

LTC3310S 5V, Multiphase (40A, 30A, 20A), Synchronous Step-Down Silent Switcher 2

DESCRIPTION

Demonstration Circuit DC2874A shows the **LTC®3310S** 10A, Low Voltage, Synchronous Step-Down Silent Switcher operating as a multiphase 2.0MHz, 3.3V to 1.2V buck regulator. The DC2874A has three build options to provide a two phase 20A, three phase 30A, or four phase 40A output solution. The LTC3310S supports adjustable output voltages from 0.5V to V_{IN} and operating frequencies from 500kHz up to 2.25MHz in multiphase operation.

DC2874A operates in pulse skip mode and allows the slave phases to stop switching first before the master starts skipping pulses for better low current efficiency.

The DC2874A also has an EMI filter to reduce conducted EMI. This EMI filter can be included by applying the input

voltage at the VIN EMI terminal. The EMI performance of the board is shown in the EMI TEST RESULTS section. The red lines in the EMI performance graphs illustrate the CISPR25 Class 5 peak limits for the conducted and radiated emission tests.

The Efficiency vs. Load graph shows the efficiency of the circuit with a 3.3V input for the 2-, 3-, 4-phase circuits.

The LTC3310S datasheet gives a complete description of the device, operation and application information. The data sheet must be read in conjunction with this demo manual. The LTC3310S is assembled in a 3mm x 3mm LQFN package with exposed pads for low thermal resistance.

Design files for this circuit board are available.

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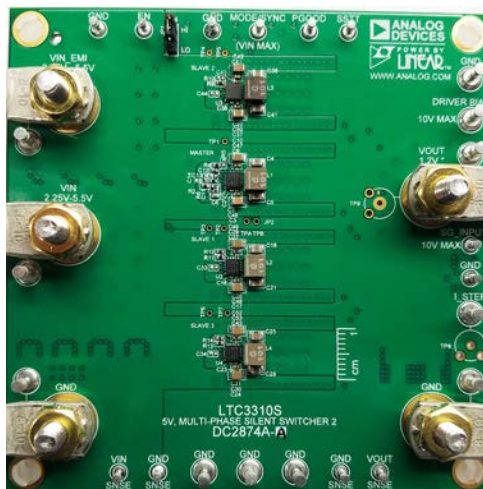
PERFORMANCE SUMMARY

Specifications are at $T_A = 25^\circ\text{C}$

| SYMBOL | PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS |
|----------------------|----------------------------------|--|-------|------|----------------|-------------|
| $V_{IN}/V_{IN\ EMI}$ | DC2874A Input Voltage Range | | 2.25 | | 5.5 | V |
| V_{OUT} | DC2874A V_{OUT} Voltage Range* | | 1.176 | 1.2 | 1.224 | V |
| I_{OUT} | DC2874A Output Current | -A, 4 phase build option -B, 3 phase build option -C, 2 phase build option | | | 40 30 20 | A A A |
| f_{SW} | Switching Frequency | V_{IN} greater than V_{OUT} | 1.8 | 2 | 2.2 | MHz |
| | Efficiency | 2, 3, or 4 phase | | 92.5 | | % |

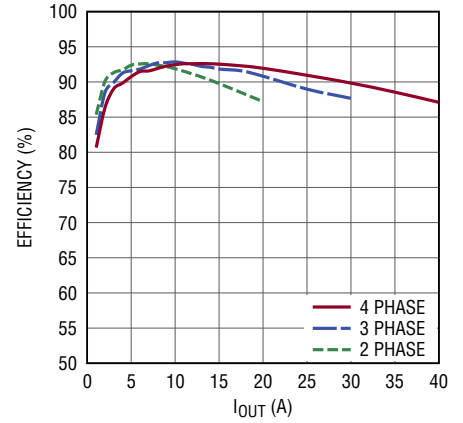
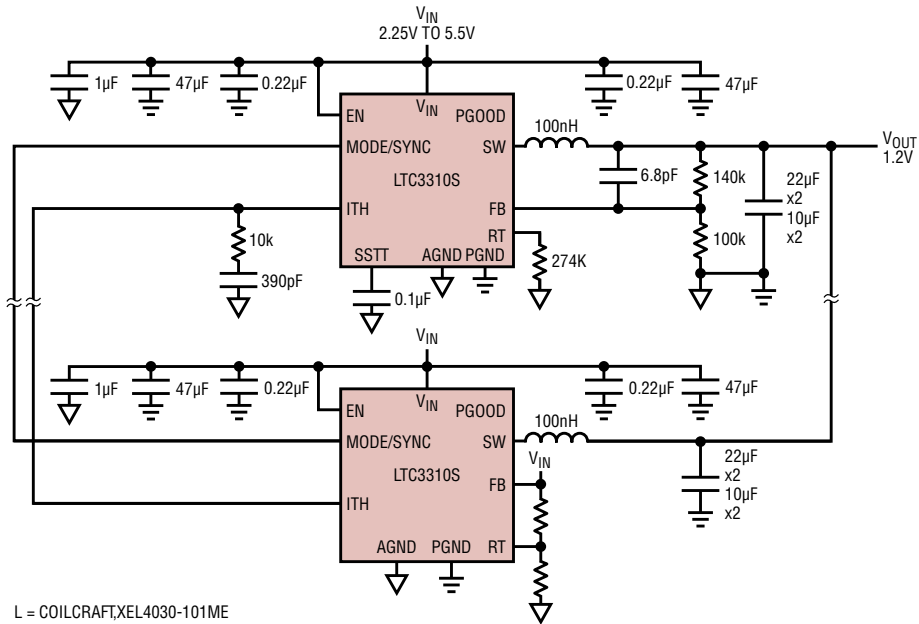
*With 1% resistors. Accuracy will improve to within 1% using 0.1% resistors.

BOARD PHOTO



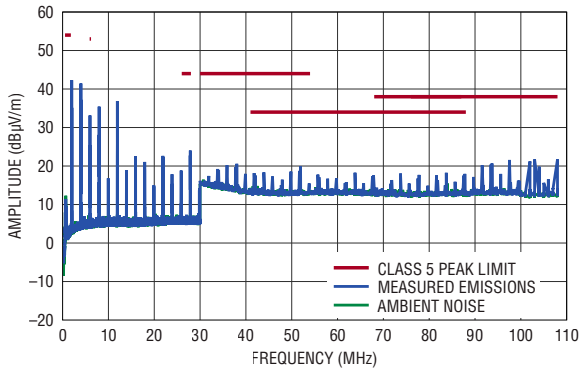
DEMO MANUAL DC2874A-A/ DC2874A-B/DC2874A-C

TYPICAL APPLICATION



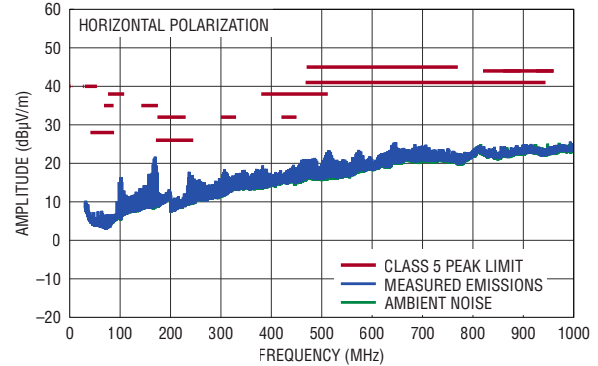
L = COILCRAFTXEL4030-101ME

Conducted EMI Performance (CISPR25 Conducted Emission Test with Class 5 Peak Limits)



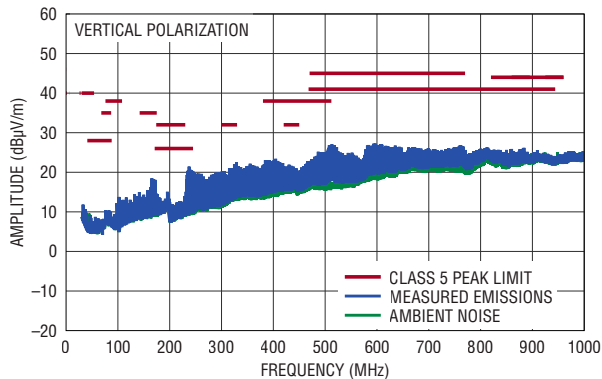
DC2874A-A 4-PHASE DEMO BOARD
(WITH EMI FILTER INSTALLED)
3.3V INPUT TO 1.2V OUTPUT AT 32A, $f_{SW} = 2\text{MHz}$

Radiated EMI Performance (CISPR25 Radiated Emission Test with Class 5 Peak Limits)



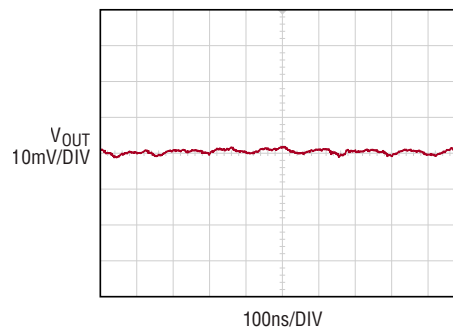
DC2874A-A 4-PHASE DEMO BOARD
(WITH EMI FILTER INSTALLED)
3.3V INPUT TO 1.2V OUTPUT AT 32A, $f_{SW} = 2\text{MHz}$

Radiated EMI Performance (CISPR25 Radiated Emission Test with Class 5 Peak Limits)



DC2874A-A 4-PHASE DEMO BOARD
(WITH EMI FILTER INSTALLED)
3.3V INPUT TO 1.2V OUTPUT AT 32A, $f_{SW} = 2\text{MHz}$

V_{OUT} Ripple (I_{OUT} = 40A)



QUICK START PROCEDURE

Demonstration circuit 2874A is easy to set up and evaluate the performance of the LTC3310S in multiphase operation. Refer to Figure 1 for the proper measurement equipment setup and jumper settings. Follow the procedure below to familiarize yourself with the DC2874A.

NOTE: For accurate V_{IN} , V_{OUT} and efficiency measurements, measure V_{IN} at the VIN SNSE and GND SNSE turrets and V_{OUT} at the VOUT SNSE and GND SNSE turrets as illustrated as VM1 and VM2 in Figure 1. When measuring the input or output voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the output voltage ripple by touching the probe tip directly across the output turrets or to TP1 as shown in Figure 2.

1. Set the JP1 Jumper to the HI position.
2. With power off, connect the input power supply to VIN and GND. If the input EMI filter is desired, connect the input power supply to VIN EMI and GND.
3. Slowly increase PS1 to 1.0V. If AM1 reads less than 20mA, increase PS1 to 3.3V. Verify that VM1 reads 3.3V and VM2 reads 1.2V. Record VM1, VM2, VM3 AM1 and AM2. Connect an oscilloscope voltage probe as shown in Figure 2. Set Channel to AC coupled, voltage scale to 10mV and time base to 100ns. Record V_{OUT} ripple voltage. Verify that PGOOD voltage is above 3V. Set the EN Jumper, JP1, to the HI position.
4. Increase the load by 1A intervals up to full load and observe the voltage output regulation, ripple voltage.
5. To test the transient response with a base load, turn off LD1 and add the desired resistor to produce a minimum load between VOUT and I_STEP turrets (RL shown on Figure 1).

Note that the total load resistance will be RL plus the parallel combination of R16 and R18 (10m Ω).

The DC2874A uses a buffered signal generator input to drive a source follower circuit and control the slew rate and amplitude of the current transient. The source follower FET, Q1, is operated in the linear region during the load step. The current step is measured as the voltage across the parallel combination of R16 and R18 (10m Ω), V_{I_STEP} .

6. Connect PS2 to the DRIVER BIAS and GND turrets. Turn on and set PS2 to 8V.
7. Measure the I_STEP voltage to observe the current, $V_{I_STEP}/10m\Omega$. Adjust the amplitude of the pulse to provide the desired transient. Adjust the rising and falling edge of the pulse to provide the desired ramp rate. Figure 3 shows a load step from 8A (RL = 150m Ω) to 36A. Refer to the following equations:

$$I_{OUT} = \frac{V_{I_STEP}}{10m\Omega} \quad (1)$$

Where:

$$V_{I_STEP} = V_{SG_INPUT} - V_{GS} \quad (2)$$

8. Set a signal generator with a 1ms pulse width, a 10ms period and an amplitude from 0V to 3V, and then connect it to the SG_INPUT turret.

NOTE: Do not allow the pulse generator to have more than a 20% duty cycle. This can allow too much power to be dissipated in Q1 and can damage the FET.

9. Connect an oscilloscope with a horizontal scale of 200us/Div with one channel having a vertical scale of 2V/Div on the SG_INPUT and another with a vertical scale of 50mV/Div to the I_STEP turret.
10. Adjust the amplitude of the SG_INPUT pulse to obtain the desired load pulse observed on the I_STEP turret.
11. Turn off PS1, PS2 and the signal generator. Remove all connections from demo board.

DEMO MANUAL DC2874A-A/ DC2874A-B/DC2874A-C

QUICK START PROCEDURE

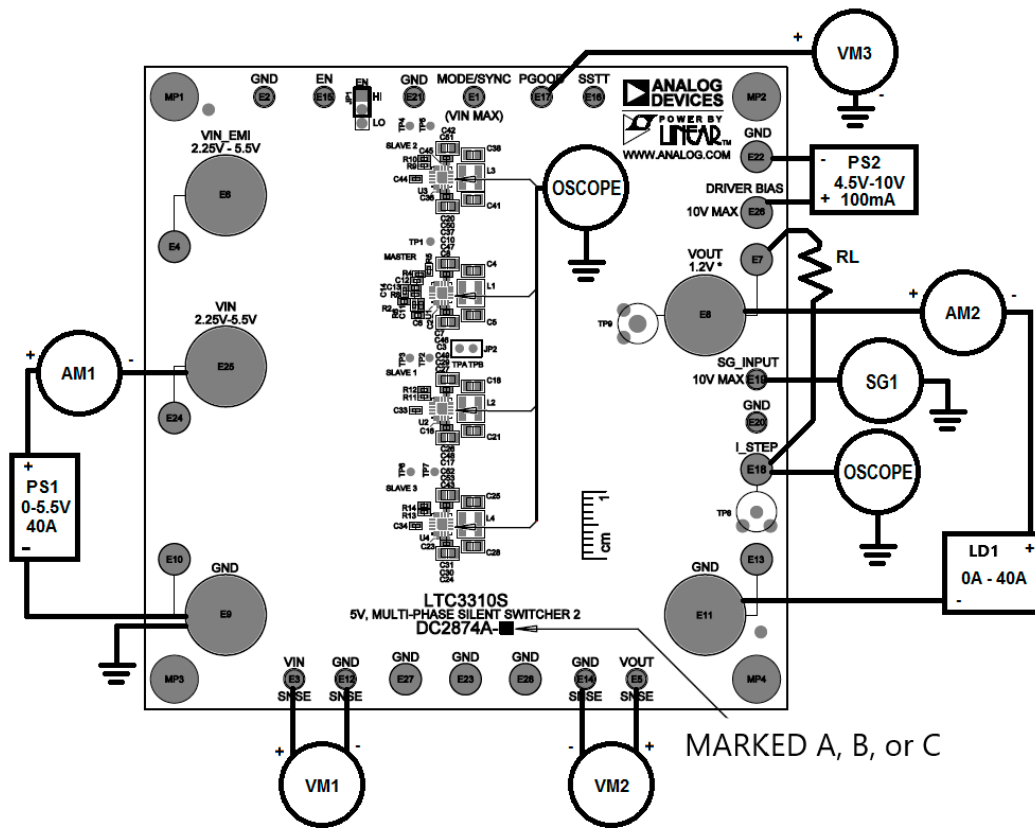


Figure 1. Test Setup for the DC2874A Demo Board

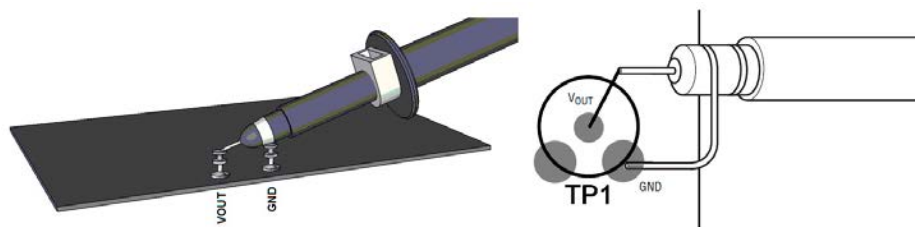


Figure 2. Technique for Measuring Output Ripple and Step Response

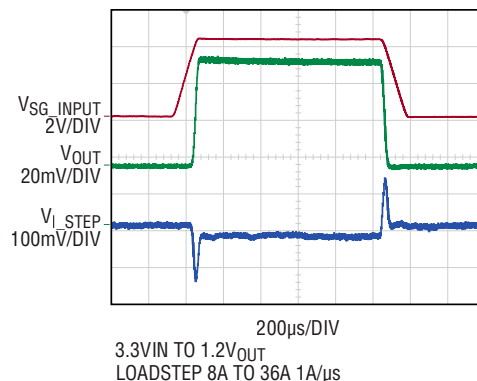


Figure 3. DC2874A-A 4-Phase Load Transient Response

THEORY OF OPERATION

Introduction to the DC2874A

The DC2874A demonstration circuit features the LTC3310S, a Low Voltage Synchronous Step-Down Silent Switcher in two, three, or four phase operation. The LTC3310S is a monolithic, constant frequency, current mode step-down DC/DC converter. Connecting the RT pin of the master phase, to a resistor to AGND programs the frequency from 500kHz to 2.25MHz and configures the MODE/SYNC pin to become clock output used to drive the MODE/SYNC pin of the slave phase(s). The DC2874A can operate with an external clock by shorting the master phase RT pin to V_{IN} by placing a 0Ω resistor in the R5 location and applying a sync pulse on the MODE/SYNC turret.

Connecting the FB pin to V_{IN} configures a phase as a slave. The MODE/SYNC becomes an input and the voltage control loop is disabled. The slave phase current control loop is still active and the peak current is controlled via the shared ITH node. The phasing of a slave phase relative to the master phase is programmed with a resistor divider on the RT pin. Refer to Table 5 of the LTC3310S datasheet for more information on setting the slave phase angle.

In the multiphase application the LTC3310S operate in pulse skip mode. At light loads, the slave phases will start pulse skipping before the master phase and can eventually stop switching as the load continues to decrease. The ability to allow the slave phases to stop switching at light loads reduces I_q current and switching losses at light loads.

Setting the compensation for the multiphase is similar to setting the compensation to a single phase. When determining the compensation components, C11, C14 and R8, controlling the loop stability and transient response are the two main considerations. The LTC3310S has been

designed to operate at a high bandwidth for fast transient response capabilities. This reduces output capacitance required to meet the desired transient voltage range. The mid-band gain of the loop increases with R8 and the bandwidth of the loop increases with decreasing C14. C11 along with R6 provides a phase lead which will improve the phase margin. C13, C33, C34, and C44 along with R12 provides a high frequency pole to reduce the high frequency gain. C13, C33, C34, and C44 are in parallel on the ITH node. The sum of these caps will be the total capacitance on the Master phase ITH pin. Too much capacitance can slow down the response time.

Loop stability is generally measured using the Bode Plot method of plotting loop gain in dB and phase shift in degrees. The 0dB crossover frequency should be less than 1/6 of the operating frequency to reduce the effects of added phase shift of the modulator. The control loop phase margin goal should be 45° or greater and a gain margin goal of 8dB or greater. Refer to the LTC3310S datasheet and [LTPowerCAD](#) for more information on choosing the required components.

The softstart of the multiphase regulator is controlled by a single cap, C12, on the master phase. After the regulator is in regulation the SSTT pin can be used to monitor the temperature of each IC. The master phase temperature can be monitored at the SSTT turret and slave 1, 2, and 3 can be monitored at TP3, 4, and 6 respectively. Calculate the die temperature with the formula below:

$$T_J(^{\circ}\text{C}) = \frac{V_{\text{SSTT}}}{4\text{mV}} - 273 \quad (3)$$

DEMO MANUAL DC2874A-A/ DC2874A-B/DC2874A-C

PARTS LIST (DEMO BOARD DC2874A-A)

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|---|-----|--|--|--------------------------------|
| Required Circuit Components | | | | |
| 1 | 4 | C2, C16, C23, C36 | CAP., 1uF, X6S, 6.3V, 20%, 0201 | MURATA, GRM033C80J105ME05D |
| 2 | 8 | C3, C10, C17, C24, C37, C42, C49, C52 | CAP., 47uF, X5R, 10V, 20%, 0805 | MURATA, GRM21BR61A476ME15L |
| 3 | 8 | C4, C5, C18, C21, C25, C28, C38, C41 | CAP., 22uF, X5R, 25V, 20%, 0805 | SAMSUNG, CL21A226MAQNNNE |
| 4 | 1 | C11 | CAP., 6.8pF, COG/NPO, 50V, +/-0.5pF, 0402 | AVX, 04025A6R8DAT2A |
| 5 | 1 | C12 | CAP., 0.1uF, X5R, 25V, 10%, 0402 | SAMSUNG, CL05A104KA5NNNC |
| 6 | 1 | C14 | CAP., 390pF, COG, 50V, 5%, 0402 | AVX, 04025A391JAT2A |
| 7 | 8 | C29, C30, C46-C48, C50, C51, C53 | CAP., 0.47uF, X7S, 10V, 10%, 0402 | MURATA, GCM155C71A474KE36D |
| 8 | 4 | L1-L4 | IND., 0.1uH, PWR, SHIELDED, 20%, 25.8A, 1.8mOhms, 4.3x4.3mm, XEL4030, AEC-Q200 | COILCRAFT, XEL4030-101MEB |
| 9 | 3 | R2, R11, R14 | RES., 100k OHMS, 1%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW0402100KFKED |
| 10 | 1 | R4 | RES., 274k OHMS, 1%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW0402274KFKED |
| 11 | 1 | R6 | RES., 140k OHMS, 1%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW0402140KFKED |
| 12 | 1 | R8 | RES., 10k OHMS, 1%, 1/16W, 0402 | VISHAY, CRCW040210K0FKEDC |
| 13 | 2 | R12, R13 | RES., 301k OHMS, 1%, 1/16W, 0402 | VISHAY, CRCW0402301KFKEDC |
| 14 | 4 | U1-U4 | IC, Low Voltage Syn. Step-Down Reg, LQFN-18 | ANALOG DEVICES, LTC3310SEV#PBF |
| Additional Demo Board Circuit Components | | | | |
| 1 | 6 | C1, C15, C39, C60, C64, C68 | CAP., 470uF, TANT. POSCAP, 6.3V, 20%, 7343, 18mOHMS, TPE | PANASONIC, 6TPE470MI |
| 2 | 7 | C6, C9, C32, C54, C57, C61, C65 | CAP., 0.1uF, X5R, 25V, 10%, 0402 | SAMSUNG, CL05A104KA5NNNC |
| 3 | 8 | C7, C8, C20, C26, C27, C31, C43, C45 | CAP., 0.01uF, X7R, 6.3V, 10%, 0201 | MURATA, GRM033R70J103KA01D |
| 4 | 1 | C19 | CAP., 22uF, X5R, 25V, 20%, 0805 | SAMSUNG, CL21A226MAQNNNE |
| 5 | 0 | C22 | CAPACITOR, OPT, 3-PIN 0402, FILTER/BYPASS | |
| 6 | 8 | C55, C56, C58, C59, C62, C63, C66, C67 | CAP., 10uF, X5R, 10V, 20%, 0603 | SAMSUNG, CL10A106MP8NNNC |
| 7 | 4 | L5-L8 | IND., 100 OHMS@100MHz, FERRITE BEAD, 25%, 8A, 6mOHMS, 1812 | WURTH ELEKTRONIK, 74279226101 |
| 8 | 1 | Q1 | XSTR., MOSFET, N-CH, 60V, 120A, TO-263 | VISHAY, SUM50020E-GE3 |
| 9 | 1 | R1 | RES., 1M OHMS, 1%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW04021M00FKED |
| 10 | 1 | R3 | RES., 249k OHMS, 1%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW0402249KFKED |
| 11 | 1 | R7 | RES., 100k OHMS, 5%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW0402100KJNED |
| 12 | 1 | R9 | RES., 0 OHM, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW04020000Z0ED |
| 13 | 2 | R16, R18 | RES., 0.02 OHM, 1%, 10W, 2828, PWR, METAL, SENSE, AEC-Q200 | VISHAY, WSHP2818R0200FEA |
| 14 | 1 | R17 | RES., 10k OHMS, 5%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW040210K0JNED |
| 15 | 1 | R19 | RES., 51 OHMS, 5%, 1/16W, 0402 | VISHAY, CRCW040251R0JNED |

DEMO MANUAL DC2874A-A/ DC2874A-B/DC2874A-C

PARTS LIST (DEMO BOARD DC2874A-A)

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|------|-----|-----------|--|-------------------------------|
| 16 | 1 | RG1 | RES., 20 OHMS, 1%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW040220R0FKED |
| 17 | 1 | U5 | IC OPAMP BUFFER 20MHZ 8DFN | ANALOG DEVICES, LT1010CDD#PBF |

Hardware: For Demo Board Only

| | | | | |
|---|----|---|--|-----------------------------------|
| 1 | 12 | E1-E3, E5, E12, E14-E17, E19-E21 | TEST POINT, TURRET, 0.064" MTG. HOLE, PCB 0.062" THK | MILL-MAX, 2308-2-00-80-00-00-07-0 |
| 2 | 11 | E4, E7, E10, E13, E18, E22-E24, E26-E28 | TEST POINT, TURRET, 0.094" MTG. HOLE, PCB 0.062" THK | MILL-MAX, 2501-2-00-80-00-00-07-0 |
| 3 | 5 | E6, E8, E9, E11, E25 | STUD, #10-32, FASTENER, 0.625" LENGTH | PENCOM, PR1422 |
| 4 | 1 | JP1 | CONN., HDR, MALE, 1x3, 2mm, VERT, STR, THT | WURTH ELEKTRONIK, 62000311121 |
| 5 | 4 | MP1-MP4 | STANDOFF, NYLON, SNAP-ON, 0.25" (6.4mm) | KEYSTONE, 8831 |
| 6 | 5 | MP5-MP9 | CONN RING FLAT 8AWG #10 CRIMP | MOLEX, 0192210223 |
| 7 | 10 | MP10-MP19 | NUT, HEX, #10-32, BRASS | PENCOM, NU1132 |
| 8 | 5 | MP20-MP24 | WASHER, #10, LOCK, EXT, TIN FINISH | PENCOM, WA4526 |
| 9 | 1 | XJP1 | CONN., SHUNT, FEMALE, 2 POS, 2mm | WURTH ELEKTRONIK, 60800213421 |

DEMO MANUAL DC2874A-A/ DC2874A-B/DC2874A-C

PARTS LIST (DEMO BOARD DC2874A-B)

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|---|-----|------------------------------|--|--------------------------------|
| Required Circuit Components | | | | |
| 1 | 3 | C2, C16, C36 | CAP, 1uF, X6S, 6.3V, 20%, 0201 | MURATA, GRM033C80J105ME05D |
| 2 | 6 | C3, C10, C17, C37, C42, C49 | CAP, 47uF, X5R, 10V, 20%, 0805 | MURATA, GRM21BR61A476ME15L |
| 3 | 6 | C4, C5, C18, C21, C38, C41 | CAP, 22uF, X5R, 25V, 20%, 0805 | SAMSUNG, CL21A226MAQNNNE |
| 4 | 1 | C11 | CAP, 6.8pF, COG/NPO, 50V, +/-0.5pF, 0402 | AVX, 04025A6R8DAT2A |
| 5 | 1 | C12 | CAP, 0.1uF, X5R, 25V, 10%, 0402 | SAMSUNG, CL05A104KA5NNNC |
| 6 | 1 | C14 | CAP, 390pF, COG, 50V, 5%, 0402 | AVX, 04025A391JAT2A |
| 7 | 6 | C29, C46-C48, C50, C51 | CAP, 0.47uF, X7S, 10V, 10%, 0402 | MURATA, GCM155C71A474KE36D |
| 8 | 3 | L1-L3 | IND., 0.1uH, PWR, SHIELDED, 20%, 25.8A, 1.8mOhms, 4.3x4.3mm, XEL4030, AEC-Q200 | COILCRAFT, XEL4030-101MEB |
| 9 | 1 | L8 | IND., 100 OHMS@100MHz, FERRITE BEAD, 25%, 8A, 6mOHMS, 1812 | WURTH ELEKTRONIK, 74279226101 |
| 10 | 1 | R2 | RES., 100k OHMS, 1%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW0402100KFKED |
| 11 | 1 | R4 | RES., 274k OHMS, 1%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW0402274KFKED |
| 12 | 1 | R6 | RES., 140k OHMS, 1%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW0402140KFKED |
| 13 | 1 | R8 | RES., 10k OHMS, 1%, 1/16W, 0402 | VISHAY, CRCW040210K0FKEDC |
| 14 | 2 | R9, R12 | RES., 243k OHMS, 1%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW0402243KFKED |
| 15 | 2 | R10, R11 | RES., 174k OHMS, 1%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW0402174KFKED |
| 16 | 3 | U1-U3 | IC, Low Voltage Syn. Step-Down Reg, LQFN-18 | ANALOG DEVICES, LTC3310SEV#PBF |
| Additional Demo Board Circuit Components | | | | |
| 1 | 6 | C6, C9, C32, C57, C61, C65 | CAP, 0.1uF, X5R, 25V, 10%, 0402 | SAMSUNG, CL05A104KA5NNNC |
| 2 | 6 | C7, C8, C20, C26, C27, C45 | CAP, 0.01uF, X7R, 6.3V, 10%, 0201 | MURATA, GRM033R70J103KA01D |
| 3 | 5 | C15, C39, C60, C64, C68 | CAP, 470uF, TANT. POSCAP, 6.3V, 20%, 7343, 18mOHMS, TPE | PANASONIC, 6TPE470MI |
| 4 | 1 | C19 | CAP, 22uF, X5R, 25V, 20%, 0805 | SAMSUNG, CL21A226MAQNNNE |
| 5 | 0 | C22 | CAPACITOR, OPT, 3-PIN 0402, FILTER/BYPASS | |
| 6 | 6 | C58, C59, C62, C63, C66, C67 | CAP, 10uF, X5R, 10V, 20%, 0603 | SAMSUNG, CL10A106MP8NNNC |
| 7 | 2 | L6, L7 | IND., 100 OHMS@100MHz, FERRITE BEAD, 25%, 8A, 6mOHMS, 1812 | WURTH ELEKTRONIK, 74279226101 |
| 8 | 5 | MP5-MP9 | CONN RING FLAT 8AWG #10 CRIMP | MOLEX, 0192210223 |
| 9 | 1 | Q1 | XSTR., MOSFET, N-CH, 60V, 120A, TO-263 | VISHAY, SUM50020E-GE3 |
| 10 | 1 | R1 | RES., 1M OHMS, 1%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW04021M00FKED |
| 11 | 1 | R3 | RES., 249k OHMS, 1%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW0402249KFKED |
| 12 | 1 | R7 | RES., 100k OHMS, 5%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW0402100KJNED |
| 13 | 2 | R16, R18 | RES., 0.02 OHM, 1%, 10W, 2828, PWR, METAL, SENSE, AEC-Q200 | VISHAY, WSHP2818R0200FEA |

DEMO MANUAL DC2874A-A/ DC2874A-B/DC2874A-C

PARTS LIST (DEMO BOARD DC2874A-B)

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|------|-----|-----------|---|-------------------------------|
| 14 | 1 | R17 | RES., 10k OHMS, 5%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW040210K0JNED |
| 15 | 1 | R19 | RES., 51 OHMS, 5%, 1/16W, 0402 | VISHAY, CRCW040251R0JNED |
| 16 | 1 | RG1 | RES., 20 OHMS, 1%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW040220R0FKED |
| 17 | 1 | U5 | IC OPAMP BUFFER 20MHZ 8DFN | ANALOG DEVICES, LT1010CDD#PBF |

Hardware: For Demo Board Only

| | | | | |
|---|----|---|--|-----------------------------------|
| 1 | 12 | E1-E3, E5, E12, E14-E17, E19-E21 | TEST POINT, TURRET, 0.064" MTG. HOLE, PCB 0.062" THK | MILL-MAX, 2308-2-00-80-00-00-07-0 |
| 2 | 11 | E4, E7, E10, E13, E18, E22-E24, E26-E28 | TEST POINT, TURRET, 0.094" MTG. HOLE, PCB 0.062" THK | MILL-MAX, 2501-2-00-80-00-00-07-0 |
| 3 | 5 | E6, E8, E9, E11, E25 | STUD, #10-32, FASTENER, 0.625" LENGTH | PENCOM, PR1422 |
| 4 | 1 | JP1 | CONN., HDR, MALE, 1x3, 2mm, VERT, STR, THT | WURTH ELEKTRONIK, 62000311121 |
| 5 | 4 | MP1-MP4 | STANDOFF, NYLON, SNAP-ON, 0.25" (6.4mm) | KEYSTONE, 8831 |
| 6 | 10 | MP10-MP19 | NUT, HEX, #10-32, BRASS | PENCOM, NU1132 |
| 7 | 5 | MP20-MP24 | WASHER, #10, LOCK, EXT, TIN FINISH | PENCOM, WA4526 |
| 8 | 1 | XJP1 | CONN., SHUNT, FEMALE, 2 POS, 2mm | WURTH ELEKTRONIK, 60800213421 |

DEMO MANUAL DC2874A-A/ DC2874A-B/DC2874A-C

PARTS LIST (DEMO BOARD DC2874A-C)

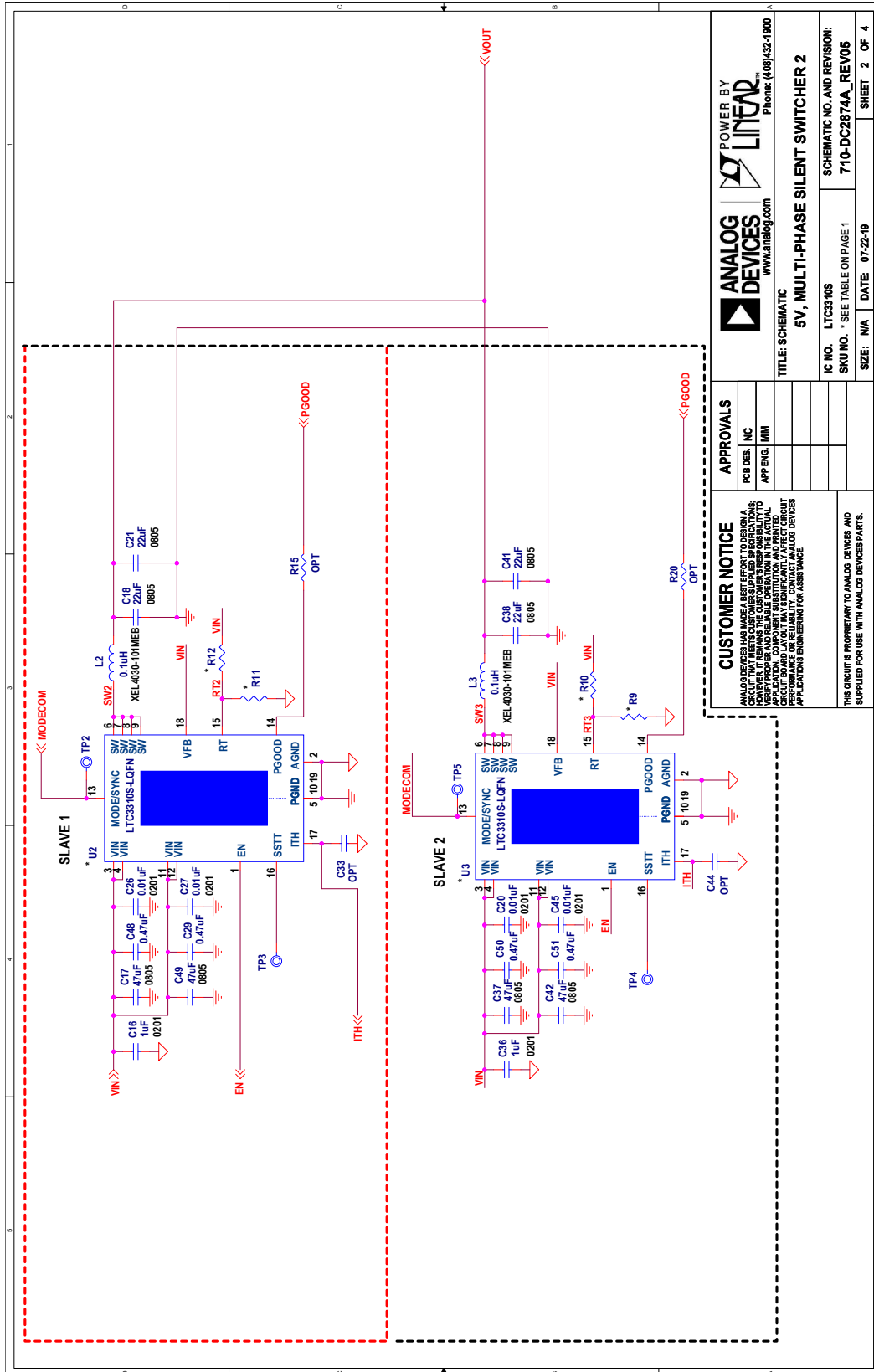
| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|---|-----|-----------------------|--|--------------------------------|
| Required Circuit Components | | | | |
| 1 | 2 | C2, C16 | CAP, 1uF, X6S, 6.3V, 20%, 0201 | MURATA, GRM033C80J105ME05D |
| 2 | 4 | C3, C10, C17, C49 | CAP, 47uF, X5R, 10V, 20%, 0805 | MURATA, GRM21BR61A476ME15L |
| 3 | 4 | C4, C5, C18, C21 | CAP, 22uF, X5R, 25V, 20%, 0805 | SAMSUNG, CL21A226MAQNNNE |
| 4 | 1 | C11 | CAP, 6.8pF, COG/NPO, 50V, +/-0.5pF, 0402 | AVX, 04025A6R8DAT2A |
| 5 | 1 | C12 | CAP, 0.1uF, X5R, 25V, 10%, 0402 | SAMSUNG, CL05A104KA5NNNC |
| 6 | 1 | C14 | CAP, 390pF, COG, 50V, 5%, 0402 | AVX, 04025A391JAT2A |
| 7 | 4 | C29, C46-C48 | CAP, 0.47uF, X7S, 10V, 10%, 0402 | MURATA, GCM155C71A474KE36D |
| 8 | 2 | L1, L2 | IND., 0.1uH, PWR, SHIELDED, 20%, 25.8A, 1.8mOhms, 4.3x4.3mm, XEL4030, AEC-Q200 | COILCRAFT, XEL4030-101MEB |
| 9 | 1 | L7 | IND., 100 OHMS@100MHZ, FERRITE BEAD, 25%, 8A, 6mOHMS, 1812 | WURTH ELEKTRONIK, 74279226101 |
| 10 | 1 | R2 | RES., 100k OHMS, 1%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW0402100KFKED |
| 11 | 1 | R4 | RES., 274k OHMS, 1%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW0402274KFKED |
| 12 | 1 | R6 | RES., 140k OHMS, 1%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW0402140KFKED |
| 13 | 1 | R8 | RES., 10k OHMS, 1%, 1/16W, 0402 | VISHAY, CRCW040210K0FKEDC |
| 14 | 2 | U1, U2 | IC, Low Voltage Syn. Step-Down Reg, LQFN-18 | ANALOG DEVICES, LTC3310SEV#PBF |
| Additional Demo Board Circuit Components | | | | |
| 1 | 5 | C6, C9, C32, C57, C61 | CAP, 0.1uF, X5R, 25V, 10%, 0402 | SAMSUNG, CL05A104KA5NNNC |
| 2 | 4 | C7, C8, C26, C27 | CAP, 0.01uF, X7R, 6.3V, 10%, 0201 | MURATA, GRM033R70J103KA01D |
| 3 | 4 | C15, C39, C60, C68 | CAP, 470uF, TANT. POSCAP, 6.3V, 20%, 7343, 18mOHMS, TPE | PANASONIC, 6TPE470MI |
| 4 | 1 | C19 | CAP, 22uF, X5R, 25V, 20%, 0805 | SAMSUNG, CL21A226MAQNNNE |
| 5 | 0 | C22 | CAPACITOR, OPT, 3-PIN 0402, FILTER/BYPASS | |
| 6 | 4 | C58, C59, C62, C63 | CAP, 10uF, X5R, 10V, 20%, 0603 | SAMSUNG, CL10A106MP8NNNC |
| 7 | 1 | L6 | IND., 100 OHMS@100MHz, FERRITE BEAD, 25%, 8A, 6mOHMS, 1812 | WURTH ELEKTRONIK, 74279226101 |
| 8 | 1 | Q1 | XSTR., MOSFET, N-CH, 60V, 120A, TO-263 | VISHAY, SUM50020E-GE3 |
| 9 | 1 | R1 | RES., 1M OHMS, 1%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW04021M00FKED |
| 10 | 1 | R3 | RES., 249k OHMS, 1%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW0402249KFKED |
| 11 | 1 | R7 | RES., 100k OHMS, 5%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW0402100KJNED |
| 12 | 1 | R11 | RES., 0 OHM, 1/16W, 0402, AEC-Q200 | NIC, NRC04ZOTRF |
| 13 | 2 | R16, R18 | RES., 0.02 OHM, 1%, 10W, 2828, PWR, METAL, SENSE, AEC-Q200 | VISHAY, WSHP2818R0200FEA |
| 14 | 1 | R17 | RES., 10k OHMS, 5%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW040210K0JNED |
| 15 | 1 | R19 | RES., 51 OHMS, 5%, 1/16W, 0402 | VISHAY, CRCW040251R0JNED |
| 16 | 1 | RG1 | RES., 20 OHMS, 1%, 1/16W, 0402, AEC-Q200 | VISHAY, CRCW040220R0FKED |
| 17 | 1 | U5 | IC OPAMP BUFFER 20MHZ 8DFN | ANALOG DEVICES, LT1010CDD#PBF |

DEMO MANUAL DC2874A-A/ DC2874A-B/DC2874A-C

PARTS LIST (DEMO BOARD DC2874A-C)

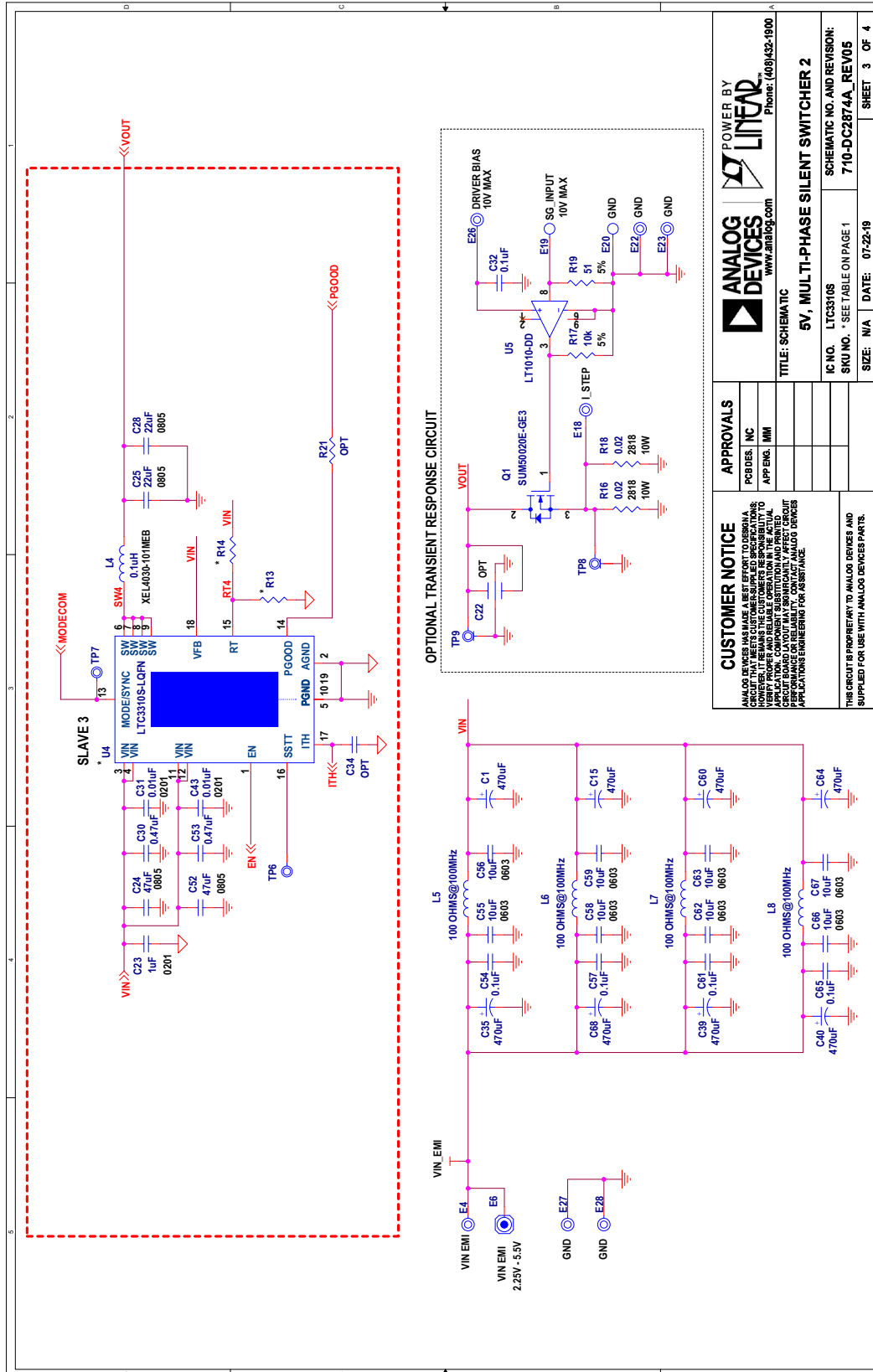
| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|--------------------------------------|-----|---|--|-----------------------------------|
| Hardware: For Demo Board Only | | | | |
| 1 | 12 | E1-E3, E5, E12, E14-E17, E19-E21 | TEST POINT, TURRET, 0.064" MTG. HOLE, PCB 0.062" THK | MILL-MAX, 2308-2-00-80-00-00-07-0 |
| 2 | 11 | E4, E7, E10, E13, E18, E22-E24, E26-E28 | TEST POINT, TURRET, 0.094" MTG. HOLE, PCB 0.062" THK | MILL-MAX, 2501-2-00-80-00-00-07-0 |
| 3 | 5 | E6, E8, E9, E11, E25 | STUD, #10-32, FASTENER, 0.625" LENGTH | PENCOM, PR1422 |
| 4 | 1 | JP1 | CONN., HDR, MALE, 1x3, 2mm, VERT, STR, THT | WURTH ELEKTRONIK, 62000311121 |
| 5 | 4 | MP1-MP4 | STANDOFF, NYLON, SNAP-ON, 0.25" (6.4mm) | KEYSTONE, 8831 |
| 6 | 5 | MP5-MP9 | CONN RING FLAT 8AWG #10 CRIMP | MOLEX, 0192210223 |
| 7 | 10 | MP10-MP19 | NUT, HEX, #10-32, BRASS | PENCOM, NU1132 |
| 8 | 5 | MP20-MP24 | WASHER, #10, LOCK, EXT, TIN FINISH | PENCOM, WA4526 |
| 9 | 1 | XJP1 | CONN., SHUNT, FEMALE, 2 POS, 2mm | WURTH ELEKTRONIK, 60800213421 |

SCHEMATIC DIAGRAM



DEMO MANUAL DC2874A-A/ DC2874A-B/DC2874A-C

SCHEMATIC DIAGRAM



SCHEMATIC DIAGRAM

| PCA ADDITIONAL PARTS | |
|----------------------|--|
| MP1 | STANDOFF,NYLON,SNAP-ON,0.25" (6.4mm) |
| MP2 | STANDOFF,NYLON,SNAP-ON,0.25" (6.4mm) |
| MP3 | STANDOFF,NYLON,SNAP-ON,0.25" (6.4mm) |
| MP4 | STANDOFF,NYLON,SNAP-ON,0.25" (6.4mm) |
| LBI | BOARD SIN LABEL |
| PCB1 | PCB, DC2874A REV05 |
| STNCL1 | TOOL, STENCIL, 700-DC2874A REV05 |
| MP5 | RING,LUG,#10,CRIMP,8 A W/G,FLAT, NON-INSULATED,SOLDERLESS TERMINAL |
| MP6 | RING,LUG,#10,CRIMP,8 A W/G,FLAT, NON-INSULATED,SOLDERLESS TERMINAL |
| MP7 | RING,LUG,#10,CRIMP,8 A W/G,FLAT, NON-INSULATED,SOLDERLESS TERMINAL |
| MP8 | RING,LUG,#10,CRIMP,8 A W/G,FLAT, NON-INSULATED,SOLDERLESS TERMINAL |
| MP9 | RING,LUG,#10,CRIMP,8 A W/G,FLAT, NON-INSULATED,SOLDERLESS TERMINAL |
| MP10 | NUT,HEX,#10-32,BRASS |
| MP11 | NUT,HEX,#10-32,BRASS |
| MP12 | NUT,HEX,#10-32,BRASS |
| MP13 | NUT,HEX,#10-32,BRASS |
| MP14 | NUT,HEX,#10-32,BRASS |
| MP15 | NUT,HEX,#10-32,BRASS |
| MP16 | NUT,HEX,#10-32,BRASS |
| MP17 | NUT,HEX,#10-32,BRASS |
| MP18 | NUT,HEX,#10-32,BRASS |
| MP19 | NUT,HEX,#10-32,BRASS |
| MP20 | WASHER,#10,LOCK,EXT,TIN FINISH |
| MP21 | WASHER,#10,LOCK,EXT,TIN FINISH |
| MP22 | WASHER,#10,LOCK,EXT,TIN FINISH |
| MP23 | WASHER,#10,LOCK,EXT,TIN FINISH |
| MP24 | WASHER,#10,LOCK,EXT,TIN FINISH |

| | | | |
|---|---|--|--|
| <p>CUSTOMER NOTICE</p> <p>ANALOG DEVICES HAS MADE A BEST EFFORT TO DESIGN A SCHEMATIC THAT IS ACCURATE AND RELIABLE. HOWEVER, IT REMAINS THE CUSTOMER'S RESPONSIBILITY TO MAKE SURE THE SCHEMATIC IS CORRECT FOR THE PARTS AND APPLICATIONS. ANALOG DEVICES DOES NOT WARRANT THE ACCURACY OF THE SCHEMATIC. ANALOG DEVICES WILL NOT BE RESPONSIBLE FOR ANY DAMAGES, INCLUDING LOST PROFITS, ARISING OUT OF OR FROM THE USE OF THE SCHEMATIC.</p> | <p>APPROVALS</p> | <p>POWER BY LINTEAR www.linthead.com Phone: (409)432-1900</p> | <p>TITLE: SCHEMATIC</p> <p>5V, MULTI-PHASE SILENT SWITCHER 2</p> |
| | <p>PCB DES: INC</p> <p>APP ENG: IMM</p> | <p>IC NO. LTC3310S</p> <p>SKU NO. - SEE TABLE ON PAGE 1</p> <p>SIZE: N/A</p> | <p>SCHEMATIC NO. AND REVISION: 710-DC2874A_REV05</p> |

DEMO MANUAL DC2874A-A/ DC2874A-B/DC2874A-C



ESD Caution

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

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Rev. 0