

## High and Low Side Driver

### Features

- Floating channel designed for bootstrap operation
- Fully operational to 200V
- Tolerant to negative transient voltage, dV/dt immune
- Gate drive supply range from 10 to 20V
- Undervoltage lockout for both channels
- 3.3V logic compatible
- Separate logic supply range from 3.3V to 20V
- Logic and power ground +/-5V offset
- CMOS Schmitt-triggered inputs with pull-down
- Shut down input turns off both channels
- Cross-conduction prevention logic
- Matched propagation delay for both channels
- Outputs in phase with inputs

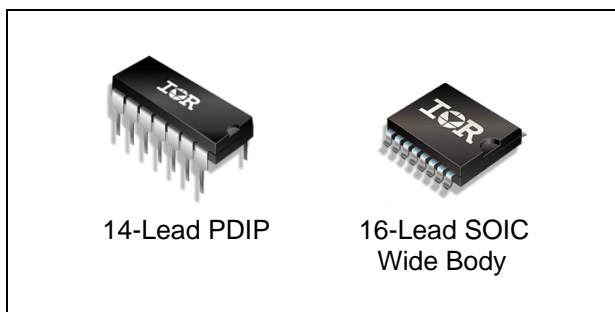
### Description

The IR2010 is a high power, high voltage, high speed power MOSFET and IGBT driver with independent high and low side referenced output channels. Logic inputs are compatible with standard CMOS or LSTTL output, down to 3.0V logic. 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 200 volts. Proprietary HVIC and latch immune CMOS technologies enable ruggedized monolithic construction.

### Product Summary

$V_{\text{OFFSET}}$ (max)	200V
$I_{\text{O+/-}}$ (typ)	3.0A / 3.0A
$V_{\text{OUT}}$	10 – 20V
$t_{\text{on/off}}$ (typ)	95ns & 65ns
Delay Matching (max)	15ns

### Package Options



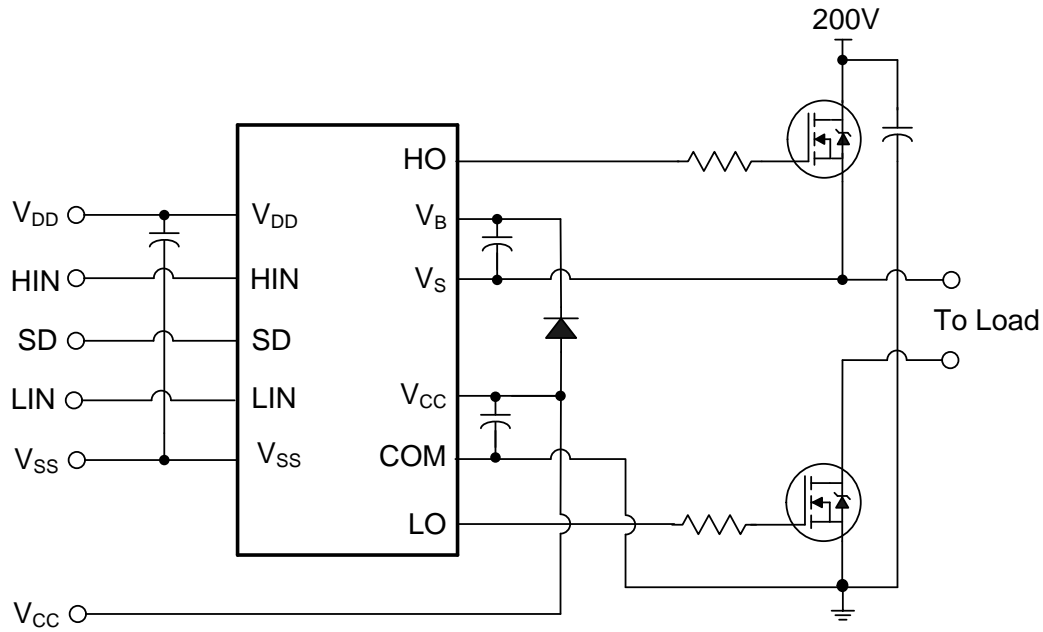
### Applications

- Converters
- DC motor drive

### Ordering Information

Base Part Number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
IR2010PBF	PDIP14	Tube	25	IR2010PBF
IR2010SPBF	SO16W	Tube	45	IR2010SPBF
IR2010SPBF	SO16W	Tape and Reel	1000	IR2010STRPBF

## Typical Connection Diagram



(Refer to Lead Assignments for correct configuration.) This diagram shows electrical connections only. Please refer to our Application Notes and Design Tips for proper circuit board layout

## 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	Definition	Min.	Max.	Units
$V_B$	High side floating supply voltage	-0.3	225	V
$V_S$	High side floating supply offset voltage	$V_B - 25$	$V_B + 0.3$	
$V_{HO}$	High side floating output voltage	$V_S - 0.3$	$V_B + 0.3$	
$V_{CC}$	Low side fixed supply voltage	-0.3	25	
$V_{LO}$	Low side output voltage	-0.3	$V_{CC} + 0.3$	
$V_{DD}$	Logic supply voltage	-0.3	$V_{SS} + 25$	
$V_{SS}$	Logic supply offset voltage	$V_{CC} - 25$	$V_{CC} + 0.3$	
$V_{IN}$	Logic input voltage (HIN, LIN & SD)	$V_{SS} - 0.3$	$V_{DD} + 0.3$	
$dV_S/dt$	Allowable offset supply voltage transient (figure 2)	—	50	V/ns
$P_D$	Package power dissipation @ $T_A \leq +25^\circ\text{C}$	14-Lead PDIP	1.6	W
		16-Lead SOIC	1.25	
$R_{thJA}$	Thermal resistance, junction to ambient	14-Lead PDIP	75	$^\circ\text{C/W}$
		16-Lead SOIC	100	
$T_J$	Junction temperature	—	150	$^\circ\text{C}$
$T_S$	Storage temperature	-55	150	
$T_L$	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  $V_S$  and  $V_{SS}$  offset rating is tested with all supplies biased at 15V differential. Typical ratings at other bias conditions are shown in figures 24 and 25.

Symbol	Definition	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	†	200	
$V_{HO}$	High side floating 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	$V_{SS} + 3$	$V_{SS} + 20$	
$V_{SS}$	Logic supply offset voltage	-5 <sup>††</sup>	5	
$V_{IN}$	Logic input voltage (HIN, LIN, & SD)	$V_{SS}$	$V_{DD}$	
$T_A$	Ambient temperature	-40	125	$^\circ\text{C}$

† Logic operational for  $V_S$  of -4 to +200V. Logic state held for  $V_S$  of -4V to  $-V_{BS}$ .

†† When  $V_{DD} < 5\text{V}$ , the minimum  $V_{SS}$  offset is limited to  $-V_{DD}$

(Please refer to the Design Tip DT97-3 for more details).

## Dynamic Electrical Characteristics

$V_{BIAS}$  ( $V_{CC}$ ,  $V_{BS}$ ,  $V_{DD}$ ) = 15V,  $C_L$  = 1000pF and  $T_A$  = 25°C and  $V_{SS}$  = COM unless otherwise specified. The dynamic electrical characteristics are measured using the test circuit shown in figure 3.

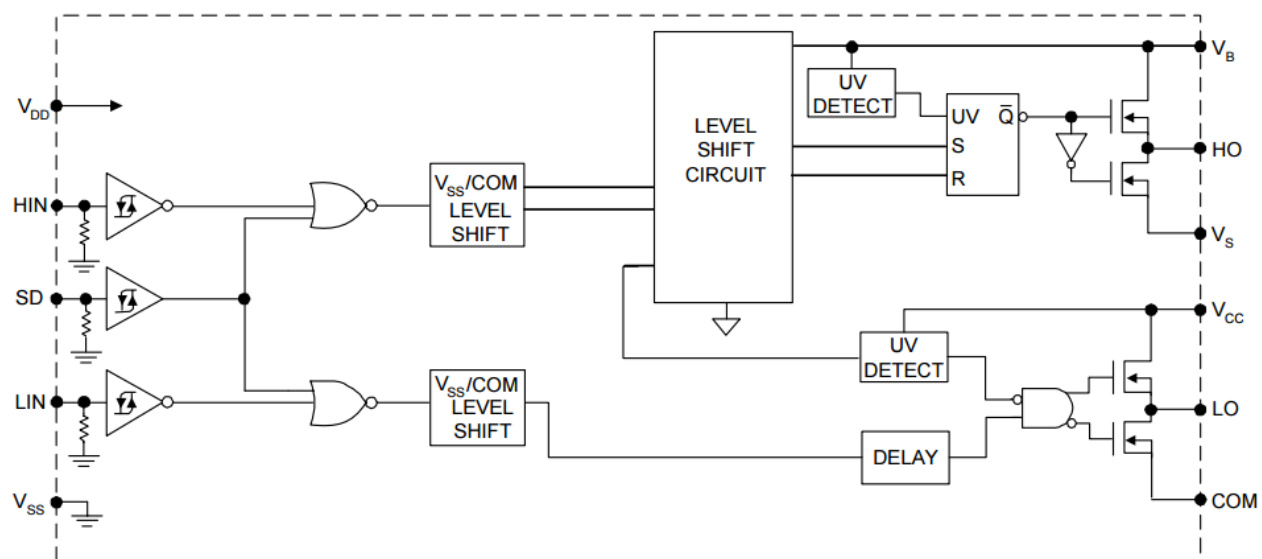
Symbol	Definition	Figure	Min.	Typ.	Max.	Units	Test Conditions
$t_{on}$	Turn-on propagation delay	7	50	95	135	ns	$V_S = 0V$
$t_{off}$	Turn-off propagation delay	8	30	65	105		$V_S = 200V$
$t_{sd}$	Shutdown propagation delay	9	35	70	105		
$t_r$	Turn-on rise time	10	—	10	20		
$t_f$	Turn-off fall time	11	—	15	25		
MT	Delay matching, HS & LS turn-on/off	6	—	—	15		

## Static Electrical Characteristics

$V_{BIAS}$  ( $V_{CC}$ ,  $V_{BS}$ ,  $V_{DD}$ ) = 15V and  $T_A$  = 25°C and  $V_{SS}$  = COM 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.

Symbol	Definition	Figure	Min.	Typ.	Max.	Units	Test Conditions
$V_{IH}$	Logic "1" input voltage	12	9.5	—	—	V	$V_{DD} = 15V$
$V_{IL}$	Logic "0" input voltage	13	—	—	6.0		$V_{DD} = 3.3V$
$V_{IH}$	Logic "1" input voltage	12	2	—	—		
$V_{IL}$	Logic "0" input voltage	13	—	—	1		$I_O = 0A$
$V_{OH}$	High level output voltage, $V_{BIAS} - V_O$	14	—	—	1.0		
$V_{OL}$	Low level output voltage, $V_O$	15	—	—	0.1		
$I_{LK}$	Offset supply leakage current	16	—	—	50	$\mu A$	$V_B = V_S = 200V$
$I_{QBS}$	Quiescent $V_{BS}$ supply current	17	—	70	210		$V_{IN} = 0V$ or $V_{DD}$
$I_{QCC}$	Quiescent $V_{CC}$ supply current	18	—	100	230		
$I_{QDD}$	Quiescent $V_{DD}$ supply current	19	—	1	5		$V_{IN} = V_{DD}$
$I_{IN+}$	Logic "1" input bias current	20	—	20	40		$V_{IN} = 0V$
$I_{IN-}$	Logic "0" input bias current	21	—	—	1.0		
$V_{BSUV+}$	$V_{BS}$ supply undervoltage positive going threshold	22	7.5	8.6	9.7	V	
$V_{BSUV-}$	$V_{BS}$ supply undervoltage negative going threshold	23	7.0	8.2	9.4		
$V_{CCUV+}$	$V_{CC}$ supply undervoltage positive going threshold	24	7.5	8.6	9.7		
$V_{CCUV-}$	$V_{CC}$ supply undervoltage negative going threshold	25	7.0	8.2	9.4		
$I_{O+}$	Output high short circuit pulsed current	26	2.5	3.0	—	A	$V_O = 0V$ , $V_{IN} = V_{DD}$ $PW \leq 10 \mu s$
$I_{O-}$	Output low short circuit pulsed current	27	2.5	3.0	—		$V_O = 15V$ , $V_{IN} = 0V$ $PW \leq 10 \mu s$

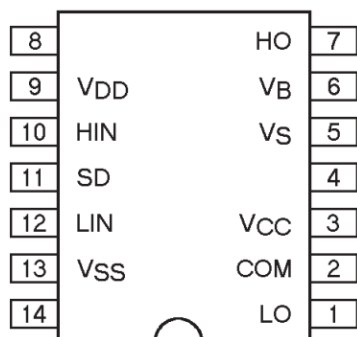
# Functional Block Diagram



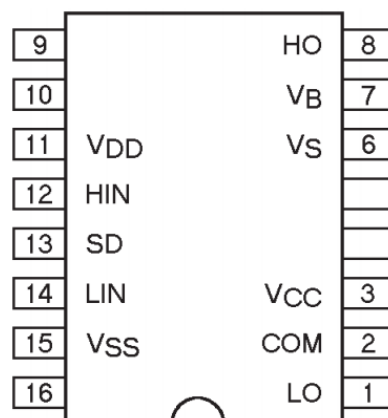
## Lead Definitions

Symbol	Description
$V_{DD}$	Logic Supply
HIN	Logic input for high side gate driver outputs (HO), in phase
SD	Logic input for shutdown
LIN	Logic input for low side gate driver outputs (LO), in phase
$V_{SS}$	Logic ground
$V_B$	High side floating supply
HO	High side gate drive output
$V_S$	High side floating supply return
$V_{CC}$	Low side supply
LO	Low side gate drive output
COM	Low side return

## Lead Assignments

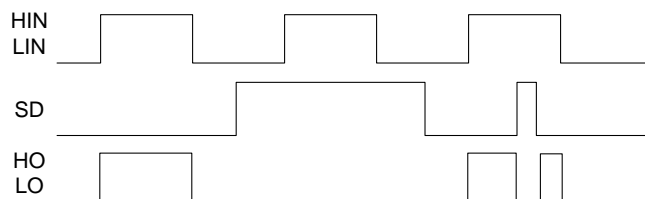


**14-Lead PDIP**

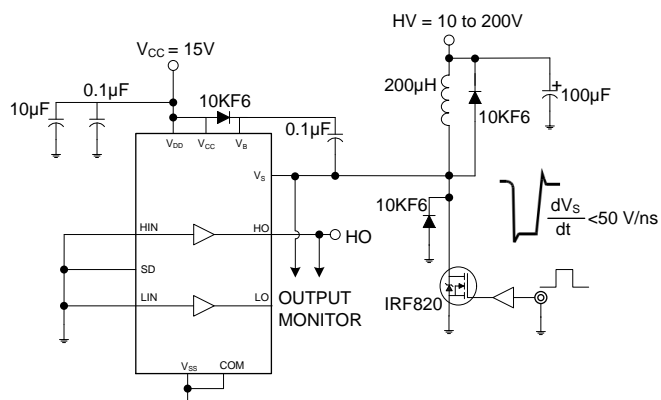


**16-Lead SOIC (Wide Body)**

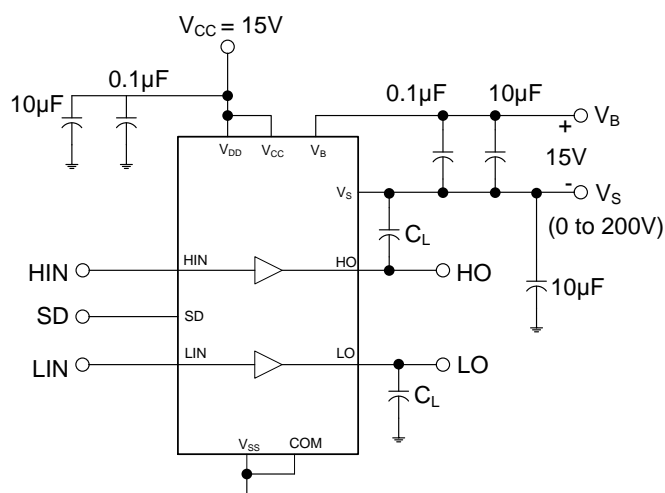
## Application Information and Additional Details



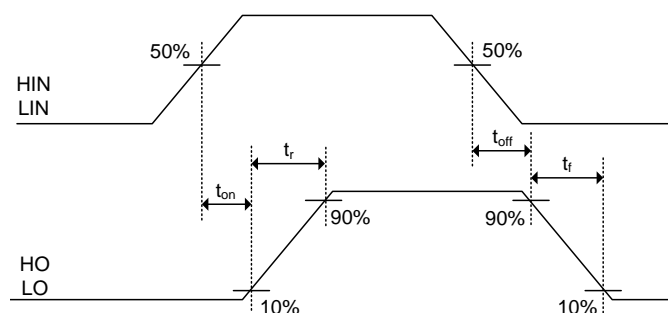
**Figure 1. Input/Output Timing Diagram**



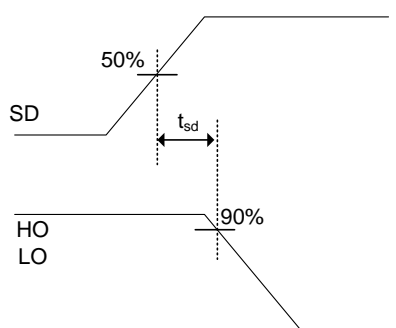
### Figure 2. Floating Supply Voltage Transient Test Circuit



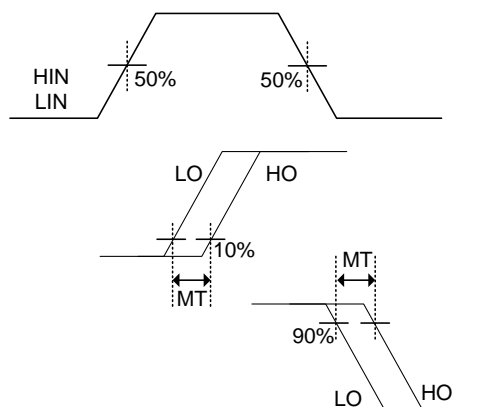
### Figure 3. Switching Time Test Circuit



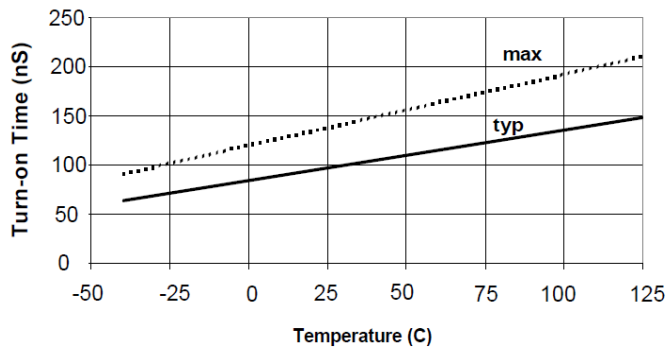
### Figure 4. Switching Time Waveform Definition



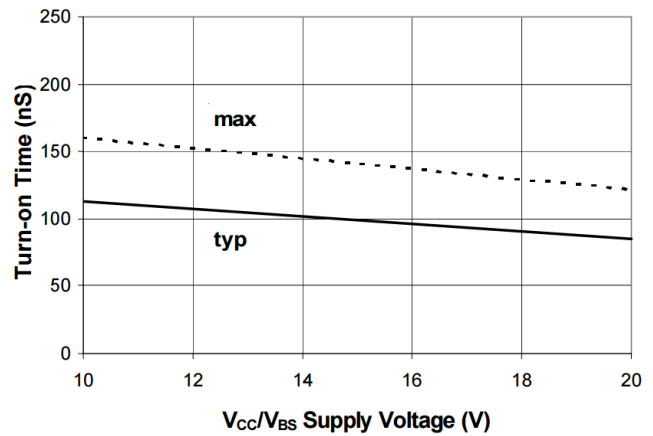
### Figure 5. Shutdown Waveform Definitions



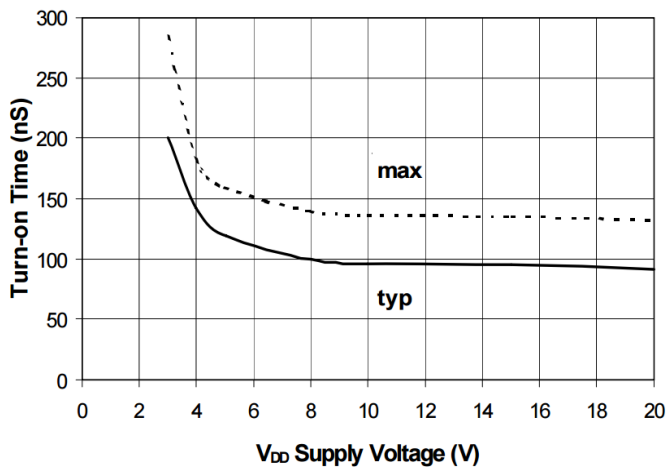
### Figure 6. Delay Matching Waveform Definitions



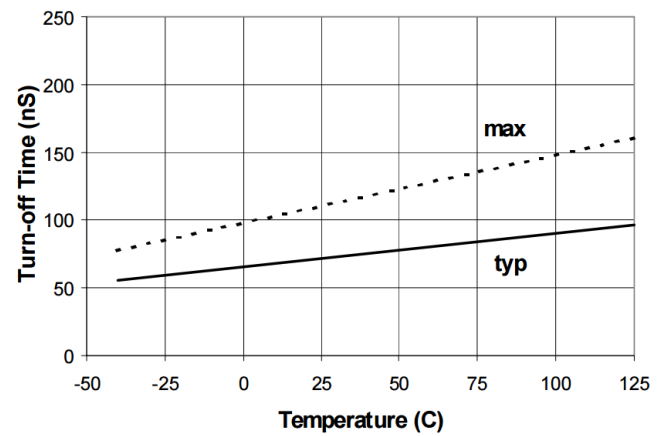
**Figure 7A. Turn-on Time vs. Temperature**



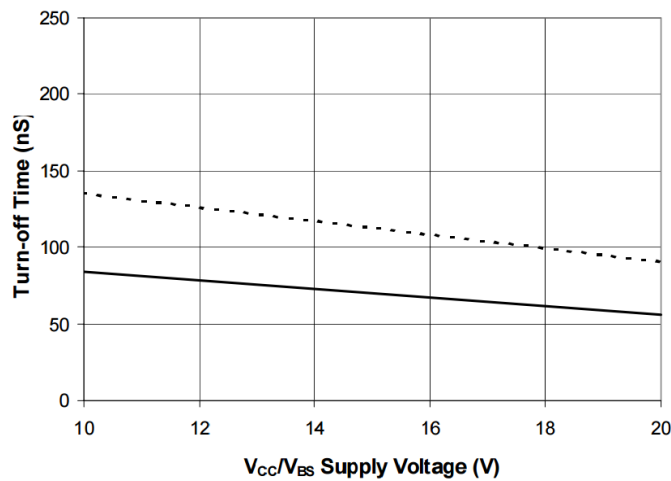
**Figure 7B. Turn-on Time vs.  $V_{CC}/V_{BS}$  Voltage**



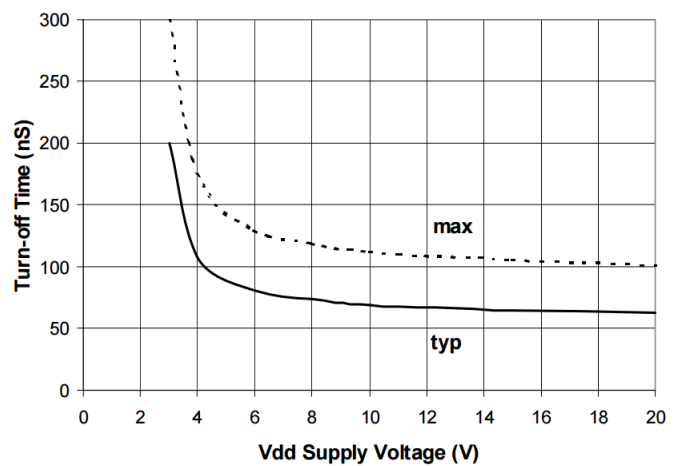
**Figure 7C. Turn-on Time vs.  $V_{DD}$  Voltage**



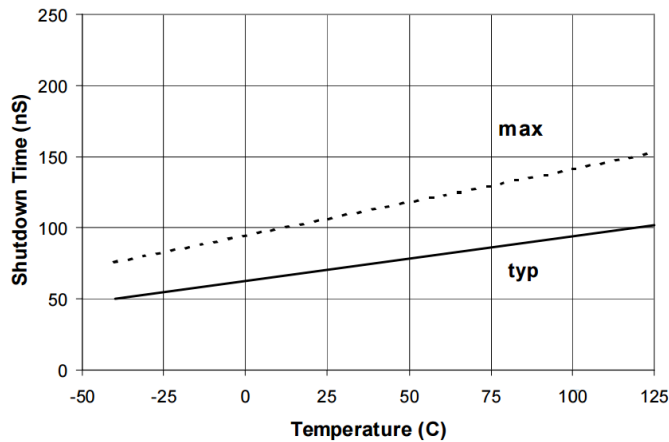
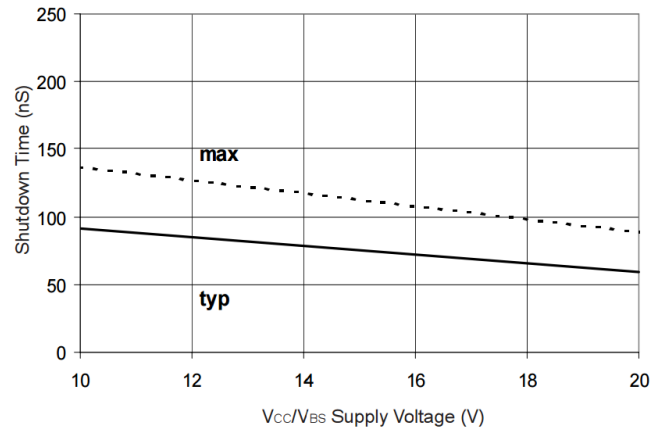
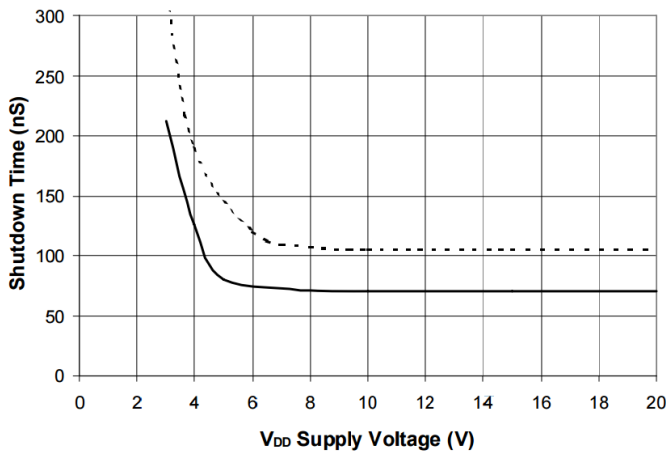
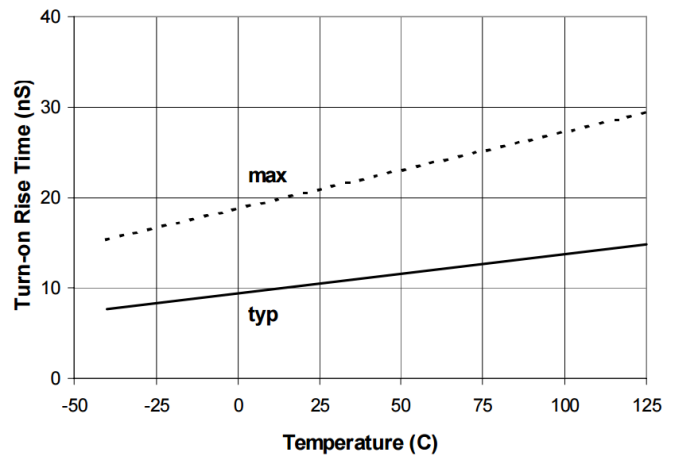
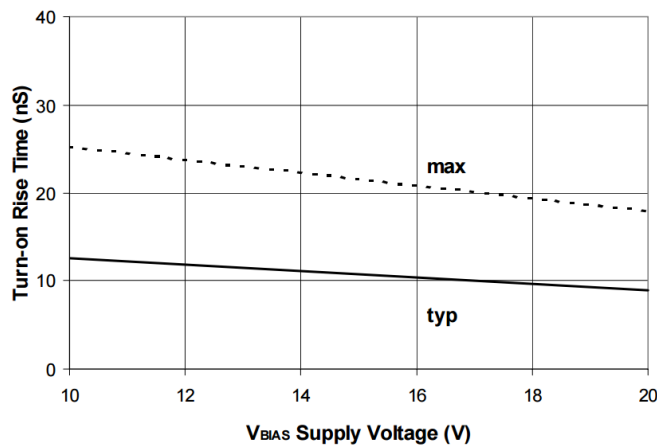
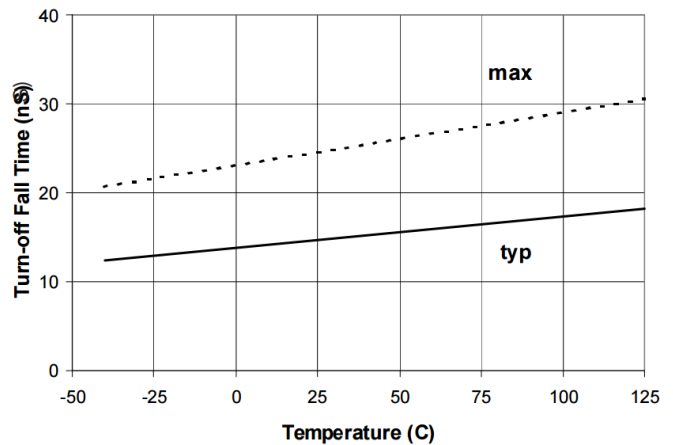
**Figure 8A. Turn-off Time vs. Temperature**

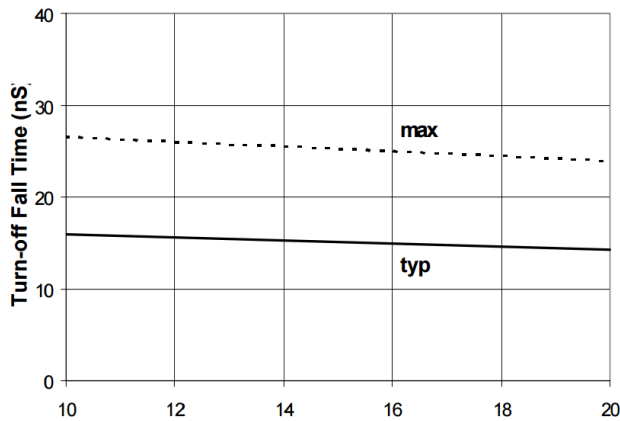


**Figure 8B. Turn-off Time vs.  $V_{CC}/V_{BS}$  Voltage**

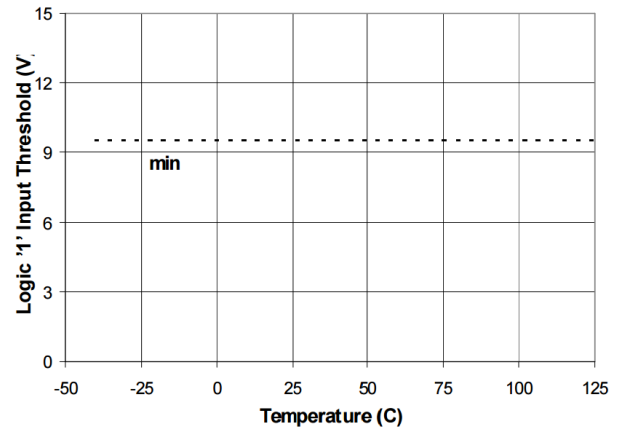


**Figure 8C. Turn-off Time vs.  $V_{DD}$  Voltage**

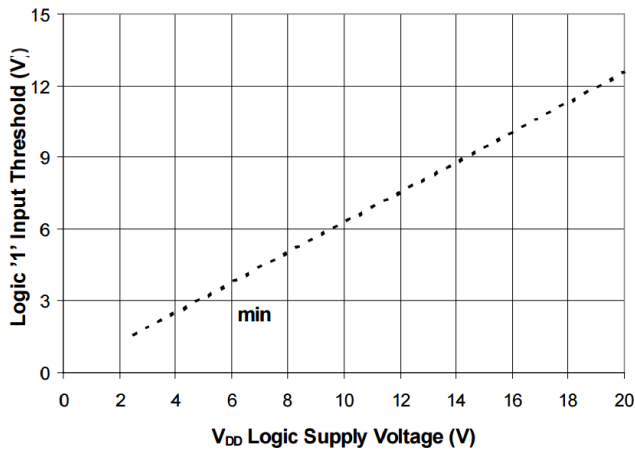

**Figure 9A. Shutdown Time vs. Temperature**

**Figure 9B. Shutdown Time vs.  $V_{CC}/V_{BS}$  Voltage**

**Figure 9C. Shutdown Time vs.  $V_{DD}$  Voltage**

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

**Figure 10B. Turn-on Rise Time vs.  $V_{BIAS}$  ( $V_{CC}=V_{BS}=V_{DD}$ ) Voltage**

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



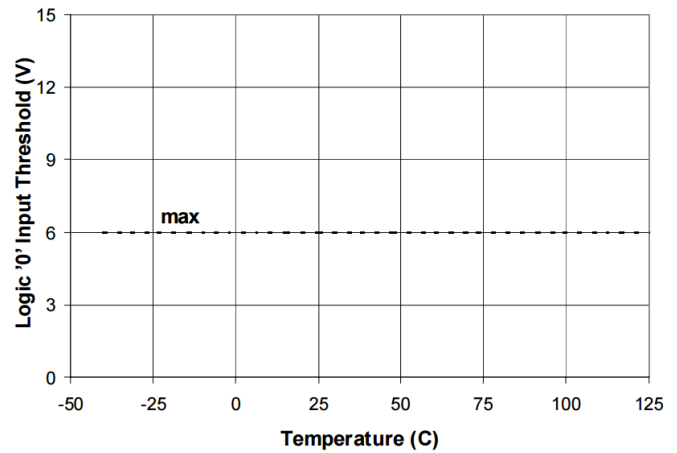
**Figure 11B. Turn-Off Fall Time vs.  $V_{BIAS}$  ( $V_{CC}=V_{BS}=V_{DD}$ ) Voltage**



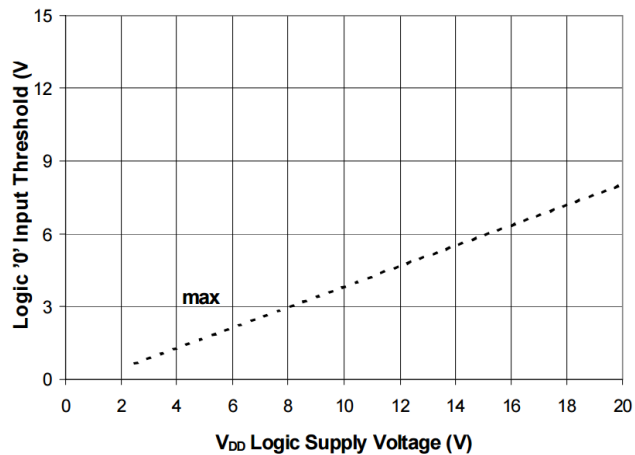
**Figure 12A. Logic "1" Input Threshold vs. Temperature**



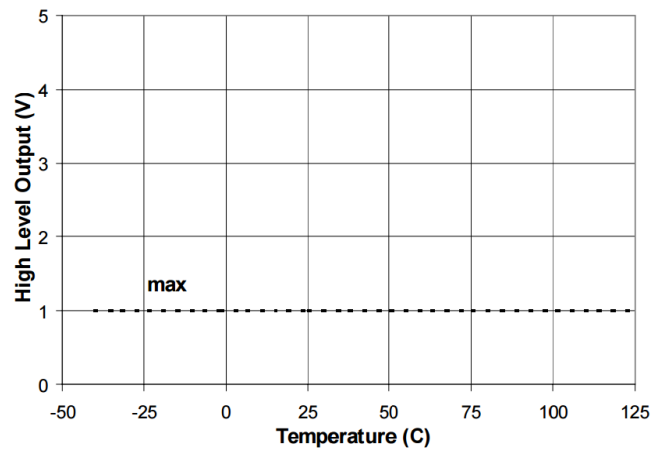
**Figure 12B. Logic "1" Input Threshold vs.  $V_{DD}$  Voltage**



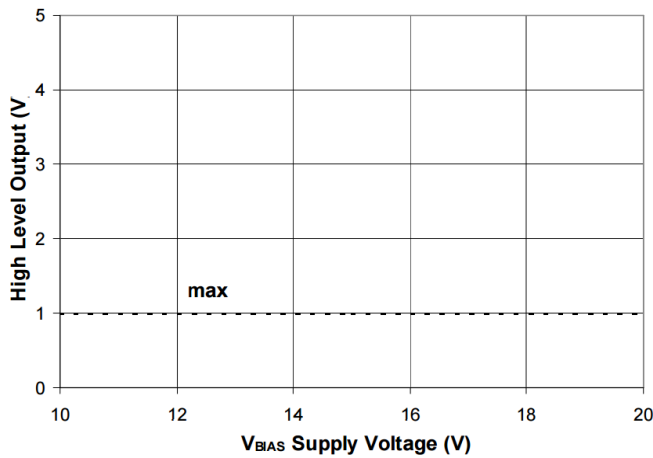
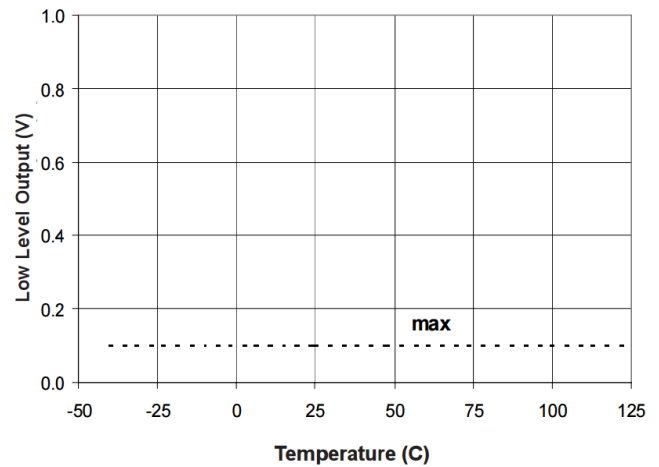
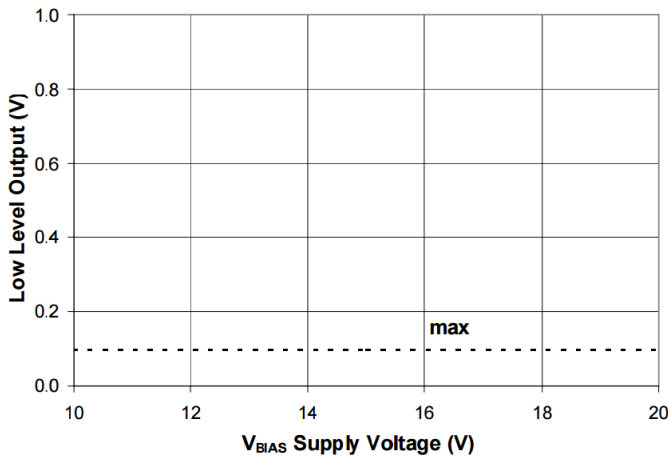
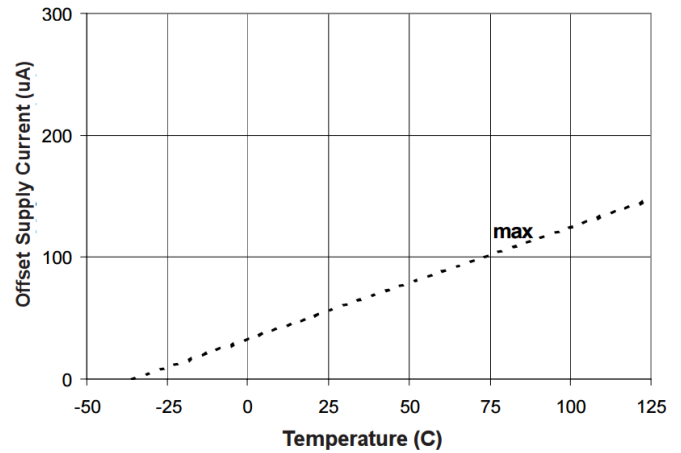
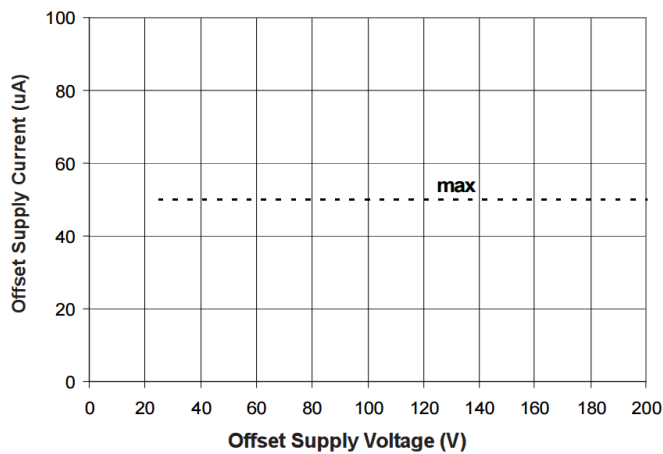
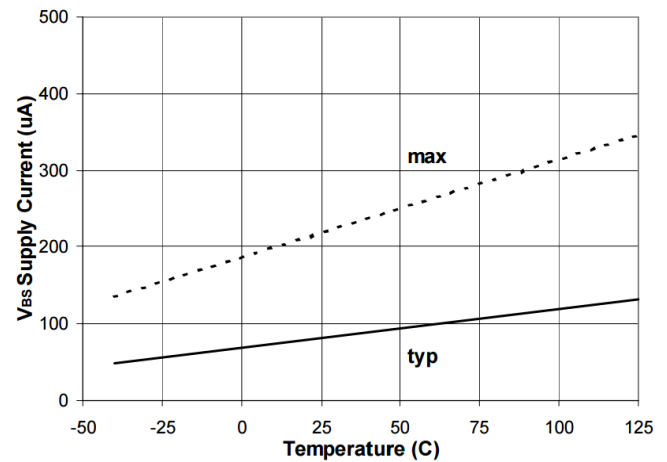
**Figure 13A. Logic "0" Input Threshold vs. Temperature**

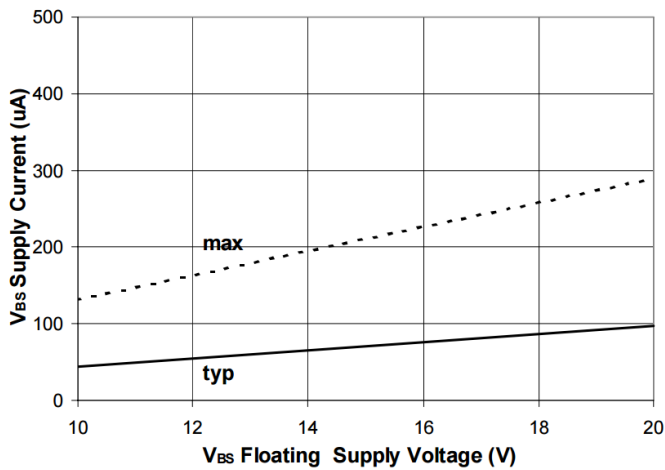
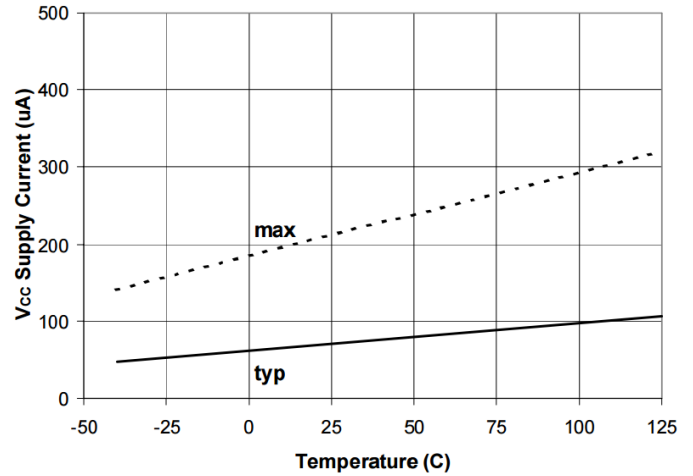
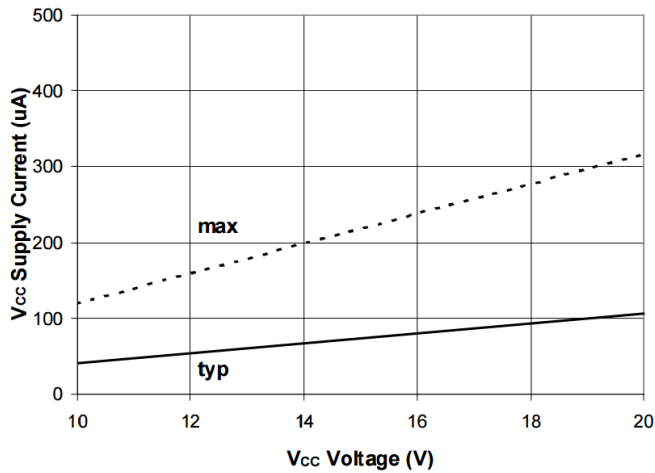
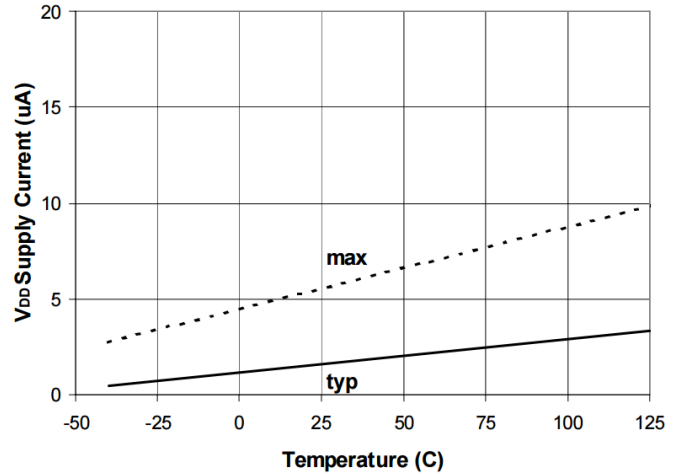
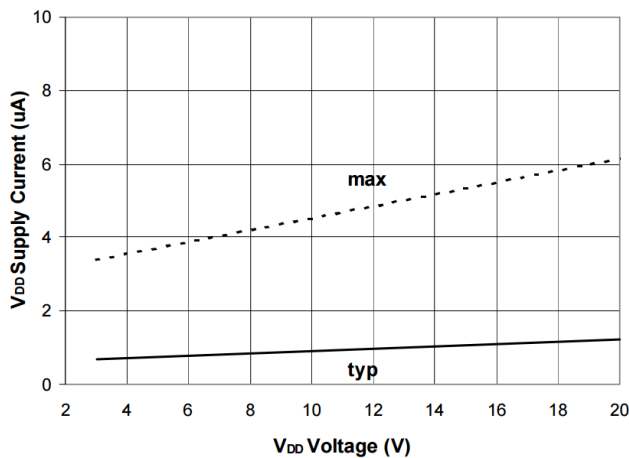
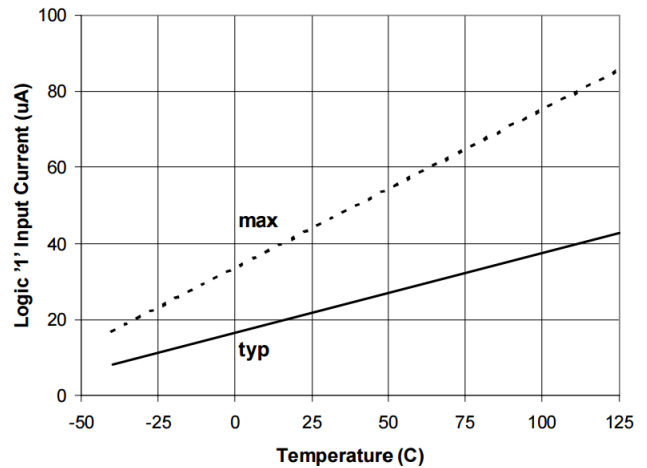


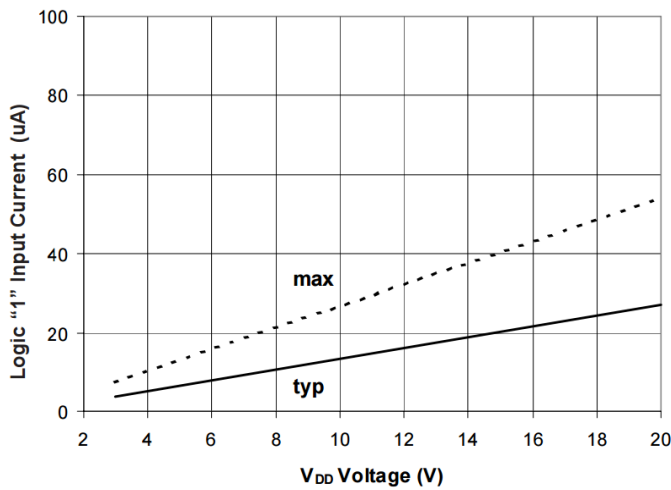
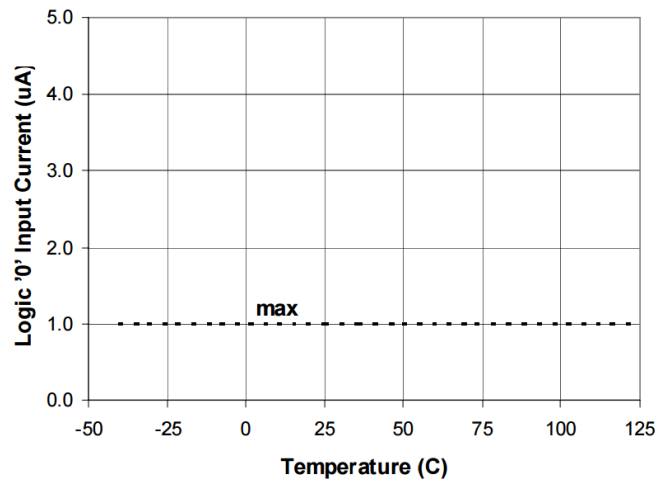
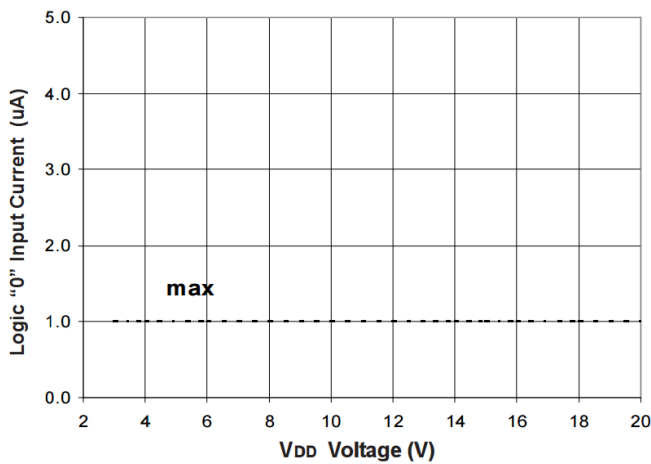
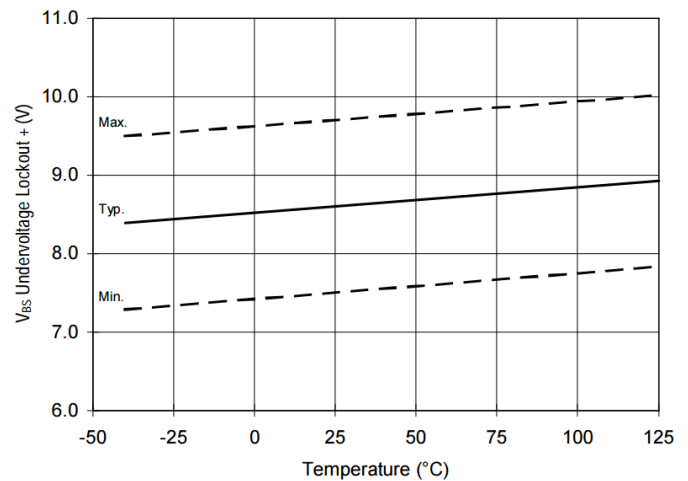
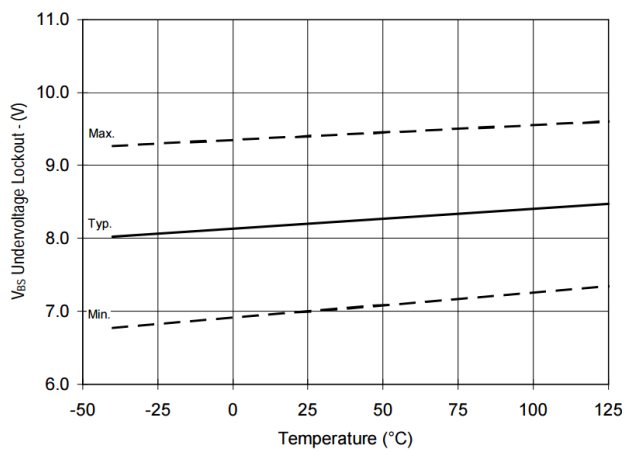
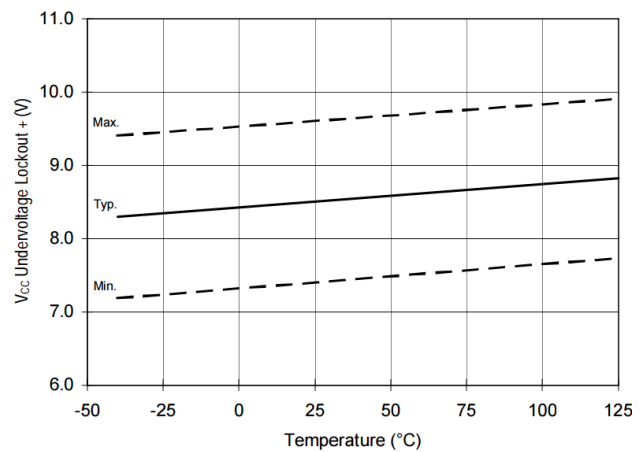
**Figure 13B. Logic "0" Input Threshold vs.  $V_{DD}$  Voltage**

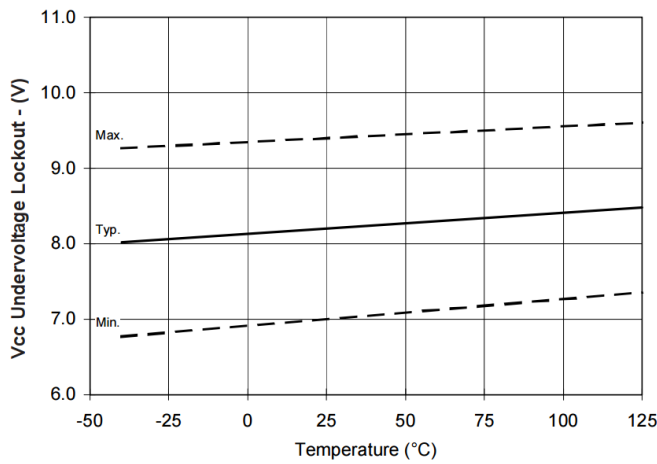
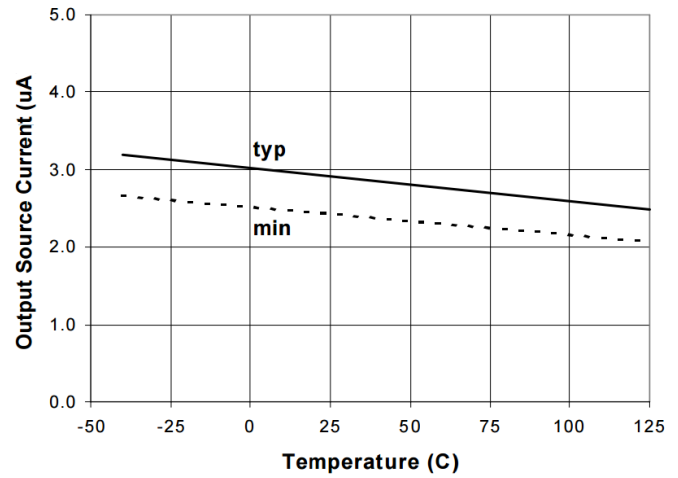
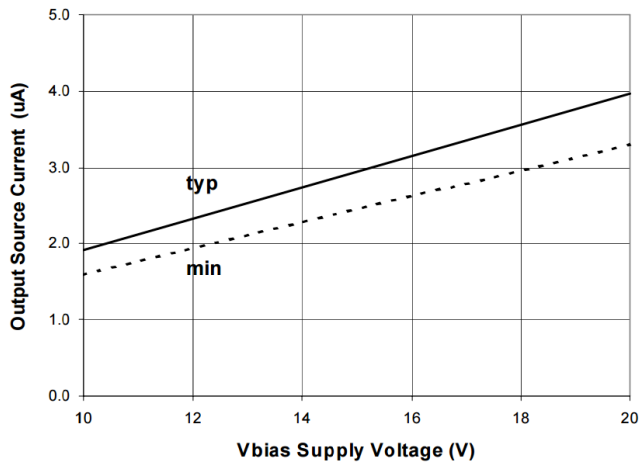
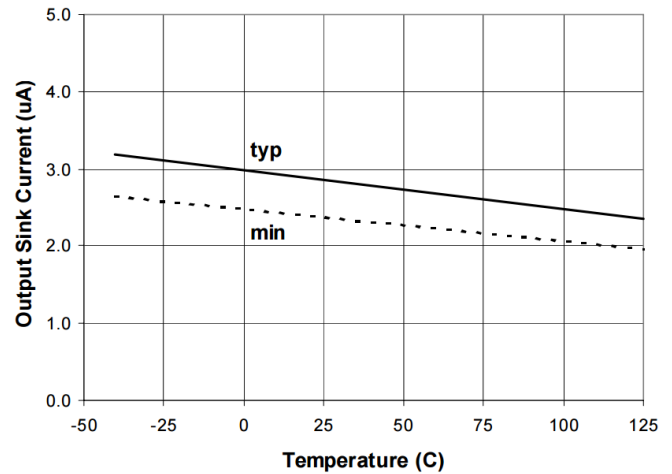
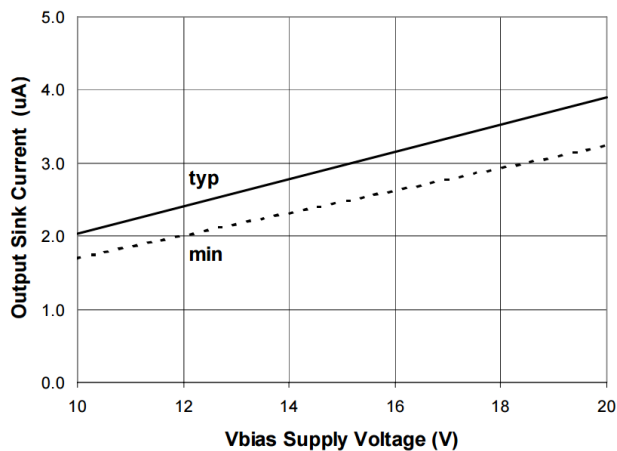
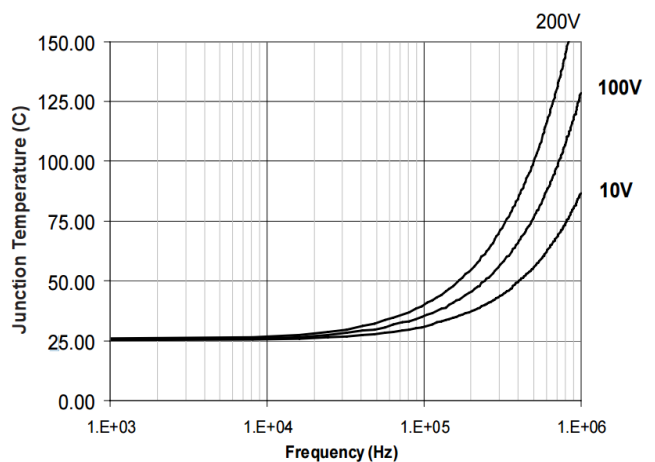


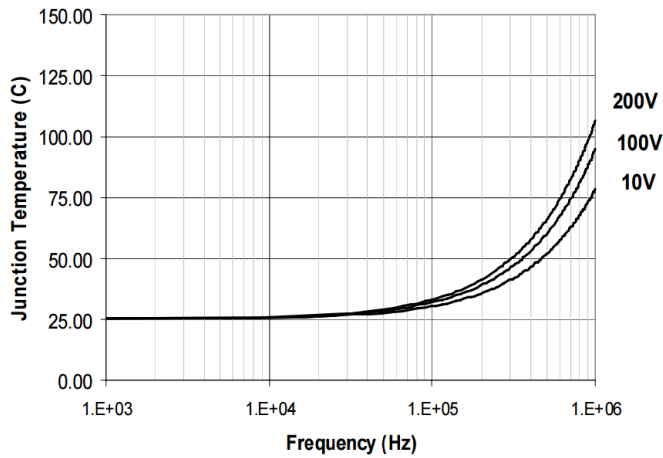
**Figure 14A. High Level Output vs. Temperature**


**Figure 14B. High Level Output vs. V<sub>BIAS</sub> Voltage**

**Figure 15A. Low Level Output vs. Temperature**

**Figure 15B. Low Level Output vs. V<sub>BIAS</sub> Voltage**

**Figure 16A. Offset Supply Current vs. Temperature**

**Figure 16B. Offset Supply Current vs. Offset Voltage**

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

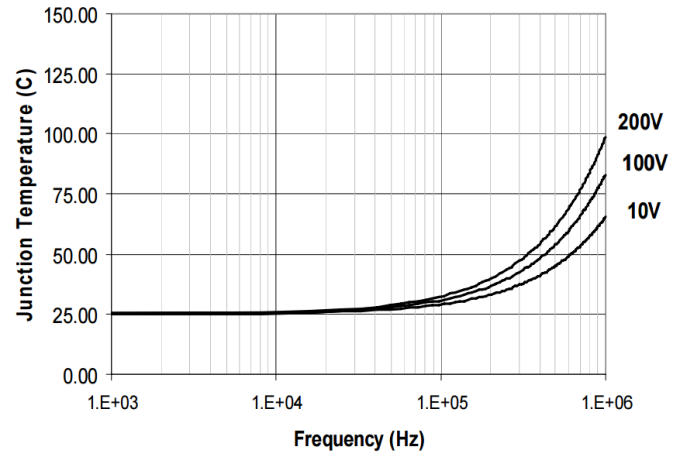

**Figure 17B. V<sub>BS</sub> Supply Current vs. V<sub>BS</sub> Voltage**

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

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

**Figure 19A. V<sub>DD</sub> Supply Current vs. Temperature**

**Figure 19B. V<sub>DD</sub> Supply Current vs. V<sub>DD</sub> Voltage**

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


**Figure 20B. Logic "1" Input Current vs. V<sub>DD</sub> Voltage**

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

**Figure 21B. Logic "0" Input Current vs. V<sub>DD</sub> Voltage**

**Figure 22. V<sub>BS</sub> Undervoltage (+) vs. Temperature**

**Figure 23. V<sub>BS</sub> Undervoltage (-) vs. Temperature**

**Figure 24. V<sub>CC</sub> Undervoltage (+) vs. Temperature**

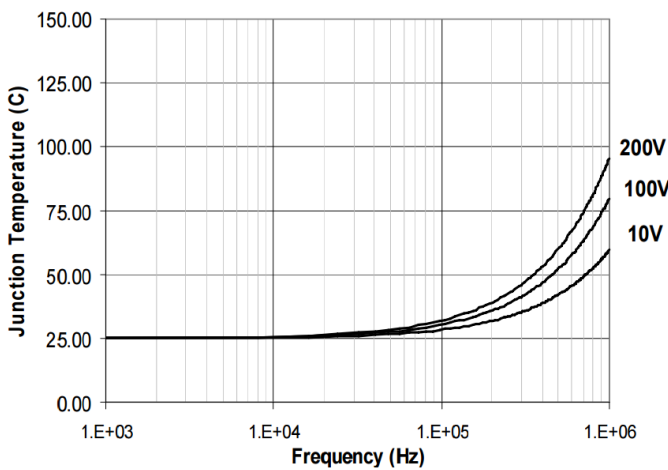

**Figure 25.  $V_{CC}$  Undervoltage (-) vs. Temperature**

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

**Figure 26B. Output Source Current vs.  $V_{BIAS}$  Voltage**

**Figure 27A. Output Sink Current vs. Temperature**

**Figure 27B. Output Sink Current vs.  $V_{BIAS}$  Voltage**

**Figure 28. IR2010  $T_j$  vs. Frequency  
 $R_{GATE} = 10\Omega$ ,  $V_{CC} = 15V$  with IRFPE50**



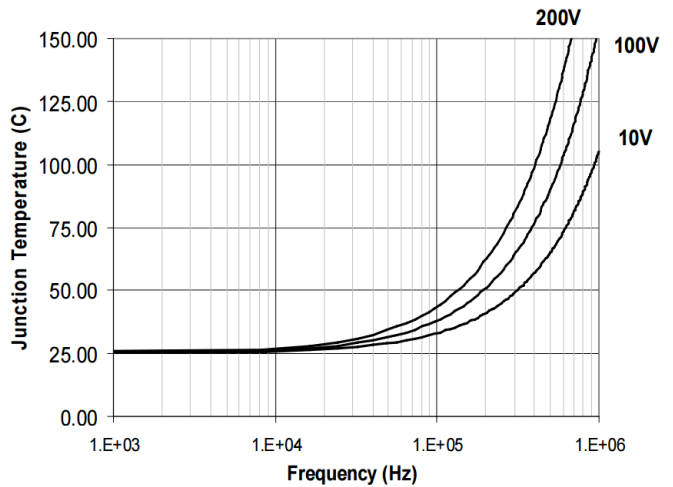
**Figure 29. IR2010 Tj vs. Frequency**  
 $R_{GATE} = 16\Omega$ ,  $V_{CC} = 15V$  with IRFBC40



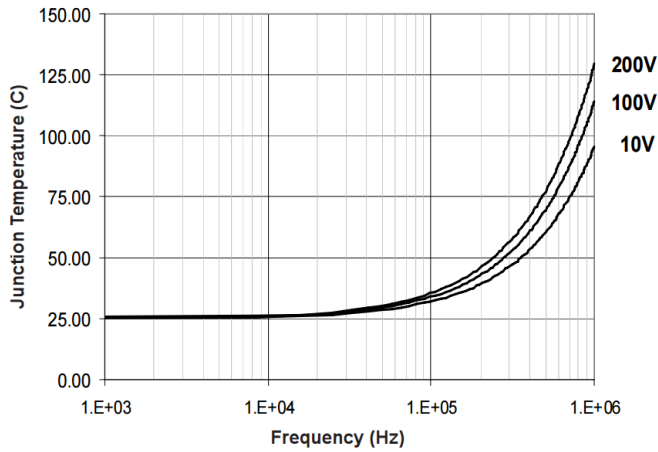
**Figure 30. IR2010 Tj vs. Frequency**  
 $R_{GATE} = 22\Omega$ ,  $V_{CC} = 15V$  with IRFBC30



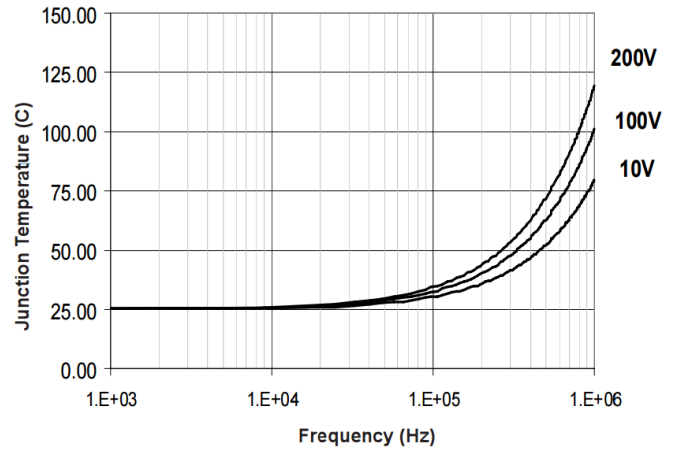
**Figure 31. IR2010 Tj vs. Frequency**  
 $R_{GATE} = 33\Omega$ ,  $V_{CC} = 15V$  with IRFBC20



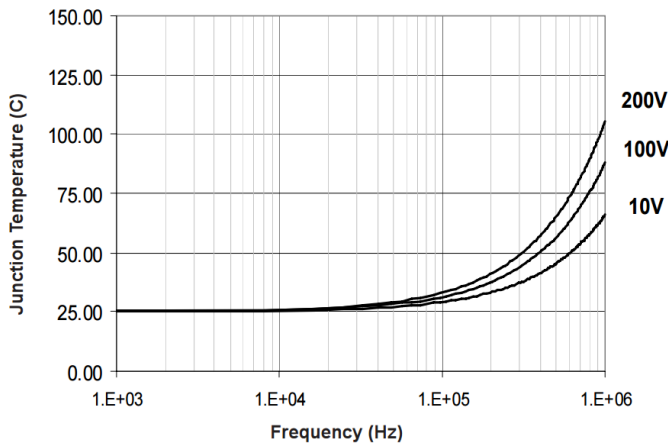
**Figure 32. IR2010 Tj vs. Frequency**  
 $R_{GATE} = 10\Omega$ ,  $V_{CC} = 15V$  with IRFBE50



**Figure 33. IR2010S Tj vs. Frequency**  
 $R_{GATE} = 16\Omega$ ,  $V_{CC} = 15V$  with IRFBC40

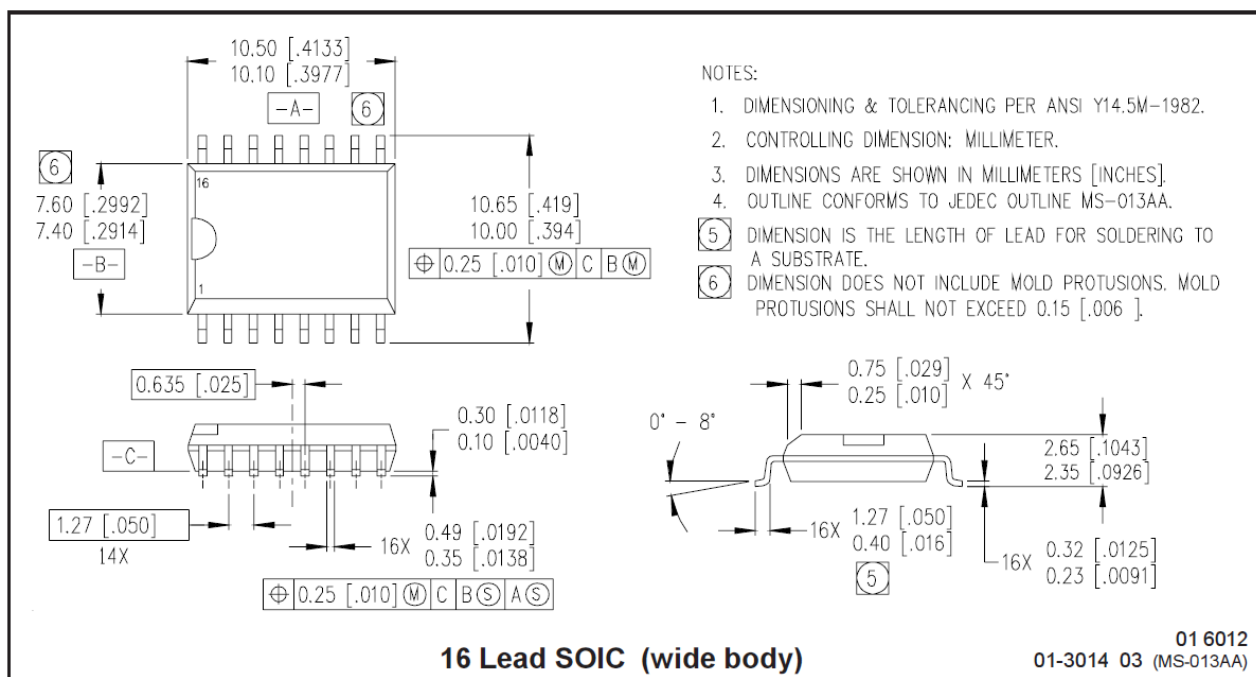
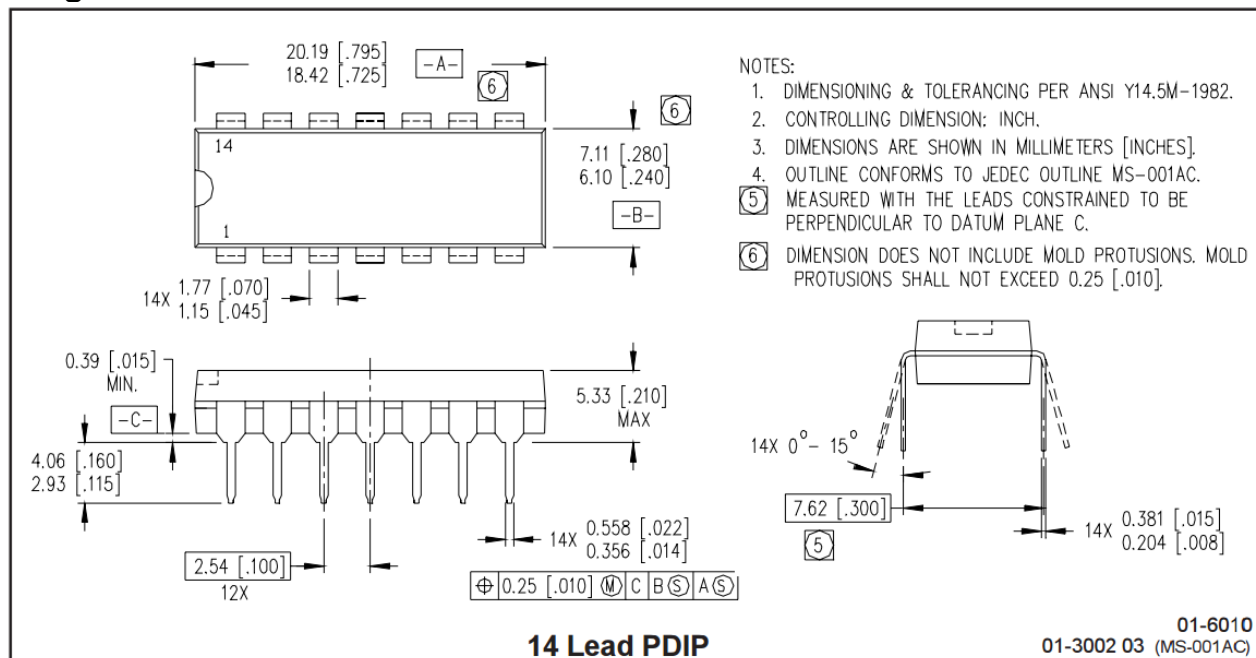


**Figure 34. IR2010S Tj vs. Frequency**  
 $R_{GATE} = 22\Omega$ ,  $V_{CC} = 15V$  with IRFBC30

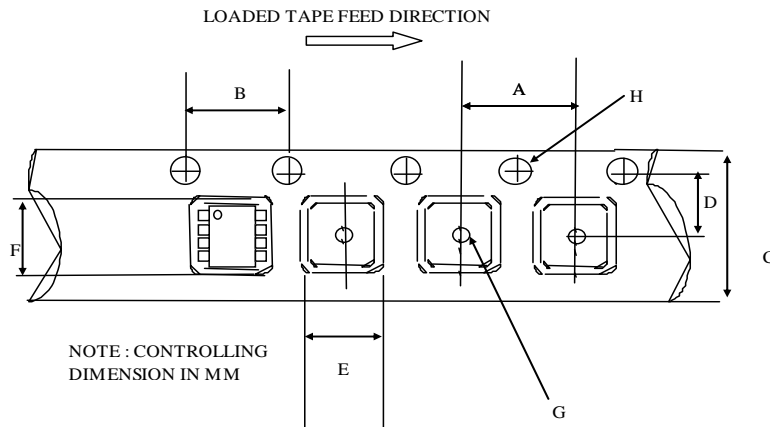


**Figure 35. IR2010S Tj vs. Frequency**  
 $R_{GATE} = 33\Omega$ ,  $V_{CC} = 15V$  with IRFBC20

## Package Details

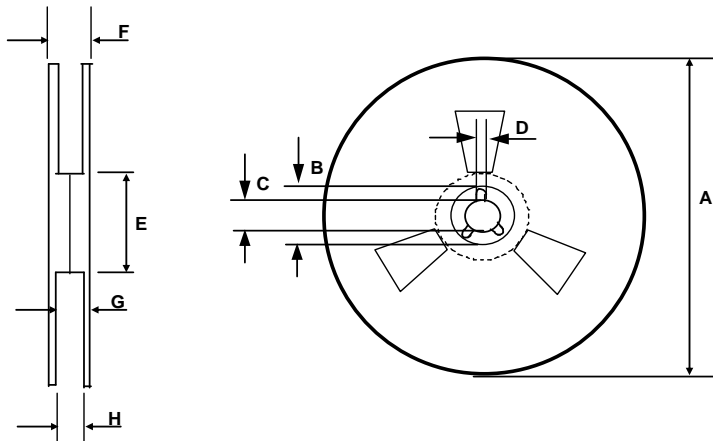


## Tape and Reel Details



CARRIER TAPE DIMENSION FOR 16SOICW

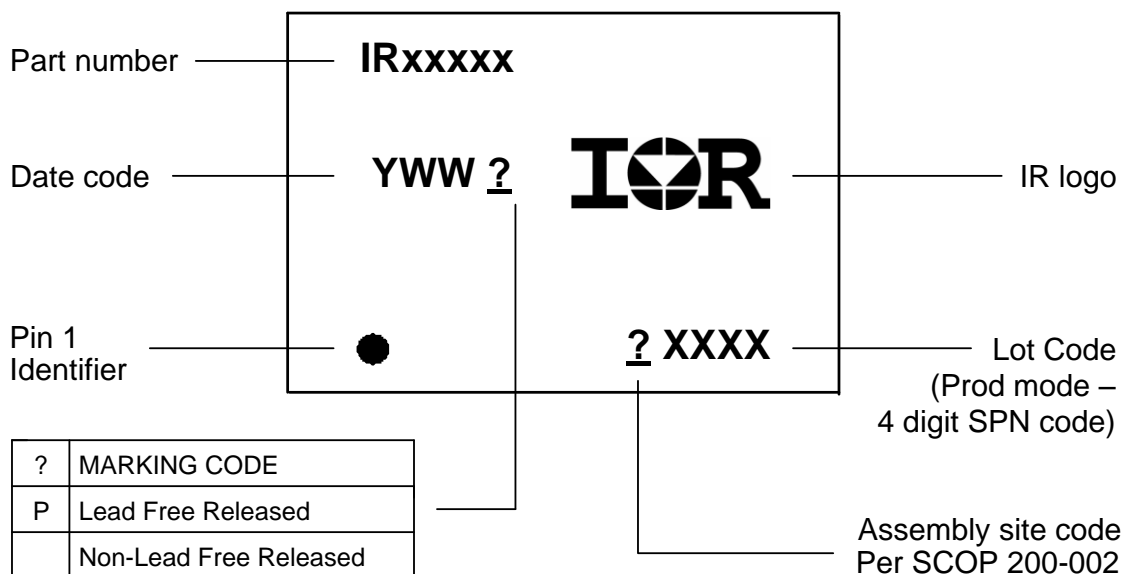
Code	Metric		Imperial	
	Min	Max	Min	Max
A	11.90	12.10	0.468	0.476
B	3.90	4.10	0.153	0.161
C	15.70	16.30	0.618	0.641
D	7.40	7.60	0.291	0.299
E	10.80	11.00	0.425	0.433
F	10.60	10.80	0.417	0.425
G	1.50	n/a	0.059	n/a
H	1.50	1.60	0.059	0.062



REEL DIMENSIONS FOR 16SOICW

Code	Metric		Imperial	
	Min	Max	Min	Max
A	329.60	330.25	12.976	13.001
B	20.95	21.45	0.824	0.844
C	12.80	13.20	0.503	0.519
D	1.95	2.45	0.767	0.096
E	98.00	102.00	3.858	4.015
F	n/a	22.40	n/a	0.881
G	18.50	21.10	0.728	0.830
H	16.40	18.40	0.645	0.724

## Part Marking Information



**Qualification Information<sup>†</sup>**

<b>Qualification Level</b>		Industrial <sup>††</sup> (per JEDEC JESD 47)
		Comments: This family of ICs has passed JEDEC's Industrial qualification. IR's Consumer qualification level is granted by extension of the higher Industrial level.
<b>Moisture Sensitivity Level</b>	16-Lead SOIC WB	MSL3 <sup>†††</sup> (per IPC/JEDEC J-STD-020)
<b>RoHS Compliant</b>		Yes

† Qualification standards can be found at International Rectifier's web site <http://www.irf.com/>

†† Higher qualification ratings may be available should the user have such requirements. Please contact your International Rectifier sales representative for further information.

††† Higher MSL ratings may be available for the specific package types listed here. Please contact your International Rectifier sales representative for further information.

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For technical support, please contact IR's Technical Assistance Center  
<http://www.irf.com/technical-info/>

**WORLD HEADQUARTERS:**  
 233 Kansas St., El Segundo, California 90245  
 Tel: (310) 252-7105