

LTM4609EV: 36V_{IN}, 34V_{OUT} Buck-Boost DC/DC μ Module[®] Regulator

DESCRIPTION

Demonstration circuit DC1477A features the LTM[®]4609EV, a high voltage, high efficiency, high density switch mode buck-boost power module. The LTM4609EV regulates an output voltage above, below or equal to the input voltage. DC1477A accepts an input voltage from 10V to 36V with a preset output voltage of 30V at up to 3A. Derating may be necessary for certain V_{IN}, V_{OUT} and thermal conditions. An input π filter option is included on the DC1477A to minimize the input ripple. The switching frequency may be synchronized to an external clock from 200kHz to

400kHz to reduce undesirable frequency harmonics and/or parallel multiple modules for even higher output current. The LTM4609 data sheet must be read in conjunction with this demo manual prior to working on or modifying demo circuit DC1477A

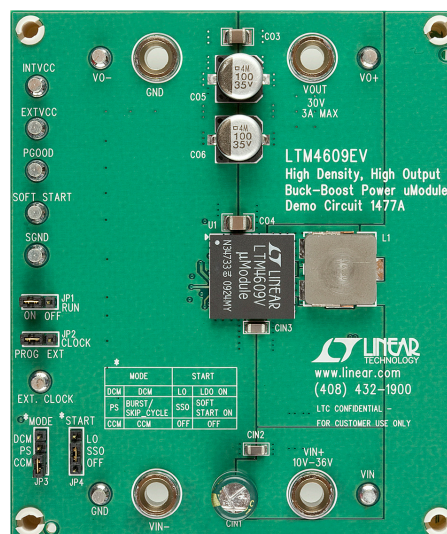
Design files for this circuit board are available at <http://www.linear.com/demo>

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PERFORMANCE SUMMARY (T_A = 25°C)

| PARAMETER | CONDITION | VALUE |
|-----------------------------------|---|---|
| Minimum Input Voltage | | 10V to 36V |
| Output Voltage V _{OUT} | | 30V \pm 2% |
| Maximum Continuous Output Current | Derating is Necessary for certain V _{IN} , V _{OUT} and Thermal Conditions | 3A DC at 10V _{IN} 8A DC at 24V _{IN} 10A DC at V _{IN} > 30V |
| Default Operating Frequency | | 300kHz |
| Efficiency | V _{IN} = 20V, V _{OUT} = 30V, I _{OUT} = 3A | 96.7%, See Figure 3 for More Information |

BOARD PHOTO



QUICK START PROCEDURE

Demonstration circuit DC1477A is an easy way to evaluate the performance of the LTM4609EV. 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 30V_{OUT} application:

| RUN | CLOCK | MODE | START |
|-----|-------|------|-------|
| ON | PROG | CCM | SSO |

2. With the power supply off, connect the input power supply, load and meters as shown in Figure 1. Preset the load to 0A and V_{IN} supply between 10V to 36V.
3. Turn on the power at the input. The output voltage should be 30V ±2%.
4. Once the proper output voltage is established, adjust the load within the operating range and observe the output voltage regulation, ripple voltage, efficiency and other parameters. A cooling fan and heat sink are necessary for V_{IN} < 10V and I_{OUT} = 3A.
5. To measure input and output ripple, please refer to Figure 2 for proper setup.
6. To adjust the switching frequency turn off the power supply and modify R6 and R7. Do not allow voltage at pin PLLFLTR to exceed 2.4V.
7. Inductor and R_{SENSE} should be modified to accommodate certain input and output condition. Refer to the data sheet for details.
8. The input filter formed by CIN2, L2 and L3, CIN3 and CIN4 is for the purpose of reducing the input voltage ripple. The magnetic beads L2 and L3 are not necessary, but they help to reduce the high frequency ringings on the input supply significantly. See Figure 5 for details.
9. The optional components R_{snb1} and C_{snb1}, R_{snb2} and C_{snb2} can be used to form RC snubber circuits on the switching nodes, which may help to reduce the output ripple. Refer to the data sheet for details.

QUICK START PROCEDURE

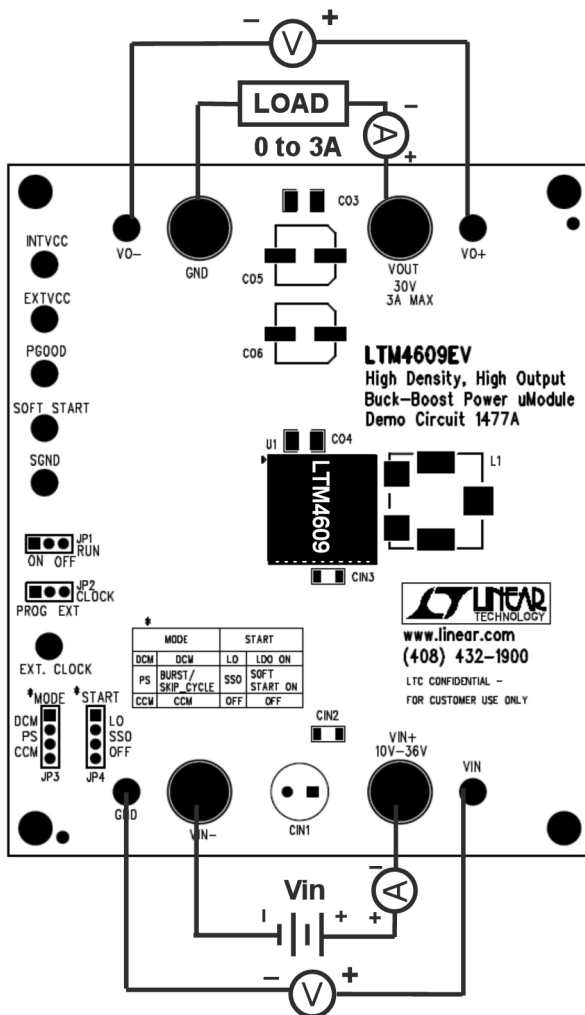
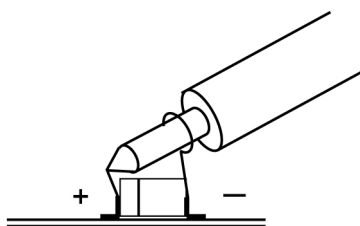


Figure 1. Test Setup of DC1477A

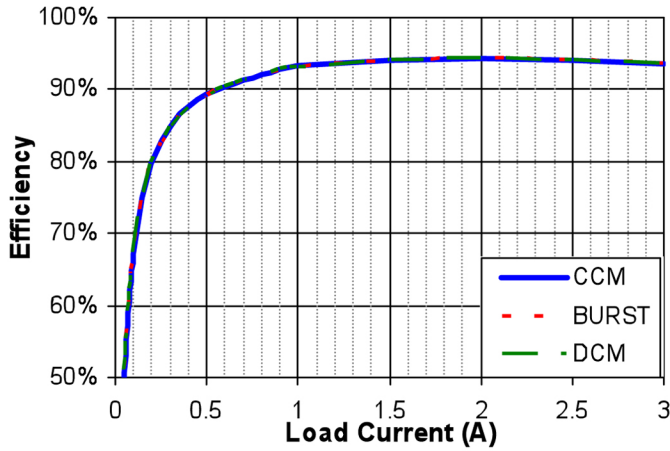


Input or Output Capacitor

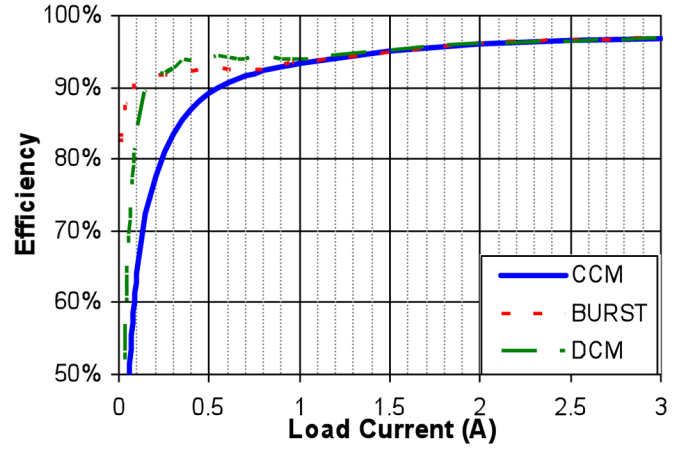
Figure 2. Proper Scope Probe Placement for Measuring Input or Output Ripple

QUICK START PROCEDURE

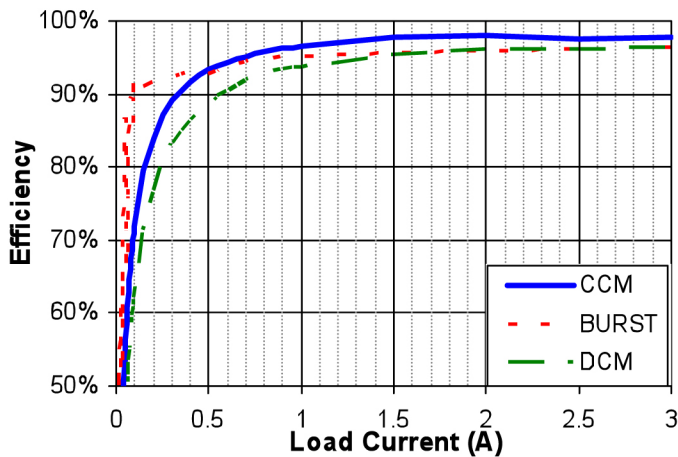
DC1477A/LTM4609 Efficiency at 10V_{IN} Input



DC1477A/LTM4609 Efficiency at 20V_{IN} Input



DC1477A/LTM4609 Efficiency at 30V_{IN} Input



DC1477A/LTM4609 Efficiency at 36V_{IN} Input

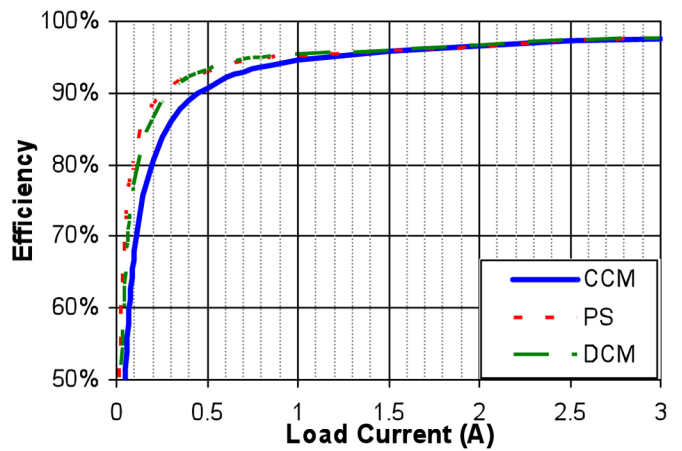
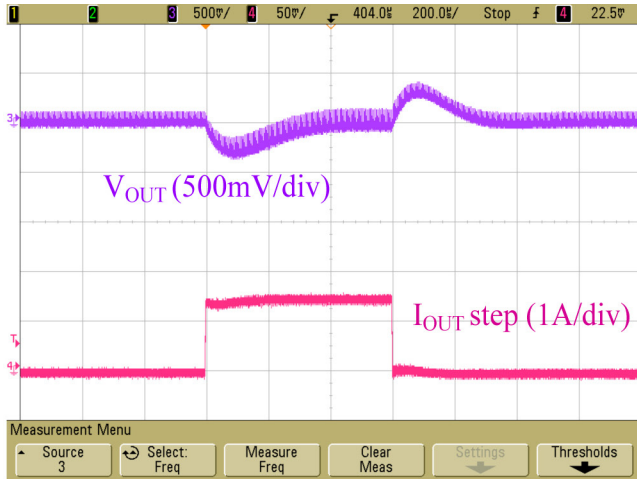
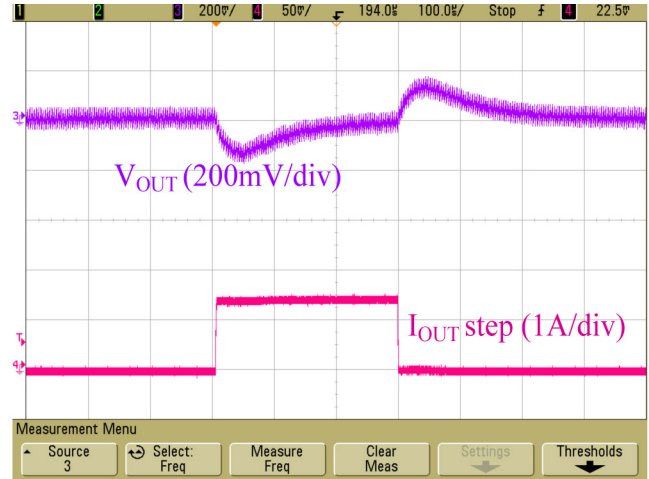


Figure 3. Measured Efficiency at Different V_{IN}

QUICK START PROCEDURE

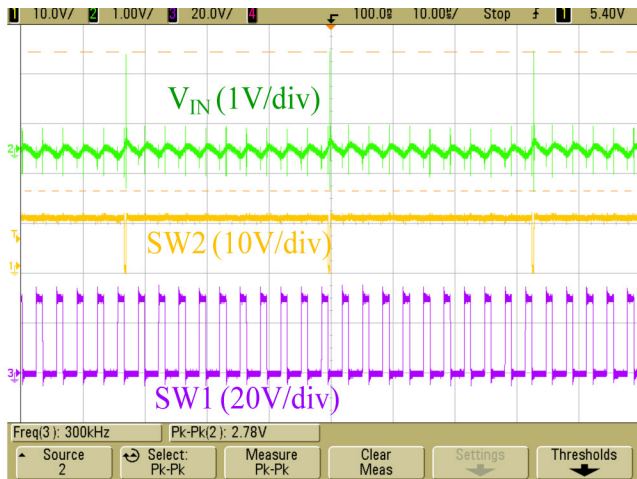


$V_{IN} = 10V$, $V_{OUT} = 30V$, CCM Mode
 1.5A to 3A Load Step
 $C_{OUT} = 2 \times 10\mu F$ Ceramic + $2 \times 100\mu F$ Alum

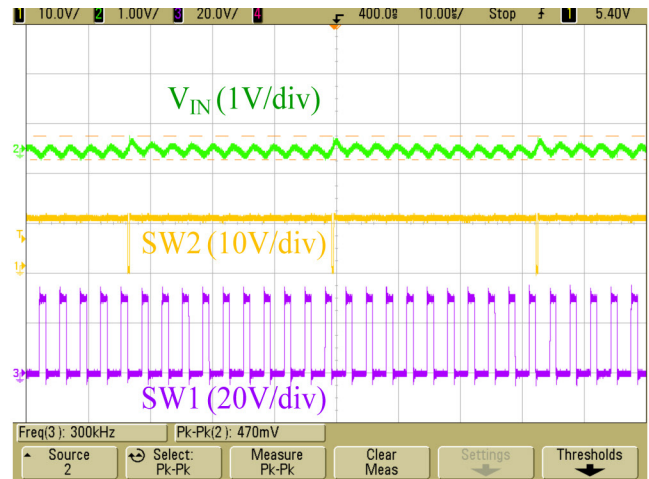


$V_{IN} = 36V$, $V_{OUT} = 30V$, CCM Mode
 1.5A to 3A Load Step
 $C_{OUT} = 2 \times 10\mu F$ Ceramic + $2 \times 100\mu F$ Alum

Figure 4. Measured Load Transient Response (1.5A Step, 50% to 100%)



$V_{IN} = 10V$, $V_{OUT} = 30V$, $I_{OUT} = 3A$
 W/O Input Filter: Short L2 and L3, Remove C_{IN2}
 V_{IN} Peak-to-Peak Ripple = 2.78V



$V_{IN} = 10V$, $V_{OUT} = 30V$, $I_{OUT} = 3A$
 W Input Filter: Stuff L2, L3 and C_{IN2}
 V_{IN} Peak-to-Peak Ripple = 0.47V

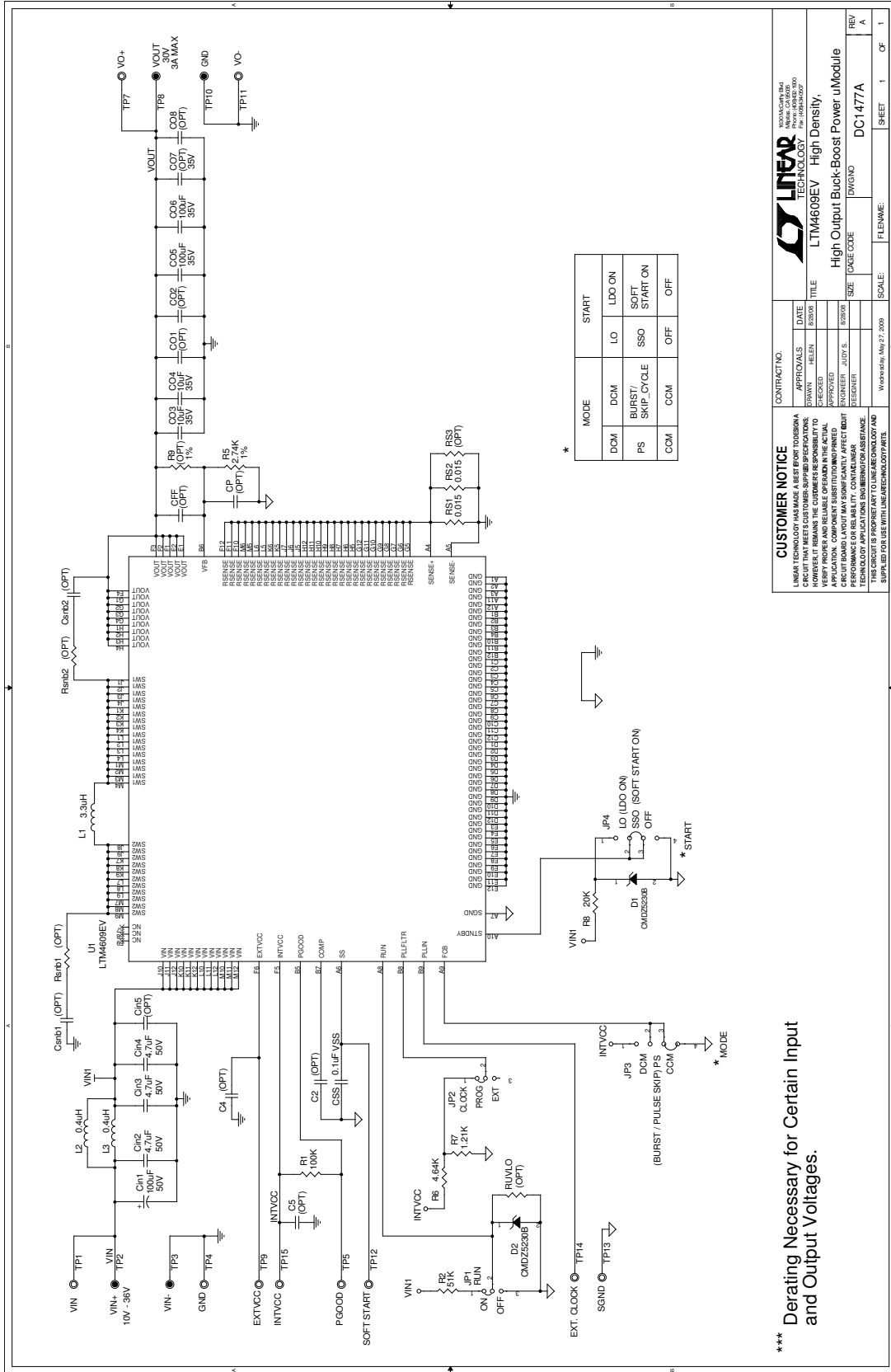
Figure 5. Input Voltage Ripple Measured at C_{IN1} with 300MHz BW Probe, with and without the Input Filter

DEMO MANUAL DC1477A

PARTS LIST

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|---|-----|---------------------------------------|---|--|
| Required Circuit Components | | | | |
| 1 | 1 | CSS | CAP, X7R, 0.1µF, 25V, 10%, 0603 | AVX, 06033C104KAT4A |
| 2 | 1 | CIN1 | CAP, ALUMINUM, 100µF, 20%, 50V | SANYO, 50ME100WX+TS (now SUNCON 50ME100WX) |
| 3 | 2 | C03, C04 | CAP, X7R, 10µF, 35V, 10%, 1210 | MURATA, GRM32ER7YA106KA12L |
| 4 | 3 | CIN2, CIN3, CIN4 | CAP, X7R, 4.7µF, 50V, 10%, 1206 | Taiyo Yuden, UMK316BJ475KL-T |
| 5 | 2 | C05, C06 | CAP, ALUMINUM, 100µF, 35V | SANYO, 35HVH100M (now SUNCON 35HVH100M) |
| 6 | 1 | L1 | IND. POWER IND, 3.3µH | VISHAY, IHLP5050FDER3R3M01 |
| 7 | 1 | R1 | RES., CHIP, 100k, 1/16W, 5%, 0603 | VISHAY, CRCW0603100KJNEA |
| 8 | 1 | R5 | RES., CHIP, 2.74k, 1/16W, 1%, 0603 | VISHAY, CRCW06032K74FKEA |
| 9 | 1 | R6 | RES., CHIP, 4.64k, 1/16W, 1%, 0603 | VISHAY, CRCW06034K64FKEA |
| 10 | 1 | R7 | RES., CHIP, 1.21k, 1/16W, 1%, 0603 | VISHAY, CRCW06031K21FKEA |
| 11 | 2 | RS1,RS2 | RES., CHIP, 0.015Ω 1/2W, 1%, 1206 | IRC, LRC-LRF1206-01-R015-F |
| 12 | 1 | U1 | I.C., LTM4609EV#PBF, 15mm x 15mm x 2.8mm LGA | LINEAR TECH., LTM4609EV#PBF |
| Additional Demo Board Circuit Components | | | | |
| 1 | 0 | CIN5, Csnb1, Csnb2 (OPT) | CAP, 1206 | |
| 2 | 0 | C2, C4, C5, CP, CFF (OPT) | CAP, 0603 | 50ME100WX+TS |
| 3 | 0 | C01, C02 (OPT) | CAP, SVP, 100µF, D3L | |
| 4 | 0 | C07 (OPT) | CAP, 1206, 35V | |
| 5 | 0 | C08 (OPT) | POSCAP, D3L | |
| 6 | 2 | D1, D2 | ZENER DIODE,4.7V | Central Semi., CMDZ5230B-7-F |
| 7 | 2 | L2, L3 | IND. POWER IND, 0.4µH, 1806 | Fair-Rite, 2518065007Y6 |
| 8 | 1 | R2 | RES., CHIP, 51k, 1/16W, 5%, 0603 | VISHAY, CRCW060351K0JNEA |
| 9 | 1 | R8 | RES., CHIP, 20k, 1/16W, 1%, 0603 | VISHAY, CRCW060320K0FKEA |
| 10 | 0 | RS3, Rsnb1, Rsnb2 (OPT) | RES.,1206 | |
| 11 | 0 | R9, RUVLO (OPT) | RES., 0603 | |
| Hardware: For Demo Board Only | | | | |
| 1 | 2 | JP1, JP2 | 2MM SINGLE ROW HEADER, 3-PIN | SAMTEC, TMM-103-02-L-S |
| 2 | 2 | JP3, JP4 | 2MM SINGLE ROW HEADER, 4-PIN | SAMTEC, TMM-104-02-L-S |
| 3 | 4 | JP1, JP2, JP3, JP4 | SHUNT | SAMTEC, 2SN-BK-G |
| 4 | 10 | TP1, TP4, TP5, TP7, TP9, TP11-TP15 | TESTPOINT, TURRET, 0.095" | MILL-MAX, 2501-2-00-80-00-00-07-0 |
| 5 | 4 | TP2, TP3, TP8, TP10 | BANANA JACK, | KEYSTONE, 575-4 |
| 6 | 4 | STAND OFF | STAND-OFF, NYLON 0.50" TALL | KEYSTONE, 8833 (SNAP ON) |

SCHEMATIC DIAGRAM



| | | | |
|--------------------|----------|------|-------------------|
| CONTRACTING NO. | | DATE | |
| APPROVALS | DATE | MODE | START |
| DESIGNED BY: HELEN | 03/20/08 | DCM | LO LDO ON |
| CHECKED BY: JUDY/S | 03/20/08 | PS | SSO SOFT START ON |
| DESIGNED BY: HELEN | 03/20/08 | CCM | CCM OFF |
| DESIGNED BY: HELEN | 03/20/08 | CCM | CCM OFF |

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***** Derating Necessary for Certain Input and Output Voltages.**



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DEMO MANUAL DC1477A

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