LTM4641
38V, 10A, Step-Down µModule Regulator with Advanced Input and Load Protection

DESCRIPTION

Demonstration circuit 1543B features the LTM®4641, a high efficiency, high density switch mode step-down power µModule regulator with superior input and load protection features. The input voltage range is from 4.5V to 38V. The output voltage is jumper programmable from 0.8V to 6V with a rated load current of 10A. Derating is necessary for certain V_{IN}, V_{OUT}, frequency and thermal conditions. DC1543B offers the TRACK/SS pin allowing the user to program output tracking or soft-start period. The DC1543B allows the user to enable/disable input undervoltage protection; input latching/non-latching overvoltage protection; and latching/non-latching overtemperature protection.

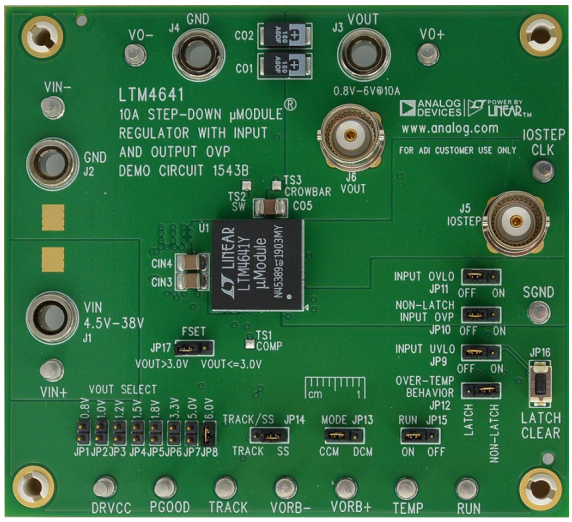
Higher efficiency at low load currents is achieved by setting the MODE pin jumper to DCM. The LTM4641 data sheet must be read in conjunction with this demo manual prior to working on or modifying demo circuit 1543B.

Design files for this circuit board are available.

PERFORMANCE SUMMARY

PARAMETER	CONDITIONS	VALUE
Input Voltage Range		4.5V to 38V
Output Voltage V_{OUT}	Jumper Selectable	0.8V, 1.0V, 1.2V, 1.5V, 1.8V, 3.3V, 5V, 6V; ±1.5%
Maximum Continuous Output Current	Derating is Necessary for Certain Operating Conditions. See Data Sheet for Details.	$10A_{DC}$
Default Operating Frequency	R_{fSET} = 680kΩ for V_{OUT} = 0.8V, 1.0V, 1.2V, 1.5V, 1.8V; R_{fSET} = ∞ (Not Stuffed) for V_{OUT} = 3.3V, 5.0V, 6.0V	255kHz (V_{OUT} = 0.8V); 320kHz (V_{OUT} = 1.0V); 385kHz (V_{OUT} = 1.2V); 480kHz (V_{OUT} = 1.5V); 575kHz (V_{OUT} = 1.8V); 360kHz (V_{OUT} = 3.3V); 550kHz (V_{OUT} = 5.0V); 660kHz (V_{OUT} = 6.0V);
Efficiency	V_{IN} = 12V, V_{OUT} = 6V, I_{OUT} = 10A	93.0% See Figure 2
Load Transient	V_{IN} = 12V, V_{OUT} = 3.3V	See Figure 3

BOARD PHOTO



QUICK START PROCEDURE

Demonstration circuit 1543B is an easy way to evaluate the performance of the LTM4641. Please refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

1. Place jumpers in the following positions for a typical 3.3V_{OUT} application:

INPUT OVLO	NON-LATCH INPUT OVP	INPUT UVLO	OVER-TEMP BEHAVIOR
OFF	OFF	OFF	NON-LATCH

RUN	MODE	TRACK/SS	V_{OUT} Select	F_{SET}
ON	CCM	SS	3.3V	V_{OUT} > 3.0V

2. With power off, connect the input power supply, load and meters as shown in Figure 1. Preset the load to 0A and V_{IN} supply to be 0V.
3. Turn on the power at the input. Increase V_{IN} to 12V **(Do not apply more than the rated maximum voltage of 38V to the board or the part may be damaged).** The output voltage should be regulated and deliver the selected output voltage ±1.5%.
4. Vary the input voltage from 4.5V to 38V and adjust the load current from 0A to 10A. Observe the output voltage regulation, ripple voltage, efficiency, and other parameters. Output voltage ripple may be measured at J6 with a BNC cable and oscilloscope. The probe channel for V_{OUT} should be set at 50Ω termination resistance to match the BNC cable.
5. (Optional) For optional load transient test, apply an adjustable pulse signal between IOSTEP_CLK and GND test points. The pulse amplitude sets the load step current amplitude. Keep the pulse width short (<1ms) and pulse duty cycle low (<5%) to limit the thermal stress on the load transient circuit. The load step current can be monitored with a BNC connected to J5 (25mV/A).
6. (Optional) To test the advanced input and load protections, put the corresponding jumper in the "ON" position. For DC1543B, the thresholds for different input and output protections are set as shown below:

INPUT OVLO		36V
NON-LATCH INPUT OVP		32V
INPUT UVLO		8V for Rising Edge 7V for Falling Edge
OVER-TEMP BEHAVIOR	**LATCH**	145°C
	NON-LATCH	145°C: Cease Regulation 135°C: Resume Regulation

QUICK START PROCEDURE

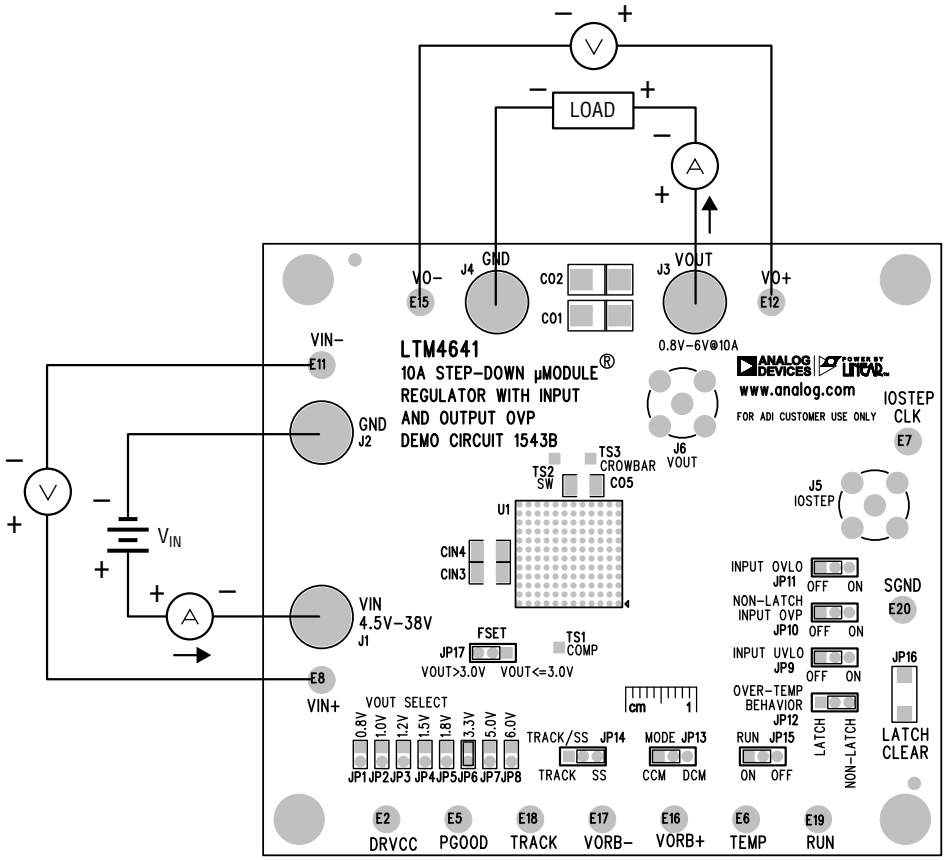
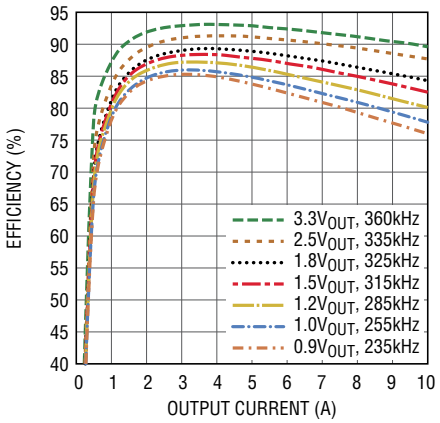


Figure 1. Proper Measurement Equipment Setup

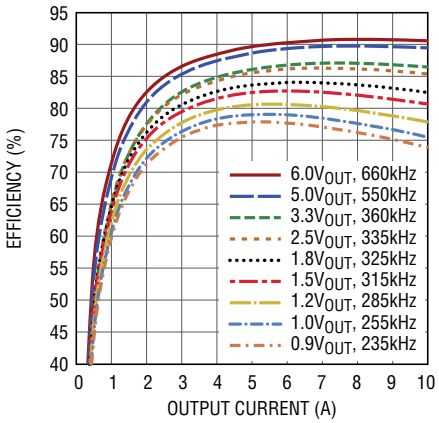
QUICK START PROCEDURE

Efficiency vs Load Current at $6V_{IN}$



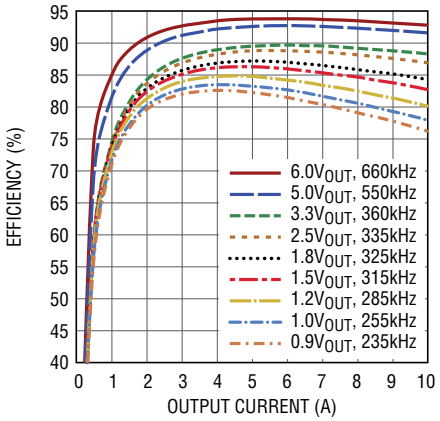
2a. V_{IN} = 6V

Efficiency vs Load Current at $24V_{IN}$



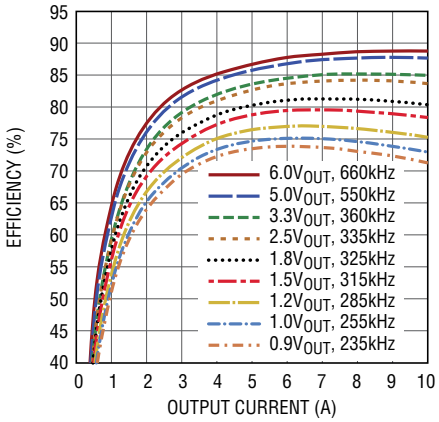
2c. V_{IN} = 24V

Efficiency vs Load Current at $12V_{IN}$



2b. V_{IN} = 12V

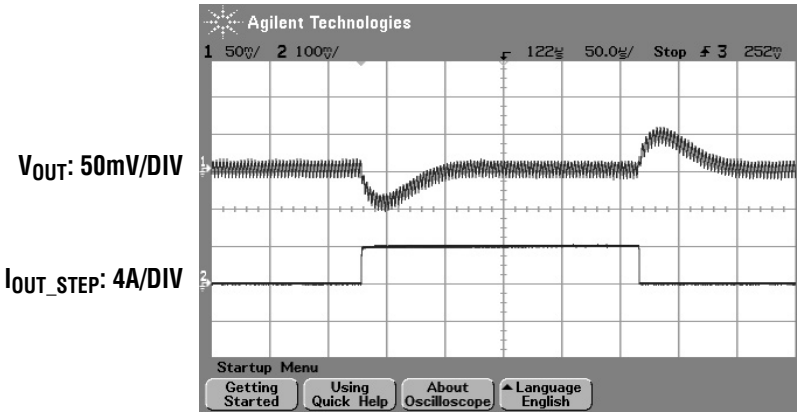
Efficiency vs Load Current at $36V_{IN}$



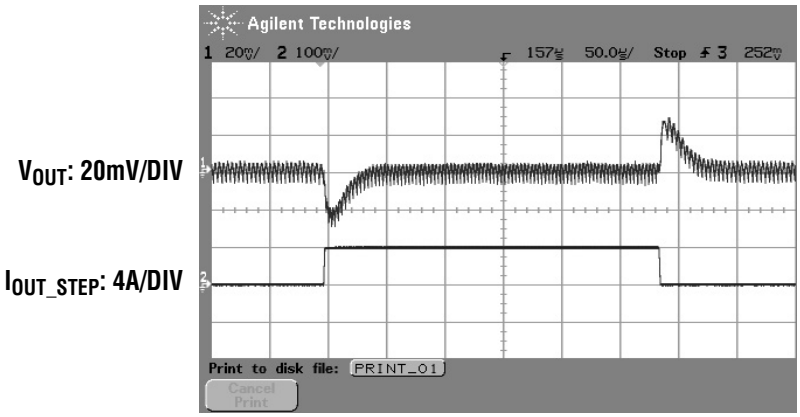
2d. V_{IN} = 36V

Figure 2. Measured DC1543B Efficiency at Different V_{IN}, V_{OUT} and f_{SW} (CCM Mode Enabled) Please refer to Table 1 in LTM4641 data sheet for the switching frequency at each output voltage.

QUICK START PROCEDURE

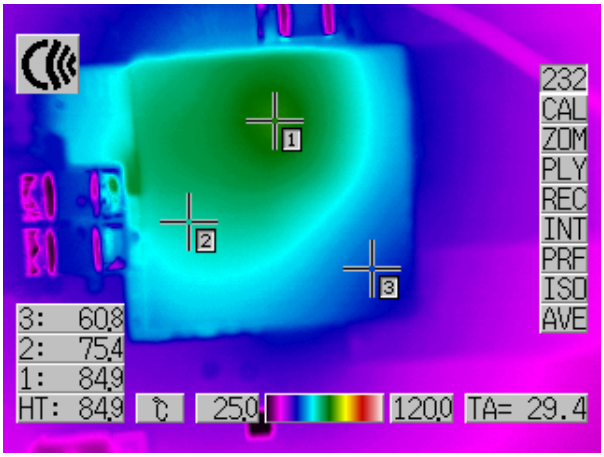


3a. V_{IN} = 12V, V_O = 3.3V, 0A to 4A Load Step



3b. V_{IN} = 12V, V_O = 1.0V, 0A to 4A Load Step

Figure 3. Measured Load Transient Responses



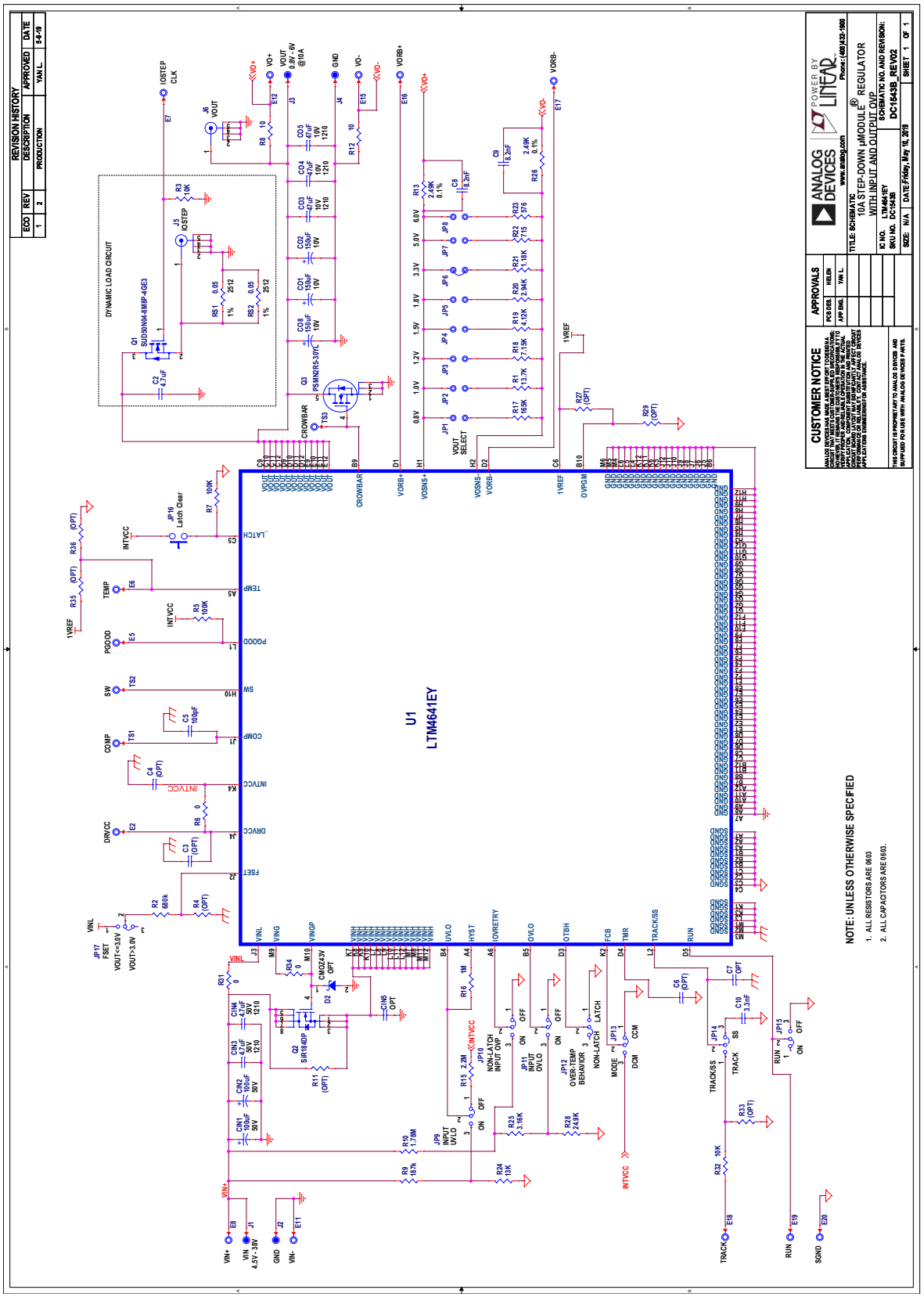
V_{IN} = 24V, V_{OUT} =6V, I_{LOAD} = 10A, Ambient Temperature = 29.4°C, No Forced Air Flow

Figure 4. Thermal Image of LTM4641

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	2	CIN2, CIN1	CAP., ALUMINUM, 100µF, 50V	SUN ELECT, 50CE100LX
2	2	CIN3, CIN4	CAP., X7R, 4.7µF, 50V, 10%, 1210	AVX, 12105C475KAT2A
3	3	CO1, CO2, CO8	CAP., POSCAP, 150µF, 10V, D3L	PANASONIC, 10TPF150ML
4	3	CO3, CO4, CO5	CAP., X7R, 47µF, 10V, 10%, 1210	AVX, 1210ZC476KAT2A
5	1	C10	CAP., X5R, 3300pF, 50V, 10%, 0603	AVX, 06035C332KAT2A
6	1	R1	RES., CHIP, 13.7k, 1/16W, 1%, 0603	VISHAY, CRCW060313K7FKEA
7	2	R5, R7	RES., CHIP, 100k, 1/16W, 1%, 0603	VISHAY, CRCW0603100KFKEA
8	2	R13, R26	RES., CHIP, 2.49k, 1/16W, ±0.1%, 0603	VISHAY, TNPW06032K49BEEA
9	1	U1	I.C., LTM4641, BGA	ANALOG DEVICES, LTM4641EY#PBF
Hardware/Components (For Demo Board Only)				
1	1	C2	CAP., X7R, 4.7µF, 25V, 10%, 0805	TDK, C2012X7RIE475K125AB
2	2	C8, C9	CAP., X5R, 8200pF, 50V, 10%, 0603	AVX, 06035C822KAT2A
3	1	R2	RES., CHIP, 680k, 1/16W, 1%, 0603	YAGEO, RC0603FR-07680KL
4	1	R15	RES., CHIP, 2.2M, 1/16W, 1%, 0603	VISHAY, CRCW06032M20FKEA
5	1	R17	RES., CHIP, 165k, 1/16W, 1%, 0603	VISHAY, CRCW0603165KFKEA
6	1	R18	RES., CHIP, 7.15k, 1/16W, 1%, 0603	VISHAY, CRCW06037K15FKEA
7	1	R19	RES., CHIP, 4.12k, 1/16W, 1%, 0603	VISHAY, CRCW06034K22FKEA
8	1	R20	RES., CHIP, 2.94k, 1/16W, 1%, 0603	VISHAY, CRCW06032K94FKEA
9	1	R21	RES., CHIP, 1.18k, 1/16W, 1%, 0603	VISHAY, CRCW06031K18FKEA
10	1	R22	RES., CHIP, 715Ω, 1/16W, 1%, 0603	VISHAY, CRCW0603715RFKEA
11	1	R23	RES., CHIP, 576Ω, 1/16W, 1%, 0603	VISHAY, CRCW0603576RFKEA
12	1	R25	RES., CHIP, 3.16k, 1/16W, 1%, 0603	VISHAY, CRCW06033K16FKEA
13	1	R28	RES., CHIP, 24.9k, 1/16W, 1%, 0603	VISHAY, CRCW060324K9FKEA
14	1	R10	RES., CHIP, 1.78M, 1/16W, 1%, 0603	VISHAY, CRCW06031M78FKEA
15	1	R24	RES., CHIP, 13k, 1/16W, 1%, 0603	VISHAY, CRCW06065K5KFKEA
16	1	R16	RES., CHIP, 1M, 1/16W, 1%, 0603	VISHAY, CRCW06031M00FKEA
17	1	R9	RES., CHIP, 187k, 1/16W, 1%, 0603	VISHAY, CRCW0603187KFKEA
18	2	R12, R8	RES., CHIP, 10Ω, 1/16W, 1%, 0603	VISHAY, CRCW060310R0FKEA
19	3	R6, R31, R34	RES., CHIP, 0Ω, 1/16W, 1%, 0603	VISHAY, CRCW06030000Z0EA
20	2	R3, R32	RES., CHIP, 10k, 1/16W, 1%, 0603	VISHAY, CRCW060310K0FKEA
21	2	RS2, RS1	RES., CHIP, 0.05Ω, 1W, 1% 2512	VISHAY, WSL2512R0500FEA
22	1	Q2	SILICON N-CHANNEL MOSFET, POWERPAK-SO8	VISHAY, SiR184DP-T1-RE3
23	1	Q3	SILICON N-CHANNEL POWER MOSFET, LFPAK	NEXPERIA PSMN2R5-30YL
24	1	Q1	N-CHANNEL 40-V MOSFET, TO-252	VISHAY, SUD50N04-8M8P-4GE3
25	0	C3, C4, C5, C6, C7(OPT)	CAP., 0603	
26	0	CIN5(OPT)	CAP., 1210	
27	0	R4, R27, R29, R33, R35, R36(OPT)	RES., 0603	
28	0	R11(OPT)	RES., 1206	
29	0	D2 (OPT)	ZENER VOLTAGE REGULATOR, SOD-523	CENTRAL SEMI., CMOZ43V TR
Hardware				
1	9	JP1-JP8, JP18	2mm SINGLE ROW HEADER, 2-PIN	SAMTEC, TMM102-02-L-S
2	8	JP9-JP15, JP18	2mm SINGLE ROW HEADER, 3-PIN	SAMTEC, TMM-103-02-L-S
3	3	JP4, JP9-JP15, JP17	SHUNT	SAMTEC, 2SN-BK-G
4	2	J5, J6	CONN, BNC, 5 PINS	CONNEX, 112404
5	4	J1-J4	JACK, BANANA	KEYSTONE, 575-4
6	13	E2, E5-E8, E11, E12, E15-E20	TESTPOINT, TURRET, 0.095"	MILL-MAX, 2501-2-00-80-00-00-07-0
7	1	JP16	ULTRA-SMALL TRACTILE SWITCH	PANASONIC, EVQPE105K
8	4	STAND OFF	STAND-OFF, NYLON 0.50" tall	KEYSTONE, 8833 (SNAP ON)

SCHEMATIC DIAGRAM



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.

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