LTC3337
Primary Battery SOH Monitor with Precision Coulomb Counter

DESCRIPTION

Demonstration circuit 2973A shows the LTC®3337 Primary Battery State of Health (SOH) monitor with precision coulomb counter operating with a configurable peak current limit. The LTC3337 supports input voltages from 1.8V to 5.5V and a peak current up to 100mA with a quiescent current of 100nA. Coulomb count, battery voltage, and Battery Series Resistance (BSR) are measurable and can be used to quantify the charge state and health of a battery.

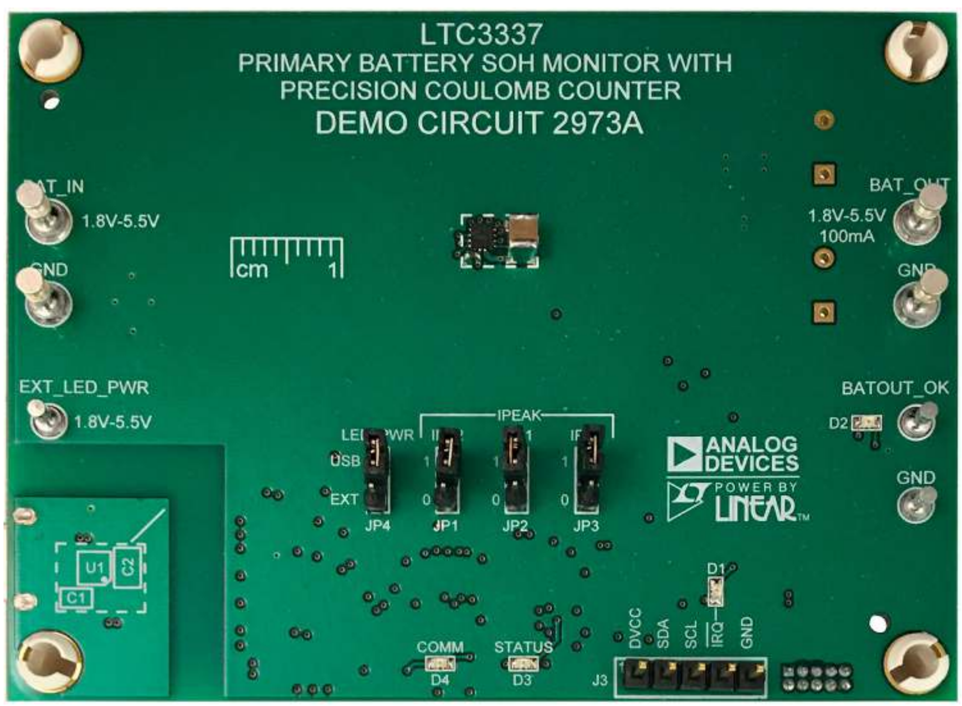
The DC2973A demonstrates a simple layout for the highest-power configuration of the LTC3337. The circuit can be reduced for lower I_{PEAK} levels. The demo board can be connected directly to a PC using a micro USB cable in order to run a GUI and configure simple a Battery State of Charge (SOC) monitor. Source code for the GUI is available and can be used as a starting point for LTC3337 firmware development.

Design files for this circuit board are available.

PERFORMANCE SUMMARY **Specifications are at T_A = 25°C**

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Voltage Range		1.8		5.5	V
I_{OUT}	Output Current	IPK2 – IPK0 = 111			100	mA

BOARD PHOTO



QUICK START PROCEDURE

Refer to Figure 1 for the proper measurement equipment setup and jumper settings. Please follow the procedure below to familiarize yourself with the DC2973A.

1. Configure the IPEAK jumpers for your chosen current limit. Choose R1 based on the formula below:

   $R1 = 10/I_{PEAK}$ (Ω)

   R1 Power Rating ≥ 2.5 • I_{PEAK} (W)

   Or use an electronic load in CC mode pulling $I_{PEAK}/2$.
2. Connect DC2973A to a computer using a USB cable and launch QuikEval™ to download and run the GUI (see GUI Application section for download instructions).
3. Enable PS1.
4. In the GUI, click the Battery Setup button and configure for your chosen battery (or use the settings shown below for a demo). Once finished, click the start button.
5. The coulomb counter is now monitoring the SOC of the battery. For higher resolution visibility, switch to the Engineering tab to view the raw Accumulated Charge count.
6. Once familiar with the operation, replace PS1 and R1 with your battery and system load, respectively.

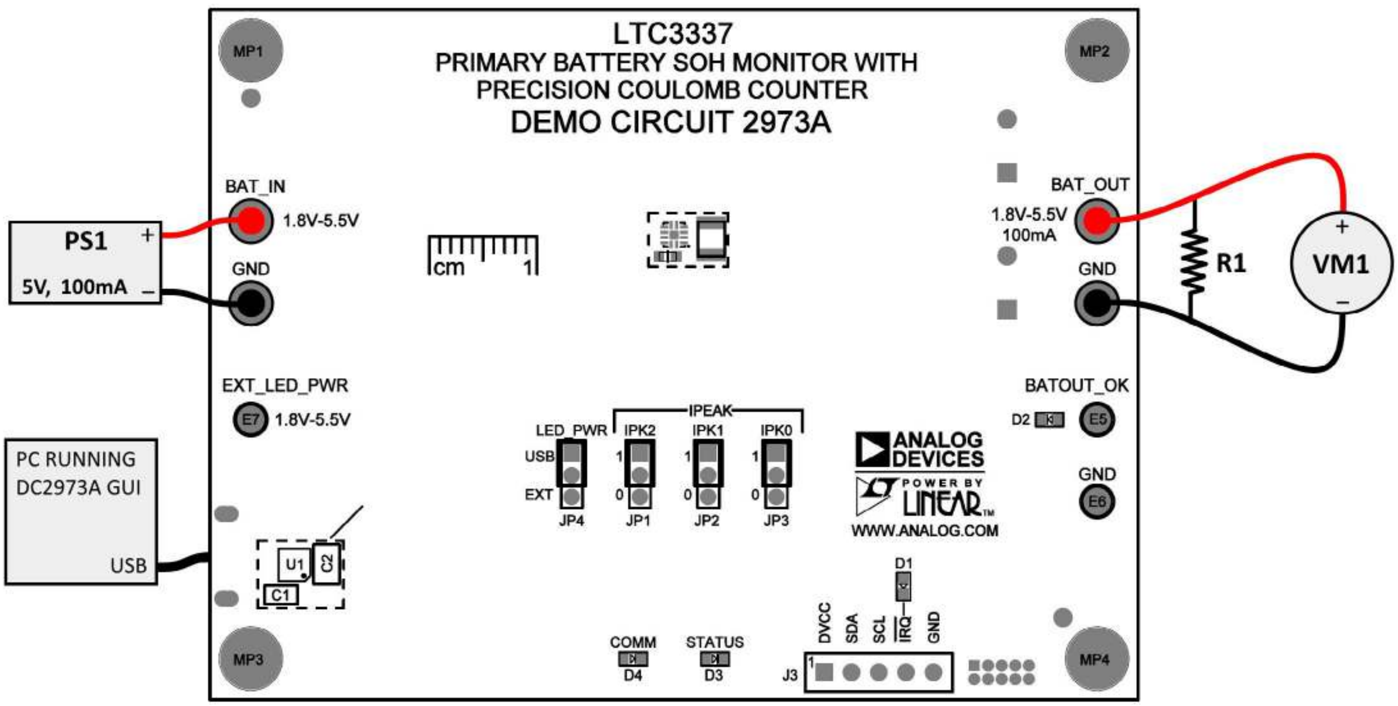


Figure 1. Quick Start Setup for the DC2973A Demo Circuit

CONFIGURING IPEAK

The peak current limit of the LTC3337 (I_{PEAK}) is configured by moving the JP1-JP3 shunts on the DC2973A demo board. Note that the IPEAK setting is locked at startup.

Refer to Table 1 to configure the IPEAK setting. This table is also located on the back of the DC2973A PCB.

Table 1. IPEAK Configuration

JUMPER CONFIGURATION			
IPK2	IPK1	IPK0	IPEAK
0	0	0	5mA
0	0	1	10mA
0	1	0	15mA
0	1	1	20mA
1	0	0	25mA
1	0	1	50mA
1	1	0	75mA
1	1	1	100mA

SOFTWARE TOOLS

On-Board Digital Interface

The LTC3337 demo board includes an Atmel SMART SAM D21 processor with an Arduino bootloader that makes it compatible with the Arduino IDE. This means users can prototype processor functionality directly in the free Arduino IDE. The SDK mentioned below includes an Arduino example project that can be opened and uploaded to the board through the Arduino IDE.

Software Development Kit

To help with learning and development of LTC3337 applications, there exists a Software Development Kit (SDK) that makes interfacing with the LTC3337 as simple as possible. The package includes a few example programs and comes fully equipped with register names and value formatting. Resources are given for both C code (with Arduino examples) and Python code. This SDK can be downloaded from the LTC3337 product webpage. Further instructions to use the SDK are included within the download.

Restoring GUI-Compatible Firmware

If the onboard firmware is changed (to upload SDK firmware, for example), it can be restored at any time through the GUI. In this case, the GUI will need to be launched manually because QuikEval will not recognize the board once it has been reprogrammed. By default, the GUI installs to:

C:\Program Files (x86)\LTC\LTC3337 GUI\em3337.exe

Debugging Custom Designs

The DC2973A's default firmware and engineering GUI tab are designed to give a high-speed debugging environment for LTC3337 operation. This functionality can be easily extended to interface with your own custom LTC3337 circuit design. To use the engineering GUI tab with a custom circuit board, simply leave the LTC3337 on the DC2973A unpowered and connect your own board to the SMBus interface accessible through header J3.

GUI APPLICATION

Introduction to the GUI

The LTC3337 GUI provides a graphical interface for some of the main features of the LTC3337. In addition, it provides an advanced debugging interface that can be used in evaluating operation of the DC2973A as well as a customer's own design.

To use the DC2973A, the PC must first have the proper software driver and GUI installed. Download the QuikEval software from www.analog.com and install the QuikEval software by running the executable ltcqev.exe. Follow the instructions to connect the DC2973A.

For more detail on GUI functions, launch the GUI and go to Window → Show Help Guide.

GUI Layout

The LTC3337 GUI is divided into a Dashboard tab, an Engineering tab, and a Schematic tab. The Dashboard tab shows a graphical representation of a some of the LTC3337's core functionality. The Engineering tab shows all registers and is intended to be used for lower-level development and debugging purposes. The Schematic tab just displays the schematic for reference.

Dashboard Tab

The Dashboard tab shows all the basic information needed to monitor a battery's state of charge. Along with the accumulated charge information, the battery voltage, series resistance, and average current are also shown. While the dashboard is open, the GUI reads data from the LTC3337 every 200ms.

To set up a battery for SoC measurement, click the Battery Setup button in the bottom-left corner. From there, configure your battery settings as required and click the Start button. This sets a target accumulated charge value at which the remaining capacity of the battery is considered to be 0%. After starting the test, intermediate calculations can be viewed by showing the Console window.

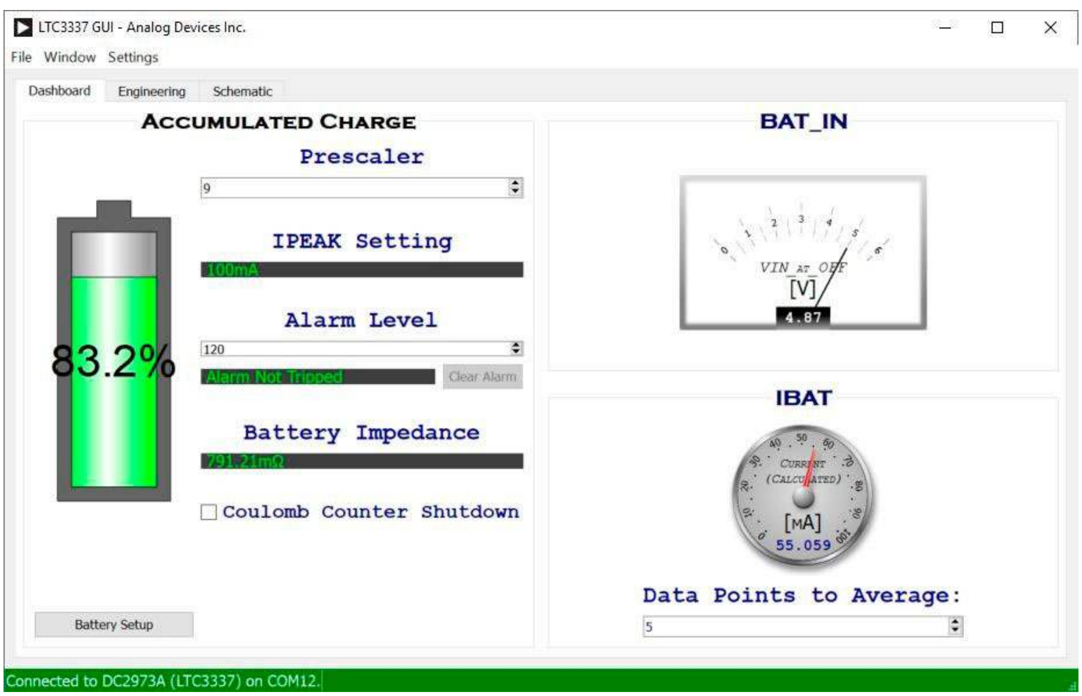


Figure 2. The Dashboard Tab

GUI APPLICATION

Engineering Tab

The Engineering tab is an advanced debugging tool which allows high-speed reading of any register. Register groupings can be displayed by activating the checkboxes in the Categories section.

To read a register, simply double-click the register name or value. To read all shown registers, double-click anywhere in the empty background space. To continuously read all shown registers, right-click and select Continuous Read from the context menu. When continuously reading, the GUI will poll all of the displayed registers as fast as possible. By default, a register entry will flash green when the new data is different from the previous data; this can be changed in the right-click context menu.

To write a register, right-click on a writable register and select Write… from the context menu. This will bring up a dialog with a few options for writing values.

For detailed information about a register, hovering over it for about a second will display the same tool tips as are visible in the other tabs of the GUI.

By default, register entries are displayed as formatted decimal values or Booleans. This can be changed to raw binary or hexadecimal notation by right-clicking on an entry and choosing Select Format.

Tabs can be added to the Engineering view by clicking the + button in the top-right corner. This allows the user to change between viewing different register groupings at ease.

Consult the Help Guide for more detail on the Engineering tab.

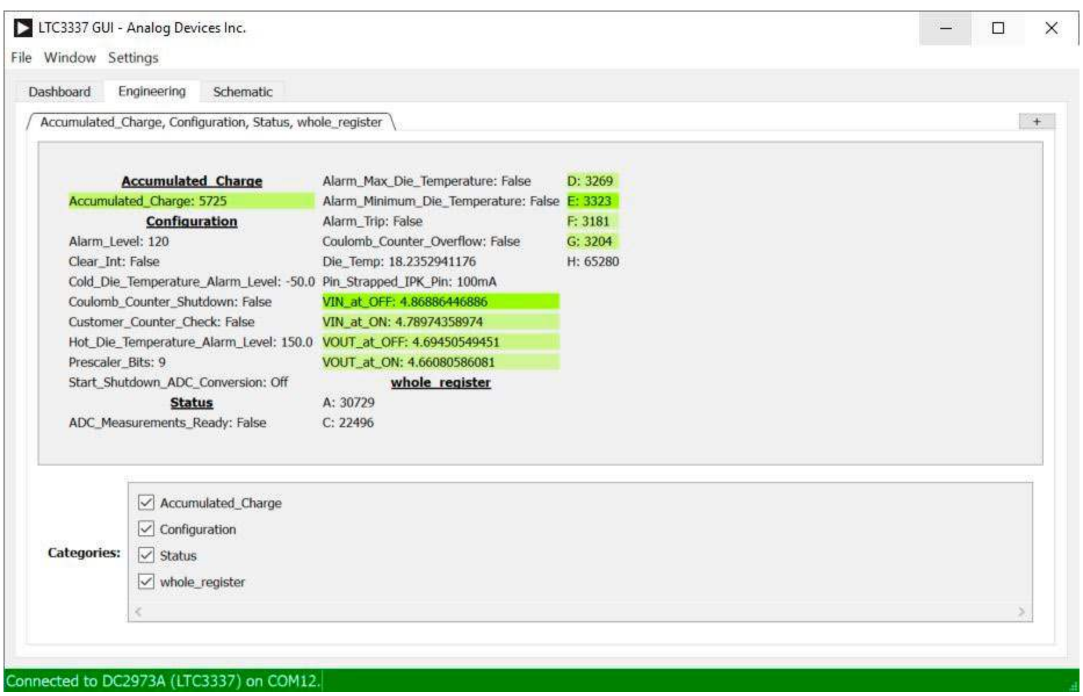


Figure 3. The Engineering Tab

GUI APPLICATION

Schematic Tab

The Schematic Tab simply shows the DC2973A schematic for quick reference while using the GUI.

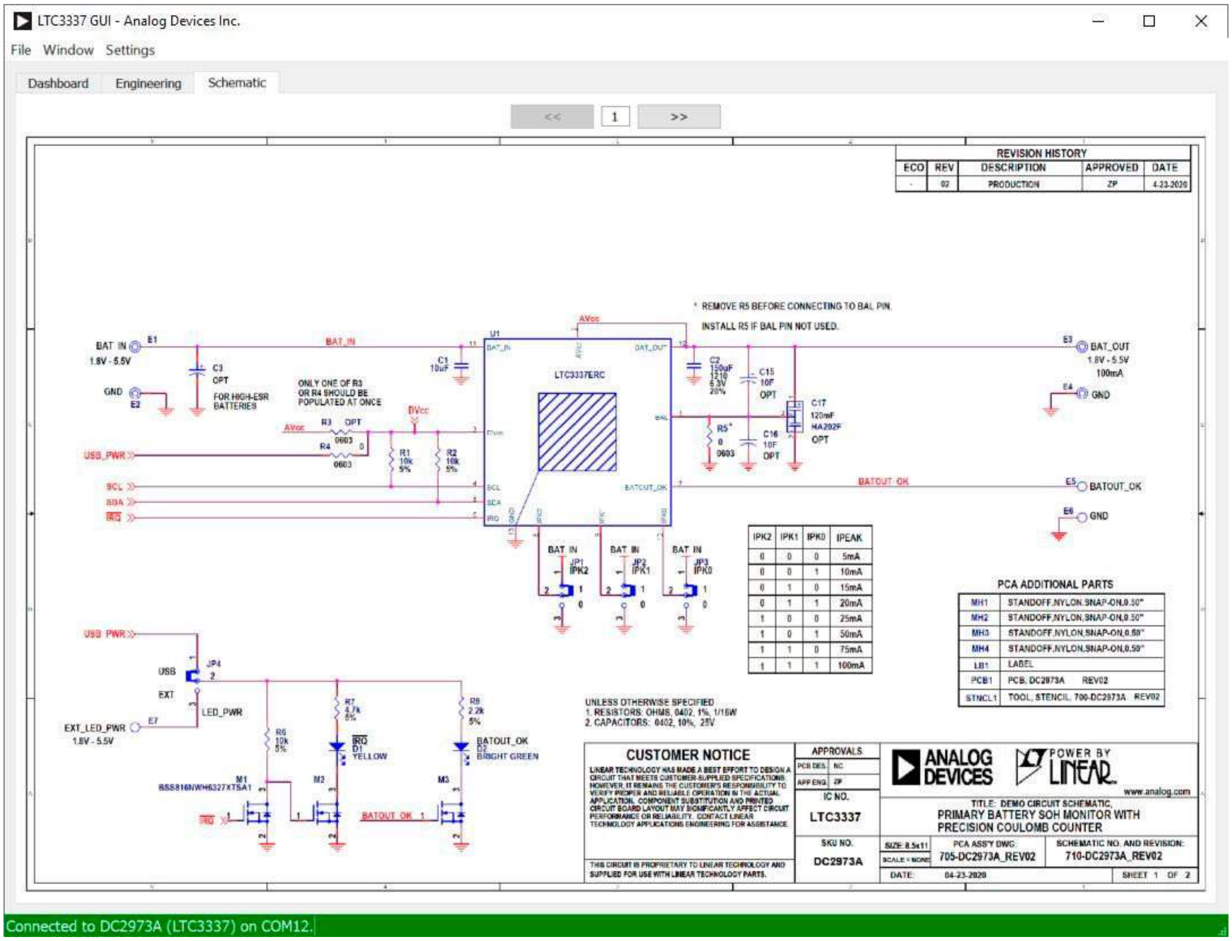


Figure 4. The Schematic Tab

GUI APPLICATION

Logger Window

The Logger can be launched by going to Window → Show Logger. This feature allows configurable logging of bitfields and can be used for rapid or long-term data collection. Data can be exported into a CSV format (for import to Excel) or to a SQL database. Note that other GUI tabs will be inactive while logging, so writing bitfields is disabled.

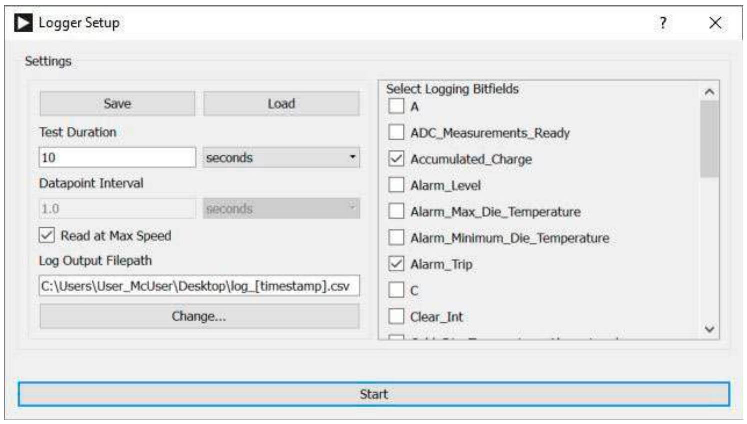


Figure 5. The Logger Window

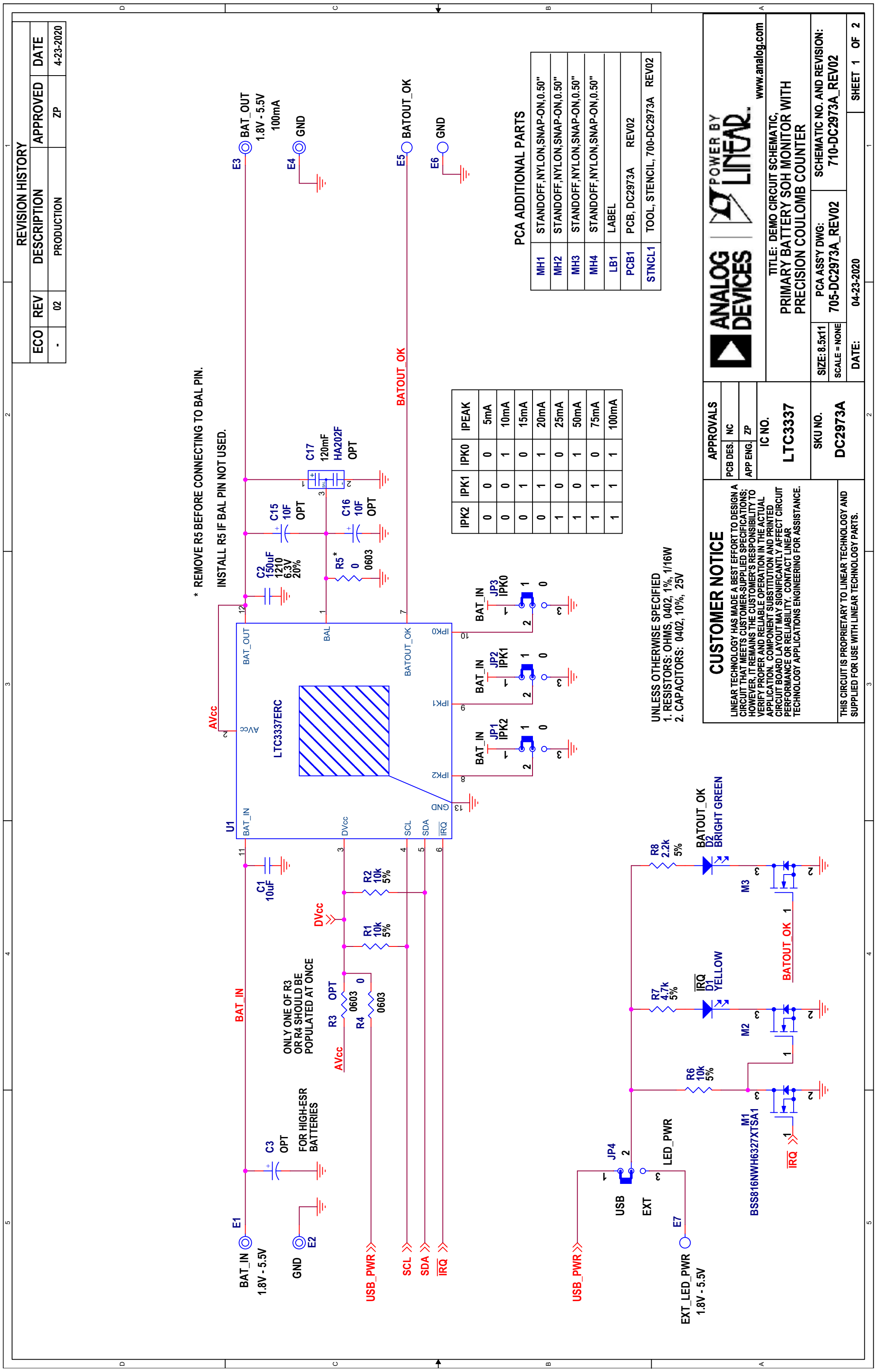
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	C1	CAP., 10µF, X5R, 10V, 10%, 0603	AVX, 0603ZD106KAT2A MURATA, GRM188R61A106KAALD SAMSUNG, CL10A106KP8NNNC
2	1	C2	CAP., 150µF, X5R, 6.3V, 20%, 1210	SAMSUNG, CL32A157MQVNNNE
3	0	C3	CAP., 180µF, ALUM POLY, OS-CON, 25V, 20%, 8mm × 11.9mm, SMD, RADIAL, E12	PANASONIC, 25SVPF180M
4	1	C4	CAP., 10µF, X5R, 6.3V, 20%, 0603	MURATA, GRM188R60J106ME47D MURATA, GRM188R60J106ME47J TAIYO YUDEN, JMK107ABJ106MA-T AVX, 06036D106MAT2A NIC, NMC0603X5R106M6.3TRPF TDK, C1608X5R0J106M080AB
5	4	C5, C6, C7, C8	CAP., 0.1µF, X5R, 10V, 20%, 0402	WURTH ELEKTRONIK, 885012105010
6	2	C9, C10	CAP., 22pF, NP0, 50V, 5%, 0402	WURTH ELEKTRONIK, 885012005057
7	2	C11, C12	CAP., 1µF, BJ, 10V, 20%, 0402	TDK, CGB2A1JB1A105M033BC
8	1	C13	CAP., 0.01µF, X7R, 25V, 10%, 0402	WURTH ELEKTRONIK, 885012205050
9	1	C14	CAP., 2.2µF, X5R, 10V, 20%, 0402	WURTH ELEKTRONIK, 885012105013
10	0	C15, C16	CAP., 10F, ULTRA, 2.7V, –10/+20%, RADIAL, THT	NESSCAP CO. LTD., BCAP0010 P270 S01 NESSCAP CO. LTD., ESHSR-0010C0-002R7
11	0	C17	CAP., 0.12F, SUPERCAP, HIGH TEMP, 5.5V, 20%, 20mm × 18mm × 2.5mm, SMD, DUAL CELL	CAP-XX, HA202F
12	2	D1, D4	LED, YELLOW, WATERCLEAR, 0603	WURTH ELEKTRONIK, 150060YS75000
13	2	D2, D3	LED, BRIGHT GREEN, WATERCLEAR, 0603	WURTH ELEKTRONIK, 150060VS75000
14	4	E1, E2, E3, E4	TEST POINT, TURRET, 0.094" MTG. HOLE, PCB 0.062" THK	MILL-MAX, 2501-2-00-80-00-00-07-0
15	3	E5, E6, E7	TEST POINT, TURRET, 0.064" MTG. HOLE, PCB 0.062" THK	MILL-MAX, 2308-2-00-80-00-00-07-0
16	1	J1	CONN., uUSB 2.0, RCPT., 5-PIN, 1PORT, REVERSE MOUNT, R/A HORZ., TYPE B, FLANGELESS	TE CONNECTIVITY, 1932788-1
17	1	J2	CONN., HDR, MALE, 2x5, 1.27mm, VERT, ST, THT	WURTH ELEKTRONIK, 62201021121
18	1	J3	CONN., HDR, MALE, 1x5, 2.54mm, VERT, ST, THT	SAMTEC, TSW-105-07-L-S
19	4	JP1, JP2, JP3, JP4	CONN., HDR, MALE, 1x3, 2mm, VERT, ST, THT, 10u" Au	SAMTEC, TMM-103-02-L-S
20	1	L1	IND., 30Ω AT 100MHz, BEAD, 10%, 6A, 10mΩ, 0805, 1LN	TDK, MPZ2012S300AT000
21	1	LB1	LABEL SPEC, DEMO BOARD SERIAL NUMBER	BRADY, THT-96-717-10
22	3	M1, M2, M3	XSTR., MOSFET, N-CH, 20V, 1.4A, SOT-323, AEC-Q200	INFINEON, BSS816NWH6327XTSA1
23	3	M4, M5, M6	XSTR., MOSFET, DUAL, N-CH, 280mA, SOT-563	DIODES INC., 2N7002VAC-7
24	4	MH1, MH2, MH3, MH4	STANDOFF, NYLON, SNAP-ON, 0.50"	KEYSTONE, 8833
25	1	PCB1	PCB, DC2973A	ADI APPROVED SUPPLIER, 600-DC2973A
26	3	R1, R2, R6	RES., 10k, 5%, 1/16W, 0402, AEC-Q200	NIC, NRC04J103TRF ROHM, MCR01MZPJ103 VISHAY, CRCW040210K0JNED
27	0	R3	RES., OPTION, 0603	
28	2	R4, R5	RES., 0Ω, 1%, 0603, AEC-Q200	KOA SPEER, RK73Z1JTTDD VISHAY, CRCW06030000Z0EA
29	3	R7, R16, R17	RES., 4.7k, 5%, 1/16W, 0402, AEC-Q200	NIC, NRC04J472TRF VISHAY, CRCW04024K70JNED

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
30	3	R8, R13, R14	RES., 2.2k, 5%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW04022K20JNED NIC, NRC04J222TRF
31	3	R9, R10, R11	RES., 301Ω, 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3EKF3010V VISHAY, CRCW0603301RFKEA NIC, NRC06F3010TRF
32	1	R12	RES., 10k, 5%, 1/16W, 0402	SAMSUNG, RC1005J103CS YAGEO, RC0402JR-0710KL
33	1	R15	RES., 1M, 5%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW04021M00JNED NIC, NRC04J105TRF
34	1	R18	RES., 100k, 5%, 1/16W, 0402, AEC-Q200	ROHM, MCR01MZPJ104 VISHAY, CRCW0402100KJNED
35	1	R19	RES., 196k, 1%, 1/10W, 0603	VISHAY, CRCW0603196KFKEA YAGEO, RC0603FR-07196KL
36	1	R20	RES., 115k, 1%, 1/10W, 0603	NIC, NRC06F1153TRF VISHAY, CRCW0603115KFKEA YAGEO, RC0603FR-07115KL
37	1	R21	RES., 1Ω, 5%, 1/16W, 0402, AEC-Q200	KOA SPEER, RK73B1ETTP1R0J STACKPOLE ELECTRONICS, INC., RMCF0402JT1R00 VISHAY, CRCW04021R00JNED
38	0	TP1, TP2	TESTPOINT, PCB COPPER FEATURE	
39	1	U1	PRIMARY BATTERY SOH MONITOR W/PRECISION COULOMB COUNTER, GQFN-12	ANALOG DEVICES, LTC3337ERC#PBF
40	1	U2	IC, USB 2.0 µModule® TRANSCEIVER, BGA-44	ANALOG DEVICES, LTM2884CY#PBF
41	1	U3	IC, MEMORY, MCU, 32-BIT, 256KB FLASH, TQFP48	MICROCHIP, ATSAMD21G18A-AUT
42	1	U4	IC, REG LDO ADJ, 100mA, TSOT23-5	ANALOG DEVICES, LT1761ES5-BYP#PBF ANALOG DEVICES, LT1761ES5-BYP#TRMPBF ANALOG DEVICES, LT1761ES5-BYP#TRPBF
43	4	XJP1, XJP2, XJP3, XJP4	CONN., SHUNT, FEMALE, 2 POS, 2mm	WURTH ELEKTRONIK, 60800213421
44	1	Y1	CRYSTAL, 32.768kHz, 12.5pF, 3.2mm × 1.5mm SMD	ABRACON, ABS07-32.768kHz-4-T ECS INC., ECS-.327-12.5-34B-TR KYOCERA, ST3215SB32768H5HPWAA NDK, (See DFF)

SCHEMATIC DIAGRAM



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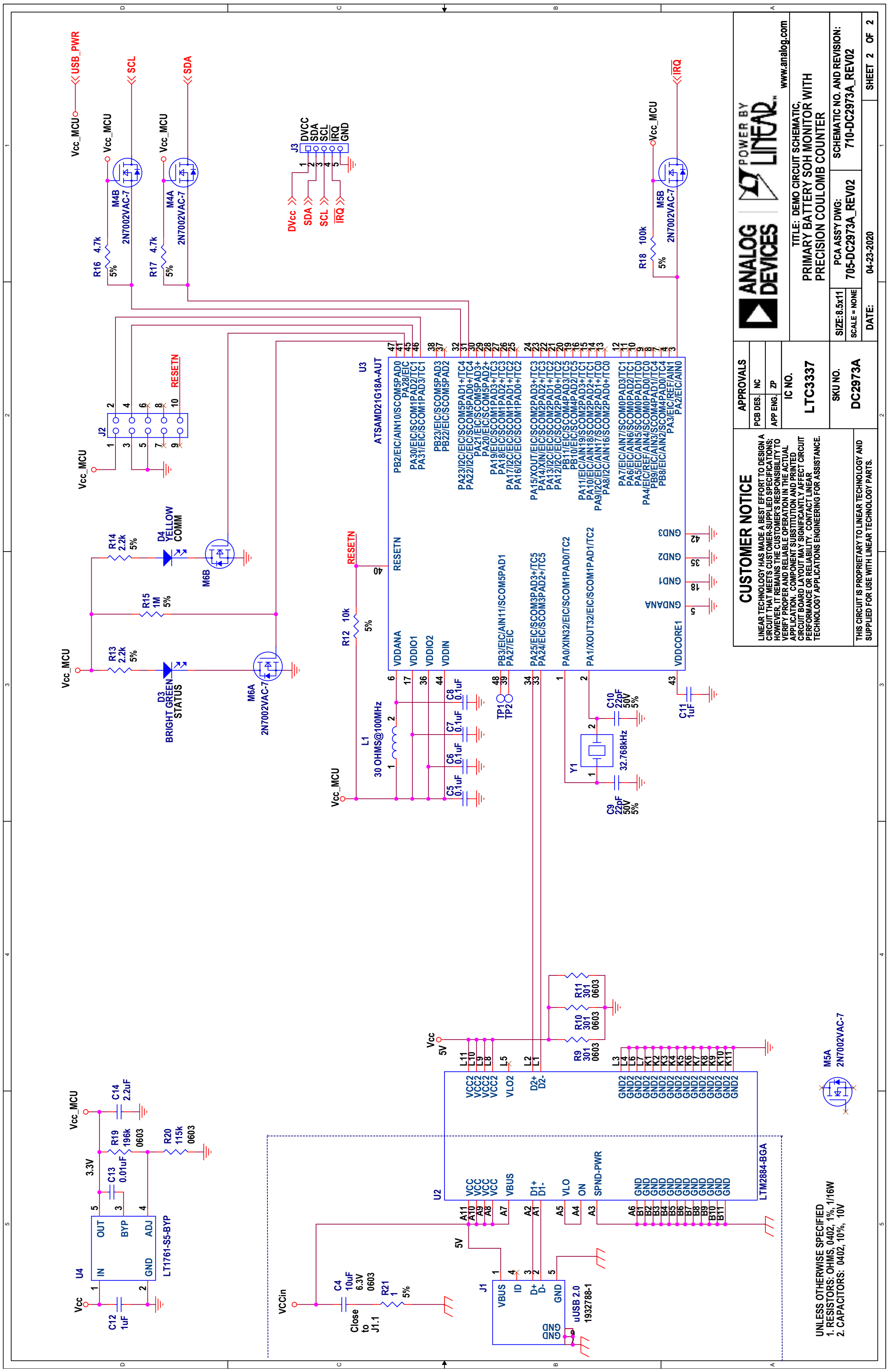

Rev. 0

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.