

LTM4671 Quad Output (Dual 12A, Dual 5A) Step-Down μ Module Regulator

DESCRIPTION

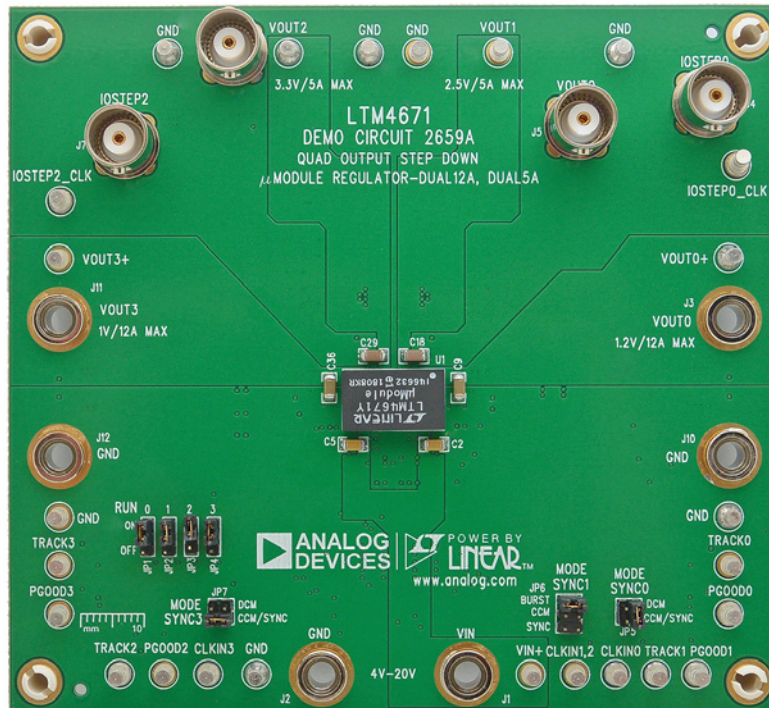
Demonstration circuit 2659A features the **LTM[®]4671** μ Module[®] regulator, a high performance high efficiency four output step-down regulator. The LTM4671EY has an operating input voltage range of 3.6V to 20V providing up to 12A from each of its two higher current rails and up to 5A from each of its two lower current rails. The two higher current rails' output voltage is programmable from 0.6V to 3.3V while the two lower current rails' output voltage is programmable from 0.6V to 5.5V. High current rails can be paralleled together, and lower current rails can be paralleled together to satisfy higher rail current requirements. The LTM4671EY is a complete multi-output DC-DC point-of-load regulator in a thermally enhanced

16mm \times 9.5mm \times 4.82mm BGA package requiring only a few input and output capacitors. Output voltage tracking is made available by the TRACK/SS pins for supply rail sequencing. Temperature sensing options are included via the TSENSE and TMON pins. External clock synchronization is available through the CLKIN pins, CLKOUT pins provide for optional synchronization of additional module phases. The LTM4671 data sheet must be read in conjunction with this demo manual for working on or modifying demo circuit 2659A

[Design files for this circuit board are available.](#)

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BOARD PHOTO



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

| PARAMETER | CONDITIONS/NOTES | VALUE |
|---|---|--|
| Input Voltage Range | | 3.6V – 20V |
| Output Voltage V_{OUT} | Jumper Selectable | $V_{OUT0} = 1.2V_{DC}$, $V_{OUT1} = 2.5V_{DC}$, $V_{OUT2} = 3.3V_{DC}$, $V_{OUT4} = 1V_{DC}$ |
| Maximum Continuous Output Current per Phase | De-Rating is Necessary for Certain Operating Conditions. See Data Sheet for Details | $I_{OUT0MAX}$, $I_{OUT3MAX} = 12A_{DC}$ $I_{OUT1MAX}$, $I_{OUT2MAX} = 5A_{DC}$ |
| Default Operating Frequency | | 600kHz (for V_{OUT0} , V_{OUT3}) 1MHz (for V_{OUT1} , V_{OUT2}) |
| Efficiency | $V_{IN} = 12V$ $V_{OUT0} = 1.2V$, $I_{OUT} = 12A$ $V_{OUT0} = 3.3V$, $I_{OUT} = 5A$ | See Figure 2 87.4% 91.6% |

QUICK START PROCEDURE

Demonstration circuit 2659A is an easy way to evaluate the performance of the LTM4671EY. Please refer to Figure 1 for test setup connections and follow the procedure below.

1. With power off, place the jumpers in the following positions:

| JP1 | JP2 | JP3 | JP4 | JP5 | JP6 | JP7 |
|------|------|------|------|-------|-------|-------|
| RUN0 | RUN1 | RUN2 | RUN3 | MODE0 | MODE1 | MODE3 |
| ON | ON | ON | ON | CCM | CCM | CCM |

2. Before connecting input supply, loads and meters, pre-set the input voltage supply to be between 4V to 20V. Pre-set the load currents to 0A.
3. With power off, connect the loads, input voltage supply and meters as shown in Figure 1.
4. Turn on input power supply. The output voltage meters for each phase should display the programmed output voltage $\pm 2\%$.
5. Once the proper output voltages are established, adjust the load currents for each phase within the 0A–12A

range for V_{OUT0} and V_{OUT3} outputs and within 0A–5A for V_{OUT1} and V_{OUT2} outputs. Observe each output's load regulation, efficiency, and other parameters. Output voltage ripples for each output should be measured across the furthest output capacitor with a BNC cable and oscilloscope. BNCs J5 and J9 are available for V_{OUT0} and V_{OUT2} ripple measurements, respectively.

6. To observe increased light load efficiency, for V_{OUT0} and V_{OUT3} place the MODE pin jumpers (JP5, JP7) in the DCM position, for V_{OUT1} and V_{OUT2} place the MODE pin jumper (JP6) in the BURST position.
7. For optional load transient testing on-board transient circuits are provided to measure transient responses on V_{OUT0} and V_{OUT2} outputs. Place a positive pulse signal between the IOSTEP_x_CLK pin and GND pins. The pulse amplitude sets the load step current amplitude. The pulse width should be short (<1ms) and pulse duty cycle should be low (<15%) to limit the thermal stress on the load transient circuit. The load step response for V_{OUT0} and V_{OUT2} can be monitored with a BNC connected to J4 (10mV/A) and J7 (20mV/A), respectively.

QUICK START PROCEDURE

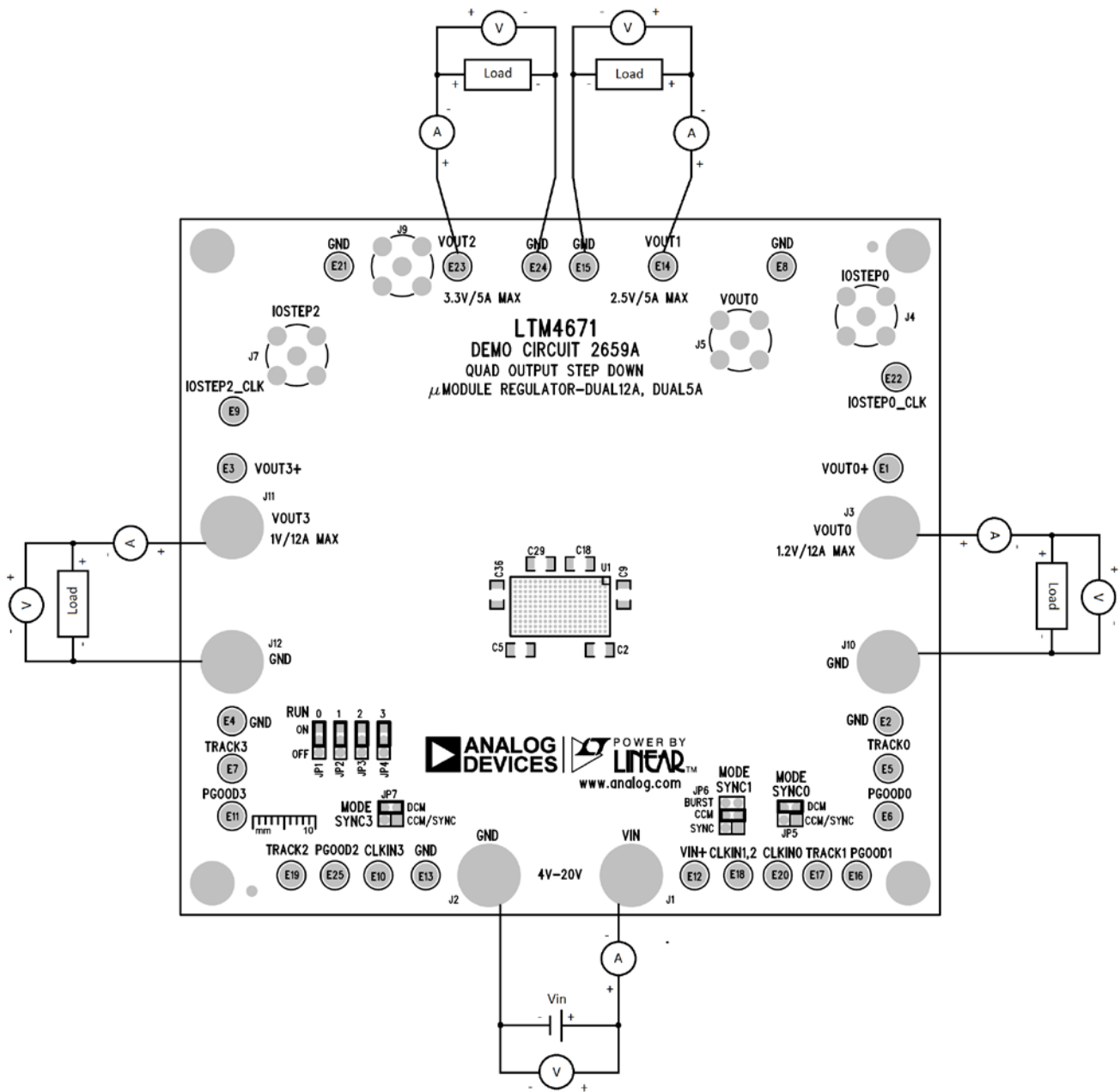
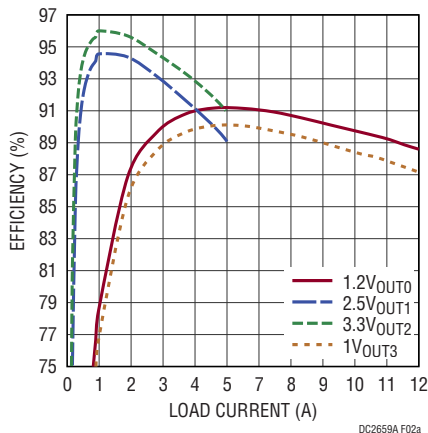
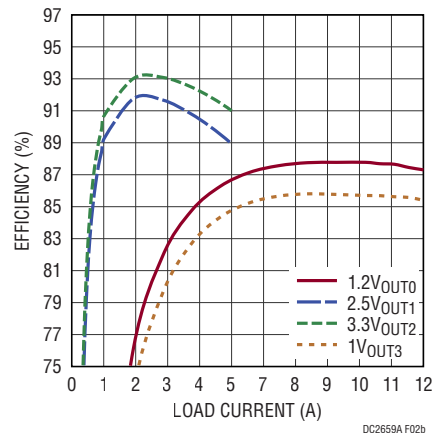


Figure 1. Test Setup of DC2659A

QUICK START PROCEDURE

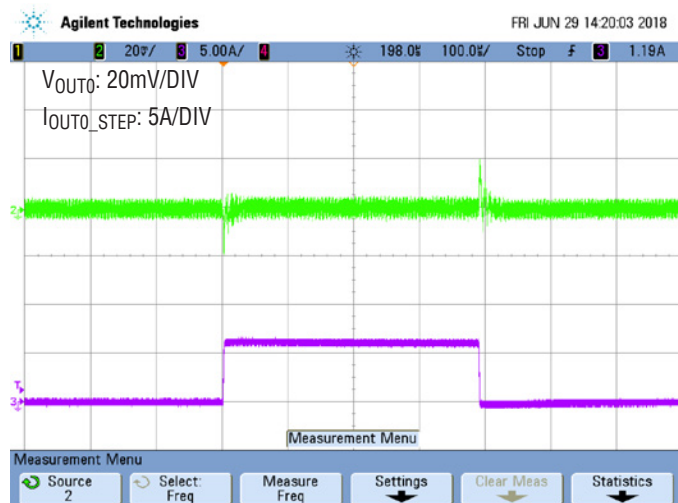


(a) 5V_{IN} CCM Efficiency

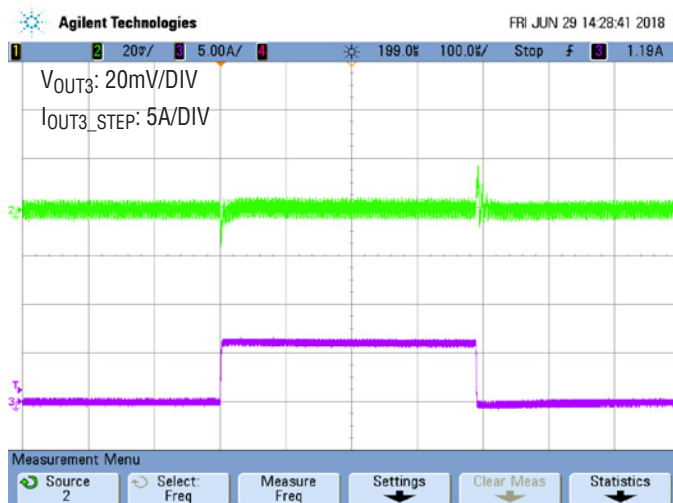


(b) 12V_{IN} CCM Efficiency

Figure 2. Measured Supply Efficiency at 5V_{IN} and 12V_{IN}



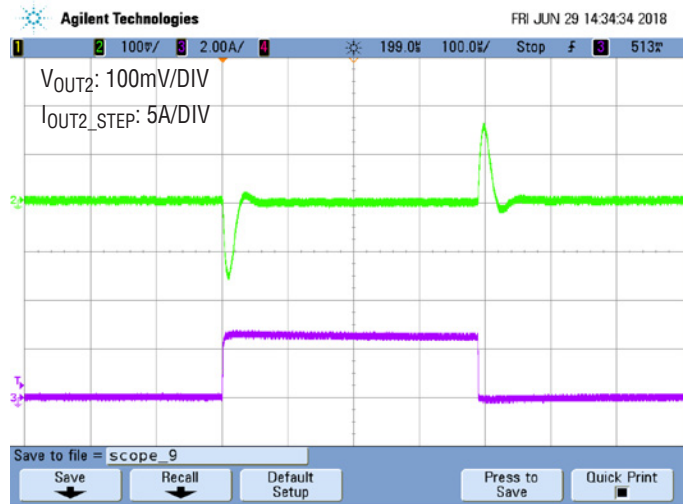
| V _{IN} (V) | V _{OUT0} (V) | C _{OUT} CERAMIC |
|---------------------|-----------------------|--|
| 12 | 1.2 | 2 × 100µF/6.3V/Ceramic +1 × 330µF/6.3V/Bulk |



| V _{IN} (V) | V _{OUT3} (V) | C _{OUT} CERAMIC |
|---------------------|-----------------------|--|
| 12 | 1 | 2 × 100µF/6.3V/Ceramic +1 × 330µF/6.3V/Bulk |

Figure 3. Measured V_{OUT0} = 1.2V and V_{OUT3} = 1V Load Transient Responses (6A Load Step)

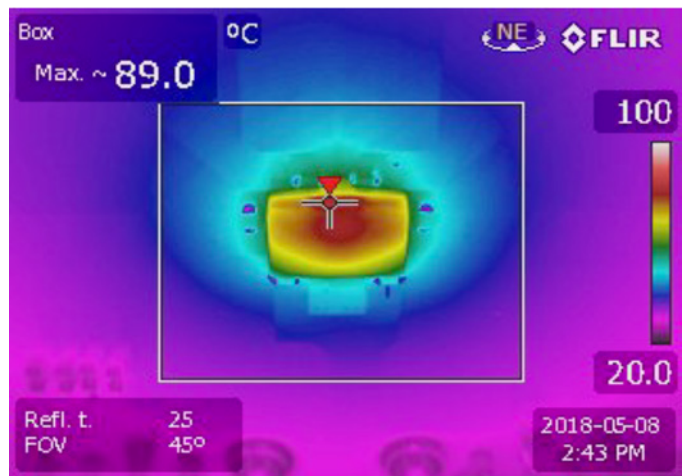
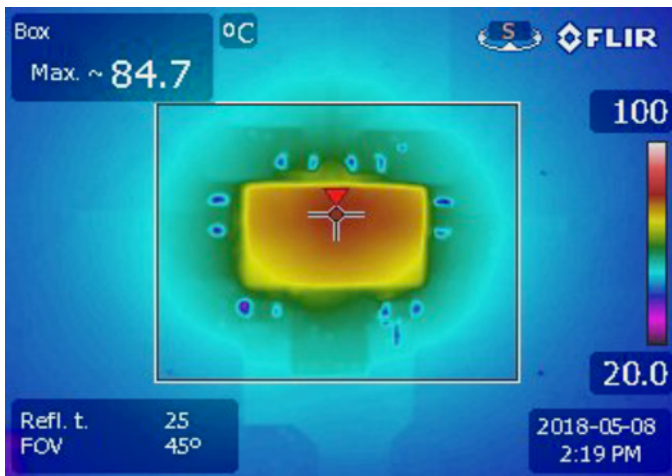
QUICK START PROCEDURE



| V _{IN} (V) | V _{OUT1} (V) | C _{OUT} CERAMIC |
|---------------------|-----------------------|---|
| 12 | 2.5 | 2 × 47µF/6.3V/Ceramic +1 × 10µF/6.3V/Ceramic |

| V _{IN} (V) | V _{OUT2} (V) | C _{OUT} CERAMIC |
|---------------------|-----------------------|---|
| 12 | 3.3 | 2 × 47µF/6.3V/Ceramic +1 × 10µF/6.3V/Ceramic |

Figure 4. Measured V_{OUT1} = 2.5V and V_{OUT2} = 3.3V Load Transient Responses (2.5A Load Step)



| V _{IN} (V) | AIRFLOW | HEATSINK | AMBIENT (°C) |
|---------------------|--------------------|----------|--------------|
| 12 | Natural Convection | None | 23 |

| V _{IN} (V) | AIRFLOW | HEATSINK | AMBIENT (°C) |
|---------------------|----------------------|----------|--------------|
| 12 | Forced Air 200LFM | None | 23 |

| CHANNEL | V _{OUT0} | V _{OUT1} | V _{OUT2} | V _{OUT3} |
|----------------------|-------------------|-------------------|-------------------|-------------------|
| V _{OUT} (V) | 1.2 | 2.5 | 3.3 | 1 |
| I _{OUT} (A) | 10 | 4 | 4 | 10 |

| CHANNEL | V _{OUT0} | V _{OUT1} | V _{OUT2} | V _{OUT3} |
|----------------------|-------------------|-------------------|-------------------|-------------------|
| V _{OUT} (V) | 1.2 | 2.5 | 3.3 | 1 |
| I _{OUT} (A) | 12 | 5 | 5 | 12 |

Figure 5. Measured Thermal Captures

DEMO MANUAL DC2659A

PARTS LIST

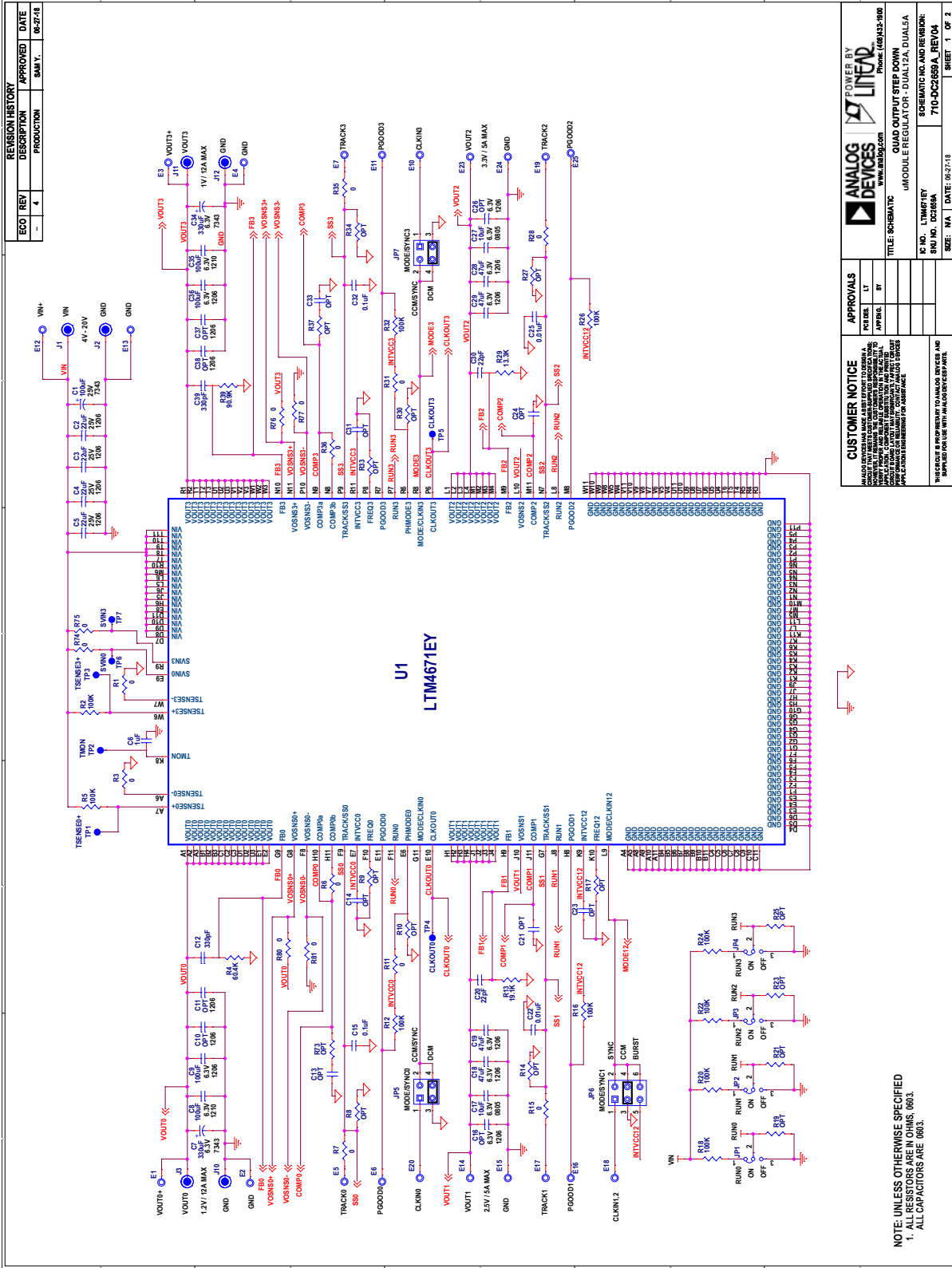
| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|---|-----|--|---|--------------------------------|
| Required Circuit Components | | | | |
| 1 | 4 | C2, C3, C4, C5 | CAP, 22 μ F, X5R, 25V, 20%, 1206 | MURATA, GRM31CR61E226ME15L |
| 2 | 2 | C8, C35 | CAP, 100 μ F, X5R, 6.3V, 20%, 1210 | TDK, C3225X5R0J107M250AC |
| 3 | 2 | C18, C28 | CAP, 47 μ F, X5R, 16V, 20%, 1206 | TDK, C3216X5R1C476M160AB |
| 4 | 1 | R4 | RES., 60.4k, 1%, 1/10W, 0603, AEC-Q200 | VISHAY, CRCW060360K4FKEA |
| 5 | 1 | R13 | RES., 19.1k, 1%, 1/10W, 0603, AEC-Q200 | VISHAY, CRCW060319K1FKEA |
| 6 | 1 | R29 | RES., 13.3k, 1%, 1/10W, 0603, AEC-Q200 | VISHAY, CRCW060313K3FKEA |
| 7 | 1 | R39 | RES., 90.9k, 1%, 1/10W, 0603, AEC-Q200 | VISHAY, CRCW060390K9FKEA |
| 8 | 1 | U1 | IC, QUAD HIGH EFFICIENCY MODULE, BGA-16mm \times 9.5mm \times 4.72mm | ANALOG DEVICES., LTM4671EY#PBF |
| Additional Demo Board Circuit Components | | | | |
| 1 | 2 | C7, C34 | CAP, 330 μ F, ALUM. ELECT., 2.5V, 20%, 7343, 9m Ω , 6.3A | PANASONIC, EEFSX0E331ER |
| 2 | 2 | C9, C36 | CAP, 100 μ F, X5R, 6.3V, 20%, 1206 | TDK, C3216X5R0J107M160AB |
| 3 | 2 | C17, C27 | CAP, 10 μ F, X5R, 16V, 10%, 0805 | MURATA, GRM21BR61C106KE15L |
| 4 | 2 | C19, C29 | CAP, 47 μ F, X5R, 16V, 20%, 1206 | TDK, C3216X5R1C476M160AB |
| 5 | 2 | C20, C30 | CAP, 22pF, C0G, 50V, 5%, 0603 | MURATA, GRM1885C1H220JA01J |
| 6 | 2 | C12, C39 | CAP, 330pF, C0G, 50V, 5%, 0603 | MURATA, GRM1885C1H331JA01J |
| 7 | 2 | C15, C32 | CAP, 0.1 μ F, X7R, 50V, 10%, 0603 | TDK, C1608X7R1H104K080AA |
| 8 | 1 | C1 | CAP, 100 μ F, TANT. POLY., 25V, 20%, 7343 | KEMET, T521X107M025ATE060 |
| 9 | 1 | C6 | CAP, 1 μ F, X5R, 16V, 10%, 0603 | MURATA, GRM188R61C105KA93D |
| 10 | 2 | C22, C25 | CAP, 0.01 μ F, X7R, 50V, 10%, 0603 | KEMET, C0603C103K5RACTU |
| 11 | 4 | C40, C43, C45, C47 | CAP, 1 μ F, X7R, 16V, 20%, 0603 | TDK, C1608X7R1C105M080AC |
| 12 | 2 | C42, C46 | CAP, 1 μ F, X7R, 50V, 10%, 0805 | MURATA, GRM21BR71H105KA12L |
| 13 | 2 | Q1, Q2 | XSTR., MOSFET, N-CH, 40V, TO-252 (DPAK) | VISHAY, SUD50N04-8M8P-4GE3 |
| 14 | 16 | R1, R3, R6, R7, R11, R15, R28, R31, R35, R36, R74, R75, R76, R77, R80, R81 | RES., 0 Ω , 1/10W, 0603, AEC-Q200 | VISHAY, CRCW06030000Z0EA |
| 15 | 10 | R2, R5, R12, R16, R26, R32, R18, R20, R22, R24 | RES., 100k, 1%, 1/10W, 0603, AEC-Q200 | VISHAY, CRCW0603100KFKEA |
| 16 | 4 | R50, R51, R82, R83 | RES., 1k, 1%, 1/10W, 0603, AEC-Q200 | VISHAY, CRCW06031K00FKEA |
| 17 | 2 | R54, R69 | RES., 10k, 1%, 1/10W, 0603, AEC-Q200 | VISHAY, CRCW060310K0FKEA |
| 18 | 1 | R55 | RES., 0.01, 1%, 1/2W, 2010, SENSE, AEC-Q200 | VISHAY, WSL2010R0100FEA |
| 19 | 1 | R70 | RES., 0.02, 1%, 1/2W, 2010, SENSE, AEC-Q200 | VISHAY, WSL2010R0200FEA |

PARTS LIST

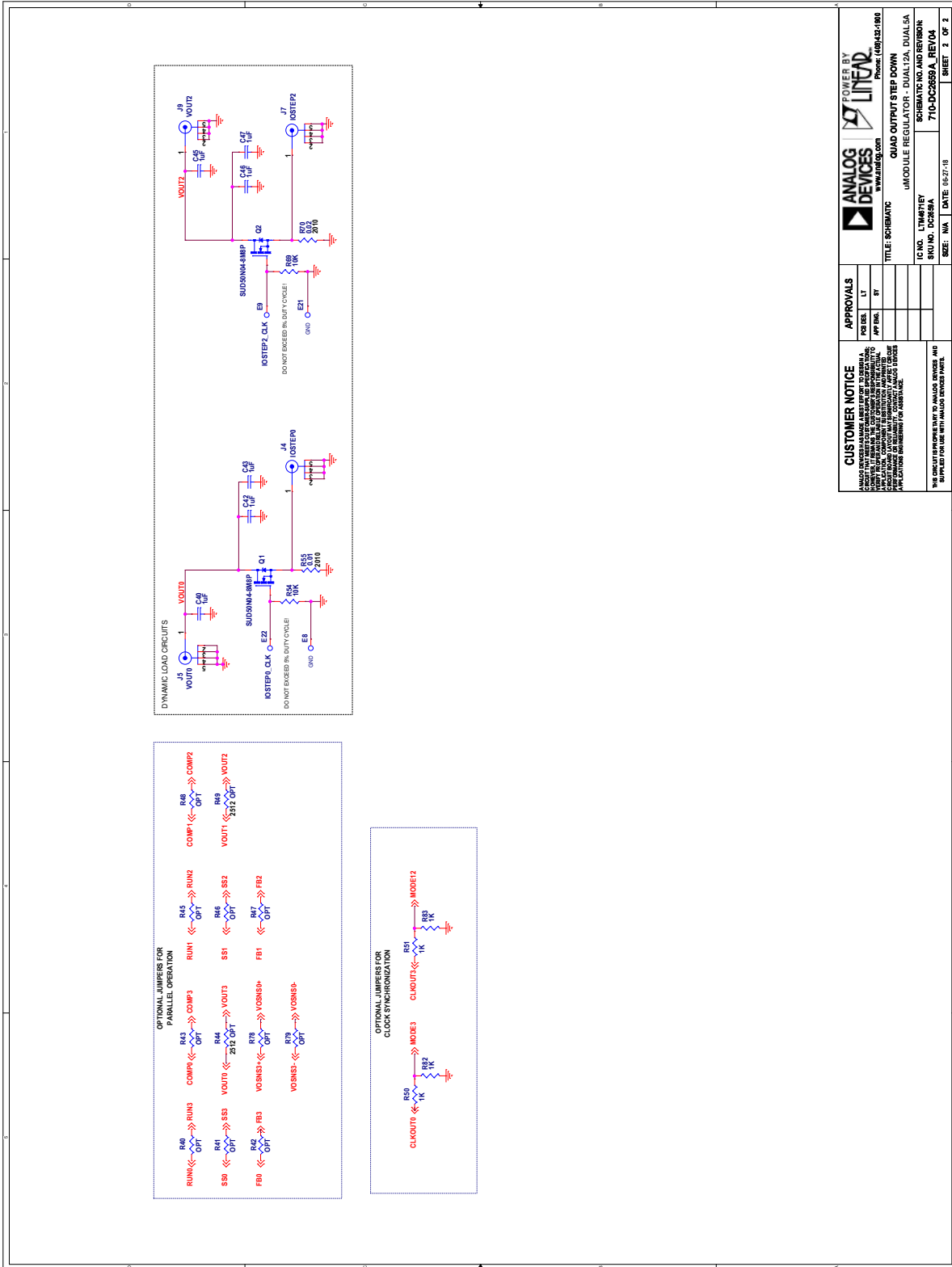
| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|-----------------|-----|--|---|-----------------------------------|
| Hardware | | | | |
| 1 | 25 | E1, E2, E3, E4, E5, E6, E7, E8, E9, E10, E11, E12, E13, E14, E15, E16, E17, E18, E19, E20, E21, E22, E23, E24, E25 | TEST POINT, TURRET, 0.094", MTG. HOLE | MILL-MAX, 2501-2-00-80-00-00-07-0 |
| 2 | 6 | J1, J2, J3, J10, J11, J12 | CONN., BANANA JACK, FEMALE, THT, NON-INSULATED, SWAGE | KEYSTONE, 575-4 |
| 3 | 4 | JP1, JP2, JP3, JP4 | CONN., HDR, MALE, 1mm x3mm x 2mm, VERT, STR, THT | WURTH ELEKTRONIK, 62000311121 |
| 4 | 4 | J4, J5, J7, J9 | CONN., RF, BNC, RCPT JACK, 5-PIN, STR, THT, 50Ω | AMPHENOL RF, 112404 |
| 5 | 2 | JP5, JP7 | CONN., HDR, MALE, 2mm x 2mm x 2mm, VERT, STR, THT | WURTH ELEKTRONIK, 62000421121 |
| 6 | 1 | JP6 | CONN., HDR, MALE, 2mm x 3mm x 2mm, VERT, STR, THT | WURTH ELEKTRONIK, 62000621121 |
| 7 | 4 | MH1, MH2, MH3, MH4 | STANDOFF, NYLON, SNAP-ON, 0.375" | KEYSTONE, 8832 |
| 8 | 7 | XJP1, XJP2, XJP3, XJP4, XJP5, XJP6, XJP7 | CONN., SHUNT, FEMALE, 2-POS, 2mm | WURTH ELEKTRONIK, 60800213421 |

DEMO MANUAL DC2659A

SCHEMATIC DIAGRAM



SCHEMATIC DIAGRAM



| | | | |
|---|--|---|--|
| | | | |
| APPROVALS POISSON: LT AP: RM: BT | | TITLE: SCHEMATIC URL: www.analog.com | |
| IC NO.: LT1M4PTEY S/N: NO. DC2659A | | QUAD OUTPUT STEP DOWN MODULE REGULATOR - DUAL/2A, DUAL/1A | |
| SIZE: 10x10 DATE: 05-27-18 | | SCHEMATIC NO. AND REVISION: 710-DC2659A_REV03 | |
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