UM0997
User manual

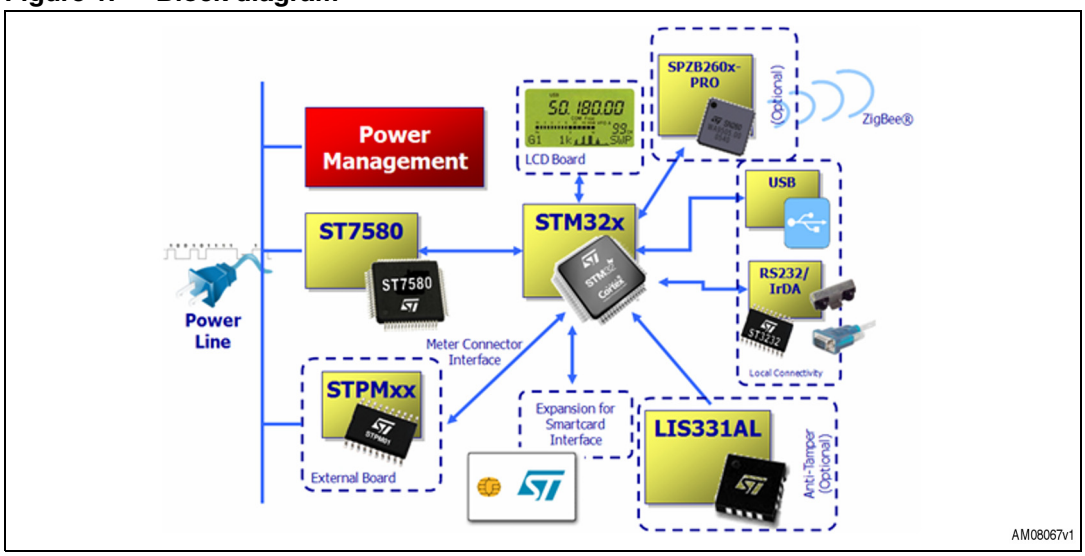
STEVAL-IPP001V2: E-meter demonstration board with PLM

Introduction

The E-meter demonstration board can be used as a guideline to designing a typical energy meter board for smart metering applications. It was designed to include advanced features as well as to fit the requirements for next generation energy meters. These extra features can be included in the board by modules for easy customizing. The board includes the following functions shown in the block diagram of *Figure 1*:

- Energy measurement by an external metrology board
- Power line communication up to 28.8 kbps
- LCD display to show energy consumption information
- USB and RS232/IrDA connectivity
- Optional ZigBee® communication capability
- Optional MEMS module support
- Expansion capability for smartcard interface

Figure 1. Block diagram



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1 Overview

1.1 Recommended reading

This document describes how to configure and use the E-meter demonstration board. Additional information can be found in the following documents which are referenced throughout this document:

- ST device datasheets and data briefs
- Third party device datasheets
- Dedicated application notes and user manuals
- E-meter demonstration board with PLM firmware user manual

1.2 Safety precautions

The board must be used only by expert technicians. Due to the high voltage (220 Vac) special care should be taken with regard to safety.

There is no protection against accidental human contact with high voltages.

After disconnecting the board from the mains, none of the live parts should be immediately touched because of the energized capacitors.

It is mandatory to use a mains insulation transformer to perform any tests on the board in which test instruments such as spectrum analyzers or oscilloscopes are used.

Do not connect any oscilloscope probes to high voltage sections in order to avoid damaging instruments and demonstration tools.

Warning: ST assumes no responsibility for any consequences which may result from the improper use of this tool

1.3 Getting technical support

Technical assistance is provided free to all customers. For technical assistance, documentation, information, and upgrades regarding ST products and services, please refer to your local distributor/office.

1.4 Package checklist

The E-Meter demonstration board with PLM kit package includes the following:

- The E-meter demonstration board with PLM
- A CD-ROM with software and documentation

2 E-meter demonstration board with PLM components

2.1 Microcontroller

The system is managed by the STM32F103VE microcontroller. It is based on the 32-bit ARM Cortex-M3 core with 72 Mhz maximum frequency, 512 KB flash and 64 KB SRAM embedded memories. For further details please refer to the STM32F103xC, STM32F103xD, and STM32F103xE; *High-density Performance line, ARM-based 32-bit MCU with up to 512 KB Flash, USB, CAN, 11 timers, 3 ADCs and 13 communication interfaces*, datasheet.

The microcontroller is driven by an external 8 MHz crystal for the high-speed main clock and a 32768 Hz for low speed RTC clock. The microcontroller can manage the M24128 EEPROM memory for data storage. Some jumpers are also connected to the microcontroller GPIO in order to allow firmware configuration.

2.2 Debug

Software debug is via a standard 20-pin JTAG connection. The JTAG connector is not insulated, so for debugging use the JTAG opto-insulation board (order code: AI-JTAG/OPTO-1/A) or a battery supplied notebook, alternatively, supply the board through an insulated AC source.

2.3 Reset

The reset sources are:

- power on reset
- push button reset
- JTAG reset from an in-circuit emulator

2.4 Power supplies

The board is powered directly by the mains. It includes an insulated extended range power supply validated in the 88 - 256 Vac range and both 50 Hz and 60 Hz frequencies.

The power supply consists of an AC-DC based on the Altair04-900 regulator; it provides 13 Vdc with 700 mA maximum current on the main output and 3.3 Vdc with 150 mA on the auxiliary output through an LF33AB linear regulator.

2.5 Power line communication

The board allows digital data communication through power line modulation using the ST7580 power line modem. For more details on the modem, please refer to the ST7580; *FSK, N-PSK multi-mode power line networking system-on-chip*, datasheet. The modem section can be fully separated from the microcontroller in order to allow the full debugging of the ST7580 firmware. In fact, this section also includes a JTAG connector, an 8 MHz crystal, and a reset button dedicated to the modem. The ST7580 is able to execute custom firmware from the serial flash memory included in the board. The ST7580 supports both B-FSK modulation up to 9600 bps and several kinds of both coded and non-coded PSK modulation

(BPSK, QPSK, 8PSK) up to 28.8 kbps. The modem supports dual-channel operation mode and AES-128 hardware encryption as well; moreover, it is compliant with CENELEC band A and B, supports zero-crossing transmission synchronization, and has a 1 Arms with 15 Vpp single-ended thanks to its integrated amplifier. The modem is able to self-adapt the current limit network properly driving the Q2 MOSFET when modulation settings are modified. This board section is insulated from the AC mains by an opto-insulator connected between the ST7580 zero-crossing pin and a coupler transformer for the transmission/reception part. *Table 1* shows the MCU resources mapping used for ST7580 management:

Table 1. STM32 resources – ST7580 function mapping

STM32 resource	ST7580 function
PA0 (USART2-CTS)	GPIO1
PC6	GPIO2
PC7	GPIO4
USART2-RTS	T-REQ
USART2-TX	RXD
USART2-RX	TXD
PC8	RESET

2.6 Metrology

The metrology section is not included in the board but is an external module connected by a standard DIL connector. This allows a modular system to be built for both three-phase and mono-phase meters; at the same time, the modular architecture allows the metrology section to be easily calibrated. A three-phase meter is built connecting the STEVAL-IPE010V1 which supports the STPMC1 plus STPMS1 energy meter chipset; for details on this demonstration board please refer to user manual for the STEVAL-IPE010V1, UM0746; *Energy meter demonstration kit based on the STPMC1 and STPMS1*. A mono-phase meter is built connecting the STEVAL-IPE002V1 demonstration board. The STEVAL-IPE003V1 and STEVAL-IPE004V1 boards can also be supported but a change in the microcontroller firmware is necessary. *Table 2* shows the MCU resources mapping for energy meter IC management:

Table 2. STM32 resources - Energy meter IC function mapping

STM32 resource	Energy meter function
PB8	SYN
SPI2-MOSI/MISO	SDA
SPI2-SCK	SCL
SPI2-NSS	SCS

2.7 User interface

The board allows user interaction through a joystick and one button; three LEDs and a 2.4" color TFT LCD display with a 240x320 resolution are used as output devices. The LCD connection with the MCU can be chosen between SPI and GPIOs emulating the SPI protocol by software. The LCD board is a spare part of the STM3210B-EVAL or of the STM3210E-EVAL. *Table 3* shows a summary of the MCU resources mapping:

Table 3. STM32 resources - user interface function mapping

STM32 resource	User interface function
SPI1-SCK/PD5	LCD-CLK
SPI1-MISO/PD4	LCD-DO
SPI1-MOSI/PD3	LCD-DI
PC12	LCD-CS
PB0	LCD-RS
PB1	LCD-WR
PB9	LCD-BACKLIGHT
PE15	JOYSTICK-UP
PE14	JOYSTICK-LEFT
PE13	JOYSTICK-RIGHT
PE12	JOYSTICK-SEL
PE11	JOYSTICK-DOWN
PE10	KEY-BUTTON
PE0	LED2
PE1	LED1
PE2	LED0

2.8 MEMS

The board includes an expansion connector for the connection of an optional MEMS module. The connector is compatible with the STEVAL-MKI021V1 demonstration board for the LIS331AL; for further details, please refer to the UM0614; *STEVAL-MKI021V1 demonstration kit for the LIS331AL,* user manual and to the LIS331AL; *MEMS inertial sensor: 3-axis - ±2g analog output "nano" accelerometer*, datasheet. *Table 4* gives details on MCU resources mapping:

Table 4. STM32 resources - MEMS function mapping

STM32 resource	MEMS function
ADC-10	X axis voltage
ADC-11	Y axis voltage
ADC-12	Z axis voltage

2.9 RS32/IrDA serial communication

The board includes a serial communication interface; it is possible to configure this interface as an insulated RS232 or as IrDA. *Table 5* shows the MCU resources mapping:

Table 5. STM32 resources - RS232/IrDA function mapping

STM32 resource	Serial communication function
UART4-TX	RS232/IrDA-TX
UART4-RX	RS232/IrDA-RX

2.10 Smartcard expansion

The board includes connectors (21) to optionally fit a smartcard interface module. *Table 6* shows the MCU resources mapping:

Table 6. STM32 resources - smartcard interface function mapping

STM32 resource	Smartcard interface function
USART1-CK	SC-CLK
USART1-TX	SC-TX
USART1-RX	SC-RX
PD2	SC-nOFF
PC5	SC-RST

2.11 ZigBee communication

The board includes a connector to optionally fit a ZigBee communication module. The connector is compatible with the SPZB260-PRO module supporting both SPI and UART communication interfaces. The SPI1, used for the ZigBee module, is shared with the LCD so if the SPI1 is used as the interface, the LCD must be used in emulation mode by GPIOs. For further details on interface configuration of the SPZB260-PRO please refer to the SPZB260-PRO; *ZigBee module*, datasheet. *Table 7* shows the MCU resources mapping:

Table 7. STM32 resources – ZigBee module function mapping

STM32 resource	ZigBee module function
SPI1-SCK	SLK
SPI1-MISO	MISO
SPI1-MOSI	MOSI
USART3-RTS	nSEL-CTS
USART3-CTS	RTS
USART3-TX	HOST-INT-RXD
USART3-RX	TXD

Table 7. STM32 resources – ZigBee module function mapping (continued)

STM32 resource	ZigBee module function
PB10	WAKE
PB11	RSTB

2.11.1 USB communication

The board supports a USB 2.0 full speed communication. Before connecting the board to a PC, make sure to take all the necessary safety precautions as the USB is not insulated.

2.11.2 General purpose configuration

The boards support five general purpose configuration jumpers for the STM32 firmware, *Table 8* shows the resource mapping:

Table 8. STM32 resources - configuration jumper function mapping

STM32 resource	Description
PE8	CONF0
PE7	CONF1
PE6	CONF2
PE5	CONF3
PE9	CONF4

2.12 Status LEDs

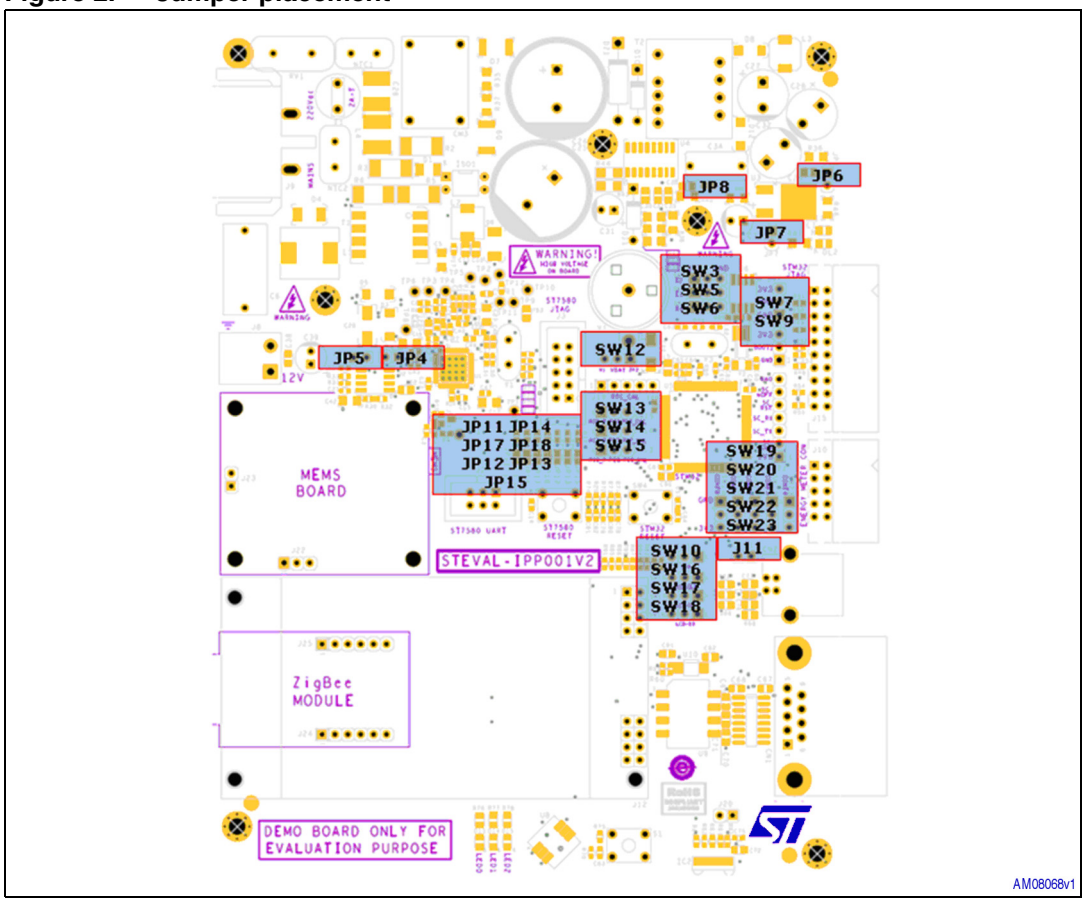
Table 9. LED description

LED	Description
D13	General purpose
D14	General purpose
D15	General purpose
DL1	13 V power supply voltage status
DL2	3.3 V power supply voltage status

2.13 Jumpers

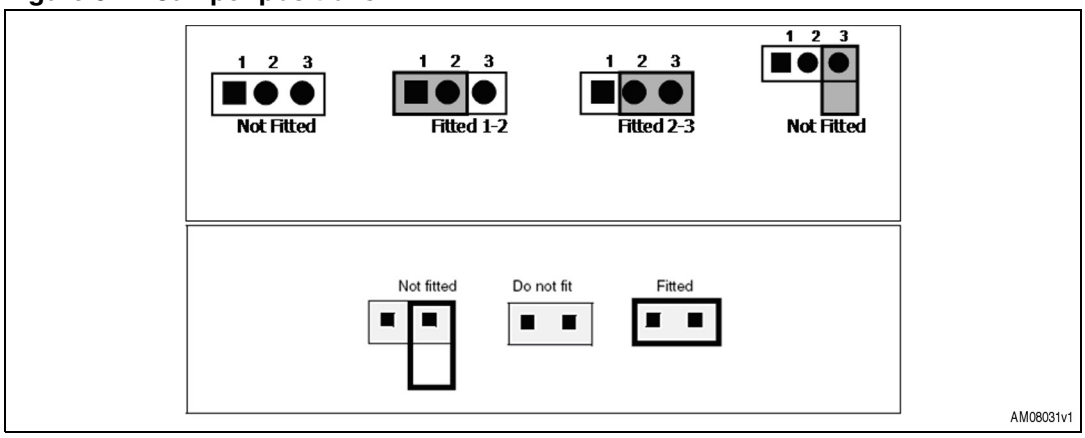
2.13.1 Jumper placement

Figure 2. Jumper placement



2.13.2 Jumper positions

Figure 3. Jumper positions



2.13.3 Jumper description and default value

Table 10. Jumper description

Jumper	Description	Default
JP6	DL1 enable – Fitted: DL1 enabled – Not fitted: DL1 disabled	Fitted
JP7	DL2 enable – Fitted: DL1 enabled – Not fitted: DL1 disabled	Fitted
JP8	To connect mains ground to board ground – Fitted: grounds connected – Not Fitted: grounds not connected	Not Fitted
SW3 SW5, SW6	EEPROM address setting – Fitted (1-2): address bit 1 – Fitted (2-3): address bit 0	Fitted (2-3)
SW7, SW9	Boot option – Fitted (1-2): boot option bit 0 – Fitted (2-3): boot option bit 1	Fitted (1-2)
SW12	STM32 VBAT option – Fitted (1-2): VBAT from power supply – Fitted (2-3): VBAT from battery ß	Fitted (1-2)
SW13, SW14, SW15	RTC calibration mode – Fitted (1-2): normal mode – Fitted (2-3): RTC calibration mode	Fitted (1-2)
SW19, SW20, SW21, SW22, SW23	General purpose configuration bit – Fitted (1-2): configuration bit 0 – Fitted (2-3): configuration bit 1	Fitted (1-2)
JP11, JP12, JP13, JP14, JP15, JP17, JP18	STM32-ST7580 Connection – Fitted: STM32-ST7580 control lines connected – Not Fitted: STM32-ST7580 control lines not connected	Fitted
J11	Energy meter board power supply option – Fitted: energy meter powered by the board – Not fitted: energy meter self powered	Fitted
SW10	Energy meter data line option – - Fitted (1-2): data line connected to SPI2-MOSI – - Fitted (2-3): data line connected to SPI2-MISO	Fitted (2-3)
SW16, SW17, SW18	LCD connection option – - Fitted (1-2): LCD controlled by SP1 – - Fitted (2-3): LCD controlled by GPIOs	Fitted (1-2)
JP5	ST7580 external flash enable – - Fitted: ST7580 run flash firmware – - Not fitted: ST7580 disabled	Not fitted

Table 10. Jumper description (continued)

Jumper	Description	Default
JP4	ST7580 external flash hold – - Fitted: flash data output disabled – - Not fitted: flash data output enabled	Not fitted
Jumper	Description	Default

2.14 Push button description

Table 11. Push button description

Switch	Description
S1	General purpose button
SW4	STM32 reset button
SW1	ST7580 reset button

2.15 Connector description

Figure 4. Auto-calibration mode connection diagram

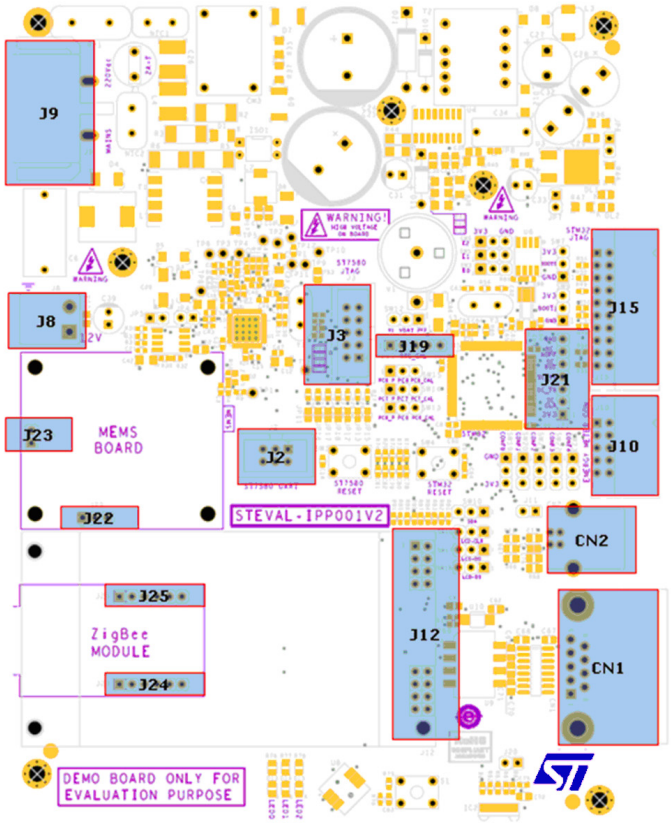


Table 12. Connector description

Connector	Description
J9	AC mains connector
J8	12 V DC output voltage
J3	JTAG connector for ST7580
J19	STM32 RTC calibration connector
J21	Smartcard expansion connector
J15	JTAG connector for STM32
J10	Metrology board connector
J2	ST7580 serial communication interface connector
J22, J23	MEMS module connectors
J24, J25	ZigBee module connectors
J12	LCD connector
CN1	RS232 connector
CN2	USB connector

3 Connectors

3.1 STM32 JTAG connector

Figure 5. STM32 JTAG connector

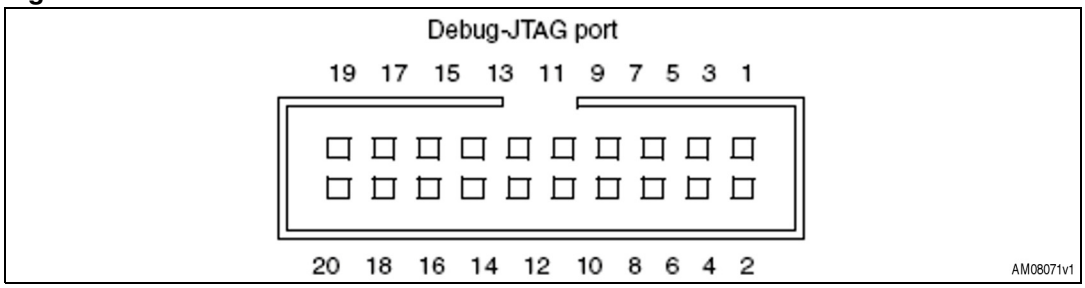


Table 13. STM32 JTAG connector description

Pin	Description	Pin	Description	Pin	Description
Even pins	Ground	5	TDI	13	TD0
1	VTref +3.3 V	7	TMS	15	notTReset
2	Vsupply +3.3 V	9	TCK	17	DBGRQS - pulled down
3	notTRST	11	RTCK (ground)	19	Pulled down

3.2 Metrology board connector

Figure 6. Energy meter IC calibration connector

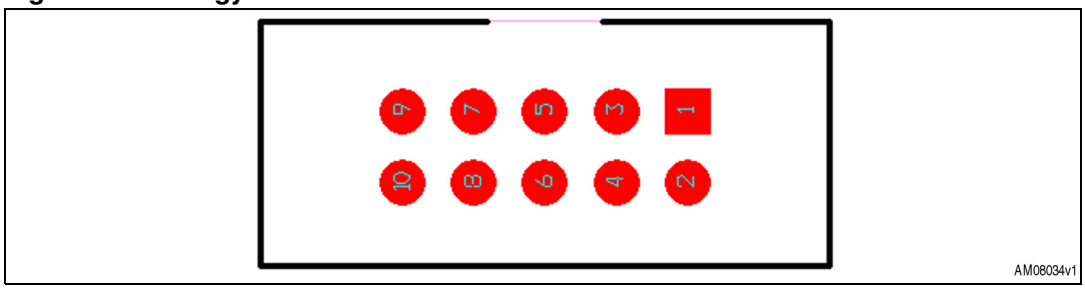


Table 14. Energy meter IC calibration connector description

Pin	Description	Pin	Description
1	Not connected	6	SCLK
2	Not connected	7	Not connected
3	GND	8	SYN
4	SDA	9	Not connected
5	SCS	10	3.3 V

3.3 ST7580 JTAG connector

Figure 7. ST7580 JTAG connector

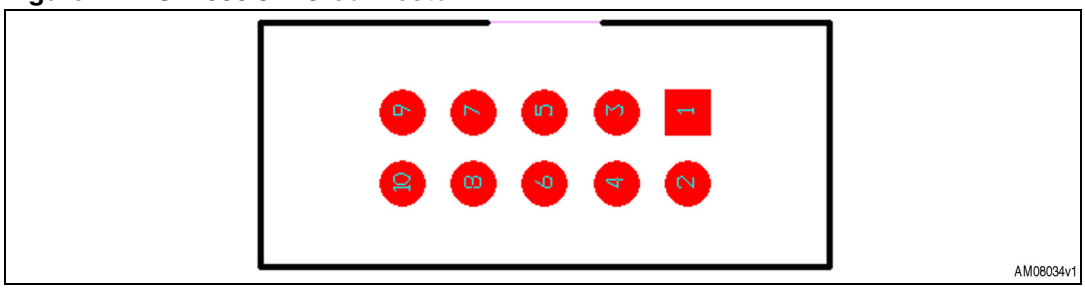


Table 15. ST7580 JTAG connector description

Pin	Description	Pin	Description
1	TCK	6	Pull up
2	GND	7	Not connected
3	TDO	8	NTRST
4	Not Connected	9	Not connected
5	TMS	10	GND

3.4 RTC calibration connector

Figure 8. RTC calibration connector

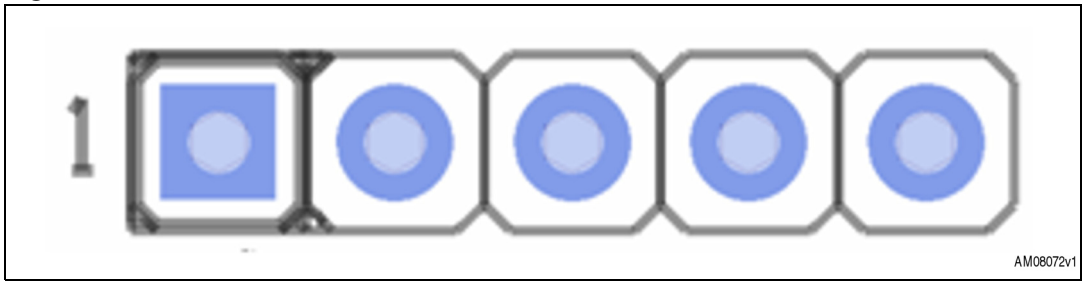


Table 16. RTC calibration connector description

Pin	Description
1	Fin: frequency coming from the main RTC board
2	GND
3	Clock-In/clock-out
4	Data-in/data-out
5	Interrupt signal-in/interrupt signal-out

3.5 Smartcard expansion connector

Figure 9. Smartcard expansion connector

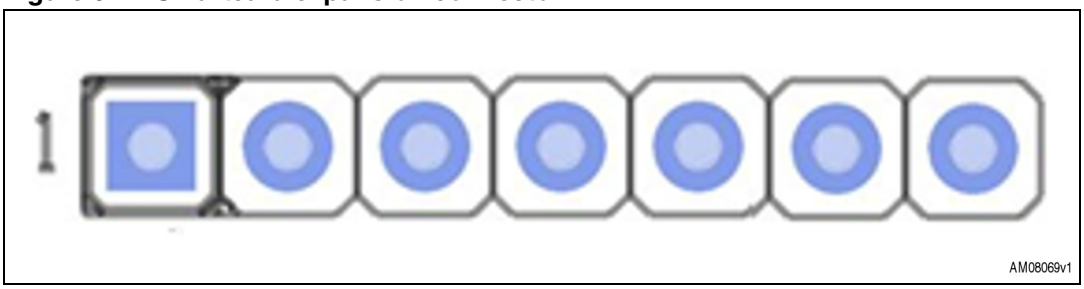


Table 17. Smartcard expansion connector description

Pin	Description
1	3.3 V
2	CLK
3	TX
4	RX
5	RST
6	NOFF
7	GND

3.6 ST7580 serial communication interface connector

Figure 10. ST7580 serial communication connector

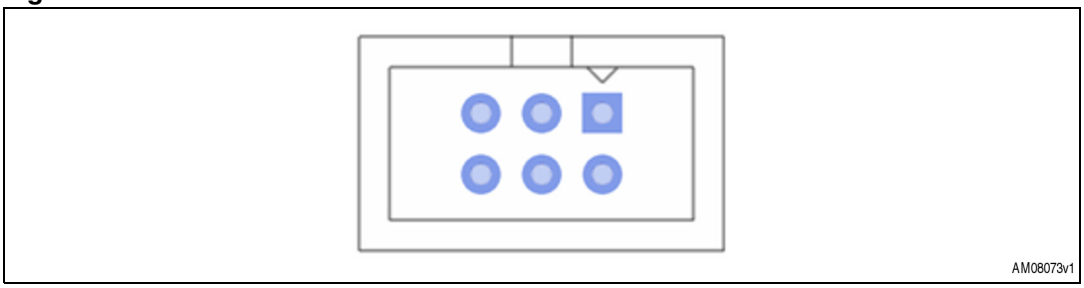


Table 18. ST7580 serial communication connector description

Pin	Description	Pin	Description
1	VDD	4	RXD
2	TXD	5	GND
3	T-REQ	6	GND

4 Board configuration

4.1 Boot

The board allows the boot options of the STM32 to be configured by setting jumpers SW7 and SW9: SW7 drives BOOT0 and SW9 drives BOOT1. *Table 19*, which is taken from the STM32 RM0008; *STM32F101xx, STM32F102xx, STM32F103xx, STM32F105xx and STM32F107xx advanced ARM-based 32-bit MCUs*, reference manual, shows the boot options of the STM32.

Table 19. Boot modes

Boot mode selection pins		Boot mode	Aliasing
BOOT1	BOOT0		
x	0	Main Flash memory	Main Flash memory is selected as boot space
0	1	System memory	System memory is selected as boot space
1	1	Embedded SRAM	Embedded SRAM is selected as boot space

4.2 LCD interface - ZigBee interface configuration

The default communication interface configuration of a ZigBee module is SPI. To use this configuration, the LCD interface must be configured in software emulation mode using GPIOs by properly setting SW16, SW17, and SW18 according to *Table 10*; in this case the LCD CLK, DO and DI are driven by PD5, PD4, and PD3 respectively. Configuring the ZigBee module in UART mode allows the LCD to be driven by SPI1; in this case R81, R82, R83, and R90 must be removed and SW16, SW17, and SW18 set according to *Table 10*. In this case the ZigBee module is driven by USART3.

4.3 RTC calibration configuration

To calibrate the STM32 RTC, the SW13, SW14, and SW15 must be set according to *Table 10*. When these switches are set in RTC calibration mode, PC6, PC7, and PC8 aren't available to drive ST7580 GPIOs.

The J19 connector is used for STM32-RTC calibration; for further information on RTC calibration methodology please refer to the AN2604; *STM32F101xx and STM32F103xx RTC calibration*, application note.

4.4 Energy meter data line configuration

It is possible to configure if using the SPI2 MOSI or SPI2 MISO as the energy meter data line setting SW10, according to *Table 10*.

4.5 RS232/IrDA configuration

It is possible to configure the UART4 as insulated RS232 or as IrDA. Fitting R59, R60 and removing R62 and R63, the UART is used as RS232; the same UART can be used as IrDA by the opposite configuration.

5 BOM list and schematics

Table 20. BOM

Ref.	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package-footprint	Manuf.	Manufacturer code	RS/distrelec/ other code	More info
CM3	IND-EPCOS-B82721K			Power line chokes 10 mH 0.7 A	Through hole	EPCOS	B82721K2701N020	Digi-Key: 495-2739-ND	Any	
CN1	PORT 0				R/A DB9 male connector (plug)	Through hole	Any		RS:542-8009	
CN2	USB_TYPE B				USB socket	Through hole	Any		Distrelec: 124164	
C2	120 pF	5 %	50 V		X7R/COG ceramic capacitor	SMD 0603	Any		Any	
C3, C48	100 pF	5 %	50 V		X7R/COG ceramic capacitor	SMD 0603	Any		Any	

Table 20. BOM (continued)

Ref.	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package-footprint	Manuf.	Manufacturer code	RS/distrelec/ other code	More info
C4, C7, C13, C14, C15, C17, C18, C19, C21, C22, C43, C47, C49, C50, C51, C52, C53, C65, C66, C64, C75,C78, C79, C80, C81, C82, C83, C87, C88, C89	100 nF	10 %	25 V		X7R ceramic capacitor	SMD 0603	Any		Any	
C5, C12, C16, C23, C42	10 µF	20 %	10 V		Y5V ceramic capacitor	SMD 1206	Any		RS:434-8097	
C6	220 nF X2	20 %	305 Vac		EMI suppression X2 capacitor	Through hole 15 mm lead spacing	Epcos	B32922A2224M	RS:497-4129	
C1, C85	10 nF	10 %	25 V		X7R ceramic capacitor	SMD 0603	Any		Any	
C8	2.2 nF	5 %	25 V		COG ceramic capacitor	SMD 0603	Any		Any	
C9	120 pF	5 %	50 V		COG ceramic capacitor	SMD 0603	Any		Any	
C10	10 nF	10 %	50 V		X7R ceramic capacitor	SMD 0805	Any		Any	

Table 20. BOM (continued)

Ref.	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package-footprint	Manuf.	Manufacturer code	RS/distrelec/ other code	More info
C11	15 nF	10 %	50 V		X7R ceramic capacitor	SMD 0805	Any		Any	
C20	47 µF	10 %	16 V		Tantalum capacitor	SMD 6032-28	Any		RS: 407-0047	
C24, C25	82 µF	20 %	350 V		Aluminum electrolytic capacitor	Through hole 18 mm diameter, 7.5 mm lead spacing	Panasonic	EEUED2V820S	RS: 526-2247	
C26	33 nF X2	10 %	250 Vac		Chip Monolithic X2 ceramic capacitors	SMD 2220	Murata	GA355XR7GB333KY06L	Distrelec: 830079	
C27	1000 µF 16 V ZL	20 %	16 V		Low ESR electrolytic capacitor	Through hole 10 mm diameter, 5 mm lead spacing	Rubycon	16ZL1000M10X20	Distrelec: 801841	
C28	470 µF 16 V ZL	20 %	16 V		Low ESR electrolytic capacitor	Through hole 10 mm diameter, 5 mm lead spacing	Rubycon	16ZL470M10X12.5	Distrelec: 801839	
C29, C30, C38, C67, C68, C69, C70, C71, C77	100 nF	10 %	25 V		X7R ceramic capacitor	SMD 0805	Any		Any	
C31	3.3 µF	20 %	35 V		Aluminum electrolytic capacitor	Through hole	Any		Any	

Table 20. BOM (continued)

Ref.	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package-footprint	Manuf.	Manufacturer code	RS/distrelec/ other code	More info
C32	330 µF	20 %	16 V		Low ESR electrolytic capacitor	Through hole	Panasonic	EEUFC1C331	RS: 315-0451	
C33	100 uF 10 V ZL	20 %	16 V		Low ESR electrolytic capacitor	Through hole	Rubycon	16ZLH100M5x11	Distrelec: 801183	
C34	2.2 nF - Y1	20 %	250 Vac		Y1 Ceramic multi-layer capacitors	Through hole	Murata	DE1E3KX222MA5B	Farnell: 3531995	
C35	1 nF	5 %	50 V		COG ceramic capacitor	SMD 0805	Any		Any	
C36	470 nF	10 %	16 V		X7R ceramic capacitor	SMD 0805	Any		Any	
C37	4.7 nF	10 %	50 V		X7R ceramic capacitor	SMD 0805	Any		Any	
C39	4.7 µF	20 %	25 V		electrolytic capacitor	Through hole	Any		Any	
C40	15 pF	5 %	50 V		COG ceramic capacitor	SMD 0805	Any		Any	
C41	4.7 pF	5 %	50 V		COG ceramic capacitor	SMD 0805	Any		Any	
C44, C45	1 nF	10 %	25 V		X7R ceramic capacitor	SMD 0603	Any		Any	
C60, C61	10 pF	5 %	50 V		COG ceramic capacitor	SMD 0603	Any		Any	

Table 20. BOM (continued)

Ref.	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package-footprint	Manuf.	Manufacturer code	RS/distrelec/ other code	More info
C62, C63	22 pF	5 %	50 V		COG ceramic capacitor	SMD 0603	Any		Any	
C72, C90	4.7 µF	20 %	10 V		Y5V ceramic capacitor	SMD 0805	Murata	GRM21BF51A475ZA01L	Distrelec: 830046	Any
C76	4.7 nF	10 %	50 V		X7R ceramic capacitor	SMD 0805	Any		Any	
C84	470 nF	10 %	16 V		X7R ceramic capacitor	SMD 0805	Any		Any	
C86	10 µF	10 %	10 V		Tantalum capacitor	SMD 6032-28	Any		RS: 648-0575	
C91, C92	47 nF	10 %	50 V		X7R ceramic capacitor	SMD 0805	Any		Any	
DL1, D14	Green		20 mA		Green LED diode	SMD 0805	Kingbright	KP-2012MGC	RS: 466-3778	
DL2, D15	Yellow		20 mA		Yellow LED diode	SMD 0805	Kingbright	KP-2012SYC	RS: 466-3835	
D13	Red		20 mA		Red LED diode	SMD 0805	Kingbright	KP-2012SRC-PRV	RS: 466-3813	
DZ1	P6KE200A		200 V		Transil™ diode	Through hole DO-204AC	STMicroelectronics	P6KE200A		ST supply
D1	LL4148		100 V/150 mA		Small signal rectifier	SMD DO213AA	Any		RS: 652-7494	Any
D3, D5	STPS1L30A		30 V/1 A		Low drop power Schottky rectifier	SMD SMA/DO-214AC	STMicroelectronics	STPS1L30A		ST supply

Table 20. BOM (continued)

Ref.	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package-footprint	Manuf.	Manufacturer code	RS/distrelec/ other code	More info
D4	SM6T15CA				Transil diode	SMD SMB/DO-214AA	STMicroelectronics	SM6T15CA		ST supply
D6	SM6T6V8CA				Transil diode	SMD SMB/DO-214AA	STMicroelectronics	SM6T6V8CA		ST supply
D7, D9	SM4007		1000 V/1A		Standard rectifier diode	SMD melf/ DO-213AB	Any		RS: 505-4939	
D8	STPS2150		150 V/2 A		Power Schottky rectifier diode	SMD SMA/DO-214AC	STMicroelectronics	STPS2150A		ST supply
D10	STTH108		800 V/1 A		High voltage ultrafast rectifier	Through hole DO-41	STMicroelectronics	STTH108		ST supply
D11	STPS1150		150 V/1 A		Power Schottky rectifier diode	Through hole DO-41	STMicroelectronics	STPS1150		ST supply
D12	STPS1L60		60 V/1 A		Power Schottky rectifier diode	SMD SMA/DO-214AC	STMicroelectronics	STPS1L60A		ST supply
F1	2A FUSE		250 Vac/2 A		Fuse, time delay, 2A	Through hole radial 5mm lead spacing	Bussmann	BK/ETF 2A	Farnell:3029979	
FB1, FB2, FB3	BLM21PG331SN1		1500 mA		EMIFIL (Inductor type) chip Ferrite Bead, Impedance 330 ohm	SMD 0805	Murata	BLM21PG331SN1	Digi-Key: BLM21PG331SN1D-ND	

Table 20. BOM (continued)

Ref.	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package-footprint	Manuf.	Manufacturer code	RS/distrelec/ other code	More info
IC1	ST3232EBDR				RS-232 drivers and receivers	SMD SO-16	STMicroelectronics	ST3232EBDR		ST supply
IC2	TFDU4301				IrDA transceiver	SMD	Vishay semiconductor	TFDU4300-TR1	Farnell: 1469607	
JP11, JP12, JP13, JP14, JP15, JP17, JP18	CLOSE									There are no components mounted
JP4, JP5, JP6, JP7	CLOSE				2-way stripline connector	Through hole 2.54 mm pitch	Any		RS:251-8086	Mount with jumper: RS: 251-8503
JP8	OPEN				Not mounted	SMD				Not mounted
J2	CON6A				6-way 2 row vertical IDC box header	Through hole 2.54 mm pitch	Any		Distrelec: 121631	
J3	CON10AP				10-way 2 row vertical IDC box header	Through hole 2.54 mm pitch	Any		RS: 473-8254	
J8	VDD_12 V				2-way horizontal header, 5.08 mm pitch	Through hole 5 mm pitch	Tyco Electronics	282815-2	RS: 361-7544	2-way screw terminal RS: 361-7320

Table 20. BOM (continued)

Ref.	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package-footprint	Manuf.	Manufacturer code	RS/distrelec/ other code	More info
J9	MAINS_CON		250Vac / 2.5A		Flush-type device plug C8 Snap-in	Through hole	Schurter	4300.0099	Distrelec: 110275	Alternative: MULTICOMP, type:JR 201S
J10	CON10				Right-angled IDC boxed header, 10-way 2 row	Through hole 2.54 mm pitch 90°	Any		RS: 473-8349	
J11, J20	Jumper				2-way stripline connector	Through hole 2.54 mm pitch	Any		RS: 251-8086	
J12	LCD connector				Mount 2 connectors: 8-way (2x4) double row strip line socket	Through hole 2.54 mm pitch	Any		RS: 488-1730	
J15	JTAG				Right-angled IDC boxed header, 20-way 2 row	Through hole 2.54 mm pitch 90°	Any		RS: 473-8377	
J19	RTC_CAL				5-way stripline connector	Through hole 2.54 mm pitch	Any		RS: 251-8121	
J21	SC_CON - NOT FIT	Not mounted			7-way stripline connector	Through hole 2.54 mm pitch			Not mounted	
J22	CON3	Not mounted			3-way top entry socket (strip female)	Through hole 2.54 mm pitch	Any		RS: 488-1724	Not mounted

Table 20. BOM (continued)

Ref.	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package-footprint	Manuf.	Manufacturer code	RS/distrelec/ other code	More info
J23	CON2	Not mounted			2-way top entry socket (strip female)	Through hole 2.54 mm pitch	Any		RS: 488-1724	Not mounted
J24	ZigBee - CONN1	Not mounted			6-way top entry socket (strip female)	Through hole 2.54 mm pitch	Any		RS: 488-1724	Not mounted
J25	ZigBee - CONN2	Not mounted			6-way top entry socket (strip female)	Through hole 2.54 mm pitch	Any		RS: 488-1724	Not mounted
L1	15 µH	10 %	2.5 A		Power inductor	SMD 10x10mm body size	EPCOS	B82464A4153K	Farnell: 7429649	
L2	220 µH	10 %	240 mA		Power inductor	SMD 6x6 mm body size	EPCOS	B82462A4224K	RS: 495-8048	
L3	4.7 µH	20 %	2 A		Power inductor	SMD 6x6 mm body size	EPCOS	B82462G4472M	Farnell: 7430000	
L4	1 mH	10 %	120 mA		Inductor	SMD 2220	EPCOS	B82442H1105K	RS: 496-1347	
L5	BEAD		2 A		High current (2A) ferrite chip bead, impedance at 100 MHz: 600 ohm	SMD 0805	KEKITAGAWA	MLB-201209-0600PN	Distrelec: 330138	
NTC1, NTC2	16 Ω	20 %	2.9 A	2.1 W	NTC resistor	Through hole Disc 5 mm lead spacing	EPCOS	B57236S0160M000	Distrelec: 730576	

Table 20. BOM (continued)

Ref.	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package-footprint	Manuf.	Manufacturer code	RS/distrelec/ other code	More info
Q2	2N7002		60 V/0.2 A		STripFET™ Power MOSFET	SMD SOT23-3L	STMicroelectronics	2N7002		
R1	47 kΩ	1 %		0.1 W	Metal film resistor	SMD 0603	Any		Any	
R2, R3, R5, R6	10 kΩ	1 %		1 W	Professional MELF resistors	SMD MMB 0207	Vishay		Distrelec: 710082	
R4	120 Ω	1 %		0.1 W	Metal film resistor	SMD 0603	Any		Any	
R7	10 kΩ	1 %		0.1 W	Metal film resistor	SMD 0603	Any		Any	
R8	39 kΩ	1 %		0.1 W	Metal film resistor	SMD 0603	Any		Any	
R9	330 Ω	1 %		0.1 W	Metal film resistor	SMD 0603	Any		Any	
R11, R18	47 kΩ	1 %		0.1 W	Metal film resistor	SMD 0603	Any		Any	
R12	1 kΩ	1 %		0.1 W	Metal film resistor	SMD 0603	Any		Any	
R13	5.1 kΩ	1 %		0.1 W	Metal film resistor	SMD 0603	Any		Any	
R14	24 kΩ	1 %		0.1 W	Metal film resistor	SMD 0603	Any		Any	
R17	150 Ω	1 %		0.1 W	Metal film resistor	SMD 0603	Any		Any	

Table 20. BOM (continued)

Ref.	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package-footprint	Manuf.	Manufacturer code	RS/distrelec/ other code	More info
R10, R15, R19, R20, R21, R23, R24, R25, R26, R27, R28, R29, R30, R31, R32, R33, R34, R58, R90, R71, R72, R73, R74, R88, R89	4.7 kΩ	1 %		0.1 W	Metal film resistor	SMD 0603	Any		Any	
R22, R61	1 kΩ	1 %		0.1 W	Metal film resistor	SMD 0603	Any		Any	
R35, R37	6.8 MΩ	5 %		0.25 W	Metal film resistor	SMD 1206	Any		Any	
R36	2.5 kΩ	5 %		0.25 W	Metal film resistor	SMD 1206	Any		Any	
R38	33 kΩ	1 %		0.25 W	Metal film resistor	SMD 1206	Any		Any	
R39	10 Ω	5 %		0.25 W	Metal film resistor	SMD 1206	Any		Any	
R40	Not mounted			0.25 W	Metal film resistor	SMD 1206				
R41	10 kΩ	1 %		0.25 W	Metal film resistor	SMD 1206	Any		Any	
R42	75 kΩ	1 %		0.25 W	Metal film resistor	SMD 1206	Any		Any	
R43	15 Ω	1 %		0.25 W	Mini-MELF resistors	SMD 1206	Any	Vishay	Distrelec:713030	

Table 20. BOM (continued)

Ref.	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package-footprint	Manuf.	Manufacturer code	RS/distrelec/ other code	More info
R44	1.2 Ω	1 %		0.25 W	Mini-MELF resistors	SMD 1206	Any	Vishay	Distrelec: 713004	
R45	8.2 kΩ	1 %		0.25 W	Metal film resistor	SMD 1206	Any		Any	
R46	1.5 kΩ	5 %		0.25 W	Metal film resistor	SMD 1206	Any		Any	
R47	330 Ω	5 %		0.25 W	Metal film resistor	SMD 1206	Any		Any	
R48, R49, R50, R51, R53, R54, R55, R57, R75	10 kΩ	1 %		0.1 W	Metal film resistor	SMD 0603	Any		Any	
R52	Not mounted					SMD 0603				Not mounted
R56	1 MΩ	1 %		0.1 W	Metal film resistor	SMD 0603	Any		Any	
R59, R60, R80, R81, R82, R83, R84, R85, R86, R87, R91	0	1 %		0.1 W	Metal film resistor	SMD 0603	Any		Any	
R62, R63	0 - not fit					SMD 0603				Not mounted
R64	5 Ω	1 %		0.1 W	Metal film resistor	SMD 0603	Any		Any	

Table 20. BOM (continued)

Ref.	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package-footprint	Manuf.	Manufacturer code	RS/distrelec/ other code	More info
R65	47 Ω	1 %		0.1 W	Metal film resistor	SMD 0603	Any		Any	
R66, R67	22 Ω	1 %		0.125 W	Metal film resistor	SMD 0805	Any		Any	
R68	1 MΩ	5 %		0.125 W	Metal film resistor	SMD 0805	Any		Any	
R69	1.5 kΩ	5 %		0.125 W	Metal film resistor	SMD 0805	Any		Any	
R70	100 Ω	1 %		0.1 W	Metal film resistor	SMD 0603	Any		Any	
R76, R77, R78	300 Ω	5 %		0.125 W	Metal film resistor	SMD 0805	Any		Any	
R79	47 Ω	1 %		0.1 W	Metal film resistor	SMD 0603	Any		Any	
RV1	S14K510	10 %	510 Vac		Disk-shaped metal-oxide varistor	Through hole	Epcos	B72214S0511K 101	Distrelec: 730933	
SW1, SW4, S1	ST7580 reset				Tactile switch 100gf	Through hole 6X6 mm 5 mm height	Any		RS:378-6410	
SW3	E0				3-way stripline connector	Through hole 2.54 mm pitch	Any		RS: 251-8092	
SW5	E1				3-way stripline connector	Through hole 2.54 mm pitch	Any		RS: 251-8092	
SW6	E2				3-way stripline connector	Through hole 2.54 mm pitch	Any		RS: 251-8092	

Table 20. BOM (continued)

Ref.	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package-footprint	Manuf.	Manufacturer code	RS/distrelec/ other code	More info
SW7	BOOT0				3-way stripline connector	Through hole 2.54 mm pitch	Any		RS: 251-8092	
SW9	BOOT1				3-way stripline connector	Through hole 2.54 mm pitch	Any		RS: 251-8092	
SW10, SW12, SW16, SW17, SW18	Switch				3-way stripline connector	Through hole 2.54 mm pitch	Any		RS: 251-8092	
SW11, SW13, SW14, SW15, SW19, SW20, SW21, SW22, SW23	Jumper				3-way stripline connector	Through hole 2.54 mm pitch	Any		RS: 251-8092	
TP1	CL				Loop terminal assembly, 1 mm hole	Through hole			RS: 101-2391	Test point
TP2	ZC_IN				Loop terminal assembly, 1 mm hole	Through hole			RS: 101-2391	
TP3	PA_IN-				Loop terminal assembly, 1 mm hole	Through hole			RS: 101-2391	

Table 20. BOM (continued)

Ref.	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package-footprint	Manuf.	Manufacturer code	RS/distrelec/ other code	More info
TP4	PA_IN+				Loop terminal assembly, 1 mm hole	Through hole			RS: 101-2391	
TP5	TX_OUT				Loop terminal assembly, 1 mm hole	Through hole			RS: 101-2391	
TP6	PA_OUT				Loop terminal assembly, 1 mm hole	Through hole			RS: 101-2391	
TP7	VDDIO				Loop terminal assembly, 1 mm hole	Through hole			RS: 101-2391	
TP8	VDD				Loop terminal assembly, 1 mm hole	Through hole			RS: 101-2391	
TP9	VDD_PLL				Loop terminal assembly, 1 mm hole	Through hole			RS: 101-2391	
TP10	VCC				Loop terminal assembly,1 mm hole	Through hole			RS: 101-2391	
TP11	VCCA				Loop terminal assembly,1 mm hole	Through hole			RS: 101-2391	

Table 20. BOM (continued)

Ref.	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package-footprint	Manuf.	Manufacturer code	RS/distrelec/ other code	More info
TP12	RX_IN				Loop terminal assembly, 1 mm hole	Through hole			RS: 101-2391	
T1	VAC 5024X044				Signal-Transformer	SMD	VAC Vacuumschmelze	T60403-K5024-X044		
T2	TDK - REV.C			6 W	General Transformers	Through hole	TDK	SRW16ES		ST supply
U1	ST7580				FSK, N-PSK multi-mode power line networking system-on-chip	SMD QFN-48	STMicroelectronics	ST7580		ST supply
U2	M25P10-A				1 Mbit, serial Flash memory, 50 MHz SPI bus interface	SMD SO8	Numonix	M25P10-AVMN6P	RS: 608-5647	
U3	LF33AB		3.3 V		Very low drop voltage regulators with inhibit	SMD DPAK	STMicroelectronics	LF33ABDT-TR		ST supply
U4	Altair04-900									ST supply
U5	STM32F103 VET6				32-bit MCU	SMD LQFP100	STMicroelectronics	STM32F103VET 6		ST supply

Table 20. BOM (continued)

Ref.	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package-footprint	Manuf.	Manufacturer code	RS/distrelec/ other code	More info
U6	M24128-BWMN6P				128 Kbit, 64 Kbit and 32 Kbit serial I²C bus EEPROM	SMD SO8	STMicroelectronics	M24128-BWMN6TP		ST supply
U7	USBLC6-2P6 - NOT FIT			Very low capacitance ESD protection	SMD SOT-666	ST	USBLC6-2P6	Not mounted	ST supply	
U8	MT008-A				Joystick					ST supply
U9	TSM0505S	10 %	5 V/5 V 200 mA		DC-DC converter	SMD SOIC-14			RS: 510-5431	
U10	IL712S-1E		2500 Vrms		Bi-directional Digi Isolator	SMD MSOP-8	NVE	IL712S-1E	RS: 418-436	
V1	Battery holder				PCB mount coin cell holder,12 mm	Through hole	Keystone	500	RS: 430-653	CR1220 lithium coin cell (RS: 597-172)
Y1,Y3	8 MHz	30 ppm			8 MHz crystal	Through hole HC49S	Any		RS: 672-0268	

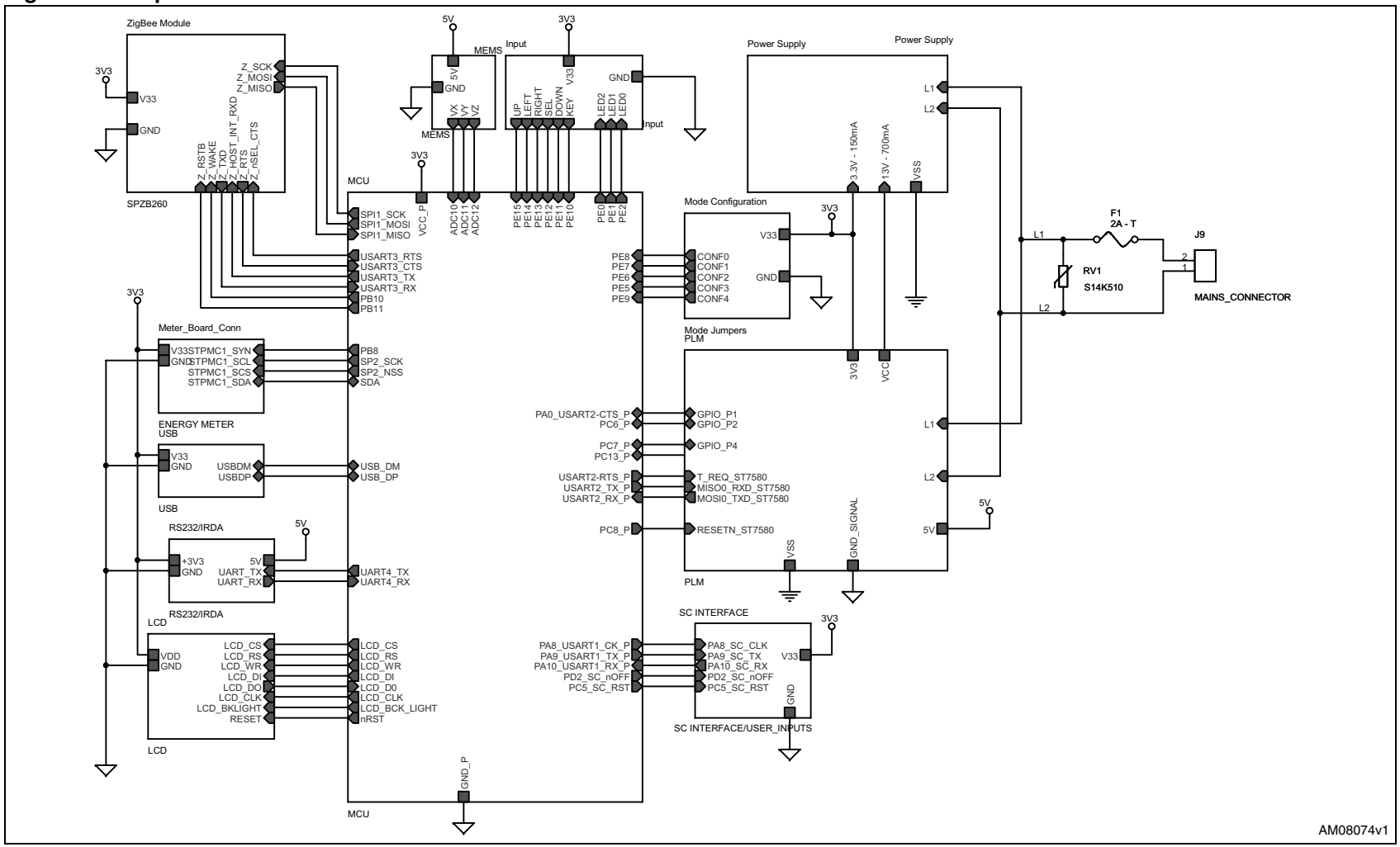
Table 20. BOM (continued)

Ref.	Part / value	Tolerance %	Voltage current	WATT	Technology information	Package-footprint	Manuf.	Manufacturer code	RS/distrelec/ other code	More info
Y2	32.768 Khz	20 ppm			32.768 kHz crystal		Any		RS: 547-6979	Mount this crystal in horizontal position
ISO1	TLP 421				Optocoupler	Through hole DIP4	Toshiba	TLP 421	Distrelec: 631515	
Spacer					5 mm metal spacer with inner and outer threads	Through hole	Any		Distrelec: 341130	
Spacer					35 mm metal spacer with RH and LH internal threads	Through hole	Any		Distrelec: 341077	
Washers					Washer M3		Any		RS: 189-620	
Nuts					Nut M3		Any		RS: 483-0502	

6 Schematics

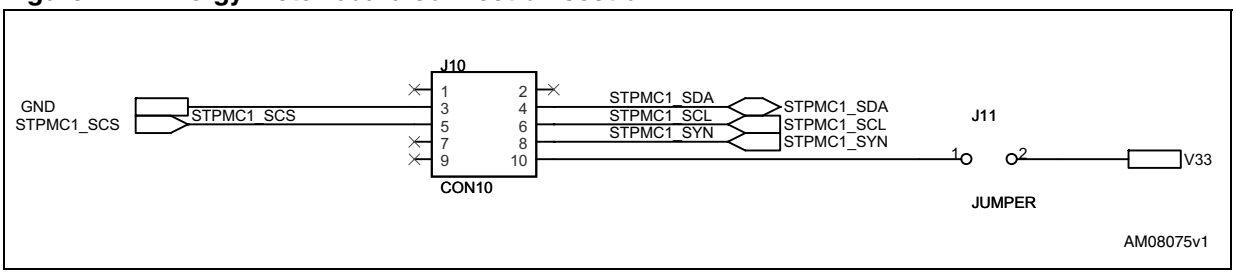
6.1 Top page

Figure 11. Top



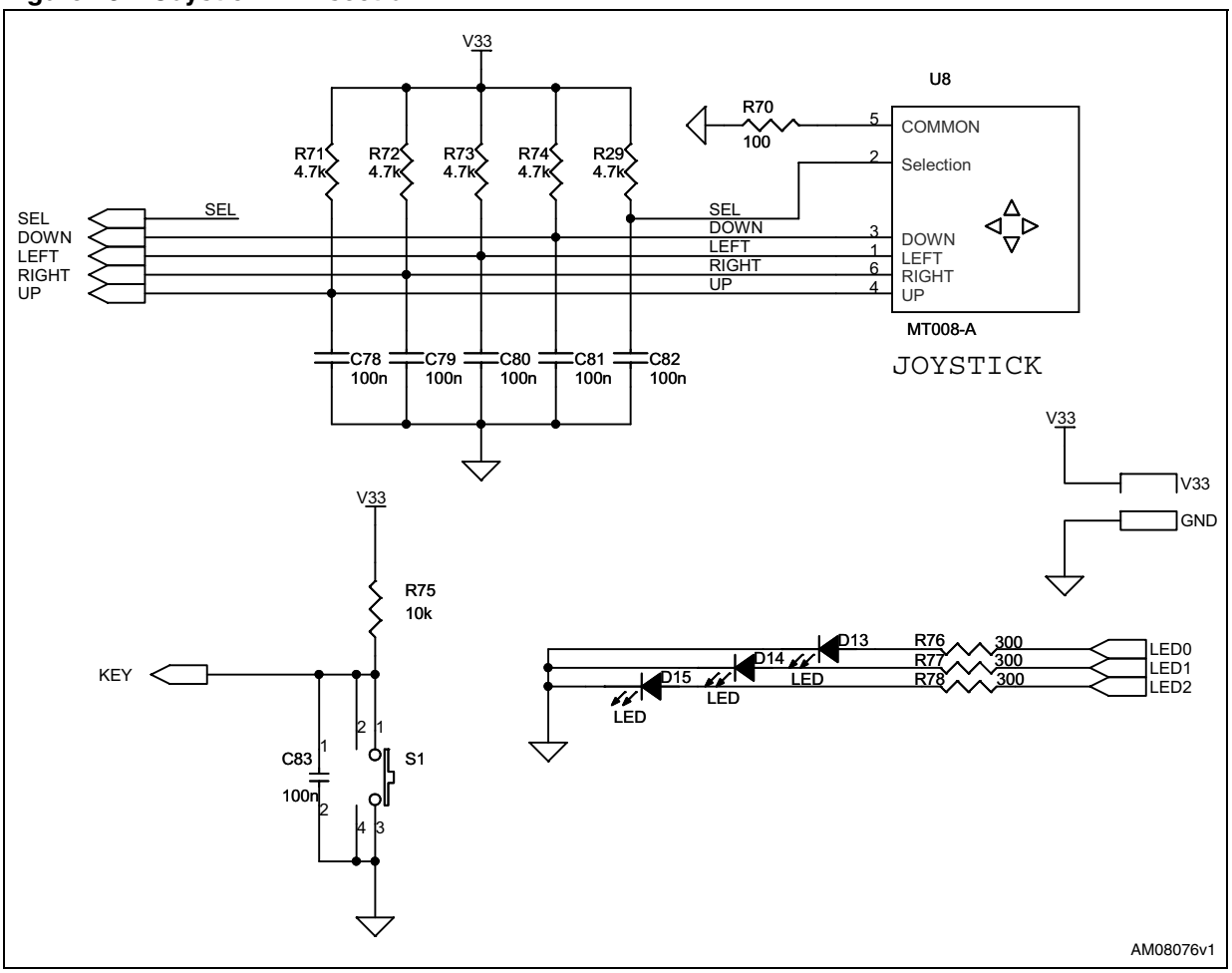
6.2 Metrology board connector

Figure 12. Energy meter board connection section



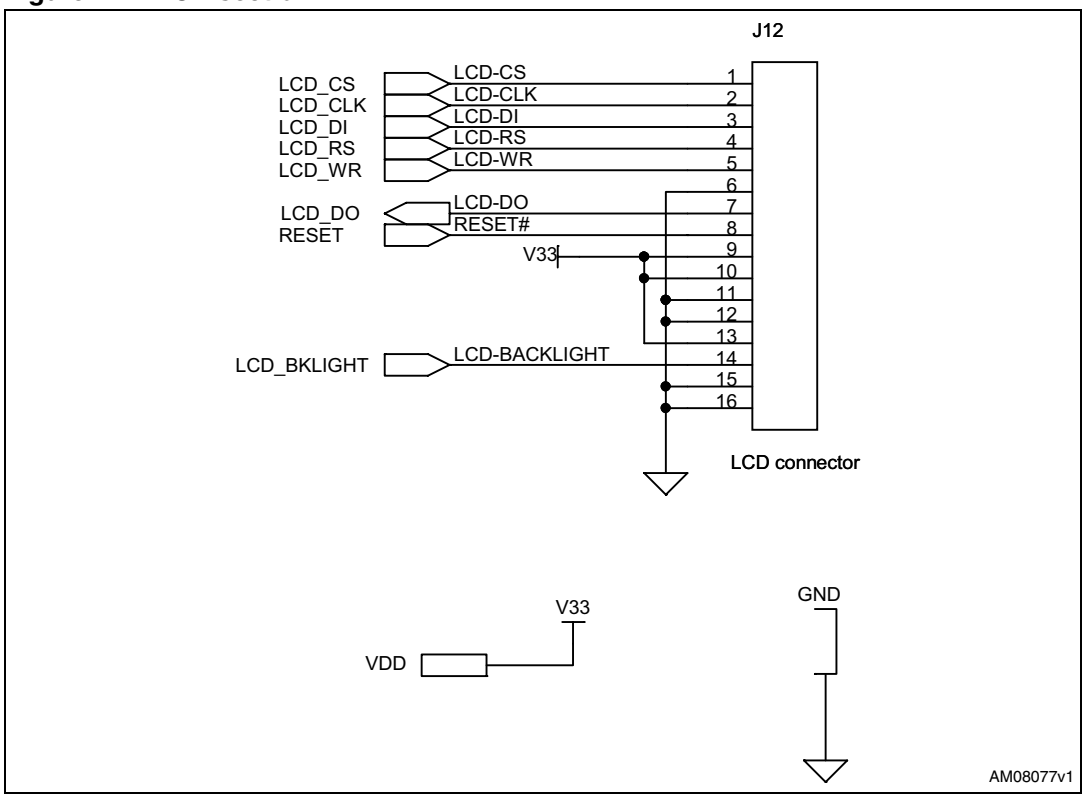
6.3 User interface

Figure 13. Joystick LED section



6.4 LCD connector

Figure 14. LCD section



6.5 MCU

Figure 15. MCU schematic page

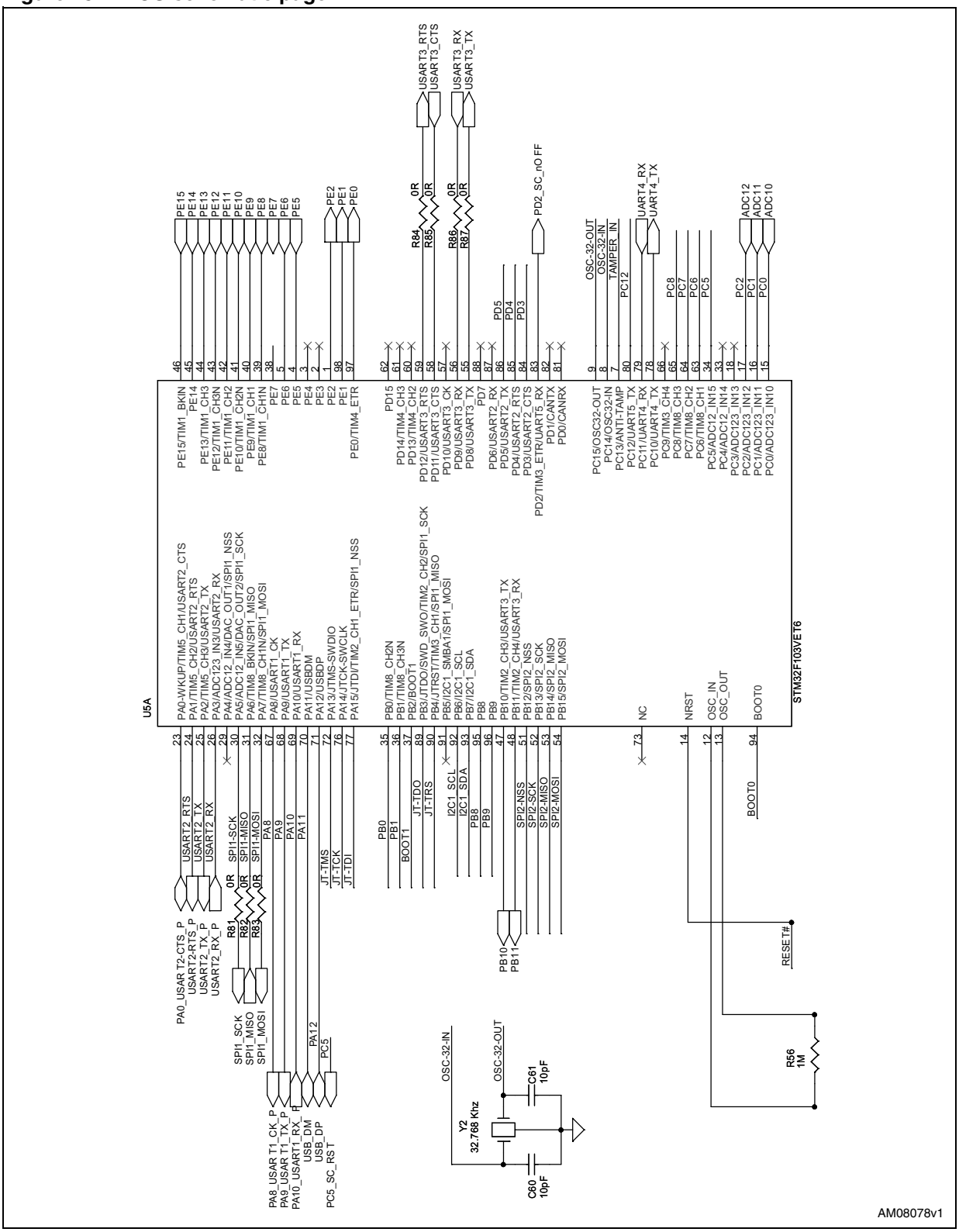


Figure 16. MCU power supply schematic page

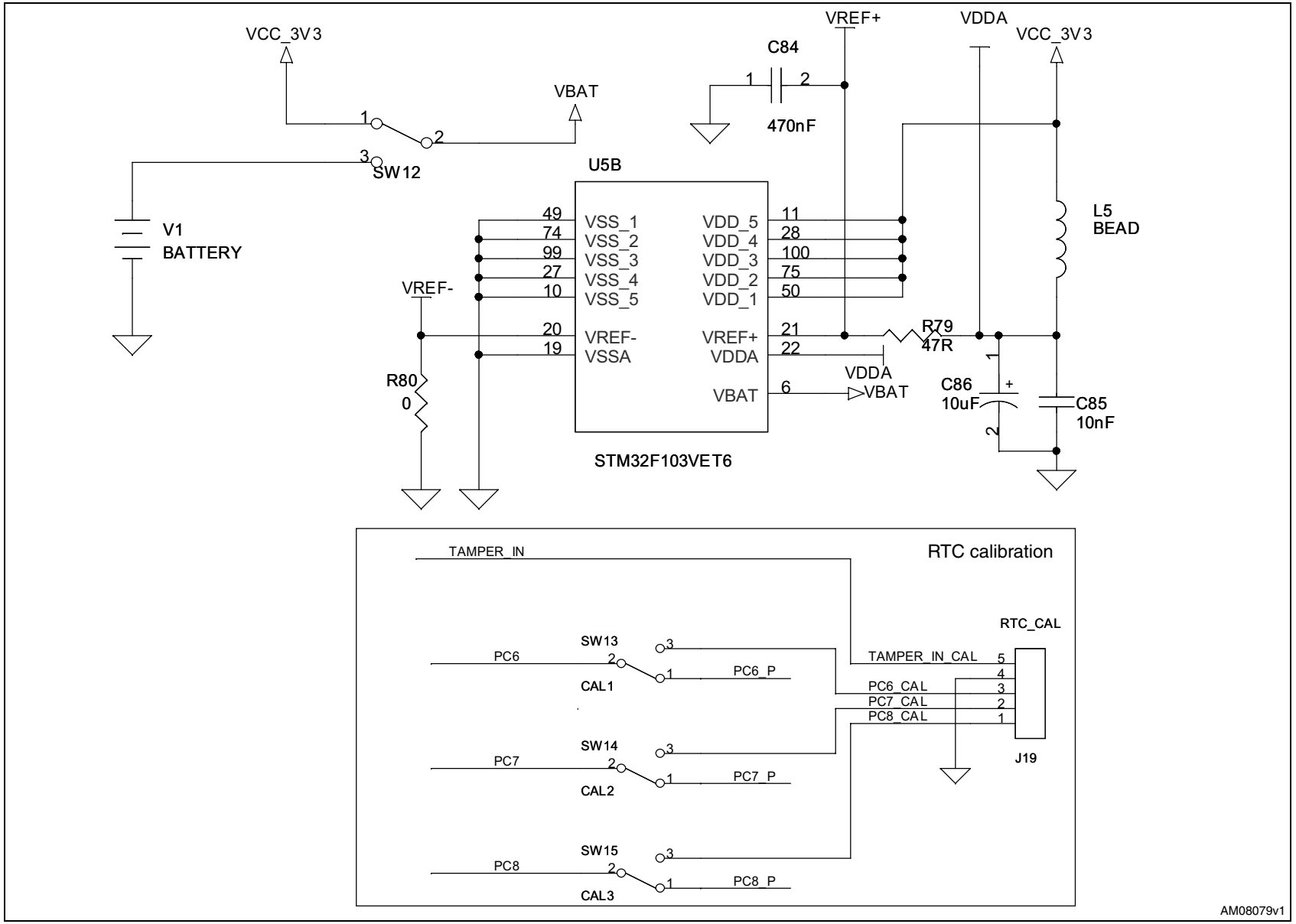


Figure 17. LCD and energy meter IC interfaces options jumpers schematic page

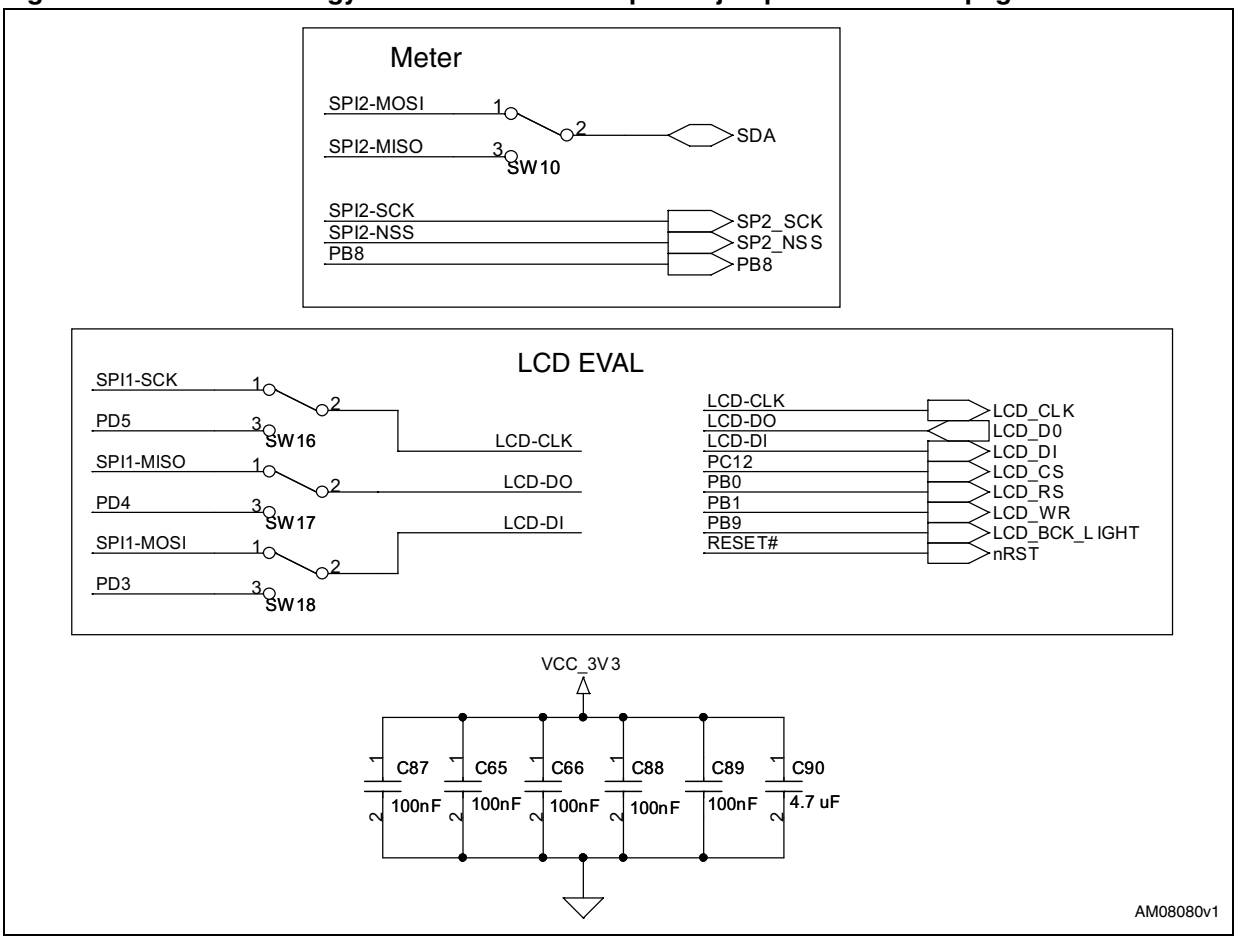
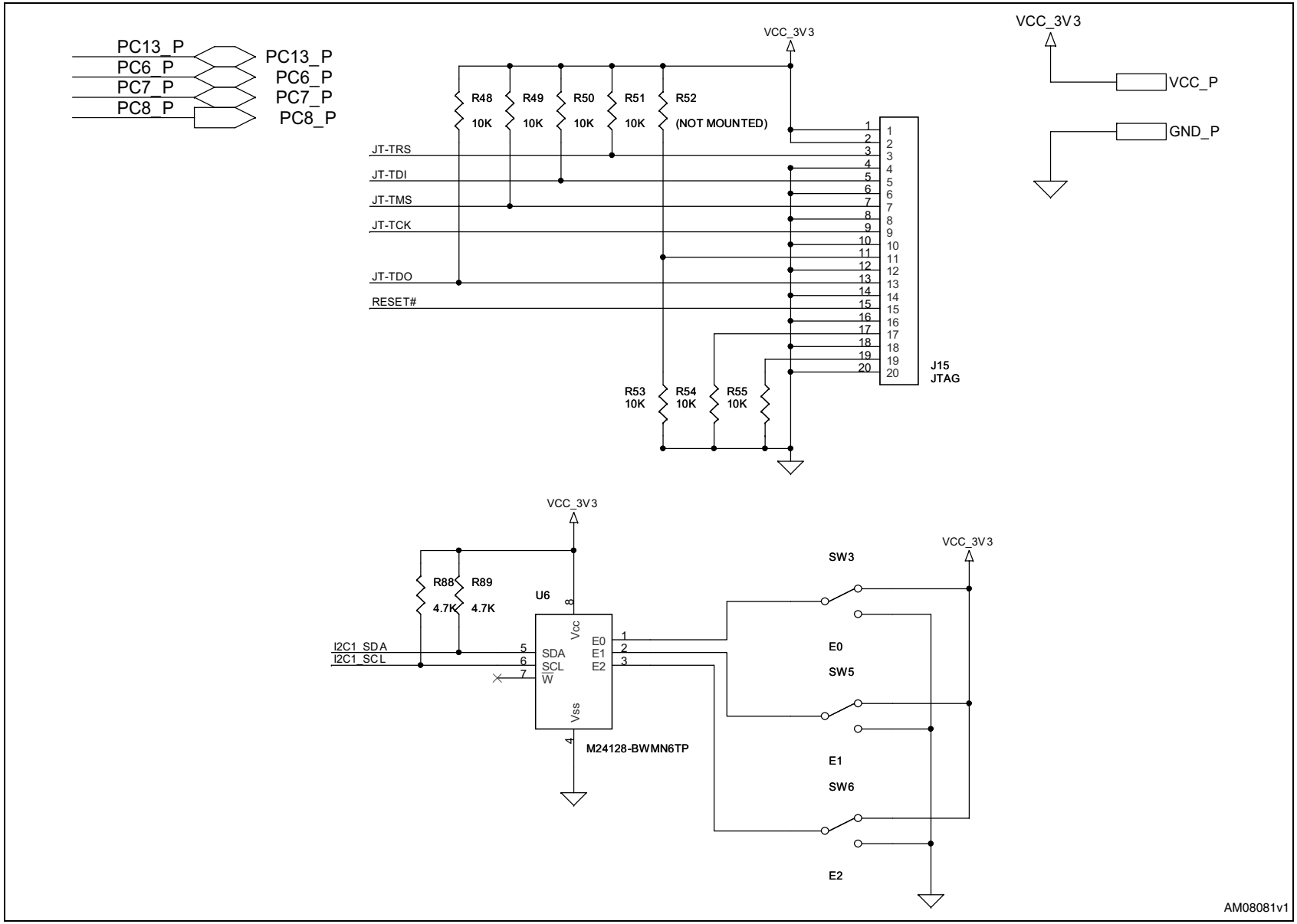
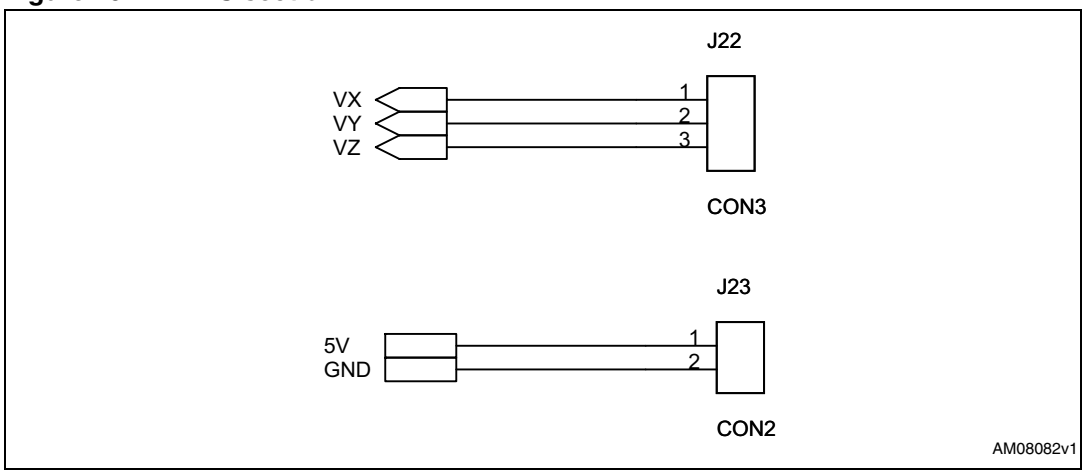


Figure 18. MCU JTAG and EEPROM schematic page



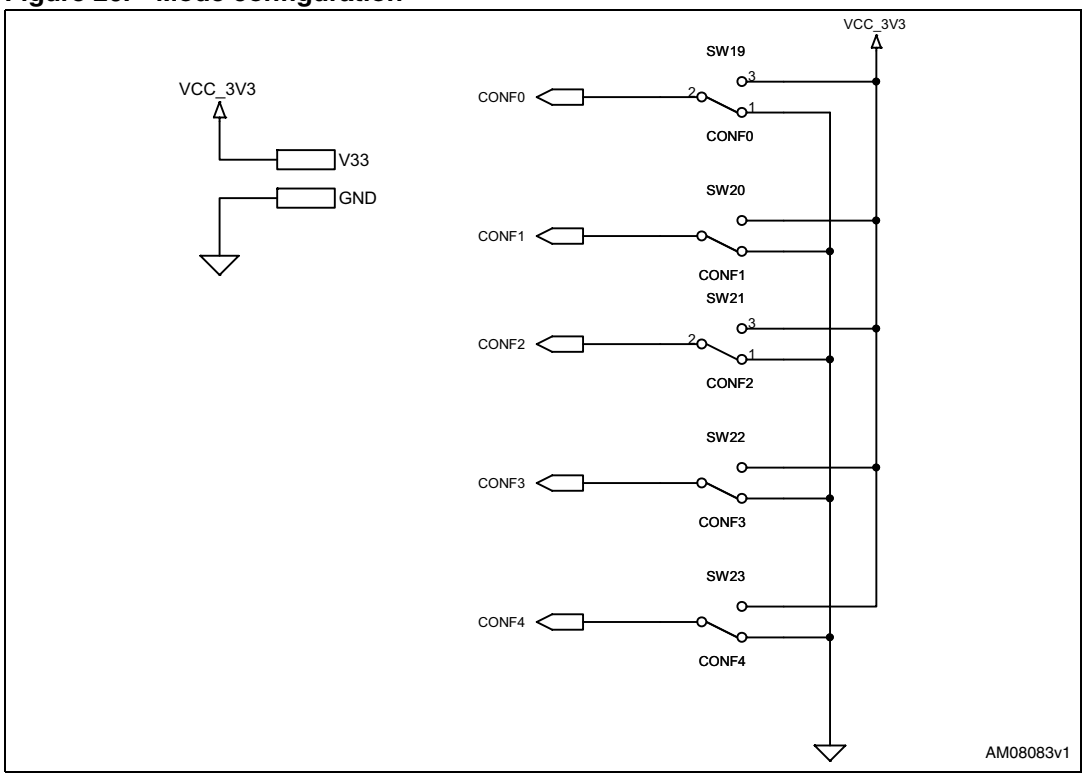
6.6 MEMS module connector

Figure 19. MEMS section



6.7 General purpose configuration jumpers

Figure 20. Mode configuration



6.8 Power line modem

Figure 21. System JTAG connector, ST7580 UART interface and 8051 program Flash memory

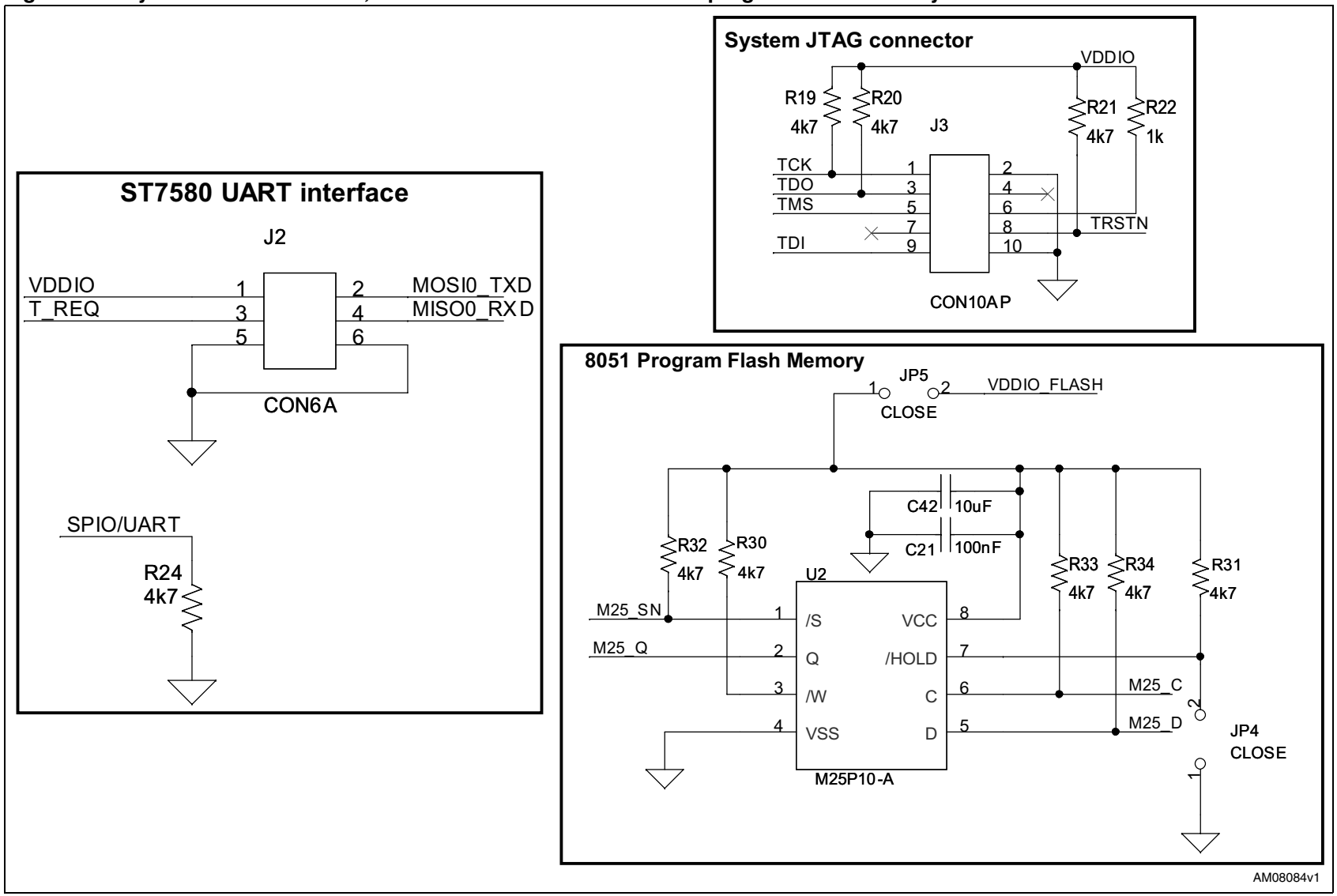


Figure 22. ST7580 schematic page

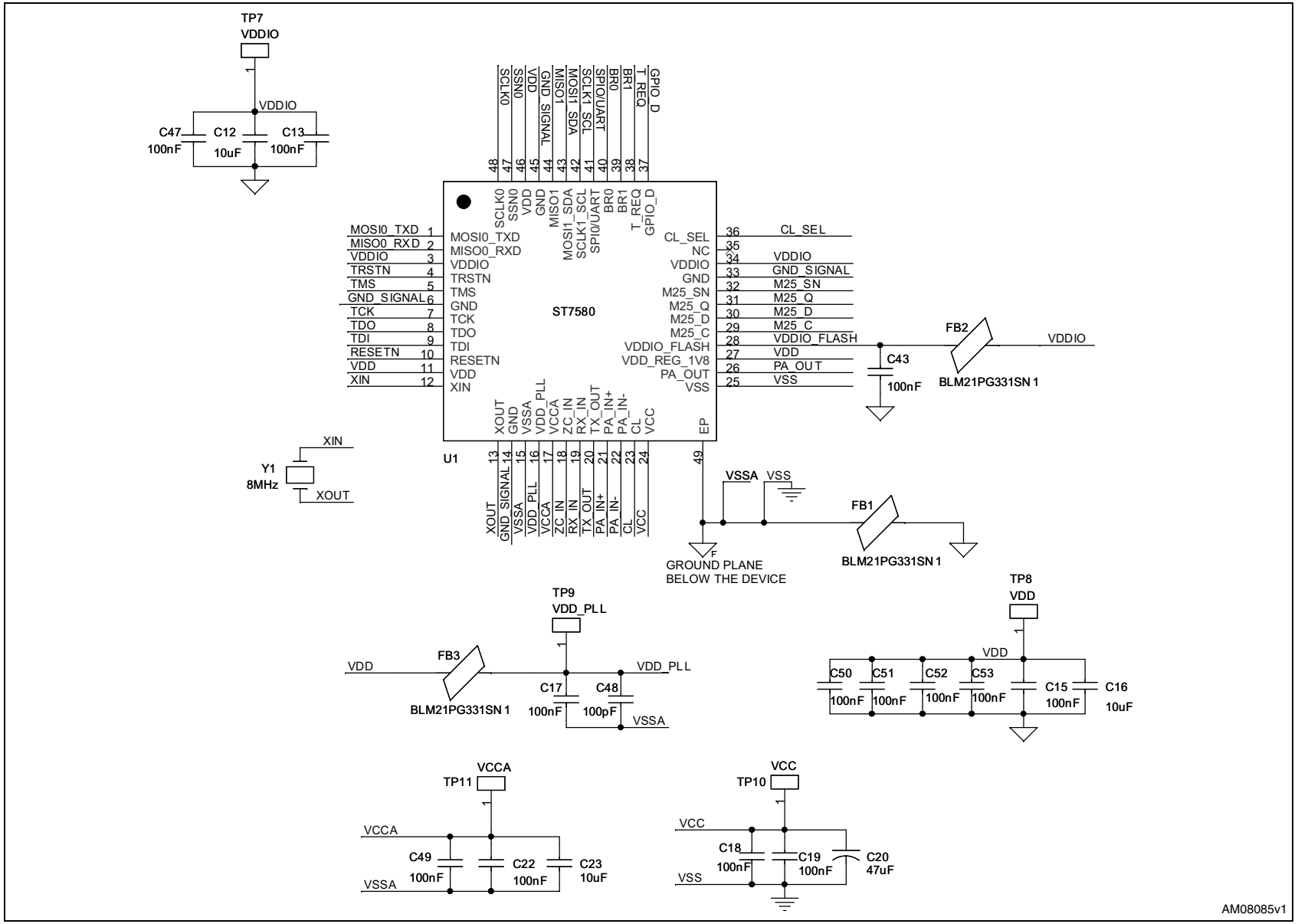


Figure 23. ST7580 reset, host interface, and current limit schematic page

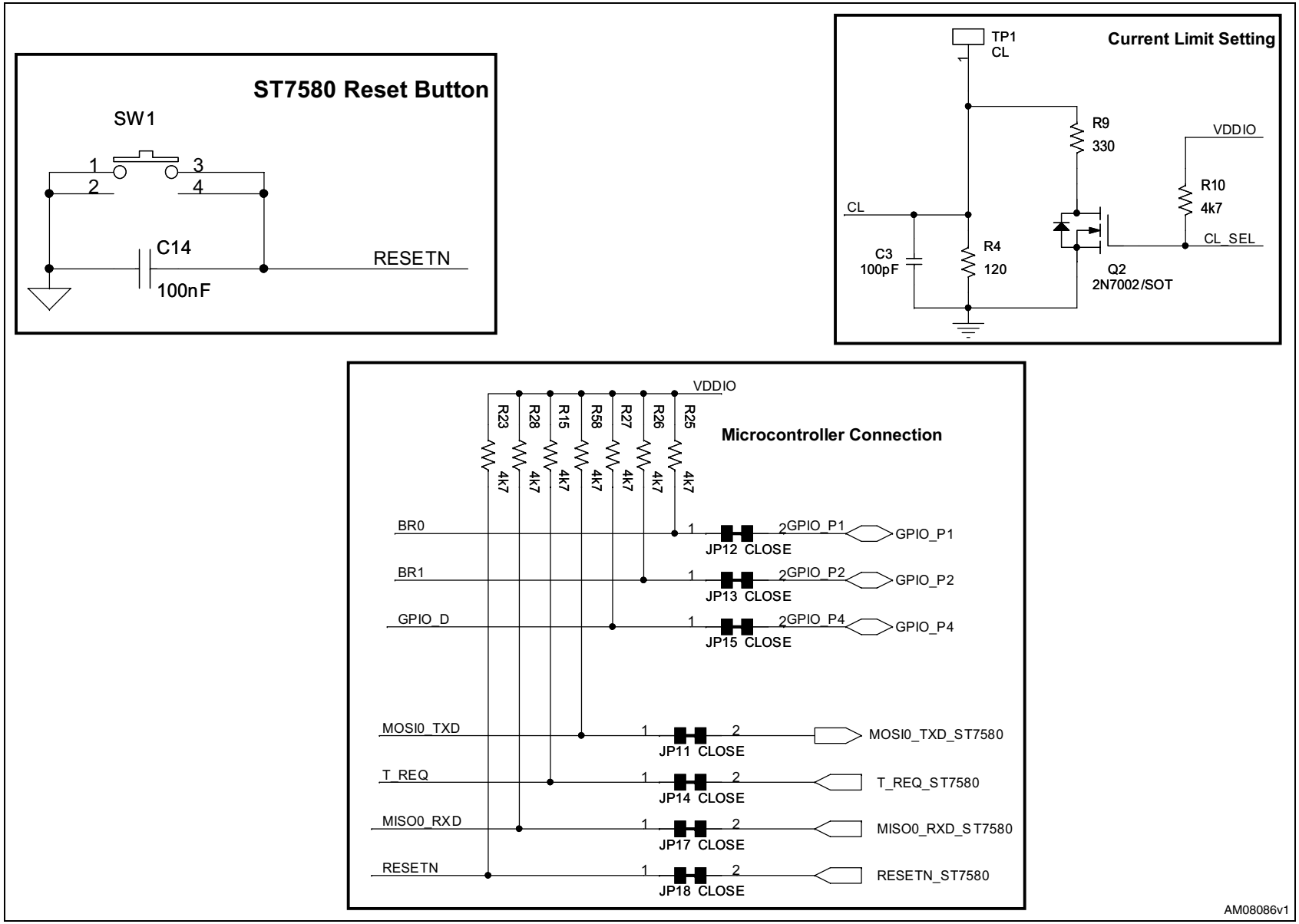
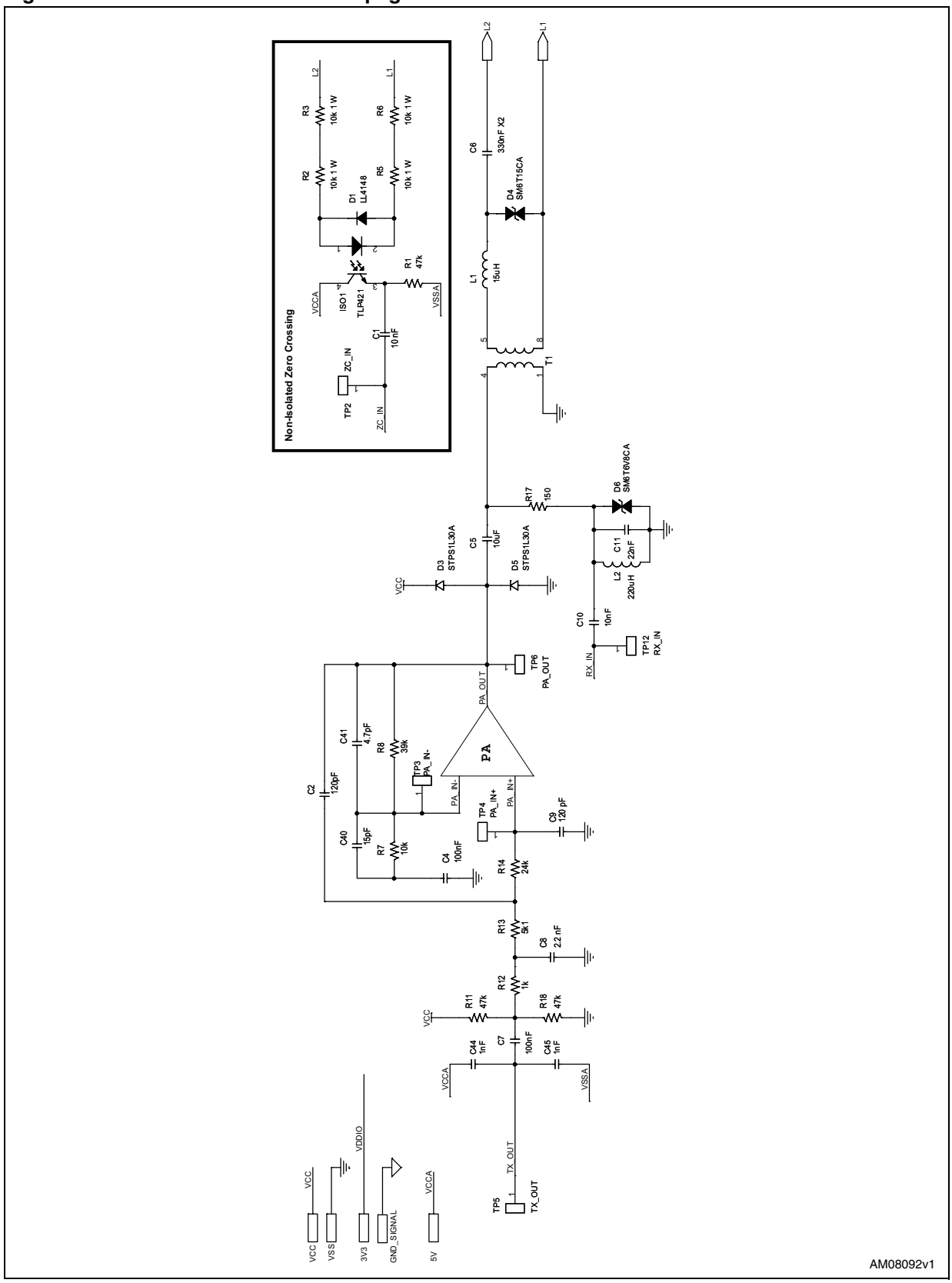


Figure 24. ST7580 filters schematic page



6.9 Power supply

Figure 25. Power supply

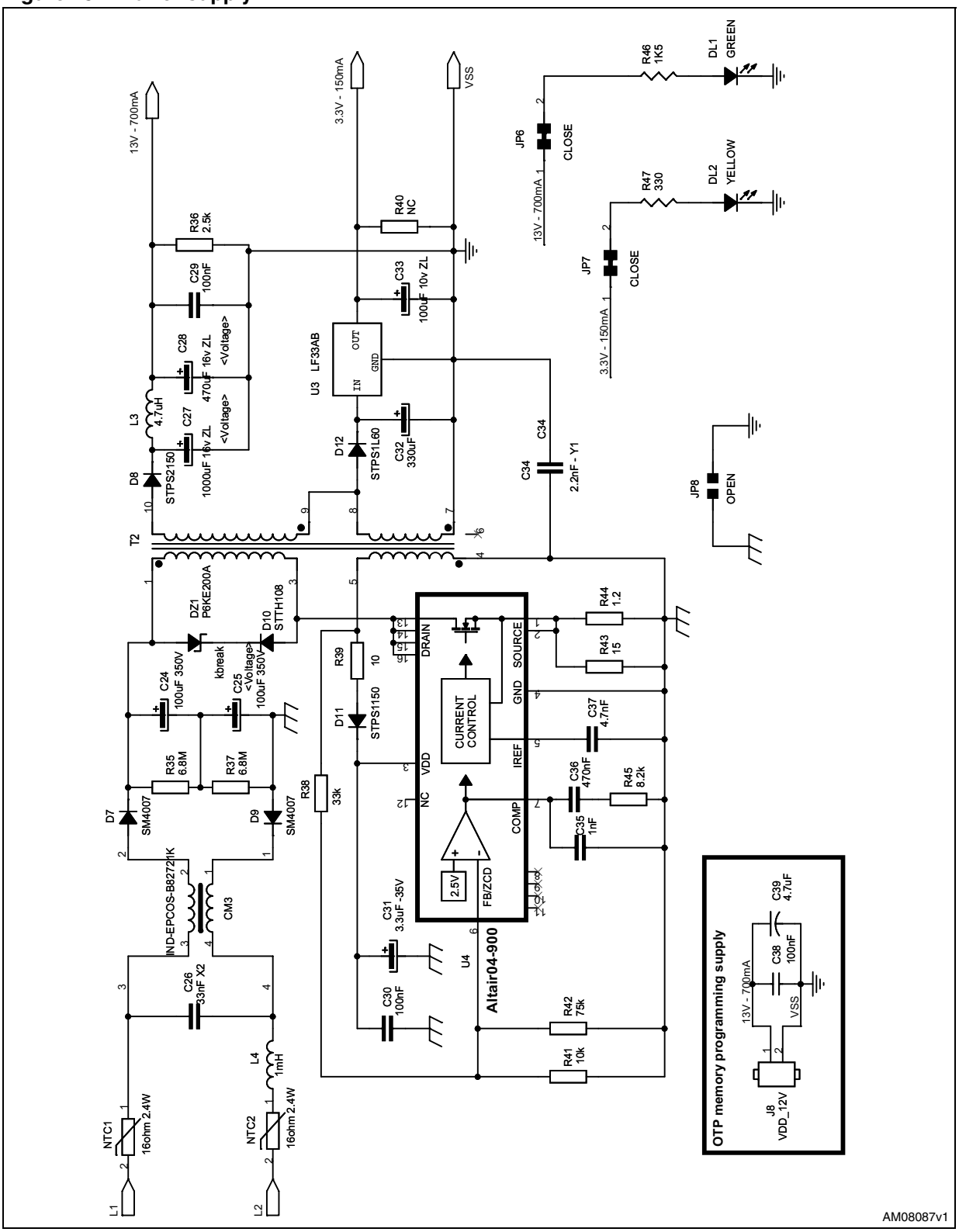


Figure 26. Power supply - RS232/IRDA

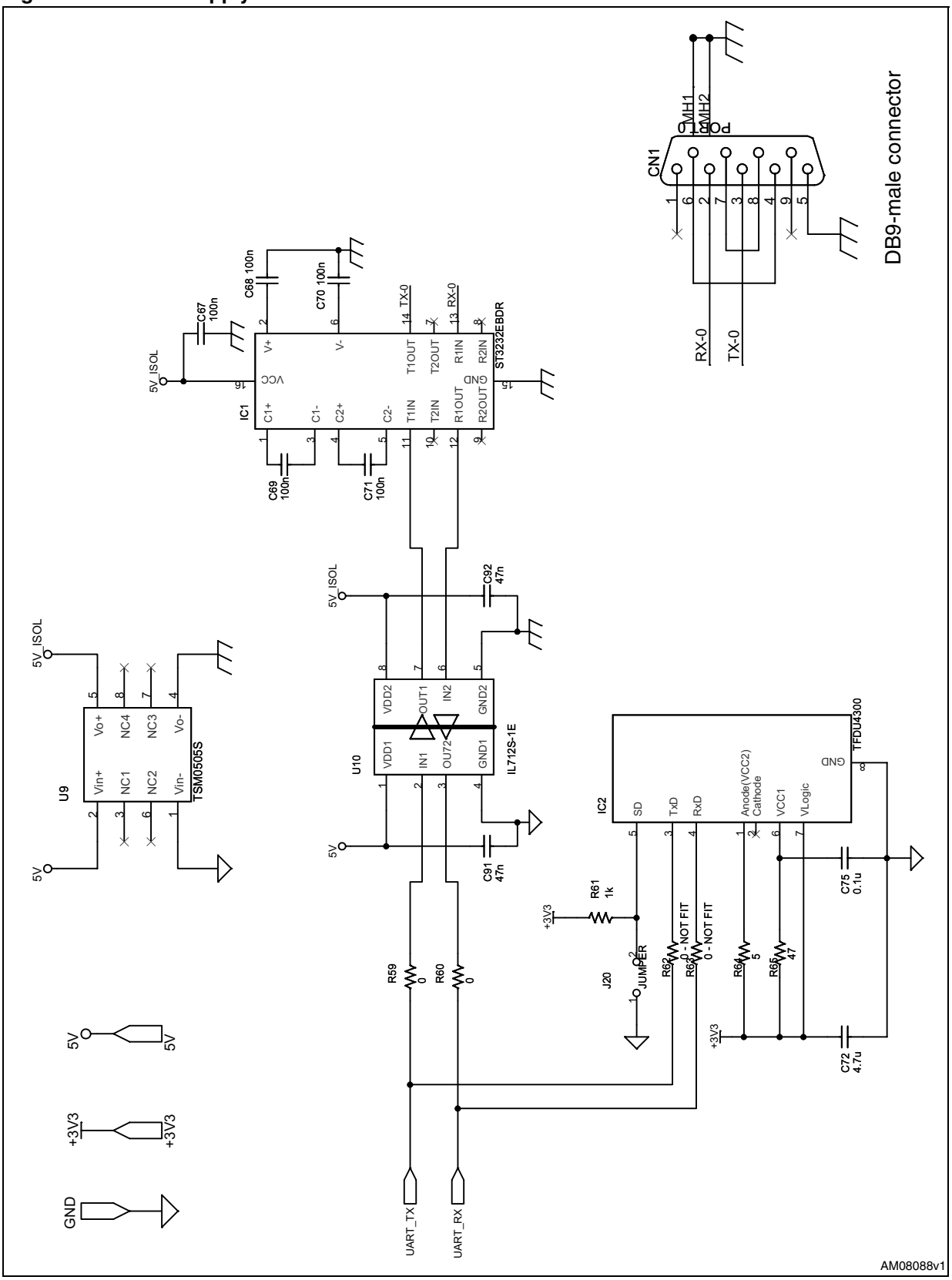
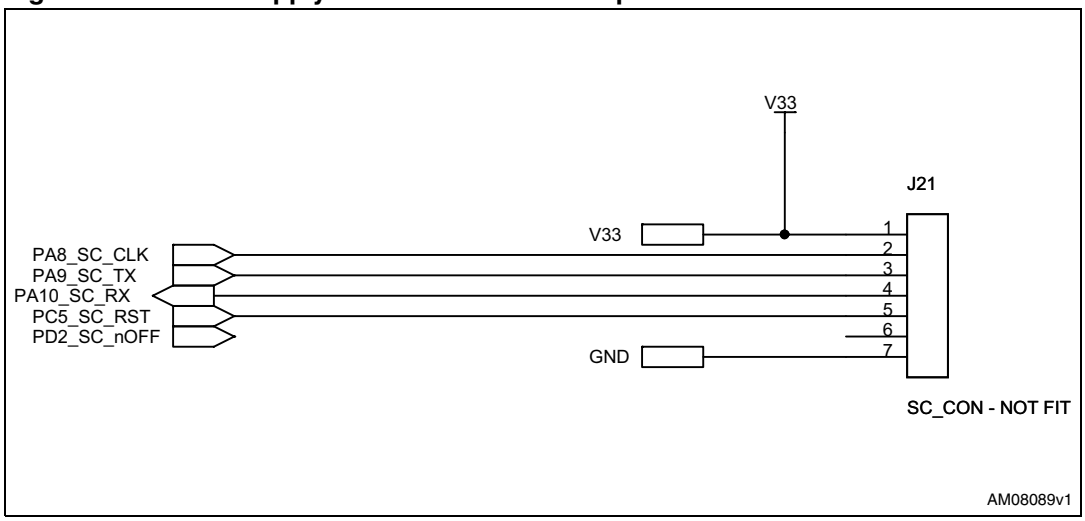
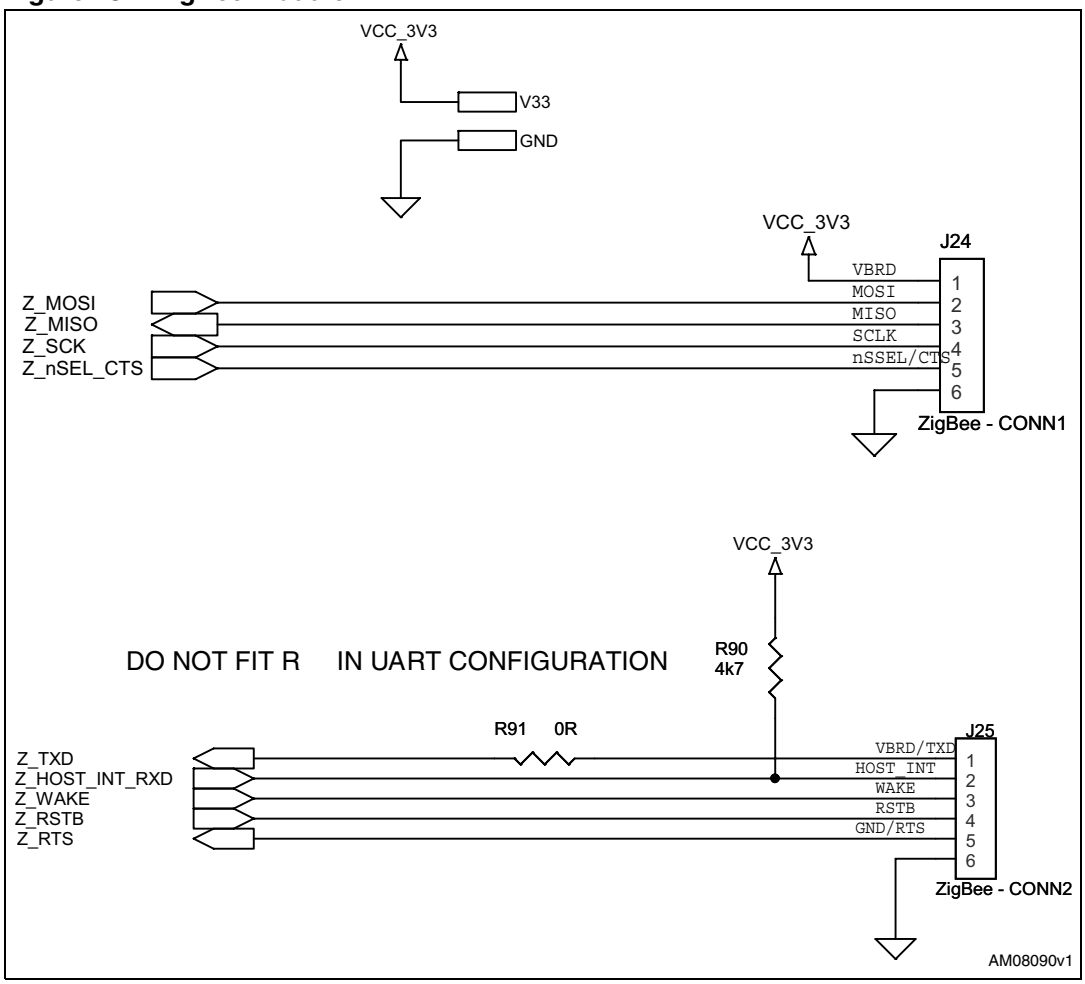


Figure 27. Power supply - SC interface / user inputs



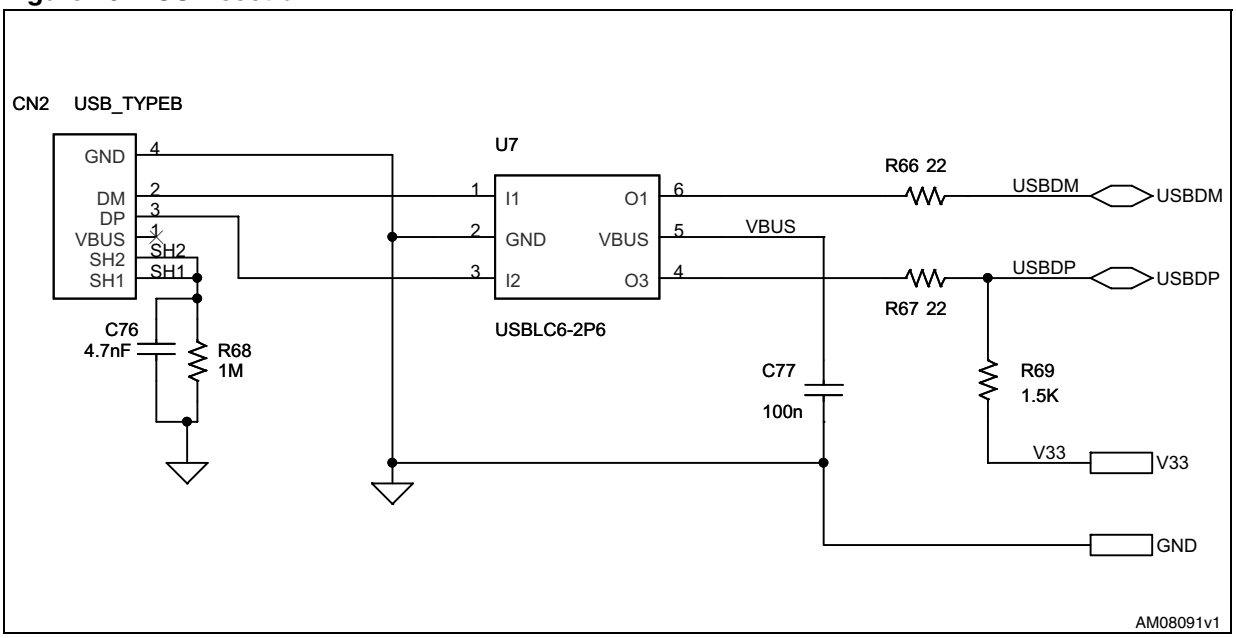
6.10 ZigBee module connector

Figure 28. ZigBee module



6.11 USB connector

Figure 29. USB section



7 Revision history

Table 21. Document revision history

Date	Revision	Changes
11-Nov-2010	1	Initial release.

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