

# LTM4639 Low $V_{IN}$ 20A DC/DC $\mu$ Module Step-Down Regulator

## DESCRIPTION

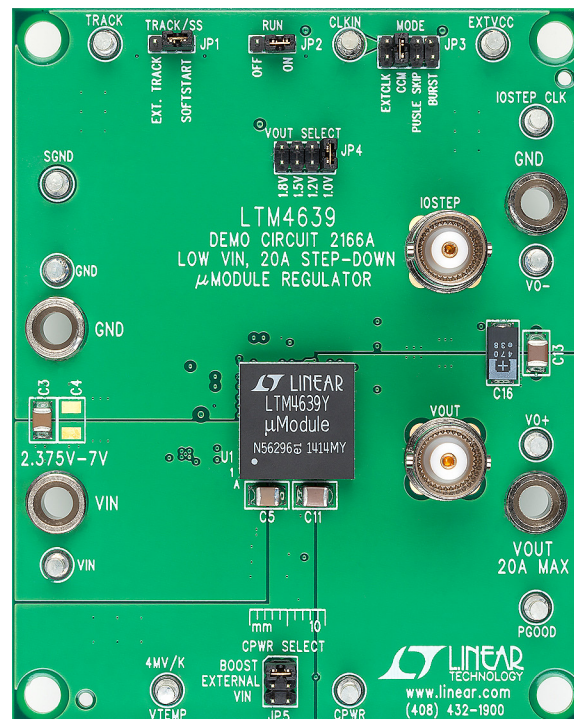
Demonstration circuit 2166A features the **LTM®4639EY**, a 20A high efficiency, switch mode step-down power  $\mu$ Module® regulator. The input voltage range is from 2.375V to 7V. The output voltage range is 0.6V to 5.5V. Derating is necessary for certain  $V_{IN}$ ,  $V_{OUT}$ , frequency and thermal conditions. The DC2166A offers the TRACK/SS pin allowing the user to program output tracking or soft-start period. The board operates in continuous conduction mode in heavy load conditions. For high efficiency at low load currents, the MODE jumper (JP3) selects pulse-skipping mode for noise sensitive applications or Burst Mode® operation in less noise sensitive applications. There is an

on board boost circuit using LT1935 to provide control power to LTM4639 when  $V_{IN}$  is less than 4.5V. LTM4639 has on board diode connected PNP transistors to monitor its internal temperature. A temperature sensor LTC2997 converts the internal temperature to an analog voltage output. The LTM4639 data sheet must be read in conjunction with this demo manual prior to working on or modifying demo circuit DC2166A.

**Design files for this circuit board are available at**  
<http://www.linear.com/demo/DC2166A>

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## BOARD PHOTO



## PERFORMANCE SUMMARY

| PARAMETER                         | CONDITIONS/NOTES                                                                    | VALUE                                                                                                                                                                |
|-----------------------------------|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Input Voltage Range               |                                                                                     | 2.375V to 7V                                                                                                                                                         |
| Output Voltages                   |                                                                                     | 1.0V, 1.2V, 1.5V, 1.8V $\pm$ 1.5%                                                                                                                                    |
| Maximum Continuous Output Current | Derating is necessary for certain operating conditions. See data sheet for details. | 20ADC                                                                                                                                                                |
| Operating Frequency               |                                                                                     | 500kHz                                                                                                                                                               |
| Efficiency                        | $V_{IN} = 3.3V$ , $I_{OUT} = 20A$                                                   | 83.2% ( $V_{OUT1} = 1.0V$ ) (Figure 2)<br>85.3% ( $V_{OUT1} = 1.2V$ ) (Figure 2)<br>87.7% ( $V_{OUT1} = 1.5V$ ) (Figure 2)<br>89.1% ( $V_{OUT1} = 1.8V$ ) (Figure 2) |
| Load Transient                    | $V_{IN} = 3.3V$ , $V_{OUT} = 1.0V$ , $I_{STEP} = 0A$ to 10A                         | 156mV (Figure 4)                                                                                                                                                     |

## QUICK START PROCEDURE

Demonstration circuit DC2166A is an easy way to evaluate the performance of the LTM4639EY. Please refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

- Place jumpers in the following positions for a typical application:

| RUN | TRACK/SS   | MODE | $V_{OUT}$ SELECT | CPWR SELECT |
|-----|------------|------|------------------|-------------|
| ON  | SOFT-START | CCM  | 1.0V             | BOOST       |

- 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 3.3V.
- Turn on the power supply at the input. The output voltage should be 1.0V  $\pm$  1.5% (0.985V to 1.015V).
- Vary the input voltage from 2.375V to 7V and adjust the load current from 0A to 20A. Observe the output voltage regulation, ripple voltage, efficiency, and other parameters.

- (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.
- (Optional) LTM4639 can be synchronized to an external clock signal. Place the JP3 jumper on EXTCLK and apply a clock signal (0V to 5V, square wave) on the CLKIN test point.
- (Optional) The outputs of LTM4639 can track another supply by setting JP1 to EXT. TRACK. If tracking external voltage is selected, the corresponding test point TRACK need to be connected to a valid voltage signal.

## QUICK START PROCEDURE

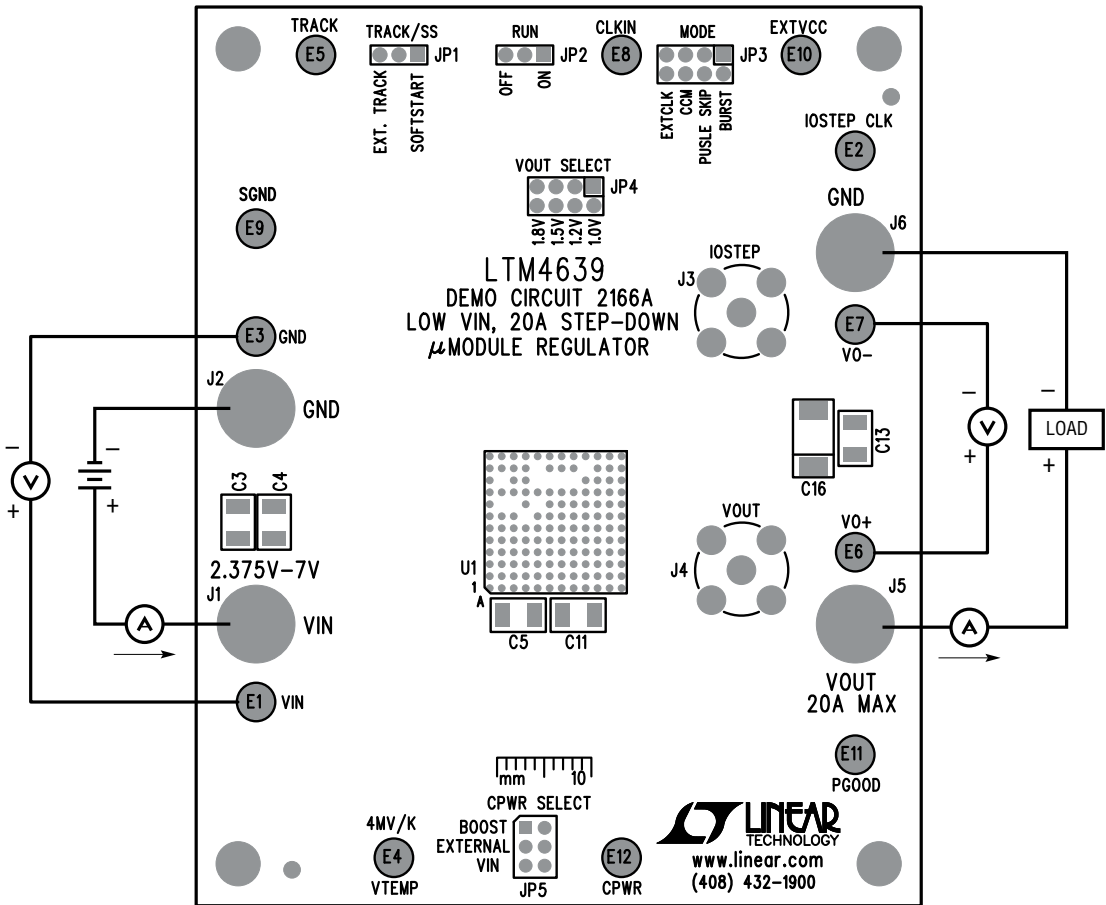


Figure 1. Measurement Setup of DC2166A

QUICK START PROCEDURE

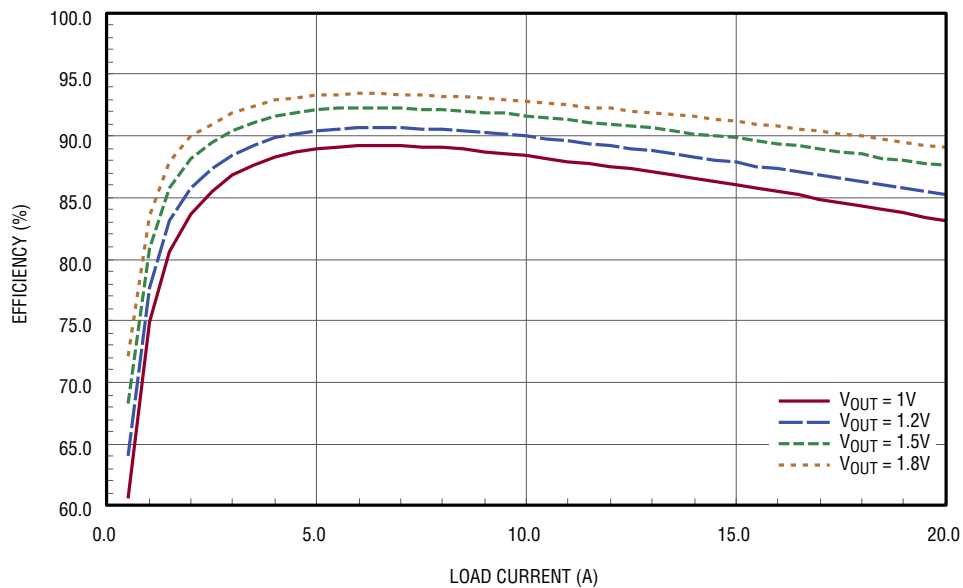


Figure 2. Measured Efficiency at  $V_{IN} = 3.3V$ ,  $f_{SW} = 500kHz$ , CCM

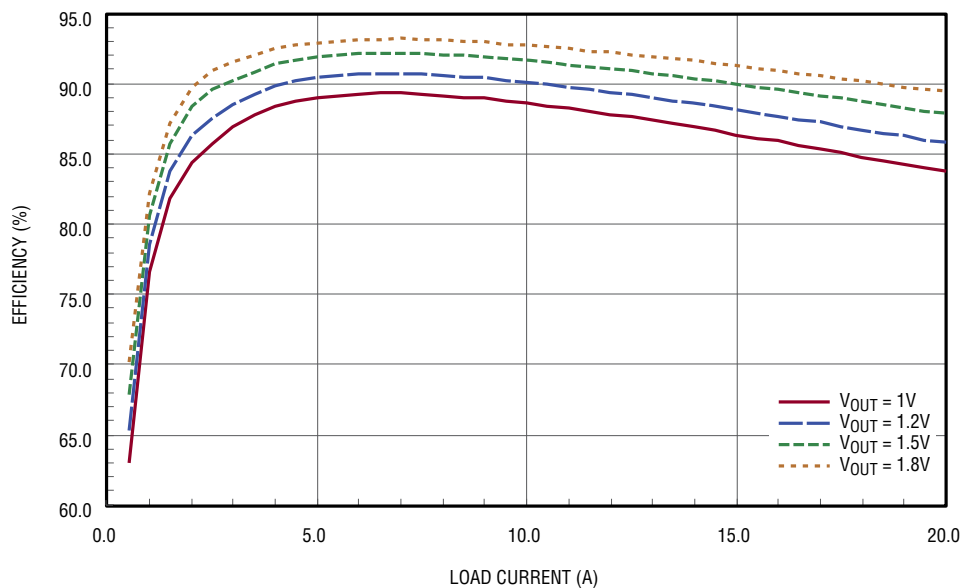
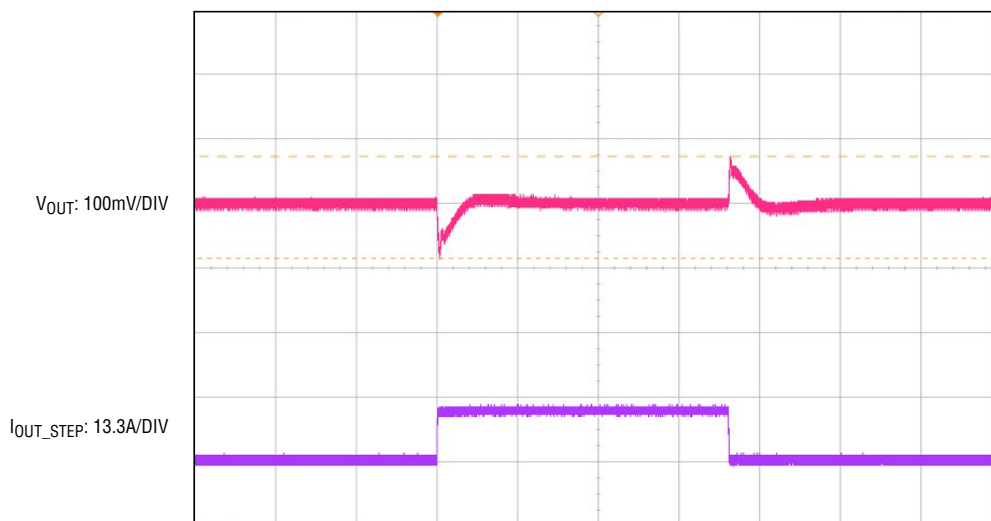
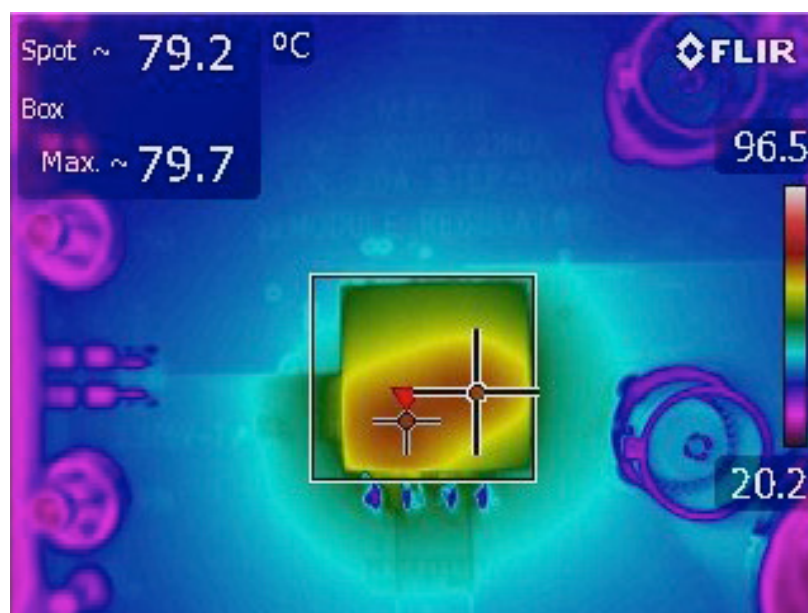


Figure 3. Measured Efficiency at  $V_{IN} = 5.0V$ ,  $f_{SW} = 500kHz$ , CCM

## QUICK START PROCEDURE



**Figure 4. Measured Load Transient**  
 $V_{IN} = 3.3\text{V}$ ,  $V_{OUT1} = 1.0\text{V}$ ,  $I_{STEP} = 0\text{A to } 10\text{A}$



**Figure 5. Thermal Image of LTM4639**  
 $V_{IN} = 3.3\text{V}$ ,  $V_{OUT} = 1.8\text{V}$ ,  $I_{LOAD} = 20\text{A}$   
 Ambient Temperature =  $23.3^{\circ}\text{C}$ , No Forced Air Flow

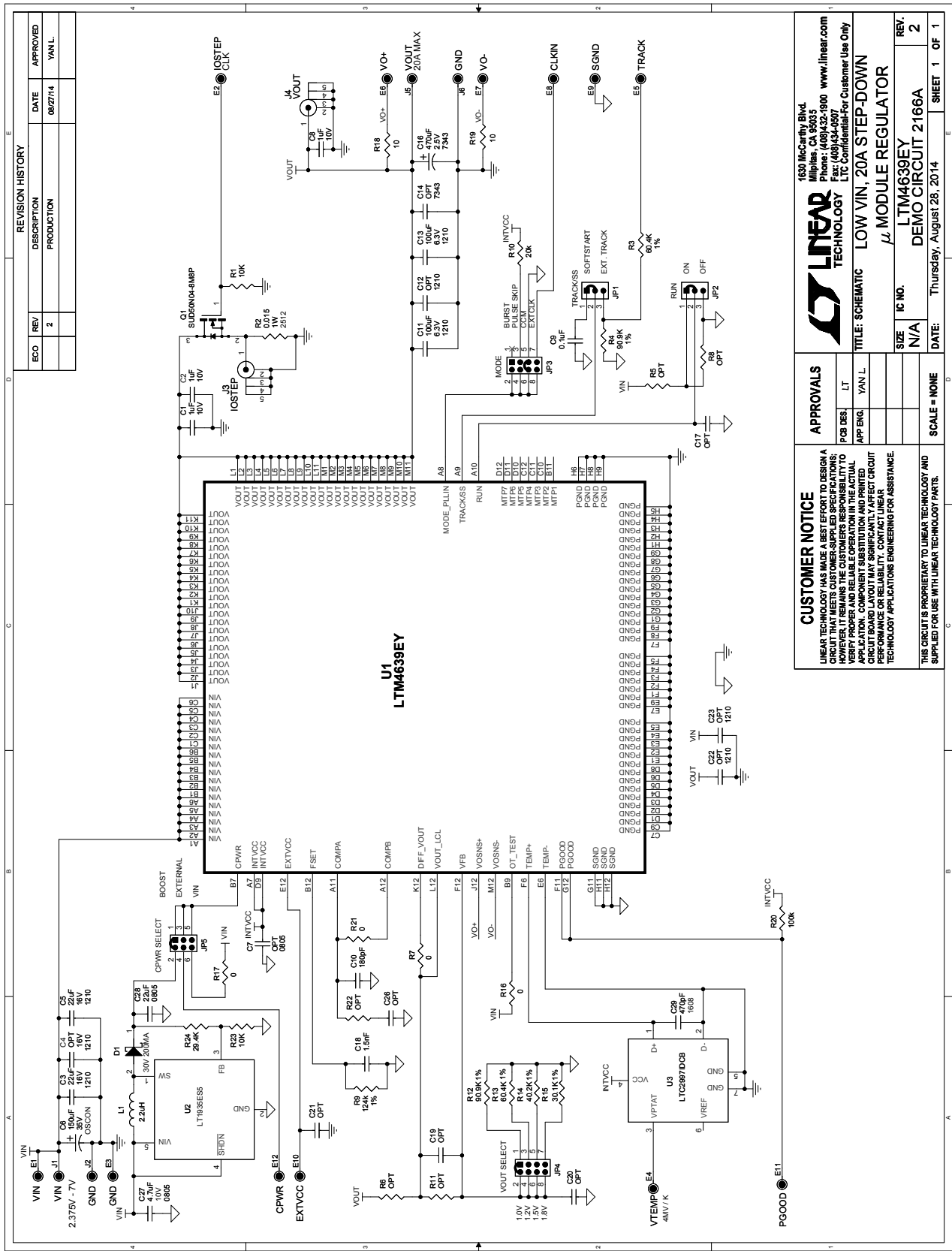
# DEMO MANUAL DC2166A

## PARTS LIST

| ITEM                                            | QTY | REFERENCE                    | PART DESCRIPTION                         | MANUFACTURER/PART NUMBER         |
|-------------------------------------------------|-----|------------------------------|------------------------------------------|----------------------------------|
| <b>Required Circuit Components</b>              |     |                              |                                          |                                  |
| 1                                               | 2   | C3, C5                       | CAP, 1210, 22 $\mu$ F, 10%, 16V, X5R     | MURATA GRM32ER61E226KE20L        |
| 2                                               | 1   | C6                           | CAP, 150 $\mu$ F, 35V, ELEC              | SUN ELEC 35CE150AX               |
| 3                                               | 1   | C9                           | CAP, 0603, 0.1 $\mu$ F, 10%, 50V, X7R    | TDK C1608X7R1H104K               |
| 4                                               | 1   | C10                          | CAP, 0603, 180pF, 10%, 10V, X7R          | AVX, 0603ZC181KAT2A              |
| 5                                               | 2   | C11, C13                     | CAP, 1210, 100 $\mu$ F, 20%, 6.3V, X5R   | TDK C3225X5R0J107M               |
| 6                                               | 1   | C16                          | CAP, 7343, 470 $\mu$ F, 20%, 2.5V POSCAP | PANASONIC 2R5TPE470M9            |
| 7                                               | 1   | C18                          | CAP, 0603, 1.5nF, 5%, 25V, X7R           | AVX 06033C152JAT2A               |
| 8                                               | 1   | R13                          | RES, 0603, 60.4k $\Omega$ , 1%, 1/10W    | VISHAY CRCW060360K4FKEA          |
| 9                                               | 1   | R12                          | RES, 0603, 90.9k $\Omega$ , 1%, 1/10W    | VISHAY CRCW060390K9FKEA          |
| 10                                              | 1   | R9                           | RES, 0603, 124k $\Omega$ , 1%, 1/10W     | VISHAY CRCW0603124K0FKEA         |
| 11                                              | 1   | R14                          | RES, 0603, 40.2k $\Omega$ , 1%, 1/10W    | VISHAY CRCW060340K2FKEA          |
| 12                                              | 1   | R15                          | RES, 0603, 30.1k $\Omega$ , 1%, 1/10W    | VISHAY CRCW060330K1FKEA          |
| 13                                              | 1   | R20                          | RES, 0603, 100k $\Omega$ , 5%, 1/10W     | VISHAY CRCW0603100KJNEA          |
| 14                                              | 1   | U1                           | IC, LTM4639EY                            | LINEAR TECH LTM4639EY#PBF        |
| <b>Additional Demo Board Circuit Components</b> |     |                              |                                          |                                  |
| 1                                               | 3   | C1, C2, C8                   | CAP, 0603, 1 $\mu$ F, 20%, 10V, X5R      | TDK, C1608X5R1A105M              |
| 2                                               | 0   | C4, C12, C22, C23            | CAP, 1210 OPTION                         | OPTION                           |
| 3                                               | 0   | C7                           | CAP, 0805 OPTION                         | OPTION                           |
| 4                                               | 0   | C14                          | CAP, 7343 OPTION                         | OPTION                           |
| 5                                               | 0   | C17, C19, C20, C21, C26      | CAP, 0603 OPTION                         | OPTION                           |
| 6                                               | 1   | C27                          | CAP, 0805, 4.7 $\mu$ F, 20%, 10V, X7R    | TDK C2012X7R1A475M               |
| 7                                               | 1   | C28                          | CAP, 0805, 22 $\mu$ F, 10%, 16V, X5R     | TDK C2012X5R1C226K               |
| 8                                               | 1   | C29                          | CAP, 0603, 470pF, 10%, 10V, X7R          | AVX, 0603ZC471KAT2A              |
| 9                                               | 1   | D1                           | DIODE, SCHOTTKY 30V                      | ON SEMI NSR0230P2T5G             |
| 10                                              | 1   | L1                           | IND, 2.2 $\mu$ H, 2012                   | TAIYO YUDEN CBC2012T2R2M         |
| 11                                              | 1   | Q1                           | XSTR, MOSFET, N-CHANNEL 30V              | VISHAY SUD50N04-8M8P-4GE3        |
| 12                                              | 2   | R1, R23                      | RES, 0603, 10k $\Omega$ , 5%, 1/10W      | VISHAY CRCW060310K0JNEA          |
| 13                                              | 1   | R2                           | RES, 2512, 0.015 $\Omega$ , 1%, 1W       | VISHAY WSL2512R0150FEA           |
| 14                                              | 1   | R3                           | RES, 0603, 60.4k $\Omega$ , 1%, 1/10W    | VISHAY CRCW060360K4FKEA          |
| 15                                              | 1   | R4                           | RES, 0603, 90.9k $\Omega$ , 1%, 1/10W    | VISHAY CRCW060390K9FKEA          |
| 16                                              | 0   | R5, R6, R8, R11, R22         | RES, 0603 OPTION                         | OPTION                           |
| 17                                              | 4   | R7, R16, R17, R21            | RES, 0603, 0 $\Omega$ JUMPER             | VISHAY CRCW06030000Z0ED          |
| 18                                              | 1   | R10                          | RES, 0603, 20k $\Omega$ , 5%, 1/10W      | VISHAY CRCW060320K0JNEA          |
| 19                                              | 2   | R18, R19                     | RES, 0603, 10 $\Omega$ , 5%, 1/10W       | VISHAY CRCW060310R0JNEA          |
| 20                                              | 1   | R24                          | RES, 0603, 29.4k $\Omega$ , 1% 1/10W     | VISHAY CRCW060329K4FKEA          |
| 21                                              | 1   | U2                           | IC, LT1935AES5                           | LINEAR TECH. LT1935ES5#PBF       |
| 22                                              | 1   | U3                           | IC, LTC2997IDCB                          | LINEAR TECH., LTC2997IDCB#PBF    |
| <b>Hardware</b>                                 |     |                              |                                          |                                  |
| 1                                               | 12  | E1-E12                       | TESTPOINT,TURRET,.094"                   | MILL-MAX 2501-2-00-80-00-00-07-0 |
| 2                                               | 2   | JP1, JP2                     | HEADER, 1 $\times$ 3, 2mm                | SULINS, NRPN031PAEN-RC           |
| 3                                               | 2   | JP3, JP4                     | HEADER, 2 $\times$ 4, DOUBLE ROW, 2mm    | SULINS, NRPN042PAEN-RC           |
| 4                                               | 2   | JP5                          | HEADER, 2 $\times$ 3, DOUBLE ROW, 2mm    | SULINS, NRPN032PAEN-RC           |
| 5                                               | 4   | J1, J2, J5, J6               | JACK, BANANA                             | KEYSTONE 575-4                   |
| 6                                               | 2   | J3,J4                        | CONN., VERT. PC-MNT, BNC 50 $\Omega$     | CONNEX 112404                    |
| 7                                               | 5   | XJP1, XJP2, XJP3, XJP4, XJP5 | SHUNT                                    | SAMTEC 2SN-BK-G                  |
| 8                                               | 4   | MH1, MH2, MH3, MH4           | STANDOFF, SNAP ON                        | KEYSTONE_8834                    |
| 9                                               | 2   |                              | STENCILS TOP AND BOTTOM                  | STENCIL DC2166A                  |

dc2166af

SCHEMATIC DIAGRAM





# DEMO MANUAL DC2166A

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