LTM4670
Low V_{IN}, Quad µModule Regulator with Configurable 10A Output Array Step-Down Regulator

DESCRIPTION

Demonstration circuit 2891A features the LTM®4670EY, a high efficiency, quad 10A step-down power µModule® regulator. The input voltage range is from 2.25V to 5.5V. The output voltage range is 0.5V to V_{IN}. Derating is necessary for certain V_{IN}, V_{OUT}, frequency and thermal conditions. The DC2891A offers the SSTT pin allowing the user to program output tracking, soft-start period and die temperature monitoring.

The MODE/SYNC pin either synchronizes the switching frequency to an external clock, is a clock output, or sets the PWM mode. The PWM modes of operation are forced continues mode for low noise or pulse-skipping mode for high efficiency at light load. The LTM4670 defaults to forced continues mode in regulation and during synchronization. The LTM4670 operates in pulse-skipping mode when both the FREQ and MODE/SYNC pins are connected to V_{IN}.

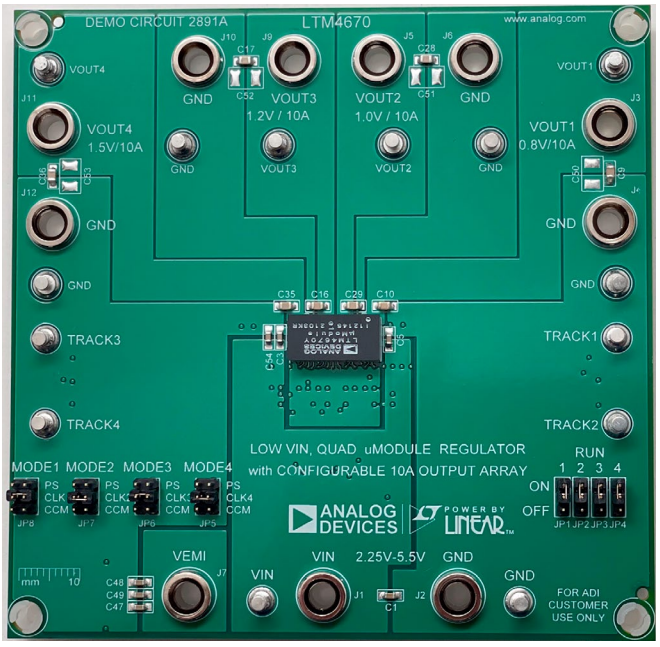
DC2891A has optional jumper resistors to parallel multiple LTM4670 channels. For paralleled channels, one channel can be set as master, and the rest can be set as slaves. The phase shift of a slave channel relative to the master channel can be programmed with a resistor divider on the FREQ pin.

For DC2891A, four channels of LTM4670 are working separately and all set as master. A multiphase oscillator LTC6902 is used to set 90-degree phase shift between adjacent phases and reduce the amount of ripple current in both the input and output capacitors.

The LTM4670 data sheet must be read in conjunction with this demo manual prior to working on or modifying demo circuit DC2891A.

Design files for this circuit board are available.

BOARD PHOTO



PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Voltage Range		2.25		5.5	V
Output Voltages	0.8V, 1.0V, 1.2V, 1.5V.			±1.5	%
Maximum Continuous Output Current	Derating is Necessary for Certain Operating Conditions. See Data Sheet for Details.		10ADC for Each Channel		ADC
Operating Frequency			2		MHz
Efficiency of Channel 1	V_{IN} = 3.3V, V_{OUT1} = 0.8V, I_{OUT1} = 10A		83.03, See Figure 2		%
Efficiency of Channel 2	V_{IN} = 3.3V, V_{OUT2} = 1.0V, I_{OUT2} = 10A		84.35, See Figure 3		%
Efficiency of Channel 3	V_{IN} = 3.3V, V_{OUT3} = 1.2V, I_{OUT3} = 10A		86.32, See Figure 4		%
Efficiency of Channel 4	V_{IN} = 3.3V, V_{OUT4} = 1.5V, I_{OUT4} = 10A		88.09, See Figure 5		%

QUICK START PROCEDURE

Demonstration circuit DC2891A is an easy way to evaluate the performance of the LTM4670EY. 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 application:

RUN1	RUN2	RUN3	RUN4
ON	ON	ON	ON

MODE1	MODE2	MODE3	MODE4
CLK1	CLK2	CLK3	CLK4

2. With power off, connect the input power supply, loads and meters as shown in Figure 1. Preset the load to 0A and V_{IN} supply to 3.3V.

3. Turn on the power supply at the input. The output voltage of channel 1 should be 0.8V ±1.5% (0.788V to 0.812V). The output voltage of channel 2 should be 1.0V ±1.5% (0.985V to 1.015V). The output voltage of channel 3 should be 1.2V ±1.5% (1.182V to 1.218V). The output voltage of channel 4 should be 1.5V ±1.5% (1.478V to 1.522V).

4. Vary the input voltage from 2.25V to 5.5V and adjust the load current of each channel from 0A–10A. Observe the output voltage regulation, ripple voltage, efficiency, and other parameters.

5. (Optional) To set one channel of LTM4670 to pulse-skipping mode, not only the MODE pin jumper of that channel needs to be put on “PS”, but also corresponding FREQ pin needs to be connected to V_{IN}. See Table 1.

Table 1.

FREQ PIN CONNECTION	MODE/ SYNC PIN CONNECTION	MODE OF OPERATION	SWITCHING FREQUENCY
V_{IN}	Clock Input	Forced Continuous	External Clock
V_{IN}	AGND	Forced Continuous	2MHz Default
V_{IN}	V_{IN}	Pulse-Skipping	2MHz Default
Resistor to AGND	Clock Output	Forced Continuous	FREQ Programmed

6. (Optional) To parallel the four channels of LTM4670 to create one single output, R32 to R46, R48 to R50 need to be changed to 0Ω. Also, R61, R62 and R63 need to be removed from the board. When working in parallel configuration, one channel can be set as master and the others can be set as slaves. The phase shift of a slave channel relative to the master channel can be programmed with a resistor divider on the FREQ pin. Please refer to the LTM4670 data sheet for details.

QUICK START PROCEDURE

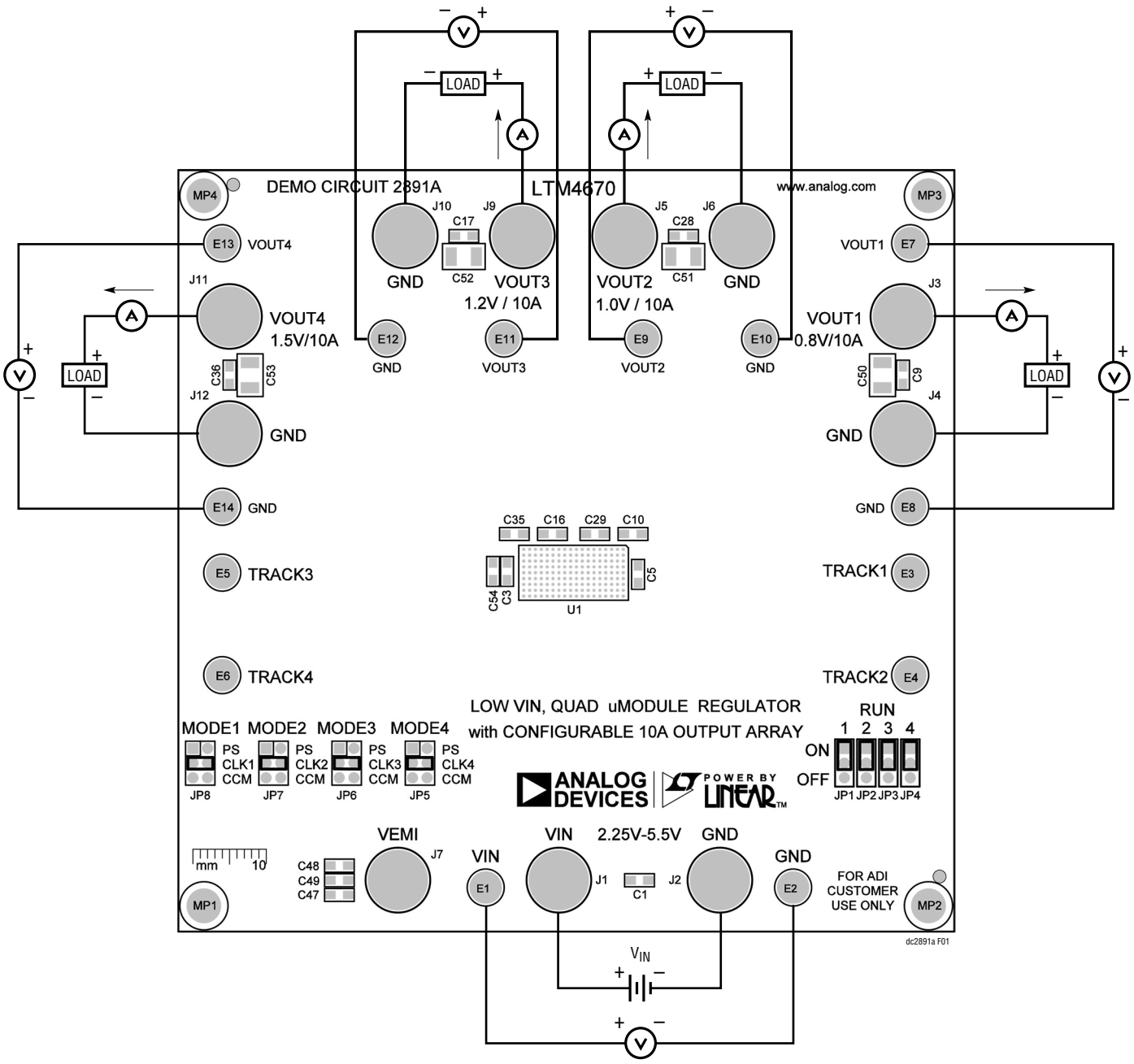


Figure 1. Measurement Setup of DC2891A

QUICK START PROCEDURE

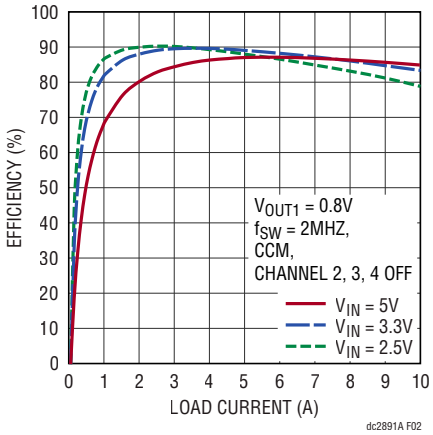


Figure 2. Measured Efficiency on Channel 1

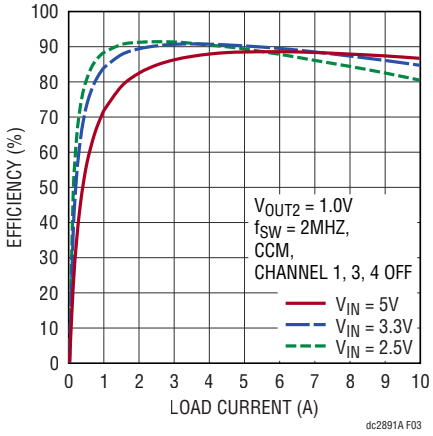


Figure 3. Measured Efficiency on Channel 2

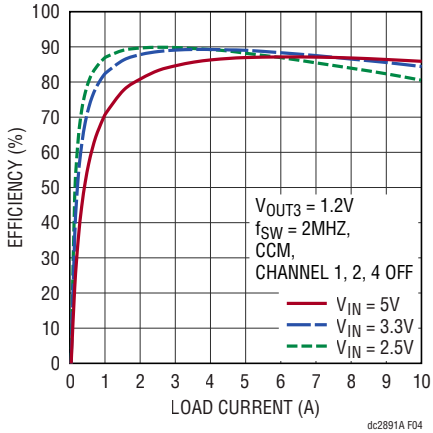


Figure 4. Measured Efficiency on Channel 3

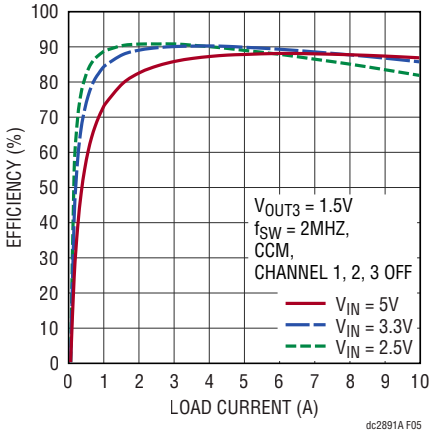
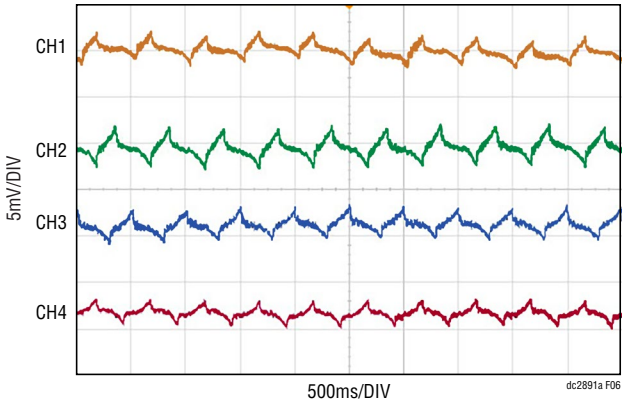


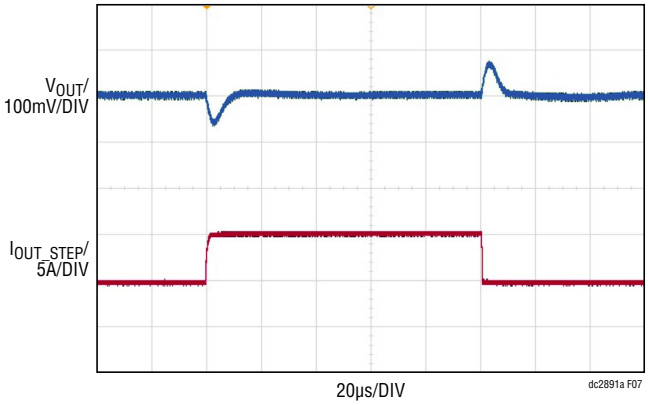
Figure 5. Measured Efficiency on Channel 4



V_{IN} = 3.3V, V_{OUT1} = 0.8V AT 10A, V_{OUT2} = 1.0V AT 10A,
V_{OUT3} = 1.2V AT 10A, V_{OUT4} = 1.5V AT 10A

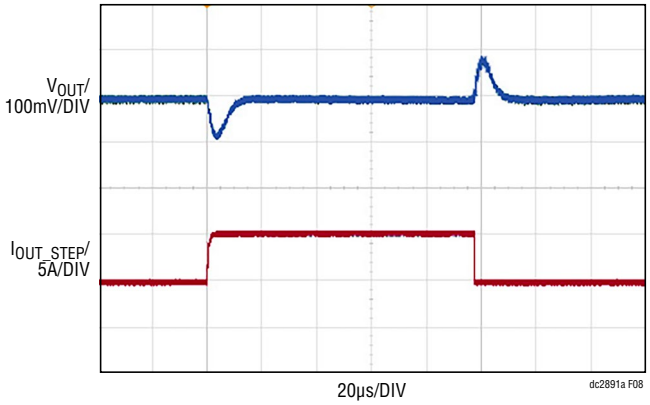
Figure 6. Output Voltage Ripples of Four Channels

QUICK START PROCEDURE



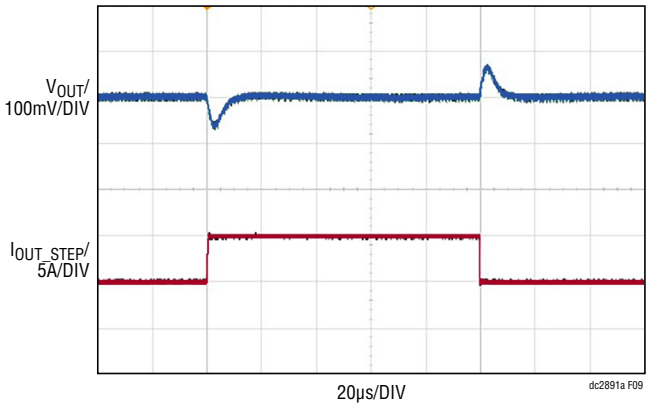
V_{IN} = 3.3V, V_{OUT1} = 0.8V, I_{STEP} = 0A TO 5A

Figure 7. Measured Channel 1 Load Transient



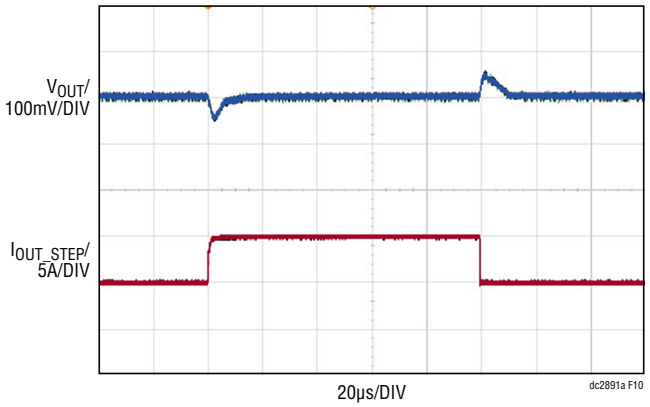
V_{IN} = 3.3V, V_{OUT2} = 1.0V, I_{STEP} = 0A TO 5A

Figure 8. Measured Channel 2 Load Transient



V_{IN} = 3.3V, V_{OUT3} = 1.2V, I_{STEP} = 0A TO 5A

Figure 9. Measured Channel 3 Load Transient



V_{IN} = 3.3V, V_{OUT4} = 1.5V, I_{STEP} = 0A TO 5A

Figure 10. Measured Channel 4 Load Transient

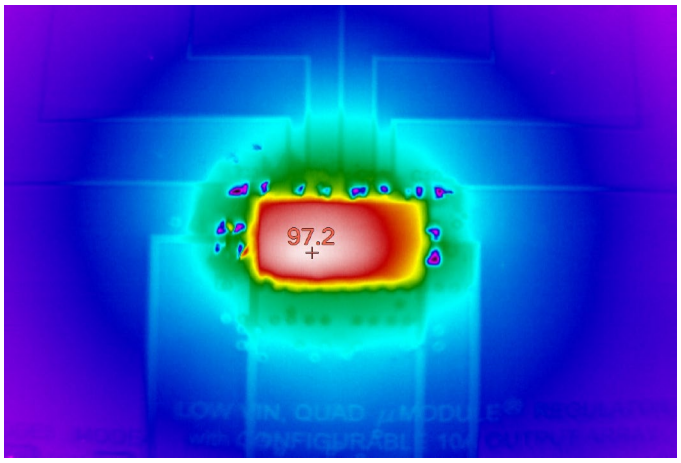


Figure 11. Thermal Image of LTM4670, V_{IN} = 3.3V, V_{OUT1} = 0.8V at 10A, V_{OUT2} = 1.0V at 10A, V_{OUT3} = 1.2V at 10A, V_{OUT4} = 1.5V at 10A, Ambient Temperature = 25°C, No Forced Airflow

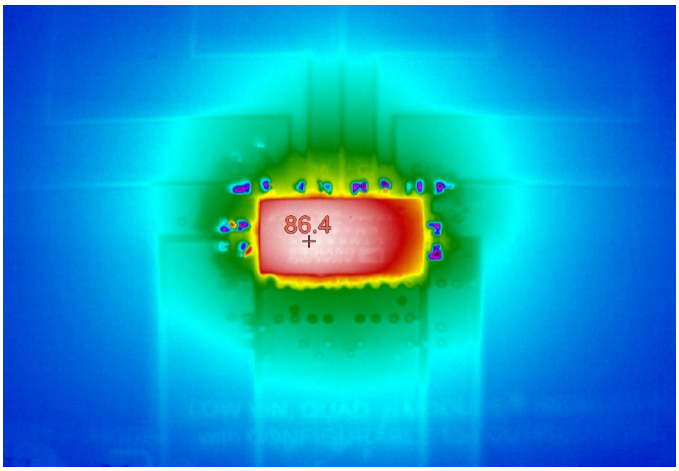
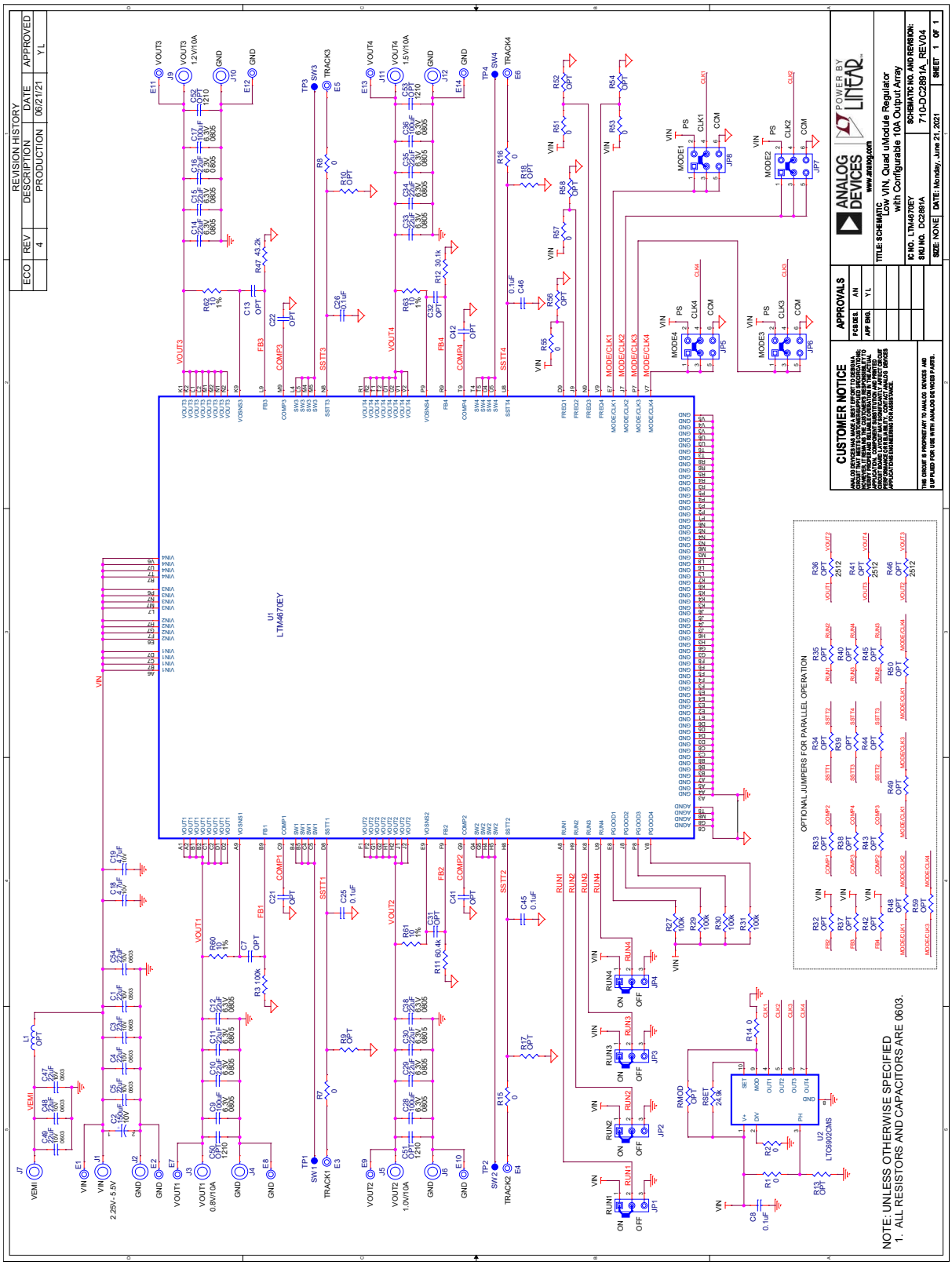


Figure 12. Thermal Image of LTM4670, V_{IN} = 5.0V, V_{OUT1} = 0.8V at 10A, V_{OUT2} = 1.0V at 10A, V_{OUT3} = 1.2V at 10A, V_{OUT4} = 1.5V at 10A, Ambient Temperature = 25°C, No Forced Airflow

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	8	C1, C3–C5, C47–C49, C54	CAP., 22µF, X5R, 10V, 20%, 0603	AVX, 0603ZD226MAT2A
2	1	C2	CAP., 150µF, ALUM ELECT, 10V, 20%, 8mm × 6.9mm	PANASONIC, 10SVP150MX
3	5	C8, C25, C26, C45, C46	CAP., 0.1µF, X7R, 50V, 10%, 0603	AVX, 06035C104KAT2A
4	4	C9, C17, C28, C36	CAP., 100µF, X5R, 6.3V, 20%, 0805	MURATA, GRM21BR60J107ME15K
5	12	C10–C12, C14–C16, C29, C30, C33–C35, C38	CAP., 22µF, X5R, 6.3V, 20%, 0805	KEMET, C0805C226M9PACTU
6	2	C18, C19	CAP., 4.7µF, X5R, 10V, 10%, 0603	SAMSUNG, CL10A475KP8NNNC
7	1	R3	RES., 100k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW0603100KFKEA
8	1	R11	RES., 60.4k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW060360K4FKEA
9	1	R12	RES., 30.1k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW060330K1FKEA
10	4	R27, R29–R31	RES., 100k, 5%, 1/10W, 0603	PANASONIC, ERJ3GEYJ104V
11	1	R47	RES., 43.2k, 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3EKF4322V
12	4	R60–R63	RES., 10Ω, 1%, 1/10W, 0603	VISHAY, CRCW060310R0FKEA
13	1	RSET	RES., 24.9k, 1%, 1/10W, 0603	NIC, NRC06F2492TRF
14	1	U1	IC, LOW V_{IN} QUAD µModule REGULATOR WITH CONFIGURABLE 10A OUTPUT ARRAY, BGA	ANALOG DEVICES, LTM4670EY#PBF
15	1	U2	IC, MULTIPHASE OSC WITH FREQ MOD, 10-PIN MSOP	ANALOG DEVICES, LTC6902CMS#PBF
Additional Demo Board Circuit Components				
1	0	C7, C13, C21, C22, C31, C32, C41, C42	CAP., OPTION, 0603	
2	0	C50-C53	CAP., OPTION, 1210	
3	0	L1	IND., OPTION, POWER, HIGH CURRENT, SMD	
4	11	R1, R2, R7, R8, R14–R16, R51, R53, R55, R57	RES., 0Ω, 1/10W, 0603, AEC-Q200	VISHAY, CRCW06030000Z0EA
5	0	R9, R10, R13, R17, R18, R32-R35, R37–R40, R42–R45, R48–R50, R52, R54, R56, R58, R59, RMOD	RES., OPTION, 0603	
6	0	R36, R41, R46	RES., OPTION, 2512	
Hardware: For Demo Board Only				
1	14	E1–E14	TEST POINT, TURRET, 0.094" MTG. HOLE, PCB 0.062" THICK	MILL-MAX, 2501-2-00-80-00-00-07-0
2	11	J1–J7, J9–J12	CONN., BANANA JACK, FEMALE, THT, NON-INSULATED, SWAGE, 0.218"	KEYSTONE, 575-4
3	4	JP1–JP4	CONN., HDR, MALE, 1×3, 2mm, VERT, STR, THT, NO SUBS. ALLOWED	WURTH ELEKTRONIK, 62000311121
4	4	JP5–JP8	CONN., HDR, MALE, 2×3, 2mm, VERT, STR, THT	WURTH ELEKTRONIK, 62000621121
5	4	MP1–MP4	STANDOFF, NYLON, SNAP-ON, 0.25" (6.4mm)	KEYSTONE, 8831
6	8	XJP1–XJP8	CONN., SHUNT, FEMALE, 2-POS, 2mm	WURTH ELEKTRONIK, 60800213421

SCHEMATIC DIAGRAM



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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