Healthcare Meters Kit

User Guide

R12AN0068EU0100
Rev.1.0
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Introduction

This Healthcare Meters Kit User Guide covers debugging and application development tasks. The kit contains modules for Activity, Blood Glucose, Blood Pressure, and Heart Rate/Pulse Oxygen, and showcases the Renesas RL78/G1D Intelligent Bluetooth® Smart Microcontroller (MCU) and Renesas Synergy™ S3A7 MCU on separate PCBs. Modules, project source code, and mobile applications for iOS and Android™ are included with the Healthcare Meters Kit.

Target Device

RL78/G1D and R7FS3A77C3A01CFP

Related Documents

Table 1 List of Related Documents

Document Name	ID No.
RL78/G1D User's Manual: Hardware	R01UH0515EJ
S3A7 User's Manual: Hardware	R01UM0002EU
Healthcare Meters Kit Quick Start Guide	R12AN0067EU
Bluetooth® Low Energy Protocol Stack Quick Start Guide	R01AN2767EJ
Bluetooth® Low Energy Protocol Stack User's Manual	R01UW0095EJ
RL78/G1D Solution Kit — PMOD Module Hardware Manual	R01AN2919EU
Renesas Synergy™ S3A7 Module Hardware Manual	R01AN3068EU
Renesas Flash Programmer V3.02	R20UT3841EJ
Importing a Renesas Synergy Project Application Note	R11AN0023EU

Contents

1. Overview

The Healthcare Meters Kit is a complete platform showcasing Renesas Healthcare application solutions. With the Healthcare Meters Kit, developers can easily start to evaluate Renesas technology and quickly leverage hardware and software solutions that improve time to market.

Figure 1 shows the Healthcare Meters Kit Modules. The S3A7 board (black) mounted on the base board (green) forms various Application Modules. The RL78/G1D PMOD Module plugs into the connector on the base board to offer Bluetooth® Low Energy (BLE) connectivity. These modules are discussed throughout this document. For more details on the Healthcare Meters Kit Modules, see *Healthcare Meters Kit Quick Start Guide* (R12AN0062EU).

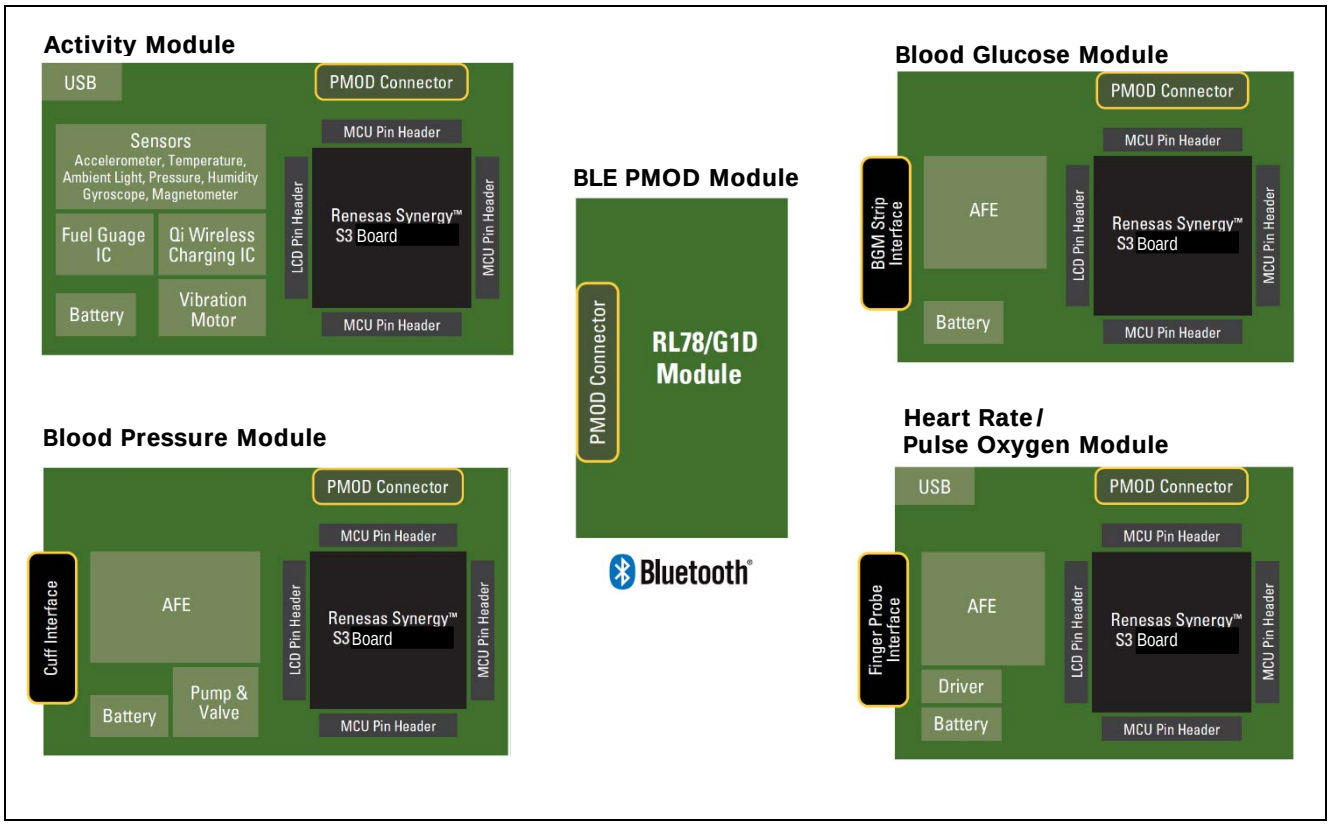

Figure 1 Healthcare Meters Kit

1.1 Solution Highlights

- Modules for various healthcare applications
  - Activity Module
  - Blood Glucose Module (BGM)
  - Blood Pressure Module (BPM)
  - Heart Rate/Pulse Oxygen Module (HRM/SpO2)
- BLE connectivity
- Form factor design for ease of use and quick adoption
- Capability for Wi-Fi® or cellular connectivity, along with cloud platform integration
- Mobile access via iOS and Android apps

1.2 Features

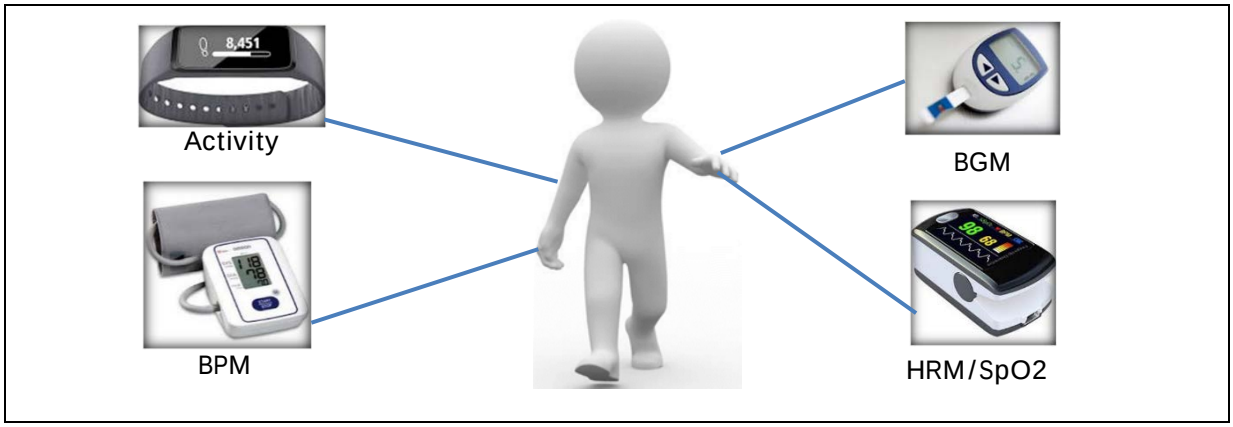

Figure 2 Healthcare Meters Kit Modules

Table 2 Healthcare Meters Kit Features Summary

Features	Summary			
	Activity	BGM	BPM	HRM/SpO2
Activity Module				
Li-Ion battery with Wireless or USB charging	✓			
Fuel Gauge IC	✓			
Ambient light sensor	✓			
Pressure Sensor	✓			
Humidity Sensor	✓			
Temperature Sensor	✓			
Vibrate motor (optional)	✓			
9-axis motion sensor (accelerometer, gyro, compass)	✓			
BLE connectivity to the mobile app	✓	✓	✓	✓
USB output for wired data transfer	✓	✓	✓	✓
Mobile app displays Steps, Distance, Calories & Light, Temperature, Humidity, Pressure	✓			
Blood Glucose Module (BGM)				
1 Coin cell or 5 V DC power operation		✓		
LCD displays blood glucose reading or status		✓		
Capacitive Touch buttons (enable to add functionality)		✓	✓	✓
BLE connectivity to the mobile app	✓	✓	✓	✓
USB output for wired data transfer	✓	✓	✓	✓
Mobile app displays Blood Glucose level		✓		

Features	Summary			
	Activity	BGM	BPM	HRM/SpO2
Blood Pressure Module (BGM)				
3 AAA batteries or 5 V DC power operation			✓	
LCD displays systolic, diastolic, pulse rate readings or status			✓	
Capacitive Touch buttons (enable to add functionality)		✓	✓	✓
BLE connectivity to the mobile app	✓	✓	✓	✓
USB output for wired data transfer	✓	✓	✓	✓
Mobile app displays Systolic, Diastolic pressure and Pulse rate			✓	
Heart Rate/Pulse Oximeter Module (HRM/SpO2)				
Li-Ion battery or 5 V DC power operation				✓
LCD displays heart rate, pulse ox (SpO2) readings or status				✓
Capacitive Touch buttons (enable to add functionality)		✓	✓	✓
BLE connectivity to the mobile app	✓	✓	✓	✓
USB output for wired data transfer	✓	✓	✓	✓
Mobile app displays Pulse Oximeter level and Heart rate				✓

1.3 Synergy Platform

The Healthcare Meters Kit leverages the power of the Synergy Software Package (SSP).

1.4 Bluetooth Smart-enabled Products

- Low-power MCU + BLE radio – RL78/G1D
- Bluetooth Smart stack & profiles from Renesas
- Custom Android & iPhone® apps to enhance the development experience

2. Development Environment

The following tables list the hardware and software environmental requirements used to compile and evaluate the sample programs included with the Healthcare Meters Kit.

Table 3 Healthcare Meters Kit Hardware Requirements

Hardware	Requirements
Host	PC/AT compatible computer Processor min. 1.6 GHz Main memory min. 4 G bytes Hard drive min. 15 G bytes space USB2.0 interface (to connect E1 emulator and RL78/G1D PMOD module or S3A7 board
Device	Activity Base Board : 1 board Blood Pressure Base Board : 1 board Heart Rate/Pulse Oximeter Base Board : 1 board Blood Glucose Base Board : 1 board S3A7 Board : 1 board RL78/G1D Solution Kit – PMOD Module : 1 board RL78/G1D Solution Kit – E1 to PMOD Module Adaptor : 1 board +5 VDC 2 A Power Supply (center positive) : 1 unit USB cable (A type male / micro-B type male) : 1 cable iOS device or Android device
Tools	Renesas On-chip Debugging Emulator E1 (R0E000010KCE00) SEGGER J-Link™ Debugging Tool

Table 4 Healthcare Meters Kit Software Requirements

Software	Requirements
Host	Windows® 7 Service Pack1 Renesas e² studio version 4.3.1.001 or later SSP 1.11 or later: go to https://synergygallery.renesas.com/ssp SEGGER J-Link Commander: https://www.segger.com/j-link-commander.html
Device	Renesas e² studio version 4.3.1.001 / Renesas CC-RL V1.03.00 or later IAR Embedded Workbench® for Renesas Synergy™ with RL78 version 1.4 (optional requirement when using IAR™ compiler for BLE module) Renesas Flash Programmer v3.01.00 or later
Other	This document with applicable software can be downloaded from the following link: https://www.renesas.com/en-us/solutions/home/healthcare/hckit.html

2.1 Restriction

The programs contained in Healthcare Meters Kit run only on aforementioned Hardware and Software environment. The programs are applicable exclusively for evaluation purposes.

2.2 Disclaimer

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2.3 How to Get a Library and Build the RL78/G1D Modem Firmware

Before making to build this sample program, it is necessary to download the following code library.

- Bluetooth® Low Energy Protocol Stack V1.11 is available at https://www.renesas.com/en-us/software/D6000616.html
- Copy files from downloaded Protocol Stack V1.11 package library folder (source folder) to Renesas Healthcare Meters Kit library folder (destination folder).

Source folder	\..\BLE_Software_Ver_1_11\RL78_G1D\Project_Source\renesas\lib
Destination folder	\..\Renesas_Healthcare_Meters_Kit\Firmware\rl78_g1d_modem\renesas\lib

This Healthcare Meters Kit includes the Renesas Flash Libraries in the following folders and their library versions are documented in R01UW0095EJ0119 section 4.3.

Library	Compiler	Folder
Code Flash	ccrl	\..\Renesas_Healthcare_Meters_Kit\Firmware\rl78_g1d_modem\renesas\src\driver\codeflash\ccrl
	cs	\..\Renesas_Healthcare_Meters_Kit\Firmware\rl78_g1d_modem\renesas\src\driver\codeflash\cs
	iar	\..\Renesas_Healthcare_Meters_Kit\Firmware\rl78_g1d_modem\renesas\src\driver\codeflash\iar
Data Flash	ccrl	\..\Renesas_Healthcare_Meters_Kit\Firmware\rl78_g1d_modem\renesas\src\driver\dataflash\ccrl
	cs	\..\Renesas_Healthcare_Meters_Kit\Firmware\rl78_g1d_modem\renesas\src\driver\dataflash\cs
	iar	\..\Renesas_Healthcare_Meters_Kit\Firmware\rl78_g1d_modem\renesas\src\driver\dataflash\iar

Note: When downloading this package with pressing “Agree” button on the Renesas web page, you officially agreed upon this enclosed Software License Agreement for Renesas Flash Library usage. Immediately register under www.renesas.eu/updates for receiving any updated information from Renesas Electronics Corporation.

3. Release Package Composition

The Healthcare Meters Kit includes the source code for the Demo Programs, as well as binary image files. The following table lists the Demo Programs folder composition in the release package.

Table 5 Healthcare Meters Kit Software Package

```
Renesas_Healthcare_Meters_Kit
  ├Document
  │   └ quick_start_guide          Bluetooth Low Energy Protocol Stack Quick Start Guide
  ├Firmware
  │   ├ rl78_g1d_modem             Sample program for RL78/G1D Bluetooth firmware (archived file)
  │   ├ ROM                        output Hex file of sample program
  │   │   ├ ROM_RL78               output Hex file of RL78 Project for rl78_g1d_modem
  │   │   └ ROM_Synergy            output Hex files of Synergy Projects for S3A7
  │   └ Synergy_project            Synergy Project for S3A7
  │       └ HC_Kit_Archive         Archived file included following projects
  │                                activity_monitor : Activity demo program
  │                                blood_glucose  : Blood Glucose Meter demo program
  │                                blood_pressure : Blood Pressure Meter demo program
  │                                pulse_oximeter : Heart Rate/Pulse Oximeter demo program
  ├Hardware
  │   ├ s3_tb                      S3A7 Board
  │   ├ s3_tb_activity             Activity base board
  │   ├ s3_tb_bgm                  Blood Glucose Meter base board
  │   ├ s3_tb_bpm                  Blood Pressure Meter base board
  │   └ s3_tb_spo2                 Heart Rate/Pulse Oximeter base board
  └Smartphone_Application
      ├ android                    Android Smartphone demo project
      └ ios                        iOS Smartphone demo project
```

4. Building Sample Project

4.1 RL78/G1D Modem Firmware

To build the RL78/G1D modem firmware, you need IAR EW for Synergy v7 and the RL78 compiler v1.40.

1. Open the BLE_Modem workspace project from the following folder.
   \..\Renesas_Healthcare_Meters_Kit\firmware\rl78_g1d_modem\renesas\tools\project\iar\BLE_Modem
   Figure 3 shows the project in the IAR EW for Synergy workspace.

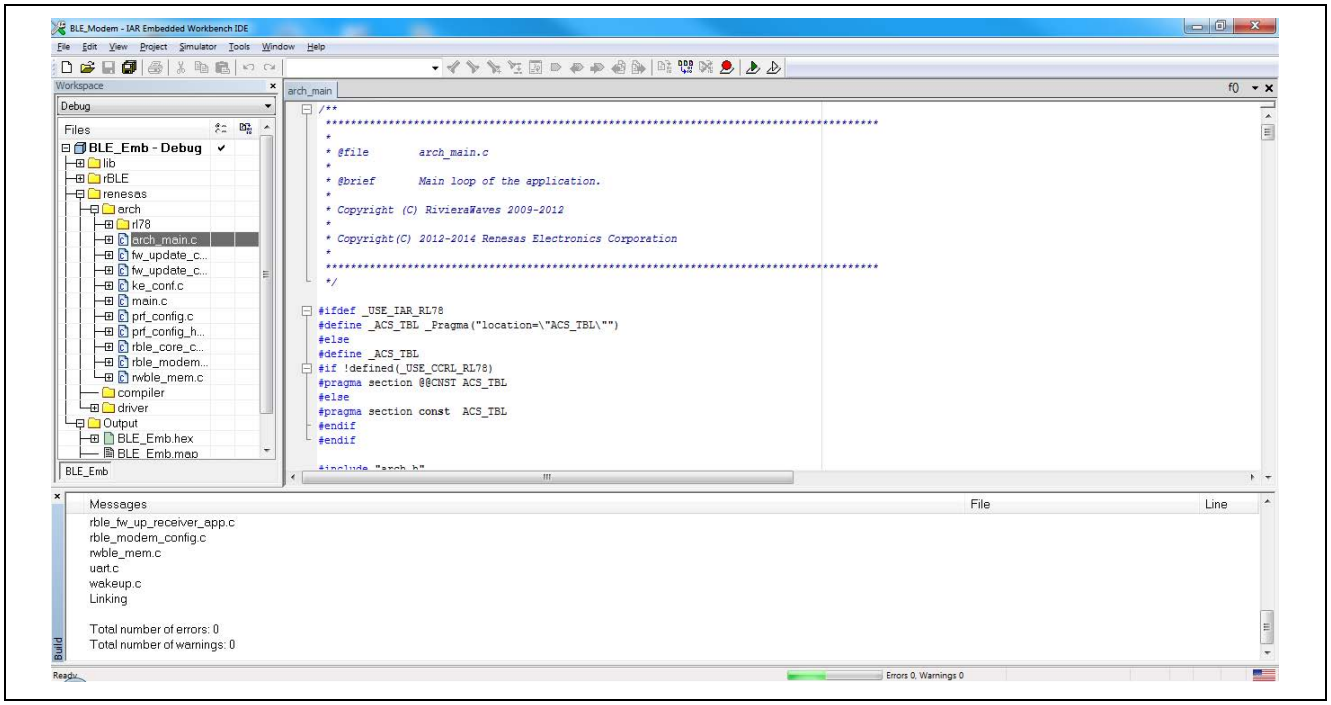


Figure 3 IAR EW for Synergy with RL78 / G1D firmware project

Note: Before building the project for binary image, make sure to select **Other**, with intel-extended in the Linker option (see Figure 4). You automatically deselect this option when the Debug option is selected.

2. Select **Rebuild All** from the **Project** pulldown menu to build the project.
   The binary image output (BLE_Emb.hex) is placed in the following folder.
   \..\Renesas_Healthcare_Meters_Kit\firmware\rl78_g1d_modem\renesas\tools\project\iar\BLE_Modem\BLE_Emb\Debug\Exe

Note: RL78/G1D modem firmware also can be built with using e^2 studio workspace. To use e^2 studio, import the project into the workspace from the following folder. For detail instructions, see R01AN2767EJ.
\..\Renesas_Healthcare_Meters_Kit\firmware\rl78_g1d_modem\renesas\tools\project\e2studio\BLE_Modem

3. Next steps:
   - To debug the project, go to Section 4.1.1.
   - To program the project, go to Section 4.1.2.

4.1.1 Debugging the Project

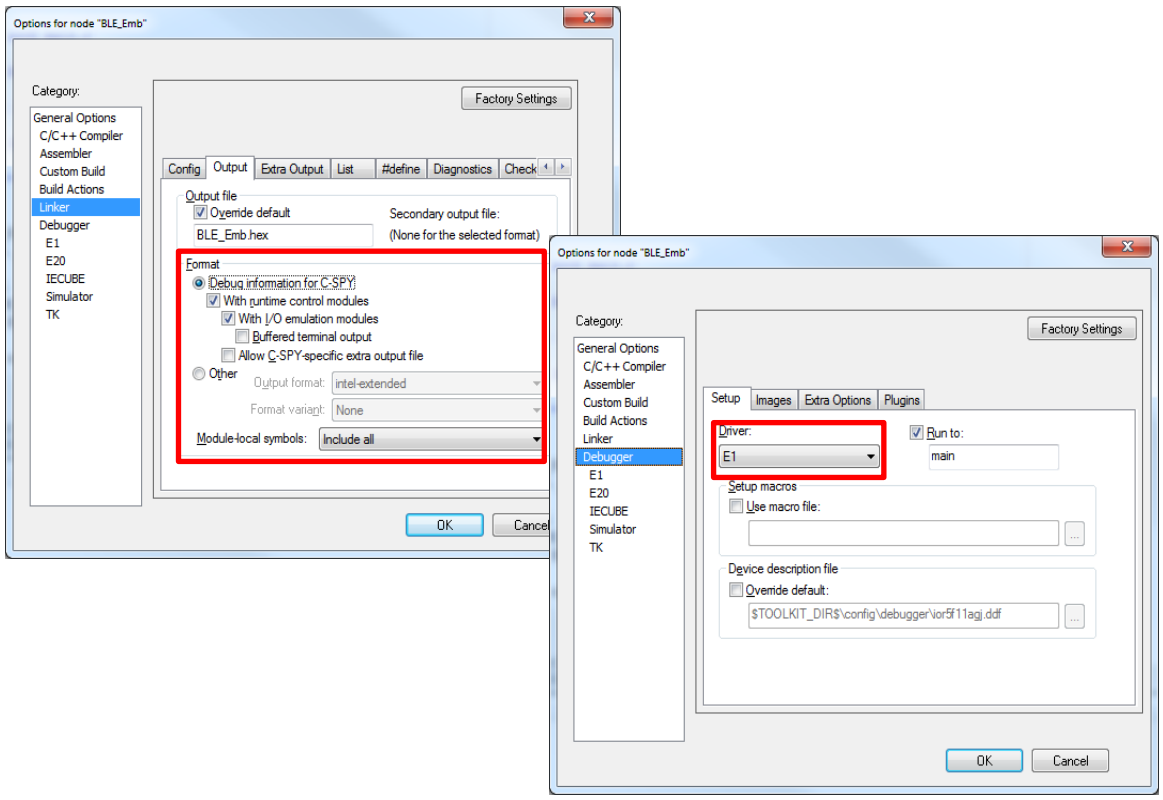


Figure 4 IAR EW for Synergy Output settings

1. In the **Options for node BLE_Emb** screen, under the **Linker** category select the **Output** tab (see Figure 4).
2. To debug the RL78/G1D modem project, select the option **Debug information for CSPY**.
   - Selecting Debug deselects the Other option.
3. In the **Debugger** category and set the Driver to **E1**.

4.1.2 Programming the Project

Figure 5 shows the BLE PMOD Adaptor and the BLE PMOD module.

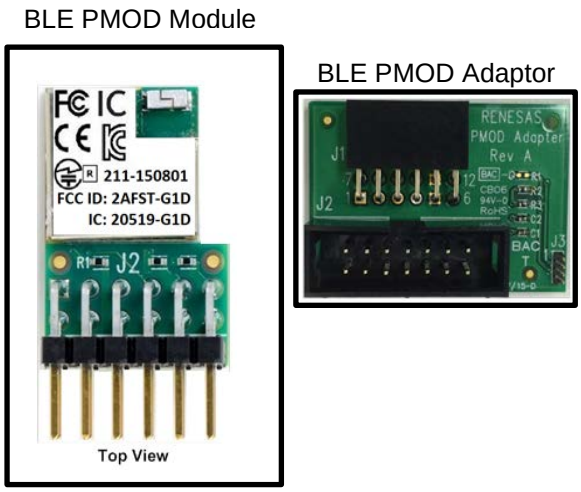


Figure 5 BLE PMOD Adaptor and BLE PMOD module

To program the RL78/G1D Bluetooth, you use the BLE PMOD Adaptor and perform the following steps:

1. Insert the Renesas BLE PMOD module into connector **J1** on the Application Base Board.
2. Connect the Renesas **E1** programmer/Debugger to connector J2 on the BLE PMOD Adaptor board.
3. To program RL78/G1D modem project output (BLE_Emb.hex), launch the **Renesas Flash Programmer** (RFP). See Figure 6 for applicable screens.
4. Create a new project. Select the **RL78 device** and set the power supply to **3.3 Volts**. Click **OK**.
5. Select the **Operation** tab to load the program file (BLE_Emb.hex).
6. Click **Start** to begin to program.
   For details on RFP usage, refer to R20UT3841E.

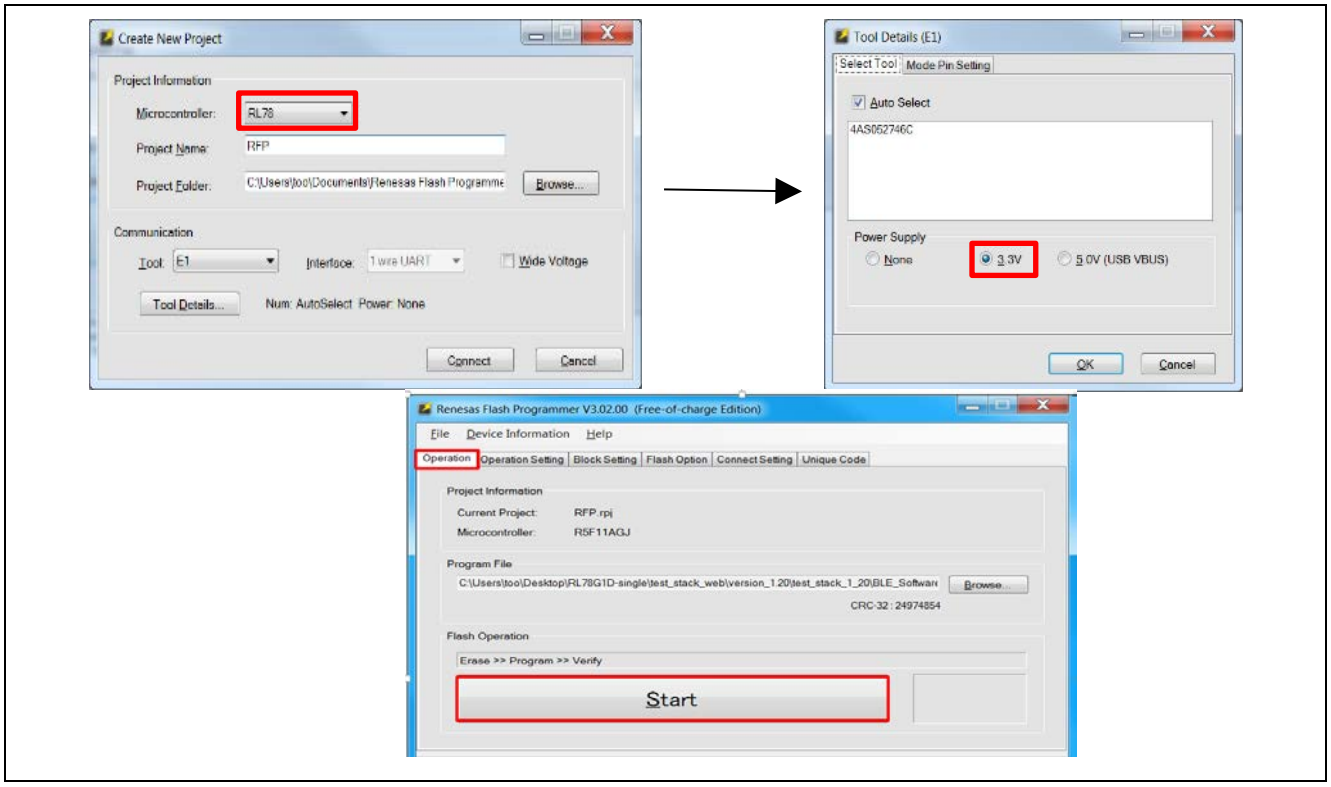


Figure 6 Renesas Flash Programmer

4.2 Renesas Synergy™ S3A7 Firmware

To build and debug Renesas Synergy™ S3A7 firmware, you need e² studio version 5.2 or later and SSP package v1.13.

1. To begin debugging, import the four projects (**s3_tb_activity**, **s3_tb_bgm**, **s3_tb_bpm**, **s3_tb_spo2**) from the following folder.
   \..\ Renesas_Healthcare_Meters_Kit \Firmware\Synergy_project.

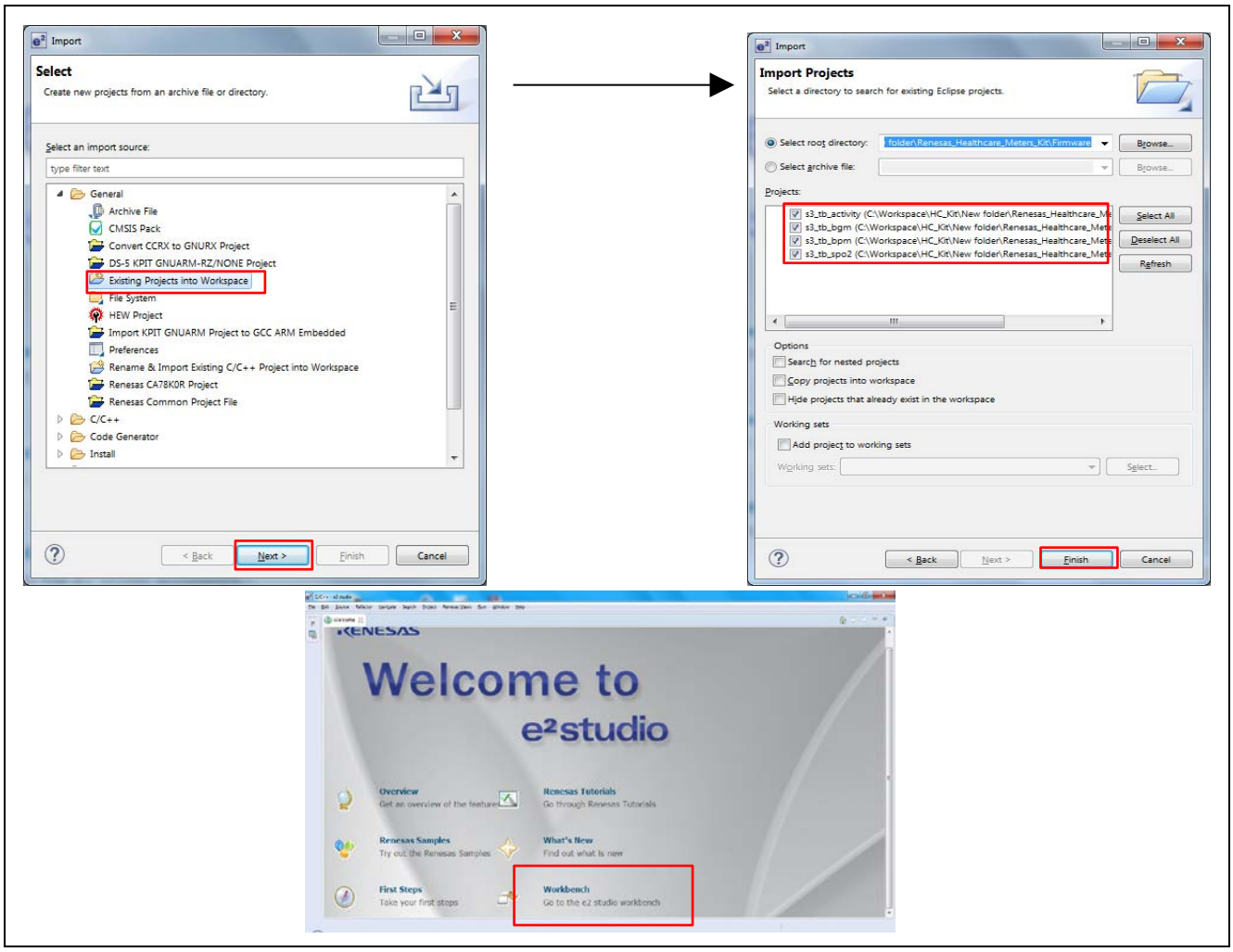


Figure 7 e² studio ISDE Environment Import Projects

1. First, launch the e² studio workspace.
2. Select **Import** from the File pulldown menu.
3. Select **Existing Projects into Workspace** from General, and click **Next**.
4. Browse the projects folder, select the files, and click **Finish**.
5. Clicking **Workbench** in the Welcome screen opens the Workspace (see Figure 8) and selects **Build All** (to build all the projects) from Project pulldown menu.

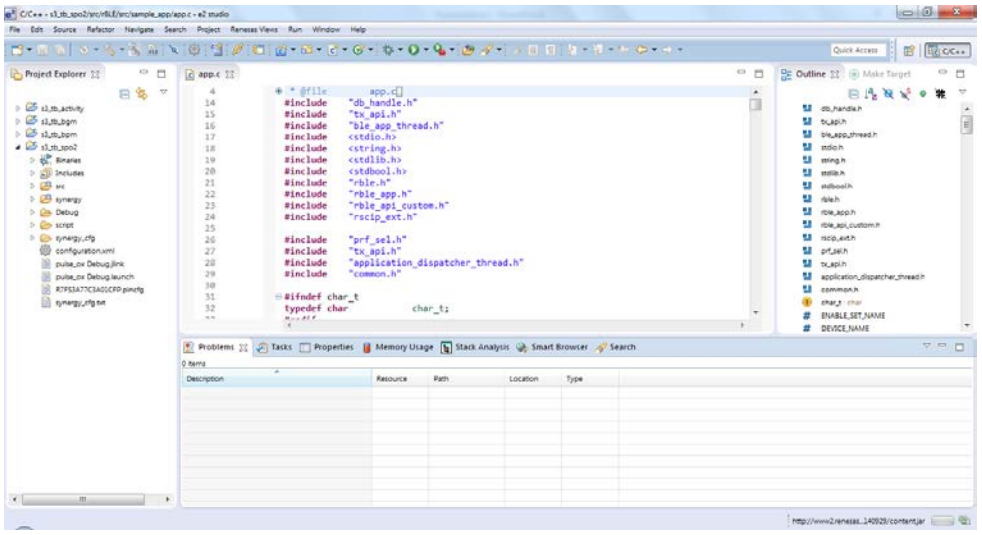


Figure 8 e² studio ISDE environment

Note: For detail instructions on importing a project, see *Importing a Renesas Synergy Project* (R11AN0023EU).

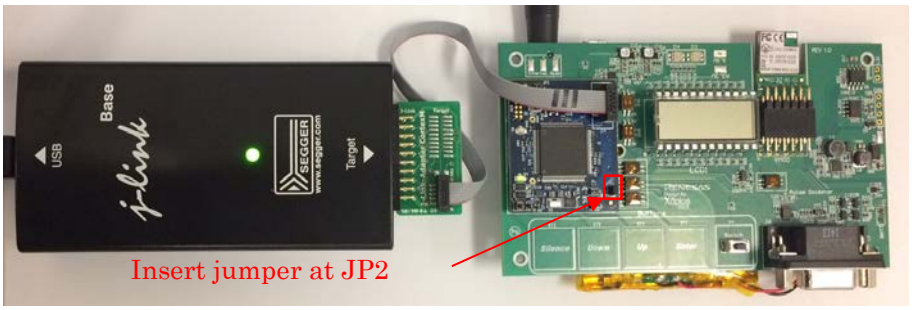


Figure 9 S3A7 board debugging setup

6. To enable JTAG debug function on the S3A7 board, do the following (see Figure 9):
   The S3A7 board uses JTAG as its programming/debugging interface.

   A. Insert shunt jumper at the JP2 location (ON position) on the S3A7 board (blue).
      JTAG can be disabled anytime, simply remove the shunt jumper at JP2 location (OFF position).
   B. Attach the J-Link connector (J14) to the SEGGER J-Link debugger unit.
   C. Mount the S3A7 board to the applicable Application base board to make an Application Module.
   D. Supply power to the Application base board using provided battery or +5 VDC Power Jack.
      Figure 9 shows the debug setting with SEGGER J-Link debugger.

Table 6 JTAG

JTAG Description	S3A7 MCU	
	Function Name	**Pin**
Test Mode Select	TMS/SWDIO	P108 (P1_8)
Test Clock	TCK/SWCLK	P300 (P3_0)
Test Data Out	TDO	P109 (P1_9)
Test Data In	TDI	P110 (P1_10)
Reset	RESET#	RESET#

4.

Note: SEGGER J-Link download link: https://www.segger.com/downloads/jlink

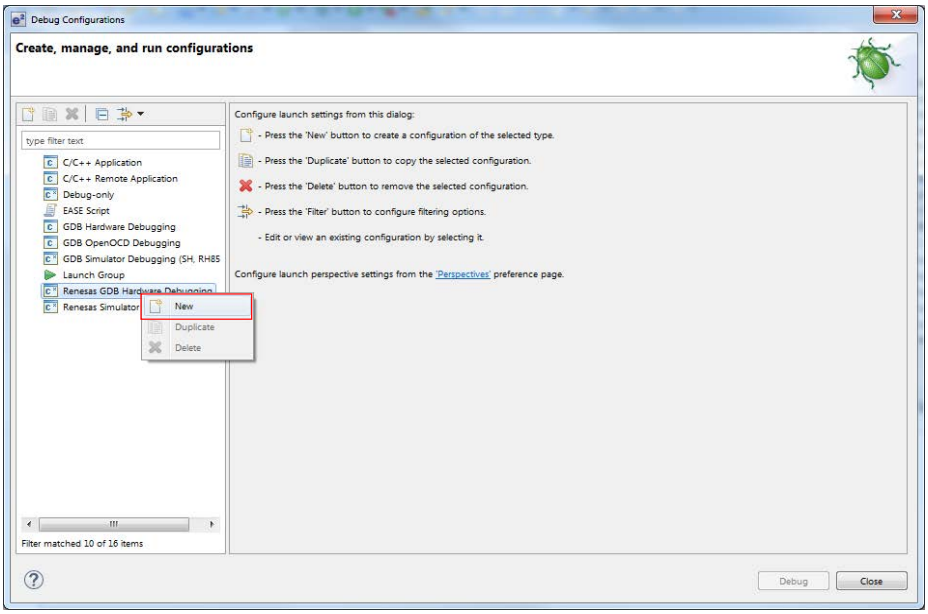


Figure 10 e² studio Debug Configuration window

7. Set the Debug configuration by selecting a project to debug.
   Figure 10 shows the Debug Configuration window.
8. Select **Debug Configuration** from the Run pulldown menu.
9. Right-click **Renesas GDB hardware Debugging**.
10. Select **New** from the options menu to create a new debug launch.

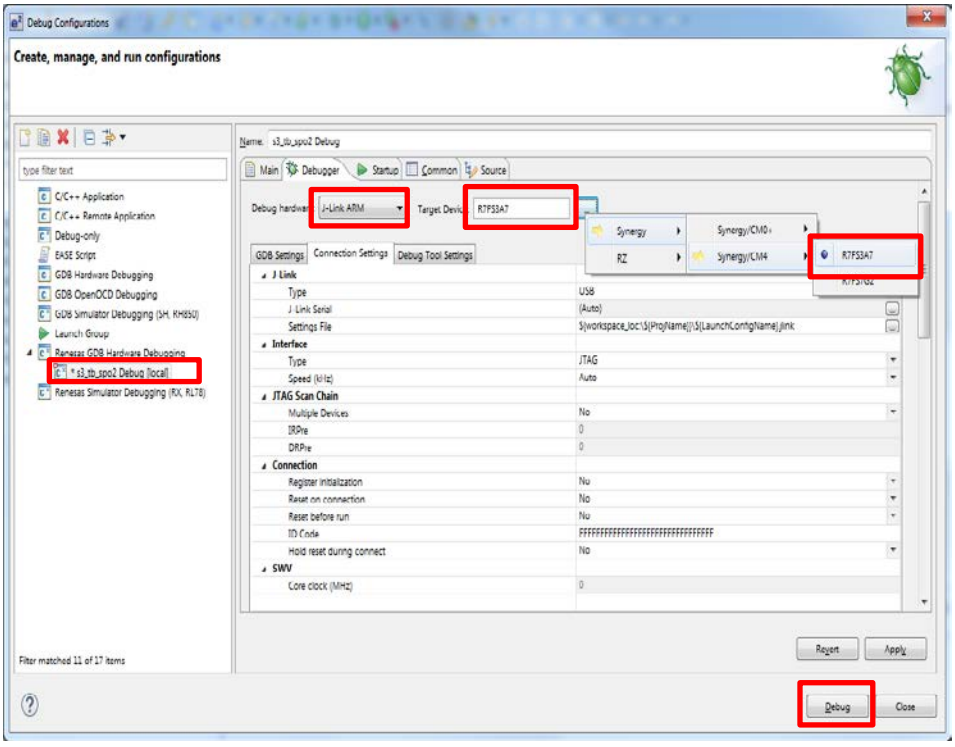


Figure 11 e² studio workspace debugging setup

11. Select the **Debugger** tab (see Figure 11).
12. Select **J-Link ARM** for debug hardware and **R7FS3A7** for the target device.
13. Click **Debug** to start debugging.
    - Figure 12 shows the **Debug** window. Click **Resume** (F8) to run the program in Debug mode.

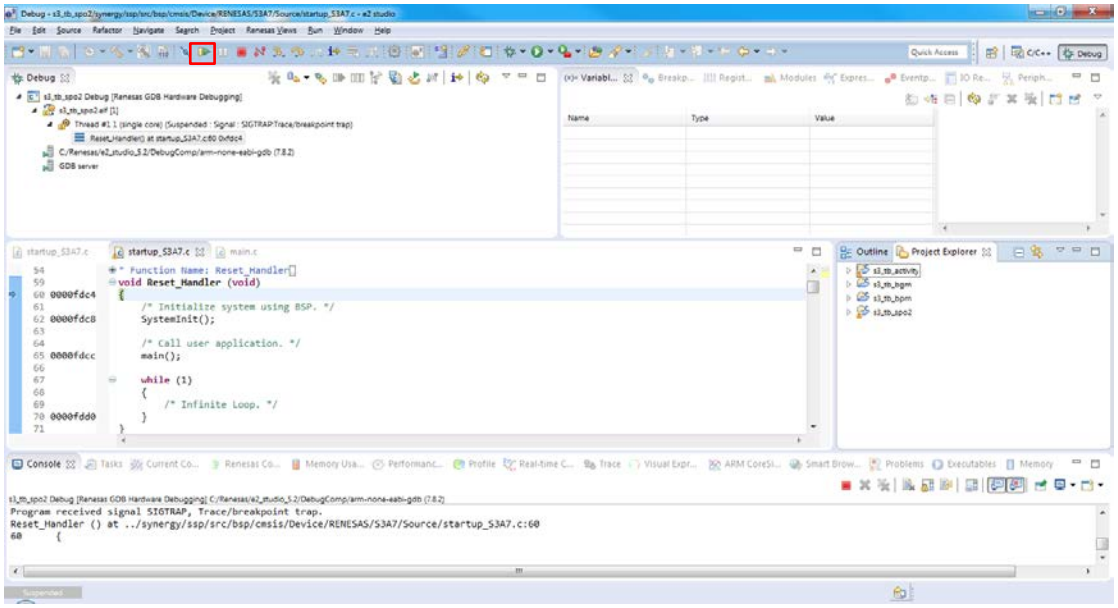


Figure 12 e² studio workspace in debugging mode

4.3 Programming the S3A7 Board

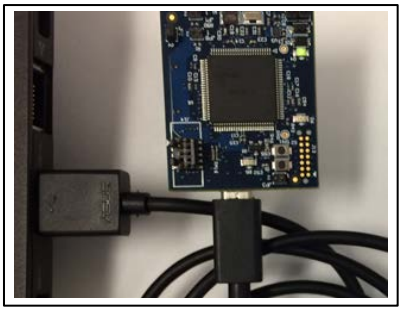


Figure 13 S3A7 board programming setup with on-board J-Link

1. To program, insert a shunt jumper at JP2 (ON position) on the S3A7 board (blue).
2. Connect the S3A7 board to the PC via the micro USB cable at J15 connector.
   - Figure 13 shows how to setup using the on-board J-Link debugger/programmer. It does not show the S3A7 board mounted on an Application base board.

Note: If you wish to use the debugger, refer to Figure 9 for the SEGGER J-Link setup and follow the associated steps.

3. Open the J-Link Commander (see Figure 14) from the **SEGGER** folder, in the **Start** menu for All Programs.

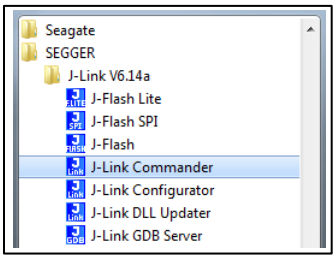


Figure 14 J-Link Commander at SEGGER folder from Start

4. Enter the following commands to program the board (see Figure 15).
   (1) **Device R7FS3A7**
   (2) **Speed 12000**
   (3) **loadbin C:\...\ROM_Synergy\file_name.hex,** 0
   (4) **s**

Note: If using the SEGGER J-Link debugger, select **J** for the target interface.

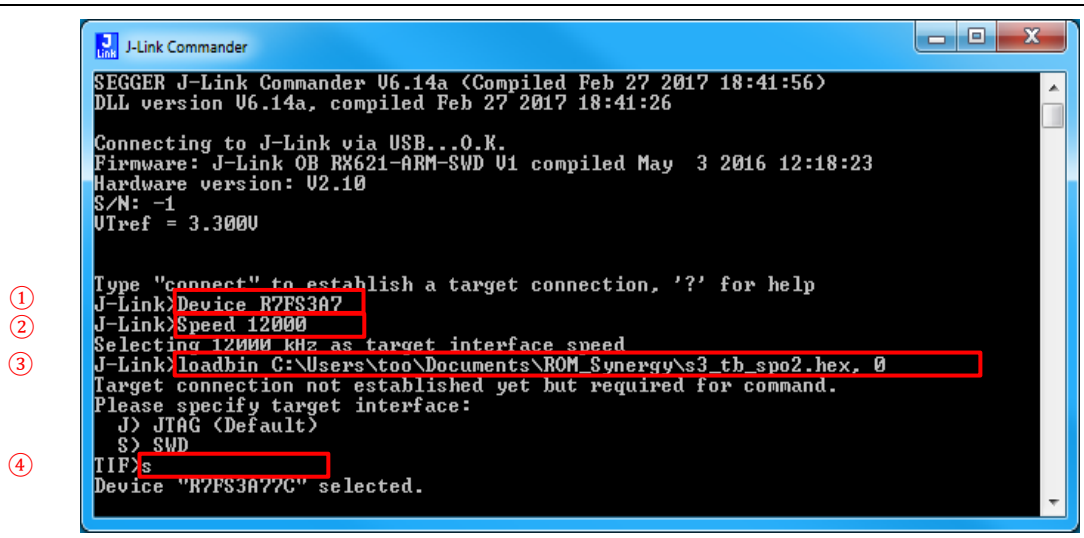


Figure 15 J-Link Commander at command prompt Windows

5. Select the appropriate binary image for respective demonstration (see Figure 16).
   This Healthcare Meters Kit includes following Hex files for respective modules.
   A. The Activity Module : activity_monitor.hex
   B. The Blood Glucose Module: blood_glucose.hex
   C. The Blood Pressure Module : blood_pressure.hex
   D. The Heart Rate/Pulse Ox Module : pulse_oximeter.hex

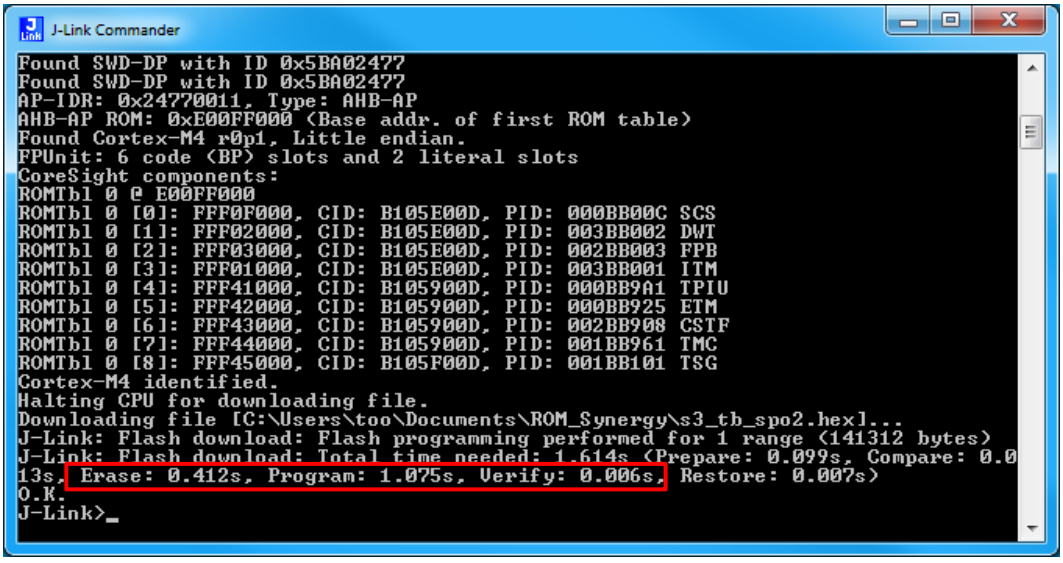


Figure 16 J-Link Commander after board programming

6. Disconnect the board from the PC to evaluate after programming.

5. Circuit Diagrams

The following circuit diagrams illustrate each hardware component in the Healthcare Meters Kit.

5.1 RL78/G1D PMOD Module

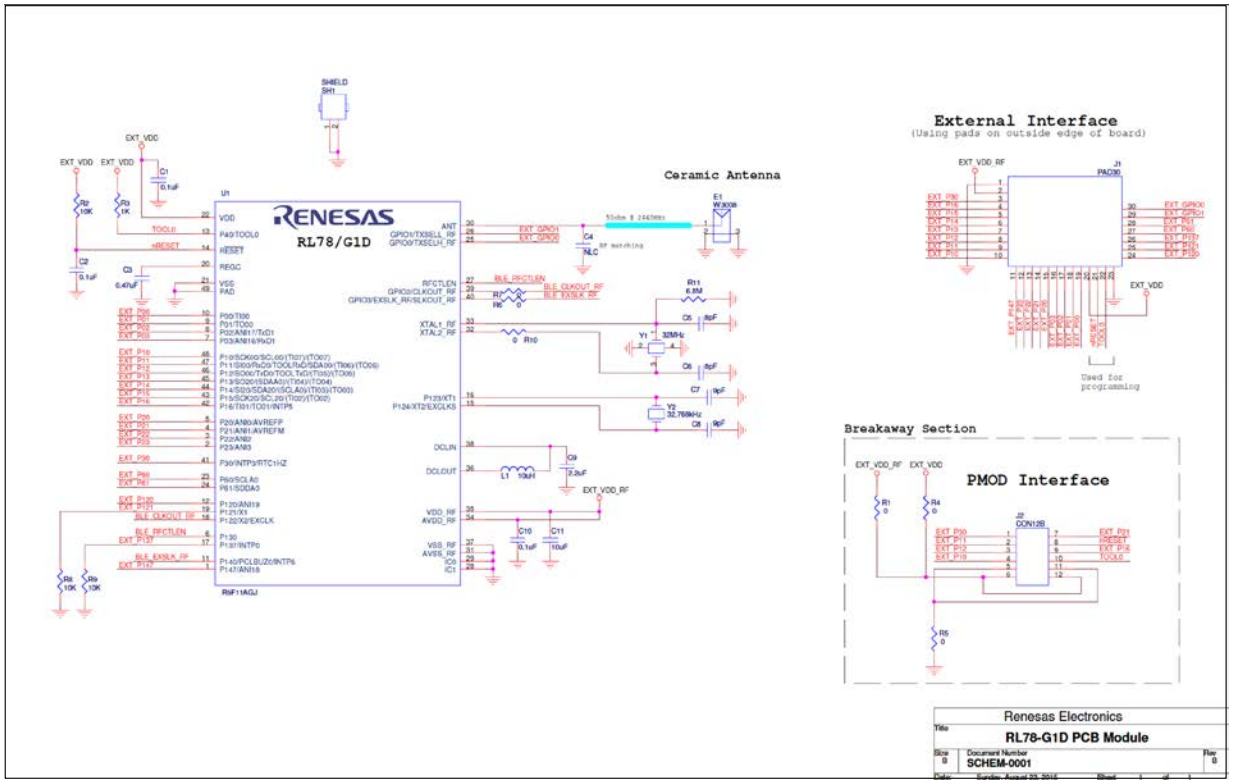
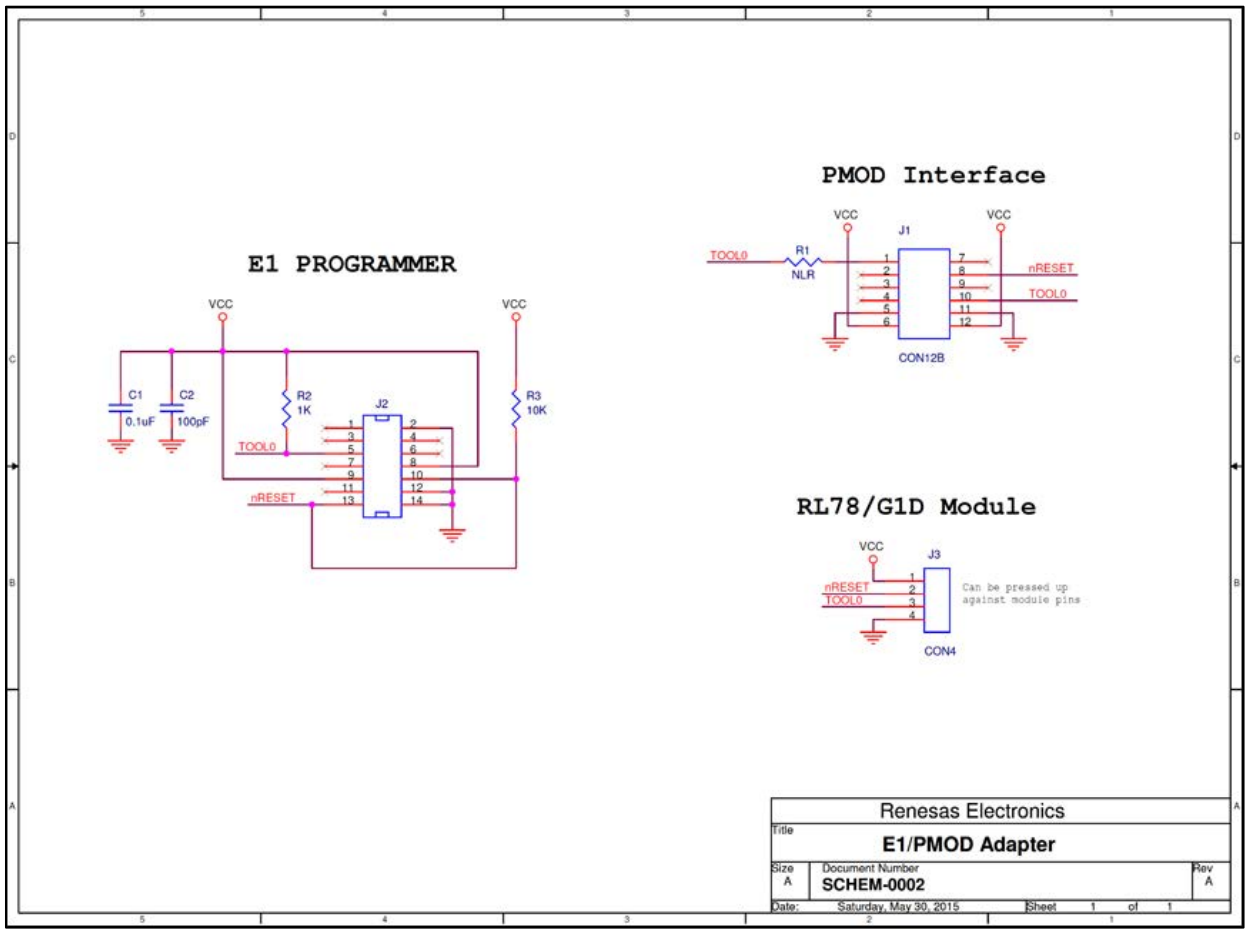
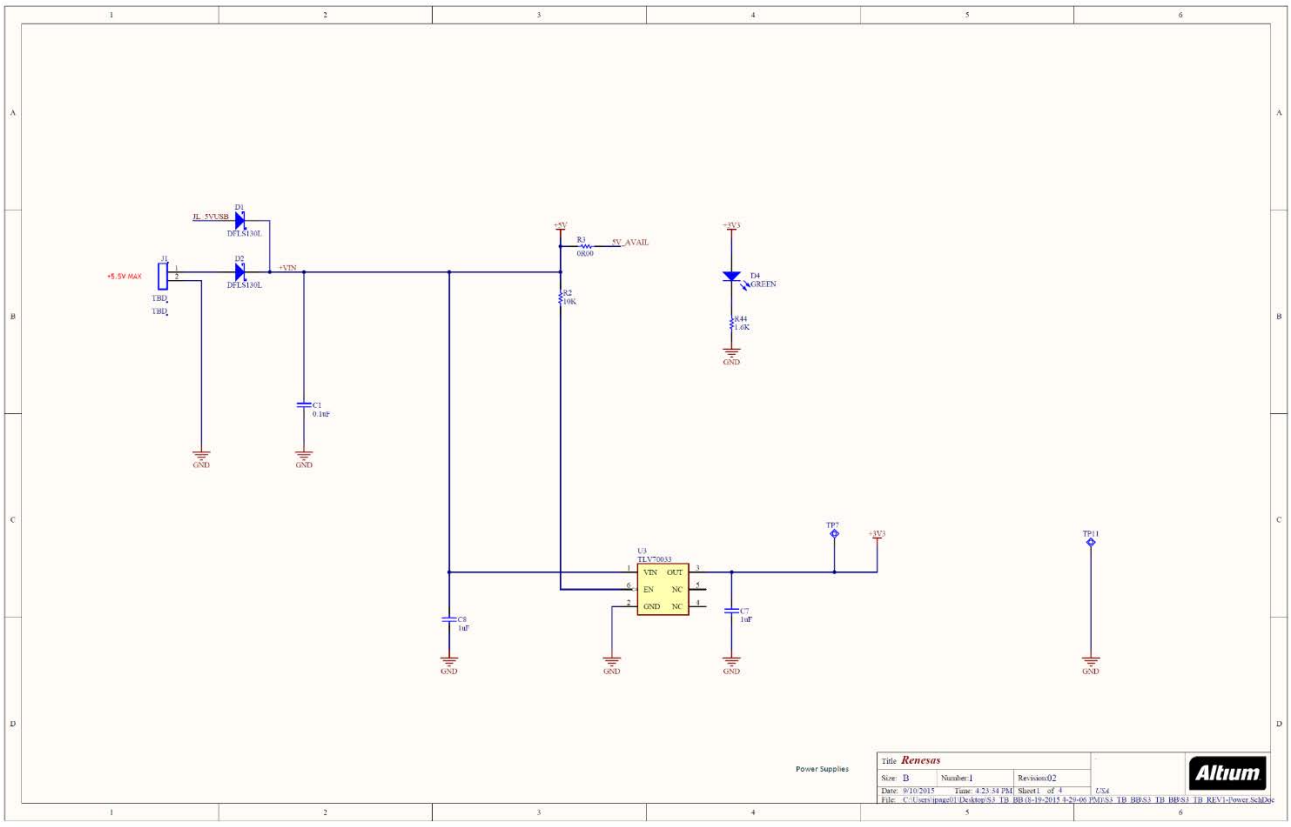


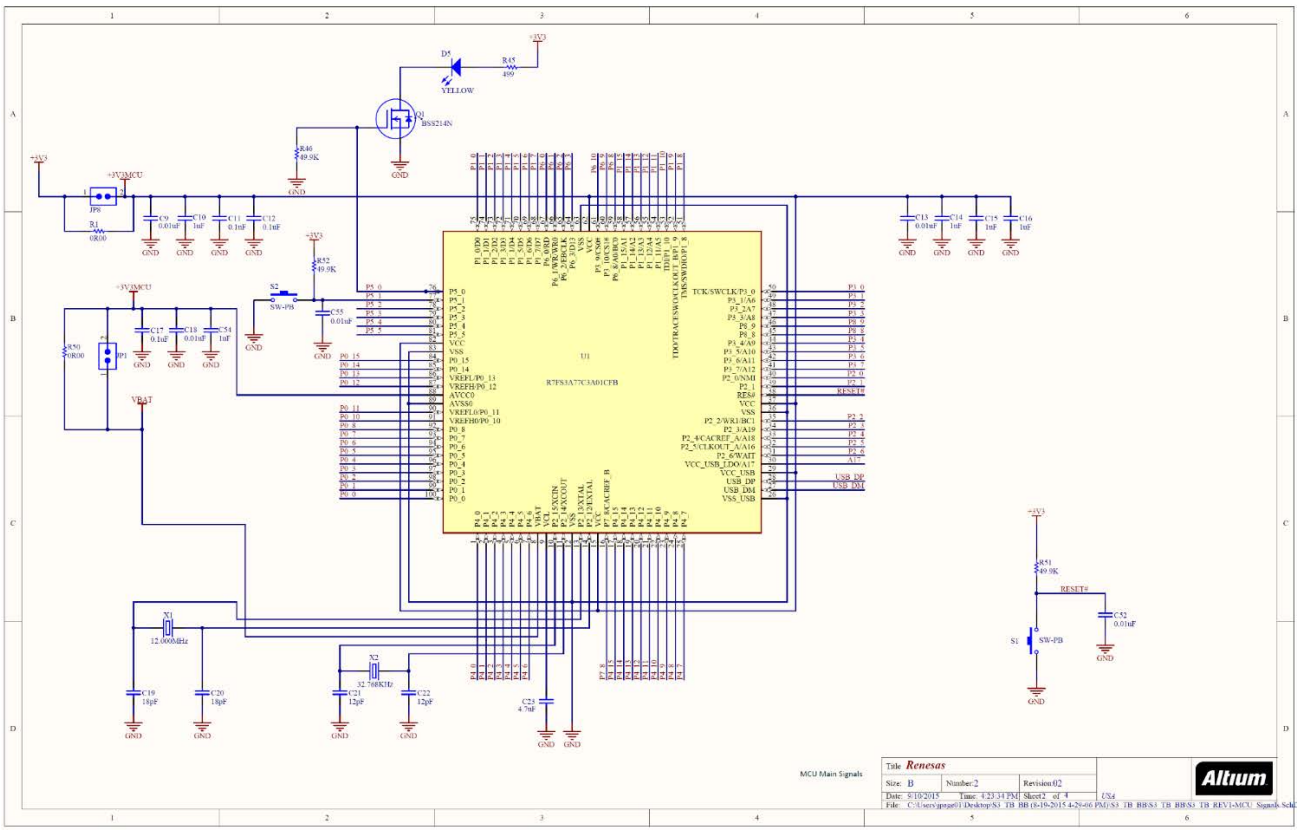
Figure 17 RL78/G1D PMOD Module

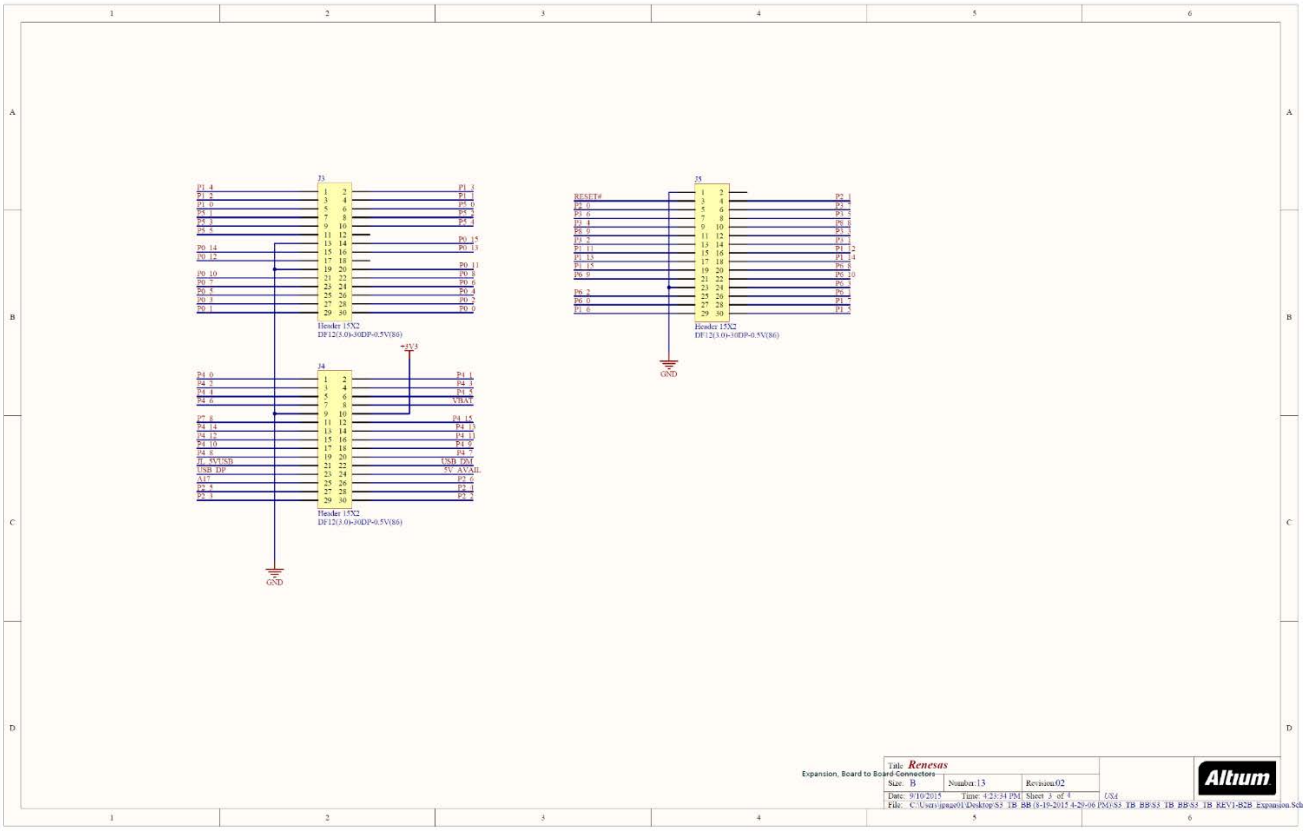
5.2 RL78/G1D PMOD Adaptor

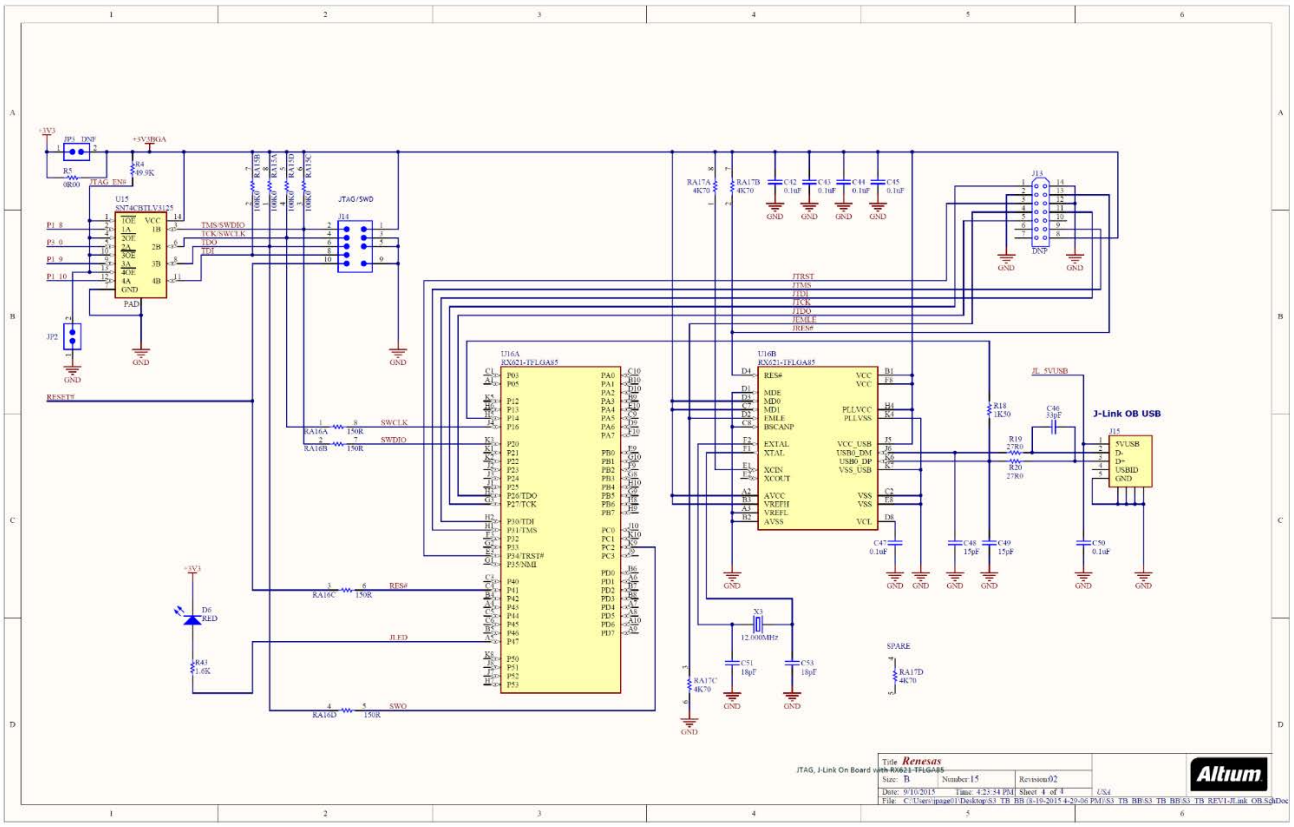


5.3 S3A7 Board

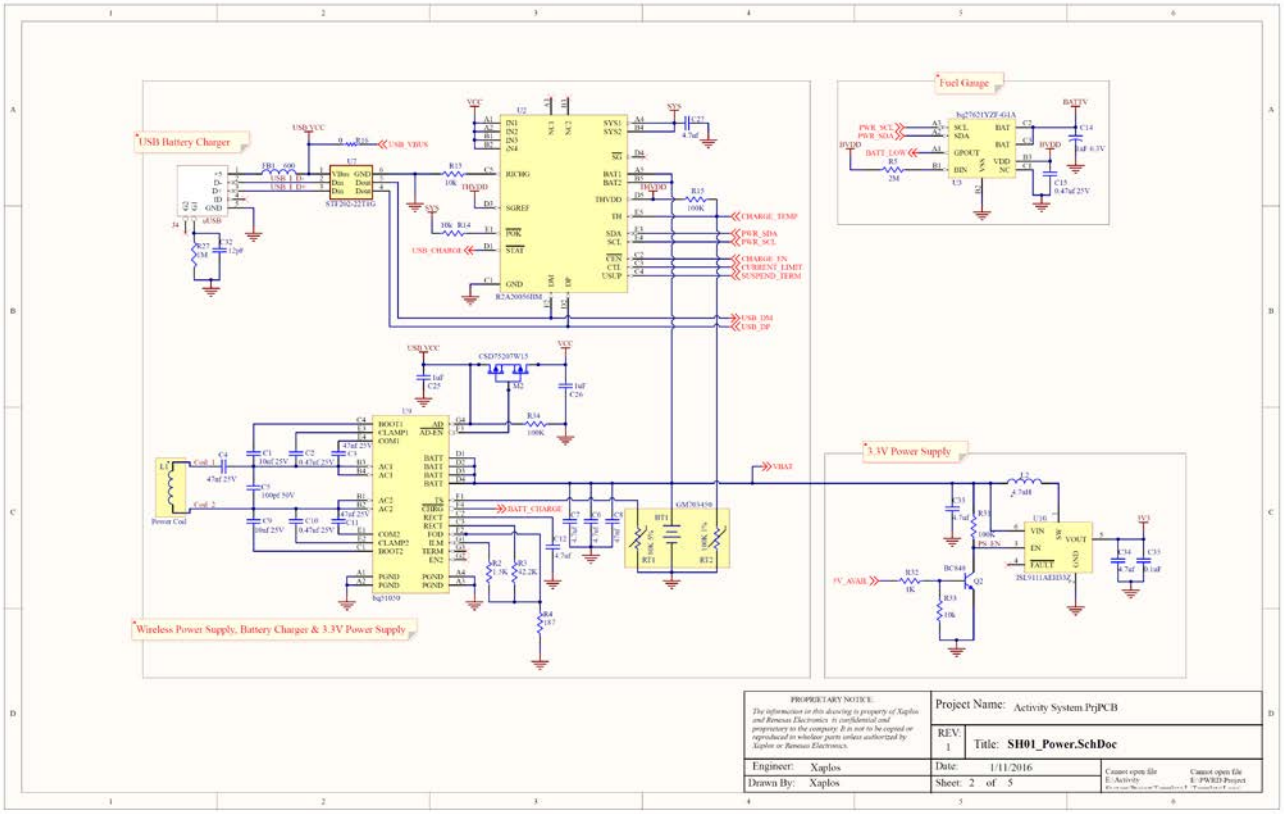


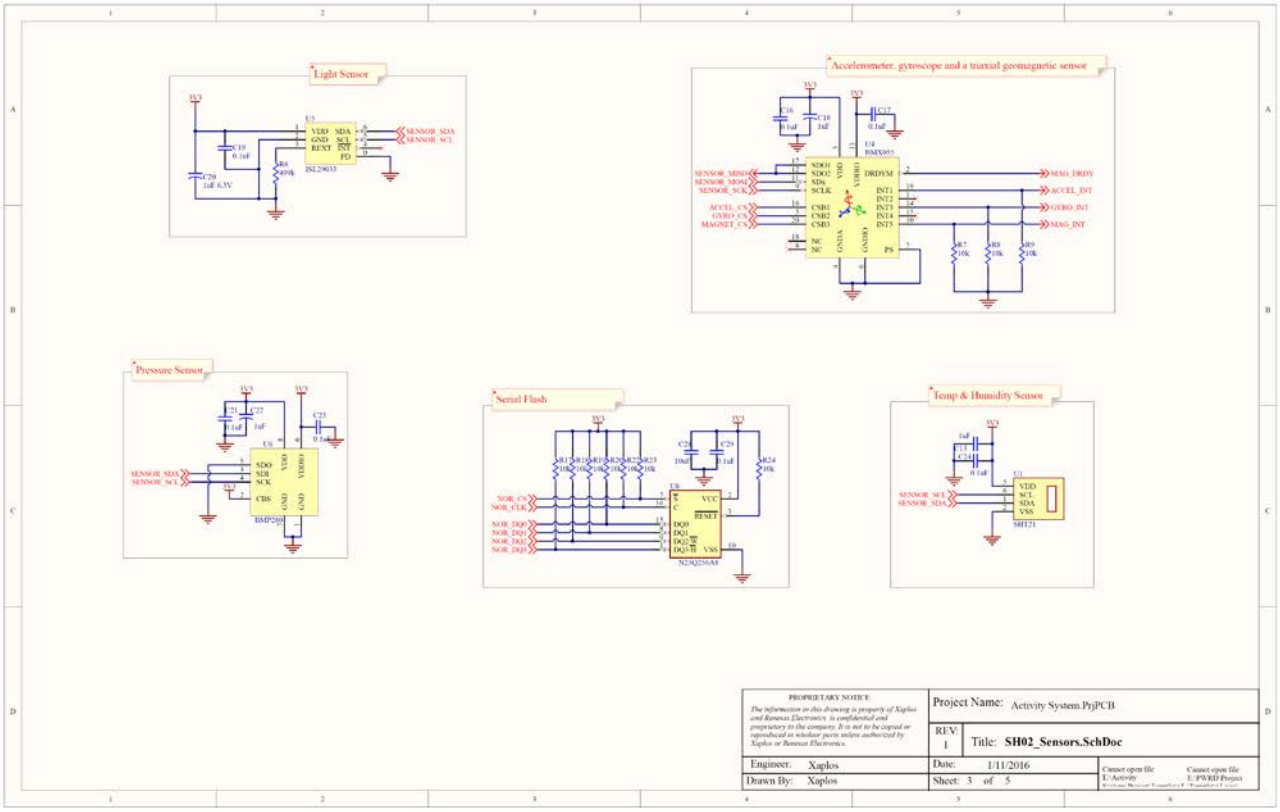

MCU Main Signals
Title Renesas
Size: B
Number:2
Revision:02
Altium

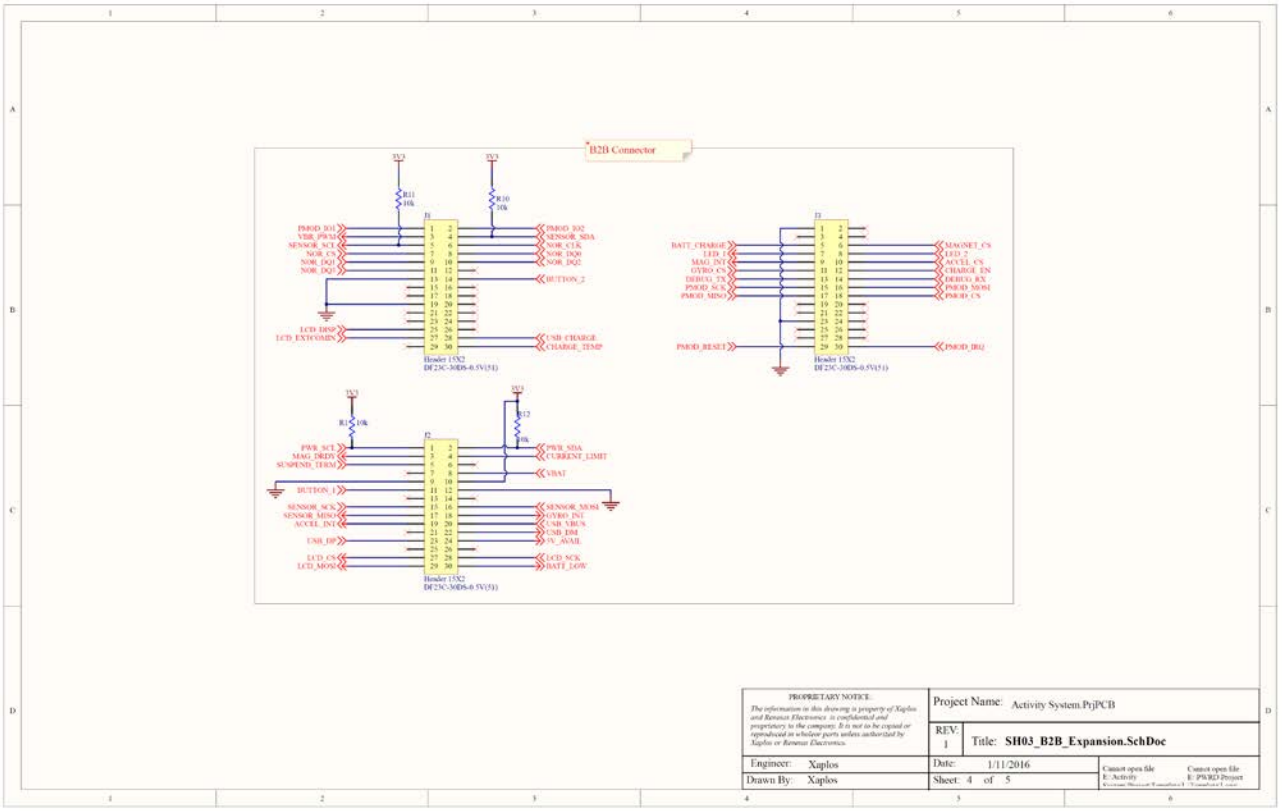

Expansion, Board to Board Connectors
Title Renesas
Size: B
Number:13
Revision:02
Altium

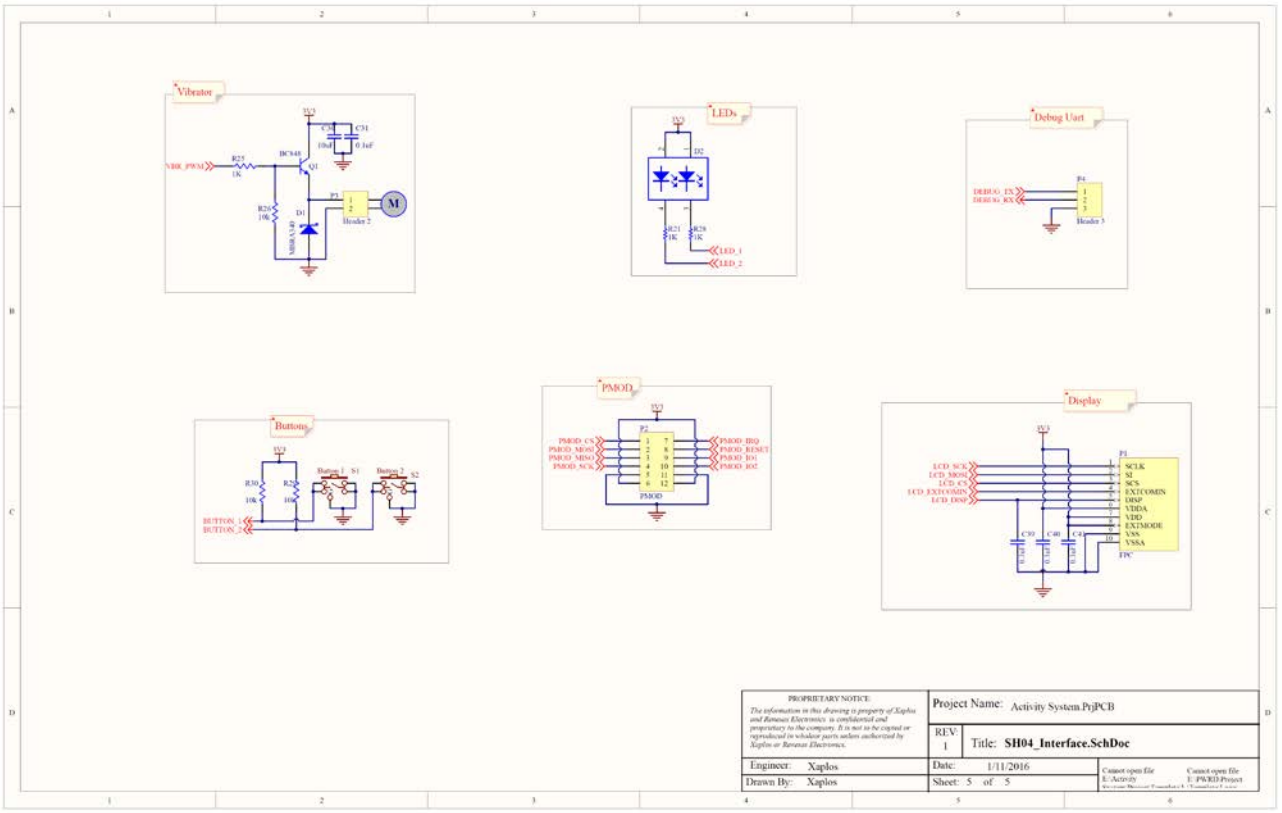


5.4 Activity Module

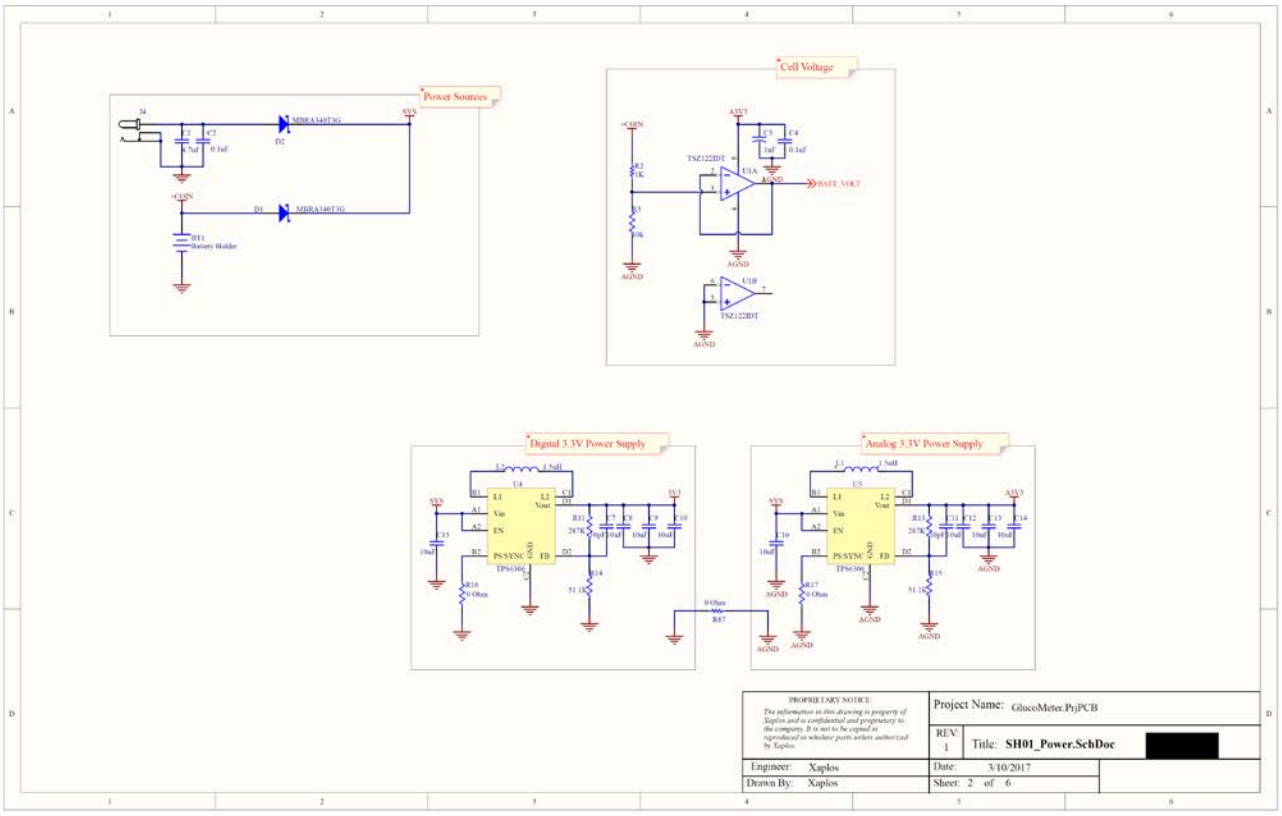


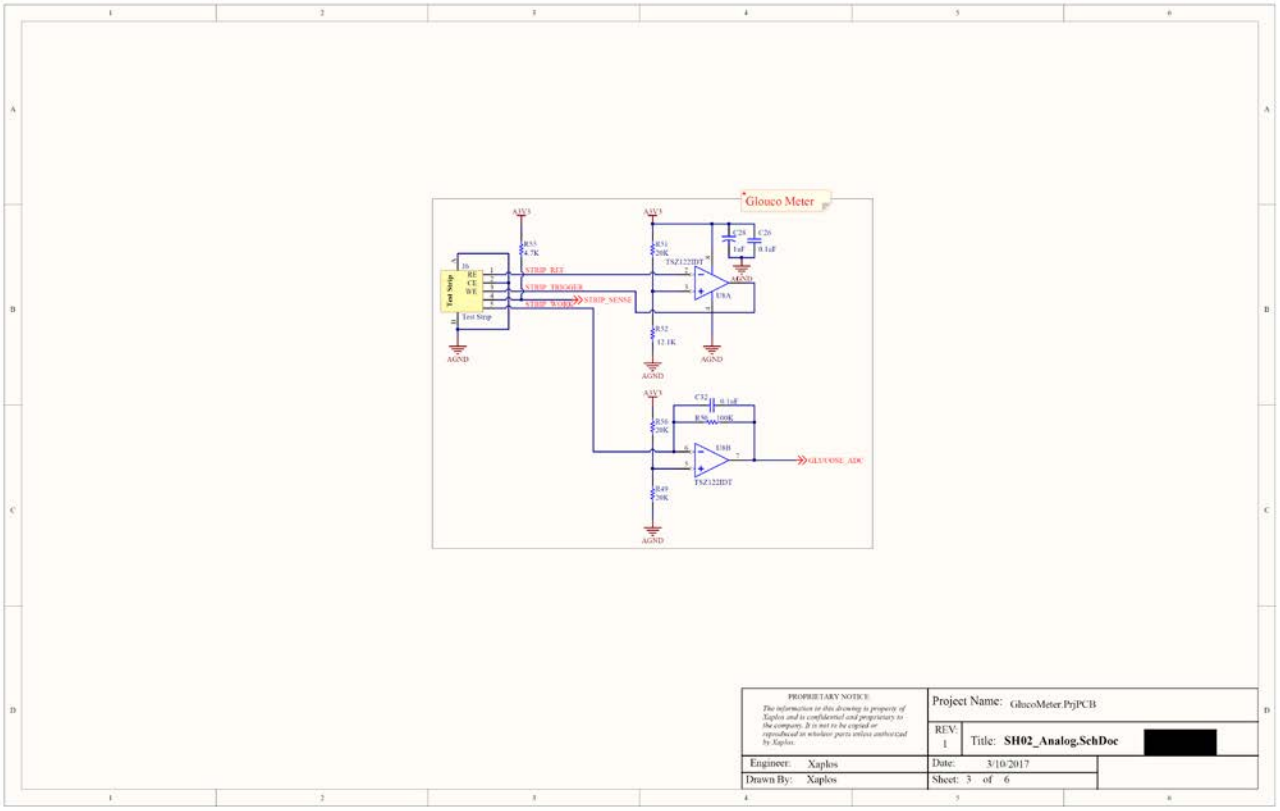

Light Sensor
Accelerometer, gyroscope and a triaxial geomagnetic sensor
Pressure Sensor
Serial Flash
Temp & Humidity Sensor
PROPRIETARY NOTICE
Project Name: Activity System.PrjPCB
REV: 1
Title: SH02_Sensors.SchDoc
Engineer: Xaplos
Drawn By: Xaplos
Date: 1/11/2016
Sheet: 3 of 5

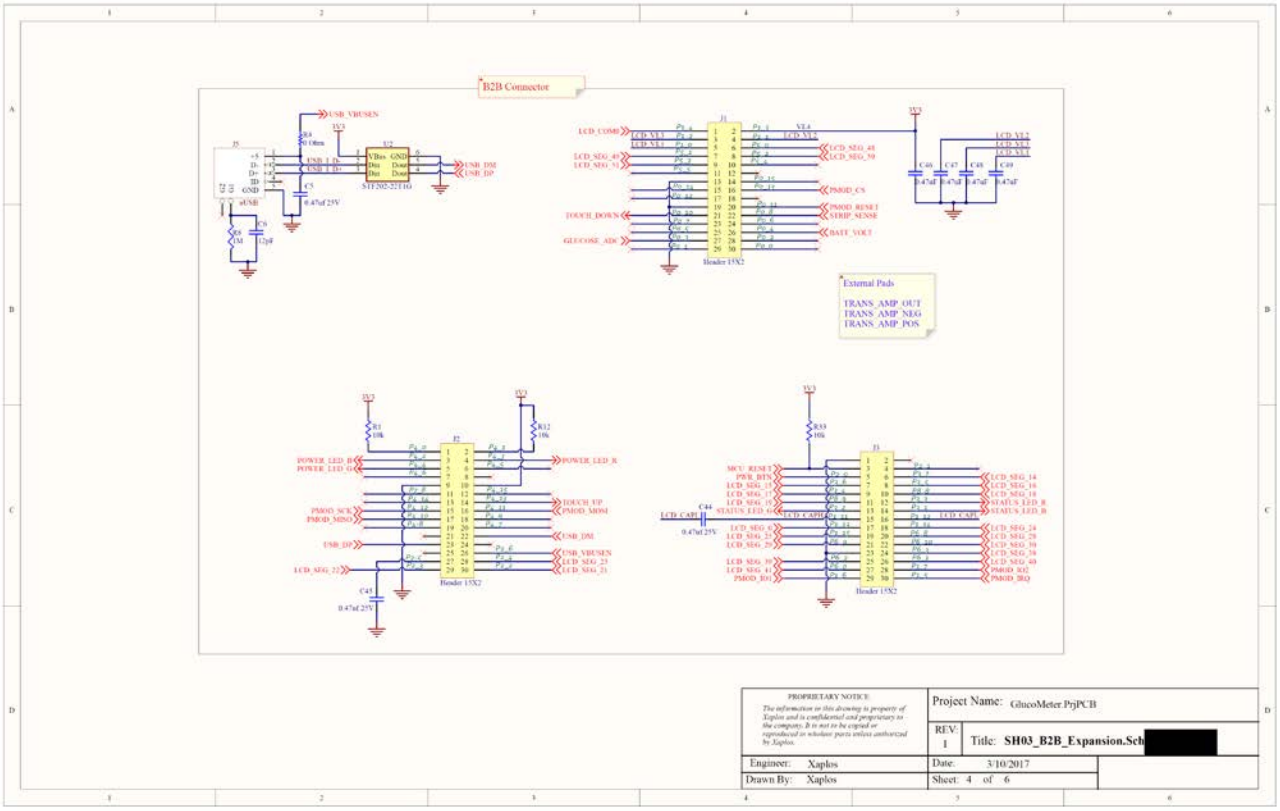

B2B Connector
PROPRIETARY NOTICE
Project Name: Activity System.PrjPCB
REV: 1
Title: SH03_B2B_Expansion.SchDoc
Engineer: Xaplos
Drawn By: Xaplos
Date: 1/11/2016
Sheet: 4 of 5

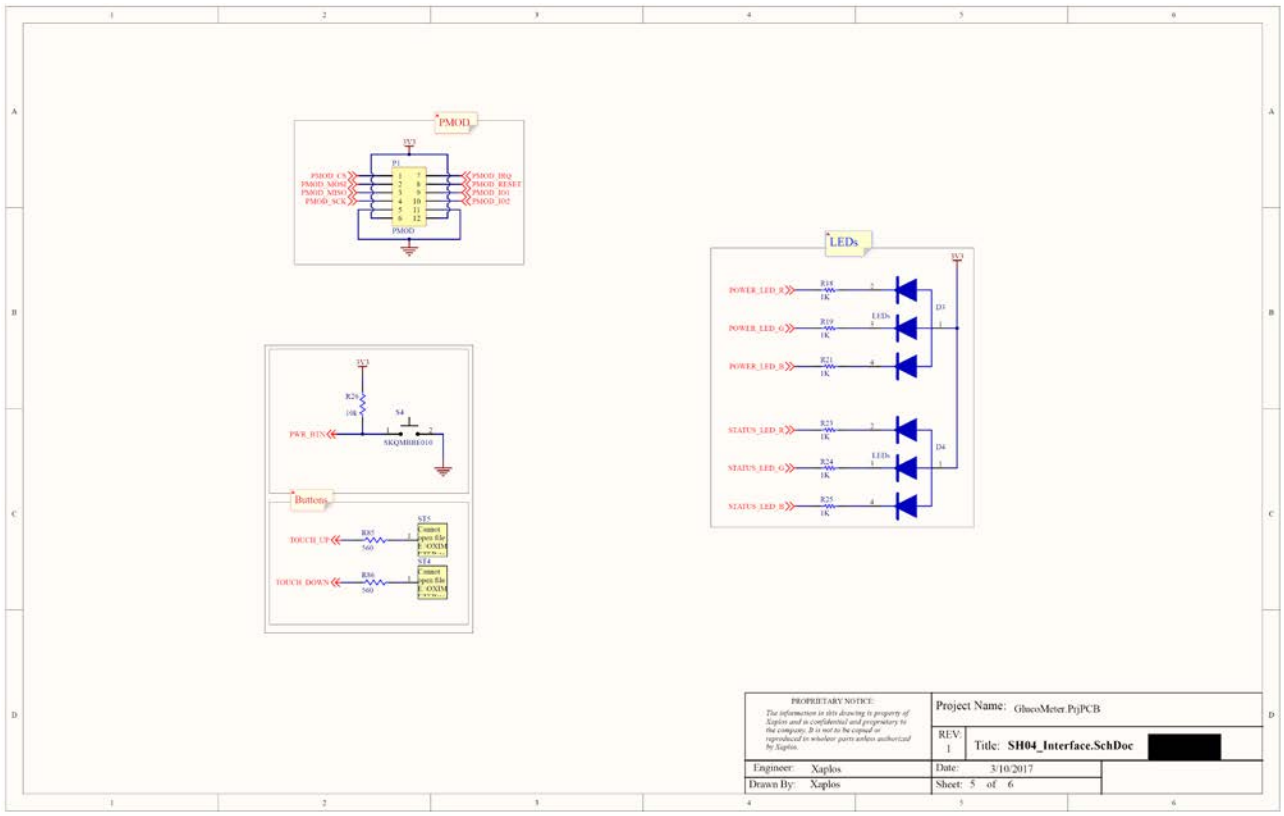


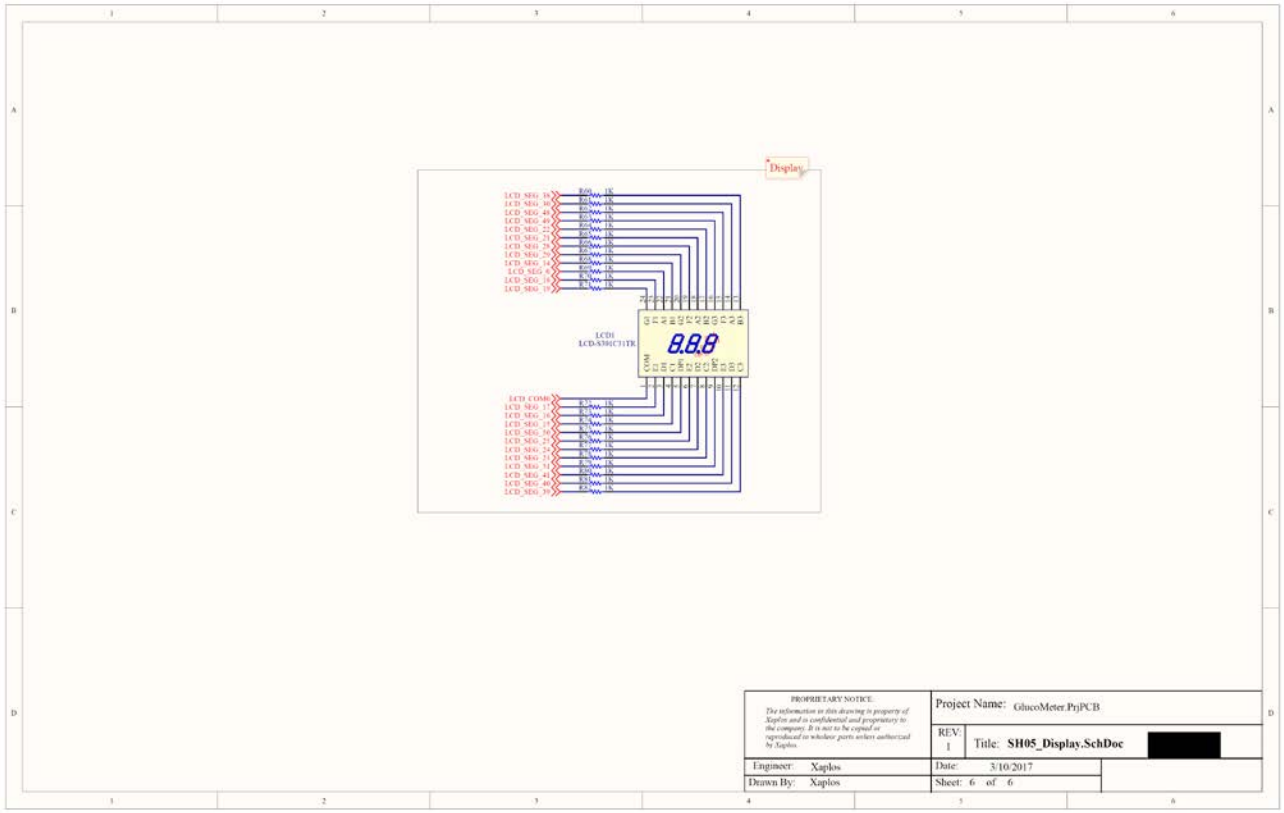
5.5 Blood Glucose Module



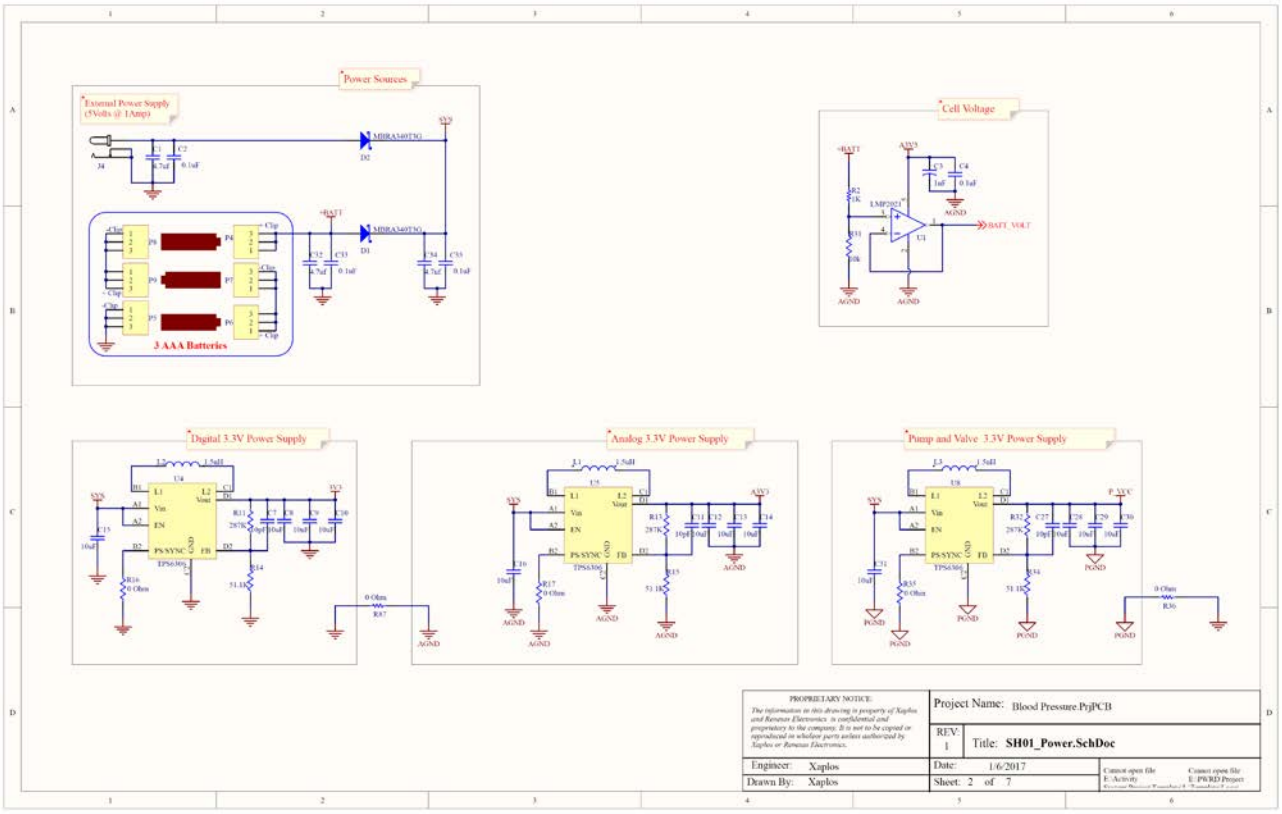

Glouco Meter
Test Strip
STRIP_BIT
STRIP_TRIGGER
STRIP_SENSE
STRIP_SCLOCK
TSZ122IDT
AGND
GLUCOSE_ADC
PROPRIETARY NOTICE
Project Name: GlucoMeter.PrjPCB
REV: 1
Title: SH02_Analog.SchDoc
Engineer: Xaplos
Drawn By: Xaplos
Date: 3/10/2017
Sheet: 3 of 6

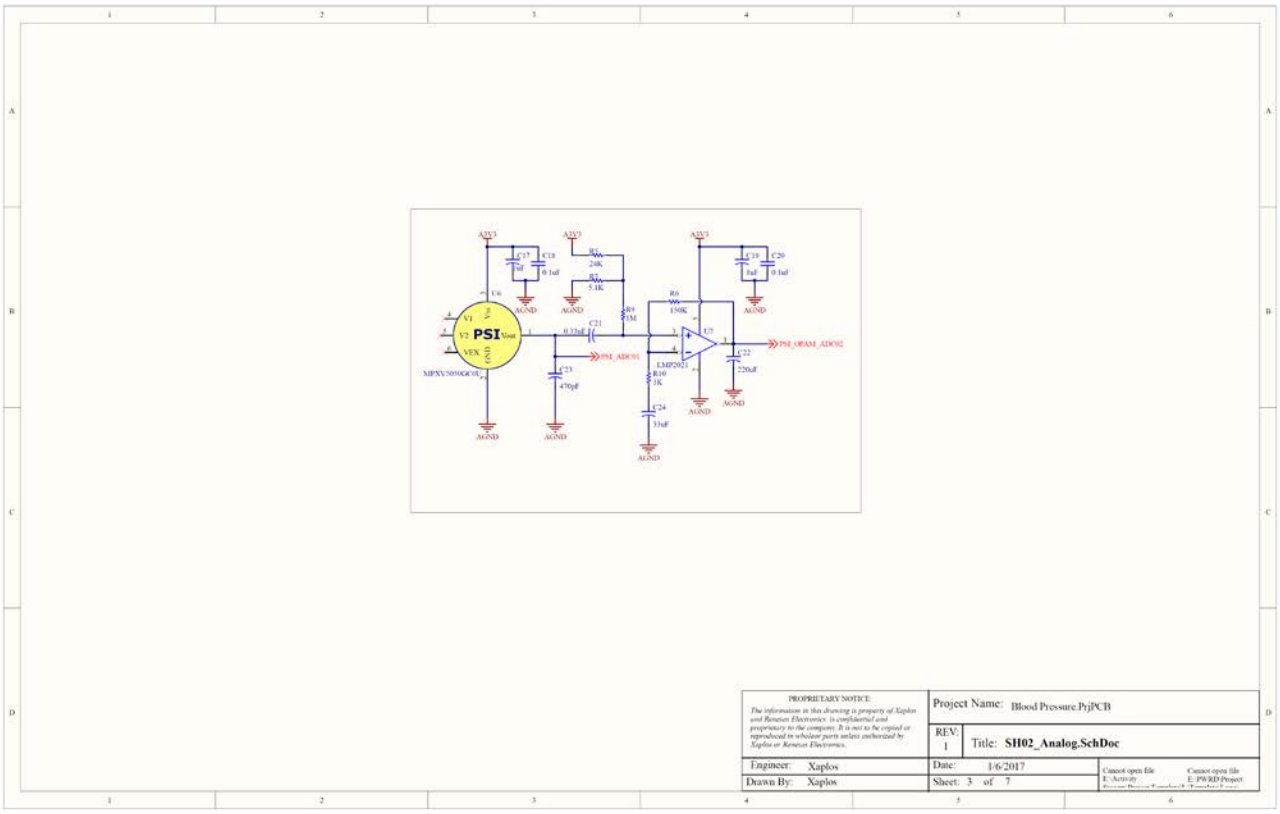

B2B Connector
USB_VBUSEN
USB_DM
USB_DP
LCD_COM0
LCD_SEG_40
LCD_SEG_55
TOUCH_DOWN
GLUCOSE_ADC
PMOD_CS
PMOD_RESET
STRIP_SENSE
BATT_VOUT
External Pads
TRANS_AMP_OUT
TRANS_AMP_NEG
TRANS_AMP_POS
POWER_LED_B
POWER_LED_G
POWER_LED_R
TOUCH_YP
PMOD_MOSI
PMOD_MISO
LCD_SEG_22
LCD_SEG_23
LCD_SEG_21
MCU_RESET
PSR_BTN
LCD_SEG_17
LCD_SEG_16
STATUS_LED
LCD_CAPH
LCD_CAPL
LCD_SEG_24
LCD_SEG_25
LCD_SEG_39
LCD_SEG_41
PMOD_IO1
LCD_SEG_14
LCD_SEG_15
STATUS_LED_R
STATUS_LED_B
LCD_SEG_29
LCD_SEG_30
LCD_SEG_54
LCD_SEG_40
PMOD_IO2
PMOD_SEQ
PROPRIETARY NOTICE
Project Name: GlucoMeter.PrjPCB
REV: 1
Title: SH03_B2B_Expansion.Sch
Engineer: Xaplos
Drawn By: Xaplos
Date: 3/10/2017
Sheet: 4 of 6

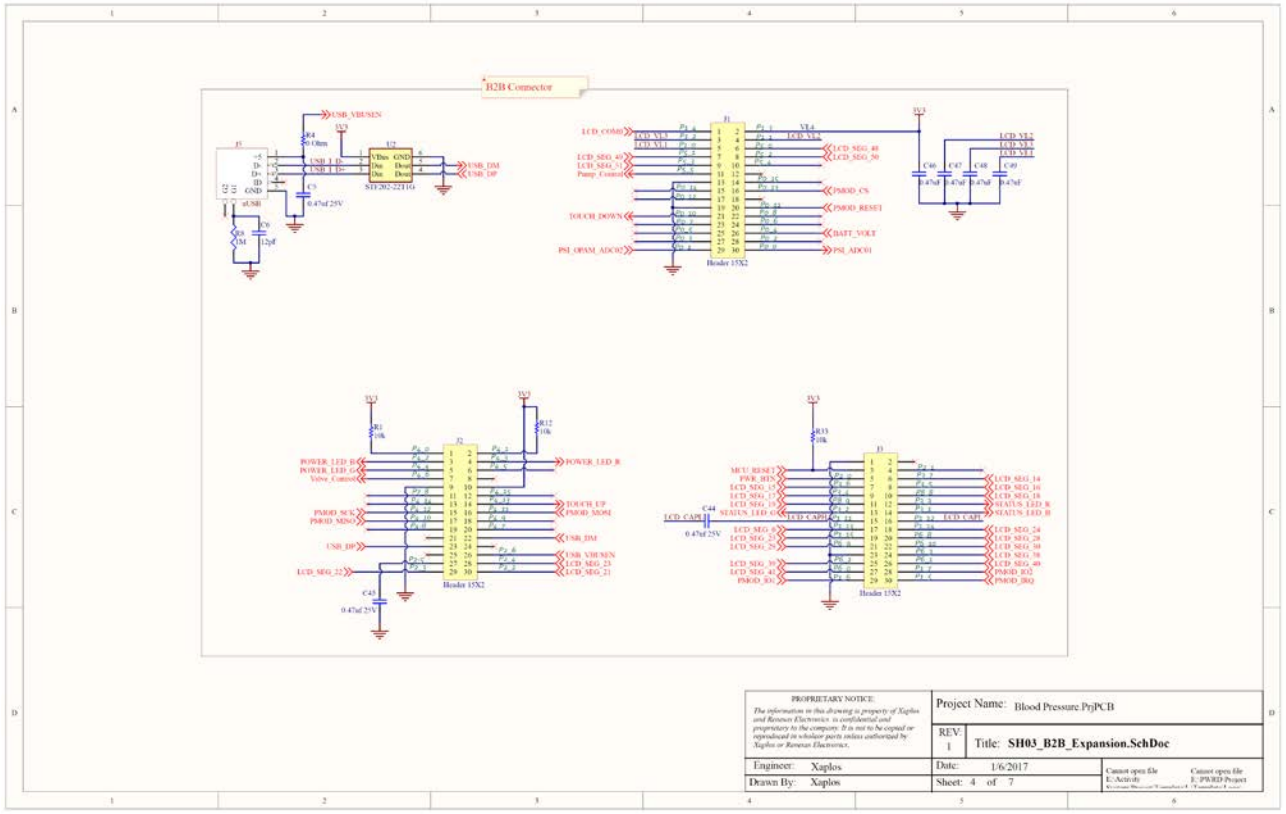

PMOD
LEDs
Buttons
PROPRIETARY NOTICE:
Project Name: GlucoMeter.PrjPCB
REV: 1
Title: SH04_Interface.SchDoc
Engineer: Xaplos
Drawn By: Xaplos
Date: 3/10/2017
Sheet: 5 of 6

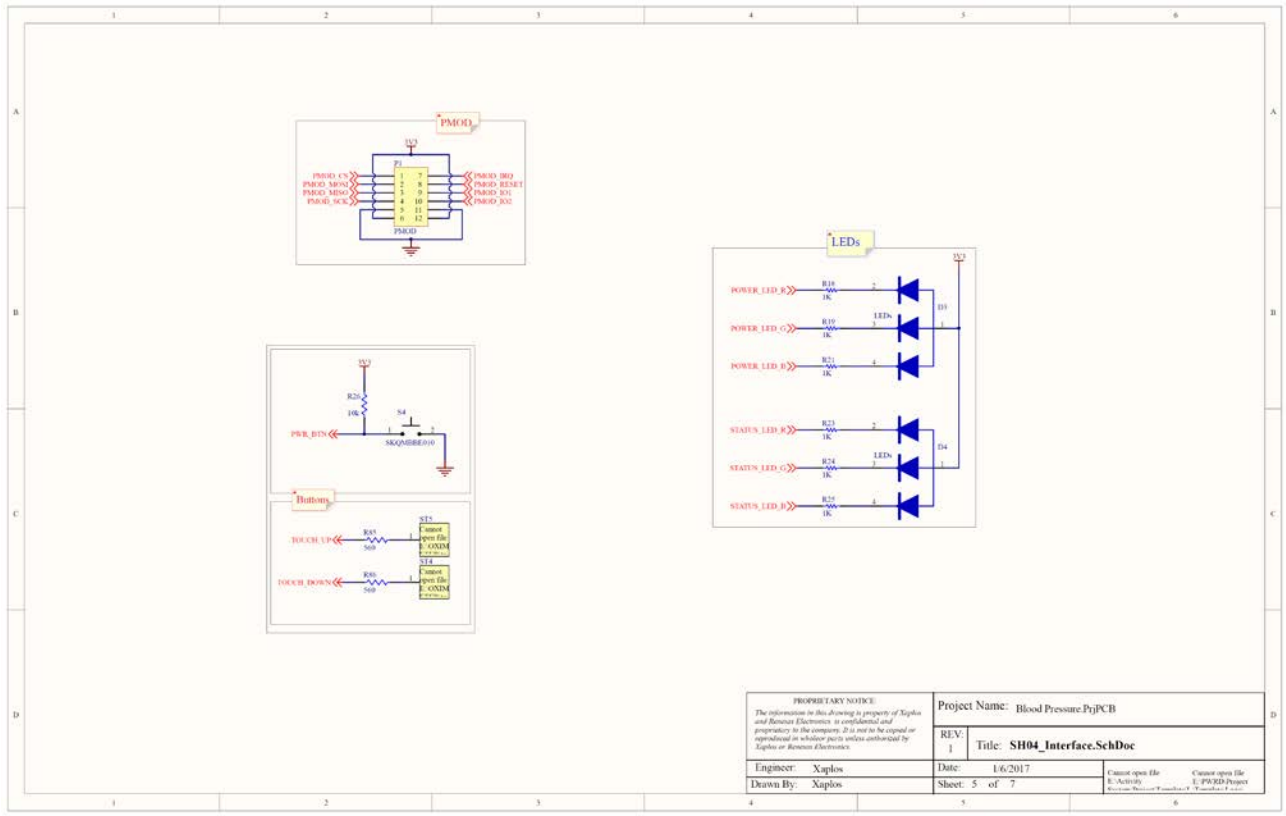

Display
PROPRIETARY NOTICE:
Project Name: GlucoMeter.PrjPCB
REV: 1
Title: SH05_Display.SchDoc
Engineer: Xaplos
Drawn By: Xaplos
Date: 3/10/2017
Sheet: 6 of 6

5.6 Blood Pressure Module

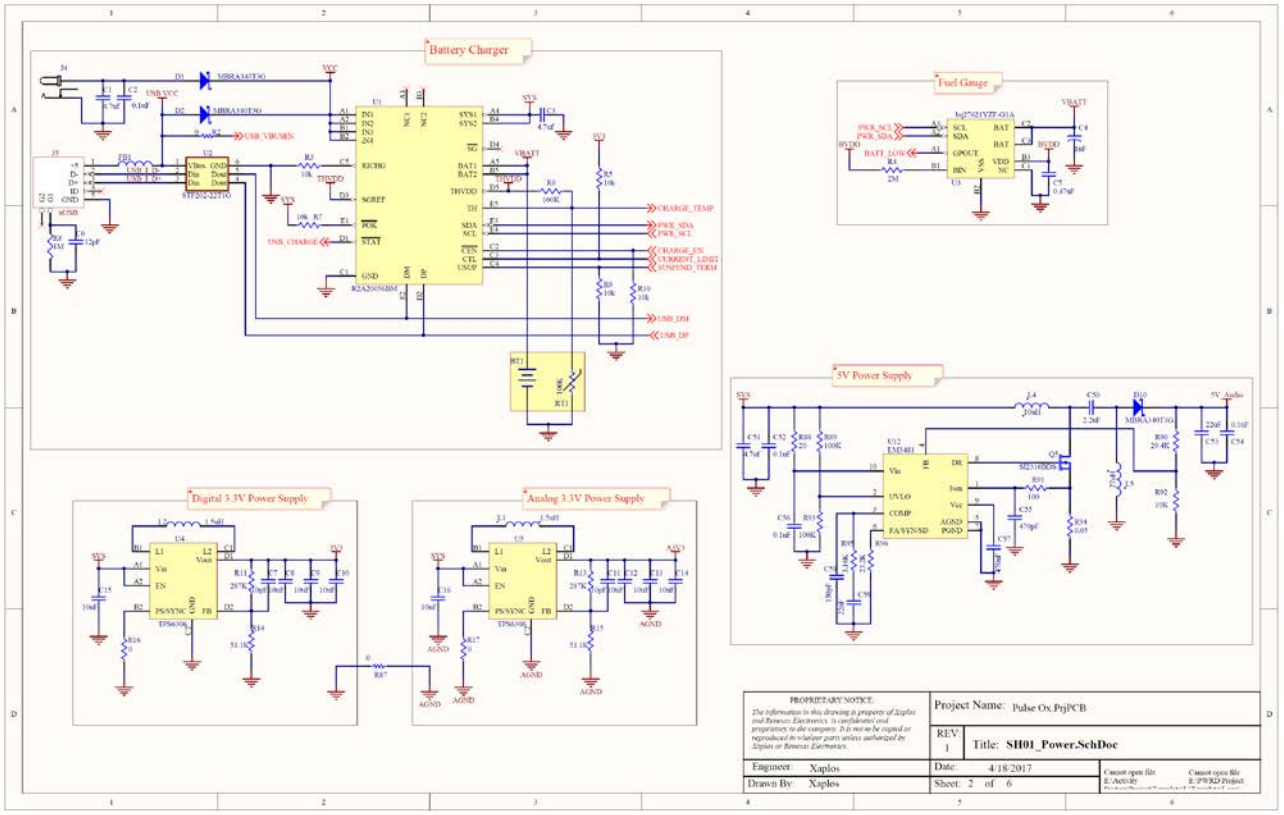


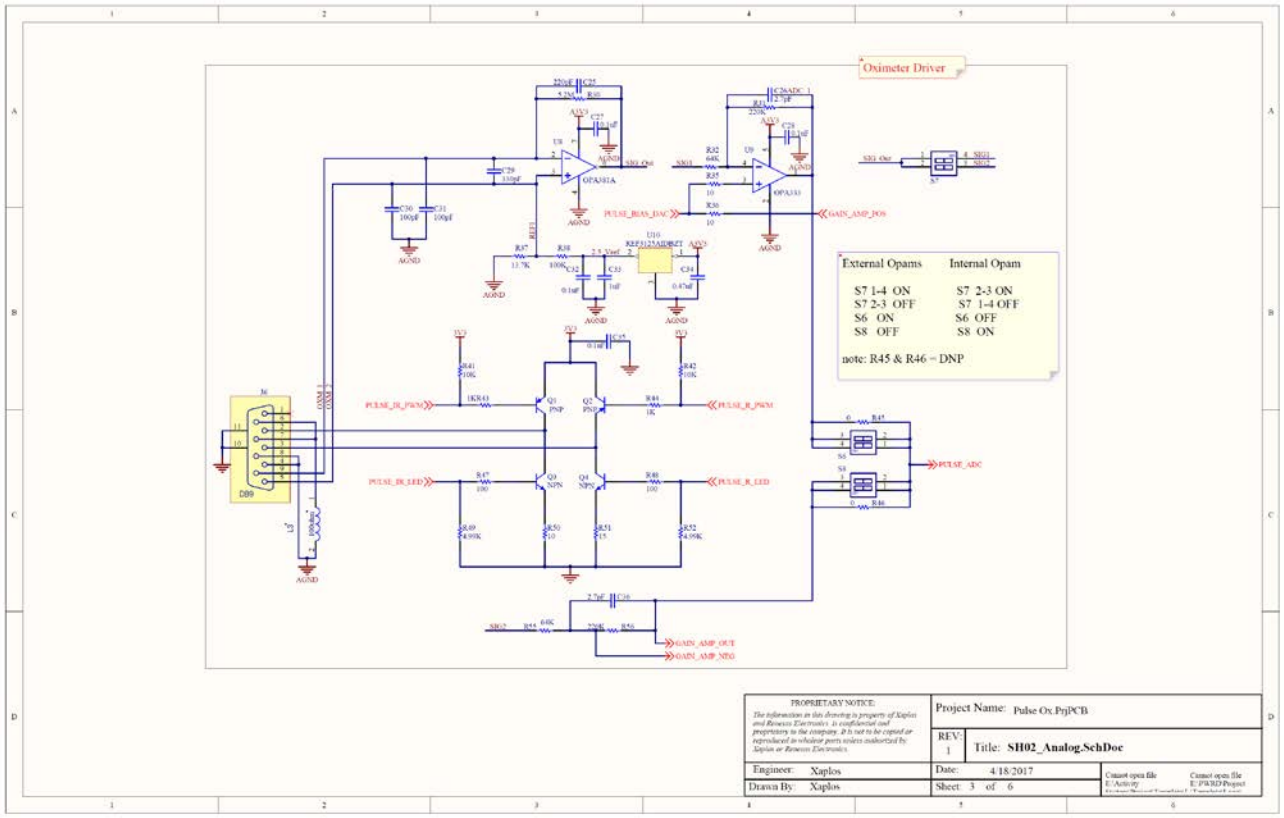


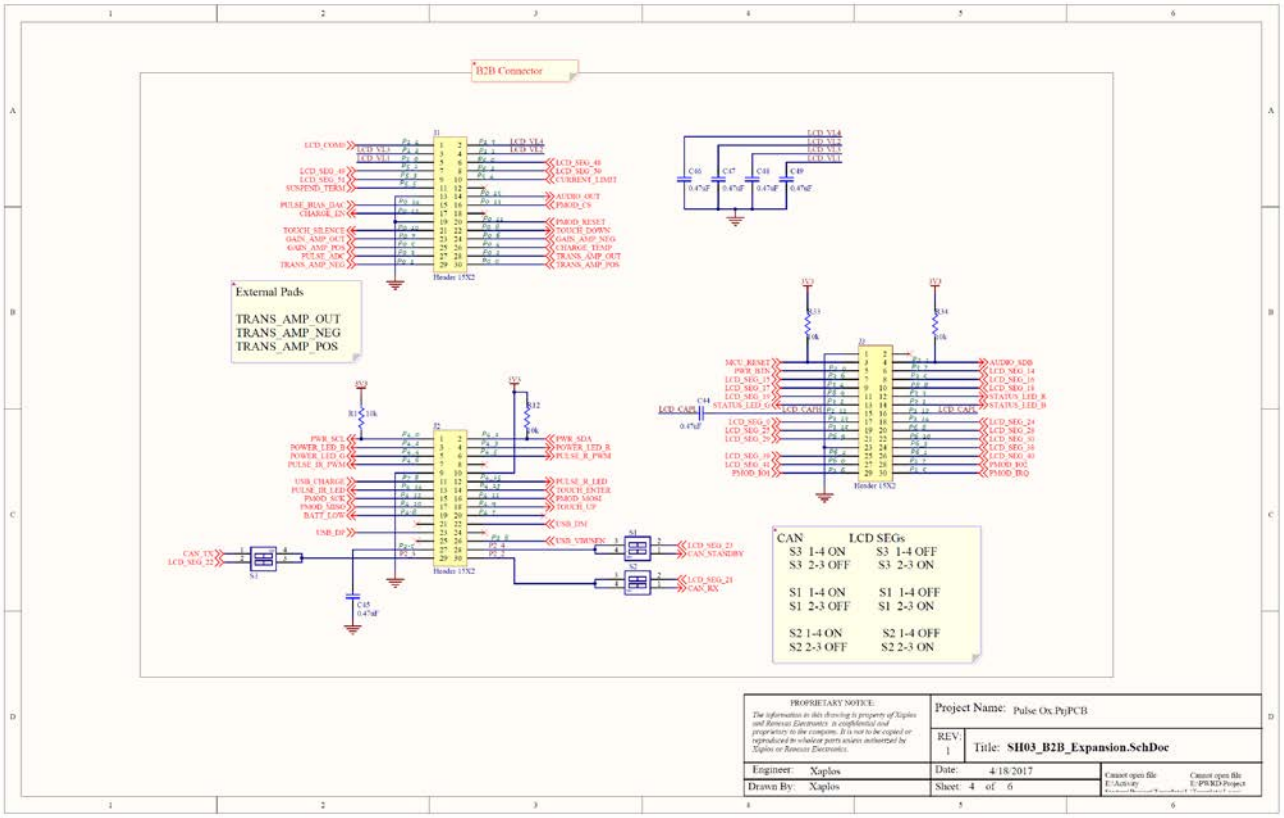

B2B Connector
PROPRIETARY NOTICE:
Project Name: Blood Pressure.PrjPCB
REV: 1
Title: SH03_B2B_Expansion.SchDoc
Engineer: Xaplos
Drawn By: Xaplos
Date: 1/6/2017
Sheet: 4 of 7

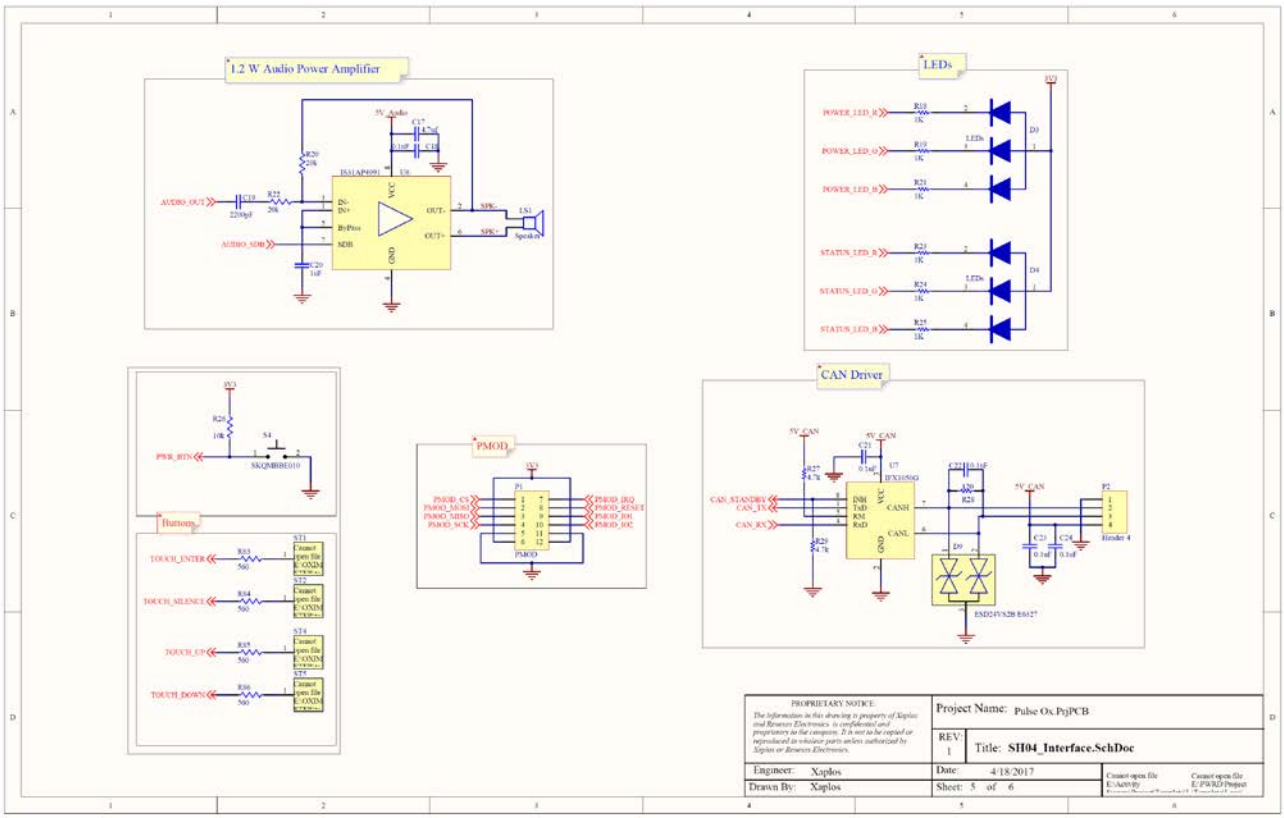

PMOD
LEDs
Buttons
PROPRIETARY NOTICE:
Project Name: Blood Pressure.PrjPCB
REV: 1
Title: SH04_Interface.SchDoc
Engineer: Xaplos
Drawn By: Xaplos
Date: 1/6/2017
Sheet: 5 of 7

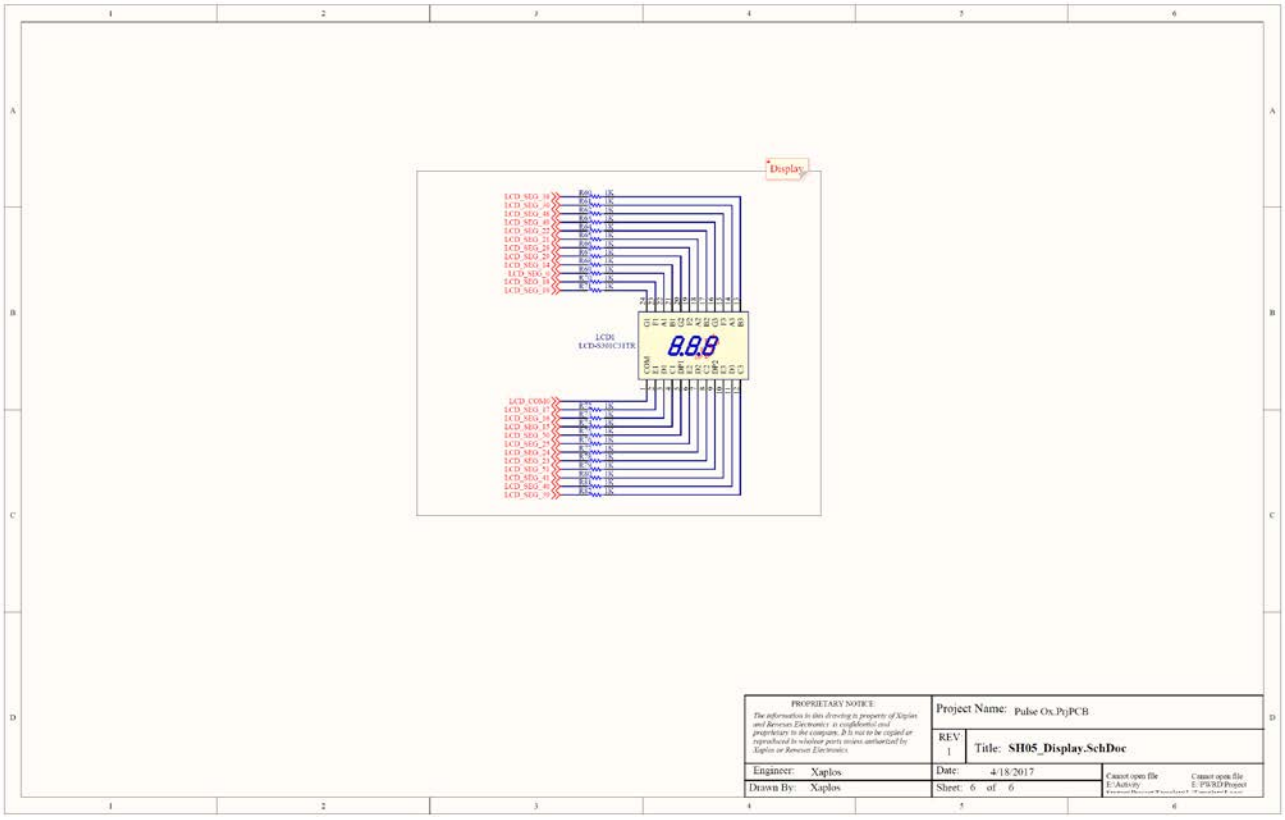
5.7 SpO2 Module






B2B Connector
External Pads
TRANS_AMP_OUT
TRANS_AMP_NEG
TRANS_AMP_POS
CAN LCD SEGs
S3 1-4 ON S3 1-4 OFF
S3 2-3 OFF S3 2-3 ON
S1 1-4 ON S1 1-4 OFF
S1 2-3 OFF S1 2-3 ON
S2 1-4 ON S2 1-4 OFF
S2 2-3 OFF S2 2-3 ON
PROPRIETARY NOTICE:
Project Name: Pulse Ox PrjPCB
REV: 1
Title: SH03_B2B_Expansion.SchDoc
Engineer: Xaplos
Drawn By: Xaplos
Date: 4/18/2017
Sheet: 4 of 6


1.2 W Audio Power Amplifier
LEDs
CAN Driver
PMOD
Buttons
PROPRIETARY NOTICE:
Project Name: Pulse Ox PrjPCB
REV: 1
Title: SH04_Interface.SchDoc
Engineer: Xaplos
Drawn By: Xaplos
Date: 4/18/2017
Sheet: 5 of 6


Display
LCD6
LCD-S301C31TR
8.8.8
PROPRIETARY NOTICE:
Project Name: Pulse Ox.PrjPCB
REV: 1
Title: SH05_Display.SchDoc
Engineer: Xaplos
Drawn By: Xaplos
Date: 4/18/2017
Sheet: 6 of 6

Website and Support

Renesas Electronics Website
http://www.renesas.com/

Inquiries
http://www.renesas.com/contact/

Revision History

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	Jul 11, 2017	–	Initial Release

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Handling of Unused Pins

   Handle unused pins in accordance with the directions given under Handling of Unused Pins in the manual.

   — The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

   The state of the product is undefined at the moment when power is supplied.

   — The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.
   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.
   In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

   Access to reserved addresses is prohibited.

   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

4. Clock Signals

   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.

   — When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.

5. Differences between Products

   Before changing from one product to another, i.e. to a product with a different part number, confirm that the change will not lead to problems.

   — The characteristics of Microprocessing unit or Microcontroller unit products in the same group but having a different part number may differ in terms of the internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

(Rev.3.0-1 November 2016)

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Colophon 6.0