Signal Chain Power
LT1956 High Voltage, Step-Down Inverting Regulator

DESCRIPTION

Demonstration circuit SCP-LT1956-IEVALZ is a 48V, 1.5A buck regulator configured as an inverting buck topology for positive to negative DC voltage conversion. This board has ample current output to drive multiple signal chains.

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-1X5BKOUT-EVALZ
SCP-THRUBRD-EVALZ
SCP-FILTER-EVALZ
SCP-1X2BKOUT-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	$V_{IN} + \lvert V_{OUT}\rvert \le 48.0V$			48	V
$V_{OUT(MAX)}$	Max Output Voltage	$V_{IN} + \lvert V_{OUT}\rvert \le 48.0V$ Output Capacitor Rating Limited Replace for higher V_{OUT}			–24	V
$I_{SW(LIM)}$	Switch Current Limit		1.5	2	3	A

BOARD IMAGE

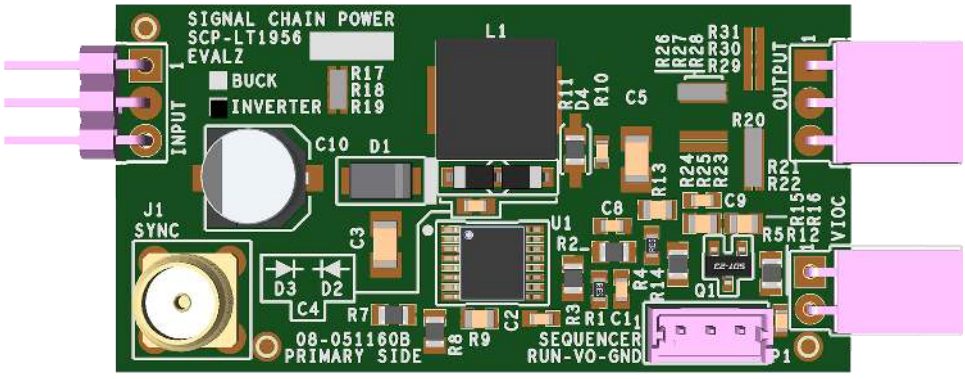


Figure 1. LT1956 High Voltage, Step-Down Inverting Regulator Board

QUICK START PROCEDURE

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

1. The SCP-LT1956-IEVALZ 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-IEVALZ (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-IEVALZ 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 voltages. 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.

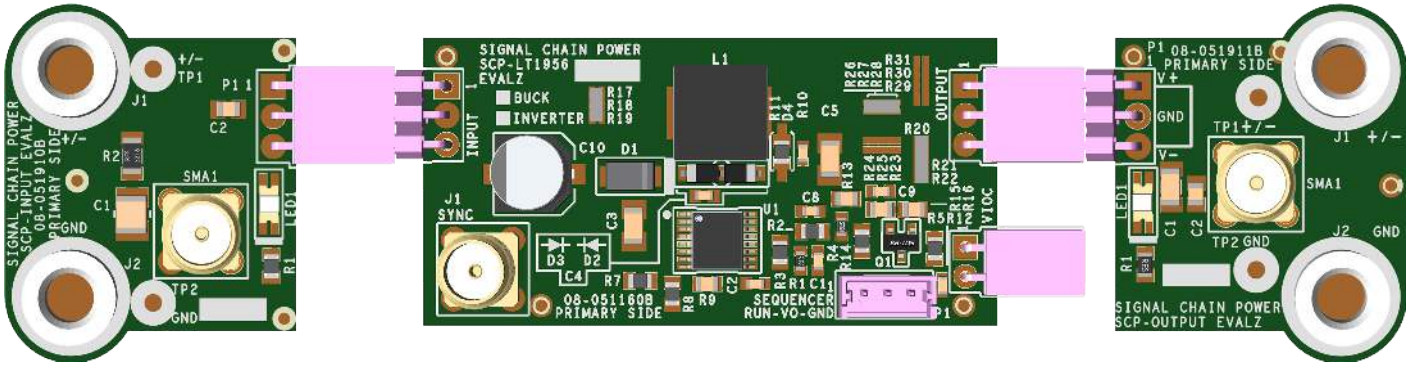


Figure 2. Proper Measurement Equipment Setup (Use SMA connectors for Measuring Input or Output Ripple)

CONFIGURATION SETTINGS

Demonstration circuit SCP-LT1956-IEVALZ is a 48V, 1.5A buck regulator configured as an inverting buck topology for positive to negative DC voltage conversion. This board has ample current output to drive multiple signal chains.

The output of the SCP-LT1956-IEVALZ is resistor-programmable from –1.22V to –24V.

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) (Note 1)	R4 (Ω)	R5 (Ω)
–1.22 (Note 2)	0	100k
–1.25 (Note 2)	5.90k	232k
–1.5 (Note 2)	115k	499k
–1.8 (Note 2)	71.5k	150k
–2.0 (Note 2)	137k	215k
–2.5 (Note 2)	124k	118k
–3.0 (Note 2)	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. Output voltage positive with respect to IC GND pin.

Note 2. 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:

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

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

Where ΔV is hysteresis in input voltage level.

VOLTAGE INPUT-TO-OUTPUT CONTROL (VIOC) IMPLEMENTATION

VIOC cannot be implemented with the board in the inverting buck configuration. If using a VIOC-capable negative linear regulator, ensure R12 and R14 are open and independently set fixed output voltages for both the SCP-LT1956-IEVALZ board and the negative linear regulator board.

BOOST PIN CONFIGURATION

The SCP-LT1956-IEVALZ 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 3. 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 4. Typical Values for Soft-Start Circuitry

Q1	C9	R15	R16
MMBT2222A	15nF	2k	47k

The values for C9 and R16 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

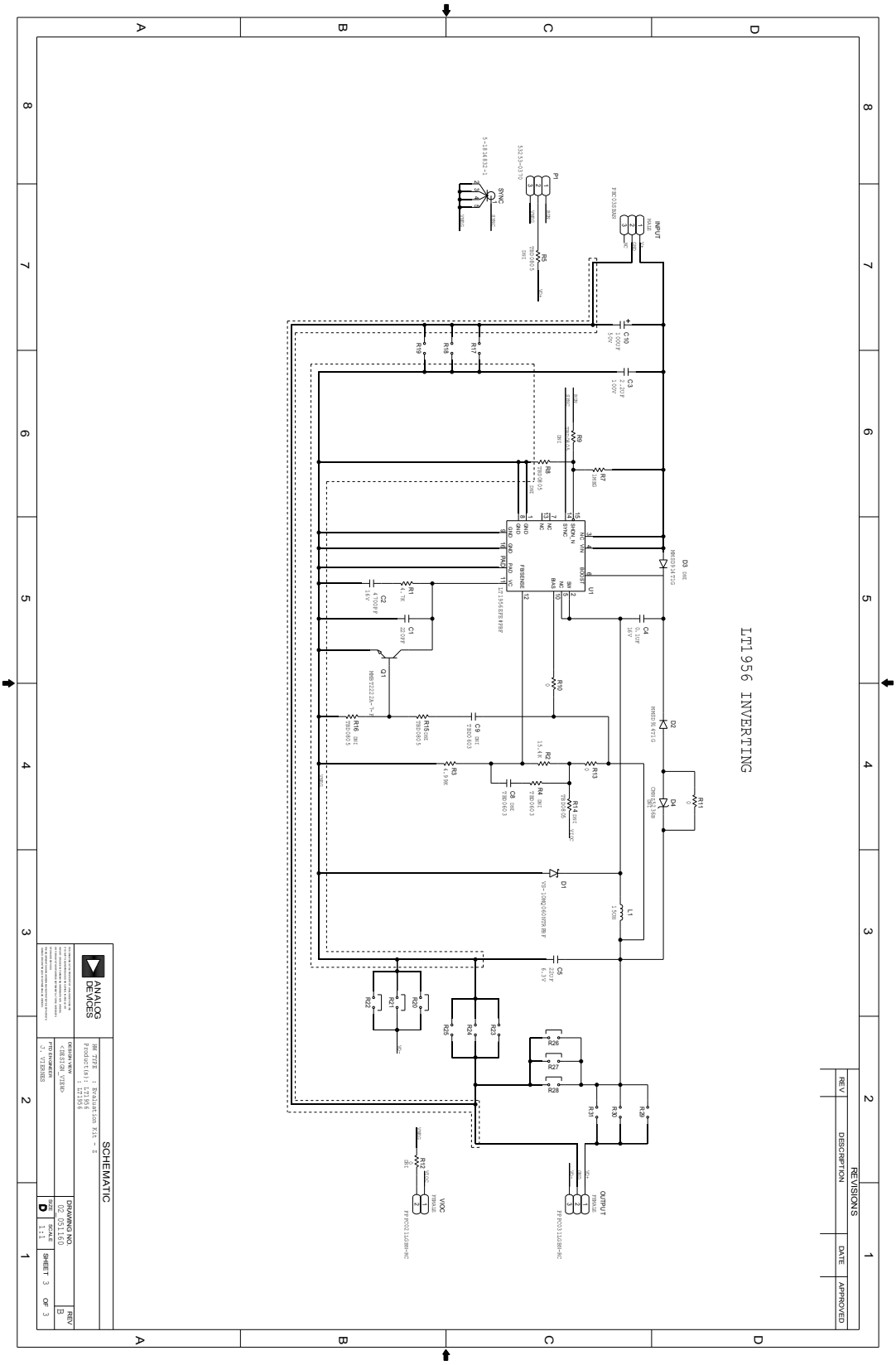
If clock synchronization is desired, the SCP-LT1956-IEVALZ can be driven from an external source via the optional SMA connector.

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 3)	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 3)	N/A
12	1	D4	DIODE ZENER (Note 3)	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 3)	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	1	R10	RES 0-OHM 1% THICK FILM 0603	PANASONIC ERJ-3GEY0R00V
20	2	R11, R13	RES 0-OHM 1% THICK FILM 0805	VISHAY CRCW08050000Z0EA
21	1	R12	RES THICK FILM 0603 (Note 3)	N/A
22	6	R5, R8, R9, R14, R15, R16	RES THICK FILM 0603 (Note 3)	N/A
23	1	R2	RES 15.4k 1% TH+ICK FILM 0805	YAGEO RC0805FR-0715K4L
24	1	R3	RES 4.99k 1% THICK FILM 0805	PANASONIC ERJ-6ENF4991V
25	1	R4	RES THICK FILM 0603 (Note 3)	N/A
26	1	R7	RES 1M 1% THICK FILM 0805	YAGEO RC0805JR-071ML
27	1	SYNC	CONN-PCB STRAIGHT SMA PCB DIE CAST (Note 3)	TE CONNECTIVITY 5-1814832-1
28	1	U1	IC HIGH VOLTAGE, 1.5A, +500KHZ STEP-DOWN SWITCHING REGULATOR	ANALOG DEVICES LT1956EFE#PBF
29	1	VIOC	CONN FEMALE 2POS 2.54MM PITCH R/A	SULLINS PPPC021LGBN-RC

Note 3. 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.

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