SIEMENS

LH1514
2 Form A
High-Frequency Solid-State Relay

FEATURES
- Load voltage, 15 V
- Load current, 150 mA
- Switching capability up to 50 MHz
- Blocking capability dependent upon signal dv/dt
- Low and typical R_{ON}, 5 Ω
- 1 ms actuation time
- Low power consumption
- 3750 Vrms I/O isolation
- Balanced switching
- Linear ac/dc operation
- Clean, bounce-free switching
- High-reliability monolithic receptor
- Surface-mountable
- UL Recognized

APPLICATIONS
- Protection switching (T1 sparing)
  —Digital access cross connects
  —D-type channel breaks
  —Intraoffice data routing
- Transmission switching
  —T1 multiplexing
  —DSO (64 Kbits/s)
  —DS1 (1.544 Mbits/s)
  —E1, DS1A (2.048 Mbits/s)
  —DS1C (3.152 Mbits/s)
  —DS2 (6.312 Mbits/s)
- Instrumentation
  —Scanners
  —Testers
  —Measurement equipment

DESCRIPTION

The LH1514 is a DPST normally open (2 Form A) SSR that can be used in balanced high-frequency applications like T1 switching. With its low ON-resistance and high actuation rate, the LH1514 is also very attractive as a general-purpose 2 Form A SSR for balanced signals.

The relays are constructed using a GaAlAs LED for actuation control and an integrated monolithic die for the switch output. The die, fabricated in a dielectrically isolated Smart Power BiCMOS, is comprised of a photodiode array, switch control circuitry, and NMOS switches.

In balanced switching applications, internal circuitry shunts high-frequency signals between two poles when the SSR is off. This balanced T termination technique provides high isolation for the load.

The relay is packaged in an 8-pin, plastic DIP (LH1514AB) or in a surface-mount gull wing (LH1514AAC).

Figure 1. Functional Diagram

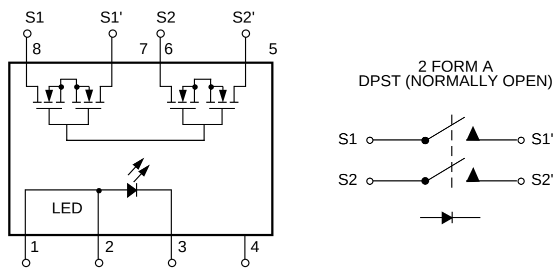
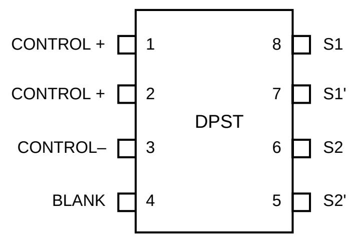


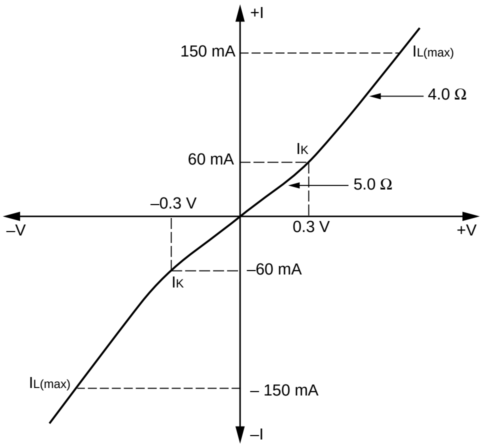
Figure 2. Pin Diagram and Pin Outs



Functional Description

Figure 3 shows the switch characteristics of the relay. The relay exhibits an ON-resistance that is exceptionally linear up to the knee current (IK). Beyond IK, the incremental resistance decreases, minimizing internal power dissipation.

Figure 3. Typical ON Characteristics



In a 2 Form A relay, to turn the relay on, forward current is applied to the LED. The amount of current applied determines the amount of light produced for the photodiode array.

This photodiode array develops a drive voltage for both NMOS switch outputs. For high-temperature or high-load current operations, more LED current is required.

For high-frequency applications, the LH1514 must be wired as shown in the Figure 16 application diagram to minimize transmission crosstalk and bleed-through. A single LH1514 package switches a single transmit twisted pair or a single receive twisted pair. In this configuration when the SSR is turned off, the SSR parries high-frequency signals by shunting them through the SSR, thereby isolating the transformer load.

When switching alternate mark inversion (AMI) coding transmission, the most critical SSR parameter is dv/dt bleed-through. This bleed-through is a result of the rise and fall time slew rates of the 3 V AMI pulses. The test circuit in Figure 4 illustrates these bleed-through glitches. It is important to recognize that the transmission limitations of the LH1514 are bleed-through related and not frequency related. The maximum frequency the LH1514 SSR can switch will be determined by the pulse rise and fall times and the sensitivity of the receive electronics to the resultant bleed-through.

At data rates above 2 Mbits/s, the 50 pF pole-to-pole capacitance of the LH1514 should be considered when analyzing the load match to the transmission line. Please refer to the *T1 Switching with the LH1514 SSR* Application Note for further information on load-matching and off-state blocking.

Absolute Maximum Ratings At 25°C

Stresses in excess of the Absolute Maximum Ratings can cause permanent damage to the device. These are absolute stress ratings only. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operational sections of the data sheet. Exposure to Absolute Maximum Ratings for extended periods can adversely affect the device reliability.

Parameter	**Symbol**	**Value**	**Unit**
Ambient Operating Temperature Range	T_A	–40 to +85	°C
Storage Temperature Range	T_{stg}	–40 to +150	°C
Pin Soldering Temperature (t=10 s max.)	T_S	260	°C
Input/Output Isolation Voltage	V_{ISO}	3750	Vrms
LED Input Ratings: Continuous Forward Current Reverse Voltage ($I_R \leq 10$ µA)	 I_F V_R	 50 10	 mA V
Output Operation: dc or Peak ac Load Voltage ($I_L \leq 1$ µA) Continuous dc Load Current Each Pole, Two Poles Operating Simultaneously	 V_L I_L	 15 150	 V mA
Power Dissipation	P_{DISS}	600	mW

Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit
LED Forward Current for Switch Turn-on (T_A=–40°C to +85°C)	I_{Fon}	8	—	20	mA

Electrical Characteristics T_A=25°C

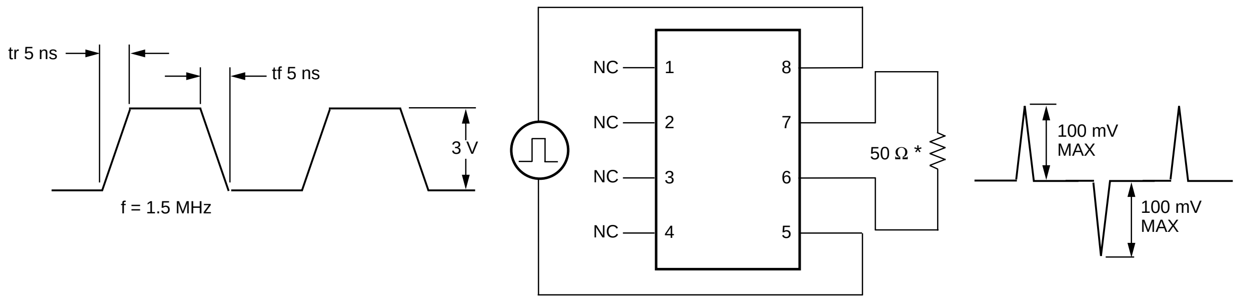
Minimum and maximum values are testing requirements. Typical values are characteristics of the device and are the result of engineering evaluations. Typical values are for information purposes only and are not part of the testing requirements.

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
LED Forward Current or Switch Turn-on	I_{Fon}	I_L=100 mA, t=10 ms	—	2.0	3.0	mA
LED Forward Current for Switch Turn-off	I_{Foff}	V_L=±10 V	0.2	1.8	—	mA
LED Forward Voltage	V_F	I_F=10 mA	1.15	1.26	1.45	V
ON-resistance	R_{ON}	I_F=10 mA, I_L=±50 mA	3.0	5.0	8.0	Ω
Pole-to-pole ON-resistance Matching (S1 to S2)	—	I_F=10 mA, I_L=±50 mA	—	0.2	1.0	DΩ
Output Off-state Bleed-through*	—	f=1.5 MHz square wave tr/tf=5 ns (See Figure 4.)	—	70	100	mV_{peak}
Output Off-state Leakage	—	I_F=0 mA, V_L=±5 V V_L=±15 V	— —	3×10^{-12} 20×10^{-12}	200×10^{-9} 1.0×10^{-6}	A A
Output Off-state Leakage Pole-to-pole	—	I_F=10 mA Pins 7, 8 ±3 V Pins 5, 6 Gnd	—	1.0	5	µA
	—	Pins 7, 8 ±15 V Pins 5, 6 Gnd	—	2.0	50	µA
Output Capacitance Pins 5 to 6, 7 to 8	—	I_F=0 mA, V_L=0	—	20	—	pF
Pole-to-pole Capacitance (S1 to S2)	—	I_F=0 mA, V_L=0 V I_F=10 mA, V_L=0 V	— —	20 50	— —	pF pF
Turn-on Time	t_{on}	I_F=10 mA, I_L=20 mA	—	0.4	1.0	ms
Turn-off Time	t_{off}	I_F=10 mA, I_L=20 mA	—	0.6	1.0	ms

* Guaranteed by component measurement during wafer probe.

Test Circuit

Figure 4. Off-State Bleed-Through



* 50 Ω load is derived from T1 applications where a 100 Ω load is paralleled with a 100 Ω line.

Typical Performance Characteristics

Figure 5. LED Forward Current for Switch Turn-On/Off

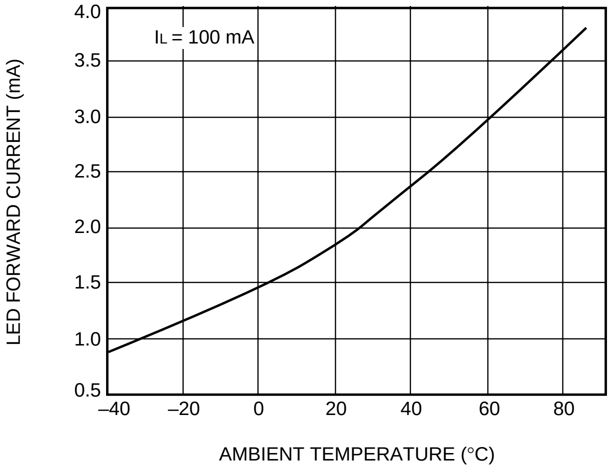


Figure 6. ON-Resistance vs. Temperature

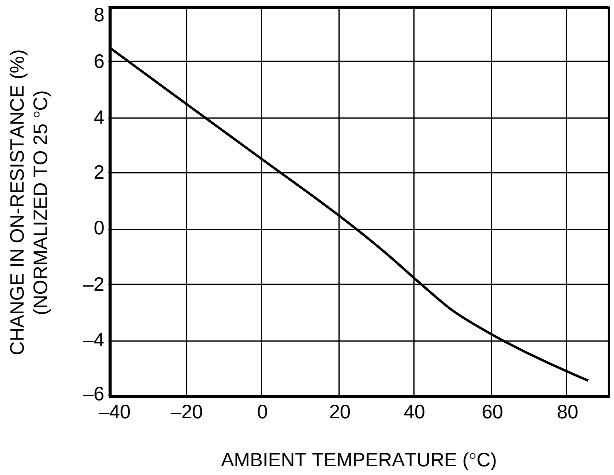


Figure 7. Leakage Current vs. Applied Voltage

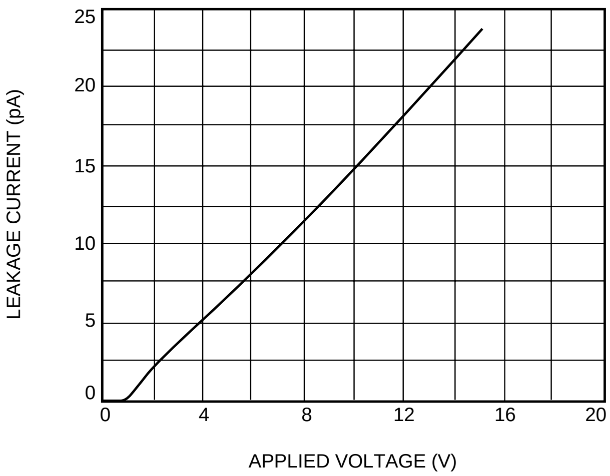
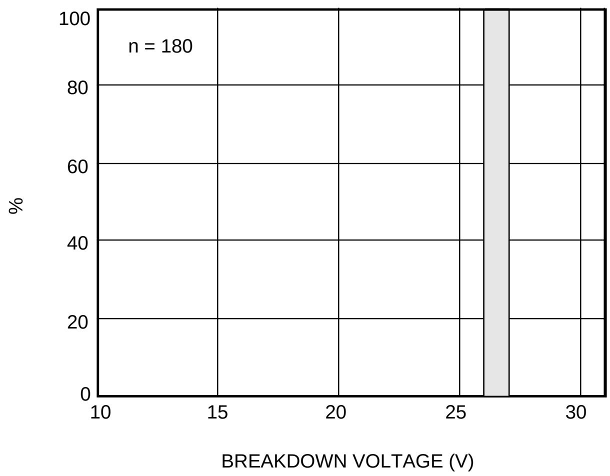


Figure 8. Breakdown Voltage Distribution



Typical Performance Characteristics (continued)

Figure 9. Output Isolation

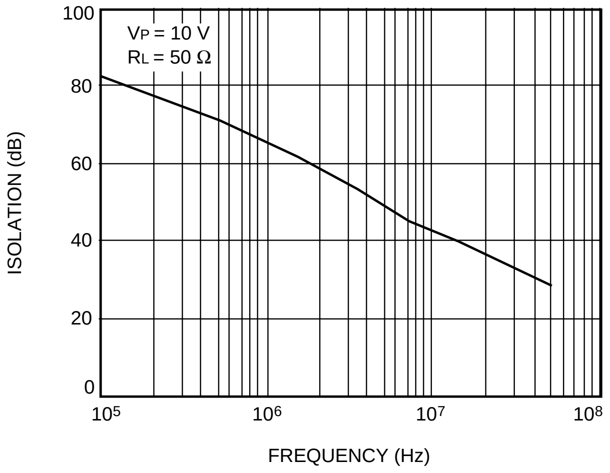


Figure 10. Bleed-Through Voltage vs. Rise Time

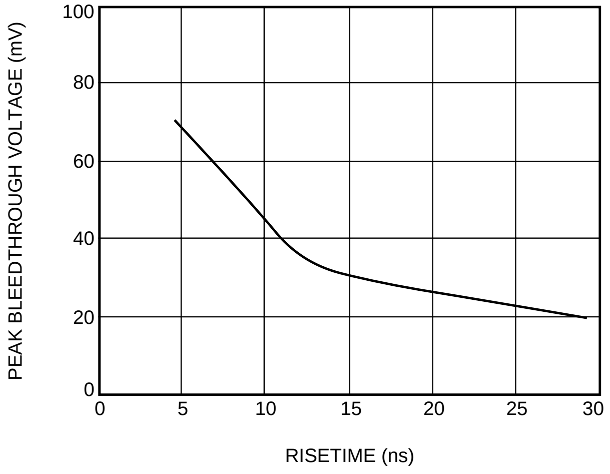


Figure 11. Insertion Loss (per Pole) vs. Frequency

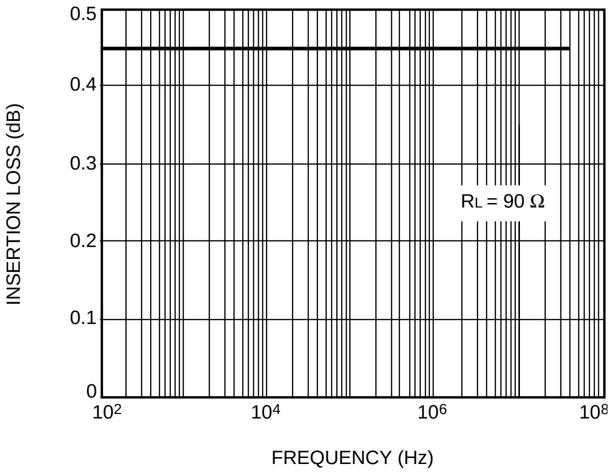


Figure 12. t_{ON}/t_{OFF} vs. Temperature

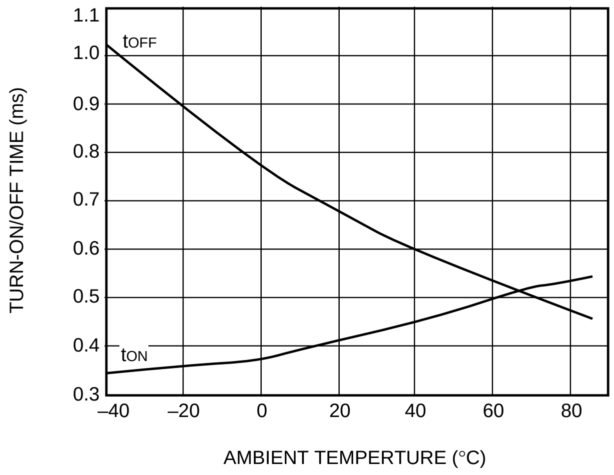


Figure 13. t_{ON} vs. LED Forward Current

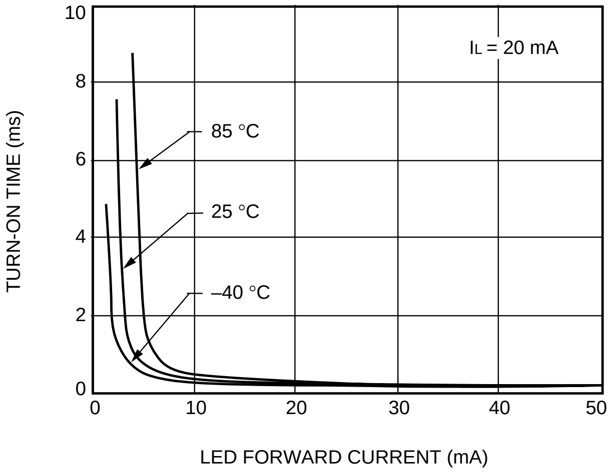
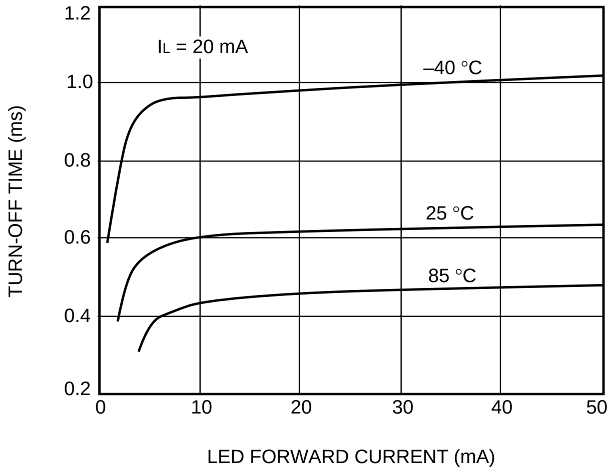


Figure 14. t_{OFF} vs. LED Forward Current



Applications

Figure 15. Protection Switching Application: T1 Interface Operating; Spare in Test Loopback Mode

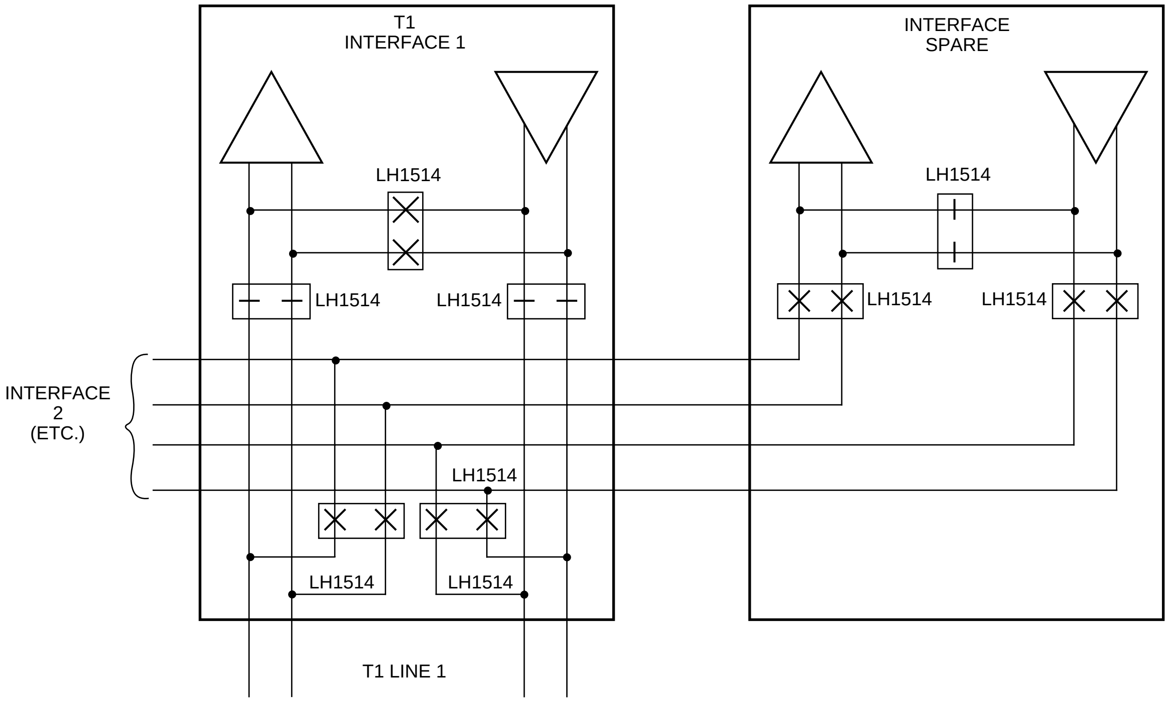
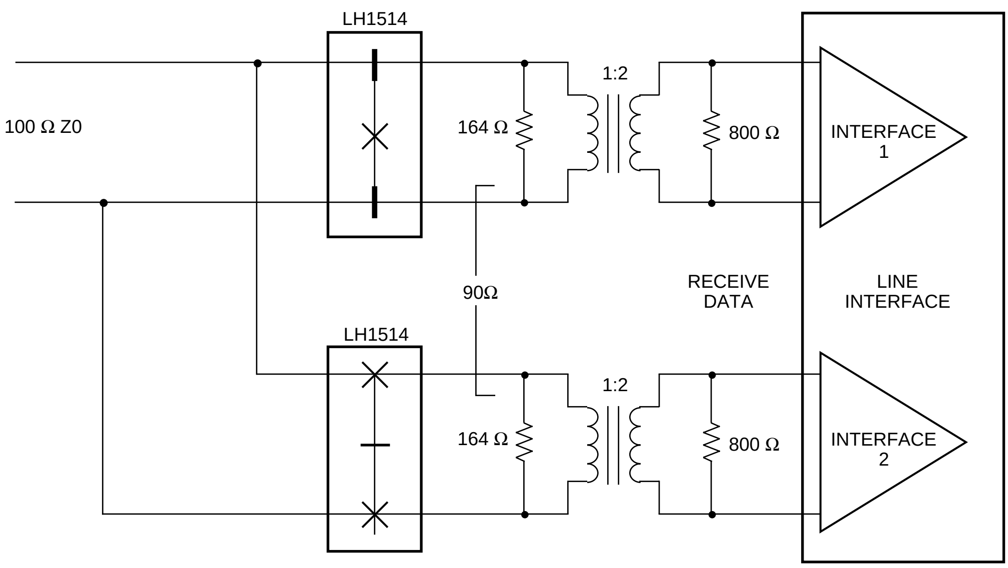


Figure 16. T1 Multiplexer Receive Data (Interface 1, Operating)



SIEMENS

LH2559

High-Voltage Interface IC
Polarity Guard and Switch Hook Control

FEATURES

- Low voltage drop polarity guard (1.4 V max at 20 mA), ideal for line-powered DAA circuits
- On-chip protection for associated DAA circuitry
- Isolated switchhook, suitable for pulse dialing
- Three functions integrated into one package, ideal for space-constrained applications
- Isolation in excess of 3750 Vrms to facilitate meeting domestic and foreign regulatory requirements
- Easy interface to AT&T and other DAA circuits
- Ideal for use in modems, answering machines, FAX machines, and other customer premises equipment

APPLICATIONS

- Modems
- FAX machines
- Answering machines
- Key telephone systems
- Equipment attached to the customer premises side of the telephone line

DESCRIPTION

The LH2559 High-Voltage Interface IC is an integrated high-voltage switch that contains a solid-state switchhook relay, a low-voltage drop polarity guard, and a protection circuit across the outputs.

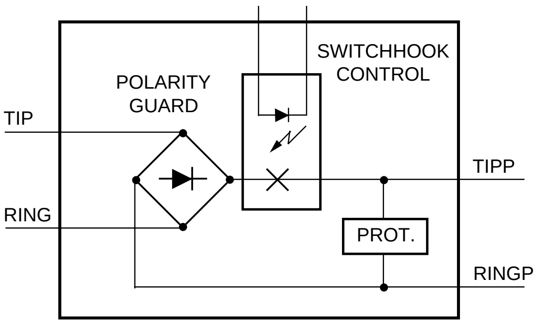
The solid-state switchhook relay is an optically coupled, low ON-resistance, MOSFET device. The 8-pin DIP/SOG version has an insulating barrier of 3750 Vrms. This device has a voltage break-down rating of 400 V.

A feature of this device is the polarity guard. A combination of diodes and MOSFETs provides for a low-voltage drop on long loops. The maximum voltage drop across both the polarity guard and the solid-state switchhook relay is only 1.4 V at 20 mA.

The 18 V protection circuit is provided to ensure the integrity of coupled low-voltage DAA circuitry, such as AT&T's ATTD2560 Interface Circuit for Optically Coupled Data Access Arrangements.

The LH2559 is packaged in an 8-pin DIP (LH2559AB) or in an 8-pin surface-mount gull-wing package (LH2559AAC).

Figure 1. Functional Block Diagram



Pin Information

Figure 2. 8-Pin DIP Diagram for LH2559

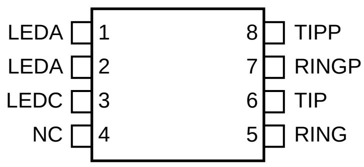


Table 1. PIN Descriptions for 8-Pin DIP/SOG Package

DIP/SOG	Symbol	Description
1	LEDA	The anode side of the LED that controls the switch.
2	LEDA	The anode side of the LED that controls the switch.
3	LEDC	The cathode side of the LED that controls the switch.
4	NC	No connection. Do NOT use as tie points.
5	RING	Ring conductor of the incoming telephone line.
6	TIP	Tip conductor of the incoming telephone line.
7	RINGP	Ring conductor of the telephone line on the user side of the polarity guard. This is a polarized RING conductor, negative with respect to TIPP.
8	TIPP	Tip conductor of the telephone line on the user side of the switchhook. This is a switched and polarized positive TIP conductor.

Functional Description

As shown in Figure 1, the LH2559 contains three functional blocks: a solid-state switchhook relay, a polarity guard, and a protection circuit.

The switchhook function is performed by using an isolated MOSFET switch that has an ON-resistance of approximately 7 Ω. This switch is controlled by an optically coupled, isolated relay-driver circuit. The relay-driver circuit is controlled by the LED input pins. When current is applied to the LED, the switch goes to an off-hook condition. The LED has an input/output isolation of 3750 Vrms, and the MOSFET switch has a breakdown voltage of 400 V. These parameters will easily meet the isolation/breakdown requirements of many regulatory agencies.

The polarity guard functions as a diode bridge, always biasing the TIPP lead positive with respect to the RINGP lead. A combination of MOSFETs and diodes is used to reduce the forward voltage drop through the device (including the switchhook) to 1.4 V maximum at 20 mA. This allows a full 4.6 V to be available to the other DAA circuitry on the equipment side of the switchhook and while still meeting the requirements of FCC Part 68 on a long loop. The device also contains an internal 18 V protection circuit to protect external equipment connected to the outputs of the device during the off-hook state.

Absolute Maximum Ratings (At 25°C)

Stresses in excess of the Absolute Maximum Ratings can cause permanent damage to the device. These are absolute stress ratings only. Functional operation of the device is not implied at these or any other conditions in excess of those indicated in the operational sections of the data sheet. Exposure to Absolute Maximum Ratings for extended periods can adversely affect device reliability.

Parameter	Symbol	Value	Unit
Power Supply	V_{SS}	5 V ± 10%	V
Ambient Operating Temperature Range	T_A	0 to 70	°C
Pin Soldering Temperature: (t=10 s max) 8-pin DIP/SOG	T_S	260	°C
Input/Output Isolation Voltage: (t=60 s min) 8-pin DIP/SOG	V_{ISO}	3750	Vrms
Breakdown Voltage TIP—TIPP	V_{BD}	400	V
LED Input Ratings: Continuous Forward Current Reverse Voltage ($I_R \leq 10$ µA)	 I_F V_R	 50 5	 mA V

Electrical Specifications (T_A=25°C)

Minimum and maximum values are testing requirements. Typical values are characteristics of the device and are the result of engineering evaluations. Typical values are for information purposes only and are not part of the testing requirements.

Table 2. Device Characteristics

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Off-state Leakage Current	I_{TIPP}	I_F=0 mA, V_{TIP}=400 V, V_{RING}=0 V, TIPP and RINGP tied together	—	—	16	µA
Total ON-resistance	R_{ON}	I_F=5 mA, I_{TIP}=30 mA, V_{RING}=0 V R_{ON}=[V (50 mA) – V (20 mA)] ÷ 30 mA TIPP and RINGP tied together	12	—	24	Ω
Total On-state Voltage	V_{TIP}	I_F=5 mA, I_{TIP}=20 mA, V_{RING}=0 V, TIPP and RINGP tied together	—	—	1.4	V
Turn-on Time	t_{on}	V_{TIPP}=0 V, V_L=50 V, TIP=R_L, R_L=1 kΩ , I_F=step from 0 mA to 5 mA	—	—	5	ms
Turn-off Time	t_{off}	V_{TIPP}=0 V, V_L=50 V, TIP=R_L, R_L=1 kΩ , I_F=step from 5 mA to 0 mA*	—	—	5	ms
Breakdown Voltage	V_{BD}	I_F=0 mA, Voltage applied between TIP and RING, TIPP and RINGP tied together	400	—	—	V
Isolation Voltage: 8-pin DIP/SOG	—	Between pins 1—4 and 5—8	3750	—	—	Vrms
LED Forward Current for Switch Turn-on	I_{FON}	I_{TIP}=100 mA, t=5 ms	—	0.2	5	mA
LED Forward Current for Switch Turn-off	I_{FOFF}	V_{TIP} V_{TIPP}=400 V, t=5 ms	0.01	0.1	—	mA
LED Forward Voltage	V_F	I_F=10 mA	1.15	1.26	1.45	V
LED Reverse Breakdown Voltage	V_{LBD}	—	5	—	—	V
Protection Voltage	V_{PROT}	—	16	18	20	V

*V_L is a power supply connected to the TIP pin through a resistance R_L.