

## LT1641-1, LT1641-2, LT4256-1, and LT4256-2 Positive High Voltage Hot Swap Controller

### DESCRIPTION

Demonstration circuit 1354B is a positive high voltage hot swap controller featuring either the [LT®1641-1](#), [LT1641-2](#), [LT4256-1](#), or [LT4256-2](#).

The board facilitates measurement of transient conditions, steady state operation with different loads, and fault conditions. The Controller responds to fault conditions such as input undervoltage(UV), output power good (PWRGD) fault, and overcurrent and response can be verified by the output voltage ( $V_{OUT}$ ) LED state and PWRGD pin signal.

All registered trademarks and trademarks are the property of their respective owners.

The LT1641-1 and LT4256-1 latch off if MOSFET shuts off under overcurrent condition, while LT1641-2 and LT4256-2 automatically restart after time-out delay.

The DC1354B contains one hot swap controller, power MOSFET, current sense resistor, enable circuit, input voltage clamp, gate protection circuit, resistive output voltage divider for feedback signal, and three LEDs to indicate the presence of input and output voltages and power good condition.

**Design files for this circuit board are available.**

### PERFORMANCE SUMMARY Specifications are at $T_A = 25^\circ\text{C}$

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
$V_{CC}$	Operating Voltage	LT1641 LT4256	9 10.8		80 80	V V
$V_{LKO}$	$V_{CC}$ Undervoltage Lockout	LT1641 LT4256	7.5	8.3 9.8	8.8	V V
$V_{UNLH}$	Undervoltage Threshold	LT1641, ON pin voltage Low to High transition LT4256, UV pin voltage Low to High transition	1.28 3.96	1.313 4	1.345 4.04	V V
$V_{FB}$	Feedback Voltage Threshold	LT1641, FB Low-to-High Transition, FB High-to-Low Transition LT4256, FB Low-to-High Transition, FB High-to-Low Transition	1.28 1.221 3.95 4.2	1.313 1.233 3.99 4.45	1.345 1.245 4.03 4.65	V V V V
$V_{SENSETRIP}$	SENSE Pin Trip-Voltage( $V_{CC}-V_{SENSE}$ )	LT1641, $V_{FB} = 0V$ $V_{FB} = 1V$ LT4256, $V_{FB} = 0V$ $V_{FB} \geq 2V$	8 39 5.5 45	12 47 14 55	17 55 22 65	mV mV mV mV
$\Delta V_{GATE}$	External N-Channel Gate Drive	LT1641, $V_{GATE} = V_{CC}$ , $10.8V \leq V_{CC} \leq 20V$ $20V \leq V_{CC} \leq 80V$ LT4256, $V_{GATE} = V_{CC}$ , $10.8V \leq V_{CC} \leq 20V$ $20V \leq V_{CC} \leq 80V$	4.5 10 4.5 10		18 18 12.5 12.8	V V V V
$I_{GATEUP}$	GATE Pin Pull-Up Current	LT1641 LT4256	5 16	10 32	20 63	$\mu A$ $\mu A$
$I_{GATEDN}$	GATE Pin Pull-Down Current	LT1641 LT4256	35 40	70 62	100 80	mA mA

## OPERATING PRINCIPLES

The LT1641-1, LT1641-2, LT4256-1, and LT4256-2 are positive high voltage hot swap controllers that have absolute maximum supply voltage ( $V_{CC}$ ) 100V and operating range (9-80) V for LT1641 and (10.8-80) V for LT4256. In the DC1354B, any controller operates on the +48V rail. Each board can easily be readjusted for any rated

voltage by replacing the enable circuit (R5, R11), input voltage clamp (D1), gate protection circuit (R8, R14, D3, D6), and resistive output voltage divider (R10, R12). The DC1354B as supplied by the factory is assembled with the SUM90N10-8m2p MOSFET in a D2PAK package and 7m $\Omega$  current sense resistor (R1).

---

## QUICK START PROCEDURE

Demonstration circuit DC1354B is easy to set up to evaluate the performance of the LT1641-1, LT1641-2, LT4256-1, and LT4256-2. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below.

The board test is performed in several steps by measuring some transient parameters and verifying successful or failed power up actions under defined conditions. In all test steps turn on switch SW\_PS to connect demo board to the +48V power supply, turn on switch SW\_PS to activate controller (connecting the ENABLE pin to the VIN +48V) and turn +48V off for resetting controller after fault.

1. It should be noted that loading parameters such as Low Capacitive Load, High Capacitive Load, Low Resistive Load, and High Resistive are different for LT4256 and for LT1641. These parameters are shown below separately for each controller:

### LT1641

- Low Capacitive Load: 1000uF
- High Capacitive Load: 8700uF
- Low Resistive Load: 10 $\Omega$ , 50W
- High Resistive Load: 5.5 $\Omega$

### LT4256

- Low Capacitive Load: 250uF
- High Capacitive Load: 3500uF
- Low Resistive Load: 11 $\Omega$ , 50W
- High Resistive Load: 5.0 $\Omega$

2. Place a scope probe to the VOUT turret, turn on controller, and measure a power-up time with no load. For LT4256 this time must be in the range (13.7 - 54) ms, and for LT1641- (43 - 173) ms.
3. Connect Low Capacitive Load to the output of hot swap circuitry (VOUT +48V turret). Turn on controller. This power up should be successful and two LEDs (VOUT - green and PWRGD - green) must light.

NOTE. The following tests verify loaded controller performance. The transients with Low Load should be successfully completed, while transients with High Load should fail. The LT1641-1 and LT4256-1 in the overcurrent fault condition are latched off, while the LT1641-2 and LT4256-2 provide retry. To avoid power MOSFET damage in the LT1641-2 and LT4256-2 High Load tests keep switch SW\_ON in the on position for a very short time.

4. Connect High Capacitive Load to the output of hot swap circuitry (VOUT +48V turret). Turn on controller. This power up should be unsuccessful, and the two LEDs remaining off will confirm this.

For LT4256-1 and LT1641-1, the failed power-up is indicated by the VOUT (green) and PWRGD (green) LED lights remaining off. Disconnect the ENABLE turret from the VIN +48V turret for short time and connect them again. The controller should be latched off in the shut off mode.

For LT4256-2 and LT1641-2, make short time connection of the ENABLE turret and VIN +48V. The VOUT (green) and PWRGD (green) LED will blink indicating an autoretry in the failed power up.

5. Load output with Low Resistive Load. Controller should successfully keep this load.
6. Turn controller on. Load output with High Resistive Load. Controller should fail to keep this load.
7. Verify that controller is alive after the overload test.

NOTE. In the designing of the power-up transient with mentioned controllers, special attention should be paid to correspondence between power MOSFET safe operating area and transient parameters (current limit level, duration of the transient, relationship between capacitive load and resistive load and timer period).

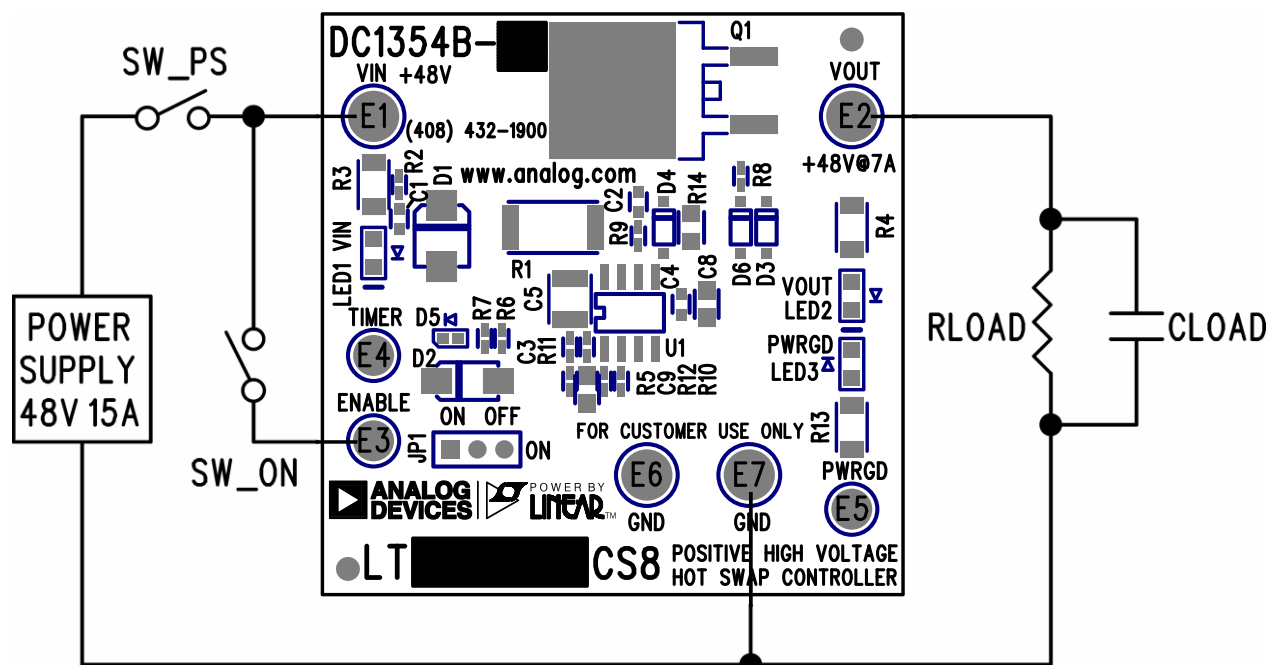


Figure 1. Proper Measurement Equipment Setup

**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 NON-INFRINGEMENT 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.