

## ASSR-1611

### High Current, 1 Form A, Solid State Relay (MOSFET) (60V/2.5A/0.1Ω)

#### Description

The Broadcom<sup>®</sup> ASSR-1611 is specifically designed for high current applications, commonly found in industrial equipment. The relay is a solid-state replacement for single-pole, normally-open, 1 Form A electromechanical relays.

The ASSR-1611 consists of an AlGaAs infrared light-emitting diode (LED) input stage that is optically coupled to a high-voltage output detector circuit. The detector consists of a high-speed photovoltaic diode array and driver circuitry to switch on/off two discrete high-voltage MOSFETs. The relay turns on (contact closes) with a minimum input current of 5 mA through the input LED. The relay turns off (contact opens) with an input voltage of 0.8V or less. The electrical and switching characteristics are specified over the temperature range of -40°C to +85°C.

The ASSR-1611 connection A, as shown in the schematic, allows the relay to switch either AC or DC loads. Connection B, with its advantages of reduced On-Resistance and higher output current, allows the relays to switch DC loads only.

#### Features

- Compact solid-state bidirectional signal switch
- Single channel normally-off Single-Pole-Single-Throw (SPST) relay
- 60V output withstand voltage
- 2.5A or 5.0A current rating
- Low input current: CMOS compatibility
- Low On-Resistance
  - 20 mΩ typical for DC only
  - 65 mΩ typical for AC/DC
- High-speed switching: 3.2 ms ( $T_{on}$ ), 0.1 ms ( $T_{off}$ ) typical
- High transient immunity: >1 kV/μs
- High input-to-output insulation voltage (safety and regulatory approved)
  - UL recognized: 3750 V<sub>rms</sub> and 5000 V<sub>rms</sub><sup>1</sup> for 1 minute per UL1577
  - CSA Component Acceptance

#### Applications

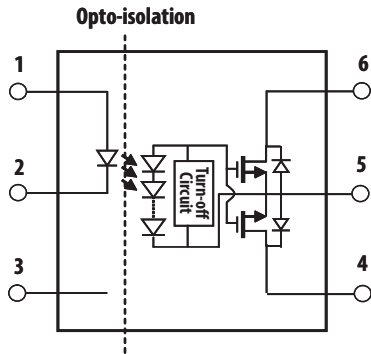
- Industrial controls
- Factory automation
- Data acquisition systems
- Measuring instruments
- Medical systems
- Security systems
- EMR/Reed Relay replacement

**CAUTION!** It is advised that normal static precautions be taken in handling and assembly of this component to prevent damage and degradation which may be induced by ESD.

The components featured in this data sheet are not to be used in military or aerospace applications or environments. The components are not AEC-Q100 qualified and are not recommended for automotive applications.

1. 5000 V<sub>rms</sub>/1 minute rating is for Option X21 only. Please consult your Broadcom sales representative.

## Functional Diagram



## Truth Table

LED	Output
Off	Open
On	Close

## Ordering Information

ASSR-1611 is UL Recognized with 3750  $V_{rms}$  and 5000  $V_{rms}$  (Option X21<sup>2</sup>) for 1 minute per UL1577 and is approved under CSA Component Acceptance Notice #5.

Part Number	Option	Package	Surface Mount	Gull Wing	Tape and Reel	Quantity
	RoHS Compliant					
ASSR-1611	-001E	300-mil	—	—	—	50 units per tube
	-301E	DIP-6	X	X	—	50 units per tube
	-501E		X	X	X	1000 units per reel

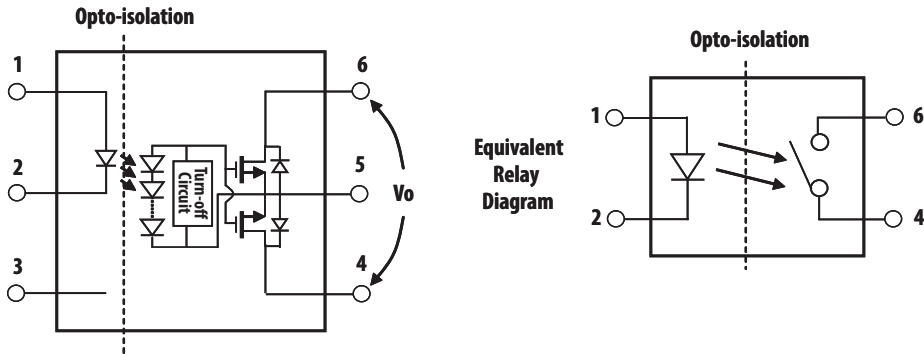
To order, choose a part number from the Part Number column and combine it with the desired option from the Option column to form an order entry.

**Example:** Select ASSR-1611-501E to order the product consisting of a 300-mil DIP-6 gull wing surface mount package in tape and reel packaging that is RoHS compliant.

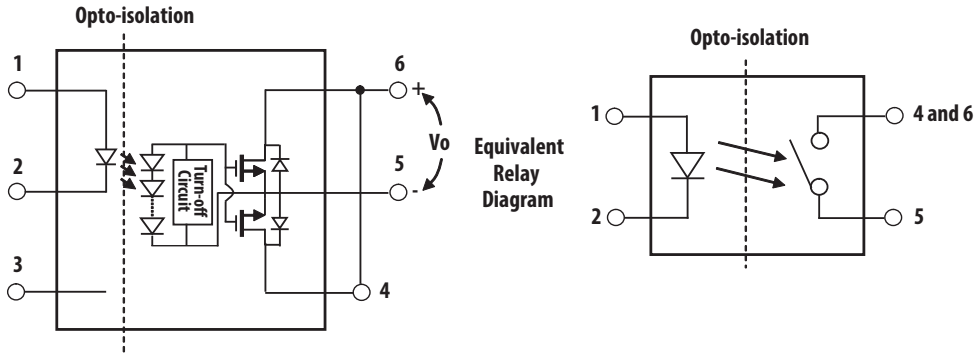
- Please contact your Broadcom sales representative.

# Schematics

## ASSR-1611 Connection A: AC/DC

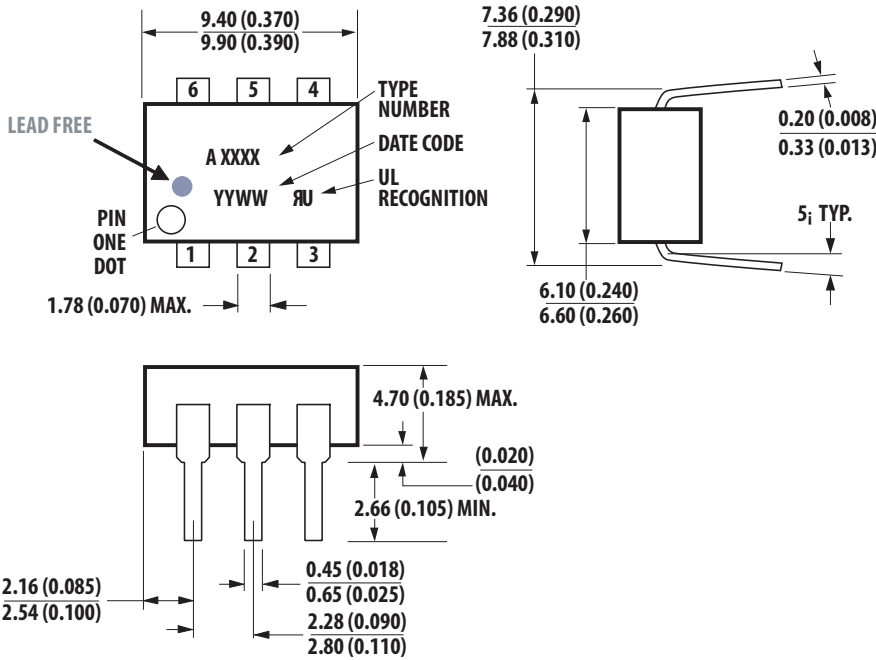


## ASSR-1611 Connection B: DC Only



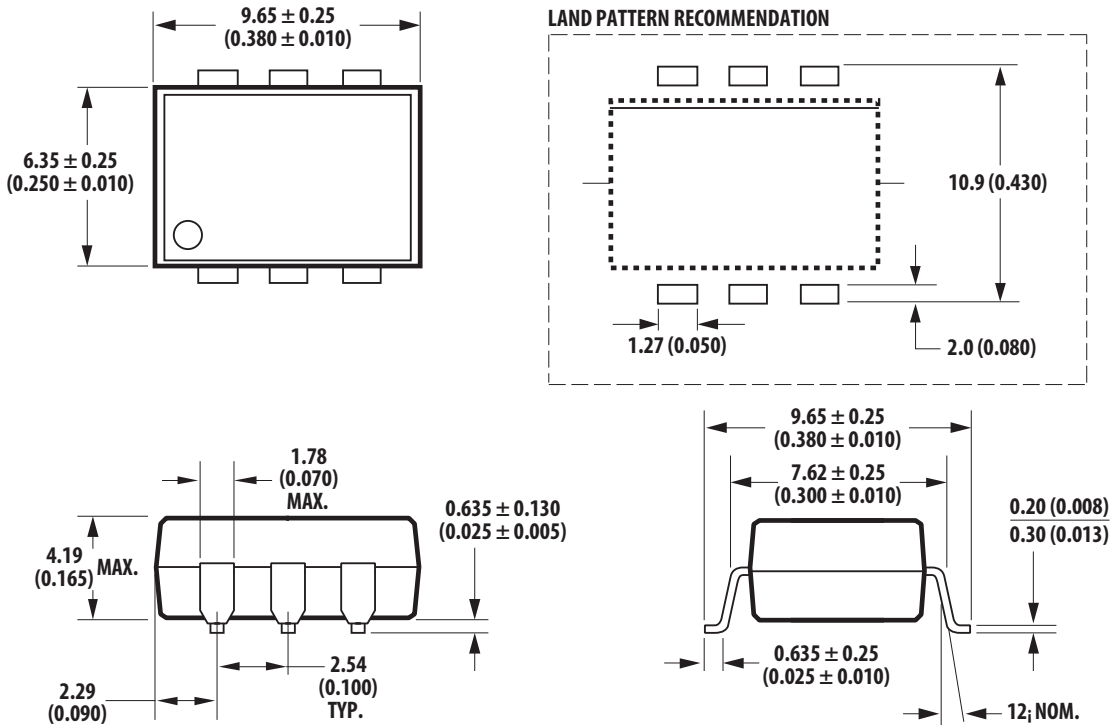
# Package Outline Drawings

## ASSR-1611 6-Pin DIP Package



DIMENSIONS IN MILLIMETERS AND (INCHES).

## ASSR-1611 6-Pin DIP Package with Gull Wing Surface Mount Option 300



NOTE: FLOATING LEAD PROTRUSION IS 0.25 mm (10 mils) MAX.

## Solder Reflow Temperature Profile

Recommended reflow condition as per JEDEC Standard, J-STD-020 (latest revision). Use non-halide flux.

## Regulatory Information

The ASSR-1611 is approved by the following organizations:

UL	Approval under UL 1577, component recognition program up to $V_{ISO} = 3750 V_{rms}$ and $V_{ISO} = 5000 V_{rms}$ (Option X21).
CSA	Approval under CSA Component Acceptance Notice #5.

## Insulation-Related and Safety-Related Specifications

Parameter	Symbol	ASSR-1611	Unit	Conditions
Minimum External Air Gap (Clearance)	L(101)	7.1	mm	Measured from input terminals to output terminals, shortest distance through air.
Minimum External Tracking (Creepage)	L(102)	7.4	mm	Measured from input terminals to output terminals, shortest distance path along body.
Minimum Internal Plastic Gap (Internal Clearance)	—	0.08	mm	Through insulation distance conductor to conductor, usually the straight line distance thickness between the emitter and detector.
Tracking Resistance (Comparative Tracking Index)	CTI	175	V	DIN IEC 112/VDE 0303 Part 1.
Isolation Group (DIN VDE0109)	—	IIIa	—	Material Group (DIN VDE 0109).

## Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Unit	Note	
Storage Temperature	$T_S$	-55	125	°C		
Operating Temperature	$T_A$	-40	85	°C		
Junction Temperature	$T_J$	—	125	°C		
Lead Soldering Cycle	Temperature	—	260	°C		
	Time	—	10	s		
Input Current	Average	—	25	mA		
	Surge	—	50			
	Transient	—	1000			
Reversed Input Voltage	$V_R$	—	5	V		
Input Power Dissipation	$P_{IN}$	—	40	mW		
Output Power Dissipation	Connection A	$P_O$	—	625	mW	
	Connection B	$P_O$	—	880	mW	
Average Output Current ( $T_A = 25^\circ\text{C}$ , $T_C \leq 100^\circ\text{C}$ )	Connection A	$I_O$	—	2.5	A	a
	Connection B	$I_O$	—	5	A	a
Output Voltage ( $T_A = 25^\circ\text{C}$ )	Connection A	$V_O$	-60	60	V	b
	Connection B	$V_O$	0	60	V	
Solder Reflow Temperature Profile	See Lead Free IR Profile.					

a. For derating, refer to [Figure 1](#), and [Figure 2](#).

b. The voltage across the output terminals of the relay should not exceed this rated withstand voltage. Overvoltage protection circuits should be added in some applications to protect against overvoltage transients.

## Recommended Operating Conditions

Parameter	Symbol	Min.	Max.	Unit
Input Current (ON)	$I_{F(ON)}$	5	20	mA
Input Voltage (OFF)	$V_{F(OFF)}$	0	0.8	V
Operating Temperature	$T_A$	-40	+85	°C

## Package Characteristics

Unless otherwise specified,  $T_A = 25^\circ\text{C}$ .

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Note
Input-Output Momentary Withstand Voltage	$V_{ISO}$	3750	—	—	$V_{rms}$	RH ≤ 50%, t = 1 minute	a, b
		5000	—	—	$V_{rms}$	RH ≤ 50%, t = 1 minute Option X21	a, b
Input-Output Resistance	$R_{I-O}$	—	$10^{14}$	—	Ω	$V_{I-O} = 500\text{ Vdc}$	
Input-Output Capacitance	$C_{I-O}$	—	0.8	—	pF	$V_{I-O} = 0\text{ Vdc}$ , f = 1 MHz	a

- a. Device is considered a two-terminal device: pins 1, 2, and 3 shorted together and pins 5, 6, and 7 shorted together.
- b. The Input-Output Momentary Withstand Voltage is a dielectric voltage rating that should not be interpreted as an input-output continuous voltage rating. For the continuous voltage rating, refer to the IEC/EN/DIN EN 60747-5-2 Insulation Characteristics Table (if applicable), your equipment level safety specification, or Broadcom Application Note 1074, *Optocoupler Input-Output Endurance Voltage*.

## Electrical Specifications (DC)

Over recommended operating  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$ ,  $I_F = 5\text{ mA}$  to  $10\text{ mA}$ , unless otherwise specified.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Fig.	Note
Output Withstand Voltage	$ V_{O(OFF)} $	60	68	—	V	$V_F = 0.8\text{V}$ , $I_O = 250\ \mu\text{A}$ , $T_A = 25^\circ\text{C}$	3	
		55	—	—	V	$V_F = 0.8\text{V}$ , $I_O = 250\ \mu\text{A}$	3	
Output Leakage Current	$I_{O(OFF)}$	—	0.01	0.1	μA	$V_F = 0.8\text{V}$ , $V_O = 60\text{V}$ , $T_A = 25^\circ\text{C}$	5	
		—	—	5	μA	$V_F = 0.8\text{V}$ , $V_O = 55\text{V}$	4	
Output Off-Capacitance	$C_{(OFF)}$	—	1400	—	pF	$V_F = 0.8\text{V}$ , $V_O = 0\text{V}$ , f = 1 MHz	6	
Output Offset Voltage	$ V_{(OS)} $	—	1	—	μV	$I_F = 5\text{ mA}$ , $I_O = 0\text{ mA}$		
Input Reverse Breakdown Voltage	$V_R$	5	—	—	V	$I_R = 10\ \mu\text{A}$		
Input Forward Voltage	$V_F$	1.1	1.3	1.7	V	$I_F = 5\text{ mA}$	7, 8	
Output On-Resistance	Connection A	—	0.065	0.1	Ω	$I_F = 5\text{ mA}$ , $I_O = 2.5\text{A}$ , Pulse ≤ 30 ms, $T_A = 25^\circ\text{C}$	9, 10	a
	Connection B	—	0.02	0.035	Ω		11	

- a. During the pulsed  $R_{(ON)}$  measurement ( $I_O$  duration ≤ 30 ms), ambient ( $T_A$ ) and case temperature ( $T_C$ ) are equal.

## Switching Specifications (AC)

Over recommended operating  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$ ,  $I_F = 5\text{ mA}$  to  $10\text{ mA}$ , unless otherwise specified.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Fig.	Note
Turn On Time	$T_{ON}$	—	3.2	5.0	ms	$I_F = 5\text{ mA}$ , $I_O = 1.0\text{A}$ , $T_A = 25^\circ\text{C}$	12, 13	
		—	—	10.0	ms	$I_F = 5\text{ mA}$ , $I_O = 1.0\text{A}$		
		—	1.6	2.5	ms	$I_F = 10\text{ mA}$ , $I_O = 1.0\text{A}$ , $T_A = 25^\circ\text{C}$	12, 14	
		—	—	5.0	ms	$I_F = 10\text{ mA}$ , $I_O = 1.0\text{A}$		
Turn Off Time	$T_{OFF}$	—	0.1	0.5	ms	$I_F = 5\text{ mA}$ , $I_O = 1.0\text{A}$ , $T_A = 25^\circ\text{C}$	15, 16	
		—	—	1	ms	$I_F = 5\text{ mA}$ , $I_O = 1.0\text{A}$		
		—	0.06	0.2	ms	$I_F = 10\text{ mA}$ , $I_O = 1.0\text{A}$ , $T_A = 25^\circ\text{C}$	15, 17	
		—	—	0.5	ms	$I_F = 10\text{ mA}$ , $I_O = 1.0\text{A}$		
Output Transient Rejection	$dV_O/dt$	1	7	—	kV/ $\mu\text{s}$	$\Delta V_O = 60\text{V}$ , $R_M \geq 1\text{ M}\Omega$ , $C_M = 1000\text{ pF}$ , $T_A = 25^\circ\text{C}$		a
Input-Output Transient Rejection	$dV_{I-O}/dt$	1	$\geq 10$	—	kV/ $\mu\text{s}$	$V_{DD} = 5\text{V}$ , $\Delta V_{I-O} = 1000\text{V}$ , $R_L = 1\text{ k}\Omega$ , $C_L = 25\text{ pF}$ , $T_A = 25^\circ\text{C}$		a

a. For the transient rejection measurements, refer to Broadcom white paper, AV02-2390EN, *Solid State Relay Transient Immunity*.

Figure 1: Maximum Output Current Rating vs. Ambient Temperature (AC/DC Connection)

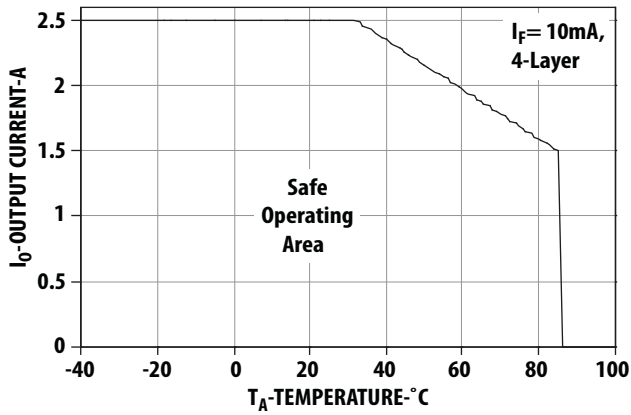


Figure 2: Maximum Output Current Rating vs. Ambient Temperature (DC Connection)

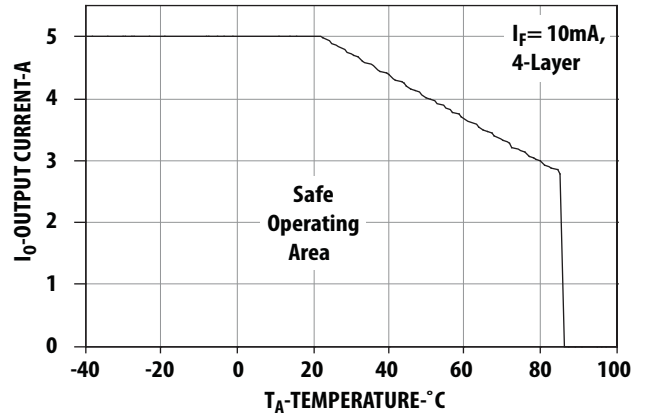


Figure 3: Normalized Typical Output Withstand Voltage vs. Ambient Temperature

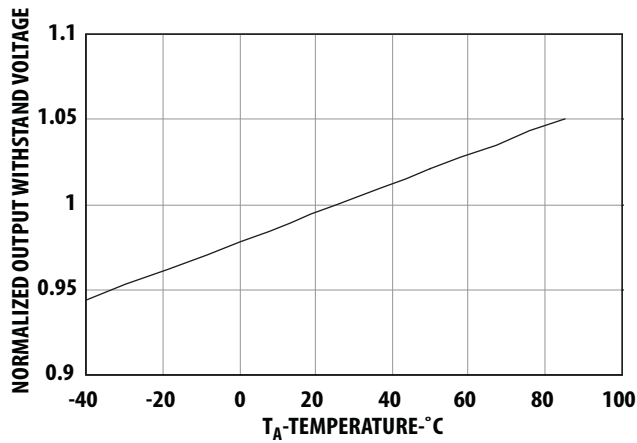


Figure 4: Typical Output Leakage vs. Ambient Temperature

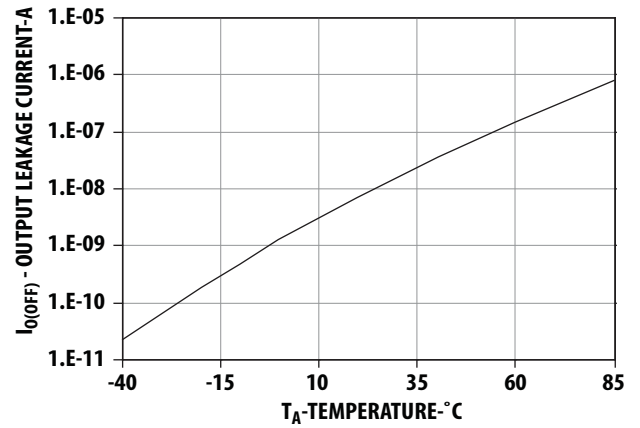


Figure 5: Typical Output Leakage vs. Output Voltage

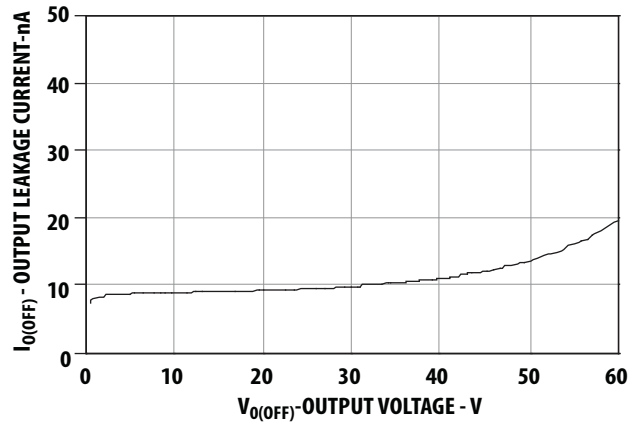


Figure 6: Typical Output Capacitance vs. Output Voltage

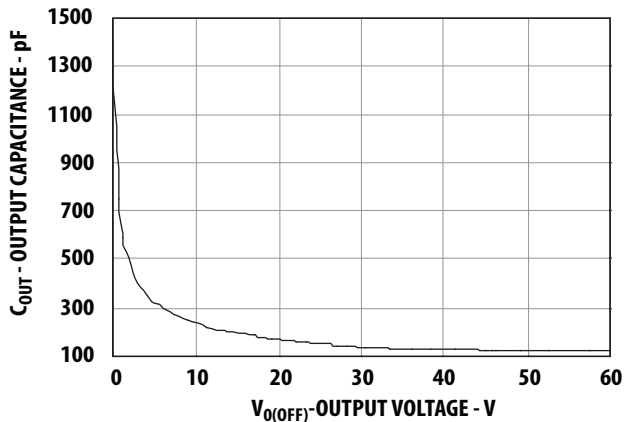




Figure 7: Typical Forward Voltage vs. Temperature

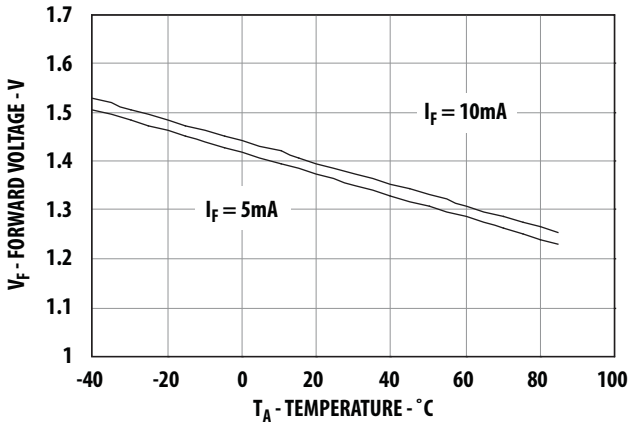


Figure 8: Typical Forward Current vs. Forward Voltage over Temperature

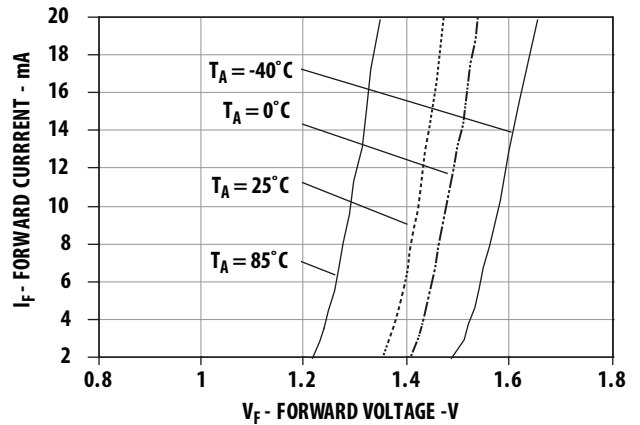


Figure 9: Typical Output Current vs. Typical Output Voltage over Temperature

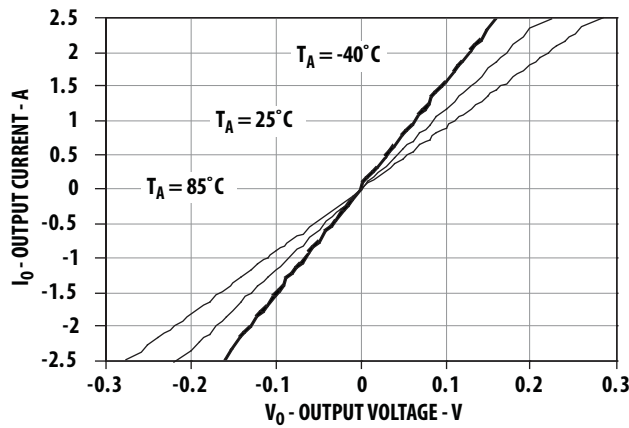


Figure 10: Typical  $R_{(ON)}$  (AC/DC Connection) vs. Temperature

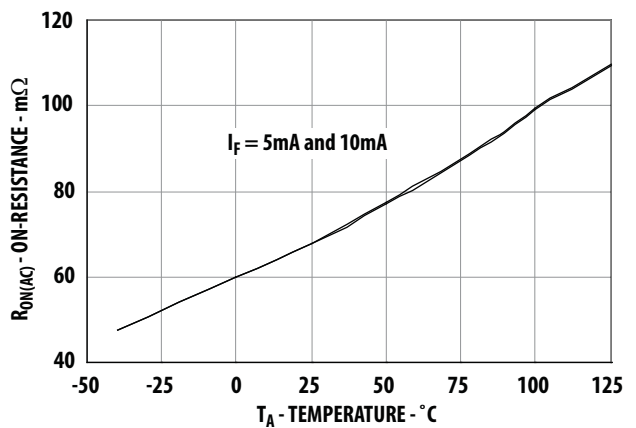


Figure 11: Typical  $R_{(ON)}$  (DC Connection) vs. Temperature

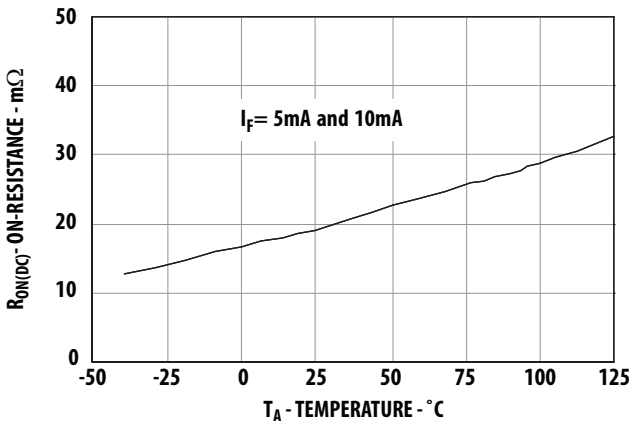


Figure 12: Typical Turn On Time vs. Input Current

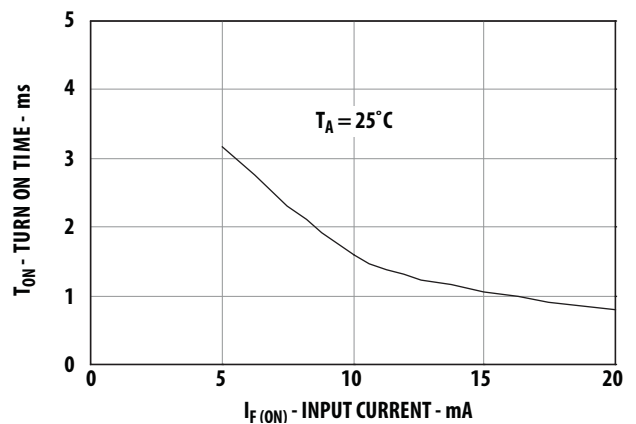


Figure 13: Typical Turn On Time vs. Ambient Temperature

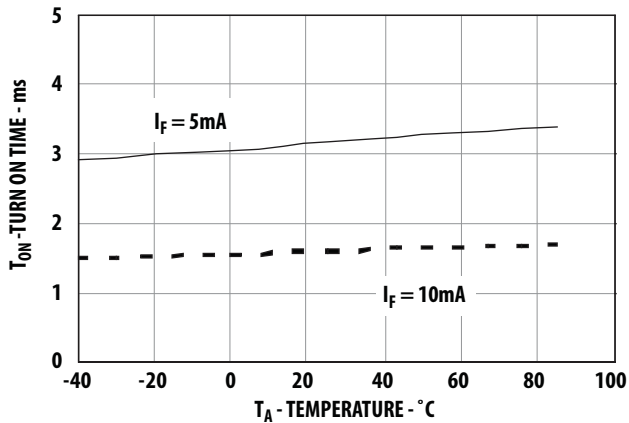


Figure 14: Typical Turn Off Time vs. Input Current

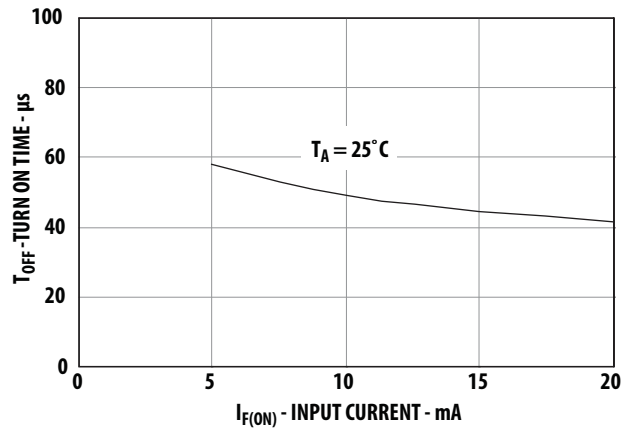


Figure 15: Typical Turn Off Time vs. Ambient Temperature

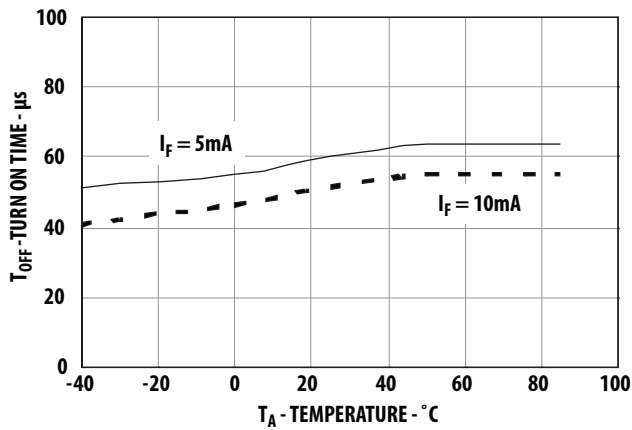


Figure 16: Switching Circuit

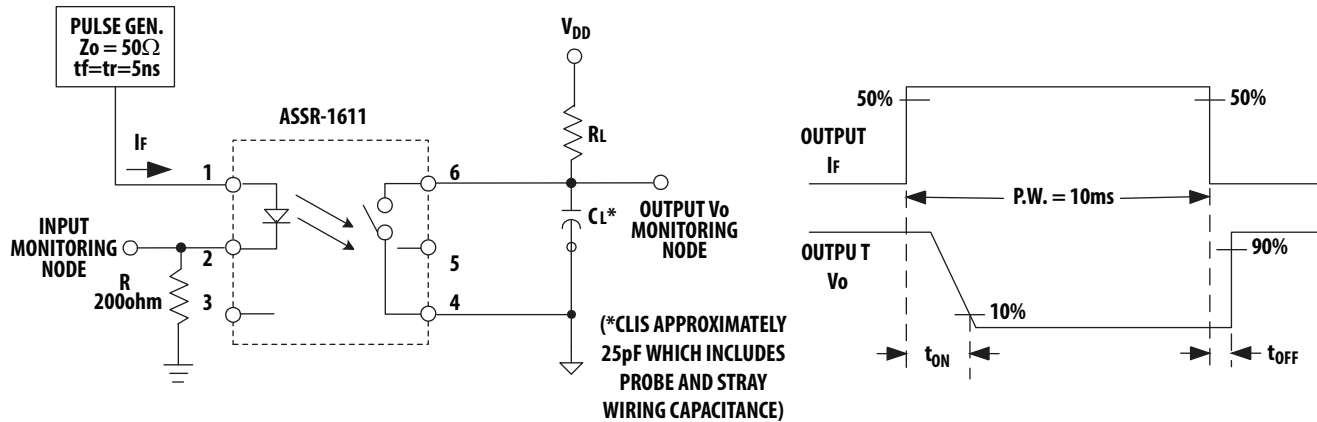
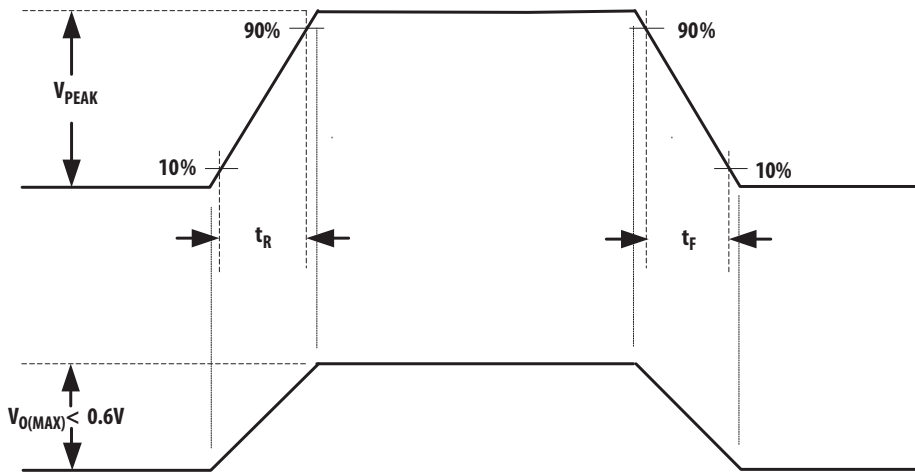
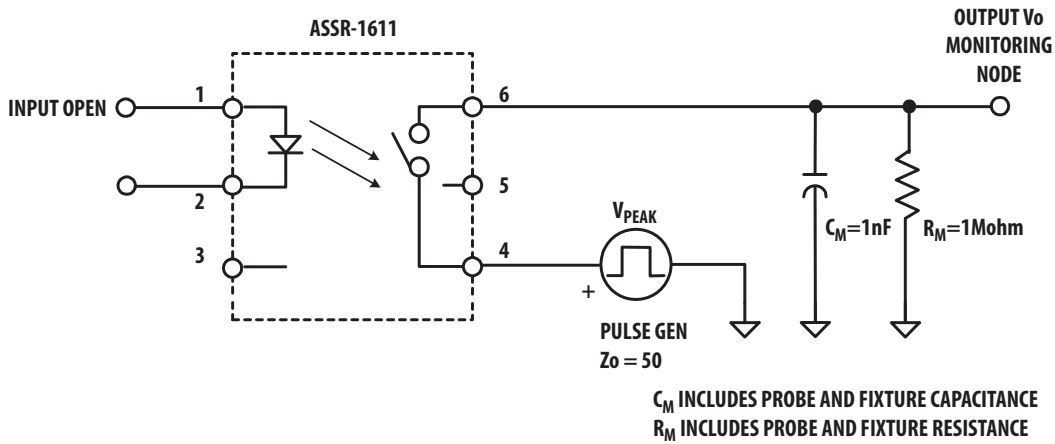


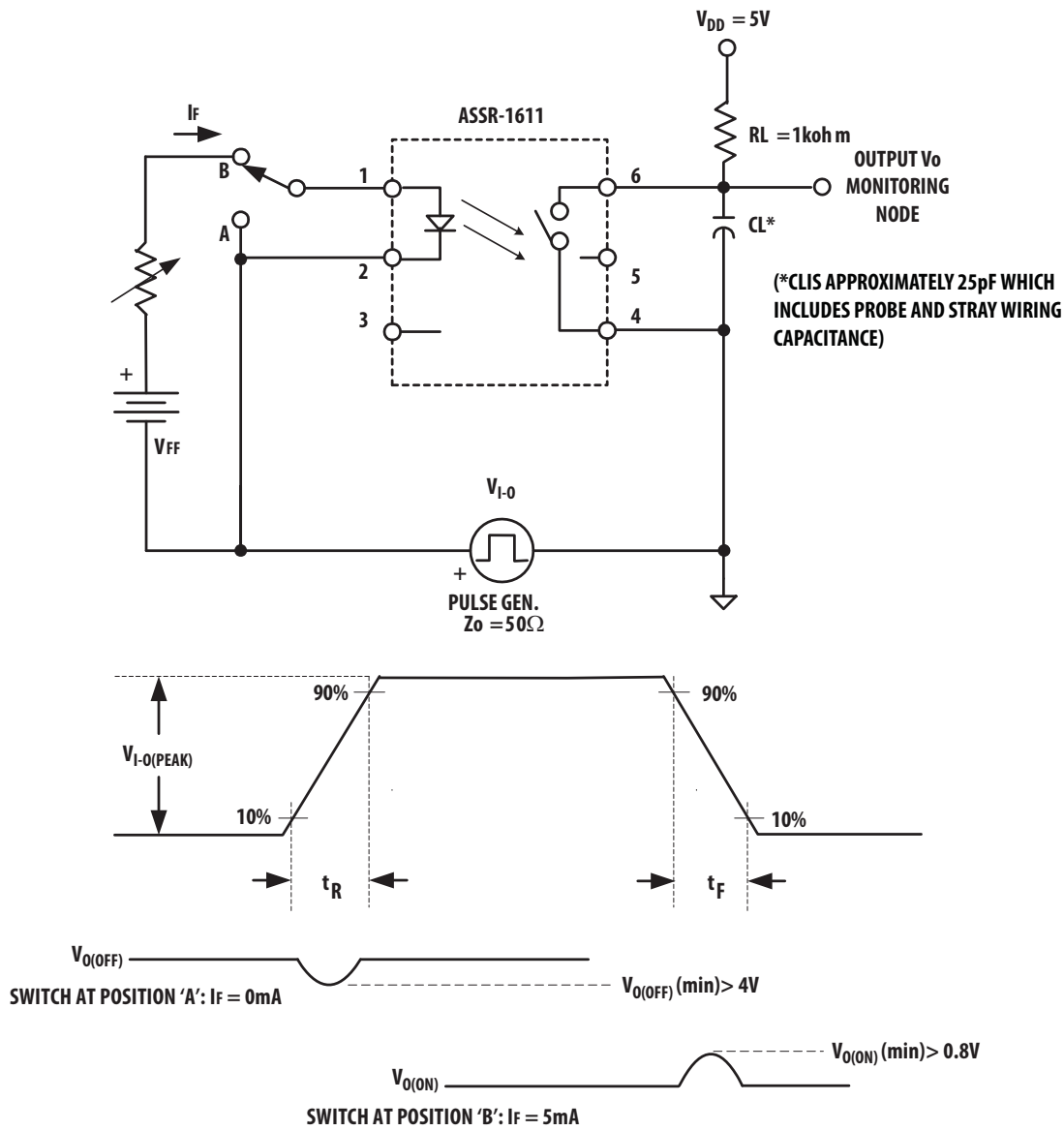
Figure 17: Output Transient Rejection Test Circuit



$$\frac{dV_0}{dt} = \frac{(0.8)V_{PEAK}}{t_R} \text{ OR } \frac{(0.8)V_{PEAK}}{t_F}$$

OVER SHOOT ON V<sub>PEAK</sub> IS TO BE 10%

Figure 18: Input-Output Transient Rejection Test Circuit



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