UM0162
USER MANUAL

Getting Started with the CAN Industrial Controller Evaluation Board using an ST10 MCU

Introduction

This user manual describes the implementation of Controller Area Network (CAN) Industrial Controller (IC) applications based on a 16-bit microcontroller from STMicroelectronics' ST10 family. ST10 microcontrollers have a C166 core that is compatible in industrial market segment. The CANIC10 can be used as a simple programmable logic controller (PLC), master or slave node in a communication system and as an evaluation board.

The CANIC10 is equipped with a sophisticated industrial sensor interface using a CLT3-4BT6 integrated device, 5Volt CMOS level parallel output interface and several bus interfaces such as RS232, RS485 and two CAN2.0B connections.

Output interface is compatible with VN808, VN808CM and VN340 Reference Design Boards (industrial high-side drivers).

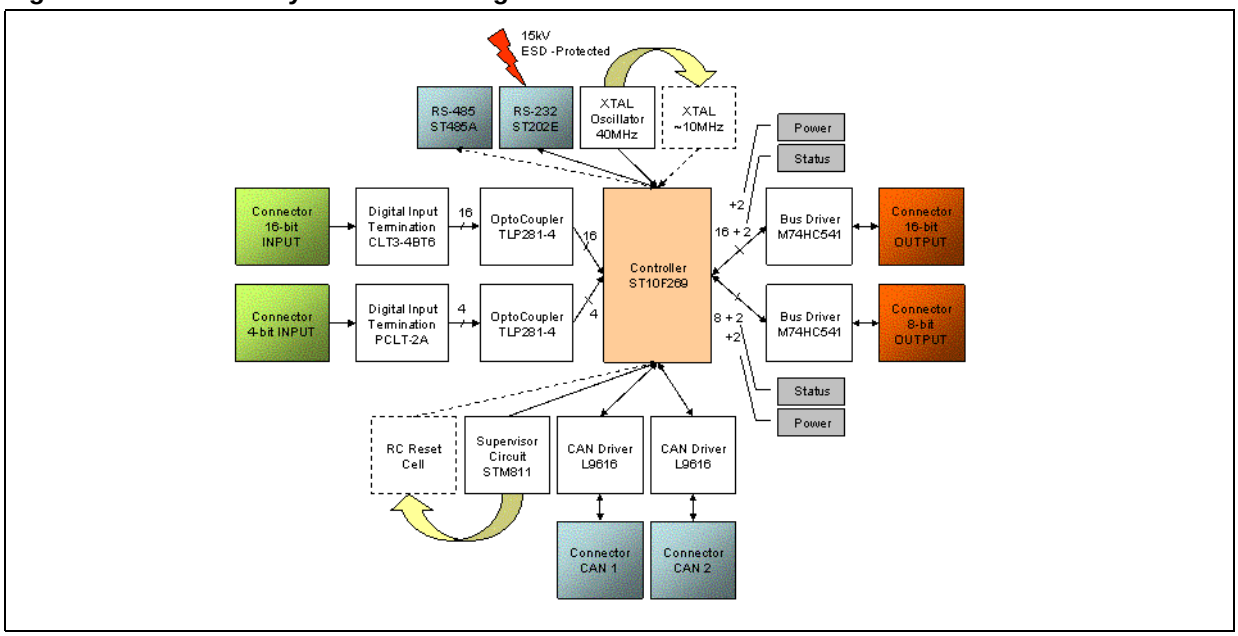
The system can be supplied either from a standard DC power supply (6 to 16V DC) or from a connected VNxxx board.

The CANIC10 package includes a CD-ROM with the application program (Intel hex file), board fabrication data (Gerber files), this user manual and other documentation for related devices.

Main Features

- 20-bit digital interface for 2-, 3-wire sensors or mechanical contact using CLT3-4BT6 and PCLT-2A Terminations supporting Type 1, 2 or 3 input characteristics according to IEC61131-2 specifications
- 24-bit digital output interface supporting VN340 and VN808 Reference Design Boards
- 16-bit ST10F269 microcontroller with a C166 core @ 40MHz
- ST202E RS-232 Transceiver with 15kV guaranteed ESD protection
- ST485A Very High-speed Low-power RS-485 Transceiver interface with bit rate up to 30Mbps
- Two L9616 High-speed CAN Bus Transceiver with bit rate up to 1Mbps
- STM811 Reset Circuit
- LF50 Very Low Dropout Voltage Regulator
- 6 to 16V DC Supply Voltage

Figure 1. CANIC10 System Block Diagram



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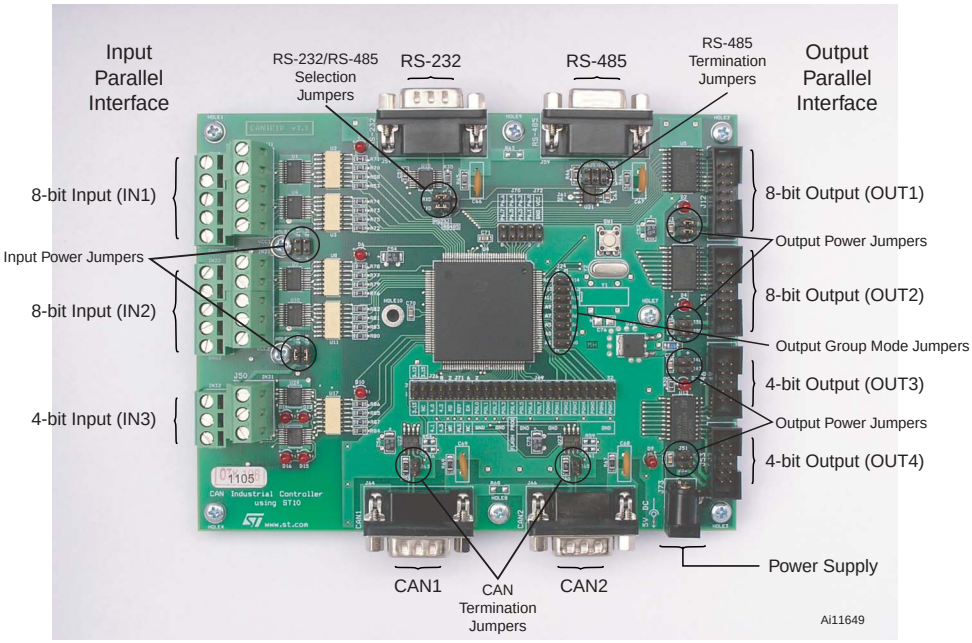
1 Hardware

The CANIC10 Evaluation Board is designed to evaluate and develop Controller Area Network (CAN) Industrial Controller (IC) applications for use with an ST10 microcontroller. The CANIC10 is manufactured on a 4-layer printed circuit board (PCB) designed with Class 6 accuracy. Total board dimensions are 155 x 120 mm. *Figure 1* indicates port and jumper locations.

Figure 1. Port and jumper locations



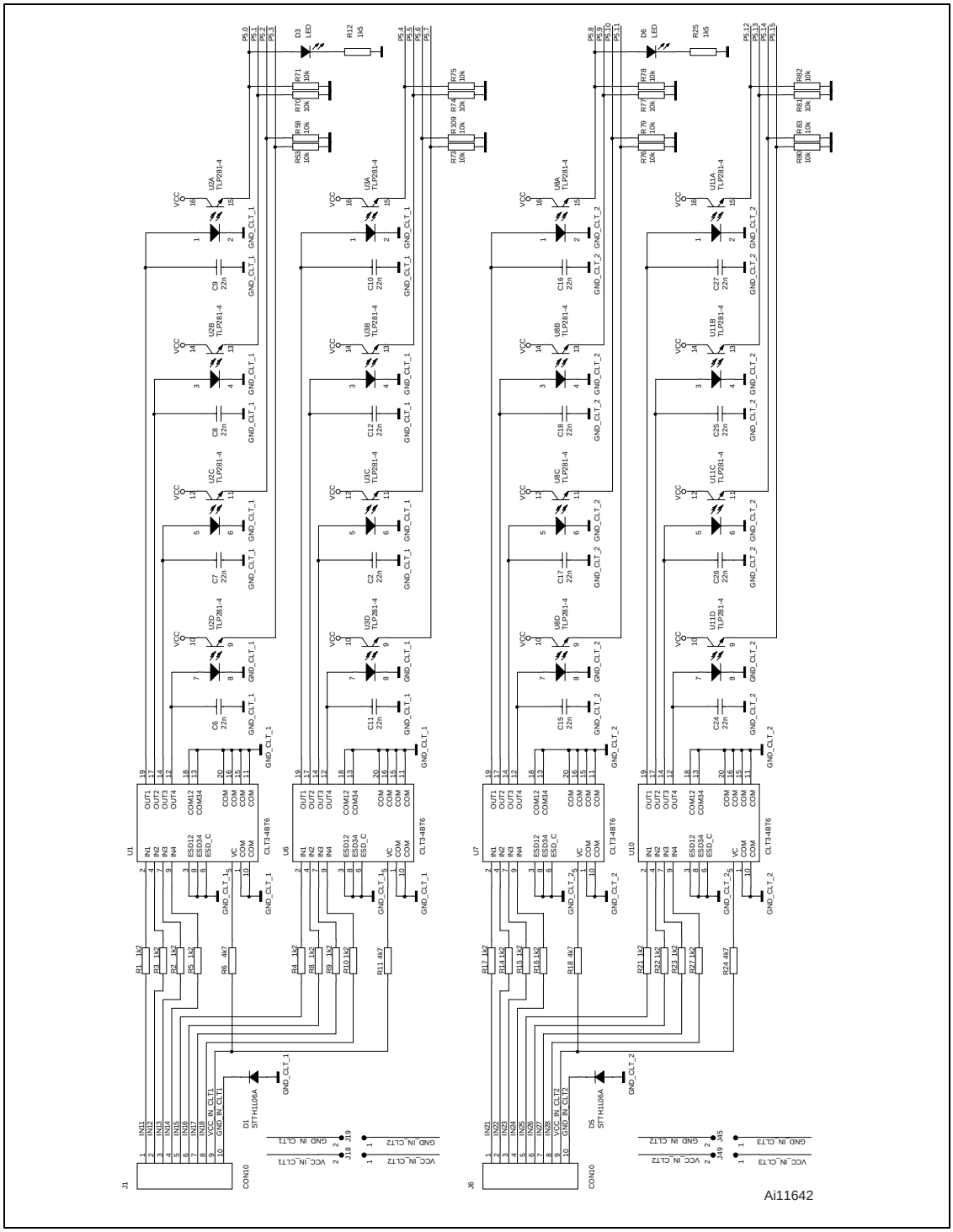
The CANIC10 Evaluation Board can be divided into several sections:

- Input Current Limited Termination (CLT)
- Input Programmable Current Limited Termination (PCLT)
- Output
- RS-232 and RS-485 Serial interfaces
- CAN interface
- Microcontroller (MCU)
- Power supply

1.1 Input Current Limited Termination (CLT)

Figure 2 shows the Input Current Limited Termination (CLT) connections.

Figure 2. Input CLT diagram



Four digital current limited termination (CLT) devices are used as an input sensor interface. Each device has four separate data channels, providing a total of 16 input channels. All CLT input channels comply with IEC61131-2 Type 1 and 3 specifications.

Signals are galvanically decoupled by optocouplers (U2, U3, U8 and U11). Additional 22-nF low-pass filter capacitors are used (C6 to C27). To reach "GND" voltage level (when input sensors are in low-level) on microcontroller ports (P5.0 - P5.15), 10-kΩ pull-down resistors are used. The CANIC10 Evaluation Board includes two additional indicator LEDs (D3 and D6) for developing applications. Diodes D1 and D5 provide reverse polarity protection.

1.1.1 Input CLT Sensor interface

The Input CLT is designed to interface with a 2- or 3-wire digital sensor and complies with IEC61131-2 Type 1 specifications. An industrial supply voltage line (24V DC) must be connected to at least one of the supply voltage inputs (placed on J1, J6 and J50)

Figure 3. Input CLT sensor interface

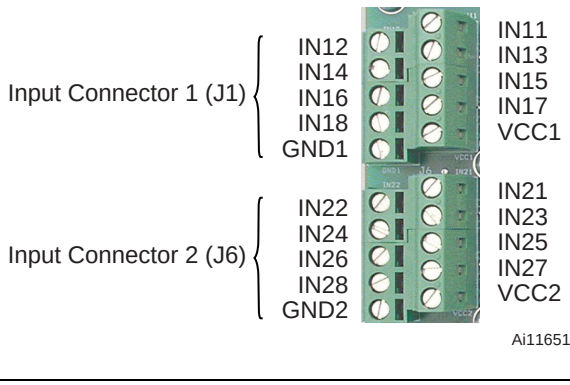
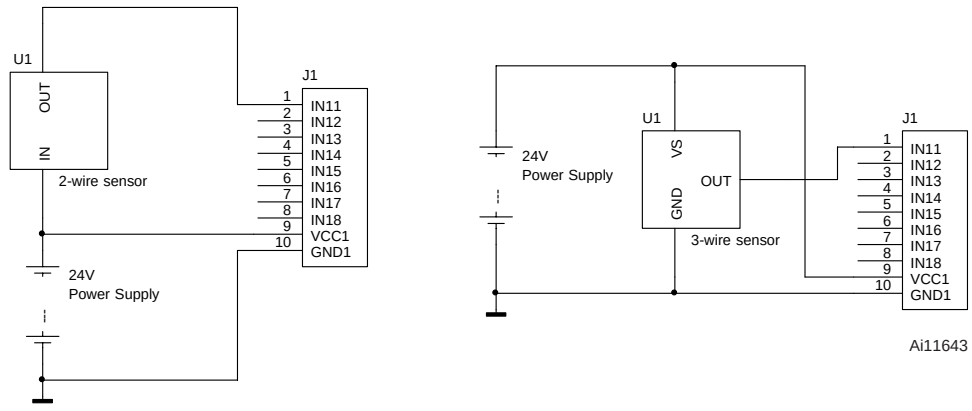


Figure 4. 2- and 3-wire digital sensor connections (Input CLT)

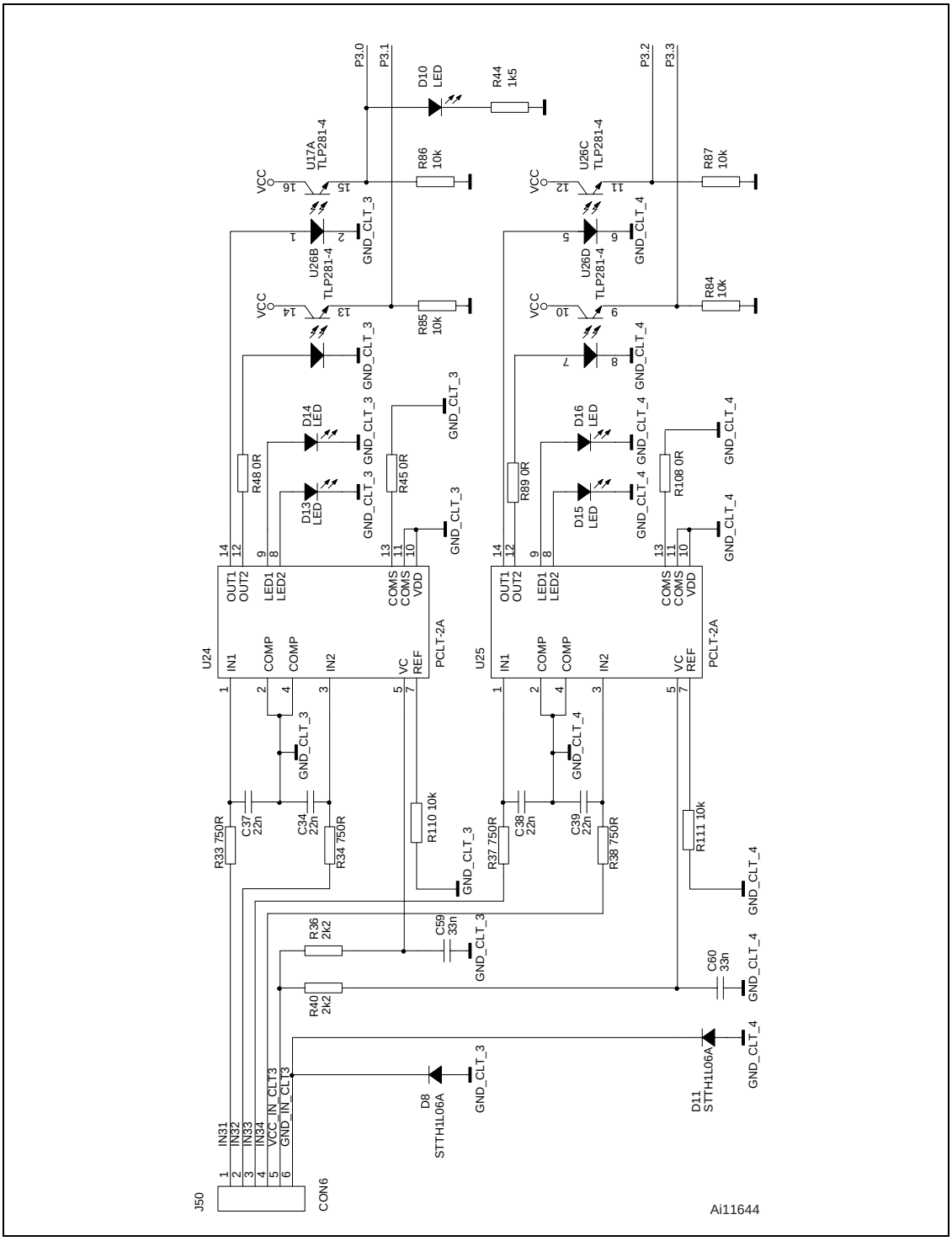


1.2 Input Programmable Current Limited Termination (PCLT)

The Input Programmable Current Limited Termination (PCLT) uses a more sophisticated interface than the CLT. PCLT devices have only two data channels but include a programmable

current limiter that operates using external resistors as shown in *Figure 5*. All PCLT input channels comply with IEC61131-2 Type 1, 2 and 3 specifications.

Figure 5. Input PCLT sensor interface



1.2.1 Input PCLT Sensor interface

The Input PCLT is designed to interface with a 2- or 3-wire digital sensor and complies with IEC61131-2 Type 1, 2 and 3 specifications. Input type characteristic can be changed choosing different resistor values as shown in *Table 1* or PCLT-2A datasheet. *Figure 6* shows the Input PCLT pinout and sensor connections are described in *Figure 7*.

Table 1. Input Type Programming

Resistors	Type 1	Type 2	Type 3	Unit
R110 and R111	22	10	22	kΩ
R33, R34, R37 and R38	2.2	0.75	1.2	kΩ
R40 and R36	2.2	2.2	2.2	kΩ

Figure 6. Input PCLT sensor interface

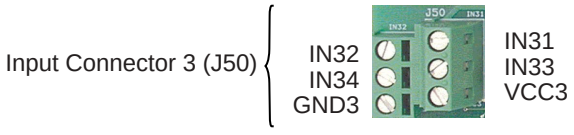
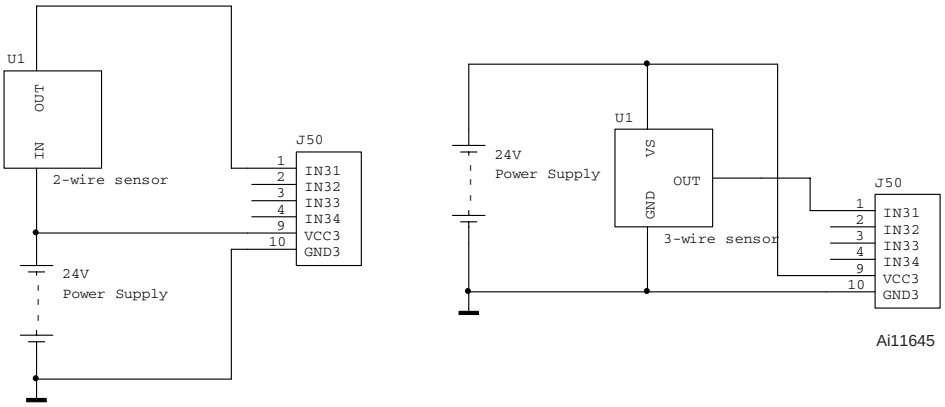


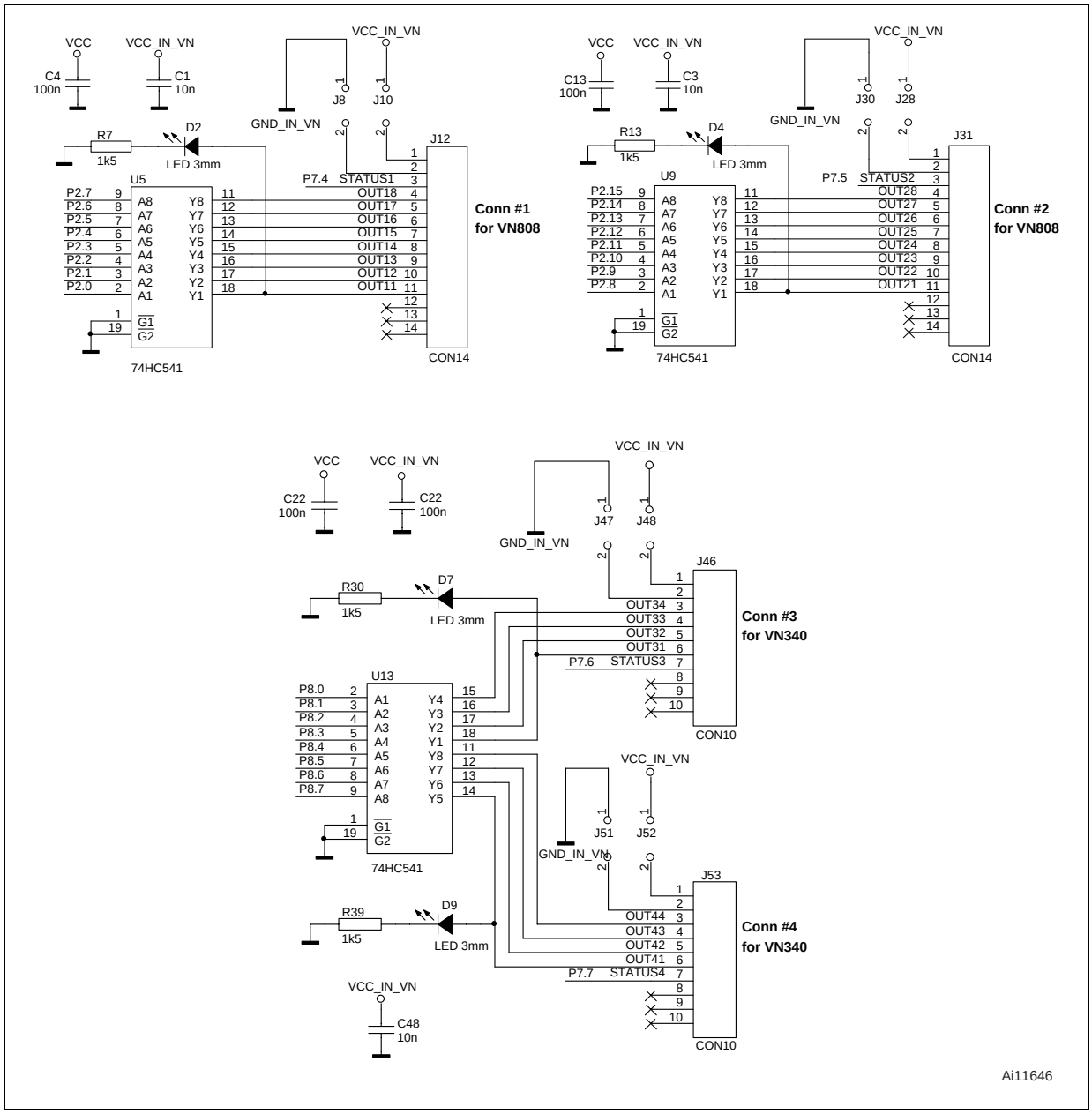
Figure 7. 2- and 3-wire digital sensor connections (Input PCLT)



1.3 Output connections

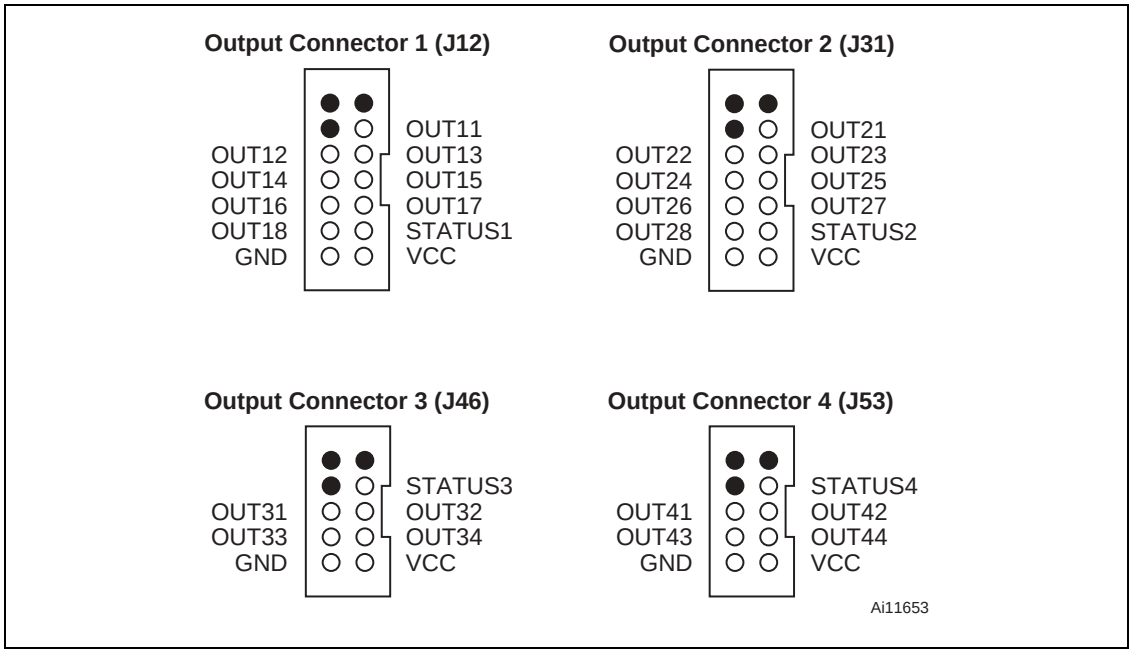
Figure 8 describes the CANIC10 output structure and its connections for supporting VN340 and VN808 Reference Design Boards.

Figure 8. Output diagram



74HC541 Octal Bus Buffers (U5, U9 and U13) with 3-state outputs are used to force microcontroller outputs. The buffer outputs are permanently selected (by pins $\overline{G1}$ and $\overline{G2}$) and connected directly to the output connectors (J12, J31, J46 and J53). These connectors can be also used to supply the CANIC10 system (in compliance with J8, J10, J30, J28, J47, J48, J51 and J52 settings).

Figure 9. Output connector pinouts



1.4 Serial interface

The CANIC10 is equipped with RS-232 and RS-485 interfaces as shown in *Figure 10* and *Figure 11*.

Figure 10. RS-232 Serial Interface Diagram

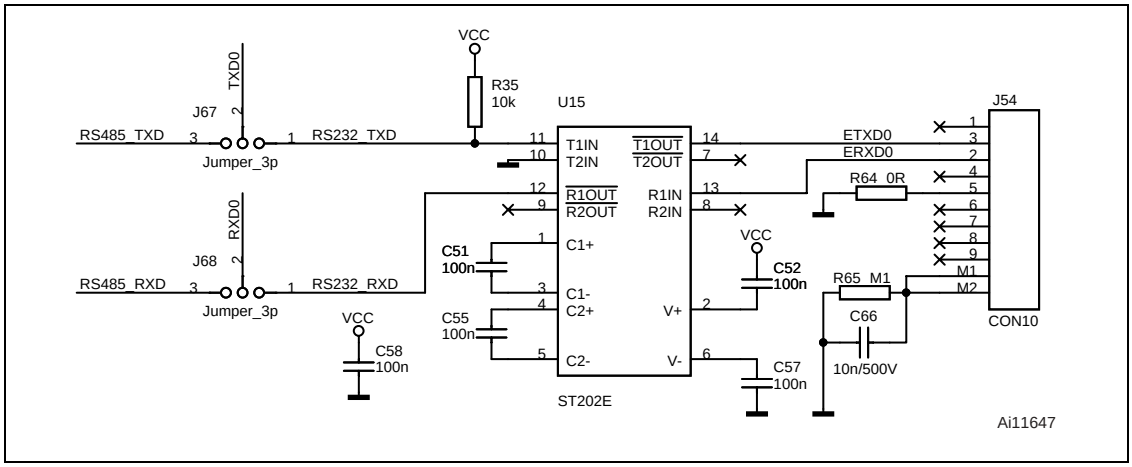
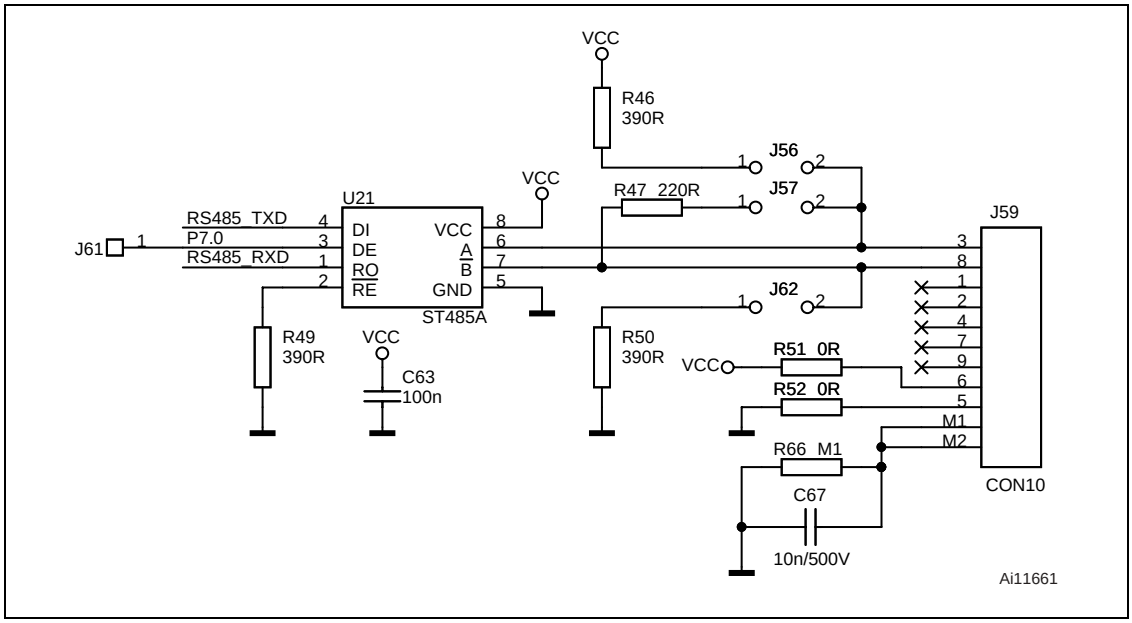


Figure 11. RS-485 Serial Interface Diagram



Jumpers J67 (Tx) and J68 (Rx) select the RS-232 or RS-485 communication channel. Connect jumper pins 1 and 2 for RS-232 communication (or pins 2 and 3 for RS-485 communication) on both the Transmit and Receive jumpers.

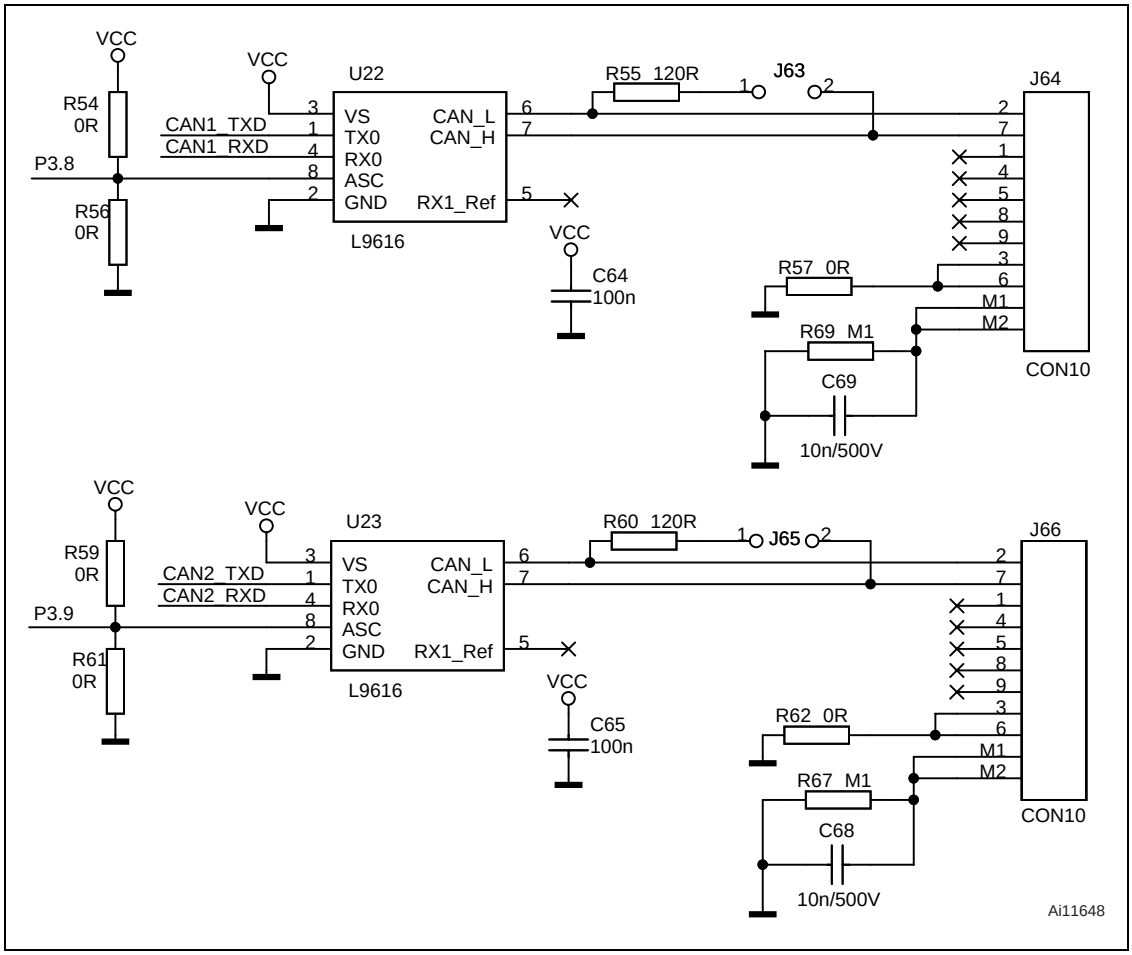
Set the endpoint cable termination for the RS-485 serial interface by closing jumpers J56, J57 and J62. Terminating resistors R46, R47 and R50 are selected for a Type-A PROFIBUS DP cable. They can be replaced with different values depending on the physical layer implemented.

Shielding of communication cables can be independent or connected together using a zero-ohm resistor (R63).

1.5 CAN interface

Figure 12 describes the two independent CAN channel connections.

Figure 12. CAN Interface Diagram



Shielding of communication cables can be independent or connected together using a zero-ohm resistor (R68).

If any of the CAN nodes are placed at the end of the CAN cable, the appropriate terminating resistors should be connected by closing jumpers J63 and J65.

The L9616 CAN transceiver has an Adjustable Slope Control feature that sets the slope speed using its ASC pin. This pin can be either hard-connected high or low using zero-ohm resistors or it can be controlled by microcontroller ports P3.8 and P3.9. *Table 2* describes the resistor assembling or control pin levels.

Table 2. CAN channel slew rate settings

Channel			Signal		Resistor Assembled
No.	**Speed**	**Slew Rate**	**No.**	**Level**	
1	Low	5 to 20 V/µs	P3.8	High	R54
	High	20 to 50 V/µs		Low	R56
2	Low	5 to 20 V/µs	P3.9	High	R59
	High	20 to 50 V/µs		Low	R61

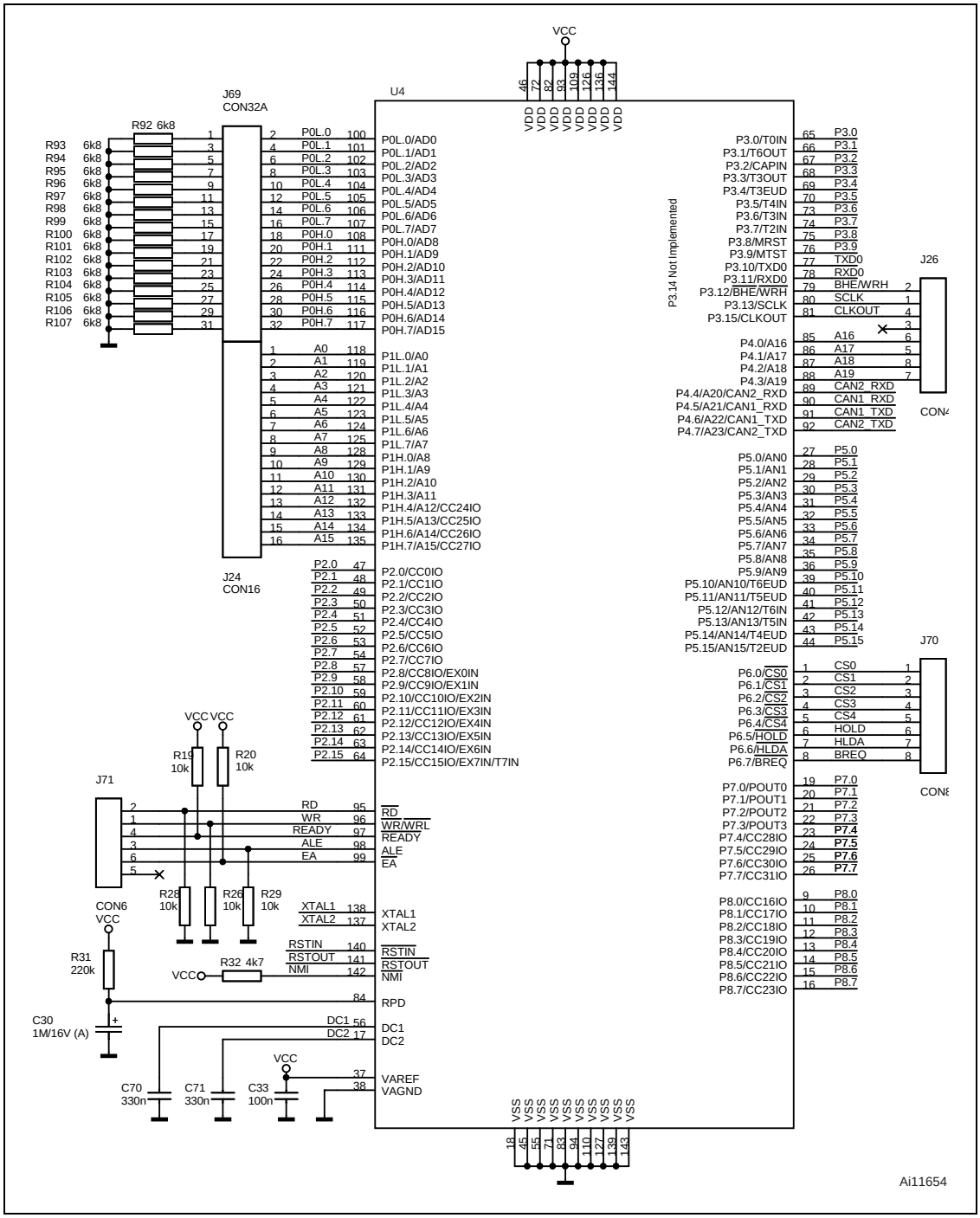
Note: 1 If a resistor assembly is used (hardware option set), the appropriate microcontroller signal should be set as an input!

2 Do not assemble both resistors of each pair as this will short-circuit the supply voltage!

1.6 Microcontroller part

Figure 13 describes the microcontroller port signal assignment and accessories connections.

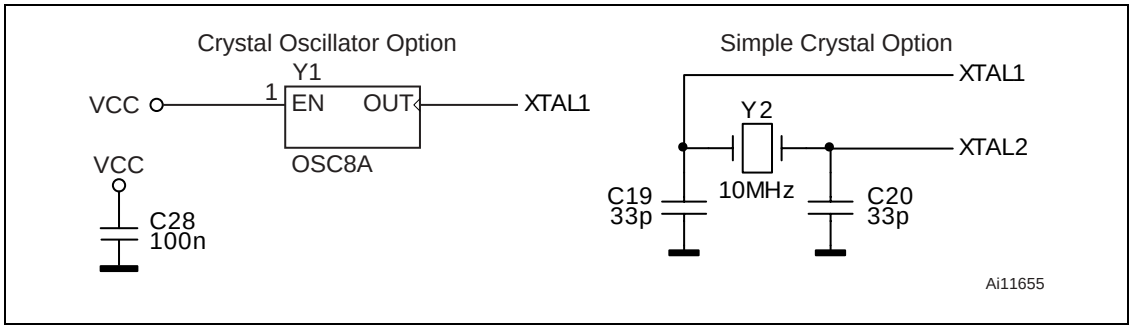
Figure 13. Microcontroller connections



1.6.1 Timing

Either a simple crystal or a crystal oscillator can be used for timing. Depending on the selected option, the crystal oscillator (Y1) or simple crystal (Y2) components are assembled as shown in *Figure 14*.

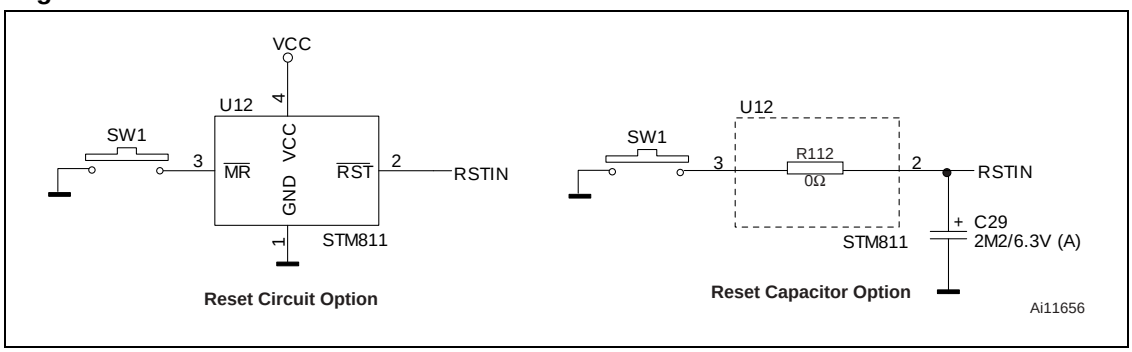
Figure 14. Timing options



1.6.2 Reset

Either a Reset Circuit or Reset Capacitor option can be used to reset the microcontroller as shown in *Figure 15*. When using an STM811 Reset Circuit (U12), C29 is not assembled. If the Reset Capacitor options is selected, assemble capacitor C29 and place a zero-ohm SMD resistor between pads 2 and 3 instead of the reset circuit.

Figure 15. Reset circuit



1.7 Power supply connections

Input CLT and PCLT devices are supplied from the input connectors (J1, J6 and J50). All inputs use a common supply voltage. Supply voltage inputs VCC1, VCC2 and VCC3 (or GND1, GND2 and GND3) can be connected together by connecting jumper pins J18, J19, J45 and J49 as shown in *Figure 16*. The advantage of connecting all supply voltage inputs is that only a single input must be connected to the supply voltage for all inputs to be supplied.

Figure 16. Supply voltage connections

1.7.1 Input CLT

If both Input CLT sensor banks (IN1x and IN2x) require an independent supply voltage, jumpers J18 and J19 must not be connected. In this case, the supply voltage should be connected to each input connector (J1 and J6) separately in order to correctly supply the corresponding input sensor bank.

In standard industrial applications, jumpers J18 and J19 are connected and the supply voltage (24V) is connected to only one single supply voltage inputs (VCC1 or VCC2; and GND1 or GND2).

1.7.2 Input PCLT

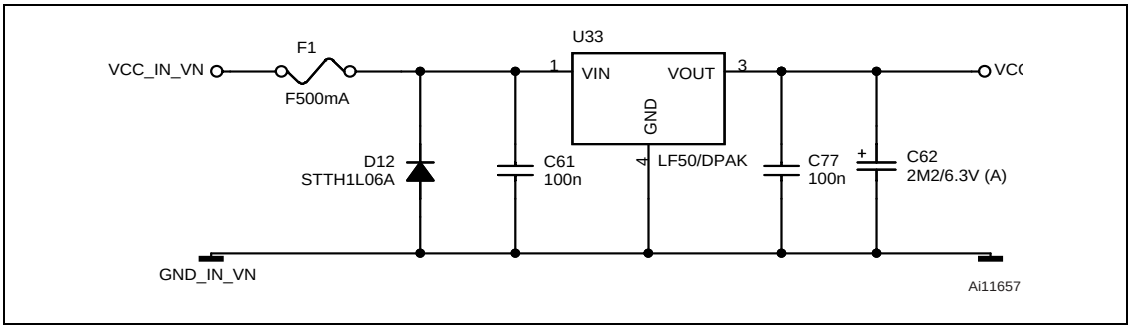
If the Input PCLT sensor bank (IN3x) requires an independent supply voltage, jumpers J45 and J49 must be open. In this case, the supply voltage should be connected to input pins VCC3 and GND3.

In standard industrial applications, jumpers J45 and J49 are closed and the sensor supply voltage (24V) is connected to only one of the supply voltage inputs (VCC2, GND2 or VCC3, GND3).

1.7.3 System supplies

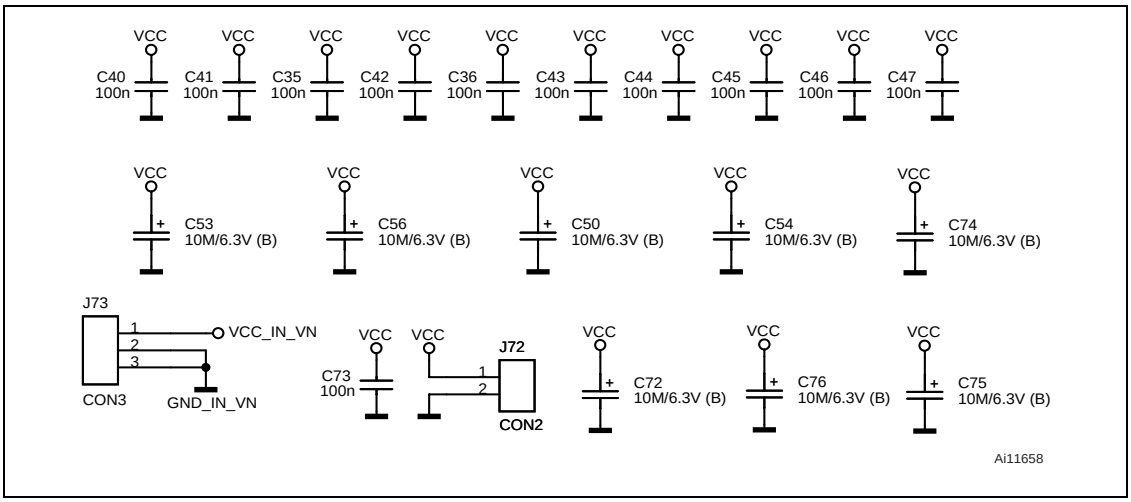
The GND and VCC pins of output connectors J12, J31, J46 and J53 (see *Figure 8* and *Figure 9*) or a standard 2.5mm coaxial supply via connector J73 (see *Figure 18*) can be used as a power supply for the system. Supply voltage should be between 6V and 16V DC.

Figure 17. Power supply diagram



To prevent supply voltage distortion, blocking capacitors are included on the board (*Figure 18*). Connector (J72) can be used to supply expansion modules connected to the board (5V DC supply).

Figure 18. Blocking capacitors and 5V output connector diagram



1.8 Jumper settings

Table 3 summarizes the jumper switches used to configure the application.

Table 3. Jumper descriptions

No.	Description	Function
J19	Negative (GND)	Input Banks 1 and 2: Supply voltage interconnection
J18	Positive (+24V)	
J45	Negative (GND)	Input Banks 2 and 3: Supply voltage interconnection
J49	Positive (+24V)	
J8	Negative (GND)	MCU and accessories: Supply voltage input from J12 connector
J10	Positive (+6V to +16V)	
J30	Negative (GND)	MCU and accessories: Supply voltage input from J31 connector
J28	Positive (+6V to +16V)	
J47	Negative (GND)	MCU and accessories: Supply voltage input from J46 connector
J48	Positive (+6V to +16V)	
J51	Negative (GND)	MCU and accessories: Supply voltage input from J53 connector
J52	Positive (+6V to +16V)	
J67	TxD signal	RS-232/RS-485 switch
J68	RxD signal	
J63	CAN 1	CAN line termination
J65	CAN 2	
J56	Pull-up	RS-485 line termination
J57	Differential	
J62	Pull-down	
J24	See *Section 2: Software*	Output mode selection
J69	See ST10 datasheet	ST10 controller initial configuration

2 Software

Inputs and outputs are divided to several groups (see *Table 4* and *Table 5*). The ST10F269 MCU is preprogrammed with a simple program. Each output group can work in two modes (bridge or toggling) selected by placing jumpers on J24 as shown in *Figure 19*.

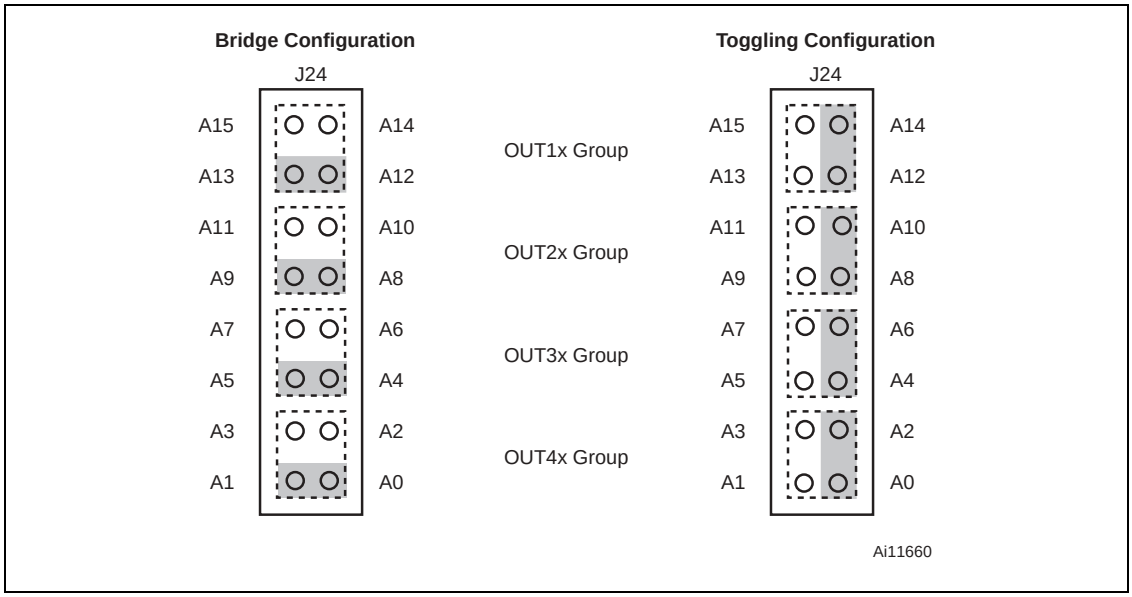
Table 4. Input group assignment

Input Group	IN1x	IN2x	IN3x
Connector No.	**J1**	**J6**	**J50**
Input No.	IN11	IN21	IN31
	IN12	IN22	IN32
	IN13	IN23	IN33
	IN14	IN24	IN34
	IN15	IN25	
	IN16	IN26	
	IN17	IN27	
	IN18	IN28	

Table 5. Output group assignment

Output Group	OUT1x	OUT2x	OUT3x	OUT4x
Connector No.	**J12**	**J31**	**J46**	**J53**
Output No.	OUT11	OUT21	OUT31	OUT41
	OUT12	OUT22	OUT32	OUT42
	OUT13	OUT23	OUT33	OUT43
	OUT14	OUT24	OUT34	OUT44
	OUT15	OUT25		
	OUT16	OUT26		
	OUT17	OUT27		
	OUT18	OUT28		

Figure 19. Jumper settings for data transmission configuration



2.1 Bridge configuration

In a Bridge configuration, the microcontroller reads the signal levels of each input and writes the data to its corresponding output. *Table 6* summarizes input/output group assignments.

Table 6. Bridge configuration group assignment

Input Group	IN11 to IN18	IN21 to IN28	IN31 to IN34	
Connector No.	J1	J6	J50	
Assigned Output Group	OUT11 to OUT18	OUT21 to OUT28	OUT31 to OUT34	OUT41 to OUT44
Connector No.	J12	J31	J46	J53

2.2 Toggling configuration

In a Toggling configuration, each output changes its logic level one after the other.

First OUTx1 is switched on for approximately 0.5 seconds. When this time expires, OUTx1 is switched off and immediately the OUTx2 is switched on. This cycle continues until the last output in the selected output group is switched off. Then, all the outputs of that group are switched off for approximately 0.5 seconds. Afterwards, the cycle repeats itself.

3 Electrical specifications and timings

Table 7. Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
Board Supply Voltage range	6	16	V DC
Current Consumption (in Run mode without Load)		150	mA
Industrial Supply Voltage range	-0.3	35	V DC
Industrial Input Voltage range	-0.3	35	V DC
Output Port Voltage range	0	5	V DC
Output Port Current range	-20	20	mA
RS-232 Channel speed		230	kbps
RS-485 Channel speed		30	Mbps
CAN Channel speed		1	Mbps

4 Revision history

Date	Revision	Changes
26-Sept-2005	1	Initial release.
24-Sep-2013	2	Updated Disclaimer.

Appendix A Bill Of Materials

Table 8. Bill of materials

ID	PCS	Part Reference	Value	Device Type	Mftr/Distri	Order Code
1	30	C1, C3, C4, C13, C22, C23, C28, C33, C35, C36, C40, C41, C42, C43, C44, C45, C46, C47, C48, C51, C52, C55, C57, C58, C61, C63, C64, C65, C73 and C77	100nF	SMD Capacitor Ceramic Size 0805		
2	20	C2, C6, C7, C8, C9, C10, C11, C12, C15, C16, C17, C18, C24, C25, C26, C27, C34, C37, C38 and C39	22nF	SMD Capacitor Ceramic Size 1206		
3	12	C50, C53, C54, C56, C72, C74, C75 and C76	10µ/6.3V (B)	SMD Tantalum Capacitor	Epcos	B45196E1106 M209
4	2	C19 and C20	30pF	SMD Capacitor Ceramic Size 0805		
5	2	C29 and C62	2.2µ/ 6.3V (A)	SMD Tantalum Capacitor Size A	Epcos	B45196E1225 M109
6	1	C30	1µ (A)	SMD Tantalum Capacitor Size A	Epcos	B45196E3105 M109
7	2	C31 and C32	330nF	Not Assembled SMD Capacitor Ceramic Size 0805		
8	2	C59 and C60	33n	SMD Capacitor Ceramic Size 1206		
9	4	C66, C67, C68 and C69	10nF/ 500V	THT Ceramic Capacitor		
10	2	C70 and C71	330nF	SMD Capacitor Ceramic Size 0805		
11	5	D1, D5, D8, D11 and D12	STTH1L 06A	Schottky Diode	ST	
12	11	D2, D3, D4, D6, D7, D9, D10, D13, D14, D15 and D16	LED	3mm Red LED 2mA	Agilent Technologies	L-HLMP-1700
13	1	F1	F500mA	SMD Fuse Fast Acting Size 1206	Farnell	968-857
14	2	J1 and J6	CON10	Double level Terminal Block MKKDS/2-5.08 + MKKDS/3-5.08	Phoenix-Contact	1725038 + 1725041
15	17	J8, J10, J18, J19, J28, J30, J45, J47, J48, J49, J51, J52, J56, J57, J62, J63 and J65	Jumper	Header 2pin 2.54mm pitch		

Table 8. Bill of materials (continued)

ID	PCS	Part Reference	Value	Device Type	Mftr/Distri	Order Code
16	2	J12 and J31	CON14	Header double line 14-pin 2.54mm pitch with housing		
17	1	J24	CON16	Header double line 16-pin 2.54mm pitch		
18	1	J26	CON4	Header double line 8-pin 2.54mm pitch		
19	2	J46 and J53	CON10	Header double line 10-pin 2.54mm pitch		
20	1	J50	CON6	Double level Terminal Block MKKDS/3-5.08	Phoenix-Contact	1725041
21	3	J54, J64 and J66	CON10	9pin D-Sub Socket	Farnell	415-5543
22	1	J59	CON10	9pin D-Sub Plug	Farnell	415-5506
23	1	J61	CON1_S	Header 1-pin 2.54mm pitch		
24	2	J67 and J68	Jumper_3p	Header single line 3-pin 2.54mm pitch		
25	1	J69	CON32A	Header double line 32-pin 2.54mm pitch		
26	1	J70	CON8	Header double line 8-pin 2.54mm pitch		
27	1	J71	CON6	Header double line 6-pin 2.54mm pitch		
28	1	J72	CON2	Header double line 2-pin 2.54mm pitch		
29	1	J73	CON3	DC Power Connector - Socket	Farnell	224-960
30	2	L1 and L2	Inductor	Not Assembled		
31	16	R1, R2, R3, R4, R5, R8, R9, R10, R14, R15, R16, R17, R21, R22, R23 and R27	1.2 kΩ	SMD Resistor Size 1206		
32	4	R6, R11, R18 and R24	4.7kΩ	SMD Resistor Size 1206		
33	2	R36 and R40	2.2 kΩ	SMD Resistor Size 1206		
34	8	R7, R12, R13, R25, R30, R39, and R44	1.5kΩ	SMD Resistor Size 0805		
35	25	R19, R20, R26, R28, R29, R35, R53, R58, R70, R71, R73, R74, R75, R76, R77, R78, R79, R80, R81, R82, R83, R84, R85, R86, R87 and R109	10kΩ	SMD Resistor Size 0805		
36	1	R31	220kΩ	SMD Resistor Size 0805		
37	1	R32	4.7kΩ	SMD Resistor Size 0805		

Table 8. Bill of materials (continued)

ID	PCS	Part Reference	Value	Device Type	Mftr/Distri	Order Code
38	4	R33, R34, R37 and R38	750Ω	SMD Resistor Size 1206		
39	4	R41, R42, R110 and R111	10kΩ	SMD Resistor Size 1206		
40	17	R43, R45, R48, R51, R52, R54, R56, R57, R59, R61, R62, R64, R88, R89, R90, R91 and R108	0Ω	SMD Resistor Size 0805	Certain resistors must not be assembled. See *Section 1: Hardware*.	
41	1	R47	220Ω	SMD Resistor Size 1206		
42	1	R49	390Ω	SMD Resistor Size 0805		
43	2	R50 and R46	390Ω	SMD Resistor Size 1206		
44	2	R55 and R60	120Ω	SMD Resistor Size 1206		
45	2	R63 and R68	0Ω	SMD Resistor Size 1206	Not assembled.	
46	4	R65, R66, R67 and R69	M1	SMD Resistor Size 1206		
47	16	R92, R93, R94, R95, R96, R97, R98, R99, R100, R101, R102, R103, R104, R105, R106 and R107	6.8kΩ	SMD Resistor Size 0805		
48	1	SW1		Push-button Switch	Omron	B3F-1000
49	4	U1, U6, U7 and U10	CLT3-4BT6	Input Current Limited Termination	ST	
50	5	U2, U3, U8, U11 and U17	TLP281-4	Optocoupler - 4 channels	ST	
51	1	U4	ST10F269	16-bit Microcontroller	ST	
52	3	U5, U9 and U13	74HC541	Octal Bus Buffer with 3 state outputs (Non-inverted)	ST	
53	1	U12	STM811	Reset IC	ST	
54	1	U15	ST202E	RS-232 Transceiver	ST	
55	1	U21	ST485A	RS-485 Transceiver	ST	
56	2	U22 and U23	L9616	High-speed CAN Bus Transceiver	ST	
57	2	U24 and U25	PCLT-2A	Input Current Limited Termination - programmable characteristic type	ST	
58	1	U33	LF50/ DPAK	Very low dropout voltage regulator	ST	
59	1	Y1	OSC8A	Unassembled 40-MHz Crystal Oscillator	Seiko Epson	SG531PH40MHZ
60	1	Y2	10MHz	10-MHz Crystal		

Appendix B PCB Layers

Figure 20. Top layer

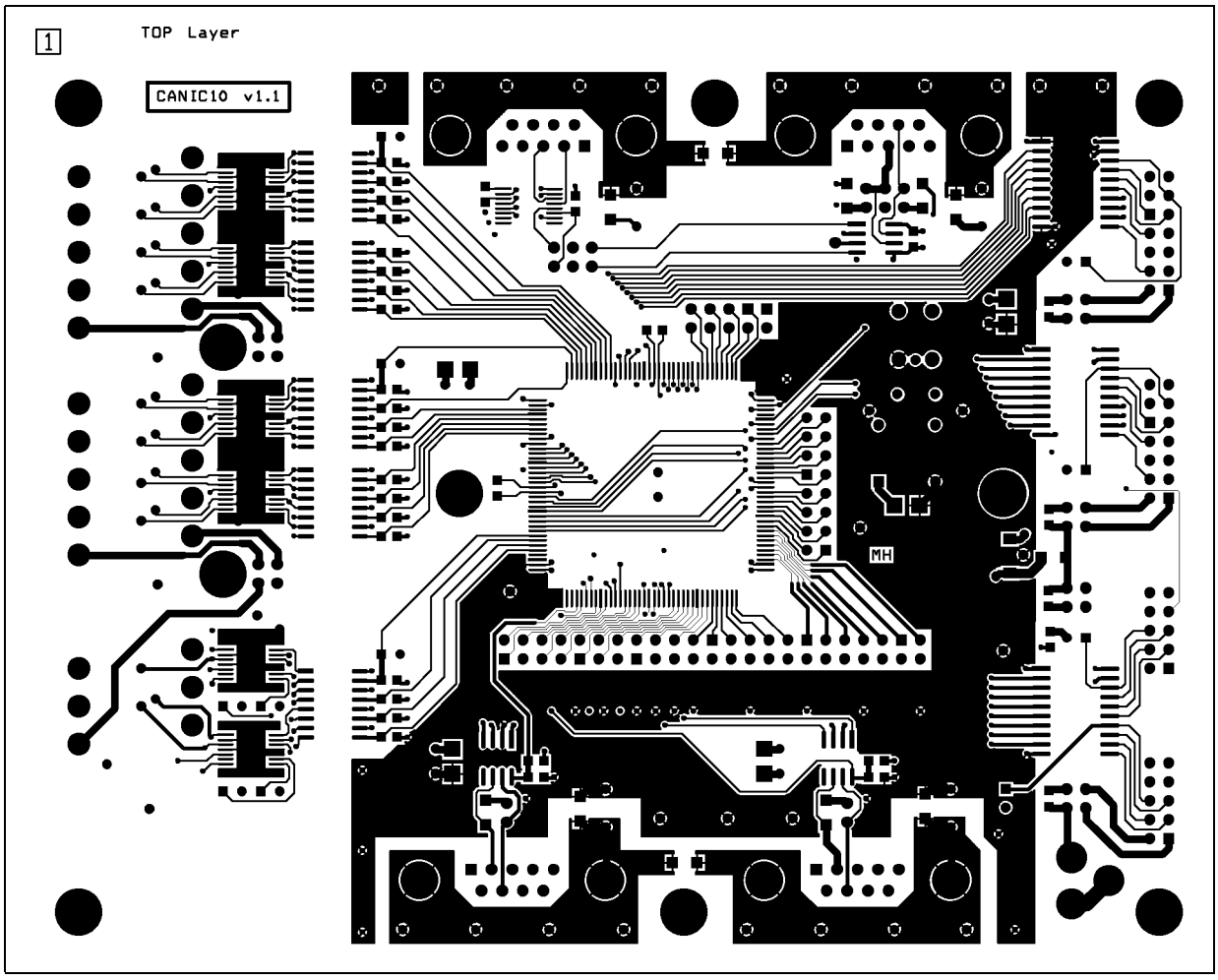


Figure 21. Bottom layer

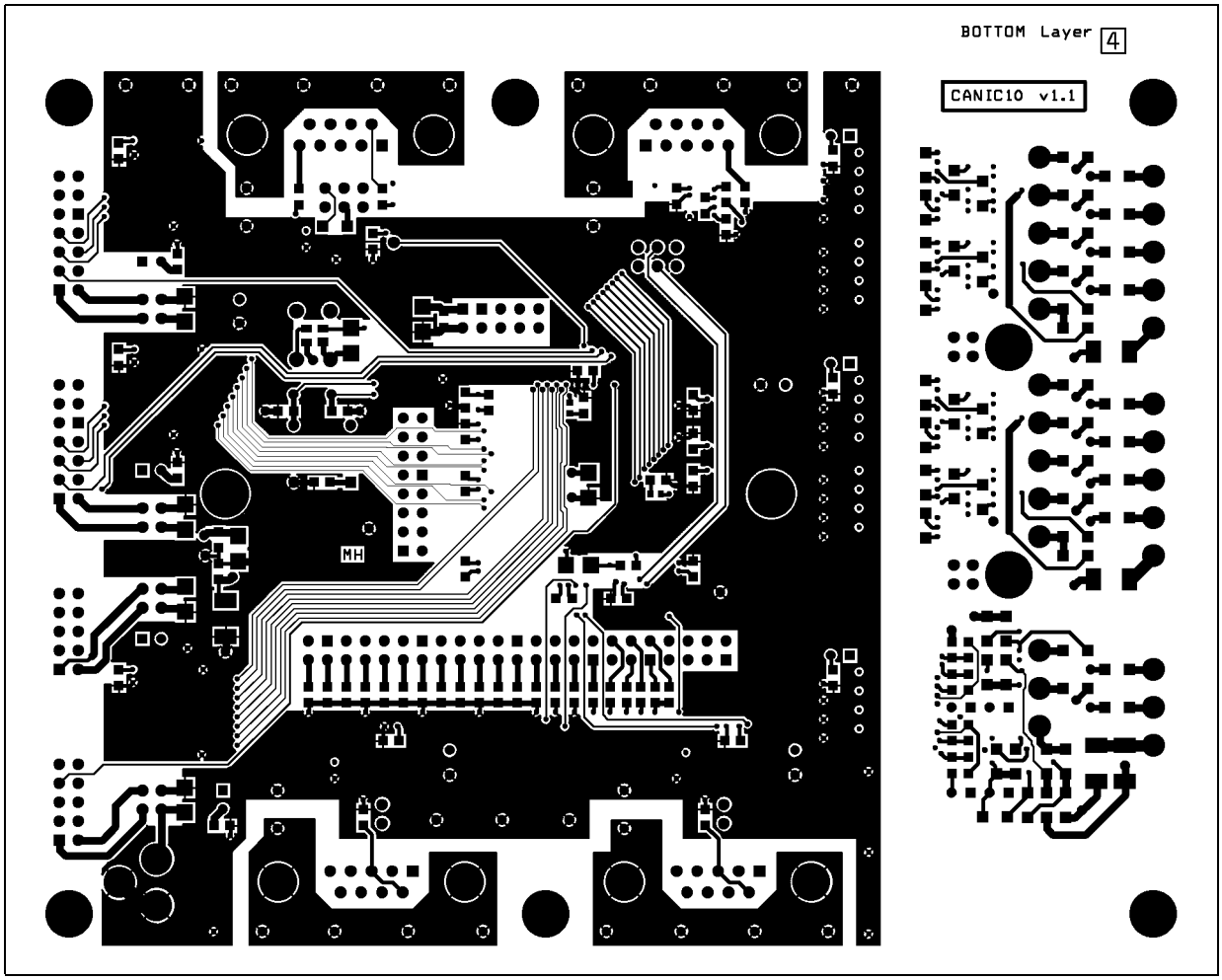


Figure 22. Ground layer

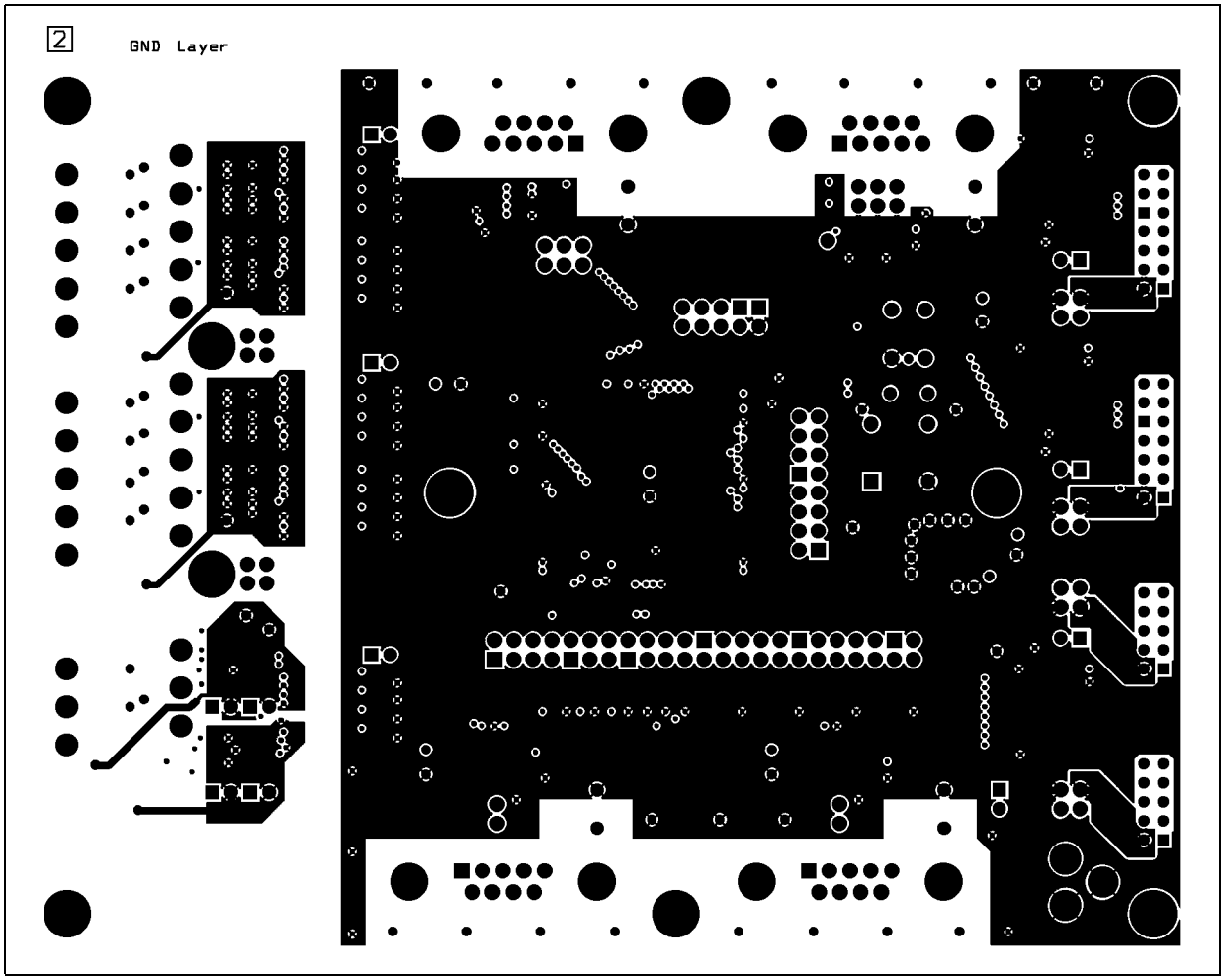


Figure 23. Power layer

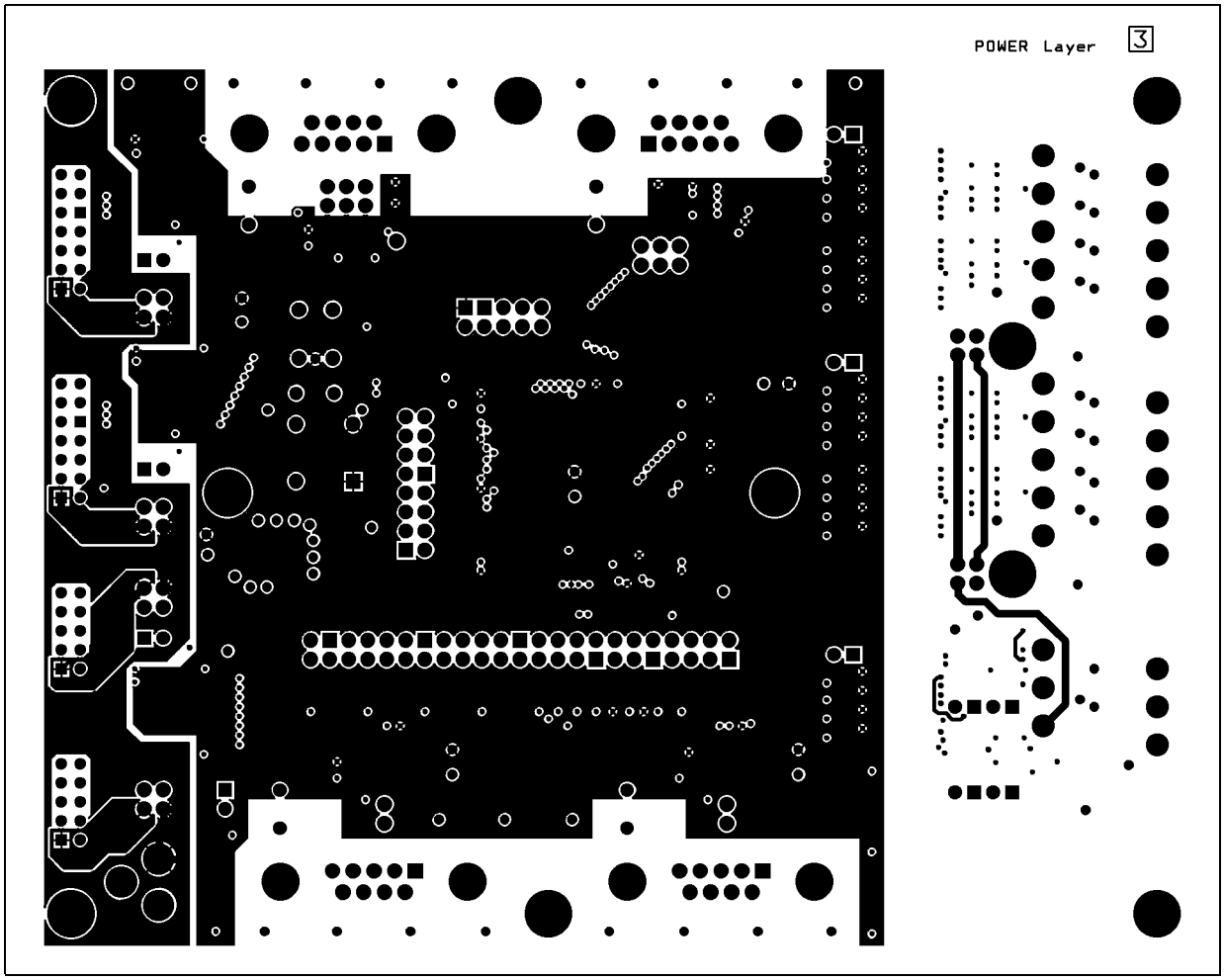


Figure 24. Silk screen top layer

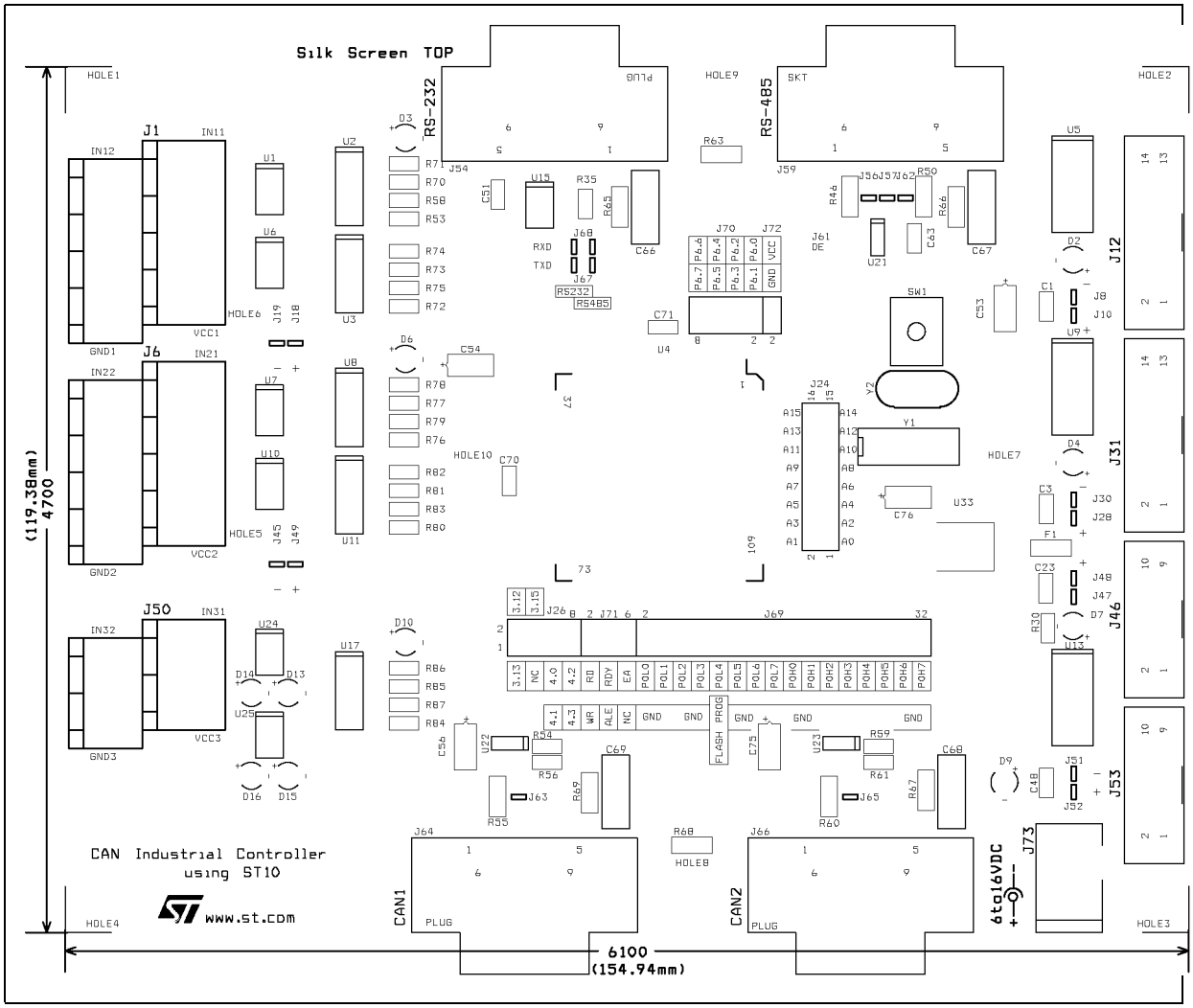
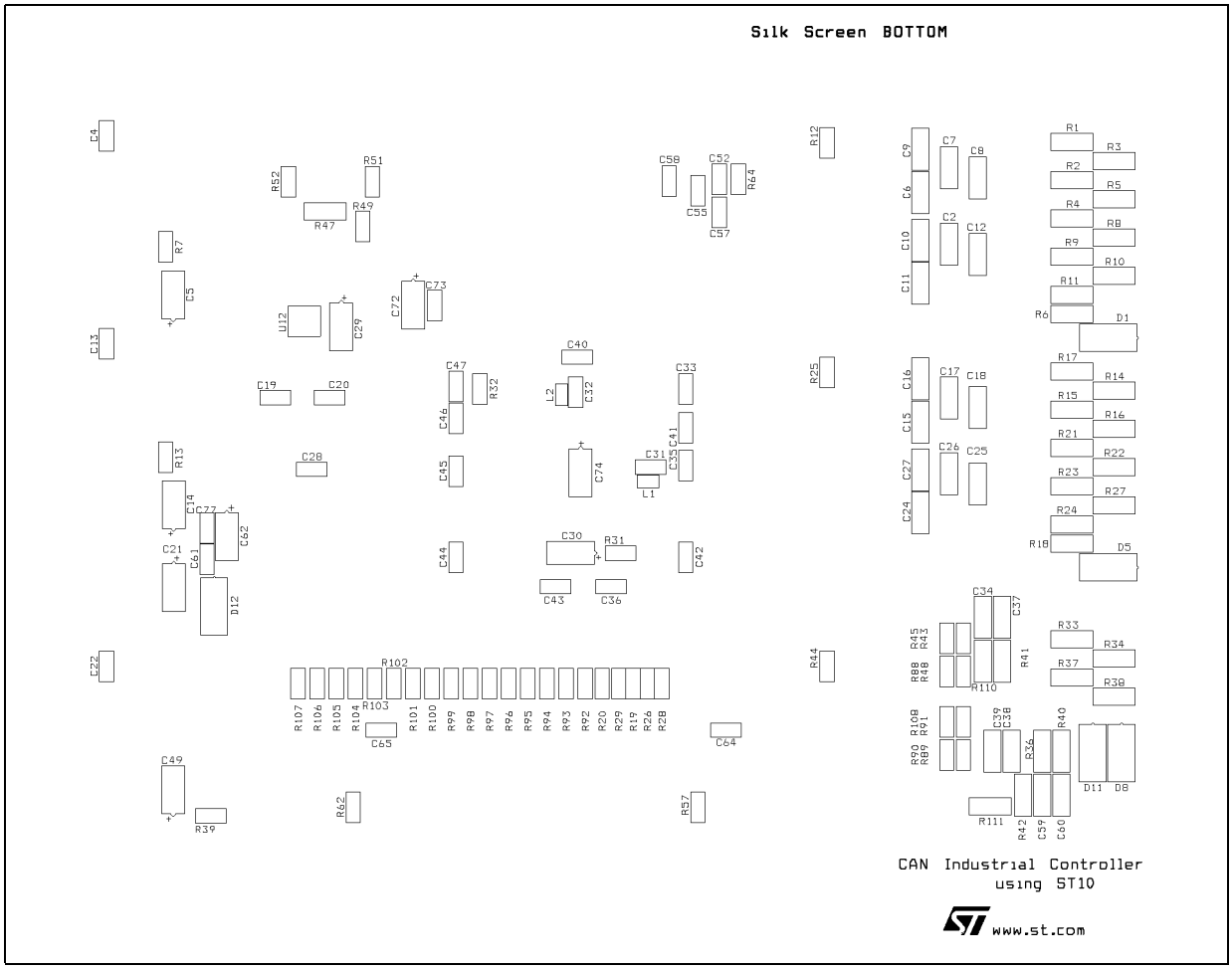


Figure 25. Silk screen bottom layer



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