# Negative Voltage Hot Swap Controller

## FEATURES

- **Allows Safe Board Insertion and Removal from a Live –48V Backplane**
- **Operates from –10V to –80V**
- **Programmable Inrush Current**
- Programmable Electronic Circuit Breaker
- Programmable Overvoltage Protection
- Programmable Undervoltage Lockout
- Power Good Control Output

## APPLICATIONS

- Central Office Switching
- –48V Distributed Power Systems
- Negative Power Supply Control

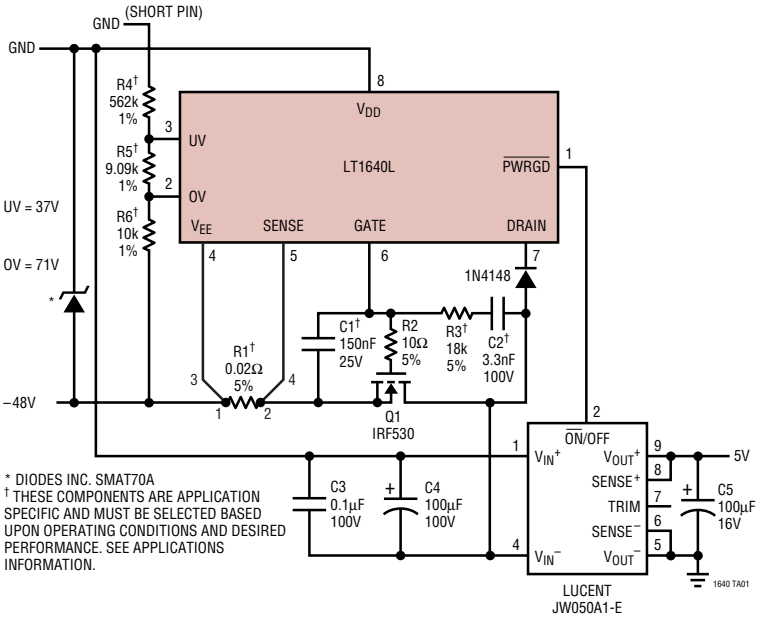
## DESCRIPTION

The LT®1640L/LT1640H is an 8-pin, negative voltage Hot Swap™ controller that allows a board to be safely inserted and removed from a live backplane. Inrush current is limited to a programmable value by controlling the gate voltage of an external N-channel pass transistor. The pass transistor is turned off if the input voltage is less than the programmable undervoltage threshold or greater than the overvoltage threshold. A programmable electronic circuit breaker protects the system against shorts. The $\overline{\text{PWRGD}}$ (LT1640L) or PWRGD (LT1640H) signal can be used to directly enable a power module. The LT1640L is designed for modules with a low enable input and the LT1640H for modules with a high enable input.

The LT1640L/LT1640H is available in 8-pin PDIP and SO packages.

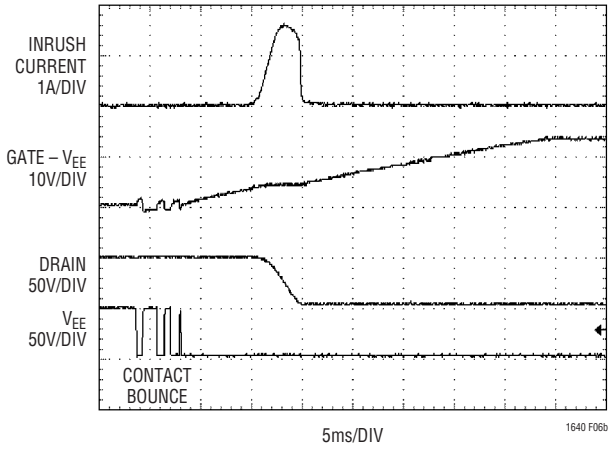
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Hot Swap is a trademark of Linear Technology Corporation.

## TYPICAL APPLICATION




* DIODES INC. SMAT70A
† THESE COMPONENTS ARE APPLICATION SPECIFIC AND MUST BE SELECTED BASED UPON OPERATING CONDITIONS AND DESIRED PERFORMANCE. SEE APPLICATIONS INFORMATION.

**Input Inrush Current**



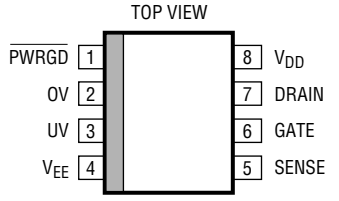
## ABSOLUTE MAXIMUM RATINGS

**(Note 1), All Voltages Referred to $V_{EE}$**

Supply Voltage ($V_{DD}$ – $V_{EE}$) ..... –0.3V to 100V
DRAIN, $\overline{PWRGD}$, PWRGD Pins ..... –0.3V to 100V
SENSE, GATE Pins ..... –0.3V to 20V
UV, OV Pins ..... –0.3V to 60V
Maximum Junction Temperature ..... 125°C

Operating Temperature Range
LT1640LC/LT1640HC ..... 0°C to 70°C
LT1640LI/LT1640HI ..... –40°C to 85°C
Storage Temperature Range ..... –65°C to 150°C
Lead Temperature (Soldering, 10 sec) ..... 300°C

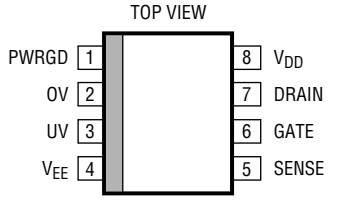
## PACKAGE/ORDER INFORMATION




N8 PACKAGE 8-LEAD PDIP
S8 PACKAGE 8-LEAD PLASTIC SO

$T_{JMAX}$ = 125°C, $\theta_{JA}$ = 120°C/W (N8)
$T_{JMAX}$ = 125°C, $\theta_{JA}$ = 150°C/W (S8)

| ORDER PART NUMBER |
|---|
| LT1640LCN8<br>LT1640LCS8<br>LT1640LIN8<br>LT1640LIS8 |
| **S8 PART MARKING** |
| 1640L<br>1640LI |




N8 PACKAGE 8-LEAD PDIP
S8 PACKAGE 8-LEAD PLASTIC SO

$T_{JMAX}$ = 125°C, $\theta_{JA}$ = 120°C/W (N8)
$T_{JMAX}$ = 125°C, $\theta_{JA}$ = 150°C/W (S8)

| ORDER PART NUMBER |
|---|
| LT1640HCN8<br>LT1640HCS8<br>LT1640HIN8<br>LT1640HIS8 |
| **S8 PART MARKING** |
| 1640H<br>1640HI |

Consult LTC Marketing for parts specified with wider operating temperature ranges.

## ELECTRICAL CHARACTERISTICS

**The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at $T_A$ = 25°C. (Note 2), $V_{DD}$ = 48V, $V_{EE}$ = 0V unless otherwise noted.**

| SYMBOL | PARAMETER | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| **DC** | | | | | | | |
| $V_{DD}$ | Supply Operating Range | | ● | 10 | | 80 | V |
| $I_{DD}$ | Supply Current | UV = 3V, OV = $V_{EE}$, SENSE = $V_{EE}$ | ● | | 1.3 | 5 | mA |
| $V_{CB}$ | Circuit Breaker Trip Voltage | $V_{CB}$ = ($V_{SENSE}$ – $V_{EE}$) | ● | 40 | 50 | 60 | mV |
| $I_{PU}$ | GATE Pin Pull-Up Current | Gate Drive On, $V_{GATE}$ = $V_{EE}$ | ● | –30 | –45 | –60 | µA |
| $I_{PD}$ | GATE Pin Pull-Down Current | Any Fault Condition | | 24 | 50 | 70 | mA |
| $I_{SENSE}$ | SENSE Pin Current | $V_{SENSE}$ = 50mV | | | –20 | | µA |
| $\Delta V_{GATE}$ | External Gate Drive | ($V_{GATE}$ – $V_{EE}$), 15V ≤ $V_{DD}$ ≤ 80V<br>($V_{GATE}$ – $V_{EE}$), 10V ≤ $V_{DD}$ < 15V | ●<br>● | 10<br>6 | 13.5<br>8 | 18<br>15 | V<br>V |
| $V_{UVH}$ | UV Pin High Threshold Voltage | UV Low to High Transition | ● | 1.213 | 1.243 | 1.272 | V |
| $V_{UVL}$ | UV Pin Low Threshold Voltage | UV High to Low Transition | ● | 1.198 | 1.223 | 1.247 | V |
| $V_{UVHY}$ | UV Pin Hysteresis | | | | 20 | | mV |
| $I_{INUV}$ | UV Pin Input Current | $V_{UV}$ = $V_{EE}$ | ● | | –0.02 | –0.5 | µA |
| $V_{OVH}$ | OV Pin High Threshold Voltage | OV Low to High Transition | ● | 1.198 | 1.223 | 1.247 | V |
| $V_{OVL}$ | OV Pin Low Threshold Voltage | OV High to Low Transition | ● | 1.165 | 1.203 | 1.232 | V |
| $V_{OVHY}$ | OV Pin Hysteresis | | | | 20 | | mV |
| $I_{INOV}$ | OV Pin Input Current | $V_{OV}$ = $V_{EE}$ | ● | | –0.03 | –0.5 | µA |

## ELECTRICAL CHARACTERISTICS

**The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at $T_A$ = 25°C. (Note 2), $V_{DD}$ = 48V, $V_{EE}$ = 0V unless otherwise noted.**

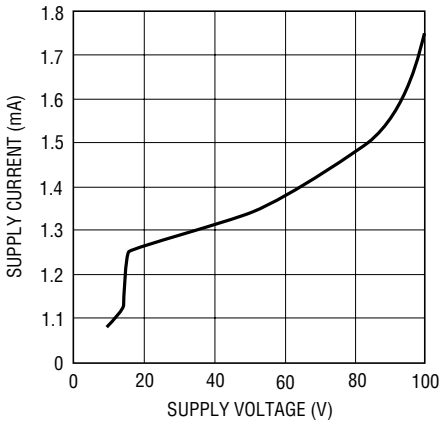
| SYMBOL | PARAMETER | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| $V_{PG}$ | Power Good Threshold | $V_{DRAIN} - V_{EE}$, High to Low Transition | | 1.1 | 1.4 | 2.0 | V |
| $V_{PGHY}$ | Power Good Threshold Hysteresis | | | | 0.4 | | V |
| $I_{DRAIN}$ | Drain Input Bias Current | $V_{DRAIN}$ = 48V | ● | 10 | 50 | 500 | µA |
| $V_{OL}$ | $\overline{PWRGD}$ Output Low Voltage | $\overline{PWRGD}$ (LT1640L), ($V_{DRAIN} - V_{EE}$) < $V_{PG}$<br>$I_{OUT}$ = 1mA<br>$I_{OUT}$ = 5mA | <br>●<br>● | | <br>0.48<br>1.50 | <br>0.8<br>3.0 | <br>V<br>V |
| | PWRGD Output Low Voltage (PWRGD – DRAIN) | PWRGD (LT1640H), $V_{DRAIN}$ = 5V<br>$I_{OUT}$ = 1mA | <br>● | | <br>0.75 | <br>1.0 | <br>V |
| $I_{OH}$ | Output Leakage | $\overline{PWRGD}$ (LT1640L), $V_{DRAIN}$ =48V, $V_{\overline{PWRGD}}$ = 80V | ● | | 0.05 | 10 | µA |
| $R_{OUT}$ | Power Good Output Impedance (PWRGD to DRAIN) | PWRGD (LT1640H), ($V_{DRAIN} - V_{EE}$) < $V_{PG}$ | ● | 2 | 6.5 | | kΩ |
| **AC** | | | | | | | |
| $t_{PHLOV}$ | OV High to GATE Low | Figures 1, 2 | | | 1.7 | | µs |
| $t_{PHLUV}$ | UV Low to GATE Low | Figures 1, 3 | | | 1.5 | | µs |
| $t_{PLHOV}$ | OV Low to GATE High | Figures 1, 2 | | | 5.5 | | µs |
| $t_{PLHUV}$ | UV High to GATE High | Figures 1, 3 | | | 6.5 | | µs |
| $t_{PHLSENSE}$ | SENSE High to Gate Low | Figures 1, 4 | | 2 | 3 | 4 | µs |
| $t_{PHLPG}$ | DRAIN Low to $\overline{PWRGD}$ Low<br>DRAIN Low to (PWRGD – DRAIN) High | (LT1640L) Figures 1, 5<br>(LT1640H) Figures 1, 5 | | | 0.5<br>0.5 | | µs<br>µs |
| $t_{PLHPG}$ | DRAIN High to $\overline{PWRGD}$ High<br>DRAIN High to (PWRGD – DRAIN) Low | (LT1640L) Figures 1, 5<br>(LT1640H) Figures 1, 5 | | | 0.5<br>0.5 | | µs<br>µs |

**Note 1:** Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

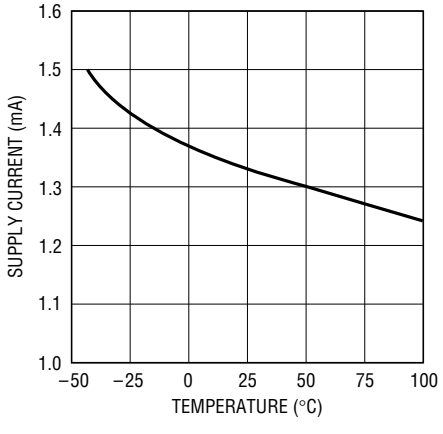
**Note 2:** All currents into device pins are positive; all currents out of device pins are negative. All voltages are referenced to $V_{EE}$ unless otherwise specified.

## TYPICAL PERFORMANCE CHARACTERISTICS

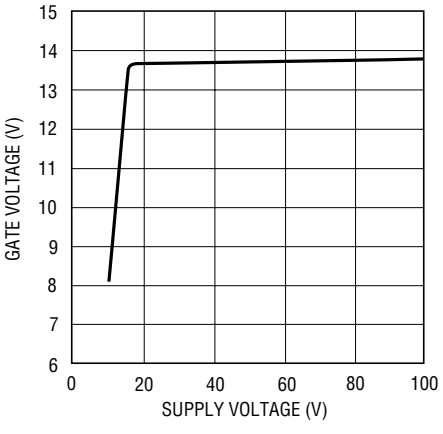
**Supply Current vs Supply Voltage**




**Supply Current vs Temperature**

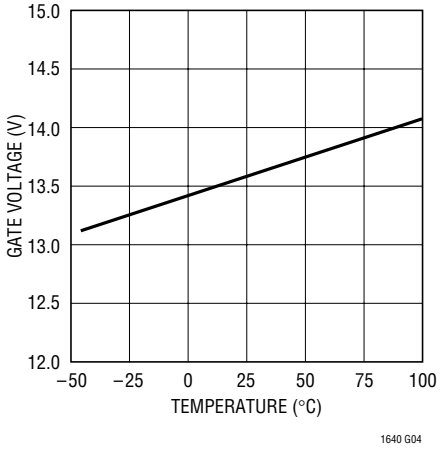



**Gate Voltage vs Supply Voltage**

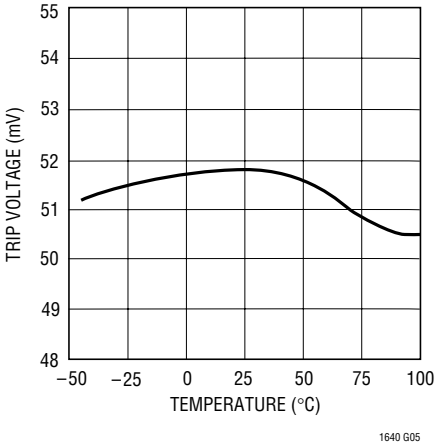


## TYPICAL PERFORMANCE CHARACTERISTICS

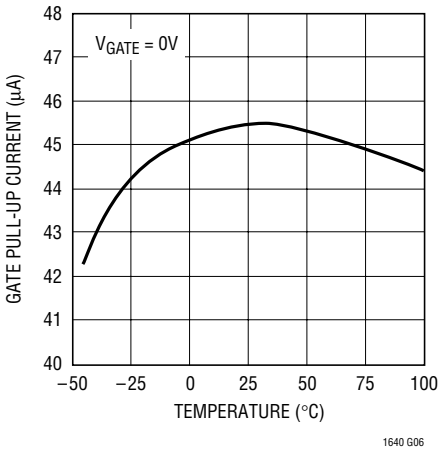
**Gate Voltage vs Temperature**



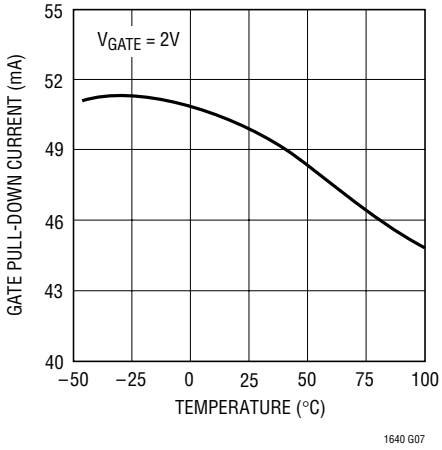

**Circuit Breaker Trip Voltage vs Temperature**



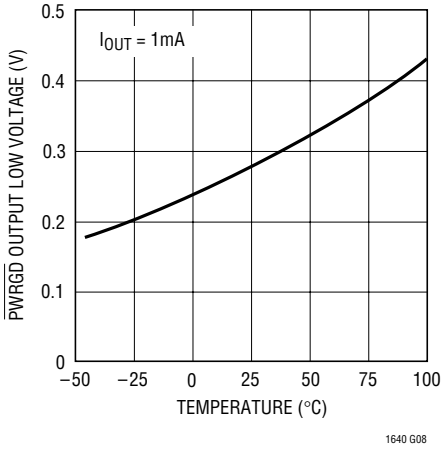

**Gate Pull-Up Current vs Temperature**



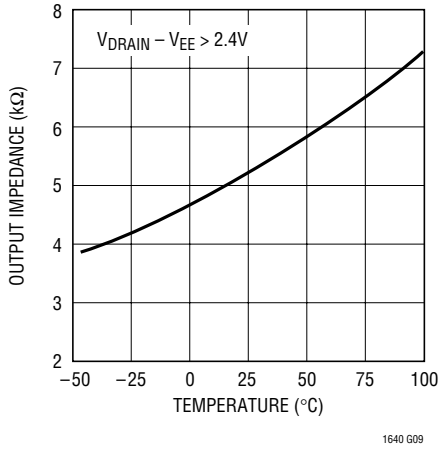

**Gate Pull-Down Current vs Temperature**




**$\overline{\text{PWRGD}}$ Output Low Voltage vs Temperature (LT1640L)**




**PWRGD Output Impedance vs Temperature (LT1640H)**




## PIN FUNCTIONS

**$\overline{\text{PWRGD}}$/PWRGD (Pin 1):** Power Good Output Pin. This pin will toggle when $V_{DRAIN}$ is within $V_{PG}$ of $V_{EE}$. This pin can be connected directly to the enable pin of a power module.

When the DRAIN pin of the LT1640L is above $V_{EE}$ by more than $V_{PG}$, the $\overline{\text{PWRGD}}$ pin will be high impedance, allowing the pull-up current of the module's enable pin to pull the pin high and turn the module off. When $V_{DRAIN}$ drops below $V_{PG}$, the $\overline{\text{PWRGD}}$ pin sinks current to $V_{EE}$, pulling the enable pin low and turning on the module.

When the DRAIN pin of the LT1640H is above $V_{EE}$ by more than $V_{PG}$, the PWRGD pin will sink current to the DRAIN pin which pulls the module's enable pin low, forcing it off. When $V_{DRAIN}$ drops below $V_{PG}$, the PWRGD sink current is turned off and a 6.5k resistor is connected between PWRGD and DRAIN, allowing the module's pull-up current to pull the enable pin high and turn on the module.

**OV (Pin 2):** Analog Overvoltage Input. When OV is pulled above the 1.223V low to high threshold, an overvoltage condition is detected and the GATE pin will be immediately pulled low. The GATE pin will remain low until OV drops below the 1.203V high to low threshold.

## PIN FUNCTIONS

**UV (Pin 3):** Analog Undervoltage Input. When UV is pulled below the 1.223V high to low threshold, an undervoltage condition is detected and the GATE pin will be immediately pulled low. The GATE pin will remain low until UV rises above the 1.243 low to high threshold.

The UV pin is also used to reset the electronic circuit breaker. If the UV pin is cycled low and high following the trip of the circuit breaker, the circuit breaker is reset and a normal power-up sequence will occur.

**$V_{EE}$ (Pin 4):** Negative Supply Voltage Input. Connect to the lower potential of the power supply.

**SENSE (Pin 5):** Circuit Breaker Sense Pin. With a sense resistor placed in the supply path between $V_{EE}$ and SENSE, the circuit breaker will trip when the voltage across the resistor exceeds 50mV. Noise spikes of less than 2µs are filtered out and will not trip the circuit breaker.

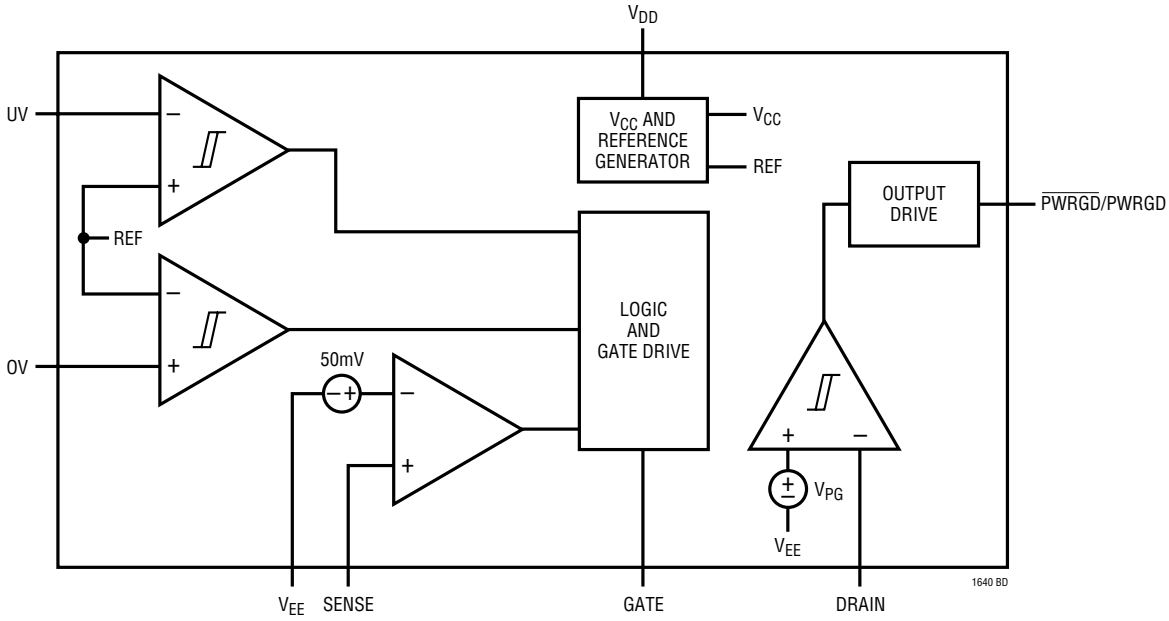
If the circuit breaker trip current is set to twice the normal operating current, only 25mV is dropped across the sense resistor during normal operation. To disable the circuit breaker, $V_{EE}$ and SENSE can be shorted together.

**GATE (Pin 6):** Gate Drive Output for the External N-Channel. The GATE pin will go high when the following start-up conditions are met: the UV pin is high, the OV pin is low and ($V_{SENSE} - V_{EE}$) < 50mV. The GATE pin is pulled high by a 45µA current source and pulled low with a 50mA current source.

**DRAIN (Pin 7):** Analog Drain Sense Input. Connect this pin to the drain of the external N-channel and the $V^-$ pin of the power module. When the DRAIN pin is below $V_{PG}$, the $\overline{PWRGD}$ or PWRGD pin will toggle.

**$V_{DD}$ (Pin 8):** Positive Supply Voltage Input. Connect this pin to the higher potential of the power supply inputs and the $V^+$ pin of the power module. The input supply voltage ranges from 10V to 80V.

## BLOCK DIAGRAM



## TEST CIRCUIT

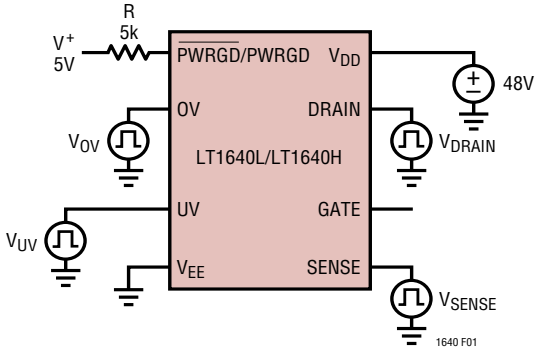



Figure 1. Test Circuit

## TIMING DIAGRAMS

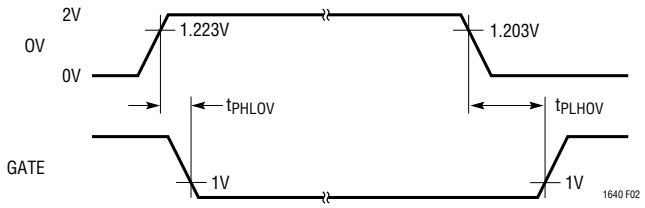



Figure 2. OV to GATE Timing

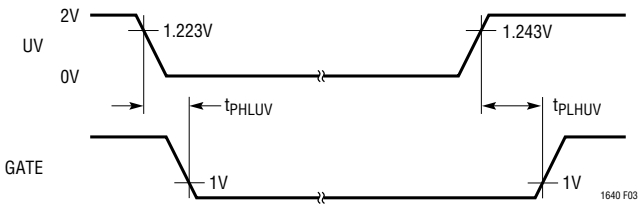



Figure 3. UV to GATE Timing

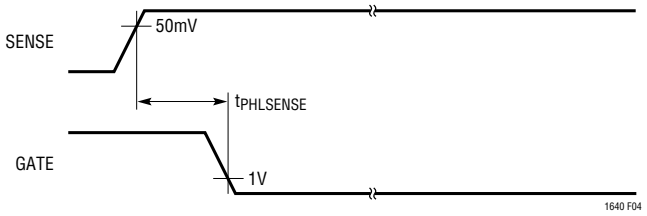



Figure 4. SENSE to GATE Timing

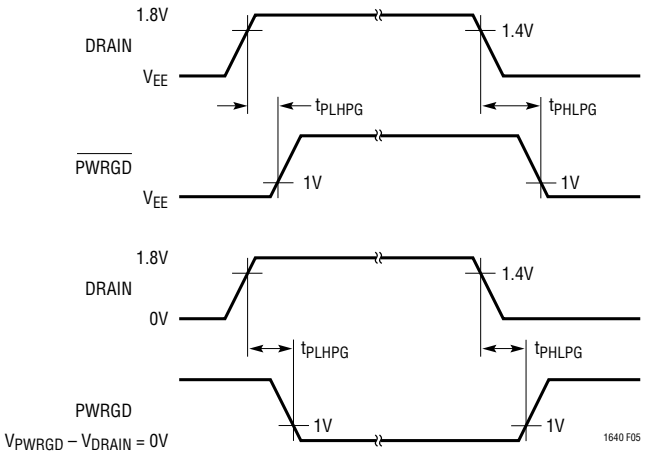



Figure 5. DRAIN to $\overline{\text{PWRGD}}$/PWRGD Timing

# APPLICATIONS INFORMATION

## Hot Circuit Insertion

When circuit boards are inserted into a live –48V backplane, the bypass capacitors at the input of the board's power module or switching power supply can draw huge transient currents as they charge up. The transient currents can cause permanent damage to the board's components and cause glitches on the system power supply.

The LT1640 is designed to turn on a board's supply voltage in a controlled manner, allowing the board to be safely inserted or removed from a live backplane. The chip also provides undervoltage, overvoltage and overcurrent protection while keeping the power module off until its input voltage is stable and within tolerance.

## Power Supply Ramping

The input to the power module on a board is controlled by placing an external N-channel pass transistor (Q1) in the power path (Figure 6a, all waveforms are with respect to the $V_{EE}$ pin of the LT1640). R1 provides current fault detection and R2 prevents high frequency oscillations. Resistors R4, R5 and R6 provide undervoltage and overvoltage sensing. By ramping the gate of Q1 up at a slow rate, the surge current charging load capacitors C3 and C4 can be limited to a safe value when the board makes connection.

Resistor R3 and capacitor C2 act as a feedback network to accurately control the inrush current. The inrush current can be calculated with the following equation:

$$I_{INRUSH} = (45\mu A \bullet C_L)/C2$$

where $C_L$ is the total load capacitance, C3 + C4 + module input capacitance.

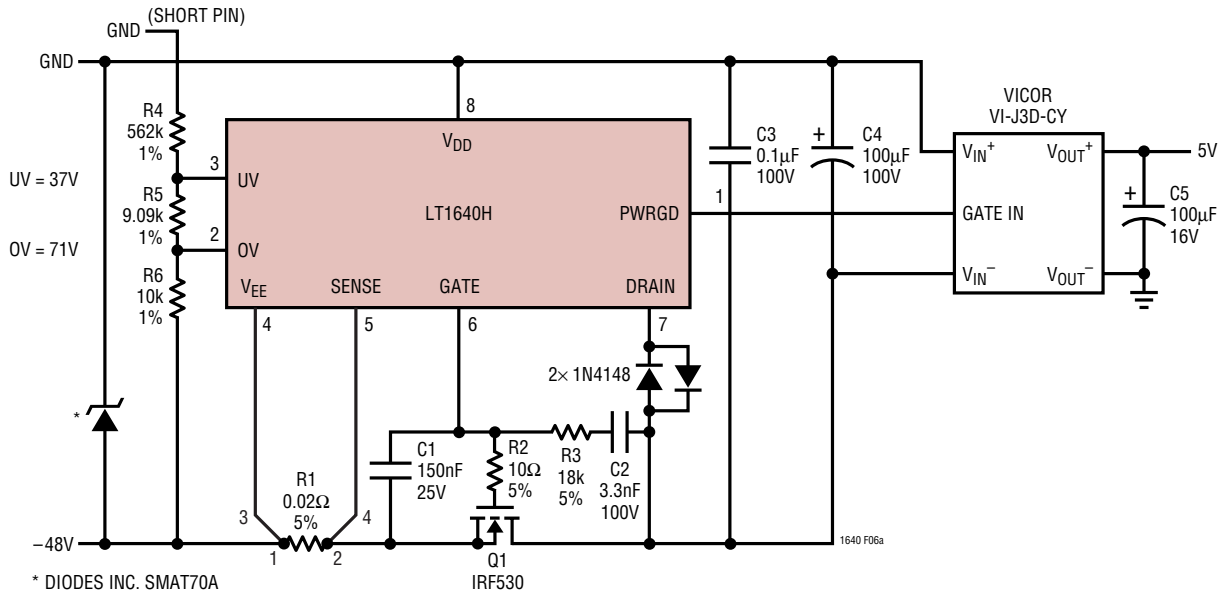



**Figure 6a. Inrush Control Circuitry**

## APPLICATIONS INFORMATION

Capacitor C1 and resistor R3 prevent Q1 from momentarily turning on when the power pins first make contact. Without C1 and R3, capacitor C2 would pull the gate of Q1 up to a voltage roughly equal to $V_{EE} \bullet C2/C_{GS}(Q1)$ before the LT1640 could power up and actively pull the gate low. By placing capacitor C1 in parallel with the gate capacitance of Q1 and isolating them from C2 using resistor R3 the problem is solved. The value of C1 should be:

$$\left(\frac{V_{INMAX} - V_{TH}}{V_{TH}}\right) \bullet (C2 + C_{GD})$$

where $V_{TH}$ is the MOSFET's minimum gate threshold and $V_{INMAX}$ is the maximum operating input voltage.

R3's value is not critical and is given by $(V_{INMAX} + \Delta V_{GATE})/5mA$.

The waveforms are shown in Figure 6b. When the power pins make contact, they bounce several times. While the contacts are bouncing, the LT1640 senses an undervoltage condition and the GATE is immediately pulled low when the power pins are disconnected.

Once the power pins stop bouncing, the GATE pin starts to ramp up. When Q1 turns on, the GATE voltage is held constant by the feedback network of R3 and C2. When the DRAIN voltage has finished ramping, the GATE pin then ramps to its final value.

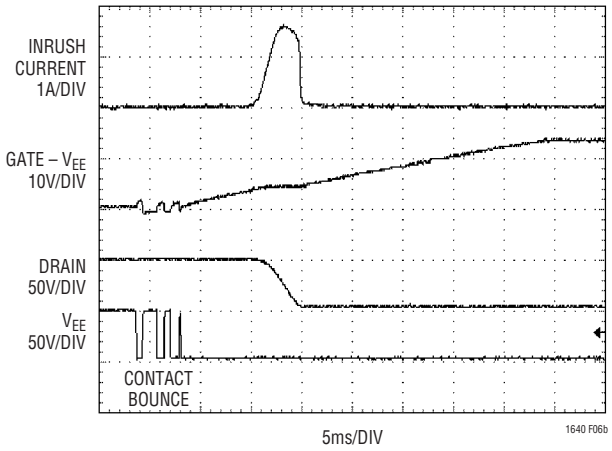



**Figure 6b. Inrush Control Waveforms**

## APPLICATIONS INFORMATION

### Electronic Circuit Breaker

The LT1640 features an electronic circuit breaker function that protects against short circuits or excessive supply currents. By placing a sense resistor between the $V_{EE}$ and SENSE pin, the circuit breaker will be tripped whenever the voltage across the sense resistor is greater than 50mV for more than 3µs as shown in Figure 7.

Note that the circuit breaker threshold should be set sufficiently high to account for the sum of the load current and the inrush current. If the load current can be controlled by the $\overline{PWRGD}$/PWRGD pin (as in Figure 6a), the threshold can be set lower, since it will never need to accommodate inrush current and load current simultaneously.

When the circuit breaker trips, the GATE pin is immediately pulled to $V_{EE}$ and the external N-channel turns off. The GATE pin will remain low until the circuit breaker is reset by pulling UV low, then high or cycling power to the part.

If more than 3µs deglitching time is needed to reject current noise, an external resistor and capacitor can be added to the sense circuit as shown in Figure 8. R7 and C3 act as a lowpass filter that will slow down the SENSE pin voltage from rising too fast. Since the SENSE pin will source current, typically 20µA, there will be a voltage drop on R7. This voltage will be counted into the circuit breaker trip voltage just as the voltage across the sense resistor. A small resistor is recommended for R7. A 100Ω for R7 will cause a 2mV error. The following equation can be used to estimate the delay time at the SENSE pin:

$$t = -R \bullet C \bullet \ln\left(1 - \frac{V(t) - V(t_0)}{V_i - V(t_0)}\right)$$

Where V(t) is the circuit breaker trip voltage, typically 50mV. $V(t_0)$ is the voltage drop across the sense resistor before the short or over current condition occurs. $V_i$ is the voltage across the sense resistor when the short current or over current is applied on it.

Example: A system has a 1A current load and a 0.02Ω sense resistor is used. An extended delay circuit needs to be designed for a 50µs delay time after the load jumps to 5A. In this case:

$V(t) = 50mV$

$V(t_0) = 20mV$

$V_i = 5A \bullet 0.02\Omega = 100mV$

If R7 = 100Ω, then C3 = 1µF.

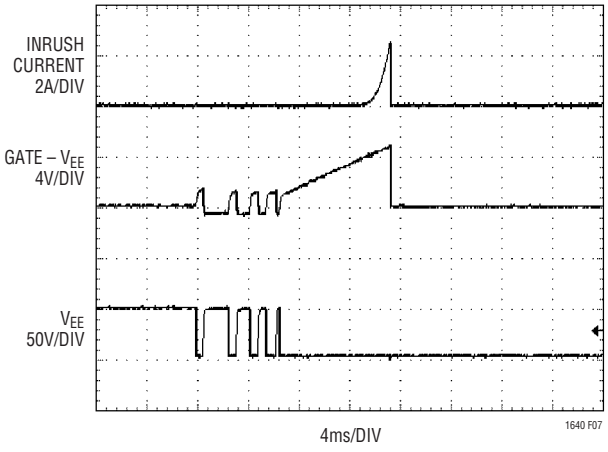



Figure 7. Start-Up Into a Short Circuit

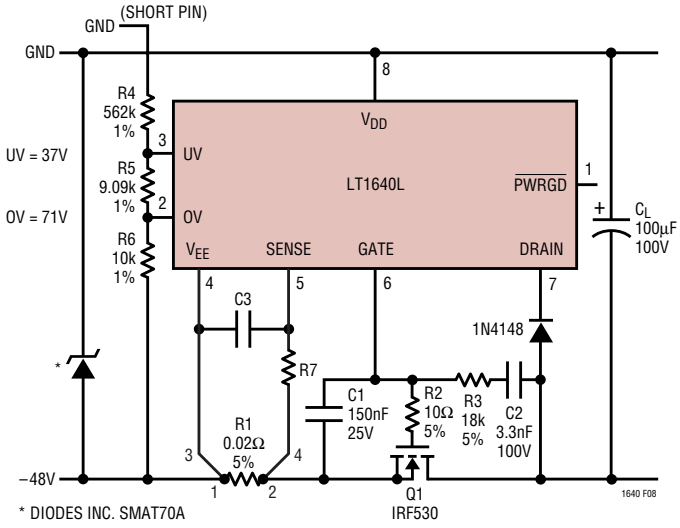



Figure 8. Extending the Short-Circuit Protection Delay

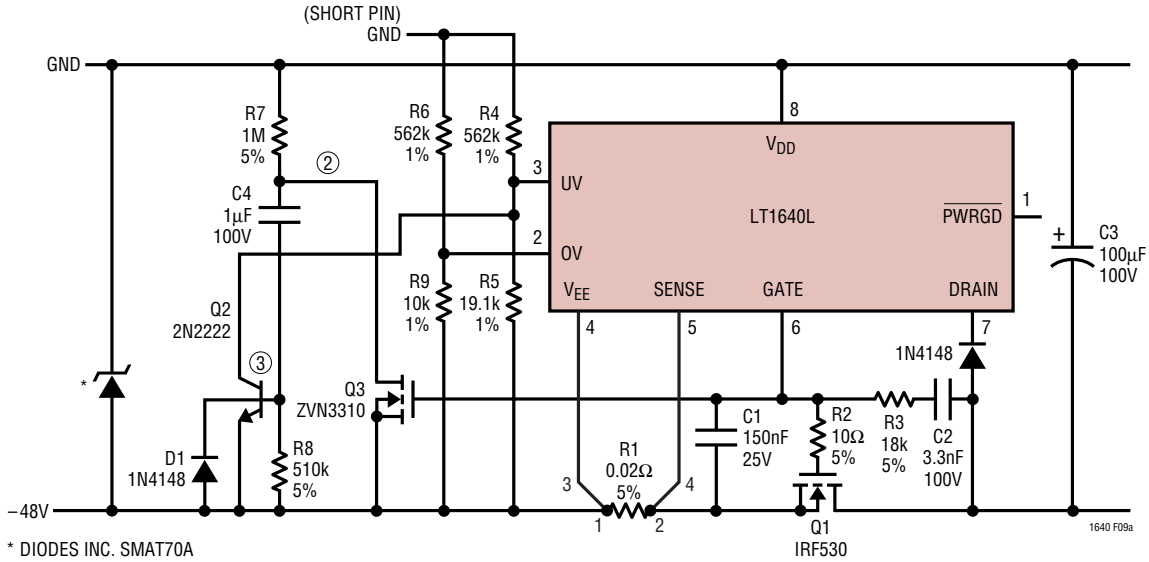
## APPLICATIONS INFORMATION

Under some conditions, a short circuit at the output can cause the input supply to dip below the UV threshold, resetting the circuit breaker immediately.

The LT1640 then cycles on and off repeatedly until the short is removed. This can be minimized by adding a deglitching delay to the UV pin with a capacitor from UV to $V_{EE}$. This capacitor forms an RC time constant with the resistors at UV, allowing the input supply to recover before the UV pin resets the circuit breaker.

A circuit that automatically resets the circuit breaker after a current fault is shown in Figure 9.

Transistors Q2 and Q3 along with R7, R8, C4 and D1 form a programmable one-shot circuit. Before a short occurs, the GATE pin is pulled high and Q3 is turned on, pulling node 2 to $V_{EE}$. Resistor R8 turns off Q2. When a short occurs, the GATE pin is pulled low and Q3 turns off. Node 2 starts to charge C4 and Q2 turns on, pulling the UV pin low and resetting the circuit breaker. As soon as C4 is fully charged, R8 turns off Q2, UV goes high and the GATE starts to ramp up. Q3 turns back on and quickly pulls node 2 back to $V_{EE}$. Diode D1 clamps node 3 one diode drop below $V_{EE}$. The duty cycle is set to 10% to prevent Q1 from overheating.



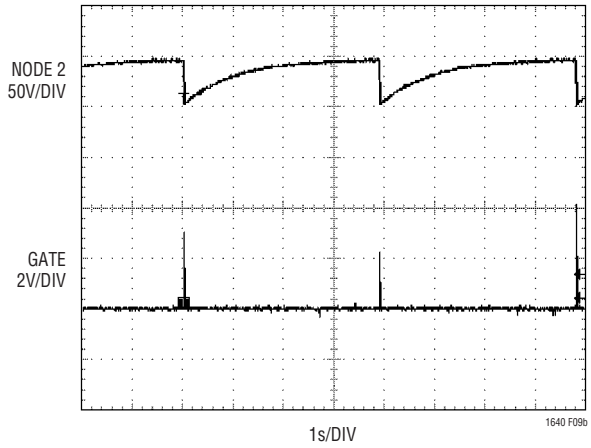




**Figure 9. Automatic Restart After Current Fault**

## APPLICATIONS INFORMATION

### Undervoltage and Overvoltage Detection

The UV (Pin 3) and OV (Pin 2) pins can be used to detect undervoltage and overvoltage conditions at the power supply input. The UV and OV pins are internally connected to analog comparators with 20mV of hysteresis. When the UV pin falls below its threshold or the OV pin rises above its threshold, the GATE pin is immediately pulled low. The GATE pin will be held low until UV is high and OV is low.

The undervoltage and overvoltage trip voltages can be programmed using a three resistor divider as shown in Figure 10a. With R4 = 562k, R5 = 9.09k and R6 = 10K, the undervoltage threshold is set to 37V and the overvoltage threshold is set to 71V. The resistor divider will also gain up the 20mV hysteresis at the UV pin and OV pin to 0.6V and 1.2V at the input respectively.

More hysteresis can be added to the UV threshold by connecting resistor R3 between the UV pin and the GATE pin as shown in Figure 10b.

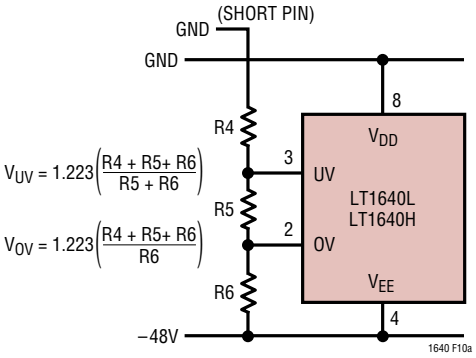



**Figure 10a. Undervoltage and Overvoltage Sensing**

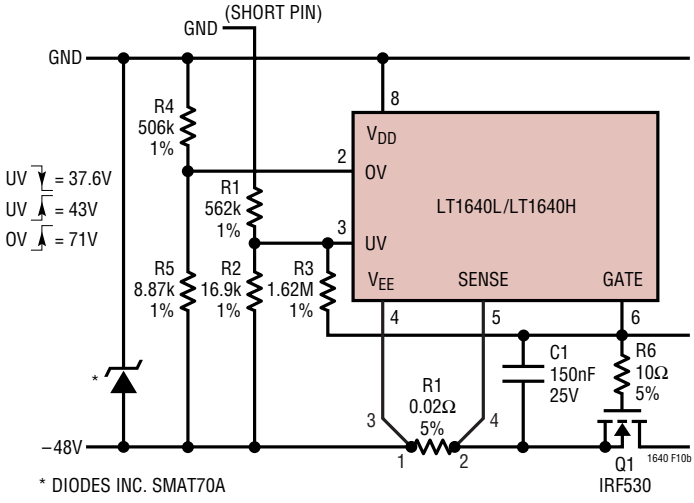



**Figure 10b. Programmable Hysteresis for Undervoltage Detection**

## APPLICATIONS INFORMATION

The new threshold voltage when the input moves from low to high is:

$$V_{UV,LH} = V_{UVH}\left(\frac{R2 \bullet R3 + R1 \bullet R3 + R1 \bullet R2}{R2 \bullet R3}\right)$$

where $V_{UVH}$ is typically 1.243V.

The new threshold voltage when the input moves from high to low is:

$$V_{UV,HL} = V_{UVL}\left(\frac{R2 \bullet R3 + R1 \bullet R3 + R1 \bullet R2}{R2 \bullet R3}\right) - \left(V_{GATE} \bullet \frac{R1}{R3}\right)$$

where $V_{UVL}$ is typically 1.223V.

The new hysteresis value will be:

$$V_{HYS} = V_{UVHY}\left(\frac{R2 \bullet R3 + R1 \bullet R3 + R1 \bullet R2}{R2 \bullet R3}\right) + \left(V_{GATE} \bullet \frac{R1}{R3}\right)$$

With R1 = 562k, R2 = 16.9k and R3 = 1.62M, $V_{GATE}$ = 13.5V and $V_{UVHY}$ = 20mV, the undervoltage threshold will be 43V (from low to high) and 37.6V (from high to low). The hysteresis is 5.4V. A separate resistor divider should be used to set the overvoltage threshold given by:

$$V_{OV} = V_{OVH}\left(\frac{R4 + R5}{R5}\right)$$

With R4 = 506k, R5 = 8.87k and $V_{OVH}$ = 1.223V, the overvoltage threshold will be 71V.

### $\overline{\text{PWRGD}}$/PWRGD Output

The $\overline{\text{PWRGD}}$/PWRGD output can be used to directly enable a power module when the input voltage to the module is within tolerance. The LT1640L has a $\overline{\text{PWRGD}}$ output for modules with an active low enable input, and the LT1640H has a PWRGD output for modules with an active high enable input.

When the DRAIN voltage of the LT1640H is high with respect to $V_{EE}$ (Figure 11), the internal transistor Q3 is turned off and R7 and Q2 clamp the PWRGD pin one diode drop (≈0.7V) above the DRAIN pin. Transistor Q2 sinks the module's pull-up current and the module turns off.

When the DRAIN voltage drops below $V_{PG}$, Q3 will turn on, shorting the bottom of R7 to DRAIN and turning Q2 off. The pull-up current in the module then flows through R7, pulling the PWRGD pin high and enabling the module.

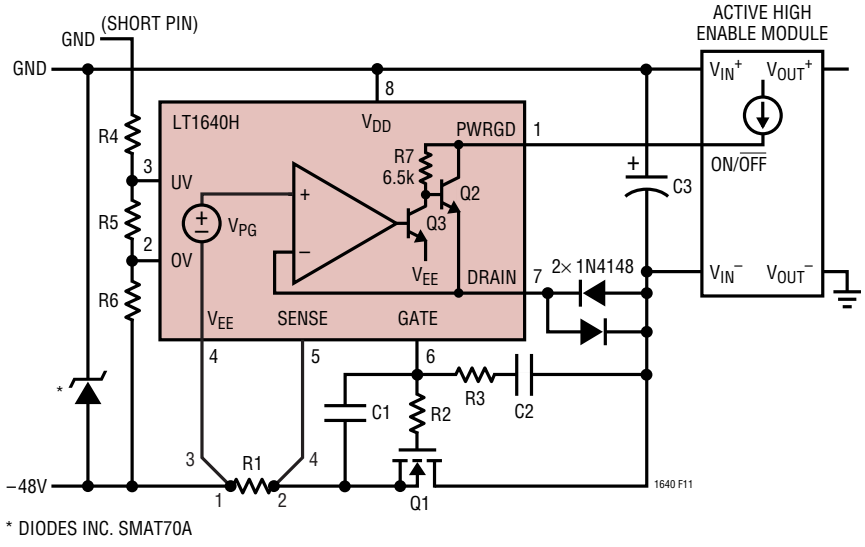



**Figure 11. Active High Enable Module**

## APPLICATIONS INFORMATION

When the DRAIN voltage of the LT1640L is high with respect to $V_{EE}$, the internal pull-down transistor Q2 is off and the $\overline{PWRGD}$ pin is in a high impedance state (Figure 12). The $\overline{PWRGD}$ pin will be pulled high by the module's internal pull-up current source, turning the module off. When the DRAIN voltage drops below $V_{PG}$, Q2 will turn on and the $\overline{PWRGD}$ pin will pull low, enabling the module.

The $\overline{PWRGD}$ signal can also be used to turn on an LED or optoisolator to indicate that the power is good as shown in Figure 13.

### Gate Pin Voltage Regulation

When the supply voltage to the chip is more than 15.5V, the GATE pin voltage is regulated at 13.5V above $V_{EE}$. If the supply voltage is less than 15.5V, the GATE voltage will be about 2V below the supply voltage. At the minimum 10V supply voltage, the gate voltage is guaranteed to be greater than 6V. The gate voltage will be no greater than 18V for supply voltages up to 80V.

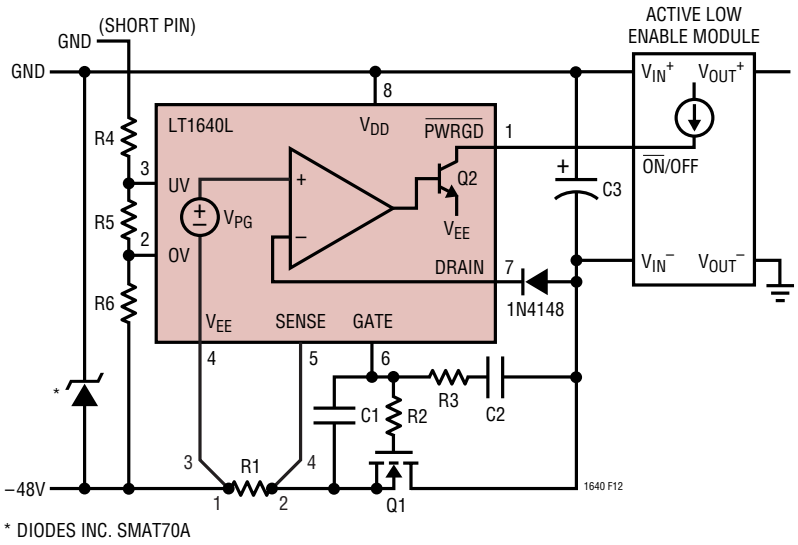



**Figure 12. Active Low Enable Module**

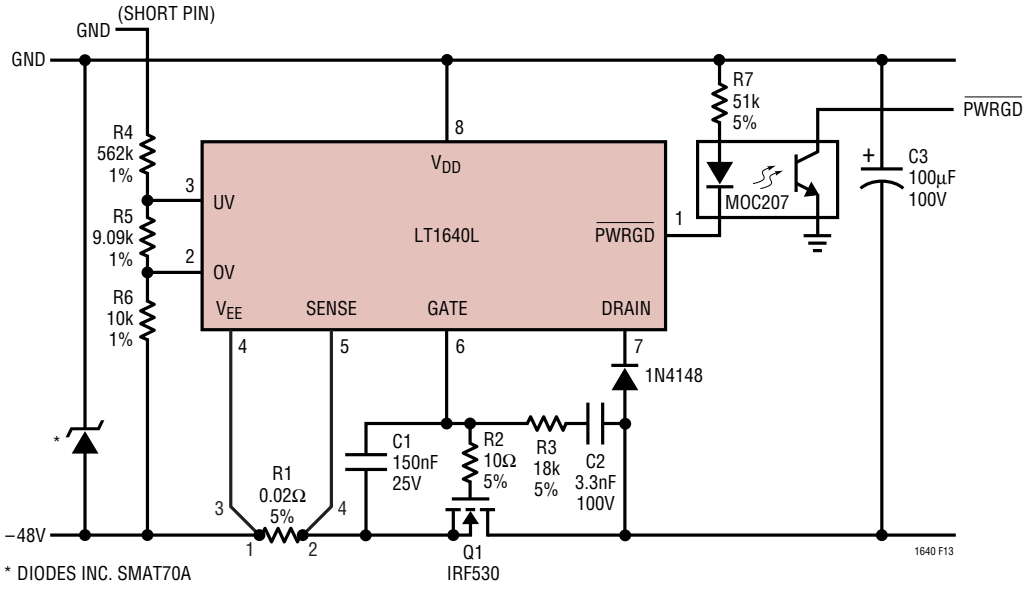
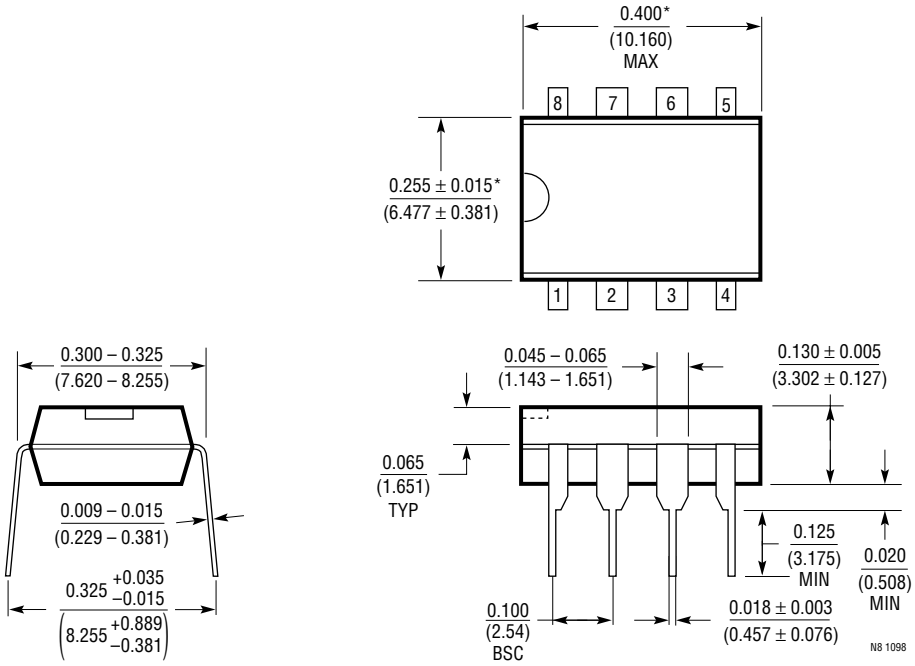



**Figure 13. Using $\overline{PWRGD}$ to Drive an Optoisolator**

## PACKAGE DESCRIPTION

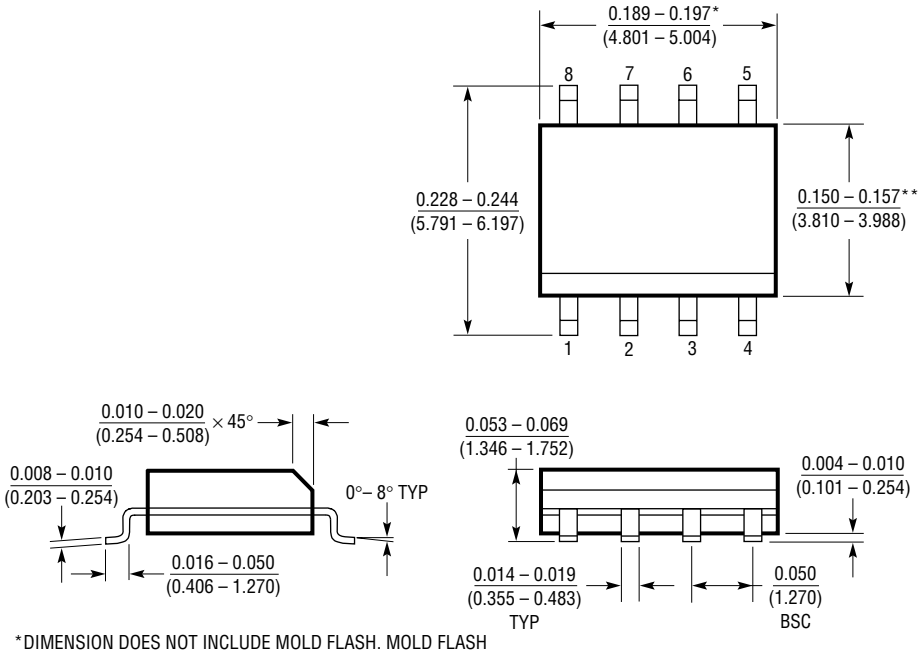
**N8 Package**
**8-Lead PDIP (Narrow .300 Inch)**
(Reference LTC DWG # 05-08-1510)




*THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.010 INCH (0.254mm)

# PACKAGE DESCRIPTION

**S8 Package**
**8-Lead Plastic Small Outline (Narrow .150 Inch)**
(Reference LTC DWG # 05-08-1610)




*DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE

**DIMENSION DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010" (0.254mm) PER SIDE

S08 1298



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## TYPICAL APPLICATION

### Using an EMI Filter Module

Many applications place an EMI filter module in the power path to prevent switching noise of the module from being injected back onto the power supply. A typical application using the Lucent FLTR100V10 filter module is shown in Figure 14. When using a filter, an optoisolator is required to prevent common mode transients from destroying the $\overline{\text{PWRGD}}$ and $\overline{\text{ON}}$/OFF pins.

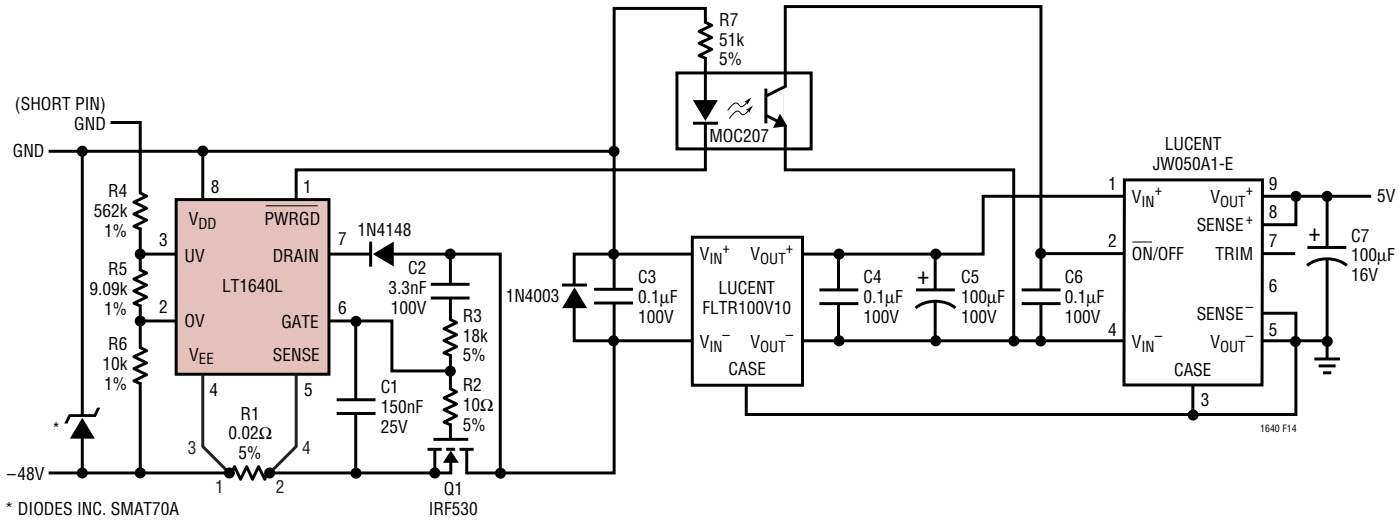



**Figure 14. Typical Application Using a Filter Module**

## RELATED PARTS

| PART NUMBER | DESCRIPTION | COMMENTS |
|---|---|---|
| LTC®1421 | Dual Channel, Hot Swap Controller | Operates from 3V to 12V |
| LTC1422 | High Side Drive, Hot Swap Controller in SO-8 | System Reset Output with Programmable Delay |
| LT1640A | –48V Hot Swap Controller in SO-8 | LT1640 Pin Compatible, Improved Drain Pin Ruggedness |
| LT1641 | 48V Hot Swap Controller | Foldback Analog Current Limit |
| LTC1642 | Fault Protected Hot Swap Controller | Operates Up to 16.5V, Protected to 33V |
| LTC1643 | PCI Hot Swap Controller | 3.3V, 5V, 12V, –12V Supplies for PCI Bus |
| LTC1645 | Dual Hot Swap Controller | Operates from 1.2V to 12V, Power Sequencing |
| LTC1646 | CompactPCI™ Hot Swap Controller | 3.3V, 5V Supplies, 1V Precharge, Local PCI Reset Logic |
| LTC1647 | Dual Hot Swap Controller | Dual ON Pins for Supplies from 3V to 15V |
| LTC4211 | Low Voltage Hot Swap Controller | 2.5V to 16.5V, Dual Level Circuit Breaker, Active Inrush Limiting |
| LT4250 | –48V Hot Swap Controller in SO-8 | LT1640 Pin Compatible, Active Current Limiting |
| LTC4251 | –48V Hot Swap Controller in SOT-23 | Active Current Limiting, Fast Circuit Breaker for Short-Circuit Faults |

CompactPCI is a trademark of the PCI Industrial Computer Manufacturers Group


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