

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

## General Purpose, Form A, Solid State Relay (Photo MOSFET)

(400V/0.12A/25Ω)



## Data Sheet



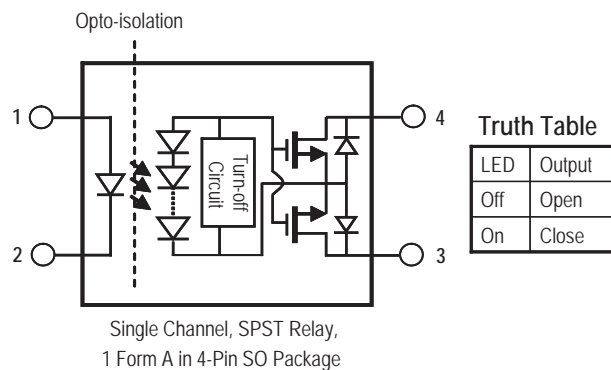
### Description

The 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 3mA 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.

### Functional Diagram



### Features

- Compact Solid-State Bi-directional 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 Connection A and B)
- Low Input Current: CMOS Compatibility
- Low On-Resistance:  
5.5Ω Typical for DC-only, 16Ω Typical for AC/DC
- Very High Output Off-state Impedance:  
10 Teraohms Typical
- High Speed Switching:  
0.1ms (Ton), 0.02ms (Toff) Typical
- High Transient Immunity: >1kV/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

**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.

## 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	300mil 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 see attached table, 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 300mil DIP-6 Gull Wing Surface Mount package in Tape and Reel packaging and RoHS Compliant.

Example 2:

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

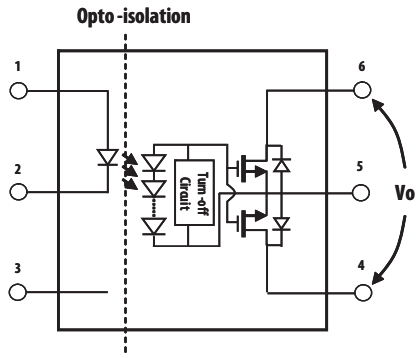
Option datasheets are available. Contact your Avago sales representative or authorized distributor for information.

## Schematic

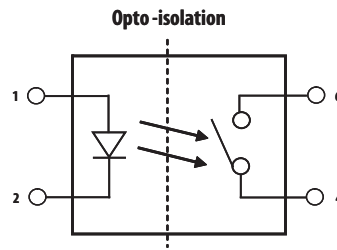
### ASSR-4110



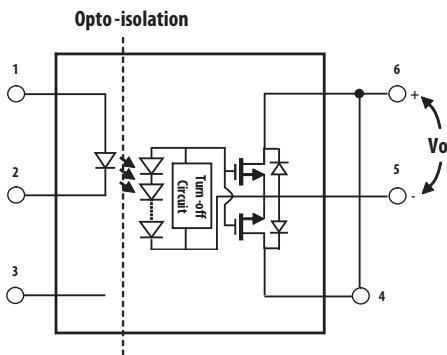
### ASSR-4111 Connection A



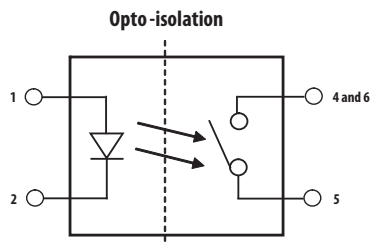
Equivalent Relay Diagram



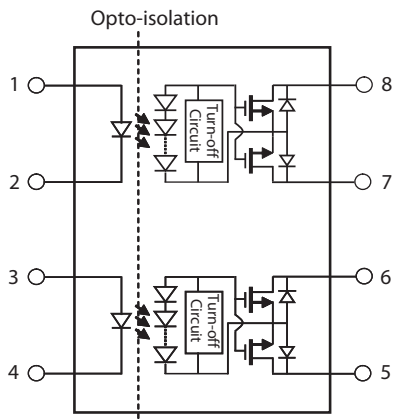
### ASSR-4111 Connection B



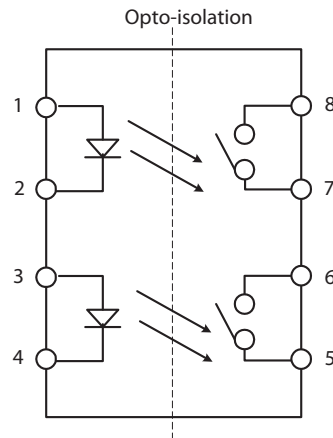
Equivalent Relay Diagram



### ASSR-4120



Equivalent Relay Diagram



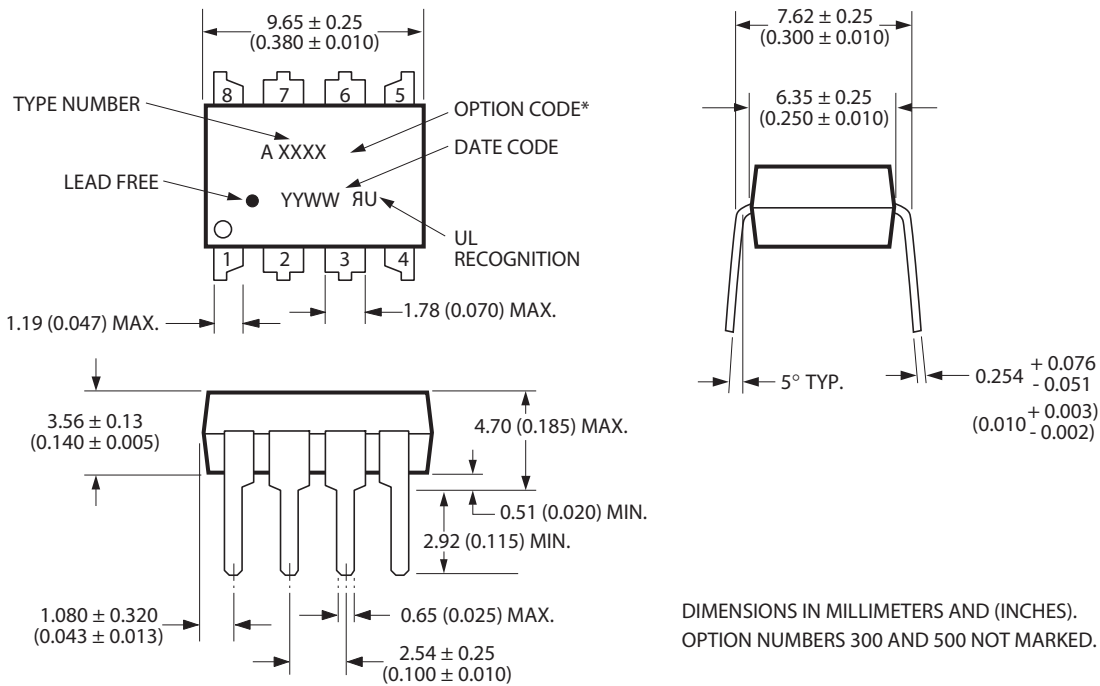


### ASSR-4111 6-Pin DIP Package with Gull Wing Surface Mount Option 300



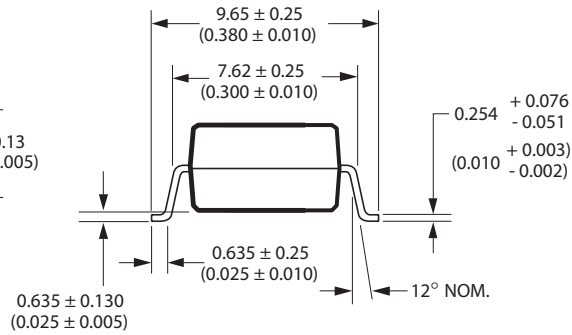
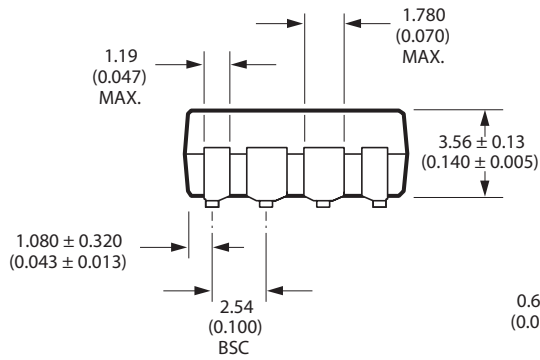
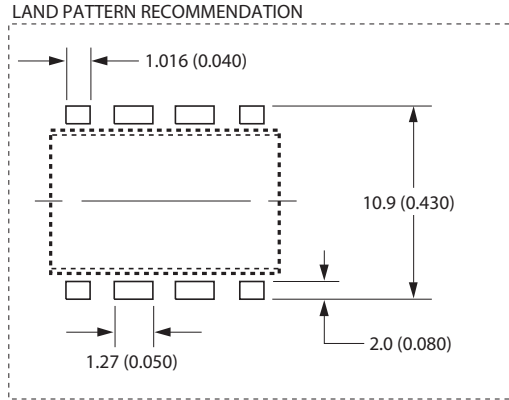
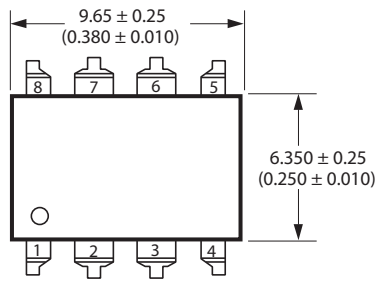
NOTE: FLOATING LEAD PROTRUSION IS 0.25 mm (10 mils) MAX.

### ASSR-4120 8-Pin DIP Package



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

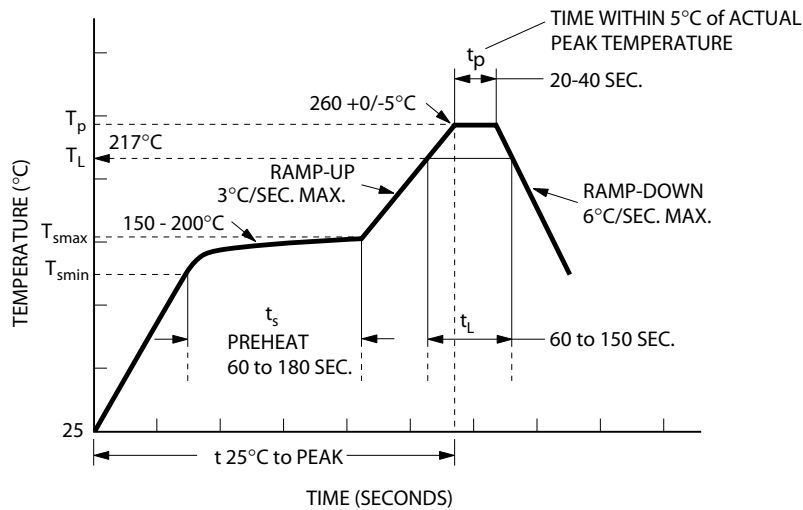
**ASSR-4120 8-Pin DIP Package with Gull Wing Surface Mount Option 300**



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



NOTES:  
 THE TIME FROM 25°C to PEAK TEMPERATURE = 8 MINUTES MAX.  
 $T_{smax} = 200^{\circ}C$ ,  $T_{smin} = 150^{\circ}C$

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  $V_{ISO} = 3750 V_{RMS}$

### CSA

Approved under CSA Component Acceptance Notice #5.

## Insulation and Safety Related Specifications

Parameter	Symbol	ASSR-4110	ASSR-4111 ASSR-4120	Units	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.	Units	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	$I_F$	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	1	
	ASSR-4111 Connection B		0.24	A		
Output Voltage ( $T_A = 25^\circ\text{C}$ )		$V_O$	-400	400	V	2
	ASSR-4111 Connection B		0	400	V	
Solder Reflow Temperature Profile	See Lead Free IR Profile					

## Recommended Operating Conditions

Parameter	Symbol	Min.	Max.	Units	Note
Input Current (ON)	$I_{F(ON)}$	3	20	mA	3
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	Sym.	Min.	Typ.	Max.	Units	Conditions	Note
Input-Output Momentary Withstand Voltage	$V_{ISO}$	3750			Vrms	$RH \leq 50\%$ , $t = 1 \text{ min}$	4, 5
Input-Output Resistance	$R_{I-O}$		$10^{12}$		$\Omega$	$V_{I-O} = 500 \text{ Vdc}$	
Input-Output Capacitance	ASSR-4110 $C_{I-O}$		0.4		pF	$f = 1 \text{ MHz}$ ; $V_{I-O} = 0 \text{ Vdc}$	4
	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	$f = 1 \text{ MHz}$ ; $V_{I-O} = 0 \text{ Vdc}$	

## 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.	Units	Conditions	Fig.	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	6
	ASSR-4111 Connection B		5.5	8.5	$\Omega$	$I_F = 5 \text{ mA}$ , $I_O = 240 \text{ mA}$ , Pulse $\leq 30 \text{ ms}$ , $T_A = 25^\circ\text{C}$		

## 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.	Units	Conditions	Fig.	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, 15	
				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, 15	
				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/ $\mu\text{s}$	$\Delta V_O = 400\text{ V}$ , $T_A = 25^{\circ}\text{C}$	16	
Input-Output Transient Rejection	$dV_{I-O}/dt$	1	$\geq 10$		kV/ $\mu\text{s}$	$\Delta V_{I-O} = 1000\text{ V}$ , $T_A = 25^{\circ}\text{C}$	17	

### Notes:

- For derating, refer to Figure 1, 2, 3 and 4.
- The voltage across the output terminals of the relay should not exceed this rated withstand voltage. Over-voltage protection circuits should be added in some applications to protect against over-voltage transients.
- Threshold to switch device is  $I_F \geq 0.5\text{ mA}$ , however, for qualified device performance over temperature range, it is recommended to operate at  $I_F = 5\text{ mA}$ .
- Device is considered as 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.
- 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 Avago Technologies Application Note 1074, "Optocoupler Input-Output Endurance Voltage."
- During the pulsed  $R_{(ON)}$  measurement ( $I_O$  duration  $\leq 30\text{ ms}$ ), ambient ( $T_A$ ) and case temperature ( $T_C$ ) are equal.

## 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.

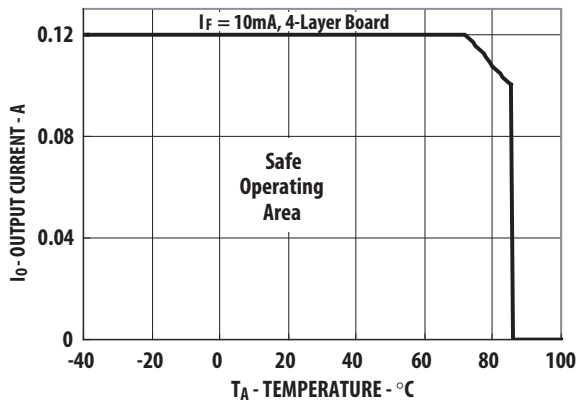


Figure 1. Maximum Output Current Rating vs Ambient Temperature (ASSR-4110-003E)

Figure 1, 2, 3 and 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  $R_{ss} = P_o(\max)/(I_o(\max))^2$  from which  $R_{ss}$  can be calculated. Staying within the safe area assures that the steady state MOSFET junction temperature remains less than 125°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 Figures 11 and 13. The changes of the turn on and turn off time with ambient temperature are also shown in Figures 12 and 14.

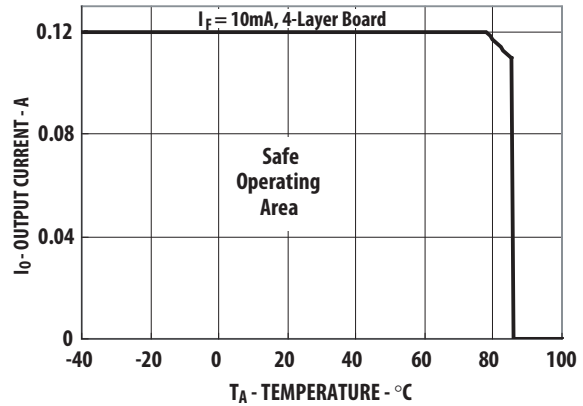


Figure 2. Maximum Output Current Rating vs Ambient Temperature (ASSR-4111-001E)

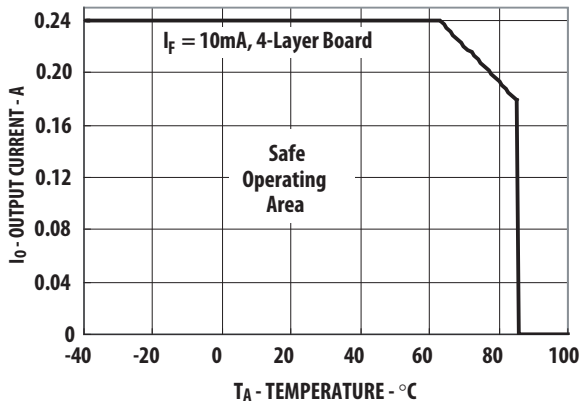


Figure 3. Maximum Output Current Rating vs Ambient Temperature (ASSR-4111-001E) DC Connection

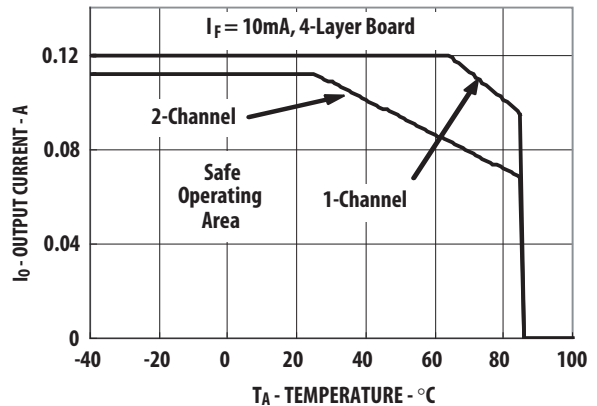


Figure 4. Maximum Output Current Rating vs Ambient Temperature, ASSR-4120-002E



Figure 5. Normalized Typical Output Withstand Voltage vs. Temperature

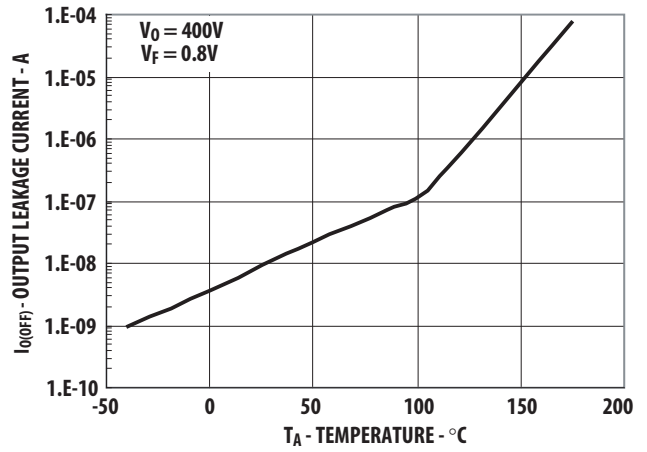


Figure 6. Typical Output Leakage Current vs. Temperature

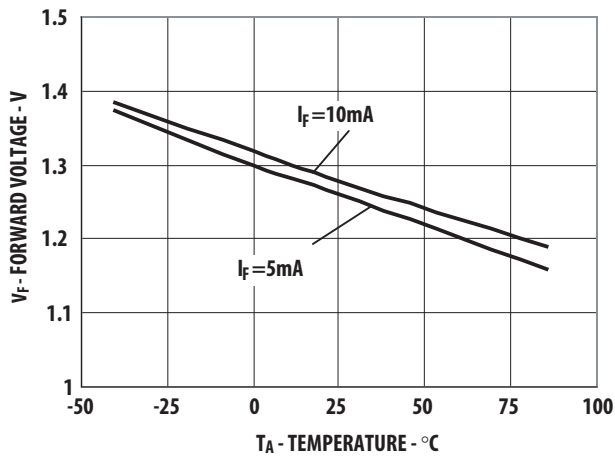


Figure 7. Typical Forward Voltage vs. Temperature

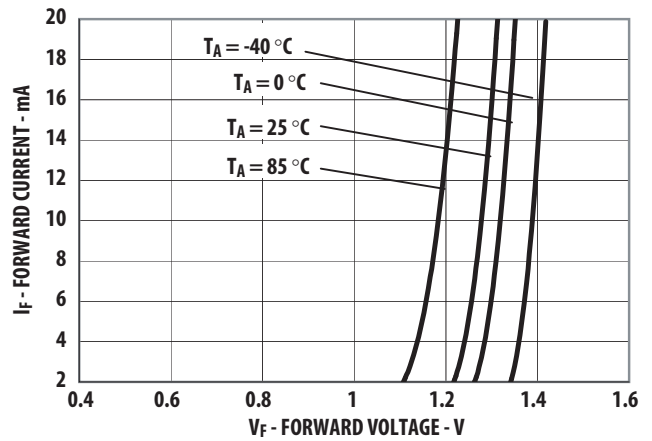


Figure 8. Typical Forward Current vs. Forward Voltage



Figure 9. Typical On Resistance vs. Temperature



Figure 10. Typical Output Current vs. Output Voltage



Figure 11. Typical Turn On Time vs. Input Current

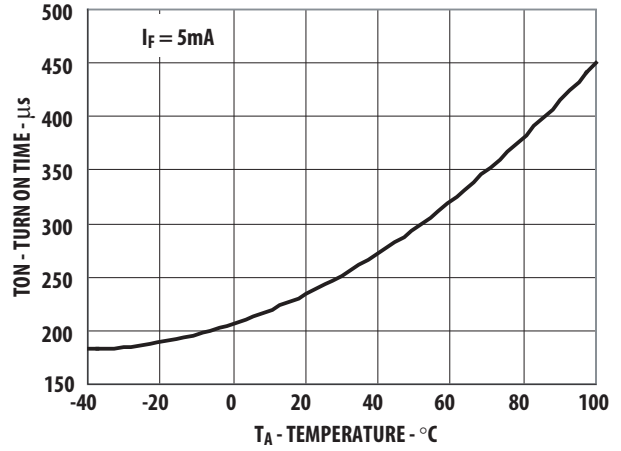


Figure 12. Typical Turn On Time vs. Temperature



Figure 13. Typical Turn Off Time vs. Input Current

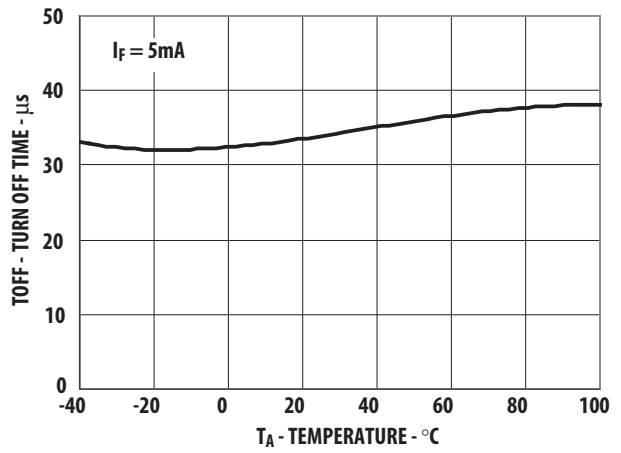


Figure 14. Typical Turn Off Time vs. Temperature



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

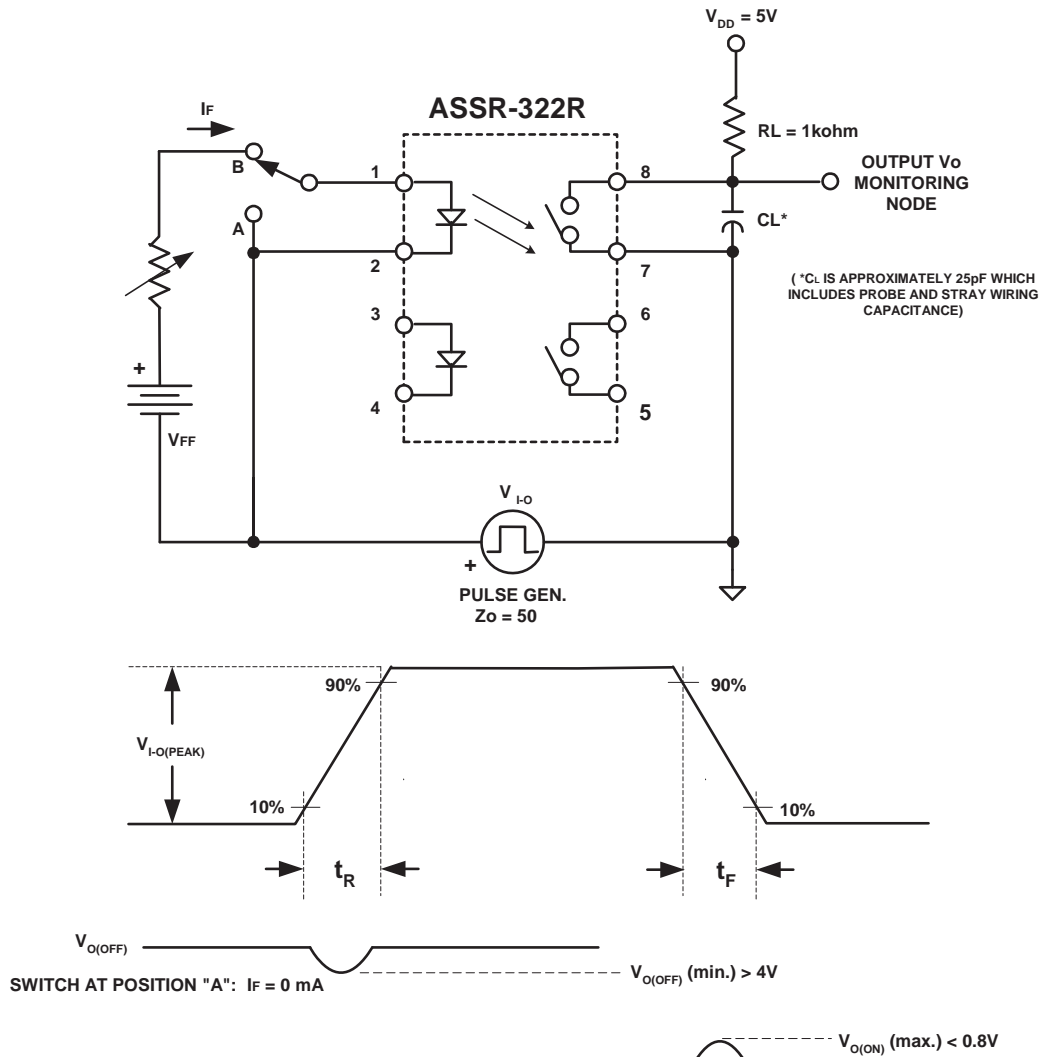
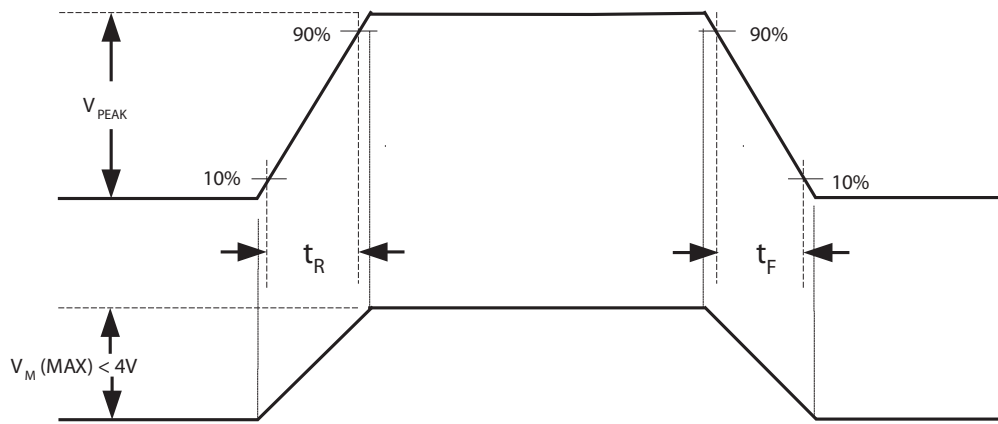


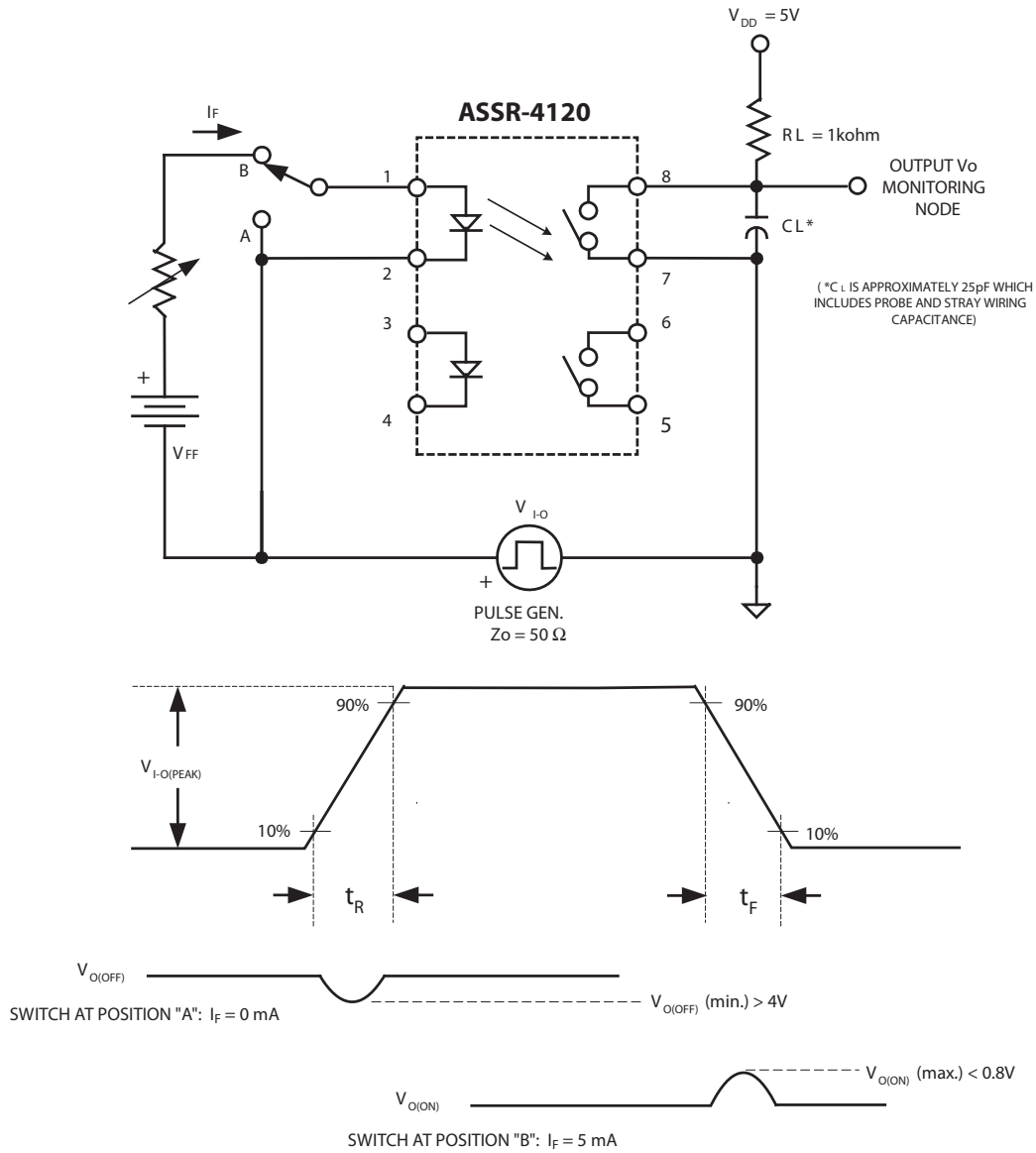
Figure 16. Switching Test circuit for  $t_{ON}$ ,  $t_{OFF}$



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

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

**Figure 17. Output Transient Rejection Test Circuit**



**Figure 18. Input - Output Transient Rejection Test Circuit**

For product information and a complete list of distributors, please go to our web site: [www.avagotech.com](http://www.avagotech.com)

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