

LTC3896

High Voltage, Low I_Q , Synchronous Inverting DC/DC Controller

DESCRIPTION

Demonstration circuit 2447A is a high voltage, high efficiency synchronous inverting converter featuring the [LTC®3896](#). This demo board has a wide input voltage range from 7V to 72V and produces a -12V output voltage.

The DC2447A is capable of delivering up to 5A of output current. Note that the thermal stress increases at lower input voltages due to increased input current.

This demo board supports four operation modes consisting of fixed-frequency modulation, pulse skipping, Burst Mode® Operation (default mode) and adjustable Burst Mode operation. During a light load condition, fixed-frequency mode reduces output voltage ripple and yields the lowest noise spectrum. Burst mode operation employs a variable frequency algorithm that minimizes the no-load quiescent current and improves light load efficiency.

The DC2447A consumes less than 12µA of current in shutdown and consumes only 100µA of quiescent current when the output is in regulation, unloaded and configured for Burst Mode operation which helps extend the run-time in battery powered applications. This demo board operates at a 300kHz switching frequency and can easily be adjusted from 50kHz to 900kHz.

To prevent high on-chip power dissipation in high input voltage applications, the LTC3896 includes an onboard

driver to drive the gate of an external N-channel MOSFET which acts as a linear regulator to power the IC.

The LTC3896 can support a wide output voltage range from -0.8V to -60V. However, the voltage difference between the input voltage and output voltage should not exceed the maximum voltage of the switching semiconductors (100V for DC2447A) and shown by the equation $|-V_{OUT}| + V_{IN} < V_{DS}$.

The DC2447A is set to provide a 10V gate drive voltage (DRV_{CC}) for the switching MOSFETs. It has an UVLO of 7.5V rising and 6.7V falling. However, the gate drive voltage and UVLO voltages can be adjusted lowered. See the LTC3896 data sheet for details.

The DC2447A was designed to support multiple footprints of input and output capacitors, and inductors to accommodate a variety of applications.

The LTC3896 data sheet gives a complete description of the part, contains operating and application information, and must be read in conjunction with this data sheet.

Design files for this circuit board are available at <http://www.linear.com/demo/DC2447A>

LT, LTC, LTM, Linear Technology, Burst Mode 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 $T_A = 25^\circ\text{C}$

PARAMETER	CONDITIONS	VALUE
Minimum Input Voltage		7V
Maximum Input Voltage		72V
Output Voltage V_{OUT} — Regulation	$V_{IN} = 7V - 72V$	-12V $\pm 2\%$
Maximum Continuous Output Current		5A
Preset Operating Frequency	$R26 = 47.5k\Omega$	300kHz
External Clock Sync. Frequency Range		75kHz – 850Hz
Efficiency	$V_{IN} = 24V$, $V_{OUT} = -12.0V$, $I_{OUT} = 5A$	93%
Typical Output Ripple V_{OUT} —	$V_{IN} = 24V$, $V_{OUT} = -12V$, $I_{OUT} = 2.5A$ (20MHz BW)	<70mV _{p-p}
Quiescent Current at Shut-Down	$V_{IN} = 24V$	<12µA

dc2447af

QUICK START PROCEDURE

Demonstration circuit 2447A is easy to set up to evaluate the performance of the LTC3896. For proper measurement equipment configuration, set up the circuit according to the diagram in Figure 1. Before proceeding to test, insert shunt into JP1 (RUN) into OFF position, which connects the RUN pin to ground (GND) and shuts down the output. Set jumper JP2 (MODE) into the FCM (Forced Continuous Conduction Mode) position.

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 V_{IN} or V_{OUT-} and GND terminals. See Figure 2 for proper scope probe technique.

1. With the DC2447A set up according to the proper measurement and equipment in Figure 1, apply 16V at V_{IN} . Measure V_{OUT-} ; it should read 0V. If desired, one can measure the shutdown supply current at this point. The supply current will be approximately 12 μ A, or less, in shutdown.
2. Turn on V_{OUT-} of the circuit by inserting the shunt in header JP1 (RUN) into the ON position. The output

voltage should be regulating. Measure V_{OUT-} and it should measure $-12.0V \pm 2\%$ (Do not apply more than the maximum voltage of 72V to the board or the part may be damaged). Vary the V_{OUT-} load, which should not exceed 5A. Vary the input voltage from 7V to 72V, the V_{OUT-} , it should measure $-12.0V \pm 2\%$.

3. Set output current to zero and move jumper JP2 (MODE) into Burst Default position and measure V_{OUT-} . It should be $-12.0V \pm 2\%$. Vary the V_{OUT-} load, which should not exceed 5A. Vary the input voltage from 7V to 72V, the V_{OUT-} , it should measure $-12.0V \pm 2\%$.
4. Set output current to zero and move jumper JP2 (MODE) into Pulse Skip position and measure V_{OUT-} . It should be $-12.0V \pm 2\%$. Vary the V_{OUT-} load, which should not exceed 5A. Vary the input voltage from 7V to 72V, the V_{OUT-} , it should measure $-12.0V \pm 2\%$.

DC2447A supports synchronization to external clock referenced to input GND; use PLLIN terminal for synchronization. PGOOD signal also referenced to input GND. To activate PGOOD functionality, connect external voltage source to terminals V_{PGOOD} and GND. DC2447A also supports $EXTV_{CC}$ function, however $EXTV_{CC}$ is referenced to V_{OUT-} .

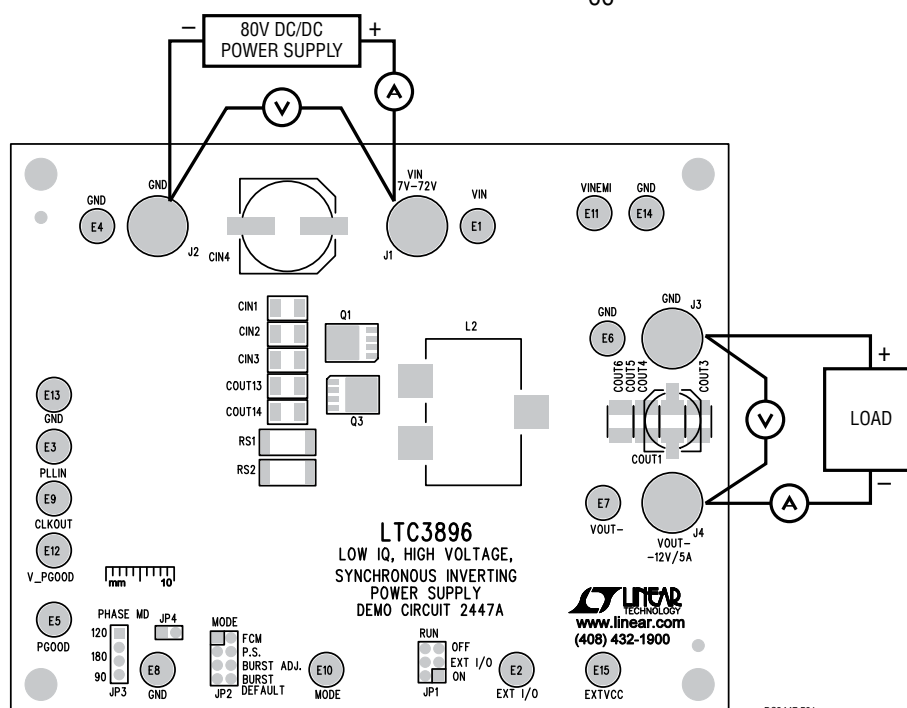


Figure 1. Proper Measurement Equipment Setup

QUICK START PROCEDURE

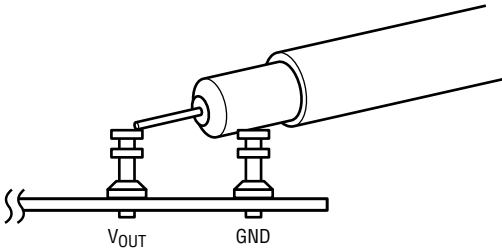


Figure 2. Measuring Input or Output Ripple

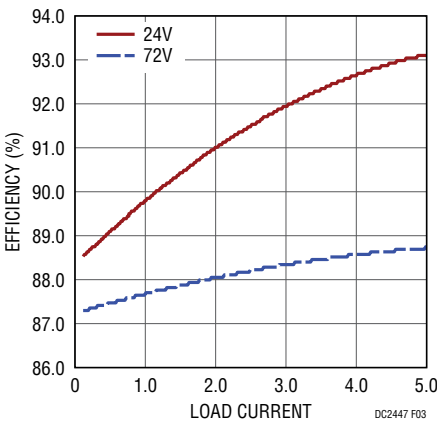
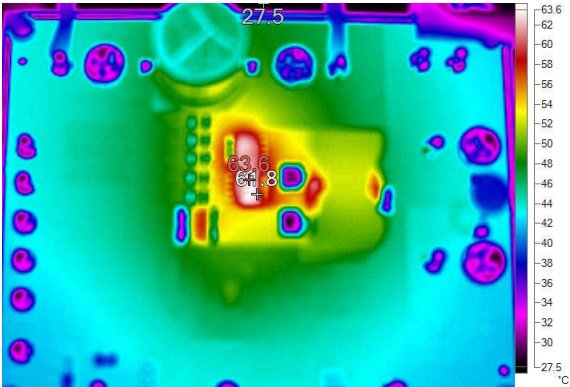
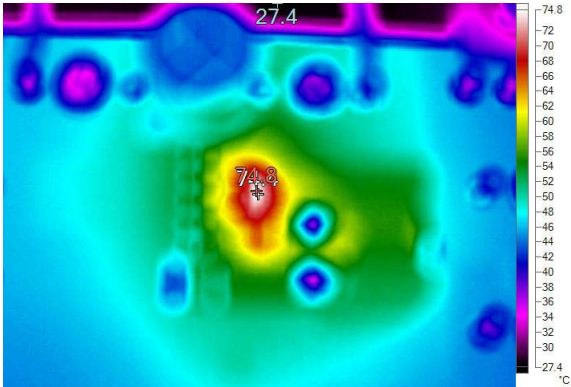


Figure 3. Efficiency vs Load Current for Different Input Voltages



a) $V_{IN} = 12V$



b) $V_{IN} = 48V$

Figure 4. Thermal Map, V_{IN} 12V and 48V (Left to Right) V_{OUT} is -12V at 5.0A. No Air Flow, $T_A = 25^\circ C$

QUICK START PROCEDURE

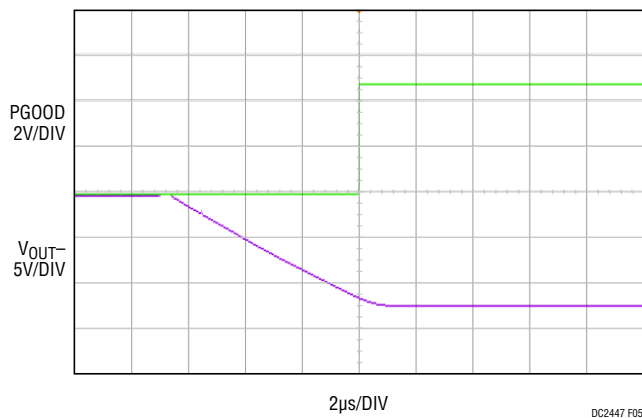


Figure 5. Start-UP to Full Load. V_PG00D Connected to External +5V. As VOUT- Approaches -12V, PG00D Signal Changes State

PARTS LIST

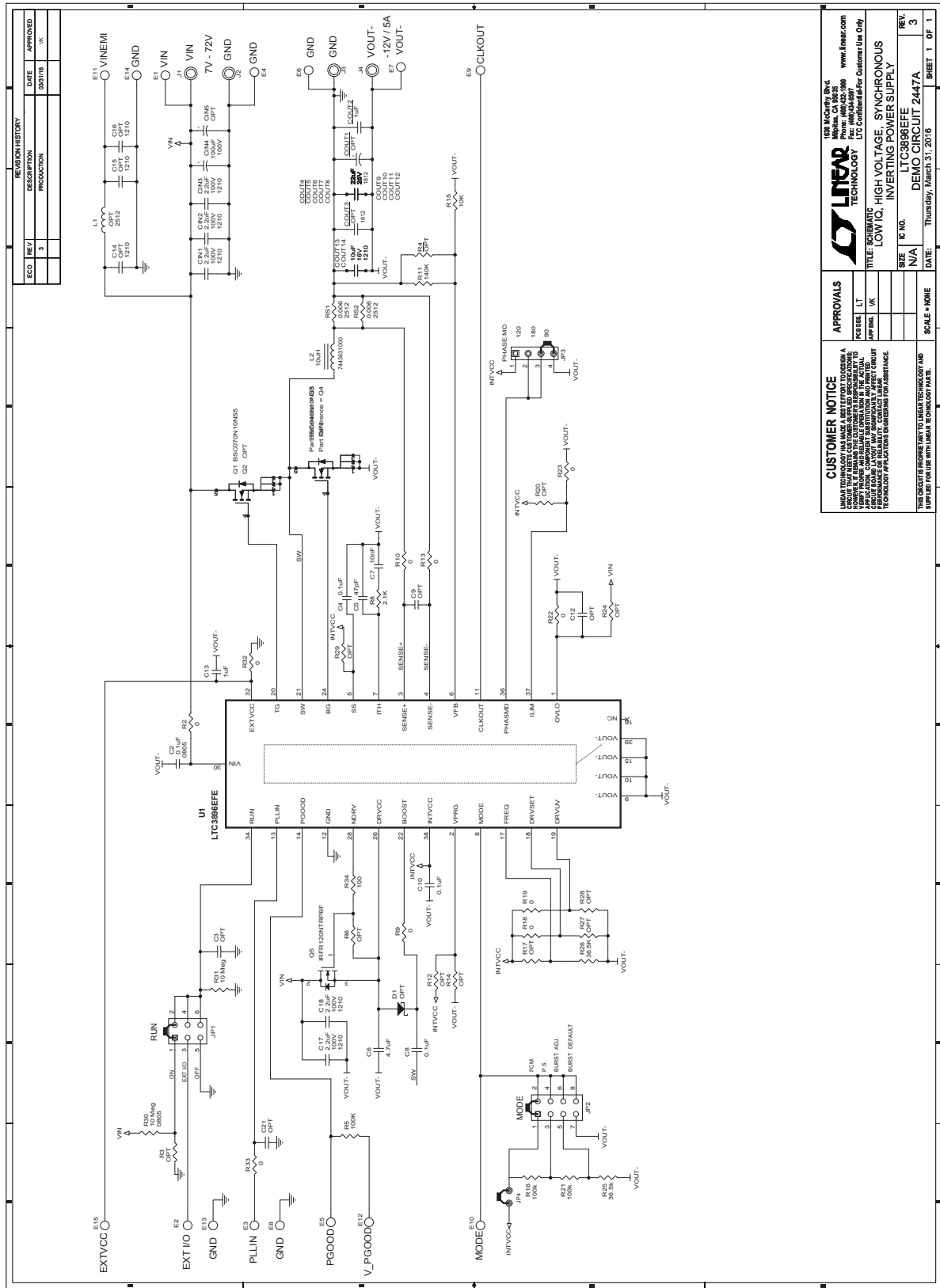
ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	5	CIN1, CIN2, CIN3, C17, C18	CAP, X7R, 2.2μF, 100V, 10%, 1210	AVX, 12101C225KAT2A
2	1	CIN4	CAP, 100μF, 100V, 20%	UNITED CHEMI-CON, EMVY101ARA101MKE0S
3	8	COUT3–COUT10	CAP, X7R, 22μF, 25V, 1812	TDK, C4532X7R1E226M250KC
4	1	COUT2	CAP, X7R, 1μF, 50V, 10%, 1210	TDK, C3225X7R1H105K
5	2	COUT13, COUT14	CAP, X5R, 10μF, 16V, 10%, 1210	AVX, 1210YD106KAT2A
6	1	C2	CAP, X7T, 0.1μF, 200V, 10%, 0805	TDK, CGJ4J3X7T2D104K125AA
7	3	C4, C8, C10	CAP, X7R, 0.1μF, 25V, 10%, 0603	TDK, C1608X7R1E104K
8	1	C5	CAP, X7R, 47pF, 50V, 10%, 0603	KEMET, C0603X470K5RACTU
9	1	C6	CAP, X5R, 4.7μF, 16V, 10%, 0603	TDK, C1608X5R1C475K080AC
10	1	C7	CAP, X7R, 10nF, 50V, 10%, 0603	KEMET, C0603C103K5RACTU
11	1	C13	CAP, X7R, 1μF, 50V, 10%, 0603	TAIYO YUDEN, UMK107AB7105KA-T
12	1	L2	INDUCTOR, POWER, 10μH	WURTH ELEKTRONIK, 7443631000
13	1	Q1	XSTR, N-CHANNEL, DMOS FET, LFPK	INFINEON, BSC070N10NS5
14	1	Q3	XSTR, N-CHANNEL, DMOS FET, LFPK	INFINEON, BSC040N10NS5
15	1	Q5	MOSFET, N-CHANNEL, 100V, TO252	INFINEON, IFR120NTRPBF
16	2	RS1, RS2	RES, 0.006Ω 1% 1/4W, 2512	VISHAY, WSL25126L000FEA
17	10	R2, R9, R10, R13, R18, R19	RES., 0Ω, 1/16W, 0603	VISHAY, CRCW06030000Z0EA
18		R22, R23, R32, R33		
19	3	R5, R16, R21	RES., 100k, 1/16W, 1% , 0603	VISHAY, CRCW0603100KFKEA
20	1	R8	RES., 2.1k, 1/16W, 1% , 0603	VISHAY, CRCW06032K1FKEA
21	1	R15	RES., 10k, 1/16W, 1% , 0603	VISHAY, CRCW060310K0FKEA
22	1	R11	RES., 140k, 1/16W, 1%, 0603	VISHAY, CRCW0603140KFKEA
23	2	R25, R26	RES., 36.5k, 1/16W, 1% , 0603	VISHAY, CRCW060336K5FKEA
24	1	R30	RES., 10M, 1/8W, 5%, 0805	VISHAY, CRCW080510M0JNEA
25	1	R31	RES., 10M, 1/10W, 5%, 0603	VISHAY, CRCW060310M0JNEA
26	1	R34	RES., 100, 1/10W, 1%, 0603	VISHAY, CRCW0603100RFKEA
27	1	U1	IC, LTC3896EFE	LINEAR TECH. LTC3896EFE#PBF
Additional Demo Board Circuit Components				
		C3, C9, C11, C12, C21	CAP, OPT, 0603	OPT
		CIN5	CAP, ALUM	OPT
		C14, C15, C16	CAP, OPT, 1210	OPT
		COUT1	CAP, ALUM	OPT
		COUT11, COUT12	CAP, OPT, 1812	OPT
		D1	DIODE, OPT, SOD123	OPT
		L1	INDUCTOR, OPT, 2512	OPT
		Q2, Q4	XSTR, OPT, LFPK	OPT
		R3, R6, R12, R14, R17, R20, R24, R27, R28, R29	RES., OPT 0603	OPT

DEMO MANUAL DC2447A

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Hardware: For Demo Board Only				
	15	E1-E15	TESTPOINT, TURRET, 0.095"	MILL-MAX, 2501-2-00-80-00-00-07-0
	1	JP1	CONN., HEADER, 2X3, 2mm	WURTH ELEKTRONIK, 620 006 211 21
	1	JP2	CONN., HEADER, 2X4, 2mm	WURTH ELEKTRONIK, 620 008 211 21
	1	JP3	CONN., HEADER, 1X4, 2mm	WURTH ELEKTRONIK, 620 004 111 21
	1	JP4	CONN., HEADER, 1X2, 2mm	WURTH ELEKTRONIK, 620 002 111 21
	4	XJP1, XJP2, XJP3, XJP4	SHUNT, 2mm	WURTH ELEKTRONIK, 608 002 134 21
	4	J1, J2, J3, J4	JACK, BANANA	KEYSTONE, 575-4

SCHEMATIC DIAGRAM



DEMO MANUAL DC2447A

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

dc2447af

Компания «Океан Электроники» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Компания «Океан Электроники» является официальным дистрибьютором и эксклюзивным представителем в России одного из крупнейших производителей разъемов военного и аэрокосмического назначения «JONHON», а так же официальным дистрибьютором и эксклюзивным представителем в России производителя высокотехнологичных и надежных решений для передачи СВЧ сигналов «FORSTAR».



JONHON

«JONHON» (основан в 1970 г.)

Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

«FORSTAR» (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели,
кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



Телефон: 8 (812) 309-75-97 (многоканальный)

Факс: 8 (812) 320-03-32

Электронная почта: ocean@oceanchips.ru

Web: <http://oceanchips.ru/>

Адрес: 198099, г. Санкт-Петербург, ул. Калинина, д. 2, корп. 4, лит. А