

---

---

**PL360G55CB-EK User Guide**

---

---

---

**Introduction**

---

PL360G55CB-EK is an evaluation kit for the PL360 modem. PL360 is a programmable modem for narrow-band Power Line Communication (PLC) from Microchip Technology Inc, able to run any PLC protocol in the frequency band below 500 kHz. The PL360 has been conceived to be driven by external Microchip host controller devices; in this case a SAMG55 ARM<sup>®</sup> Cortex<sup>®</sup>-M4 RISC processor is used. The Microchip host device loads the corresponding PLC-protocol firmware and then controls the PL360 modem operation.

The PL360G55CB-EK board has been conceived to communicate in CENELEC B-Band (95 kHz to 125 kHz) and it complies with CENELEC standard EN 50065 regulations and Smart Energy applications. It can be connected directly to AC mains or DC power rails.

---

**Contents**

---

- Welcome letter
- Board:
  - One PL360G55CB-EKv2 board
- Cable:
  - One Micro A/B-type USB cable
- Jumpers:
  - Two jumpers with pitch 1.27 mm
- Pin Headers:
  - Two 8-pin headers with pitch 2.54 mm

---

**Features**

---

- PL360G55CB-EK board mounts a PL360 PLC transceiver and a SAMG55J19 ARM Cortex M4 microcontroller.
- PL360G55CB-EK board provides a full featured platform to develop a complete communications system based on PLC technology working in CENELEC B-Band.
- PL360 is a compact and highly efficient device for a wide range of Smart Grid applications such as lighting control, industrial/home automation and renewable-energy management, among others.
- PL360G55CB-EK board provides support for:
  - PLC band characterization and noise level measurement
  - PLC sensitivity level measurement
  - Power consumption
  - Power fail detection
- PL360G55CB-EK board includes a SWD/JTAG interface for MCU debugging and programming purposes. Firmware is also upgradable via USB/serial interface
- USB 2.0 full-speed interface

- mikroBUS™ add-on connectors to integrate the board itself as a module for interfacing with other microcontrollers or microprocessors (mikroBUS main board).
- PL360G55CB-EK board can be externally supplied by:
  - mikroBUS connector
  - Micro-B USB connector
  - DC Jack connector

---

**Table of Contents**

---

Introduction.....	1
Contents.....	1
Features.....	1
1. Evaluation Kit Specifications.....	4
1.1. Safety Recommendations.....	4
1.2. Electrical Specifications.....	4
2. Getting Started.....	6
2.1. Powering-Up the Board.....	6
2.2. Running Preloaded Firmware.....	7
2.3. Code and Technical Support.....	7
3. PL360G55CB-EK Board.....	9
3.1. Overview.....	9
3.2. Features List.....	9
3.3. Hardware Description – System.....	16
3.4. Hardware Description – MCU Peripherals.....	26
3.5. Hardware Description – MCU Interface Ports.....	28
3.6. PL360G55CB-EK Schematics.....	30
3.7. PL360G55CB-EK Layout.....	34
4. Compliance for Specific Standards.....	40
5. References.....	41
6. Revision History.....	42
6.1. Rev A - 04/2019.....	42
The Microchip Web Site.....	43
Customer Change Notification Service.....	43
Customer Support.....	43
Microchip Devices Code Protection Feature.....	43
Legal Notice.....	44
Trademarks.....	44
Quality Management System Certified by DNV.....	45
Worldwide Sales and Service.....	46

## 1. Evaluation Kit Specifications

### 1.1 Safety Recommendations

This evaluation board must only be used by expert technicians. The PL360G55CB-EK board is powered from a DC power source, so only the PLC coupling stage could have a hazardous voltage when is connected to mains. The risk of electric shock is minimized since all required connectors and configuration jumpers are galvanically isolated from the coupling stage.



Be careful, there is risk of electric shock in the PLC coupling stage. A normal use of the PL360G55CB-EK board is for indoor use only.

This evaluation board does not have any switch on mains connection to switch it on or off.

To avoid damage of measurement instruments, do not connect any probe to the high voltage sections if the board is not isolated from the mains supply.

Temperature operating range should be from 0°C to +85°C. Running extended periods at minimum and maximum values may cause permanent damage to the board. Quartz crystal components could not cover previous temperature range with desired performance due to aging.

The evaluation board is intended for further engineering, development, demonstration, or evaluation purposes only. It is not a finished product, unless otherwise noted on the board/kit.



**Important:** Microchip does not assume any responsibility for the consequences arising from any improper use of this board.

### 1.2 Electrical Specifications

This section shows the electrical characteristics of the PL360G55CB-EK board.

**Table 1-1. Power Supply Requirements**

Parameter	Condition	Min.	Typ.	Max.	Unit
DC Mains Voltage Range	DC Jack Connector, J8	6	-	30	V <sub>DC</sub>
Maximum Input Current	DC Jack Connector, J8			590 <sup>1</sup>	mA
Isolation Voltage	PLC coupling transformer			3000	V <sub>AC</sub>

Note that the PL360G55CB-EK can be supplied with several power sources. For more information about the power supply system, see section [3.3.6 Power Supply System](#).

**Note:**

1. Board supplied with 6 V<sub>DC</sub>, transmission against very low impedance (2Ω) and all peripherals are on.

**Table 1-2. Power Consumption**

Parameter	Condition	Consumption	Unit
TX Power Consumption	FW: G3 CEN-B PHY TX Test Console Application. Low Impedance Load ( $2\Omega$ LISN, see Figure C.1 of ITU-T G.9901). Measured on 12V DC/DC output.	1932 <sup>1</sup>	mW
	FW: G3 CEN-B PHY TX Test Console Application. High Impedance Load (CISPR LISN, see Figure 5 of EN 50065-1). Measured on 12V DC/DC output.	322 <sup>1</sup>	mW
RX Power Consumption	Measured on 3.3V DC/DC output	264 <sup>1</sup>	mW

**Notes:**

1. These measurements were taken running the PHY TX Test Console project with a default configuration in TX and RX modes, and correspond to the whole PCBA design and not only to PL360 and SAMG55J19 devices. All PCB is supplied in the worst consumption conditions (board is supplied with a minimum input voltage,  $6 V_{DC}$ ) and emitting in CENELEC B-band. Refer to *PL360* and *SAMG55* datasheets for their respective power consumption.

## 2. Getting Started

### 2.1 Powering-Up the Board

Unpack and inspect the kit carefully.

Figure 2-1. Unpacked PL360G55CB-EK



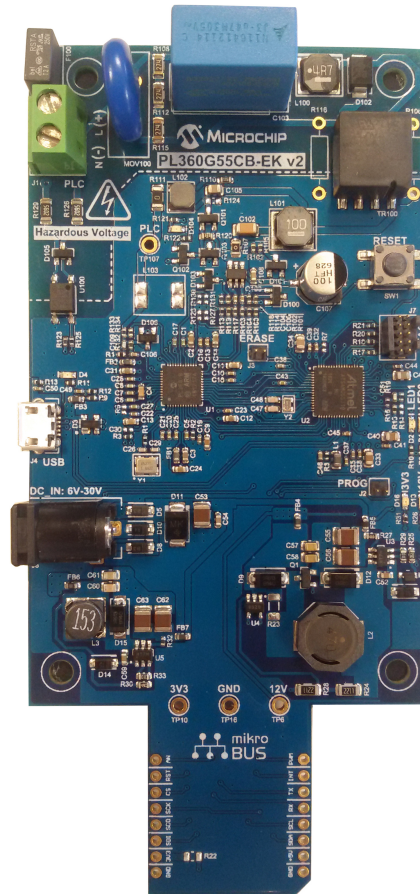
Kit contents are covered by anti-static foam. The PL360G55CB-EK board is shipped in an anti-static shielding bag.



**WARNING** The board must not be subject to high electrostatic discharge. We recommend using a grounding strap or similar ESD protective device when handling the board in hostile ESD environments. Avoid touching the components' pins or any other metallic elements on the board.

---

Figure 2-2. PL360G55CB-EKv2 Board Top View



Take into account that the connectors to supply the board are different than the one for PLC signals. The board can be supplied by three different ways:

- +5V from USB Micro-B connector (J4)
- +5V from mikroBUS connector (J6)
- DC voltage (from +6V to +30V) from DC Jack connector (J8)

## 2.2 Running Preloaded Firmware

Once the board is supplied, LEDs will show activity. The PL360G55CB-EK board is delivered with a pre-programmed application in SAMG55 Flash memory: the G3-PLC PHY Tester for CENELEC B-Band. PLC communications are developed for CENELEC B-Band in AC or DC voltage grid.

The kit includes a USB 2.0 type A to Micro-B cable that can be used to connect the board to a computer. Connect a suitable cable in the PLC connector (J1) and plug it to an AC/DC voltage grid to communicate.

By means of the PLC PHY Tester PC application, it is possible to send and receive PLC messages using the PHY layer in the CENELEC B-Band according to the binary flashed in PL360G55CB-EK board.

## 2.3 Code and Technical Support

Firmware developers can not only run the given example code, but also implement their own applications based on the provided firmware stacks.

Please note that the latest software code, documentation and support materials are available online. Follow instructions described in the welcome letter for more information.

For any technical support requests, please visit <http://support.microchip.com>.

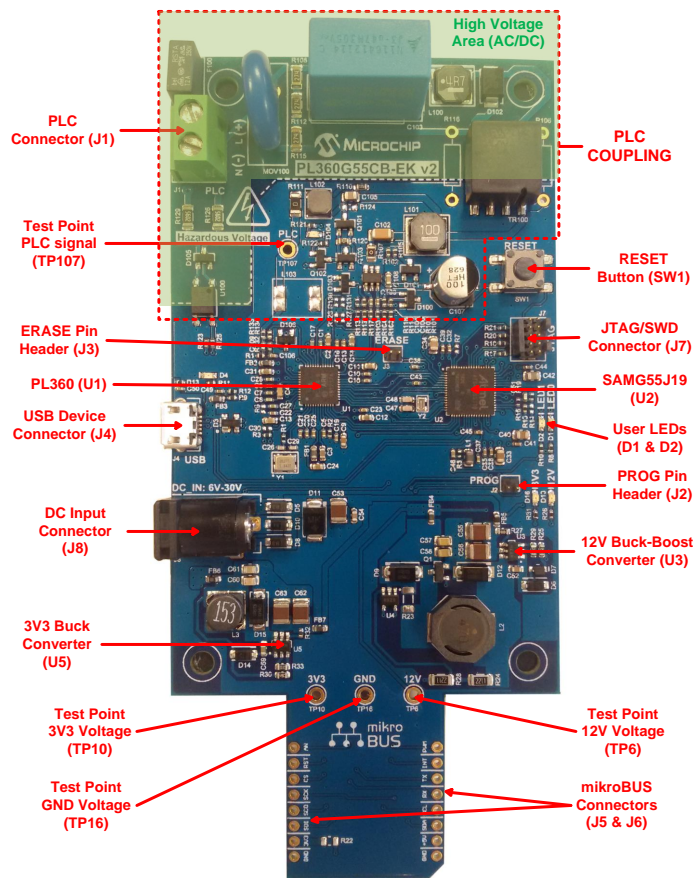
### 3. PL360G55CB-EK Board

#### 3.1 Overview

This section summarizes the PL360G55CB-EK board design. It introduces system-level concepts, such as power supply, MCU, PLC coupling, peripherals and interface board.

PL360G55CB-EK is a PLC modem board based on the PL360 transceiver and on the SAMG55 ARM Cortex-M4 RISC processor. This evaluation board can be used as a PLC modem reference design for modular architectures; or, in any case to provide a platform to develop a complete communications system over PLC technology.

**Figure 3-1. PL360G55CB-EKv2 Board Description**



#### 3.2 Features List

The PL360G55CB-EK board includes the following features:

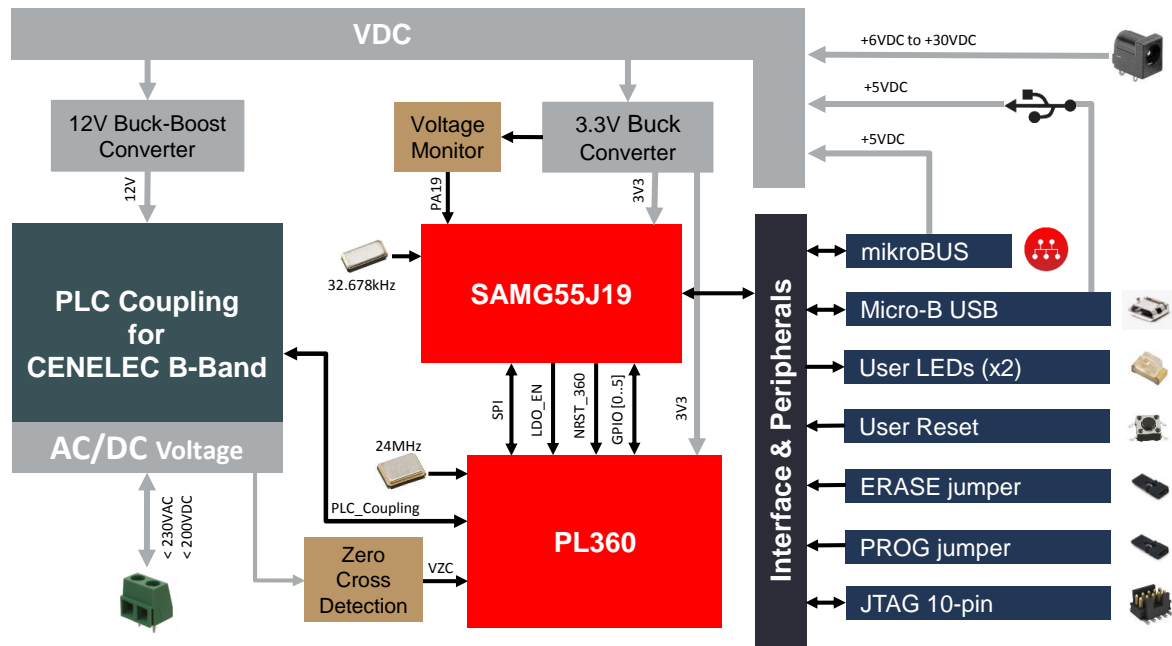
- PL360 PLC Transceiver:
  - Multi-protocol PLC modem:
    - G3-PLC
    - PRIME 1.3 and PRIME 1.4

- One SPI peripheral to external MCU
- Zero-Cross Detection
- Embedded PLC Analog Front End (AFE)
- Low-power consumption in transmission and reception
- SAMG55 MCU:
  - Core:
    - ARM Cortex-M4 running at up to 120 MHz
    - Memory Protection Unit (MPU)
    - DSP instruction set
    - Floating-Point Unit (FPU)
    - Thumb<sup>®</sup>-2 instruction set
    - Instruction and Data Cache Controller with 2 Kbytes cache memory
    - Up to 512 Kbytes of embedded Flash, 176 Kbytes of embedded SRAM, 8 Kbytes of ROM
  - Memories:
    - Up to 512 Kbytes of embedded Flash
    - Up to 176 Kbytes of embedded SRAM
    - Up to 8 Kbytes of ROM with embedded bootloader, single-cycle access at full speed
- PLC Coupling designed to communicate in CENELEC B-Band (95 kHz to 125 kHz)
- A 3.3V buck converter for the digital circuitry and a 12V Buck-Boost converter for supplying the PLC Power Amplifier. It allows supply of the board with any of the three different power sources
- Mains Zero-Crossing Detector Circuit
- Peripherals:
  - Supply monitor
  - User LEDs
  - Reset button
  - Chip Erase jumper
  - Chip Programming jumper
- Interfaces:
  - USB Device
  - mikroBUS add-on connectors
  - SWD/JTAG debugging port

### 3.2.1 PL360G55CB-EK Block Diagram

The following figure shows the block diagram of the PL360G55CB-EK board.

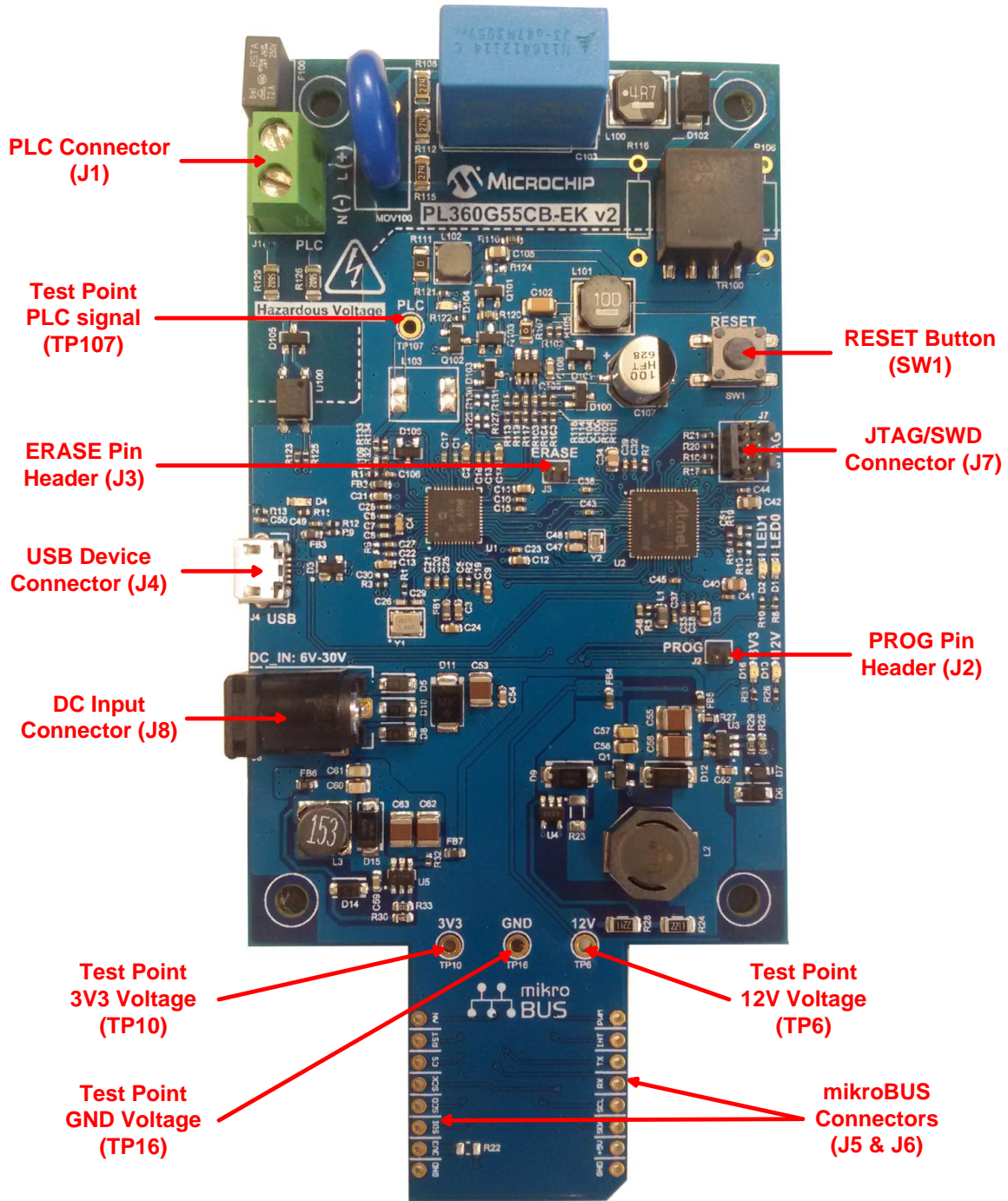
**Figure 3-2. PL360G55CB-EK Block Diagram**



### 3.2.2 Interface Connection

The PL360G55CB-EK board includes hardware interfaces such as jumpers, connectors and a button. Following figure shows an overview of the connectors, jumpers and button of the PL360G55CB-EK board.

**Figure 3-3. PL360G55CB-EK Connectors, Button and Jumpers Overview**



**3.2.2.1 Connectors**

The PL360G55CB-EK board includes the following connectors:

1. PLC connector (for an AC/DC grid), J1.

**Table 3-1. PLC Connector (for an AC/DC grid), J1**

Pin	Signal Name	Description
1	L / +VDC	Line / Positive Voltage
2	N / -VDC	Neutral / Negative Voltage

2. Micro-B female USB connector, J4.

**Table 3-2. USB Device Connector, J4**

Pin	Signal Name	Description
1	VUSB	5V power
2	D+	Data Plus
3	D-	Data Minus
4	ID	On the Go Identification
5	GND	Ground

3. mikroBUS add-on connectors, J5 and J6.

**Table 3-3. mikroBUS Connector, J5**

Pin	Mnemonic	Description
1	AN	Analog
2	RST	Reset
3	CS	SPI Chip Select
4	SCK	SPI Clock
5	SDO	SPI Master Input Slave Output
6	SDI	SPI Master Output Slave Input
7	3V3	VCC - 3.3V power
8	GND	Reference Ground

**Table 3-4. mikroBUS Connector, J6**

Pin	Mnemonic	Description
1	PWM	PWM
2	INT	Hardware Interrupt
3	TX	UART Transmit
4	RX	UART Receive
5	SCL	I <sup>2</sup> C Clock
6	SDA	I <sup>2</sup> C Data
7	5V	VCC - 5V power

.....continued		
Pin	Mnemonic	Description
8	GND	Reference Ground

4. JTAG/SWD 10-pin connector for SAMG55J19, J7.

**Table 3-5. SW-DP Connector, J7**

Pin	Mnemonic	Description
1	VCC	This is the target reference voltage. It is used to check if the target has power, to create the logic-level reference for the input comparators, and to control the output logic levels to the target. It is normally fed from V <sub>CC</sub> on the target board and must not have a series resistor.
2	SWDIO/TMS	Serial Wire Input Output / Test Mode Select. JTAG mode set input of target CPU. This pin should be pulled up on the target. Output signal that sequences the target's JTAG state machine, sampled on the rising edge of the TCK signal.
3	GND	Ground.
4	SWDCLK/TCK	Serial Wire Clock / Test Clock. JTAG clock signal to target CPU (output timing signal, for synchronizing test logic and control register access).
5	GND	Ground.
6	SWO/TDO	Test Asynchronous Data Out from target CPU.
7	KEY	-
8	NC/TDI	Not Connected / Test Data Input. JTAG data input of target CPU (serial data output line, sampled on the rising edge of the TCK signal). It is recommended that this pin is pulled to a defined state on the target board.
9	GND Detect	Ground.
10	nRESET	JTAG Reset (active-low output signal that resets the target). Output from SAM-ICE™ to the Reset signal on the target JTAG port. This pin is normally pulled HIGH on the target to avoid unintentional resets when there is no connection.

5. DC Input connector, J8.

**Table 3-6. DC Input Connector, J8**

Pin	Signal Name	Description
1	DC_IN	DC Input voltage (6 - 30V)
2	GND	Ground
3	-	-

### 3.2.2.2 Jumper Configurations

The following table describes the functionality of the jumpers.

**Table 3-7. Jumper Configuration**

Jumper	Label	Default Setting	Function
J3	ERASE	Open	SAMG55J19 Flash memory code erase (closed = erase).
J2	PROG	Open	SAMG55J19 Flash memory upgrade (closed = programming).

**Note:** Pitch jumpers are 1.27 mm (0.050").

### 3.2.2.3 Test Points

Some test points (probes and pads) have been placed on the PL360G55CB-EK board for the verification of the main signals.

**Table 3-8. Test Point Probes**

Reference	Function
TP6	12V
TP10	3V3
TP16	GND
TP107	PLC signal

**Table 3-9. Test Point Pads**

Reference	Function	Reference	Function
TP1	PROG	TP24	PL360 pin PA7
TP2	ERASE	TP25	PL360 pin PA8
TP3	SAMG55J19 pin PA12, LED D1	TP26	PL360 pin PA9
TP4	SAMG55J19 pin PA15, LED D2	TP27	PL360 pin PA0
TP5	NRST	TP28	PL360 pin PA3
TP7	12V	TP100	PL360 pin TXRX1
TP8	DC_IN	TP101	P Channel MOSFET
TP9	VDC	TP102	Line
TP11	3V3	TP103	N Channel MOSFET
TP12	Ground	TP104	Neutral
TP13	Ground	TP105	Zero cross signal, VZC
TP14	Ground	TP106	PL360 pin TXRX0
TP15	Ground	TP108	PLC RX
TP23	PL360 pin PA6	-	-

### 3.3 Hardware Description – System

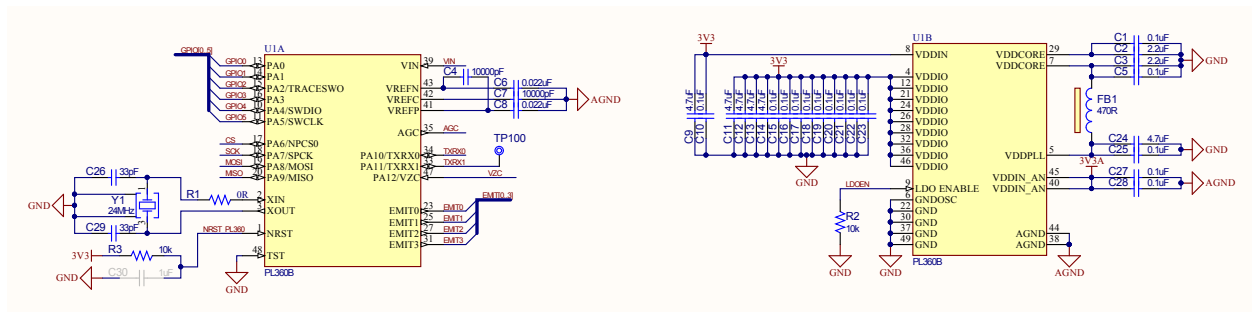
#### 3.3.1 PL360

The PL360G55CB-EK board is equipped with a PL360 device in 48-pin QFN (0.4 mm pitch).

PL360 is a multi-protocol (G3-PLC, PRIME 1.3 and PRIME 1.4) modem for Power Line Communication implementing a very flexible architecture, which allows implementation of standard and customized PLC solutions.

PL360 transceiver has been conceived to be easily managed by an external Microchip MCU through a 4-line standard Serial Peripheral Interface (SPI) accessing the internal peripheral registers. Two additional signals are used by the host microcontroller to control the PL360 transceiver: LDO enable and NRST.

**Figure 3-4. PL360 PLC Modem**



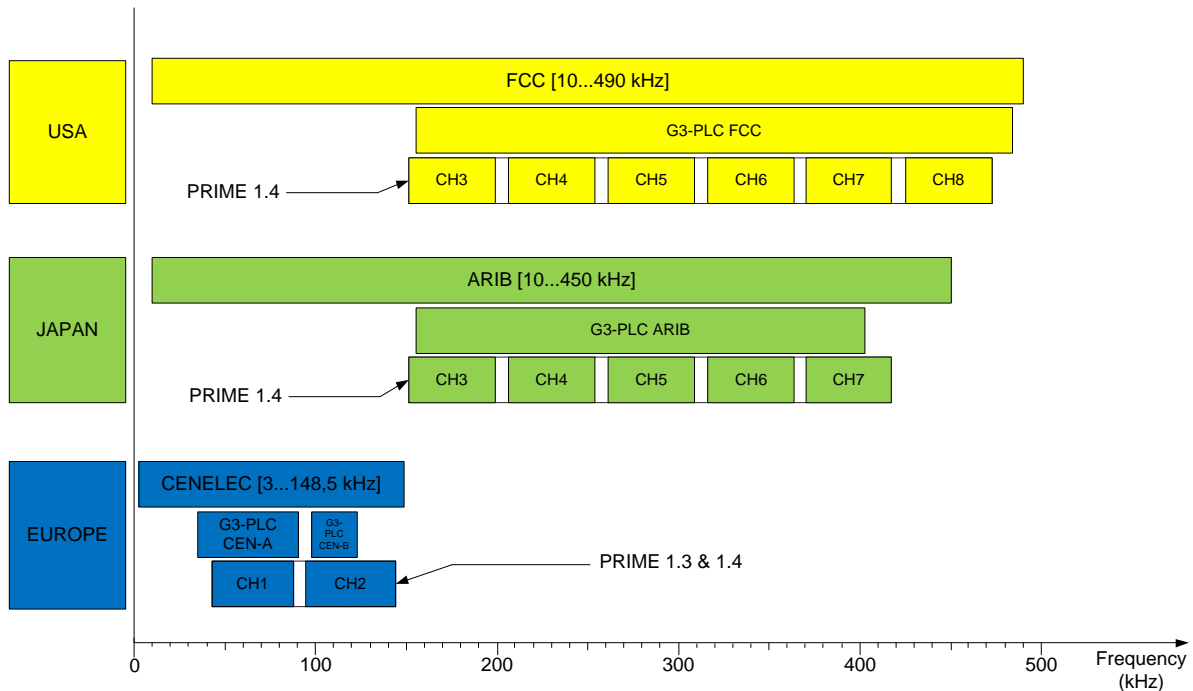
**Important:** Some GPIOs of PL360 device must be connected to the external MCU for the right implementation of the firmware of the PLC standard. G3-PLC requires a GPIO for an external interrupt line (EINT) and PRIME requires two GPIOs for an external interrupt and carrier detect indication lines (EINT and CD). Please, check this point with the firmware user guide.



**Remember:** The PL360 control lines from MCU perspective (SPI lines, EINT in GPIO3 and CD in GPIO0) are accessible via test points.

Microchip provides highly efficient, reduced BOM reference designs for different coupling options, targeting common configurations in all PLC bands (<500 kHz) complying with existing regulations.

**Figure 3-5. PLC Bands Supported by PL360**



For a further description of the PL360 device see the corresponding [PL360 datasheet](#).

### 3.3.2 SAMG55J19

The PL360G55CB-EK board is equipped with a SAMG55J19 device in 64-pin QFN. The SAM G55 devices are general-purpose low-power microcontrollers which offer high performance, processing power and small package options combined with a rich and flexible peripheral set.

The Microchip's SAM G55 embeds a Cortex-M4 CPU with an FPU (floating point unit). This ensures maximum throughput. This is very important as it allows minimization of the active power consumption and getting to sleep faster in order to reduce the overall power consumption. Additionally, the device has 30 DMA channels, which gives extremely high throughput.

The SAMG55J19 operates at a maximum speed of 120 MHz and features 512 Kbytes of Flash and up to 176 Kbytes of SRAM. The peripheral set includes eight flexible communication units comprising of USARTs, SPIs and I<sup>2</sup>C-bus interfaces (TWIs), two three-channel general-purpose 16-bit timers, two I<sup>2</sup>S controllers, one-channel pulse density modulation, one 8-channel 12-bit ADC, one Real-Time Timer (RTT) and one Real-Time Clock (RTC), both located in the ultra-low power backup area.

**Figure 3-6. SAMG55 Microcontroller**



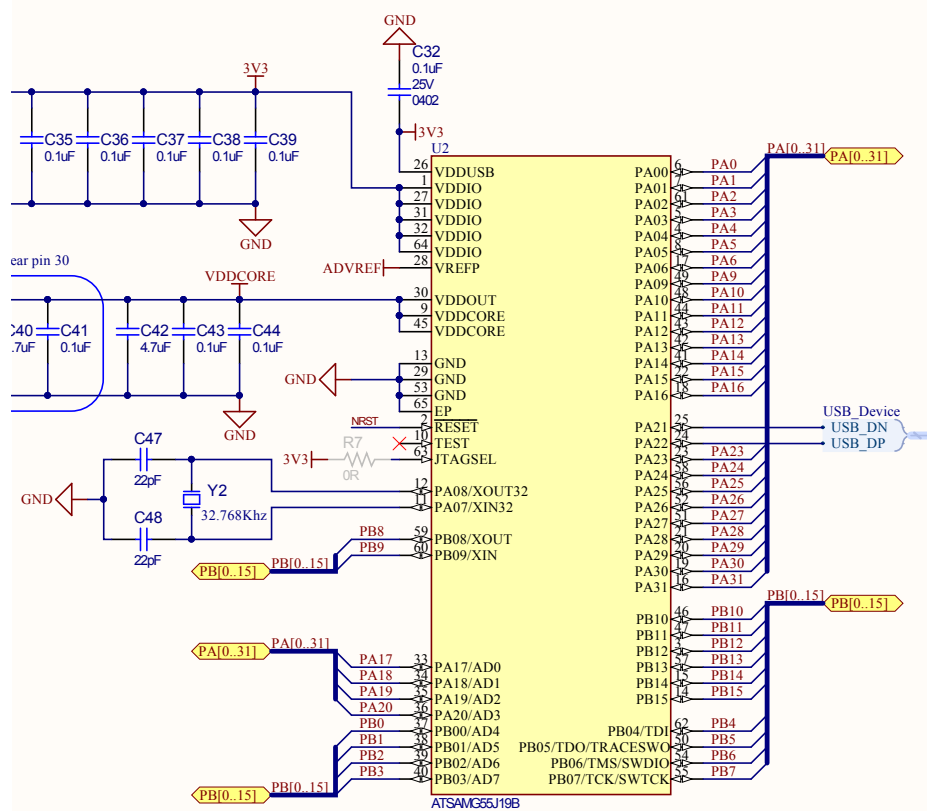
Table 3-10 and Table 3-11 summarize the functionality of each input/output line of the SAMG55J19 microcontroller in PL360G55CB-EK board.

**Table 3-10. Pinout of SAMG55J19 PortA in PL360G55CB-EK Board**

I/O LINE	Function	I/O LINE	Function
PA0	PL360 GPIO3	PA16	PL360 GPIO4
PA1	PL360 GPIO2	PA17	AD0 (mikroBUS)
PA2	Not Connected	PA18	PROG
PA3	PL360 MOSI	PA19	Voltage Monitor
PA4	PL360 MISO	PA20	Not Connected
PA5	PL360 GPIO1	PA21	USB Device Diff Negative
PA6	PL360 GPIO5	PA22	USB Device Diff Positive
PA7	XIN32	PA23	TIOA1 (mikroBUS)
PA8	XOUT32	PA24	Not Connected
PA9	SPI0 MISO (mikroBUS)	PA25	SPI0 CS0 (mikroBUS)
PA10	SPI0 MOSI (mikroBUS)	PA26	Not Connected
PA11	USB Detect	PA27	Not Connected
PA12	User LED0	PA28	Not Connected
PA13	Not Connected	PA29	PL360 NRST
PA14	WKUP8 (mikroBUS)	PA30	PL360 LDO_EN



Figure 3-8. 32.768 kHz Crystal Oscillator Scheme



### 3.3.4 Reset

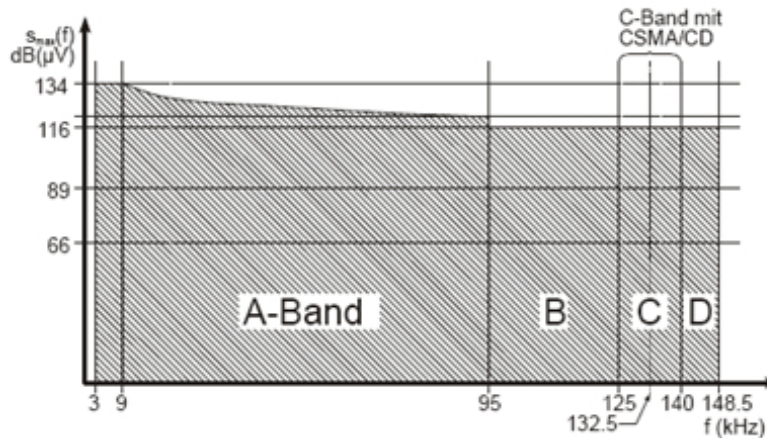
The reset sources of the PL360G55CB-EK board are:

- Power-on Reset function, embedded in the SAMG55 device.
- Push button reset. Both devices, SAMG55J19 and PL360, have a NRST pin: “NRST” for SAMG55J19 and “NRST\_360” for PL360. The user can manually reset the SAMG55J19, which manages the PL360 reset, by using the push button SW1. See section 3.4.2.2 Push Buttons.
- JTAG reset from an in-circuit emulator.

### 3.3.5 PLC Coupling Circuitry Description

The European regulations concerning Power Line Communications are described in CENELEC standard EN 50065. This standard applies to electrical equipment using signals in the frequency range 3 kHz to 148,5 kHz to transmit information on low voltage electrical systems, either on the public supply system or within installations in consumers' premises. The following figure shows the different frequency bands allocated to the different applications.

**Figure 3-9. CENELEC Frequency Bands**



The PL360G55CB-EK evaluation board communicates in the CENELEC B-Band frequency. The use of frequencies in this band shall be restricted to consumer use; for example, for end-user applications such as industrial applications.

Microchip has designed five coupling reference designs for CENELEC B-Band with variations in the BOM cost and the communication performance. [Table 3-12](#) summarizes the main features of the available designs.

**Table 3-12. Characteristics of PLCOUPxxx Boards for CENELEC B-Band**

Board Name	Description	Frequency Band (kHz)	Branch	Electrical Isolation	PRIME Channel	G3-PLC Band	Applicable Regulation
PLCOUP012-ISO	Low cost with internal driver G3 CENELEC B compliant	95 - 125	Single	Yes	-	G3 CENELEC B	CENELEC EN 50065
PLCOUP012-NONISO	Low cost with internal driver G3 CENELEC B compliant	95 - 125	Single	No	-	G3 CENELEC B	CENELEC EN 50065
PLCOUP013	Ultra low cost with internal driver and non-Isolated G3 CENELEC B compliant	95 - 125	Single	No	-	G3 CENELEC B	CENELEC EN 50065
PLCOUP014-ISO	G3 CENELEC B compliant	95 - 125	Single	Yes	-	G3 CENELEC B	CENELEC EN 50065
PLCOUP014-NONISO	G3 CENELEC B compliant	95 - 125	Single	No	-	G3 CENELEC B	CENELEC EN 50065

The PL360G55CB-EK board is assembled with the PLCOUP014-ISO coupling design. The goal is to provide a cost-optimized fully-featured design according to the G3-PLC requirements. Still, the PL360G55CB-EK board is designed to allow using all the other coupling designs by changing the corresponding components and firmware configurations.




**Important:** Check the online resources from Microchip website to download the proper files according to your desired CENELEC B-Band design.



- Adapt Input/Output impedance for optimal reception/transmission. This is controlled by TXRX0 signal
- A band-pass filtering for received signals

### 3.3.5.3 PLC Coupling Circuit

PLC coupling circuit connects the PLC signal directly to the mains grid or even to DC power rails without requiring any hardware adaptation. The main purpose of the circuit is to block the mains voltage of the grid to/from which the signal is injected/received. This is carried out in PL360G55CB-EK, see [Figure 3-10](#), by a high voltage capacitor, C103. Resistors R108, R112 and R115 allow the high voltage capacitor to discharge after disconnection from mains.

 PLC coupling components are designed for a maximum voltage of 230 V<sub>AC</sub> or 200 V<sub>DC</sub>.

The TR100 transformer (with turn ratio 1:1) provides galvanic isolation from mains. A non-isolated version could easily be implemented removing TR100, soldering R106 and R116 resistors and updating the value of L103 according to the PLCOUP014-NONISO design.

MOV100 varistor, F100 fuse and D102 TVS diode protect the coupling circuit from the overvoltages and high transient voltages (surges and spikes) from mains.

### 3.3.5.4 PLC Reception Circuit

The PLC reception circuit used in PL360G55CB-EK, see [Figure 3-10](#), is the reference design for the reception stage and it is composed of:

- Single-pole low pass filter, R133 and C109
- Automatic Gain Control (AGC) circuit. A resistor, R134, is used to attenuate the incoming PLC signal in case its amplitude is high enough to exceed the input dynamic range of the embedded ADC
- A resistor, R132, for impedance matching
- DC decoupling capacitor, C106

### 3.3.6 Power Supply System

The PL360G55CB-EK board can be powered by several power sources. Supply the board via:

- the DC jack 2.0 mm connector J8, DC\_IN, with a DC source from 6V to 30V (±5%) and 4.2W
- the USB connector (+5V), J4
- the power supply pin (+5V) of mikroBUS standard

**Table 3-13. Power Sources for PL360G55CB-EK Board**

Power Input	Voltage Requirements	Power Requirements	Connector Marking
DC Jack connector	+6V to +30V (±5%)	4.2 Watts	DC_IN
Target USB	+5V	According to USB specifications	USB
mikroBUS Power pin (+5V)	+5V	According to mainboard specifications	+5V

The PL360G55CB-EK board has two voltage rails:

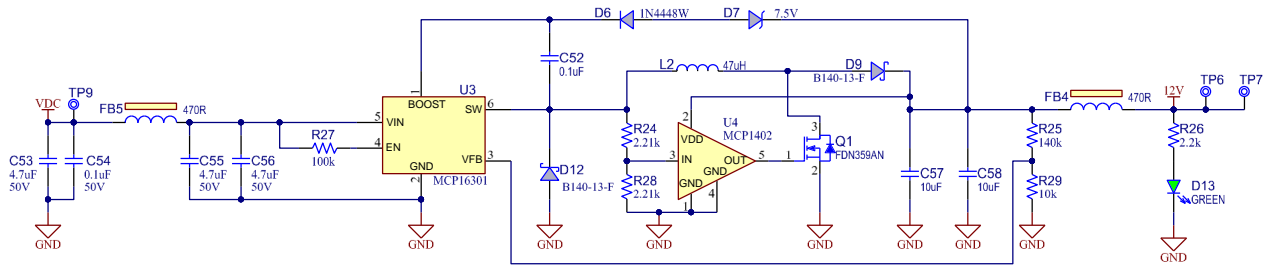
- +3.3V for the digital part of the PLC modem, PL360, and the SAMG55J19 MCU
- +12V to power the class-D amplifier of the PLC coupling circuit



Note that the PL360G55CB-EK board does not provide a power supply protection circuit; only a TVS diode is used to protect from voltage spikes at the DC rail.

The 12V voltage rail is obtained from the MC16301 buck-boost converter. For a further description about the buck-boost converter see the [MCP16301 Buck-Boost Converter User's Guide](#). If the VDC voltage is always higher than 12V, it is possible to improve the power efficiency by transforming the converter mode from buck-boost to buck, see [MCP16301 datasheet](#) for a further explanation.

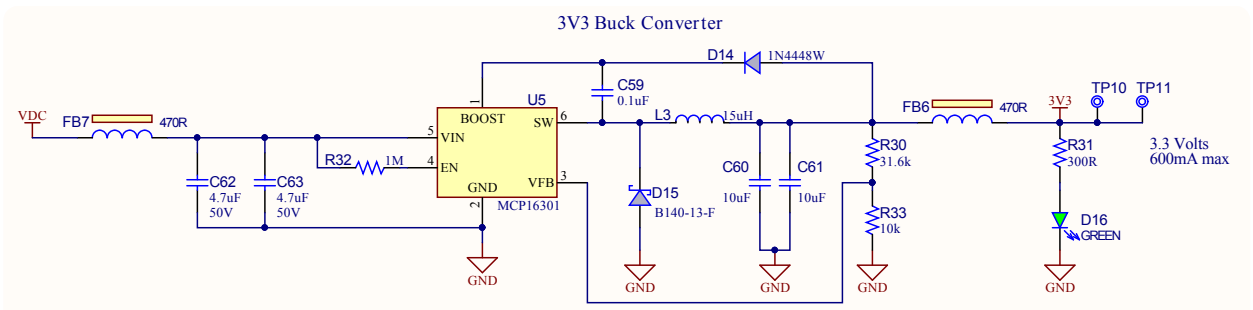
**Figure 3-11. 12V Voltage Design**



**Restriction:** Note that some power sources, such as USB port and mikroBUS rail, might have limited current capabilities and they could not supply enough current for the class-D amplifier transmitting against low impedance values. In this case, an external AC/DC power supply with enough current rating is recommended to maintain the PLC performance at its best. In case of using one, we recommend a module complying to national regulations or CISPR 32:2015.

Another buck converter, MC16301, is used to generate a regulated 3.3V voltage rail required by the PL360 modem and the SAMG55J19 MCU. For a further description about the buck converter see the [MCP16301 Buck Converter User's Guide](#).

**Figure 3-12. 3.3V Buck Converter Design**



There are one LED and two test points on each voltage rail to check whether all power supplies are operating properly.

To avoid on board self-generated disturbances within the PLC signal band, both converters are switching at 500 kHz fixed frequency, out of the PLC band (95 to 125 kHz).



**Tip:** In case of choosing a different SMPS in the customer design, it is important to analyze its potential interference on the PLC frequency band.



**Attention:** To avoid noise interferences, the switching frequency of the SMPS must be out of the PLC band and preferably in frequencies above it to avoid harmonics influence. This is essential to obtain a good reception performance.

### 3.3.6.1 PLC Rejection Filter

When the PLC coupling circuit is in parallel with the power supply circuit, the input impedance of the final equipment could be affected. If the requirements about total input impedance are not satisfied, an appropriate input filter is needed at the power supply input to increase the input impedance.

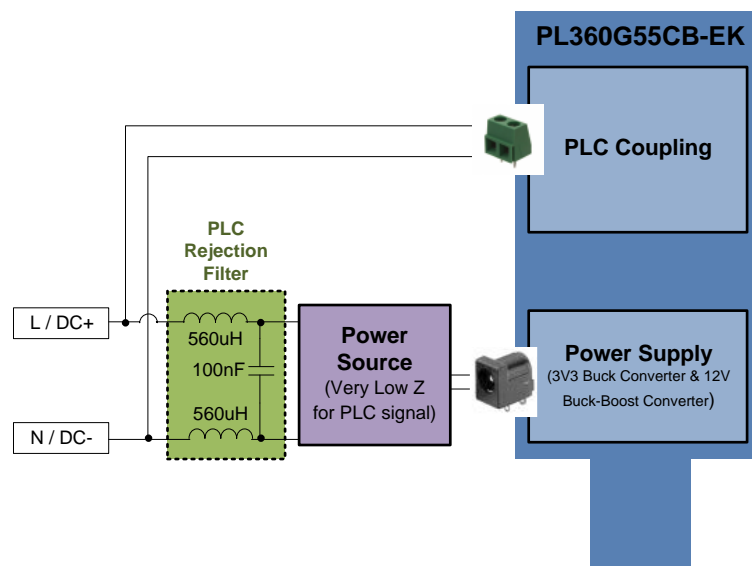
Apart from the input filter, it is also recommended to add a PLC rejection filter to avoid the absorption of the PLC signals by the power supply circuit. This filter also increases the input impedance, so it helps to achieve the requisites about input impedance.



**Notice:** The PL360G55CB-EK board has PLC coupling and power supply circuits separated, so the PLC rejection filter is not included. A PLC rejection filter is needed in case of low input impedance after connecting in the same point the PLC Coupling connector J1 and the power source of the board.

An example of PLC rejection filter is composed of two inductance in-series ( $L = 560 \mu\text{H}$ ) and a capacitor in-parallel ( $C = 100 \text{ nF}$ ) at the power supply input as shown in the following picture.

**Figure 3-13. PLC Rejection Filter Example**



### 3.3.7 Zero-Crossing Detector Circuit

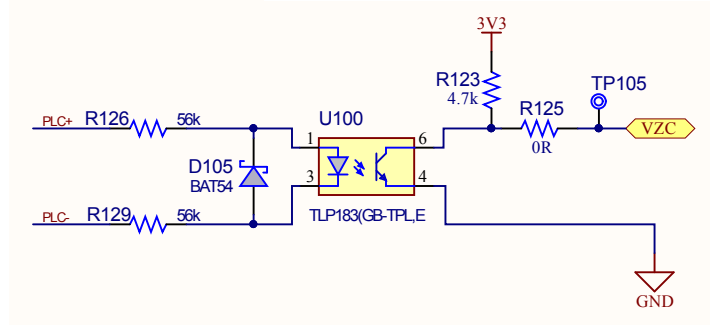
Phase identification is an important feature of devices that are connected to a Smart Grid network. A typical implementation is based on measuring the time difference between a specific PLC frame reception and the last zero crossing event of the mains single-phase to which the device is connected.



**Important:** The phase identification feature is mandatory for G3-PLC and PRIME1.4, but not for PRIME1.3.

Figure 3-14 shows the Zero-Crossing Detection circuit used in the PL360G55CB-EK board, which features detection of rising edges of the mains voltage. The output signal of the detection circuit “VZ CROSS” is connected to VZ pin of PL360 and a synchronization algorithm is applied in order to obtain an accurate measurement of the time between PLC frame reception and zero crossing events.

**Figure 3-14. Zero-Crossing Detection Circuit**



**Notice:** Designs that do not require galvanic isolation can use a simpler Zero-Crossing Detector circuit, such as a Zener diode, instead of the previous circuit.

## 3.4 Hardware Description – MCU Peripherals

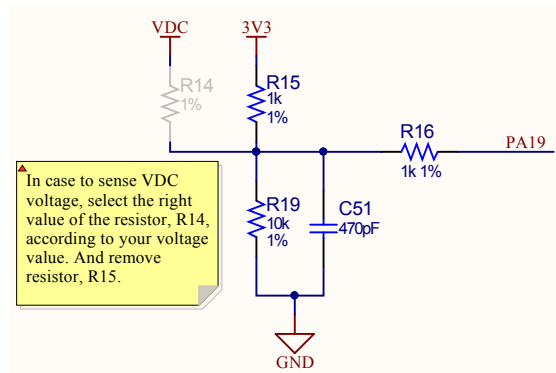
### 3.4.1 Voltage Monitor

The input pin PA19 of SAMG55J19 is used to monitor the 3.3V voltage rail through external voltage dividers. It can be used to monitor the VDC voltage rail mounting R14 and removing R15 resistor.



**Important:** The R14 resistor value depends on the voltage value of the input source power.

**Figure 3-15. Voltage Monitor Circuit**



The voltage monitor circuit allows the implementation of multiple applications such as:

- Detection of fault conditions
- Detection of Low-Power mode entering conditions
- Detection of wake-up situations

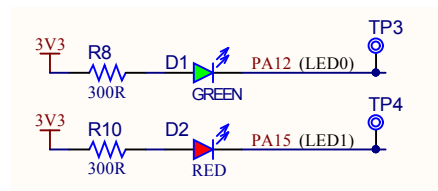
### 3.4.2 LEDs and Buttons

The PL360G55CB-EK board is equipped with several LEDs and one user push button.

#### 3.4.2.1 User LEDs

The PL360G55CB-EK board includes two general purpose LEDs, one green connected to PA12 (LED0) and one red connected to PA15 (LED1).

**Figure 3-16. User LEDs**

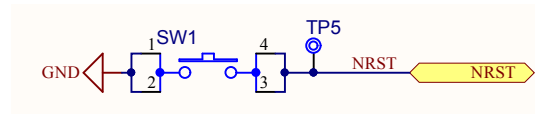


In addition, this board disposes of two green LEDs, D13 and D16, connected to 12V and 3.3V supplies for visual status of these voltages, and a yellow LED, D104, for visual indication of PLC frames transmission.

#### 3.4.2.2 Push Buttons

The PL360G55CB-EK board is equipped with a momentary push button switch mounted directly to the board. When the button is pressed it will drive the SAMG55 reset line, NRST, to GND. And PA29 will drive the PL360 reset line, NRST\_PL360, to GND.

**Figure 3-17. Reset Button**



### 3.4.3 Chip Programming

The 1x2 pin-header J2 marked as “PROG” is connected to the SAMG55J19 chip input pin (PA18) and GND. This header can be used to upgrade (using a bootloader binary file of the SAMG55J19) the PLC stack running on the SAMG55 by the USB/serial port. See *Smart Energy: Serial Bootloader User Guide* for more information.

### 3.4.4 Chip Erase

The 1x2 pin-header J3 marked as “ERASE” is connected to the SAMG55J19 chip erase pin (PB12) and 3.3V. This header can be used to re-initialize the Flash content (and some of its NVM bits) to an erased state (all bits read as logic level 1) by placing a jumper on the header and pressing the reset switch button. After a while, the erase jumper should be removed and the PCBA must be turned off and turned on by disconnecting and connecting it again to the selected power supply. See section “ERASE Pin” in the *SAMG55J19* datasheet for more information.



**Notice:** Take into account that when Flash is erased, the bootloader application will also be removed; therefore the SAMG55J19 device will be programmable only via JTAG.

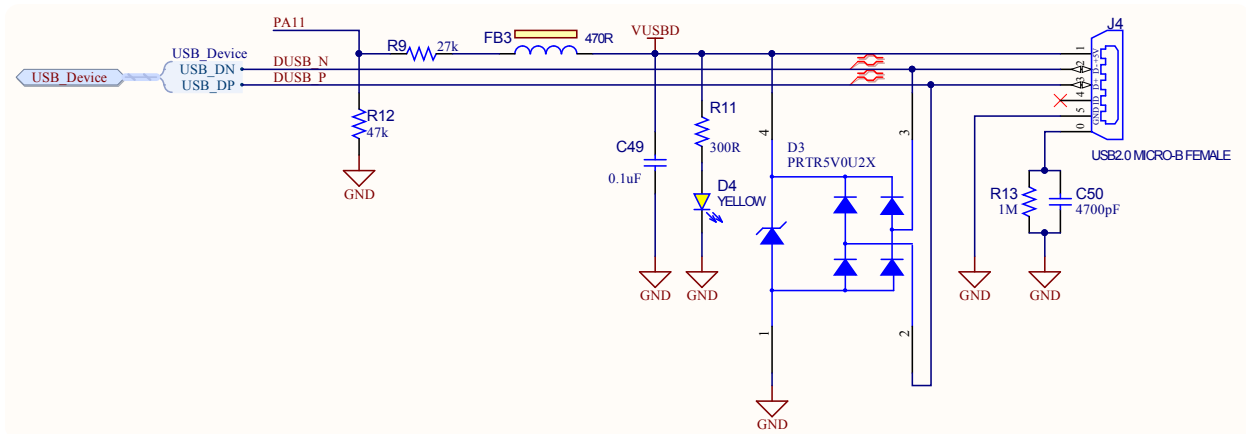
## 3.5 Hardware Description – MCU Interface Ports

### 3.5.1 USB Device Port

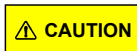
The USB Device Port (UDP) is compliant with the Universal Serial Bus (USB) 2.0 full-speed device specification. There is a USB available on the PL360G55CB-EK board that can act as both host and device. It has a Micro-B female USB connector with the silk screen USB.

The I/O line PA11 allows the application to check if VUSBD is available.

**Figure 3-18. USB Circuit**



**Important:** Check online resources from the Microchip Website to download the drivers according to your Operating System.



The USB connector is not isolated from mains. Please make use of proper isolation (i.e.: USB isolator device) in case of using this connector when the board is not galvanically isolated (using a PLC Coupling design which it is not isolated from mains). Take into account the possible noise interference that these isolators could be adding to the PLC network. For instance, you can use the [UH401](#).

### 3.5.2 SAMG55J SWD/JTAG Port

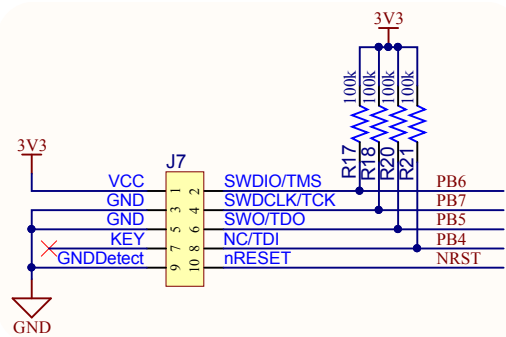
The PL360G55CB-EK board includes an SWD (Serial Wire Debug) / JTAG interface port to provide debug level access to the system-on-chip. It also embeds a serial wire trace. This connector provides the required interface for in-circuit emulators, like the [Atmel-ICE](#) or [SAM-ICE](#). The SW-DP/JTAG port is a 10-pin, dual row, 0.1-inch male connector (J7). When using the SAM-ICE, a JTAG adapter for 20 to 10 pins is necessary, e.g., [this one](#).



**Important:** Note that the PL360G55CB-EK kit does not include either Atmel SAM-ICE or Atmel-ICE JTAG emulators.

Please refer to the [SAMG55 datasheet](#) for further description of the JTAG debug port.

**Figure 3-19. JTAG/SWD Interface Schematic**



The JTAG/SWD connector is not isolated from mains. Please make use of proper isolation (i.e.: USB isolator device) if using this connector when the board is not galvanically isolated (using a PLC Coupling design which it is not isolated from mains). Take into account the possible noise interference that these isolators could be adding to the PLC network. For instance, you can use the [UH401](#).

### 3.5.3 mikroBUS Connector

The PL360G55CB-EK board incorporates mikroBUS add-on connectors (J5 and J6) to integrate the board itself as a module which is able to interface with other microcontrollers or microprocessors (main board).

The mikroBUS standard specifies the size and shape of the add-on boards, but because of special constraints, the board exceeds those limits although keeping the smallest size model S as a reference for the plug-in area.

The PL360G55CB-EK board is designed to operate only from the +5V power supply rail of the mikroBUS socket. Therefore, +3.3V power supply pin is not connected.

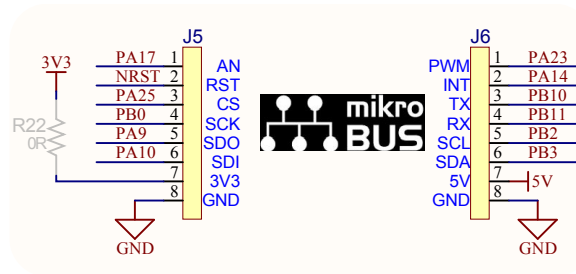


**Important:** By default, J5 and J6 headers are not populated in the board. The 8-pin headers are included in a zip bag as kit contents.

This mikroBUS standard has a pair of 1x8 male headers with the following pinout:

- SPI
- UART
- I<sup>2</sup>C
- PWM
- Interrupt
- Analog input
- Reset
- Chip Select
- +3.3V
- +5V
- Two GND pins

**Figure 3-20. mikroBUS Connector**



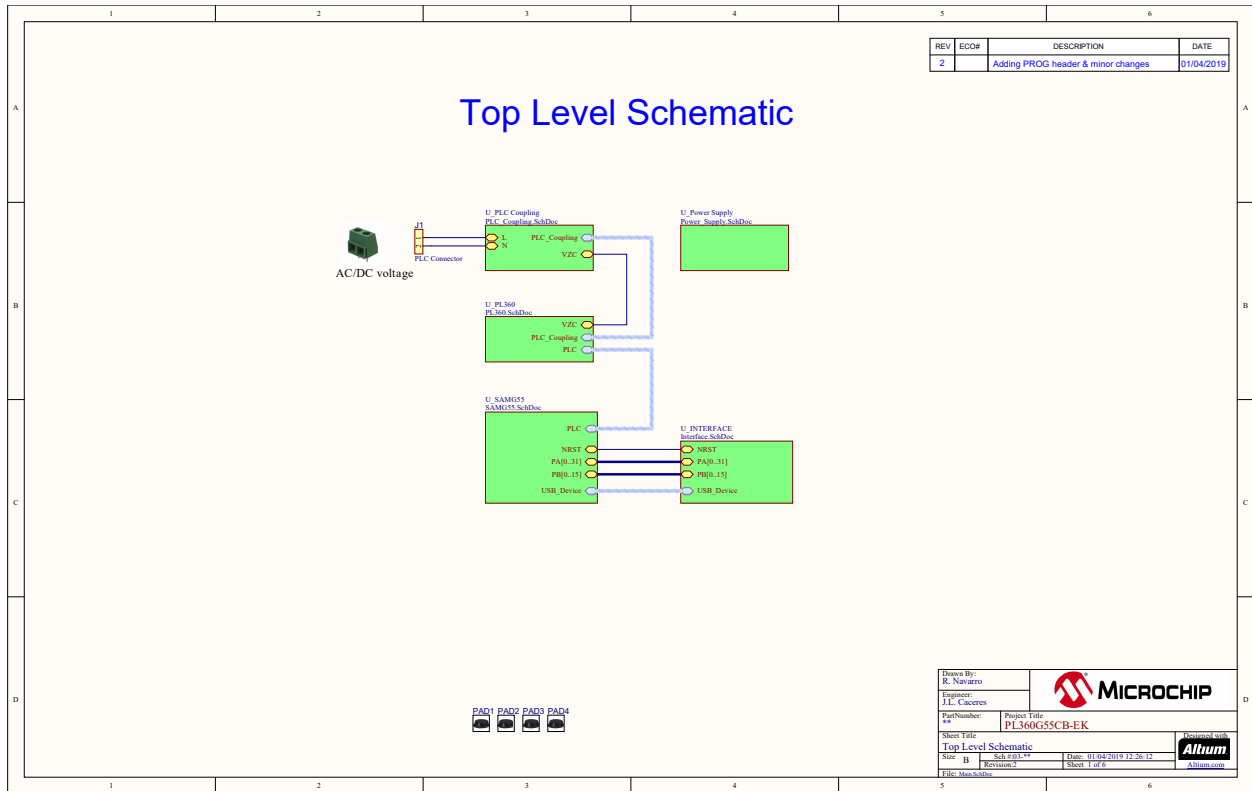
**Notice:** The [mikroBUS Xplained Pro](#) is an extension board which contains the female header to connect the mikroBUS add-on boards to the Xplained Pro MCU boards.

### 3.6 PL360G55CB-EK Schematics

This section contains the schematics for the PL360G55CB-EKv2 board:

- Top Level Schematic, [Figure 3-21](#)
- PL360 Schematic, [Figure 3-22](#)
- SAMG55 MCU Schematic, [Figure 3-23](#)
- Interface and Peripherals SAMG55 Schematic, [Figure 3-24](#)
- Power Supply Schematic, [Figure 3-25](#)
- PLC Coupling Schematic, [Figure 3-26](#)

**Figure 3-21. Top Level Schematic**



**Figure 3-22. PL360 Schematic**

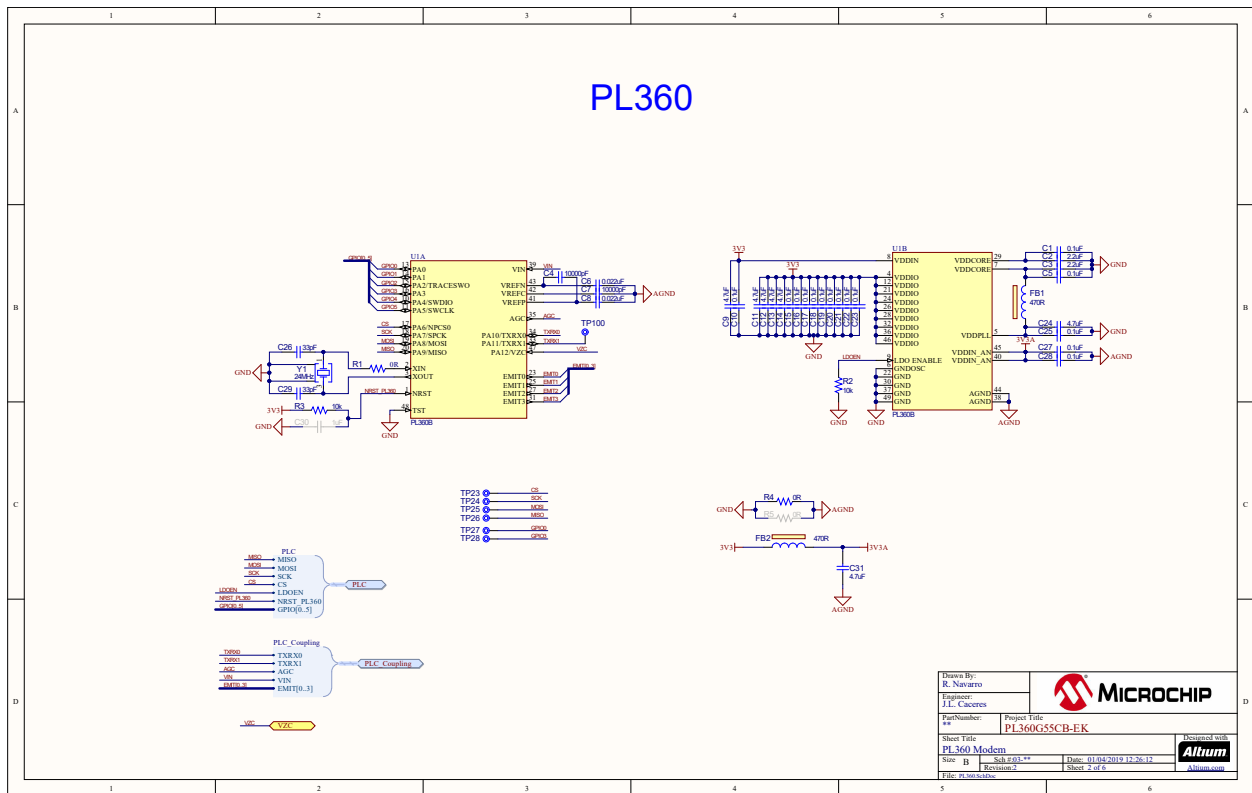


Figure 3-23. SAMG55 MCU Schematic

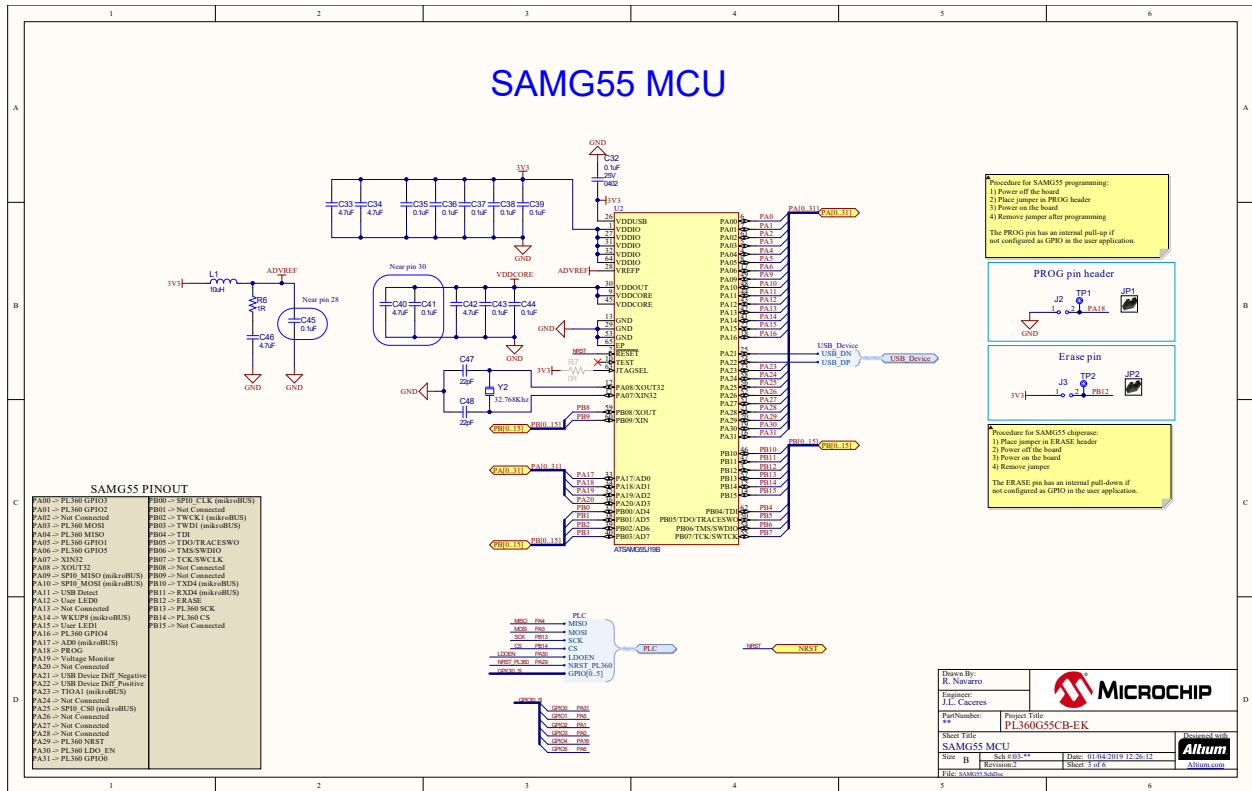


Figure 3-24. Interface and Peripherals SAMG55 Schematic

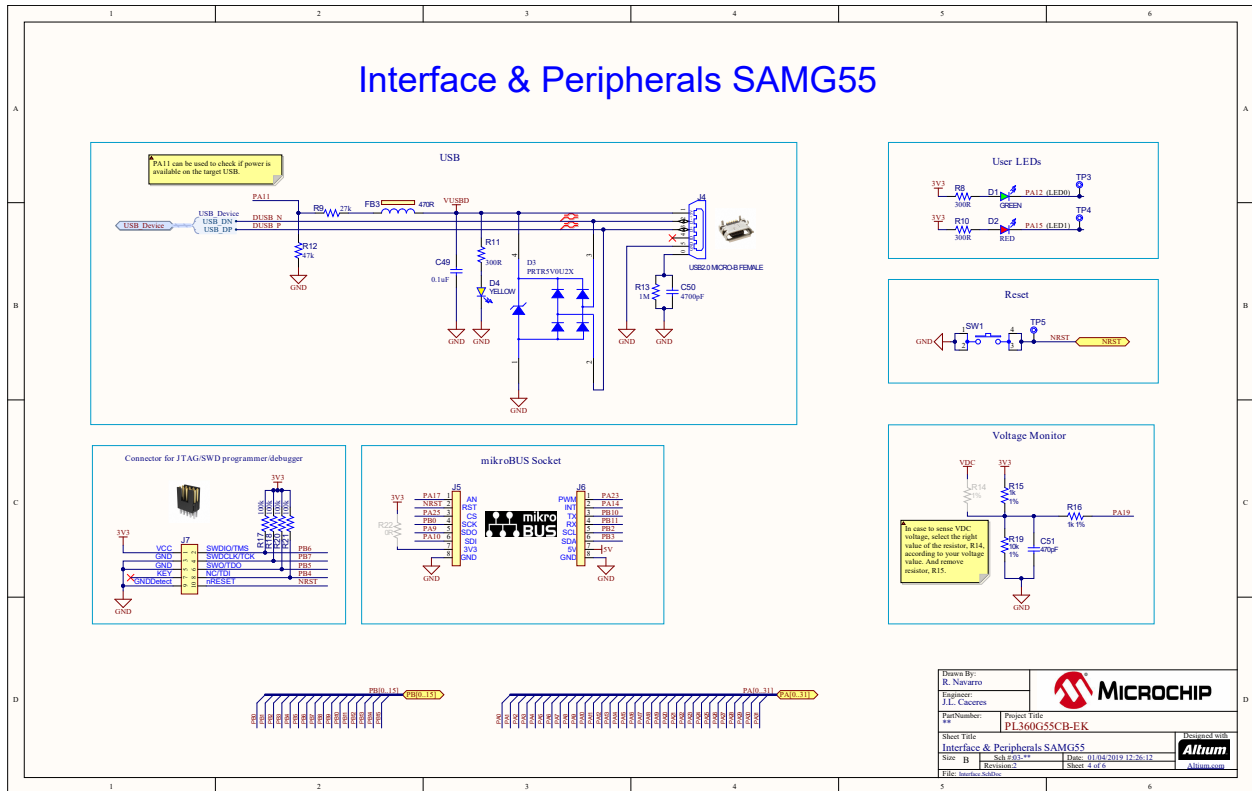


Figure 3-25. Power Supply Schematic

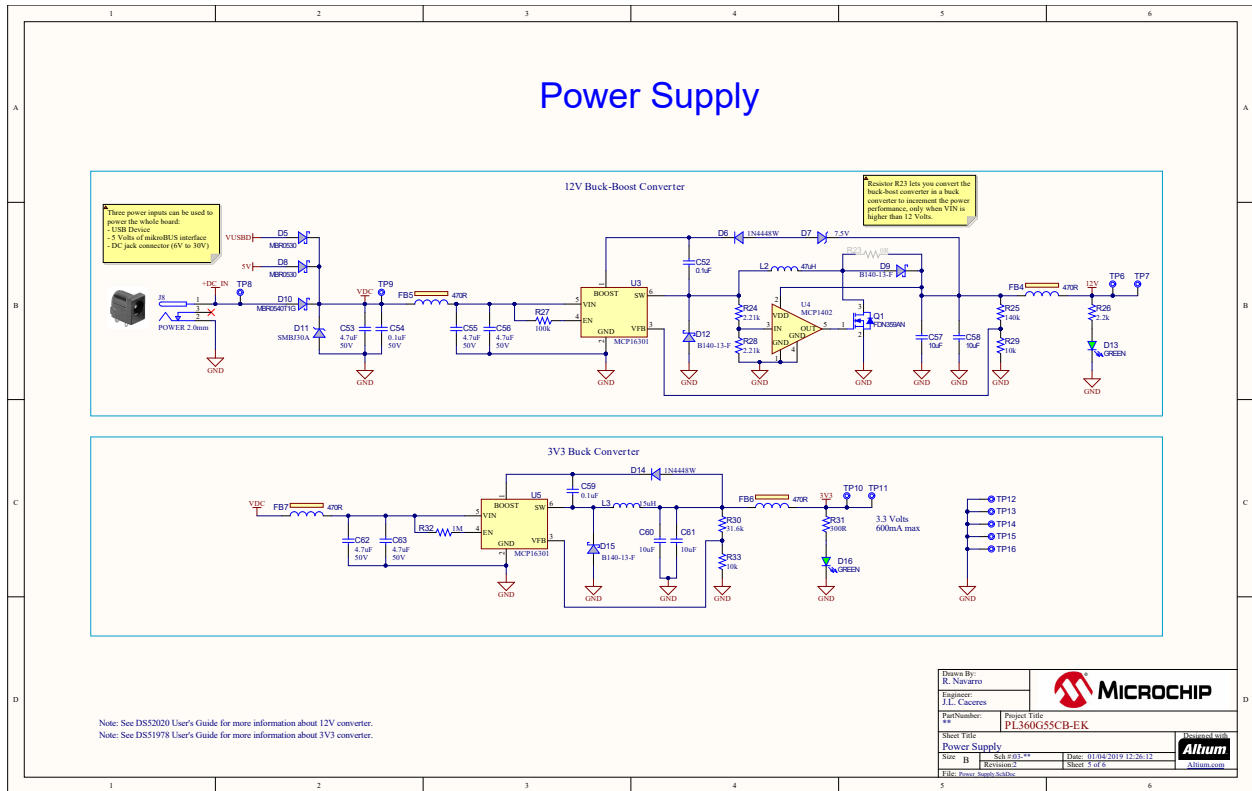
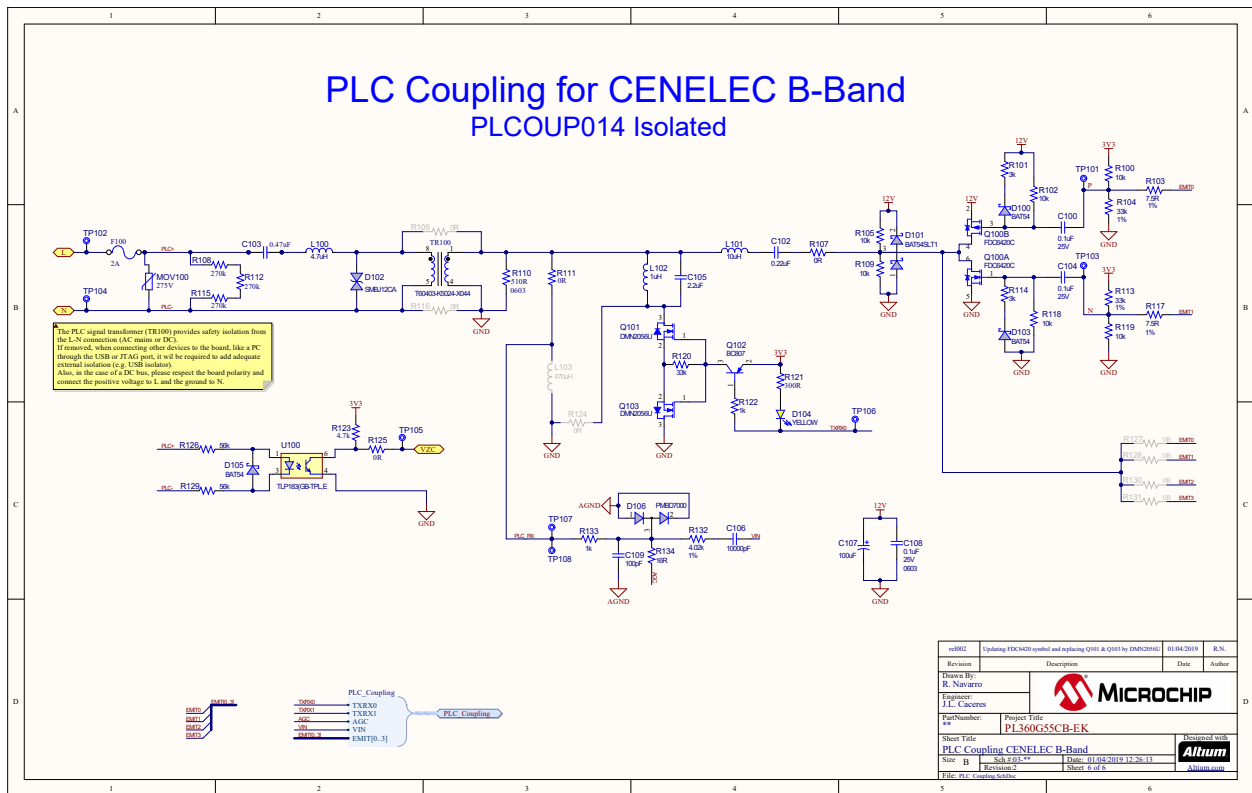


Figure 3-26. PLC Coupling Schematic



### 3.7 PL360G55CB-EK Layout

This section contains the layout graphics for the PL360G55CB-EKv2 board:

- Layer 1: Top Layer, [Figure 3-27](#)
- Layer 2: Mid Layer 1 (Ground), [Figure 3-28](#)
- Layer 3: Mid Layer 2 (Power Supplies), [Figure 3-29](#)
- Layer 4: Bottom Layer, [Figure 3-30](#)
- Top Components Placement, [Figure 3-31](#)
- Bottom Components Placement, [Figure 3-32](#)

**Figure 3-27. PL360G55CB-EKv2 Layout: Top Layer**

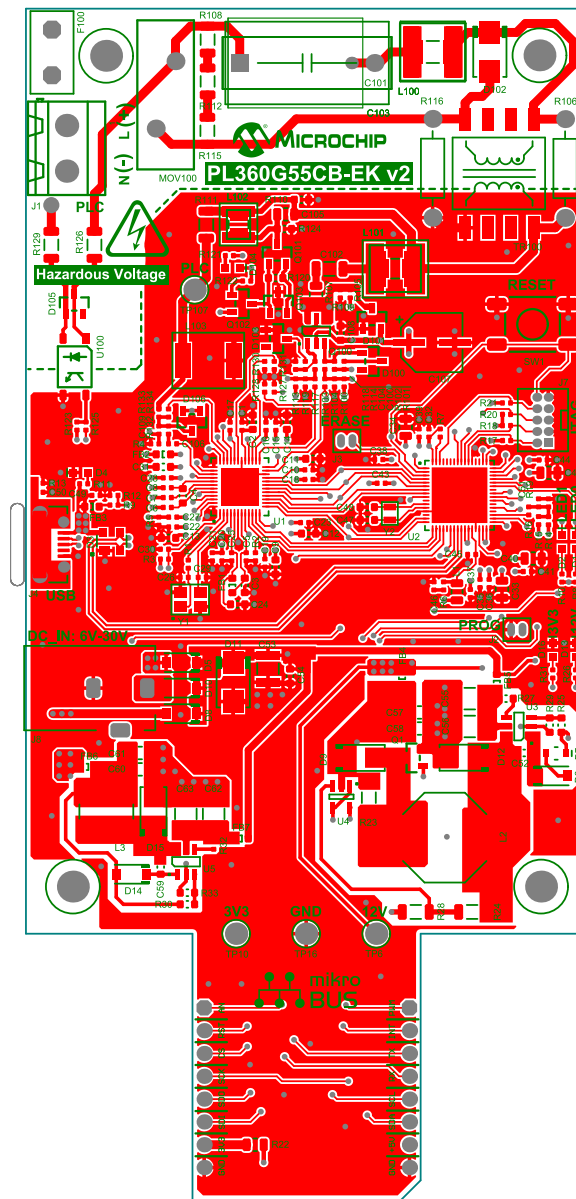


Figure 3-28. PL360G55CB-EKv2 Layout: Mid Layer 1 (Ground)

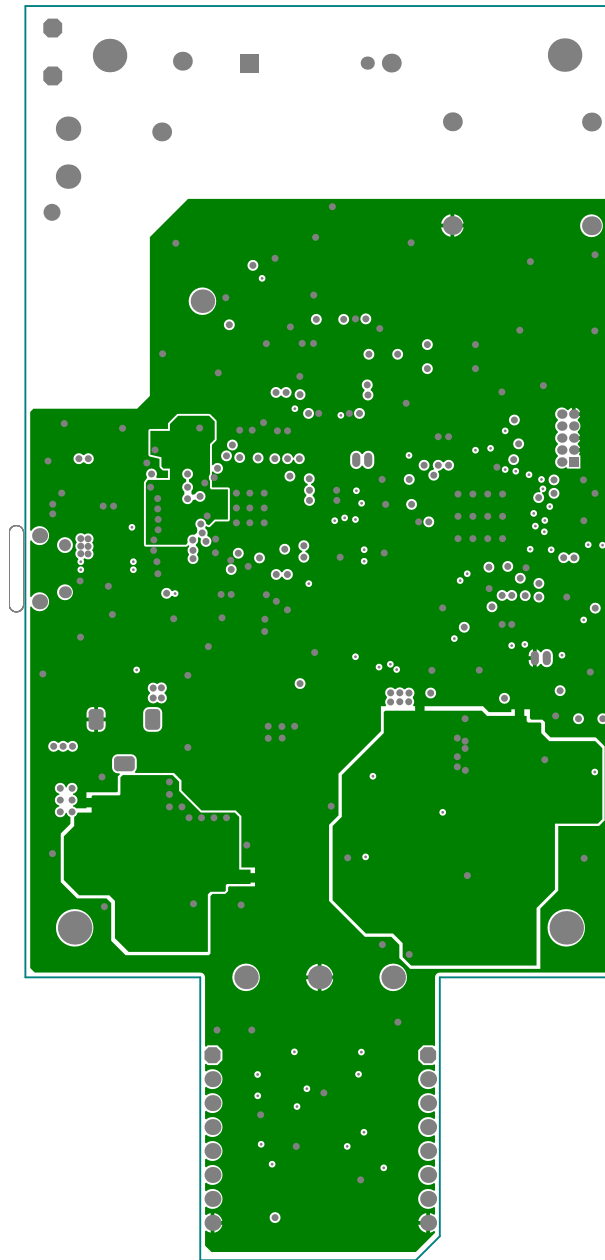
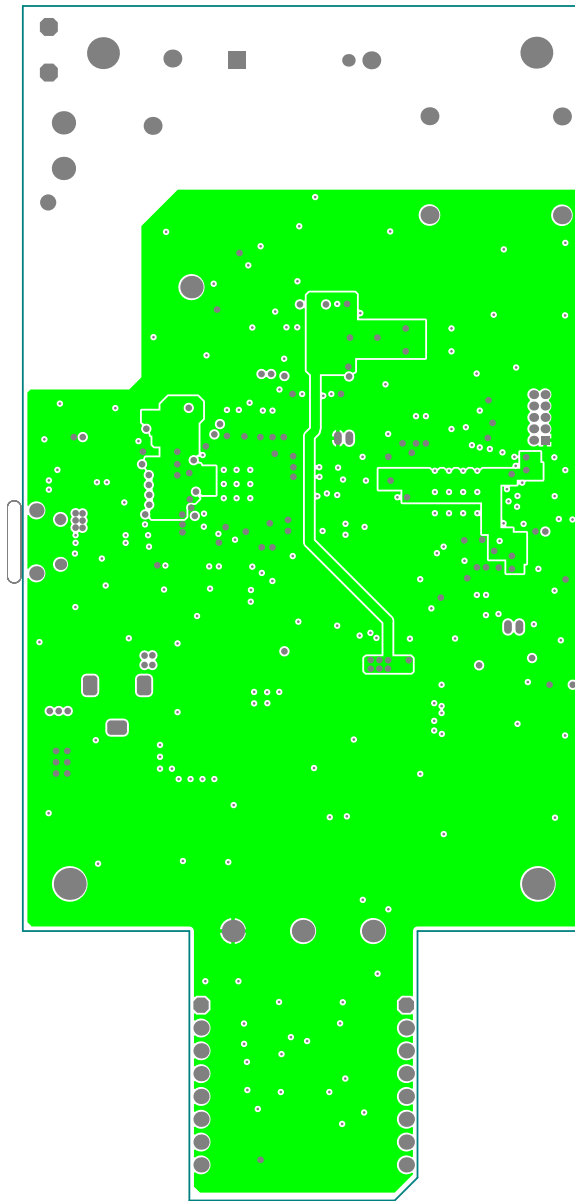


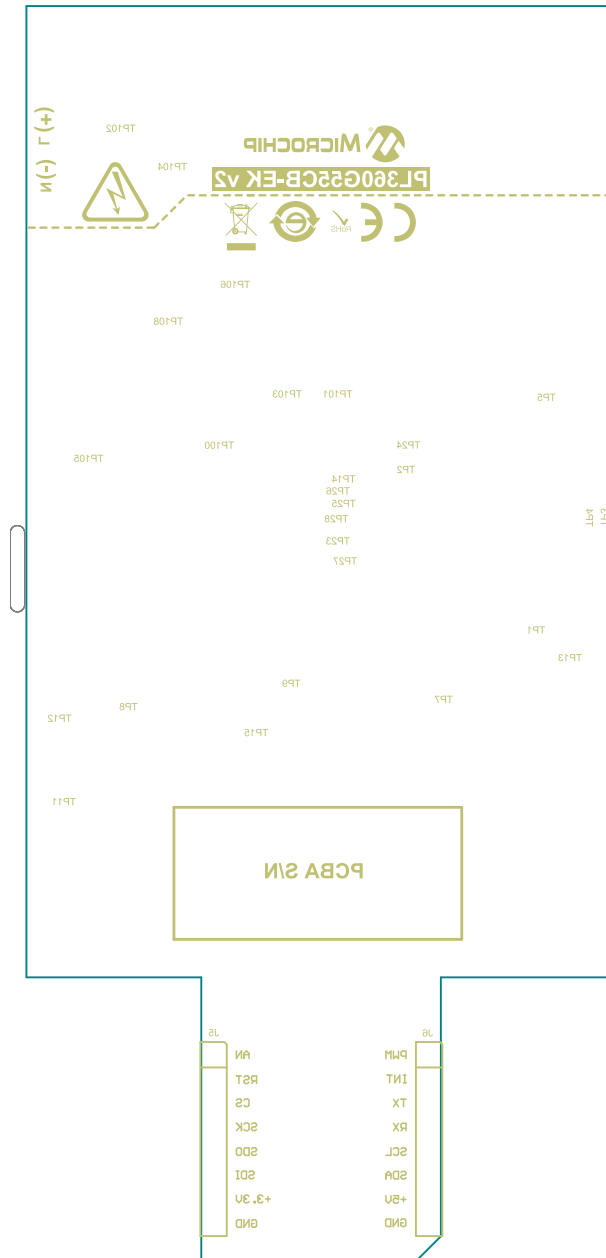
Figure 3-29. PL360G55CB-EKv2 Layout: Mid Layer 2 (Power Supplies)







**Figure 3-32. PL360G55CB-EKv2 Layout: Bottom Silkscreen**



#### **4. Compliance for Specific Standards**

The development/evaluation tool is designed to be used for research and development in a laboratory environment. This development/evaluation tool is not intended to be a finished appliance, nor is it intended for incorporation into finished appliances that are made commercially available as single functional units to end users.

The PL360G55CB-EK board is a CE mark product which passes the EN 50065-1, EN 50065-2-3, EN 50065-7 EMC standards. It also satisfies the Pb-Free and ROHS directive.

## 5. References

- CENELEC, EN 50065. Signaling on low-voltage electrical installations in the frequency range 3 kHz to 148.5 kHz, 2002
- [PL360 Datasheet, 2018](#)
- [SAMG55 Datasheet, 2016](#)
- [MCP16301 High-Voltage Input Integrated Switch Step-Down Regulator, 2015](#)
- [MCP16301 High Voltage Buck-Boost Demo Board User's Guide, 2012](#)
- [MCP16301 High Voltage Buck Converter 600mA Demo Board User's Guide, 2011](#)

**6. Revision History**

**6.1 Rev A - 04/2019**

Document	Initial release.
----------	------------------

## The Microchip Web Site

---

Microchip provides online support via our web site at <http://www.microchip.com/>. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQ), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

## Customer Change Notification Service

---

Microchip's customer notification service helps keep customers current on Microchip products. Subscribers will receive e-mail notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

To register, access the Microchip web site at <http://www.microchip.com/>. Under "Support", click on "Customer Change Notification" and follow the registration instructions.

## Customer Support

---

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or Field Application Engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at: <http://www.microchip.com/support>

## Microchip Devices Code Protection Feature

---

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.

- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as “unbreakable.”

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip’s code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

## Legal Notice

---

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE. Microchip disclaims all liability arising from this information and its use. Use of Microchip devices in life support and/or safety applications is entirely at the buyer’s risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

## Trademarks

---

The Microchip name and logo, the Microchip logo, AnyRate, AVR, AVR logo, AVR Freaks, BitCloud, chipKIT, chipKIT logo, CryptoMemory, CryptoRF, dsPIC, FlashFlex, flexPWR, Heldo, JukeBlox, KeeLoq, Kleer, LANCheck, LINK MD, maXStylus, maXTouch, MediaLB, megaAVR, MOST, MOST logo, MPLAB, OptoLyzer, PIC, picoPower, PICSTART, PIC32 logo, Prochip Designer, QTouch, SAM-BA, SpyNIC, SST, SST Logo, SuperFlash, tinyAVR, UNI/O, and XMEGA are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

ClockWorks, The Embedded Control Solutions Company, EtherSynch, Hyper Speed Control, HyperLight Load, IntelliMOS, mTouch, Precision Edge, and Quiet-Wire are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Adjacent Key Suppression, AKS, Analog-for-the-Digital Age, Any Capacitor, AnyIn, AnyOut, BodyCom, CodeGuard, CryptoAuthentication, CryptoAutomotive, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, EtherGREEN, In-Circuit Serial Programming, ICSP, INICnet, Inter-Chip Connectivity, JitterBlocker, KleerNet, KleerNet logo, memBrain, Mindi, MiWi, motorBench, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, Omniscient Code Generation, PICDEM, PICDEM.net, PICKit, PICtail, PowerSmart, PureSilicon, QMatrix, REAL ICE, Ripple Blocker, SAM-ICE, Serial Quad I/O, SMART-I.S., SQI, SuperSwitcher, SuperSwitcher II, Total Endurance, TSHARC, USBCheck, VariSense, ViewSpan, WiperLock, Wireless DNA, and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

Silicon Storage Technology is a registered trademark of Microchip Technology Inc. in other countries.

GestIC is a registered trademark of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

© 2019, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

ISBN: 978-1-5224-4370-4

## **Quality Management System Certified by DNV**

---

### **ISO/TS 16949**

Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC<sup>®</sup> MCUs and dsPIC<sup>®</sup> DSCs, KEELOQ<sup>®</sup> code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.

## Worldwide Sales and Service

AMERICAS	ASIA/PACIFIC	ASIA/PACIFIC	EUROPE
<p><b>Corporate Office</b> 2355 West Chandler Blvd. Chandler, AZ 85224-6199 Tel: 480-792-7200 Fax: 480-792-7277 Technical Support: <a href="http://www.microchip.com/support">http://www.microchip.com/support</a> Web Address: <a href="http://www.microchip.com">www.microchip.com</a></p> <p><b>Atlanta</b> Duluth, GA Tel: 678-957-9614 Fax: 678-957-1455</p> <p><b>Austin, TX</b> Tel: 512-257-3370</p> <p><b>Boston</b> Westborough, MA Tel: 774-760-0087 Fax: 774-760-0088</p> <p><b>Chicago</b> Itasca, IL Tel: 630-285-0071 Fax: 630-285-0075</p> <p><b>Dallas</b> Addison, TX Tel: 972-818-7423 Fax: 972-818-2924</p> <p><b>Detroit</b> Novi, MI Tel: 248-848-4000</p> <p><b>Houston, TX</b> Tel: 281-894-5983</p> <p><b>Indianapolis</b> Noblesville, IN Tel: 317-773-8323 Fax: 317-773-5453 Tel: 317-536-2380</p> <p><b>Los Angeles</b> Mission Viejo, CA Tel: 949-462-9523 Fax: 949-462-9608 Tel: 951-273-7800</p> <p><b>Raleigh, NC</b> Tel: 919-844-7510</p> <p><b>New York, NY</b> Tel: 631-435-6000</p> <p><b>San Jose, CA</b> Tel: 408-735-9110 Tel: 408-436-4270</p> <p><b>Canada - Toronto</b> Tel: 905-695-1980 Fax: 905-695-2078</p>	<p><b>Australia - Sydney</b> Tel: 61-2-9868-6733</p> <p><b>China - Beijing</b> Tel: 86-10-8569-7000</p> <p><b>China - Chengdu</b> Tel: 86-28-8665-5511</p> <p><b>China - Chongqing</b> Tel: 86-23-8980-9588</p> <p><b>China - Dongguan</b> Tel: 86-769-8702-9880</p> <p><b>China - Guangzhou</b> Tel: 86-20-8755-8029</p> <p><b>China - Hangzhou</b> Tel: 86-571-8792-8115</p> <p><b>China - Hong Kong SAR</b> Tel: 852-2943-5100</p> <p><b>China - Nanjing</b> Tel: 86-25-8473-2460</p> <p><b>China - Qingdao</b> Tel: 86-532-8502-7355</p> <p><b>China - Shanghai</b> Tel: 86-21-3326-8000</p> <p><b>China - Shenyang</b> Tel: 86-24-2334-2829</p> <p><b>China - Shenzhen</b> Tel: 86-755-8864-2200</p> <p><b>China - Suzhou</b> Tel: 86-186-6233-1526</p> <p><b>China - Wuhan</b> Tel: 86-27-5980-5300</p> <p><b>China - Xian</b> Tel: 86-29-8833-7252</p> <p><b>China - Xiamen</b> Tel: 86-592-2388138</p> <p><b>China - Zhuhai</b> Tel: 86-756-3210040</p>	<p><b>India - Bangalore</b> Tel: 91-80-3090-4444</p> <p><b>India - New Delhi</b> Tel: 91-11-4160-8631</p> <p><b>India - Pune</b> Tel: 91-20-4121-0141</p> <p><b>Japan - Osaka</b> Tel: 81-6-6152-7160</p> <p><b>Japan - Tokyo</b> Tel: 81-3-6880-3770</p> <p><b>Korea - Daegu</b> Tel: 82-53-744-4301</p> <p><b>Korea - Seoul</b> Tel: 82-2-554-7200</p> <p><b>Malaysia - Kuala Lumpur</b> Tel: 60-3-7651-7906</p> <p><b>Malaysia - Penang</b> Tel: 60-4-227-8870</p> <p><b>Philippines - Manila</b> Tel: 63-2-634-9065</p> <p><b>Singapore</b> Tel: 65-6334-8870</p> <p><b>Taiwan - Hsin Chu</b> Tel: 886-3-577-8366</p> <p><b>Taiwan - Kaohsiung</b> Tel: 886-7-213-7830</p> <p><b>Taiwan - Taipei</b> Tel: 886-2-2508-8600</p> <p><b>Thailand - Bangkok</b> Tel: 66-2-694-1351</p> <p><b>Vietnam - Ho Chi Minh</b> Tel: 84-28-5448-2100</p>	<p><b>Austria - Wels</b> Tel: 43-7242-2244-39 Fax: 43-7242-2244-393</p> <p><b>Denmark - Copenhagen</b> Tel: 45-4450-2828 Fax: 45-4485-2829</p> <p><b>Finland - Espoo</b> Tel: 358-9-4520-820</p> <p><b>France - Paris</b> Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79</p> <p><b>Germany - Garching</b> Tel: 49-8931-9700</p> <p><b>Germany - Haan</b> Tel: 49-2129-3766400</p> <p><b>Germany - Heilbronn</b> Tel: 49-7131-67-3636</p> <p><b>Germany - Karlsruhe</b> Tel: 49-721-625370</p> <p><b>Germany - Munich</b> Tel: 49-89-627-144-0 Fax: 49-89-627-144-44</p> <p><b>Germany - Rosenheim</b> Tel: 49-8031-354-560</p> <p><b>Israel - Ra'anana</b> Tel: 972-9-744-7705</p> <p><b>Italy - Milan</b> Tel: 39-0331-742611 Fax: 39-0331-466781</p> <p><b>Italy - Padova</b> Tel: 39-049-7625286</p> <p><b>Netherlands - Drunen</b> Tel: 31-416-690399 Fax: 31-416-690340</p> <p><b>Norway - Trondheim</b> Tel: 47-72884388</p> <p><b>Poland - Warsaw</b> Tel: 48-22-3325737</p> <p><b>Romania - Bucharest</b> Tel: 40-21-407-87-50</p> <p><b>Spain - Madrid</b> Tel: 34-91-708-08-90 Fax: 34-91-708-08-91</p> <p><b>Sweden - Gothenberg</b> Tel: 46-31-704-60-40</p> <p><b>Sweden - Stockholm</b> Tel: 46-8-5090-4654</p> <p><b>UK - Wokingham</b> Tel: 44-118-921-5800 Fax: 44-118-921-5820</p>