LT8490
High Efficiency MPPT Battery Charger Controller

DESCRIPTION

Demonstration circuit 2069A features LT®8490, a high performance buck-boost converter that implements an MPPT function and flexible charging profiles suitable for most battery types such as flooded and sealed lead acid batteries and Lithium-Ion batteries, and can operate from input voltages above, below or equal to the battery voltage.

The demo board is configured for a 17V to 54V input voltage range and the power source can be a solar panel with 36 to 72 cells (up to 200W) or a DC voltage source. Two input connectors are provided. An LTC4359 ideal diode controller protects the DC power supply output from being back fed from the solar panel. This allows, for example, that a 24VDC supply is plugged in while a solar panel with higher voltage is being used to power the circuit.

On-chip logic provides automatic true power point tracking for solar powered applications. The MPPT function not only continuously tracks the maximum power point, it is able to select the correct maximum on the power curve to increase power harvested from the panel during partial shade conditions, when multiple peaks occur on the power curve. During periods of low light, a low power mode allows the charger to deliver a small charge current even if there is not enough light for the MPPT function to operate.

The demo board output is set up for charging a 12V SLA battery with up to 16.6A charge current. Two charge configuration headers are provided so the user can select different charge algorithms.

There are two onboard LEDs that display information on the charge stage, and they will blink fault messages if the charger shuts down because of a fault. A simple serial interface also sends out status bytes that can be interpreted by external circuitry.

An RJ25 modular jack can be used to connect an external NTC temperature sensor mounted at the battery. This allows temperature compensation of the charge voltage, which is important for lead acid batteries. The same connector can be used for remote sensing of battery voltage, to compensate for voltage drops in long battery cables.

The LT8490 data sheet gives a complete description of the device, operation and application information. The data sheet must be read in conjunction with this demo manual for DC2069A. The LT8490EUKJ is assembled in a 64-lead (7mm × 11mm) plastic QFN package with a thermal pad underneath the chip. Proper board layout is essential for maximum thermal performance.

Design files for this circuit board are available at http://www.linear.com/demo/DC2069A

LT, LTC, LTM, Linear Technology and the Linear logo are registered trademarks of Linear Technology Corporation. All other trademarks are the property of their respective owners.

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Supply Range	Note: Output Power Is Limited by Input Current Limit When V_{IN} < 24V (See Figure 2)	17	30	54	V
V_{OUT}	Charge Voltage			14.2		V
I_{IN}	Maximum Input Current			10		A
I_{OUT}	Maximum Output Current	V_{IN} > 24V, V_{OUT} = 12V		16.6		A
F_{SW}	Switching Frequency			200		kHz
EFF	Efficiency at DC input	V_{IN} = 28V, V_{OUT} = 14V, I_{OUT} = 15A V_{IN} = 48V, V_{OUT} = 14V, I_{OUT} = 15A V_{IN} = 24V, V_{OUT} = 14.2V, I_{OUT} = 8A		96.3 95.6 97.3		% % %

PERFORMANCE SUMMARY

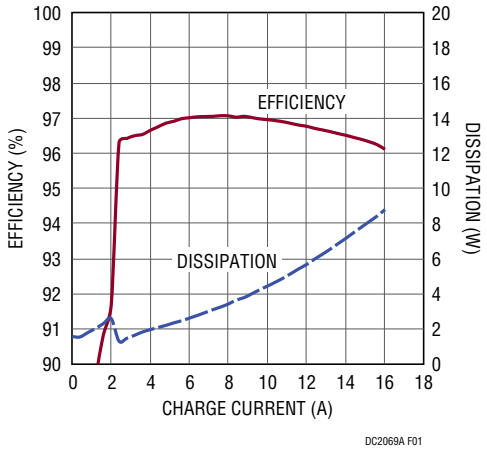


Figure 1. Efficiency as a Function of Charge Current. V_{IN} = 28V, V_{OUT} = 14.2V

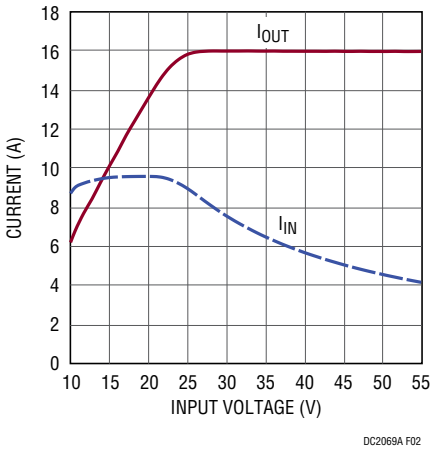
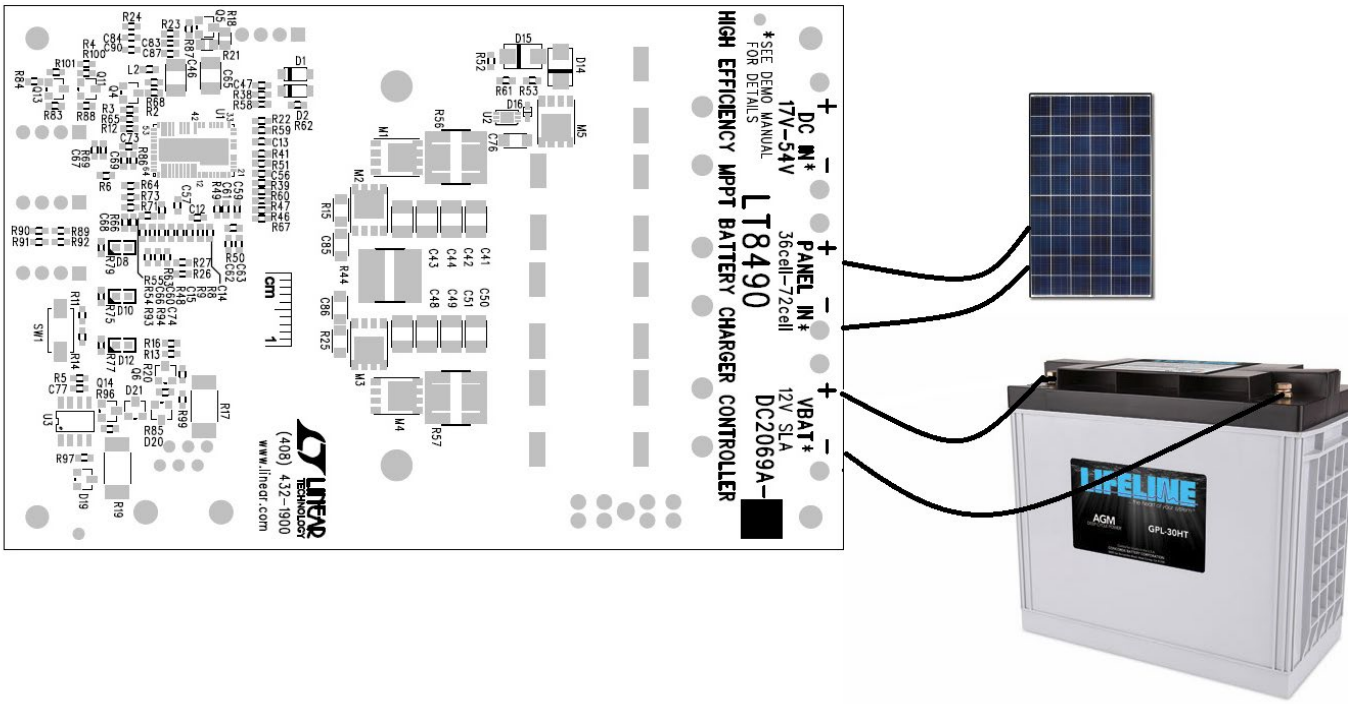


Figure 2. Input and Output Currents as a Function of Input Voltage. V_{OUT} = 13.6V

QUICK START PROCEDURE

1. Connect a 12V lead acid battery to the V_{BAT} connector, making sure that the polarity is correct. A suitable battery size is a 150Ah 12V deep cycle sealed lead acid battery, but also smaller 12V lead acid batteries can be used for testing the charging functions. Use a short battery cable that is rated for 15A or higher.
2. Connect the solar panel to the PANEL IN connector, making sure that the polarity is correct. A suitable panel is a 250W 60 cell solar panel, but any panel with 36 to 72 cells (54V maximum open circuit voltage) can be used.
3. Point the solar panel towards sunlight and monitor the MPPT charger function under different conditions, using ampere meters and voltmeters and other test equipment as needed.
4. The charger will also work with a DC power supply connected to the DC IN connector. Disconnect the solar panel before turning on the DC supply. (The charger can operate from both power sources simultaneously. However, the MPPT function will be disabled while there is DC voltage on the DC IN input, so the solar panel may not be operating at its maximum power point if the charger is also powered from the DC IN connector.) A suitable supply is a 24Vdc supply that can deliver at least 12A, but any DC power supply that has an output voltage in the range 10V to 54V and is able to deliver 250W power or 12A current can be used for evaluation.
5. Note that the charger will not start unless the output voltage is above 4.5V. This means that if the battery is replaced by an active programmable load during evaluation, a small power supply needs to be connected across the load to start the charger. A small 9V battery with a diode in series works fine.
6. Read the LT8490 data sheet for more detail on the function of the circuit and how to change the charge algorithm.



PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	C12	CAP., X7R, 1nF, 16V, 20%, 0603	AVX, 0603YC102MAT4A
2	2	C13, C47	CAP., X5R, 0.22uF, 16V, 10%, 0603	AVX, 0603YD224KAT2A
3	2	C14, C15	CAP., X7R, 3.3nF, 16V, 20%, 0603	AVX, 0603YC332MAT4A
4	5	C41, C42, C43, C44, C46	CAP., X7R, 2.2µF, 100V 10%, 1210	AVX, 12101C225KAT2A
5	3	C45, C79, C58	EP-cap, 33µF, 63V, 20%	SUNCON, 63HVH33M
6	4	C48, C49, C50, C51	CAP., X7R, 10µF, 35V 10%, 1210	MURATA, GRM32ER7YA106KA12L
7	1	C55	EP-CAP, 150µF, 25V, 20%	SANYO, 25HVH150M
8	2	C56, C57	CAP., X5R, 2.2µF, 10V, 10%, 0603	AVX, 0603ZD225KAT2A
9	1	C59	CAP., X7R, 0.1µF, 16V, 10%, 0603	AVX, 0603YC104KAT2A
10	2	C60, C61	CAP., X7R,4.7nF, 16V, 10%, 0603	AVX, 0603YC472KAT2A
11	1	C62	CAP., NP0, 220p, 16V, 5%, 0603	AVX, 0603YA221JAT2A
12	1	C63	CAP, X7R, 6.8nF, 50V, 10%, 0603	AVX, 06035C682KAT2A
13	1	C65	CAP., X7R, 1µF, 100V, 10%, 1210	AVX, 12101C105KAT2A
14	2	C66, C73	CAP., X7R, 1.0µF, 16V, 10%, 0603	AVX, 0603YC105KAT2A
15	2	C67, C68	CAP., X7R, 0.068µF, 16V, 10%, 0603	AVX, 0603YC683KAT2A
16	1	C69	CAP., X5R, 4.7µF, 6.3V, 10%, 0603	AVX, 06036D475KAT2A
17	2	C83, C84	CAP., X7R, 0.47uF, 16V, 10%, 0603	MURATA, GRM188R71C474KA88D
18	1	C85	CAP., C0G, 1000pF, 100V, 10%, 1206	AVX, 12061A102KAT2A
19	2	C87, C90	CAP., X7R, 0.01µF, 100V, 10%, 0603	MURATA, GRM188R72A103KA01D
20	2	D1, D2	ULTRA FAST RECTIFIER SINGLE, SOD-123F	CENTRAL SEMI., CMMR1U-02 TR
21	1	L1	IND, 4.7µH	COILCRAFT, SER2915L-472KL
22	1	M1	MOSFET, N-CHANNEL, 60V PG-TDSON-8	INFINEON, BSC028N06NS
23	1	M2	MOSFET, N-CHANNEL, 60V PG-TDSON-8	INFINEON, BSC016N06NS
24	2	M3, M4	MOSFET, N-CHANNEL, 25V PG-TDSON-8	INFINEON, BSC010NE2LSI
25	1	R2	RES., CHIP, 196k, 0.1W, 1%, 0603	PANASONIC, ERJ-3EKF1963V
26	1	R3	RES., CHIP, 8.06k, 0.1W, 1%, 0603	VISHAY, CRCW06038k06FKEA
27	5	R5, R8, R9, R23, R24	RES., CHIP, 10Ω, 0.1W, 1%, 0603	VISHAY, CRCW060310R0FKEA
28	1	R11	RES., CHIP, 110k, 0.1W, 1%, 0603	VISHAY, CRCW0603110KFKEA
29	1	R13	RES., CHIP, 113k, 0.1W, 1%, 0603	VISHAY, CRCW0603113KFKEA
30	1	R14	RES., CHIP, 35.7k, 0.1W, 1%, 0603	PANASONIC, ERJ-3EKF3572V
31	1	R15	RES., CHIP, 1.2, 0.25W, 1%, 1206	VISHAY, CRCW12061R20FKEA
32	1	R16	RES., CHIP, 10k, 0.1W, 1%, 0603	VISHAY, CRCW060310K0FKEA
33	1	R44	RES., SENSE, 0.004Ω, 2W, 1%, 2512	SUSUMU, RL3264SW4-004M-F-T5
34	1	R47	RES., CHIP, 215k, 0.1W, 1%, 0603	VISHAY, CRCW0603215KFKEA
35	1	R48	RES., CHIP, 21.0k, 0.1W, 1%, 0603	PANASONIC, ERJ-3EKF2102V
36	1	R49	RES., CHIP, 124k, 0.1W, 1%, 0603	PANASONIC, ERJ-3EKF1243V
37	1	R50	RES., CHIP, 4.99k, 0.1W, 1%, 0603	PANASONIC, ERJ-3EKF4991V
38	1	R54	RES., CHIP, 3.48k, 0.1W, 1%, 0603	VISHAY, CRCW06033K48FKEA
39	1	R55	RES., CHIP, 5.90k, 0.1W, 1%, 0603	VISHAY, CRCW06035K90FKEA
40	1	R56	Res., SENSE, 0.005Ω, 1W, 1%, 2512	PANASONIC, ERJM1WTF5M0U
41	1	R57	RES., CHIP, 0.003, 2W, 1%, 2512	PANASONIC, ERJM1WTF3M0U

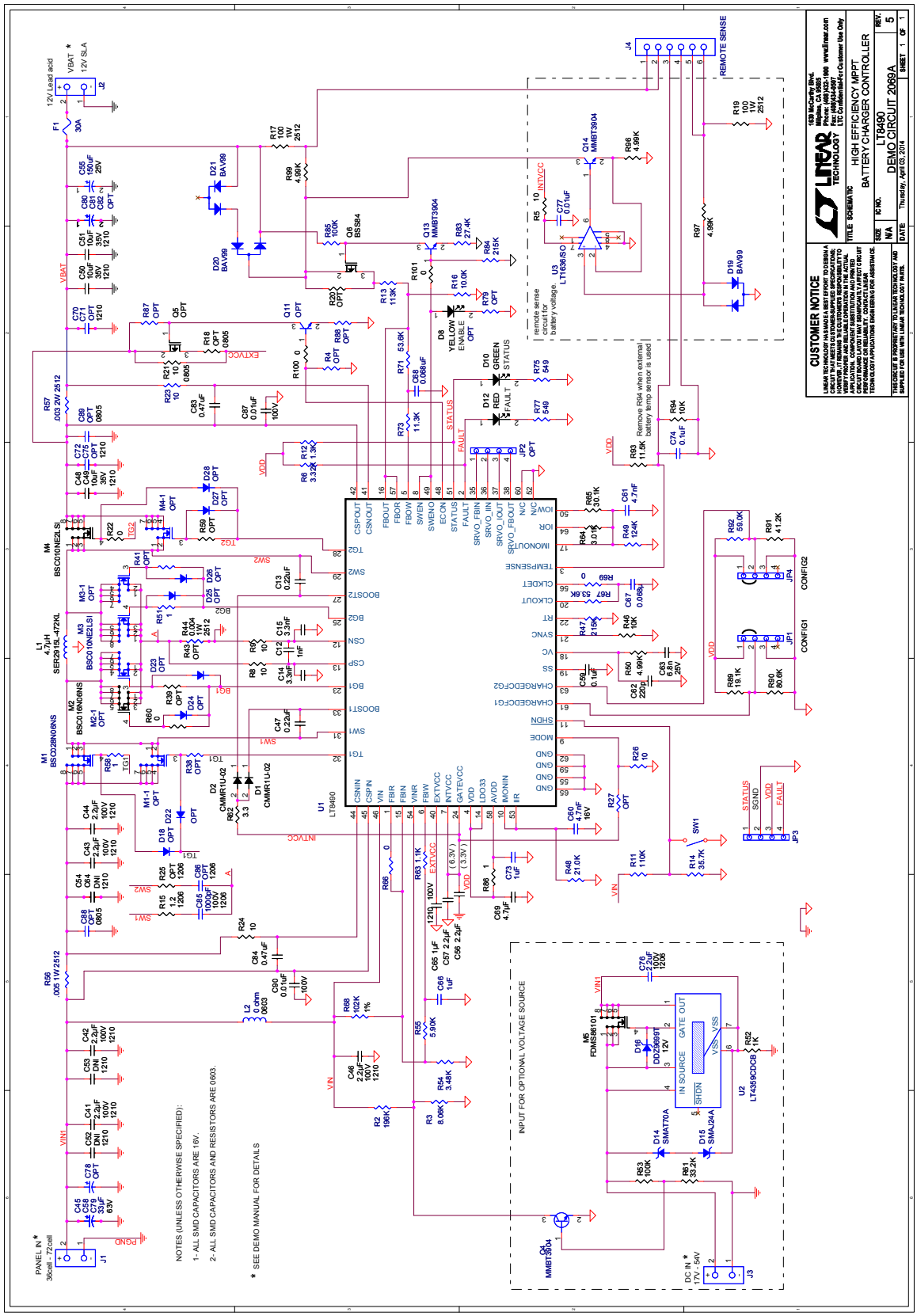
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
42	1	R62	RES., CHIP, 3.3Ω, 0.1W, 5%, 0603	PANASONIC, ERJ-3GEYJ3R3V
43	1	R63	RES., CHIP, 1.10k, 0.1W, 1%, 0603	VISHAY, CRCW06031K10FKEA
44	1	R64	RES., CHIP, 3.01k, 0.1W, 1%, 0603	PANASONIC, ERJ-3EKF3011V
45	1	R65	RES., CHIP, 30.1k, 0.1W, 1%, 0603	VISHAY, CRCW060330K1FKEA
46	2	R67, R71	RES., CHIP, 53.6k, 0.1W, 1%, 0603	VISHAY, CRCW060353K6FKEA
47	1	U1	IC., BATTERY CHARGE CONTROLLER, 64-QFN	LINEAR TECH., LT8490EUKJ#PBF
48	1		FAB, PRINTED CIRCUIT BOARDS	DEMO CIRCUIT 2069A
49	1		STENCIL (TOP AND BOTTOM IMAGES)	STENCIL DC2069A
Optional Components				
50	1	C74	CAP., X7R, 0.1µF, 16V, 10%, 0603	AVX, 0603YC104KAT2A
51	1	C76	CAP., X7R, 2.2uF, 100V, 10%, 1206	AVX, 12061C225KAT2A
52	1	C77	CAP., X7R, 0.01µF, 16V, 10%, 0603	AVX, 0603YC103KAT2A
53	1	D10	LED, GREEN, 0603	ROHM, SML-512PW (A)
54	1	D12	LED, RED, 0603	ROHM, SML-512UW
55	1	D14	DIODE, TVS UNI-DIR 70V 400W SMA	DIODES INC., SMAT70A-13-F
56	1	D15	DIODE, TVS UNI-DIR 24V 400W SMA	DIODES INC., SMAJ24A-13-F
57	1	D16	DIODE, ZENER 12V 150MW SOD523	DIODES INC., DDZ9699T-7
58	3	D19, D20, D21	DIODE, BAV99 SOT23	DIODES INC., BAV99-7-F
59	1	F1	FUSE	LITTELFUSE, 142.6185.5306
60	1	F1	FUSE HOLDER	LITTELFUSE, 178.4265.0002
61	3	JP1, JP3, JP4	4 PIN 0.100 SINGLE ROW HEADER	SAMTEC, TSW-104-07-L-S
62	2	XJP1, XJP4	SHUNT, 0.1" CENTER	SAMTEC, SNT-100-BK-G
63	3	J1, J2, J3	HOUSING, +PIN, RED	ANDERSON POWER, 1327
64	3	J1, J2, J3	HOUSING, –PIN, BLACK	ANDERSON POWER, 1327G6
65	3	J1, J2, J3	STAPLES FOR PCB ASSY.	ANDERSON POWER, 114555P2
66	6	J1, J2, J3	RIGHT ANGLE PCB CONTACTS	ANDERSON POWER, 1377G12
67	1	J4	MODULAR JACK	TE CONNECTIVITY, 5555165-1
68	1	L2	IND, 0Ω 0603	VISHAY, CRCW06030000Z0ED
69	1	M5	MOSFET, N-CHANNEL, 100V POWER 56	FAIRCHILD, FDMS86101
70	0	M1-1, M2-1, M3-1, M4-1 (OPT)	MOSFET, N-CHANNEL	
71	3	Q4, Q13, Q14	NPN TRANSISTOR, SOT23	DIODES INC., MMBT3904-7-F
72	1	Q6	P-CH MOSFET, 50V, SOT23	DIODES, BSS84-7-F
73	1	R26	RES., CHIP, 10Ω, 0.1W, 1%, 0603	VISHAY, CRCW060310R0FKEA
74	1	R6	RES., CHIP, 3.32k, 0.1W, 1%, 0603	VISHAY, CRCW06033K32FKEA
75	1	R12	RES., CHIP, 1.3k, 0.1W, 1%, 0603	VISHAY, CRCW06031K30FKEA
76	2	R46, R94	RES., CHIP, 10k, 0.1W, 1%, 0603	VISHAY, CRCW060310K0FKEA
77	2	R17, R19	RES., CHIP, 100Ω, 1W, 1%, 2512	PANASONIC, ERJ-1TNF1000U
78	1	R21	RES., CHIP, 10Ω, 1/8W, 1%, 0805	PANASONIC, ERJ-6ENF10R0V
79	6	R22, R60, R66, R69, R100, R101	RES., CHIP, 0Ω, 0.1W, 0603	VISHAY, CRCW06030000Z0ED
80	1	R84	RES., CHIP, 215k, 0.1W, 1%, 0603	VISHAY, CRCW0603215KFKEA

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
81	3	R96, R97, R99	RES., CHIP, 4.99k, 0.1W, 1%, 0603	PANASONIC, ERJ-3EKF4991V
82	3	R51, R58, R86	RES., CHIP, 1Ω, 0.1W, 1%, 0603	VISHAY, CRCW06031R00FKEA
83	1	R52	RES., CHIP, 1k, 0.1W, 1%, 0603	PANASONIC, ERJ-3EKF1001V
84	2	R53, R85	RES., CHIP, 100k, 0.1W, 1%, 0603	PANASONIC, ERJ-3EKF1003V
85	1	R61	RES., CHIP, 33.2k, 0.1W, 1%, 0603	VISHAY, CRCW060333K2FKEA
86	1	R68	RES., CHIP, 102k, 0.1W, 1%, 0603	VISHAY, CRCW0603102KFKEA
87	1	R73	RES., CHIP, 11.3k, 0.1W, 1%, 0603	VISHAY, CRCW060311K3FKEA
88	2	R75, R77	RES., CHIP, 549Ω, 0.1W, 1%, 0603	VISHAY, CRCW0603549RFKEA
89	2	R83	RES., CHIP, 27.4k, 0.1W, 1%, 0603	VISHAY, CRCW060327K4FKEA
90	1	R89	RES., CHIP, 19.1k, 0.1W, 1%, 0603	PANASONIC, ERJ-3EKF1912V
91	1	R90	RES., CHIP, 80.6k, 0.1W, 1%, 0603	PANASONIC, ERJ-3EKF8062V
92	1	R91	RES., CHIP, 41.2k, 0.1W, 1%, 0603	PANASONIC, ERJ-3EKF4122V
93	1	R92	RES., CHIP, 59.0k, 0.1W, 1%, 0603	VISHAY, CRCW060359K0FKEA
94	1	R93	RES., CHIP, 11.5k, 0.1W, 1%, 0603	VISHAY, CRCW060311K5FKEA
95	1	SW1	SWITCH, TACTILE SPST-NO 0.05A 12V	WÜRTH, 434 123 050 816
96	1	U2	IC., IDEAL DIODE CONTROLLER, DFN-6L	LINEAR TECH., LTC4359CDCB#TRPBF
97	1	U3	IC., OP AMP, SO8	LINEAR TECH., LT1636CS8#PBF

SCHEMATIC DIAGRAM



Information furnished by Linear Technology Corporation is believed to be accurate and reliable. However, no responsibility is assumed for its use. Linear Technology Corporation makes no representation that the interconnection of its circuits as described herein will not infringe on existing patent rights.

DEMONSTRATION BOARD IMPORTANT NOTICE

Linear Technology Corporation (LTC) provides the enclosed product(s) under the following **AS IS** conditions:

This demonstration board (DEMO BOARD) kit being sold or provided by Linear Technology is intended for use for **ENGINEERING DEVELOPMENT OR EVALUATION PURPOSES ONLY** and is not provided by LTC for commercial use. As such, the DEMO BOARD herein may not be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including but not limited to product safety measures typically found in finished commercial goods. As a prototype, this product does not fall within the scope of the European Union directive on electromagnetic compatibility and therefore may or may not meet the technical requirements of the directive, or other regulations.

If this evaluation kit does not meet the specifications recited in the DEMO BOARD manual the kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY THE SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THIS INDEMNITY, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user releases LTC from all claims arising from the handling or use of the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge. Also be aware that the products herein may not be regulatory compliant or agency certified (FCC, UL, CE, etc.).

No License is granted under any patent right or other intellectual property whatsoever. **LTC assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or any other intellectual property rights of any kind.**

LTC currently services a variety of customers for products around the world, and therefore this transaction **is not exclusive**.

Please read the DEMO BOARD manual prior to handling the product. Persons handling this product must have electronics training and observe good laboratory practice standards. **Common sense is encouraged**.

This notice contains important safety information about temperatures and voltages. For further safety concerns, please contact a LTC application engineer.

Mailing Address:

Linear Technology
1630 McCarthy Blvd.
Milpitas, CA 95035

Copyright © 2004, Linear Technology Corporation

© LINEAR TECHNOLOGY CORPORATION 2014