BROADCOM®

Data Sheet

ASSR-601J

1500V High Voltage Industrial Photo MOSFET

Description

The Broadcom® ASSR-601J is a high-voltage Photo MOSFET that is designed for high voltage industrial applications. The ASSR-601J 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 7 mA through the input LED. The relay turns off (contact opens) with an input voltage of 0.4V or less.

The ASSR-601J is equivalent to 1FormA Electromechanical Relays (EMR) and is available in 16-pin SOIC package. This Photo MOSFET provides reinforced insulation and reliability that delivers safe signal isolation critical in automotive and high temperature industrial applications.

Features

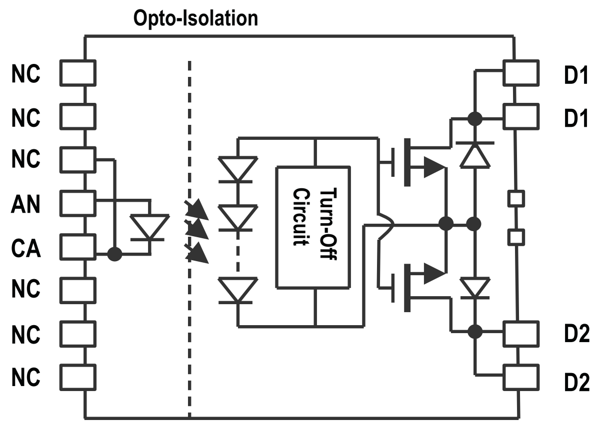
- Compact solid-state bidirectional signal switch
- Operating temperature range: –40°C to +110°C
- Breakdown voltage, V_{OFF}: 1500V at I_{DSS} = 250 µA
- Avalanche rated MOSFETs
- Output Leakage Current, I_O = 10 nA at 1000V
- On-resistance, R_{ON} < 250Ω at I_O = 50 mA
- Turn on time: T_{ON} < 4 ms
- Turn off time: T_{OFF} < 0.5 ms
- Package: 300 mil SO-16
- Creepage and clearance ≥ 8 mm (input-output)
- Creepage > 5 mm (between drain pins of MOSFETs)
- Safety and regulatory approvals:
  - IEC/EN/DIN EN 60747-5-5
  - Maximum working insulation voltage $1414V_{PEAK}$
  - $5000V_{RMS}$ for 1 minute per UL1577
  - CSA component acceptance

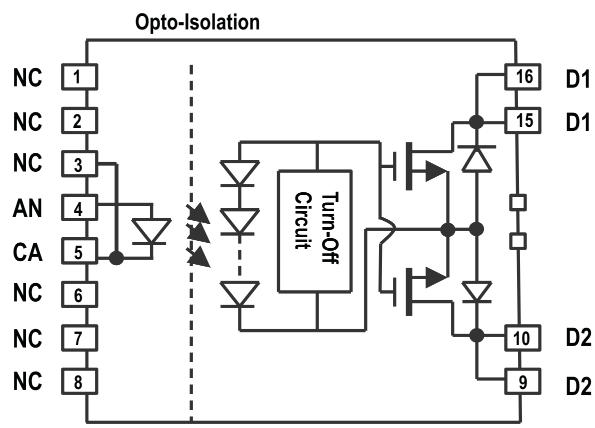
Applications

- Battery/motor/solar panel insulation resistance measurement/leakage detection
- BMS flying capacitor topology for sensing batteries
- Electro mechanical relay replacement
- Inrush current limiter protection

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. The components featured in this data sheet are not to be used in military or aerospace applications or environments.

Functional Diagram





Truth Table

LED	Output
Off	Open
On	Close

Pin Description

Pin Number	Pin Name	Description
1, 2, 6, 7, 8	NC	No connection.
3	NC	Do not connect (internally connected to Pin 5).
4	AN	Anode.
5	CA	Cathode.
9, 10	D2	Drain 2 (internally connected).
15, 16	D1	Drain 1 (internally connected).

Ordering Information

Specify part number followed by option number.

Part Number	Option (RoHS Compliant)	Package	Surface Mount	Tape and Reel	UL 5000V_{rms} / 1 Minute Rating	IEC 60747-5-5 EN/DIN EN 60747-5-5	Quantity
ASSR-601J	-000E	SO-16	X		X	X	45 per tube
	-500E		X	X	X	X	850 per reel

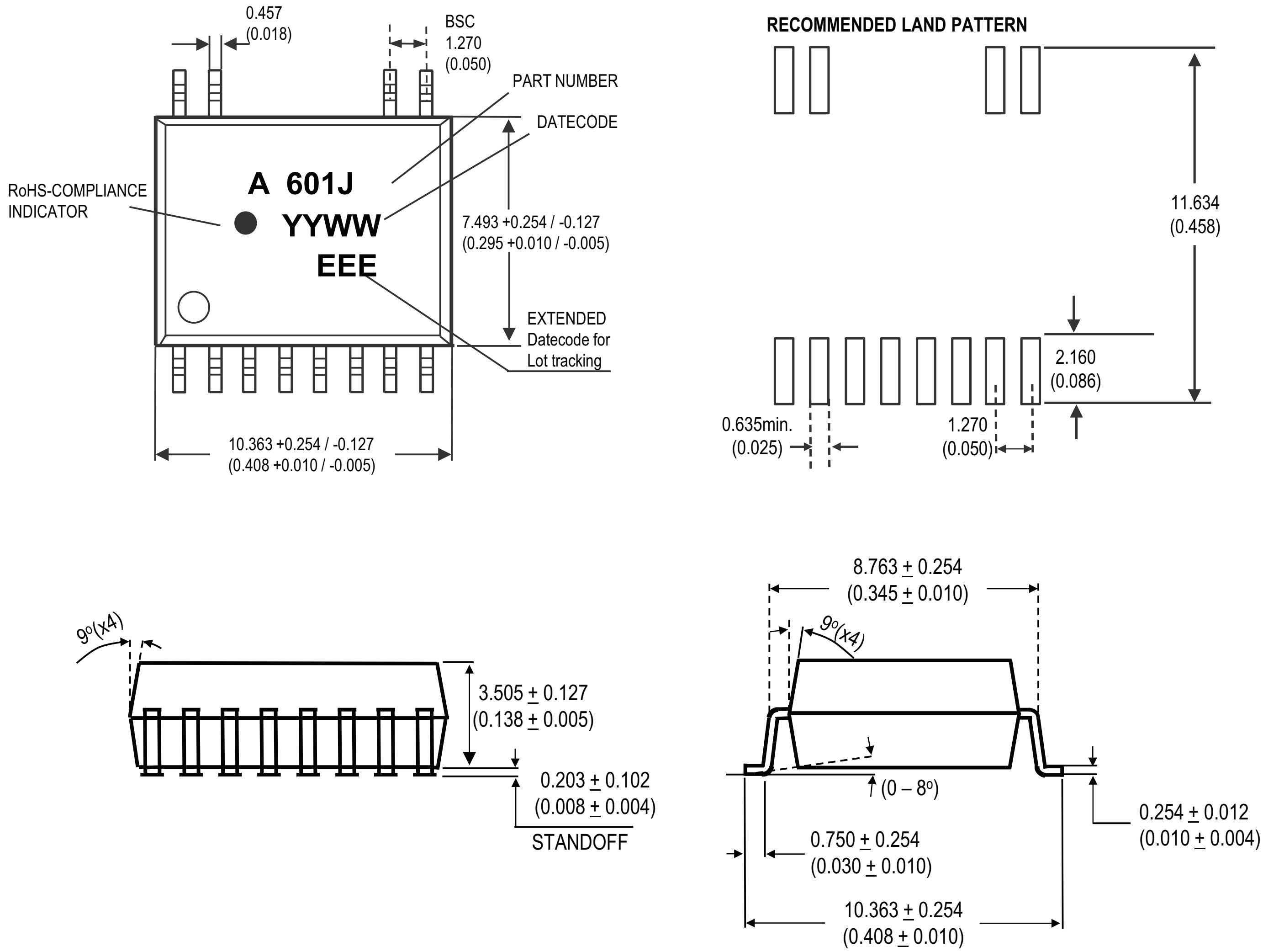
To order, choose a part number from the part number column and combine with the desired option from the option column to form an order entry.

Example 1:

ASSR-601J-500E to order product of SO-16 Surface Mount package in Tape and Reel packaging with IEC/EN/DIN EN 60747-5-5 Safety Approval in RoHS compliant.

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

Package Outline Drawings (SO-16)



NOTE: Dimensions in millimeters (inches).

NOTE:

- Lead coplanarity = 0.10 mm (0.004 in.) maximum.
- Floating lead protrusion = 0.254 mm (0.010 in.) maximum.
- Mold Flash on each side = 0.127 mm (0.005 in.) maximum.

Recommended Pb-Free IR Profile

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

NOTE: Non-halide flux should be used.

Regulatory Information

The ASSR-601J is approved by the following organizations:

UL/cUL	IEC/EN/DIN EN 60747-5-5
UL 1577, component recognition program up to V_{ISO} = 5 kV_{RMS} Approved under CSA Component Acceptance Notice #5.	IEC 60747-5-5 EN 60747-5-5 DIN EN 60747-5-5

Insulation and Safety Related Specifications

Parameter	Symbol	ASSR-601J	Unit	Conditions
Minimum External Air Gap (Clearance)	L(101)	8.3	mm	Measured from input terminals to output terminals, shortest distance through air.
Minimum External Tracking (Creepage)	L(102)	8.3	mm	Measured from input terminals to output terminals, shortest distance path along body.
Minimum Internal Plastic Gap (Internal Clearance)		0.5	mm	Through insulation distance conductor to conductor, usually the straight line distance thickness between the emitter and detector.
Tracking Resistance (Comparative Tracking Index)	CTI	>600	V	IEC 60695.

IEC/EN/DIN EN 60747-5-5 Insulation Related Characteristics

Description	Symbol	Characteristic	Units
Installation classification per DIN VDE 0110/1.89, Table 1 For rated mains voltage < 600 V_{RMS} For rated mains voltage < 1000 V_{RMS}		 I - III I - II	
Climatic Classification		40/125/21	
Pollution Degree (DIN VDE 0110/1.89)		2	
Maximum Working Insulation Voltage	V_{IORM}	1414	V_{PEAK}
Input to Output Test Voltage, Method b V_{IORM} x 1.875 = V_{PR}, 100% Production Test with t_m = 1s, Partial Discharge < 5 pC	V_{PR}	2651	V_{PEAK}
Input to Output Test Voltage, Method a V_{IORM} x 1.6 = V_{PR}, Type and sample test, t_m = 10s, Partial Discharge < 5 pC	V_{PR}	2262	V_{PEAK}
Highest Allowable Overvoltage (Transient Overvoltage, t_{ini} = 60 sec)	V_{IOTM}	6000	V_{PEAK}
Safety Limiting Values (Maximum values allowed in the event of a failure) Ambient Safety Temperature Input Current Output Power	 T_S $I_{S,INPUT}$ $P_{S,OUTPUT}$	 175 400 1200	 °C mA mW
Insulation Resistance at T_S, V_{IO} = 500V	R_S	$>10^9$	Ω

Absolute Maximum Ratings

All specifications at T_A= 25°C unless otherwise specified.

Parameter		Symbol	Min.	Max.	Units	Note
Storage Temperature		T_S	–55	150	°C	
Operating Ambient Temperature		T_A	–40	125	°C	
Junction Temperature		T_J	–40	150	°C	
Input Current	Average	$I_{F(avg)}$	—	30	mA	T_A= –40°C to +125°C
	Surge (50% duty cycle)	$I_{F(surge)}$	—	60	mA	T_A= –40°C to +125°C
Peak Transient Input Current		I_{FP}	—	1	A	f = 100 Hz, duty cycle = 0.1%
Reversed Input Voltage		BV_R	—	6	V	T_A = –40°C to +125°C
Input Power Dissipation		P_{IN}	—	100	mW	
Output Load Current		I_O	—	50	mA	
Output Avalanche Current		I_{AV}	—	0.6	mA	t_m = 1 min, duty cycle = 0.1%, cumulative of 5 mins over lifetime
Output Power Dissipation		Po	—	1000	mW	
Lead Soldering Cycle	Temperature		—	260	°C	
	Time		—	10	s	
Solder Reflow Temperature Profile		Recommended reflow condition as per JEDEC Standard J-STD-020 (latest revision).				

Recommended Operating Conditions

Parameter	Symbol	Min.	Max.	Units	Note
Input Current (ON)	$I_{F(ON)}$	7	30	mA	
Input Voltage (OFF)	$V_{F(OFF)}$	–5	0.4	V	
Operating Temperature	T_A	–40	110	°C	
Continuous Load Voltage	Vo	—	1000	V_{DC}	a
Load Current	I_O	–10	10	mA	

a. V_O is the voltage across output terminals, pins 9, 10 and pins 15, 16.

Electrical Specifications (DC)

Unless otherwise stated, all minimum/maximum specifications are over recommended operating conditions. All typical values are at T_A = 25°C, I_F = 10 mA.

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions	Figure	Note
Input Reverse Breakdown Voltage	V_R	5	—	—	V	I_R =10 µA		
Input Forward Voltage	V_F	1.25	1.55	1.85	V	I_F = 10 mA	1	
Output Withstand Voltage	$\|V_{O(OFF)}\|$	1500	1700	—	V	I_O = 250 µA, T_A = 25°C	3	a
Output Leakage Current	$I_{O(OFF)}$	—	0.3	10	nA	V_O = 1000V, T_A = 25°C	4	a
Output Capacitance	C_{OUT}	—	190	—	pF	V_O = 0V, f = 1 MHz	7	a
Output Resistance	R_{ON}	—	100	300	Ω	I_O = 2 mA	8	
		—	100	250	Ω	I_O = 10 mA	8	
		—	77	250	Ω	I_O = 50 mA, T_A = 25°C	8	

a. Device is in OFF state with $V_F \leq 0.4V$.

Switching Specifications (AC)

Unless otherwise stated, all minimum/maximum specifications are over recommended operating conditions. All typical values are at T_A = 25°C, I_F = 10 mA.

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions	Figure	Note
Turn-On Time	T_{ON}	—	0.8	4.0	ms	I_F = 10 mA, V_{DD} = 40V, R_{LOAD} = 20 kΩ	9, 11, 13	
		—	0.3	1.0	ms	I_F = 30 mA, V_{DD} = 40V, R_{LOAD} = 20 kΩ		
Turn-Off Time	T_{OFF}	—	0.05	0.5	ms	V_{DD} = 40V, R_{LOAD} = 20 kΩ	10, 12, 13	

Package Characteristics

Unless otherwise stated, all minimum/maximum specifications are over recommended operating conditions. All typical values are at T_A = 25°C.

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions	Figure	Note
Input-Output Momentary Withstand Voltage	V_{ISO}	5000	—	—	V_{RMS}	RH ≤ 50%, t_m = 1 minute; T_A = 25°C		a, b, c
Input-Output Resistance	R_{I-O}	10^9	10^{14}	—	Ω	V_{I-O} = 1000 V_{DC}		b
Input-Output Capacitance	C_{I-O}	—	0.6	—	pF	f = 1 MHz; V_{I-O} = 0 V_{DC}		b

a. The Input-Output Momentary Withstand Voltage is a dielectric voltage rating that should not be interpreted as an input-output continuous voltage rating.

b. Device considered a two-terminal device: pins 1 to 8 shorted together, and pins 9, 10, 15, and 16 shorted together.

c. In accordance with UL 1577, each optocoupler is proof tested by applying an insulation test voltage ≥ 6000 V_{RMS} for 1 second.

Typical Characteristic Curves

Figure 1: LED Forward Current vs. LED Forward Voltage

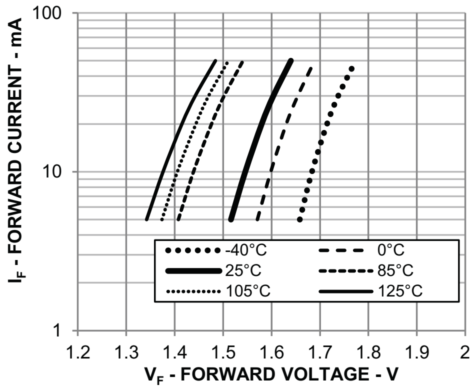


Figure 2: LED Forward Current Threshold vs. Ambient Temperature (Test Condition: I_O = 2 mA)

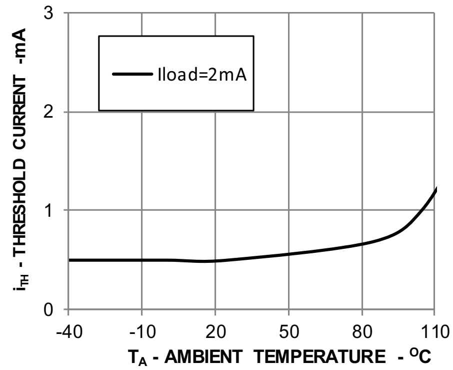


Figure 3: Output Withstand Voltage vs. Ambient Temperature (Test Condition: I_O = 250 µA)

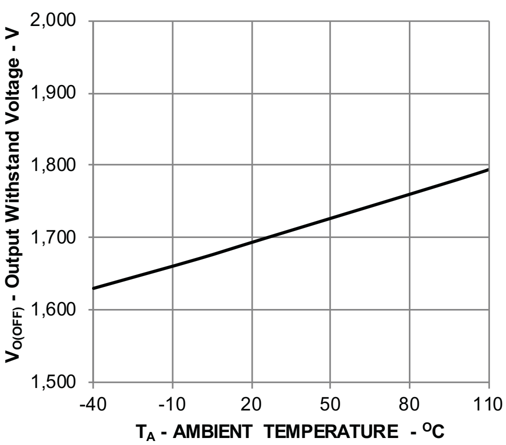


Figure 4: Output Leakage Current vs. Ambient Temperature (Test Condition: V_O = 1000V)

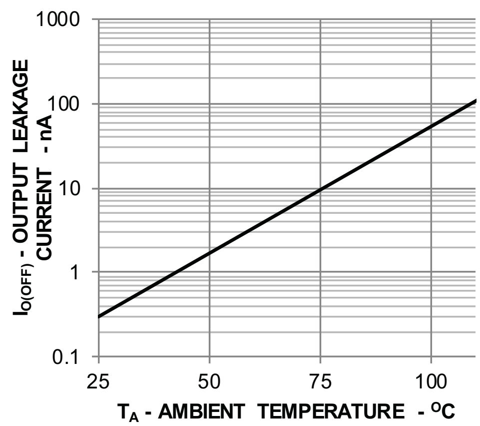


Figure 5: Output Leakage Current vs. Load Voltage (Test Condition: T_A = 25°C)

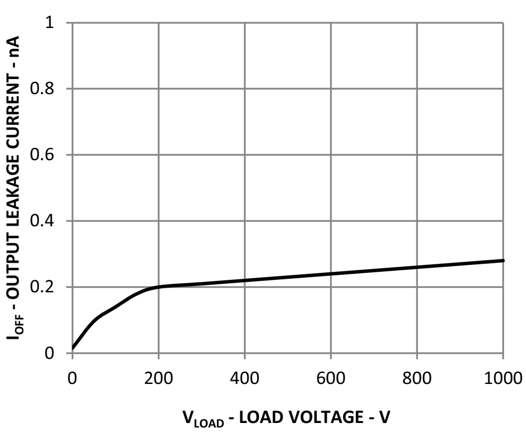


Figure 6: Output Current vs. Output Voltage

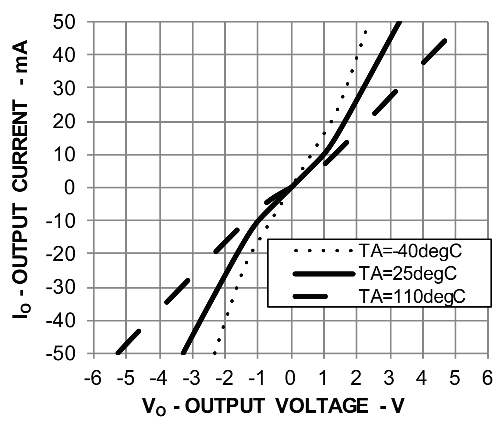


Figure 7: Output Capacitance vs. Load Voltage (Test Condition: V_{LOAD} = 0V, f = 1 MHz, T_A = 25°C)

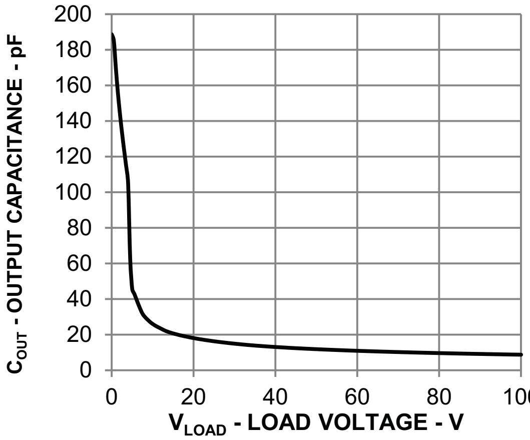


Figure 8: Typical On-Resistance vs. Ambient Temperature

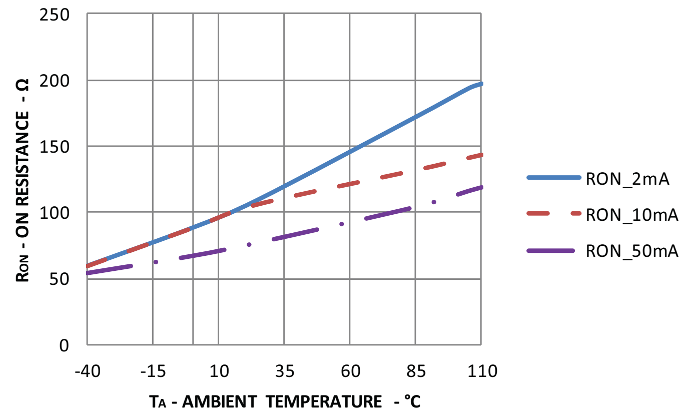


Figure 9: Turn-On Time vs. Ambient Temperature (Test Condition: V_{DD} = 40V, R_{LOAD} = 20 kΩ)

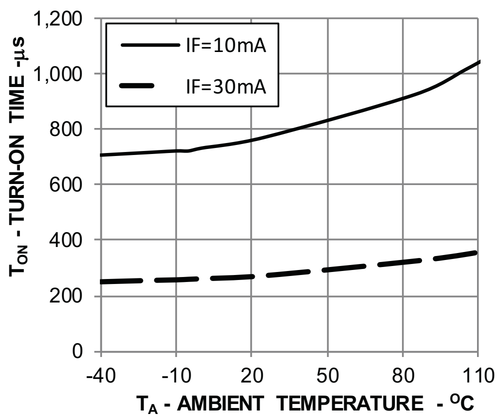


Figure 10: Turn-Off Time vs. Ambient Temperature (Test Condition: V_{DD} = 40V, R_{LOAD} = 20 kΩ)

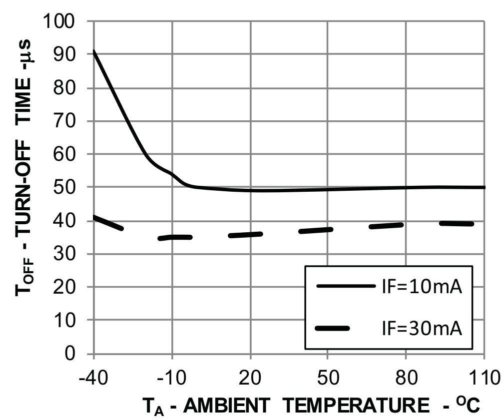


Figure 11: Turn-On Time vs. Input Forward Current (Test Condition: V_{DD} = 40V, R_{LOAD} = 20 kΩ)

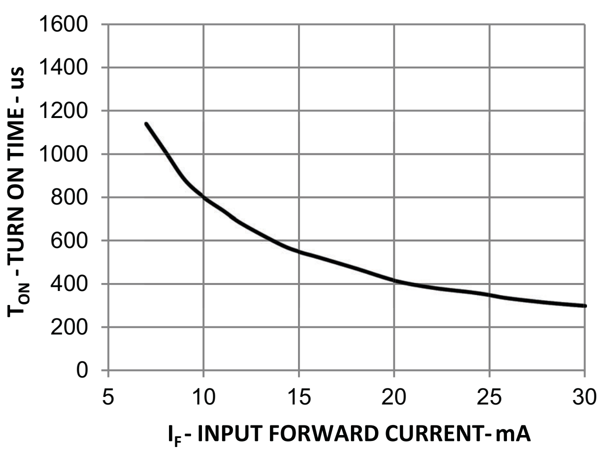


Figure 12: Turn-Off Time vs. Input Forward Current (Test Condition: V_{DD} = 40V, R_{LOAD} = 20 kΩ)

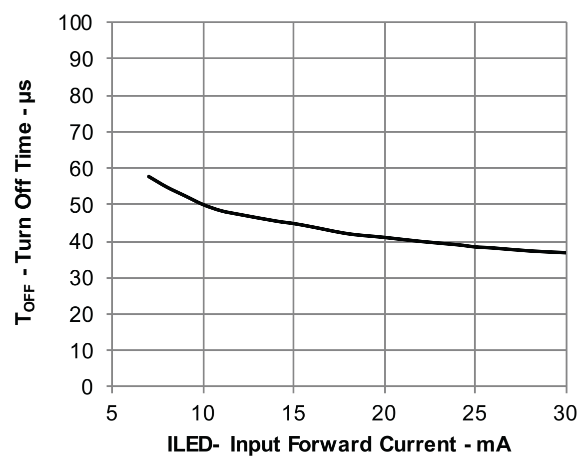
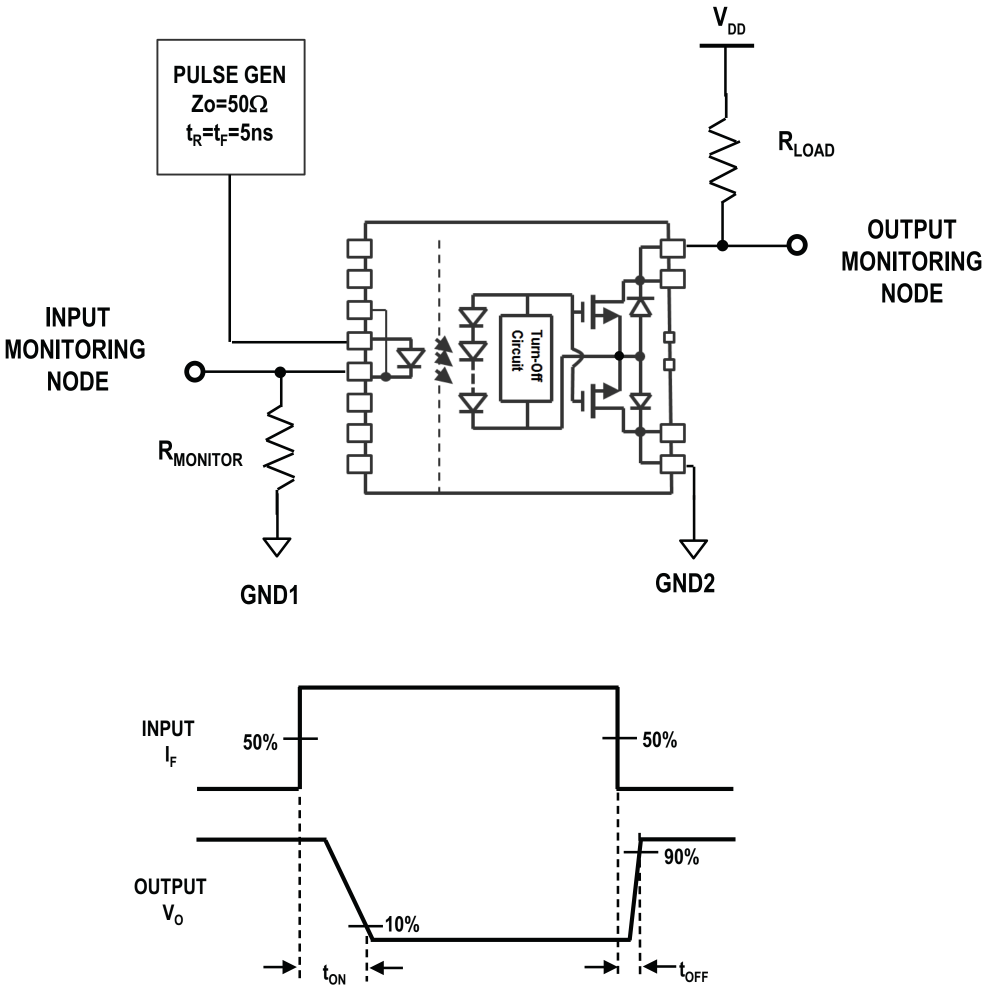


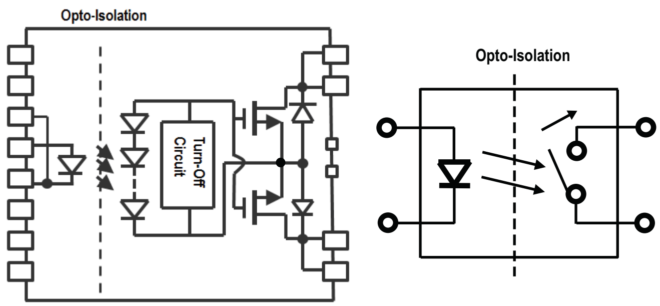
Figure 13: Switching Time Test Circuit and Waveform



Application Information

The ASSR-601J is a single-channel Photo MOSFET that is equivalent to 1FormA electromechanical relay (EMR) as shown in Figure 14. It functions like a bidirectional switch with no output power requirement. The input side is LED driven and requires a current limiting resistor (Figure 15). Recommended input forward current is 7 mA to 30 mA.

Figure 14: ASSR-601J Equivalent Circuit

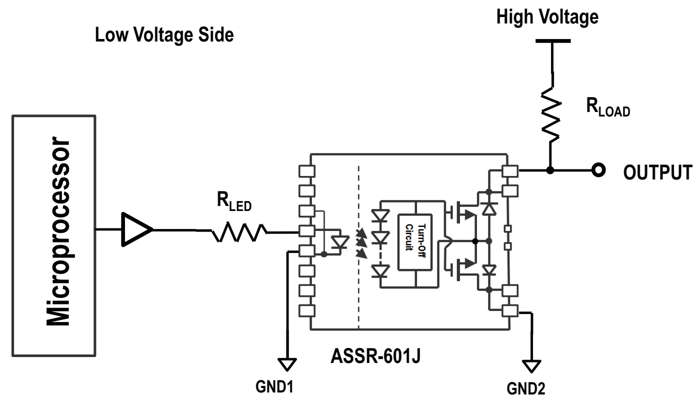


The input LED is optically coupled through a photodiode stack and a driver circuitry to switch two high-voltage MOSFETs. When current is driven into the LED, the light generates photo current on the photodiode to charge the gate of the MOSFETs, to switch and keep the power device on.

A typical application circuit (Figure 15) shows the ASSR-601J's input being controlled by the microprocessor to switch the output (high voltage side). The ASSR-601J's galvanic isolation protects the low voltage side of the circuit (input) from the high-voltage side (output).

Pins 9 to 10 and 15 to 16 are internally connected. In routing the PCB layout, either of the pins can be used. Shorting the pins (9 to 10) and (15 to 16) is also acceptable.

Figure 15: Typical Application Circuit

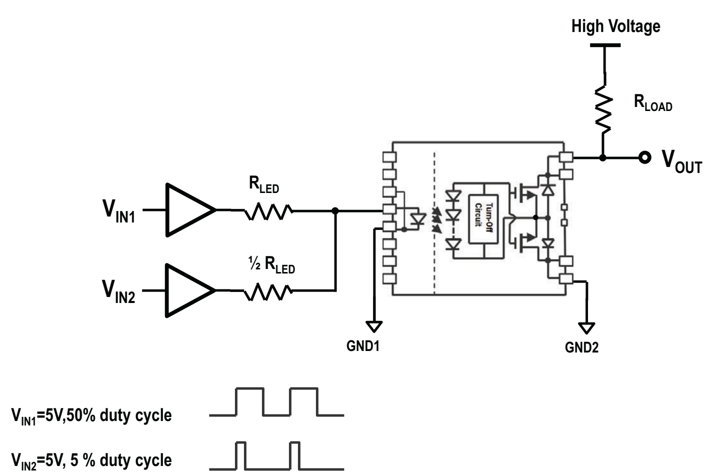


Turn On Time

T_{ON} is influenced by the level of input current. As input current is increased, the T_{ON} becomes shorter. In a situation where T_{ON} needs to be shorter than what the maximum level of input current can achieve, peaking can be implemented as shown in Figure 16.

In this peaking circuit, the LED can be driven by two inputs to achieve shorter T_{ON}. The second input V_{IN2}'s duty cycle must set to a lower duty cycle to achieve the peaking effect.

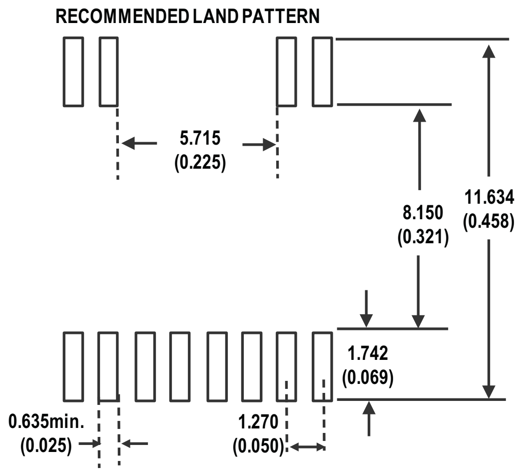
Figure 16: Peaking Circuit and Sample Input Timing



Land Pattern for 8-mm Creepage and Floating Pins

For applications that require PCB creepage of 8 mm between the control and switch sides, the land pattern below can be used.

Figure 17: Land Pattern for 8-mm Creepage



At the output side, in between pins 10 and 15, there are two floating pins. These floating pins are electrically isolated and have no circuit connection to any of the internal circuitry.

Figure 18: Floating Pins