

# IR2121

## CURRENT LIMITING LOW SIDE DRIVER

### Features

- Gate drive supply range from 12 to 18V
- Undervoltage lockout
- Current detection and limiting loop to limit driven power transistor current
- Error lead indicates fault conditions and programs shutdown time
- Output in phase with input

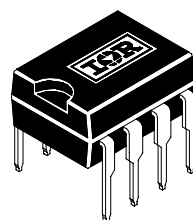
### Description

The IR2121 is a high speed power MOSFET and IGBT driver with over-current limiting protection circuitry. Latch immune CMOS technology enables ruggedized monolithic construction. Logic inputs are compatible with standard CMOS or LSTTL outputs. The output driver features a high pulse current buffer stage designed for minimum cross-conduction. The protection circuitry detects over-current in the driven power transistor and limits the gate drive voltage. Cycle-by-cycle shutdown is programmed by an external capacitor which directly controls the time interval between detection of the over-current limiting condition and latched shutdown. The output can be used to drive an N-channel power MOSFET or IGBT in the low side configuration.

### Product Summary

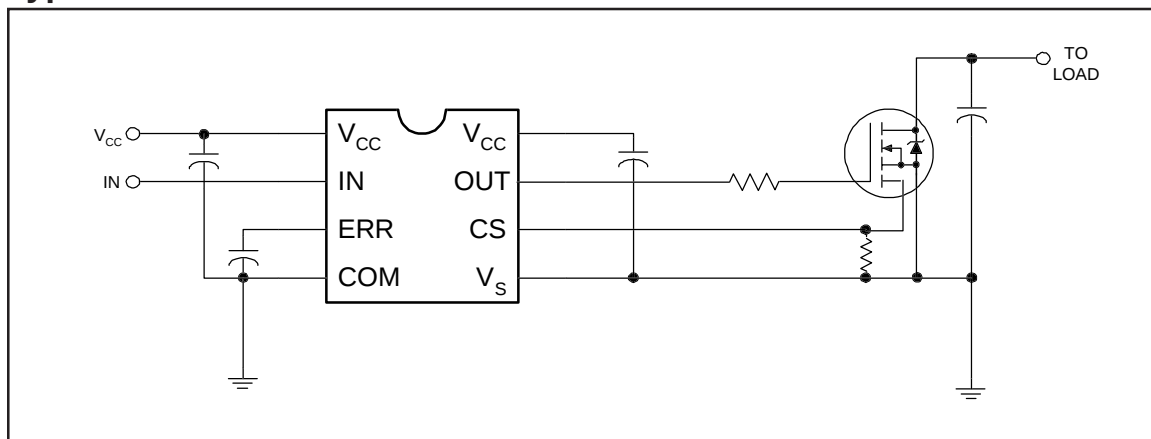
|                            |              |
|----------------------------|--------------|
| $V_{\text{OFFSET}}$        | 5V max.      |
| $I_{\text{O+/-}}$          | 1A / 2A      |
| $V_{\text{OUT}}$           | 12 - 18V     |
| $V_{\text{Csth}}$          | 230 mV       |
| $t_{\text{on/off (typ.)}}$ | 150 & 150 ns |

### Package



8 Lead PDIP

### Typical Connection



## 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.

| Symbol            | Parameter<br>Definition                            | Value                |                       | Units |
|-------------------|----------------------------------------------------|----------------------|-----------------------|-------|
|                   |                                                    | Min.                 | Max.                  |       |
| V <sub>CC</sub>   | Fixed Supply Voltage                               | -0.3                 | 25                    | V     |
| V <sub>S</sub>    | Gate Drive Return Voltage                          | V <sub>CC</sub> - 25 | V <sub>CC</sub> + 0.3 |       |
| V <sub>O</sub>    | Output Voltage                                     | V <sub>S</sub> - 0.3 | V <sub>CC</sub> + 0.3 |       |
| V <sub>IN</sub>   | Logic Input Voltage                                | -0.3                 | V <sub>CC</sub> + 0.3 |       |
| V <sub>ERR</sub>  | Error Signal Voltage                               | -0.3                 | V <sub>CC</sub> + 0.3 |       |
| V <sub>CS</sub>   | Current Sense Voltage                              | V <sub>S</sub> - 0.3 | V <sub>CC</sub> + 0.3 |       |
| P <sub>D</sub>    | Package Power Dissipation @ T <sub>A</sub> ≤ +25°C | —                    | 1.0                   | W     |
| R <sub>thJA</sub> | Thermal Resistance, Junction to Ambient            | —                    | 125                   | °C/W  |
| T <sub>J</sub>    | Junction Temperature                               | —                    | 150                   | °C    |
| T <sub>S</sub>    | Storage Temperature                                | -55                  | 150                   |       |
| T <sub>L</sub>    | Lead Temperature (Soldering, 10 seconds)           | —                    | 300                   |       |

## 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<sub>S</sub> offset rating is tested with all supplies biased at 15V differential.

| Symbol           | Parameter<br>Definition      | Value               |                     | Units |
|------------------|------------------------------|---------------------|---------------------|-------|
|                  |                              | Min.                | Max.                |       |
| V <sub>CC</sub>  | Fixed Supply Voltage         | V <sub>S</sub> + 12 | V <sub>S</sub> + 18 | V     |
| V <sub>S</sub>   | Gate Drive Return Voltage    | -5                  | 5                   |       |
| V <sub>O</sub>   | Output Voltage               | V <sub>S</sub>      | V <sub>CC</sub>     |       |
| V <sub>IN</sub>  | Logic Input Voltage          | 0                   | V <sub>CC</sub>     |       |
| V <sub>ERR</sub> | Error Signal Voltage         | 0                   | V <sub>CC</sub>     |       |
| V <sub>CS</sub>  | Current Sense Signal Voltage | V <sub>S</sub>      | V <sub>CC</sub>     |       |
| T <sub>A</sub>   | Ambient Temperature          | -40                 | 125                 | °C    |

## Dynamic Electrical Characteristics

$V_{BIAS} (V_{CC}) = 15V$ ,  $C_L = 3300 \text{ pF}$  and  $T_A = 25^\circ\text{C}$  unless otherwise specified. The dynamic electrical characteristics are defined in Figures 2 through 5.

| Symbol    | Parameter Definition                | Figure | Value |      |      | Units         | Test Conditions             |
|-----------|-------------------------------------|--------|-------|------|------|---------------|-----------------------------|
|           |                                     |        | Min.  | Typ. | Max. |               |                             |
| $t_{on}$  | Turn-On Propagation Delay           | 7      | —     | 150  | 200  | ns            | $V_{IN} = 0 \text{ \& } 5V$ |
| $t_{off}$ | Turn-Off Propagation Delay          | 8      | —     | 150  | 190  |               |                             |
| $t_{sd}$  | ERR Shutdown Propagation Delay      | 9      | —     | 1.7  | 2.2  | $\mu\text{s}$ |                             |
| $t_r$     | Turn-On Rise Time                   | 10     | —     | 43   | 60   | ns            |                             |
| $t_f$     | Turn-Off Fall Time                  | 11     | —     | 26   | 35   |               |                             |
| $t_{cs}$  | CS Shutdown Propagation Delay       | 12     | —     | 0.7  | 1.2  | $\mu\text{s}$ |                             |
| $t_{err}$ | CS to ERR Pull-Up Propagation Delay | 13     | —     | 9.0  | 12   |               | $C_{ERR} = 270 \text{ pF}$  |

## Static Electrical Characteristics

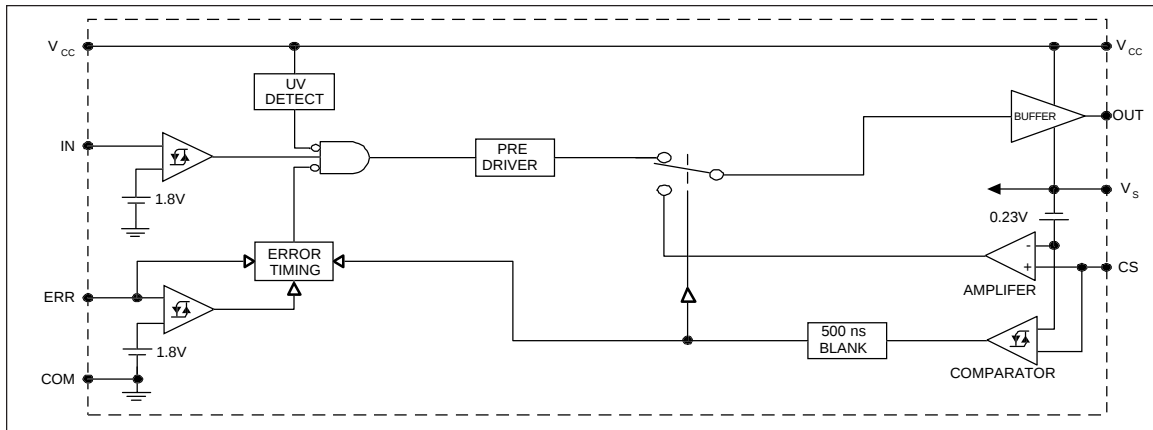
$V_{BIAS} (V_{CC}) = 15V$  and  $T_A = 25^\circ\text{C}$  unless otherwise specified. The  $V_{IN}$ ,  $V_{TH}$  and  $I_{IN}$  parameters are referenced to COM. The  $V_O$  and  $I_O$  parameters are referenced to  $V_S$ .

| Symbol      | Parameter Definition                                  | Figure | Value |      |      | Units         | Test Conditions                                      |
|-------------|-------------------------------------------------------|--------|-------|------|------|---------------|------------------------------------------------------|
|             |                                                       |        | Min.  | Typ. | Max. |               |                                                      |
| $V_{IH}$    | Logic "1" Input Voltage                               | 14     | 2.2   | —    | —    | V             |                                                      |
| $V_{IL}$    | Logic "0" Input Voltage                               | 15     | —     | —    | 0.8  |               |                                                      |
| $V_{CSTH+}$ | CS Input Positive Going Threshold                     | 16     | 150   | 230  | 320  | mV            |                                                      |
| $V_{CSTH-}$ | CS Input Negative Going Threshold                     | 17     | 130   | 200  | 260  |               |                                                      |
| $V_{OH}$    | High Level Output Voltage, $V_{BIAS} - V_O$           | 18     | —     | —    | 100  |               | $I_O = 0A$                                           |
| $V_{OL}$    | Low Level Output Voltage, $V_O$                       | 19     | —     | —    | 100  |               | $I_O = 0A$                                           |
| $I_{QCC}$   | Quiescent VCC Supply Current                          | 20     | —     | 1.1  | 2.2  | $\text{mA}$   | $V_{IN} = V_{CS} = 0V \text{ or } 5V$                |
| $I_{IN+}$   | Logic "1" Input Bias Current                          | 21     | —     | 4.5  | 10   | $\mu\text{A}$ | $V_{IN} = 5V$                                        |
| $I_{IN-}$   | Logic "0" Input Bias Current                          | 22     | —     | —    | 1.0  |               | $V_{IN} = 0V$                                        |
| $I_{CS+}$   | "High" CS Bias Current                                | 23     | —     | 4.5  | 10   |               | $V_{CS} = 3V \text{ or } 5V$                         |
| $I_{CS-}$   | "Low" CS Bias Current                                 | 24     | —     | —    | 1.0  |               | $V_{CS} = 0V$                                        |
| $V_{CCUV+}$ | $V_{CC}$ Supply Undervoltage Positive Going Threshold | 25     | 8.3   | 8.9  | 9.6  | V             |                                                      |
| $V_{CCUV-}$ | $V_{CC}$ Supply Undervoltage Negative Going Threshold | 26     | 7.3   | 8.0  | 8.7  |               |                                                      |
| $I_{ERR}$   | ERR Timing Charge Current                             | 27     | 65    | 100  | 130  | $\mu\text{A}$ | $V_{IN} = 5V, V_{CS} = 3V$<br>$ERR < V_{ERR+}$       |
| $I_{ERR+}$  | ERR Pull-Up Current                                   | 28     | 8.0   | 15   | —    | $\text{mA}$   | $V_{IN} = 5V, V_{CS} = 3V$<br>$ERR > V_{ERR+}$       |
| $I_{ERR-}$  | ERR Pull-Down Current                                 | 29     | 16    | 30   | —    |               | $V_{IN} = 0V$                                        |
| $I_{O+}$    | Output High Short Circuit Pulsed Current              | 30     | 1.0   | 1.6  | —    | A             | $V_O = 0V, V_{IN} = 5V$<br>$PW \leq 10 \mu\text{s}$  |
| $I_{O-}$    | Output Low Short Circuit Pulsed Current               | 31     | 2.0   | 3.3  | —    |               | $V_O = 15V, V_{IN} = 0V$<br>$PW \leq 10 \mu\text{s}$ |

# IR2121

International  
**IR** Rectifier

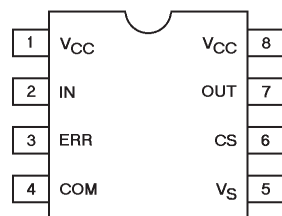
## Functional Block Diagram



## Lead Definitions

| Symbol          | Description                                                                                       |
|-----------------|---------------------------------------------------------------------------------------------------|
| V <sub>CC</sub> | Logic and gate drive supply                                                                       |
| IN              | Logic input for gate driver output (OUT), in phase with OUT                                       |
| ERR             | Serves multiple functions; status reporting, linear mode timing and cycle by cycle logic shutdown |
| COM             | Logic ground                                                                                      |
| OUT             | Gate drive output                                                                                 |
| V <sub>S</sub>  | Gate drive supply return                                                                          |
| CS              | Current sense input to current sense comparator                                                   |

## Lead Assignments



8 Lead PDIP

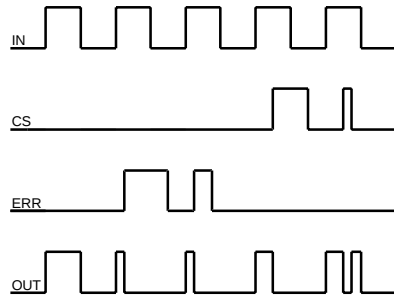


Figure 1. Input/Output Timing Diagram

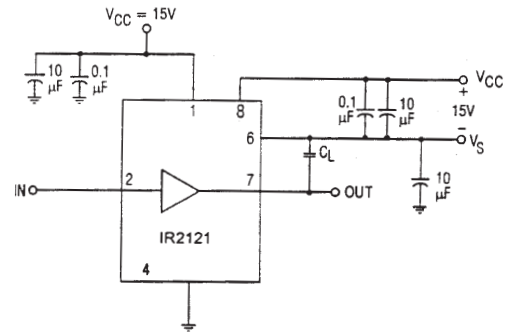


Figure 2. Switching Time Test Circuit

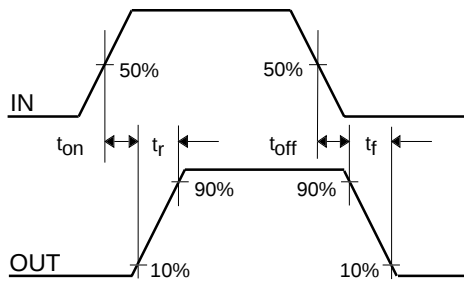


Figure 3. Switching Time Waveform Definitions

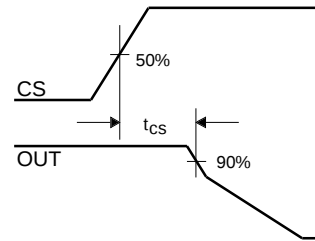


Figure 4. ERR Shutdown Waveform Definitions

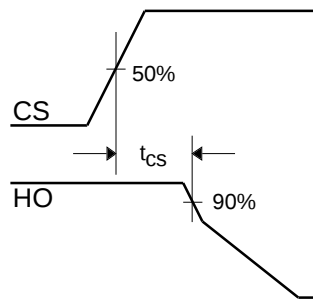


Figure 5. CS Shutdown Waveform Definitions

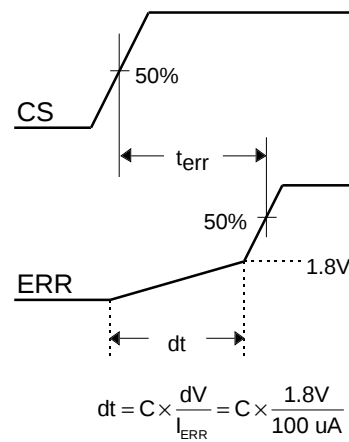
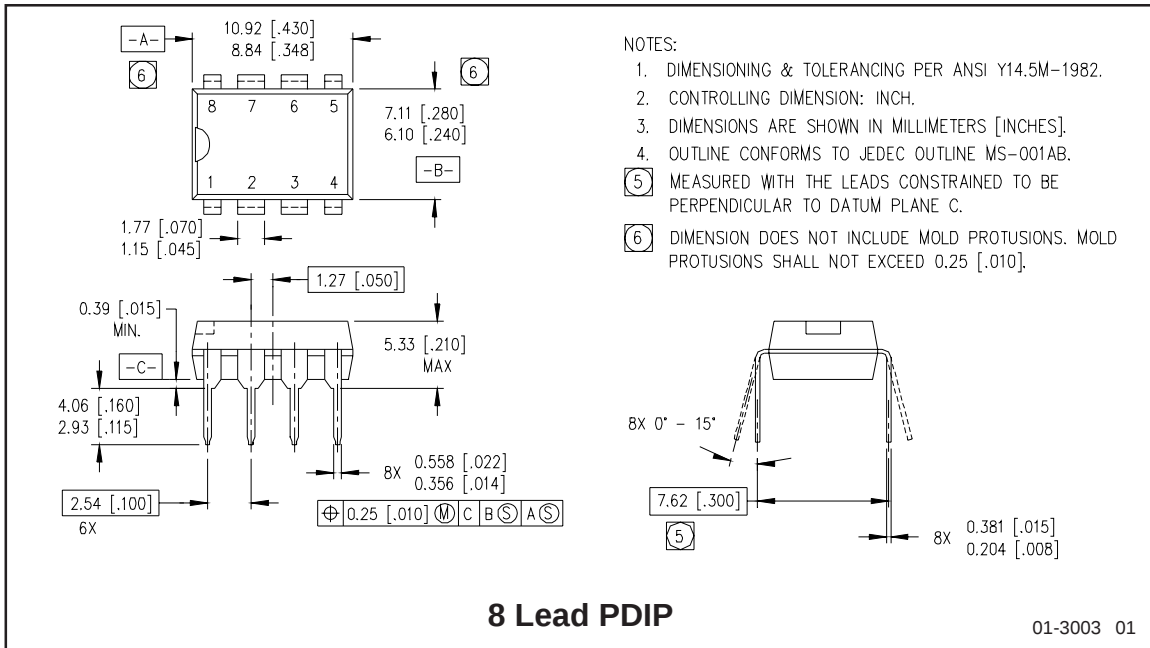


Figure 6. CS to ERR Waveform Definitions



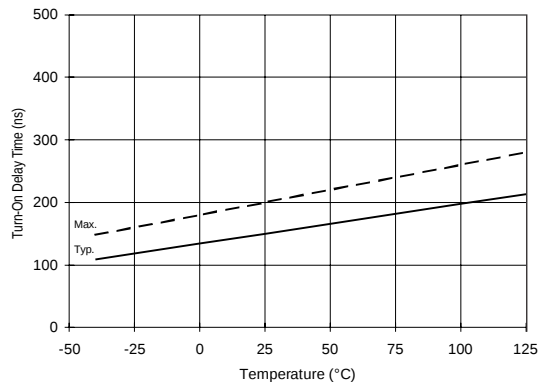


Figure 7A. Turn-On Time vs. Temperature

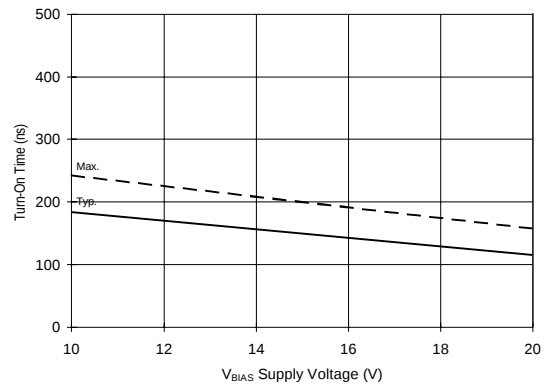


Figure 7B. Turn-On Time vs. Voltage

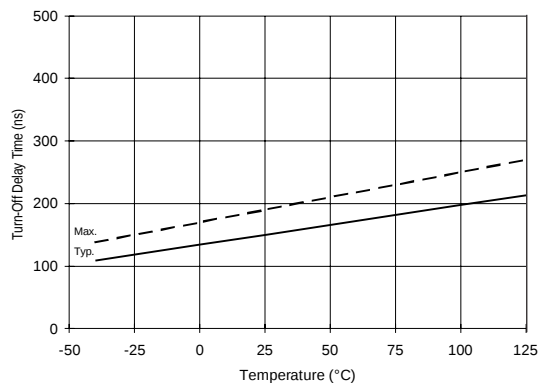


Figure 8A. Turn-Off Time vs. Temperature

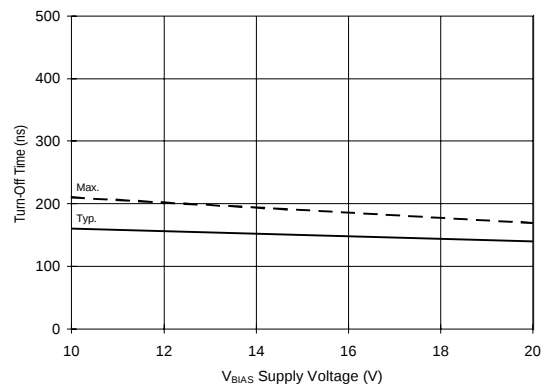


Figure 8B. Turn-Off Time vs. Voltage

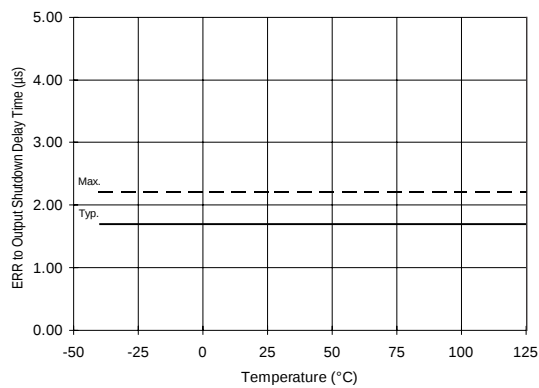


Figure 9A. ERR to Output Shutdown vs. Temperature

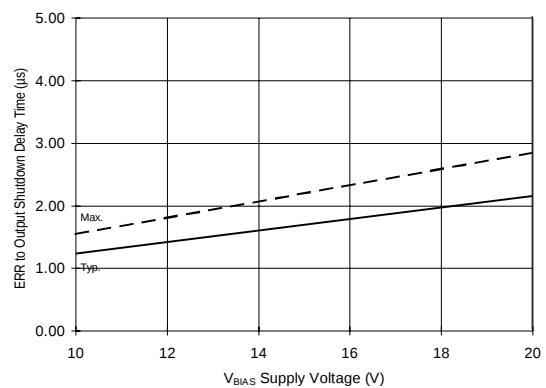


Figure 9B. ERR to Output Shutdown vs. Voltage

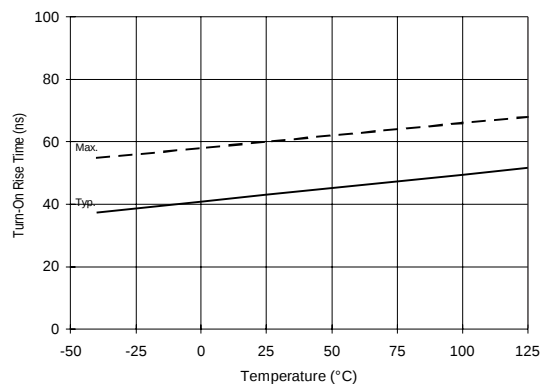


Figure 10A. Turn-On Rise Time vs. Temperature

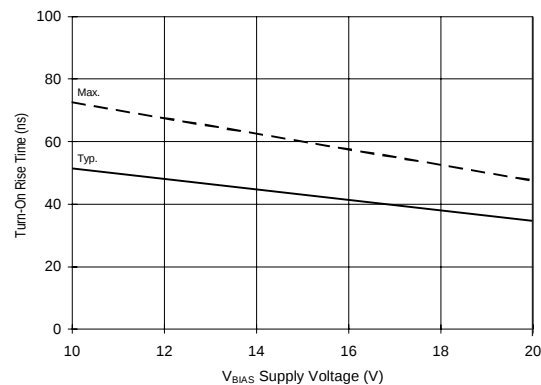


Figure 10B. Turn-On Rise Time vs. Voltage

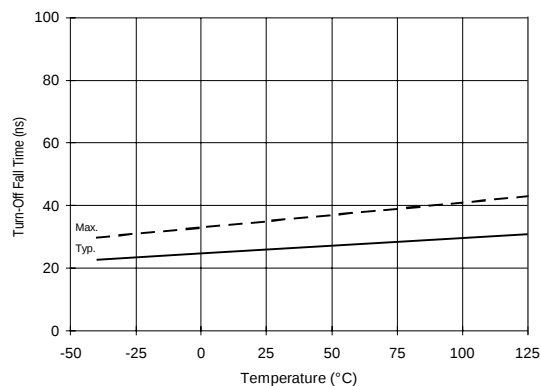


Figure 11A. Turn-Off Fall Time vs. Temperature

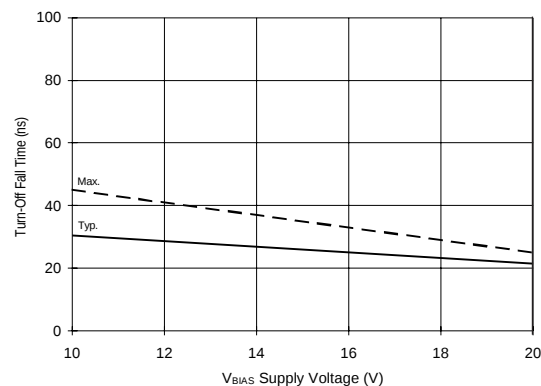


Figure 11B. Turn-Off Fall Time vs. Voltage

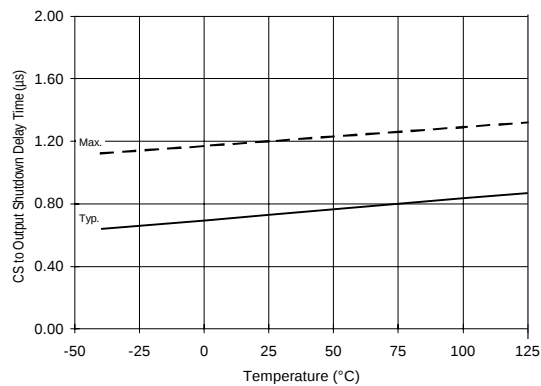


Figure 12A. CS to Output Shutdown vs. Temperature

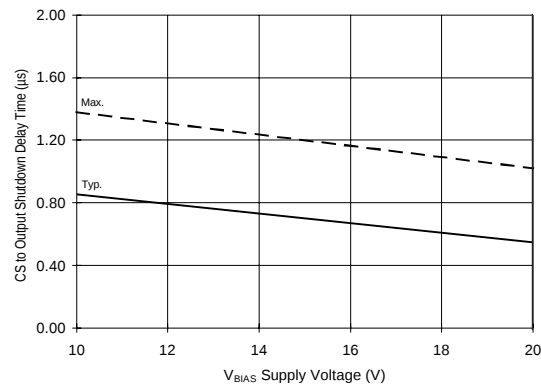


Figure 12B. CS to Output Shutdown vs. Voltage

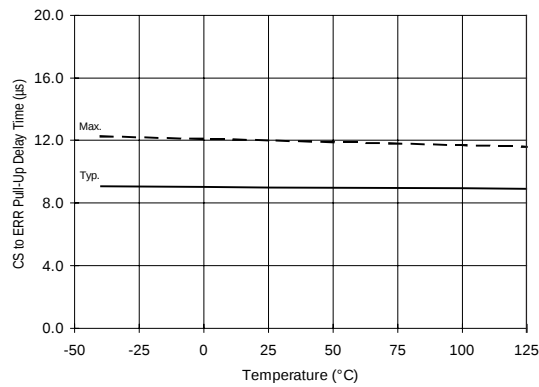


Figure 13A. CS to ERR Pull-Up vs. Temperature

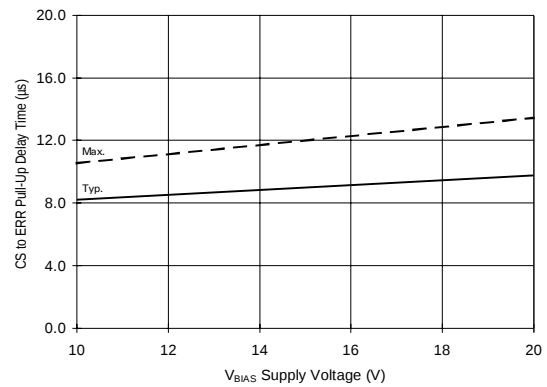


Figure 13B. CS to ERR Pull-Up vs. Voltage

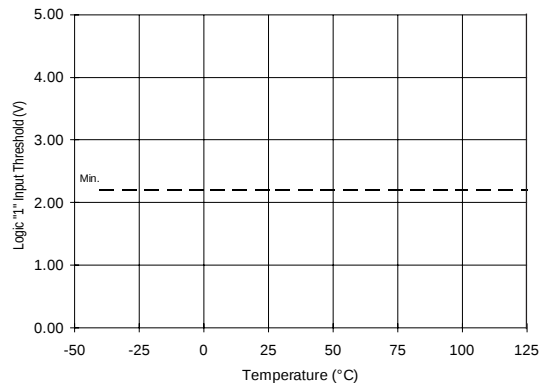


Figure 14A. Logic "1" Input Threshold vs. Temperature

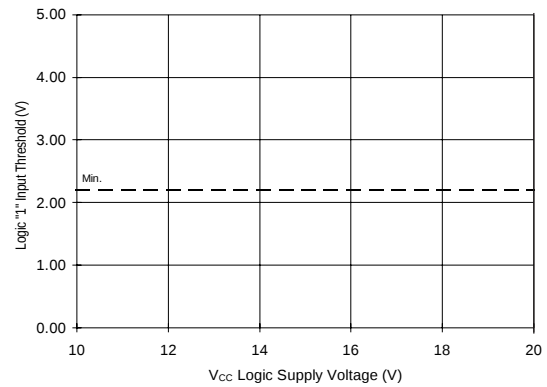


Figure 14B. Logic "1" Input Threshold vs. Voltage

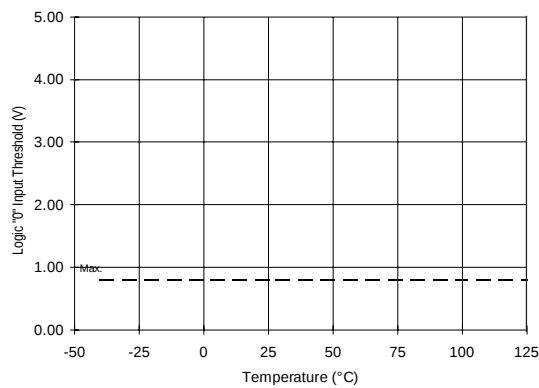


Figure 15A. Logic "0" Input Threshold vs. Temperature

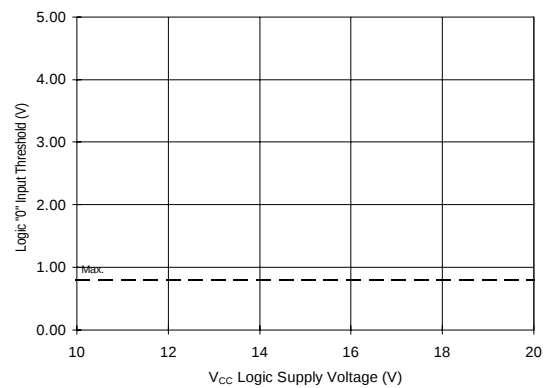


Figure 15B. Logic "0" Input Threshold vs. Voltage

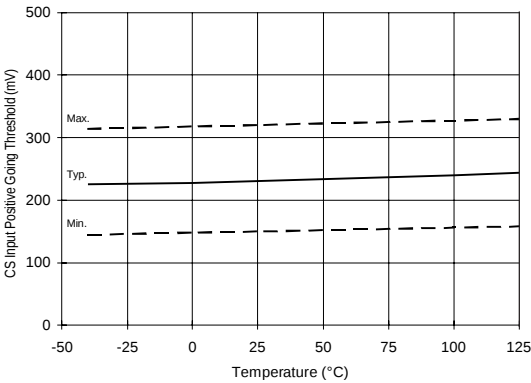


Figure 16A. CS Input Threshold (+) vs. Temperature

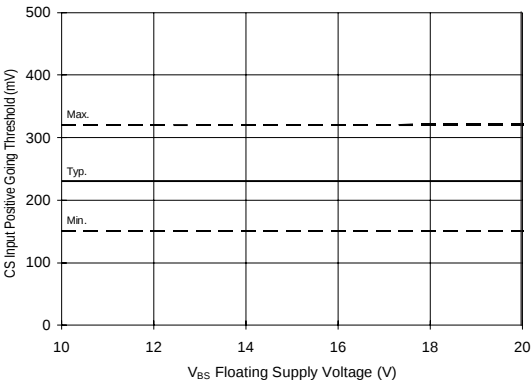


Figure 16B. CS Input Threshold (+) vs. Voltage

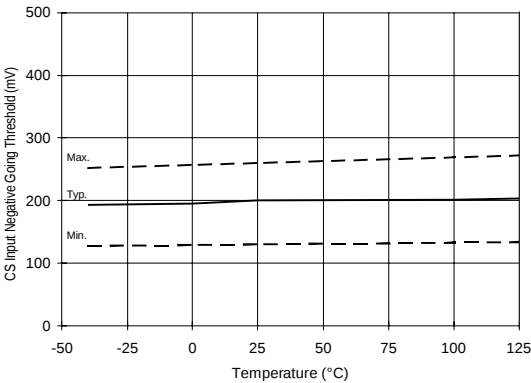


Figure 17A. CS Input Threshold (-) vs. Temperature

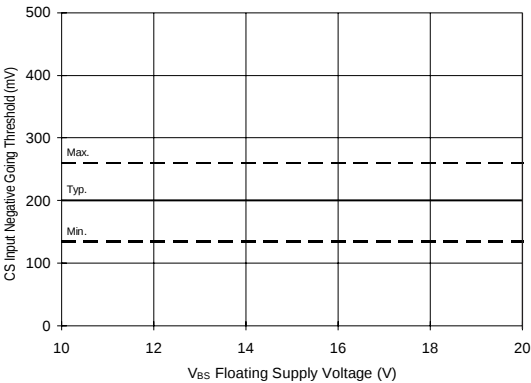


Figure 17B. CS Input Threshold (-) vs. Voltage

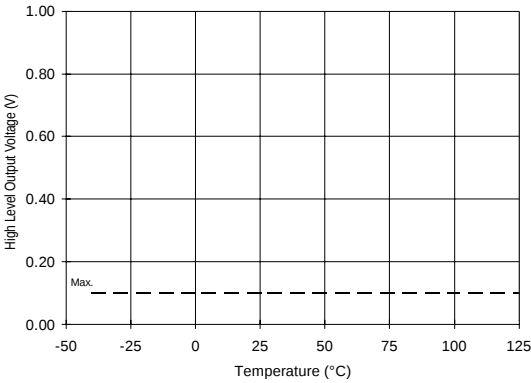


Figure 18A. High Level Output vs. Temperature

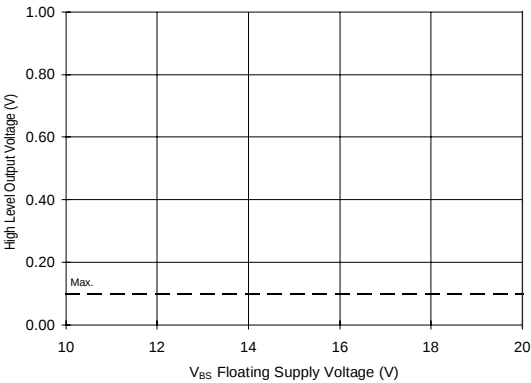


Figure 18B. High Level Output vs. Voltage

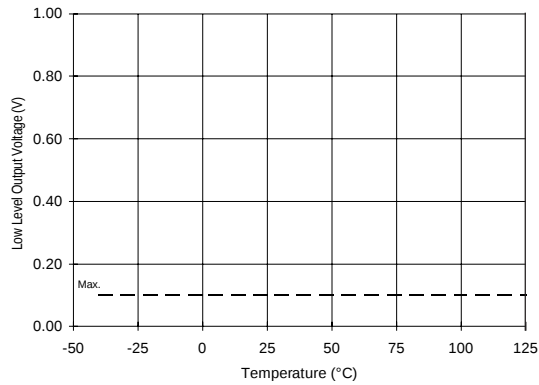


Figure 19A. Low Level Output vs. Temperature

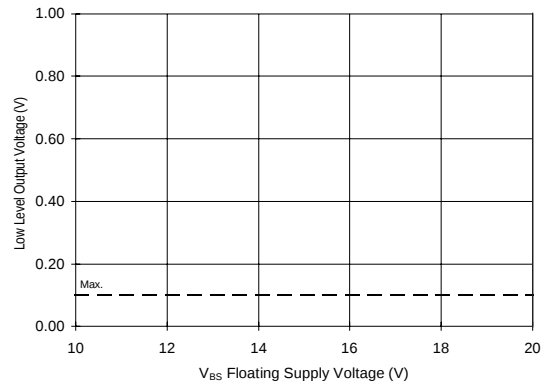


Figure 19B. Low Level Output vs. Voltage

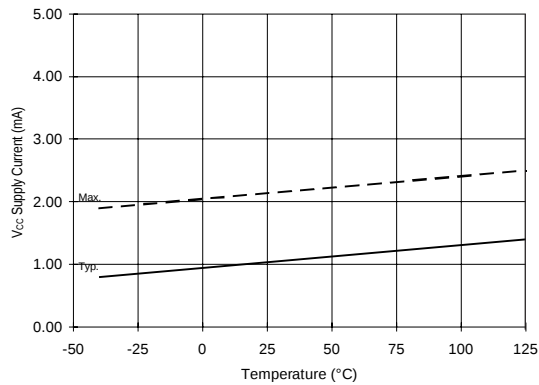


Figure 20A. V<sub>CC</sub> Supply Current vs. Temperature

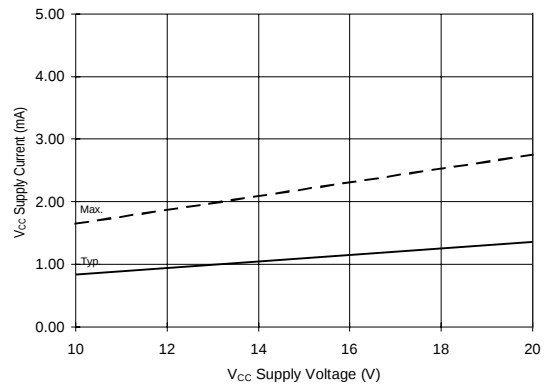


Figure 20B. V<sub>CC</sub> Supply Current vs. Voltage

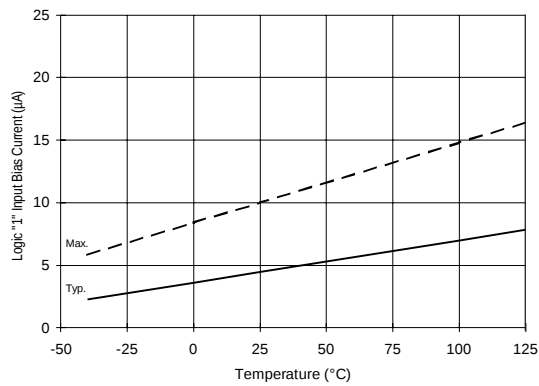


Figure 21A. Logic "1" Input Current vs. Temperature

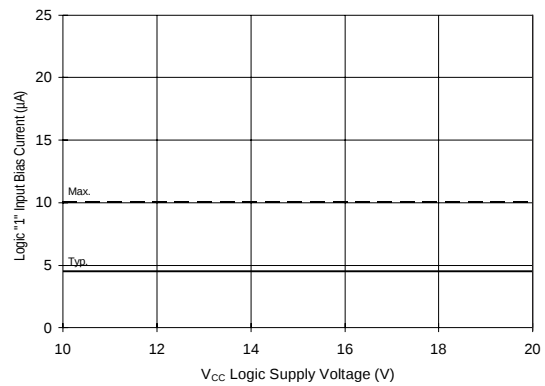


Figure 21B. Logic "1" Input Current vs. Voltage

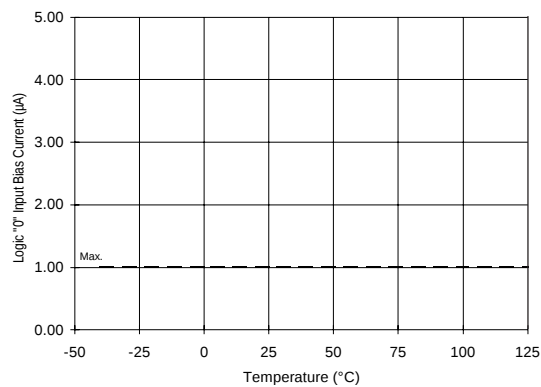


Figure 22A. Logic "0" Input Current vs. Temperature

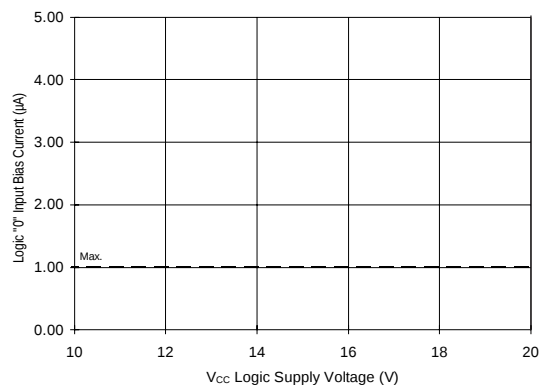


Figure 22B. Logic "0" Input Current vs. Voltage

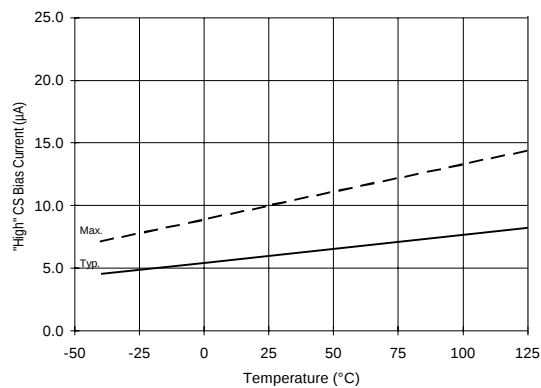


Figure 23A. "High" CS Bias Current vs. Temperature

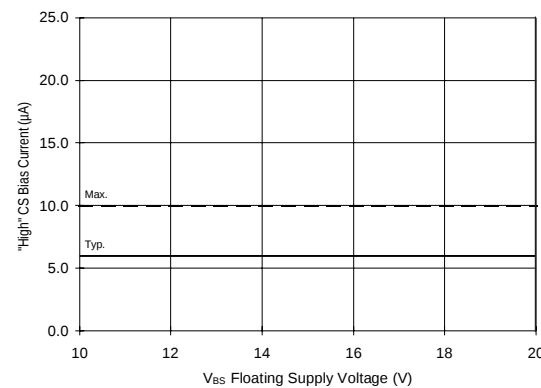


Figure 23B. "High" CS Bias Current vs. Voltage

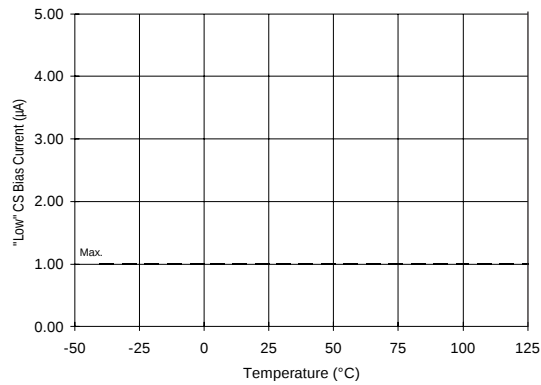


Figure 24A. "Low" CS Bias Current vs. Temperature

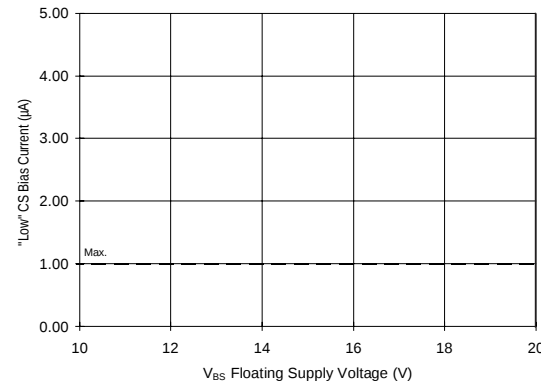
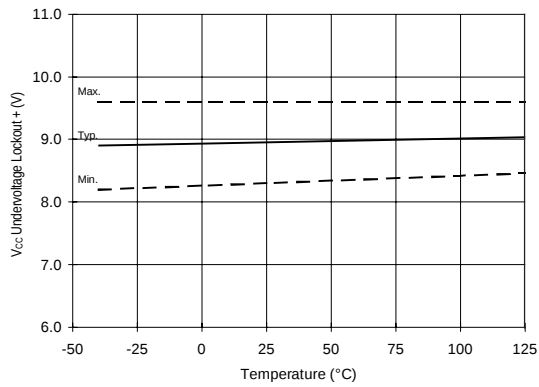
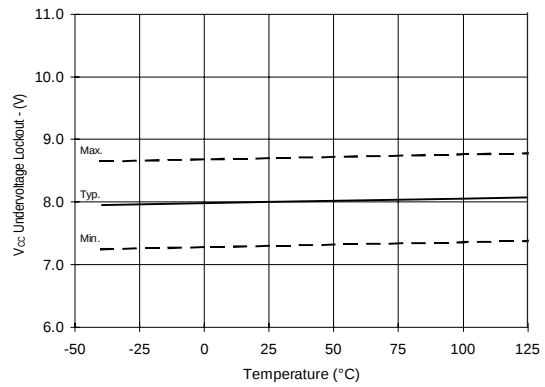


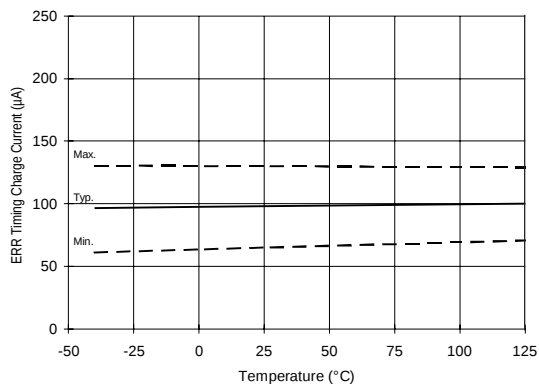
Figure 24B. "Low" CS Bias Current vs. Voltage



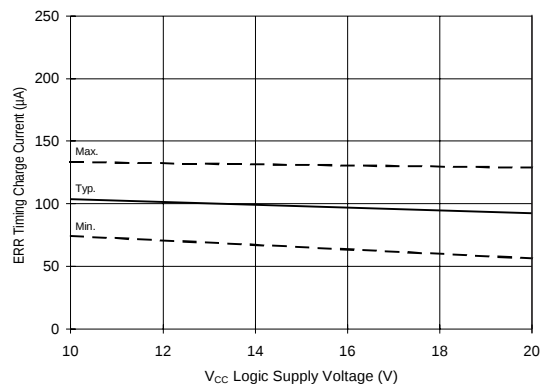
**Figure 25.  $V_{CC}$  Undervoltage (+) vs. Temperature**



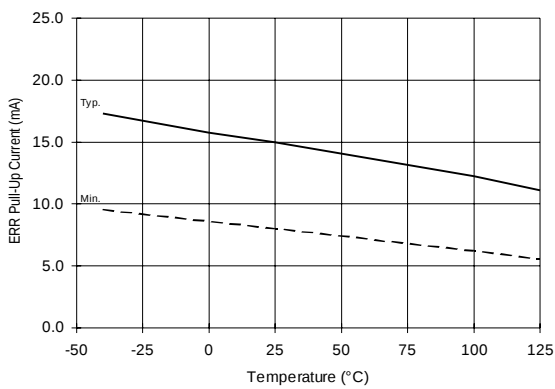
**Figure 26.  $V_{CC}$  Undervoltage (-) vs. Temperature**



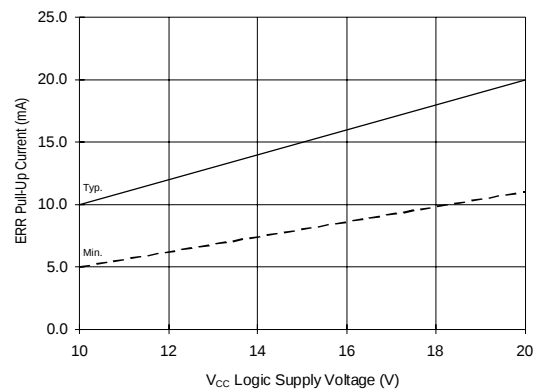
**Figure 27A. ERR Timing Charge Current vs. Temperature**



**Figure 27B. ERR Timing Charge Current vs. Voltage**



**Figure 28A. ERR Pull-Up Current vs. Temperature**



**Figure 28B. ERR Pull-Up Current vs. Voltage**

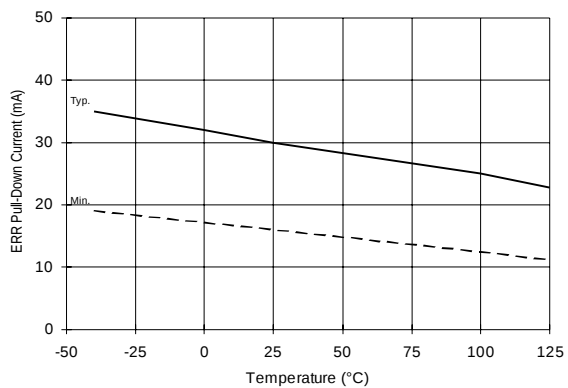


Figure 29A. ERR Pull-Down Current vs. Temperature

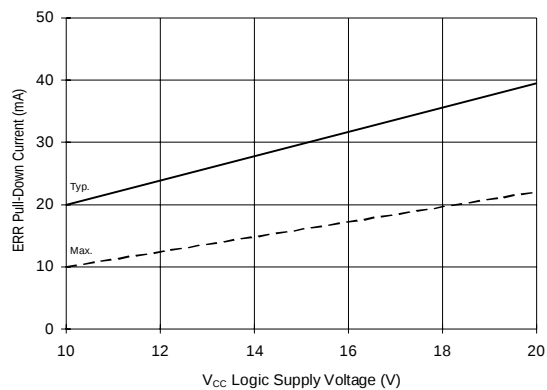


Figure 29B. ERR Pull-Down Current vs. Voltage

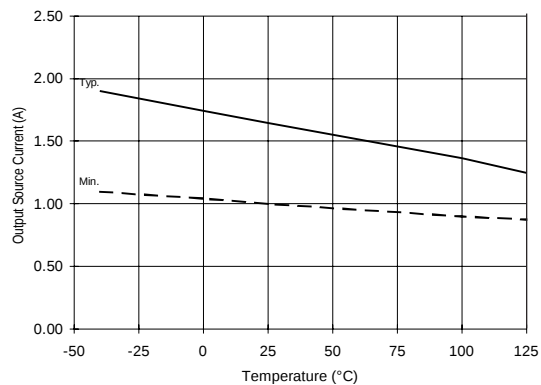


Figure 30A. Output Source Current vs. Temperature

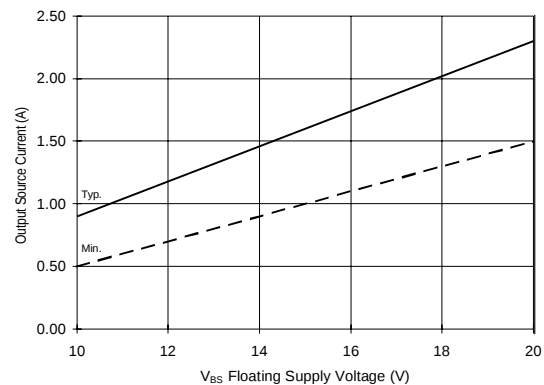


Figure 30B. Output Source Current vs. Voltage

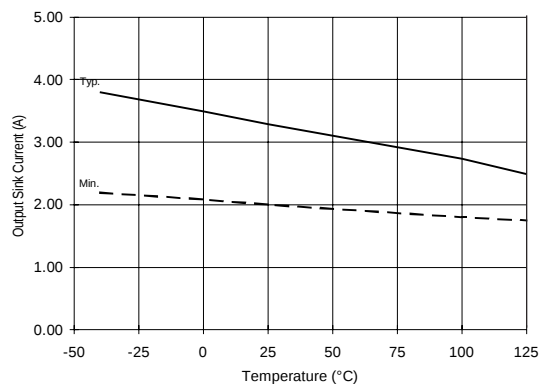


Figure 31A. Output Sink Current vs. Temperature

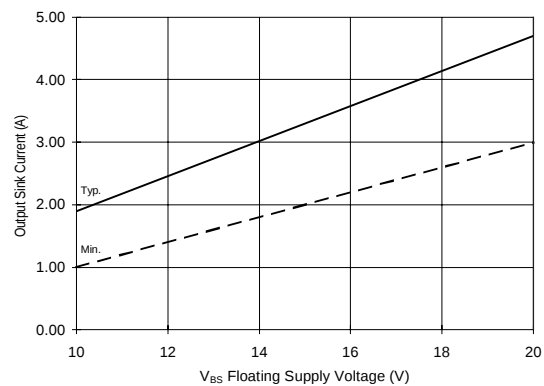
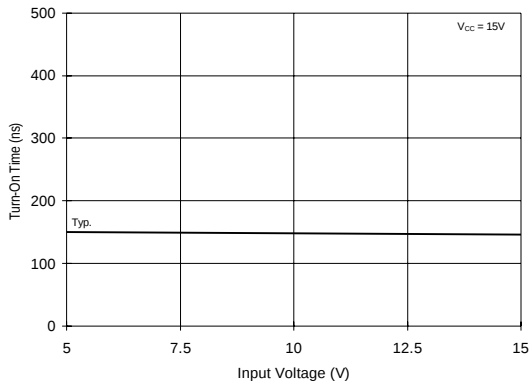
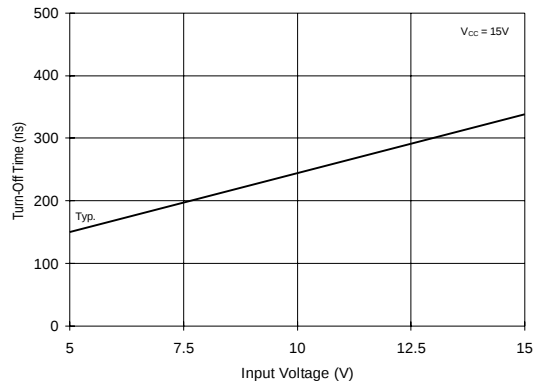


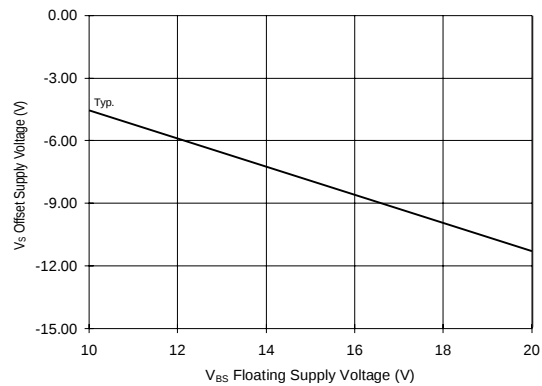
Figure 31B. Output Sink Current vs. Voltage



**Figure 32A. Turn-On Time vs. Input Voltage**



**Figure 32B. Turn-Off Time vs. Input Voltage**



**Figure 33. Maximum V<sub>S</sub> Negative Offset vs. Supply Voltage**