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FOD8332 — Input LED Drive, 2.5 A Output Current, IGBT Drive Optocoupler with Desaturation Detection, Isolated Fault Sensing, and Active Miller Clamp

# FOD8332

## Input LED Drive, 2.5 A Output Current, IGBT Drive Optocoupler with Desaturation Detection, Isolated Fault Sensing, and Active Miller Clamp

### Features

- Input LED Drive Facilitates Receiving Digitally Encoded Signals from PWM Output
- Optically Isolated Fault-Sensing Feedback
- Active Miller Clamp to Shut Off IGBT During High  $dv/dt$  without Negative Supply Voltage
- High Noise Immunity Characterized by Common Mode Rejection – 35 kV/ $\mu$ s Minimum,  $V_{CM} = 1500 V_{PEAK}$
- 2.5 A Peak Output Current Driving Capability for Medium Power IGBT
  - P-Channel MOSFETs at Output Stage Enable Output Voltage Swing Close to Supply Rail (Rail-to-Rail Output)
  - Wide Supply Voltage Range: 15 V to 30 V
- Integrated IGBT Protection
  - Desaturation Detection
  - “Soft” IGBT Turn-Off
  - Under-Voltage Lockout (UVLO) with Hysteresis
- Fast Switching Speed Over Full Operating Temperature Range
  - 250 ns Maximum Propagation Delay
  - 100 ns Maximum Pulse Width Distortion
- Extended Industrial Temperature Range:
  - $-40^{\circ}\text{C}$  to  $100^{\circ}\text{C}$
- Safety and Regulatory Approvals
  - UL1577, 4,243  $V_{RMS}$  for 1 Minute
  - DIN-EN/IEC60747-5-5:
    - 1,414  $V_{PEAK}$  Working Insulation Voltage Rating
    - 8,000  $V_{PEAK}$  Transient Isolation Voltage Rating
- 8 mm Creepage and Clearance Distances

### Applications

- AC and Brushless DC Motor Drive
- Industrial Inverter
- Uninterruptible Power Supply
- Induction Heating
- Isolated IGBT/Power MOSFET Gate Drive

### Description

The FOD8332 is an advanced 2.5 A output current IGBT drive optocoupler capable of driving medium-power IGBTs with ratings up to 1,200 V and 150 A. It is suited for fast-switching driving of power IGBTs and MOSFETs in motor-control inverter applications and high-performance power systems. The FOD8332 offers protection features necessary for preventing fault conditions that lead to destructive thermal runaway of IGBTs.

The device utilizes Fairchild’s proprietary Optoplanar<sup>®</sup> coplanar packaging technology and optimized IC design to achieve reliable high isolation and high noise immunity, characterized by high common-mode rejection and power supply rejection specifications. The device is housed in a wide-body, 16-pin, small-outline, plastic package.

The gate-driver channel consists of an aluminum gallium arsenide (AlGaAs) light-emitting diode (LED) optically coupled to an integrated high-speed driver circuit with a low- $R_{DS(ON)}$  MOSFET output stage. The fault-sense channel consists of an AlGaAs LED optically coupled to an integrated high-speed feedback circuit for fault sensing.

### Related Resources

- [FOD8316—2.5 A Output Current, IGBT Drive Optocoupler with Desaturation, Isolated Fault Sensing](#)
- [FOD8318—2.5 A Output Current, IGBT Drive Optocoupler with Active Miller Clamp, Desaturation Detection, and Isolated Fault Sensing](#)
- [FOD8333 – Input LED Drive, 2.5 A Output Current, IGBT Drive Optocoupler with Desaturation Detection, Isolated Fault Sensing, Active Miller Clamp, and Automatic Fault Reset](#)
- [AN-3009—Standard Gate-Driver Optocouplers](#)
- [www.fairchildsemi.com/search/tree/optoelectronics/](http://www.fairchildsemi.com/search/tree/optoelectronics/)

## Truth Table

LED	UVLO ( $V_{DD} - V_E$ )	DESAT Detected?	FAULT <sup>(1)</sup>	$V_O$
X	Active	X	HIGH	LOW
On	Not Active	Yes	LOW	LOW
Off	X	X	HIGH	LOW
On	Not Active	No	HIGH	HIGH

### Note:

1. FAULT pin is connected to a pull-up resistor.

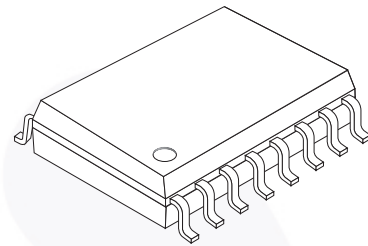
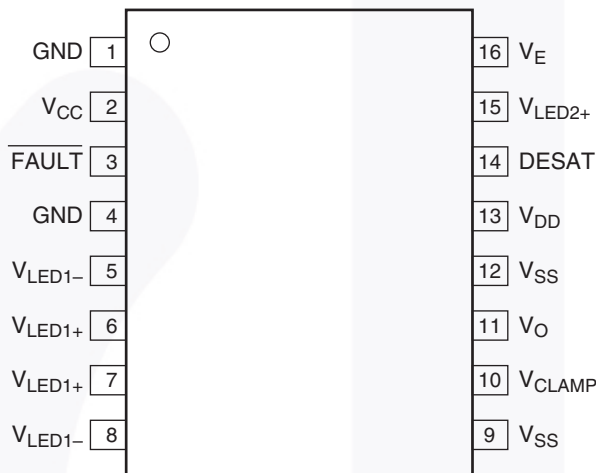


Figure 2. Pin Configuration

## Pin Definitions

Pin #	Name	Description
1	GND	Ground for Fault-Sense Optocoupler
2	$V_{CC}$	Positive Supply Voltage (3 V to 15 V) for Fault Sense Optocoupler
3	FAULT	Fault-Sense Output
4	GND	Ground for Fault-Sense Optocoupler
5	$V_{LED1-}$	LED1 Cathode
6	$V_{LED1+}$	LED1 Anode
7	$V_{LED1+}$	LED1 Anode
8	$V_{LED1-}$	LED1 Cathode
9	$V_{SS}$	Negative Output Supply Voltage
10	$V_{CLAMP}$	Clamp Supply Voltage
11	$V_O$	Gate-Drive Output Voltage
12	$V_{SS}$	Negative Output Supply Voltage
13	$V_{DD}$	Positive Output Supply Voltage
14	DESAT	Desaturation Voltage Input
15	$V_{LED2+}$	LED2 Anode (Do not connect. Leave floating.)
16	$V_E$	Output Supply Voltage/IGBT Emitter

### Block Diagram

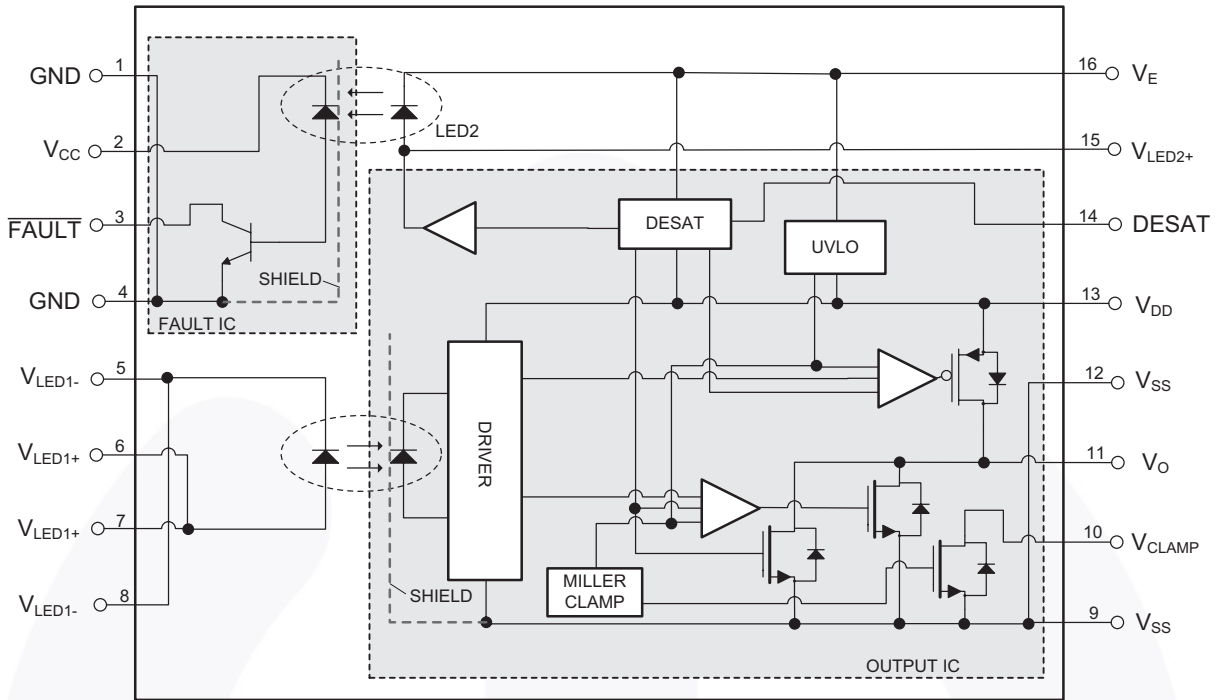


Figure 3. Functional Block Diagram

## Safety and Insulation Ratings

As per DIN EN/IEC 60747-5-5, this optocoupler is suitable for “safe electrical insulation” only within the safety limit data. Compliance with the safety ratings must be ensured by means of protective circuits.

Symbol	Parameter	Min.	Typ.	Max.	Unit
	Installation Classifications per DIN VDE 0110/1.89 Table 1				
	Rated Mains Voltage < 150 V <sub>RMS</sub>		I–IV		
	Rated Mains Voltage < 300 V <sub>RMS</sub>		I–IV		
	Rated Mains Voltage < 450 V <sub>RMS</sub>		I–IV		
	Rated Mains Voltage < 600 V <sub>RMS</sub>		I–IV		
	Rated Mains Voltage < 1000 V <sub>RMS</sub>		I–III		
	Climatic Classification		40/100/21		
	Pollution Degree (DIN VDE 0110/1.89)		2		
CTI	Comparative Tracking Index (DIN IEC 112/VDE 0303 Part 1)	175			
V <sub>PR</sub>	Input-to-Output Test Voltage, Method b, V <sub>IORM</sub> × 1.875 = V <sub>PR</sub> , 100% Production Test with t <sub>m</sub> = 1 s, Partial Discharge < 5 pC	2651			V <sub>peak</sub>
	Input-to-Output Test Voltage, Method a, V <sub>IORM</sub> × 1.6 = V <sub>PR</sub> , Type and Sample Test with t <sub>m</sub> = 10 s, Partial Discharge < 5 pC	2262			V <sub>peak</sub>
V <sub>IORM</sub>	Maximum Working Insulation Voltage	1414			V <sub>peak</sub>
V <sub>IOTM</sub>	Highest Allowable Over Voltage	8000			V <sub>peak</sub>
	External Creepage	8.0			mm
	External Clearance	8.0			mm
	Insulation Thickness	0.5			mm
T <sub>Case</sub>	Safety Limit Values – Maximum Values in Failure; Case Temperature	150			°C
P <sub>S,INPUT</sub>	Safety Limit Values – Maximum Values in Failure; Input Power	100			mW
P <sub>S,OUTPUT</sub>	Safety Limit Values – Maximum Values in Failure; Output Power	600			mW
R <sub>IO</sub>	Insulation Resistance at T <sub>S</sub> , V <sub>IO</sub> = 500 V	10 <sup>9</sup>			Ω

## Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.  $T_A = 25^\circ\text{C}$  unless otherwise specified.

Symbol	Parameter	Value	Units
$T_{STG}$	Storage Temperature	-40 to +125	$^\circ\text{C}$
$T_{OPR}$	Operating Temperature	-40 to +100	$^\circ\text{C}$
$T_J$	Junction Temperature	-40 to +125	$^\circ\text{C}$
$T_{SOL}$	Lead Solder Temperature (not certified for wave immersion) <i>Refer to reflow temperature profile on page 31</i>	260 for 10 s	$^\circ\text{C}$
$PD_I$	Input Power Dissipation <sup>(2)(3)</sup>	45	mW
$PD_O$	Output Power Dissipation <sup>(3)(4)</sup>	600	mW
<b>Gate Drive Channel</b>			
$I_{F(AVG)}$	Average Input Current	25	mA
$I_{F(PEAK)}$	Peak Transient Forward Current (Pulse Width < 1 $\mu\text{s}$ )	1.0	A
$I_{OH(PEAK)}$	Peak Output High Current <sup>(5)</sup>	3.0	A
$I_{OL(PEAK)}$	Peak Output Low Current <sup>(5)</sup>	3.0	A
$V_R$	Reverse Input Voltage	5.0	V
$V_E - V_{SS}$	Negative Output Supply Voltage <sup>(6)</sup>	-0.5 to 15	V
$V_{DD} - V_E$	Positive Output Supply Voltage	-0.5 to 35 - ( $V_E - V_{SS}$ )	V
$V_{O(PEAK)} - V_{SS}$	Gate Drive Output Voltage	-0.5 to 35	V
$V_{DD} - V_{SS}$	Output Supply Voltage	-0.5 to 35	V
$V_{DESAT}$	Desaturation Voltage	$V_E$ to $V_E + 25$	V
$I_{DESAT}$	Desaturation Current	60	mA
$V_{CLAMP} - V_{SS}$	Active Miller Clamping Voltage	-0.5 to 35	V
$I_{CLAMP}$	Peaking Clamping Sinking Current	1.7	A
$t_{R(IN)}, t_{F(IN)}$	Input Signal Rise and Fall Time	500	ns
<b>Fault Sense Channel</b>			
$V_{CC}$	Positive Input Supply Voltage	-0.5 to 20	V
$V_{\overline{FAULT}}$	$\overline{FAULT}$ Output Voltage	-0.5 to 20	V
$I_{\overline{FAULT}}$	$\overline{FAULT}$ Output Current	16.0	mA

### Notes:

- No derating required across temperature range.
- Functional operation under these conditions is not implied. Permanent damage may occur if the device is subjected to conditions outside these ratings.
- Derate linearly above  $25^\circ\text{C}$ , free air temperature at a rate of  $6.2 \text{ mW}/^\circ\text{C}$ .
- Maximum pulse width = 10  $\mu\text{s}$ .
- This negative output supply voltage is optional. It is only needed when negative gate drive is implemented.

## Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to absolute maximum ratings.

Symbol	Parameter	Min.	Max.	Unit
$T_A$	Ambient Operating Temperature	-40	+100	°C
$I_{F(ON)}$	Input Current (ON)	7	16	mA
$V_{F(OFF)}$	Input Voltage (OFF)	-3.6	0.8	V
$V_{CC}$	Supply Voltage	3	15	V
$V_{DD} - V_{SS}$	Total Output Supply Voltage	15	30	V
$V_{DD} - V_E$	Positive Output Supply Voltage <sup>(7)</sup>	15	$30 - (V_E - V_{SS})$	V
$V_E - V_{SS}$	Negative Output Supply Voltage	0	15	V
$t_{PW}$	Input Pulse Width	500		ns

### Note:

7. During power up or down, ensure that both the input and output supply voltages reach the proper recommended operating voltages to avoid any momentary instability at the output state.

## Isolation Characteristics

Apply over all recommended conditions; typical value is measured at  $T_A = 25^\circ\text{C}$ .

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
$V_{ISO}$	Input-Output Isolation Voltage	$T_A = 25^\circ\text{C}$ , Relative Humidity < 50%, $t = 1.0$ minute, $I_{I-O} \leq 10 \mu\text{A}$ , 50 Hz <sup>(8)(9)(10)</sup>	4,243			$V_{RMS}$
$R_{ISO}$	Isolation Resistance	$V_{I-O} = 500 \text{ V}^{(8)}$		$10^{11}$		
$C_{ISO}$	Isolation Capacitance	$V_{I-O} = 0 \text{ V}$ , Frequency = 1.0 MHz <sup>(8)</sup>		1		pF

### Notes:

8. Device is considered a two-terminal device: pins 1 to 8 are shorted together and pins 9 to 16 are shorted together.
9. 4,243  $V_{RMS}$  for 1-minute duration is equivalent to 5,091  $V_{RMS}$  for 1-second duration.
10. The input-output isolation voltage is a dielectric voltage rating per UL1577. It should not be regarded as an input-output continuous voltage rating. For the continuous working voltage rating, refer to equipment-level safety specification or DIN EN/IEC 60747-5-5 Safety and Insulation Ratings Table on page 4.



## Electrical Characteristics

Apply over all recommended conditions; typical value is measured at  $V_{CC} = 5\text{ V}$ ,  $V_{DD} - V_{SS} = 30\text{ V}$ ,  $V_E - V_{SS} = 0\text{ V}$ , and  $T_A = 25^\circ\text{C}$ ; unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units	Figure
<b>Gate Drive Channel</b>							
$V_F$	Input Forward Voltage	$I_F = 10\text{ mA}$	1.10	1.45	1.80	V	5
$\Delta(V_F/T_A)$	Temperature Coefficient of Forward Voltage			-1.5		mV/°C	
$BV_R$	Input Reverse Breakdown Voltage	$I_R = 10\text{ }\mu\text{A}$	5			V	
$C_{IN}$	Input Capacitance	$f = 1\text{ MHz}$ , $V_F = 0\text{ V}$		60		pF	
$I_{FLH}$	Threshold Input Current, Low-to-High	$I_O = 0\text{ mA}$ , $V_O > 5\text{ V}$		2.5	7.0	mA	30
$V_{FHL}$	Threshold Input Voltage, High-to-Low	$I_O = 0\text{ mA}$ , $V_O < 5\text{ V}$	0.8			V	31
$I_{OH}$	High Level Output Current	$V_O = V_{DD} - 3\text{ V}$ , $I_F = 10\text{ mA}$	-1.0	-2.5		A	6, 10, 32
		$V_O = V_{DD} - 6\text{ V}$ , $I_F = 10\text{ mA}^{(11)}$	-2.5			A	
$I_{OL}$	Low Level Output Current	$V_O = V_{SS} + 3\text{ V}$ , $I_F = 0\text{ mA}$	1	3		A	7, 11, 33
		$V_O = V_{SS} + 6\text{ V}$ , $I_F = 0\text{ mA}^{(12)}$	2.5			A	
$I_{OLF}$	Low Level Output Current During Fault Condition	$V_O - V_{SS} = 14\text{ V}$	70	125	170	mA	34
$V_{OH}$	High Level Output Voltage	$I_F = 10\text{ mA}$ , $I_O = -100\text{ mA}^{(13)(14)(15)}$	$V_{DD} - 1.0$	$V_{DD} - 0.2$		V	8, 10, 35
$V_{OL}$	Low Level Output Voltage	$I_F = 0\text{ mA}$ , $I_O = 100\text{ mA}$		0.1	0.5	V	9, 11, 36
$I_{DDH}$	High Level Supply Current	$V_O = \text{Open}^{(15)}$ , $I_O = 0\text{ mA}$		2.5	5.0	mA	12, 13, 37
$I_{DDL}$	Low Level Supply Current	$V_O = \text{Open}$ , $I_O = 0\text{ mA}$		2.5	5.0	mA	12, 13, 38
$I_{EL}$	$V_E$ Low Level Supply Current		-0.8	-0.5		mA	38
$I_{EH}$	$V_E$ High Level Supply Current		-0.50	-0.25		mA	37
$I_{CHG}$	Blanking Capacitor Charge Current	$V_{DESAT} = 2\text{ V}^{(15)(16)}$	-0.33	-0.25	-0.13	mA	14, 39
$I_{DSCHG}$	Blanking Capacitor Discharge Current	$V_{DESAT} = 7\text{ V}$	10	40		mA	39
$V_{UVLO+}$	Under-Voltage Lockout Threshold <sup>(14)</sup>	$I_F = 10\text{ mA}$ , $V_O > 5\text{ V}$	10.8	11.7	12.7	V	40
$V_{UVLO-}$		$I_F = 10\text{ mA}$ , $V_O < 5\text{ V}$	9.8	10.7	11.7	V	
$UVLO_{HYS}$	Under-Voltage Lockout Threshold Hysteresis			1.0		V	
$V_{DESAT}$	DESAT Threshold <sup>(14)</sup>	$V_{DD} - V_E > V_{ULVO-}$	6.0	6.5	7.2	V	15, 39
$V_{CLAMP\_THRES}$	Clamping Threshold Voltage			2.0		V	41
$I_{CLAMPL}$	Clamp Low Level Sinking Current	$V_O = V_{SS} + 2.5\text{ V}$	0.35	1.10		A	16, 42

### Electrical Characteristics (Continued)

Apply over all recommended conditions; typical value is measured at  $V_{CC} = 5\text{ V}$ ,  $V_{DD} - V_{SS} = 30\text{ V}$ ,  $V_E - V_{SS} = 0\text{ V}$ , and  $T_A = 25^\circ\text{C}$ ; unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units	Figure
<b>Fault Feedback Channel</b>							
$I_{CCH}$	$\overline{\text{FAULT}}$ High Level Supply Current	$I_{F2} = 0\text{ mA}$ , $V_{\overline{\text{FAULT}}} = \text{Open}$ , $V_{CC} = 15\text{ V}$		0.0004	2	$\mu\text{A}$	43
$I_{CCL}$	$\overline{\text{FAULT}}$ Low Level Supply Current	$I_{F2} = 16\text{ mA}$ , $V_{\overline{\text{FAULT}}} = \text{Open}$ , $V_{CC} = 15\text{ V}$		150	200	$\mu\text{A}$	44
$I_{\overline{\text{FAULTH}}}$	$\overline{\text{FAULT}}$ Logic High Output Current	$V_{\overline{\text{FAULT}}} = V_{CC} = 5.5\text{ V}$		0.02	0.50	$\mu\text{A}$	45
$I_{\overline{\text{FAULTL}}}$	$\overline{\text{FAULT}}$ Logic Low Output Current	$V_{\overline{\text{FAULT}}} = 0.4\text{ V}$ , $V_{CC} = 5.5\text{ V}$	1.1			$\text{mA}$	17, 46

**Notes:**

11. Maximum pulse width = 10  $\mu\text{s}$ , maximum duty cycle = 0.2%.
12. Minimum pulse width = 4.99 ms, minimum duty cycle = 99.8%.
13.  $V_{OH}$  is measured with the DC load current in this testing (maximum pulse width = 1 ms, maximum duty cycle = 20%). When driving capacitive loads,  $V_{OH}$  approaches  $V_{DD}$  as  $I_{OH}$  approaches zero units.
14. Positive output supply voltage ( $V_{DD} - V_E$ ) should be at least 15 V to ensure adequate margin in excess of the maximum under-voltage lockout threshold,  $V_{UVLO+}$ , of 12.7 V.
15. When  $V_{DD} - V_E > V_{UVLO}$  and the output state  $V_O$  is allowed to go HIGH, the DESAT-detection feature is active and provides the primary source of IGBT protection. UVLO is needed to ensure DESAT detection is functional.
16. The blanking time,  $t_{BLANK}$ , is adjustable by an external capacitor ( $C_{BLANK}$ ), where  $t_{BLANK} = C_{BLANK} \times (V_{DESAT} / I_{CHG})$ .

## Switching Characteristics

Apply over all recommended conditions; typical value is measured at  $V_{CC} = 5\text{ V}$ ,  $V_{DD} - V_{SS} = 30\text{ V}$ ,  $V_E - V_{SS} = 0\text{ V}$ , and  $T_A = 25^\circ\text{C}$ ; unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units	Figure	
$t_{PHL}$	Propagation Delay to Logic Low Output <sup>(18)</sup>	$R_g = 10\ \Omega$ , $C_g = 10\ \text{nF}$ , $f = 10\ \text{kHz}$ , Duty Cycle = 50%, $I_F = 10\ \text{mA}$ , $V_{DD} - V_{SS} = 30\ \text{V}$ <sup>(17)</sup>	100	135	250	ns	18, 19, 20, 21, 47	
$t_{PLH}$	Propagation Delay to Logic High Output <sup>(19)</sup>		100	150	250	ns		
PWD	Pulse Width Distortion, $ t_{PHL} - t_{PLH} $ <sup>(20)</sup>				15	100	ns	47
PDD Skew	Propagation Delay Difference Between Any Two Parts or Channels, $(t_{PHL} - t_{PLH})$ <sup>(21)</sup>			-150		150	ns	
$t_R$	Output Rise Time (10% to 90%)				50		ns	47
$t_F$	Output Fall Time (90% to 10%)				50		ns	
$t_{DESAT(LOW)}$	DESAT Sense to DESAT Low Propagation Delay <sup>(24)</sup>	$R_g = 10\ \Omega$ , $C_g = 10\ \text{nF}$ , $V_{DD} - V_{SS} = 30\ \text{V}$ $(C_{DESAT} = 100\ \text{pF}$ , $R_F = 4.7\ \text{k}\Omega$ , $V_{CC} = 5.5\ \text{V})$		0.25		$\mu\text{s}$		
$t_{DESAT(90\%)}$	DESAT Sense to 90% $V_O$ Delay <sup>(22)</sup>			0.45	0.70	$\mu\text{s}$	22, 48	
$t_{DESAT(10\%)}$	DESAT Sense to 10% $V_O$ Delay <sup>(22)</sup>				2.8	4.0	$\mu\text{s}$	23, 24, 25, 48
$t_{DESAT(FAULT)}$	DESAT Sense to Low Level FAULT Signal Delay <sup>(23)</sup>				0.5	1.5	$\mu\text{s}$	26, 48
$t_{RESET(FAULT)}$	RESET to High Level FAULT Signal Delay <sup>(25)</sup>			0.5	2.3	4.5	$\mu\text{s}$	27, 48
$t_{DESAT(MUTE)}$	DESAT Input Mute			10.0	22.0	35.0	$\mu\text{s}$	48
$t_{UVLO\ ON}$	UVLO Turn-On Delay <sup>(26)</sup>	$V_{DD} = 20\ \text{V}$ in 1.0 ms Ramp		4.0		$\mu\text{s}$	49	
$t_{UVLO\ OFF}$	UVLO Turn-Off Delay <sup>(27)</sup>			4.0		$\mu\text{s}$		
$t_{GP}$	Time-to-Good Power <sup>(28)</sup>	$V_{DD} = 0$ to 30 V in 10 $\mu\text{s}$ Ramp		2.0		$\mu\text{s}$	28, 29, 49	
$ CM_H $	Common Mode Transient Immunity at Output High	$T_A = 25^\circ\text{C}$ , $V_{CC} = 5\ \text{V}$ , $V_{DD} = 25\ \text{V}$ , $V_{SS} = \text{Ground}$ , $C_F = 15\ \text{pF}$ , $R_F = 4.7\ \text{k}\Omega$ , $V_{CM} = 1500\ V_{PEAK}$ <sup>(29)</sup>	35	50		$\text{kV}/\mu\text{s}$	51, 52	
$ CM_L $	Common Mode Transient Immunity at Output Low	$T_A = 25^\circ\text{C}$ , $V_{CC} = 5\ \text{V}$ , $V_{DD} = 25\ \text{V}$ , $V_{SS} = \text{Ground}$ , $C_F = 15\ \text{pF}$ , $R_F = 4.7\ \text{k}\Omega$ , $V_{CM} = 1500\ V_{PEAK}$ <sup>(30)</sup>	35	50		$\text{kV}/\mu\text{s}$	50, 53	

### Notes:

17. This load condition approximates the gate load of a 1200 V / 150 A IGBT.
18. Propagation delay  $t_{PHL}$  is measured from the 50% level on the falling edge of the input pulse to the 50% level of the falling edge of the  $V_O$  signal.
19. Propagation delay  $t_{PLH}$  is measured from the 50% level on the rising edge of the input pulse to the 50% level of the rising edge of the  $V_O$  signal.
20. PWD is defined as  $|t_{PHL} - t_{PLH}|$  for any given device.
21. The difference between  $t_{PHL}$  and  $t_{PLH}$  between any two parts under same operating conditions with equal loads.
22. The length of time the DESAT threshold must be exceeded before  $V_O$  begins to go LOW. This is supply voltage dependent.

23. The time from DESAT threshold is exceeded until the FAULT output goes LOW.
24. The length of time the DESAT threshold must be exceeded before  $V_O$  begins to go LOW and the FAULT output begins to go LOW.
25. The length of time from when RESET is initiated (via  $I_F$  turn-on) until FAULT output goes HIGH.
26. The UVLO turn-on delay,  $t_{UVLO\ ON}$ , is measured from the  $V_{UVLO+}$  threshold level of the rising edge of the output supply voltage ( $V_{DD}$ ) to the 5 V level of the rising edge of the  $V_O$  signal.
27. The UVLO turn-off delay,  $t_{UVLO\ OFF}$ , is measured from the  $V_{UVLO-}$  threshold level of the falling edge of the output supply voltage ( $V_{DD}$ ) to the 5 V level of the falling edge of the  $V_O$  signal.
28. The time to good power,  $t_{GP}$ , is measured from the  $V_{UVLO+}$  threshold level of the rising edge of the output supply voltage ( $V_{DD}$ ) to the 5 V level of the rising edge of the  $V_O$  signal.
29. Common-mode transient immunity at output HIGH state is the maximum tolerable negative  $dV_{CM}/dt$  on the trailing edge of the common-mode pulse,  $V_{CM}$ , to assure the output remains in HIGH state (i.e.,  $V_O > 15\text{ V}$  or  $V_{FAULT} > 2\text{ V}$ ).
30. Common-mode transient immunity at output LOW state is the maximum positive tolerable  $dV_{CM}/dt$  on the leading edge of the common-mode pulse,  $V_{CM}$ , to ensure the output remains in LOW state (i.e.,  $V_O < 1.0\text{ V}$  or  $V_{FAULT} < 0.8\text{ V}$ ).

### Timing Diagrams

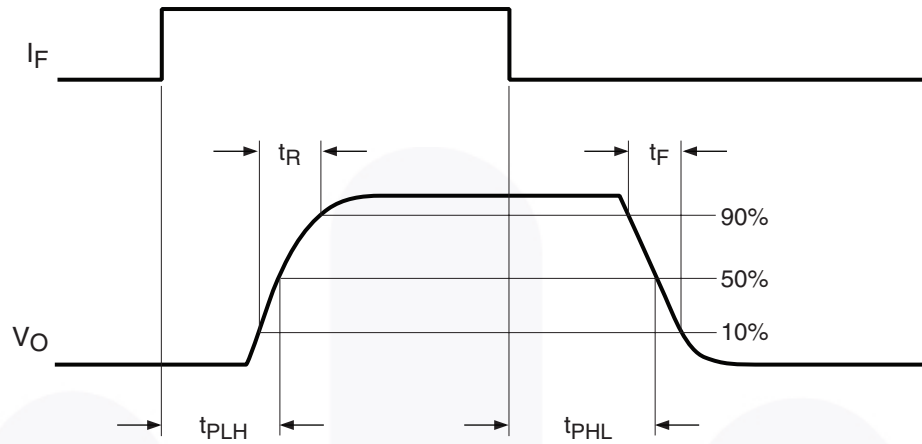


Figure 3.  $t_{PLH}$ ,  $t_{PHL}$ ,  $t_R$ , and  $t_F$  Timing Diagram

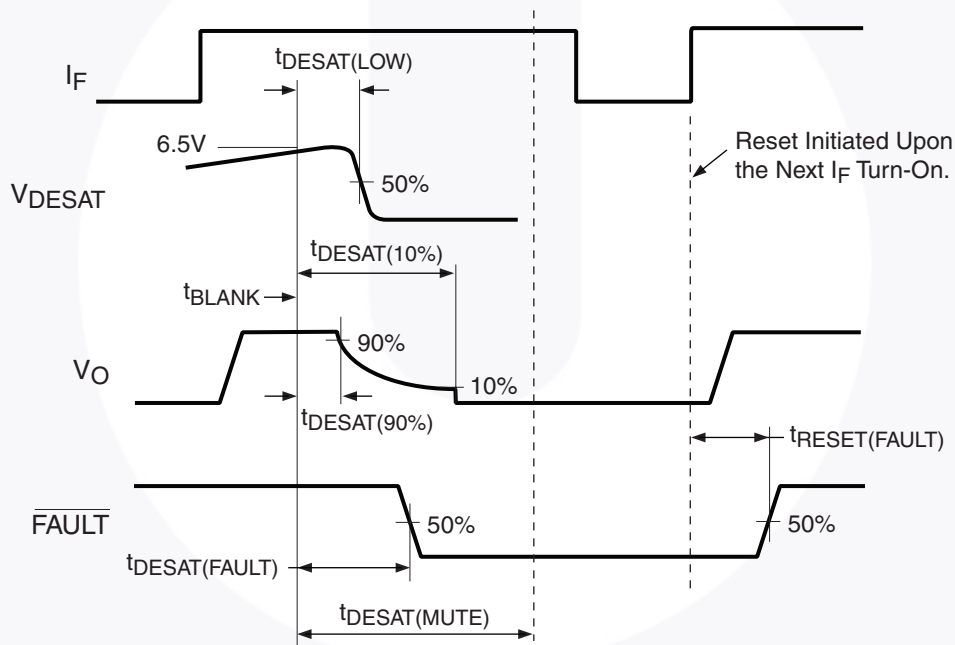
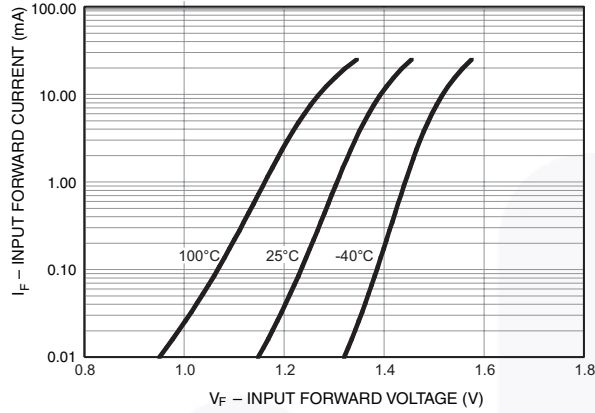


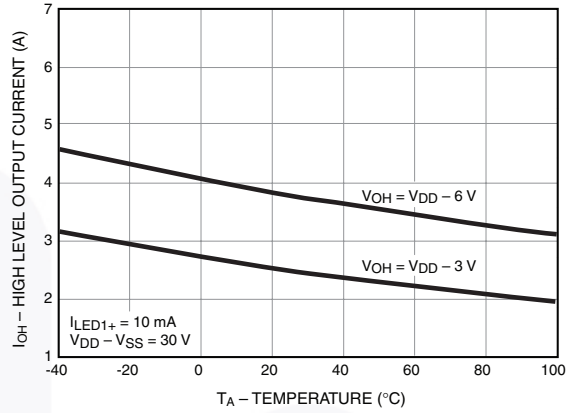
Figure 4. Definitions for DESAT,  $V_O$  and  $\overline{FAULT}$  Timing Waveforms



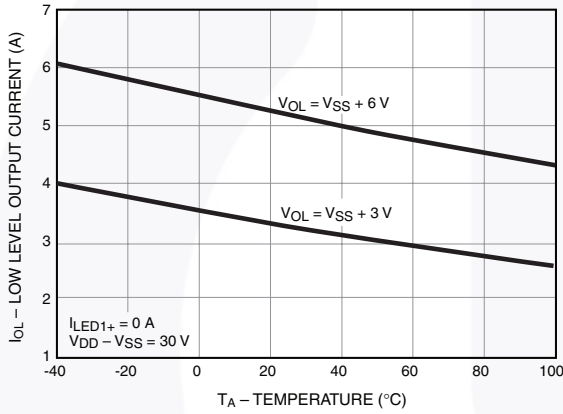
### Typical Performance Characteristics



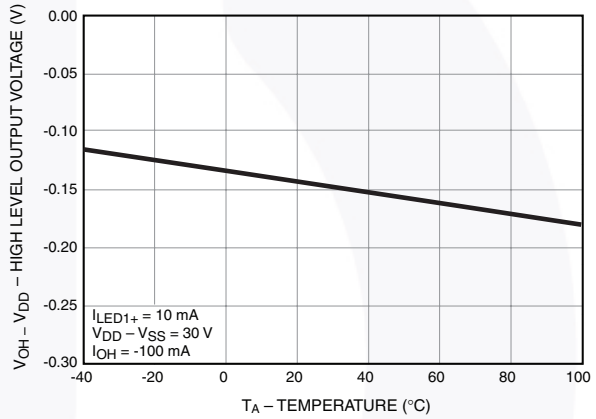
**Figure 5. Input Forward Current ( $I_F$ ) vs. Voltage ( $V_F$ )**



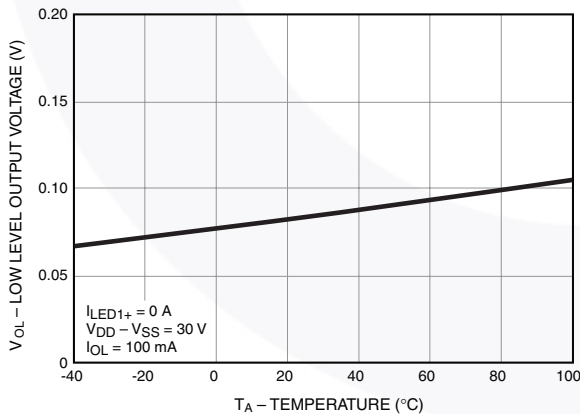
**Figure 6. High Level Output Current ( $I_{OH}$ ) vs. Temperature**



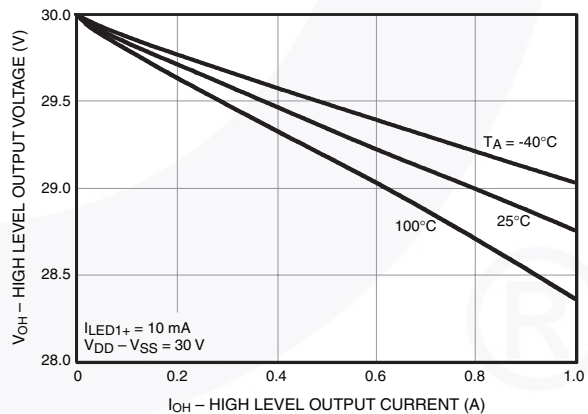
**Figure 7. Low Level Output Current ( $I_{OL}$ ) vs. Temperature**



**Figure 8. High Level Output Voltage ( $V_{OH} - V_{DD}$ ) vs. Temperature**

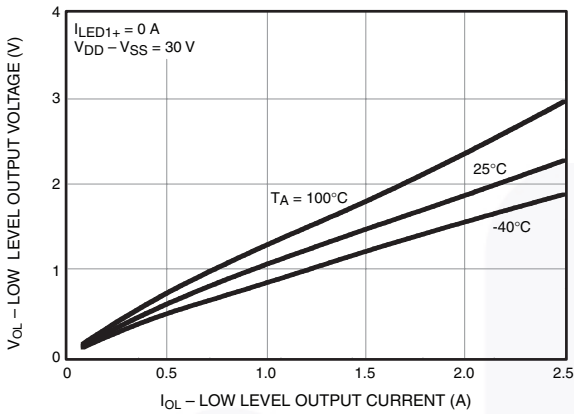


**Figure 9. Low Level Output Voltage ( $V_{OL}$ ) vs. Temperature**

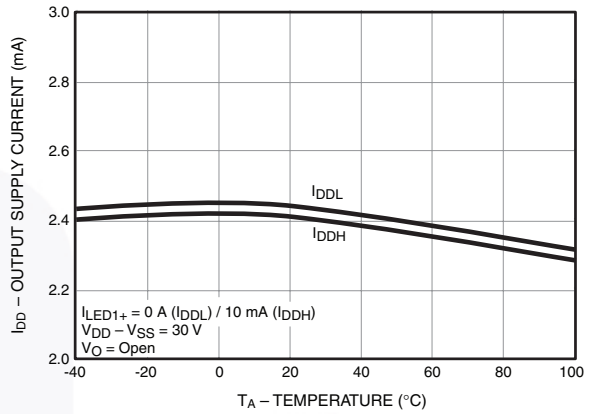


**Figure 10. High Level Output Voltage ( $V_{OH}$ ) vs. High Level Output Current ( $I_{OH}$ )**

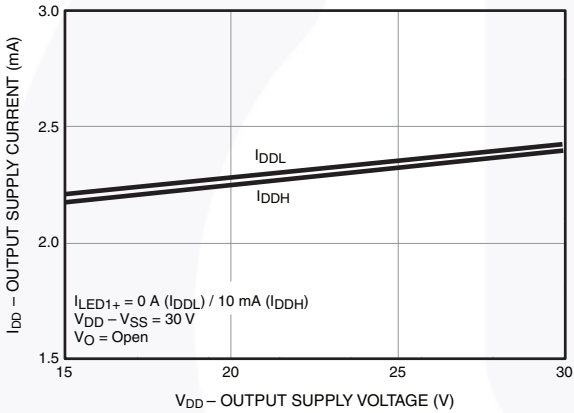
**Typical Performance Characteristics (Continued)**



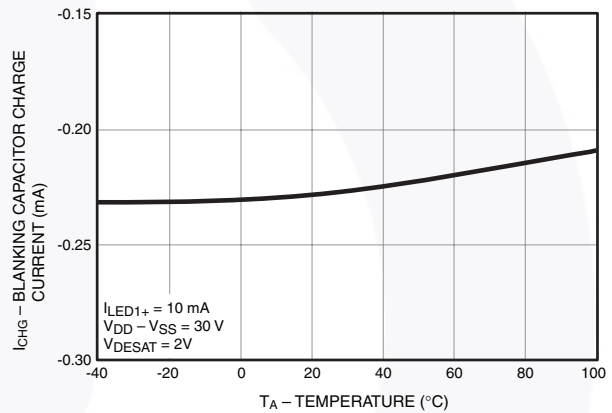
**Figure 11. Low Level Output Voltage ( $V_{OL}$ ) vs. Low Level Output Current ( $I_{OL}$ )**



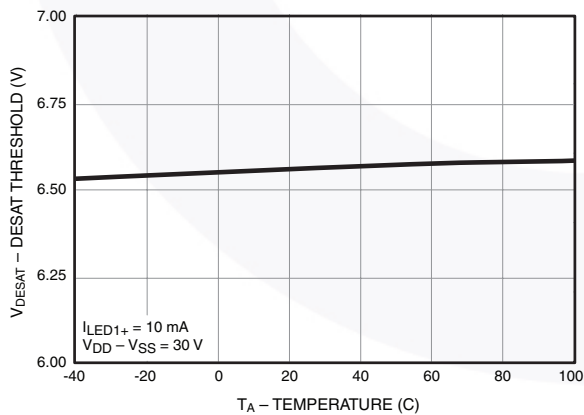
**Figure 12. Output Supply Current ( $I_{DD}$ ) vs. Temperature**



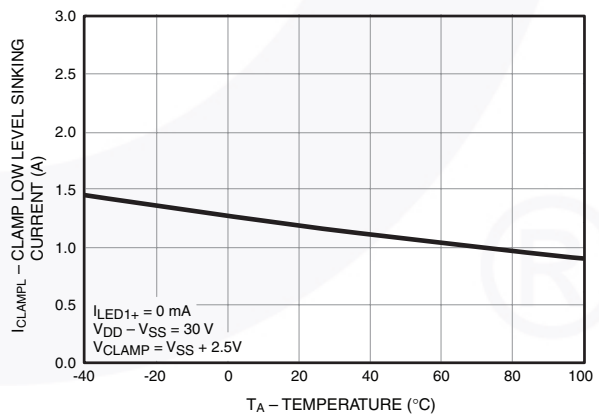
**Figure 13. Output Supply Current ( $I_{DD}$ ) vs. Voltage ( $V_{DD}$ )**



**Figure 14. Blanking Capacitor Charge Current ( $I_{CHG}$ ) vs. Temperature**

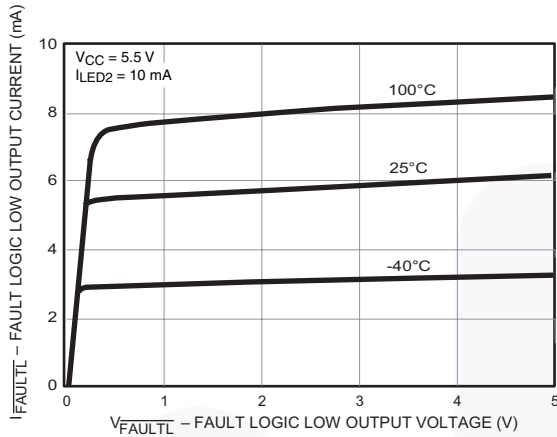


**Figure 15. DESAT Threshold ( $V_{DESAT}$ ) vs. Temperature**

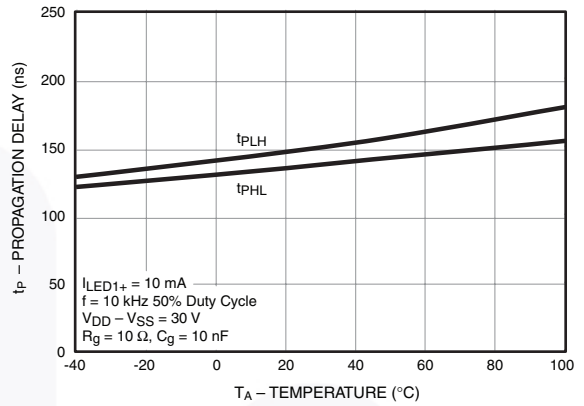


**Figure 16. Clamp Low Level Sinking Current ( $I_{CLAMPL}$ ) vs. Temperature**

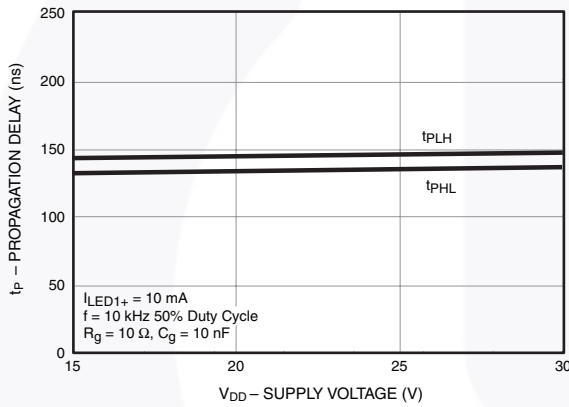
## Typical Performance Characteristics (Continued)



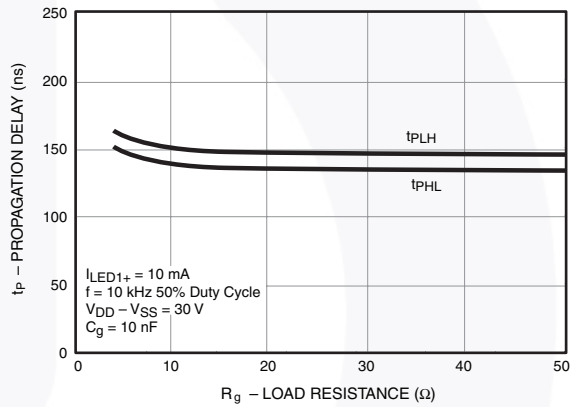
**Figure 17. FAULT Logic Low Output Current ( $I_{\text{FAULTL}}$ ) vs. Voltage ( $V_{\text{FAULTL}}$ )**



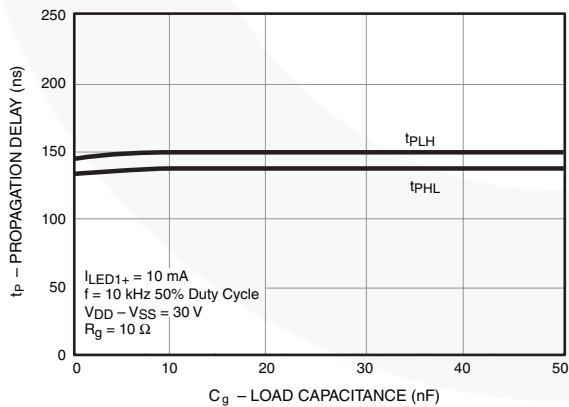
**Figure 18. Propagation Delay ( $t_p$ ) vs. Temperature**



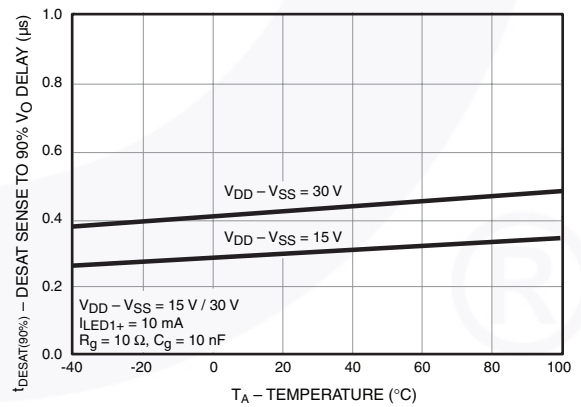
**Figure 19. Propagation Delay ( $t_p$ ) vs. Supply Voltage ( $V_{\text{DD}}$ )**



**Figure 20. Propagation Delay ( $t_p$ ) vs. Load Resistance ( $R_g$ )**

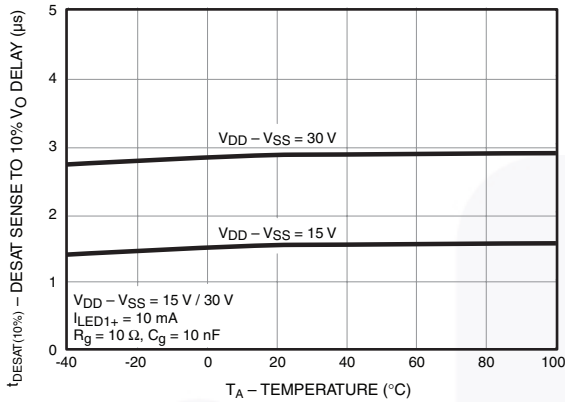


**Figure 21. Propagation Delay ( $t_p$ ) vs. Load Capacitance ( $C_g$ )**

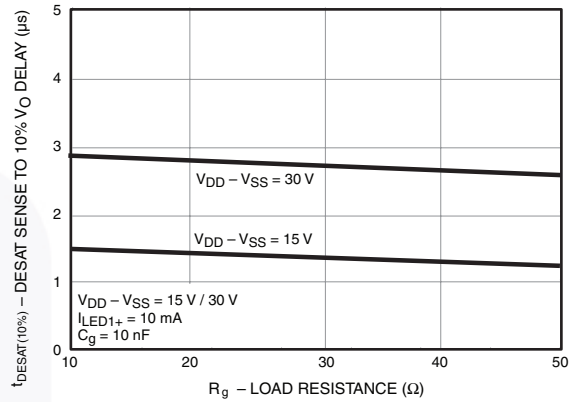


**Figure 22. DESAT Sense to 90%  $V_O$  Delay ( $t_{\text{DESAT}(90\%)}$ ) vs. Temperature**

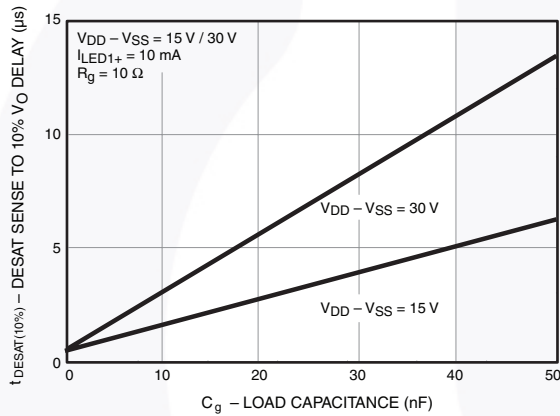
### Typical Performance Characteristics (Continued)



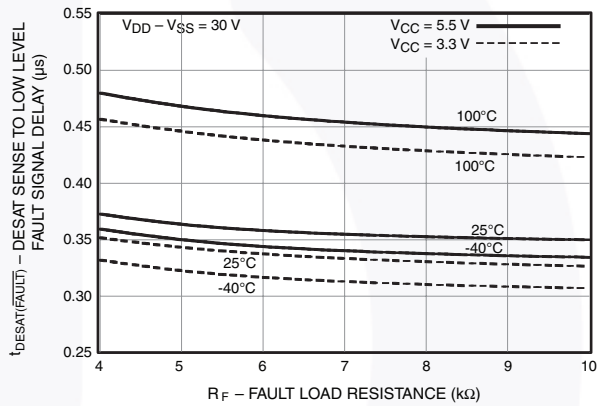
**Figure 23. DESAT Sense to 10%  $V_O$  Delay ( $t_{DESAT(10\%)}$ ) vs. Temperature**



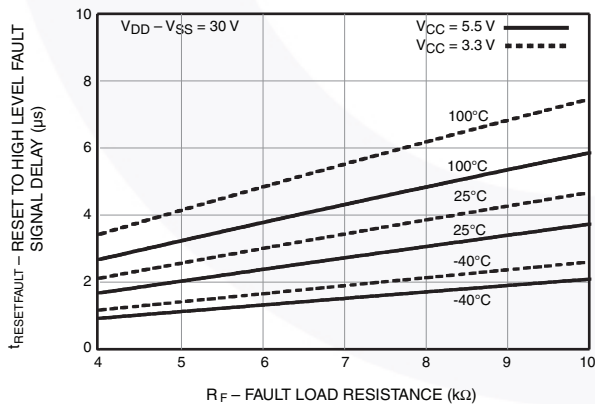
**Figure 24. DESAT Sense to 10%  $V_O$  Delay ( $t_{DESAT(10\%)}$ ) vs. Load Resistance ( $R_g$ )**



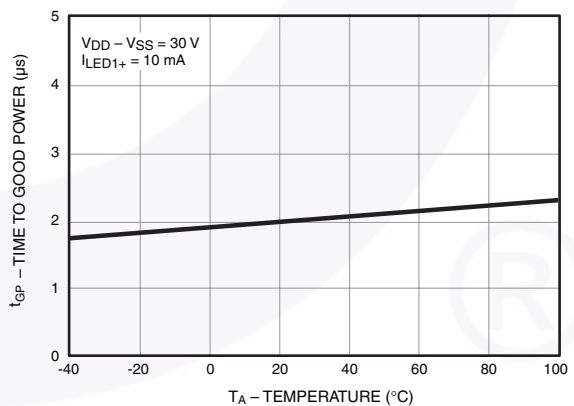
**Figure 25. DESAT Sense to 10%  $V_O$  Delay ( $t_{DESAT(10\%)}$ ) vs. Load Capacitance ( $C_g$ )**



**Figure 26. DESAT Sense to Low Level Fault Signal Delay ( $t_{DESAT(FAULT)}$ ) vs. Fault Load Resistance ( $R_F$ )**



**Figure 27. RESET to High Level Fault Signal Delay ( $t_{RESET(FAULT)}$ ) vs. Fault Load Resistance ( $R_F$ )**



**Figure 28. Time-to-Good Power ( $t_{GP}$ ) vs. Temperature**

### Typical Performance Characteristics (Continued)

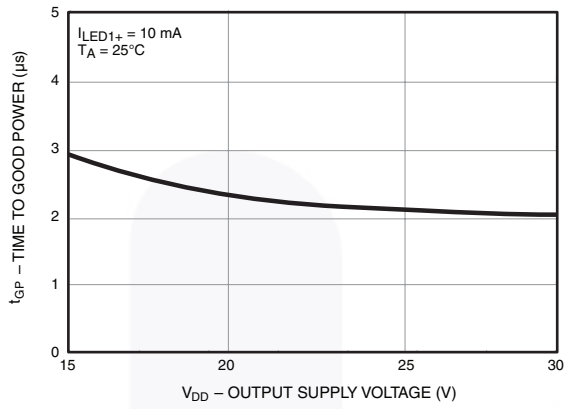


Figure 29. Time-to-Good Power ( $t_{GP}$ ) vs. Output Supply Voltage ( $V_{DD}$ )



## Test Circuits

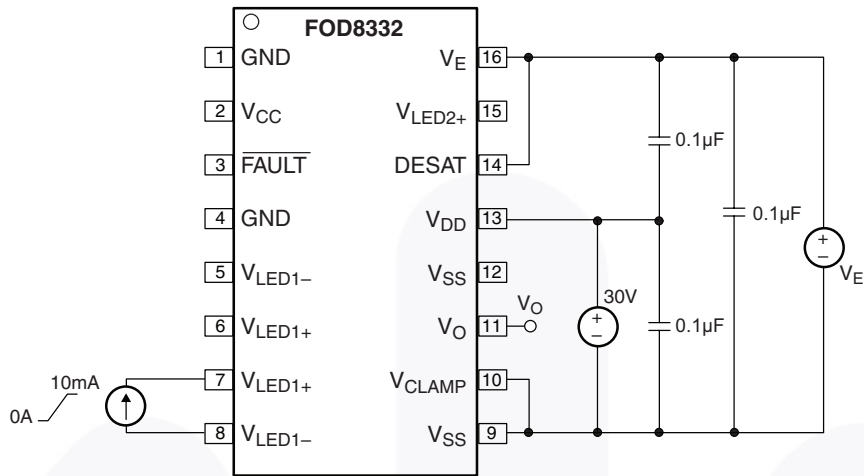


Figure 30. Threshold Input Current Low-to-High ( $I_{FLH}$ ) Test Circuit

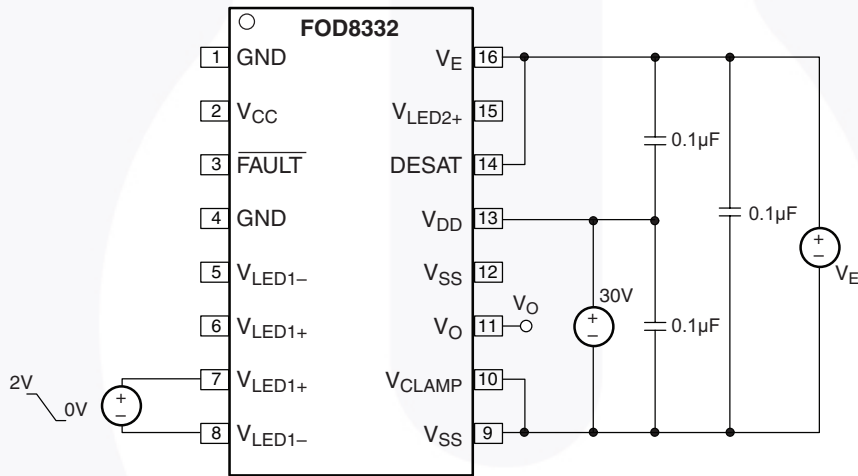


Figure 31. Threshold Input Voltage High-to-Low ( $V_{FHL}$ ) Test Circuit

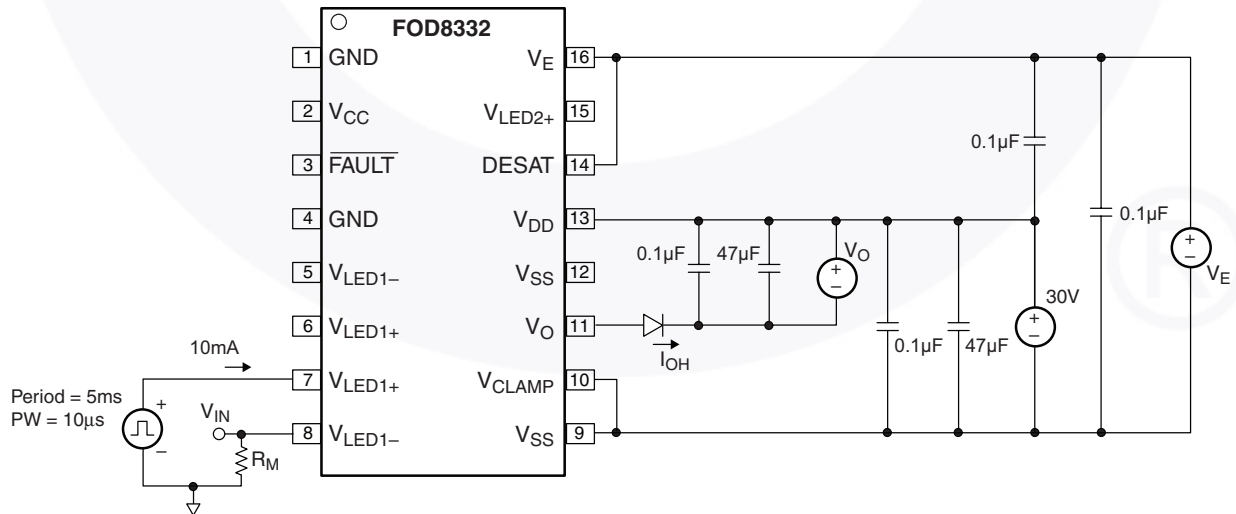
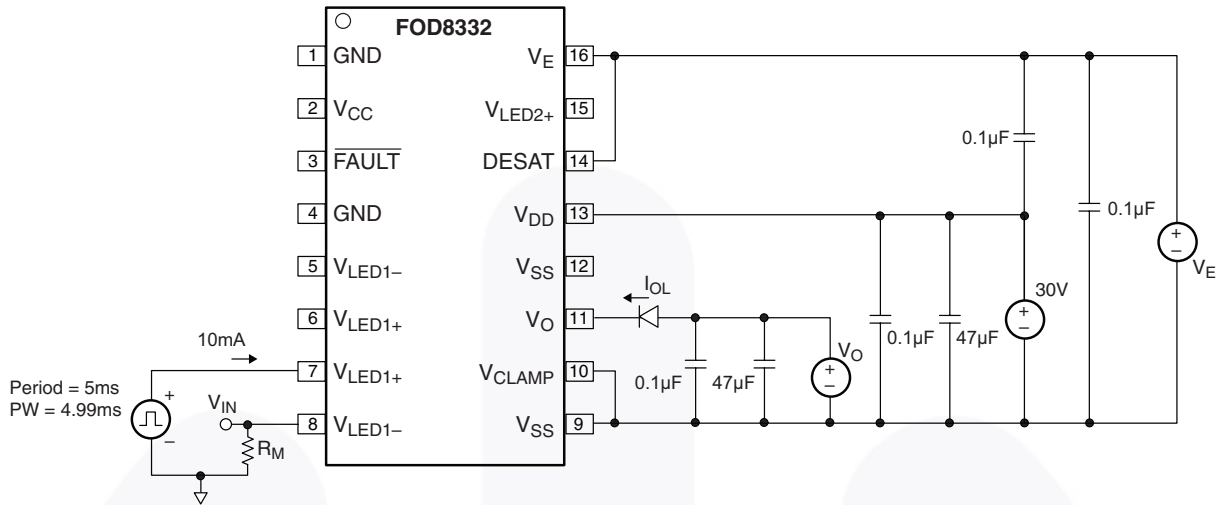
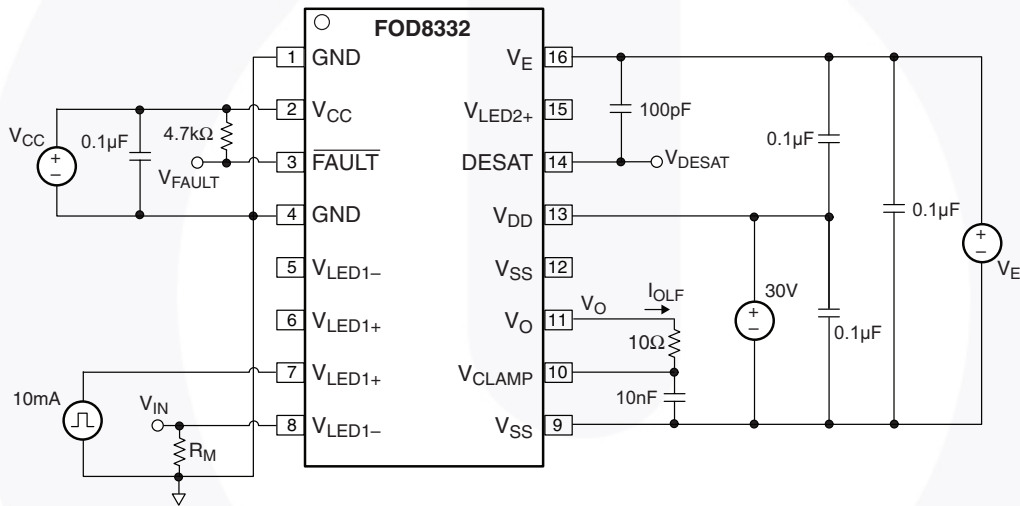


Figure 32. High Level Output Current ( $I_{OH}$ ) Test Circuit

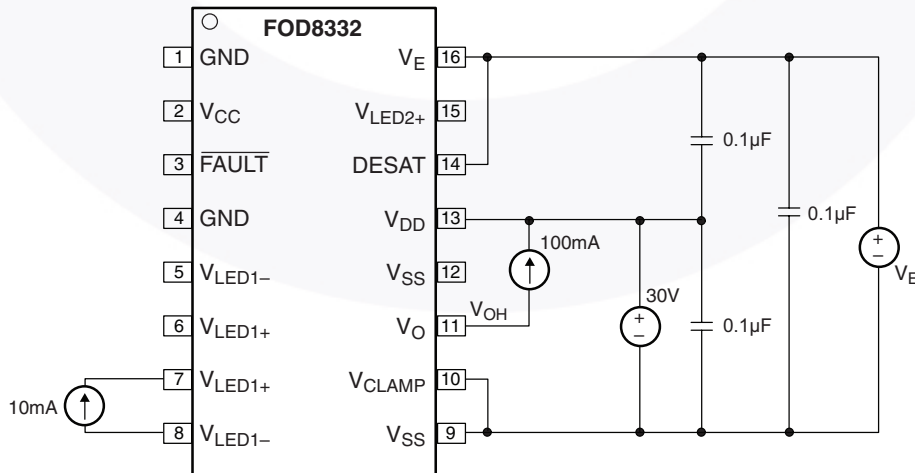
**Test Circuits** (Continued)



**Figure 33. Low Level Output Current ( $I_{OL}$ ) Test Circuit**

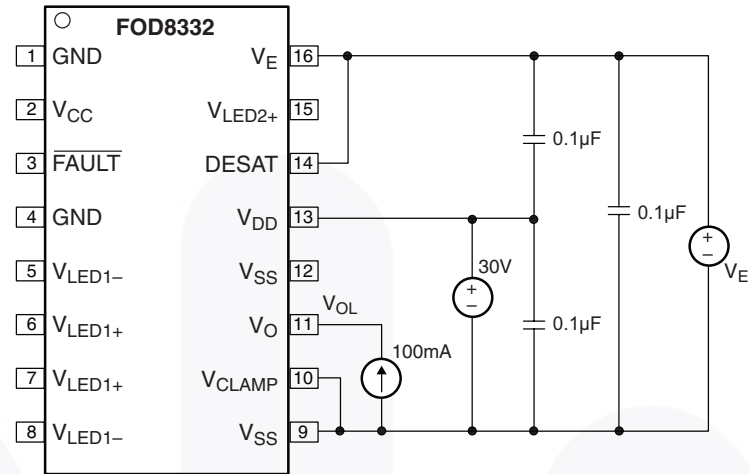


**Figure 34. Low Level Output Current During Fault Condition ( $I_{OLF}$ ) Test Circuit**

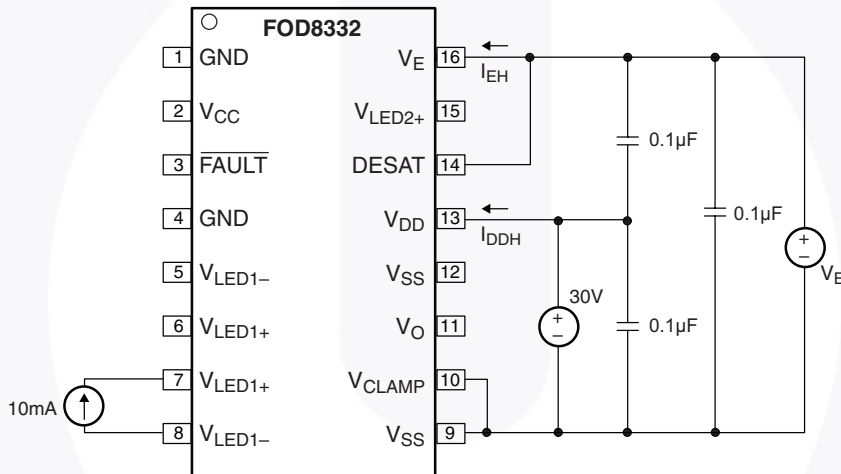


**Figure 35. High Level Output Voltage ( $V_{OH}$ ) Test Circuit**

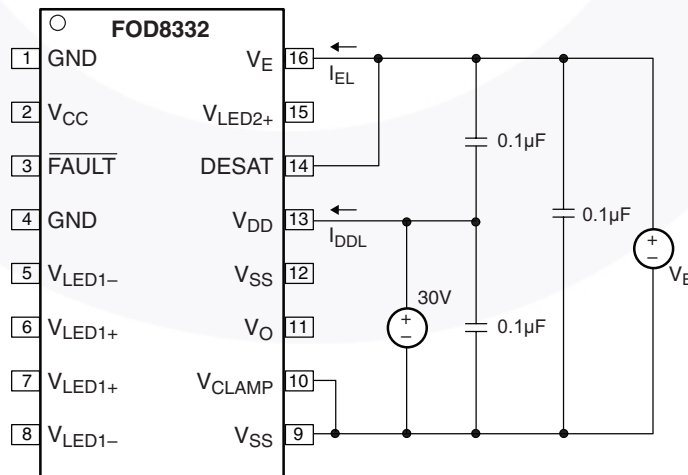
**Test Circuits** (Continued)



**Figure 36. Low Level Output Voltage ( $V_{OL}$ ) Test Circuit**

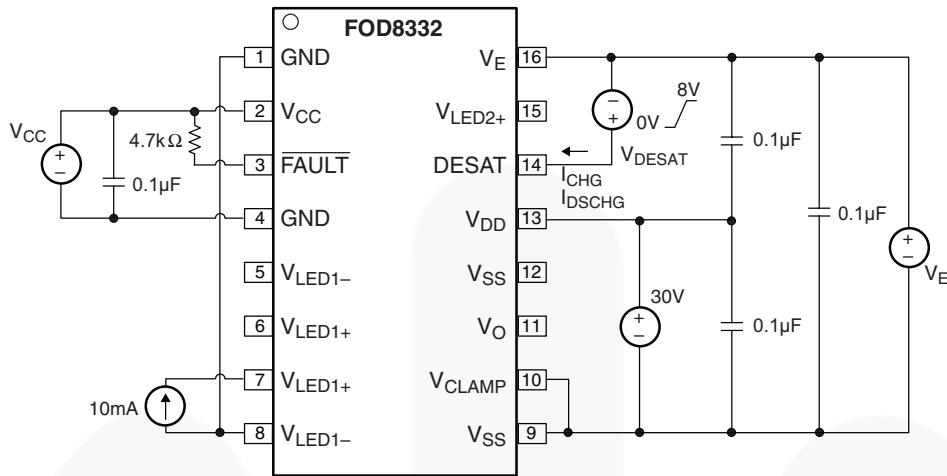


**Figure 37. High Level Supply Current ( $I_{DDH}$ ),  $V_E$  High Level Supply Current ( $I_{EH}$ ) Test Circuit**

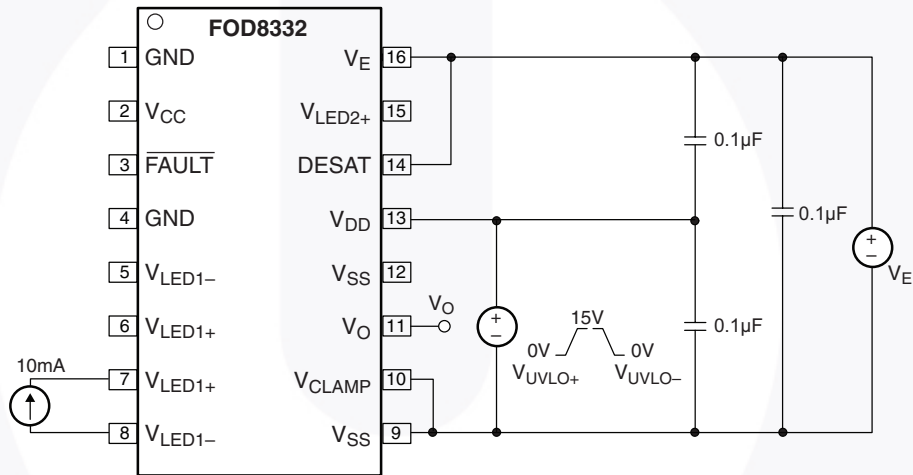


**Figure 38. Low Level Supply Current ( $I_{DDL}$ ),  $V_E$  Low Level Supply Current ( $I_{EL}$ ) Test Circuit**

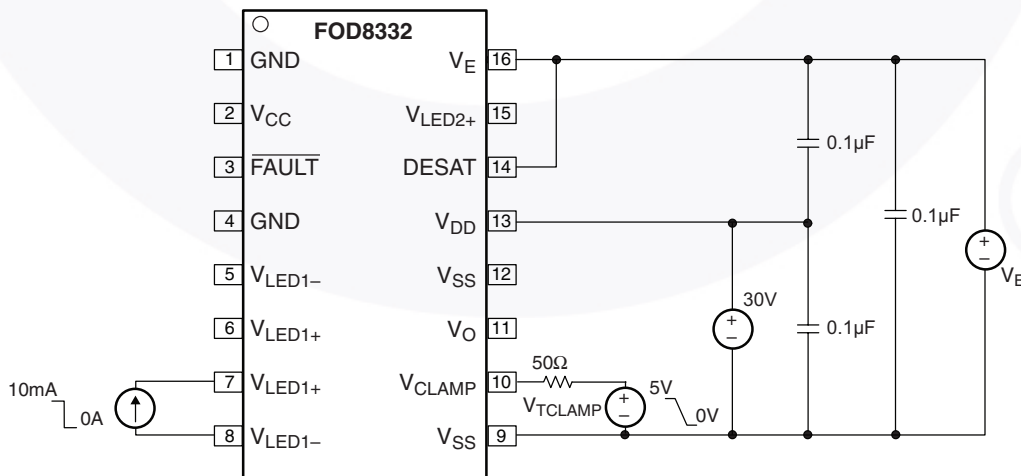
**Test Circuits** (Continued)



**Figure 39. DESAT Threshold ( $V_{DESAT}$ ), Blanking Capacitor Charge Current ( $I_{CHG}$ ), Blanking Capacitor Discharge Current ( $I_{DSCHG}$ ) Test Circuit**

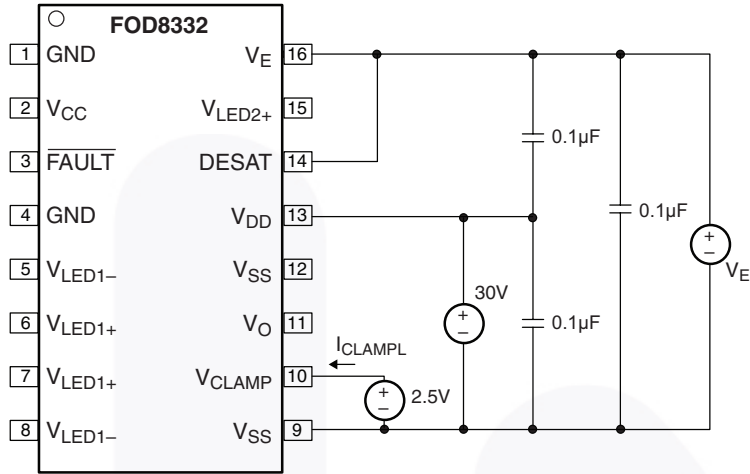


**Figure 40. Under-Voltage Lockout Threshold ( $V_{UVLO+} / V_{UVLO-}$ ), Under-Voltage Lockout Threshold Hysteresis ( $UVLO_{HYS}$ ) Test Circuit**

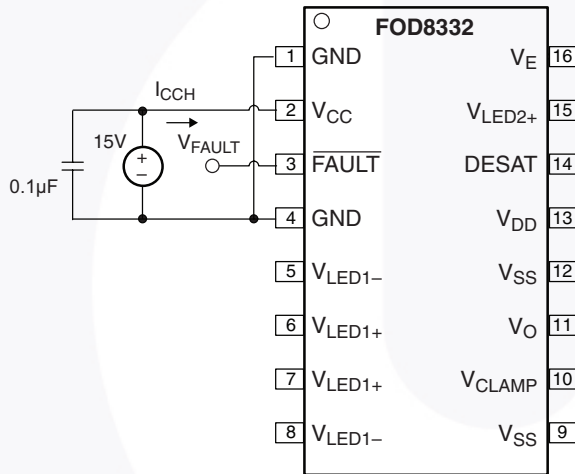


**Figure 41. Clamping Threshold Voltage ( $V_{CLAMP\_THRES}$ ) Test Circuit**

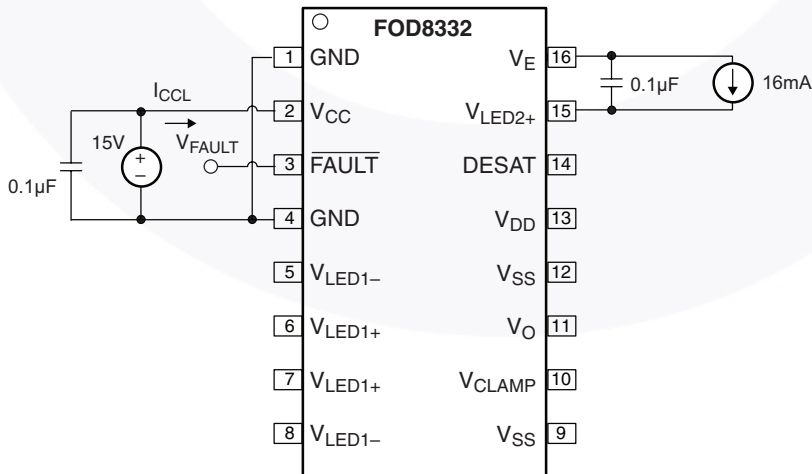
**Test Circuits** (Continued)



**Figure 42. Clamp Low Level Sinking Current ( $I_{CLAMP}$ ) Test Circuit**



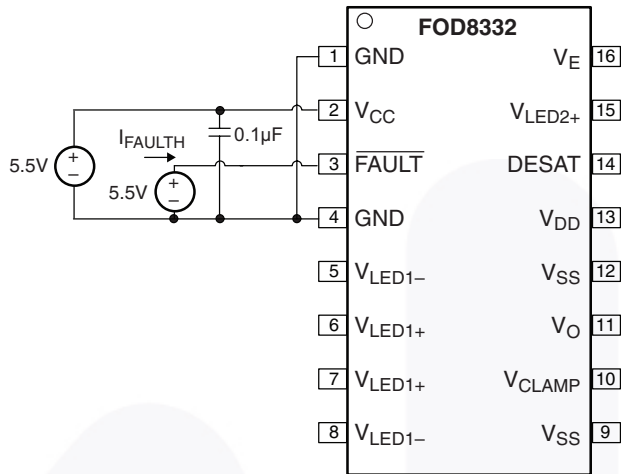
**Figure 43. FAULT High Level Supply Current ( $I_{CCH}$ ) Test Circuit**



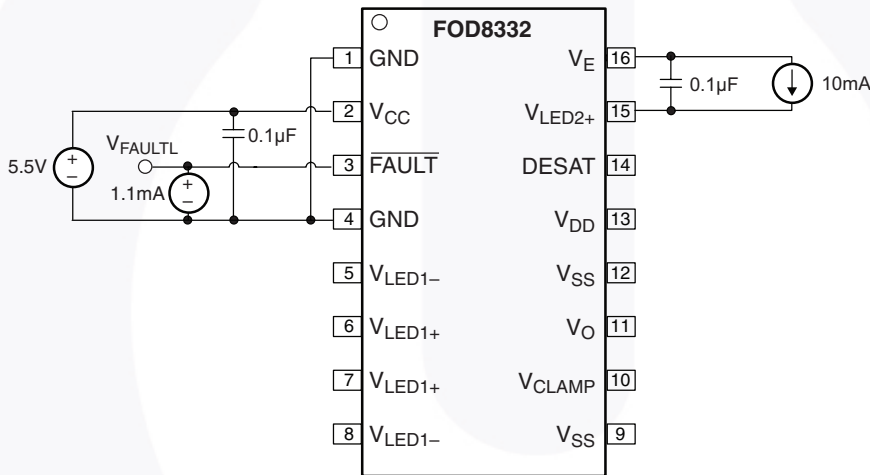
**Figure 44. FAULT Low Level Supply Current ( $I_{CCL}$ ) Test Circuit**



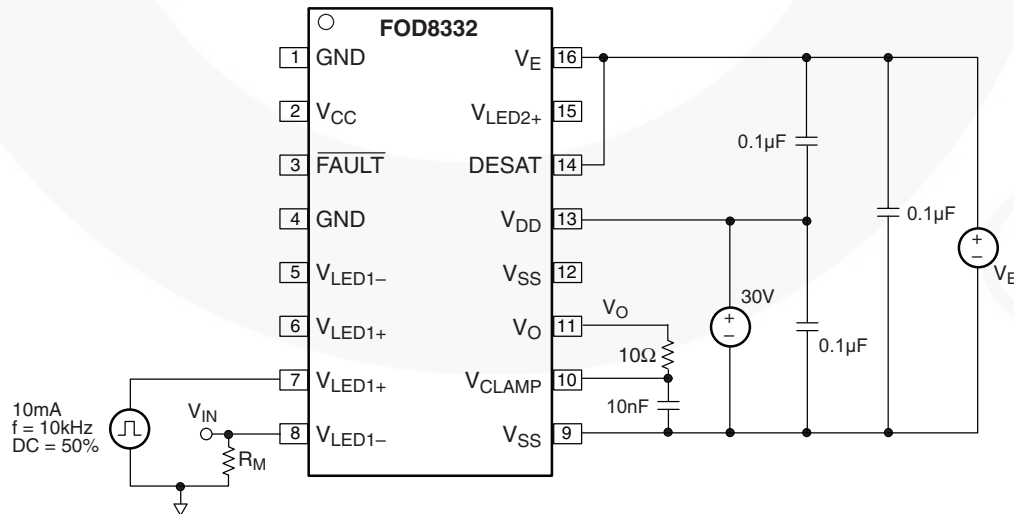
**Test Circuits** (Continued)



**Figure 45. FAULT High Level Output Current ( $I_{\text{FAULTH}}$ ) Test Circuit**

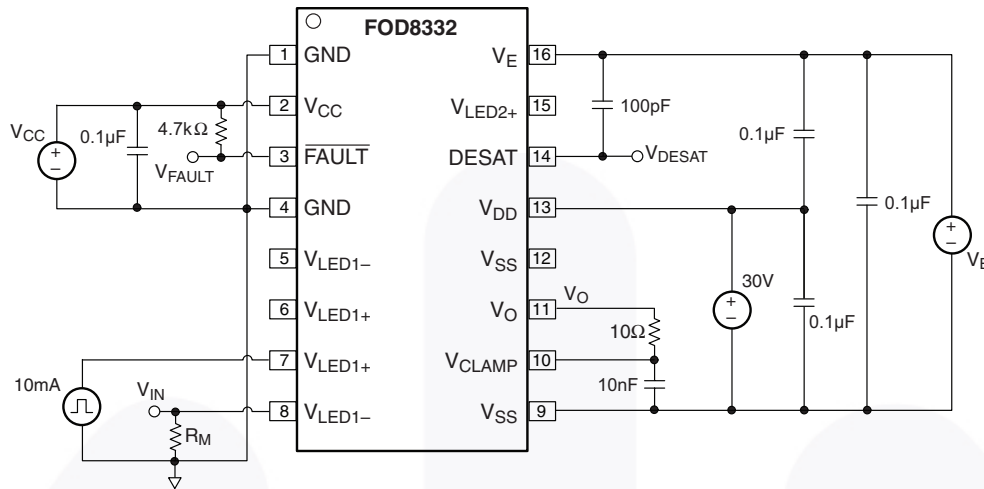


**Figure 46. FAULT Low Level Output Voltage ( $V_{\text{FAULTL}}$ ) Test Circuit**

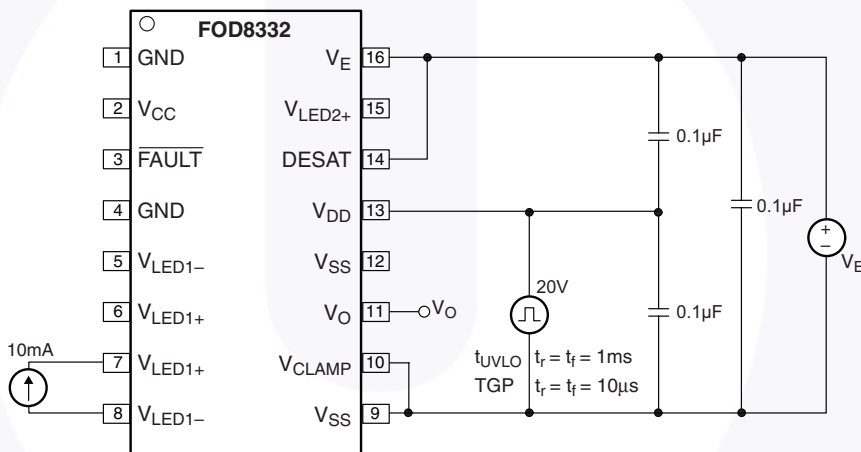


**Figure 47. Propagation Delay ( $t_{\text{PLH}}$ ,  $t_{\text{PHL}}$ ), Rise Time ( $t_{\text{R}}$ ), Fall Time ( $t_{\text{F}}$ ), Pulse Width Distortion (PWD) Test Circuit**

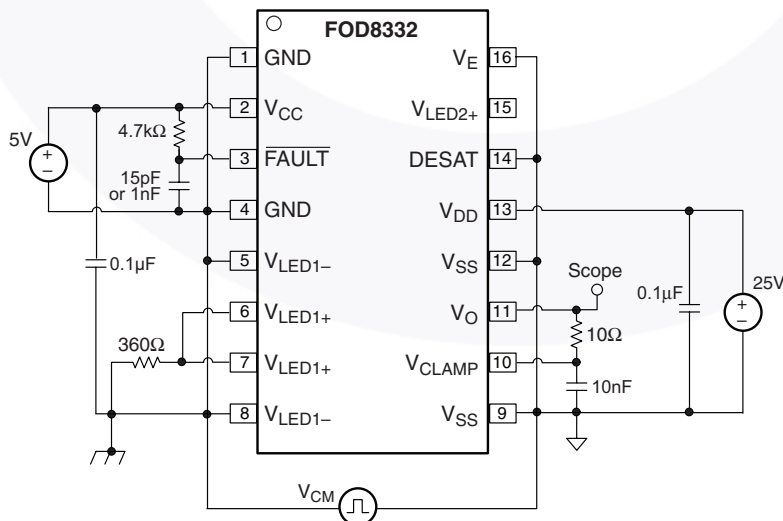
**Test Circuits** (Continued)



**Figure 48. DESAT Sense Delay ( $t_{DESAT(90\%)}$ ),  $t_{DESAT(10\%)}$ ,  $t_{DESAT(LOW)}$ ), DESAT Sense to Low Level FAULT Signal Delay ( $t_{DESAT(FAULT)}$ ), Reset to High Level FAULT Signal Delay ( $t_{RESET(FAULT)}$ ), DESAT Input Mute ( $t_{DESAT(MUTE)}$ ) Test Circuit**

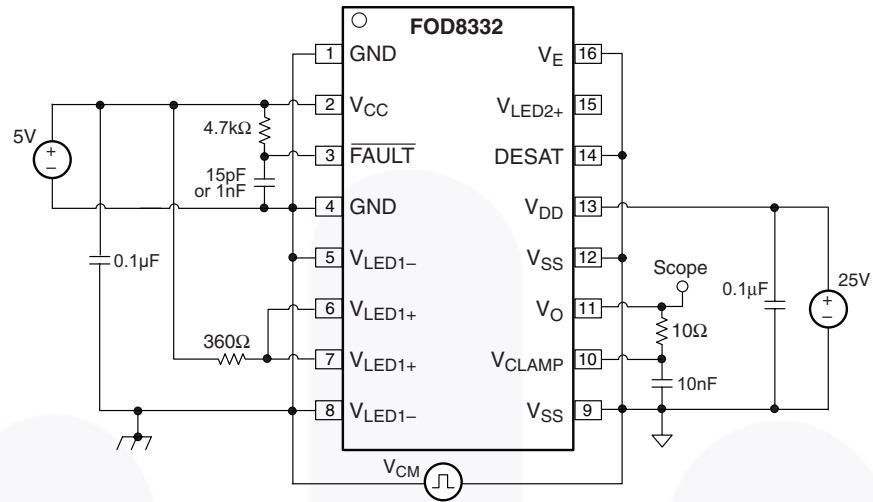


**Figure 49. Under-Voltage Lockout Delay ( $t_{UVLO}$ ), Time-to-Good-Power ( $t_{GTP}$ ) Test Circuit**

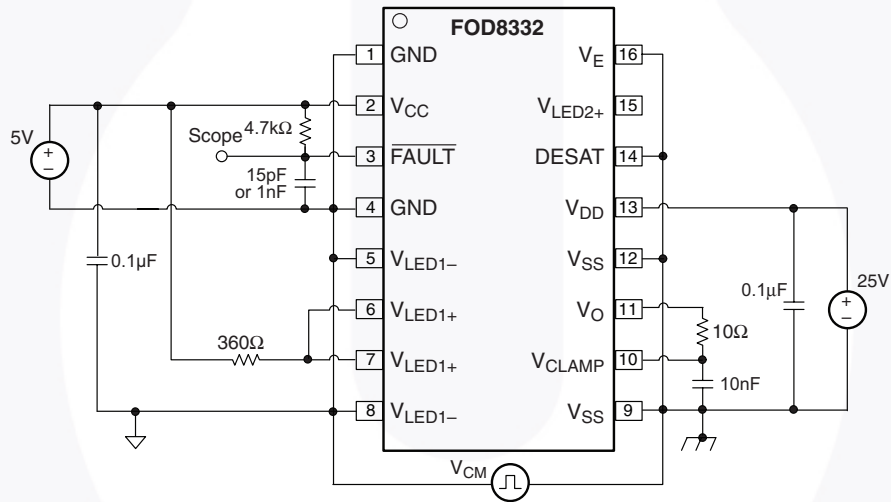


**Figure 50. Common-Mode Low (CML) LED1-Off Test Circuit**

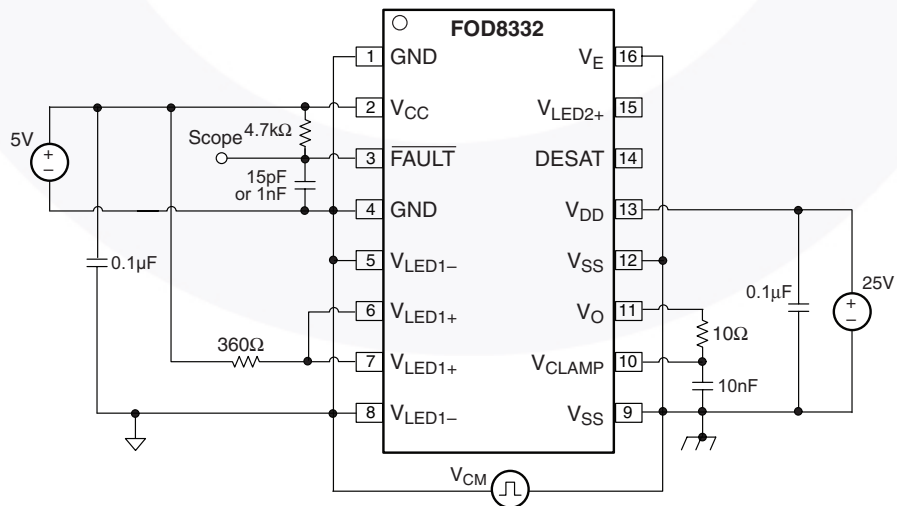
**Test Circuits** (Continued)



**Figure 51. Common-Mode High (CMH) LED1-On Test Circuit**



**Figure 52. Common-Mode High (CMH) LED2-Off Test Circuit**



**Figure 53. Common-Mode High (CML) LED2-On Test Circuit**