LTM4633
High Efficiency, Triple Output Step-Down µModule Regulator

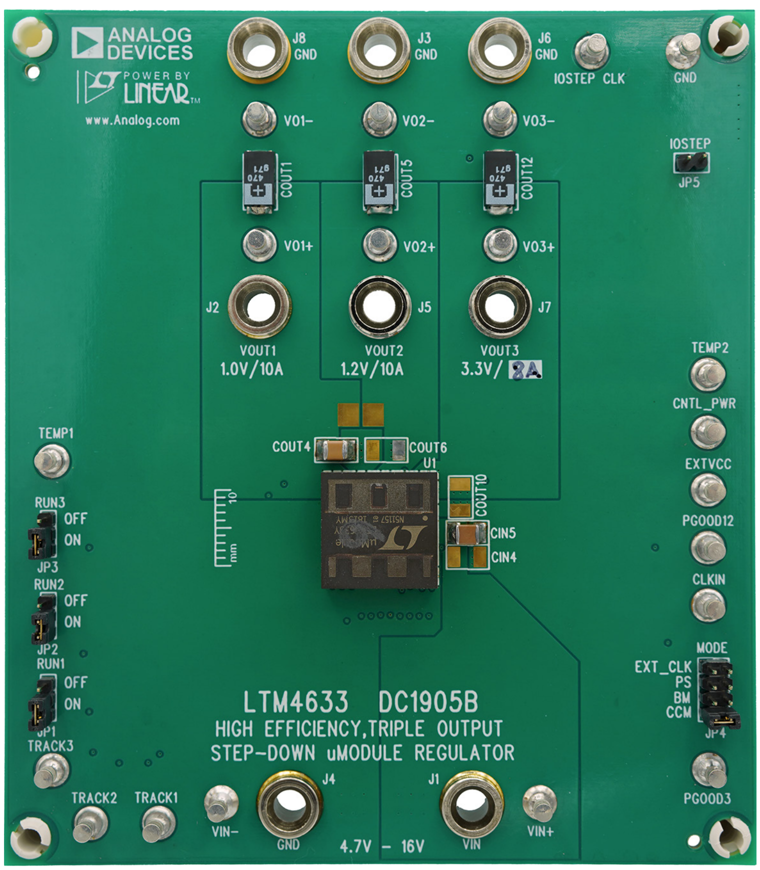
DESCRIPTION

Demonstration circuit 1905B features the LTM®4633EY, a high efficiency, triple output step-down power µModule® regulator. The input voltage range is from 4.7V to 16V with a common input source, or 2.375V to 16V with an external bias supply. The output voltage range is 0.8V to 1.8V for channels 1 and 2, and 0.8V to 5.5V for channel 3. Derating is necessary for certain V_{IN}, V_{OUT}, frequency, and thermal conditions. See Table 1 for Thermally Viable Operating Conditions. The DC1905B offers access to the TRACK/SS pins, 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 (JP4) selects pulse-skipping mode for noise sensitive applications or Burst Mode® operation in less noise sensitive applications. Channels 1 and 2 can be connected in parallel for a single 20A output solution with optional jumper resistors. The LTM4633 data sheet must be read in conjunction with this demo manual prior to working on or modifying demo circuit 1905B.

Design files for this circuit board are available.

BOARD PHOTO

Part marking is either ink mark or laser mark



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PERFORMANCE SUMMARY

Specifications are at $T_A = 25°C$

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Voltage Range		4.7		16	V
Output Voltages		1	1.2	3.3 ±1.5%	V
Maximum Continuous Output Current	Derating is necessary for certain operating conditions (Refer to data sheet for details)	10A DC for channels 1 and 2, 8A DC for channel 3 (Note 1)			
Operating Frequency	$V_{IN} \geq 6V$ (Note 2)		600		kHz
Efficiency of Channel 1	$V_{IN} = 12V$, $V_{OUT1} = 1.0V$, $I_{OUT1} = 10A$		80 (See Figure 2)		%
Efficiency of Channel 2	$V_{IN} = 12V$, $V_{OUT2} = 1.2V$, $I_{OUT2} = 10A$		83 (See Figure 3)		%
Efficiency of Channel 3	$V_{IN} = 12V$, $V_{OUT3} = 3.3V$, $I_{OUT3} = 8A$		91 (See Figure 4)		%
Load Transient of Channel 1	$V_{IN} = 12V$, $V_{OUT1} = 1.0V$, I_{STEP} = 0A to 5A		See Figure 5		
Load Transient of Channel 2	$V_{IN} = 12V$, $V_{OUT2} = 1.2V$, I_{STEP} = 0A to 5A		See Figure 6		
Load Transient of Channel 3	$V_{IN} = 12V$, $V_{OUT3} = 3.3V$, I_{STEP} = 0A to 5A		See Figure 7		

Note 1: For V_{IN} > 12V, 6A DC is maximum continuous output current when there is no forced airflow. See Table 1 for more details.

Note 2: For V_{IN} < 6V, to maintain constant frequency, remove R7 (to disconnect CNTL_PWR from V_{IN}) and apply 5V to CNTL_PWR and $EXTV_{CC}$.

QUICK START PROCEDURE

Demonstration circuit 1905B is an easy way to evaluate the performance of the LTM4633EY. See Figure 1 for the proper measurement equipment setup and follow the procedure below.

1. Place jumpers in the following positions for a typical application:

   JP1: RUN1 ON

   JP2: RUN2 ON

   JP3: RUN3 ON

   JP4: MODE CCM

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 12V.

3. Turn on the power supply at the input. The output voltage of channel 1 should be 1.0V ±1.5% (0.985V to 1.015V). The output voltage of channel 2 should be 1.2V ±1.5% (1.182V to 1.218V). The output voltage of channel 3 should be 3.3V ±1.5% (3.25V to 3.349V).

4. Vary the input voltage from 4.7V to 16V and adjust the load current from 0A to 10A for channels 1 and 2 and from 0A to 8A for channel 3. See Table 1 for Thermally Viable Operating Conditions. Observe the output voltage regulation, ripple voltage, efficiency, and other parameters.

5. (Optional) For the 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. Switch the jumper resistors R30, R31, or R34 (on the backside of boards) to apply load transient on channels 1 and 2, or channel 3, respectively.

6. (Optional) The LTM4633 can be synchronized to an external clock signal. Place the JP4 jumper on EXT_CLK and apply a clock signal (0V to 5V, square wave) on the CLKIN test point.

7. (Optional) The outputs of the LTM4633 can track another supply. If tracking external voltage is selected, the corresponding test points, TRACK1, TRACK2, and TRACK3, need to be connected to a valid voltage signal.

8. (Optional) Channels 1 and 2 can be connected in parallel for a 20A on the DC1905B. Install 0Ω resistors on R32, R33, R35, R36, and remove R15. The output voltage is set by R4 based on Equation 1.

$$V_{OUT} = 0.8V \bullet \frac{1 + \frac{60.4k}{2}}{R4} \qquad (1)$$

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QUICK START PROCEDURE

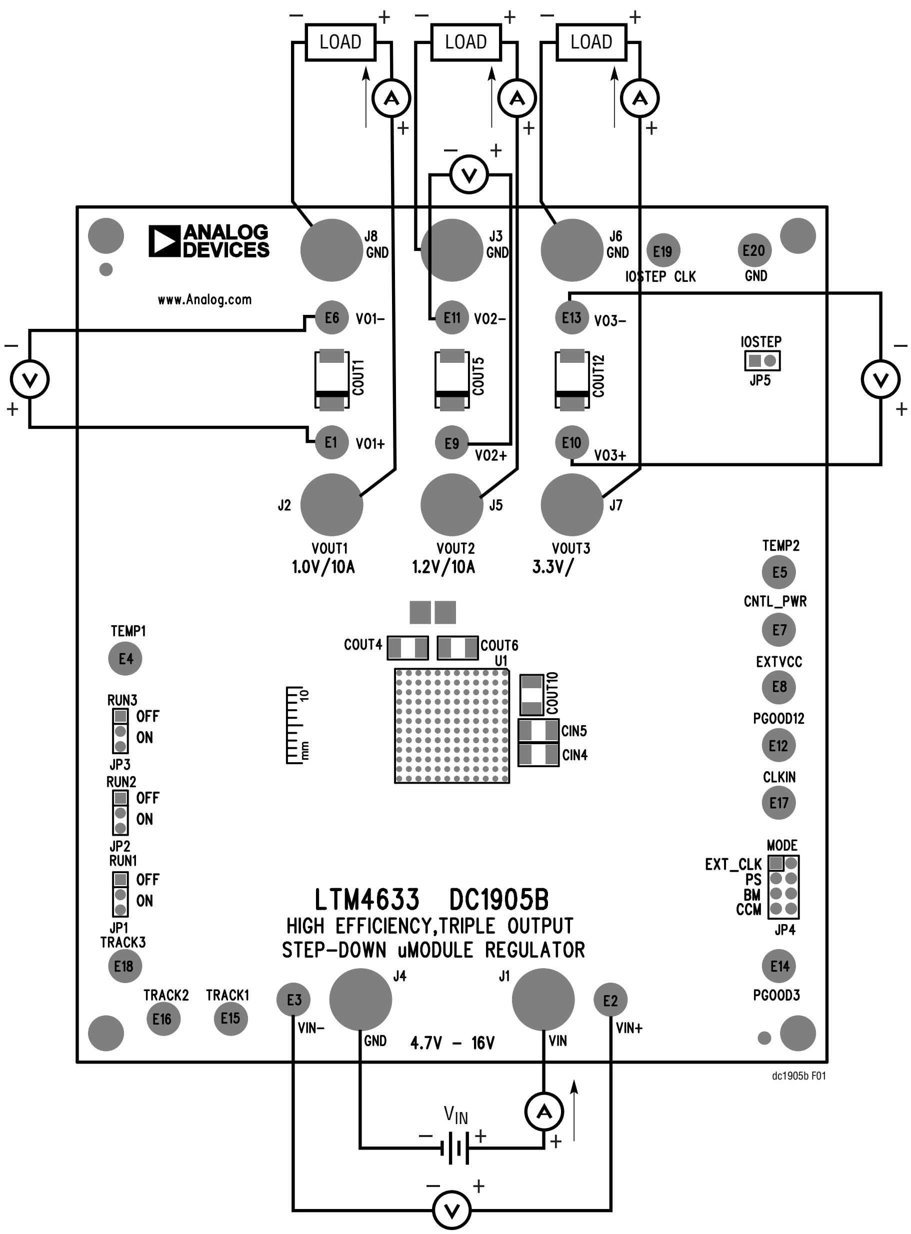


Figure 1. Measurement Setup of DC1905B

QUICK START PROCEDURE

Table 1. Thermally Viable Operating Conditions

V_{IN} (V)	LOAD ON (A)			FORCED AIRFLOW (LFM)	MODULE HIGH TEMP (°C)
	CH1	CH2	CH3		
12	10	10	3	0	81.3
12	10	10	3	200	67.6
12	10	10	5	0	89.5
12	10	10	8	0	99.1
12	10	10	8	200	78.4
12	10	10	8	400	71.6
16	10	10	3	0	91.0
16	10	10	3	200	74.3
16	10	10	5	0	94.8
16	10	10	6	0	98.0
16	10	10	8	200	85.4
16	10	10	8	400	76.5
5	10	10	3	0	74.6
5	10	10	8	0	88.3
5	10	10	8	200	71.1
5	10	10	8	400	63.2

NOTES:
Ambient Temperature = 23.9°C to 24.5°C.
No Heat Sink.
V_{OUT1} = 1V; V_{OUT2} = 1.2V; V_{OUT3} = 3.3V.
f_{SW} = 600kHz (For V_{IN} < 6V: Remove R7 and apply 5V to CNTL_PWR and EXT_VCC).
Board ran under each condition until the temperatures settled.
Thermal images were captured using the Fluke Ti401 Pro Thermal Camera.
Top of the module was painted with white-out to show the true temperatures on the thermal image.
This table reflects the unmodified demo board DC1905B only.
Thermally viable conditions for final customer designs will vary based on the characteristics of the actual design.
Never take the package temperature above 100°C.

QUICK START PROCEDURE

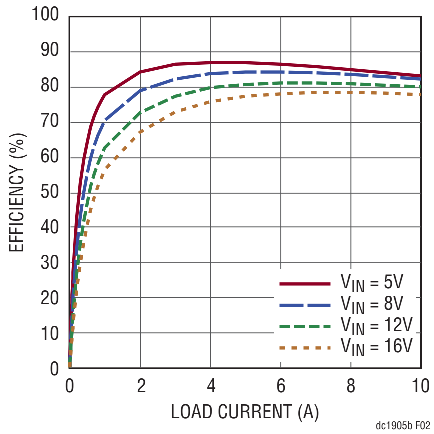


Figure 2. Measured Efficiency on Channel 1; V_{OUT1} = 1.0V, f_{SW} = 600kHz, CCM, Channels 2 and 3 Disabled

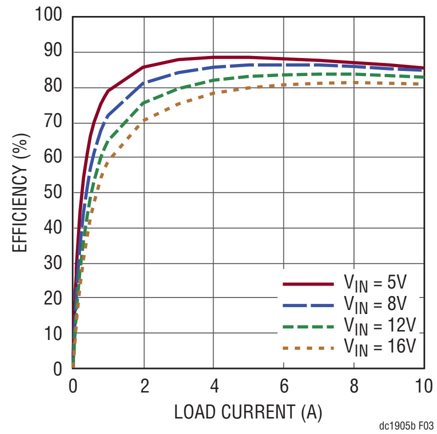


Figure 3. Measured Efficiency on Channel 2; V_{OUT2} = 1.2V, f_{SW} = 600kHz, CCM, Channels 1 and 3 Disabled

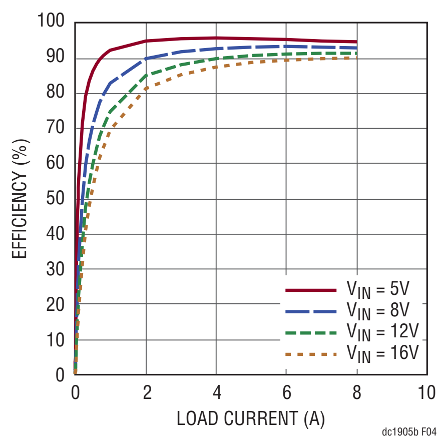


Figure 4. Measured Efficiency on Channel 3. V_{OUT3} = 3.3V, f_{SW} = 600kHz, CCM, Channels 1 and 2 Disabled

QUICK START PROCEDURE

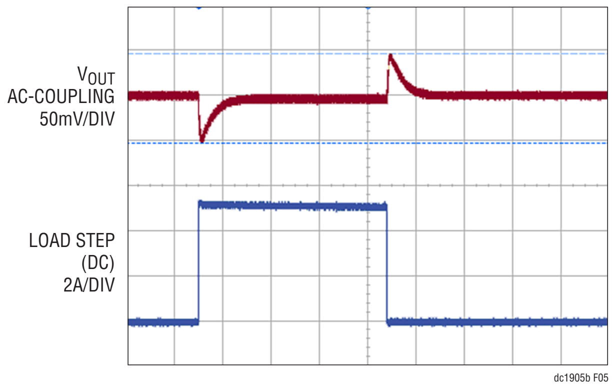


Figure 5. Measured Channel 1 Load Transient, V_{IN} = 12V, V_{OUT1} = 1.0V, I_{STEP} = 0A to 5A, dI/dt = 5A/µs

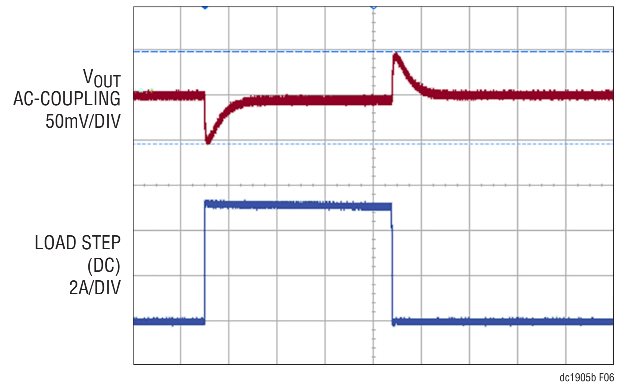


Figure 6. Measured Channel 2 Load Transient, V_{IN} = 12V, V_{OUT1} = 1.2V, I_{STEP} = 0A to 5A, dI/dt = 5A/µs

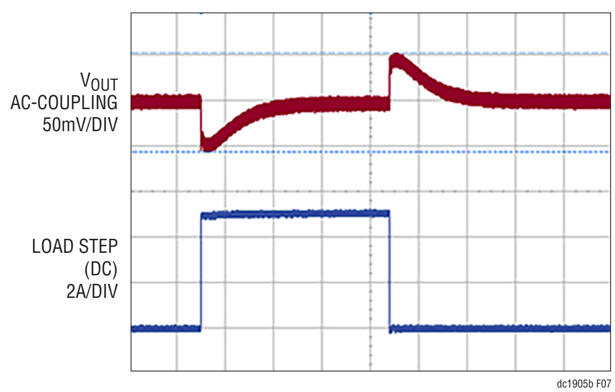


Figure 7. Measured Channel 3 Load Transient, V_{IN} = 12V, V_{OUT3} = 3.3V, I_{STEP} = 0A to 5A

QUICK START PROCEDURE

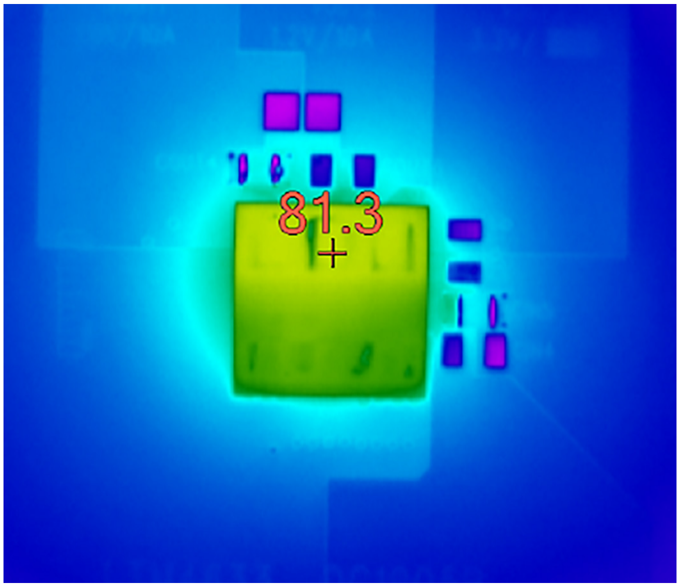


Figure 8. Thermal Image of LTM4633
V_{IN} = 12V, V_{OUT1} = 1.0V, I_{LOAD1} = 10A,
V_{OUT2} = 1.2V, I_{LOAD2} = 10A, V_{OUT3} = 3.3V, I_{LOAD3} = 3A
Ambient Temperature = 24.4°C, No Forced Airflow

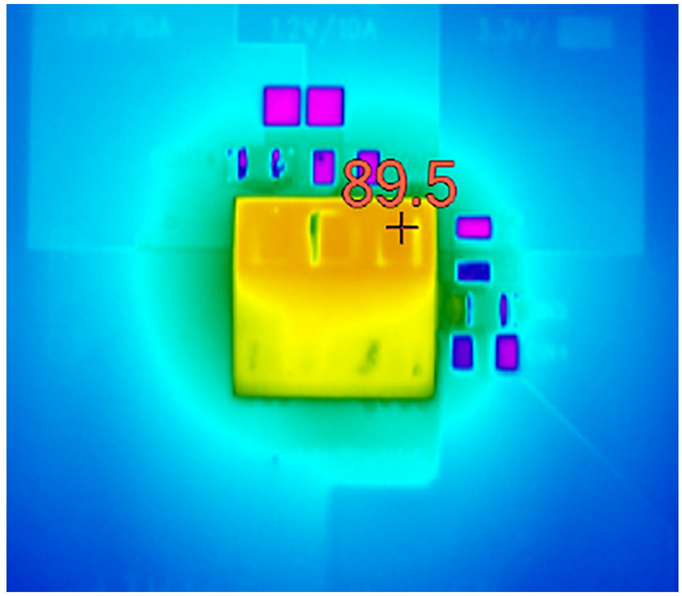


Figure 9. Thermal Image of LTM4633
V_{IN} = 12V, V_{OUT1} = 1.0V, I_{LOAD1} = 10A,
V_{OUT2} = 1.2V, I_{LOAD2} = 10A, V_{OUT3} = 3.3V, I_{LOAD3} = 5A
Ambient Temperature = 24.5°C, No Forced Airflow

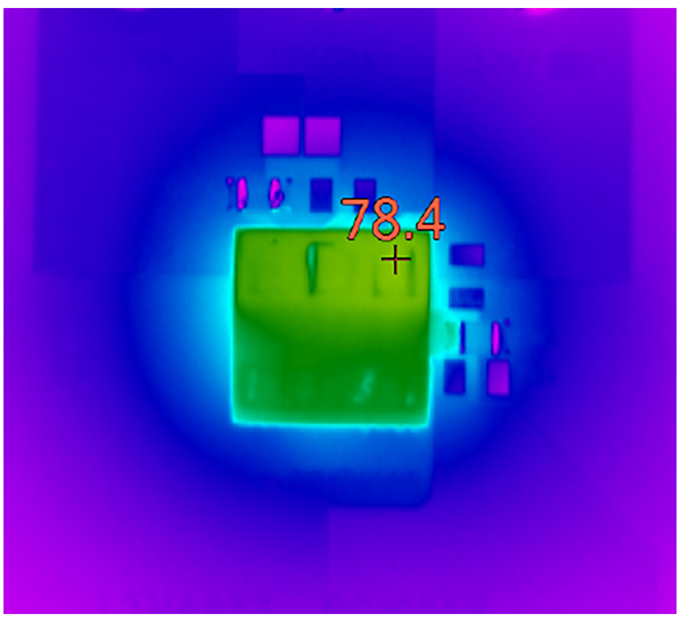
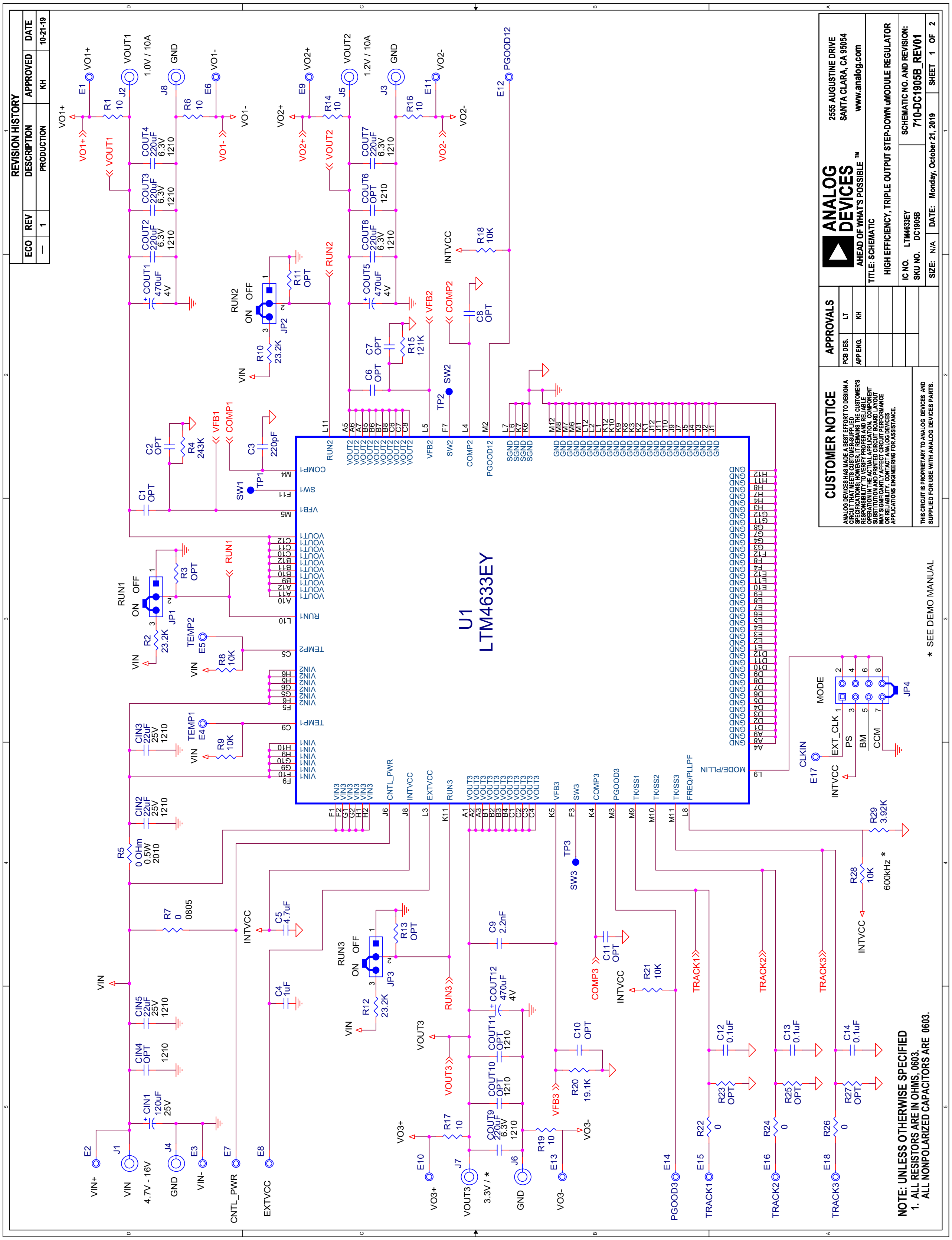


Figure 10. Thermal Image of LTM4633
V_{IN} = 12V, V_{OUT1} = 1.0V, I_{LOAD1} = 10A,
V_{OUT2} = 1.2V, I_{LOAD2} = 10A, V_{OUT3} = 3.3V, I_{LOAD3} = 8A
Ambient Temperature = 23.9°C, 200LFM Forced Airflow

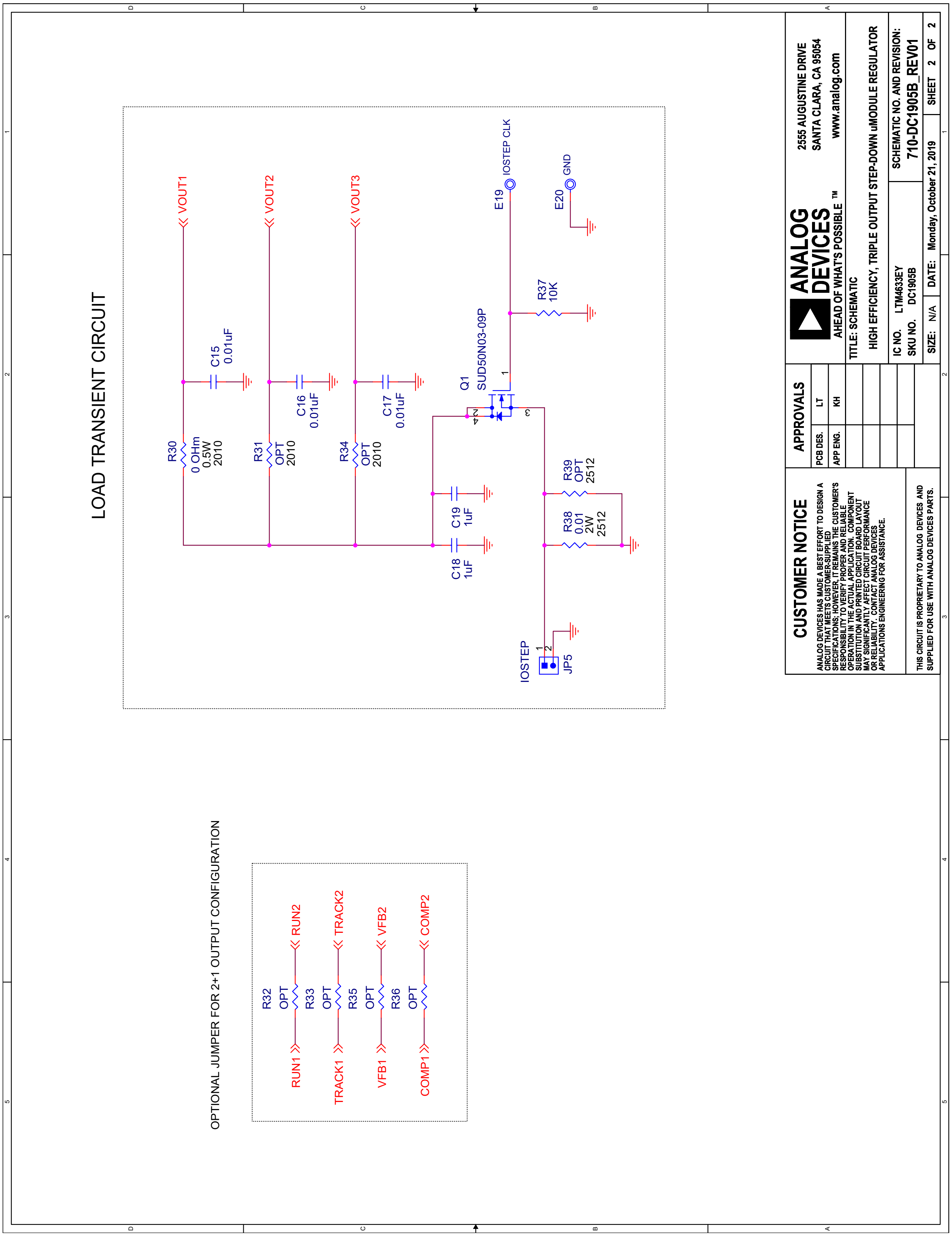
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	U1	144-P BGA, 15mm × 15mm	ANALOG DEVICES, LTM4633EY#PBF
2	1	CIN1	CAP., 120µF, 25V, ALUMINUM ELECTROLYTIC	PANASONIC, 25SVPK120M
3	3	CIN2, CIN3, CIN5	CAP., X5R, 22µF, 25V, 10%, 1210	MURATA, GRM32ER61E226KE15L
4	3	COUT1, COUT5, COUT12	CAP., 470µF, 4V, POSCAP, F8	SANYO, 4TPE470MCL
5	6	COUT2-COUT4, COUT7-COUT9	CAP., X5R, 220µF, 6.3V, 20%, 1210	MURATA, GRM32ER60J227ME05
6	1	C3	CAP., NPO, 220pF, 50V, 10%, 0603	AVX, 06035A221KAT2A
7	1	C4	CAP., X7R, 1µF, 10V, 10%, 0603	AVX, 0603ZC105KAT2A
8	1	C5	CAP., X5R, 4.7µF, 10V, 10%, 0603	AVX, 0603ZD475KAT2A
9	1	C9	CAP., X7R, 2200pF 50V, 10%, 0603	AVX, 06035C222KAT2A
10	3	C12-C14	CAP., X5R, 0.1µF, 25V, 10%, 0603	AVX, 06033D104KAT2A
11	6	R1, R6, R14, R16, R17, R19	RES., CHIP, 10Ω, 1%, 0603	VISHAY, CRCW060310R0FKEA
12	3	R2, R10, R12	RES., CHIP, 23.2k, 1%, 0603	VISHAY, CRCW060323K2FKEA
13	1	R4	RES., CHIP, 243k, 1%, 0603	VISHAY, CRCW0603243KFKEA
14	5	R8, R9, R18, R21, R28	RES., CHIP, 10k, 1%, 0603	VISHAY, CRCW060310K0FKEA
15	1	R15	RES., CHIP, 121k, 1%, 0603	VISHAY, CRCW0603121KFKEA
16	1	R20	RES., CHIP, 19.1k, 1%, 0603	VISHAY, CRCW060319K1FKEA
17	1	R29	RES., CHIP, 3.92k, 1%, 0603	VISHAY, CRCW06033K92FKEA
Additional Demo Board Circuit Components				
1	0	CIN4, COUT6, COUT10, COUT11	OPT, 1210	OPT
2	0	C1, C2, C6-C8, C10, C11	OPT, 0603	OPT
3	3	C15-C17	CAP., X7R, 0.01µF, 50V, 10%, 0603	AVX, 06035C103KAT2A
4	2	C18, C19	CAP., X7R, 1µF, 10V, 10%, 0603	AVX, 0603ZC105KAT2A
5	1	Q1	N-CHANNEL 30-V MOSFET	VISHAY, SUD50N03-09P-GE3
6	0	R3, R11, R13, R23, R25, R27, R32, R33, R35, R36	OPT, 0603	OPT
7	2	R5, R30	RES., CHIP, 0Ω, 0.5W, 2010	VISHAY, CRCW20100000Z0EF
8	1	R7	RES., CHIP, 0Ω, 1%, 0805	VISHAY, CRCW08050000Z0EA
9	3	R22, R24, R26	RES., CHIP, 0Ω, 1%, 0603	VISHAY, CRCW06030000Z0EA
10	0	R31, R34	OPT, 2010	OPT
11	1	R37	RES., CHIP, 10k, 1%, 0603	VISHAY, CRCW060310K0FKEA
12	1	R38	RES., CHIP, 0.01Ω, 2W, 2512	VISHAY, WSL2512R0100FEA
13	0	R39	OPT, 2512	OPT
Hardware: For Demo Board Only				
1	20	E1-E20	TEST POINT, TURRET 0.094" PBF	MILL-MAX 2501-2-00-80-00-00-07-0
2	3	JP1-JP3	HEADER 3-PIN, 0.079" SINGLE ROW	SULLINS, NRPN031PAEN-RC
3	1	JP4	HEADER 8-PIN, 0.079" DOUBLE ROW	SULLINS, NRPN042PAEN-RC
4	1	JP5	HEADER 2-PIN, 0.079" SINGLE ROW	SULLINS, NRPN021PAEN-RC
5	8	J1-J8	JACK BANANA	KEYSTONE, 575-4
6	4	XJP1-XJP4	SHUNT, 0.079" CENTER	SAMTEC, 2SN-BK-G
7	4	(STAND-OFF)	STAND-OFF, NYLON, 0.50"	KEYSTONE, 8833(SNAP ON)

SCHEMATIC DIAGRAM



SCHEMATIC DIAGRAM



Rev. 0

REVISION HISTORY

REV	DATE	DESCRIPTION	PAGE NUMBER
0	06/23	Initial Release.	—

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.

ANALOG DEVICES

06/23

www.analog.com