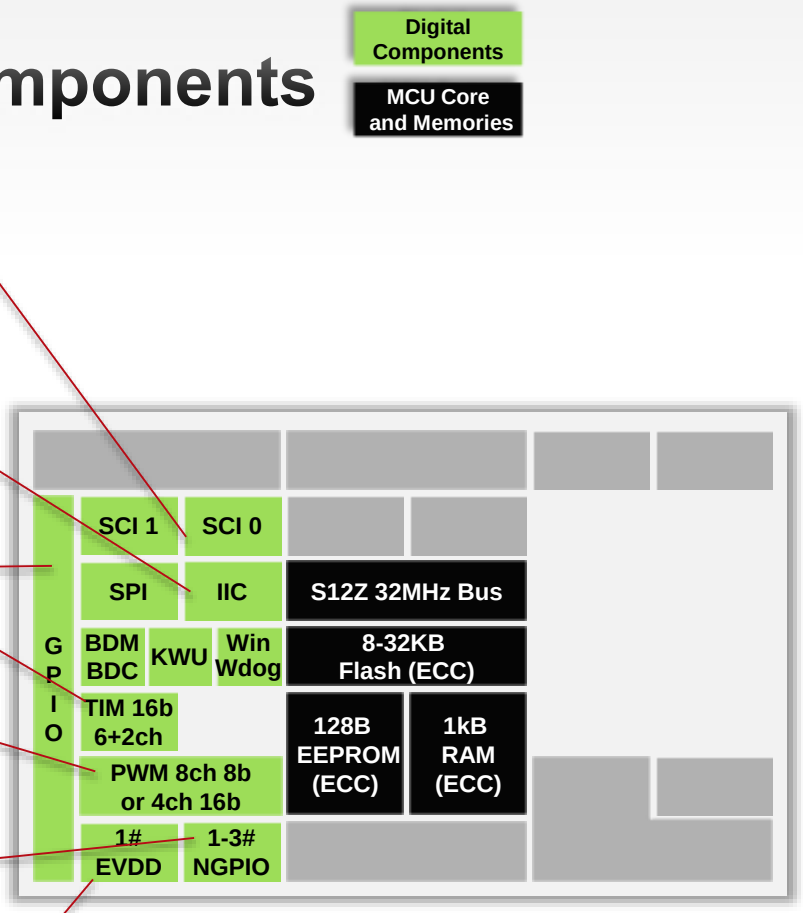
Up to 23 Wakeup pins
Combined with Analog Input pins and HV pins

2 Timer modules
6ch / 16Bit + 2ch / 16Bit

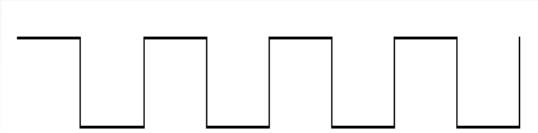
8ch PWM
Configurable to 8ch / 8Bit or 4ch / 16Bit

NGPIO (PP1/3/5)
1-3# 5V / 25mA sink
Eg. for RGB-LED

External Supply
5V / 20mA switchable for local (same PCB), over current protected. Eg. Sensor supply



Digital Components



Timer (TIM0 and TIM1)

- Two independent timer modules with own 16-bit free-running counter and with 8-bit precision prescaler
  - — 6 x 16-bit channels Timer module (TIM0) for input capture or output compare
  - — 2 x 16-bit channels Timer module (TIM1) for input capture or output compare

Pulse Width Modulation Module (PWM)

- Up to eight channel x 8-bit or up to four channel x 16-bit pulse width modulator
  - — Programmable period and duty cycle per channel
  - — Center-aligned or left-aligned outputs
  - — Programmable clock select logic with a wide range of frequencies

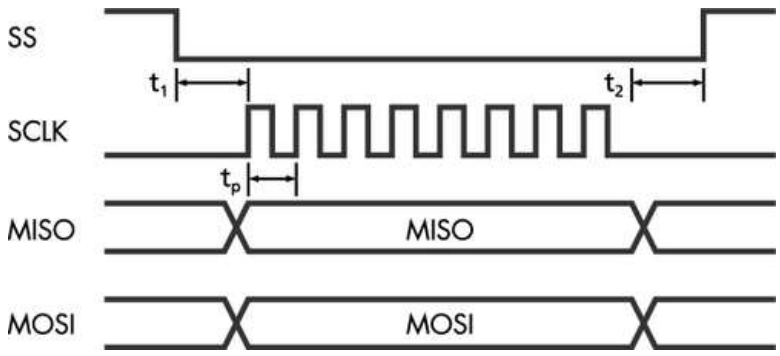
Digital Components

Serial Communication Interface Module (SCI)

- Full-duplex or single-wire operation
- Standard mark/space non-return-to-zero (NRZ) format
- Selectable IrDA 1.4 return-to-zero-inverted (RZI) format with programmable pulse widths
- Baud rate generator by a 16-bit divider from the bus clock
- Programmable character length
- Programmable polarity for transmitter and receiver
- Active edge receive wakeup
- Break detect and transmit collision detect supporting LIN

Serial Peripheral Interface Module (SPI)

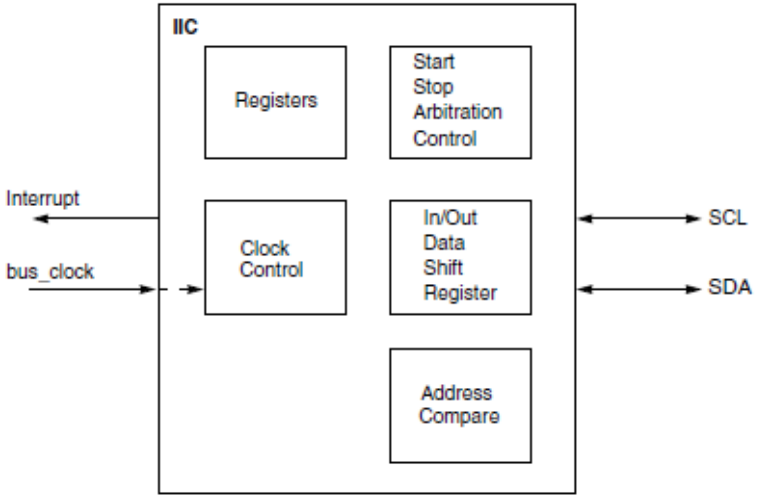
- Configurable 8- or 16-bit data size
- Full-duplex or single-wire bidirectional
- Double-buffered transmit and receive
- Master or slave mode
- MSB-first or LSB-first shifting
- Serial clock phase and polarity options



Digital Components

Inter-IC Module (IIC)

- Multi-master operation
- Software programmable for one of 256 different serial clock frequencies
- Broadcast mode support
- 10-bit address support
- Modes of Operation: Normal, wait and stop mode



Analog Components

Digital Components

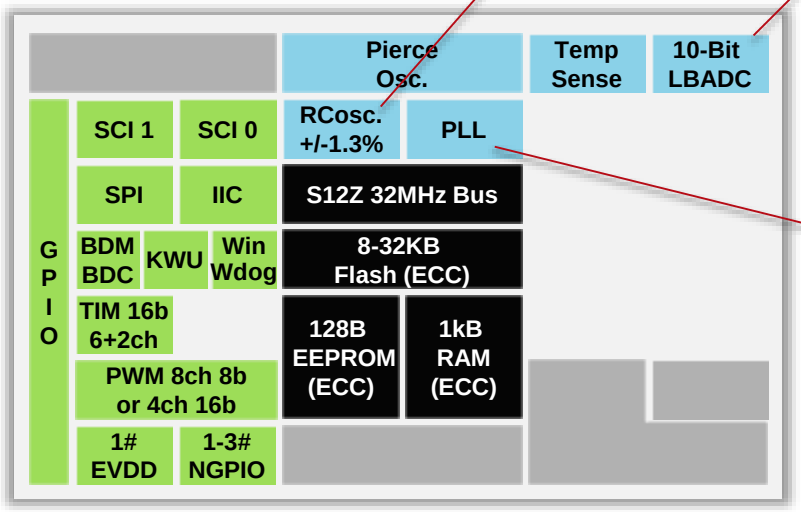
5V Analogue Components

MCU Core and Memories

On chip RC OSC
factory-trimmed to +/- 1.3% , meets LIN -needs

10Bit List Based ADC
up to 10 ext. Ch.+7 int. Ch (temp sense, supply mon., HVI, int. Ref. Voltages)
Executes command list & write result directly to RAM (DMA)

Phase Locked Loop
generates the VCOCLK by multiplying the reference clock
by a 2, 4, 6,... 126, 128



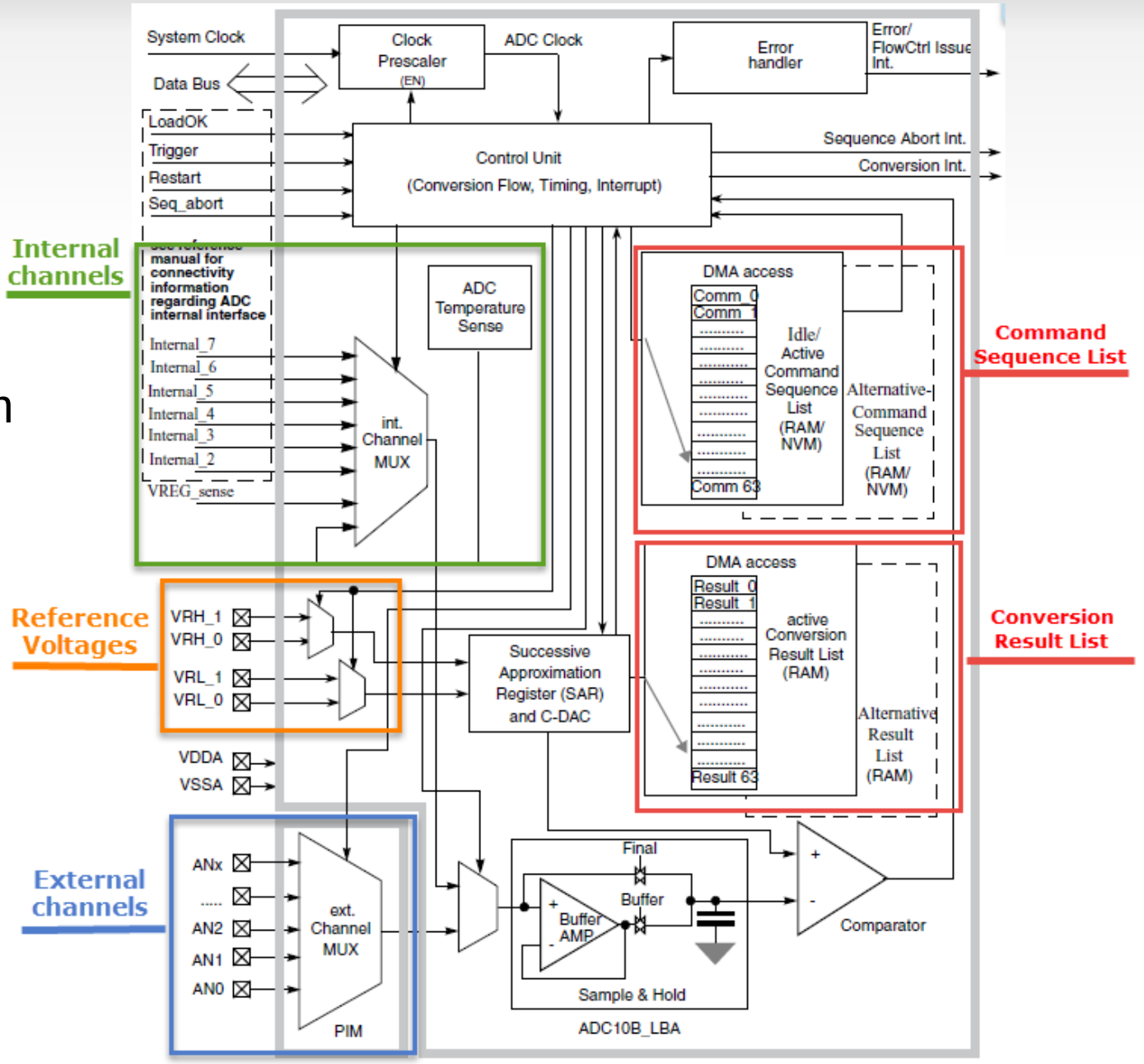
Analog Components

Analog-to-Digital Converter Module (ADC)

- 10-bit resolution
- Up to 10 external channels & 8 internal channels
- Left or right aligned result data
- Continuous conversion mode
- Programmers model with list based command and result storage architecture
- ADC directly writes results to RAM, preventing stall of further conversions
- Internal signals monitored with the ADC module
- Vrh, Vrl, (Vrl+Vrh)/2, Vsup monitor, Vbg, TempSense
- External pins can also be used as digital I/O

- ADC

  Block Diagram



Analog Components

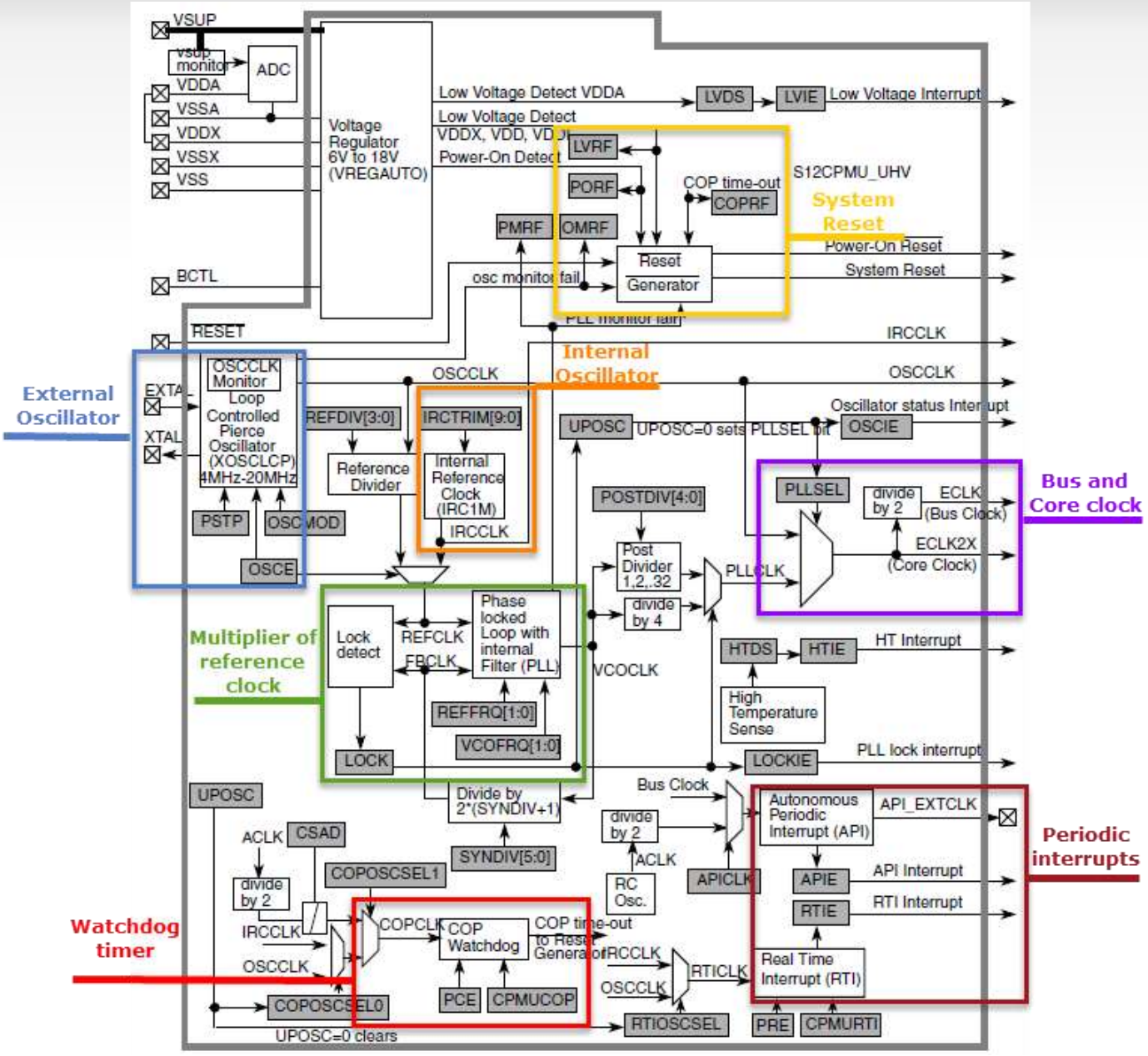
Internal RC Oscillator (IRC)

- 1 MHz internal RC oscillator with +/-1.3% accuracy over rated temperature range

Main External Oscillator (XOSCLCP)

- Amplitude controlled Pierce oscillator using 4 MHz to 20 MHz crystal
  - — Current gain control on amplitude output
  - — Signal with low harmonic distortion
  - — Low power
  - — Good noise immunity
  - — Eliminates need for external current limiting resistor
  - — Transconductance sized for optimum start-up margin

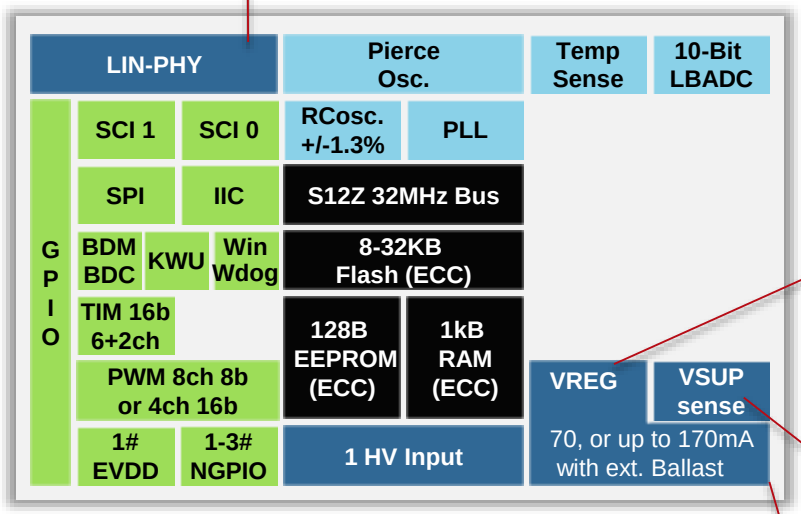
- Clock Source Diagram



High Voltaje Components

Digital Components | 5V Analogue Components | MCU Core and Memories | High-Voltage Components

LIN Physical Layer
LIN2.2 and SAE J2602 compliant
+/- 8kV ESD capability



Voltage Regulator
5V/70mA total supply or 170mA with external ballast for more current and lower power dissipation

Supply sensing
Monitoring supply voltage (sense after protection)

Packaging Options
32-LQFP and 48-LQFP
32-QFN 5x5mm

High Voltage Components

Supply Voltage Sensor (BATS)

- Monitoring of supply (VSUP) voltage
- Internal ADC interface from an internal resistive divider
- Generation of low or high voltage interrupts

On-Chip Voltage Regulator system (VREG)

- Voltage regulator
  - — Linear voltage regulator directly supplied by VSUP
  - — Low-voltage detect on VSUP
  - — Power-on reset (POR)
  - — Low-voltage reset (LVR) for VDDX domain
  - — External ballast device support to extend current capability and reduce internal power dissipation
  - — Capable of supplying both the MCU internally plus external components
  - — Over-temperature protection and interrupt
- Internal voltage regulator
  - — Linear voltage regulator with bandgap reference
  - — Low-voltage detect on VDDA
  - — Power-on reset (POR) circuit
  - — Low-voltage reset for VDD domain

High Voltage Components

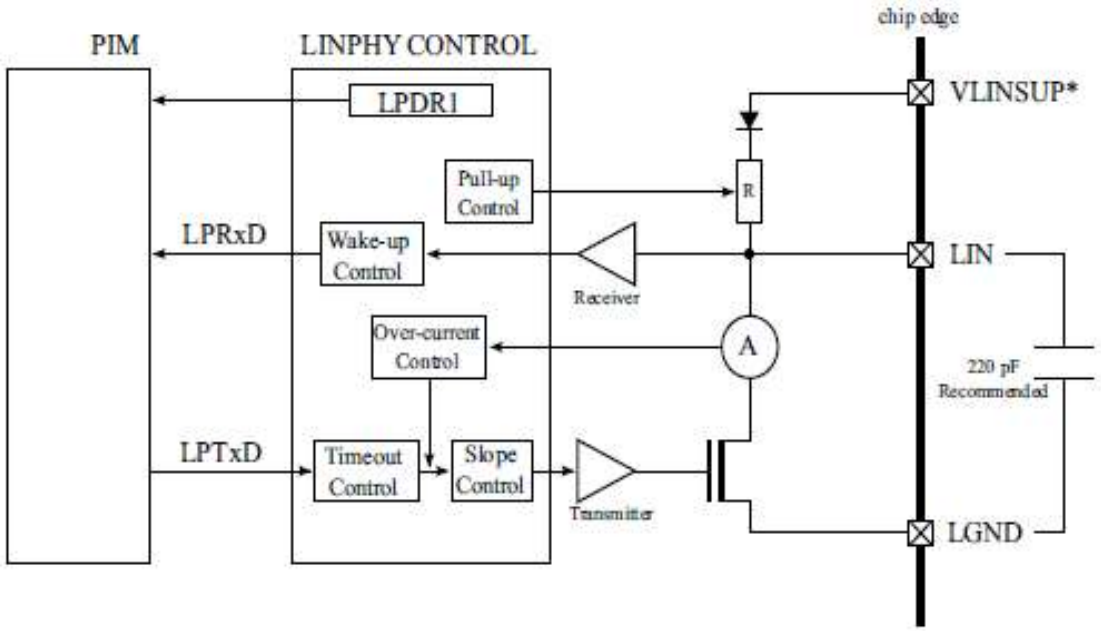
LIN physical layer transceiver

- Compliant with LIN Physical Layer 2.2 specification
- Compliant with the SAE J2602-2 LIN standard
- Standby mode with glitch-filtered wake-up
- Slew rate selection optimized for the baud rates: 10.4kBit/s, 20kBit/s and Fast Mode (up to

  250kBit/s)
- Switchable 34kΩ/330kΩ pull-ups
- Current limitation for LIN Bus pin falling edge
- Over-current protection
- LIN TxD-dominant timeout feature monitoring the LPTxD signal
- Automatic transmitter shutdown in case of an over-current or TxD-dominant timeout
- Fulfills the OEM “Hardware

High Voltage Components

- Block Diagram



High Voltage Components

LIN Modes of Operation

The LIN Physical Layer can operate in the following four modes:

1. Shutdown Mode

   The LIN Physical Layer is fully disabled. No wake-up functionality is available. The internal pullup resistor is replaced by a high ohmic one (330 kΩ) to maintain the LIN Bus pin in the recessive state. All registers are accessible.

2. Normal Mode

   The full functionality is available. Both receiver and transmitter are enabled.

3. Receive Only Mode

The transmitter is disabled and the receiver is running in full performance mode.

4. Standby Mode

Digital Components | 5V Analogue Components | MCU Core and Memories | High-Voltage Components

2 UARTs
One linked to LIN Phy, 2nd as independant Test Intf.

SPI, IIC
Serial link to other Ics, e.g sensors,…
or indep. test Interface

Up to 23 Wakeup pins
Combined with Analog Input pins and HV pins

2 Timer modules
6ch / 16Bit + 2ch / 16Bit

8ch PWM
Configurable to 8ch / 8Bit or 4ch / 16Bit

NGPIO (PP1/3/5)
1-3# 5V / 25mA sink
Eg. for RGB-LED

External Supply
5V / 20mA switchable for local (same PCB), over current protected. Eg. Sensor supply

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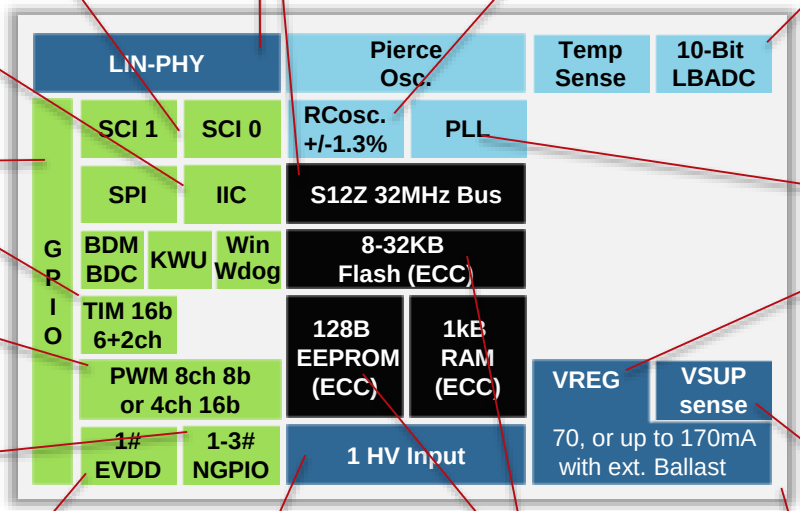
Executes command list & write result directly to RAM (DMA)



Phase Locked Loop
generates the VCOCLK by multiplying the reference clock
by a 2, 4, 6,... 126, 128

Voltage Regulator
5V/70mA total supply or 170mA with external ballast for more current and lower power dissipation

Supply sensing
Monitoring supply voltage (sense after protection)

High Voltage Input
12V Input for Switch Monitoring
Routable to ADC

EEPROM
4 byte eraseable
100k program/ erase cycles

Flash (8-32kB)
512B erasable
10k p/e cycles
Can be used for Data (parameter, config, calibr.)

Packaging Options
32-LQFP and 48-LQFP
32-QFN 5x5mm

Resets

The following resets sources are available:

- Power on reset (POR)
- Low voltage reset (LVR)
- External pin reset
- Clock monitor reset
- COP watchdog reset

S12ZVL Use Cases

S12ZVL_ Introduction

Application Diagram

Switch Panel with S12ZVL

Digital Components | 5V Analogue Components | MCU Core and Memories | High-Voltage Components

LIN Bus

LIN-PHY | Pierce Osc. | Temp Sense | 10-Bit ADC

GPIO | SCI 1 | SCI 0 | RCosc. +/-1.3% | PLL | SPI | IIC | S12Z 32MHz Bus | BDM BDC | KWU | Win Wdog | 8-32KB Flash (ECC) | TIM 16b 6+2ch | 128B EEPROM (ECC) | 1kB RAM (ECC) | PWM 8ch 8b or 4ch 16b | Vreg | Vsup sense | 1# E-Vdd | 1-3# NGPIO | HV Input | 70, or up to 170mA with ext. Ballast

Dials

Battery Voltage

On-board Switches | Off-board Switches | LED Backlight

Wakeup

Application Diagram

Intelligent Sensor Application

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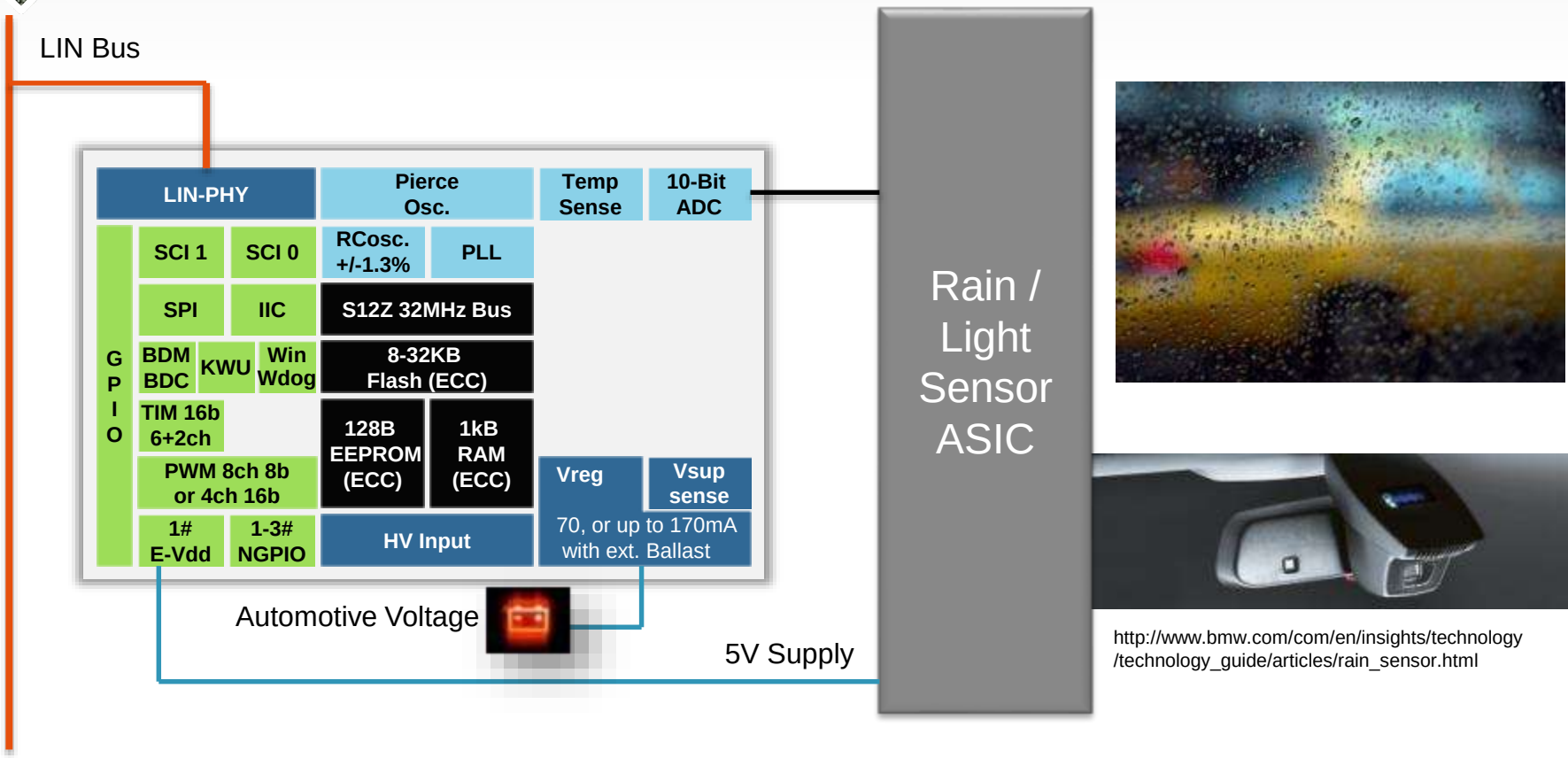
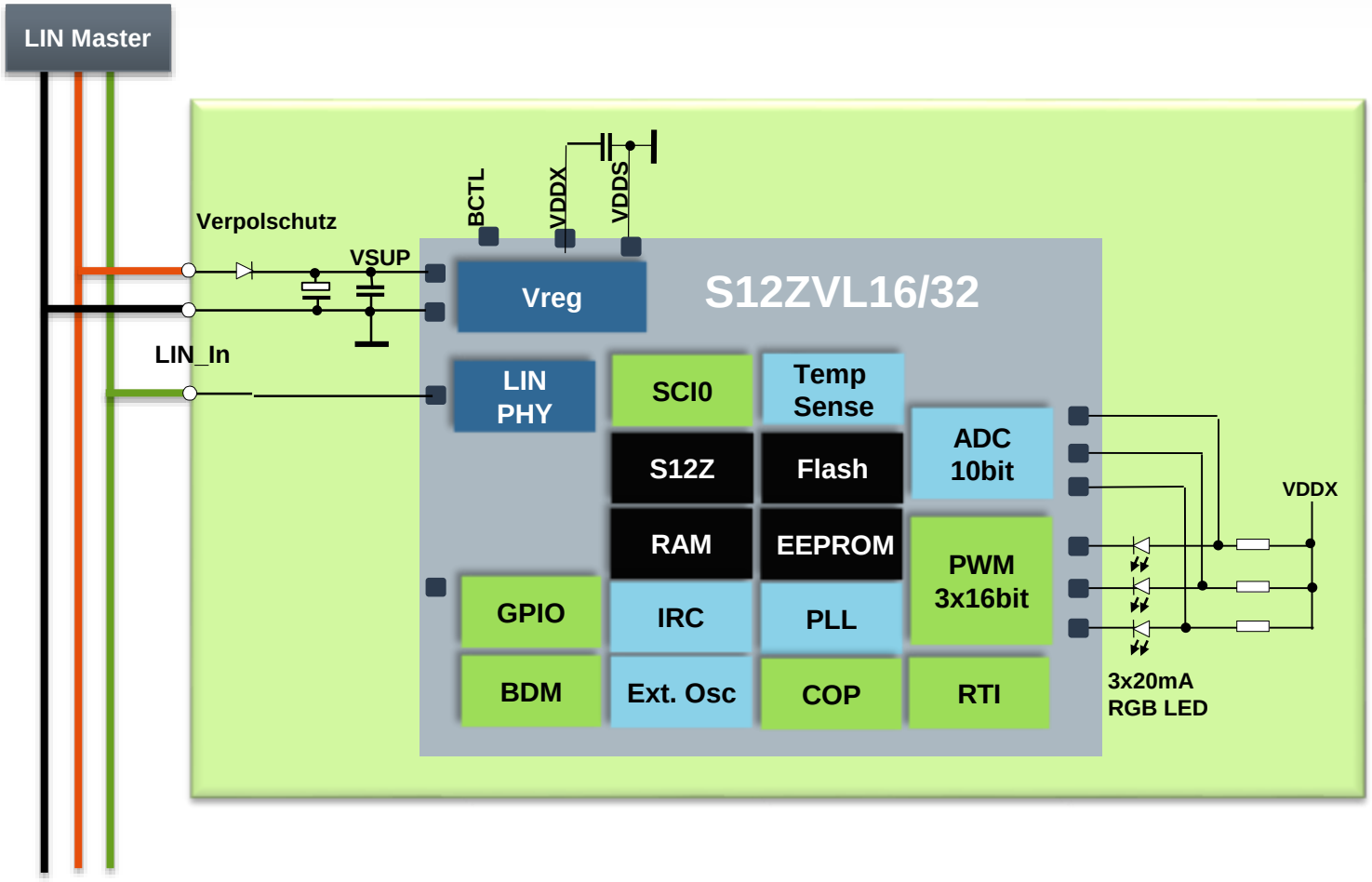


http://www.bmw.com/com/en/insights/technology/technology_guide/articles/rain_sensor.html

Application Diagram

LIN RGB application draft

Digital Components | 5V Analogue Components | MCU Core and Memories | High-Voltage Components



More S12ZVL resources

Product summary page

- www.freescale.com/S12ZVL

Application notes:

- AN5122: LIN Driver with the MagniV Family
- AN5082: MagniV in 24 V Applications
- AN4842: LIN Enabled RGB LED Lighting Application

www.Freescale.com