

## ASSR-1410, ASSR-1411, and ASSR-1420

### General-Purpose, Form A, Solid State Relay (Photo MOSFET) (60V/0.6A/1Ω)

#### Description

The Broadcom® ASSR-14XX Series 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 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-1410 and ASSR-1411, are equivalent to 1 Form A Electromechanical Relays (EMR), and the dual-channel configuration, ASSR-1420, is 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  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ . They are used for general-purpose switching of signals and low-power AC/DC loads.

ASSR-1411 enables AC/DC and DC-only output connections. For DC-only connection, the output current,  $I_O$ , increases to 1.2A and the on-resistance,  $R_{(ON)}$ , reduces to 0.5Ω.

#### Features

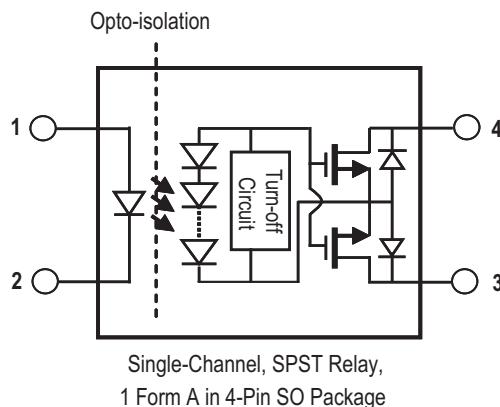
- Compact solid-state bidirectional signal switch
- Single- and dual-channel normally off Single-Pole-Single-Throw (SPST) relay
- 60V output withstand voltage
- 0.6A or 1.2A current rating (See the schematics for ASSR-1411 connections A and B.)
- Low input current: CMOS compatibility
- Low on-resistance:
  - 0.2Ω typical for DC-only
  - 0.7Ω typical for AC/DC
- High-speed switching:
  - 0.1 ms ( $T_{ON}$ ), 0.02 ms ( $T_{OFF}$ ) typical
- High transient immunity:  $>1 \text{ kV}/\mu\text{s}$
- High input-to-output insulation voltage (safety and regulatory approvals)
  - 3750 Vrms for 1 minute per UL1577
  - CSA component acceptance

#### Applications

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

**CAUTION!** Take normal static precautions in the handling and assembly of this component to prevent damage and degradation that might be induced by electrostatic discharge (ESD). The components featured in this data sheet are not recommended to be used in military or aerospace applications or environments. The components are not AEC-Q100 qualified and not recommended for automotive applications.

## Functional Diagram



## Truth Table

| LED | Output |
|-----|--------|
| Off | Open   |
| On  | Close  |

## Ordering Information

The 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-1410   | -003E          | SO-4             | X             |           |             | 100 units per tube  |
|             | -503E          |                  | X             |           | X           | 1500 units per reel |
| ASSR-1411   | -001E          | 300-mil<br>DIP-6 |               |           |             | 50 units per tube   |
|             | -301E          |                  | X             | X         |             | 50 units per tube   |
|             | -501E          |                  | X             | X         | X           | 1000 units per reel |
| ASSR-1420   | -002E          | 300-mil<br>DIP-8 |               |           |             | 50 units per tube   |
|             | -302E          |                  | X             | X         |             | 50 units per tube   |
|             | -502E          |                  | X             | X         | X           | 1000 units per reel |

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

### Example 1:

Use ASSR-1411-501E to order the product with a 300-mil DIP-6 gull wing surface-mount package in tape and reel packaging and RoHS compliance.

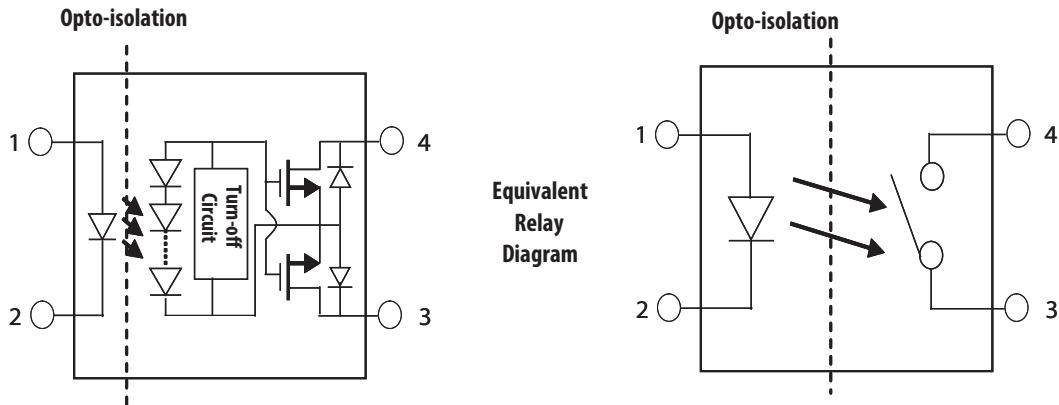
### Example 2:

Use ASSR-1420-002E to order the product with a 300-mil DIP-8 package in tube packaging and RoHS compliance.

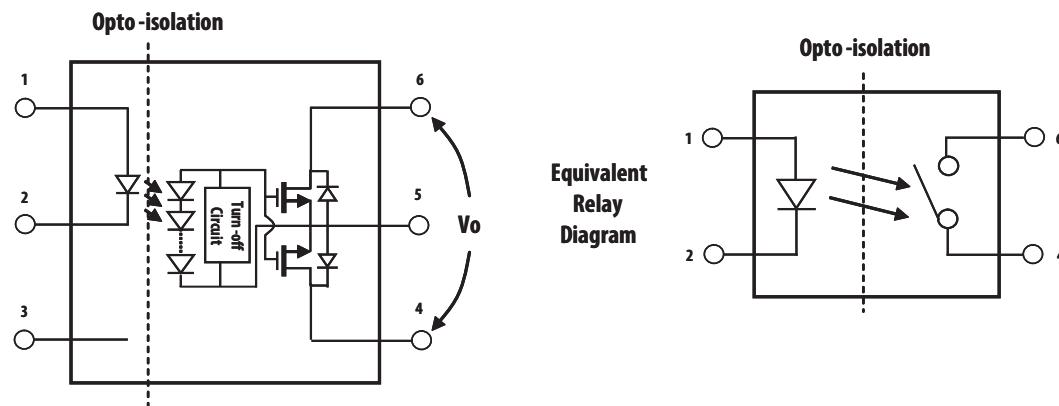
Option data sheets are available. Contact your Broadcom sales representative or authorized distributor for information.

## Schematics

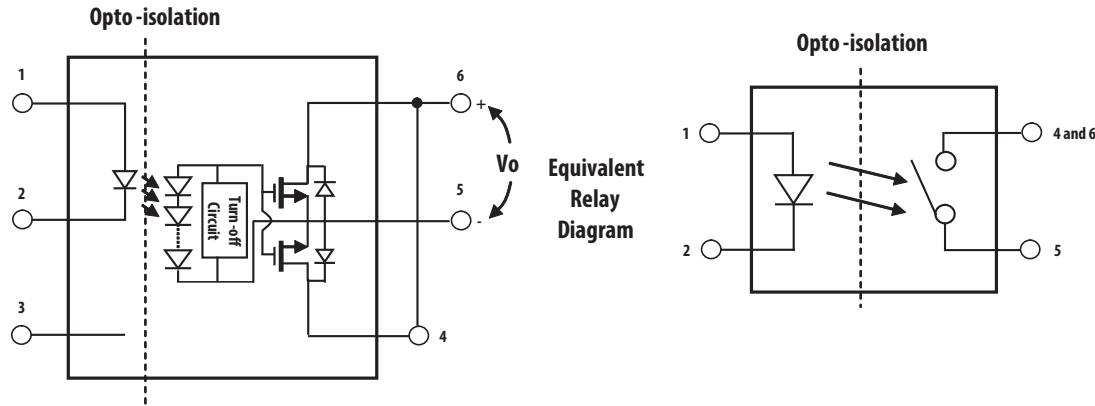
### ASSR-1410



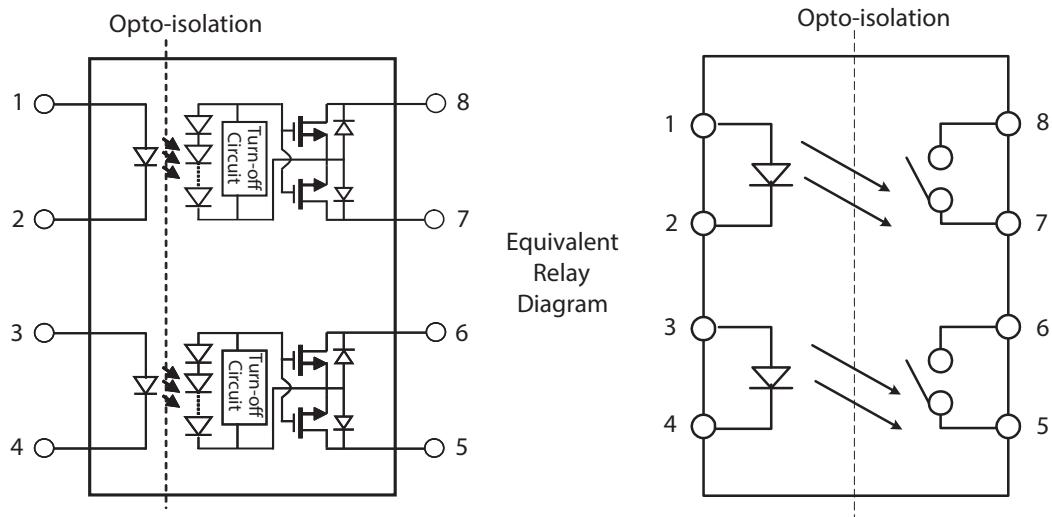
### ASSR-1411 Connection A



### ASSR-1411 Connection B

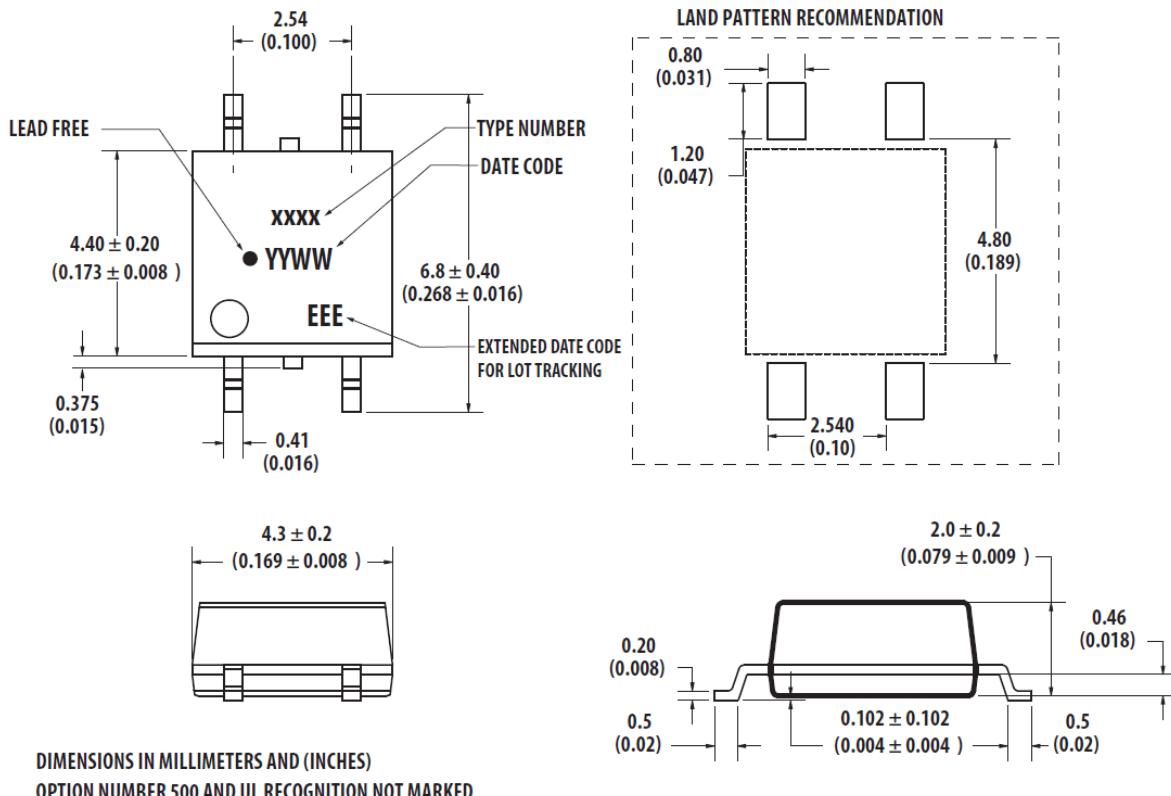


## ASSR-1420

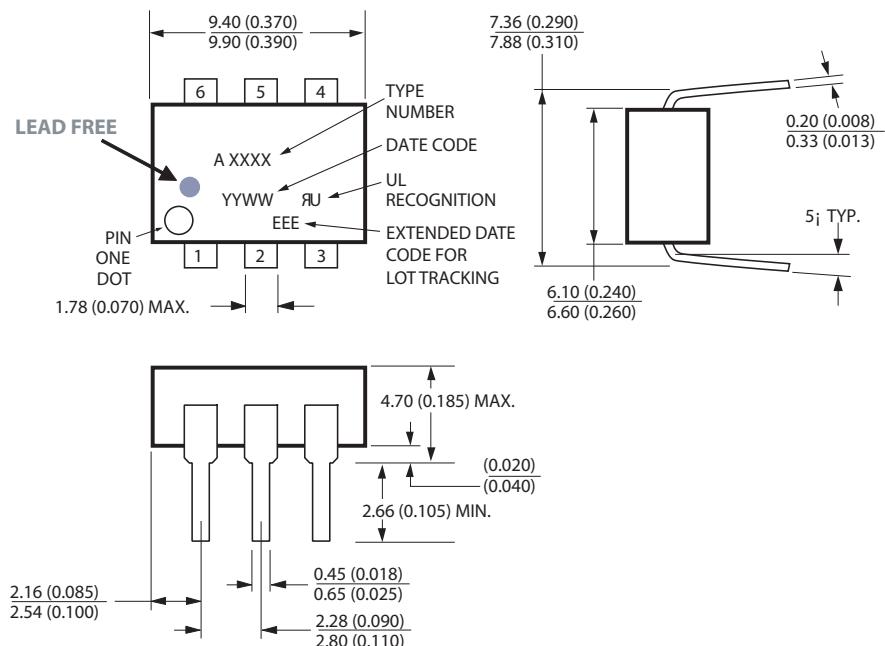


## Package Outline Drawings

### ASSR-1410 4-Pin Small Outline Package

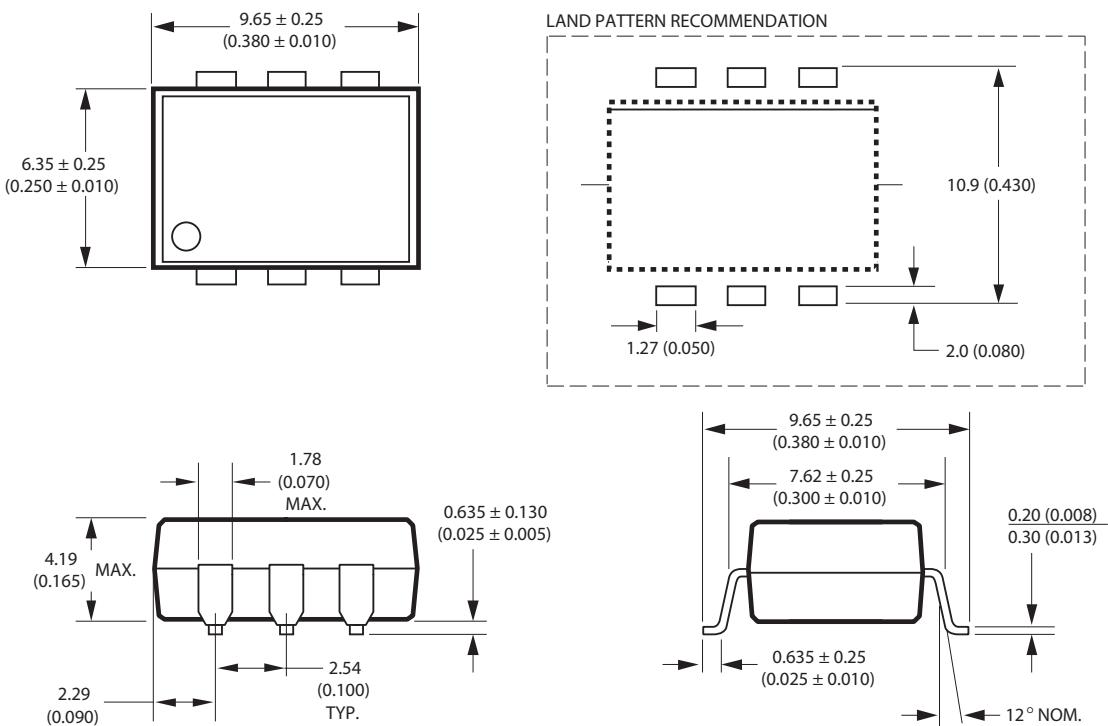


## ASSR-1411 6-Pin DIP Package



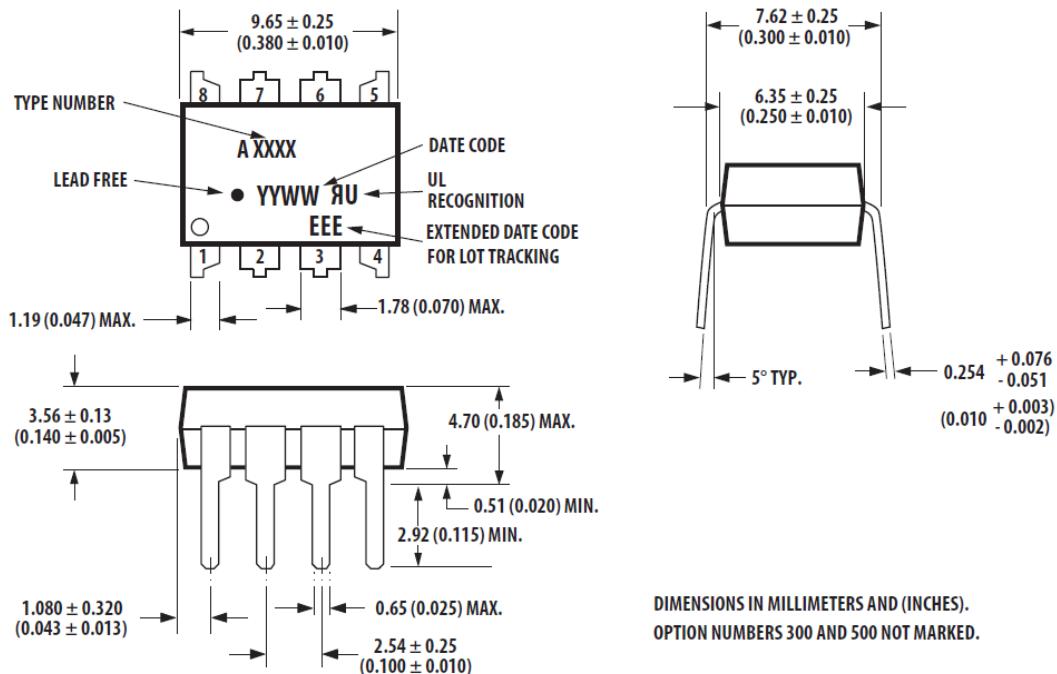
DIMENSIONS IN MILLIMETERS AND (INCHES).

## ASSR-1411 6-Pin DIP Package with Gull Wing Surface-Mount Option 300



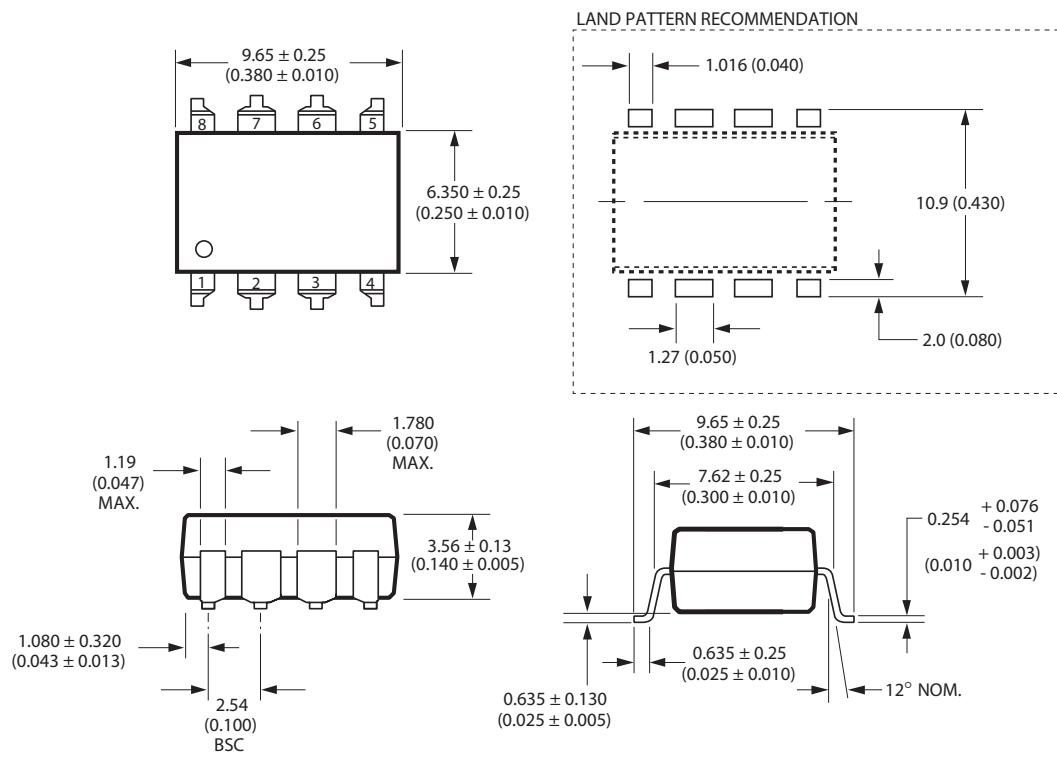
NOTE: FLOATING LEAD PROTRUSION IS 0.25 mm (10 mils) MAX.

## ASSR-1420 8-Pin DIP Package



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

## ASSR-1420 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.

## Solder Reflow Profile

Recommended reflow condition as per JEDEC Standard J-STD-020 (latest revision).

**NOTE:** Non-halide flux should be used.

## Regulatory Information

The ASSR-1410, ASSR-1411, and ASSR-1420 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-1410 | ASSR-1411<br>ASSR-1420 | 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 the 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                                     | $I_F$    | 25   | mA   |      |   |
|   | Surge                                       |          | 50   |      |      |   |
|   | Transient                                   |          | 1000 |      |      |   |
| Reversed Input Voltage  | $V_R$                                       | —        | 5    | V    |      |   |
| Input Power Dissipation   | ASSR-1410                                   | $P_{IN}$ | —    | 40   | mW   |   |
|   | ASSR-1411                                   | $P_{IN}$ | —    | 40   | mW   |   |
|   | ASSR-1420                                   | $P_{IN}$ | —    | 80   | mW   |   |
| Output Power Dissipation  | ASSR-1410                                   | $P_O$    | —    | 360  | mW   |   |
|   | ASSR-1411                                   | $P_O$    | —    | 720  | mW   |   |
|   | ASSR-1420                                   | $P_O$    | —    | 720  | mW   |   |
| Average Output Current<br>( $T_A = 25^\circ\text{C}$ , $T_C \leq 100^\circ\text{C}$ ) | ASSR-1411<br>Connection A                   | $I_O$    | —    | 0.6  | A    | a |
|   | ASSR-1411<br>Connection B                   | $I_O$    | —    | 1.2  | A    |   |
| Output Voltage ( $T_A = 25^\circ\text{C}$ )   | ASSR-1411<br>Connection A                   | $V_O$    | -60  | 60   | V    | b |
|   | ASSR-1411<br>Connection B                   | $V_O$    | 0    | 60   | V    |   |
| Solder Reflow Temperature Profile   | See <a href="#">Solder Reflow Profile</a> . |          |      |      |      |   |

a. For derating, see [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. The threshold to switch the device is  $I_F \geq 0.5$  mA; however, for qualified device performance over the temperature range, it is recommended to operate at  $I_F = 5$  mA.

## Package Characteristics

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

| Parameter                                | Symbol           | Min. | Typ.      | Max. | Unit     | Conditions  | Note |
|--|------------------|------|-----------|------|----------|---|------|
| Input-Output Momentary Withstand Voltage | $V_{\text{ISO}}$ | 3750 | —         | —    | Vrms     | $\text{RH} \leq 50\%, t = 1 \text{ minute}$         | a, b |
| Input-Output Resistance                  | $R_{\text{I-O}}$ | —    | $10^{12}$ | —    | $\Omega$ | $V_{\text{I-O}} = 500 \text{ Vdc}$                  |      |
| Input-Output Capacitance                 |                  |      |           |      |          |   | a    |
| ASSR-1410                                | $C_{\text{I-O}}$ | —    | 0.4       | —    | pF       | $f = 1 \text{ MHz}; V_{\text{I-O}} = 0 \text{ Vdc}$ |      |
| ASSR-1411                                | $C_{\text{I-O}}$ | —    | 0.5       | —    | pF       | $f = 1 \text{ MHz}; V_{\text{I-O}} = 0 \text{ Vdc}$ |      |
| ASSR-1420                                | $C_{\text{I-O}}$ | —    | 0.8       | —    | pF       | $f = 1 \text{ MHz}; V_{\text{I-O}} = 0 \text{ Vdc}$ |      |

- a. The device is considered a two-terminal device:
  - ASSR-1410 – Pin 1, 2 shorted and pin 3, 4 shorted.
  - ASSR-1411 – Pin 1, 2, 3 shorted and pin 4, 5, 6 shorted.
  - ASSR-1420 – 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                       | Symbol                | Min. | Typ. | Max. | Unit          | Conditions   | Figure | Note |
|---------------------------------|-----------------------|------|------|------|---------------|--|--------|------|
| Output Withstand Voltage        | $ V_{\text{O(OFF)}} $ | 60   | 65   | —    | V             | $V_F = 0.8V, I_O = 250 \mu\text{A}, T_A = 25^\circ\text{C}$  |        |      |
|                                 |                       | 55   | —    | —    | V             | $V_F = 0.8V, I_O = 250 \mu\text{A}$  | 5      |      |
| Output Leakage Current          | $I_{\text{O(OFF)}}$   | —    | —    | 1    | $\mu\text{A}$ | $V_F = 0.8V, V_O = 60V$  |        |      |
| Output Offset Voltage           | $ V_{\text{(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             | $I_F = 5 \text{ mA}$   | 6, 7   |      |
| Output On-Resistance            | $R_{\text{(ON)}}$     | —    | 0.2  | 1    | $\Omega$      | $I_F = 5 \text{ mA}, I_O = 600 \text{ mA},$<br>$\text{Pulse} \leq 30 \text{ ms}, T_A = 25^\circ\text{C}$ | 8, 9   | a    |
|                                 | $R_{\text{(ON)}}$     | —    | 0.1  | 0.5  | $\Omega$      | $I_F = 5 \text{ mA}, I_O = 1.2\text{A},$<br>$\text{Pulse} \leq 30 \text{ ms}, T_A = 25^\circ\text{C}$    |        |      |

- a. During the pulsed  $R_{\text{(ON)}}$  measurement ( $I_O$  duration  $\leq 30 \text{ ms}$ ), the ambient ( $T_A$ ) temperature 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  | Figure                 | Note |
|----------------------------------|---------------|------|-----------|------|-------|---|------------------------|------|
| Turn-On Time                     | $T_{ON}$      | —    | 0.25      | 0.9  | ms    | $I_F = 5 \text{ mA}$ , $I_O = 600 \text{ mA}$ , $T_A = 25^\circ\text{C}$  | <a href="#">10, 14</a> |      |
|                                  |               | —    | —         | 1.0  | ms    | $I_F = 5 \text{ mA}$ , $I_O = 600 \text{ mA}$                             | <a href="#">11</a>     |      |
|                                  |               | —    | 0.15      | 0.45 | ms    | $I_F = 10 \text{ mA}$ , $I_O = 600 \text{ mA}$ , $T_A = 25^\circ\text{C}$ |                        |      |
|                                  |               | —    | —         | 0.5  | ms    | $I_F = 10 \text{ mA}$ , $I_O = 600 \text{ mA}$                            |                        |      |
| Turn-Off Time                    | $T_{OFF}$     | —    | 0.04      | 0.2  | ms    | $I_F = 5 \text{ mA}$ , $I_O = 600 \text{ mA}$ , $T_A = 25^\circ\text{C}$  | <a href="#">12, 14</a> |      |
|                                  |               | —    | —         | 0.5  | ms    | $I_F = 5 \text{ mA}$ , $I_O = 600 \text{ mA}$                             | <a href="#">13</a>     |      |
|                                  |               | —    | 0.034     | 0.15 | ms    | $I_F = 10 \text{ mA}$ , $I_O = 600 \text{ mA}$ , $T_A = 25^\circ\text{C}$ |                        |      |
|                                  |               | —    | —         | 0.2  | ms    | $I_F = 10 \text{ mA}$ , $I_O = 600 \text{ mA}$                            |                        |      |
| Output Transient Rejection       | $dV_O/dt$     | 1    | 7         | —    | kV/μs | $\Delta V_O = 60\text{V}$ , $T_A = 25^\circ\text{C}$                      | <a href="#">15</a>     |      |
| Input-Output Transient Rejection | $dV_{I,O}/dt$ | 1    | $\geq 10$ | —    | kV/μs | $\Delta V_{I,O} = 1000\text{V}$ , $T_A = 25^\circ\text{C}$                | <a href="#">16</a>     |      |

## Applications Information

### On-Resistance and Derating Curves

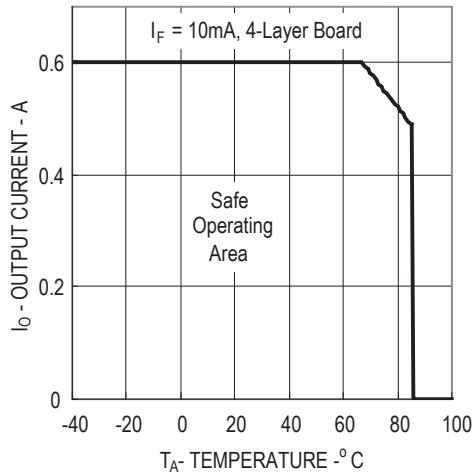
The Output On-Resistance,  $R_{(ON)}$ , specified in this data sheet is the resistance measured across the output contact when a pulsed current signal ( $I_O = 0.6\text{A}$ ) is applied to the output pins. The use of a pulsed signal ( $\leq 30 \text{ ms}$ ) implies that each junction temperature is equal 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.

Derating curves are shown in [Figure 1](#), [Figure 2](#), [Figure 3](#), and [Figure 4](#), specifying the maximum 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  $125^\circ\text{C}$ .

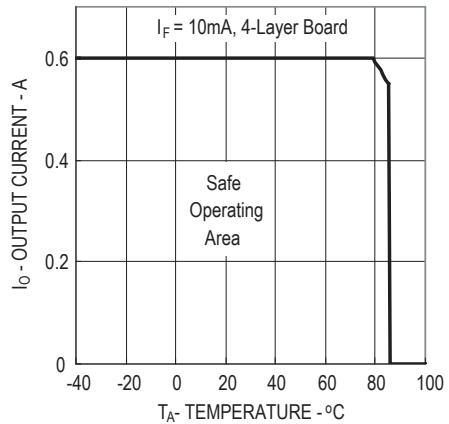
### Turn-On Time and Turn-Off Time Variation

The ASSR-14xx 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 10](#) and [Figure 12](#). The changes of the turn-on and turn-off time with ambient temperature are also shown in [Figure 11](#) and [Figure 13](#).

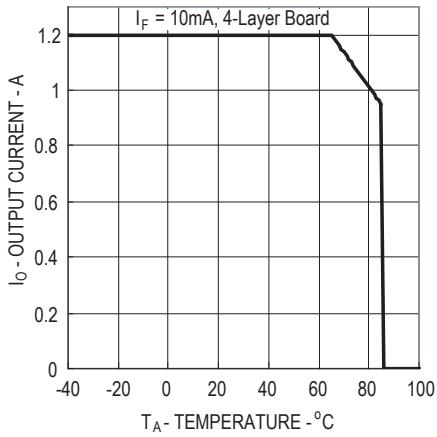
**Figure 1: Maximum Output Current Rating vs Ambient Temperature (ASSR-1410-003E)**



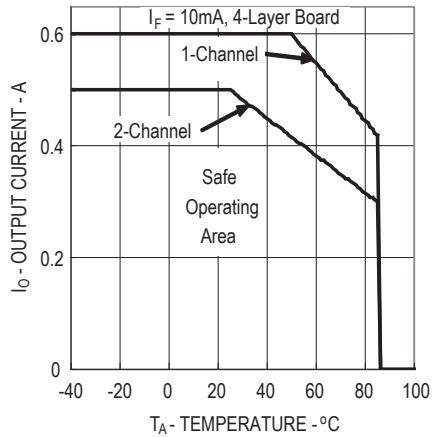
**Figure 2: Maximum Output Current Rating vs Ambient Temperature (ASSR-1411-001E)**



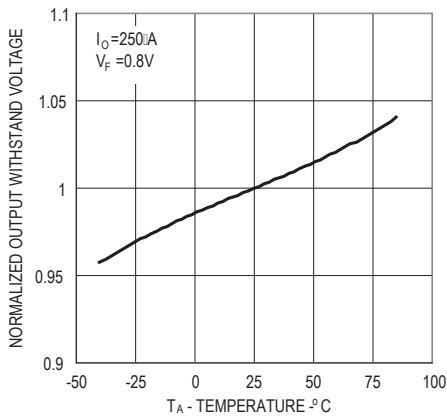
**Figure 3: Maximum Output Current Rating vs Ambient Temperature (ASSR-1411-001E DC Connection)**



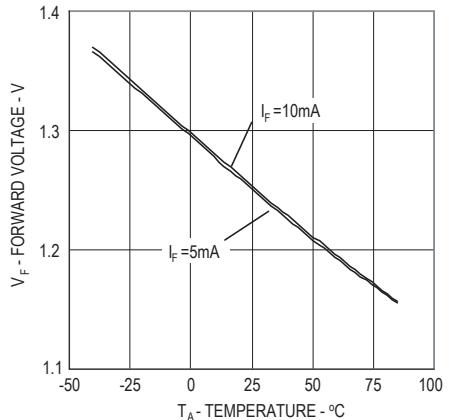
**Figure 4: Maximum Output Current Rating vs Ambient Temperature (ASSR-1420-002E)**



**Figure 5: Normalized Typical Output Withstand Voltage vs. Temperature**



**Figure 6: Typical Forward Voltage vs. Temperature**



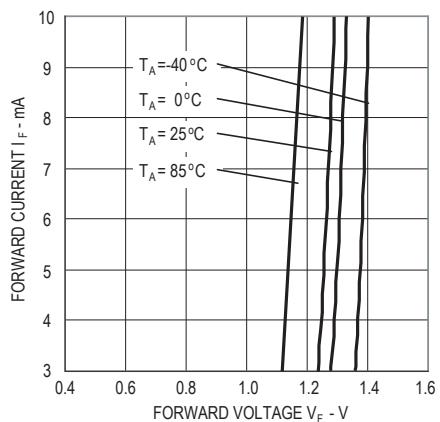
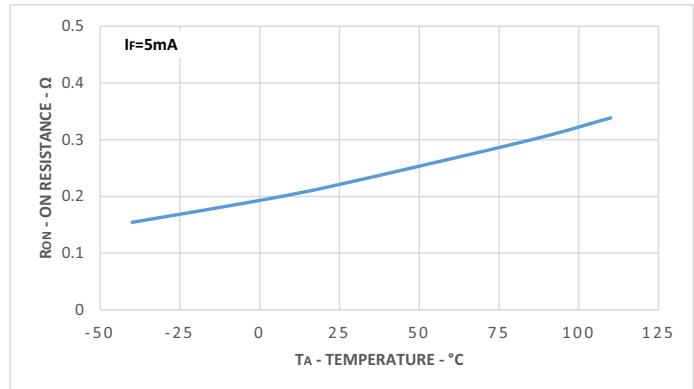
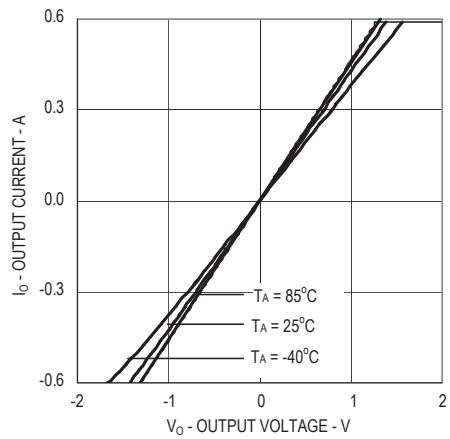
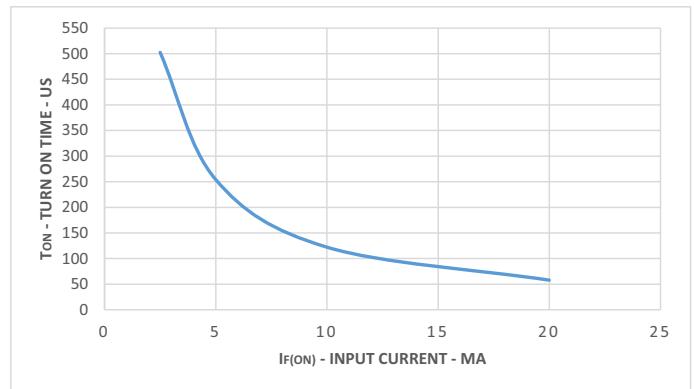
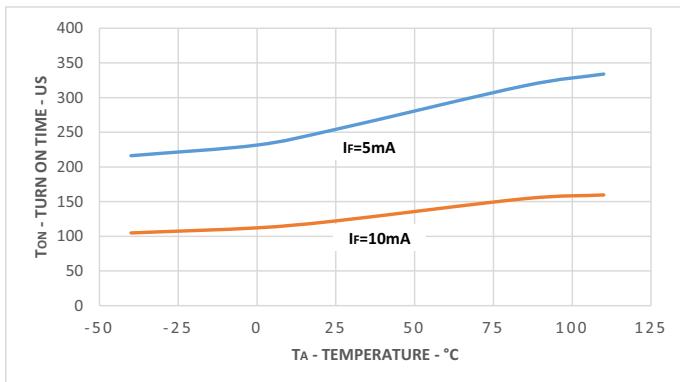
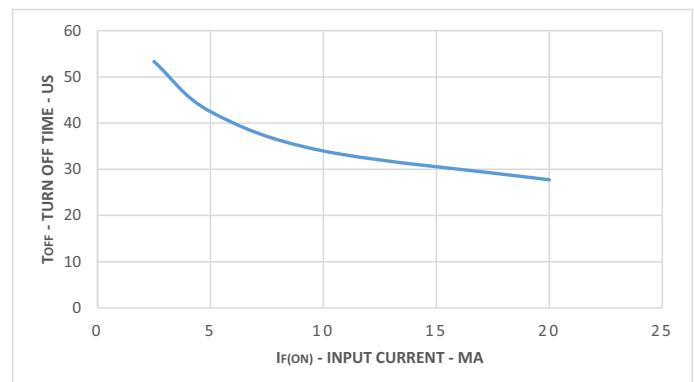
**Figure 7: Typical Forward Current vs. Forward Voltage****Figure 8: Typical On-Resistance vs. Temperature****Figure 9: Typical Output Current vs. Output Voltage****Figure 10: Typical Turn-On Time vs. Input Current****Figure 11: Typical Turn-On Time vs. Temperature****Figure 12: Typical Turn-Off Time vs. Input Current**

Figure 13: Typical Turn-Off Time vs. Temperature

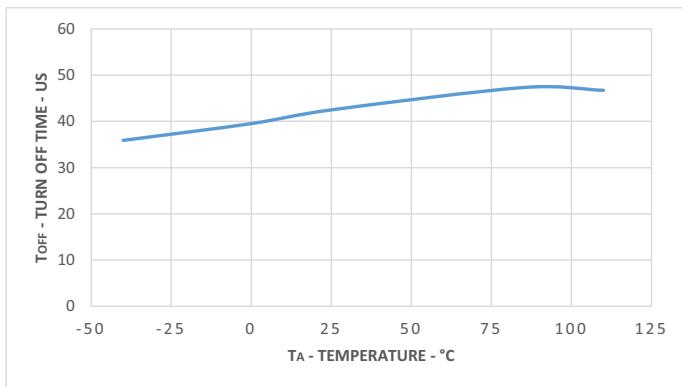
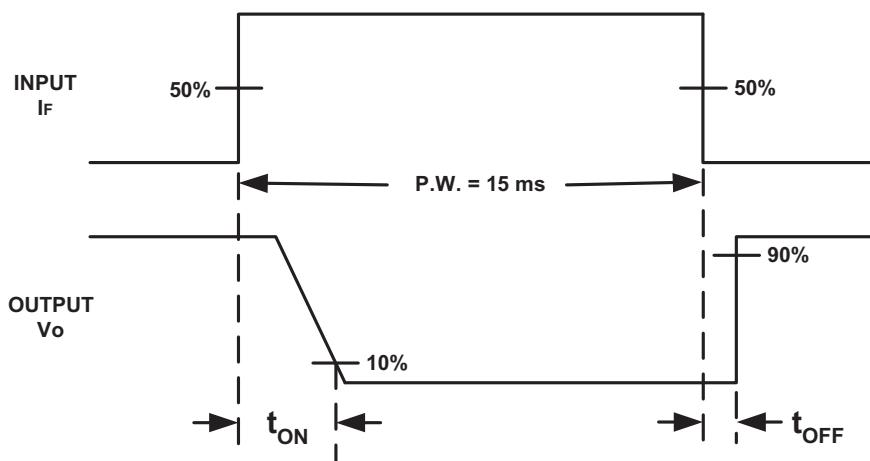
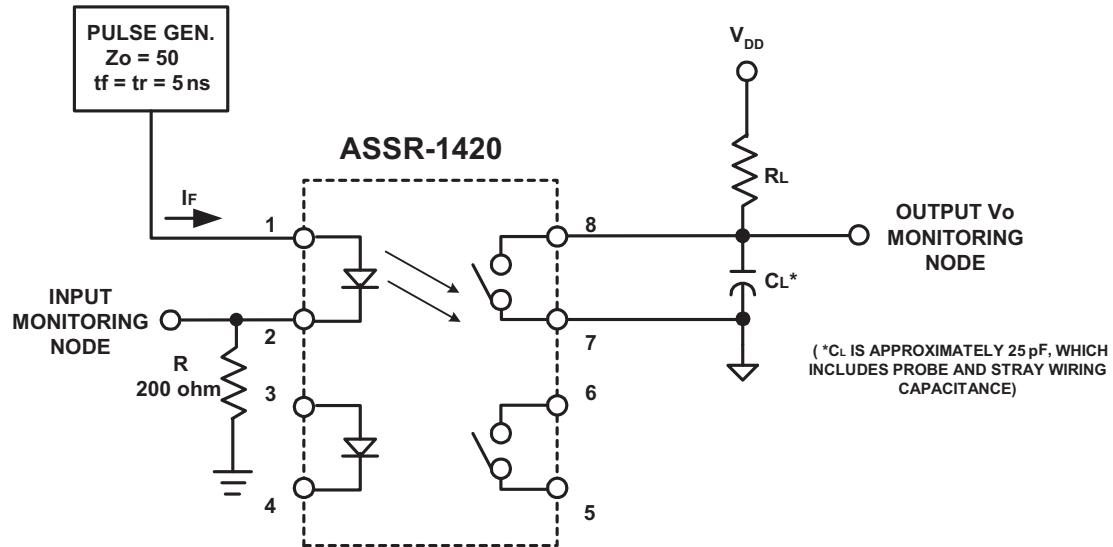
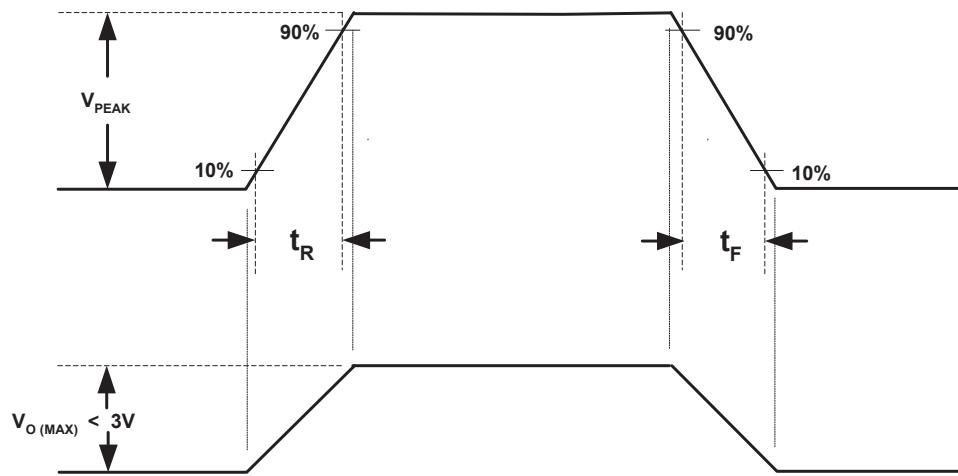
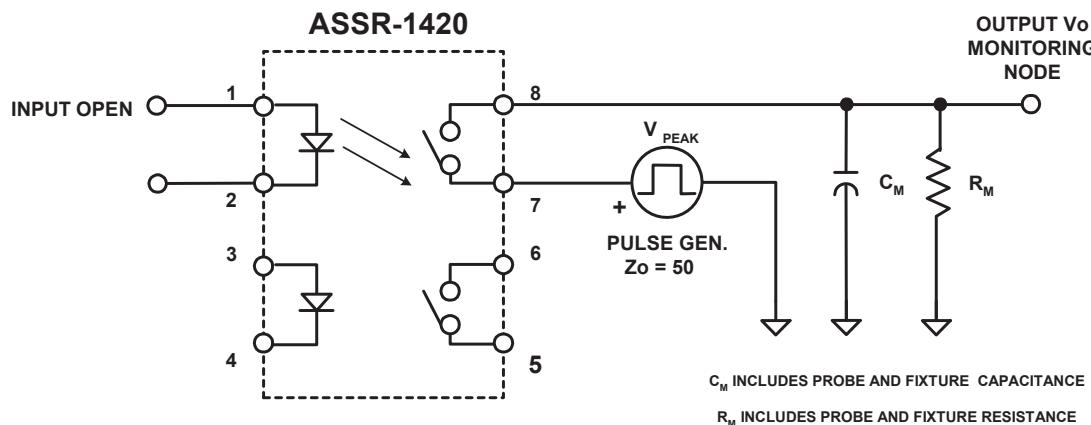
Figure 14: Switching Test Circuit for  $t_{ON}$ ,  $t_{OFF}$ 

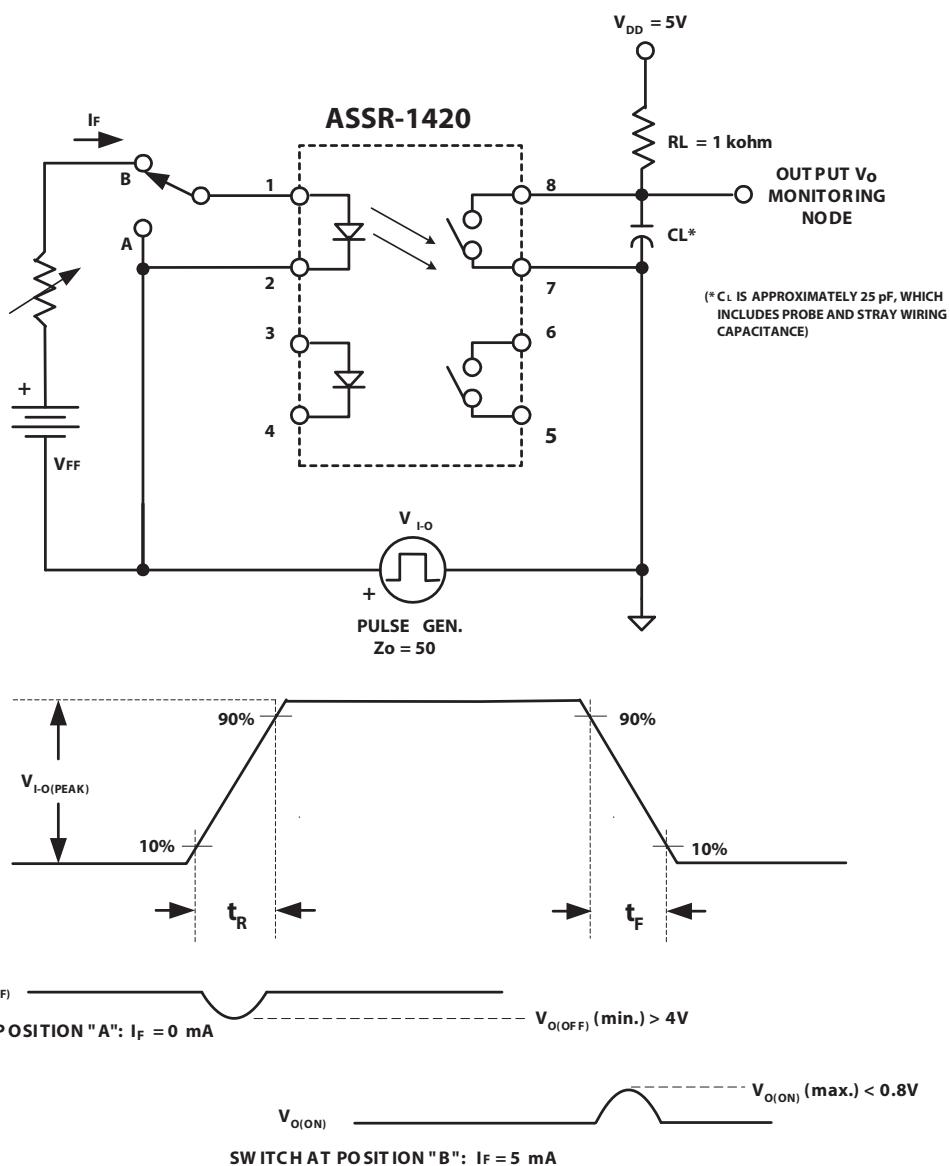
Figure 15: Output Transient Rejection Test Circuit



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

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

Figure 16: Input-Output Transient Rejection Test Circuit



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