MATRIX Mercury Boost Converter Prototype Kit

MCRY-PROTOKIT

DESCRIPTION

The MATRIX Mercury Prototype Kit is a rapid prototyping platform built around the Mercury energy harvesting boost converter. It is ideal for developing IoT sensor applications that harness energy from very low temperature differences and eliminate the need to replace or recharge batteries. The board includes an ultra-low power 16-bit microcontroller (MCU) with Bluetooth Low Energy (BLE) that is pre-programmed with a beacon application. Connect the 2-pin terminal block on the board to a suitable power source, such as a thermoelectric generator (TEG). When power is supplied, the board begins harvesting energy and stores it in the onboard storage capacitors. The MCU sends a BLE beacon transmission whenever there is sufficient energy accumulated in the capacitors. An Android app is also provided as a basic framework for building customized apps.

The board supports the addition of external hardware, and it has been optimized for low start-up voltage with a 50:1 turns ratio transformer that is on the board. Mercury features an 8-bit on-chip ADC that detects when the open circuit voltage VOC exceeds the programmed limit and turns off the input to ensure reliable operation. The outputs of the ADC are connected to the MCU to allow real-time measurements and transmission of the ADC output over BLE.

The Prototype Kit is equipped with MCRY12-125Q-42DI, which is optimized for 12Ω input impedance, 12.5μH inductor and 4.2V output. Please contact info@matrixindustries.com for customization options.

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ORDERING INFORMATION

Part Number	Type
MCRY-PROTOKIT	Prototype Kit for MATRIX Mercury Energy Harvesting Boost Converter

TYPICAL SPECIFICATIONS (25°C)

Voc	Cold-start occurs at open circuit voltage VOC=24mV and the maximum VOC=500mV.
V_{OUT}	The maximum output voltage VOUT=3V.
I_{SYSTEM}	The system standby current is 600nA.
I_{ACTIVE}	The active current is 1.2mA for 100ms, which gives 300uJ per measurement/ transmission.

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KIT FILES

MCRY-PROTOKIT BOM
MCRY-PROTOKIT PCB Layout Diagrams
MCRY-PROTOKIT Schematic
MCRY-PROTOKIT Android App

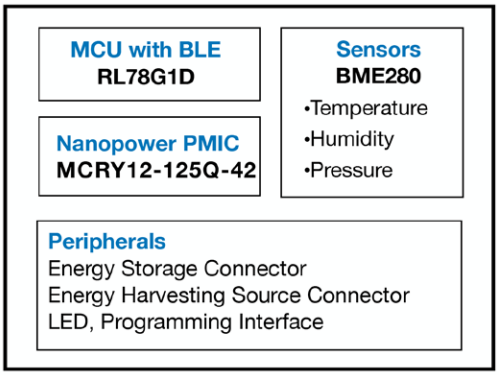

Figure 1: MCRY-PROTOKit Block Diagram

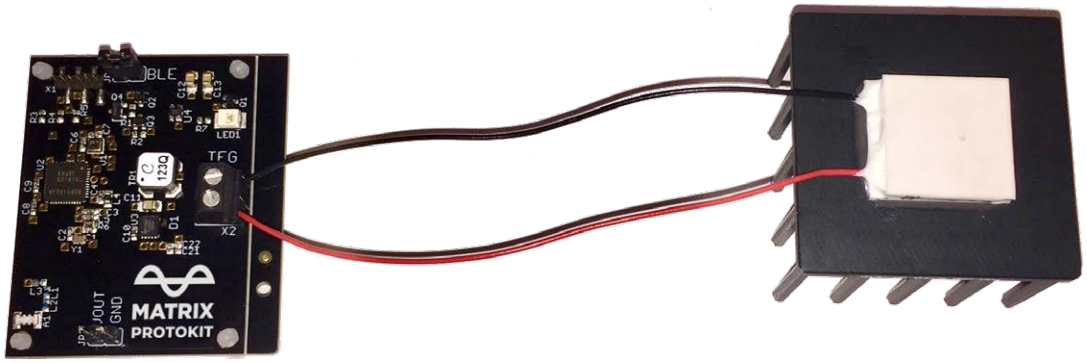

Figure 2: MCRY-PROTOKit with MATRIX Gemini TEG

QUICK START GUIDE

1. Connect the energy harvesting source to the TEG connector. Depending on the temperature gradient across the TEG, the output of the TEG can be of either polarity. First, determine the output polarity of the TEG by measuring the voltage output from the TEG whilst providing a temperature gradient. Connect the positive output of the TEG to the “TEG +” pin on the board, and the negative output to the “TEG -“ pin.
2. JP1: Close to enable BLE transmission of measurements from the MCU.
3. JP2: Use this connector to make voltage measurements of VOUT or to connect external hardware. By default, the board turns on the LED, performs a sensor measurement, and transmits the result via BLE when VOUT is about 3.1V. Within a short time VOUT drops to 2.9V and the LED is then turned off, resulting in a visible pulse of light from the LED. VOUT can drop to 1.8V before the MCU is turned off.
4. X1: Use this connector to program the MCU.

* In the absence of an energy storage device, the MCU is turned off after every transmission to optimize the system power consumption.

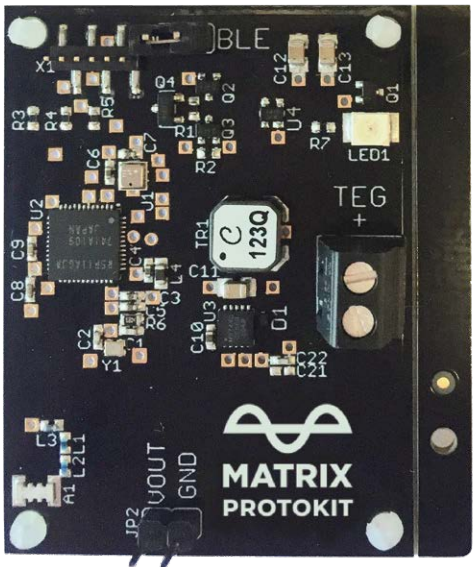

Figure 3: MCRY-PROTOKIT Board View

ANDROID APP INSTRUCTIONS

1. Save the file 'MATRIX_Blens.apk' on your Android device and install it.
2. Start the App and allow the App to use Bluetooth.
3. The App displays a list of detected sensors. Tap to select a sensor from the list.
4. The App now displays the measurement results from the onboard BME280 chip and the intervals between the last 5 transmissions from the selected sensor.
5. The screens show the VOC (VTEG), and the power output can be calculated using: POUT = efficiency*VOC2/(4*RTEG). RTEG is 12Ω and the efficiency can be looked up from the Mercury datasheet (Figure 2). If the Seebeck coefficient STEG of the TEG module is known, the VOC can also be used to estimate the temperature difference across the TEG using dT=VOC/STEG.

Please note that if a TEG is used as the energy source, the measurements of temperature is by the BME280 chip on the board, not referring to the not on either side the TEG.

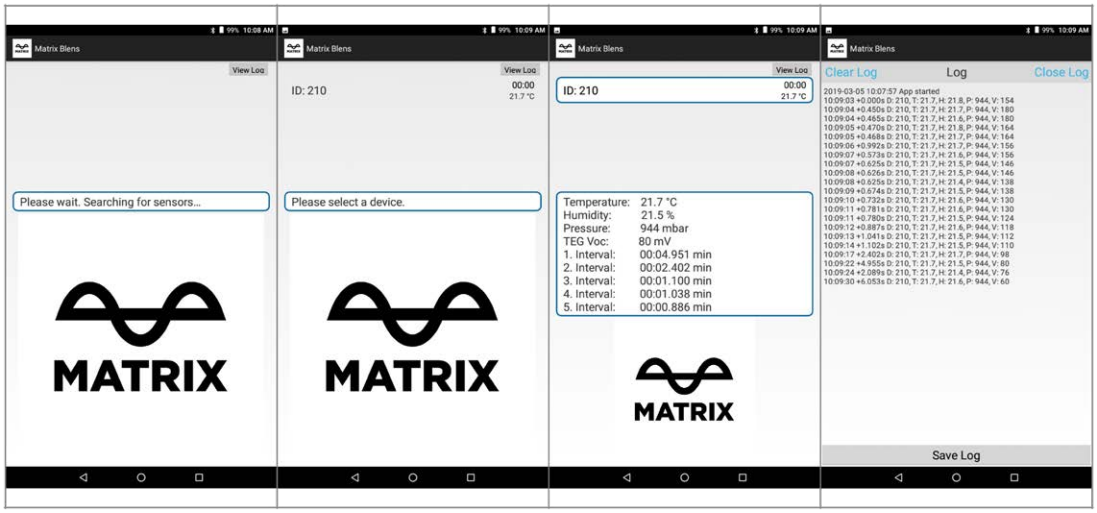

Figure 4: MCRY-PROTOKIT Android App

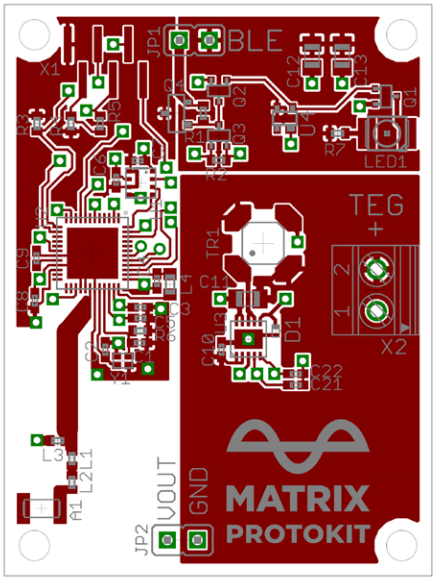

Figure 5: MCRY-PROTOKIT

SCHEMATIC

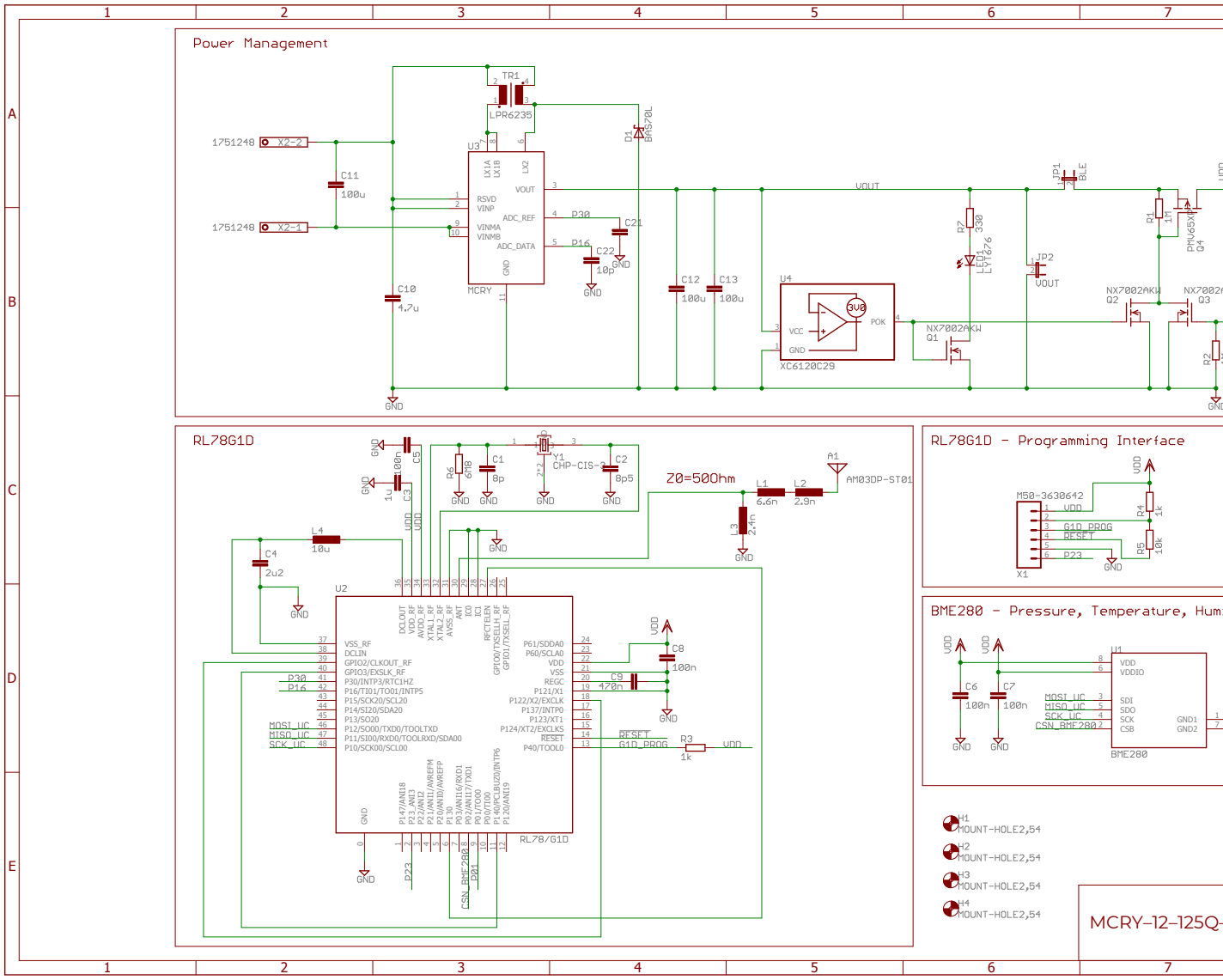

Figure 6: MCRY-PROTOKIT Schematics

BILL OF MATERIAL

Table 1: MCRY-PROTOKIT Bill of Materials

Item	DES	QTY	MFG Part #	MFG	Description
1	A1	1	AM03DP-ST01	Mitsubishi	Surface mountable dielectric chip antenna
2	C1	1	GRM1555C1H8R0CA01D	Murata	Multilayer Ceramic Capacitors MLCC - SMD/SMT 0402 8pF
3	C2	1	GRM1555C1H8R5CA1D	Murata	Multilayer Ceramic Capacitors MLCC - SMD/SMT 0402 8.5pF 50V C0G +/-0.25pF
4	C3	1	GRM152R60J105ME5D	Murata	Multilayer Ceramic Capacitors MLCC - SMD/SMT 0402 1.0µF 6.3V
5	C4	7	C0402C225K9PACTU	KEMET	Multilayer Ceramic Capacitors MLCC - SMD/SMT 6.3V 2.2µF X5R 0402 10%
6	C5, C6, C7, C8	4	GCM155R71C104KA55D	Murata	Multilayer Ceramic Capacitors MLCC - SMD/SMT 0402 0.1µF 16V X7R 10%
7	C9	1	885012105004	Wurth Electronics	Multilayer Ceramic Capacitors MLCC - SMD/SMT WCAP-CSGP 0.47µF 0402 20% 6.3V MLCC
8	C10	1	GRM155R60J475ME87J	MURATA	Multilayer Ceramic Capacitors MLCC - SMD/SMT 0402 4.7µF 6.3V
9	C11, C12, C13	3	GRM21BR60J107ME15K	Murata	Multilayer Ceramic Capacitors MLCC - SMD/SMT 0805 100µF 6.3V
10	C21	0	Not assembled		
11	C22	1	GRM1555C2A100JA01D	Murata	10pF ±5% 100V Ceramic Capacitor C0G, NP0 0402
12	D1	1	BAS70L,315	Nexperia	Schottky Diodes & Rectifiers
13	JP1, JP2	2	M20-9990245	Harwin	Headers & Wire Housings 02 SIL VERTICAL PIN HEADER GOLD HT
14	L1	1	LQW15AN6N6B00D	Murata	Fixed Inductors 6.6nH 0402
15	L2	1	LQW15AN2N9B00D	Murata	Fixed Inductors 2.9 NH +-.1NH 2.9nH 0402
16	L3	1	LQW15AN2N4B00D	Murata	Fixed Inductors 2.4 NH +-.1NH 2.4nH 0402
17	L4	1	MLZ1608N100LT000	TDK	Fixed Inductors 10 UH 20% 10µH 0603
18	LED1	1	LY T676-R1S2-26	OSRAM Opto Semiconductors	Standard LEDs - SMD Yellow 587nm
19	Q1, Q2, Q3	3	NX7002AKW,115	Nexperia	MOSFET 60 V, single N-chan Trench MOSFET SOT-323-3
20	Q4	1	PMV65XPVL	Nexperia	MOSFET PMV65XP/TO-236AB/REEL 11" Q3/T SOT-23-3
21	R1, R2	2	RC0402FR-101ML	Yageo	Thick Film Resistors - SMD 1M ohm 1% 50V General Purpose 0402
22	R3, R4	2	RK73B1ETTP102J	KOA Speer	Thick Film Resistors - SMD 0.1W 1Kohms 5% 0402
23	R5	1	RK73B1ETTP103J	KOA Speer	Thick Film Resistors - SMD 0.1W 10Kohms 5% 0402
24	R6	1	RK73H1ETTP6804F	KOA Speer	Thick Film Resistors - SMD 6.8M OHM 1% 0402
25	R7	1	RC0402JR-7D330RL	Yageo	Thick Film Resistors - SMD 330 ohm 5% 50V General Purpose 0402
26	TR1	1	LPR6235-123QMRC	Coilcraft	Coupled Inductors LPR6235 Mini Step-Up 12.5 uH 1:50 Turn 6x6 mm^2
27	U1	1	BME280	Bosch Sensortec	Board Mount Humidity Sensors LGA8
28	U2	1	R5F11AGJANB#20	Renesas	RL78 RL78/G1D Microcontroller IC 16-Bit 32MHz 256KB (256K x 8) FLASH 48-HWQFN (6x6)
29	U3	1	MCRY12-125Q-42DI	Matrix Industries	Nanopower Energy Harvesting Synchronous Boost Converter in DFN10 3x3mm^2
30	U4	1	XC6120C292NR-G	Torex Semiconductor	Supervisory Circuits SOT343R
31	X1	1	M50-3630642R	Harwin	Headers & Wire Housings 6 WAY SIL VERT SMT P/HDR T&R 1x6 50mil
32	X2	1	1985807	Phoenix Contact	2 Position Wire to Board Terminal Block Horizontal with Board 0.138" (3.50mm) Through Hole 1x2 3.5m
33	Y1	1	NX1612SA-32.000MHZ-CHP-CIS-3	NDK	32MHz ±10ppm Crystal 6pF 100 Ohms 4-SMD, No Lead

REVISION HISTORY

Revision	Date	Description
*A	March 2019	Preliminary Datasheet Release

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