Industrial PLC evaluation board with HMI interface

Features

- **STM32F746ZGT7** high-performance MCU embedding ARM® 32-bit Cortex®-M7 CPU with FPU, Chrom-ART accelerator, and DSP instructions
- **CLT01-38SQ7** octal high-speed digital input current limiter with SPI interface
- **CLT03-2Q3** dual-channel self-powered digital input current limiter
- **ISO8200AQ** galvanic isolated octal high-side smart power solid-state relay with SPI interface
- **IPS4260L** quad low-side intelligent power switch
- Main supply voltage: 18 - 32 V (24 V nominal)
- **STSW-PLC001** firmware package
- 3.5" TFT display with multitouch capability interfaced through dedicated parallel, digital RGB ports and I²C lines
- **STLD40DPUR**-based display back-light LED driver with controllable intensity
- Morpho connectors for expansion connectivity options
- Screw connectors for safer power supply and industrial IO connections
- USB connector for alternate 5 V source power supply (only for display powering and MCU programming/debug)
- Isolated USART port connector
- SWD connector for debugging and programming
- Status LEDs for inputs, outputs, and various fault conditions
- Debug LEDs
- Reset button
- Protections against surge, EMI, and input reverse voltage connection
- EMC pad and four-layer routing
- On-board RAM and serial Flash (ROM)
- Provision for RTC, USB (with one or more additional components to be mounted)
- Designed to meet IEC industrial standard requirements
- RoHS

Product summary

Product summary	
Industrial PLC evaluation board with HMI interface	STEVAL-PLC001V1
Evaluation firmware for STEVAL-PLC001V1	STSW-PLC001
Self-powered digital input current limiter	CLT03-2Q3
High speed digital input current limiter	CLT01-38SQ7
Galvanic isolated octal high side smart power solid state relay	ISO8200AQ
Quad low-side intelligent power switch	IPS4260L
High-performance and DSP with FPU ARM Cortex-M7 MCU	STM32F746ZGT7
Applications	Programmable Logic Controllers (PLC)

Description

The STEVAL-PLC001V1 evaluation board targets compact programmable logic controller (PLC) applications in the factory automation domain. It features a powerful human machine interface (HMI) thanks to the 3.5" TFT touchscreen mounted on the PCB, which eases interaction with the tool.

The board implements a galvanically isolated PLC control unit with robust digital input, digital output modules, expansion connectivity options, and interfaces.

The control unit consists of a powerful 144-pin STM32F746ZGT7 MCU, which handles the industrial IOs on one side and the TouchGFX display technology on the other side, implementing the ladder logic programming code and several additional options.

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Highly robust and reliable industrial digital input and output modules are placed symmetrically on the PCB, making the system a 12+12 PLC, that is, a PLC GUI optimized for STM32 microcontrollers, which manages 12 industrial inputs and 12 industrial outputs.

The 12 industrial inputs have been implemented through the combination of an eight-channel CLT01-38SQ7 and two dual channel CLT03-2Q3 ICs.

The CLT01-38SQ7 features 6.25 MHz SPI with daisy chain capability to connect, in this case, the eight-channel output ISO8200AQ and reverse polarity, whereas the CLT03-2Q3 features two high- and low-side compatible independent channels, which can be powered from the external sensors they interface with, and the capability of running in the 60 V range for fail-safe applications.

The 12 industrial output array consists of an eight-channel ISO8200AQ IC and a four-channel IPS4260L low-side intelligent power switch.

The ISO8200AQ offers a daisy-chain SPI interface and embedded galvanic insulation, separating logic and power side of 4 kV and making the solution cost-effective (no opto-coupler is needed).

The STEVAL-PLC001V1 also features connectivity options typical of commercial PLCs through the morpho connectors mounted on the PCB bottom, ensuring compatibility with STM32 Nucleo expansion boards.

The embedded ICs for industrial IO management allow great flexibility in terms of technical features, protections and embedded diagnostics, when interfacing industrial range inputs (that is, sensors and valves) and outputs (that is, lamps, alarms, and actuators) with the logic side.

The STSW-PLC001 companion software package, freely available on www.st.com, allows experimenting with these advanced features and their combination.

Thanks to this software and the smart user interface offered by the TouchGFX, you can learn how the ICs work and exploit ready-to-use examples as well as ladder logic demonstrations and projects.

1 Solution overview

The following block diagram shows the STEVAL-PLC001V1 architecture.

Figure 1. STEVAL-PLC001V1 functional block diagram
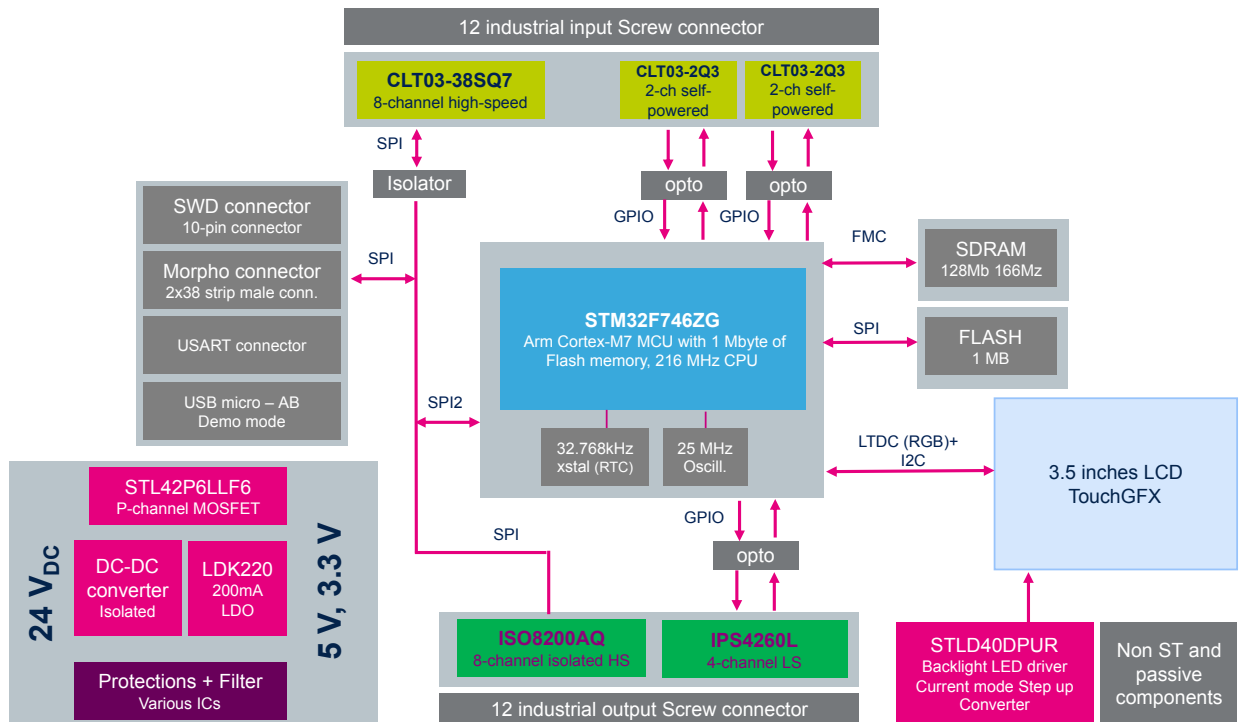
The main blocks are:

- the STM32F746ZGT7 microcontroller;
- twelve industrial inputs managed through the eight-channel CLT01-38SQ7 and the dual channel CLT03-2Q3 mounted twice;
- twelve industrial outputs on the bottom handled by other two dedicated ICs: the eight-channel ISO8200AQ and the four-channel IPS4260L.

The architecture also includes a 3.5" TFT display powered by the TouchGFX graphics engine for great flexibility in industrial IO management, giving abstraction from the hardware on one side, and full featured use of the ICs on the other side.

The morpho connectors allow connecting expansion boards and the USB connector allows supplying the board in case a 24 V power supply is not available.

Note: *When powered through the USB port, the STEVAL-PLC001V1 has limited functionalities, as it works in demo mode, allowing display management and programming features but not high current rates on the industrial IOs.*

A screw connector in the bottom-left corner is provided to power the board. All other isolated and logic supply voltages derive from this 24 V input after appropriate conditioning.

A P-channel MOSFET ensures reverse polarity protection, while other ICs are for EMI and surge protections.

A screw connector in the bottom-right corner powers field side devices.
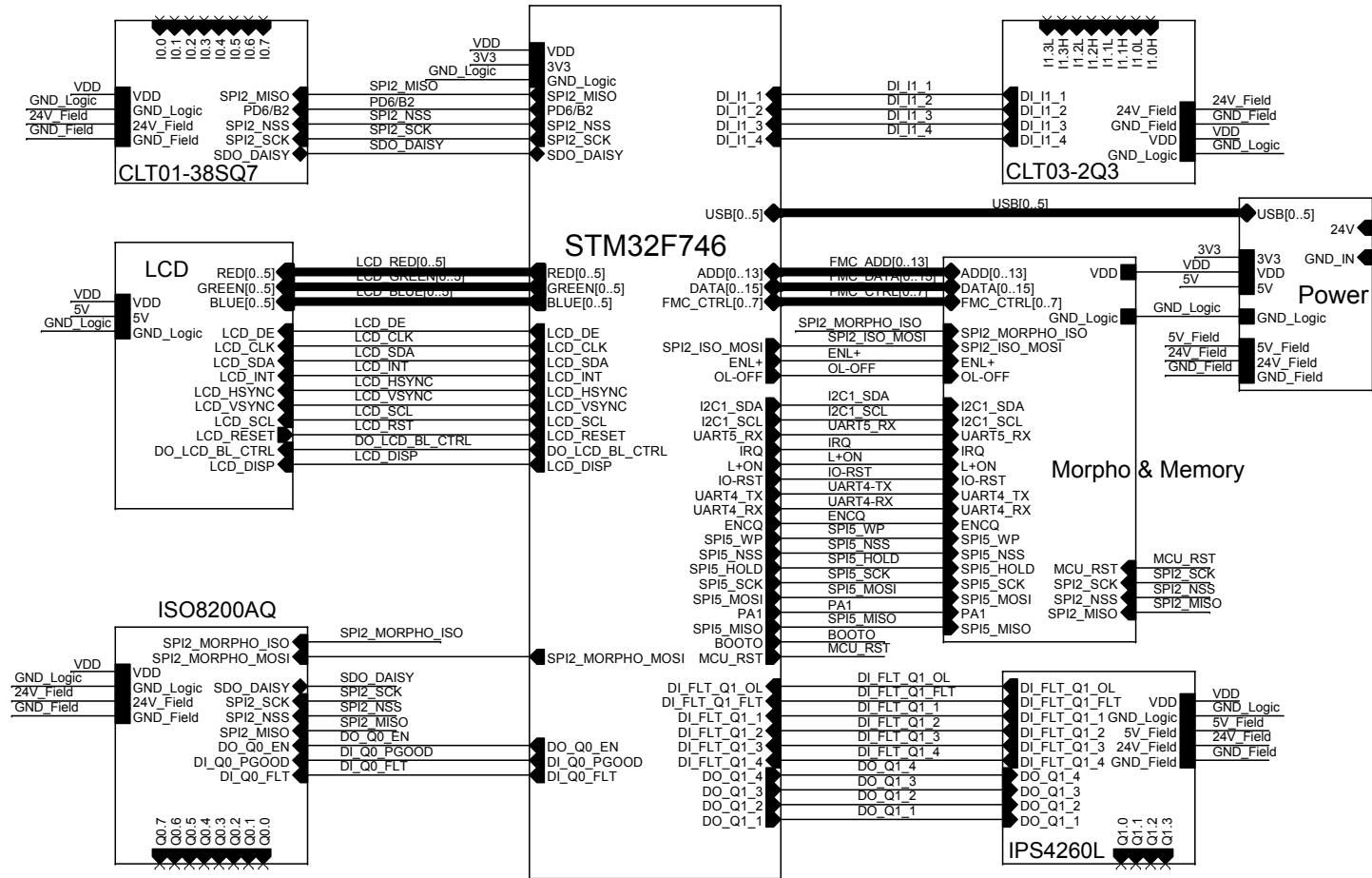
Figure 2. STEVAL-PLC001V1 circuit schematic (1 of 9)
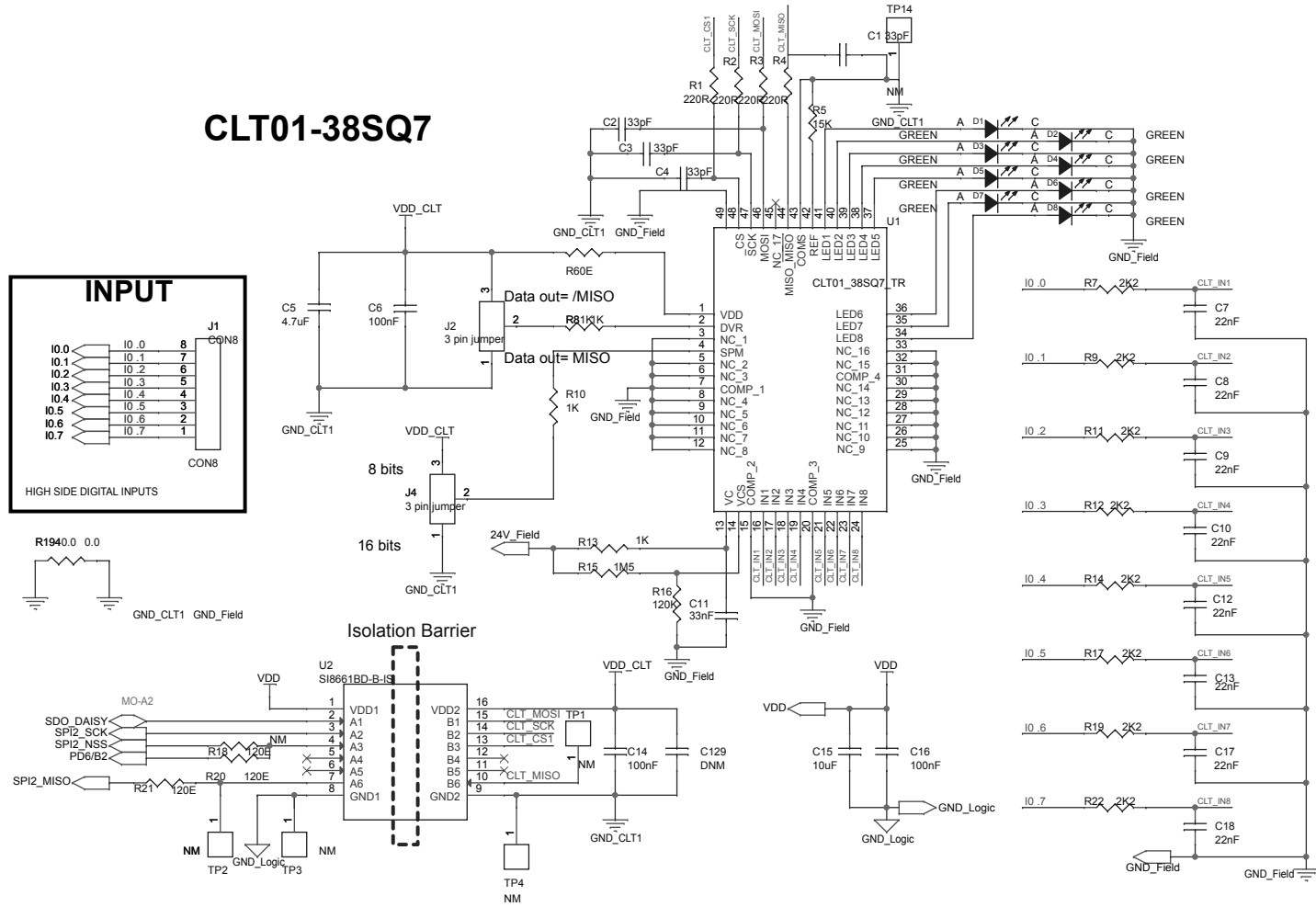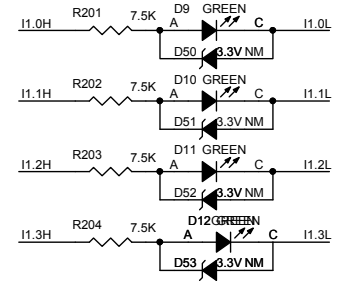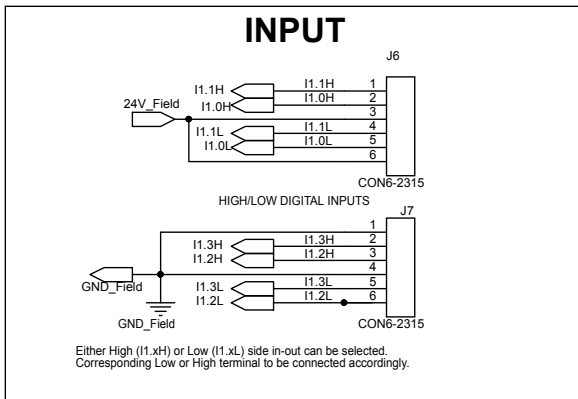
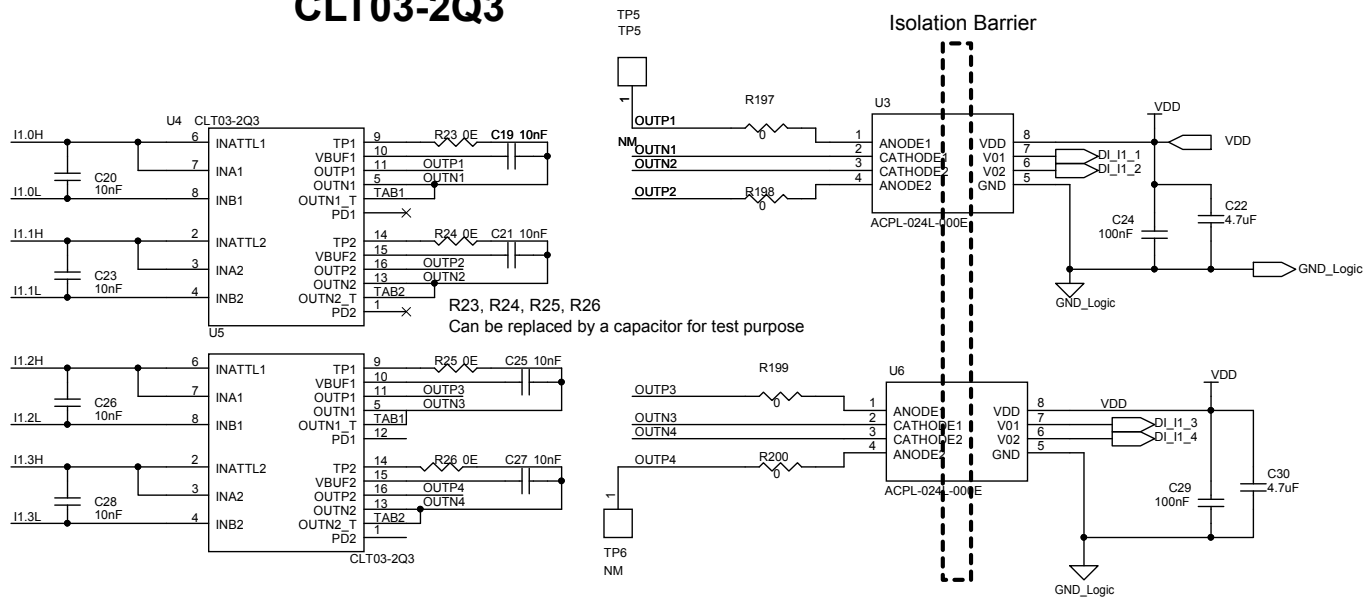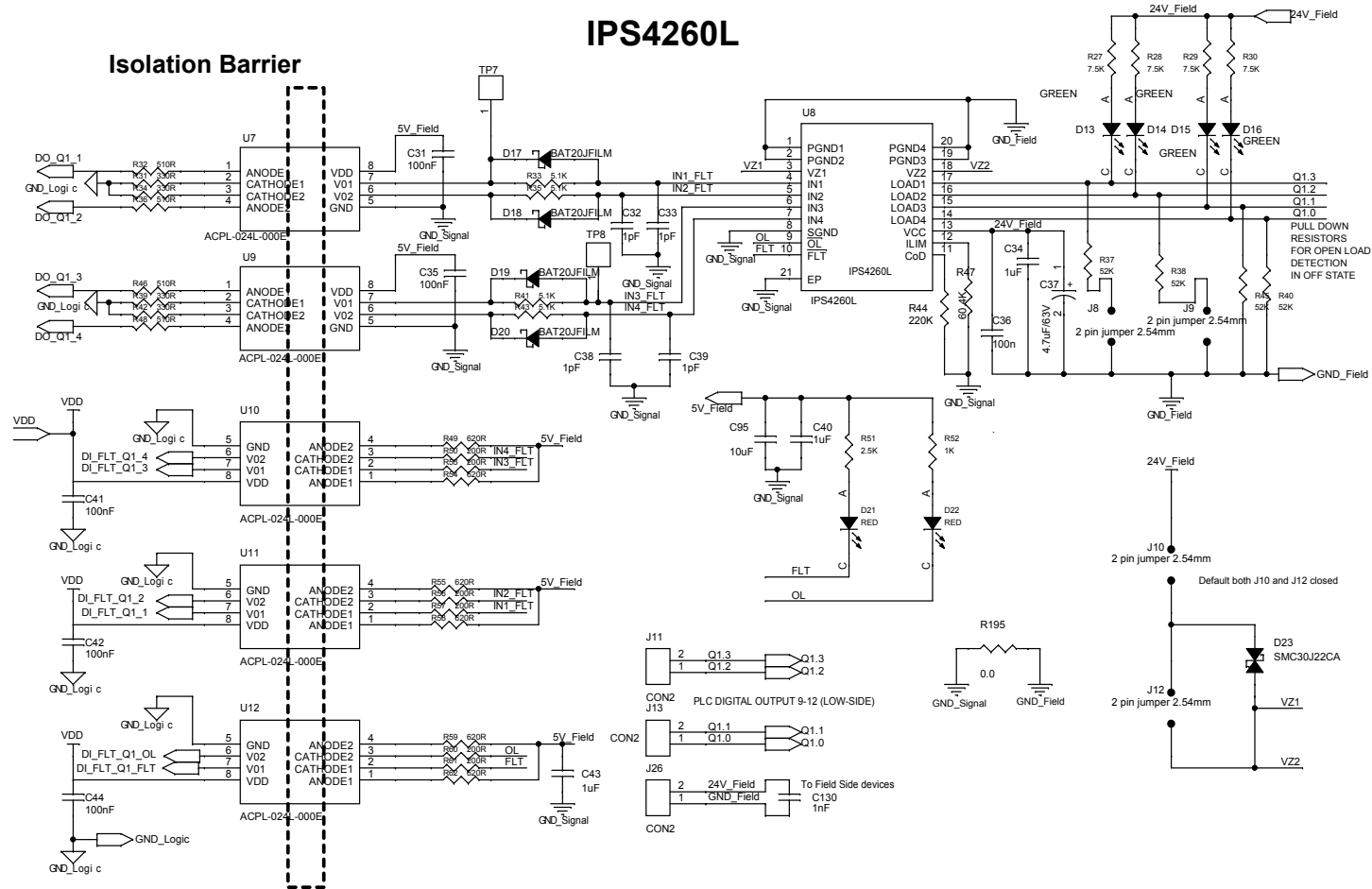## Figure 3. STEVAL-PLC001V1 circuit schematic (2 of 9)

CLT01-38SQ7

INPUT

I0.0	I0 .0	8	
I0.1	I0 .1	7	
I0.2	I0 .2	6	J1
I0.3	I0 .3	5	CON8
I0.4	I0 .4	4	
I0.5	I0 .5	3	
I0.6	I0 .6	2	
I0.7	I0 .7	1	

CON8

HIGH SIDE DIGITAL INPUTS

R194 0.0 0.0

GND_CLT1 GND_Field

TP14
C1 33pF
NM

CLT_CS1 CLT_SCK CLT_MOSI CLT_MISO
R2 R3 R4
R1
220R 220R 220R 220R
R5 15K
GND_CLT1

C2 33pF
C3 33pF
C4 33pF

VDD_CLT

GND_CLT1 GND_Field

R60E
C5 4.7uF
C6 100nF
J2 3 pin jumper
Data out= /MISO
R81 1K1K
Data out= MISO

GND_CLT1

VDD_CLT
8 bits
J4 3 pin jumper
16 bits

R10 1K
GND_Field

R194 0.0 0.0

24V_Field
R13 1K
R15 1M5
R16 120K
C11 33nF
GND_Field

Isolation Barrier

U2 SI8661BD-B-IS

MO-A2

SDO_DAISY
SPI2_SCK
SPI2_NSS
PD6/B2
SPI2_MISO

R18 120E
R20 120E
R21 120E

NM
TP2 GND_Logic TP3 NM

1	VDD1	VDD2	16	
2	A1	B1	15	CLT_MOSI
3	A2	B2	14	CLT_SCK
4	A3	B3	13	CLT_CS1
5	A4	B4	12	
6	A5	B5	11	
7	A6	B6	10	CLT_MISO
8	GND1	GND2	9	

TP1 NM
C14 100nF
C129 DNM
GND_CLT1

VDD_CLT
GND_Field

TP4 NM

U1 CLT01_38SQ7_TR

VDD
DVR
NC_1
SPM
NC_2
NC_3
COMP_1
NC_4
NC_5
NC_6
NC_7
NC_8

CS
SCK
MOSI
NC_17
MISO_MISO
COMS
REF
LED1
LED2
LED4
LED5

LED6
LED7
LED8
NC_16
NC_15
COMP_4
NC_14
NC_13
NC_12
NC_11
NC_10
NC_9

VC
VCS
COMP_2
IN1
IN2
IN3
IN4
COMP_3
IN5
IN6
IN7
IN8

CLT_IN1 CLT_IN2 CLT_IN3 CLT_IN4 CLT_IN5 CLT_IN6 CLT_IN7 CLT_IN8

GND_Field

D1 A C GREEN
D2 A C GREEN
D3 A C GREEN
D4 A C GREEN
D5 A C GREEN
D6 A C GREEN
D7 A C GREEN
D8 A C GREEN
GND_Field

VDD

VDD
C15 10uF
C16 100nF
GND_Logic
GND_Logic

I0 .0	R7 2K2	CLT_IN1	C7 22nF
I0 .1	R9 2K2	CLT_IN2	C8 22nF
I0 .2	R11 2K2	CLT_IN3	C9 22nF
I0 .3	R12 2K2	CLT_IN4	C10 22nF
I0 .4	R14 2K2	CLT_IN5	C12 22nF
I0 .5	R17 2K2	CLT_IN6	C13 22nF
I0 .6	R19 2K2	CLT_IN7	C17 22nF
I0 .7	R22 2K2	CLT_IN8	C18 22nF

GND_Field GND_Field

Figure 4. STEVAL-PLC001V1 circuit schematic (3 of 9)

CLT03-2Q3

R23, R24, R25, R26
Can be replaced by a capacitor for test purpose

Isolation Barrier

INPUT

HIGH/LOW DIGITAL INPUTS

Either High (I1.xH) or Low (I1.xL) side in-out can be selected.
Corresponding Low or High terminal to be connected accordingly.

Figure 5. STEVAL-PLC001V1 circuit schematic (4 of 9)

ISO8200AQ

PLC Digital output 1-8 (high side)

Figure 6. STEVAL-PLC001V1 circuit schematic (5 of 9)

IPS4260L

Figure 7. STEVAL-PLC001V1 circuit schematic (6 of 9)

Figure 8. STEVAL-PLC001V1 circuit schematic (7 of 9)

Morpho & Memory

Morpho Connectors
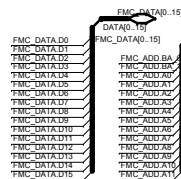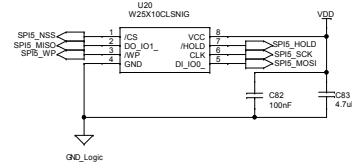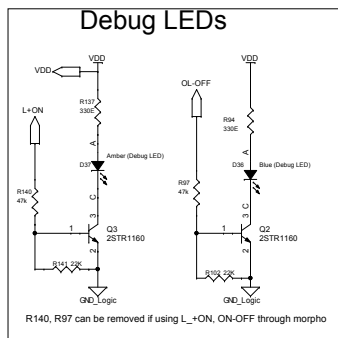
The resistors to be mounted appropiately to use STEVAL-IOM001V1 or X-NUCLEO-IOD04A1

Debug LEDs

R140, R97 can be removed if using L_+ON, ON-OFF through morpho

Figure 9. STEVAL-PLC001V1 circuit schematic (8 of 9)

LCD

Connector for TFT Display and Touch panel UI (RK043FN0...)

Figure 10. STEVAL-PLC001V1 circuit schematic (9 of 9)

Power

Provision for different footprint

DC-DC CONVERTER   Isolation

5V TO 3.3V

3 Board versions

Table 1. STEVAL-PLC001V1 versions

Finished good	Schematic diagrams	Bill of materials
STEVAL$PLC001V1A [1]	STEVAL$PLC001V1A schematic diagrams	STEVAL$PLC001V1A bill of materials

1. This code identifies the STEVAL-PLC001V1 evaluation board first version.

Revision history

Table 2. Document revision history

Date	Revision	Changes
25-Oct-2021	1	Initial release.

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