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UM0240
User manual

ST Industrial Communication Board - EVALCOMMBOARD

Introduction

ST Industrial Communication Board (order code: EVALCOMMBOARD) is a platform for Communication, Command and Control exchange with Industrial reference design boards.

Its goal is to provide ST Industrial customers a reliable and easily accessible communication channel, between a controlling PC and Industrial reference design boards.

It is a unique platform that allows evaluating a wide range of Industrial products in their application environment.

Application fields covered by this platform are:

- Power line communication
- Motor control and gate driving
- Intelligent power switches

Industrial Communication Board

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1 System overview

The ST Industrial Communication Board is a general purpose board developed around the following principles:

- Provide a reliable communication channel between a controlling PC and Industrial reference design boards
- Provide flexibility, one board to control all Industrial reference designs
- Run dedicated firmware (FW) available for all reference designs
- Interact with dedicated software (SW) implementing reference design Graphical User Interface (GUI)

This enables ST Industrial customers to control and test all products using the same controlling platform.

The ST Industrial Communication Board is based on a ST72F651AR6 USB microcontroller, providing as main interface to controlling Personal Computer a standard 12 Mbs USB, available on all modern PCs. This provides very easy interconnections to globally available laboratory equipment. An RS232 interface is present too, and can be used as spare communication port.

Specific interfaces to reference design boards are present to provide flexibility towards different applications.

A 10-bit Digital to Analog Converter (DAC) and high gain, high bandwidth amplifiers are present on board.

Jumpers, switches and LEDs give further adaptability and visualization tools.

A full range of dedicated FW, GUIs and reference design boards are available for every ST Industrial product, fully compatible with the ST Industrial Communication Board.

2 Power supply

Board components require the following voltage supplies.

Table 1. Voltages present on board

Function	Supply	Converter	Device	Input Range	Output Value
Main Power Supply	VDD	Switching Converter (Buck)	L5973D	5V ÷ 35V	5V
MCU Flash Programming	VPP	Regulated Charge Pump Converter	ST662A (pin VOUT)	Vdd	12V
OpAmp negative supply	-5V	Non regulated Charge Pump	ST662A (pin C1-)	Vdd	-5

These supplies are all derived from an input power supply that can be taken from four different sources:

1. PLM 10V: connected to the 10V line of the PLM connector
2. 5V Motor: connected to the 5V line of the Motor connector
3. Phone Jack: external connector, compatible with common notebook power supply connectors, bringing power supply in the 5V÷ 35V range
4. USB 5V: connected to the 5V line of the USB supply

This enhanced flexibility of source and source voltage selection coexists due to diodes D7, D8, D10 and D12, which prevent the reverse current flowing in the supply inputs, keeping different sources independent.

The higher voltage input will be the dominant supply.

LED D11 is turned on when the power supply is active.

Figure 1. Main power supply

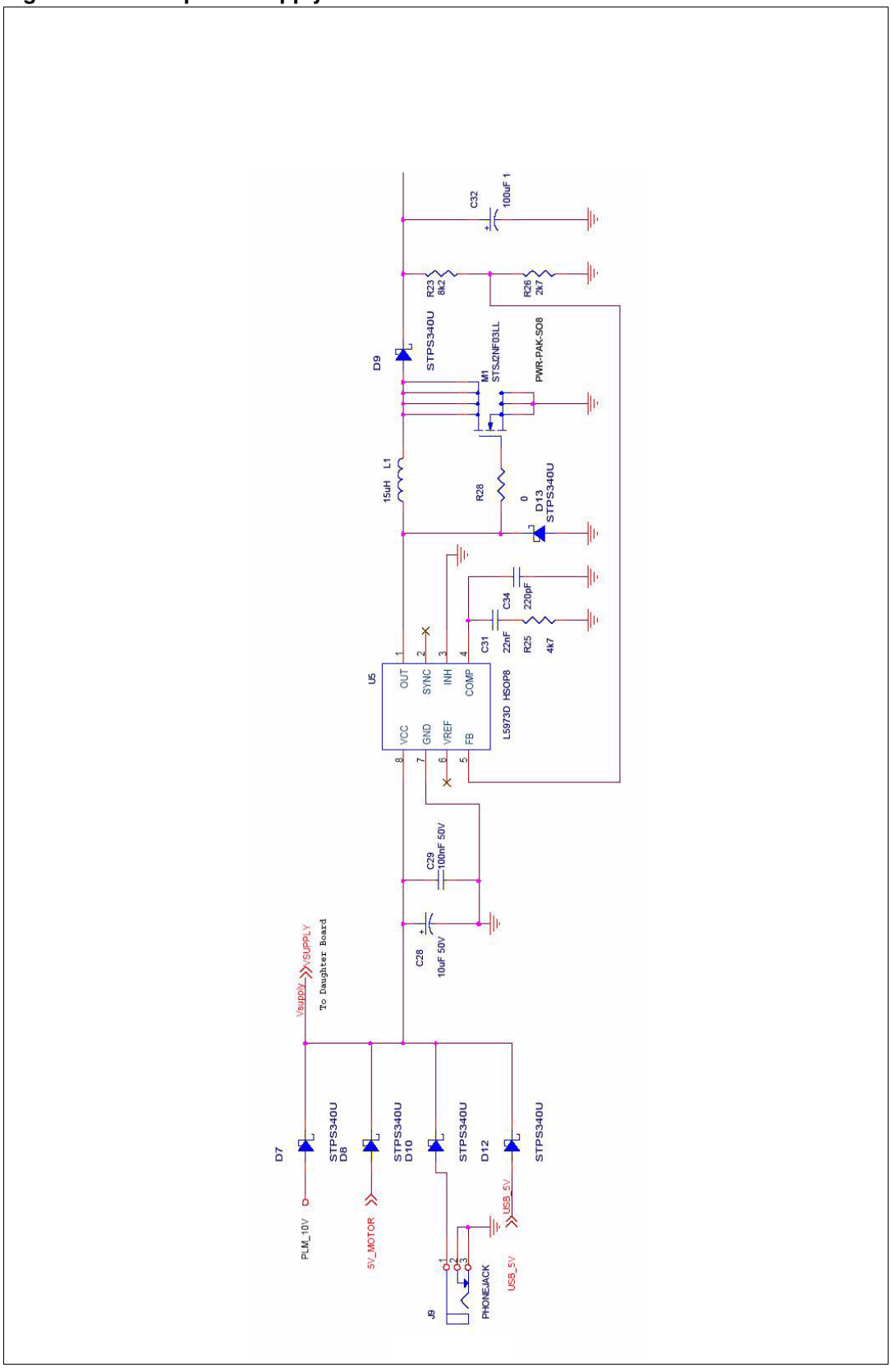


Figure 2. Flash programming and OpAmp power supply

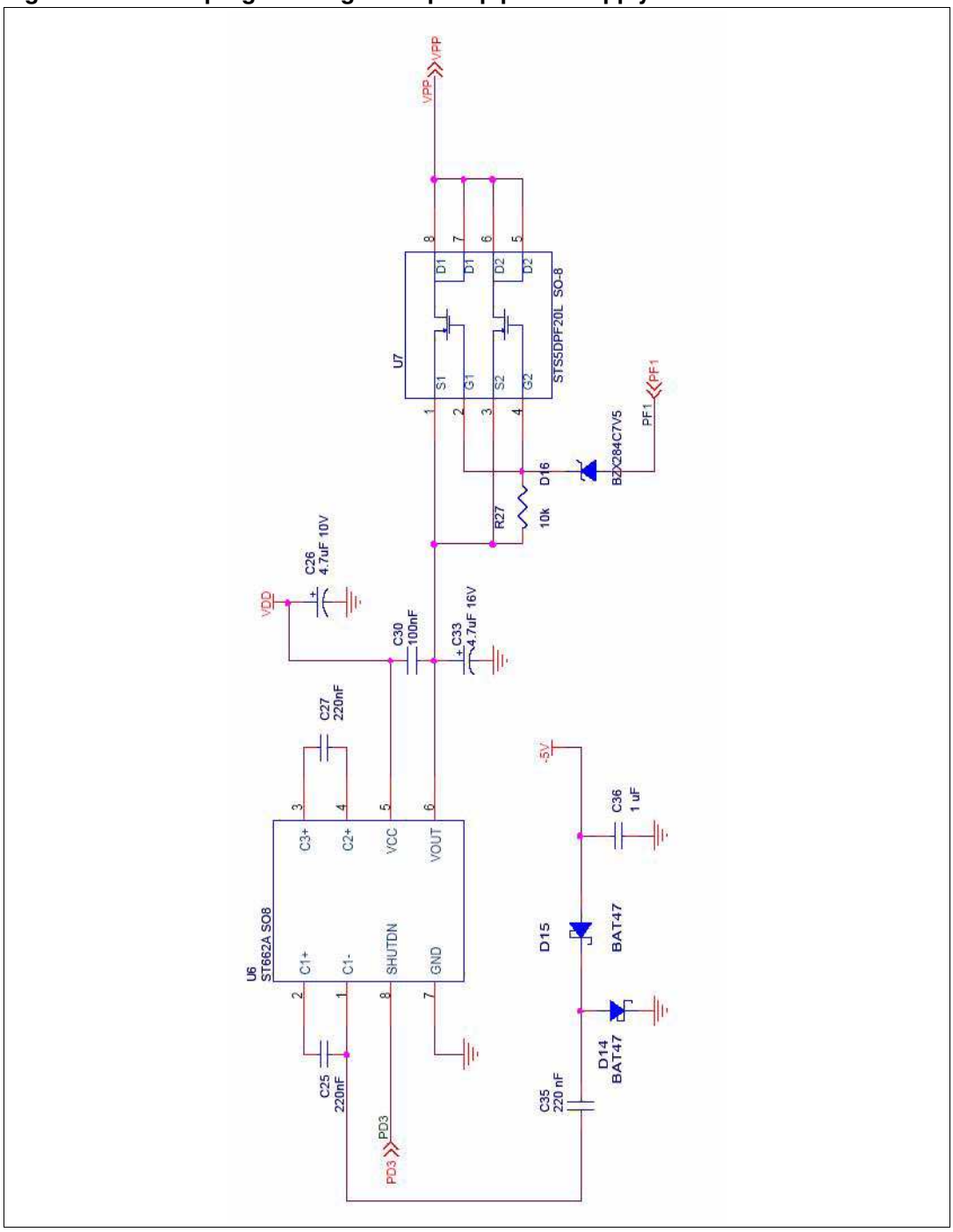
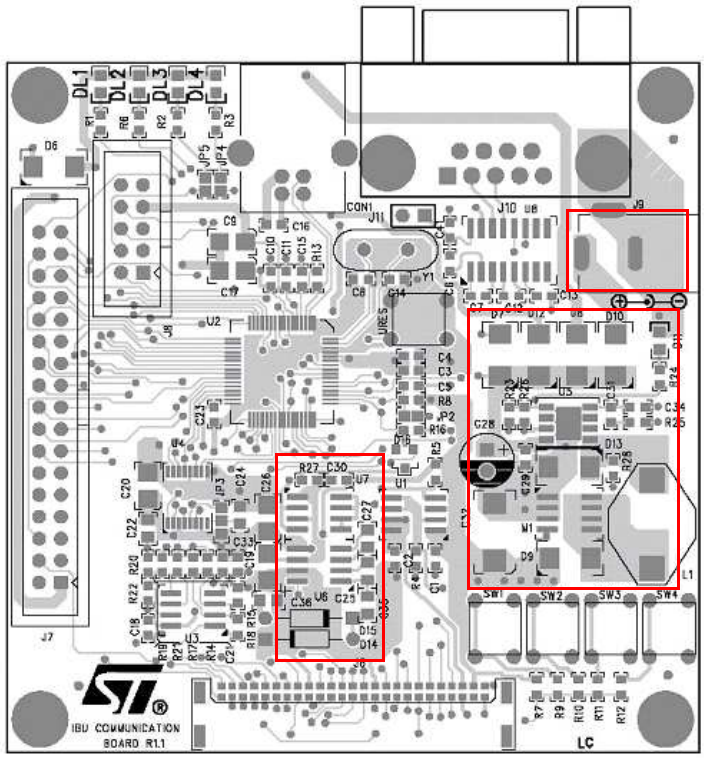


Figure 3. Power supplies PCB area



2.1 Main power supply (V_{DD})

The main power supply system of Industrial Com Board consists of a DC-DC switching converter based on step-down regulator L5973 from ST. The switching regulator is designed to provide 5V (V_{DD}) stabilized on the output with an input range 5V ÷ 35V and it can be assembled in the two following configurations:

- Buck: referring to *Figure 1*, the N-MOS M1 is removed and the diode D9 is replaced with a short
- Buck-Boost (not optimized)

2.2 MCU Flash programming (V_{PP})

A second power supply is implemented in the Industrial board, in order to provide the 12V voltage supply required by the microcontroller during the In-Application Programming (IAP) of the embedded Flash memory.

This power supply consists in a charge pump DC-DC regulator implemented by the ST device ST662A, which is a step-up converter designed for the Flash memory programming. Note that the charge pump converter is itself supplied by the switching regulator output V_{DD}.

The device can be shut down through line PD3 of the microcontroller, in order to reduce power consumption and noise when IAP is not needed.

The connection between the charge pump output and the Vpp line is switched by the P-MOS STS5DPF20L controlled by pin PF1 of the microcontroller.

This separates the IAP and In-Circuit Programming (ICP) and delivers V_{PP} with a shorter rising time.

The switch is closed when PF1 is low.

2.3 OpAmp negative supply (-5V)

The last power supply consists of a non-regulated negative charge pump derived from the pin C1- of the ST622A, which works as an oscillator between 0V and V_{CC} for the negative charge pump composed by the two diodes, D14 and D15, and the two capacitors, C35 and C36. This supply is used as negative supply for the two OPAMP U3A and U3B of LM358, in order to provide them a complete rail-to-rail output range between -5V and V_{DD}.

3 Microcontroller

3.1 Microcontroller features

The board is based on the ST72F651AR6 USB microcontroller, its mains features are:

- Up to 8MHz ST7 control unit
- 32 KBytes embedded Flash program memory
- 5 KBytes embedded RAM memory
- UVLO
- Up to 47 general purpose IOs with 3 Interrupt sources, two separated IO banks (one supplied at 5V and one between 2.7V and 5V).

This microcontroller embeds several on-chip peripherals:

- Programmable watchdog timer/counter
- Programmable DMA controller (DTC) with 256 bytes dedicated memory
- Full-speed USB controller with 5 endpoints and a 1280 bytes dedicated memory for buffers
- One 16-bit timer with 2 Output Compare units
- A 10-bit PWM generator with 2 channels
- A full-duplex SPI peripheral (master / slave)
- I²C bus interface (single master)
- 8-channels, 8-bit A/D Converter

3.2 RS-232 Interface

The RS-232 interface is emulated by software using:

- One general purpose IO () as TxD signal
- One Interrupt source IO () as RxD signal.
- One Output compare unit to generate the correct timing for transmission and reception.

The firmware implements a half-duplex RS-232 interface, whenever a simultaneous reading/writing operation occurs the writing operation is aborted and the reading operation is performed without loss of data.

3.3 Internal time base generation

An internal 1ms time base is generated using one output compare resource and a free counter. The free counter is then used to generate up to 10 programmable timeout counters (with 1ms resolution).

4 10-bit digital-to-analog converter (DAC)

The Industrial Communication Board embeds a 10(12)-bit buffered voltage-output DAC implemented by the AD5317 (AD5327) converter from Analog Devices. The IC provides four buffered rail-to-rail outputs, in the range 0 ÷ Vcc, with a slew rate of 0.7 V/µs.

The DAC is controlled by the Microcontroller (PC2, PC3, PC4) through a 3-wires serial interface and is compatible with SPI, QSPI, MICROWIRE and DSP interface standards.

The AD5317 is connected to the microcontroller through its SPI interface (MOSI to DIN and SCK to SCLK). The references for the four DACs are derived from two reference pins: VrefAB for VoutA and VoutB, VrefCD for VoutC and VoutD. These reference inputs can be configured as buffered or unbuffered inputs, through interface command.

On the Industrial board the reference for the output pair AB is connected directly to Vcc supply, while the VrefCD is available in a double option configuration, thanks to the jumper JP3:

1. Connected to the V_{CC} supply
2. Connected to the DAC output VoutB. This option is designed in order to provide a fine voltage adjustment for the CD output pair DAC reference: this function is suitable, e.g., in Motor Control Applications using Micro-stepping technique, for the synthesis of discrete sinusoidal waveforms. In fact, while the DAC output VoutC or VoutD can generate a discrete sinusoidal waveform, the DAC output VoutB is able to control the amplitude of the said signal, in order to control finely the torque of the stepper motor.

The AD5317(AD5327) DACs incorporate a power-on reset circuit, which ensures that the DAC outputs power up to 0 V and remain there until a valid write to the device takes place. There is also an asynchronous active low CLR pin, connected to the RES line of Industrial board, that clears all DACs to 0 V. The outputs of all DACs may be updated simultaneously using the asynchronous LDAC input, controlled by the MCU pin PD1.

The DAC IC contains a power-down feature that reduces the current consumption of the devices to 300 nA @ 5 V, by setting all outputs in high impedance state. The devices goes into power-down mode when the pin PD connected to the PD2 MCU line is tied low.

On the PLM connector, the four DAC outputs VOUTA, VOUTB, VOUTC and VOUTD are available directly, while on the Motor connector, VREF_A and VREF_B are available. These two signals are provided by the two difference amplifiers U3A and U3B implemented by LM358.

5 Operational amplifiers (OpAmp)

The LM358 consists of two independent, high gain (100 dB), high bandwidth (1.1 MHz) and internally compensated operational amplifiers. In the Industrial Communication Board the two amplifiers are designed in differential configuration, with a bipolar power supply 5V ÷ -5V. The output signals consists of the difference signals VREF_A and VREF_B, obtained by:

- VREF_A = VOUTC - VOUTA
- VREF_B = VOUTD - VOUTA

The main purpose of the two OPAMPs is then to provide an analog voltage shifting of the two signals VOUTC and VOUTD, with a voltage shift equal to VOUTA. The bipolar power supply of the OPAMPs guarantees an output swing both positive and negative to the resulting signals VREF_A and VREF_B.

This feature is important, for example in Motor Control Applications using Micro-stepping techniques, for the synthesis of discrete sinusoidal waveforms: the OPAMPs analog shifting provides the centering of the sinusoidal signal generated by the DACs around the 0 voltage level.

6 Interfaces and connectors

The ST Industrial Communication Board has 6 connectors to interface with power supply (J9), Personal Computer (CON1 and J10), In Circuit Communication (J8) and ST Devices Evaluation Boards (J6 and J7).

Figure 4. Industrial Communication Board connectors schematic

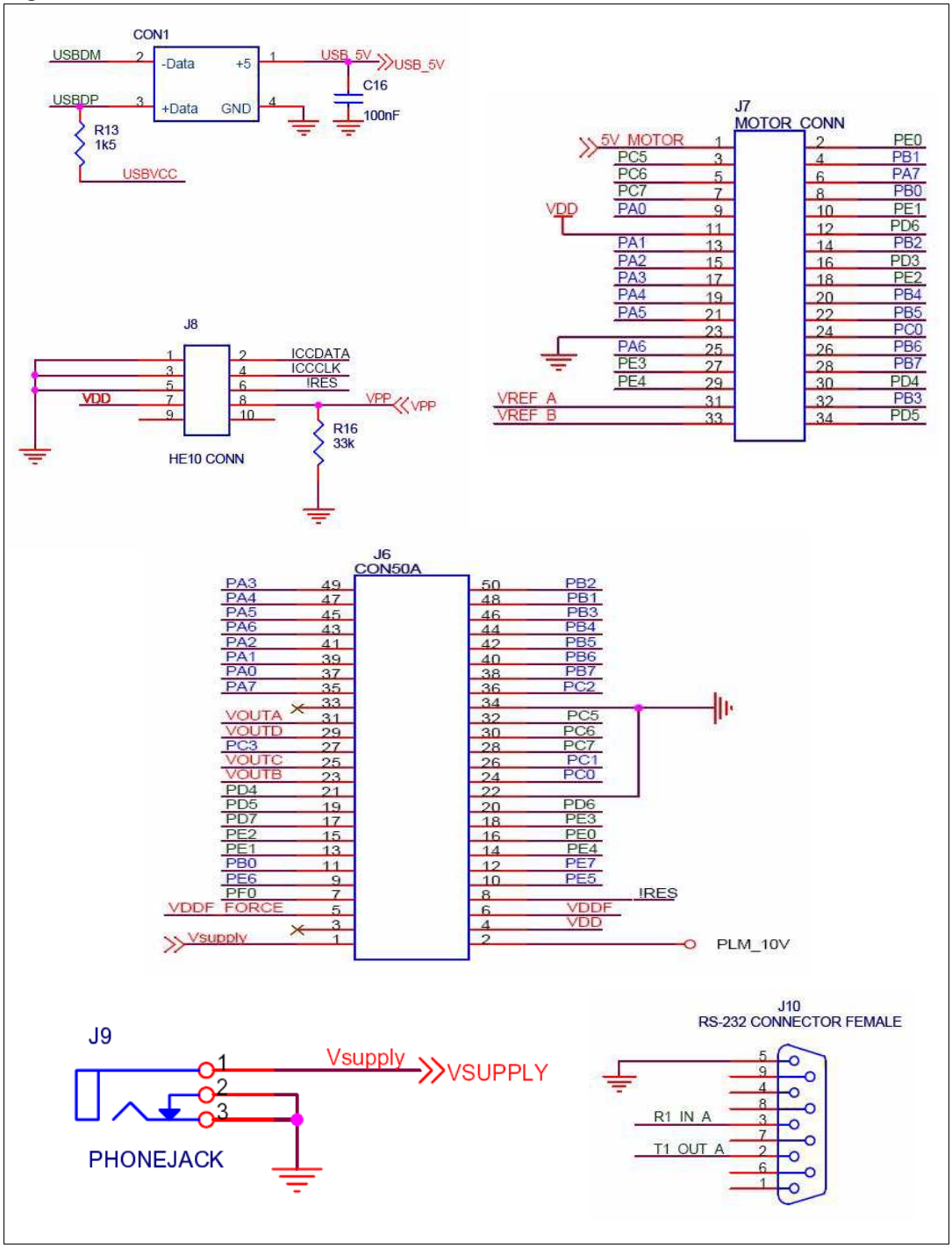
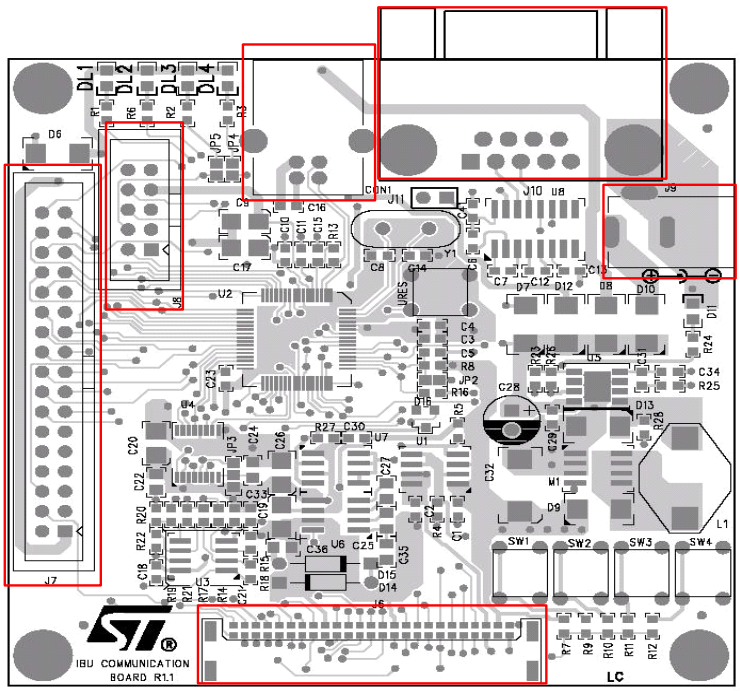


Figure 5. Industrial Communication Board connectors pcb



6.1 USB

The main communication channel with the controlling PC is through the ST72F651 Full Speed USB interface, based on a Vendor Specific Class embedded in the Industrial Communication Board firmware and a dedicated driver, part of the controlling software.

Once the USB cable is plugged to connector CON1, the Industrial Communication Board takes its power supply from the 5V USB interface of the PC.

A second function of the USB interface is to provide the DFU (Device Firmware Upgrade) functionality used to upgrade firmware.

The connecting cable should have a USB-B plug toward Industrial Communication Board and a USB-A plug toward the PC as shown in *Figure 6*.

Figure 6. USB cable plugs

6.2 RS-232 Interface

The RS-232 interface can be used as a communication channel to a PC running control software. It consists of female connector J10, where only three pins are connected with the DCE connections:

- 5 →Ground
- 3 →DCE TX
- 2 →DCE RX

So the connection to a PC RS-232 port (DTE) must be done by a direct cable connecting:

- DTE pin3 to DCE pin 3
- DTE pin 2 to DCE pin 2

RS-232 signals are obtained and adapted to 5V circuitry by means of the ST232 multi-channel RS-232 driver and receiver connected to two general purpose IOs (PD7 and PF0). The microcontroller emulates the RS-232 interface by software.

The ST232 can be powered down, to reduce power consumption when RS232 interface is not used, by opening jumper J11. In this case, two microcontroller pins (#44 and #52) can be used as General Purpose IOs (PD7 and PF0).

6.3 Motor control

Communication with Motor Control boards is possible through connector J7. This is a 34-pin connector providing the following signals, in the EVAL6207N case:

Table 2. Motor control interface pins

Pin number	Signal name	Description	Generated by
1	VCC_REF	5V Supply Voltage	EVAL6207N
3	SENSE_A	Channel A Sense Voltage	EVAL6207N
7	SENSE_B	Channel B Sense Voltage	EVAL6207N
11	+5V	5V Supply Voltage	MCU
23	Ground	Ground	
27	LIMIT_A	Channel A Over Current Flag	EVAL6207N
29	LIMIT_B	Channel B Over Current Flag	EVAL6207N
31	VREFA	Ch A PWM Current Control Ref Voltage	MCU
33	VREFB	Ch B PWM Current Control Ref Voltage	MCU
4	LIMIT_B	Channel A Over Current Flag	EVAL6207N
8	LIMIT_A	Channel B Over Current Flag	EVAL6207N
10	RCA	Ch A RC Monostable Voltage	EVAL6207N
14	ENA	Ch A Enable Signal	MCU
20	IN1	Ch A Input 1	MCU
22	IN4	Ch B Input 2	MCU
26	IN3	Ch B Input 1	MCU

Table 2. Motor control interface pins (continued)

Pin number	Signal name	Description	Generated by
28	IN2	Ch A Input 2	MCU
32	ENB	Ch B Enable Signal	MCU

6.4 Power line communication

The board can communicate with a Power Line Communication Board through its 50-pin J6 connector providing four kinds of signals: digital signals, analog signals, control signals and power signals.

Table 3. PLC interface digital signals

Pin number	Signal name	Description	Generated by
11	REGOK	Register Ok signal.	Modem
14	!CH2	Secondary channel select (active low).	MCU
18	CH2	Secondary channel select (active high).	MCU
35	CDPD	Carrier or preamble detected signal.	Modem
37	REG/DATA	Register or Data access.	Modem
39	RxD	Serial Data Out.	Modem
41	RxTx	Reception or Transmission select signal.	MCU
43	ZCOUT	Zero crossing detection output.	Modem
45	CLR/T	Serial Data Clock.	Modem
46	WD	Watchdog counter reset.	MCU
47	TOUT	Timeout event signal (even Thermal event on ST7538).	Modem
48	BU/THERM	Band in Use detection signal (even Thermal event on ST7540).	Modem
49	TxD	Serial Data Input.	MCU
50	PG	Power good signal.	Modem

Table 4. PLC interface analog signals

Pin number	Signal name	Description	Generated by
3	MCLK	Oscillator output (programmable)	Modem
5	VDDF_Force	Force MCU digital level to VDDF.	Modem
8	RESET	Reset Out for microcontroller	Modem
16	SMeter	Analog Signal Peak Meter output.	Modem

Table 5. PLC interface control signals

Pin number	Signal name	Description	Generated by
20	B_ID_PLM_1	Board ID for PLM Applications (MSB)	Modem
28	B_ID_PLM_0	Board ID for PLM Applications (LSB)	Modem

The two PLC interface control signals are connected in the PLM board either to the GND or to V_{DD} and are used to detect which modem is mounted on the board. There are four possible configurations but only two are, at present, in use:

- 00 (GND,GND) for the ST7538
- 10 (GND,V_{DD}) for the ST7540

Table 6. Power connections

Pin number	Signal name	Description	Generated by
2	PLM_10V	10V power supply	Modem
4	VDD	3.3V/5V power supply	Modem
6	VDDF	Digital power supply	Modem
22,34	GND	Ground	Ground

6.5 In-circuit communication

The In Circuit Communication connector provides access to several debug features and to the In Circuit Programming function that enables complete writing to the MCU Flash memory.

6.6 Power supply

As described in *Section 2: Power supply*, the ST Industrial Communication Board can take is power supply from different sources. If an external dedicated power supply is selected, it must be in the 5V ÷ 35V range.

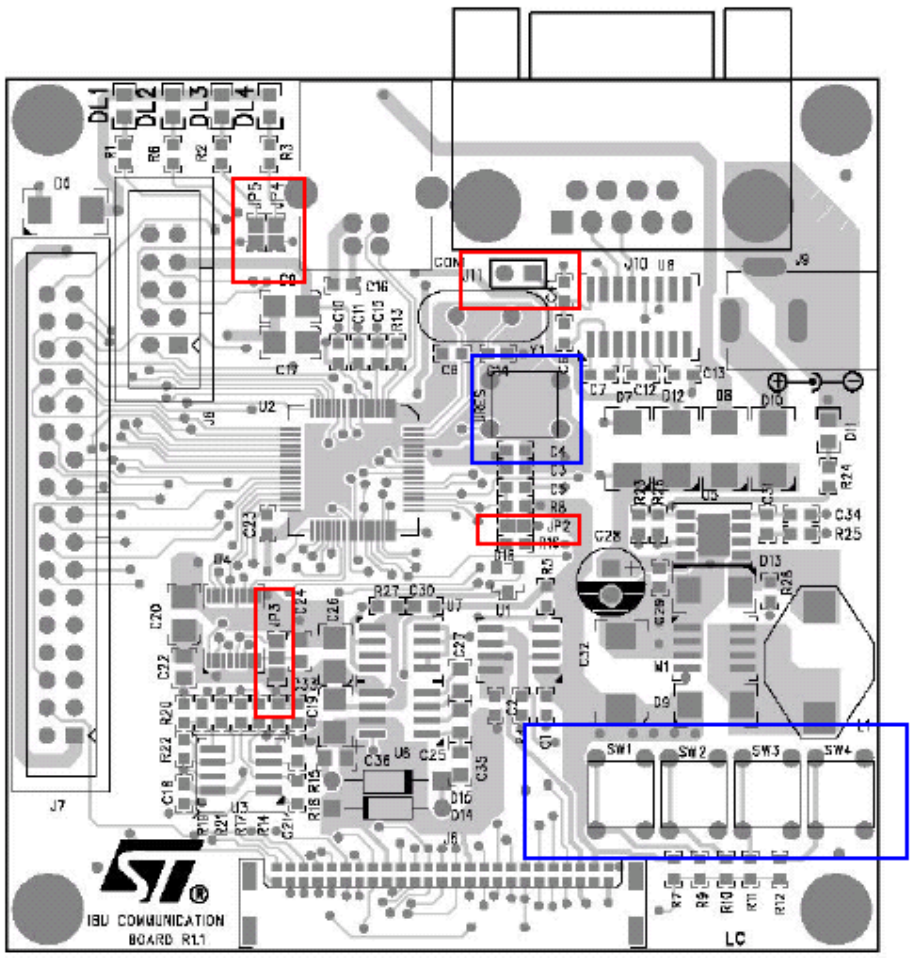
Taking into account that the board has a power consumption in steady state of approximately 50mW, a value of 500mW is suggested.

The external power supply connector is a standard 2.5-mm phone jack that is compatible with common PC notebook power supply connectors.

6.7 Jumpers

Five jumpers are present on the board to give flexibility on the use of reset management, DAC reference voltage; In Circuit Communication and RS232 interface power supply.

Figure 7. Industrial Communication Board jumpers and switches on PCB



Jumper JP2 connects the ST72F651 reset pin to a reset signal coming from the PLM board. This is used to reset the MCU after a Power Line Modem reset event.

Setting:

- Open = MCU reset not connected to PLM reset
- Closed = MCU reset connected to PLM reset

Jumper JP3 selects the DAC voltage reference for the C-D output pair. *Section 4: 10-bit digital-to-analog converter (DAC)* describes JP3 use.

Setting:

- 1-2 = Reference from VDD
- 2-3 = Reference from AB output

Jumpers JP4 and JP5 disconnect LED DL3 and DL4 loads from the MCU for use with In Circuit Communication.

Setting:

- Open = for ICC use
- Closed = for LEDs use

Jumper J11 disconnects the RS-232 level shifter from the power supply.

This reduces power consumption if the RS-232 interface is not used and frees MCU pins for another use. (Level shifter pins output are in Tri-state mode when device is off.)

Setting:

- Open = RS-232 off
- Closed = RS-232 on

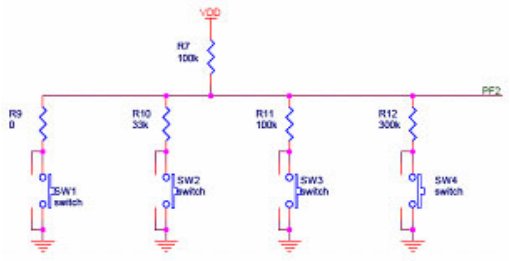
7 Switches

The board is equipped with five switches: a microcontroller reset switch (RES), and four general purpose switches (SW1, SW2, SW3 and SW4).

The RES switch is directly connected with the microcontroller RESET pin used to perform a hardware reset of the MCU. In order to guarantee the correct timing for the RESET negative pulse, an RC network is connected to the switch.

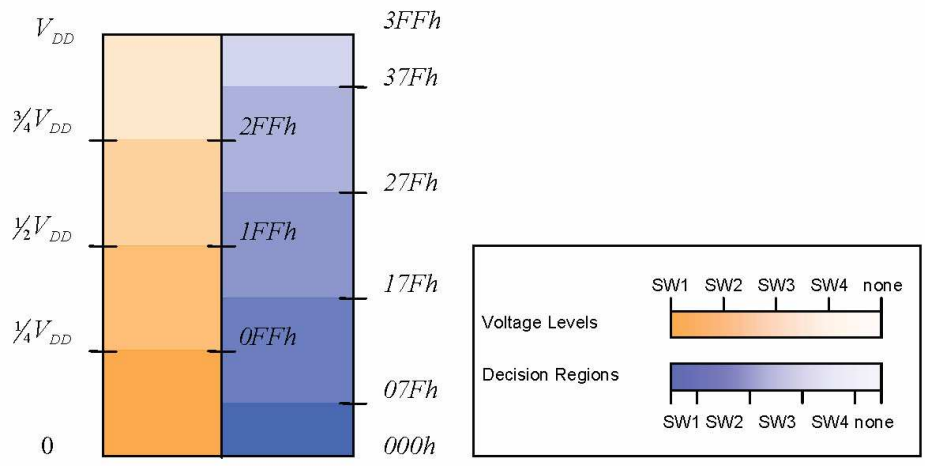
General purpose switches are connected to the AD converter embedded on the microcontroller (Channel 0 is used) through a resistor divider network.

Figure 8. General purpose switches



Each time a key is pressed, the corresponding resistor divider is activated. Then the voltage read by the ADC tells the microcontroller which button has been pressed.

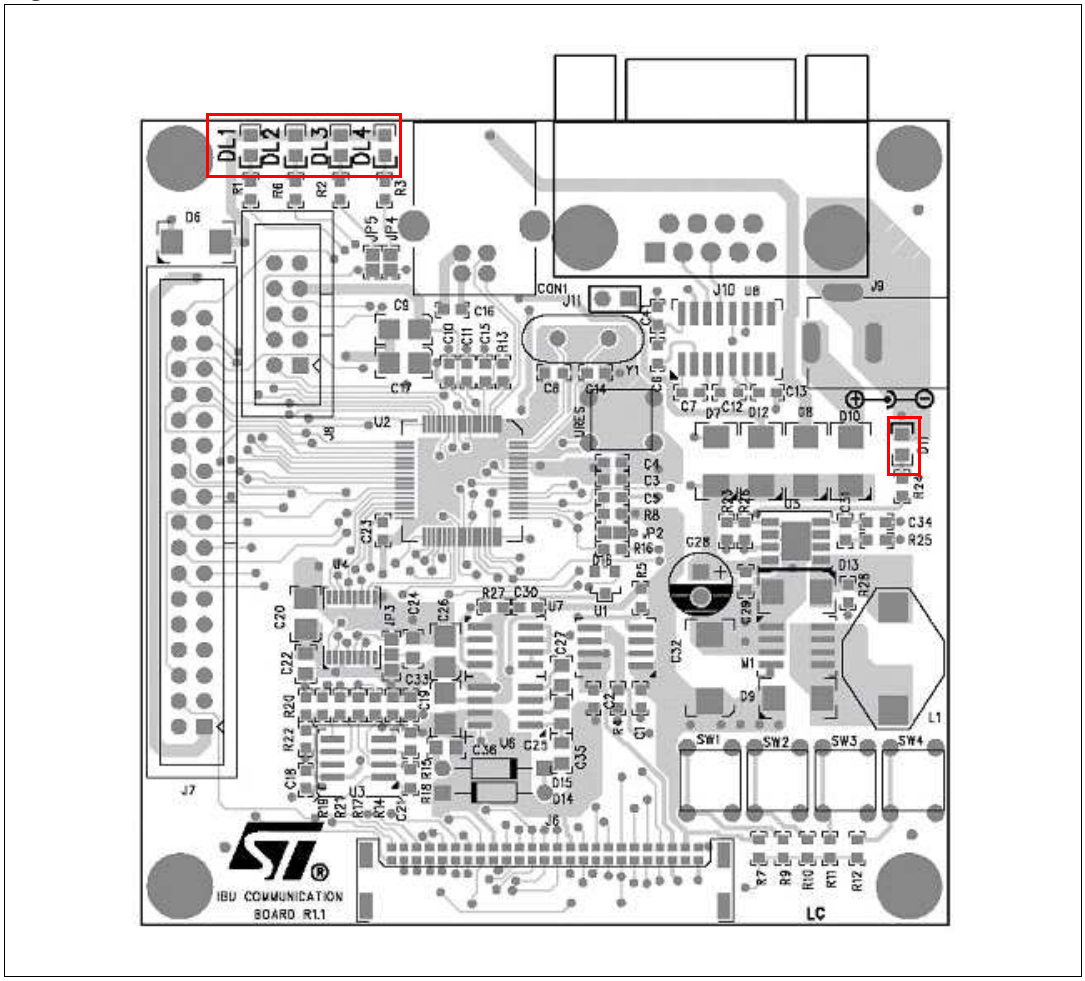
Figure 9. General purpose switches voltages and decisions level



8 LEDs

Five LEDs are present on the board for visual communication with the user. DL1, DL2, DL3, DL4 are general purpose LEDs that are User Application configurable. LED D11 is power supply (5V) on indicator.

Figure 10. Industrial Communication Board leds on PCB



9 Applications

The ST Industrial Communication Board is designed to be a general purpose control board for all Industrial applications. Currently two application fields are supported: Power Line Communication and Motor Control. Soon Intelligent Power Switch and Gate Driver applications will be covered too. Contact your local ST sales office for availability dates.

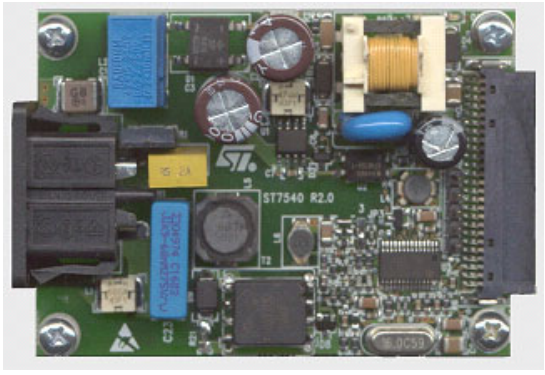
9.1 Power line communication

The PLC connector allows the use of the Communication Board with two different PLC Evaluation Boards:

- ST7538 Dual Channel Reference Design (Rev 3.1)
- ST7540 Reference Design (Rev 2.0)

Figure 11. ST7538 dual channel reference design board (Rev 3.1)

Figure 12. ST7540 reference design board (Rev 2.0)



The two Reference Design boards, based respectively on ST7538 and ST7540 FSK transceivers for Power Lines, are developed as useful tools for evaluating Power Line Communication as a solution in Automatic Meter Reading and Home Automation

applications. Both PLC Reference Design boards include a Power Supply section, specifically tailored for matching Power Line coupling requirements, and a Transceiver section designed around the ST PLC chipset, including a 16-MHz crystal oscillator and an external passive coupling filter for impedance adapting and noise filtering.

The Industrial Communication Board plus a PLC Reference Design board form a complete PLC node. With the two boards together, and using the ST7538/40 Demo SW Tool, it is possible to evaluate ST PLC chipset features and their transmitting and receiving performances through an actual communication interface on the Power Line.

9.2 Motor control

ST Motor Control devices deal with many different applications, each of them having a specific evaluation board controlled by means of the ST Industrial Communication Board.

Figure 13. Motor control evaluation board EVAL6207N

Table 7 summarizes the ST Motor Control Evaluation Board family.

Table 7. ST motor control evaluation boards

Device	Evaluation Board
L6205 PowerDIP	EVAL6205N
L6206 PowerDIP	EVAL6206N
L6206 PowerSO	EVAL6206PD
L6207N PowerDIP	EVAL6207N
L6208 PowerDIP	EVAL6208N
L6208 PowerSO	EVAL6208PD
L6235 PowerDIP	EVAL6235N
L6225 PowerSO	EVAL6225PD
L6227 PowerSO	EVAL6227PD
L6229 PowerSO	EVAL6229PD

All Motor Control evaluation boards can be connected to the Industrial Communication Board via connector J7.