User's Manual

Development Kit S128 (DK-S128)

User's Manual

Renesas Synergy™ Platform
Synergy Tools & Kits
Kit: DK-S128 v1.1

Renesas Electronics
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This Renesas Synergy™ Development Kit is only intended for use in a laboratory environment under ambient temperature and humidity conditions. A safe separation distance should be used between this and any sensitive equipment. Its use outside the laboratory, classroom, study area, or similar such area invalidates conformity with the protection requirements of the Electromagnetic Compatibility Directive and could lead to prosecution.

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:

• The user is advised that mobile phones should not be used within 10 m of the product when in use.

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

The Renesas Synergy™ Development 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

The DK-S128 is a development kit for the Renesas Synergy™ S128 Microcontroller Group in an LQFP64 package. The DK-S128 is primarily intended for software and hardware developers to develop firmware, experiment, and evaluate the extensive features of the S128 MCU Group prior to development of their own customized hardware.

2. Features

ARM® Cortex®-M0+ Core

- ARM v6-M architecture
- Maximum operating frequency: 32 MHz
- ARM Memory Protection Unit (MPU) with 8 regions
- Debug and Trace: DWT, BPU, Core Sight™ MTB-M0+
- Core Sight™ Debug Port: SW-DP

Memory

- 256 KB code flash memory
- 4 KB on-chip data flash memory (up to 100,000 erase/write cycles)
- 24 KB SRAM

Power

- Main power input of 5V to a barrel jack or USB Device input of 5V
- High efficiency 5V to 3.3V system power DC-DC converter
- Low noise 5V to 3.3V power regulator for MCU analog functions
- Lithium coin cell holder for low-power operations testing
- Several jumper-configurable headers to allow selection of regulated or battery power source, and monitoring of currents and voltages

Connectivity

- USB 2.0 Full-Speed Module (USBFS)
- SPI and I^2C interface, 8-pin header
- SEEED Grove I^2C interface

CAN transceiver

- Configurable RS232/RS485 port on an industrial-style 3.5 mm screw terminal plug connector
- Digital Addressable Lighting Interface (DALI)
- PMOD 12-pin multi-type expanded interface (firmware configured)

Analog

- Stereo audio output with headphone jack, and single microphone input
- Operational Amplifier (OPAMP) x 4
- Ambient Light and Temperature sensor.
- User-adjustable manual thumb-wheel potentiometer

Human Machine Interface

- Two capacitive touch buttons and one capacitive touch-slider
- General Purpose I/O Ports
- Up to 53 input/output pins

User I/O

- Three user configurable LEDs (red, yellow, and green)
- Two user configurable push button switches

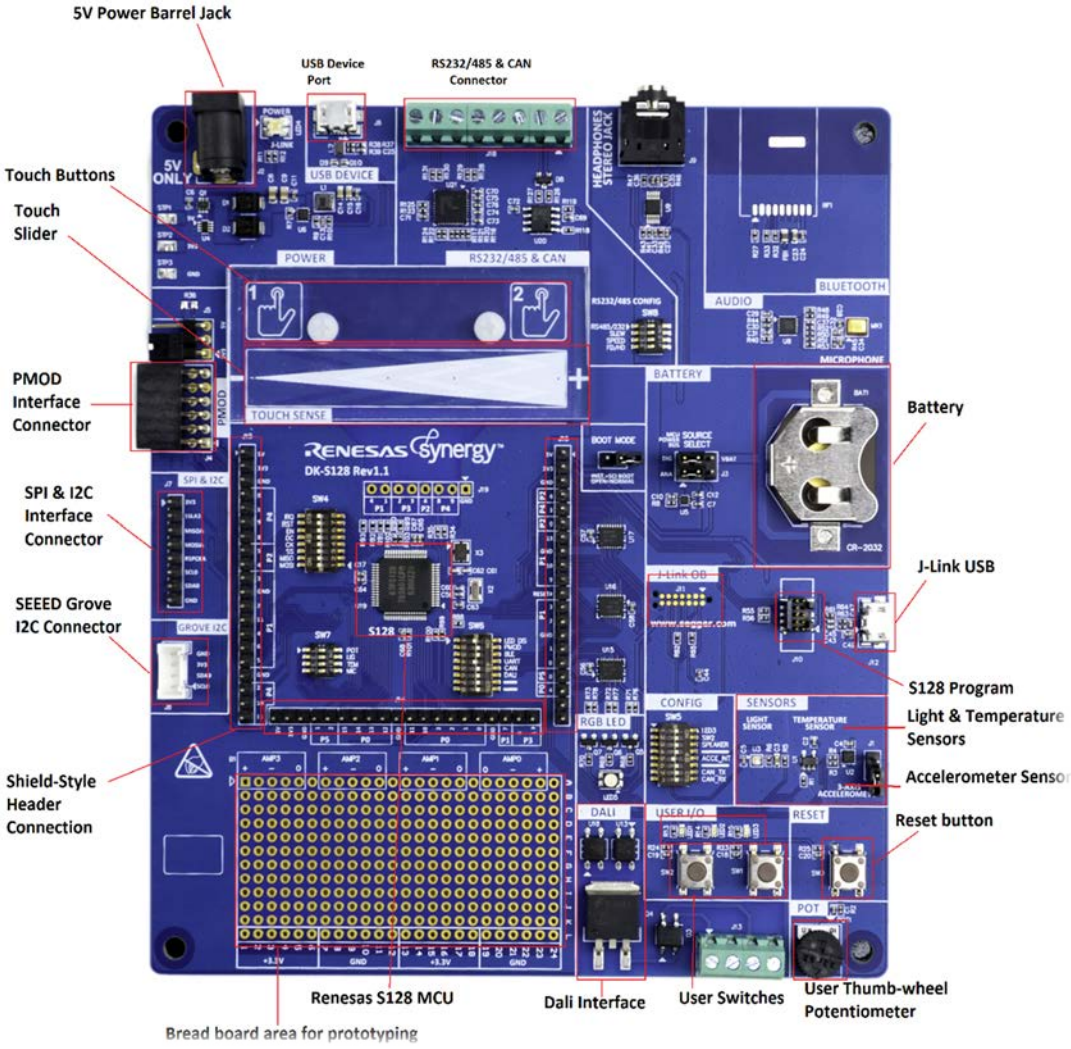


Figure 1 Main board components, top side

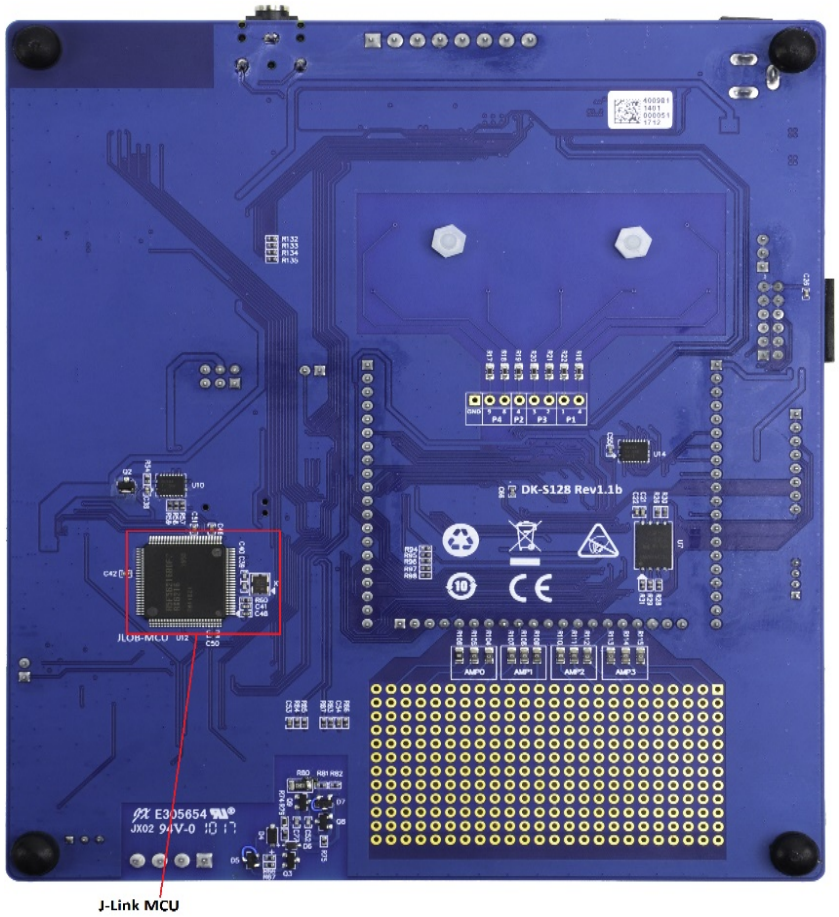


Figure 2 Main board components, bottom side

3. What's in the box

The following components are included in the DK-S128 kit:

- DK-S128 main board with installed acrylic overlay for the touch buttons, touch slider, and installed bumper feet
- One three-foot USB cable Type-A connector to Micro-B connector
- 5 shunt-jumpers for 2.54-mm headers on the DK-S128; 1 each for J1, J5, J7 and 2 for J3
- One PMOD LCD Display Board
- *Quick Start Guide (QSG)* for DK-S128

4. Getting Started

Before you start working with your development board, you will need the latest version of the Renesas Synergy™ Software Package (SSP), as well as the development tools needed to work with it.

If you are new to Renesas Synergy™ Platform development, visit our Getting Started Guide (https://www.renesas.com/en-us/products/synergy/get-started.html) on the web. This guide will provide detailed instructions on how to register an account on the Renesas Synergy™ Gallery to obtain a developer license, and how to download and install all the software and tools that are required. Once you have completed these steps, return to this section for more in-depth information on how to work with your board.

How to register for an account on the Renesas Synergy Gallery

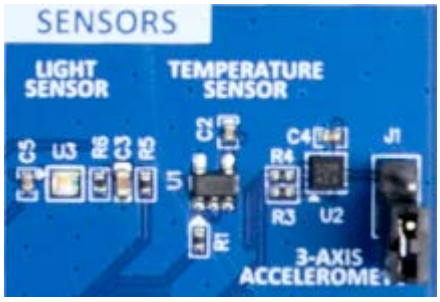
How to download and install the necessary development tools

4.1 Jumpers and DIP Switch settings

4.1.1 Default Board Configuration

J1

J1 is the Accelerometer Interrupt jumper. With the jumper installed, the interrupt from the accelerometer is connected to the Main MCU.



J3

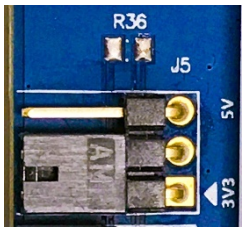
J3 is the MCU Power BUS Source Select. Refer to Table 6: Jumper J3

J17

J17 is the Boot Mode Select Jumper. With the jumper off, the board boots using the on-chip flash memory. With a jumper on, the board boots in Serial Communication Interface (SCI) Boot Mode, that allows for programming through the SCI.

J5

J5 is the PMOD Power Select jumper. This allows the user to select between +5V and +3.3V for the PMOD connector.

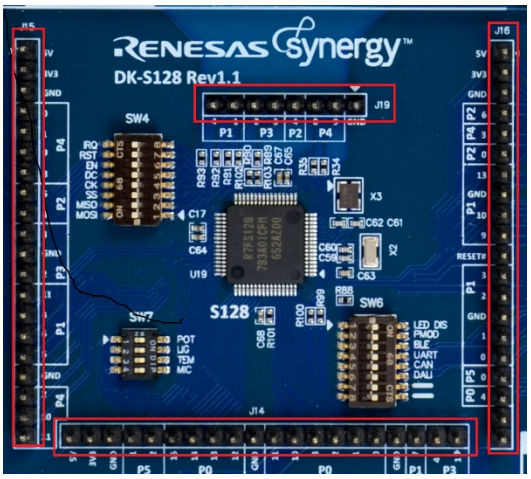


SW5

Enable switch for LED, speaker, accelerometer, and CAN.

SW8

Enable switch for configuring the serial communication protocols.



SW4

Isolation switch for PMOD signals.

SW6

Enable switch for the system peripherals.

SW7

Enable switch for the analog features.

4.1.2 Jumper and DIP Switch functionalities

DIP Switch – SW4

SW4 allows the PMOD signals to be individually accessed on pin header J15. Individual signals can be enabled or disabled, and probed on pin header.

Table 1: DIP Switch SW4

Switch ID	Logical Connection	Default	Description
S1	P4_9/PMOD_MOSI/TS5	OFF	Directly connects this MCU signal to the PMOD connector. SW6-S2 should be OFF.
S2	P4_8/PMOD_MISO/TS4	OFF	Directly connects this MCU signal to the PMOD connector. SW6-S2 should be OFF.
S3	PMOD_SS	OFF	Directly connects this MCU signal to the PMOD connector. SW6-S2 should be OFF.
S4	P2_4/PMOD_CK/TS0	OFF	Directly connects this MCU signal to the PMOD connector. SW6-S2 should be OFF.
S5	P3_3/PMOD_DC/TS2	OFF	Directly connects this MCU signal to the PMOD connector. SW6-S2 should be OFF.
S6	P3_2/PMOD_EN/TS8	OFF	Directly connects this MCU signal to the PMOD connector. SW6-S2 should be OFF.
S7	P1_11/PMOD_RST_L/TS12	OFF	Directly connects this MCU signal to the PMOD connector. SW6-S2 should be OFF.
S8	P1_4/PMOD_IRQ/TS13	OFF	Directly connects this MCU signal to the PMOD connector. SW6-S2 should be OFF.

DIP Switch – SW5

SW5 enables several analog features and the CAN Rx/Tx signals.

Table 2: DIP Switch SW5

Switch ID	Logical Connection	Default	Description
S1	P1_13/BLE_RST_L/LED3	ON	Enables LED3. SW6-S3 should be OFF.
S2	P0_4/IRQ3/SPK	ON	Enables SW2. SW5-S3 should be OFF.
S3	P0_4/IRQ3/SPK	ON	Enables speaker output. SW5-S2 should be OFF.
S4	N/C	ON	Not connected
S5	P2_6/IRQ0/SW1	OFF	Enables Accelerometer Interrupt. A shunt jumper should be installed on J1.
S6	N/C	ON	Not connected
S7	P1_9/CTX	ON	Enables CAN Tx. SW5-S8 should also be ON.
S8	P1_10/CRX	ON	Enables CAN Rx. SW5-S7 should also be ON.

DIP Switch – SW6

SW6 enables major features of the DK-S128.

Table 3: DIP Switch SW6

Switch ID	Logical Connection	Default	Description
S1	SW1_LED_DIS	OFF	Disable nature functions like LED1/2, SW-1.
S2	PMOD_EN_L	ON	Enable PMOD interface. When ON, all switches in SW4 should be OFF.
S3	RSPI_BLE_EN_L	ON	Enable RSPI, BLE and 8-pin SPI header. SW6-S4 must be off.
S4	UART_EN_L	ON	Enable UART (RS232/485) SW6-S3 must be off.
S5	RGB_EN_L	ON	Enable RGB LED
S6	DALI_EN_L	ON	Enable DALI
S7	N/C	ON	Not connected
S8	N/C	ON	Not connected

DIP Switch – SW7

SW7 enables analog input devices.

Table 4: DIP Switch SW7

Switch ID	Logical Connection	Default	Description
S1	ANA_POT	ON	Enables potentiometer
S2	ANA0_LIGHT	ON	Enables light sensor
S3	ANA1_TEMP	ON	Enables temperature sensor
S4	ANA_MIC	OFF	Enables microphone

DIP Switch – SW8

SW8 configures the serial communication protocols.

Table 5: DIP Switch SW8

Switch ID	Logical Connection	Default	Description
S1	RS_MODE_SEL	OFF	RS232/RS485 mode select. ON=RS232, OFF=RS485.
S2	RS_SLEW	OFF	RS485 slew rate control.
S3	RS_SPB	OFF	RS485 data rate control.
S4	RS_RXEN	OFF	RS232/RS485 receiver output enable.

Jumper – J3

Table 6: Jumper J3

Jumper Pins	Logical Connection	Default	Description
1-3	+3V3ANA to +3V3ANA_MCU	ON	Connects +3V3ANA output from U5 to the +3V3 analog rail of the MCU.
2-4	+3V3 to +3V3MCU	ON	Connects the main +3V3 rail to the +3V3 digital rail of the MCU.
3-5	VBAT to +3V3ANA_MCU	OFF	Connects button cell battery to +3V3ANA_MCU.
4-6	VBAT to +3V3MCU	OFF	Connects button cell battery to +3V3MCU.

Jumper – J17

Table 7: Jumper J17

Jumper Pins	Logical Connection	Default	Description
1-2	P2_1/MD/LED2 to GND	OFF	Connects the multiplexed signal to GND. By installing J17, the MCU is placed in serial Boot mode. If open, it's available for LED2.

Jumper – J1

Table 8: Jumper J1

Jumper Pins	Logical Connection	Default	Description
1-2	ACCE_INT_L to P2_6/IRQ0/SW1	OFF	Connects the multiplexed signal to the accelerometer interrupt.

Jumper – J5

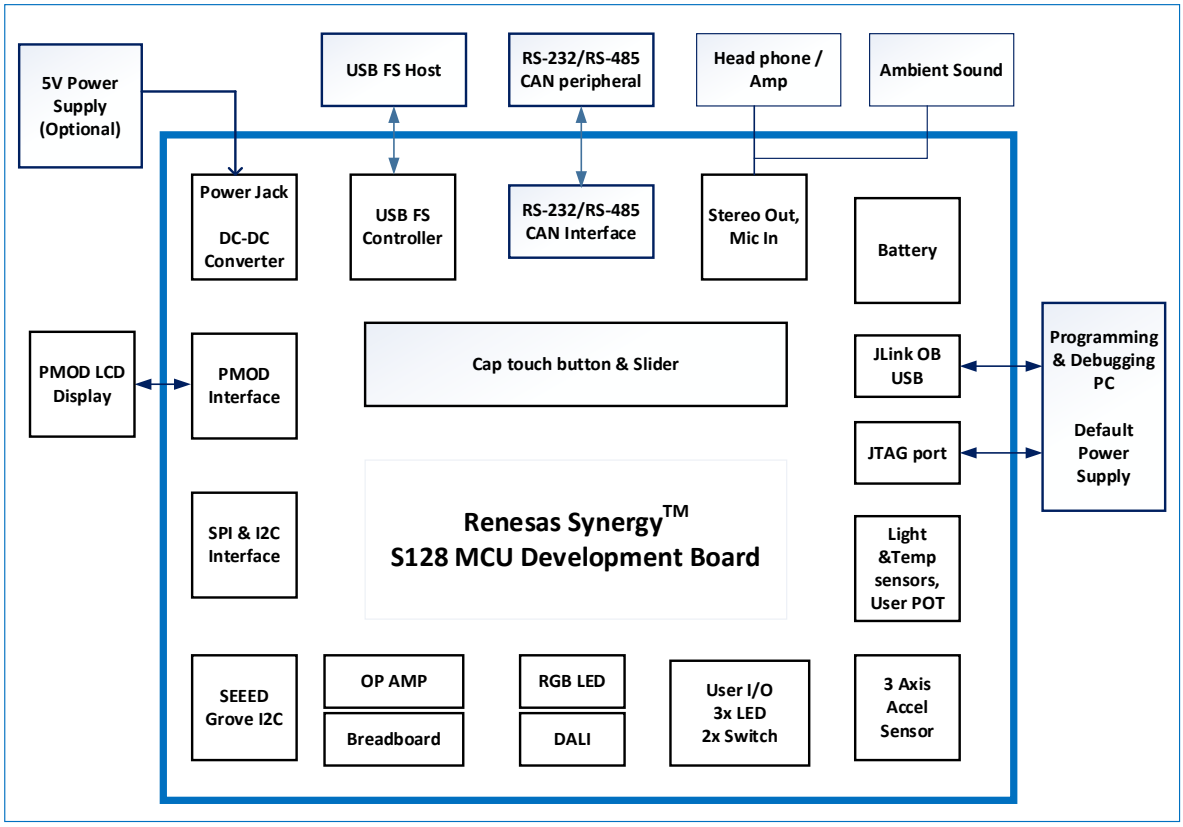
Table 9: Jumper J5 – PMOD Voltage Select

Jumper Pins	Logical Connection	Default	Description
1-2	VCC_PMOD to +3V3	1-2	Connects the VCC_MOD supply voltage rail to +3V3.
2-3	VCC_PMOD to +5V	1-2	Connects the VCC_PMOD supply voltage rail to +5V.

Note: For many of the functions on the DK-S128, serial resistors are included on the signal lines. These resistors may be removed to isolate specific functions. For example, the zero ohm resistors near the breadboard area (such as R104, R105, R106) may be removed to isolate the breadboard from the op amp. This would free the op amp to be used at the pin header. Similar techniques may be applied in other places on the DK-S128. Refer to the schematics in Section 7 for further information.

5. Hardware Layout

5.1 System block diagram



5.2 Power Requirements

This section covers information related to power supplies for DK-S128. It includes input power supply sources, power up behavior, battery supply configuration, and how to measure current consumption for the DK-S128 and other key components.

5.2.1 Power supply options

This section provides details on various input power supply options available on the DK-S128.

J-Link USB Micro-B (Default)

J-Link USB Micro-B connector J12, located near the battery holder. This connector is used for debugging and programming the MCU and it is also the primary power supply for the DK-S128. The J-Link USB limits the current through the USB connector to 500 mA.

See Section 5.3.4 for more information about the use of this USB Micro-B connector for the J-Link feature.

5V Power Barrel Jack

For board configurations that exceed 500 mA, this connector enables the use of an external 5V power supply for the DK-S128. It accepts a 5.5 mm plug. The following are the dimensions: OD x 2.1 mm ID x > = 9.5 mm insertion barrel power plug, center is positive polarity. The connector is rated 2A.

There is limited voltage protection on the 5V direct power input. Using a reverse-polarity barrel plug power source may permanently damage the unit.

External power supply

Installation of a 5V power source can be done using the Expansion Headers J14, J15 and J16. The positive (+5V) of the external power supply can be connected at J14-20, J15-1, or J16-1. The negative (Ground) of the external power supply can be connected at J14-18, J15-3 or J16-3. See Section 6 for more details on the Expansion Headers.

There is no over voltage protection on the 5-V direct power input on the Expansion Headers. Use extreme caution when connecting an external power supply to the Expansion Headers.

CR2032 lithium coin cell

Installed in BAT1 holder near the right edge of the circuit board.

When power to the DK-S128 is supplied from the lithium coin cell and J-Link circuitry operation is required for debugging, connection of the JLOB USB interface will power the J-Link circuitry. This will also have a side effect of powering some other circuitry on the DK-S128 main board that would otherwise remain un-powered for battery operation.

5.2.2 Power-up behavior

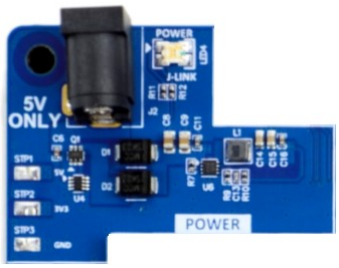
When powered from J-Link USB or the barrel jack (the 3.3V Main Power Subsystem is currently under power) the green LED in LED4 adjacent to the barrel jack will be lit. The red LED in LED4 will be controlled by the J-Link microcontroller in accordance with J-Link specifications. When both LEDs are lit, LED4 will appear orange.

5.2.3 Battery supply configuration

A lithium button cell battery may be used to provide power to the board. See Section 5.2.1 **CR2032 lithium coin cell** for information on the battery.

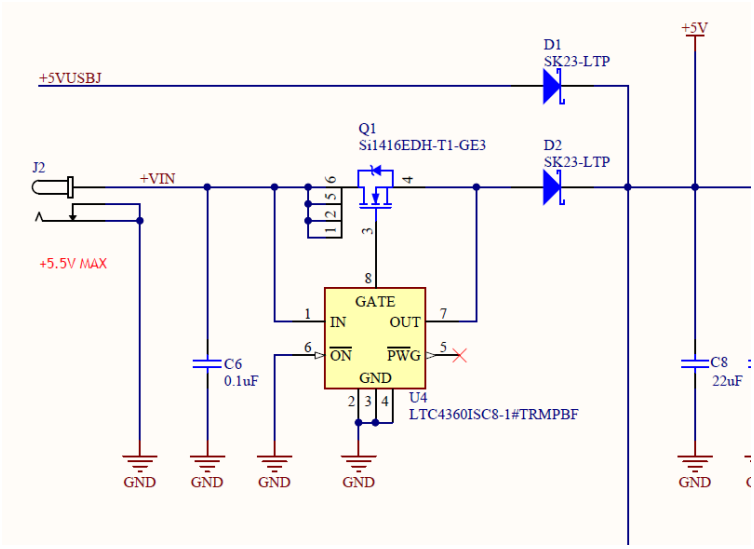
Specific jumpers must be configured to use the button cell battery. See 4.1.1 Default Board Configuration **Jumper – J3** for information on the jumper settings.

5.2.4 Power-rails on the board



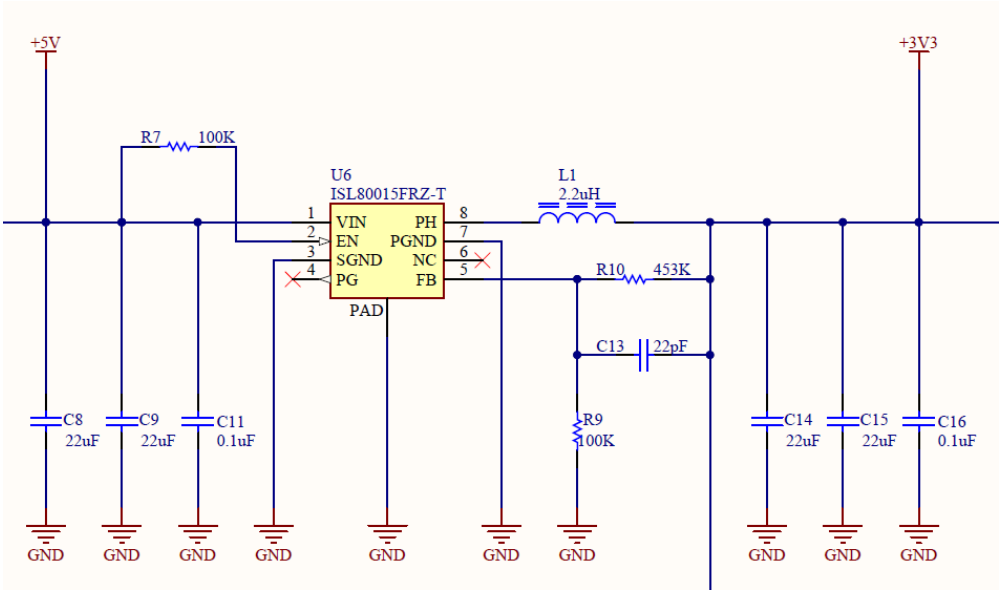
+5V Main voltage rail

Dual low drop Schottky diodes merge the two power inputs (barrel connector input and J-Link USB supply) that are available and higher is delivered downstream as the power rail +5V to power supplies for the circuitry on the DK-S128.



3.3V Main power subsystem

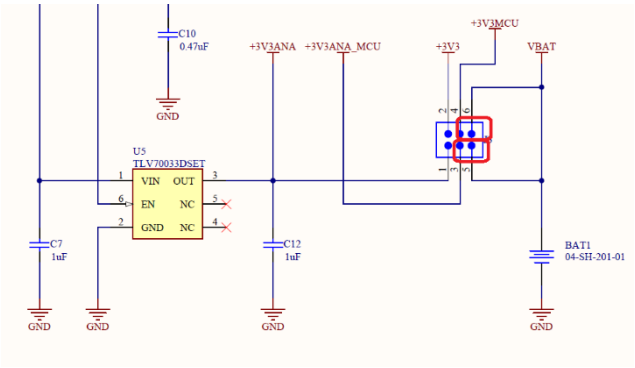
Almost all the circuits on the board require 3.3 V, including S128 memory, and logic. The +5V Main Voltage Rail power is delivered to the Intersil ISL80015 buck-boost switcher. This switcher, using a tiny inductor, creates 3.3V at up to 1.5A to the S128, and can operate with +5V rail voltage between 3.6V and 5.8V.



5.2.5 Measuring Current Consumption

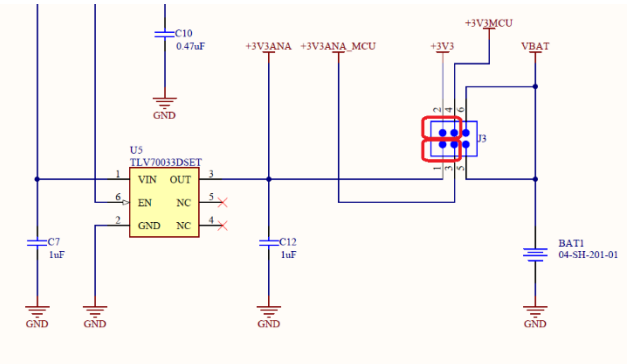
Microcontroller current

Power supply current to the S128 may be monitored by connecting ammeter leads of a multimeter in place one of three jumpers on the main board. Jumper J3 can be used to monitor the S128 current (to VCC) plus USB MCU current (to VCC_USB and VCC_USB_LDO). Jumper J3 lower center and lower left pins can be used to monitor the MCU analog current (to AVCC).



Battery current

Battery current can be measured by replacing the appropriate jumper with ammeter leads of a multimeter (or shunt resistor and voltmeter). This can be performed by using J3 upper pins to measure the S128 digital supply current, using J3 lower center and lower right pins to measure the S128 analog supply.



5.3 Connectivity and Settings

This section describes the various connectivity blocks along with any configuration options on the S128. The connector interface pinouts and signal definitions are included, along with any jumper or DIP switch settings that are required for each functional block. Usage conflicts between functional blocks are described.

5.3.1 USB Device

This USB Micro-B connection jack connects the S128 to an external USB Host, the FS capable, but does not accept power from the host. Host power voltage is checked to detect connection.

Table 10: USB device connector (J6)

USB Device Connector		DK-S128	
Pin	**Description**	**Logical Pin(s)**	**Function Name(s)**
1	VBUS, +5VDC, 15 K resistors connected in-line	P4_7	P4_7/USB_VBUS
2	Data-	USB_DM	USB_DM
3	Data+	USB_DP	USB_DP
4	USB ID, jack internal switch, cable inserted	-	(Not connected)
5	Ground	VSS	(Circuit Ground)

5.3.2 RS232/485 and CAN

The RS232/485 and CAN connectors header connects the ISL41387 RS232/485 transceiver and the IFX1050 CAN transceiver to the mating screw-terminal-block adapter supplied with the DK-S128 kit.

The DK-S128 interfaces with the ISL41387 RS232/485 transceiver as follows:

Table 11: RS232/485 transceiver

ISL41387 RS232/485 Transceiver		DK-S128	
Pin	**Description**	**Logical Pin(s)**	**Function Name(s)**
RA	Receive Channel A	P4_10	UART_RX
RB	(NOT CONNECTED)	No Connect	Not Applicable
RXEN	Receive Enable, logically compared to RXEN# (Controlled by SW8 FD/HD switch)	No Connect	Not Applicable
RXEN#, DEN	Not Receive Enable, Transmit Enable	P1_3	UART_DEN
DY	Transmitted Data Input	P4_11	UART_TX
SLEW	RS485 slew limit setting (Controlled by SW8 SLEW switch)	No Connect	Not Applicable
SPB	RS485 speed control setting (Controlled by SW8 SPEED switch)	No Connect	Not Applicable
ON	In RS232 mode only, pin HIGH enables charge pumps for supply voltage boost	P1_2	UART_ON
485/Not232	RS232/485 mode selection (Controlled by SW8 RS485/232 switch)	No Connect	Not Applicable

Note: The RS232/485 feature shares the DK-S128 signals with the RSPI feature. Only one of these features may be used at a time. See Table 3: DIP Switch SW6 for feature enable settings.

The DK-S128 interfaces with the IFX1050 CAN transceiver as follows:

Table 12: CAN transceiver

IFX1050 CAN Transceiver		DK-S128	
Pin	**Description**	**Logical Pin(s)**	**Function Name(s)**
TXD	Data for Transmission	P1_9	CAN_TX
RXD	Received Data	P1_10	CAN_RX

Note: The RS232/485 feature shares the S128 signals with the RSPI feature. Only one of these features may be used at a time. See Table 3: DIP Switch SW6 for the feature enable settings.

The RS232/485 and CAN connectors header interfaces the ISL41387 RS232/485 transceiver and the IFX1050 CAN transceiver as follows:

Table 13: RS232/485 and CAN connector (J18)

RS232/485 and CAN Connector		Transceiver	
Pin	**Description**	**Logical Pin(s)**	**Function Name(s)**
1	CANH, CAN high	CAN_H	IFX1050, High line I/O
2	CANL, CAN low	CAN_L	IFX1050, Low line I/O
3	Not Connected	No Connect	Not Applicable
4	Ground	GND	(Circuit ground, both Xcvrs)
5	A, RS232 channel 1 input, RS485 inverting input	A1	ISL41387 receive A
6	B, RS232 channel 2 input, RS485 non-inverting input	B1	ISL41387 receive B
7	Y, RS232 channel 1 output, RS485 inverting output	Y1	ISL41387 transmit Y
8	Z, RS232 channel 2 output, RS485 non-inverting output	Z1	ISL41387 transmit Z

5.3.3 Stereo Headphone Jack

This 3.5 mm stereo output jack is provided with the left output to the tip conductive region, right output to the middle conductive region, and output return to the cable-end conductive region of a miniature stereo phone plug. The input signal supplied to the headphone amplifier is from a **single** DAC on the S128, so only monaural sound will be possible.

Table 14: Stereo headphone jack (J9)

Stereo Headphone Connector		Stereo Headphone Amplifier	
Pin	**Description**	**Logical Pin(s)**	**Function Name(s)**
1	Common headphone return, sleeve	SPK_OUTI	Return for both left and right channels, and cable shield
2	Left headphone signal, plug tip	SPK_OUTL	Left output channel signal
3	Right headphone signal, plug middle ring	SPK_OUTR	Right output channel signal

Table 15: Stereo headphone amplifier (U9)

Stereo Headphone Amplifier		DK-S128	
Pin	**Description**	**Logical Pin(s)**	**Function Name(s)**
9	VM	VSS	(Circuit Ground)
5	IN_L, Left headphone input signal	P0_4	SPK_INL
1	IN_R, Right headphone signal	P0_4	SPK_INR

Note: The Stereo Headphone feature shares MCU signals with the SW2 feature. Only one of these features may be used at a time. See Table 2: DIP Switch SW5 for feature enable settings.

5.3.4 J-Link USB and Power

This USB Micro-B connection jack connects the J-Link MCU to an external USB Host, FS capable, and accepts power from the host, allowing re-programming and debug of the DK-S128 firmware.

See Section 5.2.1 under the section **J-Link USB Micro-B** for more information on using the J-Link USB Micro-B connector to supply power to the board.

Table 16: J-Link USB connector (J12)

J-Link USB Connector		JLOB Microcontroller	
Pin	**Description**	**Logical Pin(s)**	**Function Name(s)**
1	VBUS, +5VDC, connected to +5VUSBJ	-	(Not connected)
2	Data-	USB_DM	USB_DM
3	Data+	USB_DP	USB_DP
4	USB ID, jack internal switch, cable inserted	-	(Not connected)
5	Ground	VSS	(Circuit Ground)

5.3.5 DK-S128 Programming and Debug

This 1.27-mm pitch, 2x5-pin polarized header has pin 7 removed to allow the use with a pin-7-plugged debug connector. The DK-S128 Programming and Debug connector allows programming and debug of the DK-S128 using Serial Wire interface only.

Table 17: S128 Programming and Debug connector (J10)

S128 Programming and Debug Connector		DK-S128	
Pin	**Description**	**Logical Pin(s)**	**Function Name(s)**
1	ARM VCC, connected to +3V3 bus	+3V3MCU	MCU VCC
2	ARM SWDIO, Serial Wire Debug Data I/O	P1_8	P1_8/SWDIO
3	ARM GND	VSS	(Circuit Ground)
4	ARM SWCLK, Serial Wire Debug Clock	P3_0	P3_0/SWCLK
5	ARM GND	VSS	(Circuit Ground)
6	ARM SWO, Serial Wire Trace Output (optional)	-	(Not connected)
7	(pin removed)	N/A	N/A
8	Not Used	-	(Not connected)
9	GND	VSS	(Circuit Ground)
10	ARM RESET#, Pin low resets target CPU	RESET_L	RESET_L

5.3.6 J-Link JTAG Programming and Debug

This connection is for factory use only. The J-Link MCU programming should be completed using the J-Link USB Micro-B connector.

5.3.7 Grove I²C Interface

This 4-pin specialty connector is provided for ready connection to Seeed Grove I²C I/O modules for ready demonstration of various interface capabilities.

Table 18: Grove I²C connector (J8)

Grove I²C Connector		DK-S128	
Pin	**Description**	**Logical Pin(s)**	**Function Name(s)**
1	Circuit ground	VSS	(Circuit Ground)
2	+3.3V bus	-	+3V3
3	I2C serial clock	P4_0	P4_0/SCL0
4	I2C serial data	P4_1	P4_1/SDA0

Note: Although P4_0 and P4_1 can be re-configured for non-I²C use, doing so will also affect the accelerometer and the SPI and I²C connector interfaces. See Section 5.3.8: SPI and I2C Interface, and for the accelerometer see Section **Error! Reference source not found. Error! Reference source not found.**.

5.3.8 SPI and I²C Interface

The SPI and I²C interface connector is an 8-pin 2.54-mm pitch single-column header with pin connections labelled on the PCB overlay.

Table 19: SPI and I²C connector (J7)

SPI&I²C Connector		DK-S128	
Pin	**Description**	**Logical Pin(s)**	**Function Name(s)**
1	+3V3 power bus	-	(config. may connect to VCC)
2	SPI communications chip select	P2_5	P2_5/PMOD_SS
3	SPI Master-In Slave-Out	P4_8	P4_8/PMOD_MISO
4	SPI Master-Out Slave-In	P4_9	P4_9/PMOD_MOSI
5	SPI serial clock	P4_2	P4_2/PMOD_CK
6	I2C serial clock	P4_0	P4_0/SCL0
7	I2C serial data	P4_1	P4_1/SDA0
8	Circuit ground	VSS	(Circuit Ground)

Note: P4_0 and P4_1 can be re-configured for non-I²C use, however, doing so will also affect the accelerometer and the Grove I²C interface. For the Grove I²C interface, see Section 5.3.7: Grove I2C Interface, and for the accelerometer see Section 7 Sensors Schematic, **Error! Reference source not found.**.

5.3.9 PMOD Interface

The PMOD interface connector is a two column six row (12-pin) 2.54-mm pitch connector with selectable power between +5V and +3.3V (with jumper disconnect.) The interface is configurable to several alternate PMOD Standard interface configurations

A PMOD Type 1 General Purpose Input Output (GPIO) interface is achieved by connecting the daughter-card to the 6 pins closest and then to the PCB, daughter card, pin 1 on the same end as J4 pin 1 (square pad on J4 soldered pins) that will properly insert daughter pin 1 to J4-6.

Table 20: PMOD connector (J4), Type 1

PMOD Connector, Type 1 (GPIO)		DK-S128	
Pin	**Description**	**Logical Pin(s)**	**Function Name(s)**
1	(not connected)		
2	(not connected)		
3	(not connected)		
4	(not connected)		
5	(not connected)		
6	(not connected)		
7	PMOD input/output 1 (IO1)	P1_4	(discrete firmware controlled input/output)
8	PMOD input/output 2 (IO2)	P1_11	(discrete firmware controlled input/output)
9	PMOD input/output 3 (IO3)	P3_3	(discrete firmware controlled input/output)
10	PMOD input/output 4 (IO4)	P3_2	(discrete firmware controlled input/output)
11	GND	VSS	(Circuit Ground)
12	PMOD VCC, PMODA_PWR, configurable for +5V or +3.3V	-	(depends on configuration)

A PMOD Type 2A expanded Serial Peripheral Interface (SPI) is achieved by plugging the daughter card pin 1 into J4 pin 1. Firmware must properly configure all applicable pins.

Table 21: PMOD connector (J4), Type 2A

PMOD Connector, Type 2A (expanded SPI)		DK-S128	
Pin	**Description**	**Logical Pin(s)**	**Function Name(s)**
1	PMOD slave select (SS) signal	P2_5	P2_5/CTS9 (to /SS9A)
2	PMOD master out slave in (MOSI) signal	P4_9	P4_9/TXD9 (to /MOSI9A)
3	PMOD master in slave out(MISO) signal	P4_8	P4_8/RXD9 (to /MISO9A)
4	PMOD serial clock (SCK) signal	P2_4	P2_4/SCK9A
5	GND	VSS	(Circuit Ground)
6	PMOD VCC, PMODA_PWR, configurable for +5V or +3.3V	-	(depends on configuration)
7	PMOD interrupt (INT) signal	P1_4	P1_4/IRQ1
8	PMOD RESET command	P1_11	(discrete firmware controlled output)
9	PMOD unspecified signal	P3_3	(discrete firmware controlled)
10	PMOD unspecified signal	P3_2	(discrete firmware controlled)
11	GND	VSS	(Circuit Ground)
12	PMOD VCC, PMODA_PWR, configurable for +5V or +3.3V	-	(depends on configuration)

A PMOD Type 4A expanded Universal Asynchronous Receiver Transmitter (UART) is achieved by plugging the daughter card pin 1 into J4 pin 1. Firmware must properly configure all applicable pins.

Always check the jumper position prior to inserting a PMOD. Applying 5V to a 3.3V PMOD may damage the PMOD and potentially the DK-S128: The power to this port is not fuse protected.

The PMOD MCU pins are not 5V tolerant. Even though some PMODs require 5V to be powered (using the 5 position of the jumper), do not connect 5V or higher signals to the DK-S128 connected signals on this port directly. If a full level RS232 port, for example, is desired one might choose the Digilent PMOD RS232X, that plugs into J4 and translates these voltages.

Table 22: PMOD connector (J4), Type 4A

PMOD Connector, Type 4A (expanded UART)		DK-S128	
Pin	**Description**	**Logical Pin(s)**	**Function Name(s)**
1	PMOD clear to send (CTS) signal	P2_5	P2_5/CTS9A
2	PMOD transmit data (TXD) signal	P4_9	P4_9/TXD9A
3	PMOD received data (RXD) signal	P4_8	P4_8/RXD9A
4	PMOD request to send (RTS) signal	P2_4	P2_4/SCK9A (to discrete firmware controlled output, RTS)
5	GND	VSS	(Circuit Ground)
6	PMOD VCC, PMODA_PWR, configurable for +5V or +3.3V	-	(depends on configuration)
7	PMOD interrupt (INT) signal	P1_4	P1_4/IRQ1
8	PMOD RESET command	P1_11	(discrete firmware controlled output)
9	PMOD unspecified signal	P3_4	(discrete firmware controlled)
10	PMOD unspecified signal	P4_3	(discrete firmware controlled)
11	GND	VSS	(Circuit Ground)
12	PMOD VCC, PMODA_PWR, configurable for +5V or +3.3V	-	(depends on configuration)

Note: The PMOD feature shares MCU signals with the Capacitive Touch feature. Only one of these features may be used at a time. See Table 1: DIP Switch SW4 and Table 3: DIP Switch SW6 for PMOD and Capacitive Touch feature enable settings.

5.3.10 Human-Machine Interface

5.3.10.1 User touch buttons

Two capacitive touch buttons located in the upper left region of the DK-S128 are provided for user programmable control.

Table 23: User touch buttons

User Touch Button		DK-S128	
Designator	**Description**	**Logical Pin(s)**	**Function Name(s)**
TS1	User capacitive touch button 1 (leftmost)	P1_4	P1_4/TS13
TS2	User capacitive touch button 2 (rightmost)	P4_9	P4_9/TS5

Note: The Capacitive Touch feature shares DK-S128 signals with the PMOD feature. Only one of these features may be used at a time. When operating the DK-S128 capacitive touch components, set all SW4 switches to the off position and the PMOD switch on SW6 to the off position. These settings adjust the parasitic capacitance on the touch components to the proper range for sensing. See Table 1: DIP Switch SW4 and Table 3: DIP Switch SW6 for additional information.

5.3.10.2 User touch slider

One capacitive 5-segment touch slider, TSL is provided for user programmable control. See the following Table.

Table 24: User touch slider

User Touch Slider		DK-S128	
Designator	**Description**	**Logical Pin(s)**	**Function Name(s)**
TSL1-1	User capacitive slider segment 5 (leftmost)	P4_8	P4_8/TS4
TSL1-2	User capacitive slider segment 4 (left-center)	P2_4	P2_4/TS0
TSL1-3	User capacitive slider segment 3 (center)	P3_3	P3_3/TS2
TSL1-4	User capacitive slider segment 2 (right-center)	P3_2	P3_2/TS8
TSL1-5	User capacitive slider segment 1 (rightmost)	P1_11	P1_11/TS12
-	Capacitive Sensor Ground Reference	P1_12	P1_12/TSCAP

Note: The Capacitive Touch feature shares DK-S128 signals with the PMOD feature. Only one of these features may be used at a time. When operating the DK-S128 capacitive touch components, set all SW4 switches to off position and PMOD switch on SW6 to off position. These settings adjust the parasitic capacitance on the touch components to the proper range for sensing. See Table 1: DIP Switch SW4 and Table 3: DIP Switch SW6 for additional information.

5.3.10.3 User push-button switches

Near the bottom right corner of the DK-S128 in the User Input/Output region are two push-button switches, SW1 and SW2, provided for programmable control.

Table 25: User push-button switches

User Touch Button		DK-S128	
Designator	**Description**	**Logical Pin(s)**	**Function Name(s)**
SW1	Push Button Switch 1 (rightmost), LOW when pressed	P2_6	P2_6/IRQ0
SW2	Push Button Switch 2 (leftmost), LOW when pressed	P0_4	P0_4/IRQ3

Note: The interface for SW1 is shared with the interrupt for the accelerometer. The interface for SW2 is shared with the speaker DAC signal.

5.3.10.4 User LEDs

Immediately above the user push button switches are one red, one yellow, and one green LED provided for user programmable control.

Table 26: User push-button switches

User LED		DK-S128	
Designator	**Description**	**Logical Pin(s)**	**Function Name(s)**
LED1	LED 1 (leftmost, red), power from MCU	P4_3	P4_3/LED1
LED2	LED 2 (center, yellow), power from MCU	P2_1	P2_1/LED2
LED3	LED 3 (rightmost, green), power from MCU	P1_13	P1_13/LED3

Note: The interface for LED2 is shared with the Boot Mode Select. See Table 7: Jumper J17 for further information.

5.3.10.5 User potentiometer

Immediately to the right of the user push button switches is one 10 kΩ thumbwheel potentiometer with its voltage tap terminal fed to the DK-S128.

Table 27: User potentiometer

User Potentiometer		DK-S128	
Designator	**Description**	**Logical Pin(s)**	**Function Name(s)**
POT1	10 kΩ thumbwheel potentiometer	P5_0	P5_0/AN013

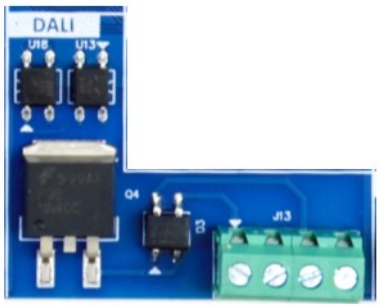
5.3.10.6 Reset push-button switch

A push-button switch, SW3, is located near the center of the lower edge of the DK-S128. SW3 will cause the DK-S128 to reset when pressed.

Table 28: Reset switch

Reset Switch		DK-S128	
Designator	**Description**	**Logical Pin(s)**	**Function Name(s)**
SW3	Push Button Switch, LOW when pressed	RESET#	RESET#

5.3.10.7 DALI interface



A DALI Interface Connector (J13) is located near the lower right section of the board.

Digital Addressable Lighting Interface (DALI) is an international standard (IEC 62386) that defines a standard for electronic control gear and electronic control devices.

The DK-S128 contains a hardware DALI 2.0 peripheral. The DK-S128 includes additional hardware to interface with the DALI peripheral, and may be used as either a DALI Master or a DALI Slave.

The DALI specification defines signal voltage levels that are much higher than the rest of the DK-S128. Circuitry on the DK-S128 provides the electrical interface needed to interface the DALI signal levels with the low voltage signal levels of the S128 MCU. Details of the electrical circuits can be found on page 6 of the electrical schematic. See Section **Error! Reference source not found.**.

Signals on the DALI bus are higher voltage than other signals on the DK-S128 and may pose a risk of electric shock. Use caution when working with these signals, and follow all DALI guidelines to ensure user safety.

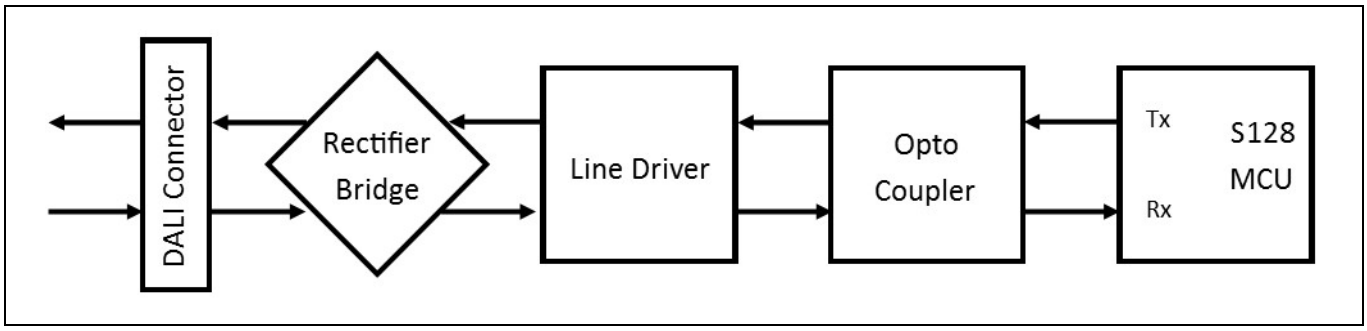


Figure 3: DALI interface circuit

Table 29: DALI connector (J13)

DALI Bus Connector		Description
Pin	**Signal**	
1	DA-1	Two terminal points are electrically connected for each signal to allow easy daisy chaining of the DALI systems. The DALI specification indicates that the bus lines are interchangeable.
2		
3	DA-2	
4		

DALI TX/RX		DK-S128	
	Description	**Logical Pin(s)**	**Function Name(s)**
	DALI - TX	P1_1	P1_1/DALI_TX
	DALI - RX	P1_0	P1_0/DALI_RX

5.3.11 PWM RGB LED

An RGB LED is located right above the DALI circuitry. With DALI being used for lighting protocol, the RGB LED allows visual feedback typically required with DALI system development.

Note that each element of the RGB LED is connected to a PWM-capable GPIO of the DK-S128 that can provide dimming capabilities. This allows for simulations of real-world lighting controls.

Table 30: RGB LED (LED5)

User LED		DK-S128	
Designator	**Description**	**Logical Pin(s)**	**Function Name(s)**
LED5 - R	LED5 – RED Element	P1_7	P1_7/LED_R
LED5 - G	LED5 – GREEN Element	P3_1	P3_1/LED_G
LED5 - B	LED5 – BLUE Element	P3_4	P3_4/LED_B

5.3.12 OP AMP

The DK-S128 provides four internal Operational Amplifier (OPAMP) blocks. These blocks and pins are brought out to the board as open-ended, which means they are not connected to any peripherals by default. The connections to the DK-S128 OPAMP is located near the lower left section of the board.

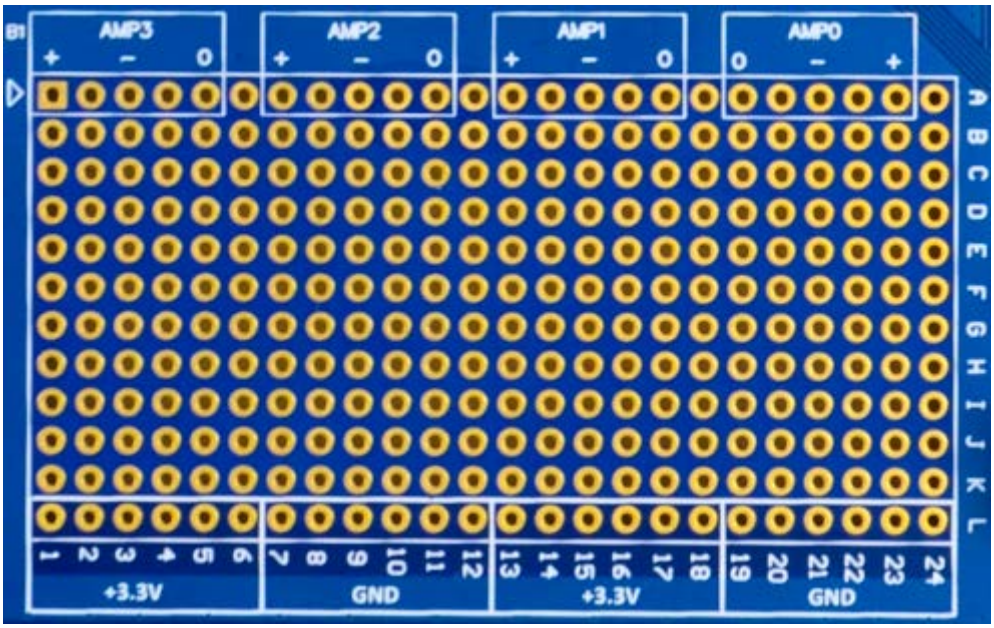
Each connection to the OPAMP block is grouped into three connections. Positive Input, Negative Input and finally the Output pin.

Table 31: DK-S128 OPAMP Mapping

OPAMP Block		DK-S128	
Designator	**Description**	**Logical Pin(s)**	**Function Name(s)**
AMP0 +	AMP0 +, positive input	P0_0	P0_0/OP0+
AMP0 -	AMP0 -, negative input	P0_1	P0_1/ OP0-
AMP0 O	AMP0 O, output	P0_2	P0_2/ OP0O
AMP1 +	AMP1 +, positive input	P0_13	P0_13/ OP1+
AMP1 -	AMP1 -, negative input	P0_12	P0_12/ OP1-
AMP1 O	AMP1 O, output	P0_10	P0_10/ OP1O
AMP2 +	AMP2 +, positive input	P0_15	P0_15/ OP2+
AMP2 -	AMP2 -, negative input	P0_14	P0_14/ OP2-
AMP2 O	AMP2 O, output	P0_11	P0_11/ OP2O
AMP3 +	AMP3 +, positive input	P5_1	P5_1/ OP3+
AMP3 -	AMP3 -, negative input	P5_2	P5_2/ OP3-
AMP3 O	AMP3 O, output	P0_3	P0_3/ OP3O

5.3.13 Breadboard area

The DK-S128 provides a breadboard area for quick circuit prototyping development. While normally intended for OPAMP circuit development, this breadboard area can be used for any other circuit prototyping. Note that in the bottom area, 3.3V power supply and ground connection points are provided for easy access.



6. Expansion Connectors

The **shield**-style header connection consists of four 2.54-mm pitch 20-pin and 8-pin headers with their topmost and bottom-most pins aligned horizontally and parallel to each other with 57.4 mm separation center-to-center. These connectors are located on either side of the. 5V and 3.3V power buses, as well as ground are accessible on the pins of these connectors, as are many of the DK-S128 port pins.

The DK-S128 port pins that are load-sensitive (such as pins used for capacitive sensing), or interface high-speed data and require impedance control (such as USB) are not made accessible here.

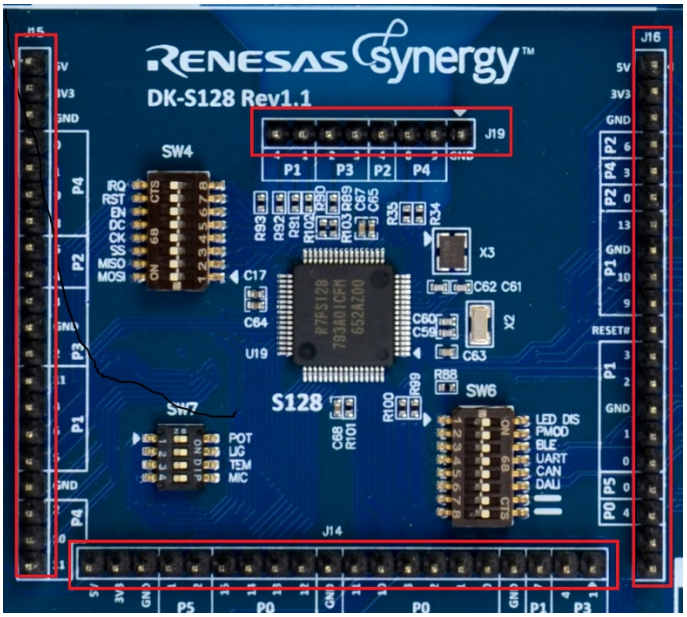


Table 32: Shield-Style Header connectors (J14)

Shield-Style Header Connectors		DK-S128	
Pin	**Description**	**Logical Pin(s)**	**Function Name(s)**
J14-1	PWM 3 Interface	P3_1	P3_1/PWM3
J14-2	PWM 2 Interface	P3_4	P3_1/PWM2
J14-3	PWM 1 Interface	P1_7	P3_1/PWM1
J14-4	Ground	-	GND
J14-5	OP AMP 0, Positive Input	P0_0	P0_0/OP1+
J14-6	OP AMP 0, Negative Input	P0_1	P0_1/OP0-
J14-7	OP AMP 0, Output	P0_2	P0_2/OP0O
J14-8	OP AMP 3, Output	P0_3	P0_3/OP3O
J14-9	OP AMP 1, Output	P0_10	P0_10/OP1O
J14-10	Ground	-	GND
J14-11	OP AMP 2, Output	P0_11	P0_11/OP2O
J14-12	OP AMP 1, Negative Input	P0_12	P0_12/OP1-
J14-13	OP AMP 1, Positive Input	P0_13	P0_13/OP1+
J14-14	OP AMP 2, Negative Input	P0_14	P0_14/OP2-
J14-15	OP AMP 2, Positive Input	P0_15	P0_15/OP2+
J14-16	OP AMP 3, Negative Input	P5_2	P5_2/OP3-
J14-17	OP AMP 3, Positive Input	P5_1	P5_1/OP3+
J14-18	Ground	-	GND
J14-19	connected to +3V3 bus	VCC	MCU power
J14-20	connected to +5V bus	-	(Not connected)

Table 33: Shield-Style Header connectors (J15)

Shield-Style Header Connectors		DK-S128	
Pin	**Description**	**Logical Pin(s)**	**Function Name(s)**
J15-1	connected to +5V bus	-	(Not connected)
J15-2	connected to +3V3 bus	VCC	MCU power
J15-3	Ground	-	GND
J15-4	I2C communication clock	P4_0	P4_0/SCL0
J15-5	I2C communication data	P4_1	P4_1/SDA0
J15-6	PMOD interface or capacitive touch sensing	P4_9	P4_9/PMOD_MOSI/TS5
J15-7	PMOD interface or capacitive touch sensing	P4_8	P4_8/PMOD_MISO/TS4
J15-8	PMOD interface	P2_5	P2_5/PMOD_SS
J15-9	PMOD interface or capacitive touch sensing	P2_4	P2_4/PMOD_CK/TS0
J15-10	PMOD interface or capacitive touch sensing	P3_3	P3_3/PMOD_DC/TS2
J15-11	Ground	P1_3	GND
J15-12	Switch setting	-	SW_PMOD_EN_L
J15-13	PMOD interface or capacitive touch sensing	P1_11	P1_11/PMOD_RST_L/TS12
J15-14	PMOD interface or capacitive touch sensing	P1_4	P1_4/PMOD_IRQ/TS13_R
J15-15	SPI interface chip select	P1_6	P1_6/SPI_SS3
J15-16	SPI interface chip select	P1_5	P1_5/SPI_SS2
J15-17	Ground	-	GND
J15-18	BLE IRQ on IRQ4	P4_2	P4_2/IRQ4-BLE_IRQ_L
J15-19	SPI and UART interface	P4_10	P4_10/SPI_MISO/UART_RX
J15-20	SPI and UART interface	P4_11	P4_11/SPI_MOSI/UART_TX

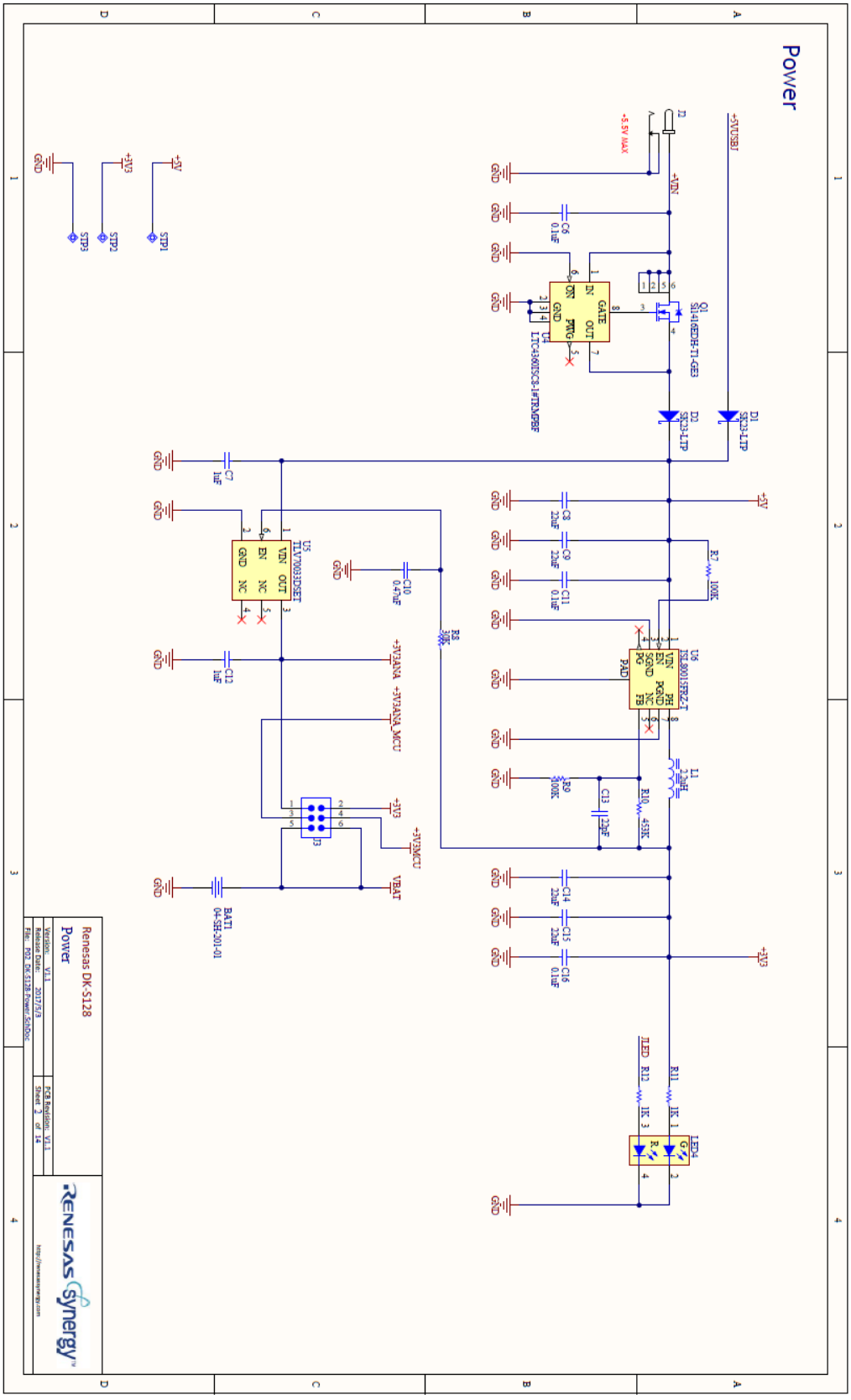
Table 34: Shield-Style Header connectors (J16)

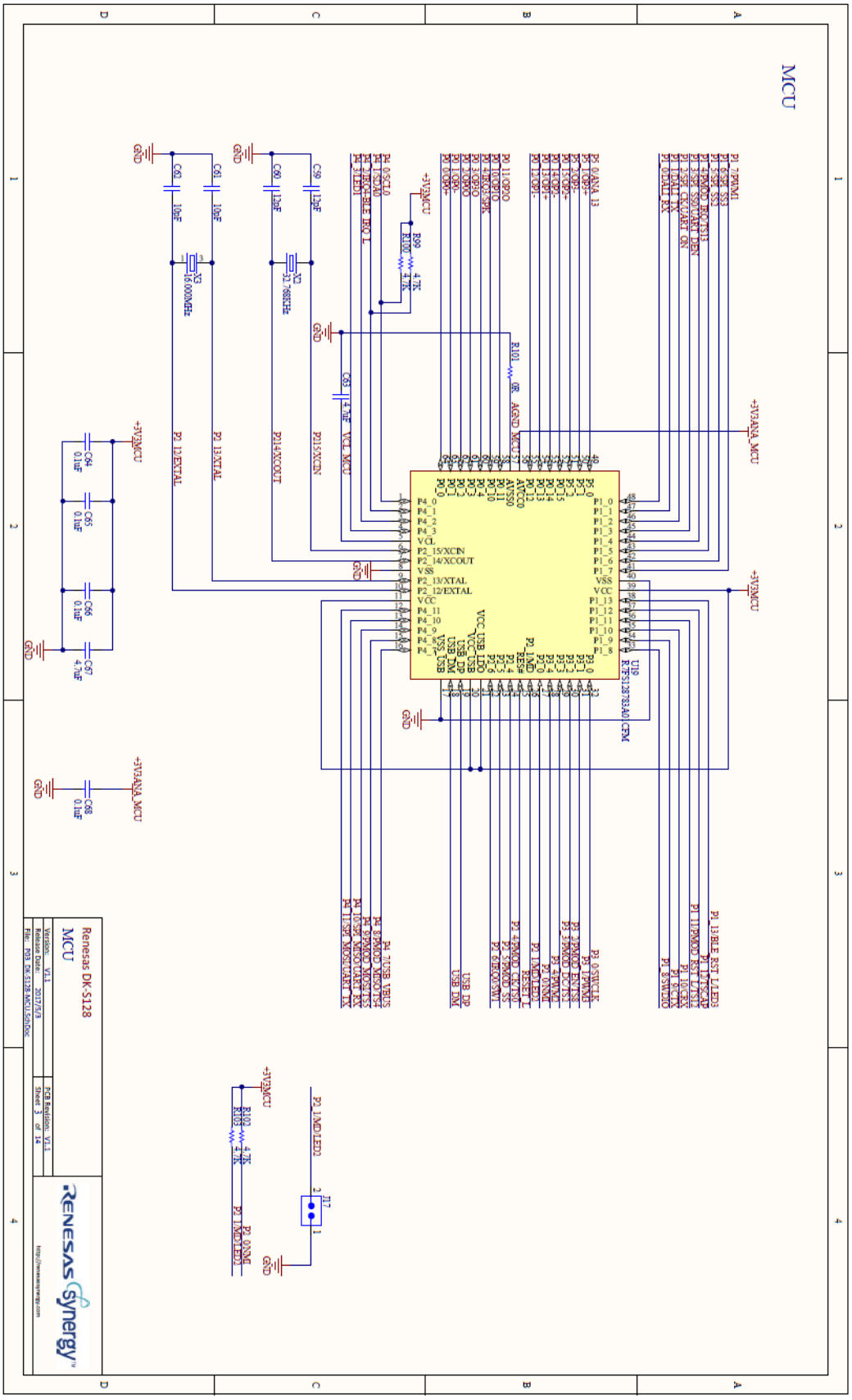
Shield-Style Header Connectors		DK-S128	
Pin	**Description**	**Logical Pin(s)**	**Function Name(s)**
J16-1	connected to +5V bus	-	(Not connected)
J16-2	connected to +3V3 bus	VCC	MCU power
J16-3	Ground	-	GND
J16-4	IRQ0	P2_6	P2_6/IRQ0/SW1
J16-5	GPIO for LED1	P4_3	P4_3/LED1
J16-6	None-maskable interrupt	P2_0	P2_0/NMI
J16-7	BLE reset or GPIO for LED3	P1_13	P1_13/BLE_RST_L/LED3
J16-8	Ground	-	GND
J16-9	CAN receive	P1_10	P1_10/CRX
J16-10	CAN transmit	P1_9	P1_9/CTX
J16-11	MCU Reset	RES#	RESET_L
J16-12	SPI chip select or UART interface	P1_3	P1_3/SPI_SS0/UART_DEN
J16-13	SPI clock or UART interface	P1_2	P1_2/SPI_CK/UART_ON
J16-14	Ground	-	GND
J16-15	DALI interface data transmit	P1_1	P1_1/DALI_TX
J16-16	DALI interface data receive	P1_0	P1_0/DALI_RX
J16-17	RS232/485 transmit signal to ISL41387	P4_11	P4_11/TXD0
J16-18	IRQ3	P0_4	P0_4/IRQ3/SPK
J16-19	Not connected	-	Not connected
J16-20	Not connected	-	Not connected

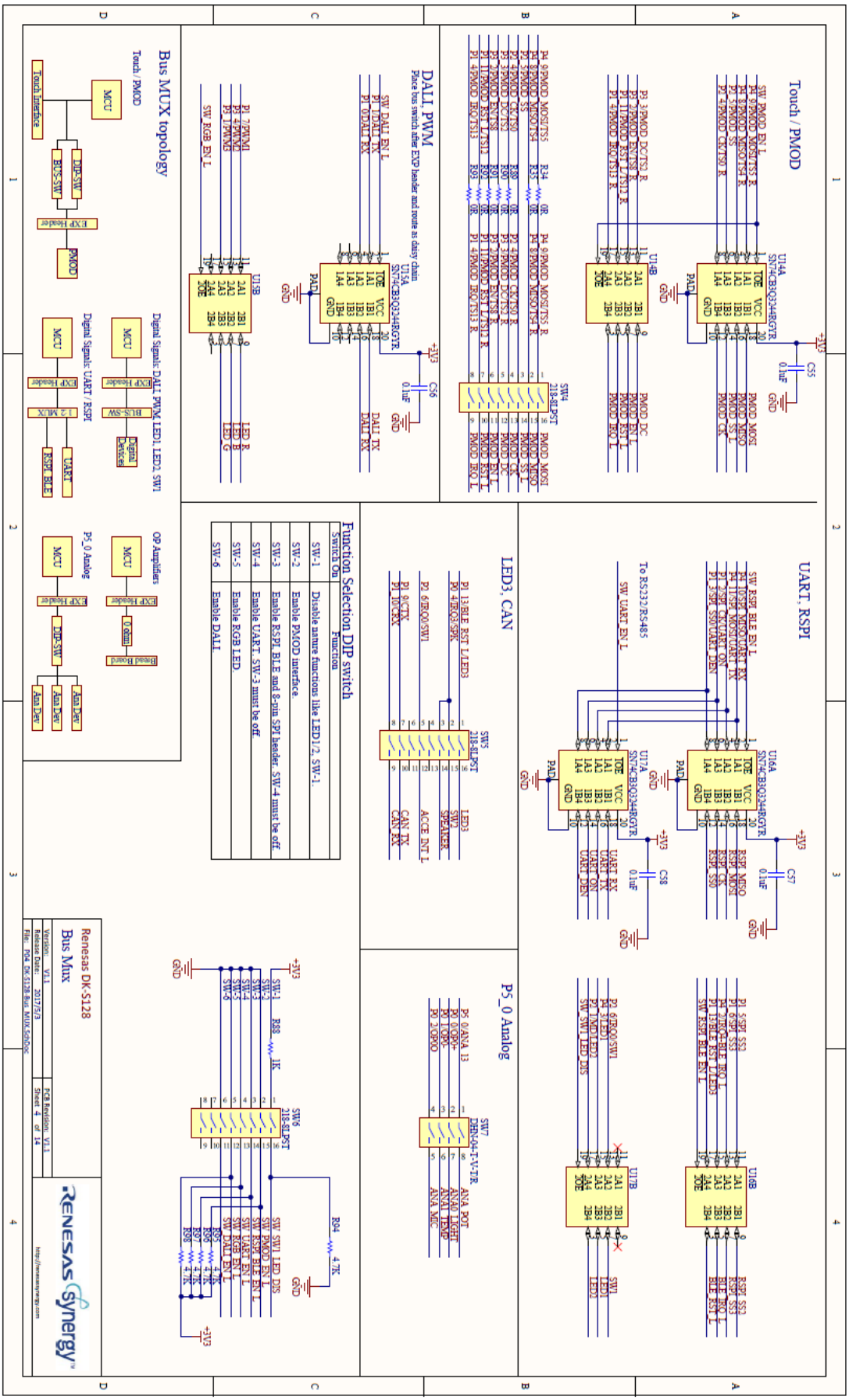
Table 35: Shield-Style Header connectors (J19)

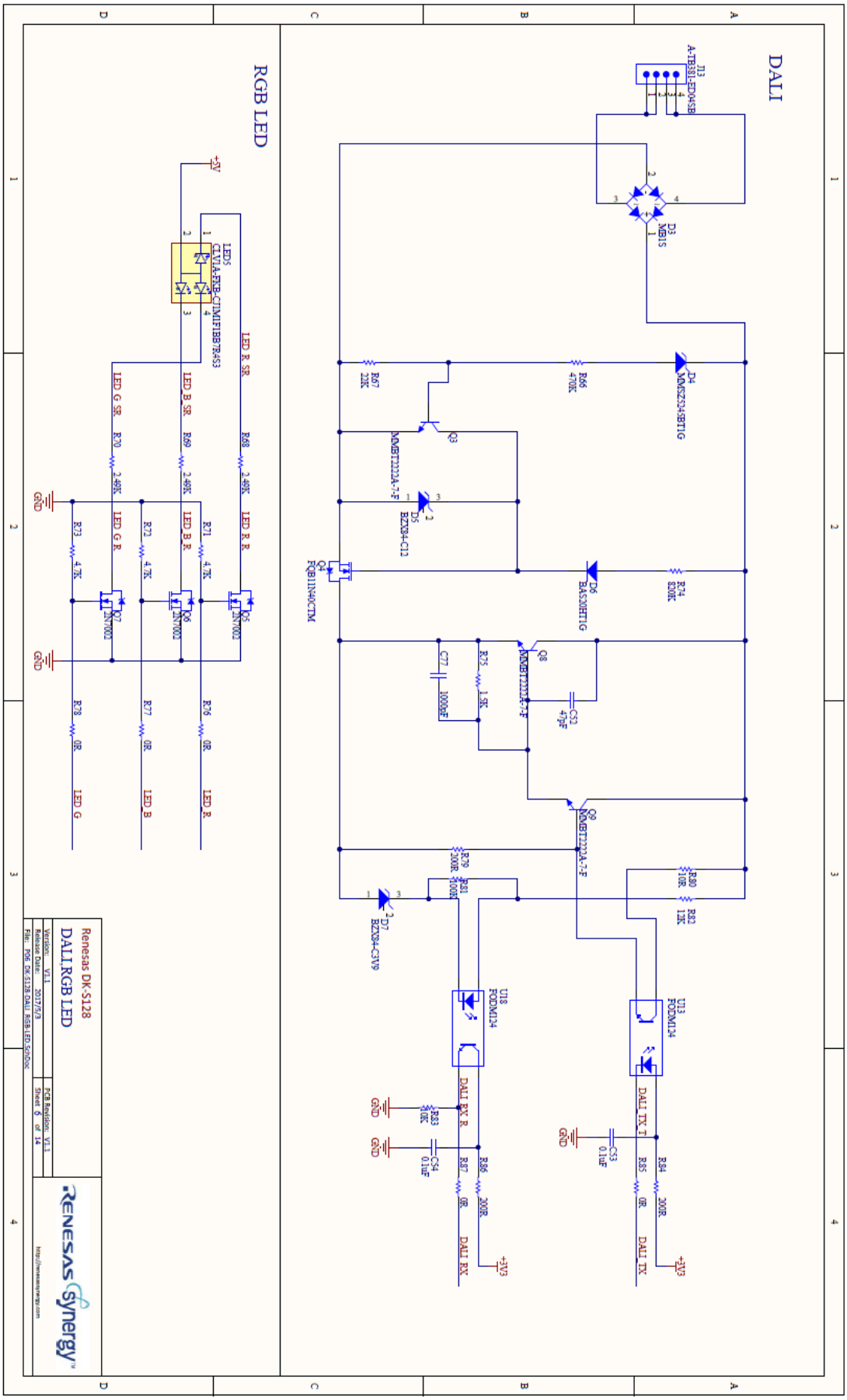
Shield-Style Header Connectors		DK-S128	
Pin	**Description**	**Logical Pin(s)**	**Function Name(s)**
J19-1	Ground	-	GND
J19-2	Cap Touch TS5	P4_9	P4_9/PMOD_MOSI/TS5
J19-3	Cap Touch TS4	P4_8	P4_8/ PMOD_MISO/TS4
J19-4	Cap Touch TS0	P2_4	P2_4/ PMOD_CK/TS0
J19-5	Cap Touch TS2	P3_3	P3_3/ PMOD_DC/TS2
J19-6	Cap Touch TS8	P3_2	P3_2/ PMOD_EN/TS8
J19-7	Cap Touch TS12	P1_11	P1_11/ PMOD_RST_L/TS12
J19-8	Cap Touch TS13	P1_4	P1_4/ PMOD_IRQ/TS13

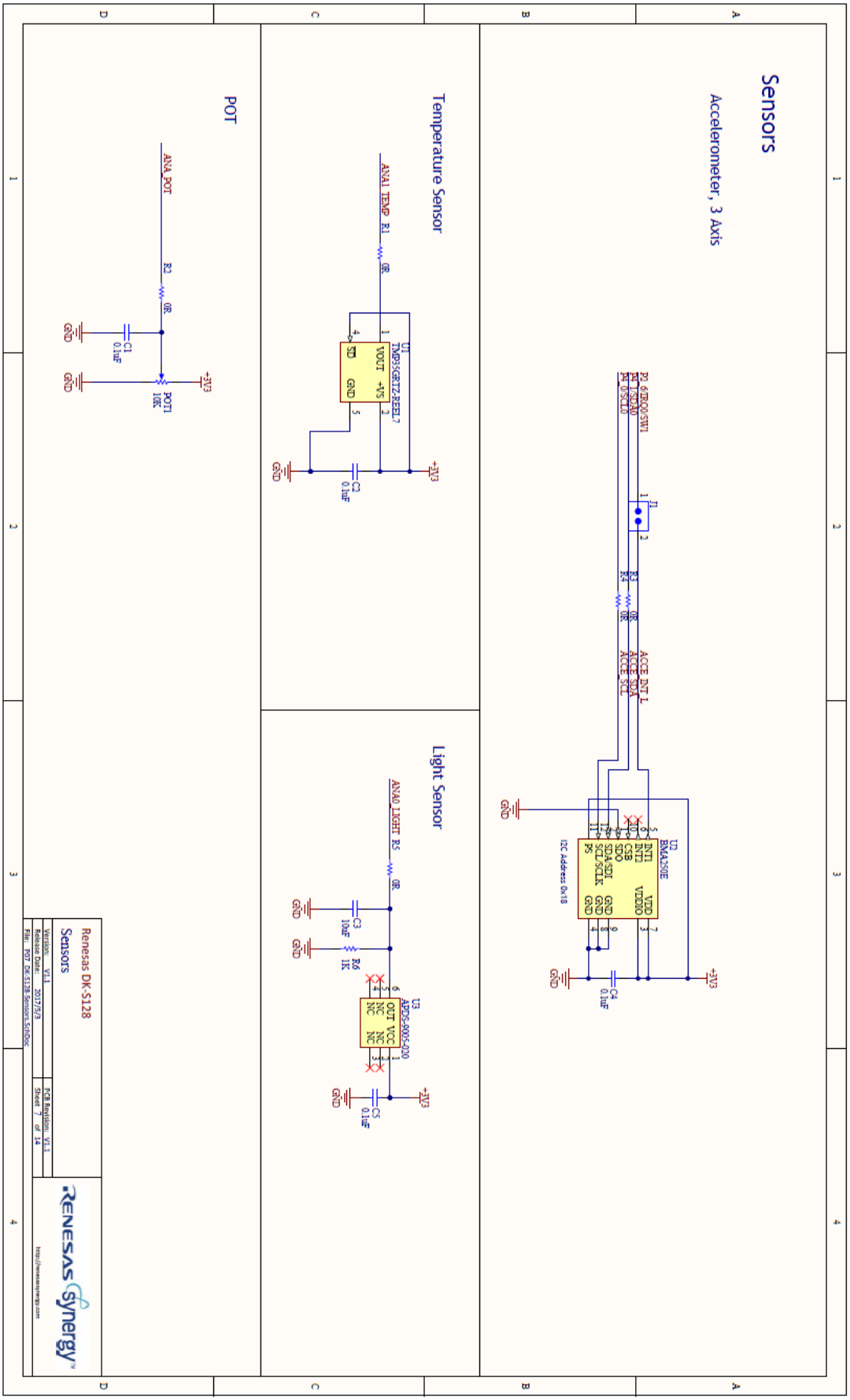
7. Electrical Schematics

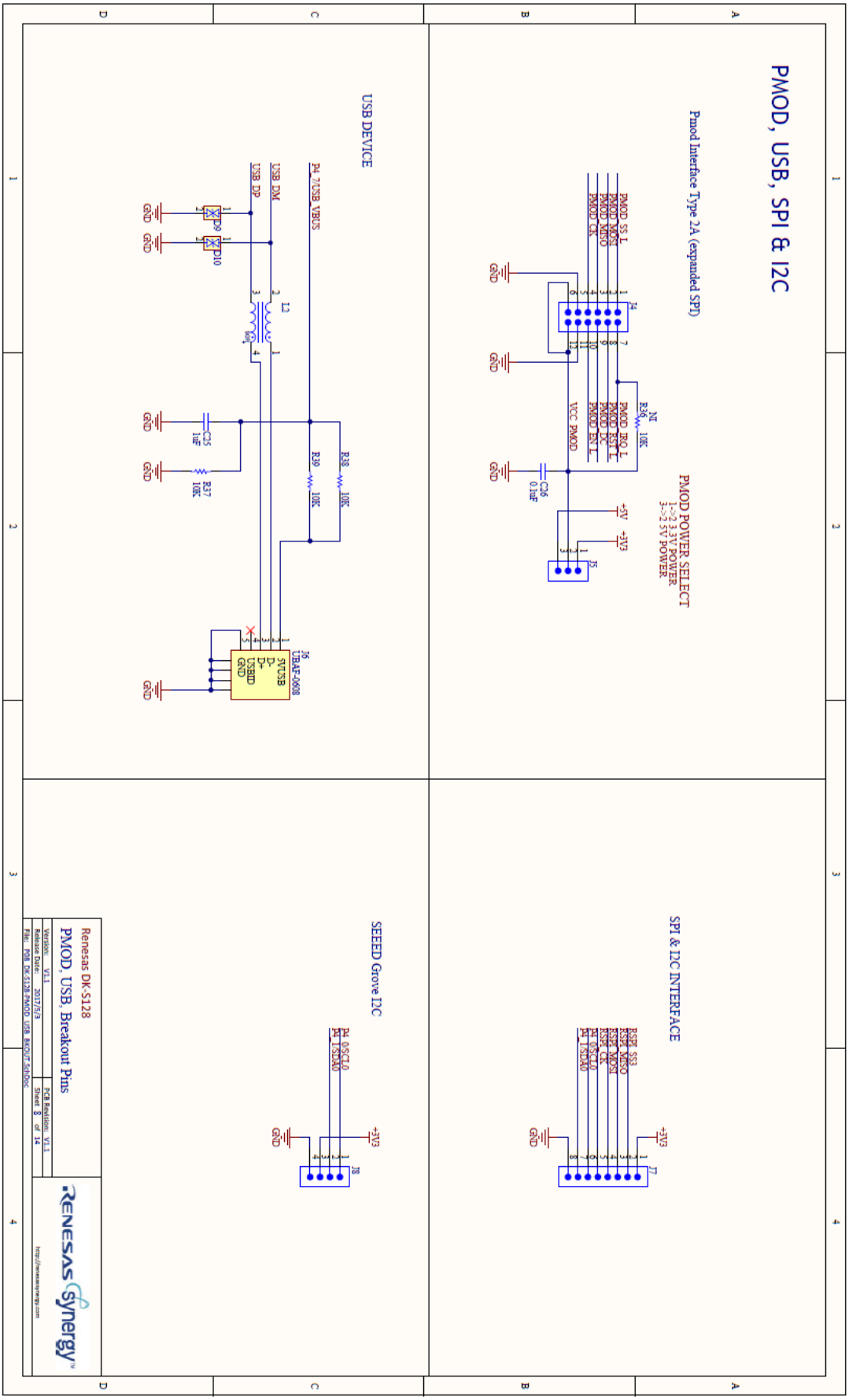


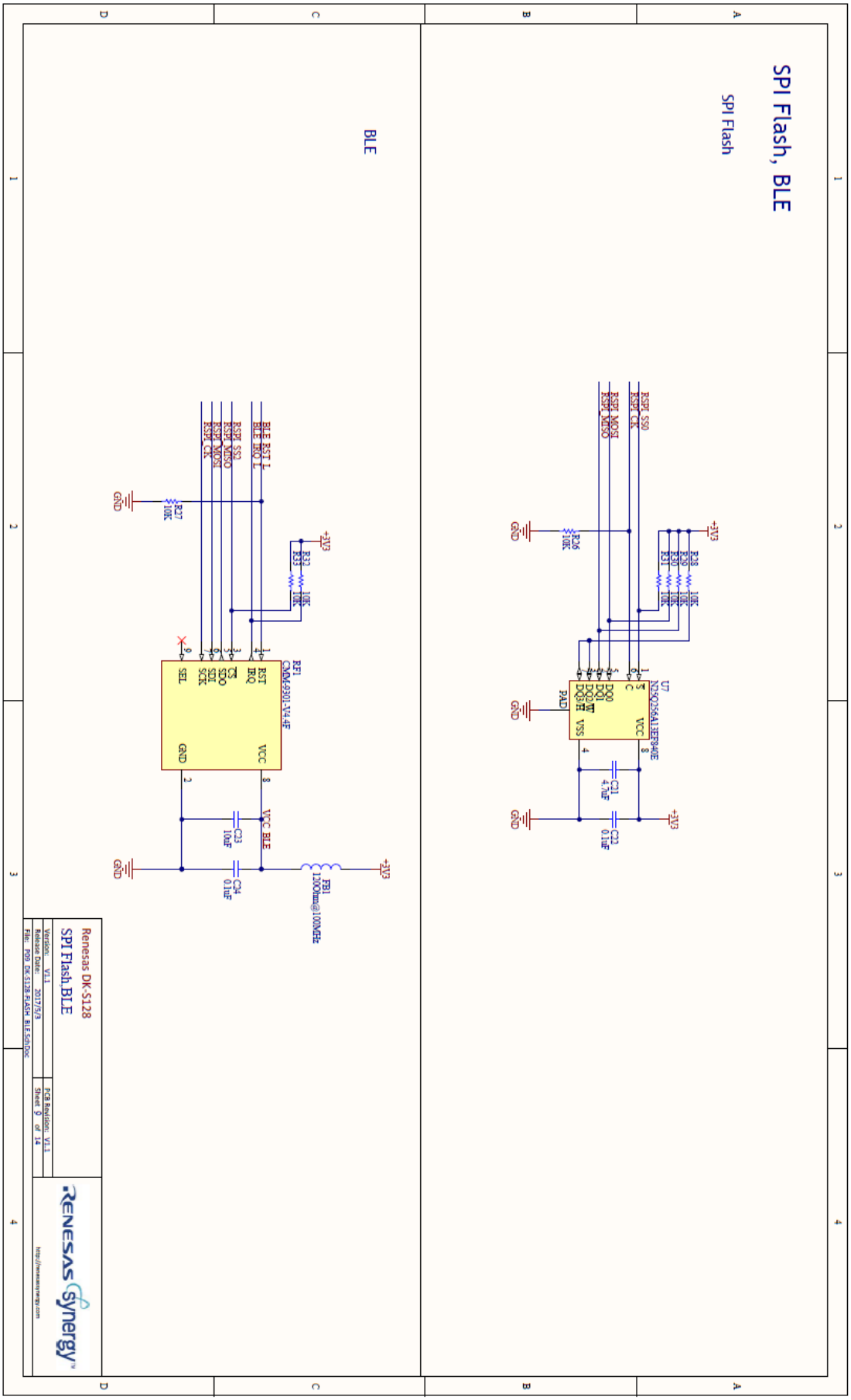

MCU
Renesas DK-S128
MCU
Version: V1.1
Release Date: 2017/6/3
File: P03_DK-S128 MCU.SchDoc
PCB Revision: V1.1
Sheet 3 of 14
RENESAS synergy
+3V3MCU
+3V3ANA_MCU
GND
U19
R7FS128783A40CFM
P2_13/XTAL
P2_12/EXTAL
P2_15/XCIN
P2_14/XCOUT
VCL_MCU
P2_1/MD/LED2
P0_0/SWCLK
P1_13/BLE_RST_LLED3
USB_DP
USB_DM

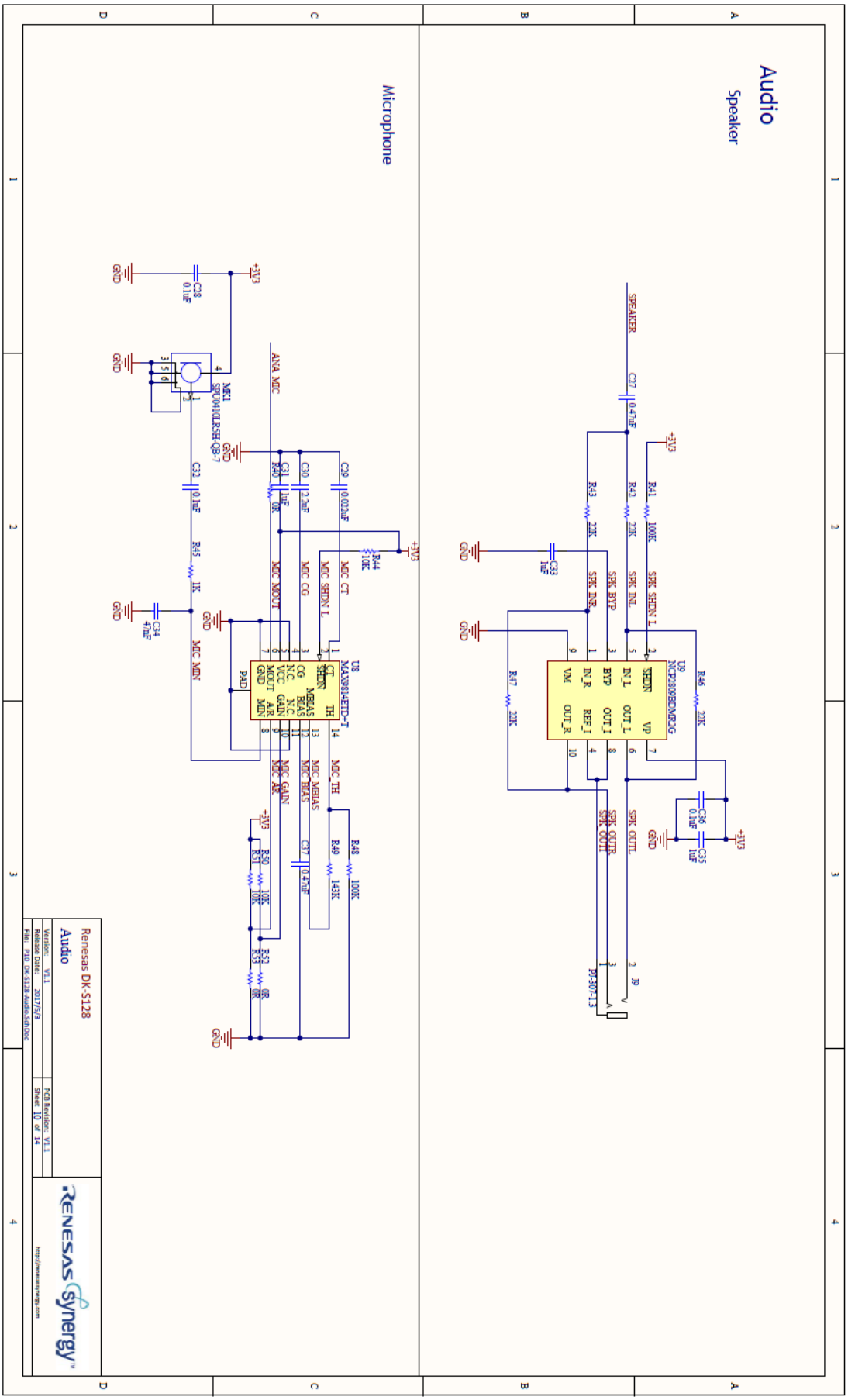

Touch / PMOD
UART, RSPI
DALI PWM
LED3, CAN
P5_0 Analog
Bus MUX topology
Function Selection DIP switch
Renesas DK-S128
Bus Mux

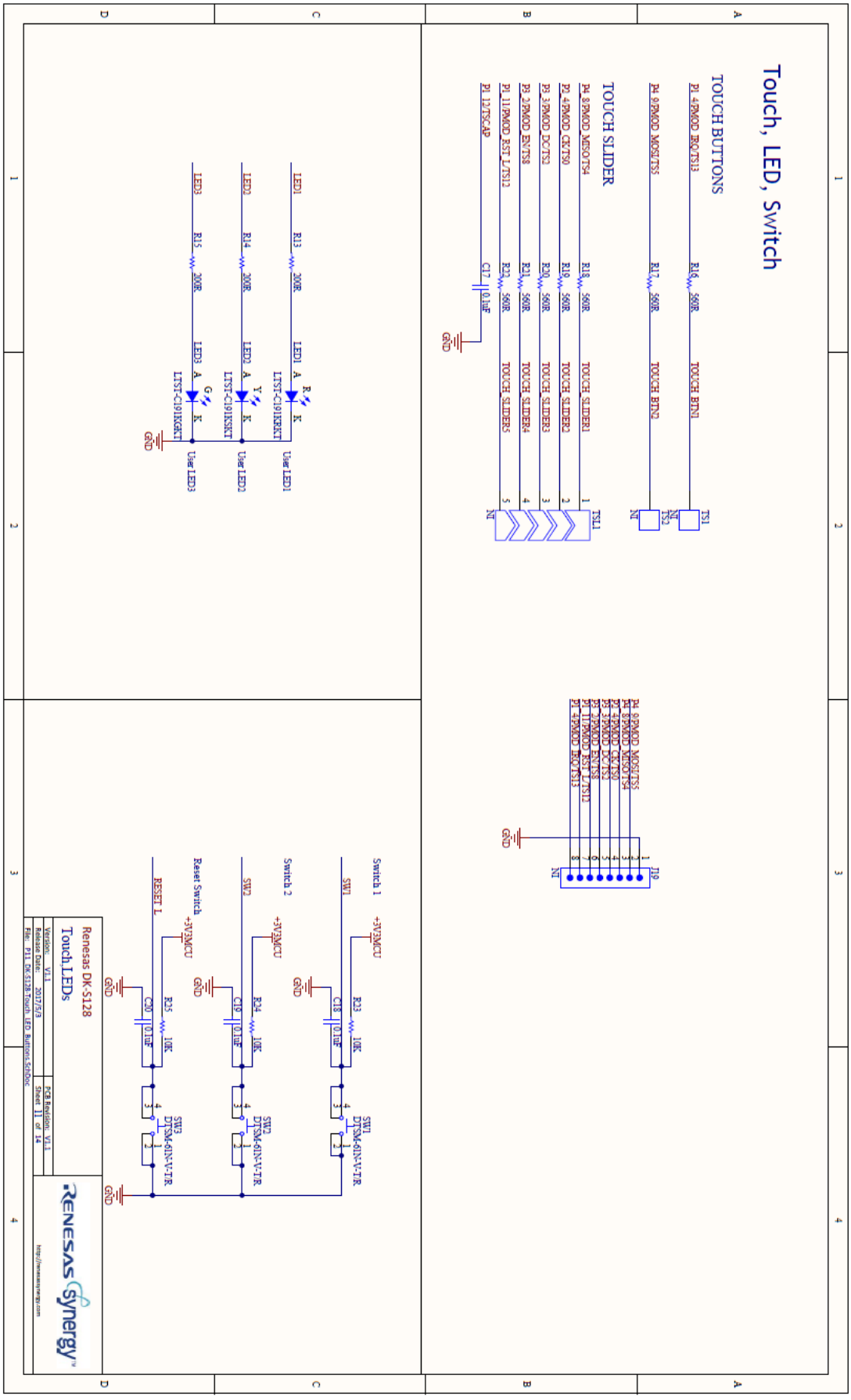

DALI
RGB LED
Renesas DK-S128
DALI,RGB LED
Renesas Synergy

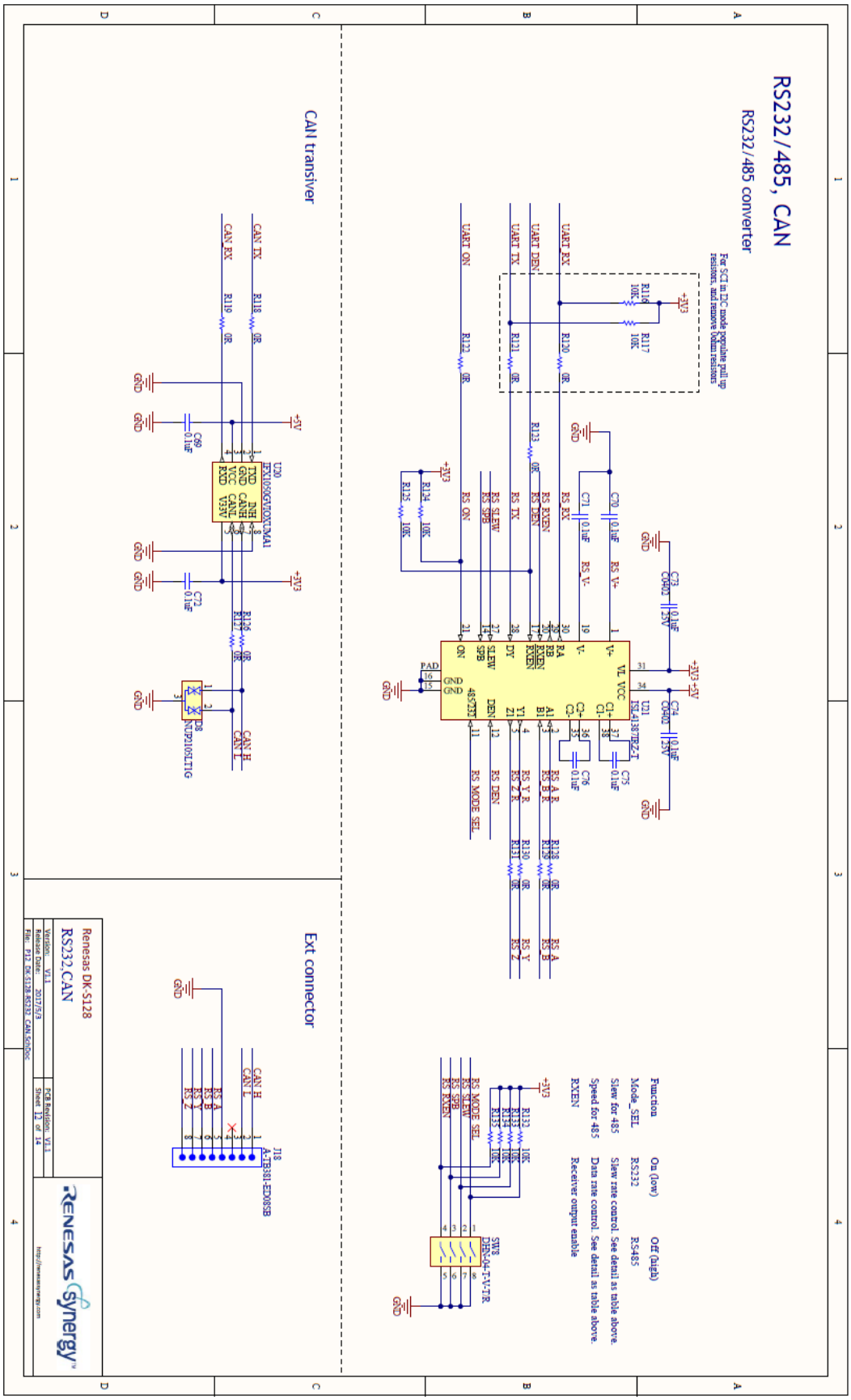

Sensors
Accelerometer, 3 Axis
Temperature Sensor
Light Sensor
POT
Renesas DK-S128
Sensors

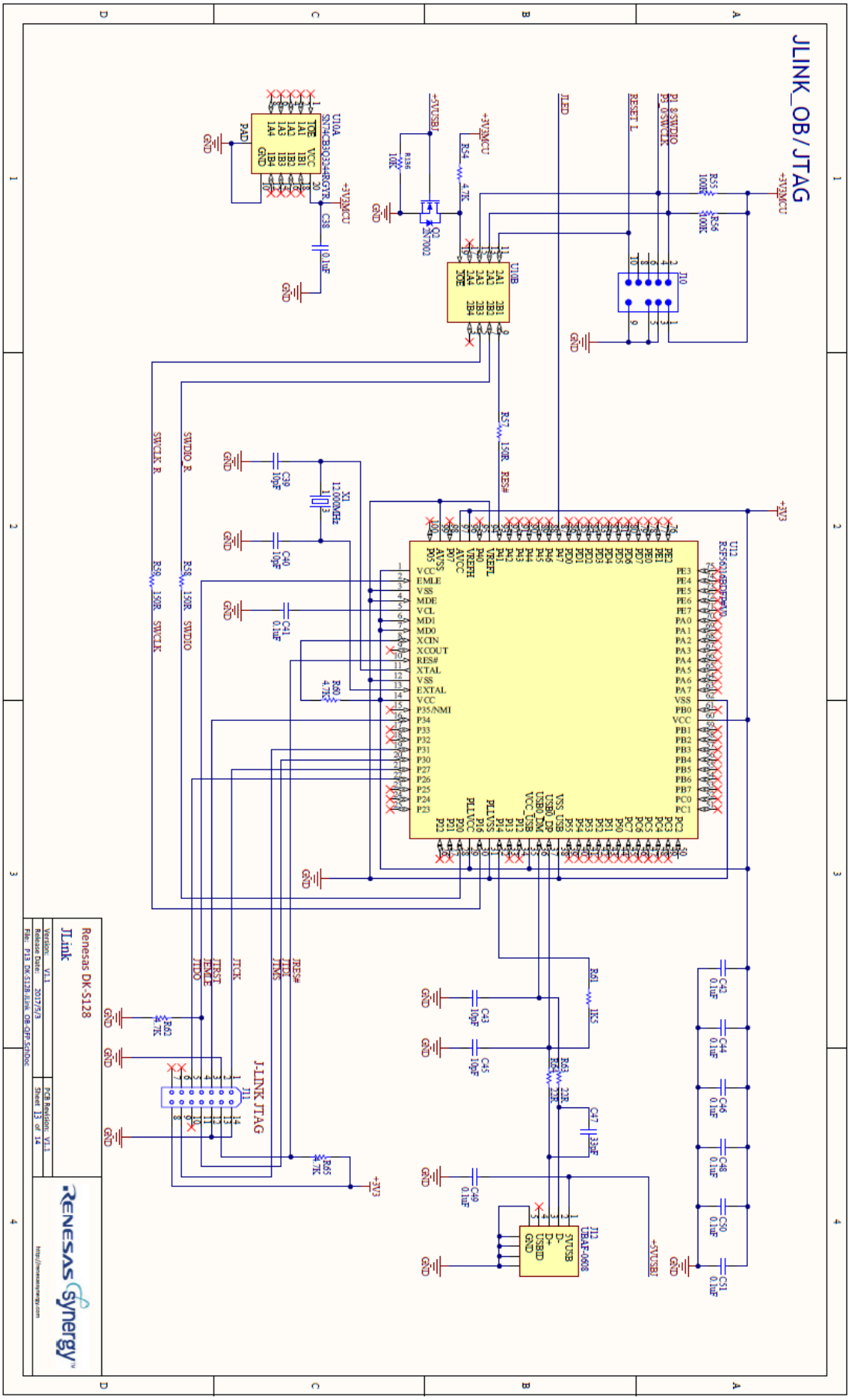

PMOD, USB, SPI & I2C
Pmod Interface Type 2A (expanded SPI)
PMOD POWER SELECT
1-2:3.3V POWER
3-5:5V POWER
USB DEVICE
SEEED Grove I2C
SPI & I2C INTERFACE
Renesas DK-S128
PMOD, USB, Breakout Pins
Version: V1.1
Release Date: 2017/5/3
PCB Revision: V1.1
Sheet 8 of 14
File: PMOD_USB_BKOUT.SchDoc
RENESAS synergy

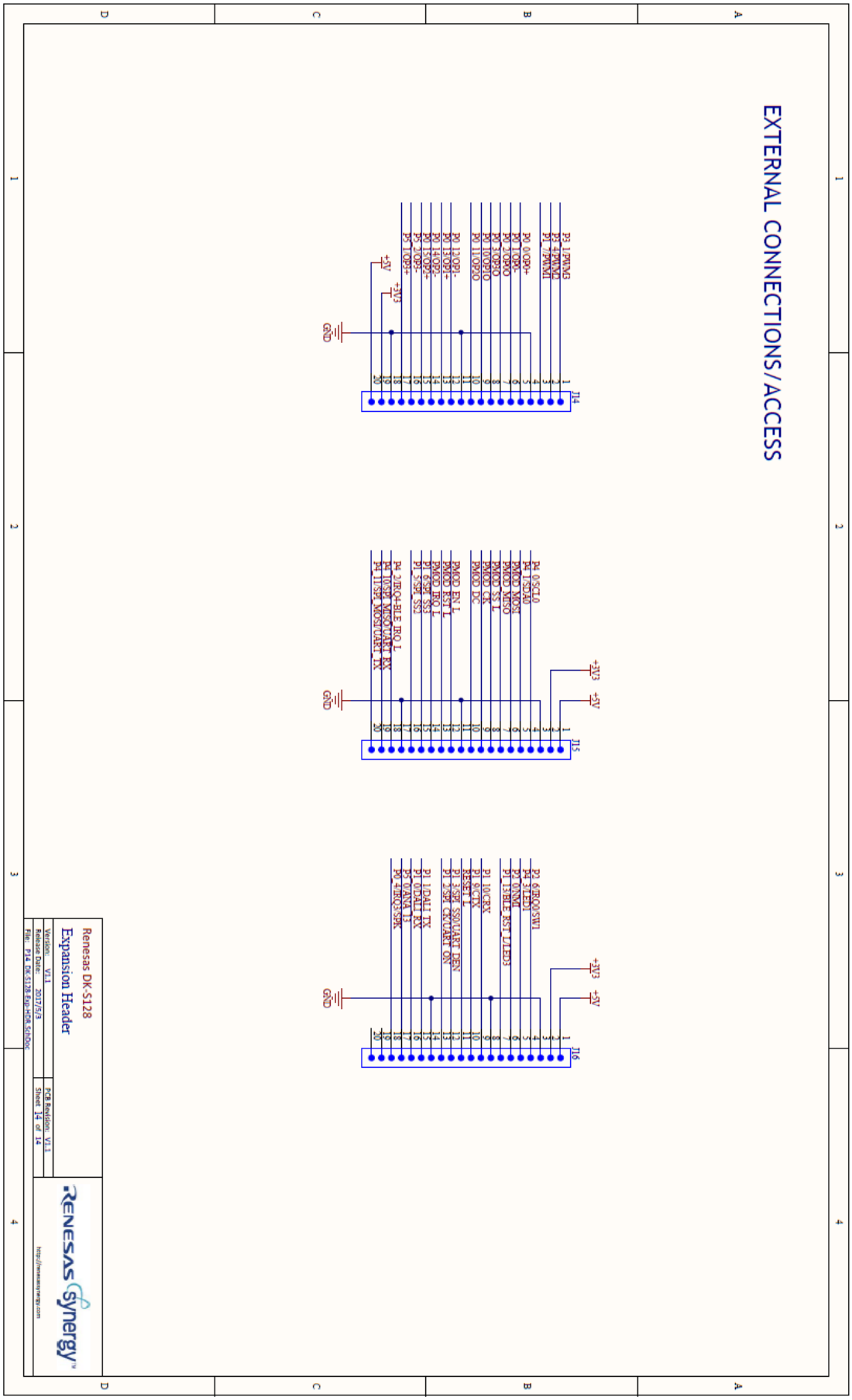

SPI Flash, BLE
SPI Flash
BLE
Renesas DK-S128
SPI Flash,BLE


Audio
Speaker
Microphone
Renesas DK-S128
Audio
Renesas Synergy

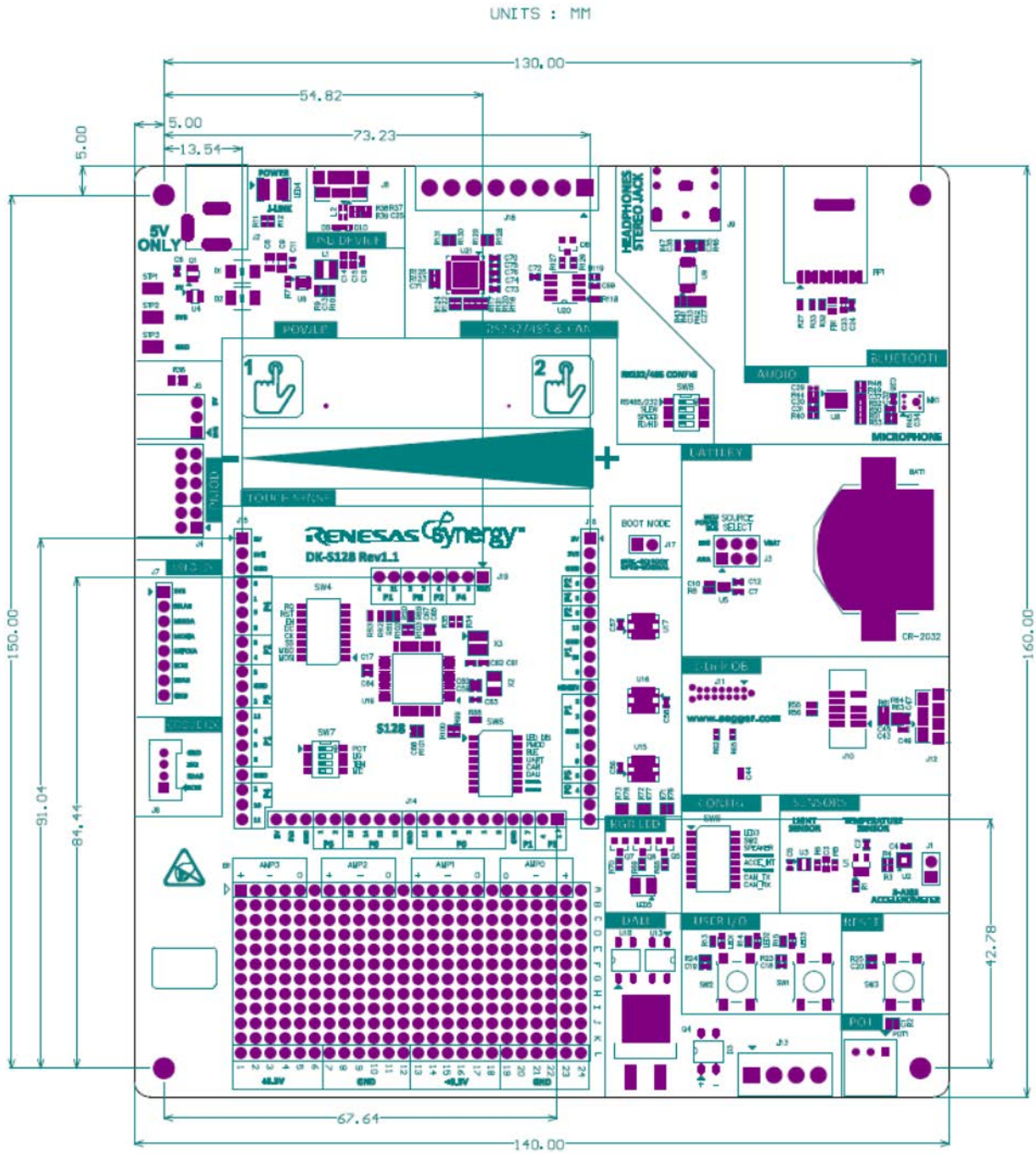

Touch, LED, Switch
TOUCH BUTTONS
TOUCH SLIDER
Renesas DK-S128
Touch,LEDs


RS232/485, CAN
RS232/485 converter
CAN transiver
Ext connector
Renesas DK-S128
RS232,CAN
Function
On (low)
Off (high)
Mode_SEL
RS232
RS485
Slew for 485
Slew rate control. See detail as table above.
Speed for 485
Data rate control. See detail as table above.
RXEN
Receiver output enable


JLINK_OB/JTAG
Renesas DK-S128
JLink
J-LINK JTAG
RENESAS synergy


EXTERNAL CONNECTIONS/ACCESS
Renesas DK-S128
Expansion Header
Version: V1.1
Release Date: 2017/5/3
File: P14_DK-S128 Exp-HDR.SchDoc
PCB Revision: V1.1
Sheet 14 of 14
RENESAS synergy
https://renesassynergy.com
J14
J15
J16
GND
+5V
+3V3

8. Mechanical drawing



9. Certifications

FCC Compliance

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

China SJ/T 113642014, 10year environmental protection use period.

EU RoHS

EU EMI/EMC compliance

10. Additional Resources

For more information on how to order this kit from Renesas or from a local distributor, please visit the kit page on our website. In addition to ordering information, you will also be able to download schematics, relevant application projects, technical updates and more. The Out of Box demo that came with this development board can also be found on the kit page, should you ever wish to restore your kit to its default configuration.

- DK-S128 Kit page: http://www.renesassynergy.com/kits/dk-s128
  To learn more about Renesas Synergy development tools, MCUs and utilities: http://www.renesassynergy.com/
  and https://www.renesas.com/en-us/products/synergy/gallery
- For technical support resources, including access to live chat with a Renesas Synergy Platform expert, visit http://renesassynergy.com/support

More information on specific Renesas Synergy resources can be found by following the links below.

Synergy Kits - http://www.renesassynergy.com/kits
Synergy Microcontrollers - http://www.renesassynergy.com/microcontrollers
Synergy Software - http://www.renesassynergy.com/software
Synergy Solutions - http://www.renesassynergy.com/solutions

- The Renesas Synergy Knowledge Base contains many useful articles for Renesas Synergy developers.
  Renesas Synergy Knowledge Base
- Please also visit our Professor IoT blog for technical articles on the latest additions to the Renesas Synergy platform:
  Professor IoT Blog
- For regional support resources:
  America - https://renesas.zendesk.com/anonymous_requests/new
  Europe - http://www.renesas.eu/support/index.jsp
  Japan – https://www.renesas.com/ja-jp/support/contact.html

Revision History

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	Aug 18, 2017	-	Initial release
1.01	Nov 30, 2017	-	Minor corrections

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Publication Date: Rev.1.01 Nov 30, 2017

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Colophon 4.1

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