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ADI Confidential

Vital Signs Monitoring (VSM) Watch

FEATURES

Vital signs monitoring platform
Wearable battery powered platform
Real-time live data view
Data storage to flash memory for offline analyses
Easy configuration

DEVICES HOSTED IN THE VSM WATCH

nRF52840
ADP5360
ADXL362
ADPD4100
AD8233
AD5940
AD7156

EVALUATION KIT CONTENTS

The VSM Watch
Charging Cradle
USB Type A to micro-USB cable
Firmware Debug Board

SOFTWARE NEEDED

VSM WaveTool

GENERAL DESCRIPTION

The vital signs monitoring (VSM) watch, EVAL-HCRWATCH4Z, is a modular development, demonstration, and data collection platform for high performance vital signs monitoring applications based on Analog Devices, Inc. analog front ends and sensors.

It is a wearable, battery-powered device which enables the continuous monitoring and on-demand spot check measurement of photoplethysmography (PPG), electrodermal activity (EDA, bioimpedance-based), skin temperature, electrocardiography (ECG, biopotential based), and motion/activity (based on a 3-axis accelerometer).

It allows for synchronized, multiparameter data storage on internal memory for later data retrieval and offline analysis and/or live monitoring on a PC (Windows® OS) or Android or iOS-based device.

PREPARING THE VSM WATCH

Before using the VSM Watch, proper preparations must be made. Ensure the battery of the watch is charged and the WaveTool program for PC is successfully installed. See the Powering Up the System for the First Time sections for installation instructions. The watch firmware must be upgraded using the VSM WaveTool.

CONDITIONS REGARDING THE USE OF THIS PRODUCT IN HEALTHCARE APPLICATIONS

This device design is being provided as-is without any express or implied representations or warranties of any kind and the use of this device shall impose no legal obligation on Analog Devices, Inc., and its subsidiaries, employees, directors, officers, servants, and agents. In addition, it is understood and agreed to that the device is not authorized for use in safety critical healthcare applications (such as life support) in which malfunction or failure of a product can be expected to result in personal injury or death. This device must not be used for diagnostic purposes. It must not be used with a defibrillator or other equipment that produces high voltages more than the supply rails on the evaluation board.

This device is provided for evaluation and development purposes only. It is not intended for use as, or as part of, a product. Any use of the device in such applications is at your own risk and you shall fully indemnify Analog Devices, its subsidiaries, employees, directors, officers, servants and agents for all liability and expenses arising from such unauthorized usage. You are solely responsible for compliance with all legal and regulatory requirements connected to such use.

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4/2021—Revision 0: Initial Version

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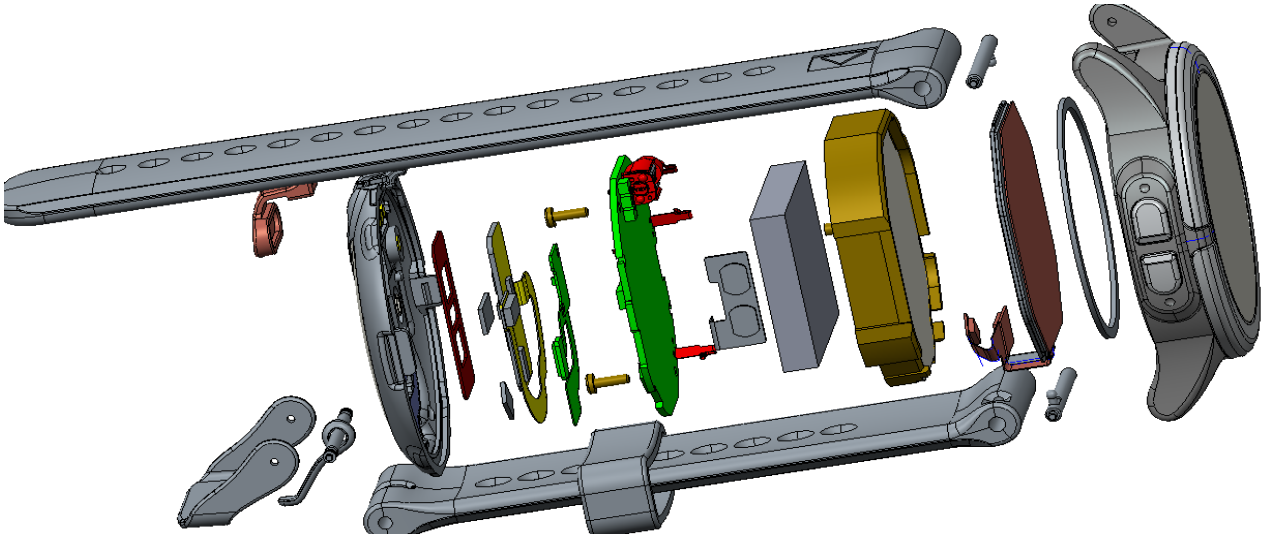


Figure 2. VSM Watch Expanded View

Figure 3. Connections and Buttons – Top of Watch

Figure 4. Connections and Buttons – Bottom of Watch

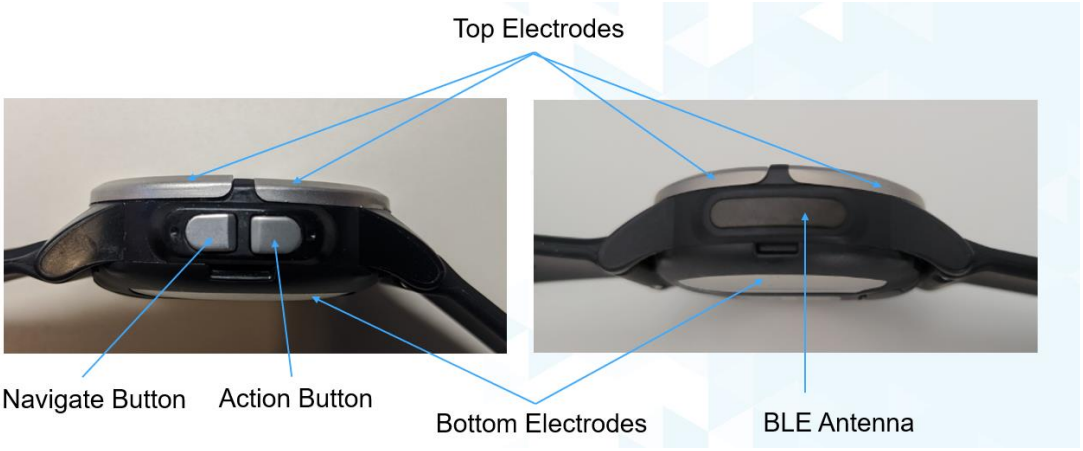


Figure 5. Connections and Buttons - Sides

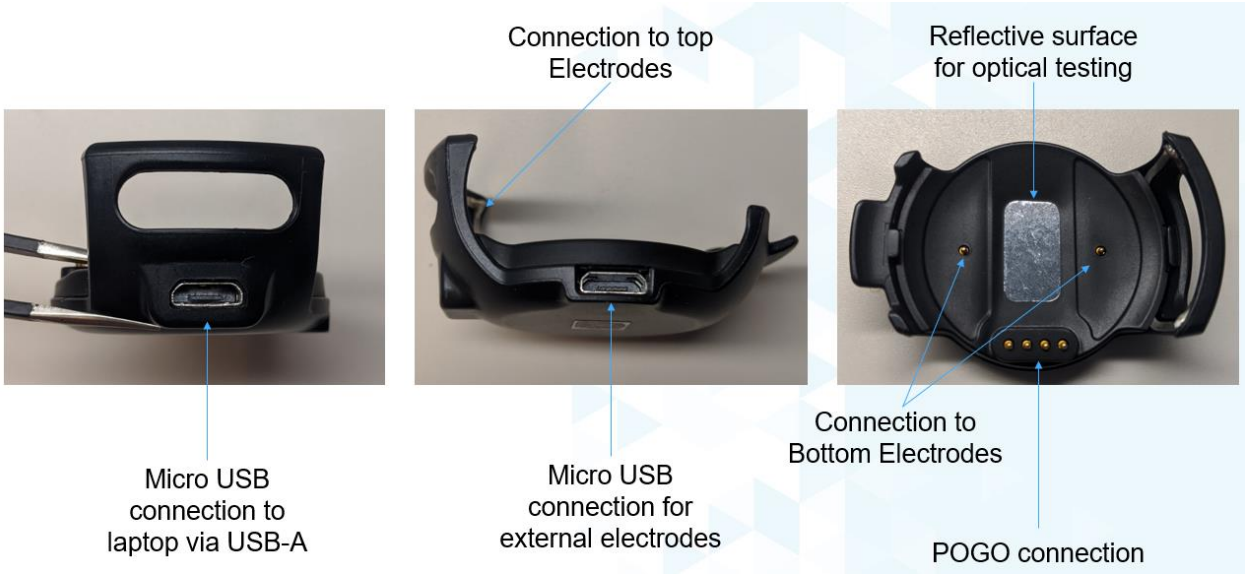


Figure 6. Charging Cradle

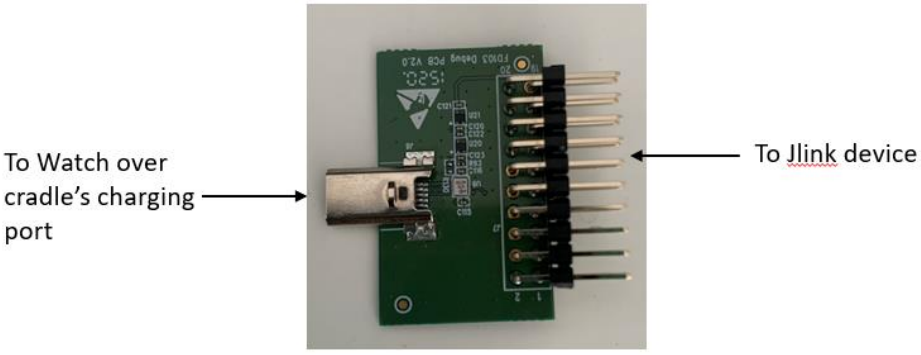


Figure 7: Firmware Debug Board

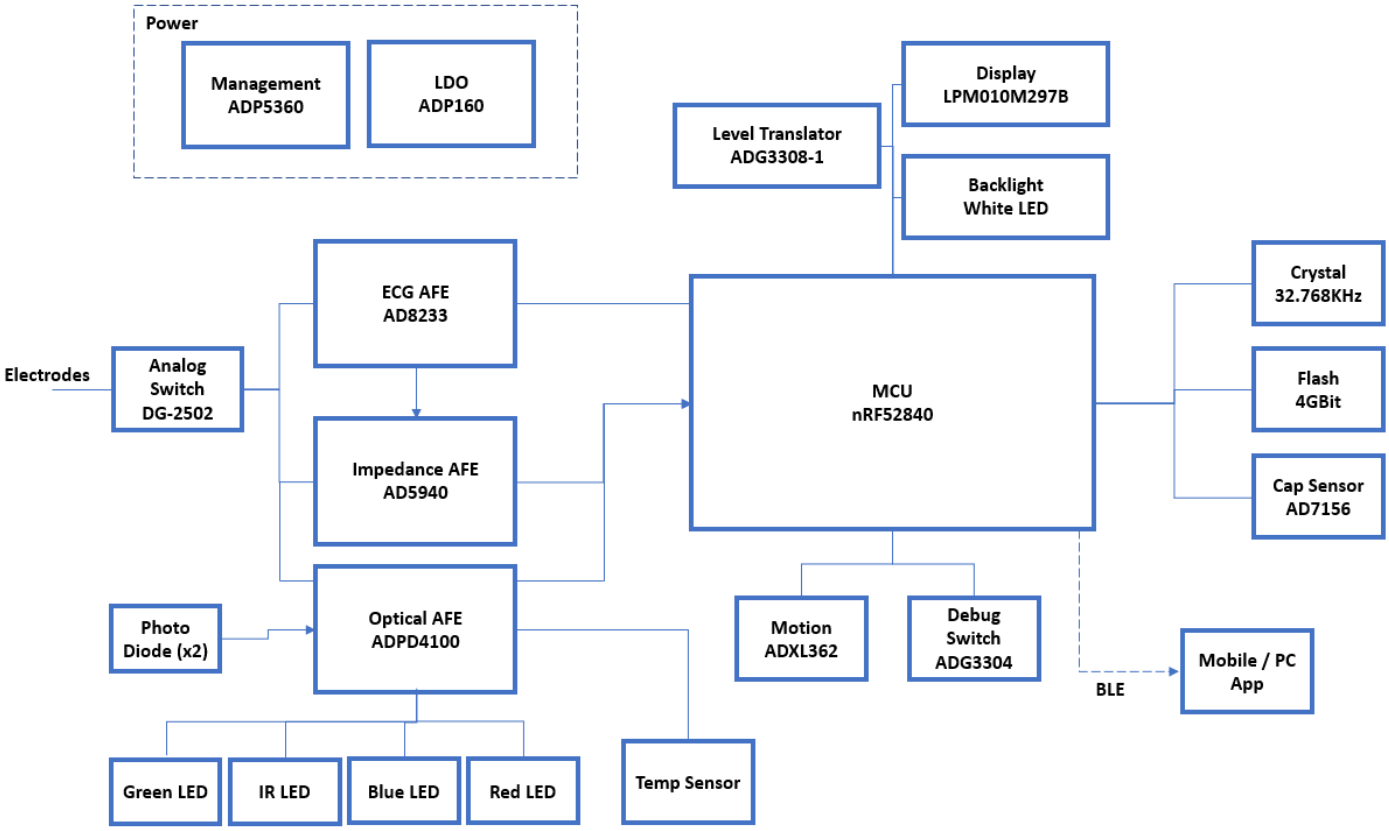


Figure 8. Simplified Electrical Block Diagram

EVALUATION PLATFORM

OVERVIEW

The VSM Watch is a modular development, demonstration, and data collection platform for high performance vital signs monitoring applications based on Analog Devices analog front ends and sensors.

The platform optimized electrical and mechanical design hosts all the required circuits to sense, condition, digitize, process, store, and wirelessly transmit real-time, vital sign related data. This platform does the following:

- Minimizes the risks associated with a new electronic design
- Minimizes the time to market for a new final product
- Facilitates the evaluation of a wide range of Analog Devices solutions in a single battery-powered wearable ecosystem
- Highlights and addresses the challenges associated with a wearable device
- Allows the developer to focus on other added value tasks such as algorithm development and the overall firmware for engineering and scientific research and validation

This platform is NOT intended to do the following:

- Act as the final product for a specific application
- Demonstrate an application specific optimized design. Trade-offs have been made to allow platform flexibility

The evaluation platform kit contains the following items:

- The VSM platform (the watch)
- Charging Cradle
- A USB Type A to micro-USB cable
- Firmware Debug Board

Figure 9. Box Contents

The USB cable is used for the following purposes:

1. Recharge the battery via the charging cradle (connecting the watch to a PC or wall adaptor)
2. Upgrade the platform firmware (using the software tools provided and as explained in the **Error! Reference source not found.** section)
3. Download data stored in the internal flash memory for offline data analyses or other purposes

Only use the watch with the USB cable provided.

POWERING UP THE SYSTEM FOR THE FIRST TIME

The VSM Watch is shipped from the factory in an ultra-low-power shipment mode. To exit this power mode, place the watch into the cradle with connected USB cable providing power.

Before using the watch for the first time, fully charge the battery by connecting the VSM Watch to a PC or wall adaptor using the USB cable provided. A firmware upgrade may be required. Details can be found in the **Error! Reference source not found.** section.

WATER RESISTANCE

The watch is IP68 rated. Despite this rating, please exercise caution if showering, swimming, or doing any other activity with the VSM Watch that exposes it directly to moisture.

SOFTWARE

For information on the VSM Watch Software, please refer to the **VSM Watch Software User Guide**.

BLUETOOTH USB PC DONGLE (NRF52840)

The VSM Watch platform leverages an off-the-shelf Nordic BLE dongle for communicating wirelessly with a PC. The nRF52840 is available for purchase separately through multiple online vendors. Custom FW for this dongle can be found at https://www.nordicsemi.com/Software-and-tools/Development-Kits/nRF52840-Dongle

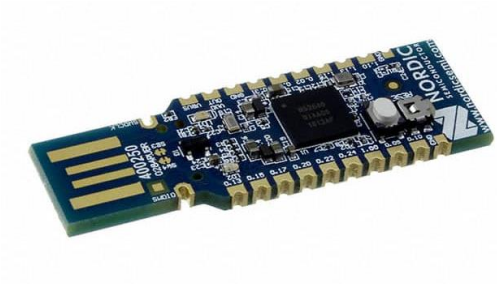


Figure 10. BLE USB PC Dongle (nRF52840)

BUTTONS

Two buttons are found on the side of the watch. An explanation of their uses is found in the tables below.

Table 1. Button Descriptions

Button		Description
Navigation		Press to proceed to the next screen
Action		Press for 'OK'

Table 2. Button Usage in Watch App

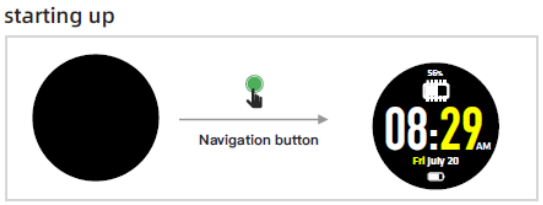
Button Combination	Button Actions	Button Press Timings (sec)
Action button Short press	select current page action	0.05
Action button Short press	navigate to next page	0.05
Action button Long press	back to previous page action	3
Navigate button Long press	call soft reset of watch app	3
Action + Navigate button Long press	enter Bootloader	3
Navigate button Long press when Watch is powered down	Watch wakes up	1

Table 3. Button Usage in Bootloader

Button Combination	Button Actions	Button Press Timings (sec)
Action button Short press	No action	-
Navigate button Short press	No action	-
Action button Long press	No action	-
Navigate button Long press	Enter Watch app	7
Action + Navigate button Long press	Enter Watch app	7
Action button Short press	No action	-

DISPLAY INDICATORS

Starting Up

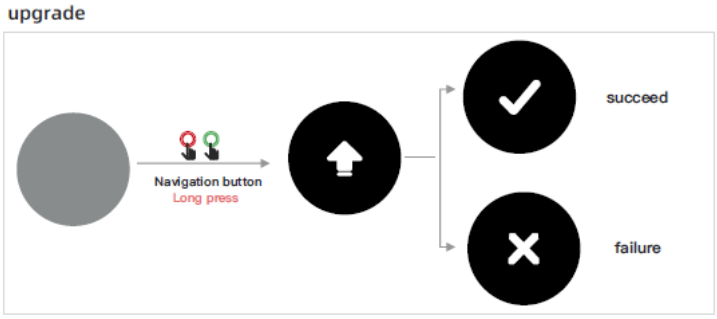


In power off mode, press the Navigation button for 1s to start the machine

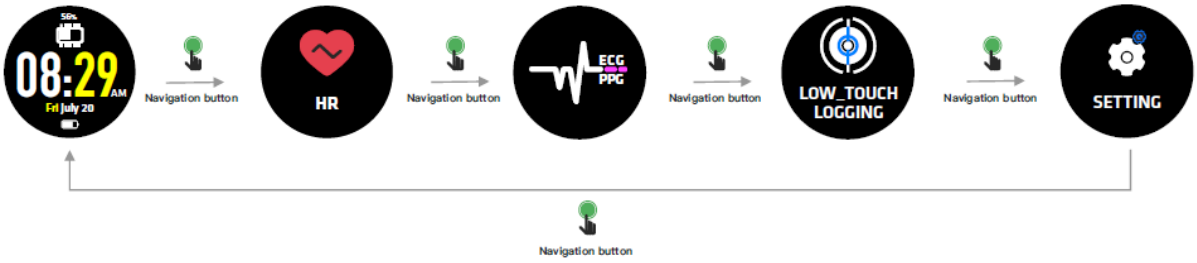
It must be started with a charging cable

Restart from any Page

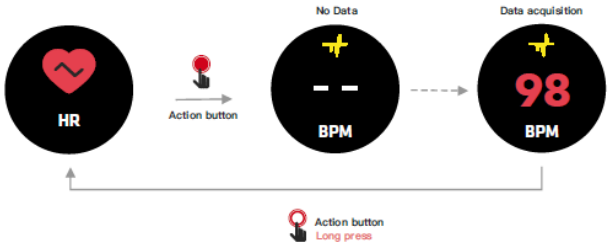
Firmware upgrade



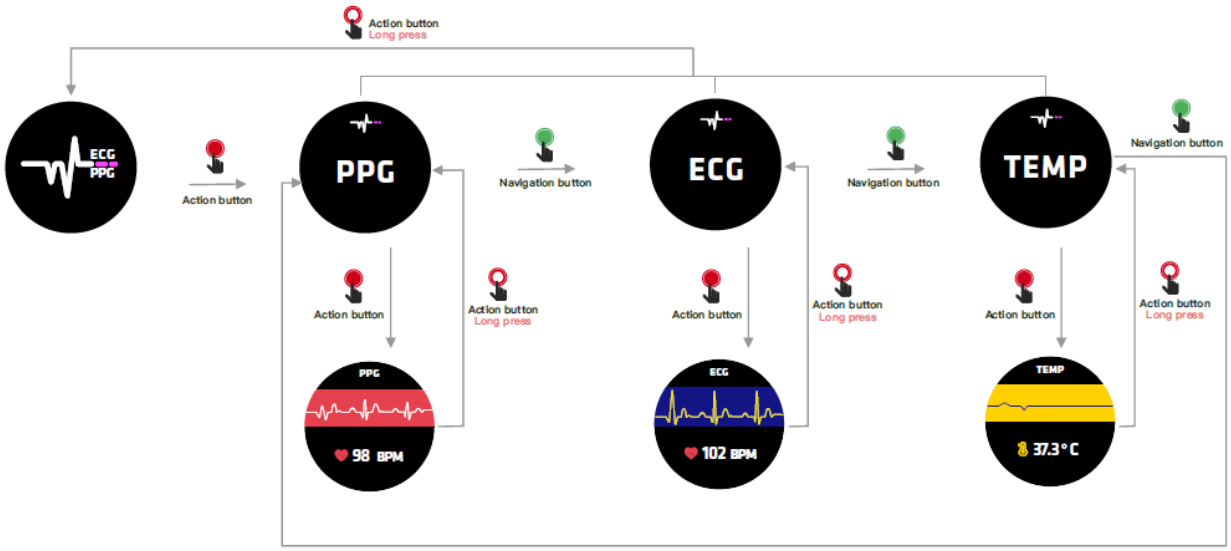
Main Page Interface



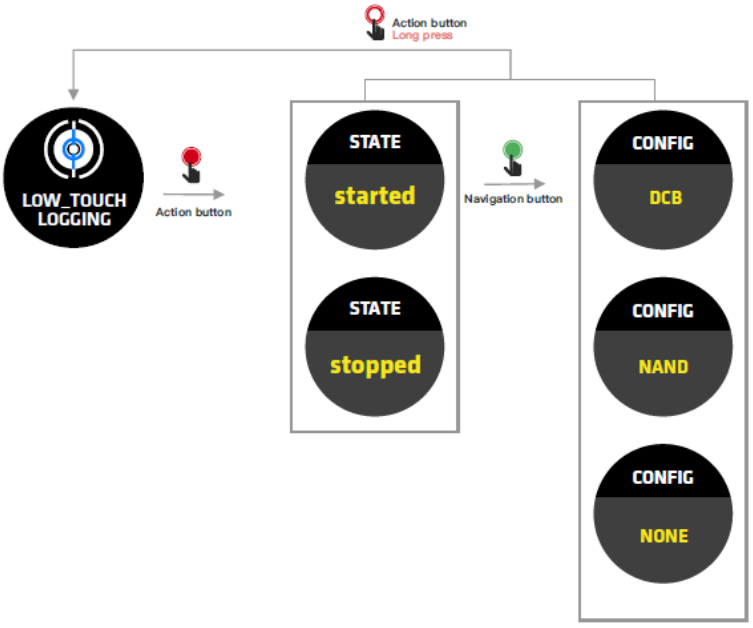
Heart Rate Page



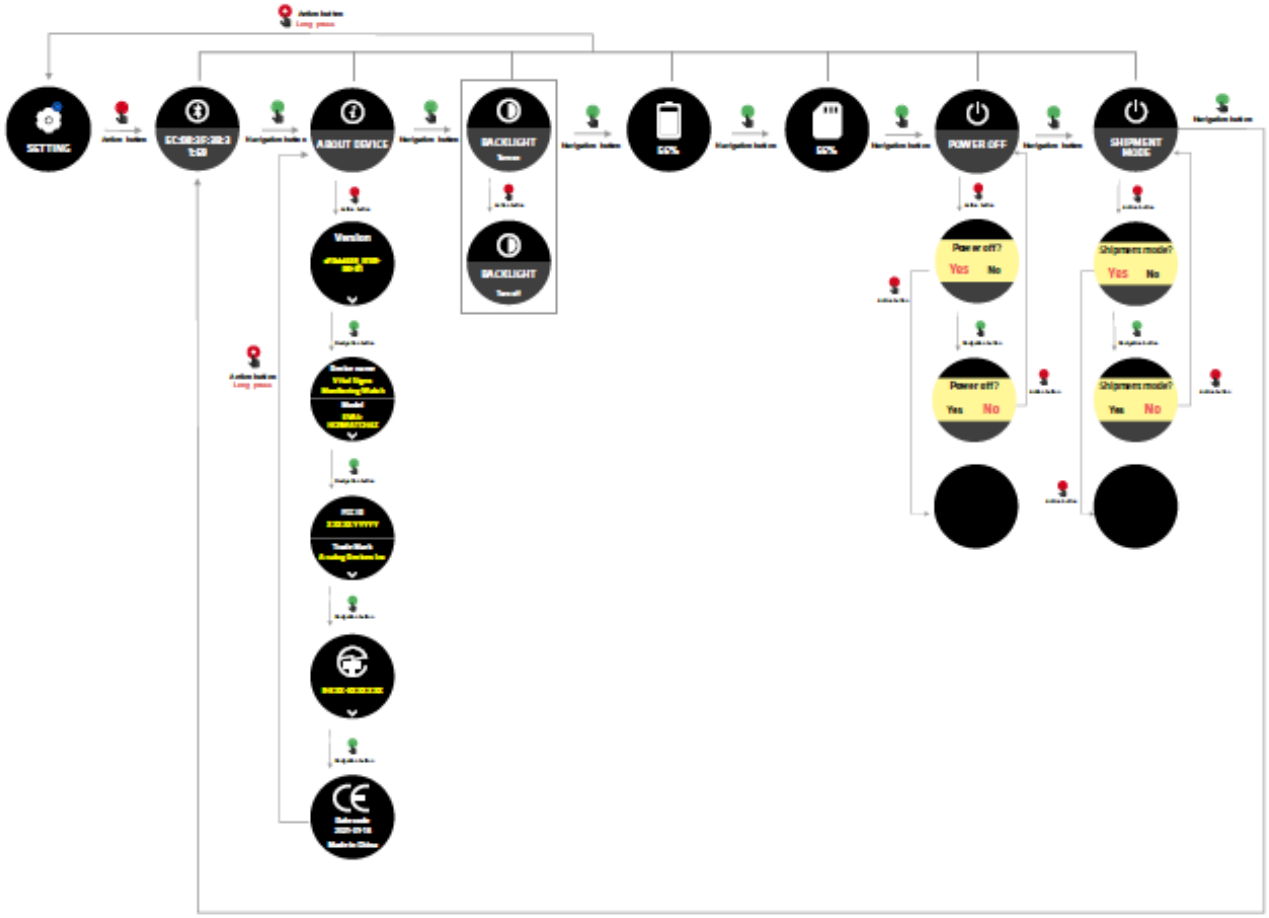
Waveform Page



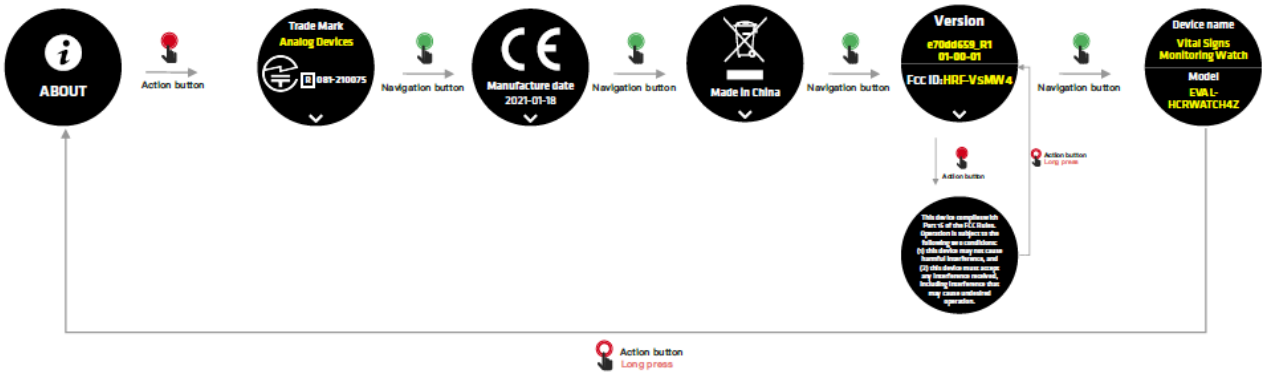
Low Touch Page



Setting Page



About Page



VITAL SIGNS MONITORED

To minimize the power line interference (50 Hz/60 Hz) and improve the quality of the output signal, it is recommended to use the BLE link.

PHOTOPLETHYSMOGRAPHY (PPG)—ADPD4100

The ADPD4100 operates as a complete multimodal sensor front end, stimulating up to eight LEDs (four on the VSM Watch) and measuring the return signal on up to eight separate current inputs. Twelve time slots are available, enabling 12 separate measurements per sampling period.

The data output and functional configuration utilize an I2C interface on the ADPD4001 or a serial port interface (SPI) on the ADPD4000. The control circuitry includes flexible LED signaling and synchronous detection. The devices use a 1.8 V analog core and 1.8 V/3.3 V compatible digital input/output (I/O).

Refer to the ADPD4100 product page and data sheet for further details.

Details regarding the hardware implementation are found in Table 4 and Table 5.

Table 4. Electrical Connections to the ADPD4100 Inputs

Input Pin	Description
IN-1	VEMD8080 Photodiode 1
IN-2	VEMD8080 Photodiode 2
IN-3	Temp Sensor
IN-4	Temp Sensor
IN-5	ECG / Bio-Z
IN-6	ECG / Bio-Z
IN-7	ECG / Bio-Z
IN-8	ECG / Bio-Z

Table 5. Electrical Connections to the ADPD4100 LED Current Sinks

Current Sink	Color	Wavelength	No. of LEDs
LED1A	Green	530 nm	1
LED2A	Infrared	940 nm	1
LED3A	Red	660 nm	1
LED4A	Blue	470 nm	1

For more details on how to configure various slots of ADPD4100 and other configuration information check ADPD4100 datasheet from below link https://www.analog.com/media/en/technical-documentation/data-sheets/adpd4100-4101.pdf

MOTION AND ACTIVITY - ADXL362

Motion is sensed by the ADXL362, an ultra-low power, 3-axis, ±2 g/±4 g/±8 g digital output high resolution (1 mg/LSB) accelerometer. Its power consumption is 1.8 µA at 100 samples per second (SPS) and 3.0 µA at 400 SPS, while its motion activated wake-up mode only requires 270 nA.

A pedometer algorithm is embedded for evaluation that can be enabled in WaveTool.

Check ADXL362 datasheet for more details on various configuration options available for this part https://www.analog.com/media/en/technical-documentation/data-sheets/ADXL362.pdf

ELECTROCARDIOGRAPHY - AD8233

The AD8233 is a 50 µA 2.0 mm × 1.7 mm WLCSP low noise single lead analog output biopotential front end.

Integrated ECG Electrodes

The AD8233 is connected to the electrodes hosted in the top and bottom surfaces of the watch. The two electrodes on the top of the watch are connected to IN− pin and RLD pin, while the two electrodes on the bottom of the watch are shorted together (temporarily while this measurement is active) and connected to the IN+ input.

The quality of the contact of the bottom electrodes has a dramatic effect on the output waveform. Dry, hairy skin poses a challenge for this measurement until moisture accumulates between the skin and the electrodes. This usually happens a few minutes after the user puts on the device. Accumulated moisture decreases the contact impedance and, therefore, the quality of the output waveform improves.

The configuration of this signal chain is like an ambulatory ECG device (Holter monitor).

Table 6. Electrical Specifications of the ECG Signal Chain[1]

Specification	Value (typ)	Unit
Passing Bandwidth	0.4 to 42	Hz
High-Pass Filter	First Order	N/A
Low-Pass Filter	Second order (quality factor = 0.671)	N/A
AD8233 Gain	151	V/V
ADC Resolution	16	bits
Noise RTI	13	µV p-p
Sampling Rate	50 to 1000	SPS

[1] N/A means not applicable.

Check AD8233 datasheet for more details of the part https://www.analog.com/media/en/technical-documentation/data-sheets/ad8233.pdf

External ECG Cables

The charging cradle provides a secondary micro-USB connection to be used with external wired electrodes.

BIO-IMPEDANCE – AD5940

Impedance is measured using the AD5940 Impedance AFE. Proper electrical contact between these two electrodes and the skin is critical for accurate and reliable long-term measurement. Adequate tightness of the watch strap helps achieve a proper contact and wearing the watch beside (but not on top of) the ulnar styloid process (the protruding wrist bone) also helps ensure a reliable and high-quality measurement.

Note that these two electrodes are also used by the ECG measurement, which temporarily shorts them together. Therefore, the impedance measurement is not valid while the ECG measurement is ongoing.

Table 7. Electrical Specifications of the AD5940

Specification	Value (Typ)	Unit
Conductivity Range	0.2 to 20	µS (3%)
Accuracy at 0.2 µs	3	%
Accuracy at 1 µs	0.8	%
Accuracy at 10 µs	0.1	%
Accuracy at 20 µs	3	%
Resolution at 1 µs	1	nS
Resolution at 10 µs	2	nS
Excitation Frequency	100	Hz
Sampling Rate	30	SPS

check AD5940 data sheet for more details on configuration and usage of the part
https://www.analog.com/media/en/technical-documentation/data-sheets/AD5940-5941.pdf

SKIN AND AMBIENT TEMPERATURE

The skin temperature measurement is based on a thermistor (NTCG104EF104FTDSX). The thermistor used in the skin temperature measurement is thermally coupled to the bottom of the watch. This thermistor is connected to one of the analog inputs of the ADPD4100 and its performance is heavily dependent on the mechanical connection that is made to the body. Being said that this version of watch has a poor heat conduction between the thermistor and watch body which results is larger inaccuracy in the temperature data then theoretical value of 0.2^0C. To overcome this shortcoming user is allowed to configure a temperature correction factor using Analog WaveTool depending on the temperature deviation seen in their device. The procedure to configure the correction factor is explained in detail in the getting started guide.

Table 8. Electrical Specifications of the Signal Chain That Measures Skin Temperature

Specification	Value (Typ)
Temperature Range	−30°C to +50°C
Resolution at 25°C	0.1°C

USE CASES

Basic modes of operation have been designed for the VSM Watch that are selectable by supplied Device Configuration Files:

- High Performance PPG
- Synchronized PGG with EDA
- Synchronized PPG with ECG spot-check
- High Performance ECG spot-check
- Multi-wavelength PPG
- *Future Use Cases will continue to be developed*

These modes of operation are intended to demonstrate the different types of configurations that are possible with the VSM Watch but are not specific to an end-application. The high configurability of the VSM Watch allows for the possibility to program a configuration that cannot be supported by the existing hardware, software, and firmware. Users can load these Use Cases as a known-good starting to point to explore measurements of interest before modifying the platform for their specific purpose.

Please refer to the Software User Guide for details on how to evaluate and modify these Use Cases in WaveTool.

Table 9. Use Case Table

Use Case	PPG	Motion	Impedance	ECG	Temp.
Shipment Mode	Off	Off	Off	Off	Off
Hibernate	Off	Off	Off	Off	Off
PPG – High Performance (1 LED)	500 SPS	50 SPS			1 SPS
ECG – High Performance	50 SPS	50 SPS		1000 SPS	1 SPS
PPG + Impedance (1 LED)	100 SPS	50 SPS	30 SPS		1 SPS
PPG + ECG (1 LED)	100 SPS	50 SPS		250 SPS	1 SPS
PPG – All LEDs	100 SPS	50 SPS			1 SPS

All Use Cases are designed to allow for automatic logging to the onboard NAND Flash when the watch detects that it is being worn based on its capacitive sensor. Logging in progress indicator on the watch display (as shown in the figure below) is seen only when this feature is used to indicate active logging and percent of memory used.

Figure 11. Nand Flash logging indicator with memory used in percent

Table 10. Default ADPD4100 Configuration for each Use Case:

Use Case	Sampling Rate	TIA Gain CH1/CH2	Pulse width	Slot/Wavelength	Number of Pulses
PPG – High Performance (1 LED)	500 SPS	50/50	2	F/530	64
ECG – High Performance	50 SPS	50/50	2	F/530	64
PPG + Impedance (1 LED)	100 SPS	50/50	2	F/530	64
PPG + ECG (1 LED)	100 SPS	50/50	2	F/530	64
PPG – All LEDs	100 SPS	50/50	2	F/530, G/660, H/850, I/470	64

Table 11. Default ADXL362 configuration for each Use Case:

Use Case	Sampling Rate	Measurement Range
PPG – High Performance (1 LED)	50 SPS	8g
ECG – High Performance	50 SPS	8g
PPG + Impedance (1 LED)	50 SPS	8g
PPG + ECG (1 LED)	50 SPS	8g
PPG – All LEDs	50 SPS	8g

Table 12. Default AD5940 Configuration for each Use Case:

Use Case	Sampling Rate	TIA Gain
PPG – High Performance (1 LED)	NA	
ECG – High Performance	1000 SPS	
PPG + Impedance (1 LED)	30 SPS	
PPG + ECG (1 LED)	250 SPS	
PPG – All LEDs	NA	

Table 13. Default AD8233 Configuration for each Use Case:

Use Case	AC/DC coupling	FR mode	Gain
PPG – High Performance (1 LED)	NA	NA	NA
ECG – High Performance	DC Coupling	On	150k
PPG + Impedance (1 LED)	NA	NA	NA
PPG + ECG (1 LED)	DC Coupling	On	150K
PPG – All LEDs	NA	NA	NA

EMBEDDED ALGORITHMS FOR EVALUATION

Basic algorithms are included with the VSM Watch to demonstrate this type of functionality. More advanced algorithms with specific device configurations are provided here.

PEDOMETER

A pedometer algorithm takes raw data from the 3-axis accelerometer and outputs the steps taken.

AUTOMATIC GAIN CONTROL

The digitized output of the ADPD4100 is fed to this algorithm to ensure that the LED current and AFE gain is configured appropriately to maximize the usefulness of the Optical Signal. The default target is 70% of the allowable range for each LED (independently determined). This Gain Control is *not* optimized to achieve an ideal performance versus power. Further improvements can be made based on the end application's requirements to achieve a better battery life.

HEART RATE MONITORING

This algorithm measures heart rate using PPG/ADPD signal while removing the motion-based interference. It operates on a single channel PPG/ADPD signal, together with 3-axis accelerometer data to produce the heart rate. The algorithm is provided as a pre-built Cortex-M4 library along with header file. It is designed to work with synchronized PPG and accelerometer data at 50Hz.

SIGNAL QUALITY INDEX

PPG signals collected via wearable devices are prone to noise sources and other artefacts that negatively impact the measurement accuracy of the sensor. The Signal Quality Index (SQI) algorithm gives a score (index) for each time window/segment of PPG data in order to determine if it is of a sufficiently high quality to be useful for other vital sign extraction or clinical diagnostic algorithms estimate of the heart rate. The SQI feature is supported for PPG signal frequencies ranging from 25-100Hz. The SQI score is a floating-point value between 0(poor signal quality) and 1(excellent quality). The WaveTool has option to display the SQI in all use-case views. The SQI can be calculated on any of the Green, Red, IR or Blue LEDs present on watch.

ECG HEART RATE MONITORING

This algorithm measures heart rate from the ECG signal by detecting the QRS peak of the ECG signal. The algorithm is provided as a pre-built Cortex-M4 library along with header file. It is designed to work with ECG signal with ODR up to 200Hz.

BATTERY LIFE AND MEMORY FOOTPRINT

BATTERY LIFE

The battery life is determined by the type and number of sensors enabled, the sampling rate configured and is also dependent on other configuration details such as the LED current in the photoplethysmography measurements.

Table 10. System Battery Life for Several Use Cases

Use Case	Memory	Live BLE	Battery Life (Hours)
Shipment Mode	No	No	30000+
Hibernate	No	No	1000+
PPG – High Performance	Yes	Yes	14
ECG – High Performance	Yes	Yes	40
PPG + Impedance	Yes	Yes	50
PPG + ECG	Yes	Yes	40
PPG – All LEDs	Yes	Yes	20

The VSM watch is powered by a rechargeable 200 mAh battery.

Note: All the default use cases are designed to maximize the performance. By modifying various parameters of the AFEs one can achieve longer battery duration. For instance in ADPD4100, the default gain in AGC algorithm is set to 25K, so as to get best PPG performance with various skin tones. Setting the gain to 100k/200k and lowering current value will result in significant improvement in battery duration for continuous usage.

MEMORY FOOTPRINT

The watch hosts a 512 MB memory.

The actual capacity of the memory is determined by the type and number of sensors enabled and the sampling rate configured.

Table 11. Memory Capacity (in Hours) for Different Use Cases

Vital Signs	Memory Capacity (Hours)
PPG – High Performance	18
ECG – High Performance	22
PPG + Impedance	63
PPG + ECG	43
PPG – All LEDs	23

SCHEMATIC, LAYOUT AND BLOCK DIAGRAM

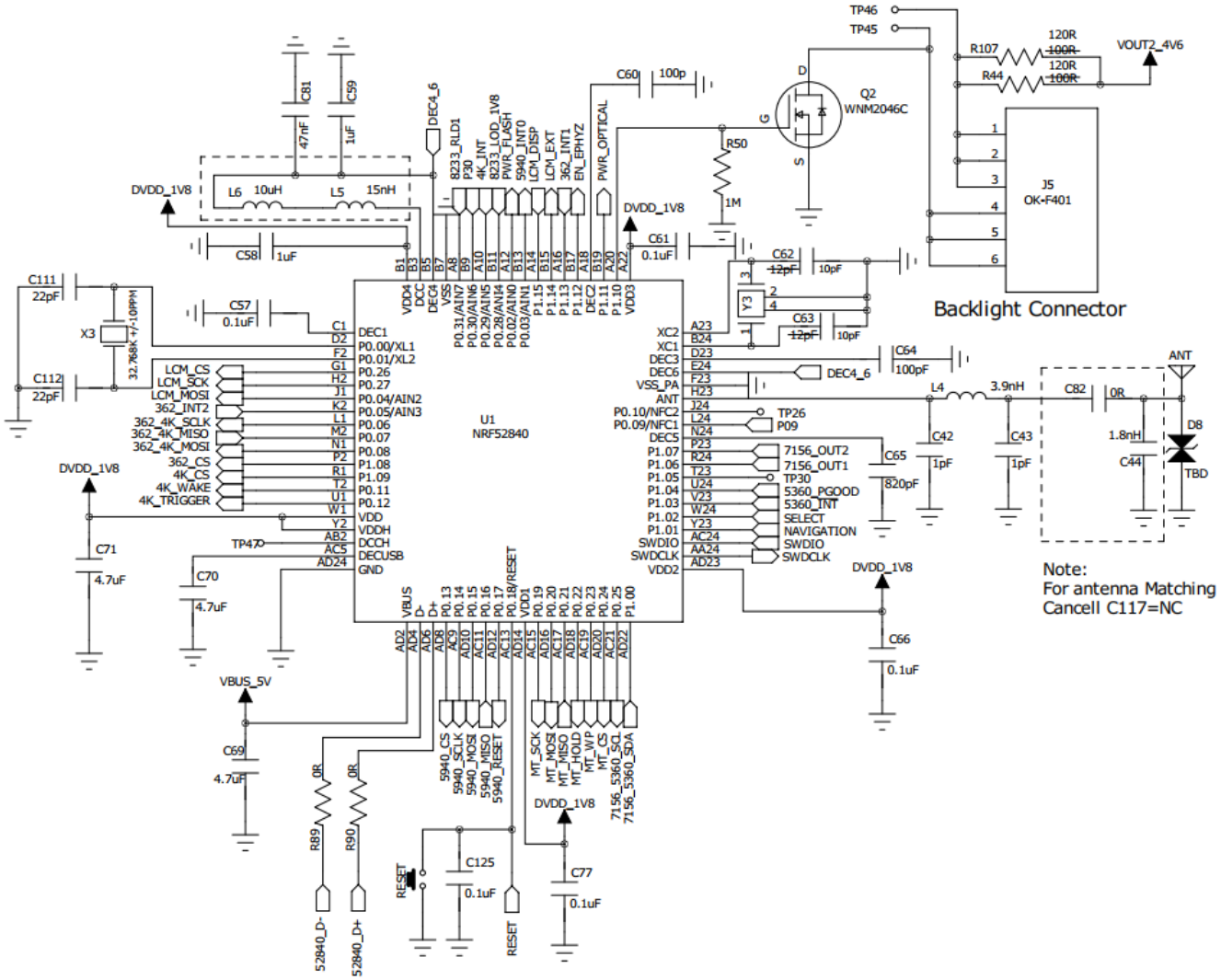


Figure 11 - Microcontroller connections

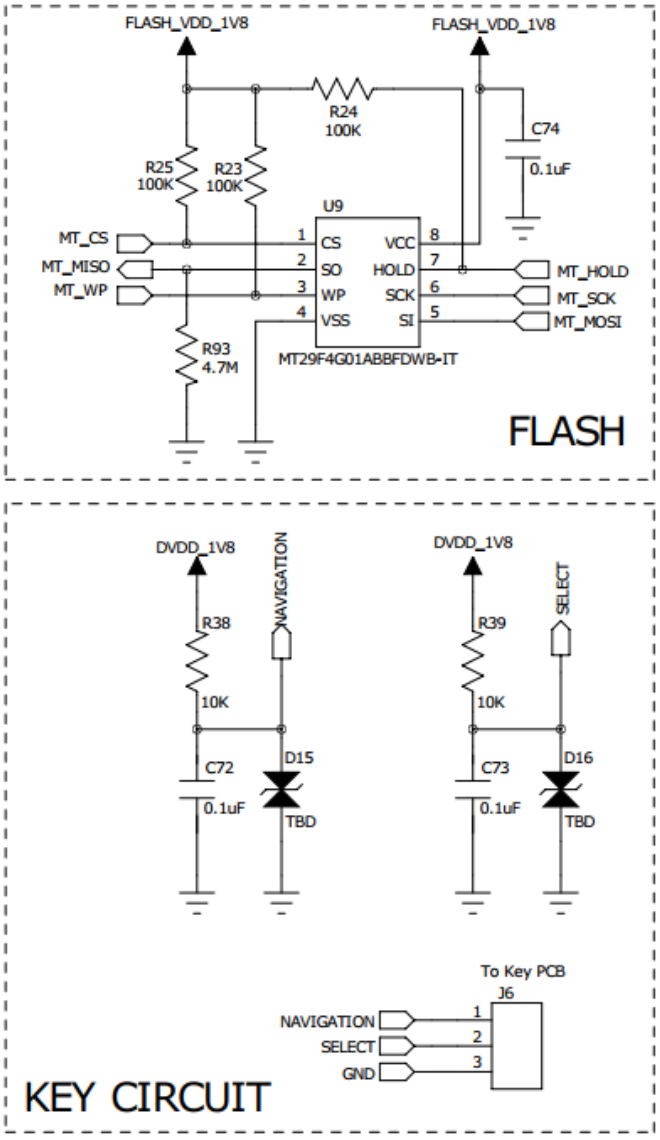


Figure 12 - Memory and Buttons

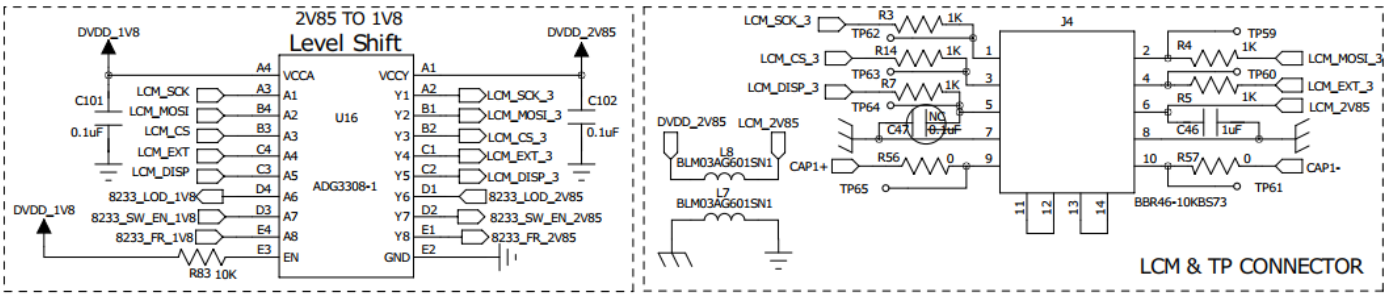


Figure 13 - Level Shifter + Display Connections

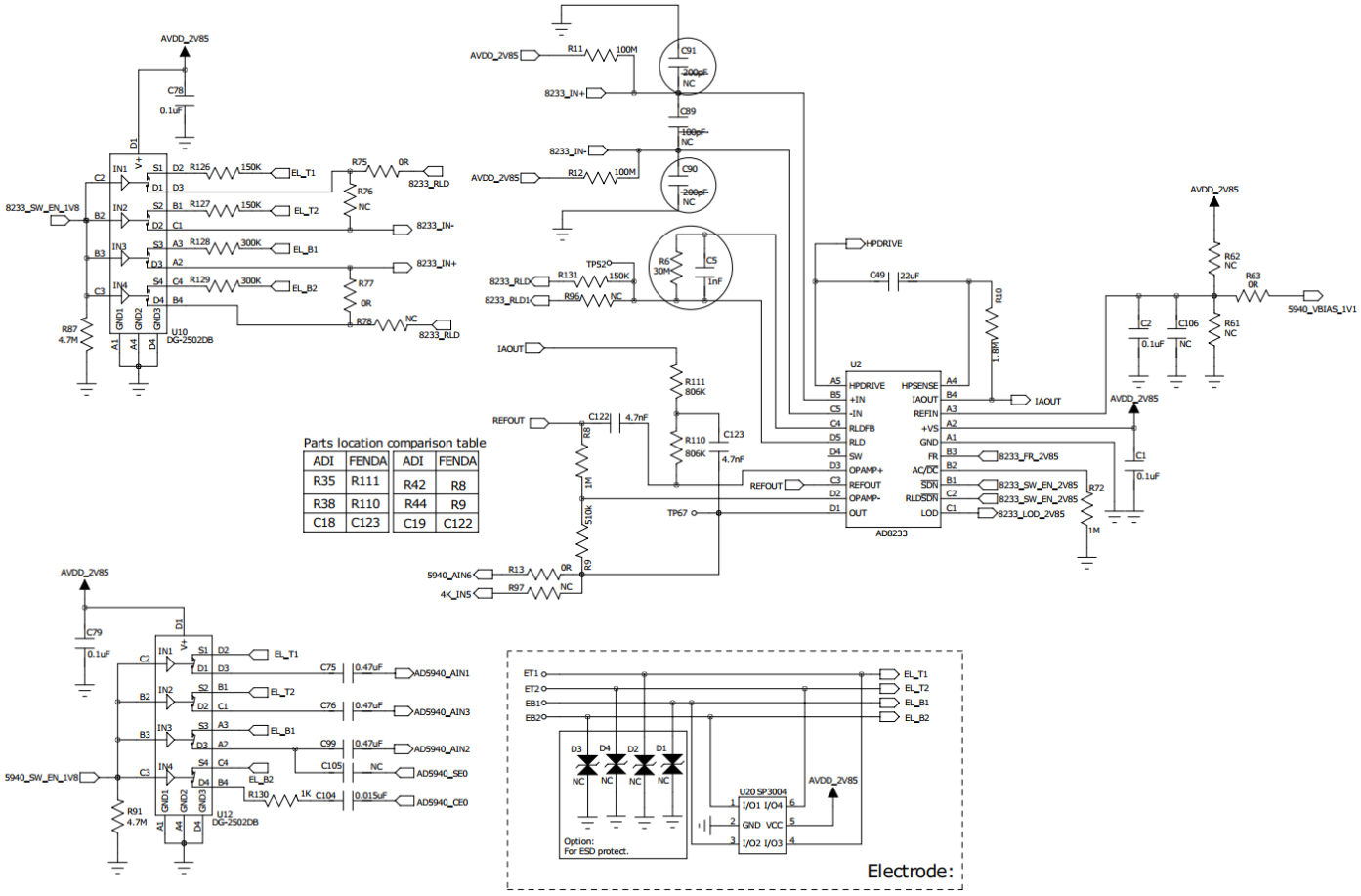


Figure 14 - ECG Circuitry

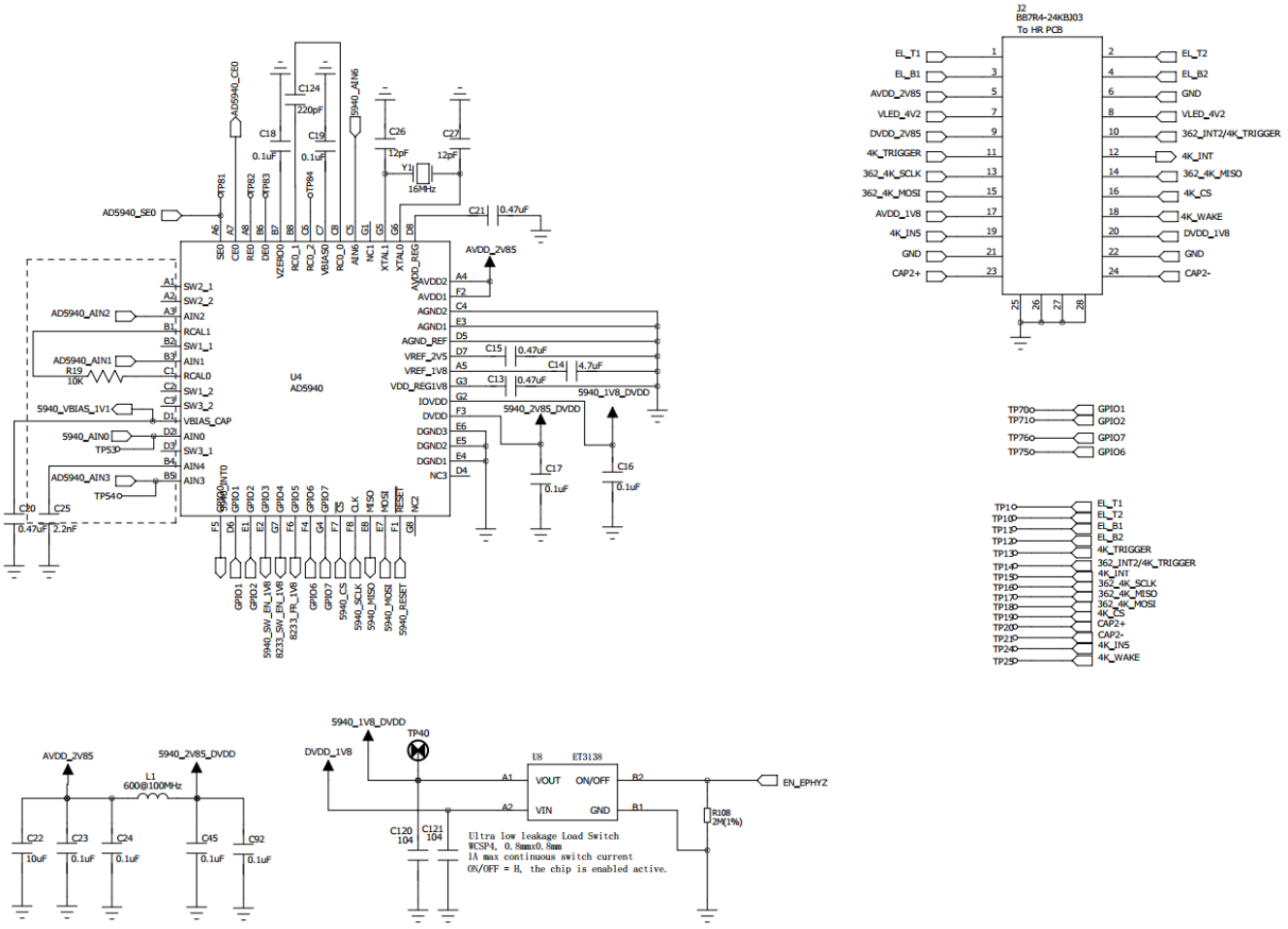


Figure 15 - AD5940 Circuitry + Connection to Optical Board

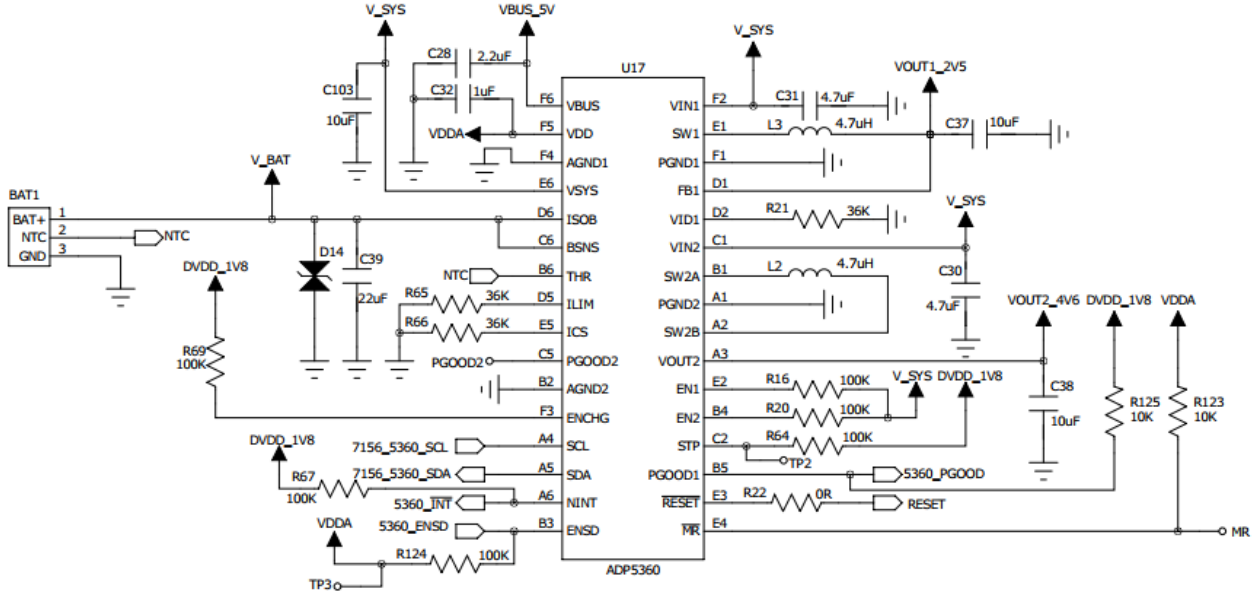


Figure 16 - PMIC Circuitry

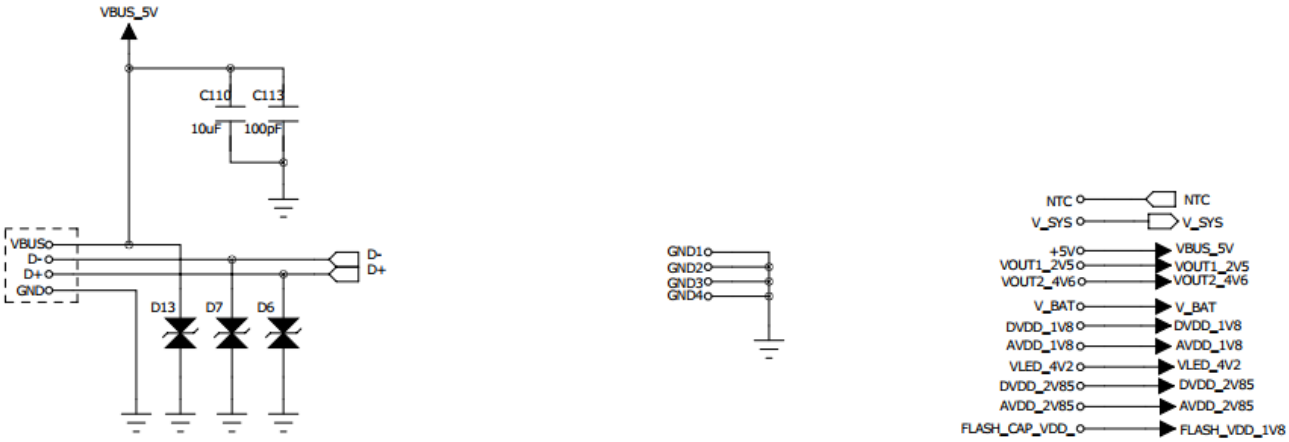


Figure 17 - USB Connection + Test Points

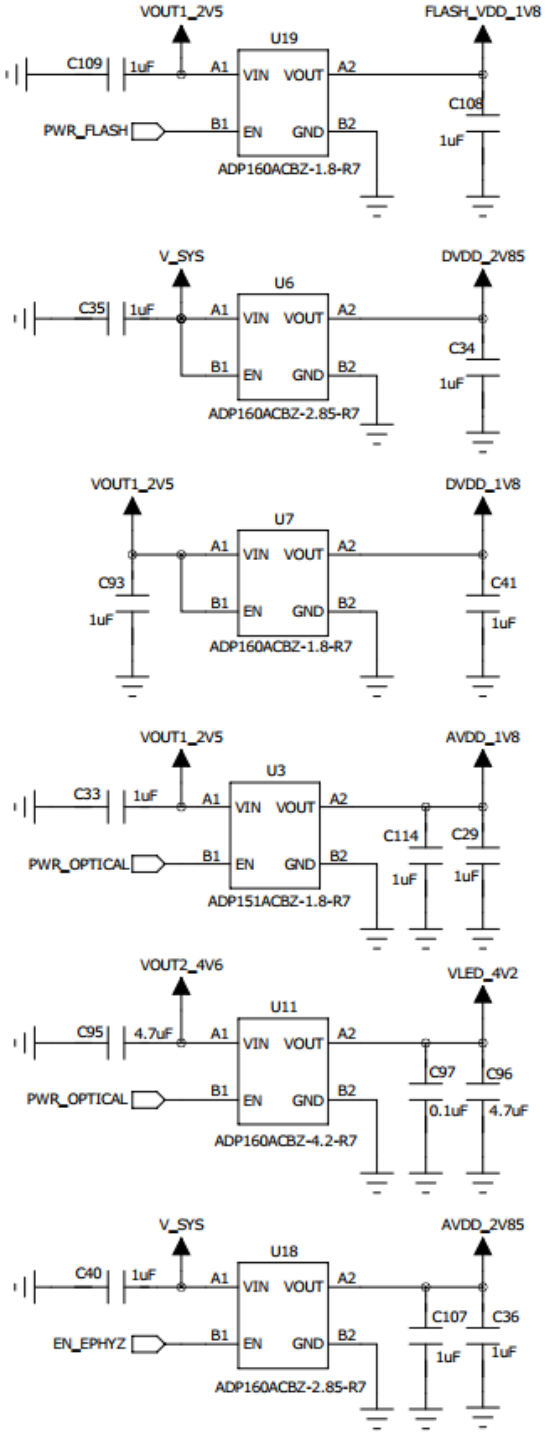


Figure 18 - Voltage Regulation

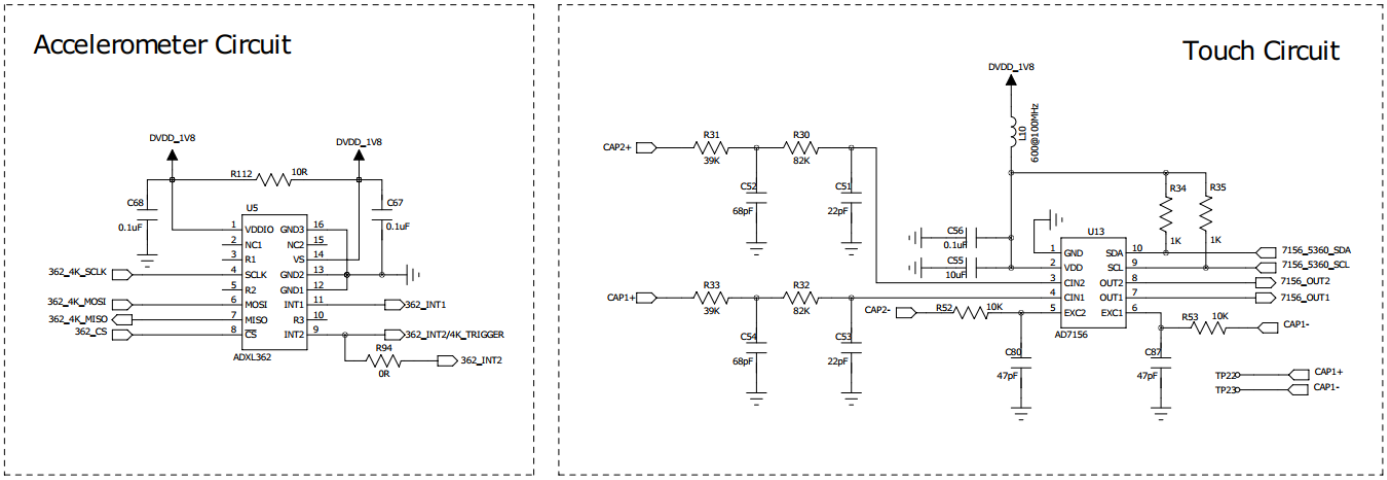
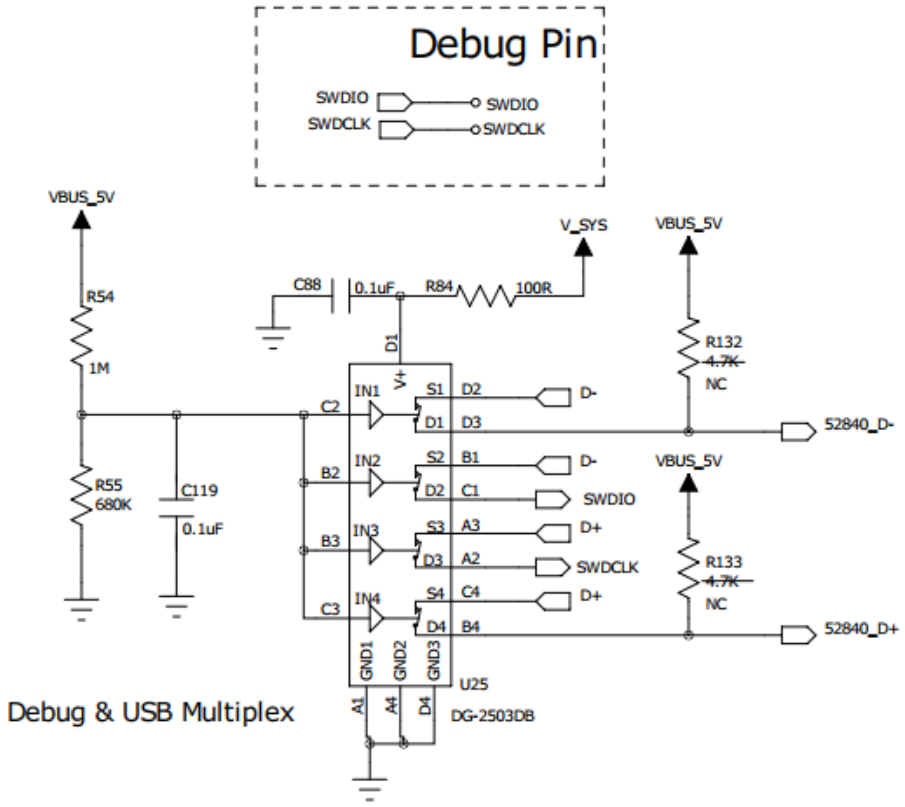


Figure 19 - Accelerometer and Capacitive Touch Circuits



TRUTH TABLE						
DG2501		DG2502		DG2503		
LOGIC	SWITCH	LOGIC	SWITCH	LOGIC	SW1, SW4	SW2, SW3
0	ON	0	OFF	0	OFF	ON
1	OFF	1	ON	1	ON	OFF

Figure 20 - Debug Switch (Communication + FW Programming)

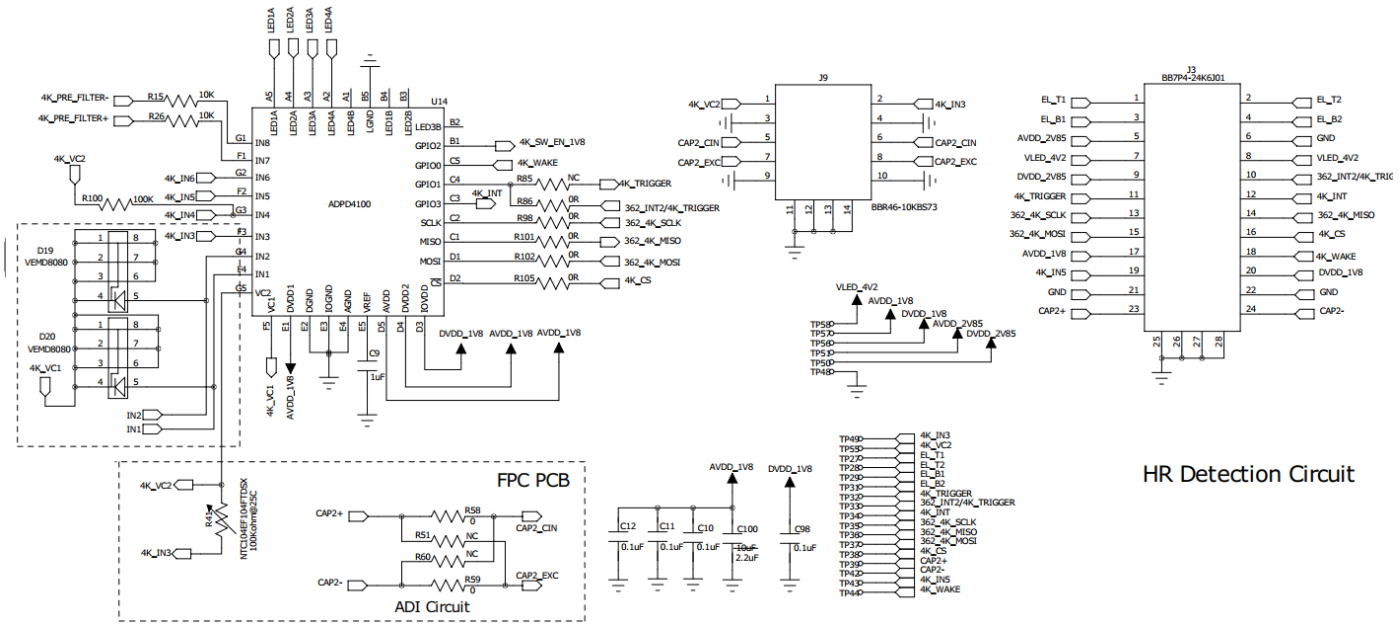


Figure 21 - Optical Board Circuitry

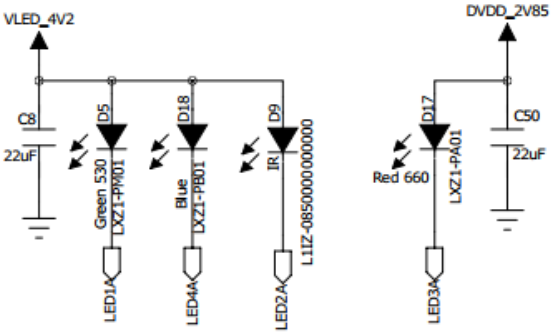


Figure 22 - LED Connections

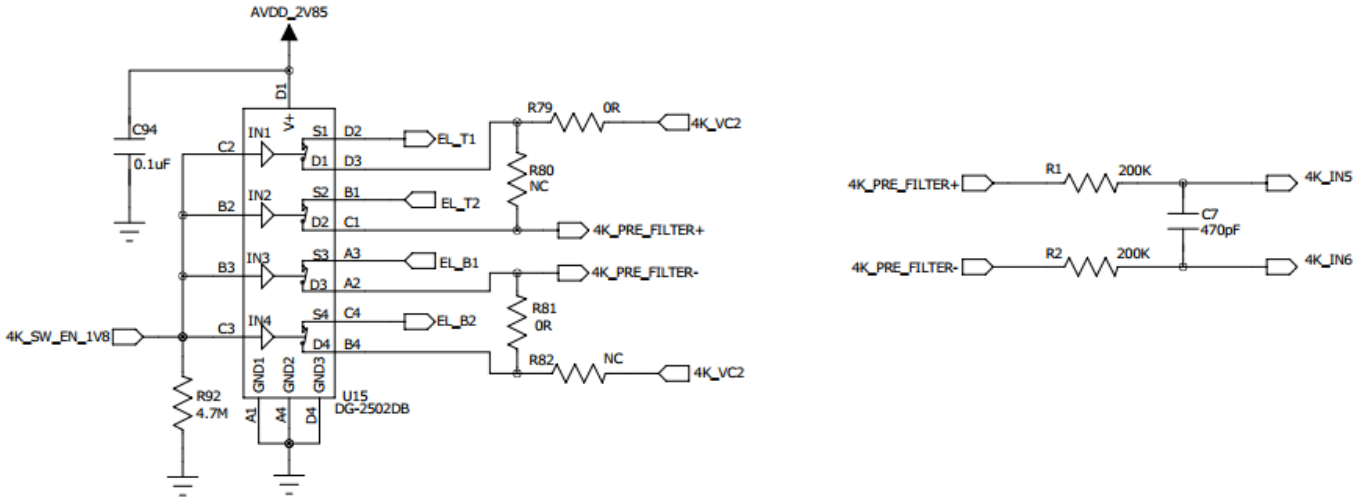


Figure 23 - Electrode Connections for ADPD4100

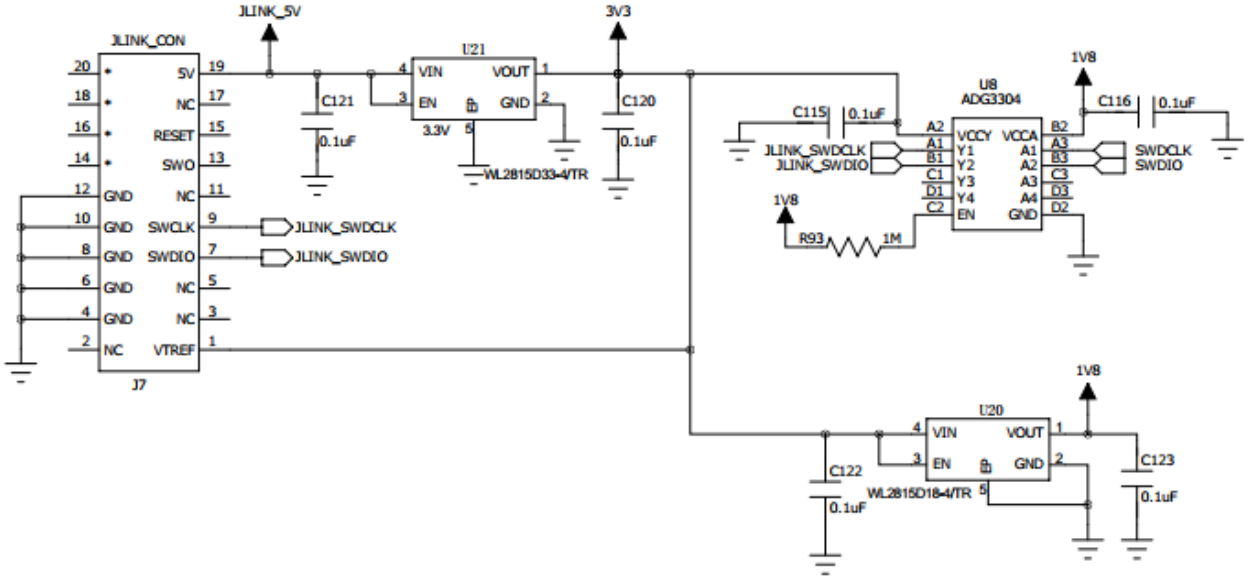


Figure 24 - Debug Board Schematic

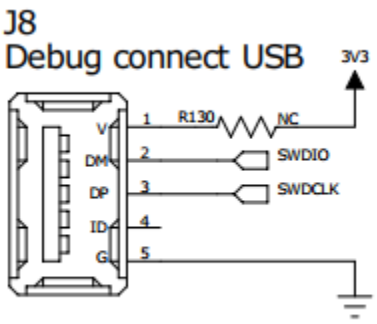


Figure 25 - Debug Board Connector Pinout

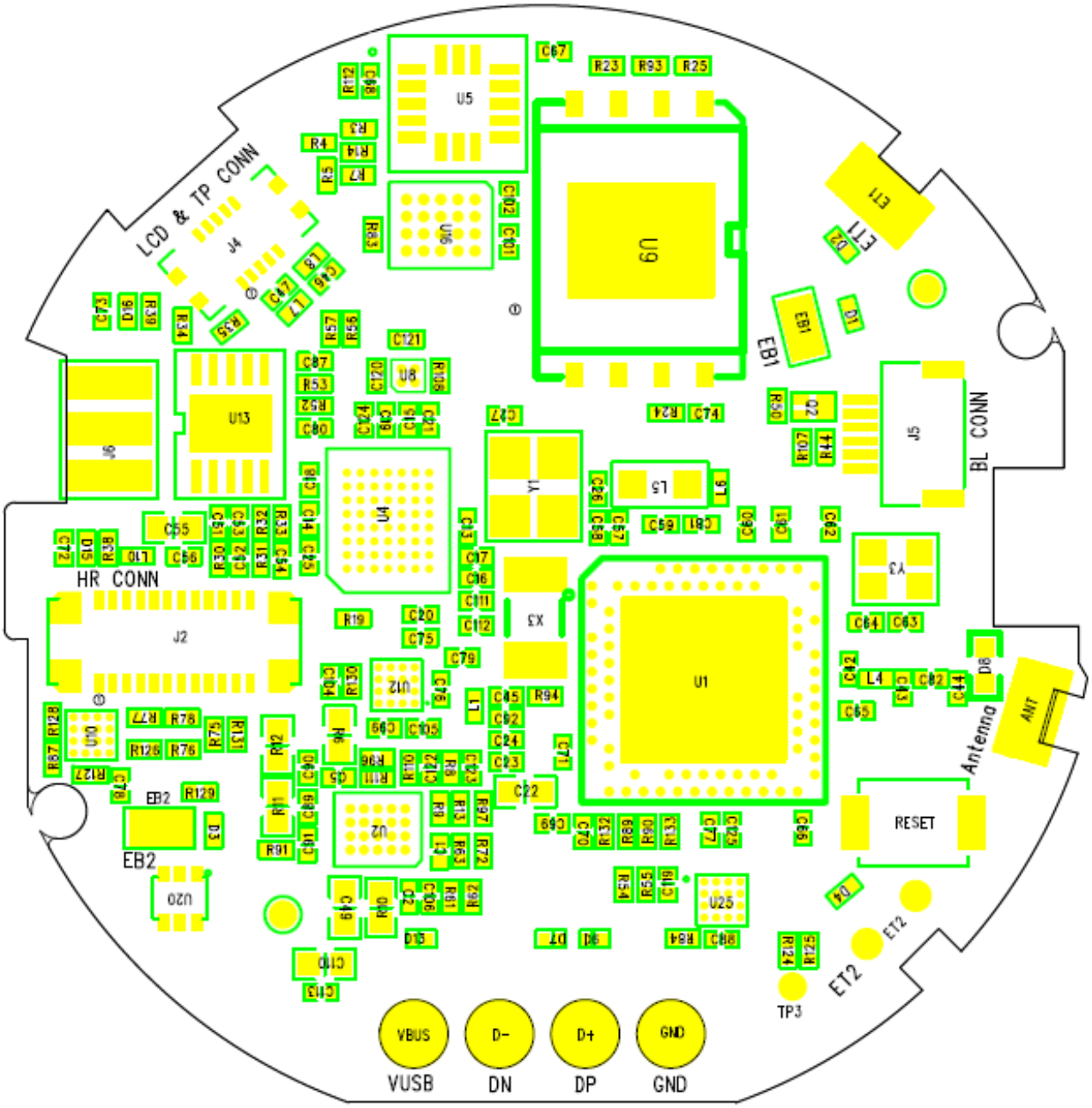


Figure 26 - Main PCB Layout Top View

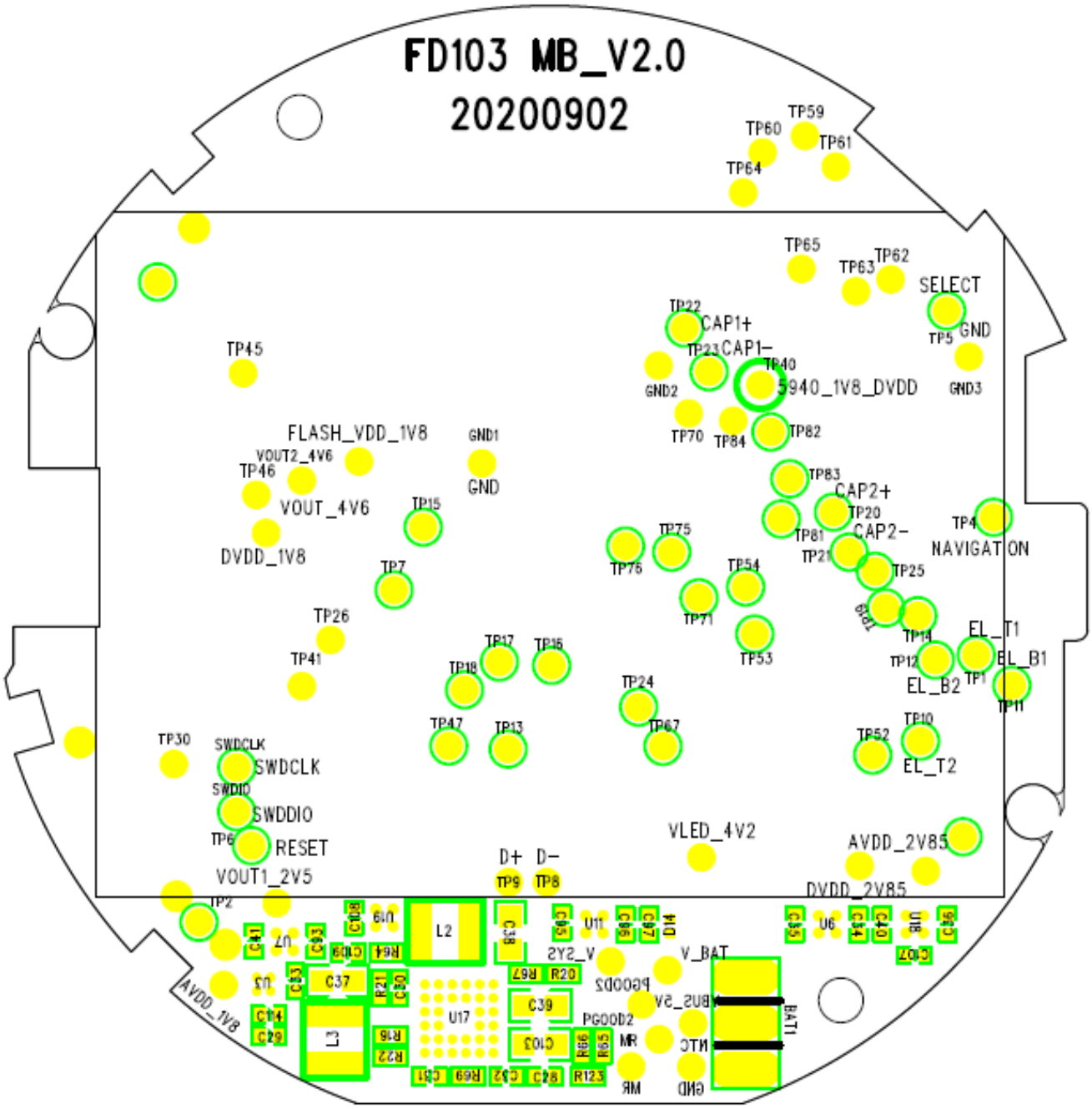


Figure 27 - Main PCB Layout Bottom View

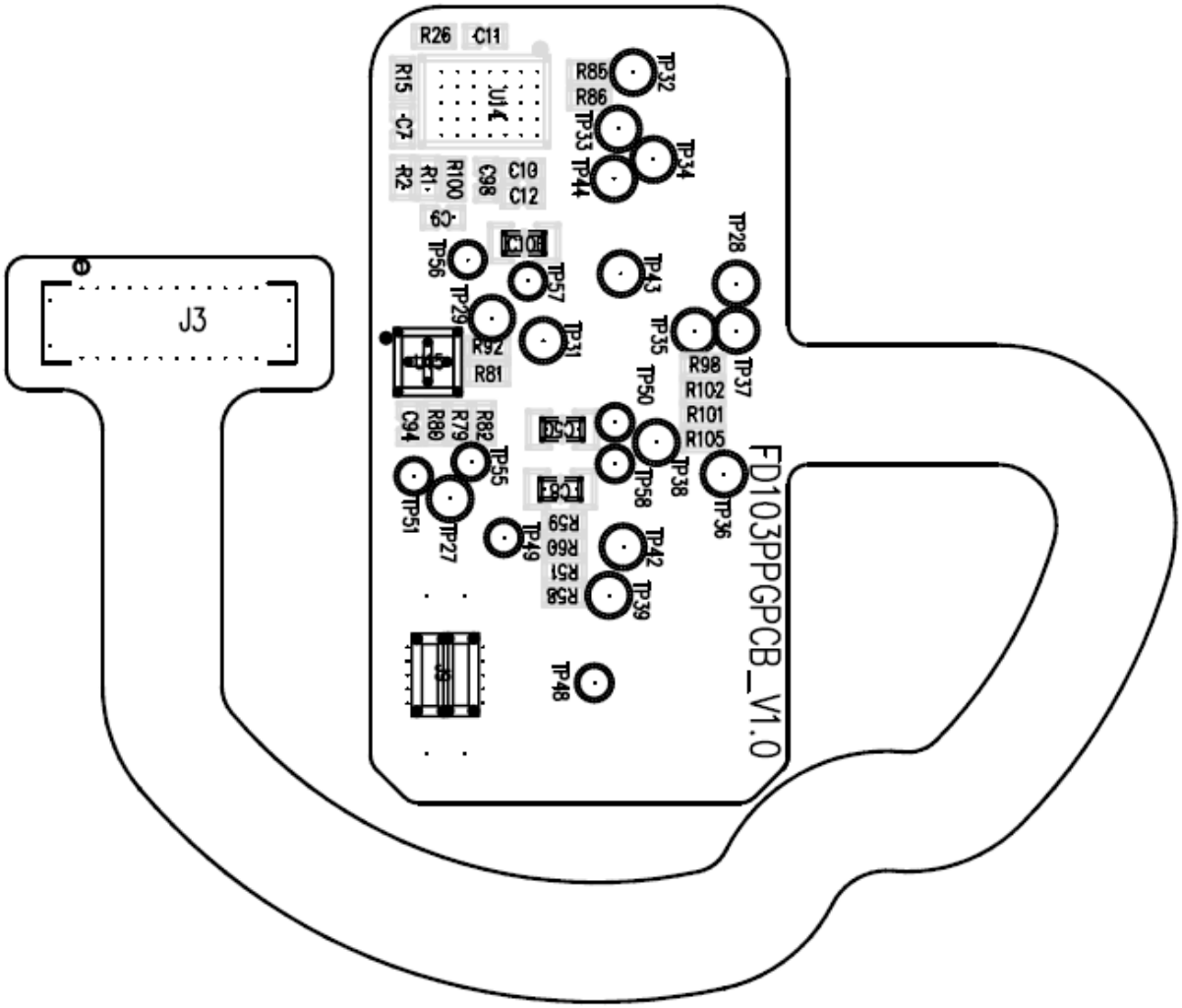


Figure 28 - Optical/HR PCB Layout Top View

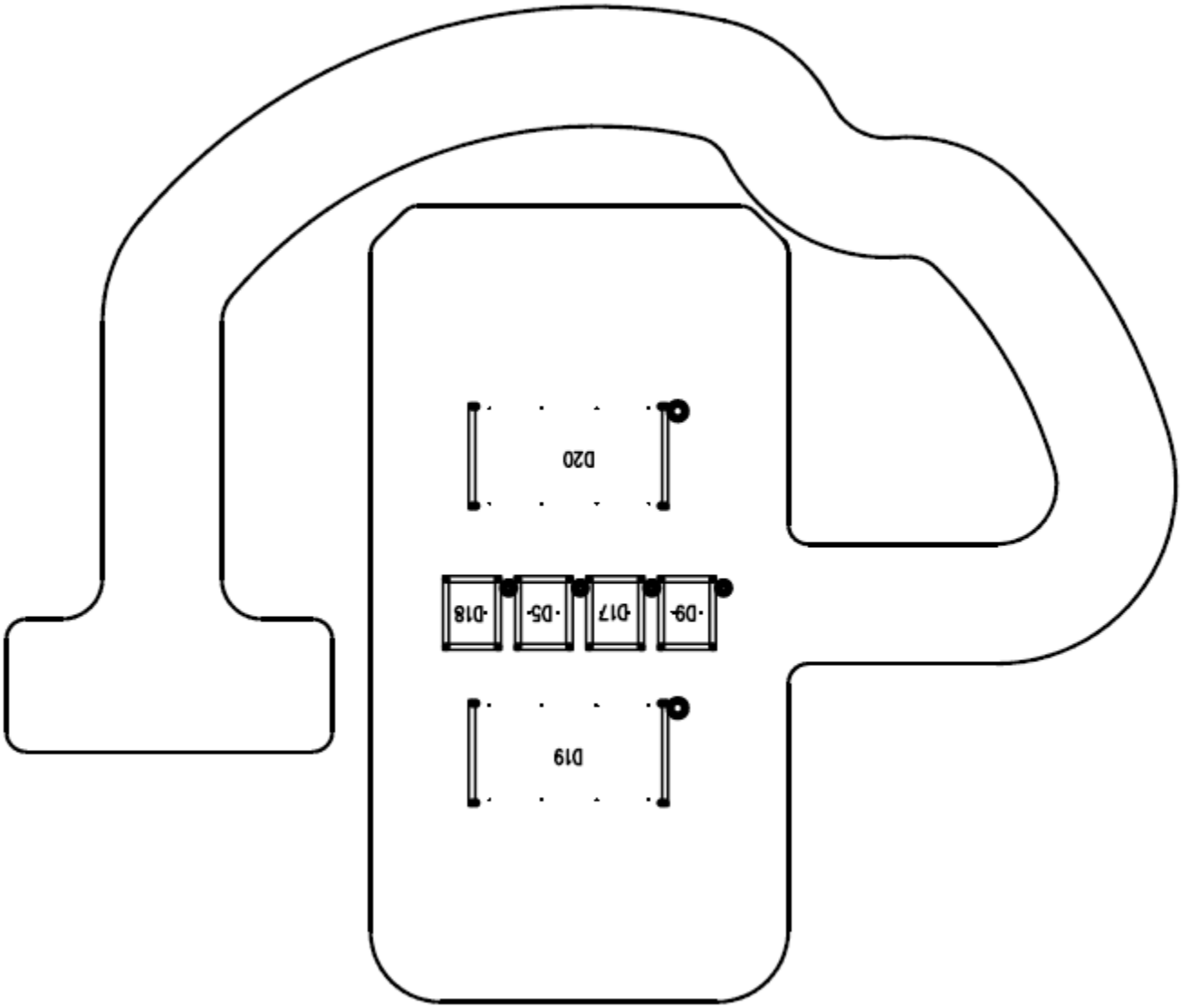


Figure 29 - Optical/HR PCB Layout Bottom View

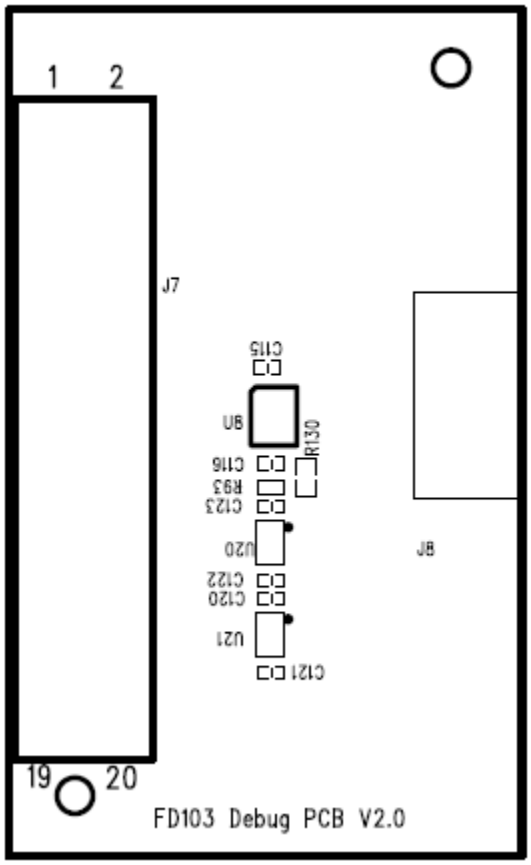


Figure 30 - Debug PCB Layout Top View

BILL OF MATERIAL

Table 12 - Electrical Bill of Materials

#	Name	Description	P/N	Mfr	Qty	Location
1	**FD103 Assembly**	**FD103 ADI Assembly**				
2	* Li-ion Battery	BATTERY,3.8V,210mAh, L26.5*W20*H4.0mm, RoHS2.0+Reach			1	BAT1
3	* Backlight	Backlight B0101105A	B0101105A	EVER JET	1	FOR J5
4	***KEYFPCA**	**FD103 KEYFPC ASSEMBLE, RoHS2.0+Reach**			1	KEYFPC Assembly
5	*KEY FPC	Key FPC with 2pcs dome switch key, FPC L50*W25*T0.7mm			1	
6	* Dome key	DOME KEY			2	NAVIGATION, SELECT
7	*** LCM**	**FD103, LCM With TP, RoHS2.0+Reach**				
8	* LCD display	JDI, LPM010M297B,LCM,RGB,L30.591xW29.291xH0.844mm,Rohs	LPM010M297B	JDI	1	FOR J1
9	* TP	Touch Panel,Size:L29.09W29.09T0.2,FPC，FPC L21.31mm*W12.1mm*T0.13mm			1	
10	*FPC connector	10062827-0810EDLF,FPC connector,8Pin,FPC Connector,10062827-0810EDLF,FCI,8Pin,0.5pitch,RoHS2.0+Reach	10062827-0810EDLF	FCI	1	J1
11	*B-B connector	BBR16-10K6S21,Pitch=0.35mm,B-B connector,10pin,Tap,RoHS2.0+Reach	BBR16-10K6S21	ACON	1	J7
12	*** Main SMDA**	**FD103 Main PCBA Board SMT Assemble,RoHS2.0+Reach**			1	
13	*SMD RESISTOR	120R 1/20W ±1% 0201 TAP RoHS2.0+Reach			2	R44,R107
14	*SMD RESISTOR	YAGEO 300K 1/20W ±1% 0201 TAP RoHS2.0+Reach	Yageo	Yageo	2	R128,R129
15	* SMD CAPACITOR	MEDICAL SPECIAL Murata,GRM0335C1H100FA01D,50V,10pF,±1%,NPO,0201,TAP,RoHS2.0+Reach	GRM0335C1H100FA01D	Murata	2	C62,C63
16	SCAN CODE LABLE	MEDICAL SPECIAL SCAN CODE LABLE|7*7mm|SCAN CODE LABLE(HIGH TEMP RESIST)|PRINT|ROHS2.0,Reach			1	
17	8 LAYER PCB BOARD	FD103 MAIN PCB,0.8,FR4,IMG,GREEN,WHIT,Φ33T0.8, RoHS2.0+Reach			1	
18	* SMD IC	ECG,ADI,AD5940BCBZ,WLCSP56,TAP,High Precision, Impedance, and Electrochemical Front End,RoHS2.0+Reach	AD5940BCBZ	ADI	1	U4
19	* SMD IC	ADI,AD7156BCPZ-REEL,2-channel Capacitance converter,WLCSP10,TAP,RoHS2.0+Reach	AD7156BCPZ-REEL	ADI	1	U13
20	* SMD IC	ADI,AD8233ACBZ-R7,heart rate monitor,20-UFBGA，WLCSP,TAP,RoHS2.0+Reach	AD8233ACBZ-R7	ADI	1	U2
21	* SMD IC	ADI,ADG3308BCBZ-1-REEL,8-channel Level Translators,20-WLCSP（2.5x2）,TAP,RoHS2.0+Reach	ADG3308BCBZ-1-REEL	ADI	1	U16
22	* SMD IC	LDO,Type:ADP160ACBZ-1.8-R7,1.8V,150mA,Iq 1uAWLCSP,TAP,RoHS2.0+Reach	ADP160ACBZ-1.8-R7	ADI	2	U7,U19
23	* SMD IC	LDO,ADI,ADP160ACBZ-4.2-R7,Type:ADP160ACBZ-4.2-R7,4.2V,150mA,Iq 1uAWLCSP,TAP,RoHS2.0+Reach	ADP160ACBZ-4.2-R7	ADI	1	U11
24	* SMD IC	LDO,ADI,ADP160ACBZ-2.85-R7,ADP160ACBZ-2.85-R7,2.85V,150mA,Iq 1uA,WLCSP,TAP,RoHS2.0+Reach	ADP160ACBZ-2.85-R7	ADI	2	U6,U18

25	* SMD IC	PMIC,ADI,ADP5360ACBZ-1-R7,with buck&buck-boost,TAP,RoHS2.0+Reach	ADP5360ACBZ-1-R7	ADI	1	U17
26	* SMD IC	ADI,ADXL362BCCZ-RL7,Accelerometer,16-LGA（3x3.25）,TAP,RoHS2.0+Reach	ADXL362BCCZ-RL7	ADI	1	U5
27	* SMD IC	Vishay,DG-2502DB-T2-GE1,Quad SPST Analog Switches,WCSP16,TAP,RoHS2.0+Reach	DG-2502DB-T2-GE1	VISHAY	2	U10,U12
28	* SMD IC	Vishay,DG-2503DB-T2-GE1,Quad SPST Analog Switches,WCSP16,TAP,RoHS2.0+Reach	DG-2503DB-T2-GE1	VISHAY	1	U25
29	* SMD IC	Flash,Micron,MT29F4G01ABBFDWB-IT:F,4Gb,U-PDFN,TAP,RoHS2.0+Reach	MT29F4G01ABBFDWB-IT:F	Micron	1	U9
30	* SMD IC	MEDICAL SPECIAL BEL CHIP,NORDIC,NRF52840-QIAA-R D00,AQFN73 7*7mm,TAP,RoHS2.0+Reach	NRF52840-QIAA-R D00	Nordic	1	U1
31	* SMD IC	LOAD SWITCH,ETEK,ET3138,Input1.2-5.5VWLCSP4,TAP,RoHS2.0+Reach	ET3138	LUXEON	1	U8
32	* SMD CAPACITOR	YAGEO,CC0201KRX5R6BB104,10V,0.1uF,±10%,X5R,0201,TAP,RoHS2.0+Reach	CC0201KRX5R6BB104	YAGEO	30	C1,C2,C16,C17,C18,C19,C23,C24,C45,C56,C57,C61,C66,C67,C68,C72,C73,C74,C77,C78,C79,C88,C92,C97,C101,C102,C119,C120,C121,C125
33	* SMD CAPACITOR	YAGEO,CC0201KRX5R5BB474,6.3V,0.47uF,±10%,X5R,0201,TAP,RoHS2.0+Reach	CC0201KRX5R5BB474	YAGEO	7	C13,C15,C20,C21,C75,C76,C99
34	* SMD INDUCTOR	MurataLQP03TQ12NH02D12nH±3%500MHz690mOhm250mA0201RoHS2.0+Reach	LQP03TQ12NH02D	Murata	1	C44
35	* SMD CAPACITOR	MEDICAL SPECIAL YAGEO,CC0201JRNPO8BN101,25V,100P,±5%,NPO,0201,TAP,RoHS2.0+Reach	CC0201JRNPO8BN101	YAGEO	3	C60,C64,C113
36	* SMD CAPACITOR	Samsung,CL05A106MQ5NUNC,6.3V,10uF,±20%,X5R,0402,TAP,RoHS2.0+Reach	CL05A106MQ5NUNC	Samsung	5	C22,C37,C38,C55,C103
37	* SMD CAPACITOR	MEDICAL SPECIAL Samsung,CL05A106MP5NUNC,10V,10uF,±20%,X5R,0402,TAP,RoHS2.0+Reach	CL05A106MP5NUNC	Samsung	1	C110
38	* SMD CAPACITOR	YAGEO,CC0201JRNPO9BN120,50V,12pF,±5%,NPO,0201,TAP,RoHS2.0+Reach	CC0201JRNPO9BN120	YAGEO	2	C26,C27
39	* SMD CAPACITOR	MURATA,GJM0335C1E1R0WB01D,25V,1pF,±0.05pF,,,0201,TAP,RoHS2.0+Reach	GJM0335C1E1R0WB01D	Murata	1	C43
40	* SMD CAPACITOR	Samsung,CL03A105MP3NSNC,10V,1uF,±20%,X5R,0201,TAP,RoHS2.0+Reach	CL03A105MP3NSNC	Samsung	16	C29,C32,C33,C34,C35,C36,C40,C41,C46,C58,C59,C93,C107,C108,C109,C114
41	* SMD CAPACITOR	,,C0201X5R222K250NTA,,,2.2nF,,,X5R,CRYSTAL,0201,TAP,RoHS2.0+Reach	C0201X5R222K250NTA(/)		1	C25
42	* SMD CAPACITOR	MEDICAL SPECIAL MURATA,GRM033R61A225KE47D,10V,2.2uF,±10%,X5R,0201,TAP,RoHS2.0+Reach	GRM033R61A225KE47D	Murata	1	C28

43	* SMD CAPACITOR	YAGEO,CC0201JRNPO8BN220,25V,22P,±5%,NPO,0201,TAP,RoHS2.0+Reach	CC0201JRNPO8BN220	YAGEO	4	C51,C53,C111,C112
44	* SMD CAPACITOR	Samsung,CL05A226MQ5QUNC,6.3V,22uF,±20%,X5R,0402,TAP,RoHS2.0+Reach	CL05A226MQ5QUNC	Samsung	2	C39,C49
45	* SMD CAPACITOR	Murata,GRM035R60J475ME15D,6.3V,4.7?F,±20%,X5R,0201,TAP,RoHS2.0+Reach	GRM035R60J475ME15D	Murata	8	C14,C30,C31,C69,C70,C71,C95,C96
46	* SMD CAPACITOR	* SMD CAPACITOR|SMD|47nF|6.3V|X5R|±10%|0201，|TAP|ROHS2.0,Reach	02016D473KAT2A		1	C81
47	* SMD CAPACITOR	YAGEO,CC0201JRNPO8BN470,25V,47pF,±5%,NPO,0201,TAP,RoHS2.0+Reach	CC0201JRNPO8BN470	YAGEO	2	C80,C87
48	* SMD CAPACITOR	MURATA,GRM0335C1H680JA01D,50V,68pF,±5%,C0G,NP0,0201,TAP,RoHS2.0+Reach	GRM0335C1H680JA01D	Murata	2	C52,C54
49	* SMD CAPACITOR	MURATA,GRM033R71E821KA01D,25V,820pF,±10%,X7R,0201,TAP,RoHS2.0+Reach	GRM033R71E821KA01D	Murata	1	C65
50	* SMD CRYSTAL	"CRYSTAL,,,32.768khz,+/-10ppm,,,,,TAP,RoHS2.0+Reach"			1	X3
51	* SMD CRYSTAL	"16MHz,±20ppm,8pF,2520,TAP,RoHS2.0+Reach"			1	Y1
52	* SMD CRYSTAL	MEDICAL SPECIAL "Murata,XRCGB32M000F2P10R0,32Mhz,±20ppm,8pF,2016,TAP,RoHS2.0+Reach"	XRCGB32M000F2P10R0	Murata	1	Y3
53	* SMD TVS DIODE	LRC,LESD11D5.0CT5G 0201,TAP,RoHS2.0+Reach	LESD11D5.0CT5G	LRC	4	D6,D7,D13,D14
54	* SMD TVS DIODE	Willsemi,ESD5311N-2/TR 0402,TAP,RoHS2.0+Reach	ESD5311N-2/TR	Willsemi	1	D8
55	* SMD TVS DIODE	B-TRON,BTRD02A035 0201,TAP,RoHS2.0+Reach	BTRD02A035	B-TRON	2	D15,D16
56	* SMD INDUCTOR	MEIJE MGFL1608F100MT-LF10uH±20%0603TAPRoHS2.0+Reach	MGFL1608F100MT-LF	Meije	1	L5
57	* SMD POWER INDUCTOR	MurataLQP03HQ15NJ0215nH±5%300mA0201TAPRoHS2.0+Reach	LQP03HQ15NJ02	Murata	1	L6
58	* SMD INDUCTOR	SMD INDUCTOR|0201|3.0nH|±0.1nH|0.25Ω|450mA|TAP|RESEARCH PART|ROHS2.0,Reach	LQP03TG3N0B02D	Murata	1	L4
59	* SMD INDUCTOR	TDKVLS201612CX-4R7M4.7uH±20%1MHz252mOHM,MAX1.12A2016RoHS2.0+Reach	VLS201612CX-4R7M	TDK	2	L2,L3
60	* SMD BEAD	Murata,BLM03AG601SN1,600ohm@100MHz,100MA,0201,0201,TAP,RoHS2.0+Reach	BLM03AG601SN1	Murata	4	L1,L7,L8,L10
61	* SMD MOSFET	MEDICAL SPECIAL Willsemi,WNM2046,nCHANNEL,0.7A,20V,0402,TAP,RoHS2.0+Reach	WNM2046	Willsemi	1	Q2
62	*SMD RESISTOR	MEDICAL SPECIAL YAGEO RC0201JR-070RL 0Ω 1/20W ±5% 0201 TAP RoHS2.0+Reach	RC0201JR-070RL	YAGEO	10	R13,R22,R56,R57,R63,R75,R77,R89,R90,R94
63	*SMD RESISTOR	MEDICAL SPECIAL YAGEO RC0201FR-07100KL 100K 1/20W ±1% 0201 TAP RoHS2.0+Reach	RC0201FR-07100KL	YAGEO	9	R16,R20,R23,R24,R25,R64,R67,R69,R124
64	*SMD RESISTOR	MEDICAL SPECIAL YAGEO RC0201FR-0710KL 10K 1/20W ±1% 0201 TAP RoHS2.0+Reach	RC0201FR-0710KL	YAGEO	7	R38,R39,R52,R53,R83,R123,R125
65	*SMD RESISTOR	MEDICAL SPECIAL YAGEO RC0201FR-071ML 1M 1/20W ±1% 0201 TAP RoHS2.0+Reach	RC0201FR-071ML	YAGEO	4	R8,R50,R54,R72
66	*SMD RESISTOR	MEDICAL SPECIAL YAGEO RC0201FR-072ML 2M 1/20W ±1% 0201 TAP RoHS2.0+Reach	RC0201FR-072ML	YAGEO	1	R108

67	*SMD RESISTOR	MEDICAL SPECIAL Yageo RC0201JR-07100RL 100 Ohms 1/20W ±5% 0201 TAP RoHS2.0+Reach	RC0201JR-07100RL	YAGEO	1	R84
68	*SMD RESISTOR	YAGEO RC0402FR-071M8L 1.8M 1/16W ±1% 0402 TAP RoHS2.0+Reach	RC0402FR-071M8L	YAGEO	1	R10
69	*SMD RESISTOR	SEI RVC0402JT100M 100M 1/16W ±5% 0402 TAP RoHS2.0+Reach	RVC0402JT100M	SEI	2	R11,R12
70	*SMD RESISTOR	YAGEO RC0201JR-0736KL 36K 1/20W ±1% 0201 TAP RoHS2.0+Reach	RC0201JR-0736KL	YAGEO	3	R21,R65,R66
71	*SMD RESISTOR	680K 1/20W ±1% 0201 TAP RoHS2.0+Reach			1	R55
72	*SMD RESISTOR	Yageo RC0201FR-0739KL 39K 1/20W ±1% 0201 TAP RoHS2.0+Reach	RC0201FR-0739KL	YAGEO	2	R31,R33
73	*SMD RESISTOR	82K 1/20W ±1% 0201 TAP RoHS2.0+Reach			2	R30,R32
74	*SMD RESISTOR	4.7M 1/20W ±1% 0201 TAP RoHS2.0+Reach			3	R87,R91,R93
75	*B-B connector	ACON,BB7R4-24KBJ03,Pitch=0.4mm,B-BCONNECTOR,24pin,TAP,RoHS2.0+Reach	BB7R4-24KBJ03	ACON	1	J2
76	*B-B connector	OCN,OK-F401-06125,Pitch=0.4mm,FPCCONNECTOR,6pin,TAP,RoHS2.0+Reach	OK-F401-06125	OCN	1	J5
77	*B-B connector	ACON,BBR46-10KBS73,Pitch=0.35mm,B-BCONNECTOR,10pin,TAP,RoHS2.0+Reach	BBR46-10KBS73	ACON	1	J4
78	*SMT POGO PING	FD103|SMT POGO PING|2.2*1.2*1.2mm|SUS301|Golden|Gold-plated|Salt spray48H,|SMDTAP, XINGWEI PN:O-shape12B|ROHS2.0,Reach			2	EB1,EB2
79	* SMD IC	LDO,ADI,ADP151ACBZ-1.8-R7,1.8V,WLCSP,TAP,RoHS2.0+Reach	ADP151ACBZ-1.8-R7	ADI	1	U3
80	* SMD IC	TVS Diode Array,Littelfuse,SP3004-04XTG,SOT-563,TAP,RoHS2.0+Reach	SP3004-04XTG	Littelfuse	1	U20
81	*SMD RESISTOR	EYANG R0201RXX102XF20LHZ 1K 1/20W ±1% 0201 TAP RoHS2.0+Reach	R0201RXX102XF20LHZ	EYANG	3	R34,R35,R130
82	*SMD RESISTOR	10R 1/20W ±5% 0201 TAP RoHS2.0+Reach			1	R112
83	*SMD RESISTOR	150K 1/20W ±1% 0201 TAP RoHS2.0+Reach			3	R126,R127,R131
84	*SMD RESISTOR	510K 1/20W ±5% 0201 TAP RoHS2.0+Reach			1	R9
85	*SMD RESISTOR	SMD RESISTOR|30M|1/16W|±1%|0402|TAP|ROHS2.0,Reach	0402WGF3005TCE		1	R6
86	*SMD RESISTOR	RTT018063FTH 806K 1/20W ±1% 0201 TAP RoHS2.0+Reach	RTT018063FTH		2	R110,R111
87	*SMD RESISTOR	RTT011002BTH 10K 1/20W ACCURACY 0201 TAP ±0.1% RoHS2.0+Reach	RTT011002BTH		1	R19
88	* SMD CAPACITOR	MURATA,GRM033R71E102KA01D,25V,1nF,±10%,X7R,0201,TAP,RoHS2.0+Reach	GRM033R71E102KA01D	Murata	1	C5
89	* SMD CAPACITOR	6.3V,4.7nF,±10%,X5R,0201,TAP,RoHS2.0+Reach			2	C122,C123
90	* SMD CAPACITOR	25V,220pF,±5%,NPO,0201,TAP,RoHS2.0+Reach			1	C124
91	* SMD CAPACITOR	,0201X153K100CT,10V,15nF,10%,X5R,0201,TAP,RoHS2.0+Reach	0201X153K100CT		1	C104
92	*SMD RESISTOR	MEDICAL SPECIAL YAGEO RC0201FR-071KL 1K 1/20W ±1% 0201 TAP RoHS2.0+Reach	RC0201FR-071KL	Yageo	5	R3,R4,R5,R7,R14

93	* SMD CAPACITOR	MEDICAL SPECIAL Murata,GRM0335C1H1R2BA01D,50V,1.2pF,±0.1pF,NPO,0201,TAP,RoHS2.0+Reach	GRM0335C1H1R2BA01D	Murata	1	C42
94	* SMD CAPACITOR	Murata,GJM0335C1E1R5WB01D,25V,1.5pF,±0.05pF,CAP,0201,TAP,RoHS2.0+Reach	GJM0335C1E1R5WB01D	Murata	1	C82
95	**Debug Adapter SMTA**	**FD103,*PCBA ,Debug Adapter PCBA,RoHS2.0+Reach**			1	
96	* SMD IC	level translator,ANALOG DEVICES,ADG3304BCBZ-REEL7,; ,LFCSP,TAP,RoHS2.0+Reach	ADG3304BCBZ-REEL7	ADI	1	U8
97	* SMD IC	WillsemiWL2815D18-4/TR,1.8V LDO,DFN1010-4L,TAP,RoHS2.0+Reach	WL2815D18-4/TR	Willsemi	1.0	U20
98	*SMD RESISTOR	1M 1/20W ±1% 0201 TAP RoHS2.0+Reach			1.0	R93
99	* SMD CAPACITOR	TDK,C0603X5R1A104K030BC,10V,0.1uF, ±10%,,,0201,TAP,RoHS2.0+Reach	C0603X5R1A104K030BC	TDK	6.0	C115,C116,C120,C121,C122,C123
100	* SMD IC	LDO,Willsemi,WL2815D33-4/TR,3.3V LDO,DFN1010-4L,TAP,RoHS2.0+Reach	WL2815D33-4/TR	Willsemi	1.0	U21
101	USB plug	Micro USB 5P ,Silver color,USB Plug,12.1*9.23*2.85mm,TAP,RoHS2.0+Reach			1.0	J8
102	4 Layer PCB	Debug PCB,1.0mm,FR4,Green,White,33*20*1.0mm,RoHS2.0+Reach			1.0	
103	**HR SMTA**	**FD103,HR SMTA ASSEMBLE, RoHS2.0+Reach**				
104	SCAN CODE LABLE	MEDICAL SPECIAL SCAN CODE LABLE|7*7mm|SCAN CODE LABLE(HIGH TEMP RESIST)|PRINT|ROHS2.0,Reach			1	
105	* SMD IC	Vishay,DG-2502DB-T2-GE1,Quad SPST Analog Switches,WCSP16,TAP,RoHS2.0+Reach	DG-2502DB-T2-GE1	VISHAY	1	U15
106	* SMD IC	SMD IC|Analog front end|BGA 35|TAP|1.8V, −40°C to +85°C|ROHS2.0,Reach	ADPD4100BCBZR7	ADI	1	U14
107	* SMD LED	LUXEON,LXZ1-PM01,Green,L1.7xW1.3xH0.59mm,TAP,RoHS2.0+Reach	LXZ1-PM01	LUXEON	1	D5
108	Infrared emission tube	Infrared emission tube|SMD1.90*1.37*0.90mm|1A|2.9V|ROHS2.0,Reach	L1IZ-0940000000000	LUXEON	1	D9
109	* SMD LED	LUXEON,LXZ1-PA01,Red,L1.7xW1.3xH0.59mm,RoHS2.0+Reach	LXZ1-PA01	LUXEON	1	D17
110	* SMD LED	LUXEON,LXZ1-PB01,Blue,L1.7xW1.3xH0.59mm,TAP,RoHS2.0+Reach	LXZ1-PB01	LUXEON	1	D18
111	*Silicon PIN Photodiode	*Silicon PIN Photodiode|SMT IC|TAP|ROHS2.0,Reach	VEMD8080		2	D19,D20
112	*B-B connector	ACON,BBR46-10KBS73,Pitch=0.35mm,B-BCONNECTOR,10pin,TAP,RoHS2.0+Reach	BBR46-10KBS73	ACON	1	J9
113	*B-B connector	ACON,BB7P4-24K6J01,Pitch=0.4mm,*B-BCONNECTOR,24pin,TAP,RoHS2.0+Reach	BB7P4-24K6J01	ACON	1	J3
114	*SMD RESISTOR	MEDICAL SPECIAL YAGEO RC0201JR-070RL 0Ω 1/20W ±5% 0201 TAP RoHS2.0+Reach	RC0201JR-070RL	Yageo	9	R58,R59,R79,R81,R86,R98,R101,R102,R105
115	*SMD RESISTOR	MEDICAL SPECIAL YAGEO RC0201FR-07100KL 100K 1/20W ±1% 0201 TAP RoHS2.0+Reach	RC0201FR-07100KL	Yageo	1	R100

116	*SMD RESISTOR	4.7M 1/20W ±1% 0201 TAP RoHS2.0+Reach	/(/)		1	R92
117	* SMD CAPACITOR	YAGEO,CC0201KRX5R6BB104,10V,0.1uF,±10%,X5R,0201,TAP,RoHS2.0+Reach	CC0201KRX5R6BB104	Yageo	5	C10,C11,C12,C94,C98
118	* SMD CAPACITOR	Samsung,CL05A226MQ5QUNC,6.3V,22uF,±20%,X5R,0402,TAP,RoHS2.0+Reach	CL05A226MQ5QUNC	Samsung	2	C8,C50
119	* SMD CAPACITOR	Murata,GRM0335C1E471JA01D,25V,470pF,±5%,C0G,0201,TAP,RoHS2.0+Reach	GRM0335C1E471JA01D	Murata	1	C7
120	* SMD CAPACITOR	Samsung,CL03A105MP3NSNC,10V,1uF,±20%,X5R,0201,TAP,RoHS2.0+Reach	CL03A105MP3NSNC	Samsung	1	C9
121	6LAYER PCB BOARD	FD103,0.6mm,FR4,Immersion Golde,Gree,White,L30*26*1.0mm,RoHS2.0+Reach			1	
122	*SMD RESISTOR	MEDICAL SPECIAL YAGEO RC0201FR-0710KL 10K 1/20W ±1% 0201 TAP RoHS2.0+Reach	RC0201FR-0710KL	Yageo	2	R15,R26
123	*SMD RESISTOR	MEDICAL SPECIAL YAGEO RC0201FR-07200KL 200K 1/20W ±1% 0201 TAP RoHS2.0+Reach	RC0201FR-07200KL	Yageo	2	R1,R2
124	* SMD CAPACITOR	Samsung,CL05A225MQ5NSNC,6.3V,2.2uF,±20%,X5R,0402,TAP,RoHS2.0+Reach	CL05A225MQ5NSNC	Samsung	1	C100
125	*B-B connector	Thermistor Connector	BBR16-10K6S21	ACON	1	J8
126	* SMD Thermistor	Thermistor	NTC104EF104FTDSX	TDK	1	R41

FCC COMPLIANCE STATEMENT

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.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

-- Reorient or relocate the receiving antenna.

-- Increase the separation between the equipment and receiver.

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

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

ORDERING INFORMATION

DEVICE MODELS

Table 13. Device Models

Model	Description
EVAL-HCRWATCH4Z	ADI Study Watch for VSM Solutions Eval

ESD Caution
ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

County, Massachusetts, and Customer hereby submits to the personal jurisdiction and venue of such courts. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to this Agreement and is expressly disclaimed.

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