User's Manual

Promotion Kit S5D9 (PK-S5D9)

User's Manual

Renesas Synergy™ Platform
Synergy Tools & Kits
Kits: PK-S5D9 v1.0

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The product generates, uses, and can radiate radio frequency energy and may cause harmful interference to radio communications. - There is no guarantee that interference will not occur in a particular installation. If this equipment causes harmful interference to radio or television reception, which can be determined by turning the equipment off or on, you are encouraged to try to correct the interference by one or more of the following measures:

• Ensure attached cables do not lie across the equipment.

• Reorient the receiving antenna.

• Increase the distance between the equipment and the receiver.

• Connect the equipment into an outlet on a circuit different from that which the receiver is connected.

• Power down the equipment when not in use.

• Consult the dealer or an experienced radio/TV technician for help.

Note: It is recommended that wherever possible shielded interface cables are used.

The product is potentially susceptible to certain EMC phenomena. To mitigate against them it is recommended that the following measures be undertaken:

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• The user is advised to take ESD precautions when handling the equipment.

The Renesas Synergy™ Promotion Kit does not represent an ideal reference design for an end product and does not fulfill the regulatory standards for an end product.

1. Overview

1.1 Features

The PK-S5D9 is a single-board kit for the Renesas Synergy S5D9 Group Microcontrollers (MCUs), with a 176-pin LQFP package. The board provides easy-to-access interfaces to the peripherals of the S5D9 Group MCUs for application development.

The PK-S5D9 includes four header connectors for direct access to the I/O pins in the MCU, and connectors for USB, Ethernet, RS-232/485, and CAN.

The PK-S5D9 incorporates a 2.4-in. QVGA (240 x 320) TFT display with capacitive touch screen.

As a promotion kit, the PK-S5D9 is designed to demonstrate the main features of the Synergy Platform using the S5D9 Group MCUs. This is an initial evaluation platform that you can use to determine which kit is appropriate for further development of your product.

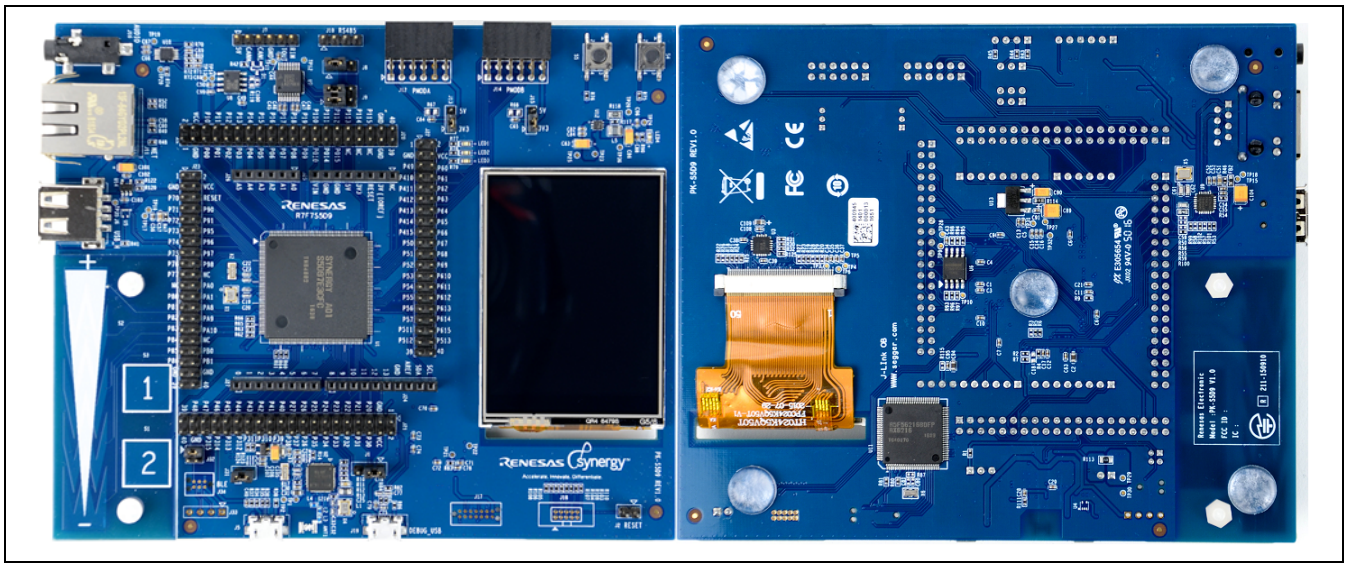

Figure 1.1 PK-S5D9 board

1.2 In the Box

The following components are included in the PK-S5D9:

- PK-S5D9 board
- 3-foot USB Type-A to Micro-B cable for debugger and power connection
- Quick Start Guide.

1.3 Block Diagram

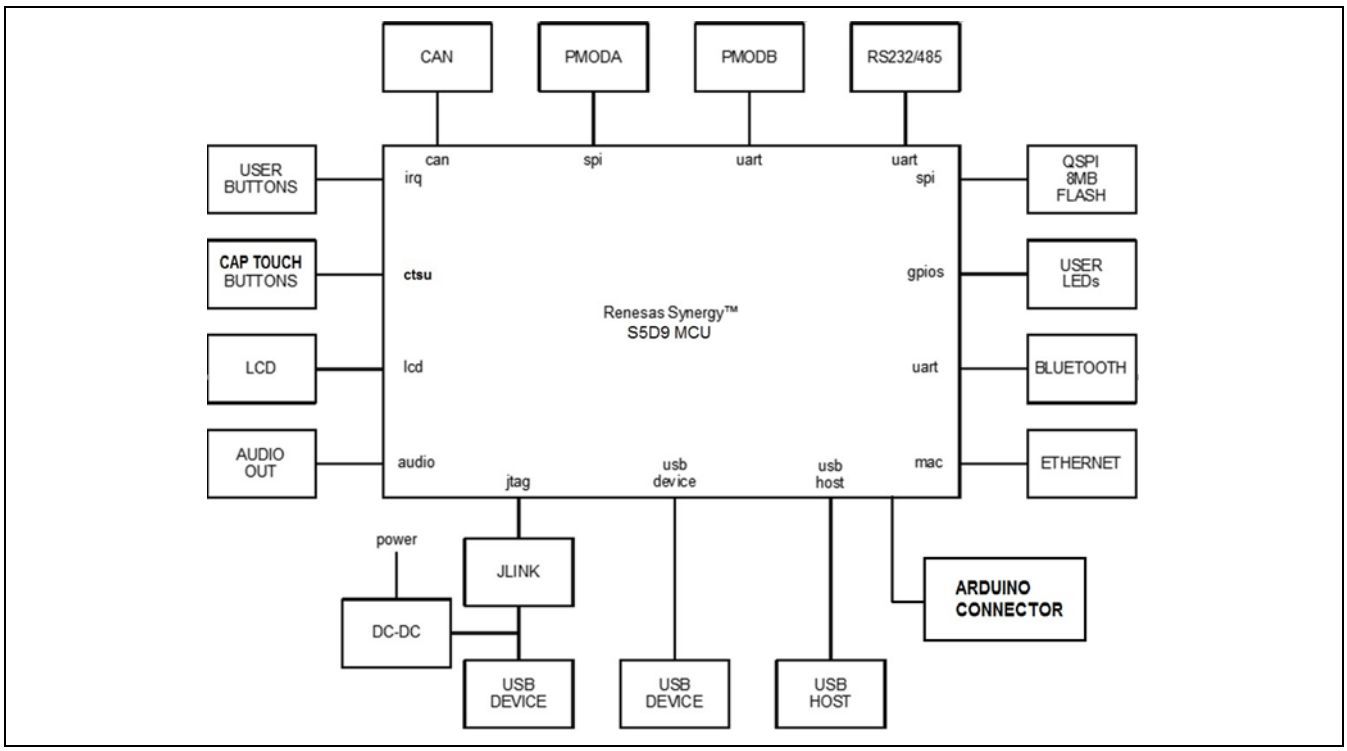

Figure 1.2 PK-S5D9 block diagram

1.4 Hardware Features

The PK-S5D9 contains the following hardware:

- S5D9 Group MCUs with a 176 LQFP package
- Four connectors that provide access to most of signals in the S5D9 Group MCUs
- Low cost QVGA TFT touch screen
- Three user LEDs
- Arduino Shield Uno compatible socket
- Two mechanical switches connected directly to S5D9 Group MCUs interrupt pins
- Two capacitive touch-buttons connected to pins that can generate interrupts
- One capacitive touch slider
- Audio output
- QSPI memory (8 MB)
- SPI, IIC, CAN, and SCI interface.

1.5 Resources

The following documents are related to S5D9 Group MCUs and PK-S5D9:

- PK-S5D9 Quick Start Guide
- PK-S5D9 Board Schematics
- S5D9 Group Microcontrollers User's Manual
- S5D9 Group Microcontrollers Datasheet.

2. Getting Started

To start working with the PK-S5D9, see the Quick Start Guide included in the kit.

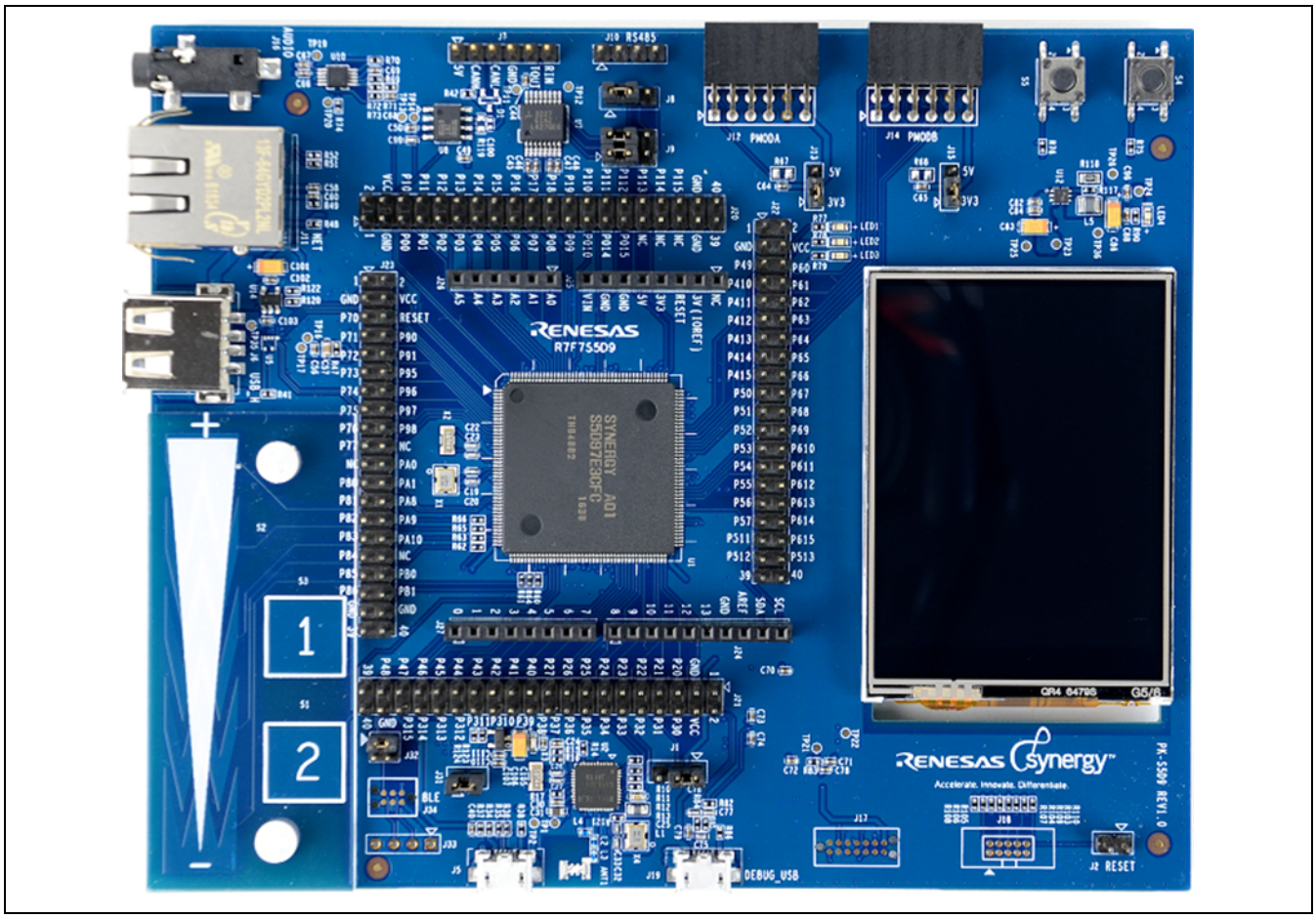

Figure 2.1 PK-S5D9 board close-up

3. Power Supply Requirements

3.1 Power Supply

Power is supplied to the PK-S5D9 through the debug USB connector (J19). The PK-S5D9 requires 5V applied on this interface (USB standard). Once power is supplied, the power supply indicator LED4 lights up in green.

3.2 Power-up Behavior

When power is supplied to the PK-S5D9, the power-on reset (POR) monitor of the MCU resets the MCU. The memory from which the MCU starts program execution after reset depends on jumper J1. If J1 is in position 1-2 (default), the MCU starts execution from internal flash (ROM). If J1 is in position 2-3, the MCU starts execution in USB program mode, which enables you to load a program directly to the internal MCU flash through the USB device interface using Renesas RFP software. Figure 3.1 shows the startup mode circuit for the CPU.

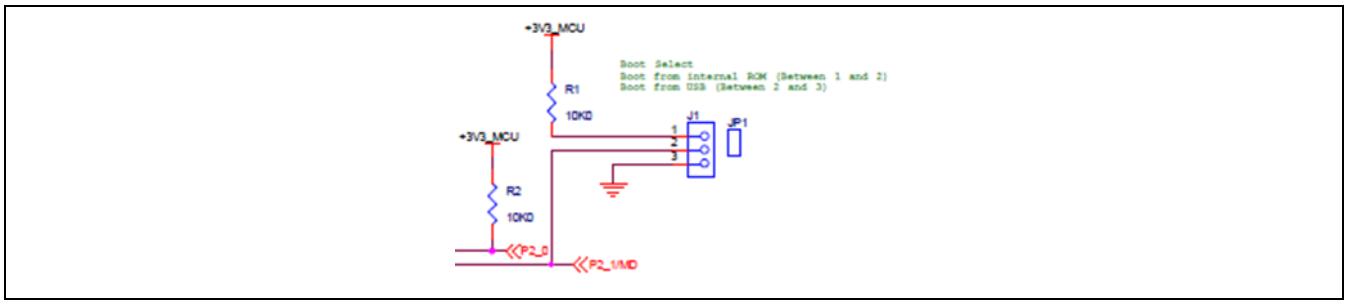

Figure 3.1 CPU startup mode

The J2 jumper can force the MCU to reset. Figure 3.2 shows the CPU reset control circuit.

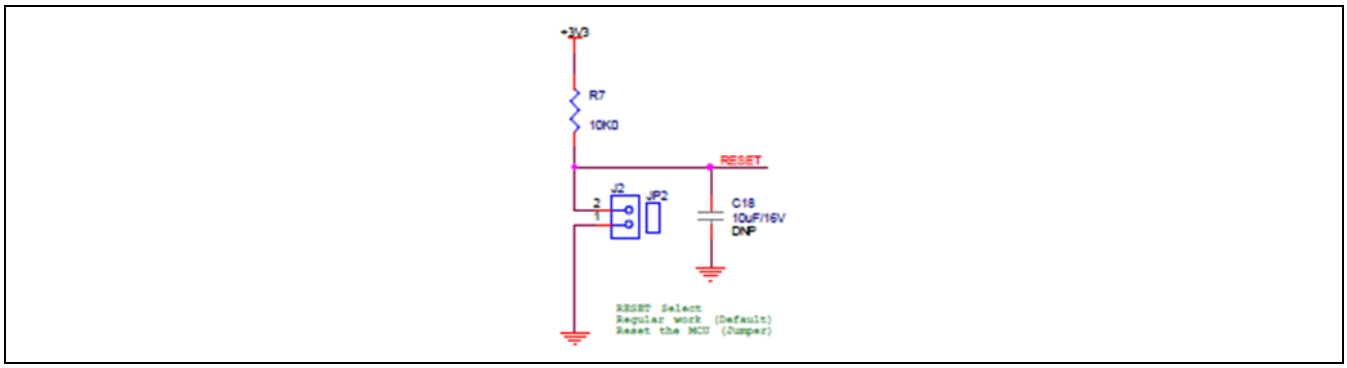

Figure 3.2 CPU reset control

3.3 MCU Current

The MCU digital power supply power consumption can be measured by removing the J31 jumper and measuring the current draw across it as shown in Figure 3.3.

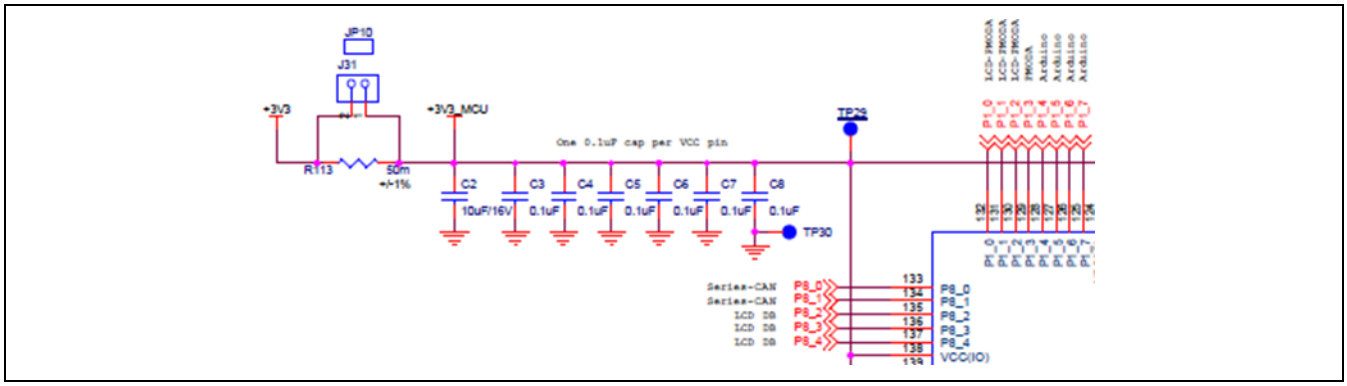

Figure 3.3 Measuring digital current consumption on the MCU

Power consumption for the MCU analog supply requires removing resistor R114 and measuring current across it, as shown in Figure 3.4.

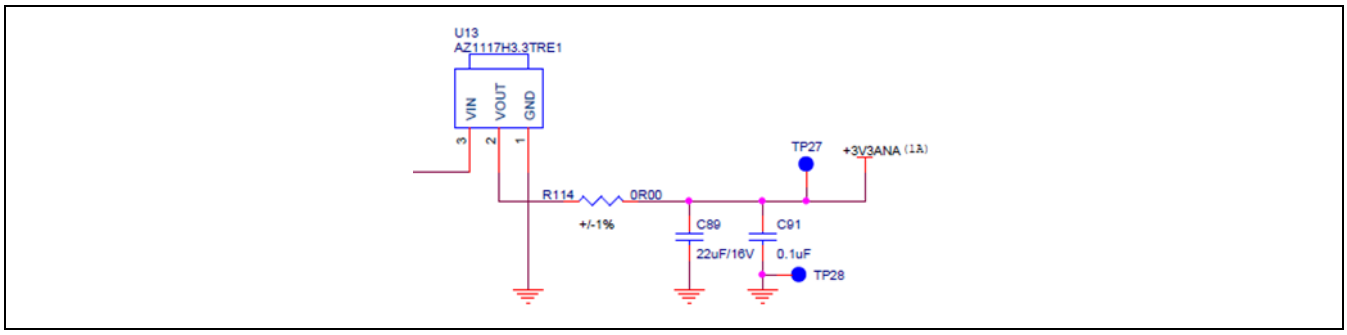

Figure 3.4 Measuring analog current consumption on the MCU

4. Board Components

4.1 J-Link® On-board Debugger

The PK-S5D9 features a SEGGER J-Link® on-board debugger, accessible through the J19 USB connector. Alternatively, the onboard debugger can be bypassed by removing resistors R107, R108, R109, and R110. Once removed, JTAG/SWD debugging can be done through the J18 header. Figure 4.1 shows the JTAG debugging connections.

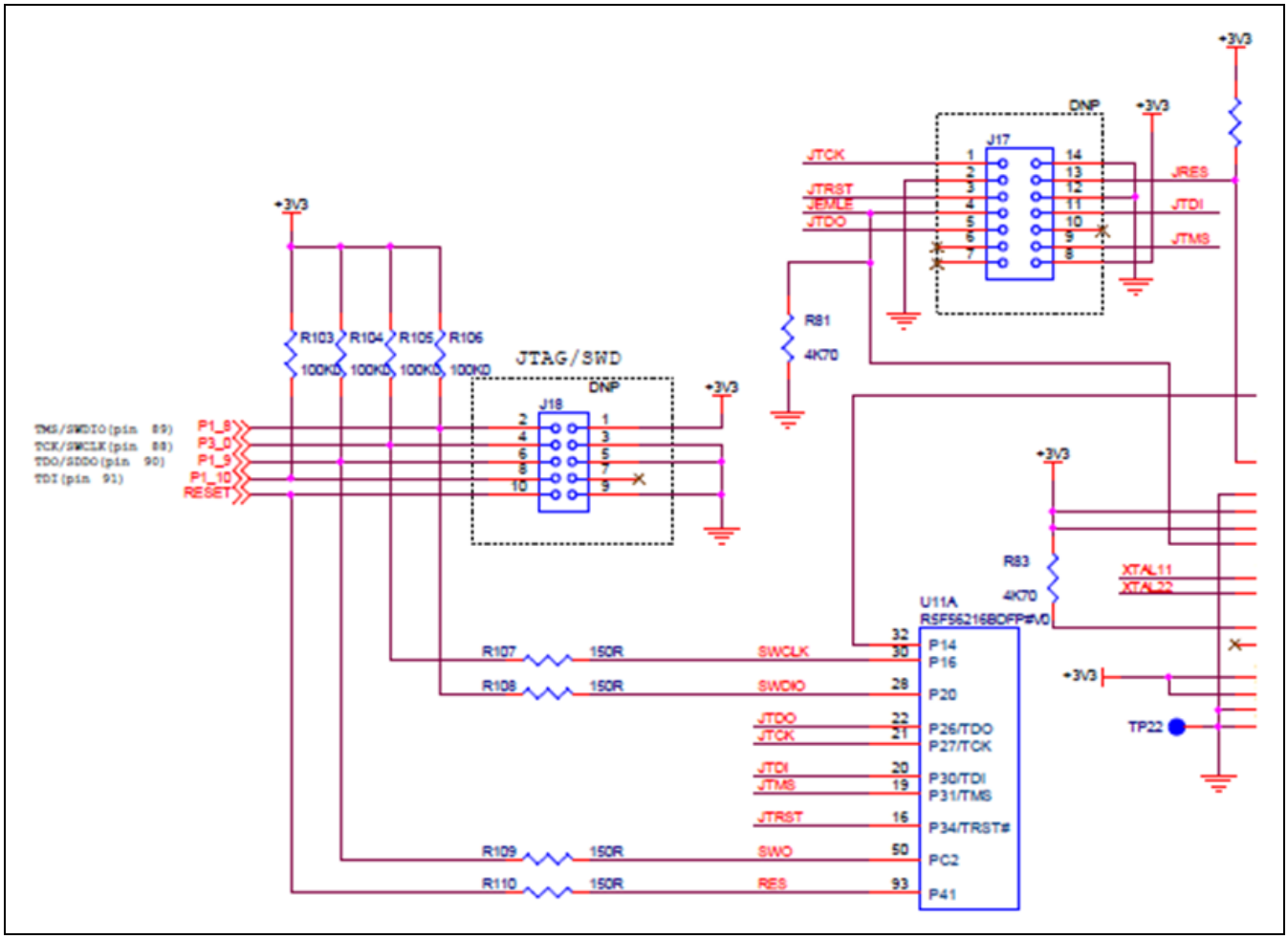

Figure 4.1 On/off-board JTAG debugging

4.2 LCD

The PK-S5D9 incorporates a 2.4-in. LCD panel with a touch screen interface. The LCD is connected directly to the LCD interface of the MCU. The LCD panel is a HaoRan HT024K5QV50T, which uses an Ilitek ILI9341V driver IC. The mode of operation of the Ilitek driver is selected with R19, R20, R22, R23, R26, R27, R28 and R29, as shown in Figure 4.2. The default mode of operation is the 4-wire, 8-bit serial interface.

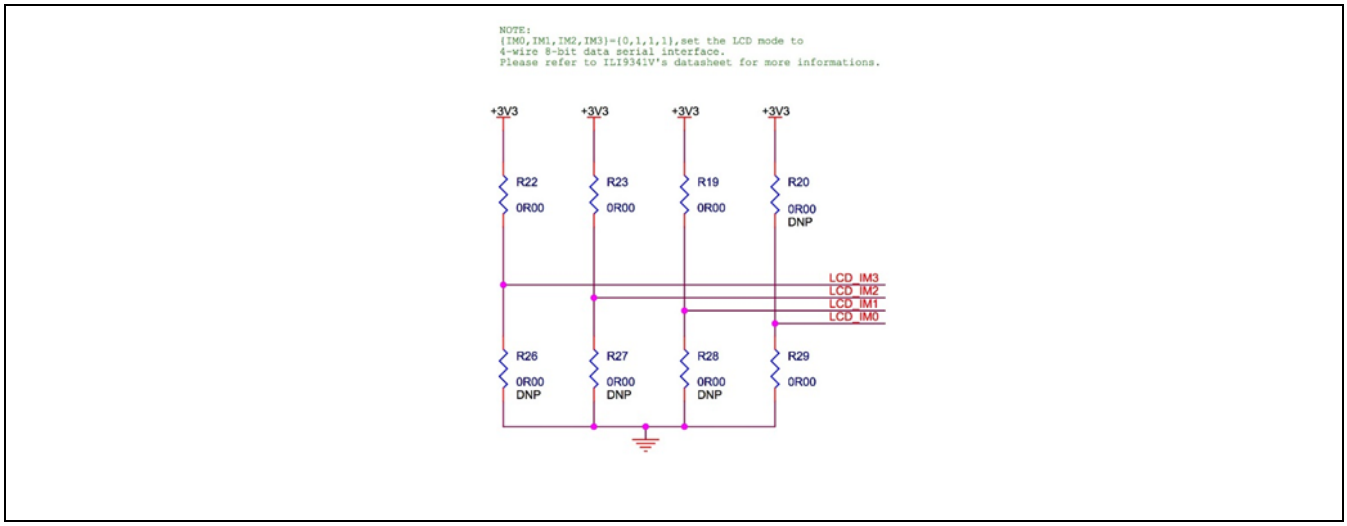

Figure 4.2 LCD interface mode selection

Touch-screen sensing uses a Semtech SX8656 resistive touch-screen controller, connected to the MCU through an I²C bus. Figure 4.3 shows the touch-screen controller connections.

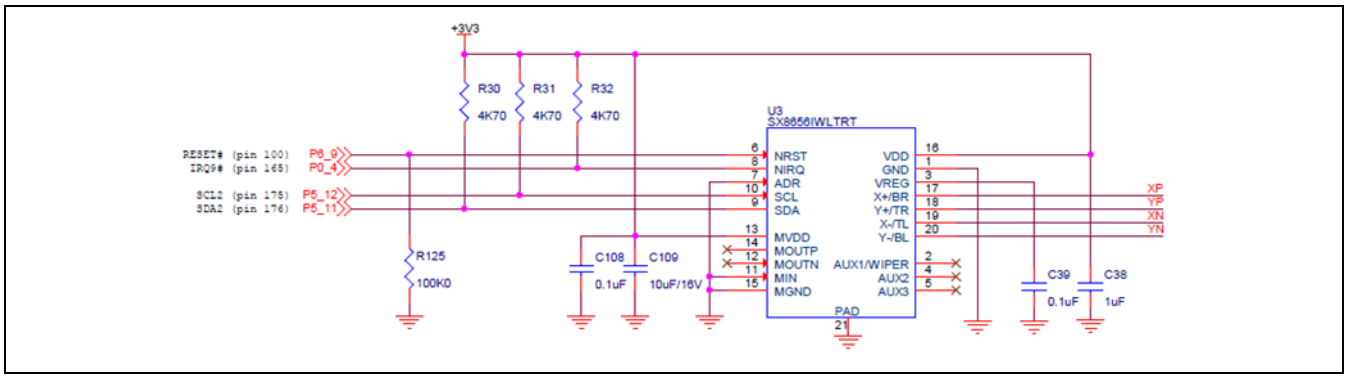

Figure 4.3 Touch-screen controller

4.3 Ethernet

The PK-S5D9 includes a Micrel KSZ8081 10/100 Ethernet physical interface. The Ethernet connection is through the RJ-45 standard connector J11.

4.4 Pmod-compatible Interfaces

The PK-S5D9 includes two standard Pmod™-compatible interfaces. PMODA, available on the J12 connector, exposes an SPI interface, three GPIO lines, and an interrupt line to the MCU. The PMODA interface connections are shown in Figure 4.4.

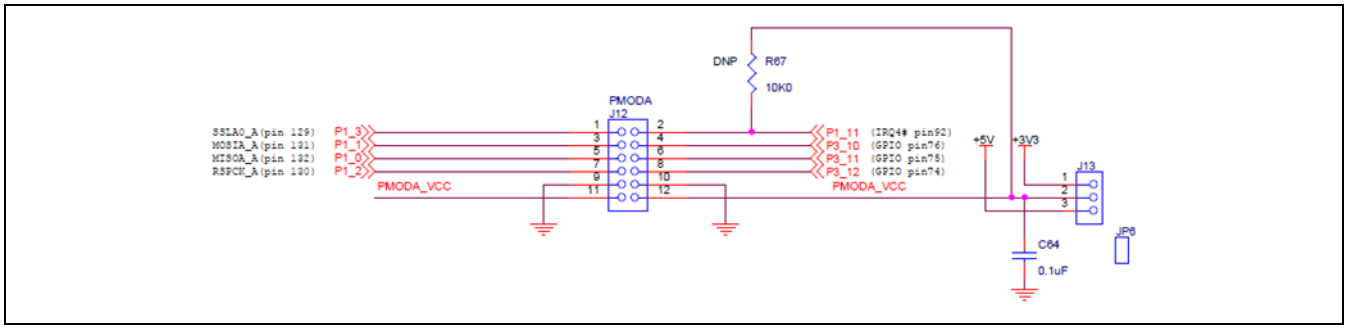

Figure 4.4 PMODA interface

PMODB, available on the J14 connector, exposes a UART, three GPIO lines, and an interrupt line to the MCU. Figure 4.5 shows the PMODB interface connections.

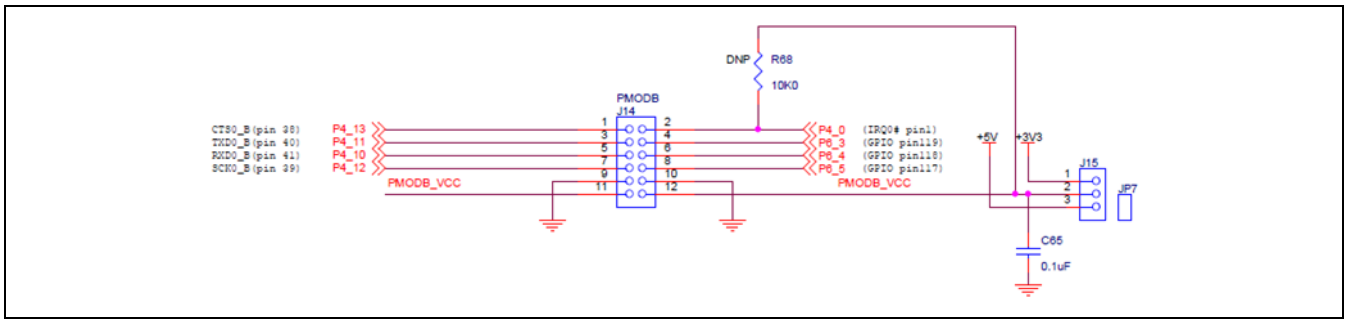

Figure 4.5 PMODB interface

Both PMOD interfaces can output either 5V or 3.3V, depending on the position of the J13 and J15 jumpers.

4.5 CAN, RS-232/485

The PK-S5D9 includes a UART interface (either RS-232 or RS-485) and a CAN interface. The CAN interface is exposed on connector J7, while the UART interface is available on connector J7 in RS-232 format (jumper J9 has to be in positions 1-3 and 2-4), or in raw TTL format in connector J10 (jumper J9 has to be in positions 3-5 and 4-6 to be connected to an external RS-485 converter). The RS-232/485 and CAN interface connections are shown in Figure 4.6.

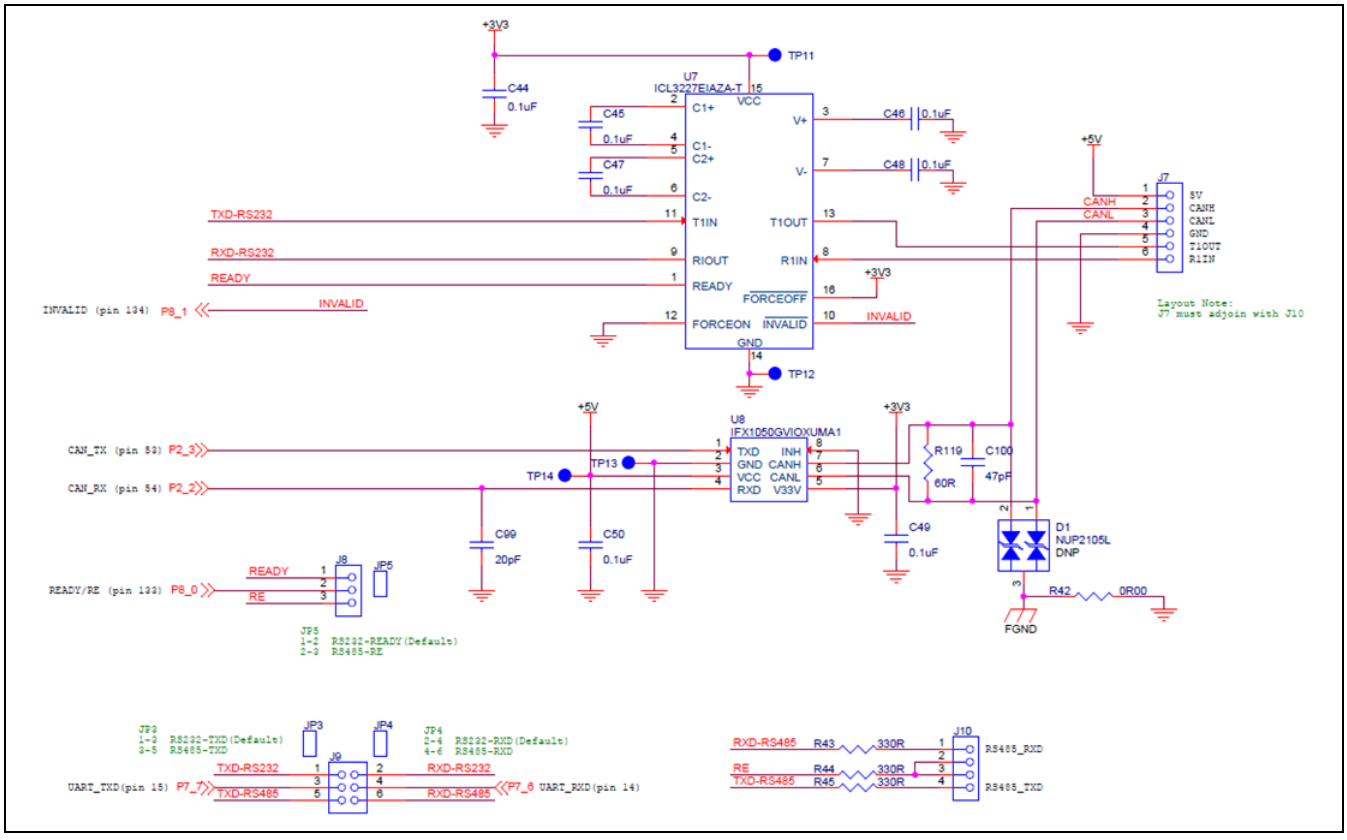

Figure 4.6 RS-232/485 and CAN interfaces

4.6 USB Device Port

The PK-S5D9 is equipped with a USB full-speed (12-Mbps) device port on J5. The PK-S5D9 cannot be powered through this interface (power still needs to be applied through the USB device port J19), but connection to this port can be

detected since the power pin of this port is connected to the MCUs GPIO. Figure 4.7 shows the USB device port connections.

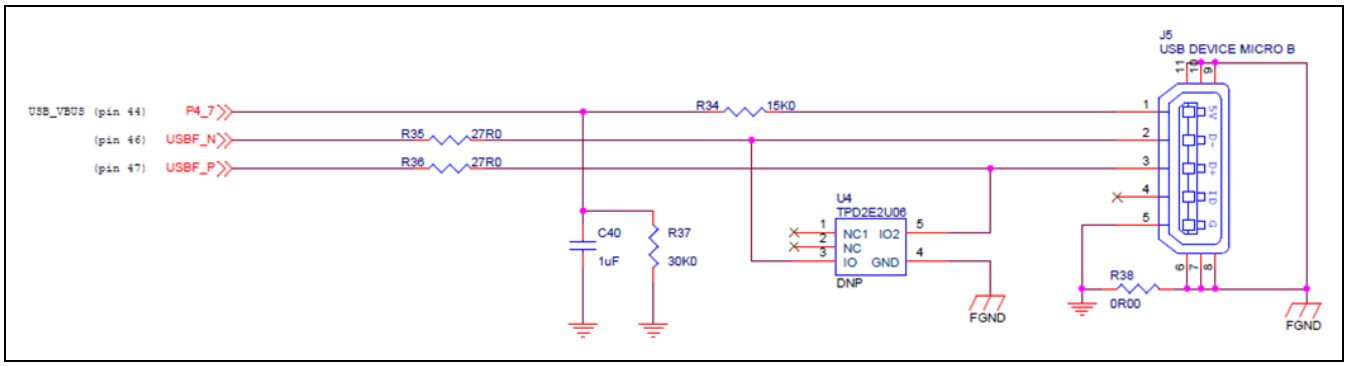

Figure 4.7 USB device port

4.7 USB Host Port

The PK-S5D9 is equipped with a USB high-speed (480-Mbps) host port on J6. This host port can source a minimum current of 150 mA to devices connected to it. Over-consumption conditions on devices can be detected. Figure 4.8 shows the USB host port connections.

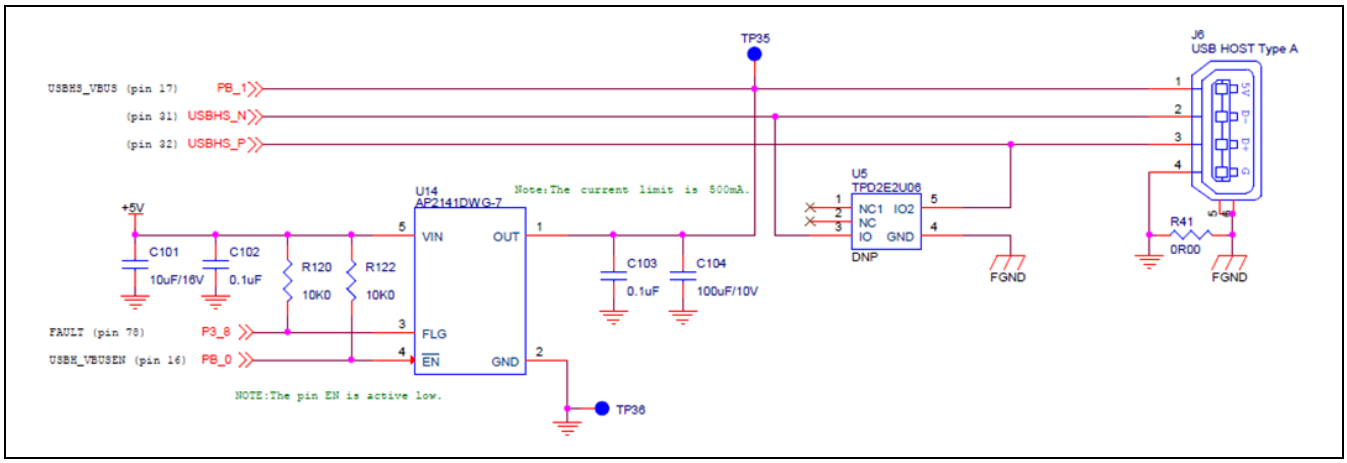

Figure 4.8 USB host port

4.8 Capacitive Touch Interface

The PK-S5D9 contains two capacitive touch buttons (S1 and S3) and one slider (S2) connected to the capacitive touch-sensing unit (CTSU) on the MCU. Figure 4.9 shows the connections for the two capacitive buttons and the slider.

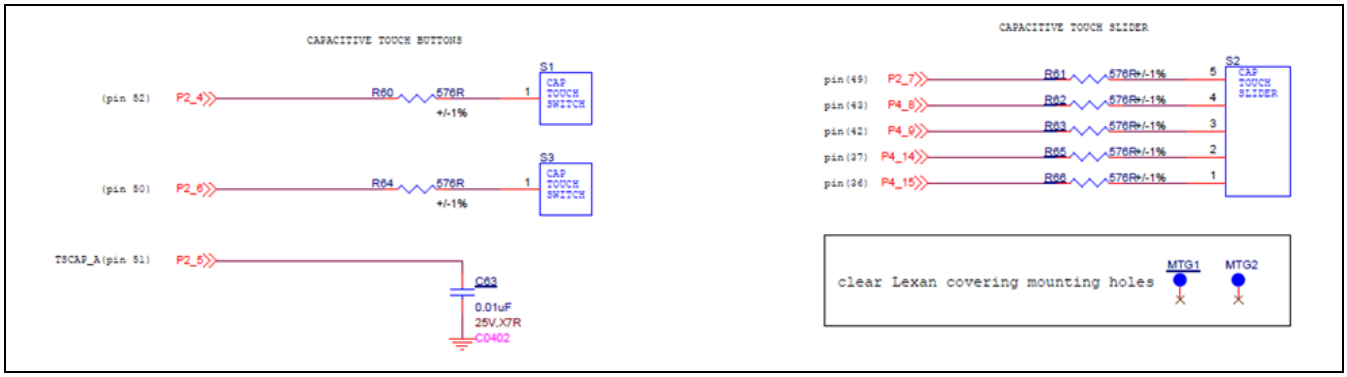

Figure 4.9 Capacitive touch buttons and slider

4.9 Audio

The PK-S5D9 contains an amplified mono audio output on a standard 3.5 mm audio jack J16. The audio is generated with a D/A converter on output DA0, and the amplification gain can be changed by modifying resistor pairs R70/R71 and R73/R72. The audio output connections are shown in Figure 4.10.

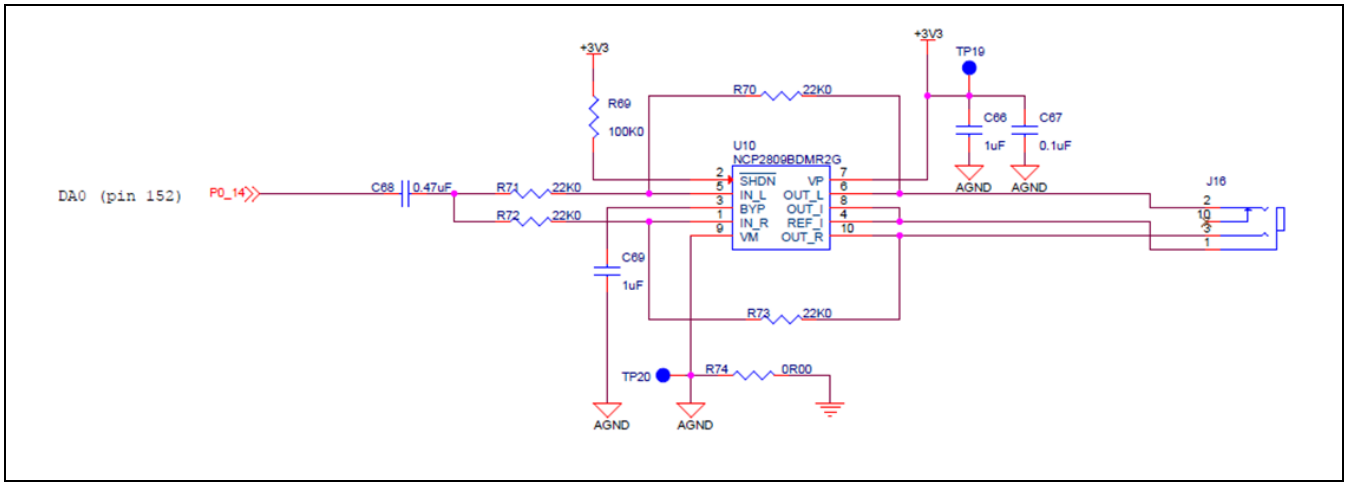

Figure 4.10 Audio output

4.10 User Buttons and LEDs

The PK-S5D9 includes two user buttons directly wired to interrupt pins on the MCU, as well as three generic user LEDs connected to the MCUs GPIO pins. Figure 4.11 shows the user buttons and LED connections.

Figure 4.11 User buttons and LEDs

4.11 QSPI Flash

The PK-S5D9 includes a 64 Mb (8 MB) QSPI flash connected to the QSPI interface of the MCU. Figure 4.12 shows the connections for the QSPI flash.

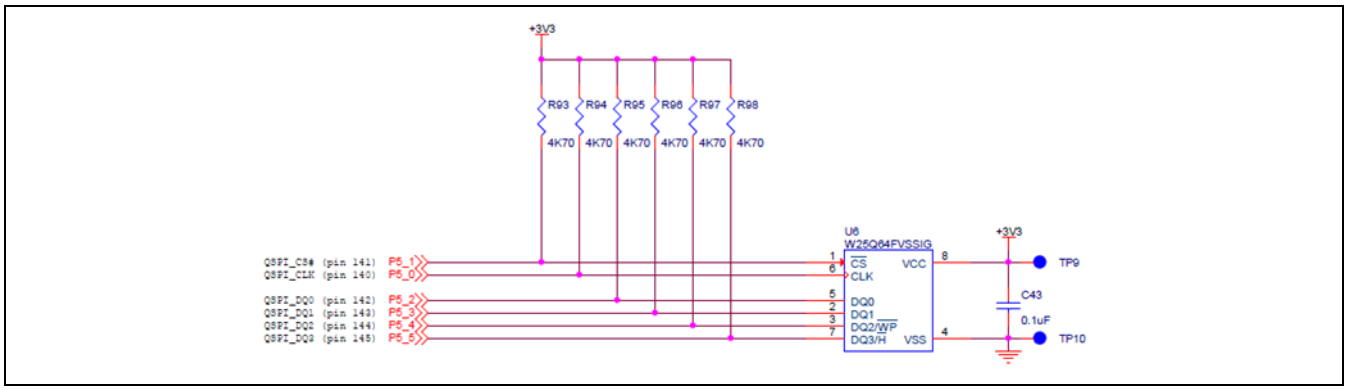

Figure 4.12 QSPI flash

4.12 Arduino Shield Interface

The PK-S5D9 includes one Arduino Shield compatible interface, so that Arduino Shield boards can expand the PK-S5D9 functionality. The Arduino Shield interface is implemented with the J24, J25, J26, and J27 connectors. Figure 4.13 shows the Arduino Shield interface connections.

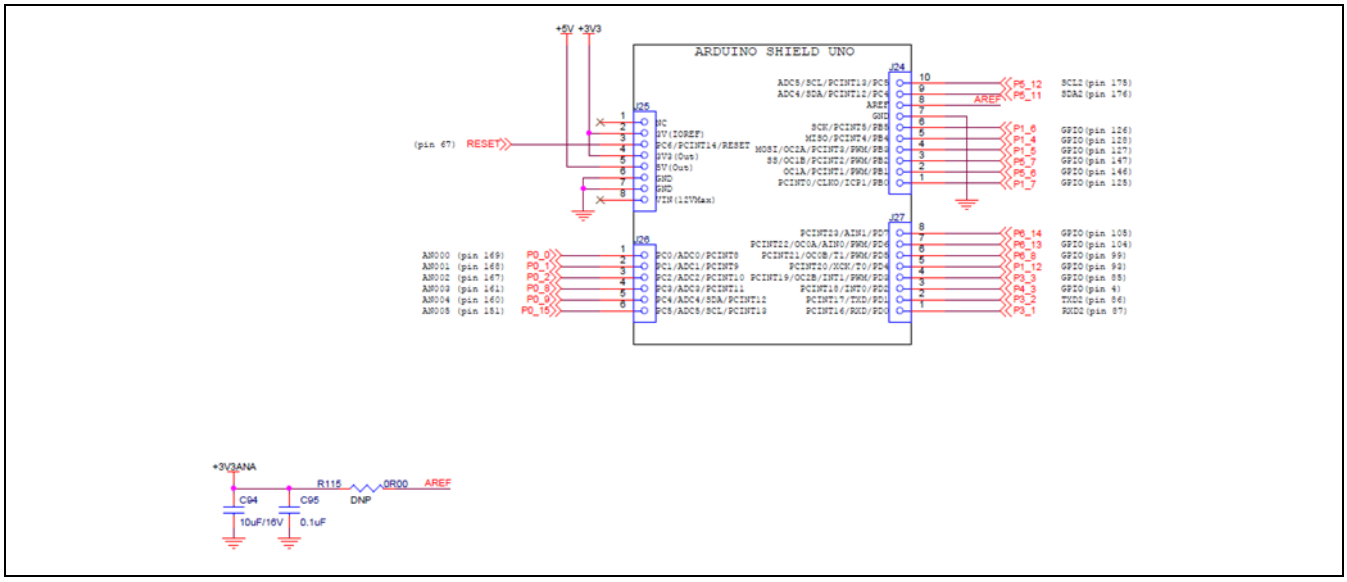

Figure 4.13 Arduino Shield interface

4.13 Breakout Headers

All of the MCUs I/O pins are accessible through four double row 2.54-mm (0.1-in.) pitch breakout headers (J20 through J23) as shown in Figure 4.14.

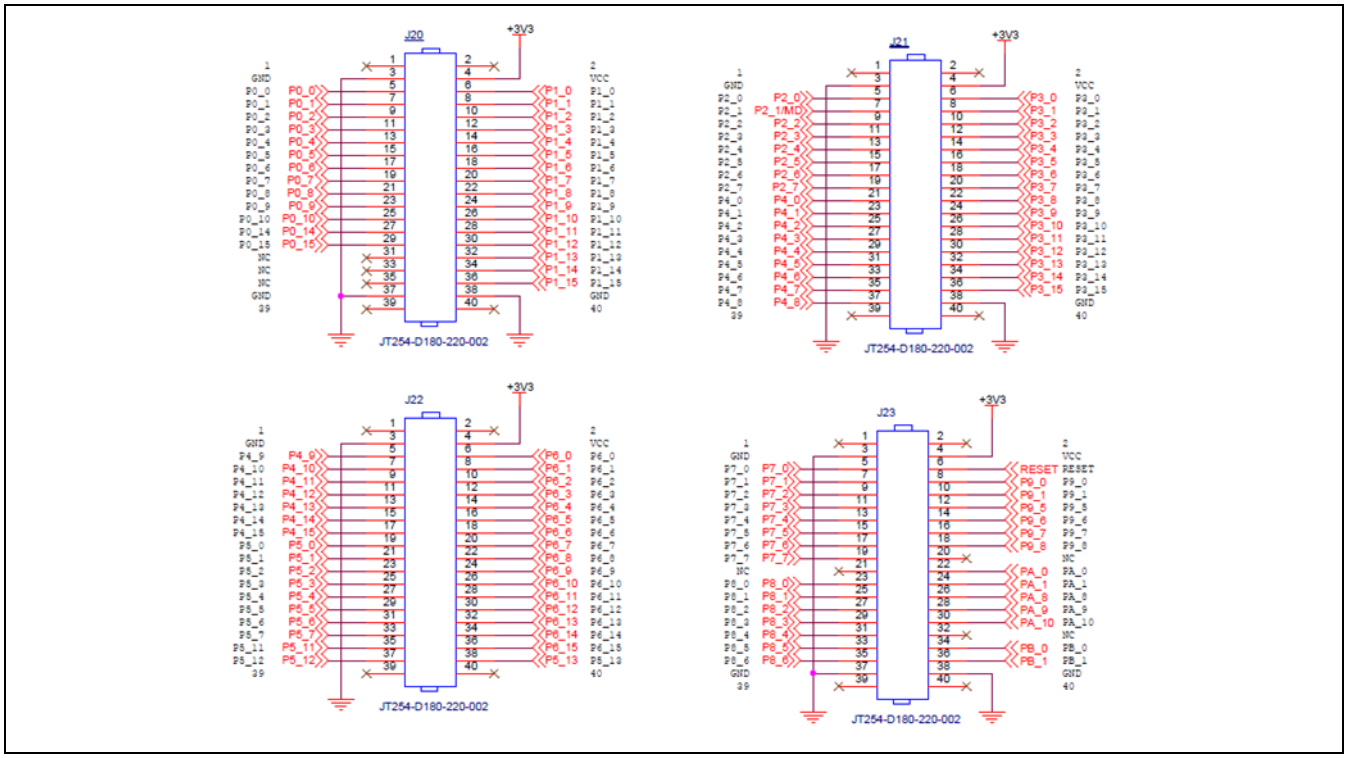

Figure 4.14 MCUs breakout headers

5. Board Layout

The PK-S5D9 board measures 145 mm x 120 mm. Figure 5.1 shows the location of all the relevant board components described in the prior section.

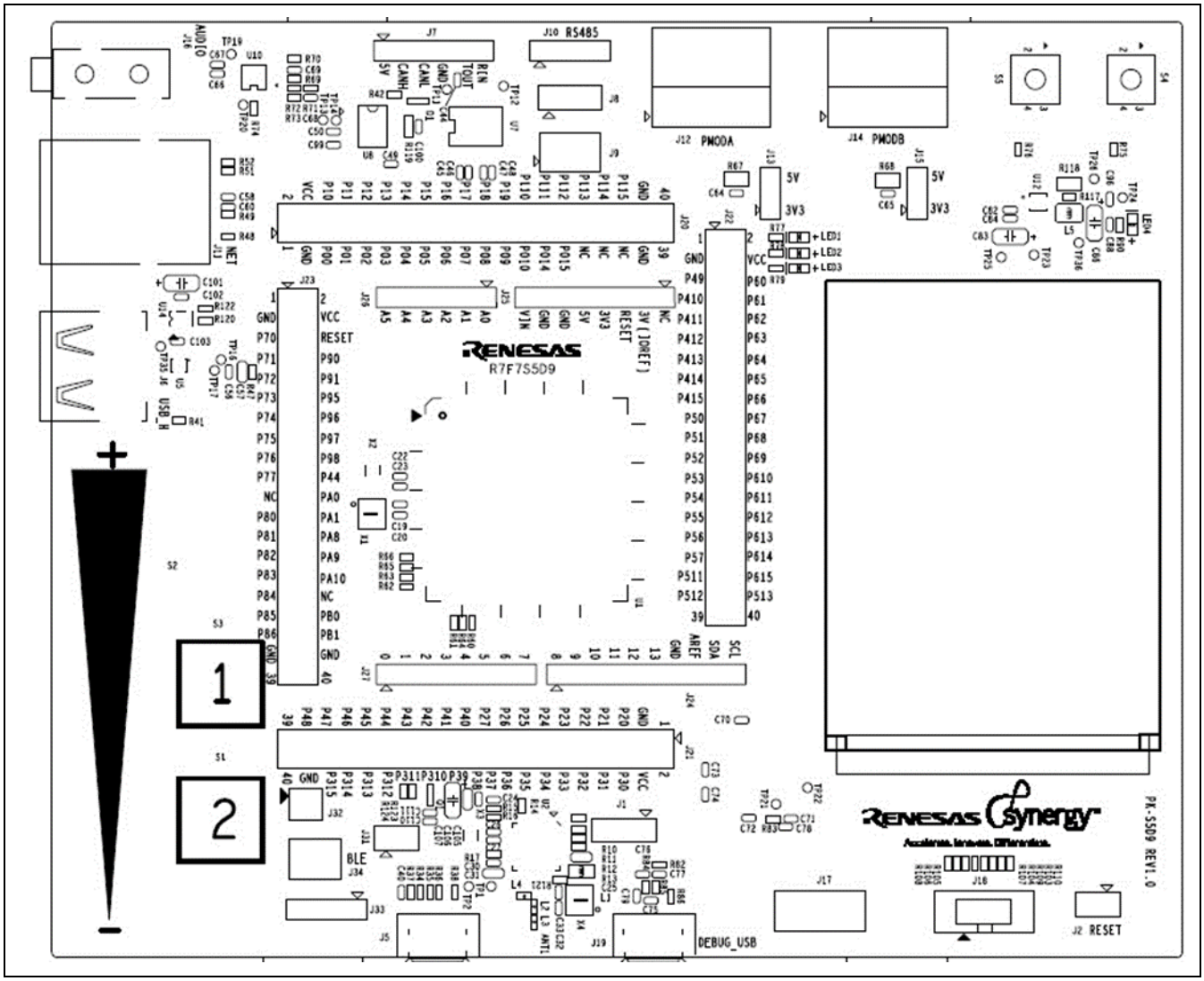

Figure 5.1 PK-S5D9 component placement

6. Configuration

The PK-S5D9 has several configuration options set by jumpers. Table 6.1 lists the different jumpers and their positions.

Table 6.1 PK-S5D9 configuration jumpers

Jumper	Function
J1	MCU boot selection. If J1 is in position 1-2 (default), the MCU boots in normal mode (from its ROM). If J1 is set on the 2-3 position, the MCU boots in USB programming mode, which allows programming the MCU flash through the USB port.
J2	MCU reset. If J2 is set, MCU is reset. If J2 is open, MCU reset is released.
J8	RS-232 transmit-ready/RS-485 receive enable selector jumper. If J8 is in position 1-2 (default), the RS-232 driver transmit ready signal (which, indicates that the transmit voltages are appropriate) is connected to an MCU GPIO signal. If J8 is in position 2-3, the (external) RS-485 driver's receive enable is connected to the same MCU GPIO signal.
J9	RS-232/485 mode selection jumper. If J9 is in position 1-3 and 2-4 (default), the MCUs SCI3 port is connected to the RS-232 driver (which is exposed on the J7 port). If J9 is in the 3-5 and 4-6 position, the MCUs SCI3 port is connected to the RS-485 port (J10) for an off-board driver.
J13	PMODA 3.3V/5V output selection. If J13 is set on the position labeled 5V, then 5V is provided on the PMODA connector. If J13 is set on the position labeled 3V3, then 3.3V are provided in the PMODA interface.
J15	PMODB 3.3V/5V output selection. If J15 is set on the position labeled 5V, then 5V is provided on the PMODB connector. If J15 is set on the position labeled 3V3, then 3.3V is provided on the PMODB interface.
J31	Power measurement jumper for S5D9. If J31 is installed, (digital) MCU current goes through the jumper. If J31 is removed, the (digital) MCU current consumption goes through an ammeter connected across pins 1 and 2 of J31.

6.1 RS-232 Transceiver Configuration

The PK-S5D9 exposes the Serial Communication Interface (SCI3) in the MCU through three different electrical interfaces: RS-232, (external) RS-485, and the MCU breakout headers. Table 6.2 summarizes the configuration alternatives for this port.

Table 6.2 Configuration options for RS-232/485 port

Option	J8	J9
RS-232 on J7	1-2	1-3 and 2-4
RS-485 on J10 (external converter)	2-3	3-5 and 4-6
TTL interface on MCU breakout headers J20-J23	removed	removed

7. Connectivity

The following sections describe in detail the interfaces available on the PK-S5D9, including the MCU resources utilized in each.

7.1 USB Host Port

The PK-S5D9 includes a USB host/high-speed port (J6). This port supplies current to devices connected to it through a current limited power switch (U14). The power output can be enabled through USBH_VBUSEN pin of the MCU and monitored through USBHS_VBUS pin. Table 7.1 shows the MCU functions used for the USB host port.

Table 7.1 USB host port functions

S5D9 Pin	Function name
USBHS_DM	USBHS_N
USBHS_DP	USBHS_P
PB01	USBHS_VBUS (monitor)
PB00	USBH_VBUSEN
P308	FAULT (monitor)

7.2 USB Device Port

The PK-S5D9 includes one USB device/full-speed port (J5). A USB connection can be detected by monitoring the status of the power pin of the USB device connector through its connection to a GPIO pin on the MCU. Table 7.2 shows the MCU functions used for the USB device port.

Note: Only connect a host to this device port when the board is powered.

Table 7.2 USB device port functions

S5D9 Pin	Function name
USB_DM	USBF_N
UDB_DP	USBF_P
P407	USB_VBUS (monitor)

7.3 Ethernet

The PK-S5D9 includes an RJ45 Ethernet connector to the on-board Ethernet PHY. Table 7.3 shows the pins of the MCU used on the PK-S5D9 when connected as a RMII interface to the PHY. In addition, interrupt IRQ14 is connected to the Ethernet PHY.

The Ethernet PHY is clocked by its own oscillator based on a 25 MHz crystal (X5).

Since the Ethernet connector (J11) is connected to the MCU through other components, only the functions used by the Ethernet module on the MCU are shown in Table 7.3.

Table 7.3 Ethernet functions

S5D9 Pin	Function name
P010	ETH_IRQ14#
P806	ETH_RESET#
P401	ETH_MDC
P402	ETH_MDIO
P705	ETH_CRS_DV
P405	ETH_TXD_EN
P700	ETH_TDX0
P406	ETH_TXD1
P702	ETH_RXD0
P703	ETH_RXD1
P704	ETH_RX_ER
P701	ETH (reference clock)

7.4 LCD

The PK-S5D9 includes a 240 x 320 QVGA LCD panel with touch-screen interface. This display is connected directly to the MCUs display port, and through a touchscreen controller IC to the display's touch-screen interface. Table 7.4 and Table 7.5 list the functions used by the LCD display and touch-screen controller on the MCU.

Table 7.4 LCD functions (J3)

S5D9 Pin	Function name
P610	LCD_RESET
P314	LCD_VSYNC
P313	LCD_HSYNC
P900	LCD_CLK_B
P315	LCD_Data_Enable
P901	LCD_D15
P908	LCD_D14
P907	LCD_D13
P906	LCD_D12
P905	LCD_D11
P615	LCD_D10
PA08	LCD_D9
PA09	LCD_D8
PA10	LCD_D7
PA01	LCD_D6
PA00	LCD_D5
P607	LCD_D4
P606	LCD_D3
P802	LCD_D2
P803	LCD_D1
P804	LCD_D0
P611	LCD_CS
P102	LCD_SCK
P115	LCD_WR
P114	LCD_RD
P101	LCD_MOSI
P100	LCD_MISO

Table 7.5 LCD touchscreen functions

S5D9 Pin	Function name
P609	RESET#
P004	IRQ9#
P512	SCL2
P511	SDA2

7.5 Pmod-compatible Ports

The PK-S5D9 includes two Pmod™-compatible ports, PMODA (J12), and PMODB (J14). Both can output either 3.3 V or 5 V supply, configurable by jumpers. Table 7.6 and Table 7.7 show the MCU functions used for these ports.

Table 7.6 PMODA port functions

S5D9 Pin	Function name
P103	SSLA0_A
P101	MOSIA_A
P100	MISOA_A
P102	RSPCK_A
P111	IRQ4#
P310	GPIO (PMOD pin 4)
P311	GPIO (PMOD pin 6)
P312	GPIO (PMOD pin 8)

Table 7.7 PMODB port functions

S5D9 Pin	Function name
P413	CTS0_B
P411	TXD0_B
P410	RXD0_B
P412	SCK0_B
P400	IRQ0#
P603	GPIO (PMOD pin 4)
P604	GPIO (PMOD pin 6)
P605	GPIO (PMOD pin 8)

7.6 JTAG/SWD

The PK-S5D9 provides several alternatives for JTAG emulation/debugging. An onboard SEGGER J-Link® SWD debugger is accessible through the debugging/power USB port (J19). There is also direct access to the MCUs JTAG/SWD port through connector J18. To enable the direct access connector, the resistors that connect the onboard J-Link® debugger with the MCU (R107, R108, R109, and R110) must be removed. Table 7.8 shows the MCU functions connected to the direct access JTAG/SWD connector.

Table 7.8 JTAG/SWD functions

S5D9 Pin	Function name
P108	TMS/SWDIO
P300	TCK/SWCLK
P109	TDO/SDDO
P110	TDI
RESET	RESET

7.7 UART and CAN

The PK-S5D9 exposes the MCU UART and a CAN interface (J7 and J10) as external connections. The UART interface can be configured to operate in RS-232 mode or in RS-485 (with an external driver IC) depending on the position of jumpers J8 and J9. Table 7.9 and Table 7.10 show the MCU functions connected to these interfaces.

Table 7.9 UART interface functions

S5D9 Pin	Function name
P706	UART_RXD
P707	UART_TXD
P801	INVALID
P800	READY (RS-232) or RE (RS-485)

Table 7.10 CAN interface functions

S5D9 Pin	Function name
P203	CAN_TX
P202	CAN_RX

8. Connections of Port and Connector

Table 8.1 shows port and peripheral functions of the MCUs and connections with PK-S5D9 connector.

Table 8.1 Port and peripheral functions of the MCUs and connections with PK-S5D9 connector

Port	Peripheral	Signal	PK-S5D9 connector
P000	Arduino Shield	AN000	J26 (1)
P001	Arduino Shield	AN001	J26 (2)
P002	Arduino Shield	AN002	J26 (3)
P004	LCD (Touchscreen)	IRQ9#	N/A
P005	User Button	IRQ10#	S5
P006	User Button	IRQ11#	S4
P008	Arduino Shield	AN003	J26 (4)
P009	Arduino Shield	AN004	J26 (5)
P010	Ethernet	ETH_IRQ14#	N/A
P014	Audio	DA0	N/A
P015	Arduino Shield	AN005	J26 (6)
P100	LCD/PMODA	LCD_MISO/MISOA_A	J3 (18) / J12 (5)
P101	LCD/PMODA	LCD_MOSI/MOSIA_A	J3 (17) / J12 (3)
P102	LCD/PMODA	LCD_SCK/RSPCK_A	J3 (14) / J12 (7)
P103	PMODA	SSLA0_A	J12 (1)
P104	Arduino Shield	N/A	J24 (4)
P105	Arduino Shield	N/A	J24 (5)
P106	Arduino Shield	N/A	J24 (6)
P107	Arduino Shield	N/A	J24 (1)
P108	JTAG	TMS/SWDIO	J18 (2)
P109	JTAG	TDO/SDDO	J18 (6)
P110	JTAG	TDI	J18 (8)
P111	PMODA	IRQ4#	J12 (2)
P112	Arduino Shield	N/A	J27 (5)
P113	Bluetooth™	BLE_PWR_EN	N/A
P202	CAN	CAN_RX	N/A
P203	CAN	CAN_TX	N/A
P204	Cap Touch	N/A	S1
P205	Cap Touch	TSCAP_A	N/A
P206	Cap Touch	N/A	S3
P207	Cap Touch	N/A	S2 (5)
P300	JTAG	TCK/SWCLK	J18 (4)
P301	Bluetooth/Arduino Shield	RXD2/RXD2	N/A/J27 (1)
P302	Bluetooth/Arduino Shield	TXD2/TXD2	N/A/J27 (2)
P303	Arduino Shield	N/A	J27 (4)
P304	Bluetooth	RXD6_A	N/A
P305	Bluetooth	TXD6_A	N/A
P306	Bluetooth	SCK6_A	N/A
P308	USB Host	FAULT	N/A

P309	Bluetooth	BLE_RESET	N/A
P310	PMODA	N/A	J12 (4)
P311	PMODA	N/A	J12 (6)
P312	PMODA	N/A	J12 (8)
P313	LCD	LCD_HSYNC	J3 (40)
P314	LCD	LCD_VSYNC	J3 (41)
P315	LCD	LCD_Data_Enable	J3 (38)
P400	PMODB	IRQ0#	J14 (2)
P401	Ethernet	ETH_MDC	N/A
P402	Ethernet	ETH_MDIO	N/A
P403	Arduino Shield	N/A	J27(3)
P405	Ethernet	ETH_TXD_EN	N/A
P406	Ethernet	ETH_TXD1	N/A
P407	USB Device	USB_VBUS	J5 (1)
P408	Cap Touch	N/A	S2 (4)
P409	Cap Touch	N/A	S2 (3)
P410	PMODB	RXD0_B	J14 (5)
P411	PMODB	TXD0_B	J14 (3)
P412	PMODB	SCK0_B	J14 (7)
P413	PMODB	CTS0_B	J14 (1)
P414	Cap Touch	N/A	S2 (2)
P415	Cap Touch	N/A	S2 (1)
P500	QSPI Flash	QSPI_CLK	N/A
P501	QSPI Flash	QSPI_CS#	N/A
P502	QSPI Flash	QSPI_DQ0	N/A
P503	QSPI Flash	QSPI_DQ1	N/A
P504	QSPI Flash	QSPI_DQ2	N/A
P505	QSPI Flash	QSPI_DQ3	N/A
P506	Arduino Shield	N/A	J24 (2)
P507	Arduino Shield	N/A	J24 (3)
P511	LCD (Touchscreen)/Arduino Shield	SDA2/SDA2	N/A/J24 (9)
P512	LCD (Touchscreen)/Arduino Shield	SCL2/SCL2	N/A/J24 (10)
P600	User LED	N/A	LED1
P601	User LED	N/A	LED2
P602	User LED	N/A	LED3
P603	PMODB	N/A	J14 (4)
P604	PMODB	N/A	J14 (6)
P605	PMODB	N/A	J14 (8)
P606	LCD	LCD_D3	J3 (24)
P607	LCD	LCD_D4	J3 (25)
P608	Arduino Shield	N/A	J27 (6)
P609	LCD (Touchscreen)	RESET#	N/A
P611	LCD	LCD_CS	J3 (13)
P613	Arduino Shield	N/A	J27 (7)
P614	Arduino Shield	N/A	J27 (8)

P615	LCD	LCD_D10	J3 (31)
P700	Ethernet	ETH_TXD0	N/A
P701	Ethernet	ETH	N/A
P702	Ethernet	ETH_RXD0	N/A
P703	Ethernet	ETH_RXD1	N/A
P704	Ethernet	ETH_RX_ER	N/A
P705	Ethernet	ETH_CRS_DV	N/A
P706	RS-232	UART_RXD	J9 (4)
P707	RS-232	UART_TXD	J9 (3)
P800	RS-232	READY/RE	J8 (2)
P801	RS-232	INVALID	N/A
P802	LCD	LCD_D2	J3 (23)
P803	LCD	LCD_D1	J3 (22)
P804	LCD	LCD_D0	J3 (21)
P806	Ethernet	ETH_RESET#	N/A
P900	LCD	LCD_CLK_B	J3 (39)
P901	LCD	LCD_D15	J3 (37)
P905	LCD	LCD_D11	J3 (33)
P906	LCD	LCD_D12	J3 (34)
P907	LCD	LCD_D13	J3 (35)
P908	LCD	LCD_D14	J3 (36)
PA00	LCD	LCD_D5	J3 (26)
PA01	LCD	LCD_D6	J3 (27)
PA08	LCD	LCD_D9	J3 (30)
PA09	LCD	LCD_D8	J3 (29)
PA10	LCD	LCD_D7	J3 (28)
PB00	USB Host	USBH_VBUSEN	N/A
PB01	USB Host	USBHS_VBUS	J6 (1)
RESET	JTAG	RESET	J18 (10)
USBHS_N	USB Host	USBHS_N	J6 (2)
USBHS_P	USB Host	USBHS_P	J6 (3)
USBF_N	USB Device	USBF_N	J5 (2)
USBF_P	USB Device	USBF_P	J5 (3)

Revision History

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	Feb 16, 2017	-	1st release
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