

# IR2110E6

## HIGH AND LOW SIDE DRIVER

### Features

- Floating channel designed for bootstrap operation  
Fully operational to +600V  
Tolerant to negative transient voltage  
dV/dt immune
- Gate drive supply range from 10 to 20V
- Undervoltage lockout for both channels
- Separate logic supply range from 5 to 20V  
Logic and power ground  $\pm 5V$  offset
- CMOS Schmitt-triggered inputs with pull-down
- Cycle by cycle edge-triggered shutdown logic
- Matched propagation delay for both channels
- Outputs in phase with inputs

### Product Summary

|                                  |                        |
|----------------------------------|------------------------|
| <b>V<sub>OFFSET</sub></b>        | <b>600V max.</b>       |
| <b>I<sub>O</sub>+/-</b>          | <b>2A / 2A</b>         |
| <b>V<sub>OUT</sub></b>           | <b>10 - 20V</b>        |
| <b>t<sub>on/off</sub> (typ.)</b> | <b>120 &amp; 94 ns</b> |
| <b>Delay Matching</b>            | <b>10 ns</b>           |

### Description

The IR2110E6 is a high voltage, high speed power MOSFET and IGBT driver with independent high and low side referenced output channels. Proprietary HVIC and latch immune CMOS technologies enable ruggedized monolithic construction. Logic inputs are compatible with standard CMOS or LSTTL outputs. The output drivers feature a high pulse current buffer stage designed for minimum driver cross-conduction. Propagation delays are matched to simplify use in high frequency applications. The floating channel can be used to drive an N-channel power MOSFET or IGBT in the high side configuration which operates up to 600 volts.

### Absolute Maximum Ratings

Absolute Maximum Ratings indicate sustained limits beyond which damage to the device may occur. All voltage parameters are absolute voltages referenced to COM. The Thermal Resistance and Power Dissipation ratings are measured under board mounted and still air conditions. Additional information is shown in Figures 28 through 35.

| Symbol              | Parameter                                                   | Min.                  | Max.                  | Units |
|---------------------|-------------------------------------------------------------|-----------------------|-----------------------|-------|
| V <sub>B</sub>      | High Side Floating Supply Absolute Voltage                  | -0.5                  | V <sub>S</sub> + 20   | V     |
| V <sub>S</sub>      | High Side Floating Supply Offset Voltage                    | —                     | 600                   |       |
| V <sub>HO</sub>     | High Side Output Voltage                                    | V <sub>S</sub> -0.5   | V <sub>B</sub> + 0.5  |       |
| V <sub>CC</sub>     | Low Side Fixed Supply Voltage                               | -0.5                  | 20                    |       |
| V <sub>LO</sub>     | Low Side Output Voltage                                     | -0.5                  | V <sub>CC</sub> + 0.5 |       |
| V <sub>DD</sub>     | Logic Supply Voltage                                        | -0.5                  | V <sub>SS</sub> + 20  |       |
| V <sub>SS</sub>     | Logic Supply Offset Voltage                                 | V <sub>CC</sub> - 20  | V <sub>CC</sub> + 0.5 |       |
| V <sub>IN</sub>     | Logic Input Voltage (HIN, LIN & SD)                         | V <sub>SS</sub> - 0.5 | V <sub>DD</sub> + 0.5 |       |
| dV <sub>S</sub> /dt | Allowable Offset Supply Voltage Transient (Fig. 16)         | —                     | 50                    | V/ns  |
| P <sub>D</sub>      | Package Power Dissipation @ T <sub>A</sub> ≤ 25°C (Fig. 19) | —                     | 1.6                   | W     |
| R <sub>thJA</sub>   | Thermal Resistance, Junction to Ambient                     | —                     | 75                    | °C/W  |
| T <sub>j</sub>      | Junction Temperature                                        | -55                   | 125                   | °C    |
| T <sub>S</sub>      | Storage Temperature                                         | -55                   | 150                   |       |
| T <sub>L</sub>      | Package Mounting Surface Temperature                        | 300 (for 5 seconds)   |                       |       |
|                     | Weight                                                      | 0.45 (typical)        |                       | g     |

# IR2110E6

## Recommended Operating Conditions

The Input/Output logic timing diagram is shown in Figure 1. For proper operation the device should be used within the recommended conditions. The  $V_S$  and  $V_{SS}$  offset ratings are tested with all supplies biased at 15V differential. Typical ratings at other bias conditions are shown in Figures 36 and 37.

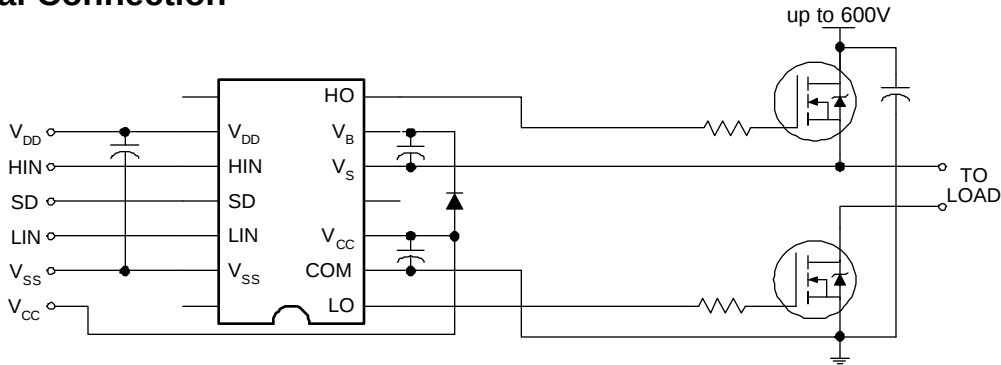
| Symbol   | Parameter                                          | Min.         | Max.          | Units |
|----------|----------------------------------------------------|--------------|---------------|-------|
| $V_B$    | High Side Floating Supply Absolute Voltage         | $V_S + 10$   | $V_S + 20$    | V     |
| $V_S$    | High Side Floating Supply Offset Voltage           | -4           | 600           |       |
| $V_{HO}$ | High Side Output Voltage                           | $V_S$        | $V_B$         |       |
| $V_{CC}$ | Low Side Fixed Supply Voltage                      | 10           | 20            |       |
| $V_{LO}$ | Low Side Output Voltage                            | 0            | $V_{CC}$      |       |
| $V_{DD}$ | Logic Supply Voltage                               | $V_{SS} + 5$ | $V_{SS} + 20$ |       |
| $V_{SS}$ | Logic Supply Offset Voltage                        | -5           | 5             |       |
| $V_{IN}$ | Logic Input Voltage ( $H_{IN}$ , $L_{IN}$ & $SD$ ) | $V_{SS}$     | $V_{DD}$      |       |

## Dynamic Electrical Characteristics

$V_{BIAS}$  ( $V_{CC}$ ,  $V_{BS}$ ,  $V_{DD}$ ) = 15V, and  $V_{SS}$  = COM unless otherwise specified. The dynamic electrical characteristics are measured using the test circuit shown in Figure 3.

| Symbol    |                                     | $T_j = 25^{\circ}C$ |      |      | $T_j = -55 \text{ to } 125^{\circ}C$ |     | Units | Test Conditions                         |
|-----------|-------------------------------------|---------------------|------|------|--------------------------------------|-----|-------|-----------------------------------------|
|           |                                     | Min                 | Typ. | Max. | Min.                                 | Max |       |                                         |
| $t_{on}$  | Turn-On Propagation Delay           | —                   | 120  | 150  | —                                    | 260 | ns    | $V_S = 0V$                              |
| $t_{off}$ | Turn-Off Propagation Delay          | —                   | 94   | 125  | —                                    | 220 |       | $V_S = 600V$                            |
| $t_{sd}$  | Shutdown Propagation Delay          | —                   | 110  | 140  | —                                    | 235 |       | $V_S = 600V$                            |
| $t_r$     | Turn-On Rise Time                   | —                   | 25   | 35   | —                                    | 50  |       | $C_L = 1000pf$                          |
| $t_f$     | Turn-Off Fall Time                  | —                   | 17   | 25   | —                                    | 40  |       | $C_L = 1000pf$                          |
| Mt        | Delay Matching, HS & LS Turn-On/Off | —                   | —    | 10   | —                                    | —   |       | $ H_{ton}-L_{ton} / H_{toff}-L_{toff} $ |

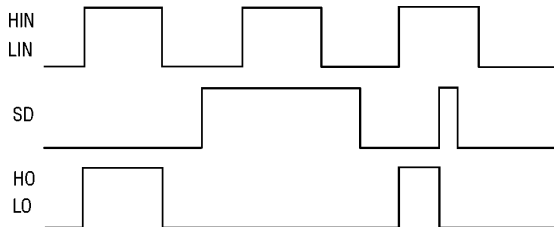
## Typical Connection



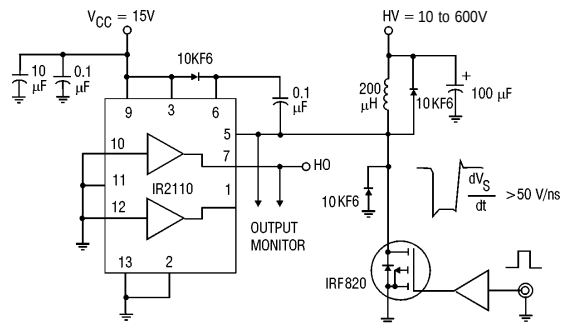
## Static Electrical Characteristics

$V_{BIAS}$  ( $V_{CC}$ ,  $V_{BS}$ ,  $V_{DD}$ ) = 15V, unless otherwise specified. The  $V_{IN}$ ,  $V_{TH}$  and  $I_{IN}$  parameters are referenced to  $V_{SS}$  and are applicable to all three logic input leads: HIN, LIN and SD. The  $V_O$  and  $I_O$  parameters are referenced to COM and are applicable to the respective output leads: HO or LO.

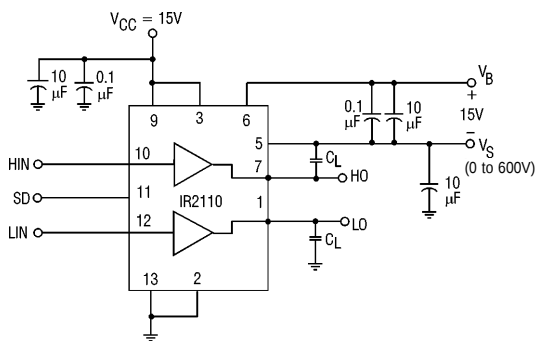
|             |                                                       | $T_J = 25^{\circ}\text{C}$ |      |      | $T_J = -55 \text{ to } 125^{\circ}\text{C}$ |      |         |                                                        |
|-------------|-------------------------------------------------------|----------------------------|------|------|---------------------------------------------|------|---------|--------------------------------------------------------|
| Symbol      | Parameter                                             | Min                        | Typ. | Max. | Min.                                        | Max. | Units   | Test Conditions                                        |
| $V_{IH}$    | Logic "1" Input Voltage                               | 3.1                        | —    | —    | 3.3                                         | —    | V       | $V_{DD} = 5V$                                          |
|             |                                                       | 6.4                        | —    | —    | 6.8                                         | —    |         | $V_{DD} = 10V$                                         |
|             |                                                       | 9.5                        | —    | —    | 10                                          | —    |         | $V_{DD} = 15V$                                         |
|             |                                                       | 12.6                       | —    | —    | 13.3                                        | —    |         | $V_{DD} = 20V$                                         |
| $V_{IL}$    | Logic "0" Input Voltage                               | —                          | —    | 1.8  | —                                           | 1.7  | V       | $V_{DD} = 5V$                                          |
|             |                                                       | —                          | —    | 3.8  | —                                           | 3.6  |         | $V_{DD} = 10V$                                         |
|             |                                                       | —                          | —    | 6    | —                                           | 5.7  |         | $V_{DD} = 15V$                                         |
|             |                                                       | —                          | —    | 8.3  | —                                           | 7.9  |         | $V_{DD} = 20$                                          |
| $V_{OH}$    | High Level Output Voltage, $V_{BIAS} - V_O$           | —                          | 0.7  | 1.2  | —                                           | 1.5  | V       | $V_{IN} = V_{IH}$ , $I_O = 0A$                         |
| $V_{OL}$    | Low Level Output Voltage, $V_O$                       | —                          | —    | 0.1  | —                                           | 0.1  |         | $V_{IN} = V_{IL}$ , $I_O = 0A$                         |
| $I_{LK}$    | Offset Supply Leakage Current                         | —                          | —    | 50   | —                                           | 250  | $\mu A$ | $V_B = V_S = 600V$                                     |
| $I_{QBS}$   | Quiescent $V_{BS}$ Supply Current                     | —                          | 125  | 230  | —                                           | 500  |         | $V_{IN} = 0V$ or $V_{DD}$                              |
| $I_{QCC}$   | Quiescent $V_{CC}$ Supply Current                     | —                          | 180  | 340  | —                                           | 600  |         | $V_{IN} = 0V$ or $V_{DD}$                              |
| $I_{QDD}$   | Quiescent $V_{DD}$ Supply Current                     | —                          | 5    | 30   | —                                           | 60   |         | $V_{IN} = 0V$ or $V_{DD}$                              |
| $I_{IN+}$   | Logic "1" Input Bias Current                          | —                          | 15   | 40   | —                                           | 70   |         | $V_{IN} = V_{DD}$                                      |
| $I_{IN-}$   | Logic "0" Input Bias Current                          | —                          | —    | 1    | —                                           | 10   |         | $V_{IN} = 0V$                                          |
| $V_{BSUV+}$ | $V_{BS}$ Supply Undervoltage Positive Going Threshold | 7.5                        | 8.6  | 9.7  | —                                           | —    | V       |                                                        |
| $V_{BSUV-}$ | $V_{BS}$ Supply Undervoltage Negative Going Threshold | 7.0                        | 8.2  | 9.4  | —                                           | —    |         |                                                        |
| $V_{CCUV+}$ | $V_{CC}$ Supply Undervoltage Positive Going Threshold | 7.4                        | 8.5  | 9.6  | —                                           | —    |         |                                                        |
| $V_{CCUV-}$ | $V_{CC}$ Supply Undervoltage Negative Going Threshold | 7.0                        | 8.2  | 9.4  | —                                           | —    |         |                                                        |
| $I_{O+}$    | Output High Short Circuit Pulsed Current              | 2                          | —    | —    | —                                           | —    | A       | $V_{OUT} = 0V$ , $V_{IN} = V_{DD}$<br>$PW < = 10\mu s$ |
| $I_{O-}$    | Output Low Short Circuit Pulsed Current               | 2                          | —    | —    | —                                           | —    |         | $V_{OUT} = 15V$ , $V_{IN} = 0V$<br>$PW < = 10\mu s$    |



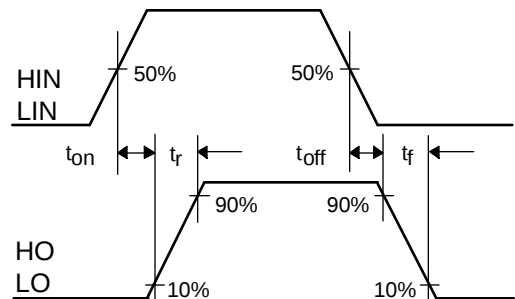
**Figure 1. Input/Output Timing Diagram**



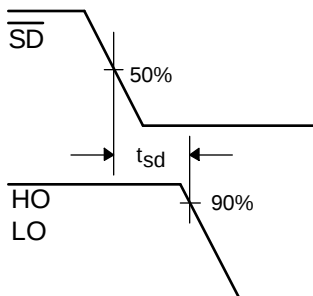
**Figure 2. Floating Supply Voltage Transient Test Circuit**



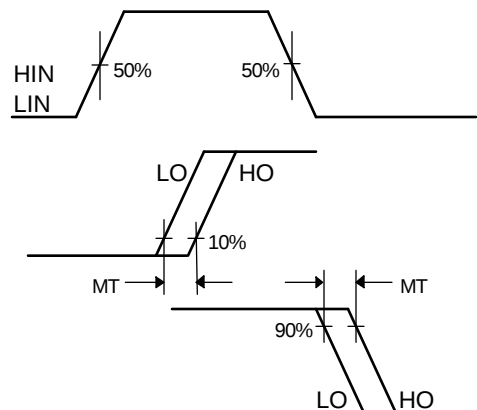
**Figure 3. Switching Time Test Circuit**



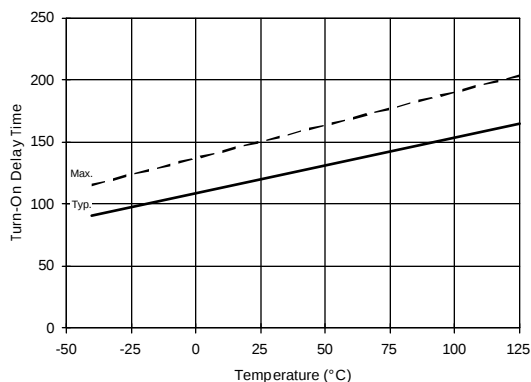
**Figure 4. Switching Time Waveform Definition**



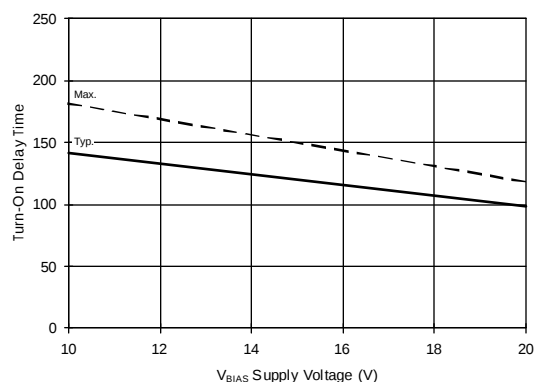
**Figure 5. Shutdown Waveform Definitions**



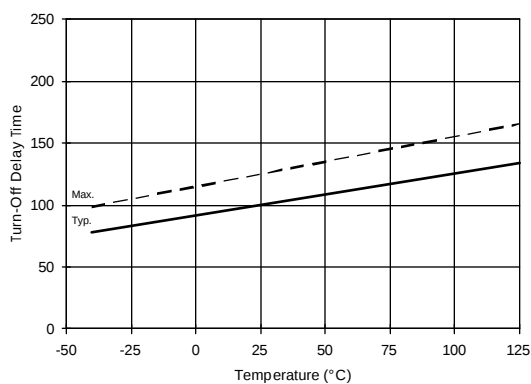
**Figure 6. Delay Matching Waveform Definitions**



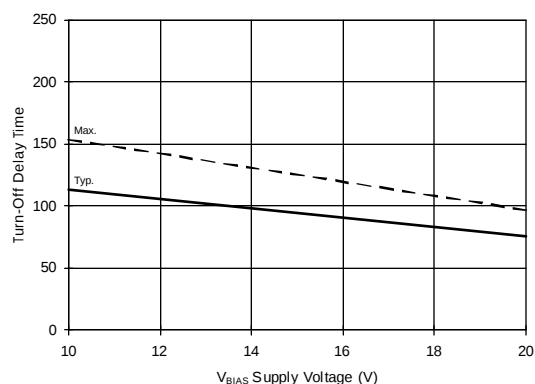
**Figure 7A. Turn-On Time vs. Temperature**



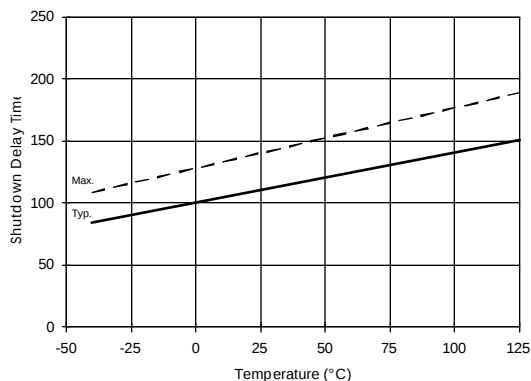
**Figure 7B. Turn-On Time vs. Voltage**



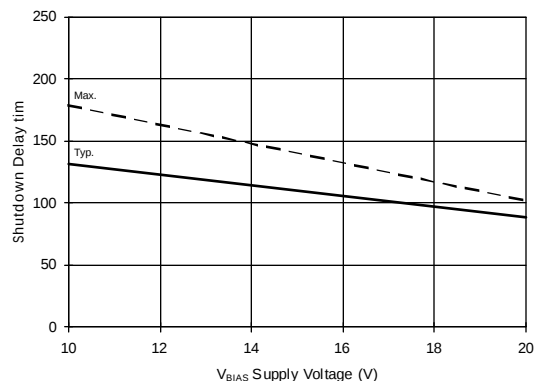
**Figure 8A. Turn-Off Time vs. Temperature**



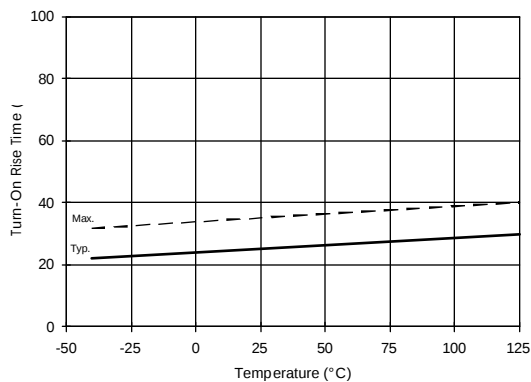
**Figure 8B. Turn-Off Time vs. Voltage**



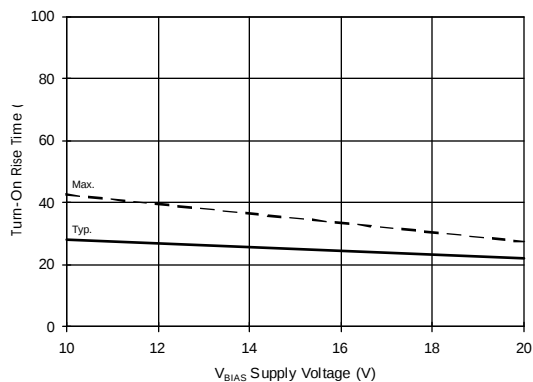
**Figure 9A. Shutdown Time vs. Temperature**



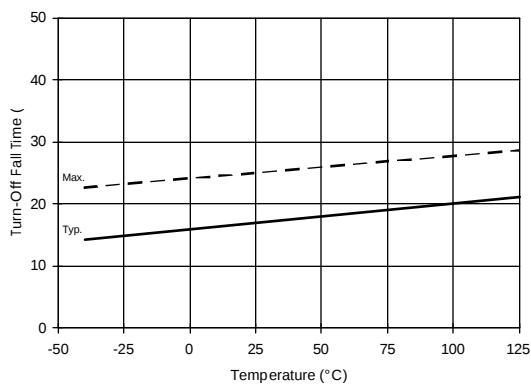
**Figure 9B. Shutdown Time vs. Voltage**



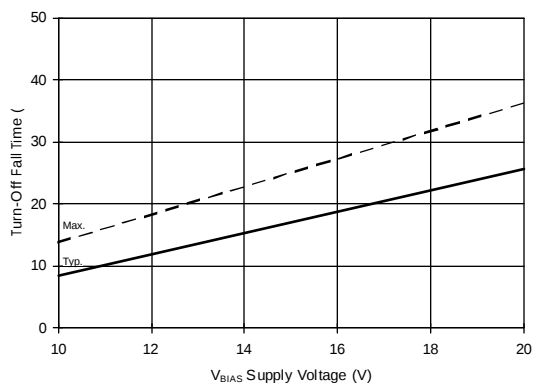
**Figure 10A. Turn-On Rise Time vs. Temperature**



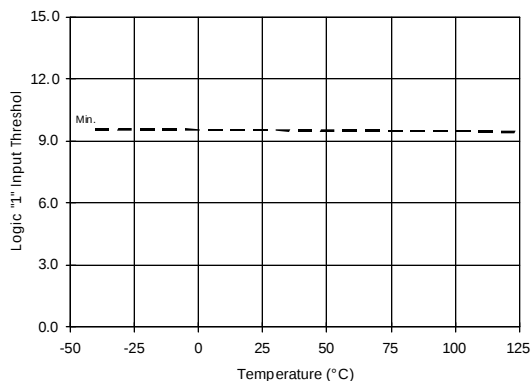
**Figure 10B. Turn-On Rise Time vs. Voltage**



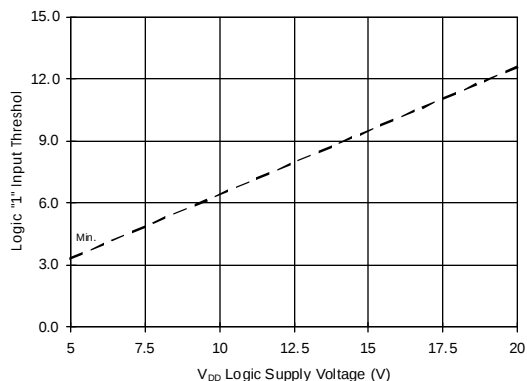
**Figure 11A. Turn-Off Fall Time vs. Temperature**



**Figure 11B. Turn-Off Fall Time vs. Voltage**



**Figure 12A. Logic "1" Input Threshold vs. Temperature**



**Figure 12B. Logic "1" Input Threshold vs. Voltage**

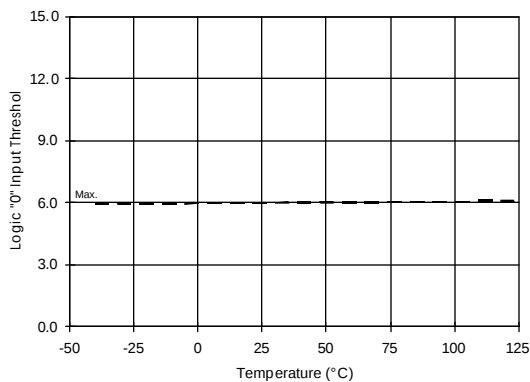


Figure 13A. Logic "0" Input Threshold vs. Temperature

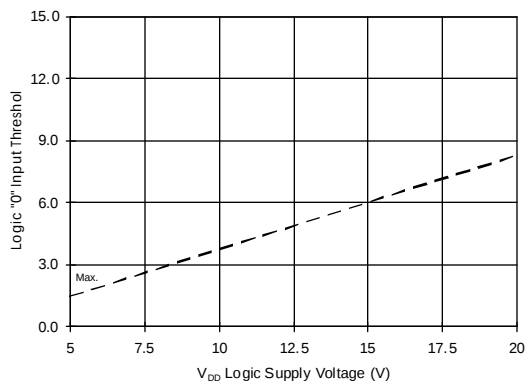


Figure 13B. Logic "0" Input Threshold vs. Voltage

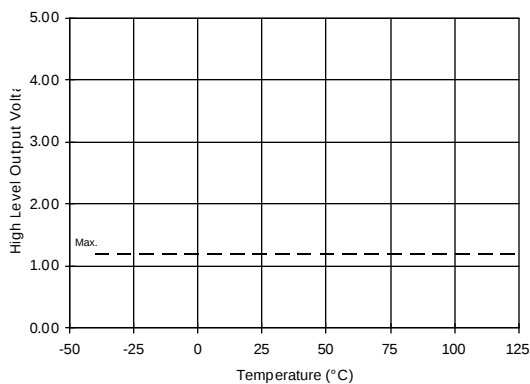


Figure 14A. High Level Output vs. Temperature

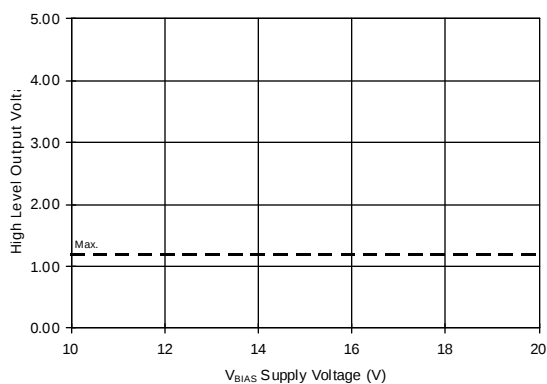


Figure 14B. High Level Output vs. Voltage

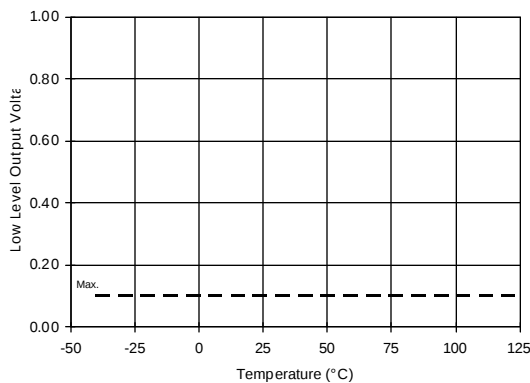


Figure 15A. Low Level Output vs. Temperature

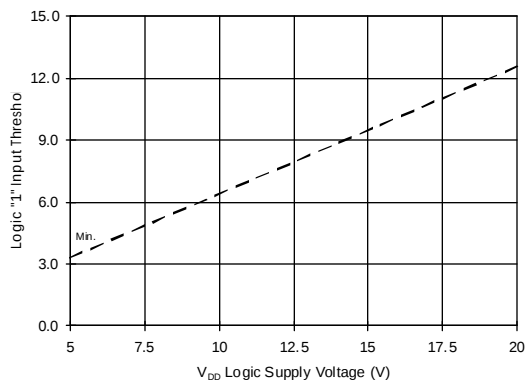


Figure 15B. Low Level Output vs. Voltage

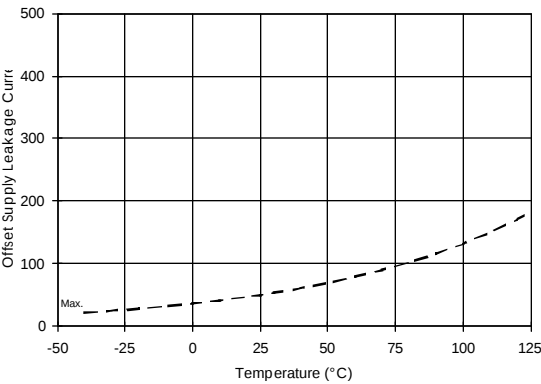


Figure 16A. Offset Supply Current vs. Temperature

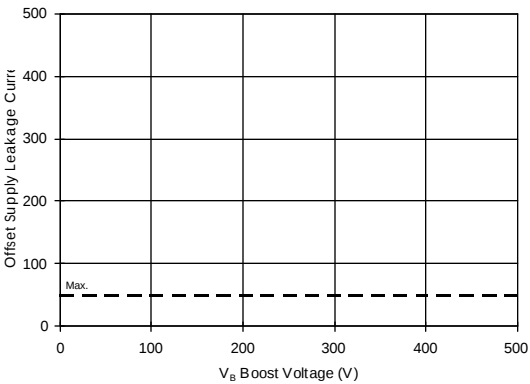


Figure 16B. Offset Supply Current vs. Voltage

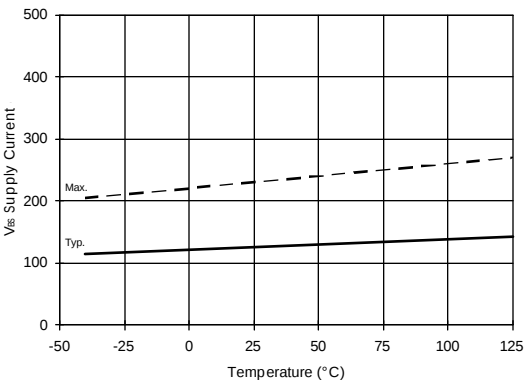


Figure 17A. V<sub>BS</sub> Supply Current vs. Temperature

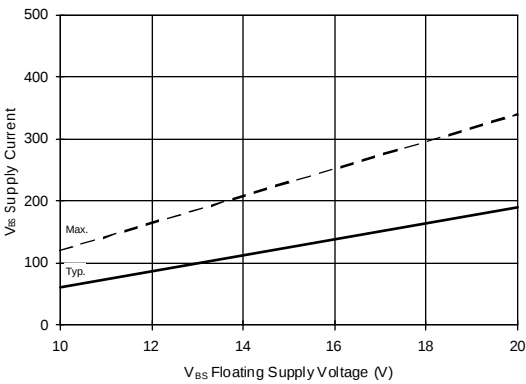


Figure 17B. V<sub>BS</sub> Supply Current vs. Voltage

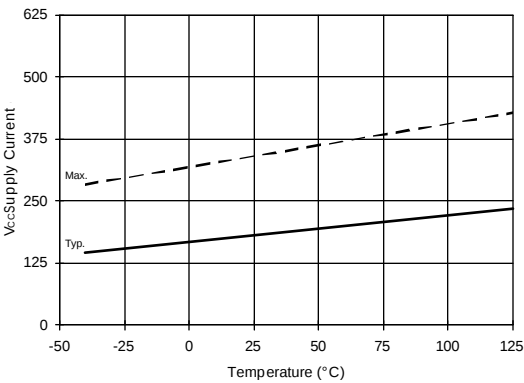


Figure 18A. V<sub>CC</sub> Supply Current vs. Temperature

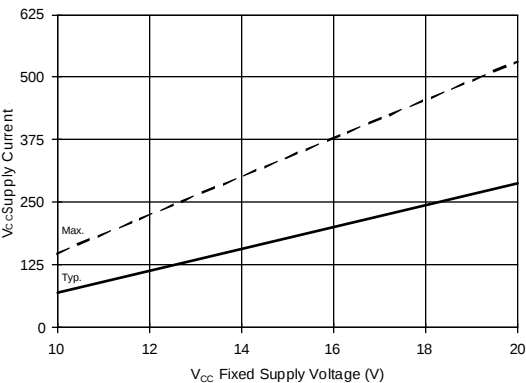
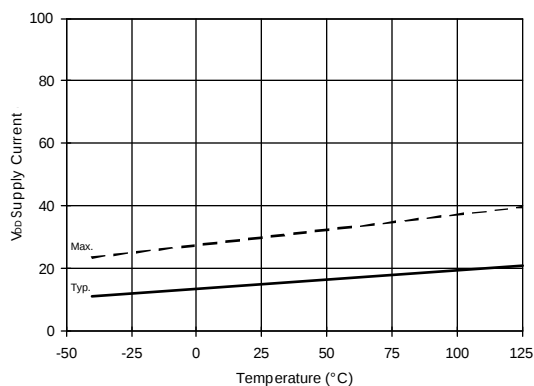
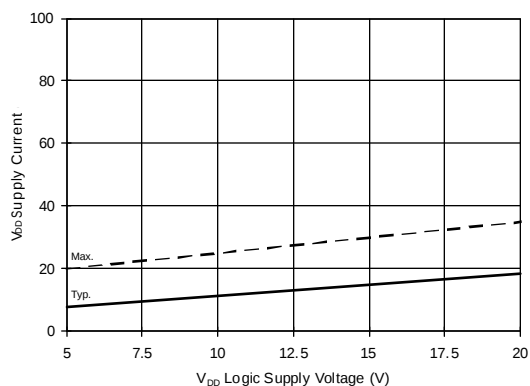


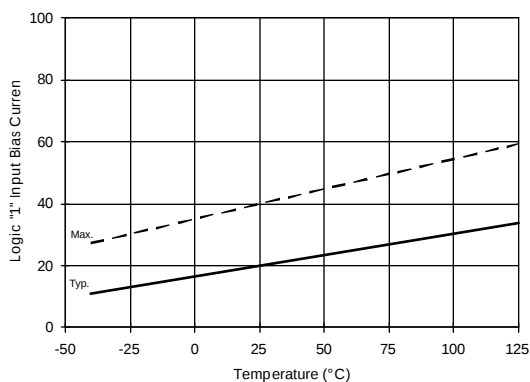
Figure 18B. V<sub>CC</sub> Supply Current vs. Voltage



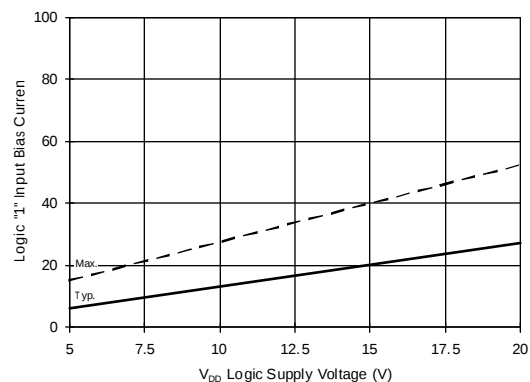
**Figure 19A.  $V_{DD}$  Supply Current vs. Temperature**



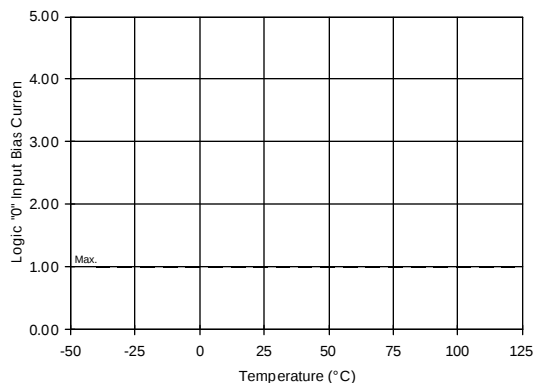
**Figure 19B.  $V_{DD}$  Supply Current vs. Voltage**



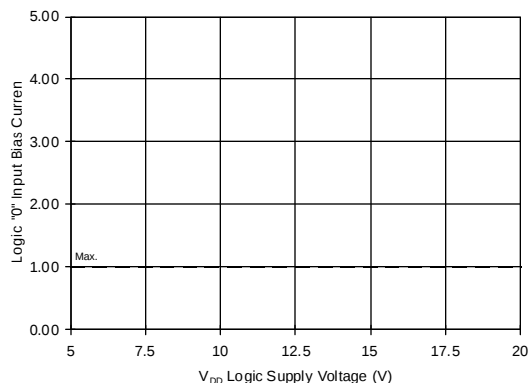
**Figure 20A. Logic "1" Input Current vs. Temperature**



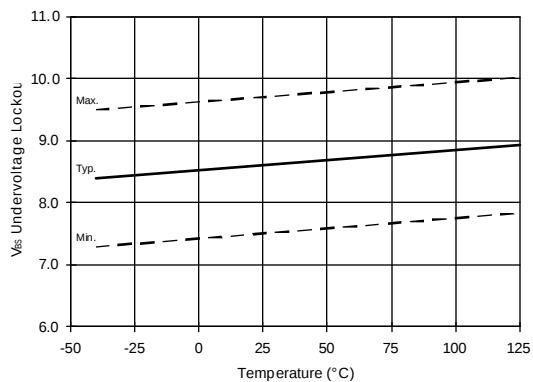
**Figure 20B. Logic "1" Input Current vs. Voltage**



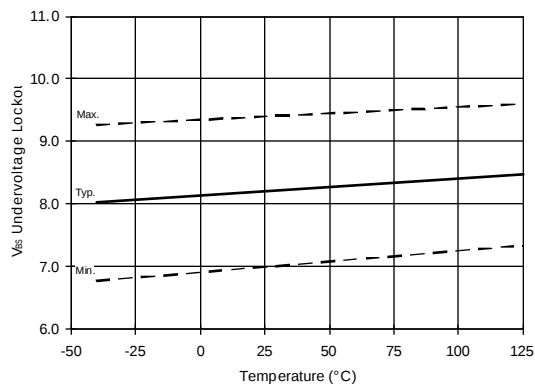
**Figure 21A. Logic "0" Input Current vs. Temperature**



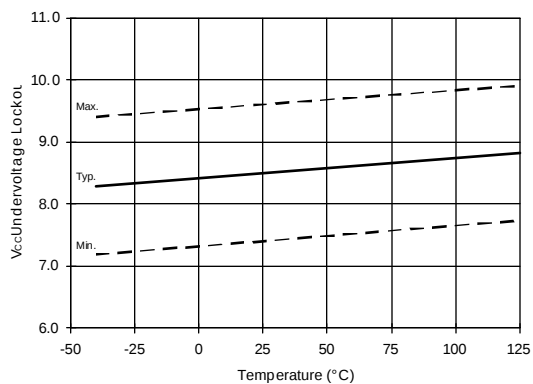
**Figure 21B. Logic "0" Input Current vs. Voltage**



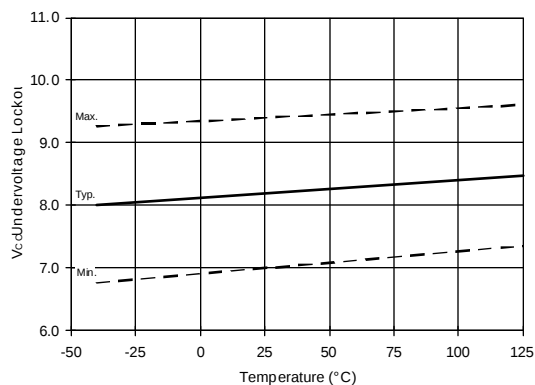
**Figure 22.  $V_{BS}$  Undervoltage (+) vs. Temperature**



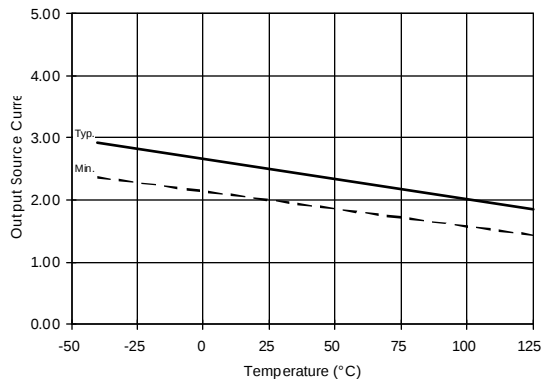
**Figure 23.  $V_{BS}$  Undervoltage (-) vs. Temperature**



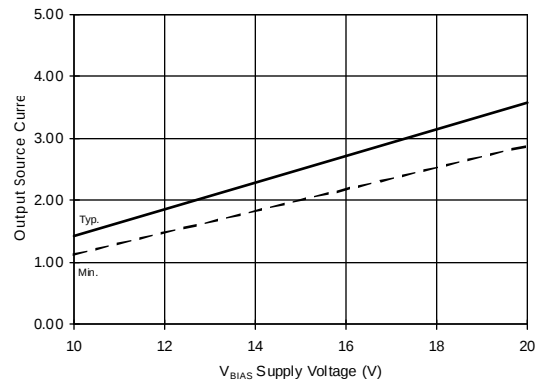
**Figure 24.  $V_{CC}$  Undervoltage (+) vs. Temperature**



**Figure 25.  $V_{CC}$  Undervoltage (-) vs. Temperature**



**Figure 26A. Output Source Current vs. Temperature**



**Figure 26B. Output Source Current vs. Voltage**

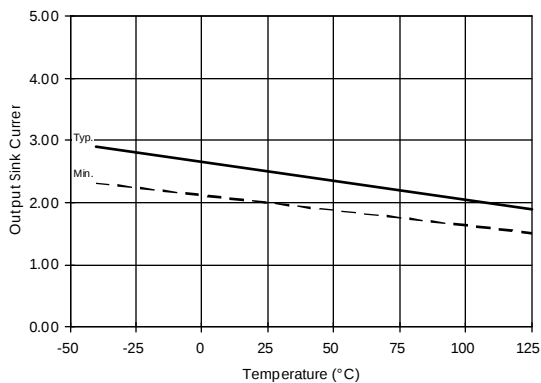


Figure 27A. Output Sink Current vs. Temperature

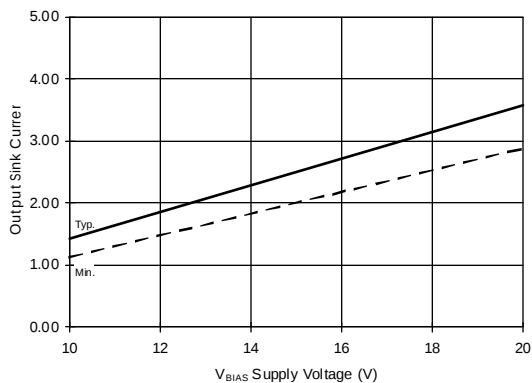


Figure 27B. Output Sink Current vs. Voltage

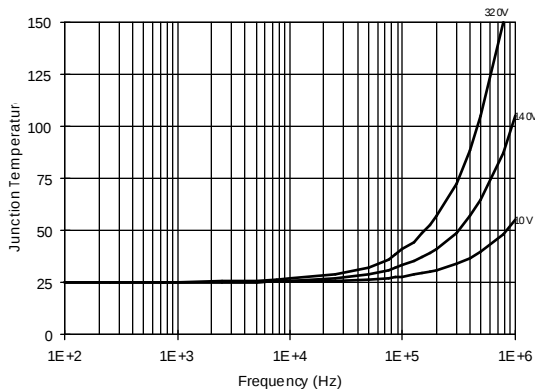


Figure 28. IR2110  $T_J$  vs. Frequency (IRFBC20)  
 $R_{GATE} = 33\Omega$ ,  $V_{CC} = 15V$

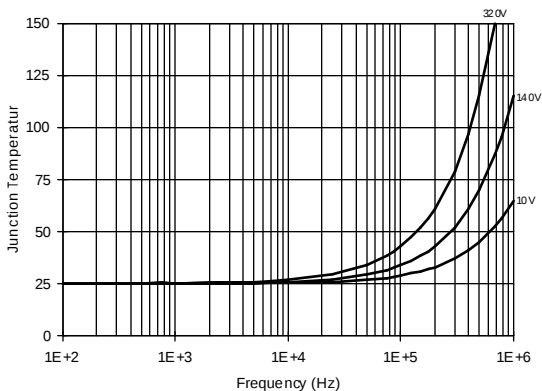


Figure 29. IR2110  $T_J$  vs. Frequency (IRFBC30)  
 $R_{GATE} = 22\Omega$ ,  $V_{CC} = 15V$

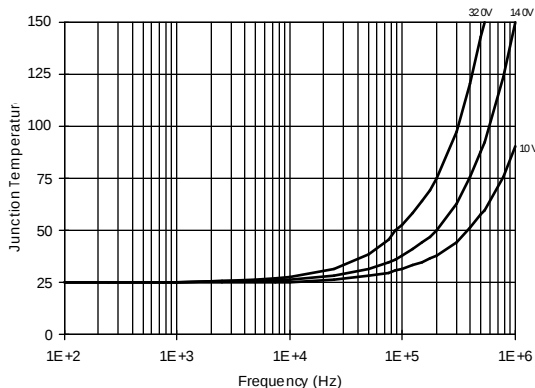


Figure 30. IR2110  $T_J$  vs. Frequency (IRFBC40)  
 $R_{GATE} = 15\Omega$ ,  $V_{CC} = 15V$

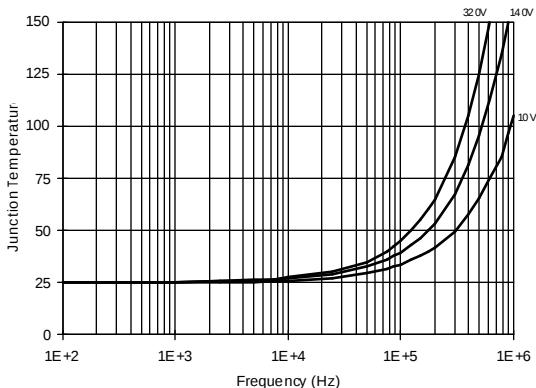
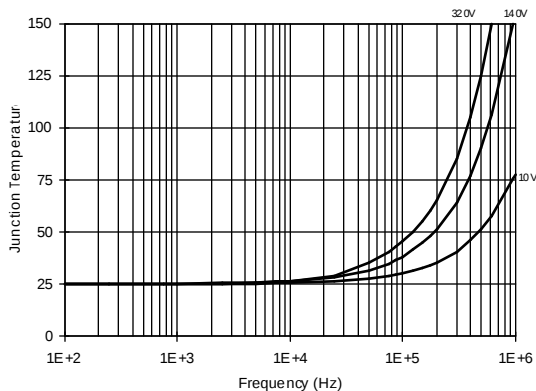
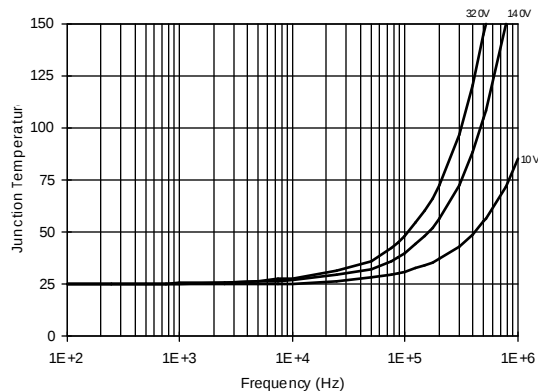


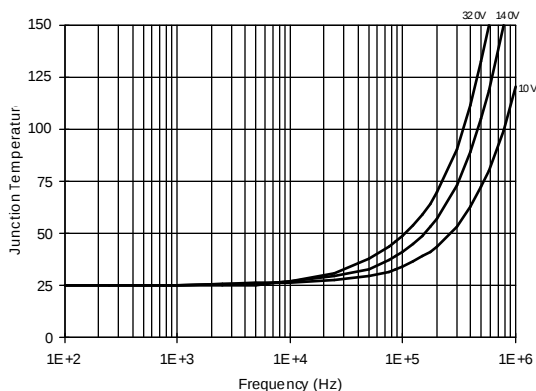
Figure 31. IR2110  $T_J$  vs. Frequency (IRFPE50)  
 $R_{GATE} = 10\Omega$ ,  $V_{CC} = 15V$



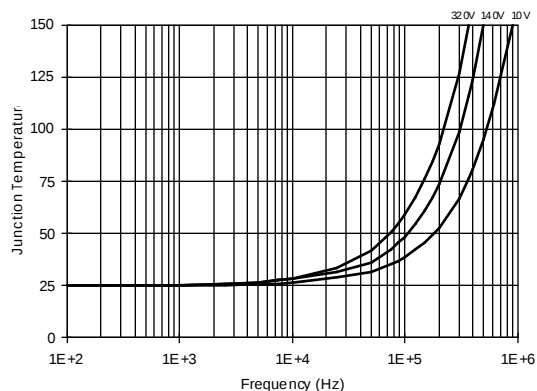
**Figure 32. IR2110S  $T_J$  vs. Frequency (IRFBC20)**  
 $R_{GATE} = 33\Omega$ ,  $V_{CC} = 15V$



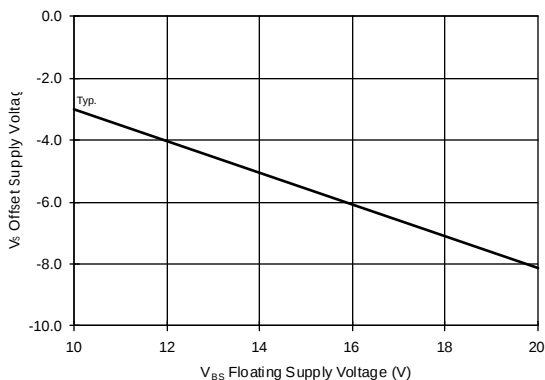
**Figure 33. IR2110S  $T_J$  vs. Frequency (IRFBC30)**  
 $R_{GATE} = 22\Omega$ ,  $V_{CC} = 15V$



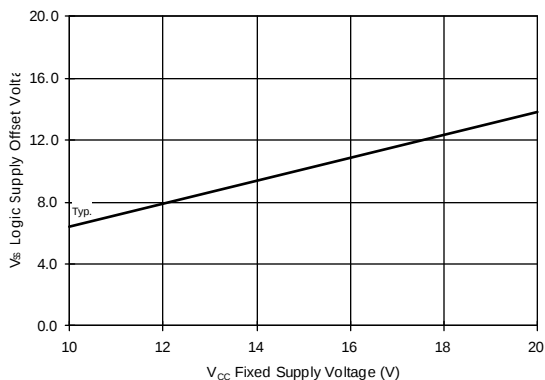
**Figure 34. IR2110S  $T_J$  vs. Frequency (IRFBC40)**  
 $R_{GATE} = 15\Omega$ ,  $V_{CC} = 15V$



**Figure 35. IR2110S  $T_J$  vs. Frequency (IRFPE50)**  
 $R_{GATE} = 10\Omega$ ,  $V_{CC} = 15V$

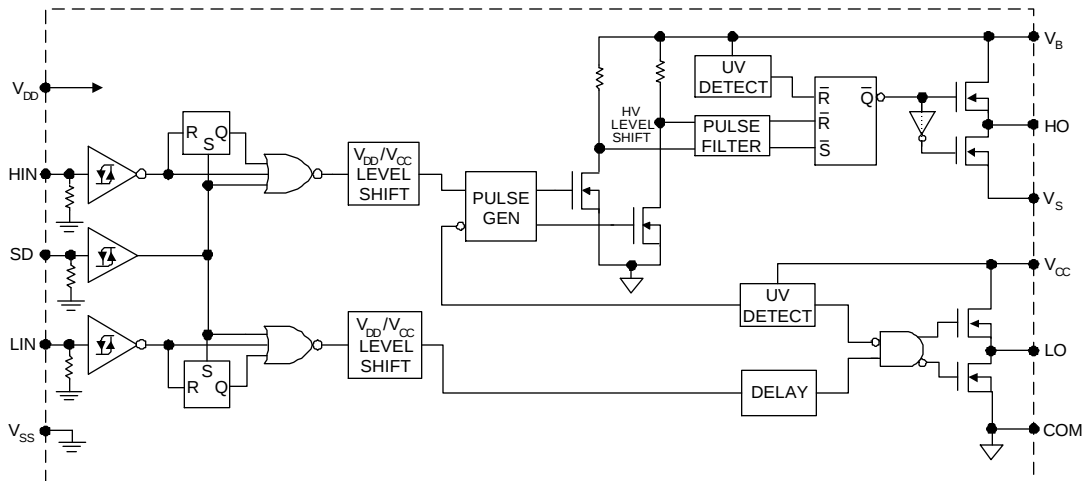


**Figure 36. Maximum  $V_S$  Negative Offset vs.  $V_{BS}$  Supply Voltage**



**Figure 37. Maximum  $V_{SS}$  Positive Offset vs.  $V_{CC}$  Supply Voltage**

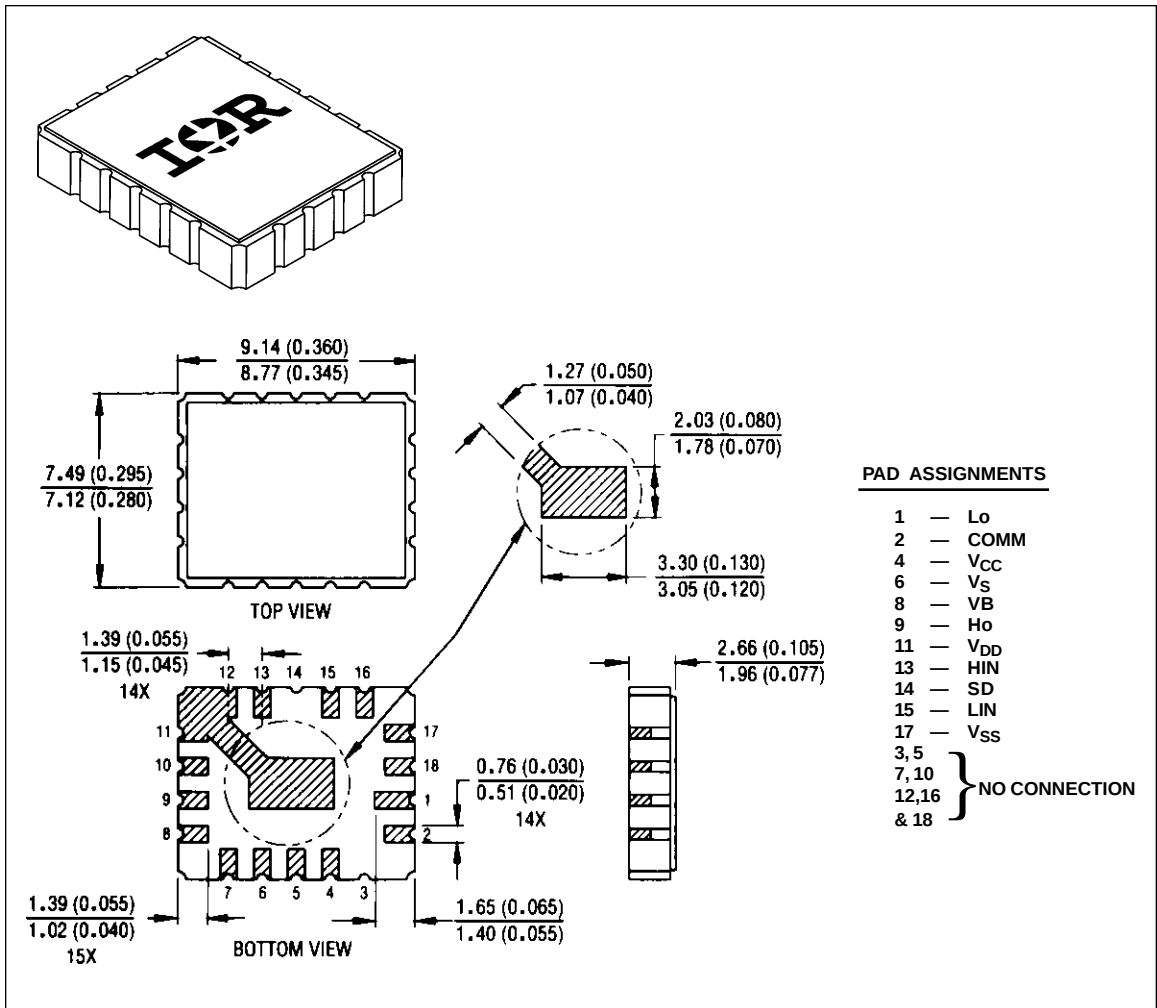
## Functional Block Diagram



## Lead Definitions

| Lead            |                                                             |
|-----------------|-------------------------------------------------------------|
| Symbol          | Description                                                 |
| V <sub>DD</sub> | Logic supply                                                |
| HIN             | Logic input for high side gate driver output (HO), in phase |
| SD              | Logic input for shutdown                                    |
| LIN             | Logic input for low side gate driver output (LO), in phase  |
| V <sub>SS</sub> | Logic ground                                                |
| V <sub>B</sub>  | High side floating supply                                   |
| HO              | High side gate drive output                                 |
| V <sub>S</sub>  | High side floating supply return                            |
| V <sub>CC</sub> | Low side supply                                             |
| LO              | Low side gate drive output                                  |
| COM             | Low side return                                             |

## Case Outline and Dimensions — LCC

International  
**IR** Rectifier**WORLD HEADQUARTERS:** 233 Kansas St., El Segundo, California 90245, Tel: (310) 322 3331**EUROPEAN HEADQUARTERS:** Hurst Green, Oxted, Surrey RH8 9BB, UK Tel: (44) 0883 713215**IR CANADA:** 7321 Victoria Park Ave., Suite 201, Markham, Ontario L3R 3L1, Tel: (905) 475 1897**IR GERMANY:** Saalburgstrasse 157, 61350 Bad Homburg Tel: 6172 37066**IR ITALY:** Via Liguria 49, 10071 Borgaro, Torino Tel: (39) 1145 10111**IR FAR EAST:** K&H Bldg., 2F, 3-30-4 Nishi-Ikeburo 3-Chome, Toshima-Ki, Tokyo 171 Tel: (03)3983 0641**IR SOUTHEAST ASIA:** 315 Outram Road, #10-02 Tan Boon Liat Building, Singapore 0316 Tel: 65 221 8371<http://www.irf.com/>

Data and specifications subject to change without notice. 9/96