

20A, 16V Dual-Phase Silent Switcher Step-Down Regulator with Digital Power System Management

General Description

Evaluation kit EVAL-LT7170-1-AZ is a dual-phase single-output monolithic DC/DC synchronous step-down regulator with a 2.9V or 1.5V with EXT_{VCC} to 16V input range featuring [LT®7170-1](#). The output can supply 20A continuous load current. The Silent Switcher® regulator structure is incorporated into the LT7170-1 to minimize EMI and reduce PCB layout sensitivity. It also integrates digital power system management functionality, allowing for programmability and telemetry with a PMBus/I²C compliant serial interface. Refer to the LT7170-1 data sheet for more detailed information.

The EVAL-LT7170-1-AZ evaluation board is designed for 1.0V output with a switching frequency set at 1MHz. The controlled on-time valley current-mode control with 25ns typical minimum on-time enables a high switching frequency at a low output voltage with excellent transient response in a small overall solution size.

The EVAL-LT7170-1-AZ has EMI filters installed for improved conducted and radiated EMI performances, which are shown in [Figure 5](#). The red lines in Figure 5 are CISPR32 limit for industrial application requirement. The figure shows that the circuit passes the test with a wide margin.

The EVAL-LT7170-1-AZ powers up to default settings and produces power based on the NVM configuration without the need for any serial bus communication. This allows easy evaluation of the DC/DC converter. To fully explore the power system management features of the part, download the GUI software LTpowerPlay® onto the 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, and store the configuration in NVM, view telemetry of voltage, current, temperature, and fault status. The NVM can be programmed up to three times.

GUI Download

The software can be downloaded from [LTpowerPlay](#).

The LT7170-1 data sheet gives a complete description of the part, operation, and application information. The data sheet must be read in conjunction with this demo manual for EVAL-LT7170-1-AZ.

For more details and instructions of the LTpowerPlay, refer to LTpowerPlay GUI for the LT7170-1 Quick Start Guide.

Performance Summary Specifications are at T_A = 25°C

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Voltage Range	V _{IN}		2.9*		16	V
Default Output Voltage	V _{OUT}			1.0		V
Maximum Continuous Output Current	I _{OUT}			20		A
Switching Frequency	f _{SW}		0.925	1	1.075	MHz
Efficiency	Eff	V _{IN} = 12V, I _{OUT} = 10A		87.6		%

* The minimum V_{IN} is limited by U3 (LTC4413) that provides RUN and VPULLUP signal. LT7170-1 is capable of minimum V_{IN} of 1.5V with separate 3V ≤ EXT_{VCC} ≤ 5.5V. For more details, refer to the [LT7170-1 data sheet](#).

Quick Start Procedure

The EVAL-LT7170-1-AZ is easy to set up to evaluate the performance of the LT7170-1. See [Figure 1](#) for proper measurement equipment setup, and follow the procedure below:

NOTE: When measuring the input or output voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. See [Figure 2](#) for the proper scope technique.

1. Set an input power supply that is capable of 16V/10A. Then turn off the supply.
2. With power off, connect the supply to the input terminals VEMI and GND. Set the default jumper position: SW1: ON.
3. Turn on the power at the input.

NOTE: Make sure that the input voltage never exceeds 16V.

4. Check for the proper output voltages of $1.0V \pm 0.25\%$ (0.997V~1.003V). Turn off the power at the input.
5. Once the proper output voltage is established, connect variable loads capable of sinking 20A at 1.0V to the output terminals V_{OUT} and GND. Set the current to 0A.
 - a. If efficiency measurements are desired, ammeters can be put in series with the output load to measure the EVAL-LT7170-1-AZ's output current and in series with the power supply to measure the input current.
 - b. Voltmeters can be placed across the output terminals (VSENSE+, VSENSE-) to get accurate output voltage measurements.
 - c. Voltmeters can be placed across the input terminals (VIN_SENSE, GND) to get accurate input voltage measurements.
 - d. To achieve the best efficiency and accuracy, remove R11/R16 and populate R21/R22 only on the bottom layer of the board.

6. Turn on the power at the input.

NOTE: If there is no output, temporarily disconnect the load to make sure that the load is not set too high.

7. Once the proper output voltages are established again, adjust the load and/or input within the operating range and observe the output voltage regulation, ripple voltage, efficiency, and other desired parameters.
8. Connect the dongle and control the output voltages from the GUI. See the LTpowerPlay GUI for the LT7170-1 Quick Start Guide for details.

NOTE: When measuring the output or input voltage ripple, do not use the long ground lead on the oscilloscope probe. See [Figure 2](#) for the proper scope probe technique. Short, stiff leads need to be soldered to the (+) and (-) terminals of an output capacitor. The probe's ground ring needs to touch the (-) lead, and the probe tip needs to touch the (+) lead.

Connecting a PC to EVAL-LT7170-1-AZ

Use a PC to reconfigure the power management features of the LT7170-1, such as V_{OUT} , current limit, switching frequency, OV/UV limits, control loop compensation, temperature fault limits, sequencing parameters, the fault log, fault responses, and other functionalities. The DC1613A dongle may be plugged in when a V_{IN} is present. [Figure 3](#) shows a demo setup of connecting a PC to EVAL-LT7170-1-AZ.

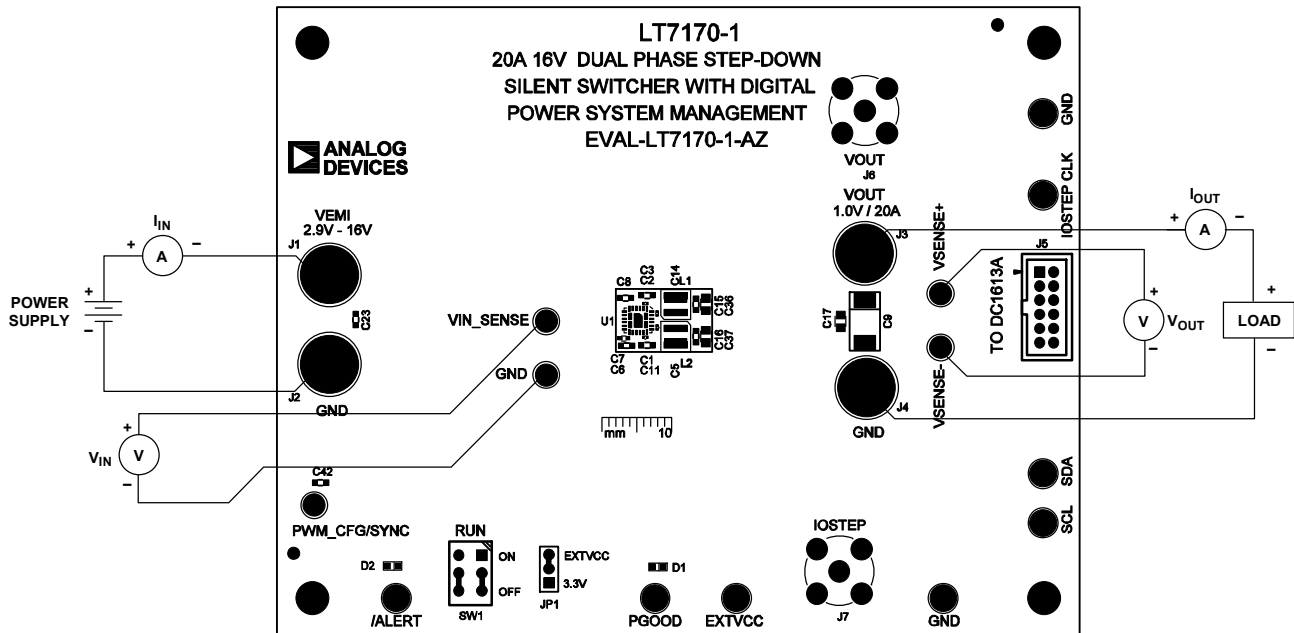


Figure 1. Proper Measurement Equipment Setup

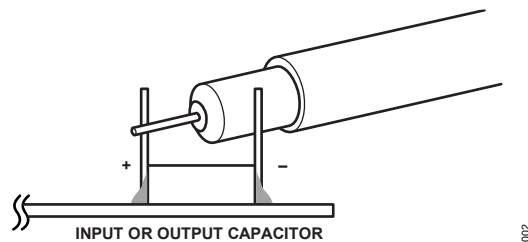


Figure 2. Scope Probe Placement for Measuring Input or Output Voltage Ripple

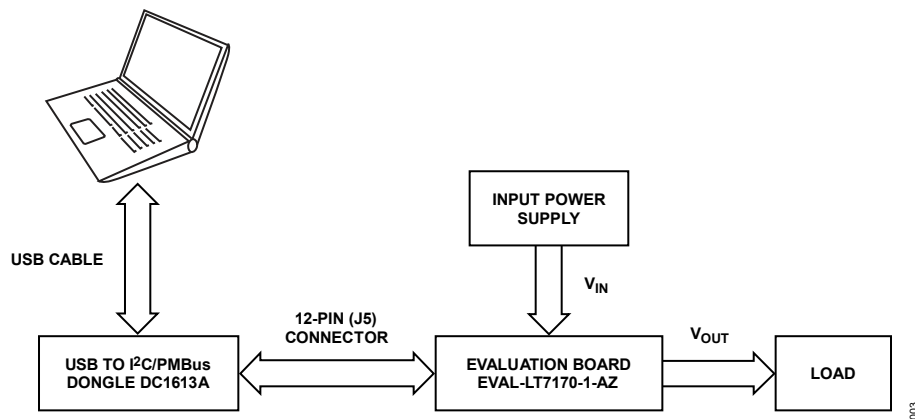


Figure 3. Demo Setup with PC

Typical Performance Characteristics

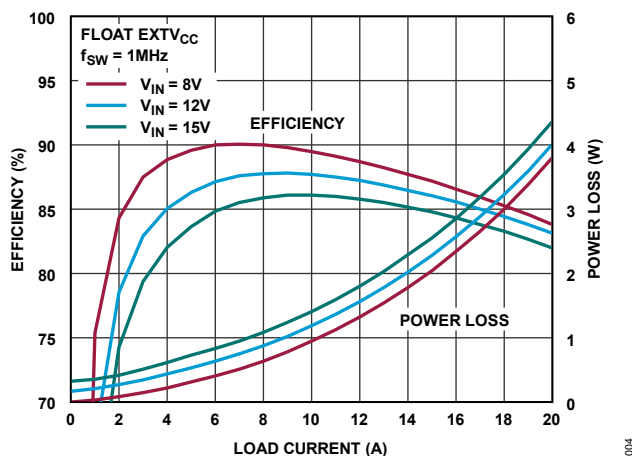
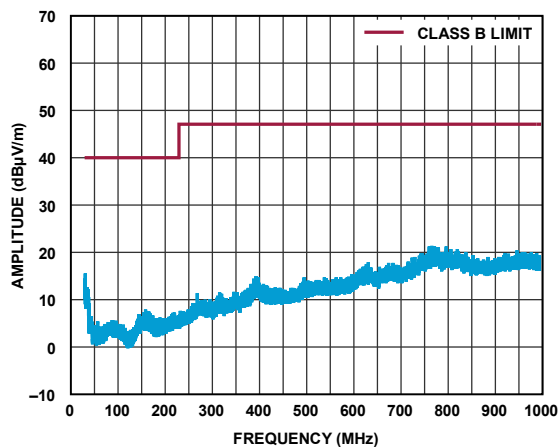
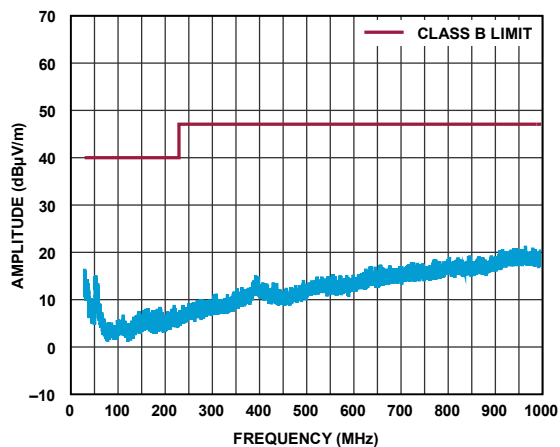


Figure 4. Efficiency vs. Load Current at 1MHz Switching Frequency



EVAL-LT7170-1-AZ DEMO BOARD
(WITH EMI FILTER INSTALLED)
12V INPUT TO 1V OUTPUT AT 20A, $f_{SW} = 1\text{MHz}$



EVAL-LT7170-1-AZ DEMO BOARD
(WITH EMI FILTER INSTALLED)
12V INPUT TO 1V OUTPUT AT 20A, $f_{SW} = 1\text{MHz}$

Figure 5. EVAL-LT7170-1-AZ Radiated EMI Performance

LTpowerPlay is a powerful, Windows®-based development environment supporting Analog Devices' Digital Power System Management (DPSM) ICs and µModule® regulators. The software supports a variety of different tasks. Use LTpowerPlay to evaluate Analog Devices' ICs by connecting to an evaluation board system. LTpowerPlay can also be used in offline mode (with no hardware present) in order to build a multichip configuration file that can be saved and reloaded at a later time. LTpowerPlay provides unprecedented diagnostic and debug features. It becomes a valuable diagnostic tool during board bring-up to program or tweak the power management scheme in a system or to diagnose power issues when bringing up rails. LTpowerPlay utilizes the DC1613A USB-to-SMBus controller to communicate with one of many potential demo systems 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 [LTpowerPlay | Analog Devices](#).

The screenshot displays the LTSpice software interface during the configuration of a custom IC model named 'U0 (7H4F) - L7170_1'. The main configuration window is divided into several tabs: Setup, All Global, All Paged, Config, Addressing/WP, On/Off/Margin, PWM Configuration, Voltage, Current, Temperature, Timing, Watchdog/PGOOD, Fault Responses, and Fault Sharing. The 'Config' tab is active, showing detailed parameters for the device.

- Input Voltage:** VIN_UV_WARN_LIMT_PAGED is set to +1.0000 V, VIN_ON_PAGED is 2.4004 V, and VIN_OFF_PAGED is 1.3495 V.
- Output Voltage:** VOUT_OV_FAULT_LIMIT is +10.0 % above/below VOUT, VOUT_OV_WARN_LIMIT is +7.5 % above/below VOUT, VOUT_MARGIN_HIGH is +5.0 % above/below VOUT, VOUT_MARGIN_LOW is -5.0 % above/below VOUT, VOUT_UV_WARN_LIMIT is -6.5 % above/below VOUT, and VOUT_UV_FAULT_LIMIT is -7.0 % above/below VOUT.
- Fault Responses:** Includes sections for Input Voltage, Output Voltage, and Miscellaneous faults.
- Timing:** TON_MAX_FAULT_LIMIT is set to 5.000 ms.

A 'Telemetry' window provides real-time monitoring of the device's internal state, such as STATUS_BYTE, STATUS_WORD, STATUS_TEMP_GLOBAL, STATUS_CML, STATUS_VOUT, STATUS_IOUT, STATUS_MFR_SPECIFIC..., MFR_COMMON, MFR_PADS, MFR_PIN_CONFIG_STA..., READ_FREQUENCY, and various output voltage and current levels.

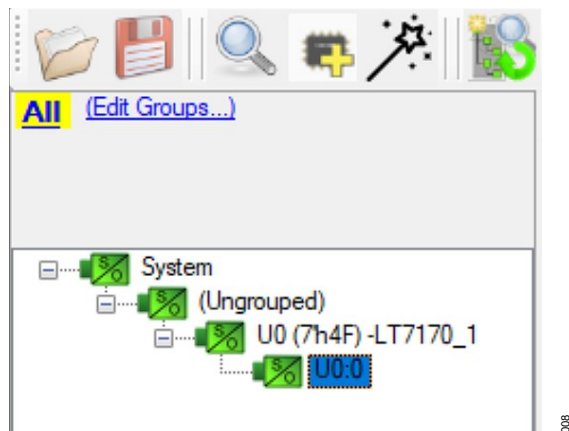
At the bottom, two plots are visible: 'Idealized On/Off Waveforms' showing a single pulse, and 'READ_VOUT' showing a noisy signal over time.

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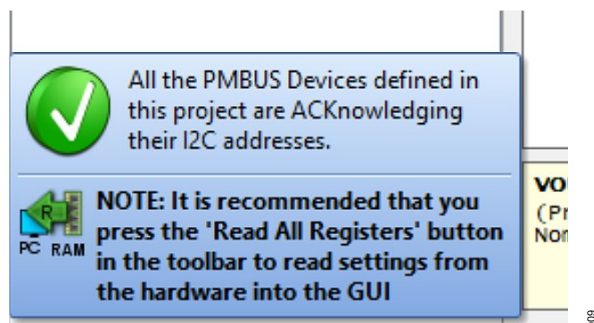
LTpowerPlay Quick Start Procedure

The following procedure describes how to use LTpowerPlay to monitor and change the settings of LT7170-1.

1. Download and install the LTpowerPlay GUI: [LTpowerPlay | Analog Devices](#).
2. Launch the LTpowerPlay GUI.
3. The GUI should automatically identify the EVAL-LT7170-1-AZ. The system tree on the left-hand side should look like the image below.



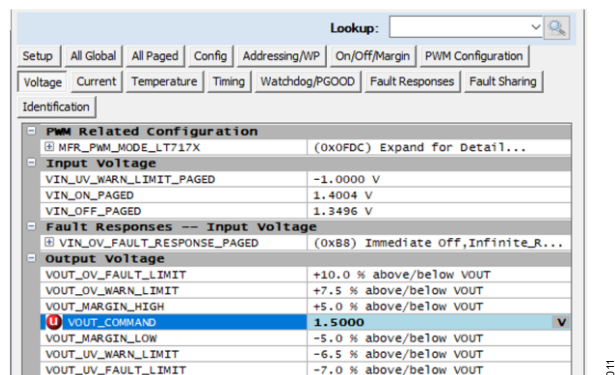
4. A green message box shows for a few seconds in the lower left-hand corner, confirming that LT7170-1 is communicating:



5. In the toolbar, click the **R** (RAM to PC) icon to read the RAM from the LT7170-1. This reads the configuration from the RAM of the LT7170-1 and loads it into the GUI.



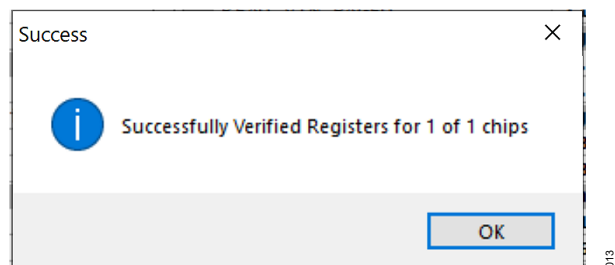
6. To change the output voltage to a different value, like 1.5V, in the **Config** tab, type in 1.5 in the **VOUT_COMMAND** box under the **Voltage** tab, as shown below.



7. Then, click the **W** (PC to RAM) icon to write the register values to the LT7170-1. After finishing this step, the output voltage changes to 1.5V.



8. If the write is successful, the following message will appear.



9. To save the changes to NVM in the tool bar, click the **RAM to NVM** button.



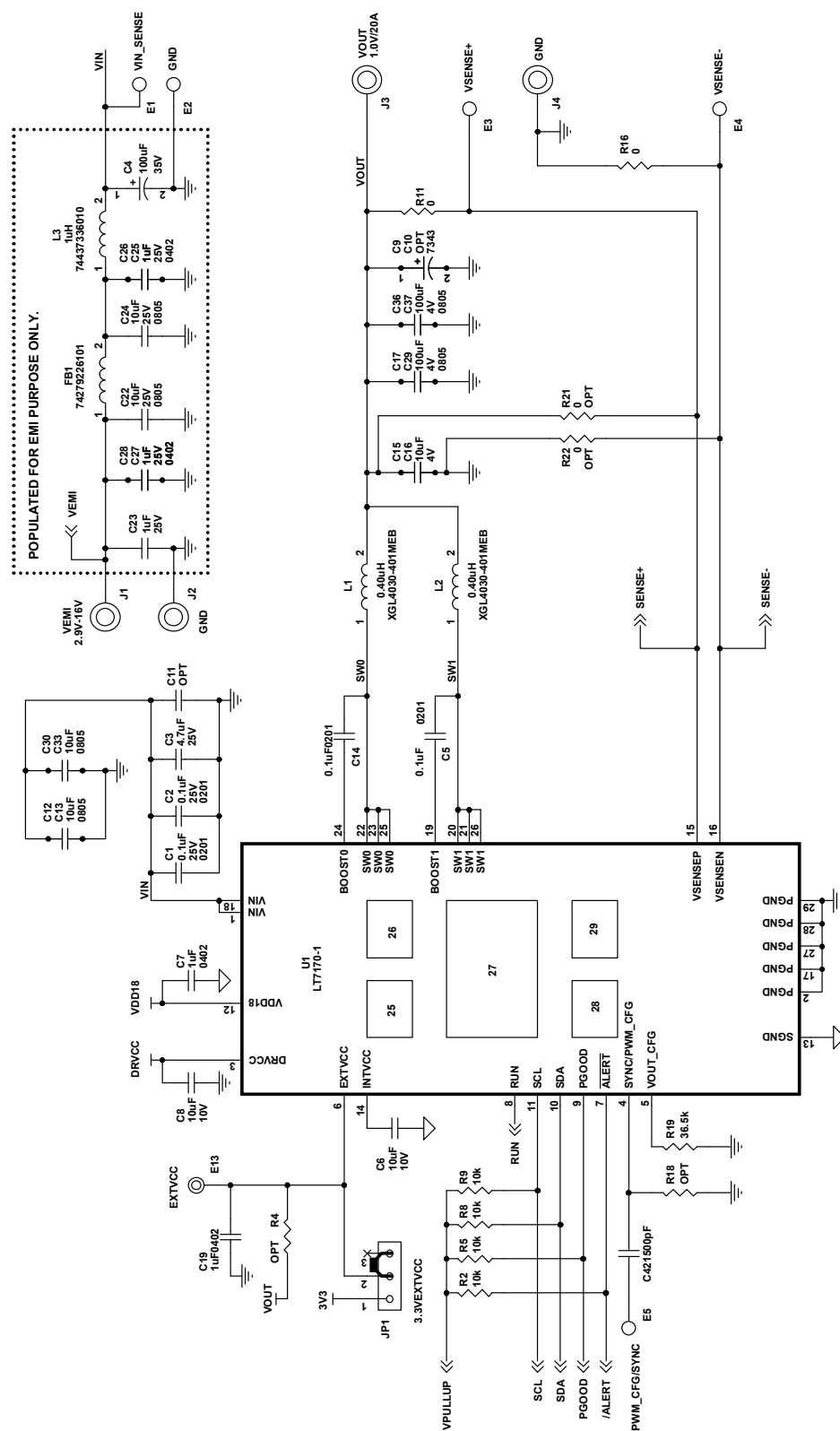
10. Save the evaluation board configuration to a (*.proj) file. Click the **Save** icon and save the file with a new name.

Bill of Materials

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
REQUIRED CIRCUIT COMPONENTS				
1	4	C1, C2, C5, C14	CAP., 0.1µF, X6S, 25V, 10%, 0201	TAIYO YUDEN, TMK063C6104KP-F
2	1	C3	CAP., 4.7µF, X6S, 25V, 10%, 0603	MURATA, GRM188C81E475KE11D
3	2	C6, C8	CAP., 10µF, X6S, 10V, 10%, 0603	MURATA, ZRB18AC81A106KE01L
4	1	C7	CAP., 1µF, X7S, 10V, 10%, 0402	MURATA, GRM155C71A105KE11D
5	2	C15, C16	CAP., 10µF, X7S, 4V, 20%, 0603	TDK, C1608X7S0G106M080AB
6	1	C19	CAP., 1µF, X7S, 10V, 10%, 0402	MURATA, GCM155C71A105KE38D
7	4	C17, C29, C36, C37	CAP., 100µF, X6S, 4V, 20%, 0805	MURATA, GRM21BC80G107ME15L
8	2	L1, L2	IND., 0.40µH, 22.5A, 32.8mΩ	COILCRAFT, XGL4030-401MEC
9	1	U1	IC, 20A, 16V REGULATOR, LQFN-24	ANALOG DEVICES, LT7170RV-1#TRPBF
ADDITIONAL EVALUATION BOARD CIRCUIT COMPONENTS				
1	1	C4	CAP., 100µF, ALUM, 35V, 20%	PANASONIC, EEHZZK1V101XP
2	0	C9, C10	CAP., OPTION, 7343	
3	0	C11	CAP., OPTION, 0603	
4	6	C12, C13, C22, C24, C30, C33	CAP., 10µF, X7S, 25V, 10%, 0805	MURATA, GRM21BC71E106KE11L
5	3	C18, C20, C21	CAP., 4.7µF, X5R, 25V, 10%, 0603	MURATA, GRM188R61E475KE15D
7	1	C23	CAP., 1µF, X5R, 25V, 10%, 0603	AVX, 06033D105KAT2A
8	4	C25, C26, C27, C28	CAP., 1µF, X5R, 25V, 10%, 0402	MURATA, GRM155R61E105KA12D
9	1	C31	CAP., 0.1µF, X7R, 10V, 20%, 0603	AVX, 06033C104MAT2A
10	3	C32, C34, C35	CAP., 1µF, X7R, 6.3V, 10%, 0402	MURATA, GRM155R70J105KA12D
11	1	C38	CAP., 1µF, X7R, 50V, 10%, 0603	AVX, 06035C105KAT2A
12	2	C39, C40	CAP., 0.01µF, X7R, 25V, 10%, 0603	AVX, 06033C103K4Z2A
13	1	C41	CAP., 10µF, X7R, 10V, 10%, 0805	AVX, 08053C106KAT2A
14	1	C42	CAP., 1500pF, X7R, 25V, 10%, 0603	AVX, 06033C152KAT2A
15	1	D1	LED, GREEN, DIFFUSED, 0603	BROADCOM INC., HSMG-C190
16	1	D2	LED, RED, DIFFUSED, 0603	BROADCOM INC., HSMH-C190
17	1	FB1	FERRITE BEAD, 100Ω@100MHz, 1812	WURTH ELEKTRONIK, 74279226101
18	1	L3	IND., 0.47µH, 6.8A, 14mΩ	WURTH ELEKTRONIK, 744373240047
19	1	Q1	MOSFET, N-CH, 25V, 70A, Power-SO8	NEXPERIA, PSMN5R4-25YLDX
20	1	Q2	MOSFET, N-CH, 60V, 300mA, SOT-23-3	VISHAY, 2N7002K-T1-GE3
21	4	R2, R5, R8, R9	RES., 10kΩ, 1%, 1/10W, 0603	VISHAY, CRCW060310K0FKEA

22	2	R3, R12	RES., 866Ω, 1%, 1/10W, 0603	VISHAY, CRCW0603866RFKEA
23	0	R4, R18	RES., OPTION, 0603	
24	2	R6, R13	RES., 4.99kΩ, 1%, 1/10W, 0603	PANASONIC, ERJ3EKF4991V
25	1	R7	RES., 10mΩ, 1%, 3W, 6.3 X3.1mm	SUSUMU, KRL6432E-C-R010-F-T1
26	1	R10	RES., 49.9Ω, 1%, 1/10W, 0603	PANASONIC, ERJ3EKF49R9V
27	3	R11, R16, R20	RES., 0Ω, 1/10W, 0603	VISHAY, CRCW06030000Z0EA
28	1	R19	RES., 36.5kΩ, 1%, 1/10W, 0603	YAGEO RC0603FR-0736K5L
29	0	R21, R22	RES., OPTION, 0603	
30	1	R14	RES., 1MΩ, 1%, 1/10W, 0603,	NIC, NRC06F1004TRF
31	1	U2	IC, EEPROM, 2Kb (256x8), TSSOP-8	MICROCHIP, 24LC025-I/ST
32	1	U3	IC, 2.6A, 2.5V-5.5V IDEAL DIO, 10DFN	ANALOG DEVICES, LTC4413EDD#PBF
33	1	U4	IC, 200mA LDO, MSOP-8	ANALOG DEVICES, LT3063EMS8E-3.3#PBF
HARDWARE: FOR EVALUATION BOARD ONLY				
1	5	E1, E2, E3, E4, E5	TEST POINT, TURRET, 0.064"	MILL-MAX, 2308-2-00-80-00-00-07-0
2	8	E6, E7, E8, E9, E10, E11, E12, E13	TEST POINT, TURRET, 0.094"	MILL-MAX, 2501-2-00-80-00-00-07-0
3	4	J1, J2, J3, J4	BANANA JACK, FEMALE	KEYSTONE, 575-4
4	1	J5	CONN., HDR, MALE, 2x6,2mm	AMPHENOL, 98414-G06-12ULF
5	2	J6, J7	CONN., BNC, 50Ω	AMPHENOL RF, 112404
6	1	JP1	CONN., HDR, MALE, 1x3, 2mm	WURTH ELEKTRONIK, 62000311121
7	4	MP1, MP2, MP3, MP4	STANDOFF, NYLON, SNAP-ON, 0.50"	KEYSTONE, 8833
8	1	SW1	SWITCH, SLIDE, DPDT, 0.3A, 6VDC, PTH	C&K, JS202011CQN
9	1	XJP1	CONN., SHUNT, FEMALE, 2-POS, 2mm	WURTH ELEKTRONIK, 60800213421

Schematic Diagram



NOTE: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS AND CAPACITORS ARE 0603.

916

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Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	2/24	Initial release	—
A	6/24	Updated Performance Summary table	1

Notes

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