IR2136STRPBF-HX 600 V three-phase gate driver IC with OCP, Enable, and Fault

Description

The IR2136STRPBF-HX are high-voltage, high-speed power MOSFET and IGBT drivers featuring three independent output channels referenced to both high and low sides, specifically designed for 3-phase applications. The proprietary HVIC technology facilitates a robust monolithic construction. Logic inputs are compatible with CMOS or LSTTL outputs, down to a logic level of 3.3 V. A current trip function is available that can terminate all six outputs based on an external current sense resistor. Additionally, an enable function allows for the simultaneous termination of all six outputs.

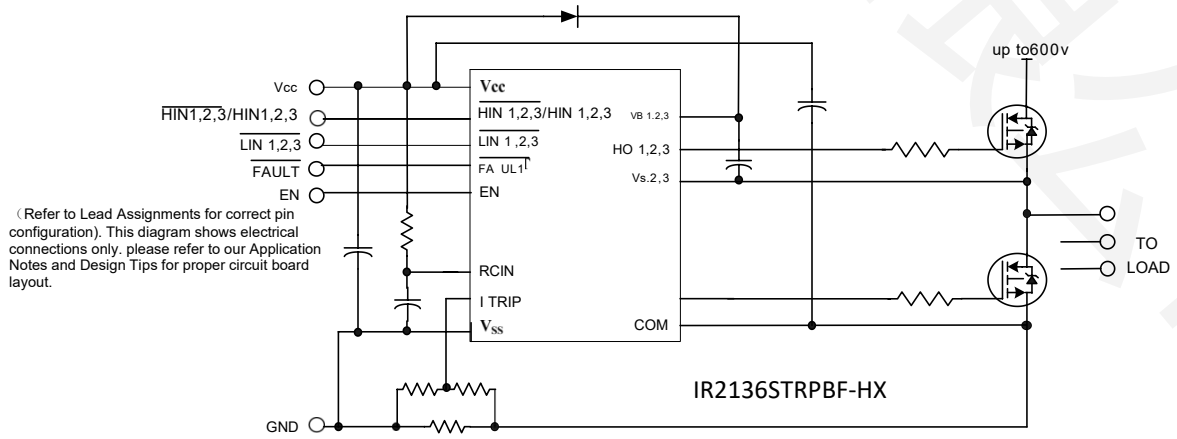
An open-drain FAULT signal is provided to indicate occurrences of overcurrent or undervoltage shutdowns. Overcurrent fault conditions are automatically cleared after a delay that can be programmed externally via an RC network connected to the RCIN input. The output drivers incorporate a high pulse current buffer stage engineered to minimize driver cross-conduction. Propagation delays are matched to facilitate ease of use in high-frequency applications.

The floating channels can drive N-channel power MOSFETs or IGBTs in a high-side configuration capable of operating up to 600 V.

Features

- ★ Floating channel designed for bootstrap operation
- ★ Fully operational to +600 V
- ★ Tolerant to negative transient voltage, dV/dt immune
- ★ Gate drive supply range from 10 V to 20 V
- ★ Undervoltage lockout for all channels
- ★ Over-current shutdown turns off all six drivers
- ★ Independent 3 half-bridge drivers
- ★ Matched propagation delay for all channels
- ★ Cross-conduction prevention logic
- ★ Low side output out of phase with inputs. High side outputs out of phase
- ★ 3.3 V logic compatible
- ★ Lower di/dt gate drive for better noise immunity
- ★ Externally programmable delay for automatic fault clear
- ★ All parts are LEAD-FREE

Typical Connection



（Refer to Lead Assignments for correct pin 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_S	High side offset voltage		$V_{B\ 1,2,3}$ - 25	$V_{B\ 1,2,3}$ + 0.3	V
V_B	High side floating supply voltage		-0.3	625	
V_{HO}	High side floating output voltage		$V_{S1,2,3}$ - 0.3	$V_{B\ 1,2,3}$ + 0.3	
V_{CC}	Low side and logic fixed supply voltage		-0.3	25	
V_{SS}	Logic ground		V_{CC} - 25	V_{CC} + 0.3	
$V_{LO1,2,3}$	Low side output voltage		-0.3	V_{CC} + 0.3	
V_{IN}	Input voltage LIN, HIN, ITRIP, EN		V_{SS} -0.3	Lower of (V_{SS} + 15) or V_{CC} + 0.3)	
V_{RCIN}	RCIN input voltage		V_{SS} -0.3	V_{CC} + 0.3	
V_{FLT}	$\overline{\text{FAULT}}$ output voltage		V_{SS} -0.3	V_{CC} + 0.3	
dV/dt	Allowable offset voltage slew rate			50	V/ns
P_D	Package power dissipation @ $T_A \le +25$ °C	(28 lead SOIC)		1.6	W
Rth_{JA}	Thermal resistance, junction to ambient	(28 lead SOIC)		78	°C/W
T_J	Junction temperature			150	°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 Fig. 1. For proper operation the device should be used within the recommended conditions. All voltage parameters are absolute referenced to COM. The V_S offset ratings are tested with all supplies biased at a 15 V differential.

Symbol	Definition		Min	Max	Units
$V_{B1,2,3}$	High side floating supply voltage	IR2136STRPBF-HX	$V_{S1,2,3}$ +10	$V_{S1,2,3}$ + 20	V
			$V_{S1,2,3}$ +12	$V_{S1,2,3}$ + 20	
$V_{S\ 1,2,3}$	High side floating supply offset voltage		Note 1	600	
$V_{HO\ 1,2,3}$	High side output voltage		$V_{S1,2,3}$	$V_{B1,2,3}$	
$V_{LO1,2,3}$	Low side output voltage		0	V_{CC}	
V_{CC}	Low side and logic fixed supply voltage	IR2136STRPBF-HX	10	20	
			12	20	
V_{SS}	Logic ground		-5	5	
V_{FLT}	$\overline{\text{FAULT}}$ output voltage		V_{SS}	V_{CC}	
V_{RCIN}	RCIN input voltage		V_{SS}	V_{CC}	

Note 1: Logic operational for V_S of (COM - 5 V) to (COM + 600 V). Logic state held for V_S of (COM - 5 V) to (COM V_{BS}). (Please refer to the Design Tip DT97-3 for more details).

Note 2: All input pins and the ITRIP and EN pins are internally clamped with a 5.2 V zener diode.

Recommended Operating Conditions - (Continued)

The input/output logic-timing diagram is shown in Fig. 1. For proper operation the device should be used within the recommended conditions. All voltage parameters are absolute referenced to COM. The V_S offset ratings are tested with all supplies biased at a 15 V differential.

Symbol	Definition	Min	Max	Units
V_{ITRIP}	ITRIP input voltage	V_{SS}	V_{SS} + 5	V
V_{IN}	Logic input voltage LIN, HIN (IR2136), EN	V_{SS}	V_{SS} + 5	
T_A	Ambient temperature	-40	125	°C

Note 2: All input pins and the ITRIP and EN pins are internally clamped with a 5.2 V zener diode.

Static Electrical Characteristics

V_{BIAS} (V_{CC},$V_{BS1,2,3}$) = 15 V unless otherwise specified. The V_{IN}, V_{TH}, and I_{IN} parameters are referenced to V_{SS} and are applicable to all six channels (HIN1,2,3 and LIN1,2,3). The V_O and I_O parameters are referenced to COM and $V_{S1,2,3}$ and are applicable to the respective output leads: HO1,2,3 and LO1,2,3.

Symbol	Definition	Min	Typ	Max	Units	Test Conditions
V_{IH}	Logic “0” input voltage LIN1,2,3, HIN1,2,3 IR2136	3.0	—	—	V	
V_{IL}	Logic “1” input Voltage LIN1,2,3, HIN1,2,3 IR2136	—	—	0.8		
$V_{EN,TH+}$	Enable positive going threshold	—	—	3		
$V_{EN,TH-}$	Enable negative going threshold	0.8	—	—		
$V_{RCIN,\ TH+}$	RCIN positive going threshold	—	8	—		
$V_{RCIN,\ HYS}$	RCIN input hysteresis	—	3	—		
V_{OH}	High level output voltage, V_{BIAS} - V_O	—	0.9	1.4		Io = 20 mA
V_{OL}	Low level output voltage, V_O	—	0.4	0.6		

Static Electrical Characteristics - (Continued)

V_{BIAS} (V_{CC},$V_{BS1,2,3}$) = 15 V unless otherwise specified. The V_{IN}, V_{TH}, and I_{IN} parameters are referenced to V_{SS} and are applicable to all six channels (HIN1,2,3 and LIN1,2,3). The V_O and I_O parameters are referenced to COM and $V_{S1,2,3}$ and are applicable to the respective output leads: HO1,2,3 and LO1,2,3.

Symbol	Definition		Min	Typ	Max	Units	Test Conditions
V_{CCUVH} V_{BSUVH}	V_{CC} and V_{BS} supply undervoltage lockout hysteresis	IR2136STRPBF-HX	0.3	0.7	—		
I_{LK}	Offset supply leakage current		—	—	50	μA	$V_{B1,2,3}$ = $V_{S1,2,3}$ = 600 V
I_{QBS}	Quiescent V_{BS} supply current		—	70	120		V_{IN} = 0 V or 5 V
I_{QCC}	Quiescent V_{CC} supply current		—	1.6	2.3	mA	
$V_{IN,CLAMP}$	Input clamp voltage (HIN, LIN, ITRIP and EN)		4.9	5.2	5.5	V	I_{IN} =100 μA
I_{ITRIP+}	“High” ITRIP input bias current		—	30	100		V_{ITRIP} = 5 V
I_{ITRIP-}	“Low” ITRIP input bias current		—	0	1		V_{ITRIP} = 0 V
I_{EN+}	“High” ENABLE input bias current		—	30	100		V_{ENABLE} = 5 V
I_{EN-}	“Low” ENABLE input bias current		—	0	1		V_{ENABLE} =0 V
I_{RCIN}	RCIN input bias current		—	0	1		Vrcin= 0 V or 15 V
I_{O+}	Output high short circuit pulsed current		120	200	—	mA	Vo =0 V, PW ≤10 μs
I_{O-}	Output low short circuit pulsed current		250	350	—		Vo =15 V, PW ≤10 μs
R_{on_RCIN}	RCIN low on resistance		—	50	100	Ω	
R_{on_FAULT}	$\overline{FAULT}$ low on resistance		—	50	100		

Dynamic Electrical Characteristics

V_{CC} = V_{BS} = V_{BIAS} = 15 V, $V_{S1,2,3}$ = V_{SS} = COM, T_A = 25 °C and CL = 1000 pF unless otherwise specified.

Symbol	Definition	Min	Typ	Max	Units	Test Conditions
t_r	Turn-on rise time	—	125	190		
t_f	Turn-off fall time	—	50	75		
t_{ITRIP}	ITRIP to output shutdown propagation delay	500	750	1000		V_{ITRIP} = 5 V
t_{bl}	ITRIP blanking time	100	150	—		V_{IN} = 0 V or 5 V V_{ITRIP} = 5 V
t_{FLT}	ITRIP to $\overline{FAULT}$ propagation delay	400	600	800		
t_{FILIN}	Input filter time (HIN, LIN)	100	200	—		V_{IN} = 0 V & 5 V
t_{FLTCLR}	FAULT clear time RCIN: R = 2 MΩ, C = 1 nF	1.3	1.65	2	ms	V_{IN} = 0 V or 5 V V_{ITRIP} = 0 V
DT	Deadtime	220	290	360	ns	V_{IN} = 0 V & 5 V
MT	Matching delay ON and OFF	—	40	75		External dead time >400 ns
MDT	Matching delay, max (t_{on}, t_{off}) – min (t_{on}, t_{off}), (t_{on}, t_{off} are applicable to all 3 channels)	—	25	70		
PM	Output pulse width matching (pwin-pwout) (Fig.2)	—	40	75		

Note: For high side PWM, HIN pulse width must be ≥ 1 µs.

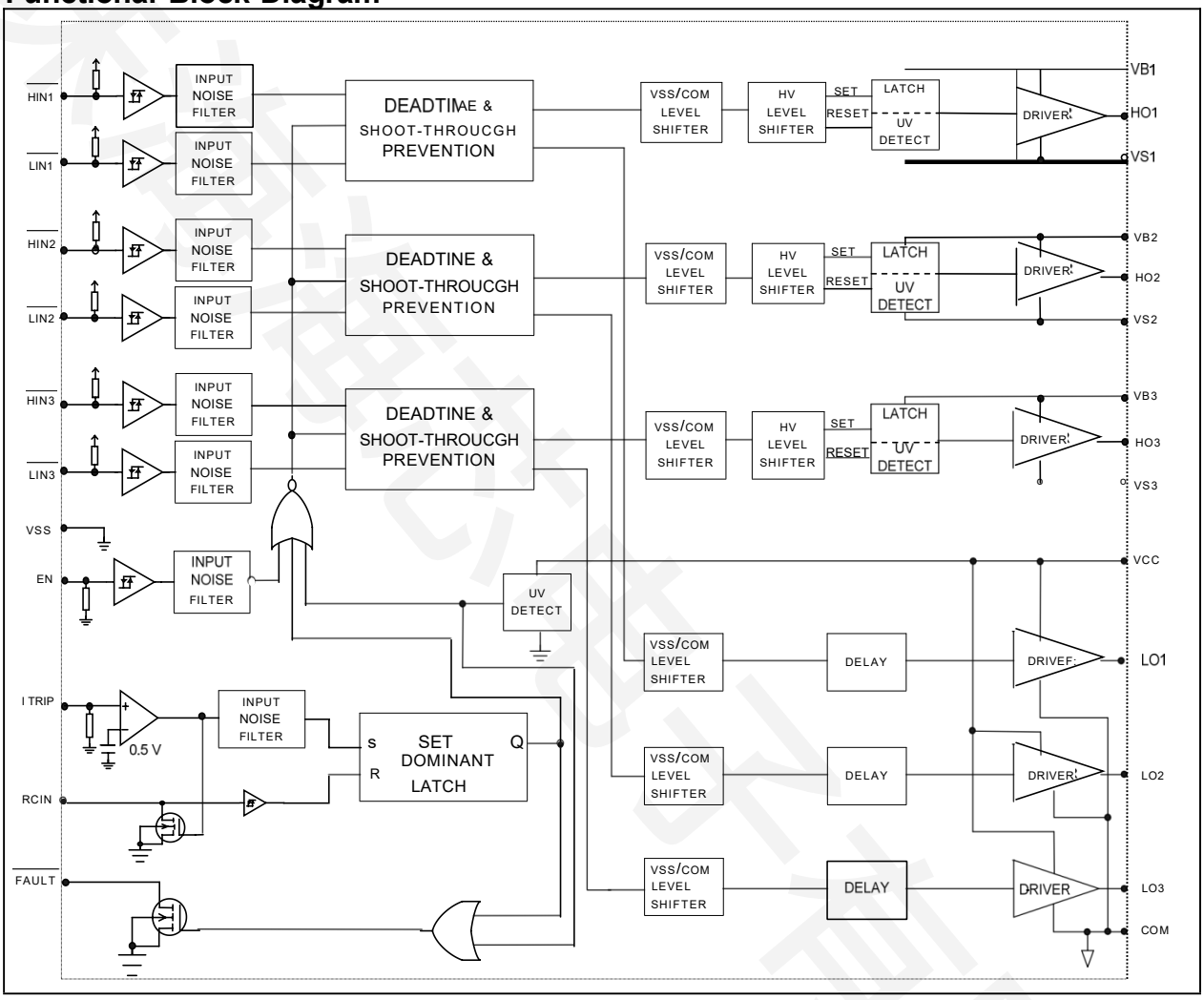
VCC	VBS	ITRIP	ENABLE	FAULT	LO1,2,3	HO1,2,3
<UVCC	X	X	X	0 (note 1)	0	0
15 V	<UVBS	0 V	5 V	high imp	LIN1,2,3	0
15 V	15 V	0 V	5 V	high imp	LIN1,2,3	HIN1,2,3
15 V	15 V	>V_{ITRIP}	5 V	0 (note 2)	0	0
15 V	15 V	0 V	0 V	high imp	0	0

Note 1: A shoot-through prevention logic prevents LO1,2,3 and HO1,2,3 for each channel from turning on simultaneously.

Note 2: UVCC is not latched, when V_{CC} > UV_{CC}, FAULT returns to high impedance.

Note 3: When ITRIP < V_{ITRIP}, FAULT returns to high-impedance after RCIN pin becomes greater than 8 V (@ V_{CC} = 15 V).

Functional Block Diagram

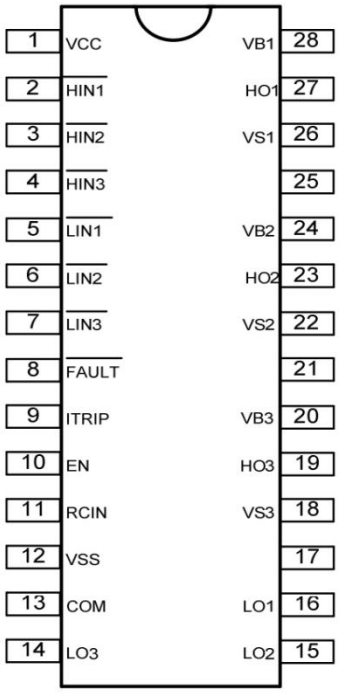


Lead Definitions

Symbol	Description
V_{CC}	Low side and logic fixed supply
V_{SS}	Logic ground
HIN1,2,3 HIN1,2,3	Logic inputs for high side gate driver outputs (HO1,2,3), out of phase (IR2136STRPBF-HX])
$\overline{\text{LIN1,2,3}}$	Logic input for low side gate driver outputs (LO1,2,3), out of phase
FAULT	Indicates over-current (ITRIP) or low-side undervoltage lockout has occurred. Negative logic, open-drain output
EN	Logic input to enable I/O functionality. I/O logic functions when ENABLE is high (i.e., positive logic) No effect on FAULT and not latched
ITRIP	Analog input for overcurrent shutdown. When active, ITRIP shuts down outputs and activates FAULT and RCIN low. When ITRIP becomes inactive, FAULT stays active low for an externally set time T_{FLTCLR}, then automatically becomes inactive (open-drain high impedance).
RCIN	External RC network input used to define FAULT CLEAR delay, $T_{FLTCLR,}$ approximately equal to R*C. When RCIN>8 V, the FAULT pin goes back into open-drain high-impedance
COM	Low side gate drivers return
$V_{B1,2,3}$	High side floating supply
HO1,2,3	High side gate driver outputs
$V_{S1,2,3}$	High voltage floating supply return
LO1,2,3	Low side gate driver outputs

Note: All input pins and the ITRIP pin are internally clamped with a 5.2 V zener diode.

Lead Assignments



28 Lead SOIC (wide body)

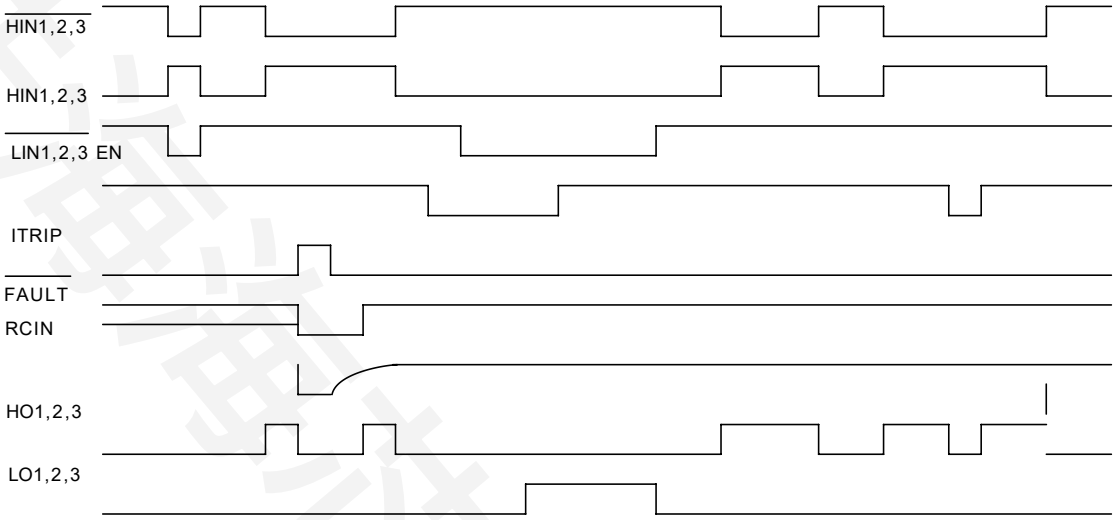


Fig. 1. Input/Output Timing Diagram

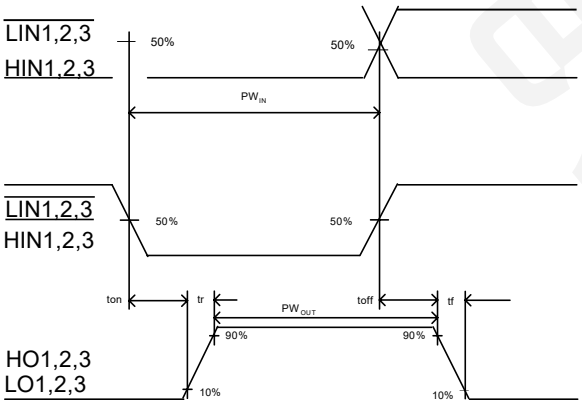


Fig. 2. Switching Time Waveforms

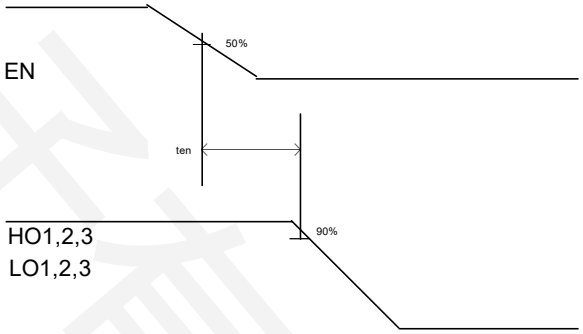


Fig. 3. Output Enable Timing Waveform

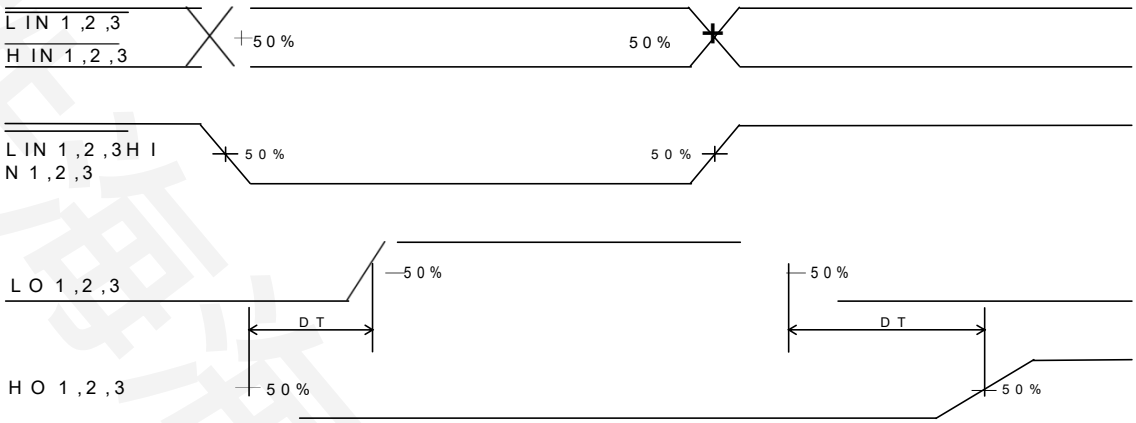


Fig. 4. Internal Deadtime Timing Waveforms

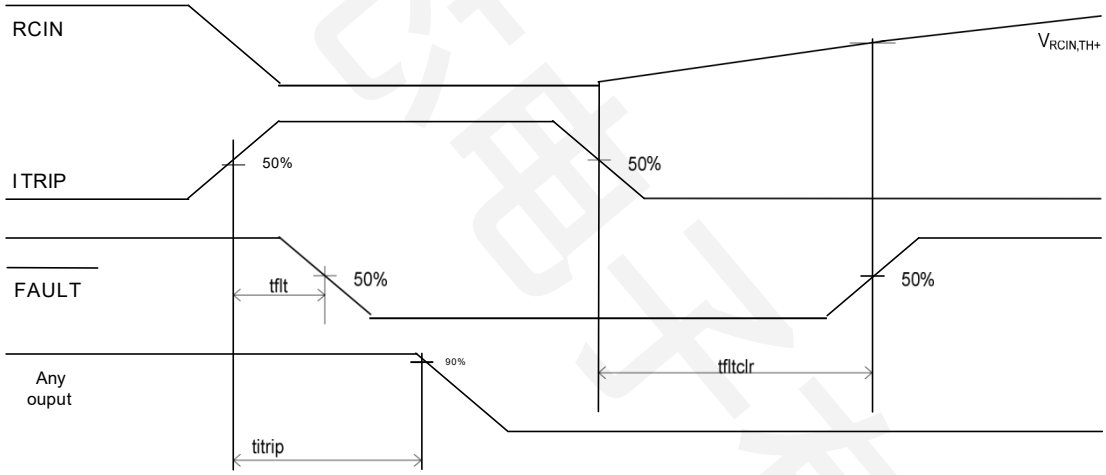


Fig. 5. ITRIP/RCIN Timing Waveforms

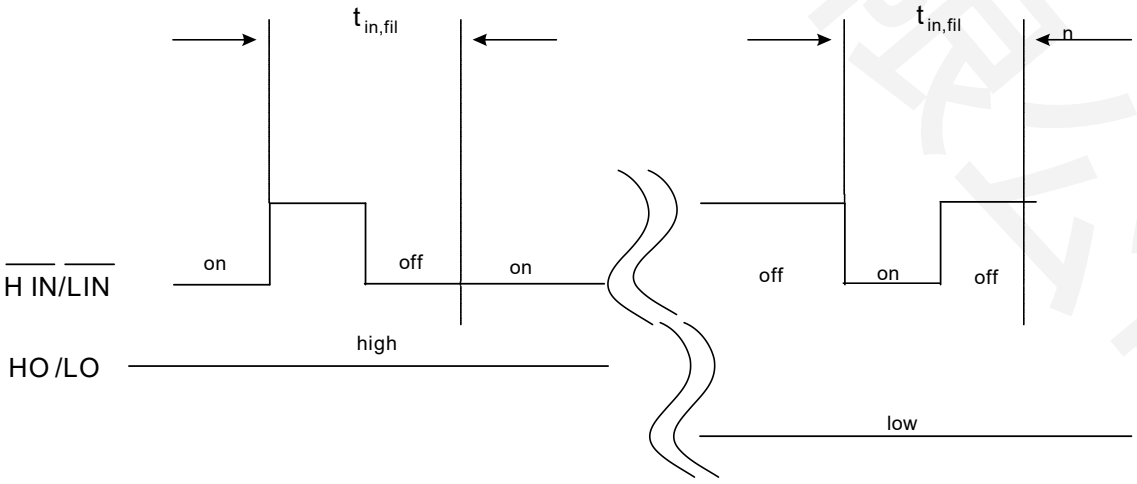


Fig. 6. Input Filter Function

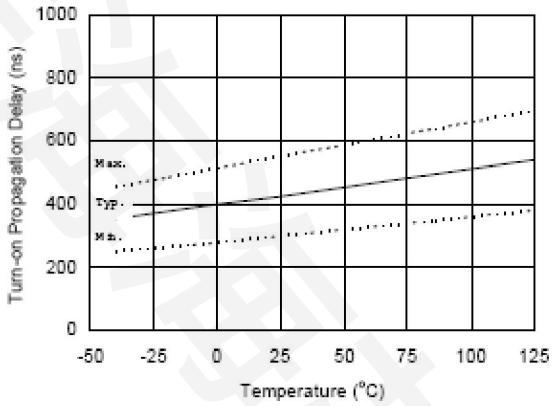


Figure 6A. Turn-on Propagation Delay vs. Temperature

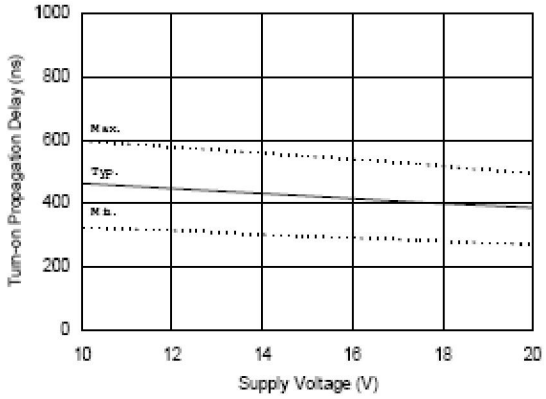


Figure 6B. Turn-on Propagation Delay vs. Supply Voltage

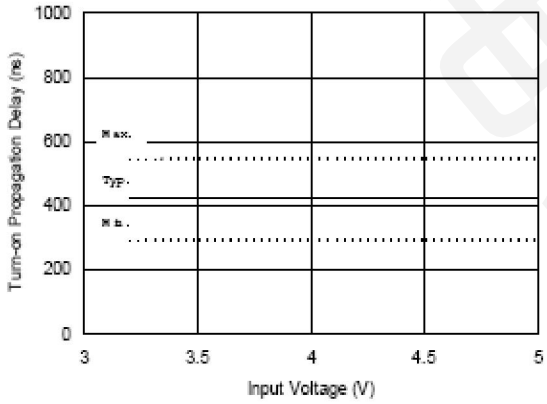


Figure 6C. Turn-on Propagation Delay vs. Input Voltage

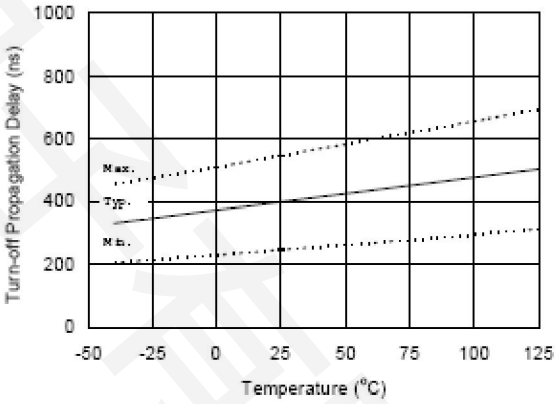


Figure 7A. Turn-off Propagation Delay vs. Temperature

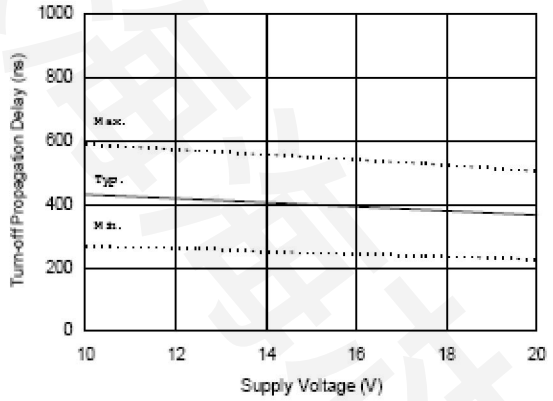


Figure 7B. Turn-off Propagation Delay vs. Supply Voltage

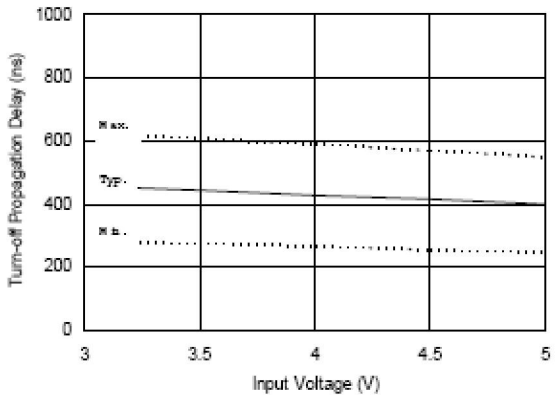


Figure 7C. Turn-off Propagation Delay vs. Input Voltage

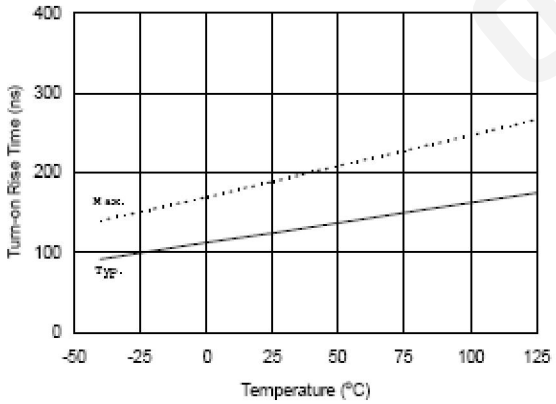


Figure 8A. Turn-on Rise Time vs. Temperature

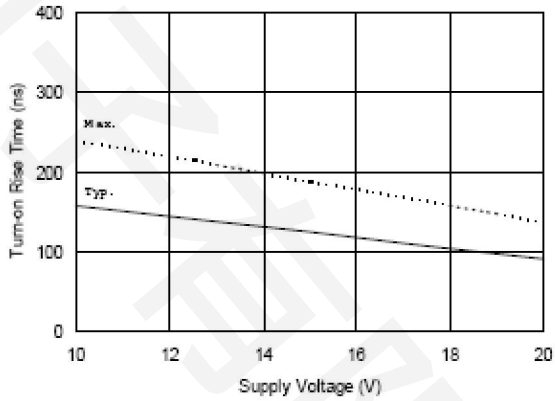


Figure 8B. Turn-on Rise Time vs. Supply Voltage

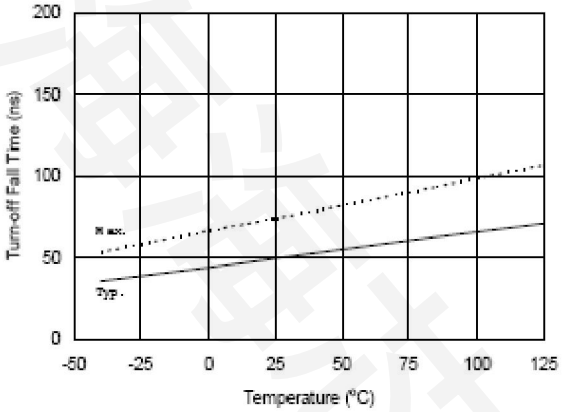


Figure 9A. Turn-off Fall Time vs. Temperature

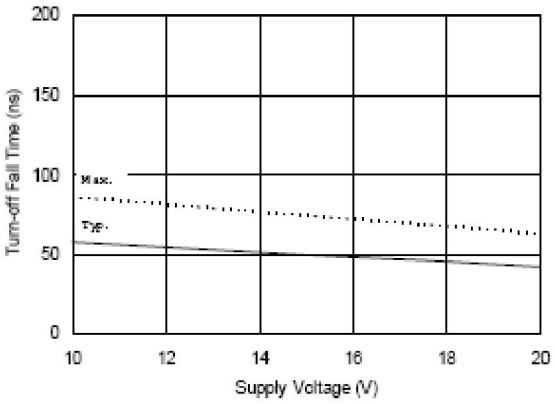


Figure 9B. Turn-off Fall Time vs. Supply Voltage

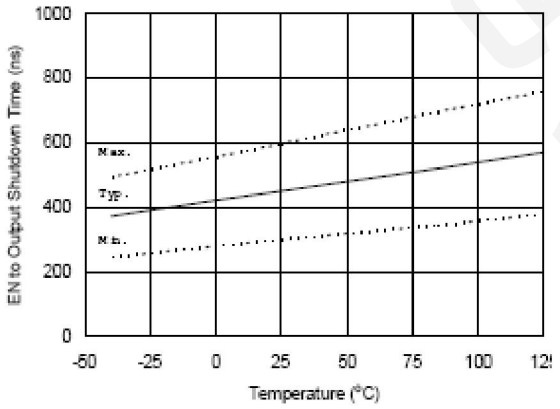


Figure 10A. EN to Output Shutdown Time vs. Temperature

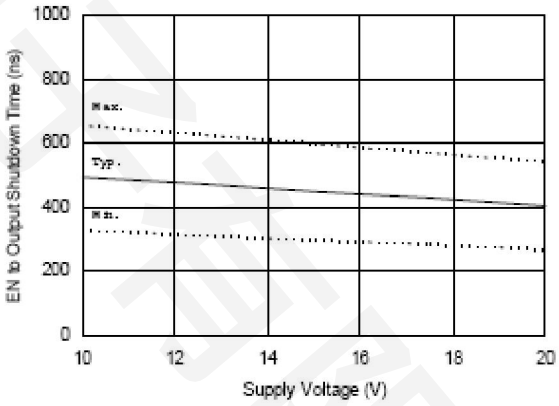


Figure 10B. EN to Output Shutdown Time vs. Supply Voltage

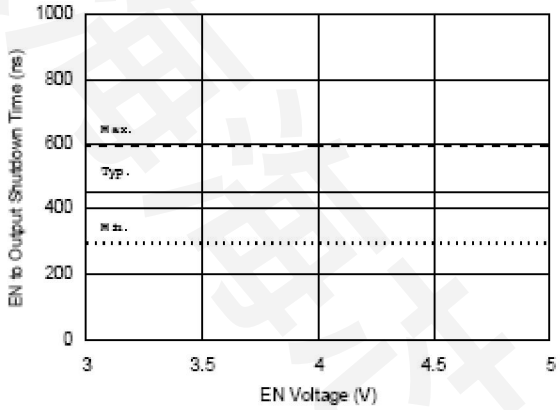


Figure 10C. EN to Output Shutdown Time vs. EN Voltage

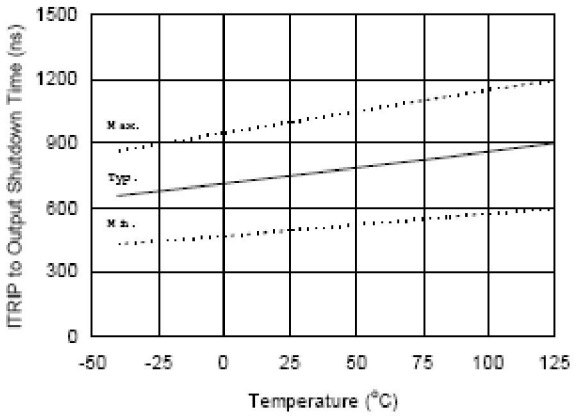


Figure 11A. ITRIP to Output Shutdown Time vs. Temperature

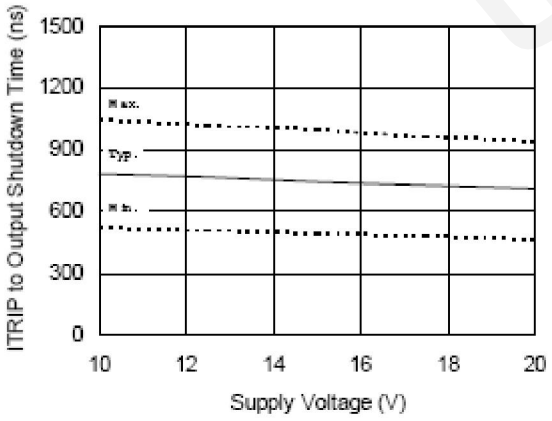


Figure 11B. ITRIP to Output Shutdown Time vs. Supply Voltage

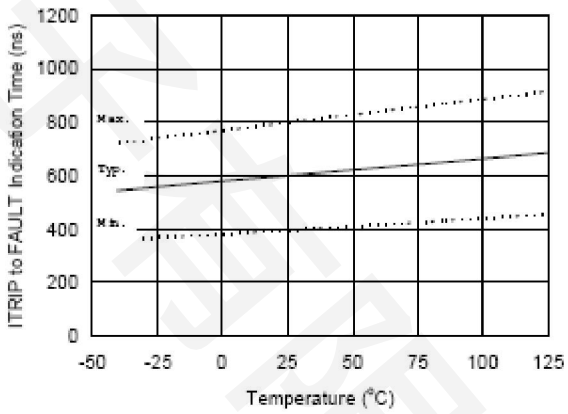


Figure 12A. ITRIP to FAULT Indication Time vs. Temperature

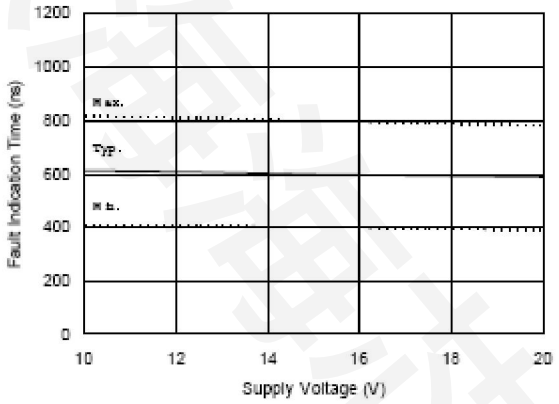


Figure 12B. ITRIP to FAULT Indication Time vs. Supply Voltage

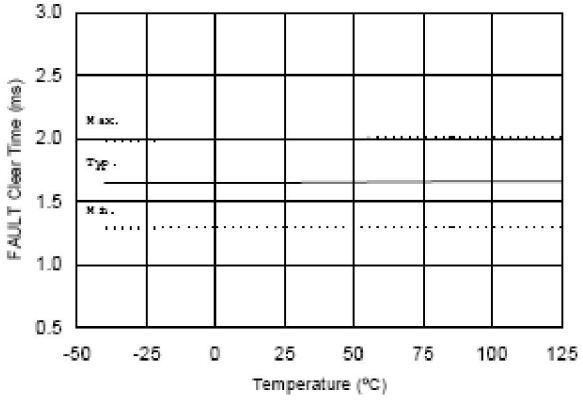


Fig13A. FAULT Clear Time vs. Temperature

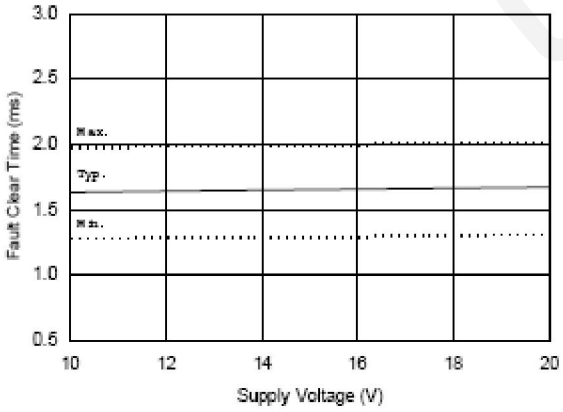


Figure 13B. FAULT Clear Time vs. Supply Voltage

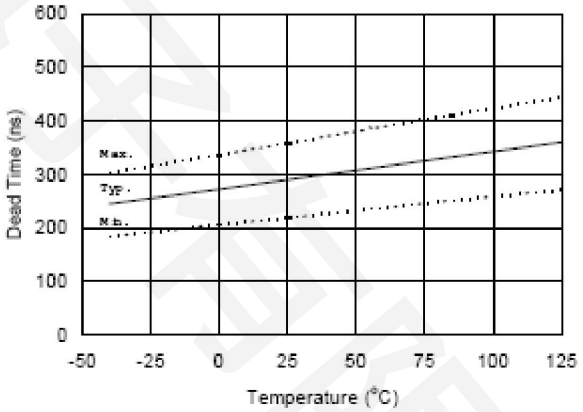


Figure 14A. Dead Time vs. Temperature

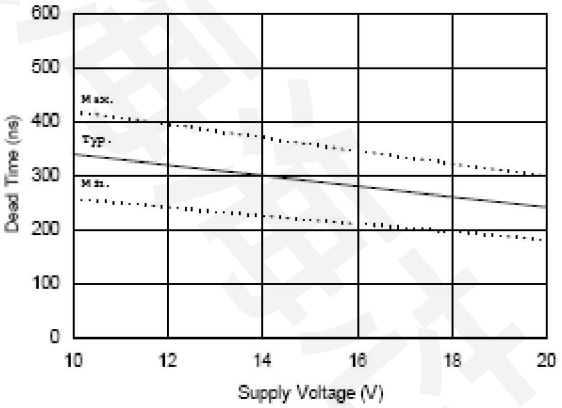


Figure 14B. Dead Time Time vs. Supply Voltage

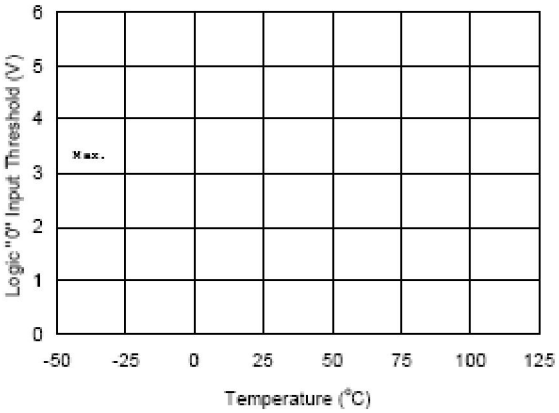


Figure 15A. Logic "0" Input Threshold vs. Temperature

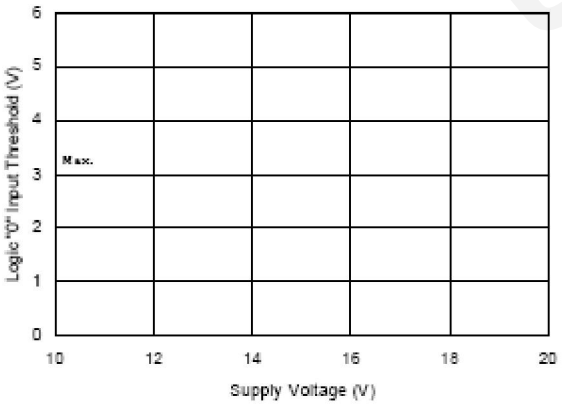


Figure 15B. Logic "0" Input Threshold vs. Supply Voltage

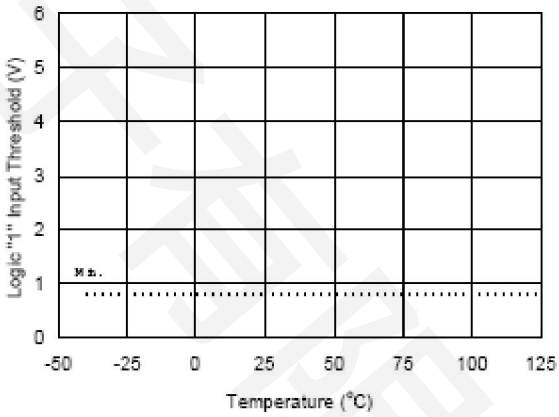


Figure 16A. Logic "1" Input Threshold vs. Temperature

Figure 16B. Logic "1" Input Threshold vs. Supply Voltage

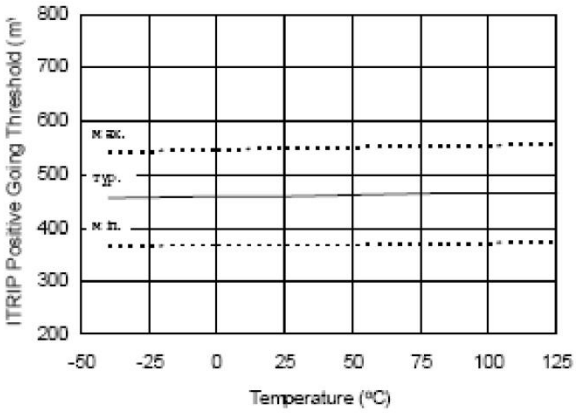


Figure 17A. ITRIP Positive Going Threshold vs. Temperature

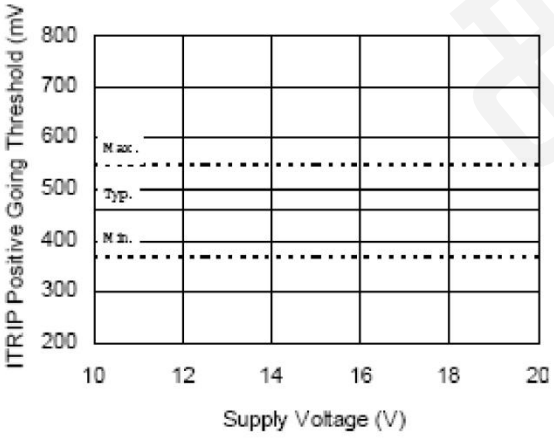


Figure 17B. ITRIP Positive Going Threshold vs. Supply Voltage

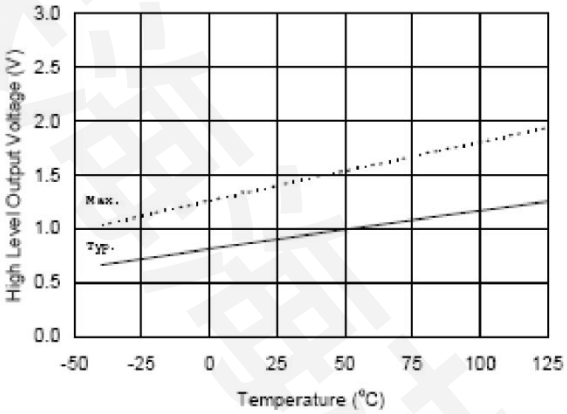


Figure 18A. High Level Output vs. Temperature

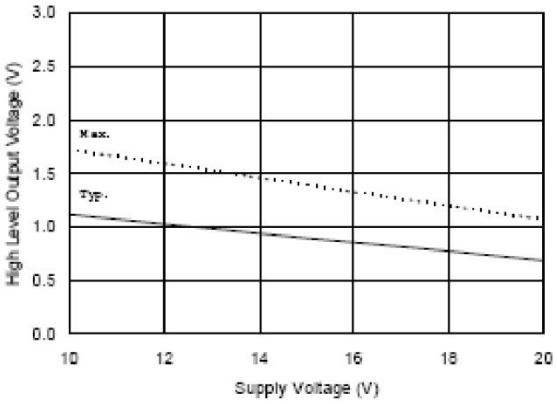


Figure 18B. High Level Output vs. Supply Voltage

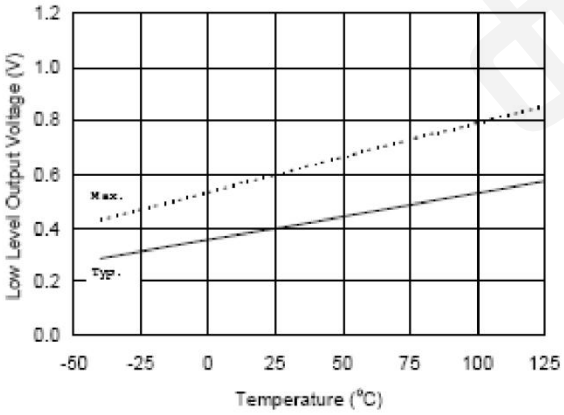


Figure 19A. Low Level Output vs. Temperature

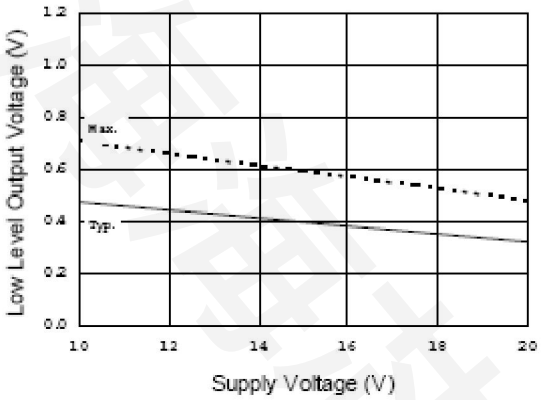


Figure 19B. Low Level Output vs. Supply Voltage

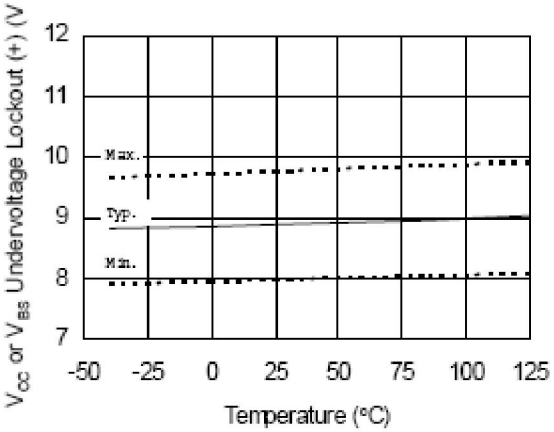


Figure 20. V_{CC} or V_{BS} Undervoltage (+) vs. Temperature

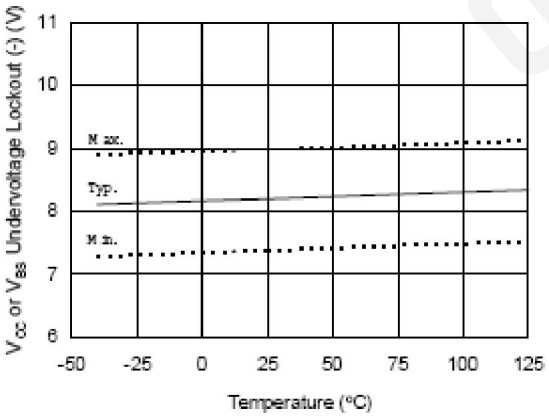


Figure 21. V_{CC} or V_{BS} Undervoltage (-) vs. Temperature

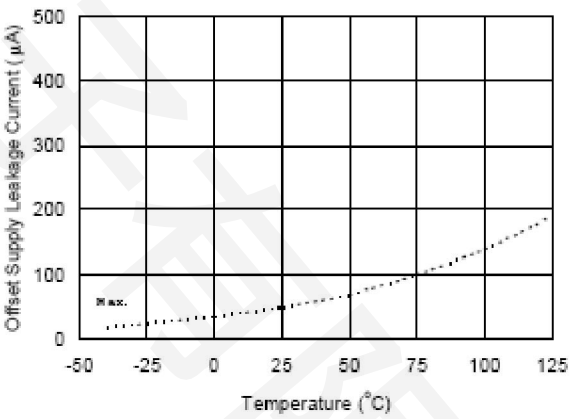


Figure 22A. Offset Supply Leakage Current vs. Temperature

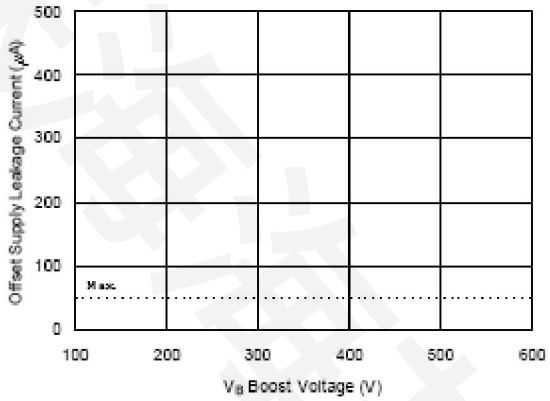


Figure 22B. Offset Supply Leakage Current vs. V_B Boost Voltage

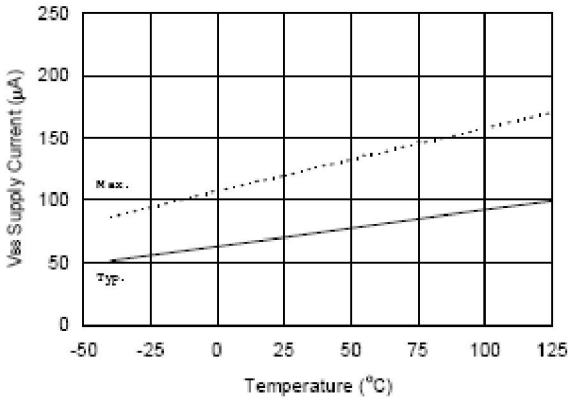


Figure 23A. V_{BS} Supply Current vs. Temperature

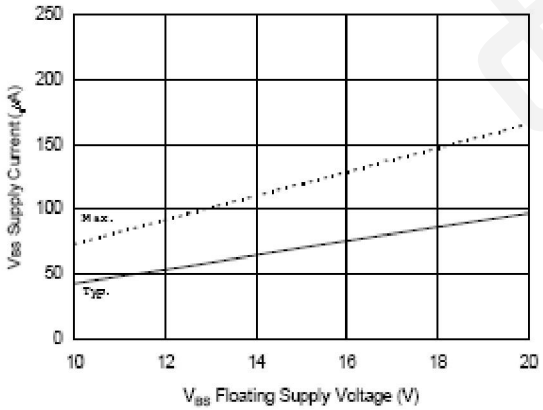


Figure 23B. V_{BS} Supply Current vs. V_{BS} Floating Supply Voltage

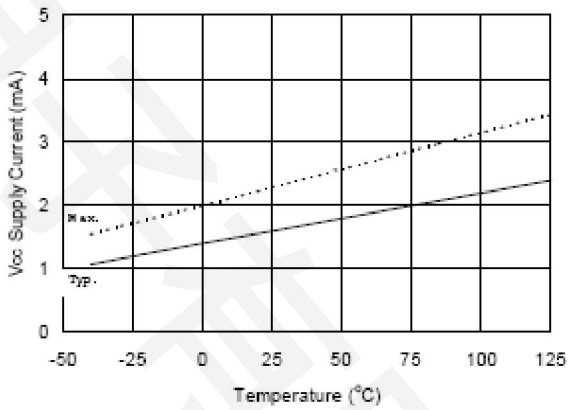


Figure 24A. V_{CC} Supply Current vs. Temperature

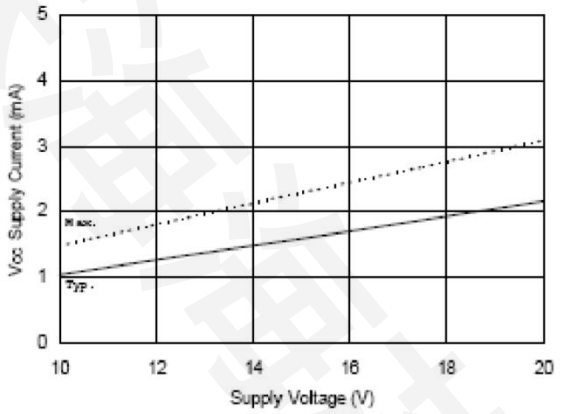


Figure 24B. V_{CC} Supply Current vs. V_{CC} Supply Voltage

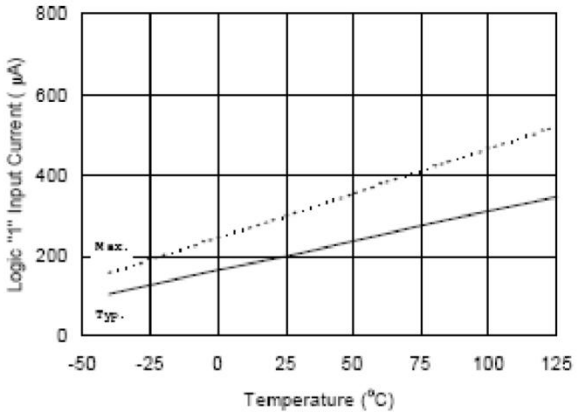


Figure 25A. Logic "1" Input Current vs. Temperature

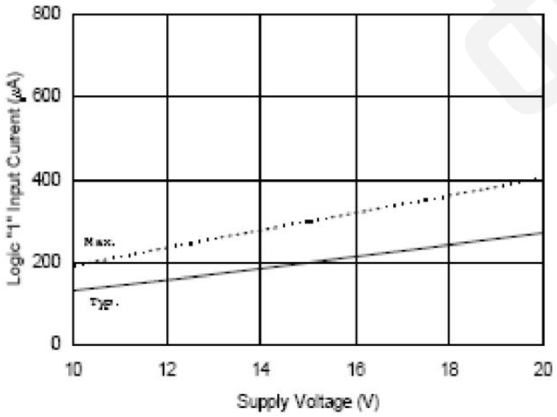


Figure 25B. Logic "1" Input Current vs. Supply Voltage

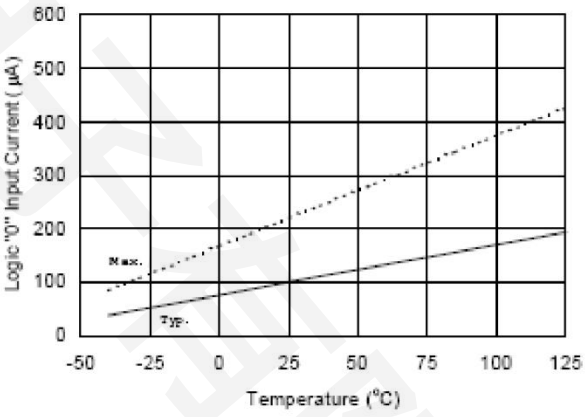


Figure 26A. Logic "0" Input Current vs. Temperature

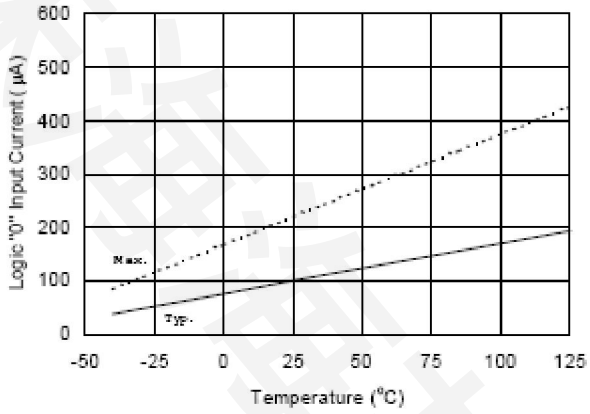


Figure 27. Logic "0" Input Current vs. Temperature

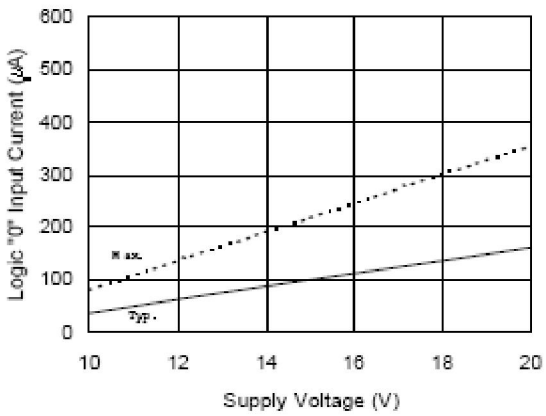


Figure 28. Logic "0" Input Current vs. Supply Voltage

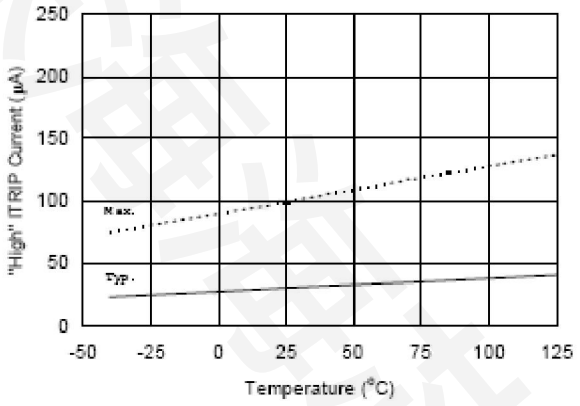


Figure 29A. "High" ITRIP Current vs. Temperature

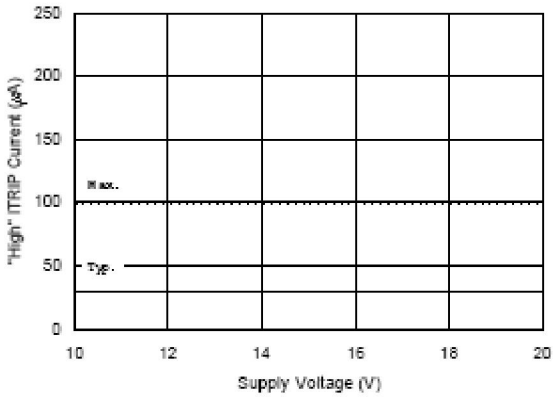


Figure 29B. "High" ITRIP Current vs. Supply Voltage

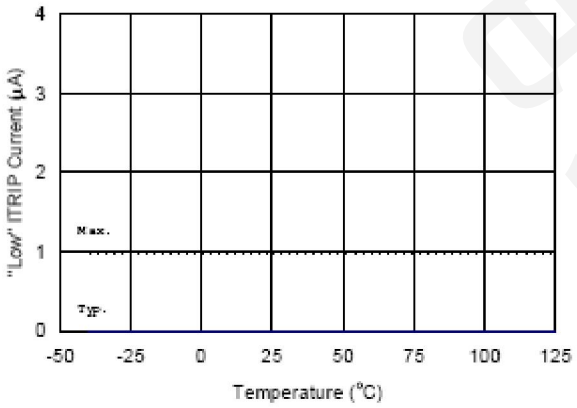


Figure 30A."Low" ITRIP Current vs. Temperature

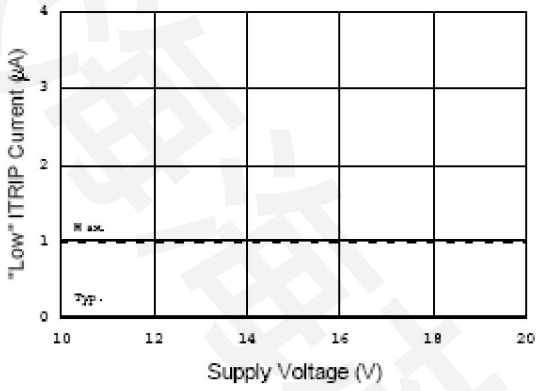


Figure 30B. "Low" ITRIP Current vs. Supply Voltage

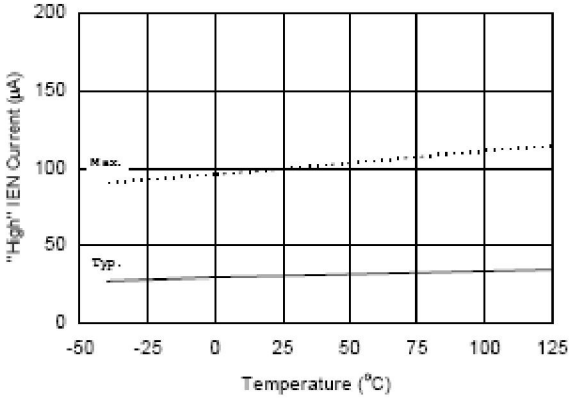


Figure 31A. "High" IEN Current vs. Temperature

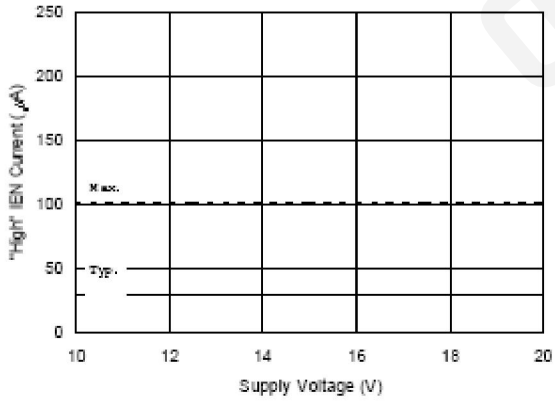


Figure 31B. "High" IEN Current vs. Supply Voltage

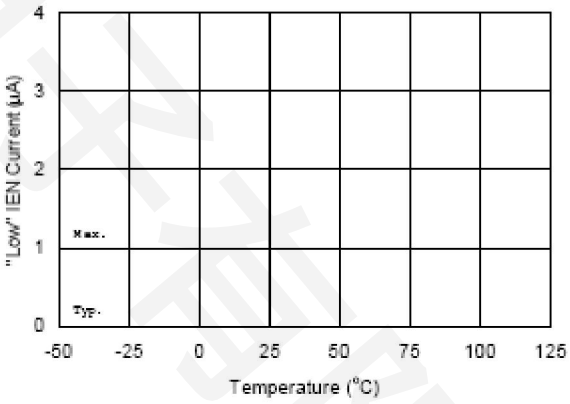


Figure 32A. "Low" IEN Current vs. Temperature

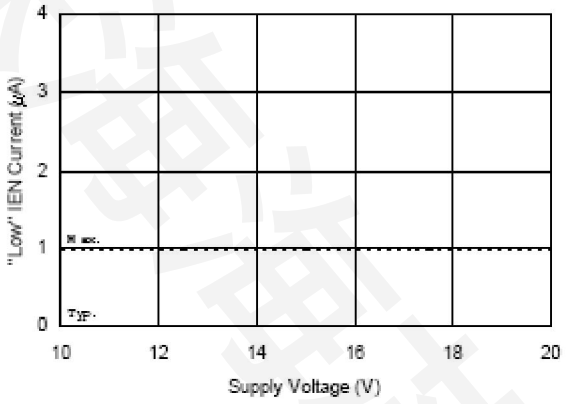


Figure 32B. "Low" IEN Current vs. Supply Voltage

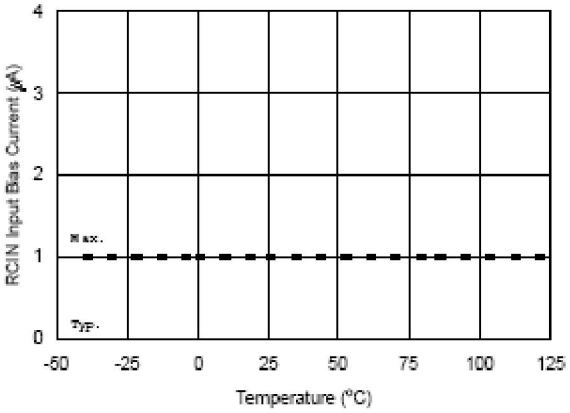


Figure 33A. RCIN Input Bias Current vs. Temperature

Figure 34B. "Low" IEN Current vs. Supply Voltage

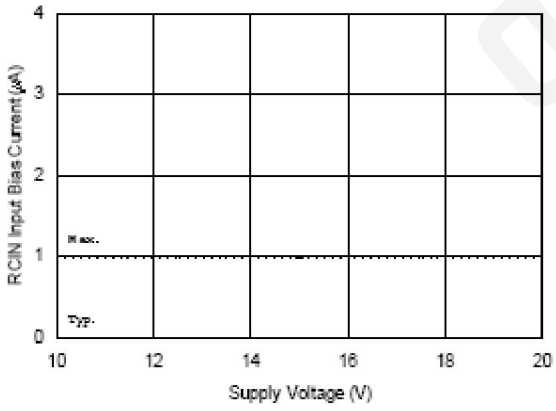


Figure 33B. RCIN Input Bias Current vs. Supply Voltage

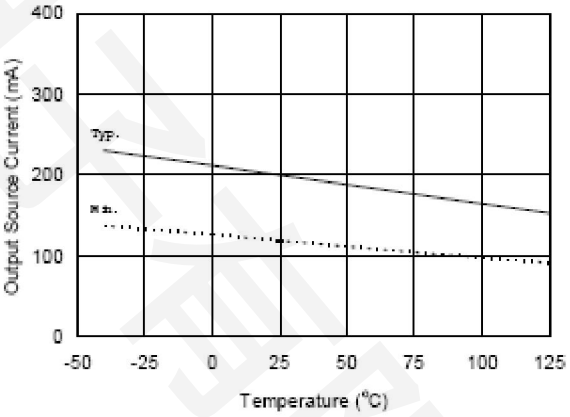


Figure 34A. Output Source Current vs. Temperature

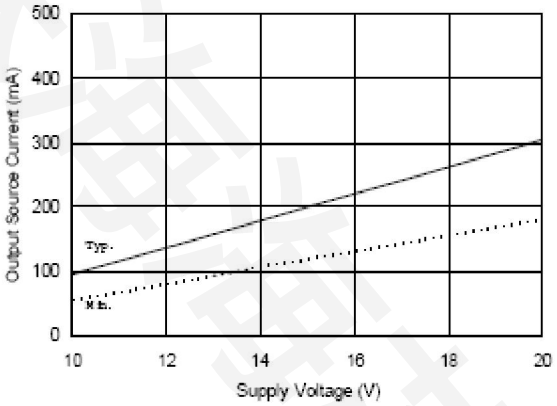


Figure 34B. Output Source Current vs. Supply Voltage

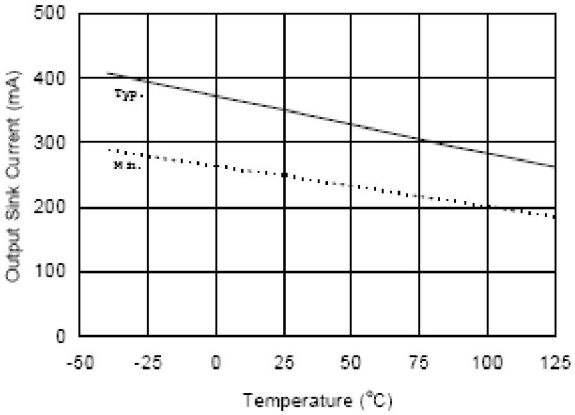


Figure 35A. Output Sink Current vs. Temperature

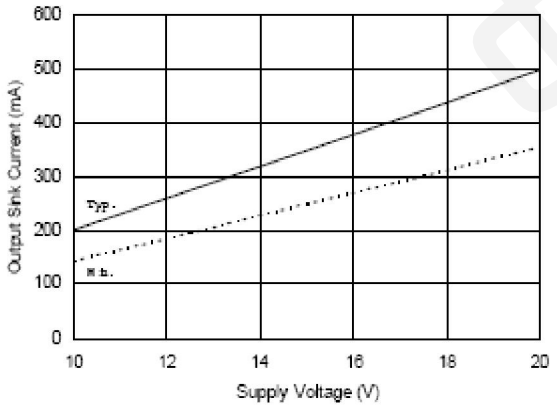


Figure 35B. Output Sink Current vs. Supply Voltage

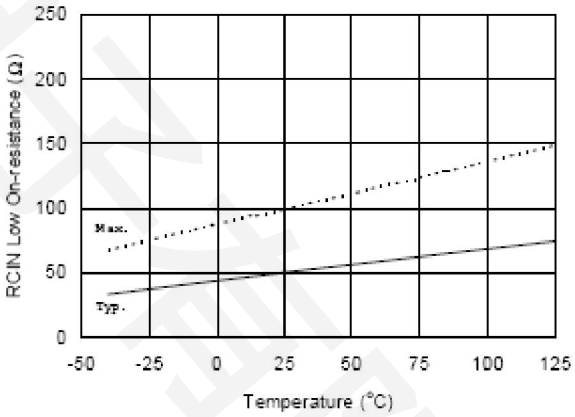


Figure 36A. RCIN Low On-resistance vs. Temperature

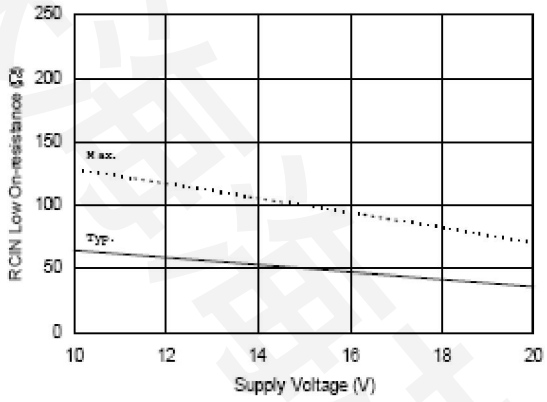


Figure 36B. RCIN Low On-resistance vs. Supply Voltage

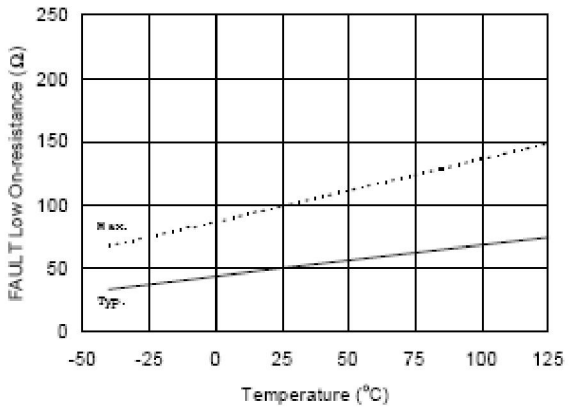


Figure 37A. FAULT Low On-resistance vs. Temperature

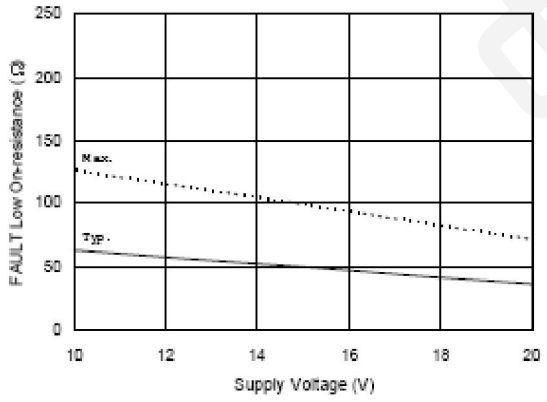


Figure 37B. FAULT Low On-resistance vs. Supply Voltage

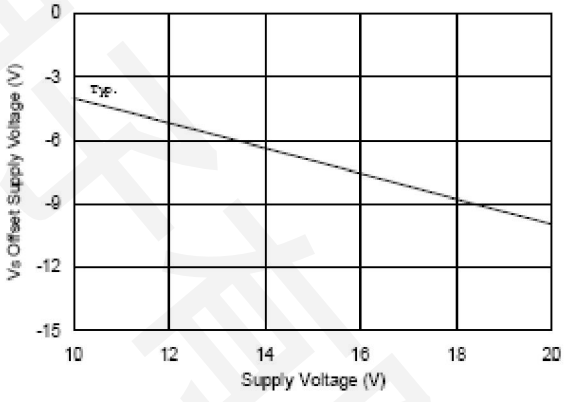


Figure 38. Maximum V_S Negative Offset vs. V_{BS} Supply Voltage

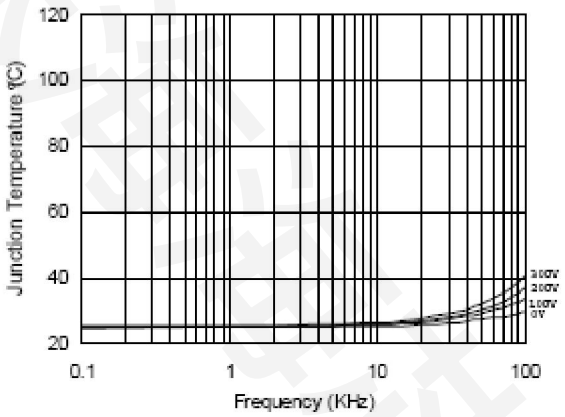


Figure 39. IR2136STRPBF-HX vs.Frequency(IRG4BC20W)，Rgate=33Ω，Vcc=15V

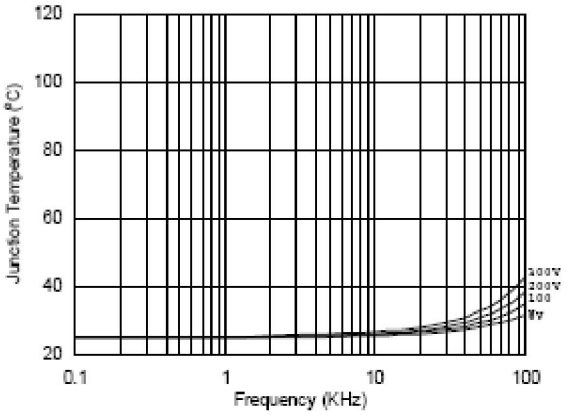


Figure 40. IR2136STRPBF-HX vs.Frequency(IRG4BC30W)，Rgate=15Ω，Vcc=15V

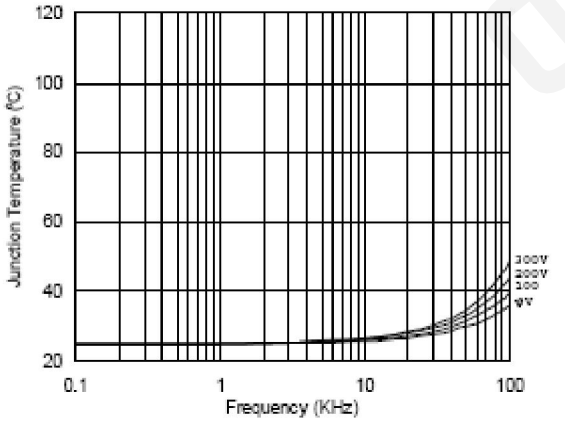


Figure 41. IR2136STRPBF-HX vs.Frequency(IRG4BC40W)，Rgate=10Ω，Vcc=15V

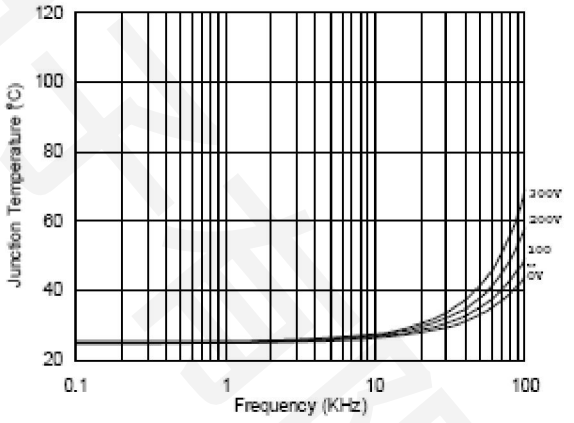


Figure 42. IR2136STRPBF-HX vs.Frequency(IRG4PC50W)，Rgate=5Ω，Vcc=15V

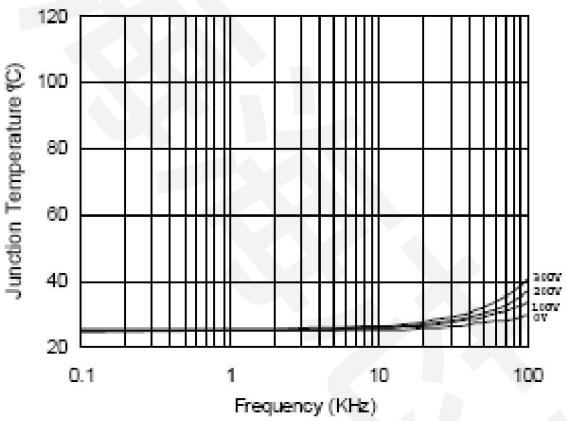


Figure 43. IR2136STRPBF-HX vs.Frequency(IRG4BC20W), Rgate=33Ω，Vcc=15V

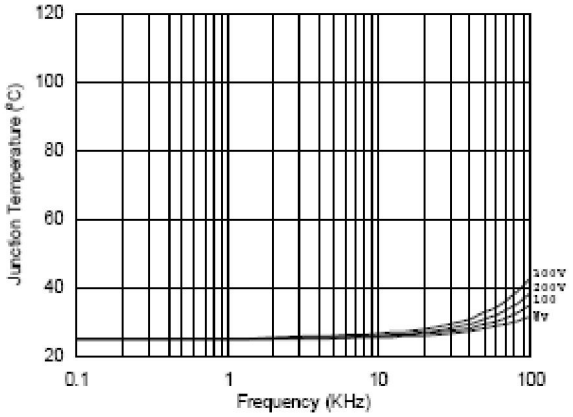


Figure 44. IR2136STRPBF-HX vs.Frequency(IRG4BC30W), Rgate=15Ω，Vcc=15V

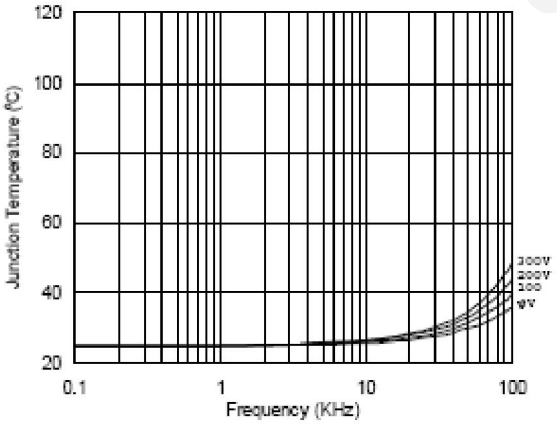


Figure 45. IR2136STRPBF-HX vs.Frequency(IRG4BC40W), Rgate=10Ω，Vcc=15V

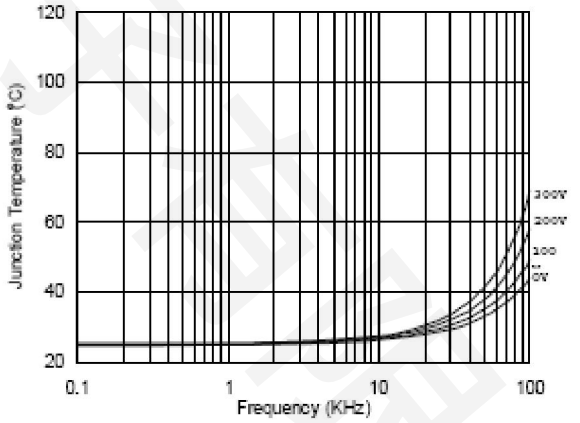


Figure 46. IR2136STRPBF-HX vs.Frequency(IRG4PC50W), Rgate=5Ω，Vcc=15V

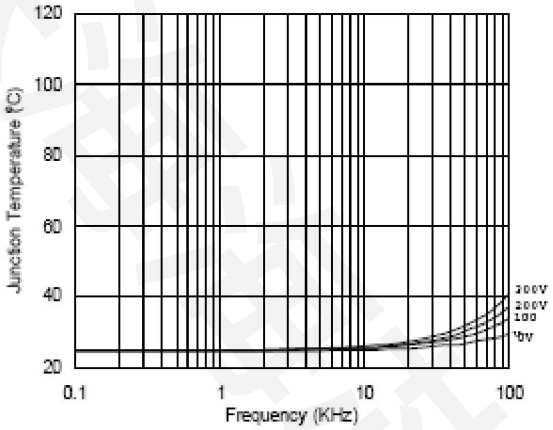


Figure 47. IR2136STRPBF-HX vs.Frequency(IRG4BC20W), Rgate=33Ω, Vcc=15V

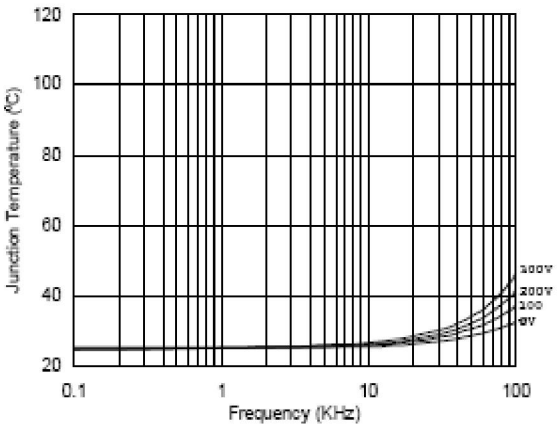


Figure 48. IR2136STRPBF-HX vs.Frequency(IRG4BC30W), Rgate=15Ω, Vcc=15V

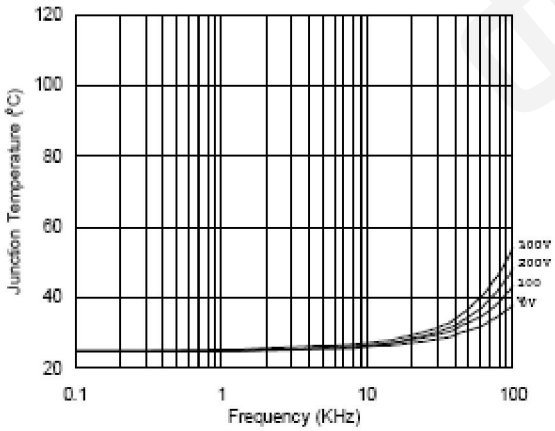


Figure 49. IR2136STRPBF-HX vs.Frequency(IRG4BC40W), Rgate=10Ω, Vcc=15V

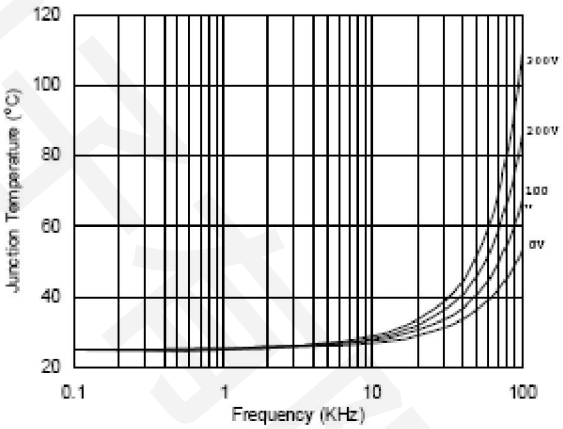


Figure 50. IR2136STRPBF-HX vs.Frequency(IRG4PC50W), Rgate=5Ω, Vcc=15V

Case Outlines