LTC3555

DESCRIPTION

Demonstration Circuit 1020 is a High Efficiency USB Power Manager + Three Step-Down DC/DC Converters featuring the LTC®3555. The LTC®3555 is a highly integrated power management and battery charger IC for Li-Ion/polymer battery applications. It includes a high efficiency current limited switching PowerPath manager with automatic load prioritization, a battery charger, an ideal diode and three general purpose synchronous step-down switching regulators. Designed specifically for USB applications, the LTC3555's switching power manager automatically limits input current to a maximum of either 100mA or 500mA for USB applications or 1A for AC-powered applications. Unlike linear PowerPath controllers, the LTC3555's switching input stage transmits nearly all of the 2.5W available from the USB port to the system load with minimal power wasted as heat. This feature allows the LTC3555 to provide more power to the application and eases the constraint of thermal budgeting in small spaces. Two of the three general purpose switching regulators can provide up to 400mA and the third can deliver 1A. The entire product can be started from an external push button and subsequently controlled via I^2C. The LTC3555 is available in the 28-pin (4mm × 5mm × 0.75mm) QFN surface mount package.

Design files for this circuit board are available. Call the LTC factory.

TABLE 1. TYPICAL SPECIFICATIONS (25°C)

Input Voltage Range VBUS	4.35V to 5.5V
VOUT	3.4V to 4.7V (Mode and load dependent)
LDO3V3	3.3V (Load and VOUT dependent)
Output Float Voltage VBAT (constant voltage mode)	4.2V
Output Charge Current IBAT (constant current mode)	0.5A, (RPROG = 2.00K)
VOUT1	3.3V, 400mA
VOUT2	3.0V-1.6V, 400mA
VOUT3	1.5V-0.8V, 1A

QUICK START PROCEDURE

Demo Circuit 1020 is best evaluated using a Li-Ion or Li-Polymer battery. When using a battery simulator for evaluation, oscillations must be verified with a real battery at the same conditions because it is difficult to match the impedance of a real battery. Capacitor C15 was added to simulate the low impedance of a real battery. It will allow proper operation of the demo circuit with or without a battery and even with a battery simulator consisting of a power supply in parallel with a 3.6 Ohm resistor.

Complete the Quick Start Procedure outlined in the Quick Start Guide for Demo Circuit 590 available from the Linear Technology Web Site, prior to proceeding.

Refer to Figure 2 for the proper measurement equipment setup and jumper settings and follow the procedure below.

NOTE: When measuring the input or output voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the input or output voltage ripple by touching the probe tip directly across the VBUS or VOUT(x) and GND terminals. See Figure 3 for proper scope probe technique.

1. After following the software installation procedure in the DC590 Quick Start Guide, connect the DC1020, the DC590 and the Host PC as shown in Figure 1. The following demonstration software should pop-up as soon as the DC1020 board is connected to the Host PC.

FIGURE 1: Graphical User Interface Demonstration Software for DC1020.

2. If using an external supply, connect a 0 to 6V, 1.5A supply with voltage adjusted to 0V between the VBUS and GND terminals. Connect a voltmeter across the VBUS and GND terminals. If using the USB input option, have cable ready to plug in for when all loads and jumpers are set. Connect the positive terminal of a voltmeter to CLPROG and the negative terminal to GND to measure the average input current. The voltage on CLPROG will reach 1.188 Volts when the average input current limit is reached. **Do not use the USB input and an external supply at the same time**.
3. Set JP1, NTC jumper to INT to use the demo board resistor network. To use an external NTC resistor, connect the external NTC resistor between the J2-3 terminal and the GND terminal. Then set the NTC jumper to EXT.
4. Set JP2 and JP3 (ILIM0 and ILIM1 respectively) to "LO". At Power-up, the average input current setting will be equal to the value set by the position of JP2 and JP3 until an I^2C command is received and over-writes that default value.

TABLE 2. Input Current Limit Settings

ILIM1	ILIM0	CURRENT LIMIT
0	0	100mA (1X)
0	1	1A (10X)
1	0	0.5mA (SUSP)
1	1	500mA (5X)

5. Connect a 0 to 25mA adjustable load in series with an ammeter between the LDO3V3 and GND terminals. Connect a voltmeter between the LDO3V3 and GND terminals.
6. Connect a 0 to 2A adjustable load in series with an ammeter between the VOUT terminal and the GND terminal. Connect a voltmeter between the VOUT and GND terminals.
7. Connect a 0 to 400mA adjustable load in series with an ammeter between the VOUT1 and GND terminals. Connect a voltmeter between the VOUT1 and GND terminals.
8. Connect a 0 to 400mA adjustable load in series with an ammeter between the VOUT2 and GND terminals. Connect a voltmeter between the VOUT2 and GND terminals.
9. Connect a 0 to 1.0A adjustable load in series with an ammeter between the VOUT3 and GND terminals. Connect a voltmeter between the VOUT3 and GND terminals.
10. Connect a Li-Ion or Li-Polymer battery with the positive lead to the BAT terminal and the negative lead to a GND terminal. Connect the positive lead of a voltmeter to the BAT terminal and the negative lead to the GND terminal. Connect the positive terminal of a voltmeter to PROG and the negative terminal to GND to measure the current flowing into the battery.

The voltage on PROG will read 1 Volt when the maximum charge current is reached. Observe VOUT and the LDO3V3 output.

11. If using the USB input, plug in the USB cable and observe the charge current, and the various output voltages. If using an external power supply, slowly increase the supply and observe that the LTC3555 starts to use the VBUS input power as VBUS reaches 4.35V.
12. Discharge the battery voltage to 2.5 volts. If Charger mode is on, observe it is charging in trickle charge mode and the charge current is 50mA. As the battery voltage increase above 2.85V observe that the charger goes into full constant current mode. Observe that VOUT stays above 3.6V when the input current limit is not exceeded and BAT drops below 3.3 Volts. Remove the NTC jumper on JP1. Observe the CHRG LED slow blinking rate (1.5Hz at 50% Duty Cycle). Also observe the 35KHz pulse-width varying duty cycle between 6.25% and 93.75% on the $\overline{\text{CHRG}}$ terminal with an oscilloscope. Reinstall the NTC jumper.
13. Increase the VOUT load and observe when the input current starts to limit. When input current limit is reached, additional load smoothly transitions to the battery through the ideal diode. Due to the high efficiency of the switching regulator, the sum of the charge and load current may be significantly above the input current, depending on the voltage on the BAT pin.
14. Repeat step 13 with different current limit modes.
15. Set the VBUS input supply to 5V. Observe the battery current as the battery voltage increases above 4.1V. The Charge current starts to decrease as the battery voltage increases towards 4.2V.

See the LTC3555 data sheet for more information on how this part performs.

APPLICATION INFORMATION

This demo circuit is designed to demonstrate the full capability of the device. Not all components are required in all applications. The critical circuit components are on the top of the board near the IC.

The input capacitor network of C18 and R26 is used to dampen input source inductances that commonly occur in laboratory setups with twisted leads and a bench power supply. When using a USB cable or adaptor cable this input damping network will likely not be required. Please note that the in-circuit capacitance of the specified 10uF, 0805 ceramic capacitor for C18 and C1 is approximately 5uF each at applied voltage.

VOUT Capacitor C5 is only required when using the 10X mode. The LTC3555 requires a minimum of 10uF on the VOUT pin in 10X mode for stability. As an alternative to using two smaller X5R capacitors, one larger X5R ceramic capacitor would be acceptable, provided that the actual in-circuit capacitance with 4.5 Volts applied is greater than 10uF.

Capacitor C15 is included to simulate a low impedance battery. It is especially helpful when testing the demo circuit with a battery simulator comprised of a power supply with a 3.6 Ohm power resistor across it. The leads connecting the power supply to the demo circuit should be a twisted pair to minimize lead inductance; although, even twisted pairs can introduce enough inductance into the circuit to cause instability in the battery charger section without the presence of C15. Capacitor C15 will also provide proper operation of the circuit without a battery present. It is possible to replace C15 with a ceramic capacitor in series with a resistor to stabilize the battery charger when no battery is present. Please refer to the datasheet for the suggested capacitor and resistance range.

When not using the 3.3 Volt LDO (LDO3V3) connect VOUT to LDO3V3 by installing R9, which eliminates the need for capacitor C3.

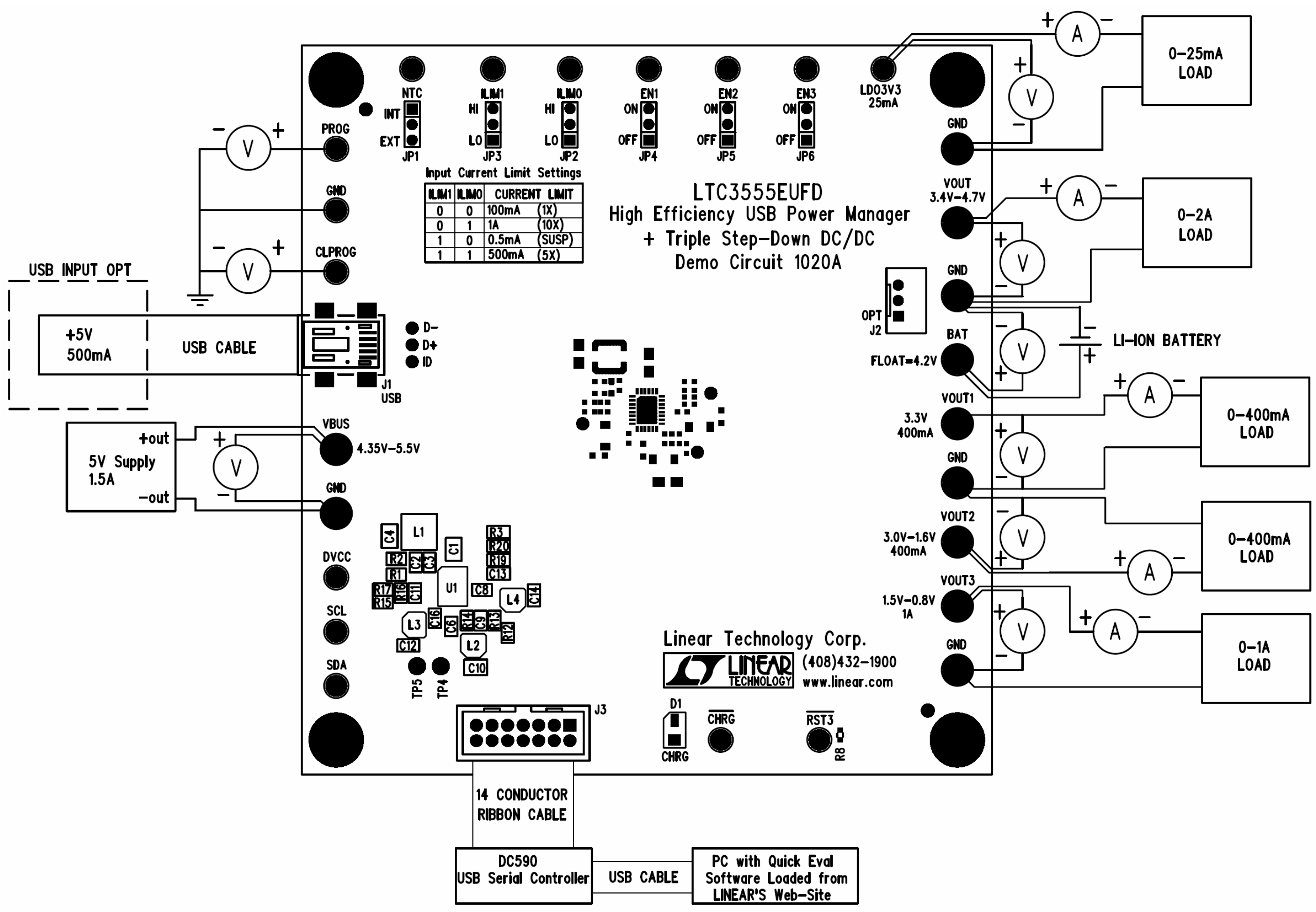

FIGURE 2: Proper Measurement Equipment Setup for DC1020

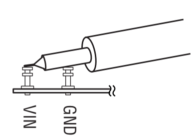

FIGURE 3: Measuring Input or Output Ripple Voltage

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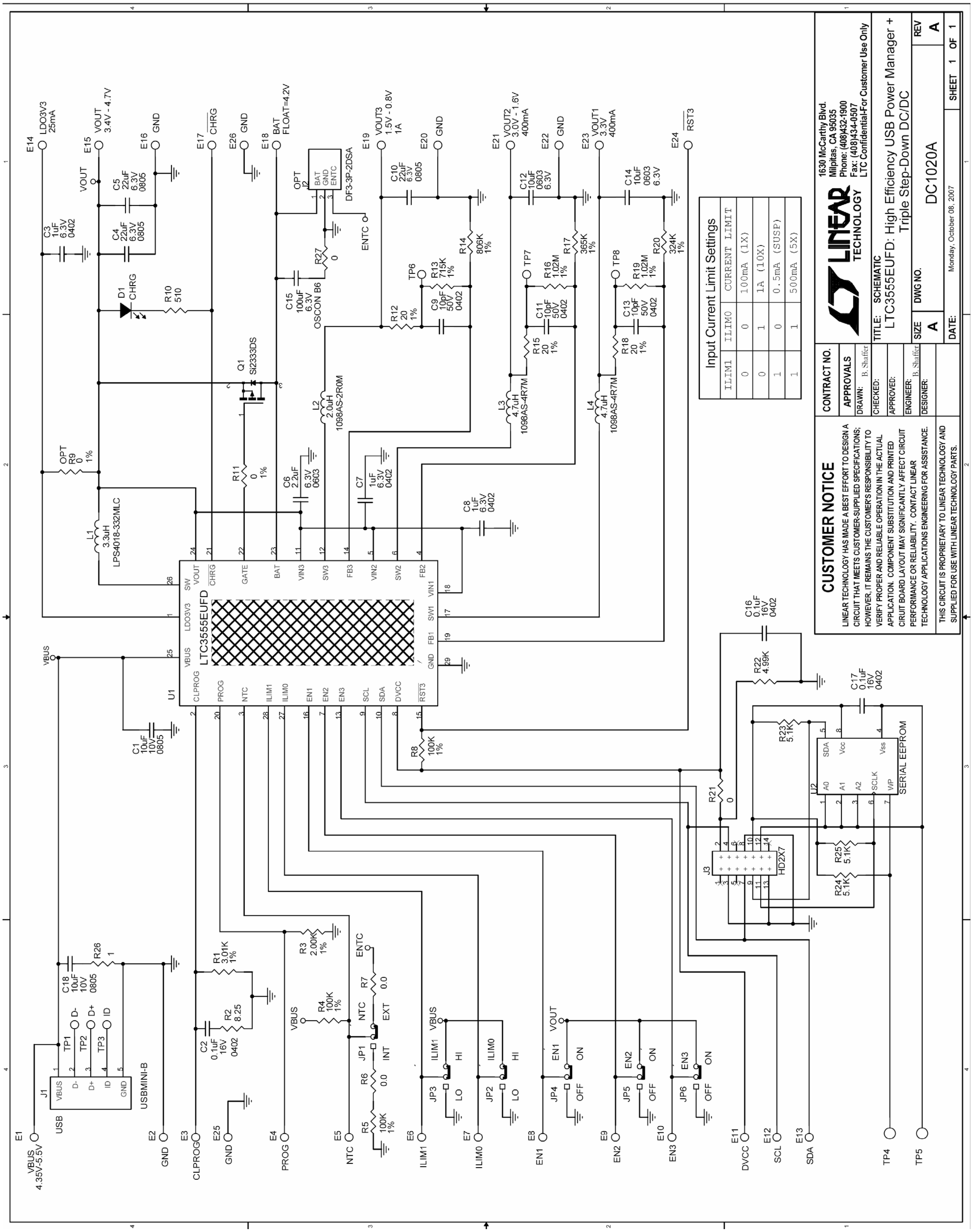

FIGURE 4: Circuit Schematic

Linear Technology Corp. | Parts List | *Bill Of Material*

LTC3555EUFD

Eval Bd. #: DC1020A, Sch. Rev A

7/24/2007

Item	Qty	Reference - Des	Part Description	Manufacturer, Part #
REQUIRED CIRCUIT COMPONENTS:				
1	1	C1	CAP, CHIP, X5R, 10uF, 10V, 0805	MUR, GRM21BR61A106KE19
2	1	C2	CAP, CHIP, X7R, 0.1uF, 16V, 0402	MUR, GRM155R71C104KA88
3	3	C3, C7, C8	CAP, CHIP, X5R, 1.0uF, 6.3V, 0402	TDK, C1005X5R0J105M
4	2	C4, C10	CAP, CHIP, X5R, 22uF, 6.3V, 0805	MUR, GRM21BR60J226ME39
5	1	C6	CAP, CHIP, X5R, 2.2UF, 6.3V, 0603	TDK, C1608X5R0J225M
6	3	C9, C11, C13	CAP, CHIP, COG, 10pF, 50V, 0402	MUR, GRM1557U1H100JZ01D
7	2	C12, C14	CAP, CHIP, X5R, 10uF, 6.3V, 0603	TDK, C1608X5R0J106M
8	1	R1	RES, 0402 3.01K OHMS 1% 1/16W	VISHAY, CRCW04023K01FKED
9	1	R2	RES, 0402 8.25 OHMS 1% 1/16W	VISHAY CRCW04028R25FNED
10	1	R3	RES, 0402 2.00K OHM 1% 1/16W	VISHAY, CRCW04022K00FKED
11	1	R13	RES, 0402 715K OHM 1% 1/16W	VISHAY, CRCW0402715KFKED
12	1	R14	RES, 0402 806K OHM 1% 1/16W	VISHAY, CRCW0402806KFKED
13	2	R16, R19	RES, 0402 1.02M OHMS 1% 1/16W	VISHAY, CRCW04021M02FKED
14	1	R17	RES, 0402 365K OHM 1% 1/16W	VISHAY, CRCW0402365KFKED
15	1	R20	RES, 0402 324K OHM 1% 1/16W	VISHAY, CRCW0402324KFKED
16	1	L1	INDUCTOR, 3.3uH, 0.08Ohms, 2.2A	COILCRAFT, LPS4018-332MLC
17	1	L2	INDUCTOR, 2.0uH, 0.067Ohms, 1.9A	TOKO, 1098AS-2R0M
18	2	L3,L4	INDUCTOR, 4.7uH, 0.130Ohms, 1.3A	TOKO, 1098AS-4R7M
19	1	U1	USB PWR MGR + TRIPLE STEP-DOWN DC/DC	LINEAR TECH, LTC3555EUFD
ADDITIONAL DEMO BOARD CIRCUIT COMPONENTS:				
1	1	C5	CAP, CHIP, X5R, 22uF, 6.3V, 0805	MUR, GRM21BR60J226ME39
2	1	C15	CAP, CHIP OS-CON, 100uF, 6.3V,B6	SANYO, 6SVPC100MY
3	2	C16, C17	CAP, CHIP, X7R, 0.1uF, 16V, 0402	MUR, GRM155R71C104KA88
4	1	C18	CAP, CHIP, X5R, 10uF, 10V, 0805	MUR, GRM21BR61A106KE19
5	3	R4,R5,R8	RES, 0402, 100K OHMS, 1%, 1/16W	VISHAY, CRCW0402100KFKED
6	5	R6,R7,R11,R21,R27	RES, 0402 0 OHMS 1/16W	VISHAY CRCW04020000Z0ED
7	0	R9 - OPT	RES, 0402 0 OHMS 1/16W	VISHAY CRCW04020000Z0ED
8	1	R10	RES, 0402 510 OHMS 1% 1/16W	VISHAY CRCW0402510RFNED
9	3	R12,R15,R18	RES, 0402 20.0 OHM 1% 1/16W	VISHAY CRCW040220R0FNED
10	1	R22	RES, 0402 4.99K OHMS 1% 1/16W	VISHAY, CRCW04024K99FKED
11	3	R23,R24,R25	RES, 0402 5.10K OHMS 1% 1/16W	VISHAY, CRCW04025K10FKED
12	1	R26	RES, 0402 1 OHMS 5% 1/16W	VISHAY, CRCW04021R00JNED
13	1	D1	LED, GREEN	PANASONIC, LN1351C-(TR)
14	1	Q1	XSTR, MOSFET P- CHANNEL	SILICONIX, Si2333DS
15	1	U2	SERIAL EEPROM	MICROCHIP, 24LC025-I/ST
HARDWARE FOR DEMO BOARD ONLY:				
1	1	J1	CONN, USB MINI-B	TYCO, 1734035-2
2	0	J2 (OPT)	CONN, DF3-3P-2DSA	HIROSE, DF3-3P-2DSA
3	1	J3	HEADER, 2X7PIN, 0.079CC	MOLEX, 87831-1420
4	11	E1,E2,E15,E16,E18,E19,E20,E21, E22,E23, E26	TURRET, 0.09 DIA	MILLMAX, 2501-2
5	15	E3,E4,E5,E6,E7,E8,E9,E10,E11,E 12,E13,E14,E17,E24,E25	TURRET, 0.061 DIA	MILLMAX, 2308-2
6	6	JP1,JP2,JP3,JP4,JP5,JP6	HEADER,3 PINS 2mm	SAMTEC, TMM-103-02-L-S
7	6	JP1,JP2,JP3,JP4,JP5,JP6	SHUNT, 2mm	SAMTEC, 2SN-BK-G
8	4		STAND-OFF, NYLON 0.25" tall (SNAP ON)	KEYSTONE, 8831 (SNAP ON)

FIGURE 5: Bill of Materials