LTC7106 and LTM4636 7-Bit DAC with PMBus Controlled Step-Down µModule Regulator

DESCRIPTION

Demonstration circuit 2830A features the LTM®4636EY, a 40A high efficiency, switch mode step-down µModule® regulator which is controlled by the LTC®7106EDDB, a precision, bidirectional, 7-Bit current DAC with PMBus interface. The LTC7106 is used to adjust the output voltage of the LTM4636 by way of the PMBus. The LTM4636's input voltage range is from 4.7V to 15V and the output voltage range is from 0.6V to 3.3V. De-rating is necessary for certain VIN, VOUT, frequency and thermal conditions. The LTC7106 requires an input voltage from 2.5V to 5.5V and on DC2830A it's powered directly from the DC1613A dongle. The LTC7106 provides three ranges of IDAC output current: Nominal Range (–64µA to 63µA), Range High (–256µA to 252µA) and Range Low (–16µA to 15.75µA). The nominal range is optimized with the highest accuracy.

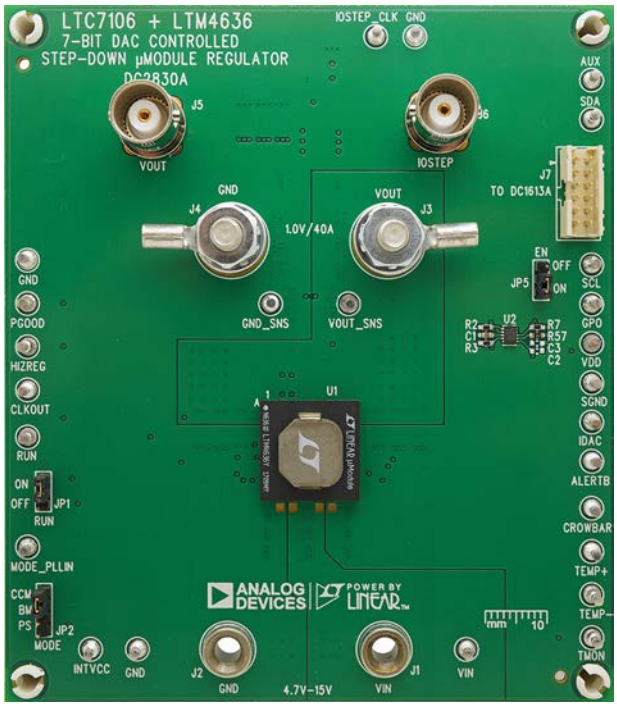
It is recommended that users design the resistor divider using the nominal range of the IDAC setting.

To explore the power system management features of the LTC7106, download the GUI software LTpowerPlay® onto your PC and use ADI's I²C/SMBus/PMBus Dongle DC1613A to connect to the board. LTpowerPlay allows the user to reconfigure the part on-the-fly, view IDAC current value and fault status.

The LTM4636 and LTC7106 data sheets must be read in conjunction with this demo manual prior to working on or modifying demo circuit DC2830A.

Design files for this circuit board are available.

BOARD PHOTO



PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

IC	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
LTM4636	Input Voltage Range		4.7		15	V
	Output Voltages			1.0 ±2.3%		V
	Maximum Continuous Output Current	De-rating is necessary for certain operating conditions. See data sheet for details.		40		A_{DC}
	Operating Frequency			350		kHz
	Efficiency	V_{IN} = 12V, V_{OUT} = 1.0V, I_{OUT} = 40A		87.1		%
	Load Transient	V_{IN} = 12V, V_{OUT} = 1.0V, I_{STEP} = 30A to 40A		49		mV
LTC7106	I_{DAC} Operation Voltage		0.4		2.0	V
	Output Current Range	Nominal, LSB = 1µA	–64		63	µA
		Range High, LSB = 4µA	–256		252	µA
		Range Low, LSB = 0.25µA	–16		15.75	µA
	I_{DAC} Accuracy	Nominal Range	–1.5		0.8	%

QUICK START PROCEDURE

Demonstration circuit 2830A makes it easy to use the LTC7106 to adjust the LTM4636 output voltage. This demo manual will focus on the evaluation of LTC7106. For the LTM4636 evaluation procedure, please refer to the DC2230A-A demo manual on the Analog Devices website. Please refer to Figure 1 for proper demo board setup with PC and follow the procedure below:

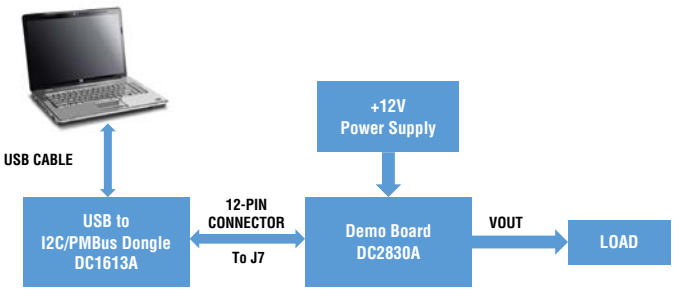


Figure 1. Demo Setup with PC of DC2830A

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

MODE (JP2)	RUN (JP1)	EN (JP5)
CCM	ON	OFF

2. 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 12V.
3. Turn on the power supply at the input. The output voltage should be 1.0V ±2.3% (0.977V to 1.023V).
4. Vary the input voltage from 4.7V to 15V and vary the load current from 0A to 40A. Observe the output voltage regulation, ripple voltage, efficiency, and other parameters.
5. Once the proper output voltage is established on the LTM4636 output, place the EN jumper (JP5) in the ON position to enable the LTC7106.

QUICK START PROCEDURE

6. Open the LTpowerPlay software and adjust the IDAC current value of the LTC7106. Monitor the regulator's output voltage as IDAC is changing. See LTpowerPlay Quick Start session for details.

7. The output voltage will change by the following equation, where R_{FB1} is the top resistor of the voltage divider and I_{DAC} is the programmed bidirectional current of the LTC7106. In the LTM4636, R_{FB1} is 4.99k inside the module. Therefore, the user can simply choose I_{DAC} value accordingly to achieve the desired V_{OUT} adjustment. See Figure 2 for a typical V_{OUT} waveform with ±20µA I_{DAC}.

$$\Delta V_{OUT} = -I_{DAC} \bullet R_{FB1}$$

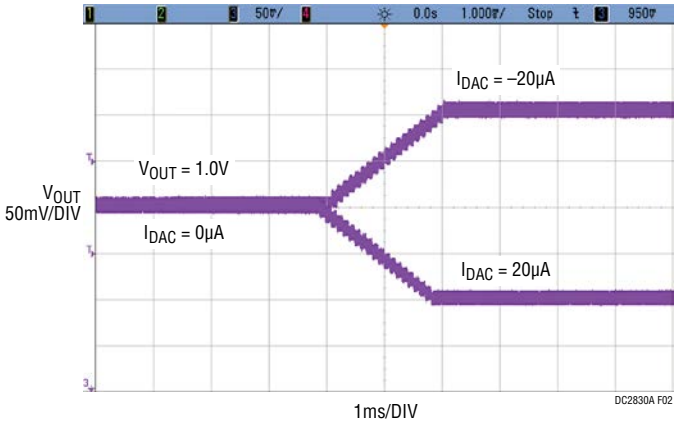


Figure 2. Typical Margin High and Margin Low Waveforms of LTM4636 by LTC7106

LTpowerPlay SOFTWARE GUI

LTpowerPlay is a powerful Windows based development environment that supports Linear Technology power system management ICs, including the LTC3880, LTC3883, LTC3882, LTC3815, LTC2974 and LTC2978. The software supports a variety of different tasks. You can use LTpowerPlay to evaluate Linear Technology ICs by connecting to a demo board system. LTpowerPlay utilizes the DC1613A USB-to-SMBus controller to communicate with one of many potential targets, including the LTC7106's DC2830A demo system, or a customer board. The software also provides an automatic update feature to keep the software current with the latest set of device drivers and documentation. The LTpowerPlay software can be downloaded from:

http://www.analog.com/en/design-center/ltpower-play.html.

To access technical support documents for LTC Digital Power Products visit Help. View online help on the LTpowerPlay menu.

LTpowerPlay SOFTWARE GUI

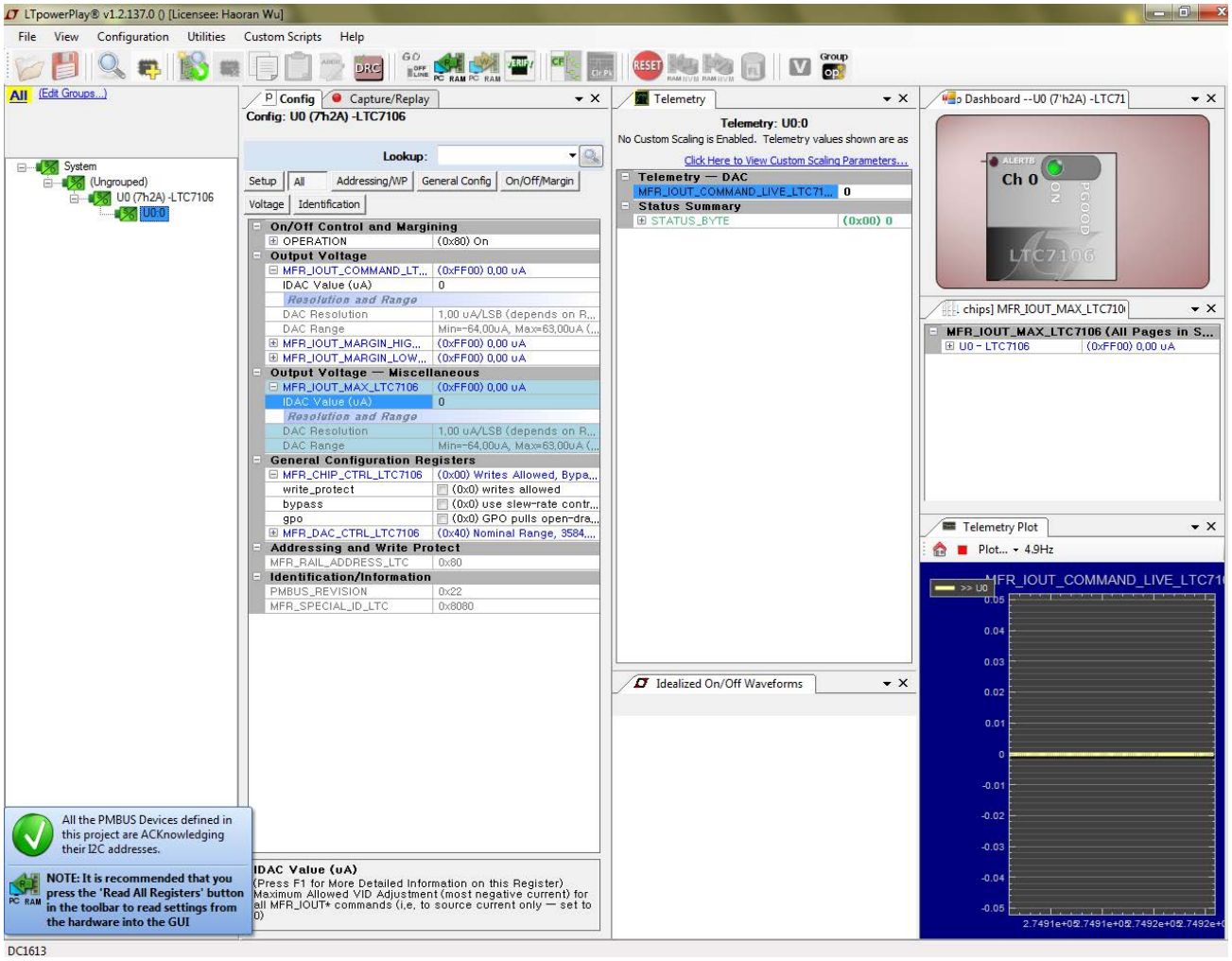


Figure 3. LTpowerPlay Main Interface for LTC7106

LTpowerPlay QUICK START PROCEDURE

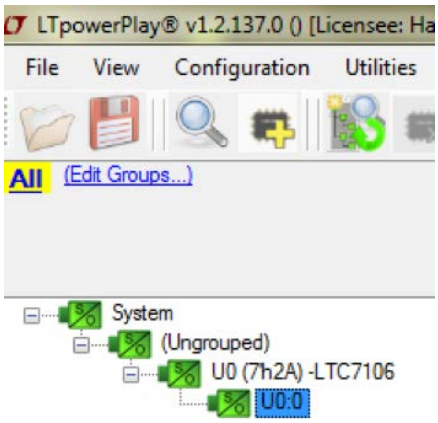
The following procedure describes how to use LTpowerPlay to monitor and change the settings of LTC7106.

1. Download and install the LTPowerPlay GUI:

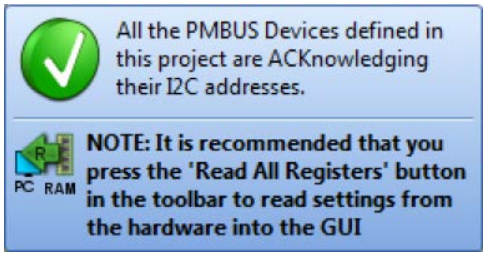
   http://www.analog.com/en/design-center/ltpower-play.html

2. Launch the LTpowerPlay GUI.

a. The GUI should automatically identify the DC2830A. The system tree on the left-hand side should look like this:

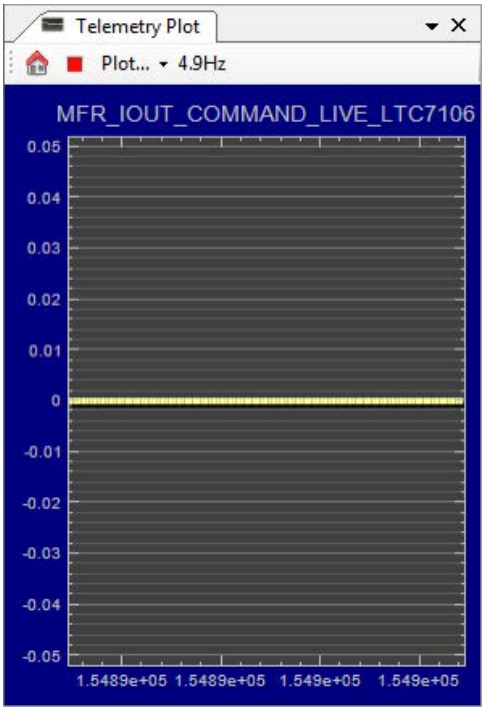


b. A blue message box shows for a few seconds in the lower left-hand corner, confirming that the LTC7106 is communicating:

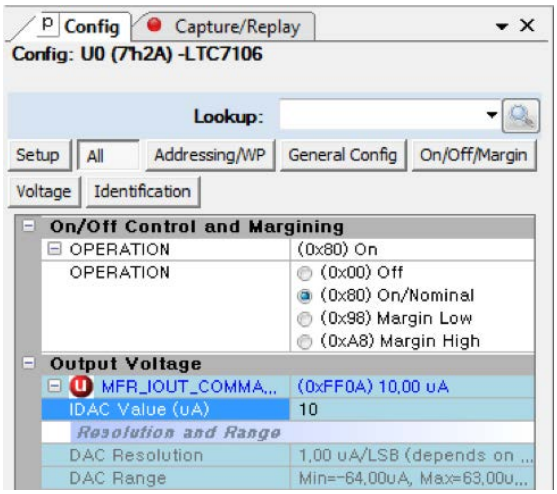


c. In the Toolbar, click the "R" icon (RAM to PC) to read the RAM from the LTC7106.

This reads the configuration from the RAM of LTC7106 and loads it into the GUI. When first powering on, you should read IDAC current at zero (high impedance IDAC) due to the LTC7106's internal power-on reset circuitry until a valid write takes place. The IDAC current value can be plotted in real time, shown in the following screenshot (at zero when first powering on):



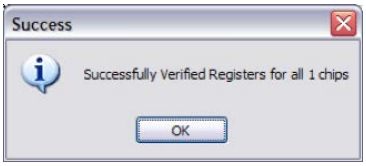
d. If you want to change the IDAC current to 10µA for example, in the Config tab, type "10" in the MFR_IOUT_COMMAND_LTC7106:



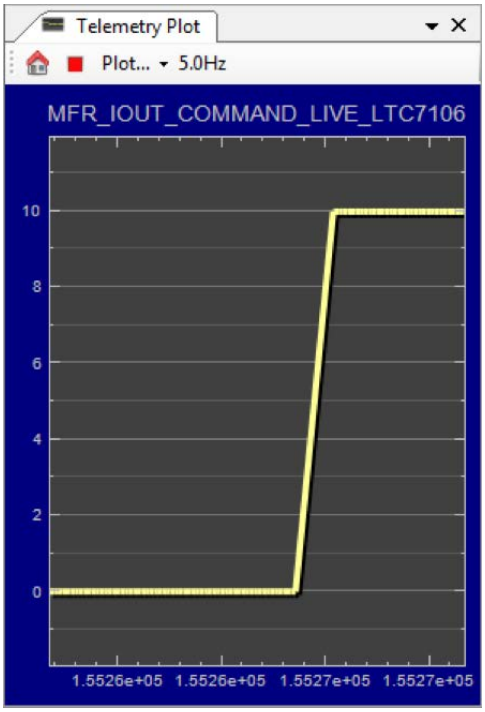
Then, click the "W" icon (PC to RAM) to write these register values to the LTC7106.

LTpowerPlay QUICK START PROCEDURE

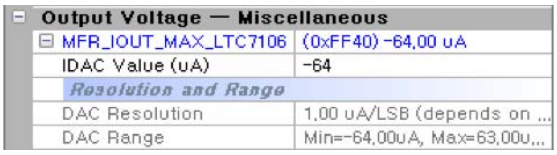
If the write is successful, you will see the following message:



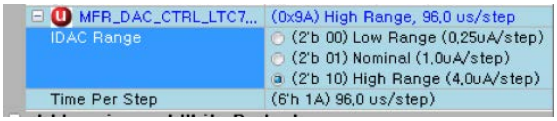
In the Telemetry Plot, you will see IDAC current value change to the commanding value:



e. If you want to change the IDAC current to a negative value (meaning sinking current), you need to change the MFR_IOUT_MAX_LTC7106 to a negative value first (see data sheet for more details).



f. You can also change IDAC range between Nominal, Low and High Range, as well as the Time Per Step in LTpowerPlay, as shown in the following picture.



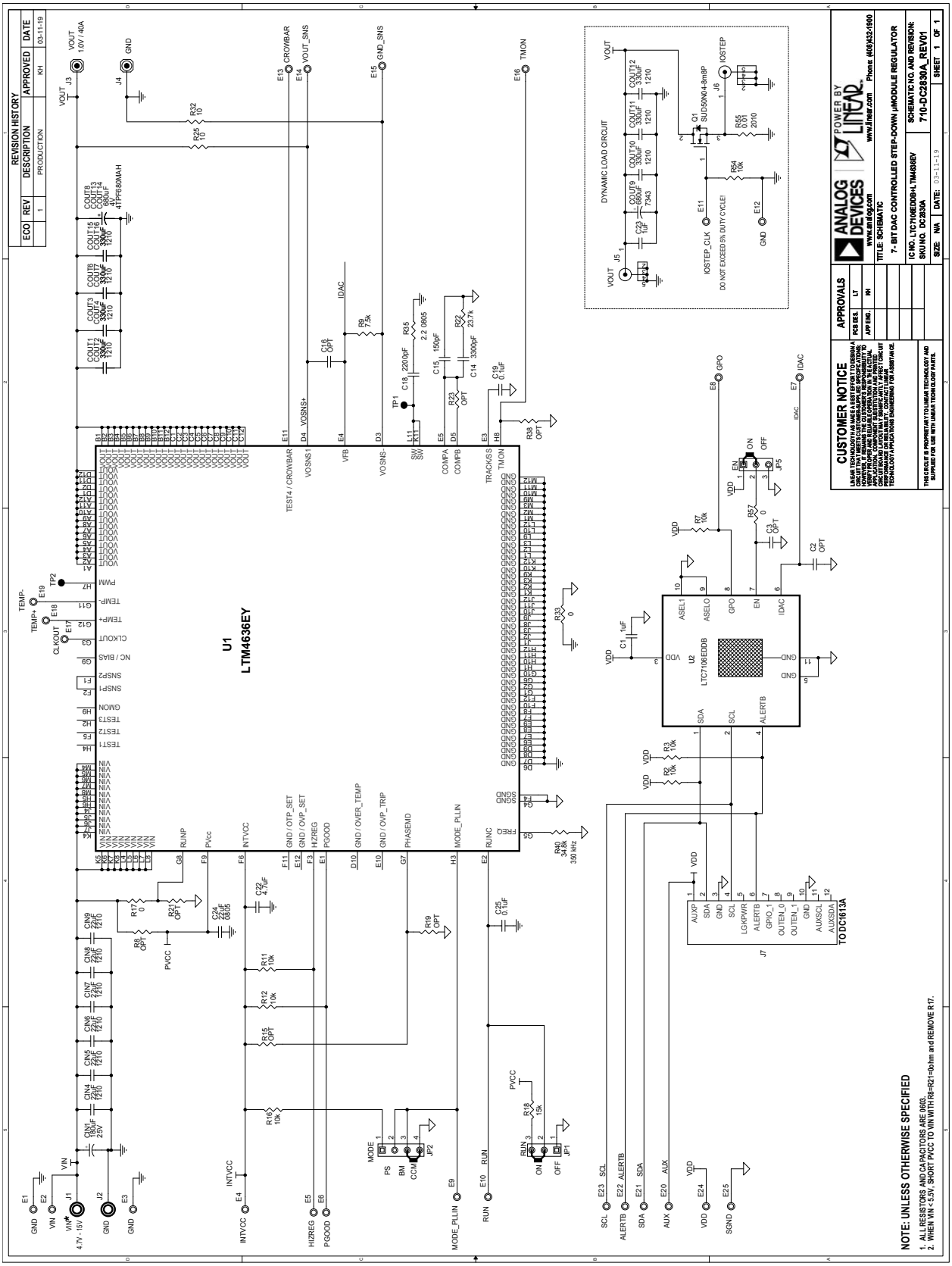
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	C1	CAP., 1µF, X5R, 10V, 10%, 0603	AVX, 0603ZD105KAT2A
2	1	C14	CAP., 3300pF, X7R, 50V, 10%, 0603	MURATA, GRM188R71H332KA01D
3	1	C15	CAP., 150pF, X7R, 50V, 10%, 0603	AVX, 06035C151KAT2A
4	1	C18	CAP., 2200pF, X7R, 25V, 10%, 0603	AVX, 06033C222KAT2A
5	2	C19, C25	CAP., 0.1µF, X5R, 16V, 10%, 0603	AVX, 0603YD104KAT2A
6	1	C22	CAP., 4.7µF, X5R, 10V, 10%, 0603	TAIYO YUDEN, LMK107BJ475KA-T
7	1	C23	CAP., 1µF, X5R, 25V, 10%, 0603	TAIYO YUDEN, TMK107BJ105KA-T
8	1	C24	CAP., 22µF, X5R, 6.3V, 20%, 0805	MURATA, GRM21BR60J226ME39L
9	1	CIN1	CAP., 180µF, ALUM. POLY., 25V, 20%, 8x12mm SMD, E12	PANASONIC, 25SVPF180M
10	6	CIN4-CIN9	CAP., 22µF, X5R, 16V, 20%, 1210	MURATA, GRM32ER61C226ME20L
11	11	COUT1-COUT4, COUT6, COUT7, COUT10-COUT12, COUT15, COUT16	CAP., 330µF, X5R, 4V, 20%, 1210	MURATA, GRM32ER60G337ME05L
12	4	COUT8, COUT9, COUT13, COUT14	CAP., 680µF, TANT, POLYMER, 4V, 20%, 7343	PANASONIC, 4TPF680MAH
13	1	Q1	XSTR., MOSFET, N-CH, 40V, TO-252 (DPAK)	VISHAY, SUD50N04-8M8P-4GE3
14	7	R2, R3, R7, R11, R12, R16, R54	RES., 10k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW060310K0FKEA
15	1	R9	RES., 7.5k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW06037K50FKEA
16	3	R17, R33, R57	RES., 0Ω, 1/10W, 0603, AEC-Q200	VISHAY, CRCW06030000Z0EA
17	1	R18	RES., 15k, 1%, 1/10W, 0603	YAGEO, RC0603FR-0715KL
18	1	R22	RES., 23.7k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW060323K7FKEA
19	2	R25, R32	RES., 10Ω, 1%, 1/10W, 0603	VISHAY, CRCW060310R0FKEA
20	1	R35	RES., 2.2Ω, 5%, 1/8W, 0805, AEC-Q200	VISHAY, CRCW08052R20JNEA
21	1	R40	RES., 34.8k, 1%, 1/10W, 0603	VISHAY, CRCW060334K8FKEA
22	1	R55	RES., 0.01Ω, 1%, 1/2W, 2010, SENSE, AEC-Q200	VISHAY, WSL2010R0100FEA
23	1	U1	IC, 40A DC/DC MODULE REGULATOR, BGA-144	ANALOG DEVICES, LTM4636EY#PBF
24	1	U2	IC, 7-BIT CURRENT DAC WTIH PMBus, DFN-10	ANALOG DEVICES, LTC7106EDDB#PBF
Additional Demo Board Circuit Components				
1	0	C2, C3, C16	CAP., OPTION, 0603	
2	0	R8, R15, R19, R21, R23, R38	RES., OPTION, 0603	

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Hardware: For Demo Board Only				
1	25	E1-E25	TEST POINT, TURRET, 0.064" MTG. HOLE, PCB 0.062" THICK	MILL-MAX, 2308-2-00-80-00-00-07-0
2	2	J1, J2	CONN., BANANA JACK, FEMALE, THT, NON-INSULATED, SWAGE, 0.218"	KEYSTONE, 575-4
3	2	J3, J4	STUD, FASTENER, #10-32	PENNENGINEERING, KFH-032-10ET
4	2	J5, J6	CONN., RF, BNC, RCPT JACK, 5-PIN, STR, THT, 50Ω	AMPHENOL RF, 112404
5	1	J7	CONN., SHROUDED HDR, MALE, 2x6, 2mm, VERT, STR, THT	FCI, 98414-G06-12ULF
6	2	JP1, JP5	CONN., HDR., MALE, 1x3, 2mm, VERT, STR, THT	SULLINS CONNECTOR SOLUTIONS, NRPN031PAEN-RC
7	1	JP2	CONN., HDR., MALE, 1x4, 2mm, THT, STR	SULLINS CONNECTOR SOLUTIONS, NRPN041PAEN-RC
8	4	MP1-MP4	STANDOFF, NYLON, SNAP-ON, 0.625"	KEYSTONE, 8834
9	4	MP5-MP8	NUT, HEX, STEEL, ZINC PLATE, 10-32	KEYSTONE, 4705
10	4	MP9, MP10, MP13, MP14	WASHER, FLAT, STEEL, ZINC PLATE, OD: 0.436 [11.1]	KEYSTONE, 4703
11	2	MP11, MP12	RING, LUG, CRIMP, #10, NON-INSULATED, SOLDERLESS TERMINALS	KEYSTONE, 8205
12	2	MP15, MP16	WASHER, #10, LOCK, EXT, TIN FINISH	PENCOM, WA4526
13	3	XJP1, XJP2, XJP5	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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