Signal Chain Power
LT1956 High Voltage Step-Down Switching Regulator

DESCRIPTION

Demonstration circuit SCP-LT1956-BEVALZ is a 48V, 1A load current, monolithic step-down DC/DC switching converter with a wide input range for applications which require higher input voltage.

Like all boards in the Signal Chain Power series, this board is designed to be easily plugged into other SCP boards to form a complete signal chain power system, enabling fast evaluation of low power signal chains. To evaluate this board, some universal SCP hardware is required, namely:

SCP-INPUT-EVALZ
SCP-OUTPUT-EVALZ
SCP-FILTER-EVALZ
SCP-THRUBRD-EVALZ
SCP-1X2BKOUT-EVALZ
SCP-1X5BKOUT-EVALZ
SCP-5X1-EVALZ

To properly evaluate SCP series demo boards, you will need the SCP Configurator companion software. SCP Configurator can help you choose the right board and topology for your design.

Note that this Demo Manual does not cover details important to the operation and configuration regarding the LT1956. Please refer to the LT1956 datasheet for a complete description of the part.

Design files for this circuit board are available.

Table 1. Performance Summary

SYMBOL	PARAMETER	NOTES	MIN	TYP	MAX	UNITS
$V_{IN(MAX)}$	Max Input Voltage				48	V
$V_{OUT(MAX)}$	Max Output Voltage	Output capacitor rating limited. Replace for higher V_{OUT}.			24	V
$I_{SW(LIM)}$	Switch Current Limit		1.5	2.0	3.0	A

BOARD IMAGE

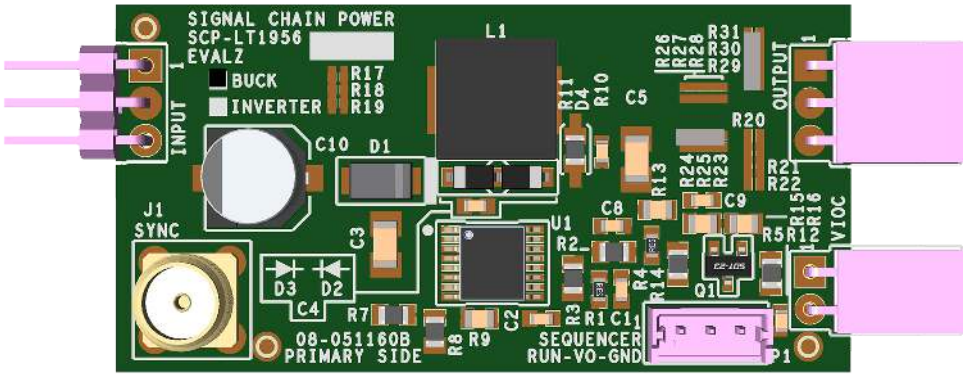


Figure 1. SCP-LT1956-BEVALZ Board

QUICK START PROCEDURE

Demonstration circuit SCP-LT1956-BEVALZ is easy to set up to evaluate the performance of any SCP hardware configuration.

1. The SCP-LT1956-BEVALZ ships with a default output voltage of 5V. To change the output voltage, see "Configuration Settings" section, and modify the board accordingly. Be sure to check for open connections or solder shorts after making any modifications.
2. Connect the SCP-INPUT-EVALZ and SCP-OUTPUT-EVALZ boards to the SCP-LT1956-BEVALZ (refer to Figure 2) and connect the input board to a voltage source, V_{SOURCE}. Connect the output board to a voltmeter or dynamic load. Slowly raise the input voltage until the SCP-LT1956-BEVALZ powers up into regulation and sweep V_{SOURCE} through the desired range of operation.

   NOTE: Make sure that the input voltage is always within spec. If using a dynamic load to measure output voltage, make sure the load is initially set to zero.
3. Check for proper output voltage. The output should be regulated at the programmed value (±5%).
4. Once the proper output voltage is established, power off V_{SOURCE} and similarly test other boards in the SCP system until all elements have been individually verified prior to assembling into the final circuit configuration.

   NOTE: When measuring the input or output voltage ripple, use the optional SMA connector locations available on the input, output, 1 × 5, 1 × 2, and 5 × 1 breakout boards. Avoid using the test point connections with long scope leads.

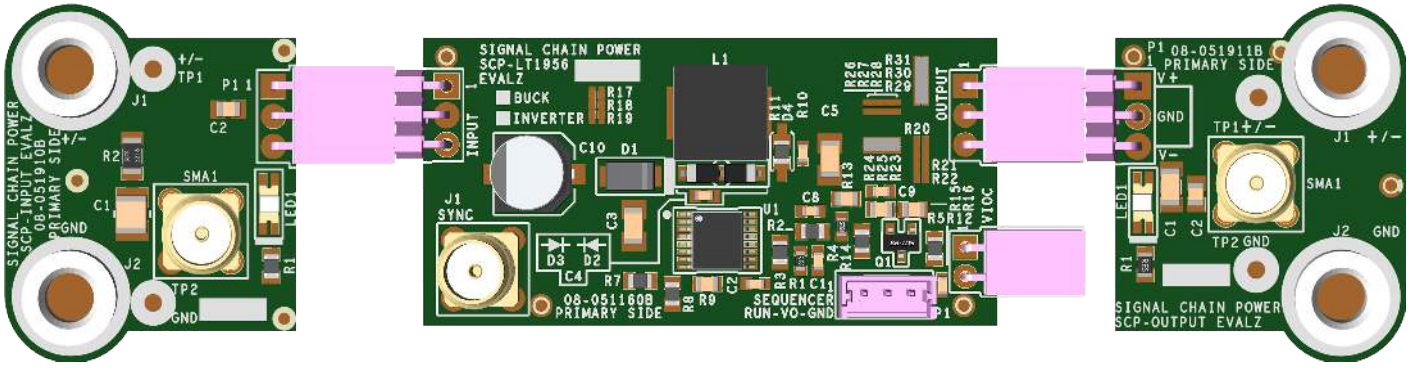


Figure 2. Proper Measurement Equipment Setup (Use SMA connectors for Measuring Input or Output Ripple)

CONFIGURATION SETTINGS

Demonstration circuit SCP-LT1956-BEVALZ is a 48V, 1A load current, monolithic step-down DC/DC switching converter with a wide input range for applications which require higher input voltage. The circuit by default is designed for 7.5V to 25V input to 5.0V output at 1A load current.

The output of the SCP-LT1956-BEVALZ is resistor-programmable from 1.22V to 24V. The board can be configured to drive VIOC-capable linear regulators.

OUTPUT VOLTAGE PROGRAMMING

$$V_{OUT} = 1.219V\left(1+\frac{R4}{R5}\right)$$

Table 2. Resistor Selection Guide for Common Output Voltages

V_{OUT} (V)	R4 (Ω)	R5 (Ω)
1.22 (Note 1)	0	100k
1.25 (Note 1)	5.90k	232k
1.5 (Note 1)	115k	499k
1.8 (Note 1)	71.5k	150k
2.0 (Note 1)	137k	215k
2.5 (Note 1)	124k	118k
3.0 (Note 1)	115k	78.7k
3.3	174k	102k
3.5	232k	124k
4.0	232k	102k
4.5	309k	115k
5.0	332k	107k
5.5	357k	102k
6.0	604k	154k
6.5	162k	37.4k
7.0	887k	187k
7.5	137k	26.7k
8.0	107k	19.1k
8.5	107k	17.8k
9.0	137k	21.5k
9.5	127k	18.7k
10.0	768k	107k
12.0	130k	14.7k
16.0	348k	28.7k
18.0	158k	11.5k
20.0	909k	59.0k
24.0	499k	26.7k

Note 1. See BIAS pin function description in datasheet.

$\overline{SHDN}$ PIN CONFIGURATION

The $\overline{SHDN}$ pin is tied to the optional SCP Run/Sequence header P1. To create a harness for this function, use Molex part 0510650300 with crimp pin 50212-8000.

To use an active run signal, use a 1.00MΩ resistor for either pull-up or pull-down resistors R7 and R8, short R9 with 0Ω, and use the drive signal from connector P1.

If precision undervoltage lockout (UVLO) operation is desired, program enable divider R7 and R8 such that:

$$R7 = \frac{V_{IN} - 2.38V \bullet \frac{\Delta V}{1+V_{OUT}} + \Delta V}{2.38V - (R8 \bullet 5.5\mu A)}$$

$$R8 = R7\frac{V_{OUT}}{\Delta V}$$

Where ΔV is hysteresis in input voltage level.

VOLTAGE INPUT-TO-OUTPUT CONTROL (VIOC) IMPLEMENTATION

To implement the VIOC function for this regulator, set R12 and R14 to 0Ω, respectively. Refer to the "Configuration Settings" section in the Demo Manual for the low-dropout (LDO) linear regulator board and use the following configuration for this board.

Table 3. VIOC Cross-Reference Designators

VIOC SETTING REFERENCES	R_{BOT}	R_{TOP}	R_{MAX}
V_{OUT} Reference Designators	R3	R2	R13

$$V_{LDOIN} - V_{LDOOUT} = V_{VIOC} = 1.219V\left(\frac{R_{BOT}+R_{TOP}}{R_{BOT}}\right)$$

$$V_{(MAX)LDOIN} = 1.219V\left(\frac{R_{BOT}+R_{TOP}+R_{MAX}}{R_{BOT}}\right)+I_{SINK}R_{MAX}$$

I_{SINK} is the current through R_{MAX}, typically 15µA, so R_{BOT} should be sized such that the divider current runs a minimum of 100µA to minimize the I_{SINK} error term.

BOOST PIN CONFIGURATION

The SCP-LT1956-BEVALZ uses a catch diode and capacitor to drive the integrated switch. It requires at least 3.0V to operate. At output voltages less than 3.0V, the boost diode can be moved to location D3, but care must be taken not to exceed the maximum boost pin voltage rating with $2 \times V_{IN}$. Due to the small size of the SCP board, if thermal concerns become critical at higher output voltage, the series Zener diode D4 can allow the boost diode voltage in excess of 3.0V to be dissipated outside the IC package.

Table 4. Boost Diode Connection Options

V_{OUT}	BOOST DIODE OPTION
> 3.0V	Use default D2
< 3.0V	Move D2 to D3 location. Avoid V_{IN} > 24V
> 10V	Consider removing R11; $V_{Z(D4)} = V_{OUT} - 2.5V$

OPTIONAL SOFT START

If inrush current or output voltage slew rate is a concern, an optional soft-start circuit is available to be stuffed. Refer to the following table for typical values (V_{OUT} = 5.0V).

Table 5. Typical Values for Soft-Start Circuitry

Q1	C9	R15	R16
MMBT2222A	15nF	2k	47k

The values for C_9 and R_{16} can be modified to give a desired rise time as:

$$t_{RISE} = \frac{R16 \bullet C9 \bullet V_{OUT}}{V_{BE}}$$

R2 limits base current during voltage transients.

SYNC PIN CONFIGURATION

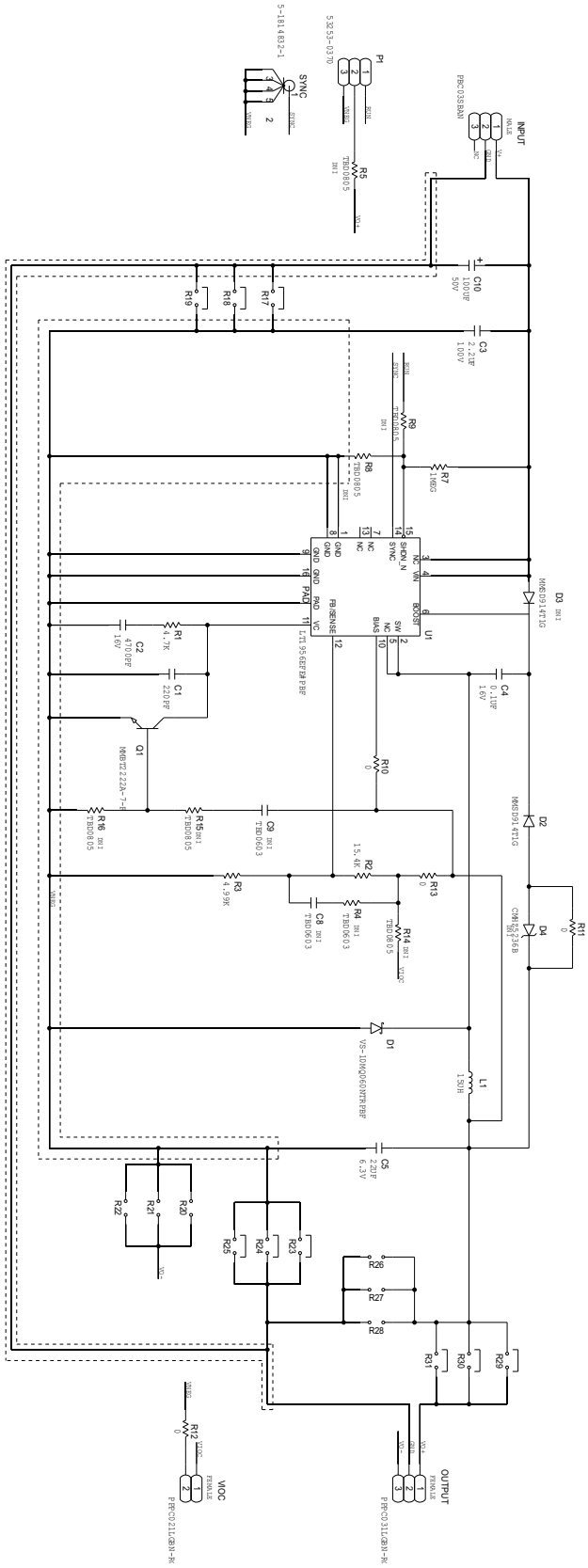
If clock synchronization is desired, the SCP-LT1956-BEVALZ can be driven from an external source via the optional SMA connector.

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
1	1	PCB	PCB	ANALOG DEVICES 08_051160b
2	1	C1	CAP 220pF 50V CER NPO 0603	YAGEO CC0603JRNPO9BN221
3	1	C10	CAP 100uF 50V ALUM RAD	NICHICON CORP UCM1H101MCL1GS
4	1	C2	CAP 4.7nF 16V CER X7R 0603	KEMET C0603C472K4RACTU
5	1	C3	CAP 4.7uF 50V CER X7R 1206	SAMSUNG CL31B475KBHNNNE
6	1	C4	CAP 0.1uF 50V CER X7R 0603	SAMSUNG CL10B104KB8NNNC
7	1	C5	CAP 22uF 25V CER X5R 1206	SAMSUNG CL31A226KAHNNNE
8	2	C8, C9	CAP MLCC 0603 (Note 2)	N/A
9	1	D1	DIODE SCHOTTKY RECTIFIER, 1A	VISHAY VS-10MQ060NTRPBF
10	1	D2	DIODE SWITCHING, FAST SPEED	ONSEMI MMSD914T1G
11	1	D3	DIODE SCHOTTKY (Note 2)	N/A
12	1	D4	DIODE ZENER (Note 2)	N/A
13	1	INPUT	CONN MALE 3POS 2.54MM PITCH R/A	SULLINS PBC03SBAN
14	1	L1	IND 15uH 1.4A 0.084-OHM	SUMIDA CDRH6D28NP-150NC
15	1	OUTPUT	CONN FEMALE 3POS 2.54MM PITCH R/A	SULLINS PPPC031LGBN-RC
16	1	P1	CONN-PCB 3POS HEADER WIRE TO BRD WAFER ASSY STRAIGHT 2MM PITCH (Note 2)	MOLEX 53253-0370
17	1	Q1	TRANS GP BJT NPN 0.6A	DIODES INC MMBT2222A-7-F
18	1	R1	RES 4.7k 5% THICK FILM 0603	YAGEO RC0603JR-074K7L
19	2	R10, R12	RES 0-OHM 1% THICK FILM 0603	PANASONIC ERJ-3GEY0R00V
20	2	R11, R13	RES 0-OHM 1% THICK FILM 0805	VISHAY CRCW08050000Z0EA
21	6	R5, R8, R9, R14, R15, R16	RES THICK FILM 0805 (Note 2)	N/A
22	1	R2	RES 15.4k 1% THICK FILM 0805	YAGEO RC0805FR-0715K4L
23	1	R3	RES 4.99k 1% THICK FILM 0805	PANASONIC ERJ-6ENF4991V
24	1	R4	RES THICK FILM 0603 (Note 2)	N/A
25	1	R7	RES 1M 1% THICK FILM 0805	YAGEO RC0805JR-071ML
26	1	SYNC	CONN-PCB STRAIGHT SMA PCB DIE CAST (Note 2)	TE CONNECTIVITY 5-1814832-1
27	1	U1	IC HIGH VOLTAGE, 1.5A, +500KHZ STEP-DOWN SWITCHING REGULATOR	ANALOG DEVICES LT1956EFE#PBF
28	1	VIOC	CONN FEMALE 2POS 2.54MM PITCH R/A	SULLINS PPPC021LGBN-RC

Note 2. These items are not stuffed (DNI).

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.

Legal Terms and Conditions

By using the evaluation board discussed herein (together with any tools, components documentation or support materials, the "Evaluation Board"), you are agreeing to be bound by the terms and conditions set forth below ("Agreement") unless you have purchased the Evaluation Board, in which case the Analog Devices Standard Terms and Conditions of Sale shall govern. Do not use the Evaluation Board until you have read and agreed to the Agreement. Your use of the Evaluation Board shall signify your acceptance of the Agreement. This Agreement is made by and between you ("Customer") and Analog Devices, Inc. ("ADI"), with its principal place of business at One Technology Way, Norwood, MA 02062, USA. Subject to the terms and conditions of the Agreement, ADI hereby grants to Customer a free, limited, personal, temporary, non-exclusive, non-sublicensable, non-transferable license to use the Evaluation Board FOR EVALUATION PURPOSES ONLY. Customer understands and agrees that the Evaluation Board is provided for the sole and exclusive purpose referenced above, and agrees not to use the Evaluation Board for any other purpose. Furthermore, the license granted is expressly made subject to the following additional limitations: Customer shall not (i) rent, lease, display, sell, transfer, assign, sublicense, or distribute the Evaluation Board; and (ii) permit any Third Party to access the Evaluation Board. As used herein, the term "Third Party" includes any entity other than ADI, Customer, their employees, affiliates and in-house consultants. The Evaluation Board is NOT sold to Customer; all rights not expressly granted herein, including ownership of the Evaluation Board, are reserved by ADI. CONFIDENTIALITY. This Agreement and the Evaluation Board shall all be considered the confidential and proprietary information of ADI. Customer may not disclose or transfer any portion of the Evaluation Board to any other party for any reason. Upon discontinuation of use of the Evaluation Board or termination of this Agreement, Customer agrees to promptly return the Evaluation Board to ADI. ADDITIONAL RESTRICTIONS. Customer may not disassemble, decompile or reverse engineer chips on the Evaluation Board. Customer shall inform ADI of any occurred damages or any modifications or alterations it makes to the Evaluation Board, including but not limited to soldering or any other activity that affects the material content of the Evaluation Board. Modifications to the Evaluation Board must comply with applicable law, including but not limited to the RoHS Directive. TERMINATION. ADI may terminate this Agreement at any time upon giving written notice to Customer. Customer agrees to return to ADI the Evaluation Board at that time. LIMITATION OF LIABILITY. THE EVALUATION BOARD PROVIDED HEREUNDER IS PROVIDED "AS IS" AND ADI MAKES NO WARRANTIES OR REPRESENTATIONS OF ANY KIND WITH RESPECT TO IT. ADI SPECIFICALLY DISCLAIMS ANY REPRESENTATIONS, ENDORSEMENTS, GUARANTEES, OR WARRANTIES, EXPRESS OR IMPLIED, RELATED TO THE EVALUATION BOARD INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY, TITLE, FITNESS FOR A PARTICULAR PURPOSE OR NONINFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. IN NO EVENT WILL ADI AND ITS LICENSORS BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES RESULTING FROM CUSTOMER'S POSSESSION OR USE OF THE EVALUATION BOARD, INCLUDING BUT NOT LIMITED TO LOST PROFITS, DELAY COSTS, LABOR COSTS OR LOSS OF GOODWILL. ADI'S TOTAL LIABILITY FROM ANY AND ALL CAUSES SHALL BE LIMITED TO THE AMOUNT OF ONE HUNDRED US DOLLARS ($100.00). EXPORT. Customer agrees that it will not directly or indirectly export the Evaluation Board to another country, and that it will comply with all applicable United States federal laws and regulations relating to exports. GOVERNING LAW. This Agreement shall be governed by and construed in accordance with the substantive laws of the Commonwealth of Massachusetts (excluding conflict of law rules). Any legal action regarding this Agreement will be heard in the state or federal courts having jurisdiction in Suffolk County, Massachusetts, and Customer hereby submits to the personal jurisdiction and venue of such courts. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to this Agreement and is expressly disclaimed.