

LTM4607EV High Efficiency PolyPhase Buck-Boost Power Supply

DESCRIPTION

Demonstration circuit DC1601B is a PolyPhase® power supply featuring the LTM®4607 power module, a complete high efficiency switching mode buck-boost power supply. The DC1601B input voltage range is from 6V to 36V and is capable of delivering high power through paralleled LTM4607 modules. The demo circuit can deliver up to 10A of output current for two paralleled modules (DC1601B-A), 15A for three paralleled modules (DC1601B-B) and up to 20A for four paralleled modules (DC1601B-C). The DC1601B demonstrates that paralleling modules is easy and reliable.

The output voltage for the board is 12V. The rated load current per module is 5A in boost mode, however current derating may be necessary under certain V_{IN} , V_{OUT} , frequency, and thermal conditions. An onboard external clock is provided for synchronization and interleaving of

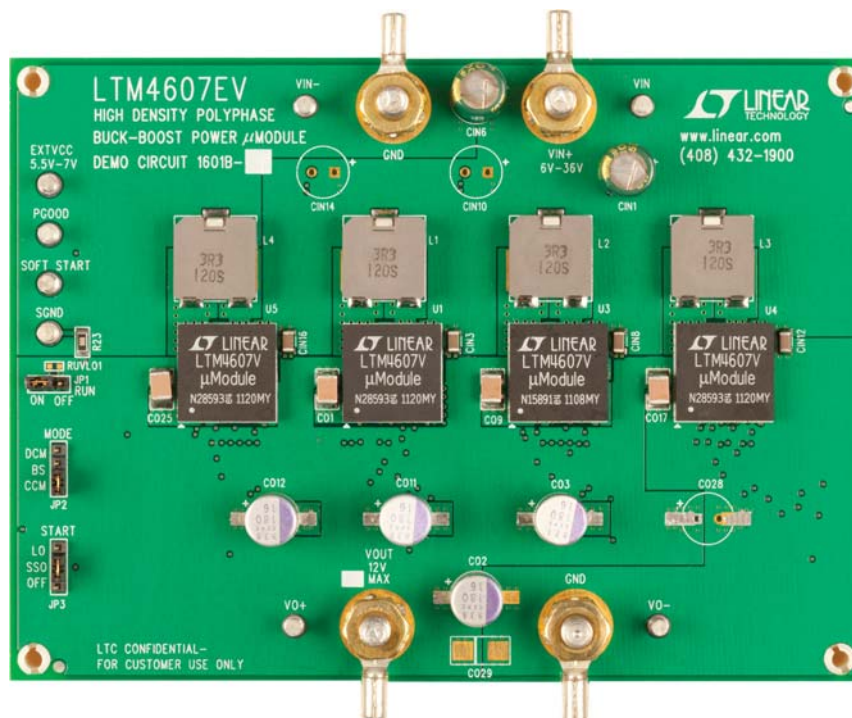
phases to minimize input and output ripple. An internal phase-locked loop allows the LTM4607 to be synchronized to an external clock within the range of 200kHz to 400kHz. The LTM4607 default switching frequency on the DC1601B is set to 300kHz through the onboard LTC6902 clock generator which interleaves the paralleled phases. The frequency and phase separation set by the LTC6902 are resistor programmable.

These features, including the availability of the LTM4607 in a compact thermally enhanced 15mm × 15mm × 2.8mm LGA package make the demonstration circuit ideal for use in high density point of load regulation applications.

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

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BOARD PHOTO



DC1601B-C
SHOWN

DEMO MANUAL DC1601B

PERFORMANCE SUMMARY (T_A = 25°C)

PARAMETER	CONDITIONS	VALUE
Maximum Input Voltage		36V
Minimum Input Voltage		6V
Output Voltage V _{OUT}	Programmed by R22	12V
Maximum Continuous Output Current I _{OUT(MAX)}	Current Derating May Be Necessary for Certain V _{IN} , V _{OUT} , Frequency and Thermal Conditions.	10A (DC1601B-A) 15A (DC1601B-B) 20A (DC1601B-C)
Default Operating Frequency		300kHz
External Clock Sync. Frequency Range		200kHz to 400kHz
Output Voltage Ripple (Typical)	V _{OUT} = 12V 300kHz (20MHz BW)	V _{IN} = 9V, I _{OUT} = 10A (DC1601B-A), See Figure 5a V _{IN} = 12V, I _{OUT} = 15A (DC1601B-B), See Figure 5b V _{IN} = 32V, I _{OUT} = 20A (DC1601B-B), See Figure 5c
Efficiency	V _{IN} = 9V, V _{OUT} = 12V 300kHz	95.7% at I _{OUT} = 10A (DC1601B-A), See Figure 2a 94.8% at I _{OUT} = 15A (DC1601B-B), See Figure 2b 94.8% at I _{OUT} = 20A (DC1601B-C), See Figure 2c
Load Transient	V _{OUT} = 12V 300kHz (20MHz BW)	V _{IN} = 9V, I _{OUT} = 10A (DC1601B-A), See Figure 4a V _{IN} = 12V, I _{OUT} = 15A (DC1601B-B), See Figure 4b V _{IN} = 32V, I _{OUT} = 20A (DC1601B-B), See Figure 4c

QUICK START PROCEDURE

Demonstration circuit DC1601B is easy to set up to evaluate the performance of paralleled LTM4607 modules. Please refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

1. 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. Place jumpers in the following positions for a typical 12V_{OUT} application:

JP2	JP1	JP3
MODE	RUN	START
CCM	OFF	SSO

2. Turn on the power at the input. Increase V_{IN} to 18V (Do not hot-plug the input supply or apply more than the rated maximum voltage of 36V to the board or the modules may be damaged).

3. Set the run pin jumper (JP1) to the ON position. The output voltage should be regulated. The output voltage meter should read 12V \pm 2% (11.76V to 12.24V).

4. Vary the input voltage from 6V to 36V and adjust the load current from 0A to 10A (for DC1601B-A), 0A to 15A (for DC1601B-B), 0A to 20A (for DC1601B-C). V_{OUT} should remain regulated at 12V \pm 2% (11.76V to 12.24V). Observe the load regulation, efficiency and other parameters.

5. Set the load current to 0A. Set the RUN pin jumper (JP1) to the OFF position. Turn off input supply before disconnecting the circuit.

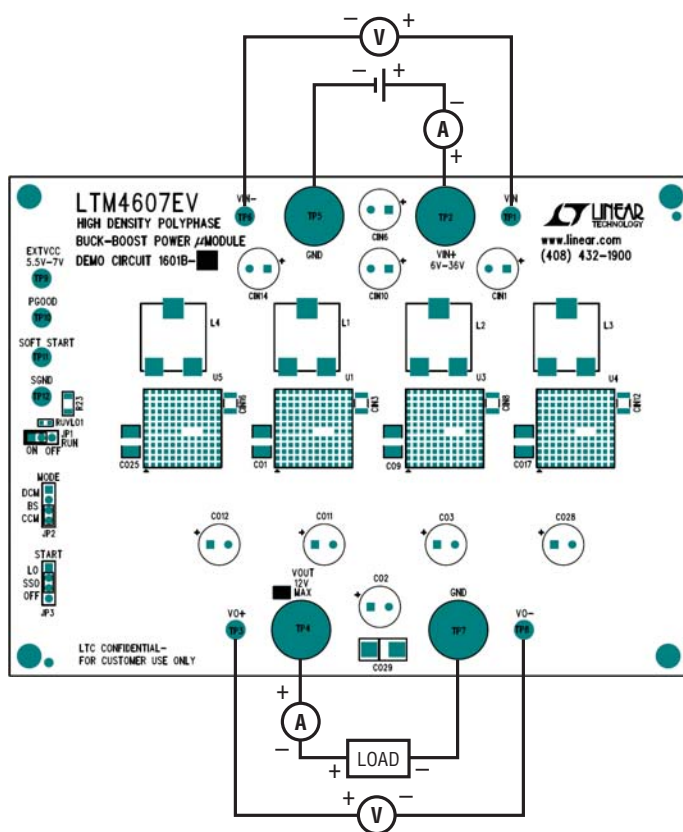


Figure 1

DEMO MANUAL DC1601B

QUICK START PROCEDURE

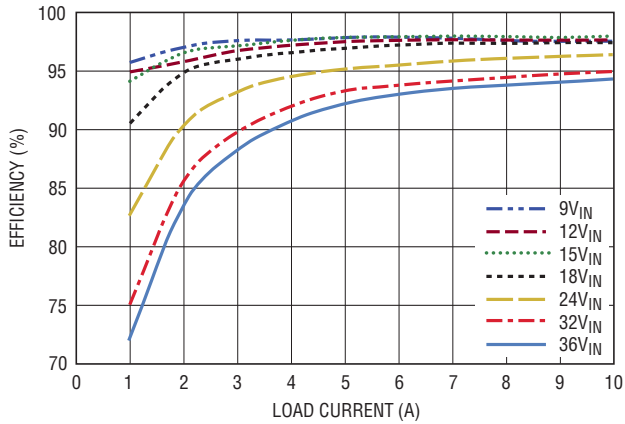


Figure 2a. Measured Efficiency at 12V_{OUT}, 300kHz (DC1601B-A)

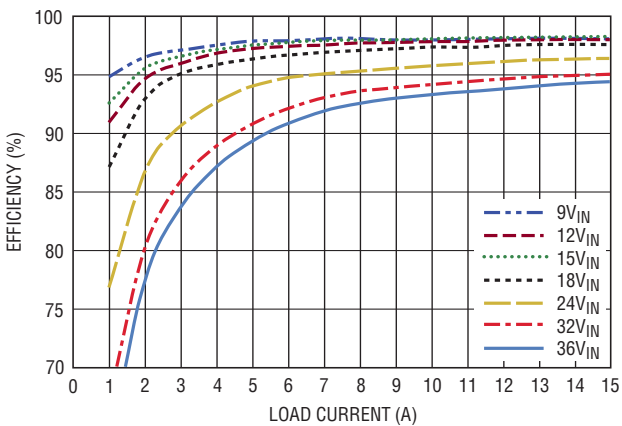


Figure 2b. Measured Efficiency at 12V_{OUT}, 300kHz (DC1601B-B)

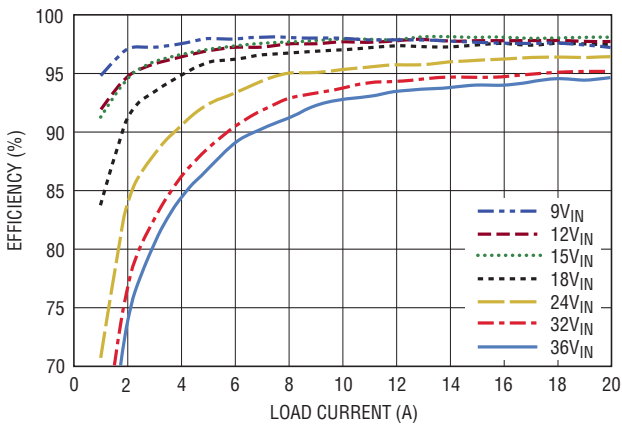


Figure 2c. Measured Efficiency at 12V_{OUT}, 300kHz (DC1601B-C)

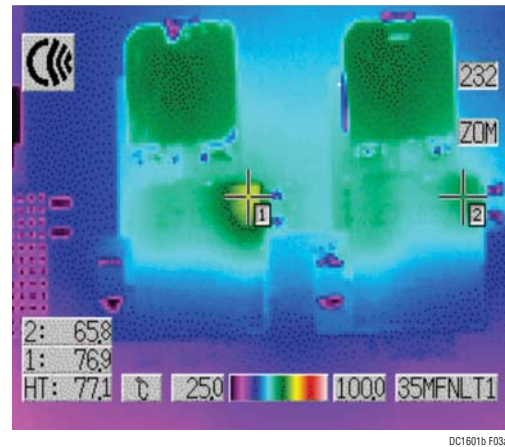


Figure 3a. Thermal Capture at 6V_{IN}, 12V_{OUT}, 10A, 300kHz (DC1601B-A) No Forced Airflow (Convection)

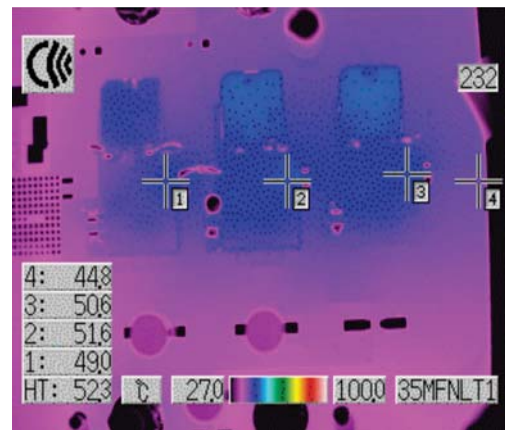


Figure 3b. Thermal Capture at 12V_{IN}, 12V_{OUT}, 15A, 300kHz (DC1601B-B) No Forced Airflow (Convection)

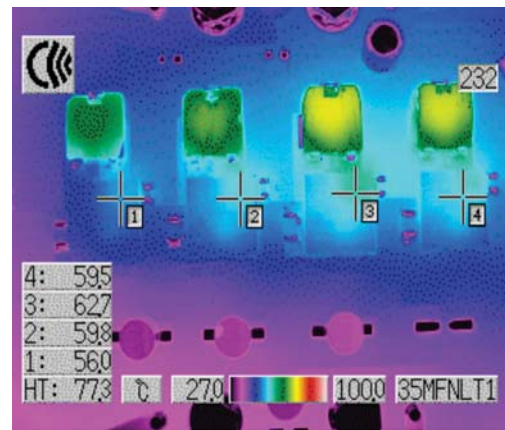


Figure 3c. Thermal Capture at 32V_{IN}, 12V_{OUT}, 20A, 300kHz (DC1601B-C) No Forced Airflow (Convection)

QUICK START PROCEDURE

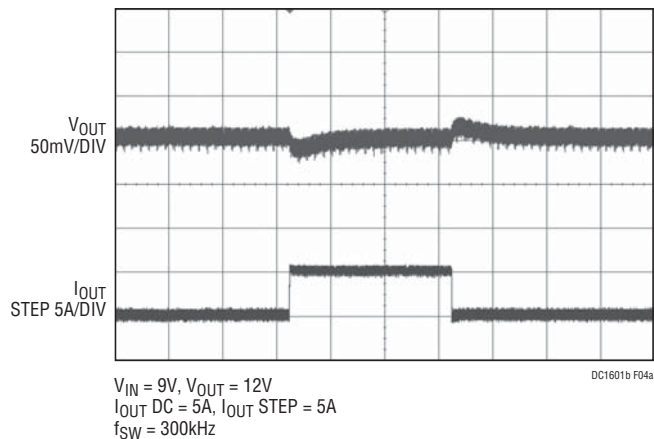


Figure 4a. Measured Load Step Response (DC1601B-A)

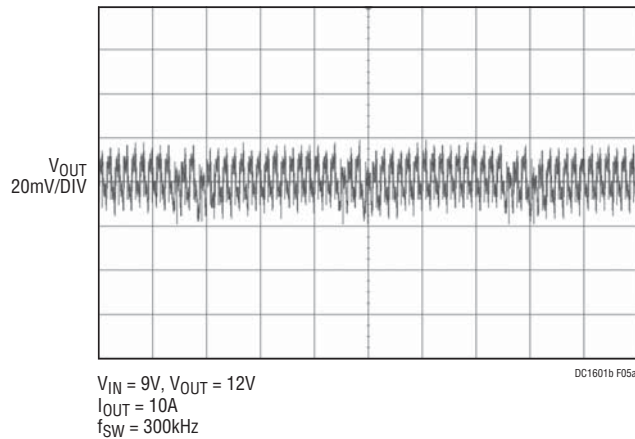


Figure 5a. Measured Output Voltage Ripple (DC1601B-A)

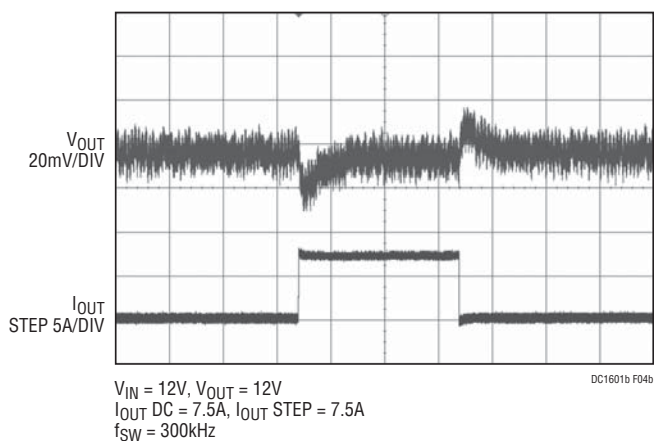


Figure 4b. Measured Load Step Response (DC1601B-B)

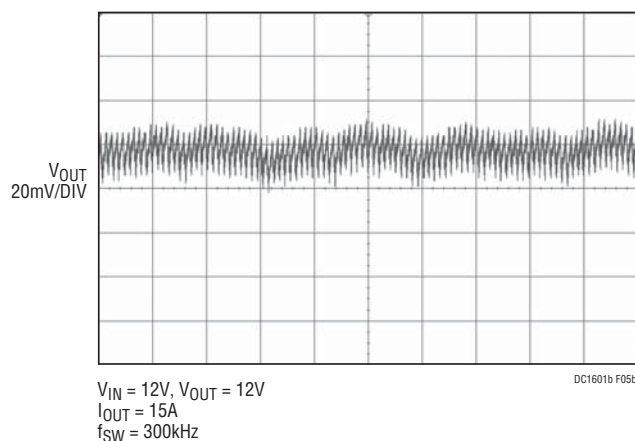


Figure 5b. Measured Output Voltage Ripple (DC1601B-B)

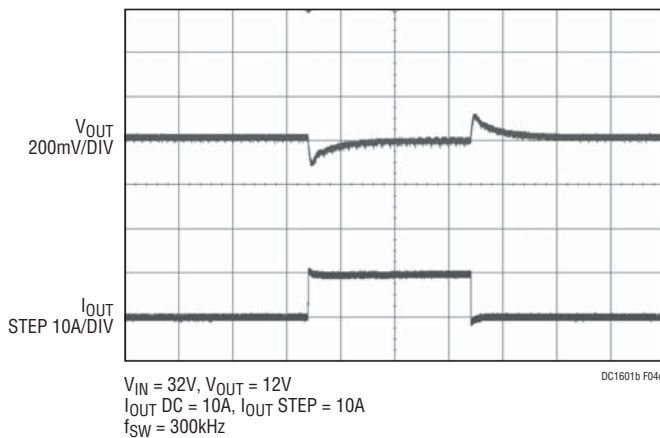


Figure 4c. Measured Load Step Response (DC1601B-C)

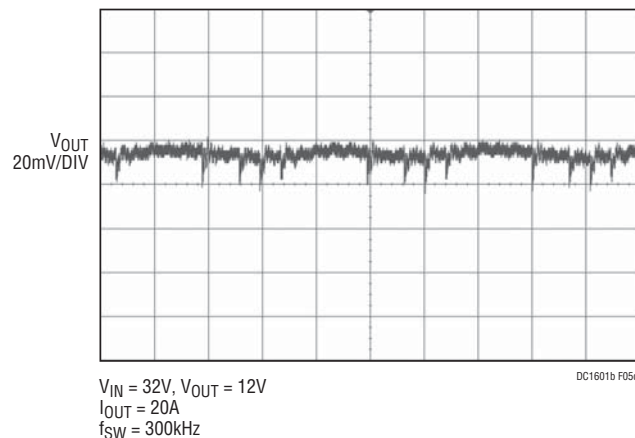


Figure 5c. Measured Output Voltage Ripple (DC1601B-C)

dc1601bf

DEMO MANUAL DC1601B

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Common Required Circuit Components:				
1	2	CIN1, CIN6	CAP, ALUM, 100µF, 20%, 50V	SUNCON, 50ME100WX+TS
2	4	CIN2, CIN3, CIN7, CIN8	CAP, X5R, 4.7µF, 10%, 50V, 1206	TAIYO YUDEN, UMK316BJ475KL-T
3	4	CO1, CO4, CO9, CO10	CAP, X5R, 22µF, 25V, 20%, 1812	TDK, C4532X5R1E226M
4	4	CO2, CO3, CO11, CO12	CAP, OS-CON, 180µF, 16V, E9	SANYO, 16SEPC180MX+T
5	1	CSS1	CAP, X7R, 0.01µF, 25V, 10%, 0603	AVX, 06033C103KAT4A
6	1	C4	CAP, X5R, 0.1µF, 25V, 10%, 0603	AVX, 06033D104KAT4A
7	2	C3, C6	CAP, COG, 22pF, 25V, 10%, 0603	AVX, 06033A220KAT4A
8	2	L1, L2	IND IRON POWER SMT FIXED, 3.3µH	TOKO, FDA1254-3R3M=P3
9	4	RS1 TO RS4	RES, CHIP, 0.015Ω 1/2W, 1%, 1206	VISHAY, WSL1206R0150FEA
10	1	R1	RES, CHIP, 100k, 1/16W, 5%, 0603	VISHAY, CRCW0603100KJNEA
11	4	R10 TO R13	RES, CHIP, 0Ω, 0603	VISHAY, CRCW06030000Z0EA
12	4	R6, R7, R8, R9	RES, CHIP, 100Ω, 1/16W, 1%, 0603	VISHAY, CRCW0603100RFKEA
13	1	U2	IC, LTC6902CMS	LINEAR TECHNOLOGY, LTC6902CMS#PBF
Common Additional Demo Board Circuit Components:				
1	0	C1, C2, C5, C7, C9 TO C17	CAP, 0603	
2		CFF1, CP1 TO CP4 (OPT)		
3	0	CO7, CO15, CO23, CO31, CIN9,	CAP, 1206	
4		CIN4, CIN5, CIN13, CIN17 (OPT)		
5	0	CIN10, CIN14 (OPT)	CAP, ALUM, SIZE 8mm × 12.5mm	
6	0	CO28 (OPT)	CAP, OS-CON, 180µF, 16V, E9	SANYO, 16SEPC180MX
7	0	RUVL01, R3, (OPT)	RES, CHIP, 0603	
8	0	CO19, CO20, CO27 (OPT)	CAP, OS-CON, F8	
9	0	CO5, CO13, CO21, CO29 (OPT)	CAP, D3L	
10	1	D1	ZENER DIODE, 4.7V	CENTRAL SEMI, CMDZ5230B-7-F
11	1	R2	RES, CHIP, 5.1k, 1/16W, 5%, 0805	VISHAY, CRCW08055K10JNEA
12	1	R23	RES, CHIP, 0, 1206	VISHAY, CRCW12060000Z0EA
Common Hardware:				
1	1	JP1	2mm SINGLE ROW HEADER, 3-PIN	SAMTEC, TMM-103-02-L-S
2	2	JP2, JP3	2mm SINGLE ROW HEADER, 4-PIN	SAMTEC, TMM-104-02-L-S
3	3	JP1, JP2, JP3	SHUNT	SAMTEC, 2SN-BK-G
4	8	TP1, TP3, TP6, TP8 TO TP12	TESTPOINT, TURRET, 0.095"	MILL-MAX, 2501-2-00-80-00-00-07-0
5	8	TP2, TP4, TP5, TP7(X2)	STUD, TESTPIN	PEM KFH-032-10
6	4	TP2, TP4, TP5, TP7	NUT, BRASS 10-32	ANY #10-32
7	4	TP2, TP4, TP5, TP7	RING, LUG #10	KEYSTONE #10
8	4	TP2, TP4, TP5, TP7	WASHER, TIN PLATED BRASS	ANY #10
9	4	STAND OFF	STAND-OFF, NYLON 0.50" TALL	KEYSTONE, 8833 (SNAP ON)

PARTS LIST

Demo Board 1601B-A

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components:				
1	1	DC1601 (COMMON BOM)		
2	1	R4	RES, CHIP, 0 Ω , 0603	VISHAY, CRCW06030000Z0EA
3	1	R5	RES, CHIP, 154k, 1/16W, 1%, 0603	VISHAY, CRCW0603154KFKEA
4	1	R22	RES, CHIP, 3.57k, 1/16W, 1%, 0603	VISHAY, CRCW06033K57FKEA
5	2	U1, U3	IC, LTM4607EV#PBF, 15mm \times 9mm \times 2.3mm	LINEAR TECHNOLOGY, LTM4607EV#PBF

Additional Demo Board Circuit Components:

1	0	CIN11, CIN12, CIN15, CIN16 (OPT)	CAP, 1206	
2	0	CO17, CO18, CO25, CO26 (OPT)	CAP, 1812	
3	0	C8, C10 (OPT)	CAP, 0603	
4	0	L3, L4 (OPT)	IND IRON POWER SMT FIXED, 3.3 μ H	
5	0	R14 TO R21 (OPT)	RES, CHIP, 0603	
6	0	RS5 TO RS8 (OPT)	RES, CHIP, 1206	
7	0	U4, U5 (OPT)	IC, LTM4607EV#PBF, 15mm \times 9mm \times 2.3mm	LINEAR TECHNOLOGY, LTM4607EV#PBF

Demo Board 1601B-B

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components:				
1	1	DC1601 (COMMON BOM)		
2	2	CIN11, CIN12	CAP, X7R, 4.7 μ F, 50V, 10%, 1206	MURATA, GRM31CR71H475K
3	2	CO17, CO18	CAP, X5R, 22 μ F, 16V, 20%, 1812	TDK, C4532X7R1C226M
4	1	C8	CAP, NPO, 22pF, 50V, 5%, 0603	AVX, 06035A220JAT2A
5	1	L3	IND IRON POWER SMT FIXED, 3.3 μ H	TOKO, FDA1254-3R3M=P3
6	1	R5	RES, CHIP, 205k, 1/16W, 1%, 0603	VISHAY, CRCW0603205KFKEA
7	4	R14 TO R17	RES, CHIP, 0 Ω , 0603	VISHAY, CRCW06030000Z0EA
8	1	R22	RES, CHIP, 2.37k, 1/16W, 1%, 0603	VISHAY, CRCW06032K37FKEA
9	2	RS5, RS6	RES, CHIP, 0.015 Ω 1/2W, 1%, 1206	VISHAY, WSL1206R0150FEA
10	3	U1, U3, U4	I.C., LTM4607EV#PBF, 15mm \times 9mm \times 2.3mm	LINEAR TECHNOLOGY, LTM4607EV#PBF

Additional Demo Board Circuit Components:

1	0	CIN15, CIN16 (OPT)	CAP, 1206	
2	0	CO25, CO26 (OPT)	CAP, 1812	
3	0	C10 (OPT)	CAP, 0603	
4	0	L4 (OPT)	IND IRON POWER SMT FIXED, 3.3 μ H	
5	0	R4, R18 TO R21 (OPT)	RES, CHIP, 0603	
6	0	RS7, RS8 (OPT)	RES, CHIP, 1206	
7	0	U5 (OPT)	IC, LTM4607EV#PBF, 15mm \times 9mm \times 2.3mm	LINEAR TECH., LTM4607EV#PBF

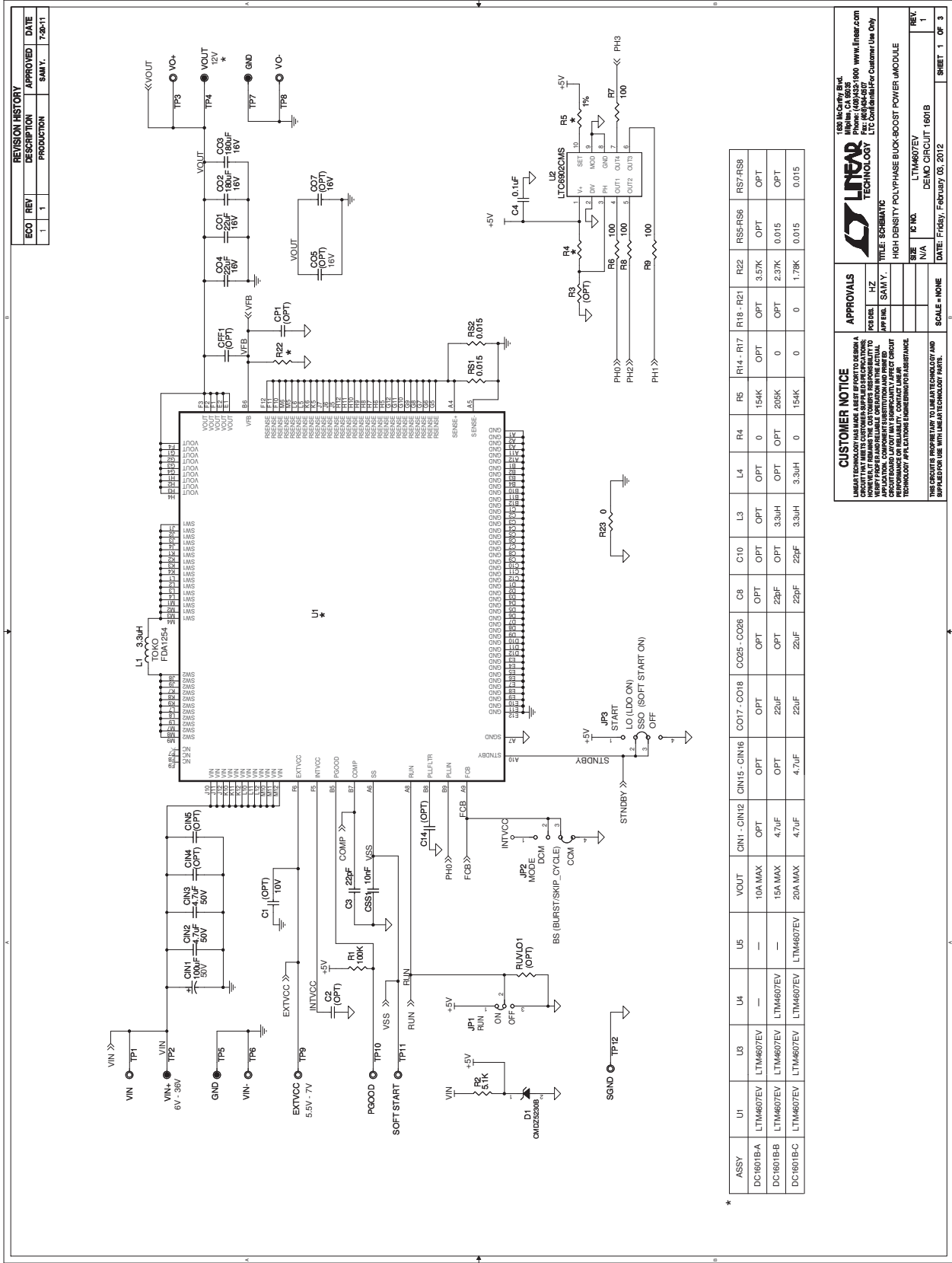
DEMO MANUAL DC1601B

PARTS LIST

Demo Board 1601B-C

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components:				
1	1	DC1601 (COMMON BOM)		
2	4	CIN11, CIN12, CIN15, CIN16	CAP, X7R, 4.7 μ F, 10%, 50V, 1206	MURATA, GRM31CR71H475K
3	4	CO17, CO18, CO25, CO26	CAP, X5R, 22 μ F, 16V, 20%, 1812	TDK, C4532X7R1C226M
4	2	C8, C10	CAP, NPO, 22pF, 50V, 5%, 0603	AVX, 06035A220JAT2A
5	2	L3, L4	IND IRON POWER SMT FIXED, 3.3 μ H	TOKO, FDA1254-3R3M=P3
6	9	R4, R14 TO R21	RES, CHIP, 0 Ω , 0603	VISHAY, CRCW06030000Z0EA
7	1	R5	RES, CHIP, 154k, 1/16W, 1%, 0603	VISHAY, CRCW0603154KFKEA
8	1	R22	RES, CHIP, 1.78k, 1/16W, 1%, 0603	VISHAY, CRCW06031K78FKEA
9	4	RS5 TO RS8	RES, CHIP, 0.015 Ω 1/2W, 1%, 1206	VISHAY, WSL1206R0150FEA
10	4	U1, U3, U4, U5	IC, LTM4607EV#PBF, 15mm \times 9mm \times 2.3mm	LINEAR TECHNOLOGY, LTM4607EV#PBF

SCHEMATIC DIAGRAM



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DESIGNER	HZ
APP'N	SAAMY

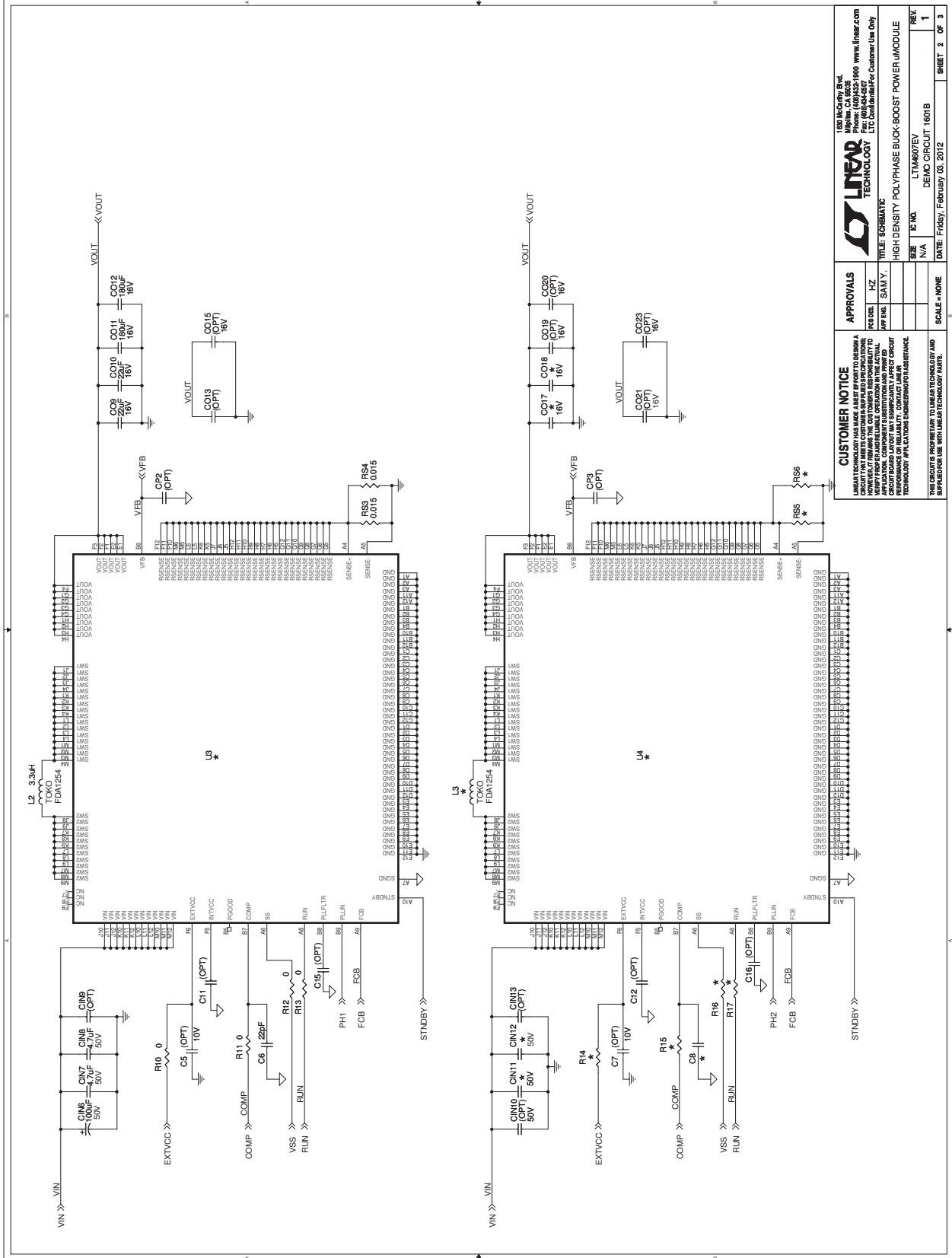
LINEAR TECHNOLOGY
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TITLE: SCHEMATIC
HIGH DENSITY POLY-PHASE BUCK-BOOST POWER MODULE

REV: 1
 DATE: Friday, February 03, 2012
 SCALE: NONE
 SHEET: 1 OF 3

DEMO MANUAL DC1601B

SCHEMATIC DIAGRAM



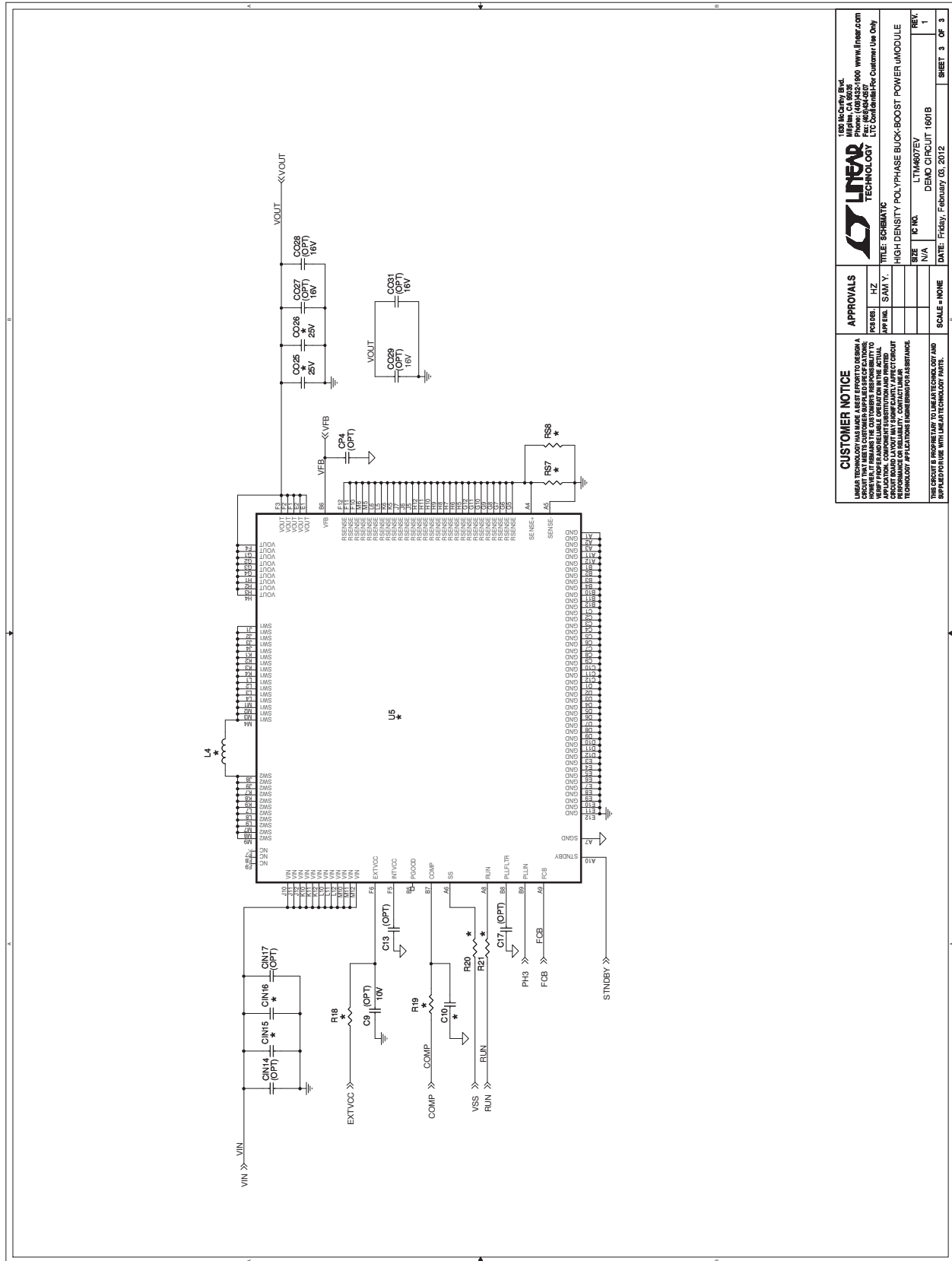
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		SCALE	HOME
		DATE	Friday, February 03, 2012
		REV	1
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LINEAR TECHNOLOGY
 HIGH DENSITY POLYPHASE BUCK-BOOST POWER MODULE
 DEMO CIRCUIT 1601B
 LTM4607EV

SCHEMATIC DIAGRAM



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APPROVALS
 DESIGNED BY: HZ
 APP'D BY: S.A.M. Y.
 SCALE: NONE

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TITLE: SCHEMATIC
PROJECT: HZ
DATE: Friday, February 03, 2012

LT1601EV
 DEMO CIRCUIT 1601B

REV: 1
SHEET 3 OF 3



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DEMO MANUAL DC1601B

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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.

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