

## ASSR-4110, ASSR-4111, ASSR-4120

### General-Purpose, Form A, Solid State Relay (Photo MOSFET) (400V/0.12A/25Ω)

#### Description

The Broadcom<sup>®</sup> ASSR-41xx Series consists of an AlGaAs infrared light-emitting diode (LED) input stage 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 3 mA through the input LED. The relay turns off (contact opens) with an input voltage of 0.8V or less.

The single channel configurations, ASSR-4110 and ASSR-4111, are equivalent to 1 Form A Electromechanical Relays (EMR), and the dual channel configuration, ASSR-4120, are equivalent to 2 Form A EMR. They are available in 4-pin SO, 6-pin DIP, 8-pin DIP and Gull Wing Surface Mount for DIP packages. Their electrical and switching characteristics are specified over the temperature range of -40°C to +85°C. They are used for general purpose switching of signals and low power AC/DC loads.

ASSR-4111 enables AC/DC and DC-only output connections. For DC-only connection, the output current,  $I_o$ , increases to 0.24A and the on-resistance,  $R(ON)$  reduces to 8.5Ω.

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

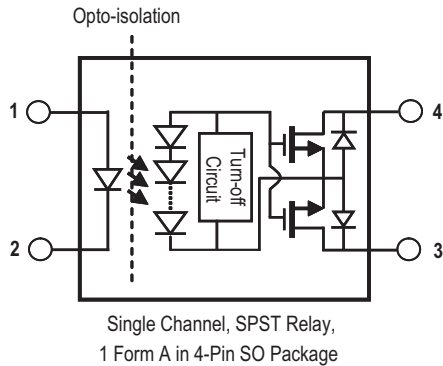
#### Features

- Compact solid-state bidirectional signal switch
- Single and dual channel normally-off Single-Pole-Single-Throw (SPST) relay
- 400V output withstand voltage
- 0.12A or 0.24A current rating (See schematic for ASSR-4111 connections A and B.)
- Low input current: CMOS compatibility
- Low on-resistance:
  - 5.5Ω typical for DC-only
  - 8Ω typical for AC/DC
- High speed switching:
  - 0.1 ms ( $T_{ON}$ ), 0.02 ms ( $T_{OFF}$ ) typical
- High transient immunity: >1 kV/μs
- High input-to-output insulation voltage (safety and regulatory approvals)
  - 3750 Vrms for 1 min per UL1577
  - CSA component acceptance

#### Applications

- Telecommunication switching
- Data communications
- Industrial controls
- Medical
- Security
- EMR/Reed Relay replacement

## Functional Diagram



## Truth Table

LED	Output
Off	Open
On	Close

## Ordering Information

ASSR-xxxx is UL Recognized with 3750 Vrms for 1 minute per UL1577 and is approved under CSA Component Acceptance Notice #5.

Part Number	Option	Package	Surface Mount	Gull Wing	Tape & Reel	Quantity
	RoHS Compliant					
ASSR-4110	-003E	SO-4	X			100 units per tube
	-503E		X		X	1500 units per reel
ASSR-4111	-001E	300-mil DIP-6				50 units per tube
	-301E		X	X		50 units per tube
	-501E		X	X	X	1000 units per reel
ASSR-4120	-002E	300-mil DIP-8				50 units per tube
	-302E		X	X		50 units per tube
	-502E		X	X	X	1000 units per reel

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

### Example 1:

ASSR-4111-501E to order product of 300-mil DIP-6 Gull Wing Surface Mount package in Tape and Reel packaging and RoHS Compliant.

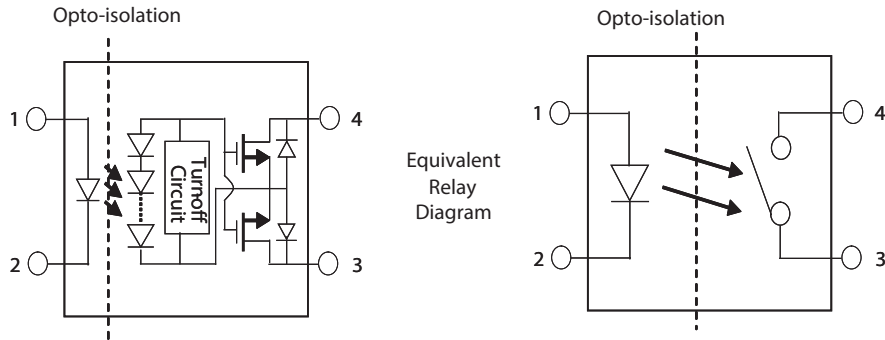
### Example 2:

ASSR-4120-002E to order product of 300-mil DIP-8 package in tube packaging and RoHS Compliant.

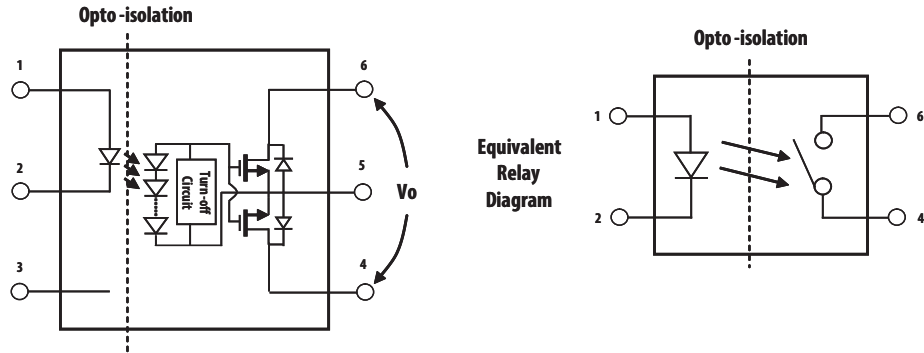
Option data sheets are available. Contact your Broadcom sales representative or authorized distributor for information.

# Schematic

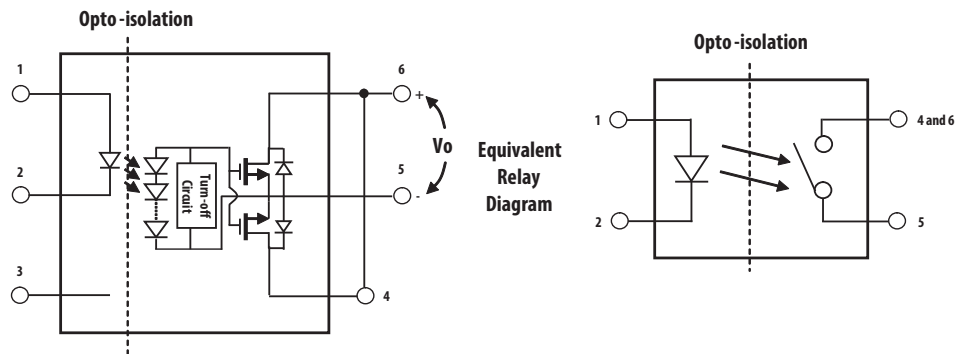
## ASSR-4110



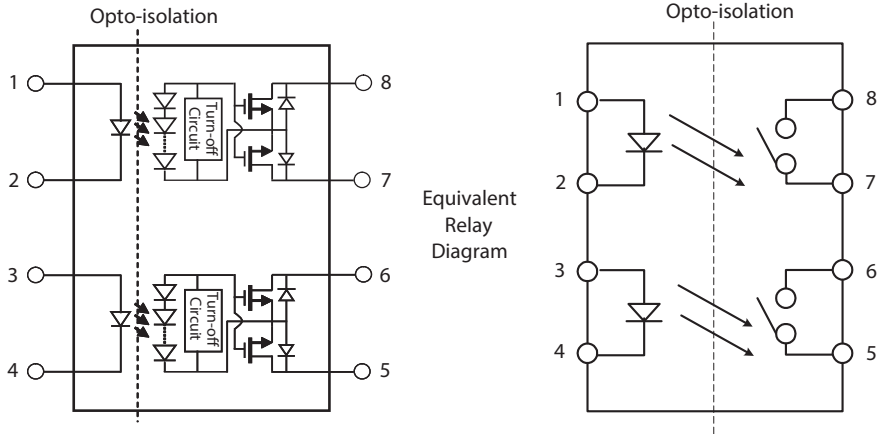
## ASSR-4111 Connection A



## ASSR-4111 Connection B

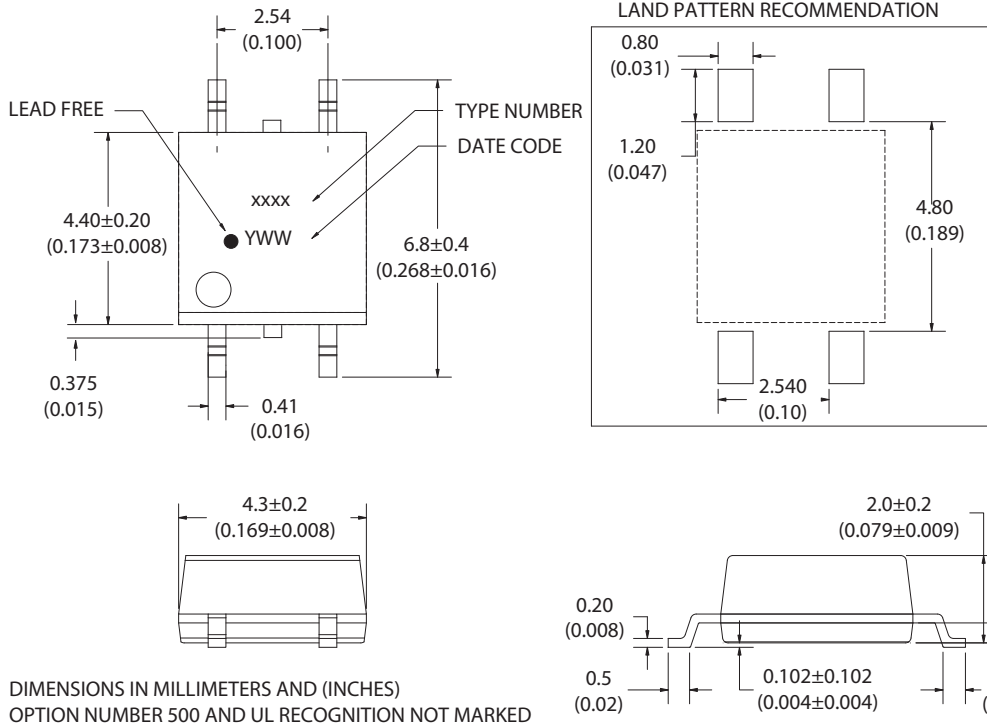


# ASSR-4120

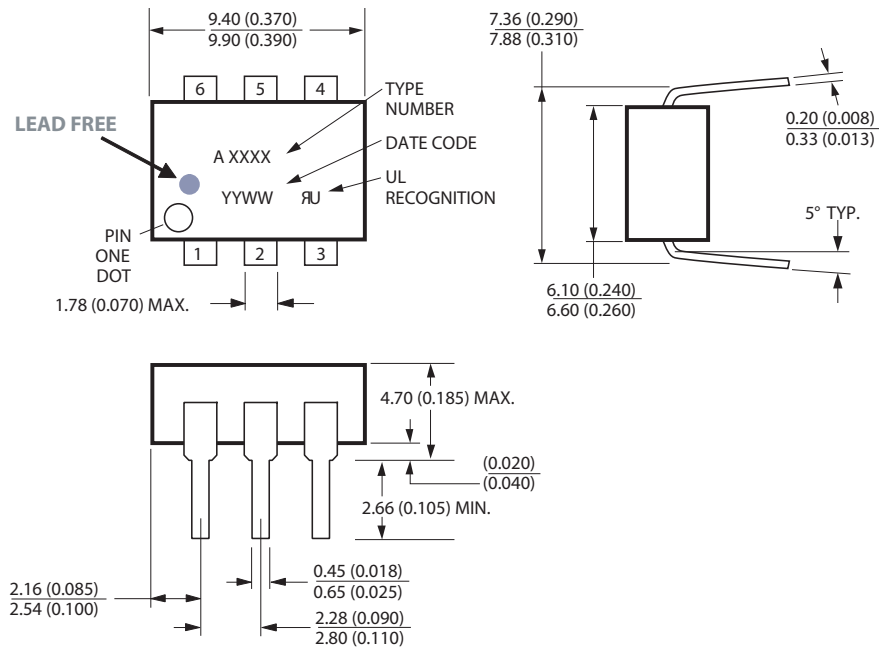


## Package Outline Drawings

### ASSR-4110 4-Pin Small Outline Package

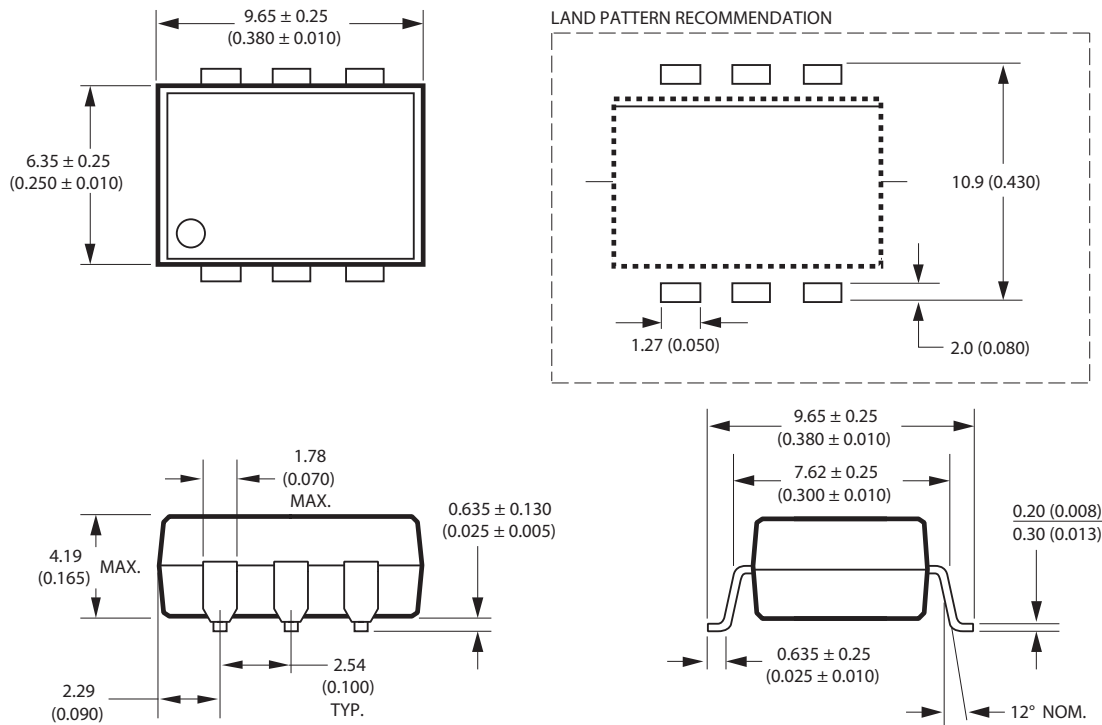


## ASSR-4111 6-Pin DIP Package



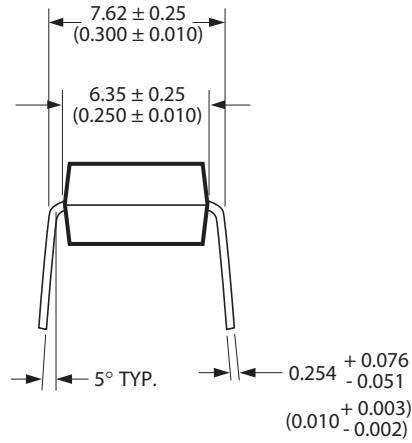
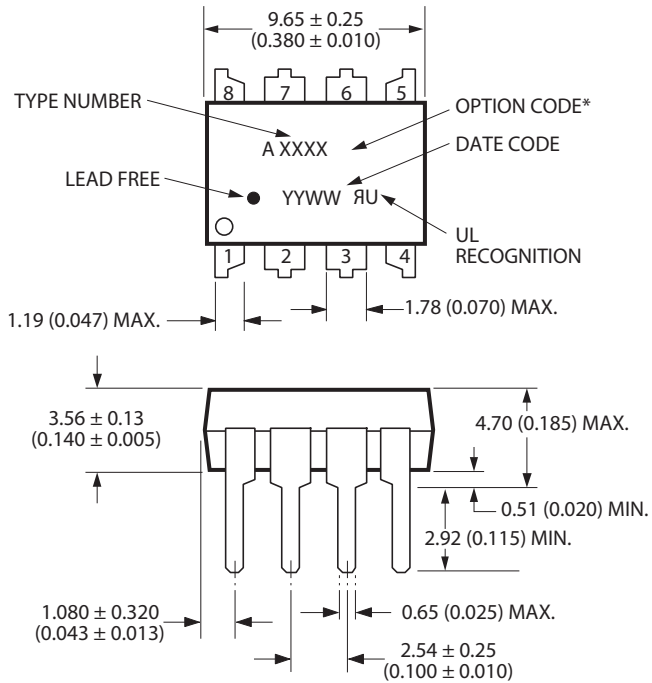
DIMENSIONS IN MILLIMETERS AND (INCHES).

## ASSR-4111 6-Pin DIP Package with Gull Wing Surface Mount Option 300



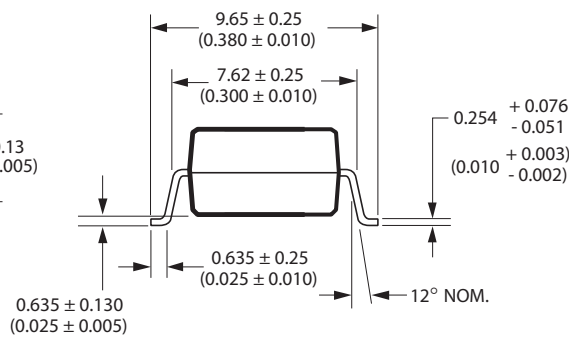
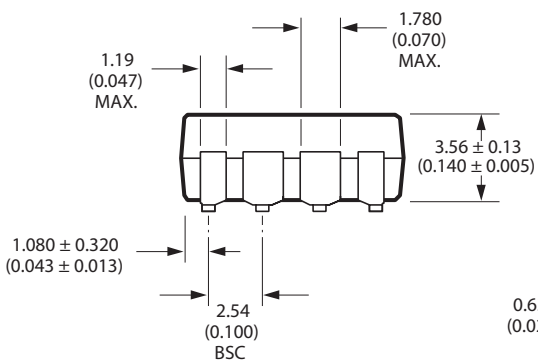
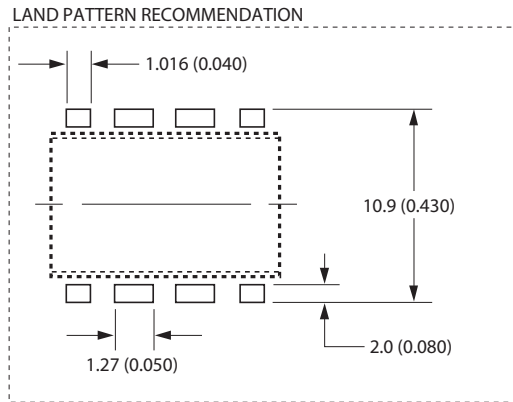
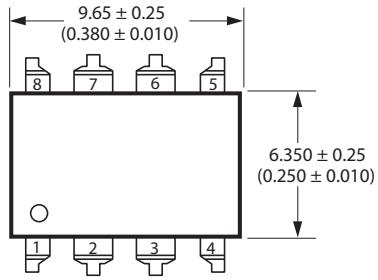
NOTE: FLOATING LEAD PROTRUSION IS 0.25 mm (10 mils) MAX.

# ASSR-4120 8-Pin DIP Package



DIMENSIONS IN MILLIMETERS AND (INCHES).  
OPTION NUMBERS 300 AND 500 NOT MARKED.

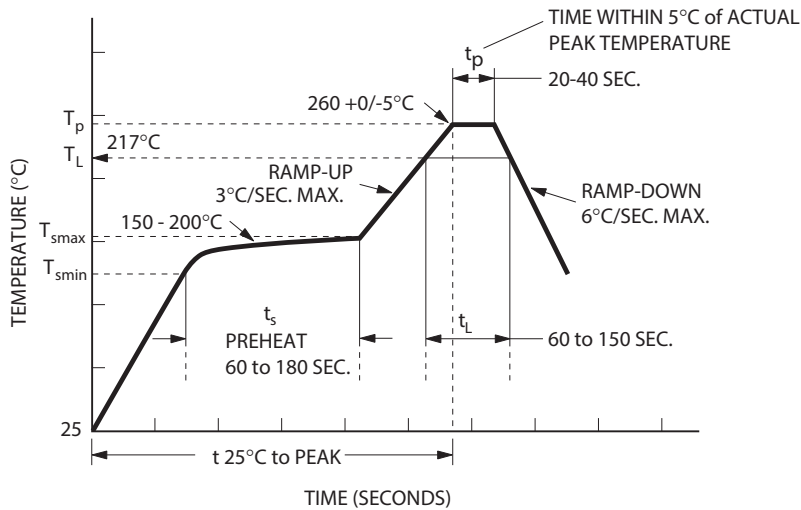
# ASSR-4120 8-Pin DIP Package with Gull Wing Surface Mount Option 300



DIMENSIONS IN MILLIMETERS (INCHES).  
LEAD COPLANARITY = 0.10 mm (0.004 INCHES).

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

## Lead Free IR Profile



Non-halide flux should be used.

## Regulatory Information

The ASSR-4110, ASSR-4111, and ASSR-4120 are approved by the following organizations:

### UL

Approved under UL 1577, component recognition program up to  $V_{ISO} = 3750$  Vrms.

### CSA

Approved under CSA Component Acceptance Notice #5.

## Insulation and Safety Related Specifications

Parameter	Symbol	ASSR-4110	ASSR-4111 ASSR-4120	Unit	Conditions
Minimum External Air Gap (Clearance)	L(101)	4.9	7.1	mm	Measured from input terminals to output terminals, shortest distance through air.
Minimum External Tracking (Creepage)	L(102)	4.9	7.4	mm	Measured from input terminals to output terminals, shortest distance path along body.
Minimum Internal Plastic Gap (Internal Clearance)		0.08	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	175	V	DIN IEC 112/VDE 0303 Part 1.
Isolation Group (DIN VDE0109)		IIIa	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	ASSR-4110	$P_{IN}$	—	40	mW	
	ASSR-4111	$P_{IN}$	—	40	mW	
	ASSR-4120	$P_{IN}$	—	80	mW	
Output Power Dissipation	ASSR-4110	$P_O$	—	360	mW	
	ASSR-4111	$P_O$	—	490	mW	
	ASSR-4120	$P_O$	—	720	mW	
Average Output Current ( $T_A = 25^\circ\text{C}$ , $T_C \leq 100^\circ\text{C}$ )		$I_O$	—	0.12	A	a
	ASSR-4111 Connection B		—	0.24	A	
Output Voltage ( $T_A = 25^\circ\text{C}$ )		$V_O$	-400	400	V	b
	ASSR-4111 Connection B		0	400	V	b
Solder Reflow Temperature Profile	See <a href="#">Lead Free IR Profile</a> .					

a. For derating, refer to [Figure 1](#), [Figure 2](#), [Figure 3](#), and [Figure 4](#).

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	Note
Input Current (ON)	$I_{F(ON)}$	3	20	mA	a
Input Voltage (OFF)	$V_{F(OFF)}$	0	0.8	V	
Operating Temperature	$T_A$	-40	+85	°C	

a. Threshold to switch device is  $I_F \geq 0.5$  mA; however, for qualified device performance over temperature range, it is recommended to operate at  $I_F = 5$  mA.

## Package Characteristics

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

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions	Note
Input-Output Momentary Withstand Voltage	$V_{ISO}$	3750	—	—	Vrms	$RH \leq 50\%$ , $t = 1 \text{ min.}$	a, b
Input-Output Resistance	$R_{I-O}$	—	$10^{12}$	—	$\Omega$	$V_{I-O} = 500 \text{ Vdc}$	
Input-Output Capacitance							a
ASSR-4110	$C_{I-O}$	—	0.4	—	pF	$f = 1 \text{ MHz}$ ; $V_{I-O} = 0 \text{ Vdc}$	
ASSR-4111	$C_{I-O}$	—	0.5	—	pF	$f = 1 \text{ MHz}$ ; $V_{I-O} = 0 \text{ Vdc}$	
ASSR-4120	$C_{I-O}$	—	0.8	—	pF	$f = 1 \text{ MHz}$ ; $V_{I-O} = 0 \text{ Vdc}$	

- a. Device is considered a two-terminal device:  
 ASSR-4110 — pin 1, 2 shorted and pin 3, 4 shorted.  
 ASSR-4111 — pin 1, 2, 3 shorted and pin 4, 5, 6 shorted.  
 ASSR-4120 — pin 1, 2, 3, 4 shorted and pin 5, 6, 7, 8 shorted.
- 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	Sym.	Min.	Typ.	Max.	Unit	Conditions	Figure	Note
Output Withstand Voltage	$ V_{O(OFF)} $	400	450	—	V	$V_F = 0.8\text{V}$ , $I_O = 250 \mu\text{A}$ , $T_A = 25^\circ\text{C}$		
		360	—	—	V	$V_F = 0.8\text{V}$ , $I_O = 250 \mu\text{A}$	5	
Output Leakage Current	$I_{O(OFF)}$	—	0.5	100	nA	$V_F = 0.8\text{V}$ , $V_O = 400\text{V}$ , $T_A = 25^\circ\text{C}$		
		—	—	1	$\mu\text{A}$	$V_F = 0.8\text{V}$ , $V_O = 400\text{V}$	6	
Output Offset Voltage	$ V_{(OS)} $	—	1	—	$\mu\text{V}$	$I_F = 5 \text{ mA}$ , $I_O = 0 \text{ mA}$		
Input Reverse Breakdown Voltage	$V_R$	5	—	—	V	$I_R = 10 \mu\text{A}$		
Input Forward Voltage	$V_F$	1.1	1.3	1.65	V	$I_F = 5 \text{ mA}$	7, 8	
Output On-Resistance	$R_{(ON)}$	—	16	25	$\Omega$	$I_F = 5 \text{ mA}$ , $I_O = 120 \text{ mA}$ , Pulse $\leq 30 \text{ ms}$ , $T_A = 25^\circ\text{C}$	9, 10	a
	$R_{(ON)}$	—	5.5	8.5	$\Omega$	$I_F = 5 \text{ mA}$ , $I_O = 240 \text{ mA}$ , Pulse $\leq 30 \text{ ms}$ , $T_A = 25^\circ\text{C}$		a

- a. During the pulsed  $R_{(ON)}$  measurement ( $I_O$  duration  $\leq 30 \text{ ms}$ ), 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	Sym.	Min.	Typ.	Max.	Unit	Conditions	Figure	Note
Turn On Time	$T_{ON}$	—	0.25	0.5	ms	$I_F = 5\text{ mA}$ , $I_O = 120\text{ mA}$ , $T_A = 25^\circ\text{C}$	11, 16	
		—	—	1.0	ms	$I_F = 5\text{ mA}$ , $I_O = 120\text{ mA}$	12	
			0.1	0.25	ms	$I_F = 10\text{ mA}$ , $I_O = 120\text{ mA}$ , $T_A = 25^\circ\text{C}$		
			—	0.5	ms	$I_F = 10\text{ mA}$ , $I_O = 120\text{ mA}$		
Turn Off Time	$T_{OFF}$	—	0.02	0.2	ms	$I_F = 5\text{ mA}$ , $I_O = 120\text{ mA}$ , $T_A = 25^\circ\text{C}$	13, 16	
		—	—	0.5	ms	$I_F = 5\text{ mA}$ , $I_O = 120\text{ mA}$	14	
			0.02	0.15	ms	$I_F = 10\text{ mA}$ , $I_O = 120\text{ mA}$ , $T_A = 25^\circ\text{C}$		
			—	0.2	ms	$I_F = 10\text{ mA}$ , $I_O = 120\text{ mA}$		
Output Transient Rejection	$dV_O/dt$	1	7	—	kV/ $\mu\text{s}$	$\Delta V_O = 400\text{V}$ , $T_A = 25^\circ\text{C}$	17	
Input-Output Transient Rejection	$dV_{I-O}/dt$	1	$\geq 10$	—	kV/ $\mu\text{s}$	$\Delta V_{I-O} = 1000\text{V}$ , $T_A = 25^\circ\text{C}$	18	

## Applications Information

### On-Resistance and Derating Curves

The Output On-Resistance,  $R_{(ON)}$ , specified in this data sheet, is the resistance measured across the output contact when a pulsed current signal ( $I_O = 120\text{ mA}$ ) is applied to the output pins. The use of a pulsed signal ( $\leq 30\text{ ms}$ ) implies that each junction temperature is equal to the ambient and case temperatures. The steady-state resistance,  $R_{ss}$ , on the other hand, is the value of the resistance measured across the output contact when a DC current signal is applied to the output pins for a duration sufficient to reach thermal equilibrium.  $R_{ss}$  includes the effects of the temperature rise in the device.

Figure 1, Figure 2, Figure 3, and Figure 4 specify the maximum average output current allowable for a given ambient temperature. The maximum allowable output current and power dissipation are related by the expression  $R_{ss} = P_o(\text{max}) / (I_o(\text{max}))^2$  from which  $R_{ss}$  can be calculated. Staying within the safe area ensures that the steady-state MOSFET junction temperature remains less than  $125^\circ\text{C}$ .

### Turn On Time and Turn Off Time Variation

The ASSR-41xx Series exhibits a very fast turn on and turn off time. Both the turn on and turn off time can be adjusted by choosing proper forward current as depicted in Figure 11 and Figure 13. The changes of the turn on and turn off time with ambient temperature are also shown in Figure 12 and Figure 14.

Figure 1: Maximum Average Output Current Rating vs. Ambient Temperature (ASSR-4110-003E)

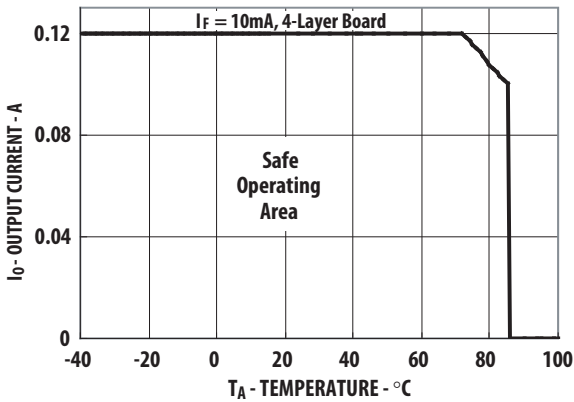


Figure 2: Maximum Output Current Rating vs. Ambient Temperature (ASSR-4111-001E)

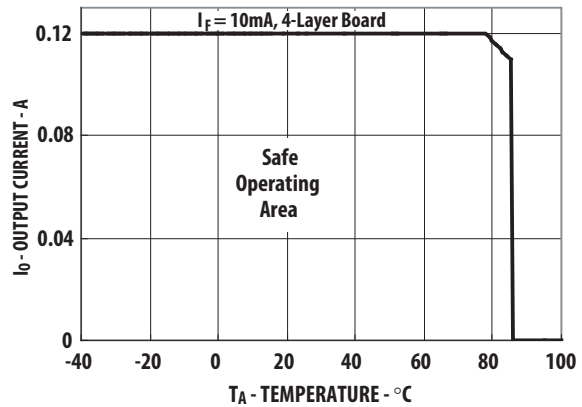


Figure 3: Maximum Output Current Rating vs. Ambient Temperature (ASSR-4111-001E) DC Connection

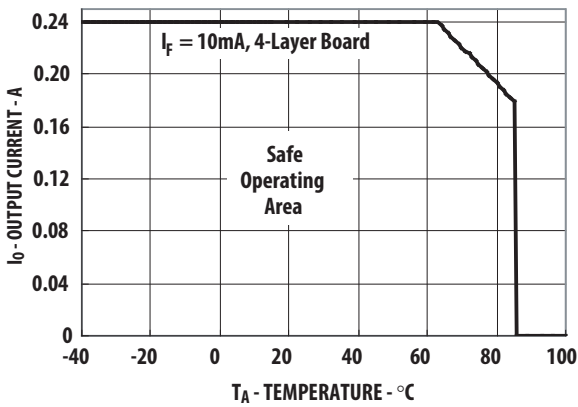


Figure 4: Maximum Output Current Rating vs. Ambient Temperature (ASSR-4120-002E)

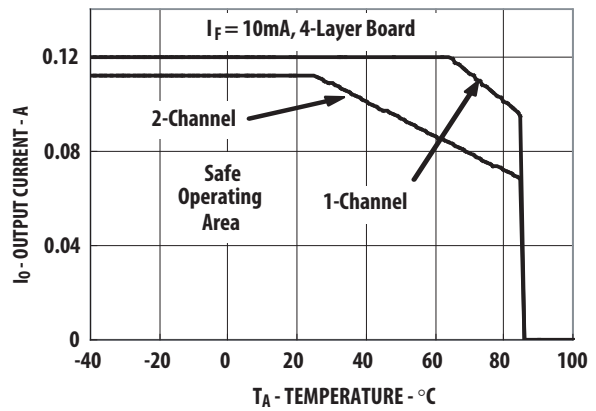


Figure 5: Normalized Typical Output Withstand Voltage vs. Temperature

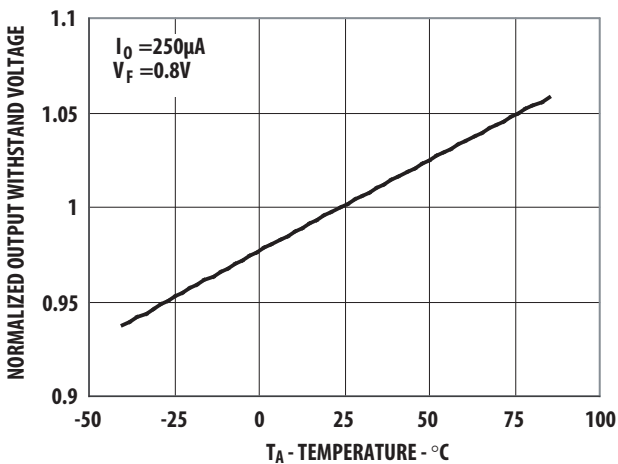


Figure 6: Typical Output Leakage Current vs. Temperature

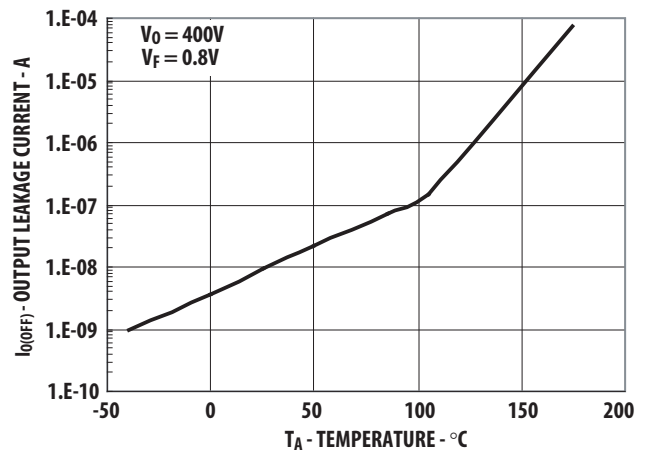


Figure 7: Typical Forward Voltage vs. Temperature

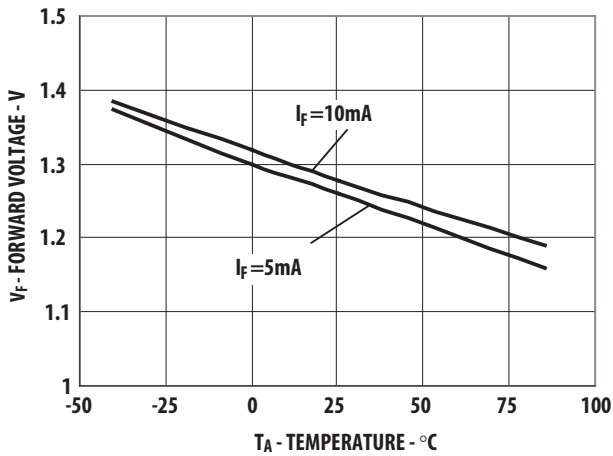


Figure 8: Typical Forward Current vs. Forward Voltage

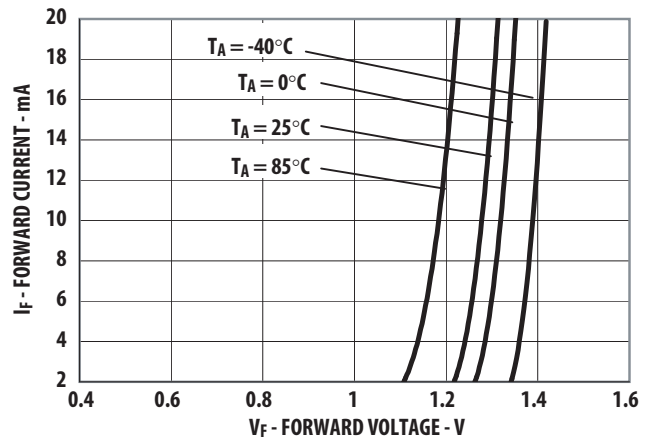


Figure 9: Typical On Resistance vs. Temperature

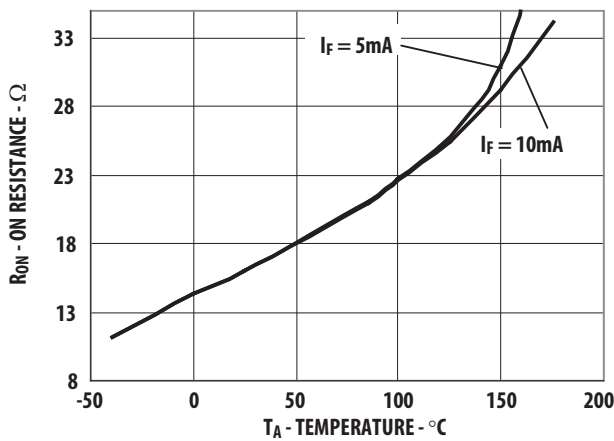


Figure 10: Typical Output Current vs. Output Voltage

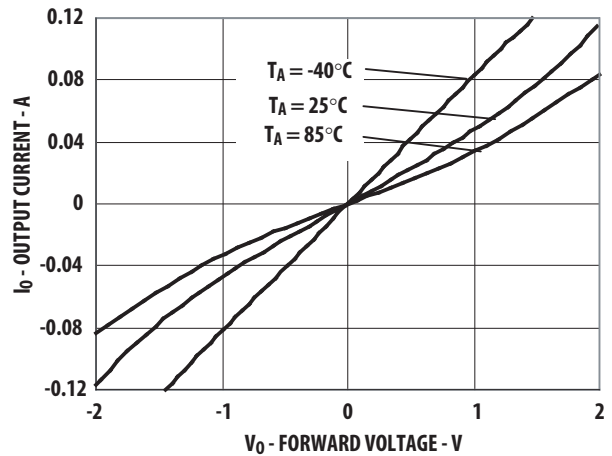


Figure 11: Typical Turn On Time vs. Input Current

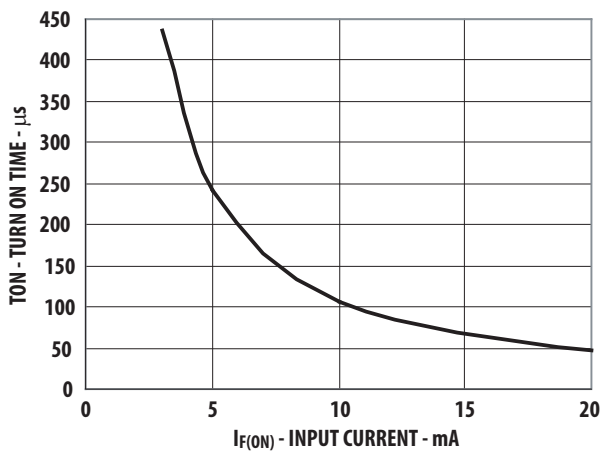


Figure 12: Typical Turn On Time vs. Temperature

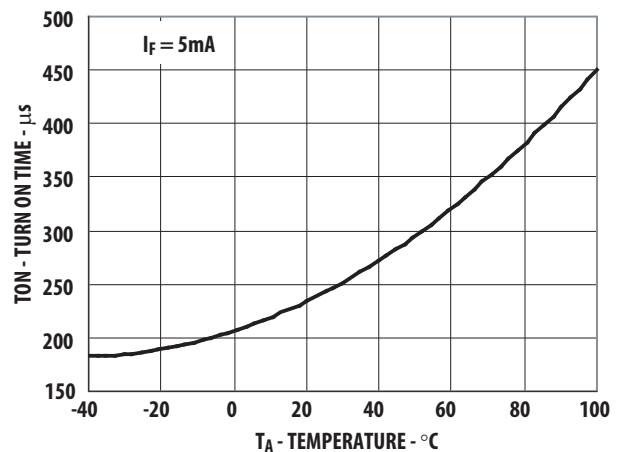


Figure 13: Typical Turn Off Time vs. Input Current

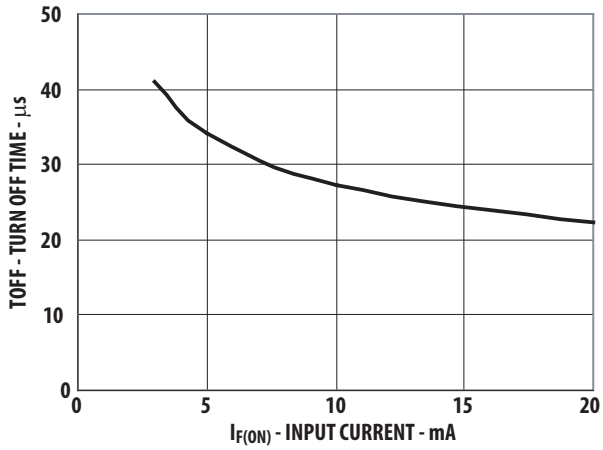


Figure 14: Typical Turn Off Time vs. Temperature

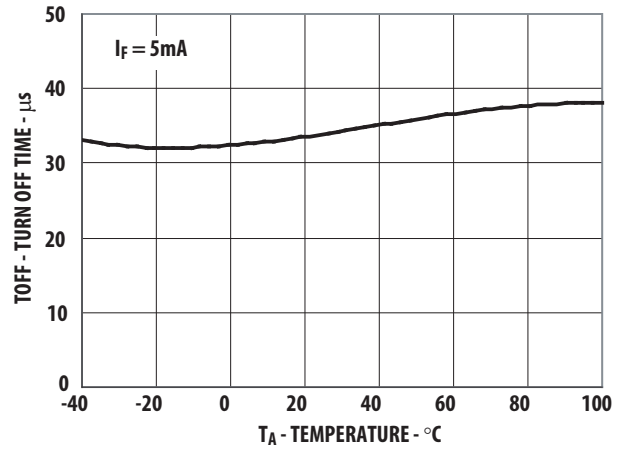


Figure 15: Typical Output Off-State Capacitance vs. Output Voltage

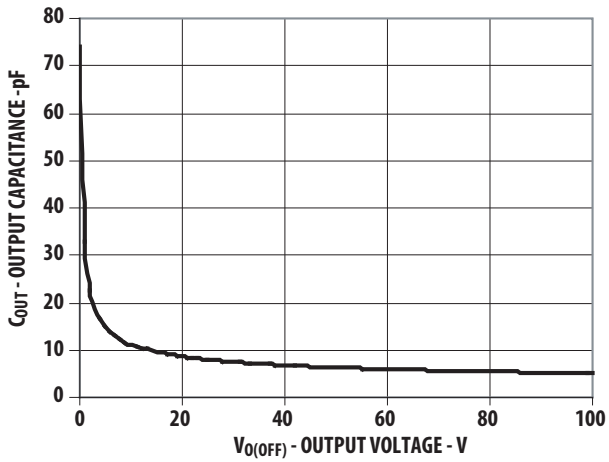


Figure 16: Switching Test Circuit for  $t_{ON}$ ,  $t_{OFF}$

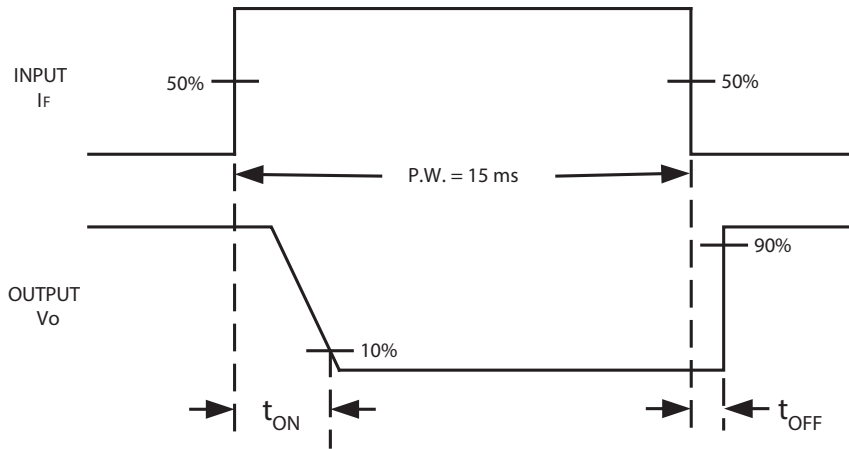
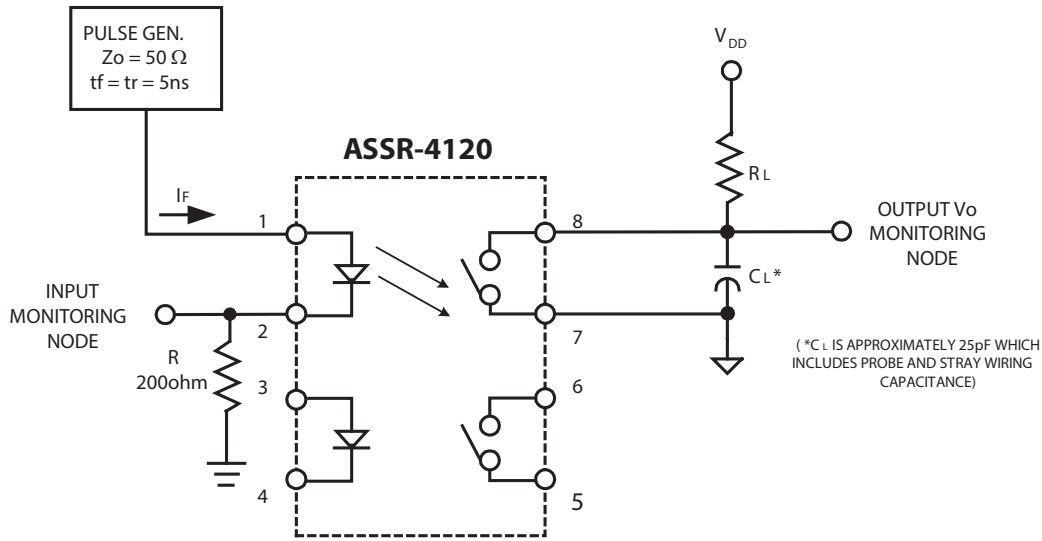
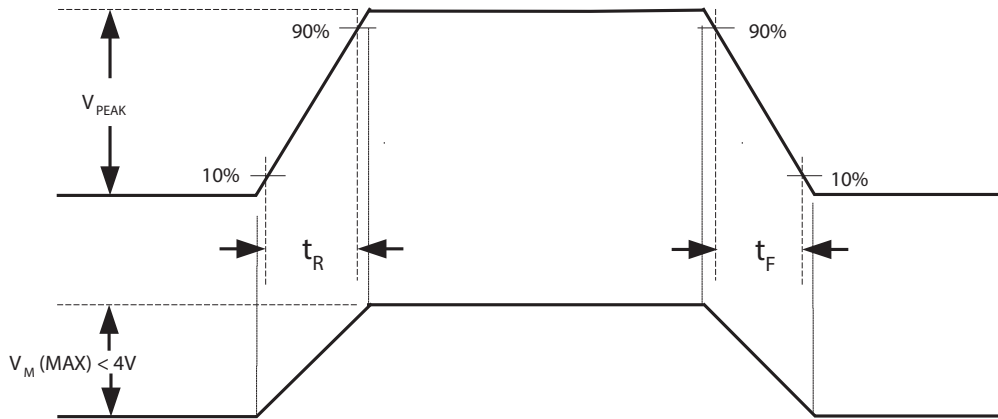
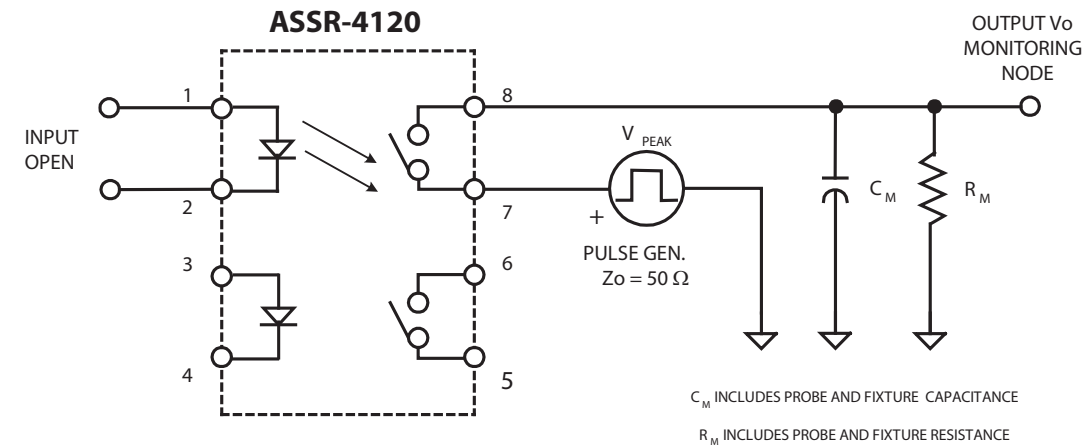


Figure 17: Output Transient Rejection Test Circuit

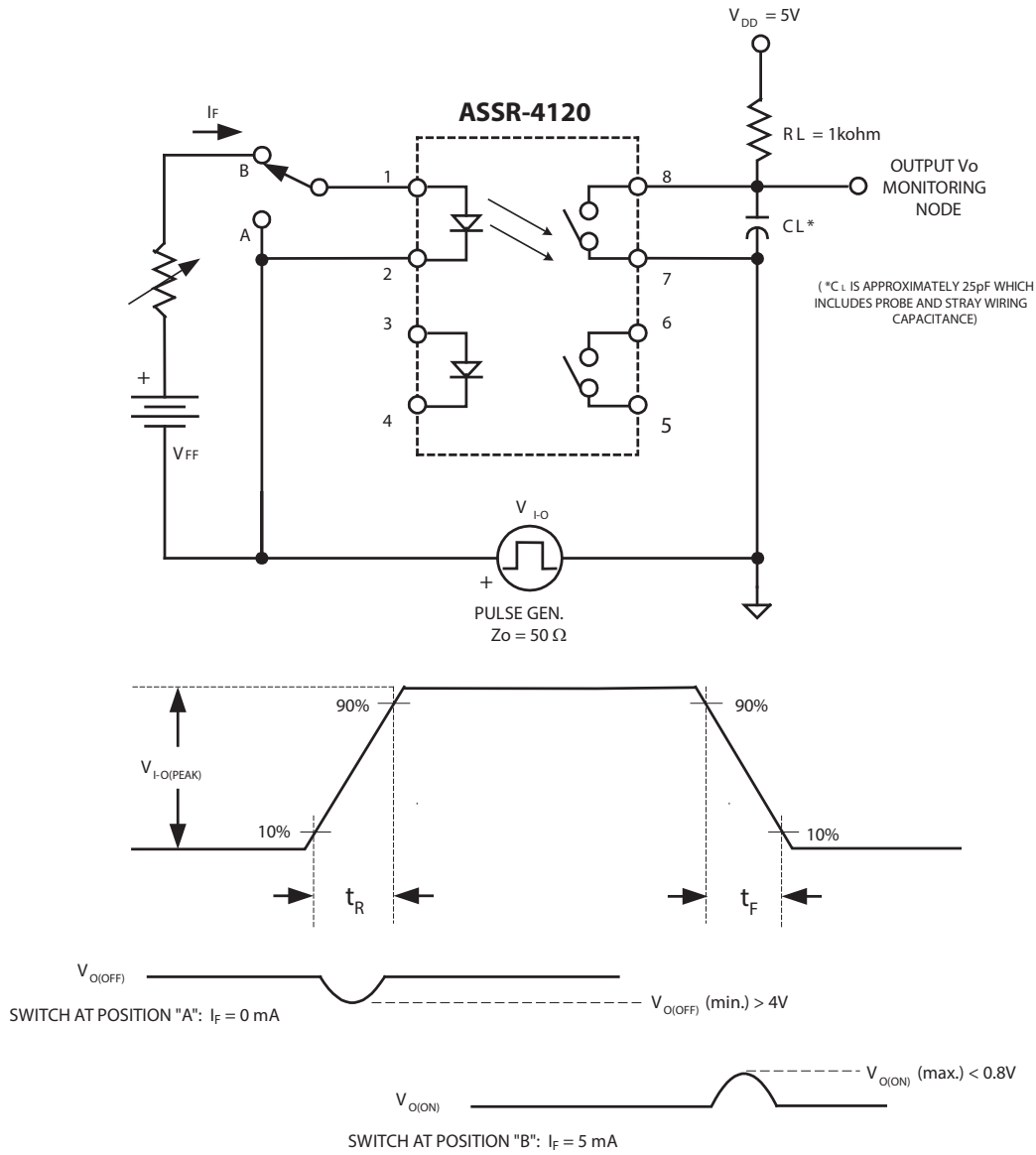


$$\frac{dV_0}{dt} = \frac{(0.8)V_{PEAK}}{t_R} \text{ OR } \frac{(0.8)V_{PEAK}}{t_F}$$

OVERSHOOT ON  $V_{PEAK}$  IS TO BE  $\leq 10\%$



Figure 18: Input-Output Transient Rejection Test Circuit



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