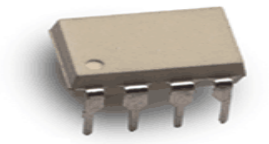
HCPL-7800
Isolation Amplifier

Description

The HCPL-7800 isolation amplifier family was designed for current sensing in electronic motor drives. In a typical implementation, motor currents flow through an external resistor and the resulting analog voltage drop is sensed by the HCPL-7800. A differential output voltage is created on the other side of the HCPL-7800 optical isolation barrier. This differential output voltage is proportional to the motor current and can be converted to a single-ended signal by using an op-amp. Since common-mode voltage swings of several hundred volts in tens of nanoseconds are common in modern switching inverter motor drives, the HCPL-7800 was designed to ignore very high common-mode transient slew rates (of at least 10 kV/ms).

Lifecycle status: Active



The high CMR capability of the HCPL-7800 isolation amplifier provides the precision and stability needed to accurately monitor motor current in high noise motor control environments, providing for smoother control (less "torque ripple") in various types of motor control applications.

The product can also be used for general analog signal isolation applications requiring high accuracy, stability, and linearity under similarly severe noise conditions. For general applications, we recommend the HCPL-7800 (gain tolerance of /- 3%). The HCPL-7800 utilizes sigma delta (S-D) analog-to-digital converter technology, chopper stabilized amplifiers, and a fully differential circuit topology.

Together, these features deliver unequaled isolation-mode noise rejection, as well as excellent offset and gain accuracy and stability over time and temperature. This performance is delivered in a compact, auto-insertable, industry standard 8-pin DIP package that meets worldwide regulatory safety standards. (A gull-wing surface mount option #300 is also available).

Features

- 15 kV/us Common-Mode Rejection at VCM = 1000 V
- Compact, Auto-Insertable Standard 8-pin DIP Package
- 0.00025 V/V/ degrees C Gain Drift vs. Temperature
- 0.3 mV Input Offset Voltage
- 100 kHz Bandwidth
- 0.004% Nonlinearity
- Worldwide Safety Approval:
  UL 1577 (3750 Vrms/1 min.), CSA and IEC/EN/DIN EN 60747-5-2
- Advanced Sigma-Delta (S-D) A/D Converter Technology
- Fully Differential Circuit Topology
- Options available are:

300 = Surface Mount Option
500 = Tape and Reel Packaging Option

Applications

Motor Phase and Rail Current Sensing

Inverter Current Sensing

Switched Mode Power Supply Signal Isolation

General Purpose Current Sensing and Monitoring

General Purpose Analog Signal Isolation

HCPL-7800A/HCPL-7800
Isolation Amplifer

AVAGO TECHNOLOGIES

Datasheet

Lead (Pb) Free
RoHS 6 fully compliant

RoHS 6 fully compliant options available;
-xxxE denotes a lead-free product

Description

The HCPL-7800(A) isolation amplifier family was designed for current sensing in electronic motor drives. In a typical implementation, motor currents flow through an external resistor and the resulting analog voltage drop is sensed by the HCPL-7800(A). A differential output voltage is created on the other side of the HCPL-7800(A) optical isolation barrier. This differential output voltage is proportional to the motor current and can be converted to a single-ended signal by using an op-amp as shown in the recommended application circuit. Since common-mode voltage swings of several hundred volts in tens of nanoseconds are common in modern switching inverter motor drives, the HCPL-7800(A) was designed to ignore very high common-mode transient slew rates (of at least 10 kV/µs).

The high CMR capability of the HCPL-7800(A) isolation amplifier provides the precision and stability needed to accurately monitor motor current in high noise motor control environ-ments, providing for smoother control (less "torque ripple") in various types of motor control applications.

The product can also be used for general analog signal isolation applications requiring high accuracy, stability, and linearity under similarly severe noise con-ditions. For general applications, we recommend the HCPL-7800 (gain tolerance of ±3%). For precision applications Avago Technologies offers the HCPL-7800A with part-to-part gain tolerance of ±1%. The HCPL-7800(A) utilizes sigma delta (Σ−Δ) analog-to-digital converter technology, chopper stabilized amplifiers, and a fully differential circuit topology.

Together, these features deliver unequaled isolation-mode noise rejection, as well as excellent offset and gain accuracy and stability over time and temperature. This performance is delivered in a compact, auto-insertable, industry standard 8-pin DIP package that meets worldwide regulatory safety standards. (A gull-wing surface mount option #300 is also available).

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- Compact, Auto-Insertable Standard 8-pin DIP Package
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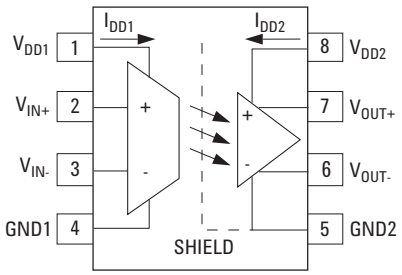
- Advanced Sigma-Delta (Σ−Δ) A/D Converter Technology
- Fully Differential Circuit Topology

Applications

- Motor Phase and Rail Current Sensing
- Inverter Current Sensing
- Switched Mode Power Supply Signal Isolation
- General Purpose Current Sensing and Monitoring
- General Purpose Analog Signal Isolation

Functional Diagram



NOTE: A 0.1 µF bypass capacitor must be connected between pins 1 and 4 and between pins 5 and 8.

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

HCPL-7800A/HCPL-7800 is UL Recognized with 3750 Vrms for 1 minute per UL1577.

Part number	Option: RoHS Compliant	Option: Non-RoHS Compliant	Package	Surface Mount	Gull Wing	Tape & Reel	IEC/EN/DIN EN 60747-5-2	Quantity
HCPL-7800A HCPL-7800	-000E	No option	300 mil DIP-8				X	50 per tube
	-300E	#300		X	X		X	50 per tube
	-500E	#500		X	X	X	X	1000 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:

HCPL-7800A-500E to order product of Gull Wing Surface Mount package in Tape and Reel packaging with IEC/EN/DIN EN 60747-5-2 Safety Approval in RoHS compliant.

Example 2:

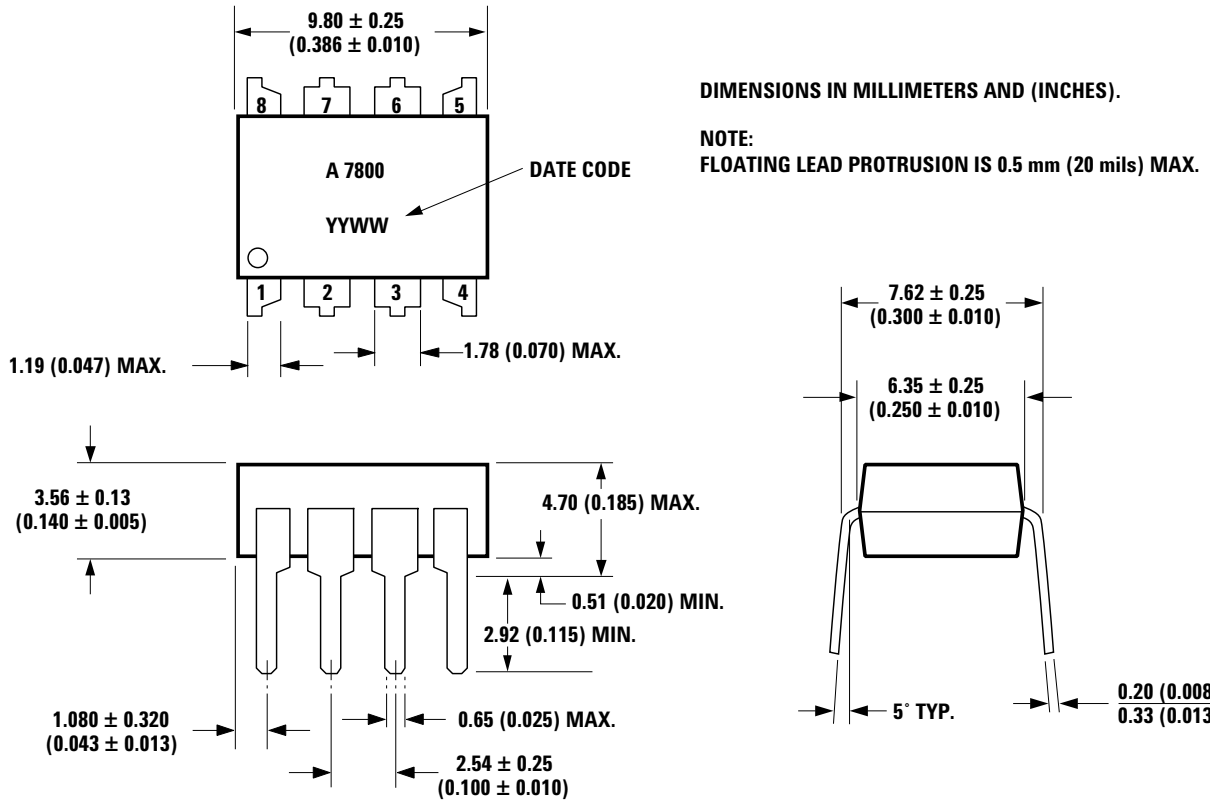
HCPL-7800 to order product of 300 mil DIP package in tube packaging and non-RoHS compliant.

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

Remarks: The notation '#XXX' is used for existing products, while (new) products launched since 15th July 2001 and RoHS compliant option will use '-XXXE'.

Package Outline Drawings

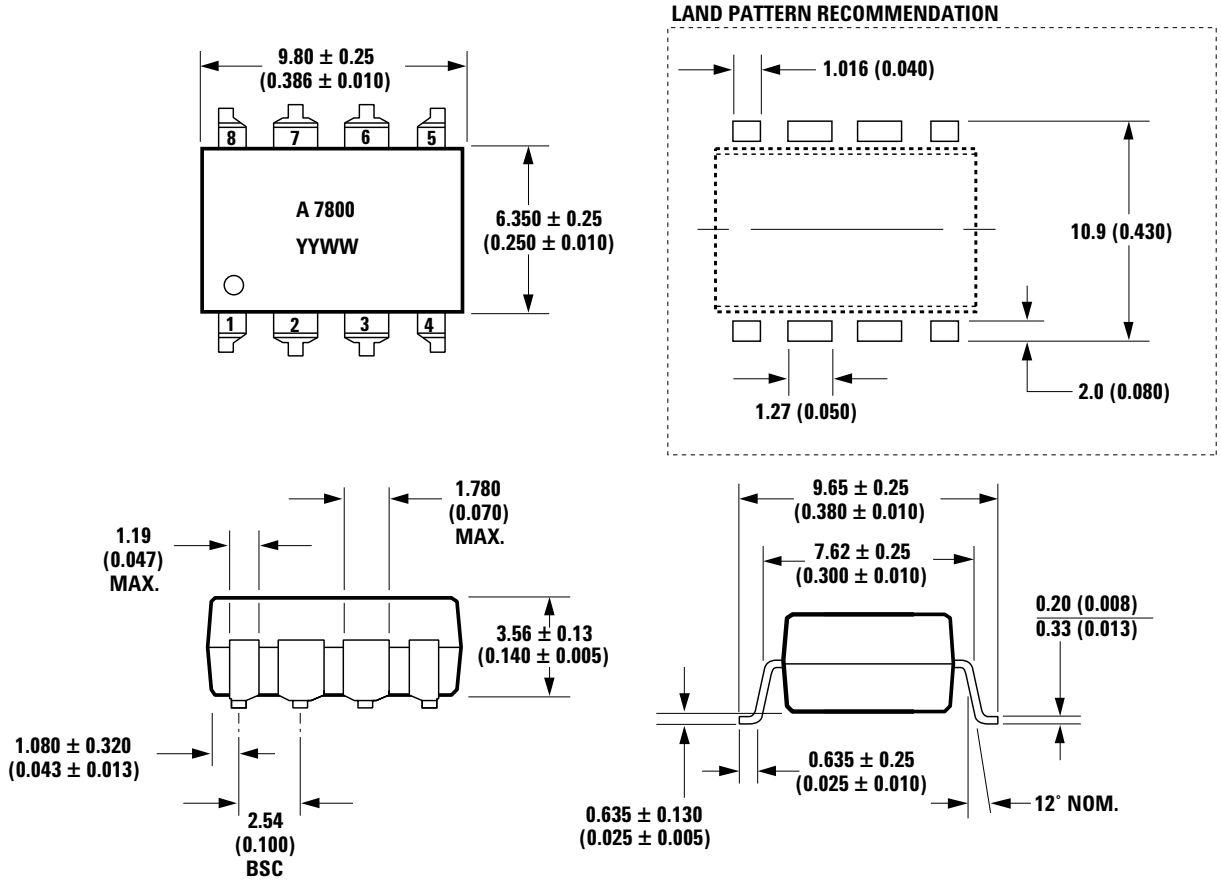
Standard DIP Package



Note:

Initial or continued variation in the color of the HCPL-7800(A)'s white mold compound is normal and does not affect device performance or reliability.

Gull Wing Surface Mount Option 300



DIMENSIONS IN MILLIMETERS (INCHES).
TOLERANCES (UNLESS OTHERWISE SPECIFIED): xx.xx = 0.01, xx.xxx = 0.005

LEAD COPLANARITY MAXIMUM: 0.102 (0.004)

NOTE: FLOATING LEAD PROTRUSION IS 0.5 mm (20 mils) MAX.

Regulatory Information

The HCPL-7800(A) has been approved by the following organizations:

IEC/EN/DIN EN 60747-5-2

Approved under:
IEC 60747-5-2:1997 + A1:2002
EN 60747-5-2:2001 + A1:2002
DIN EN 60747-5-2 (VDE 0884 Teil 2): 2003-01.

UL

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

CSA

Approved under CSA Component Acceptance Notice #5, File CA 88324.

IEC/EN/DIN EN 60747-5-2 Insulation Characteristics[1]

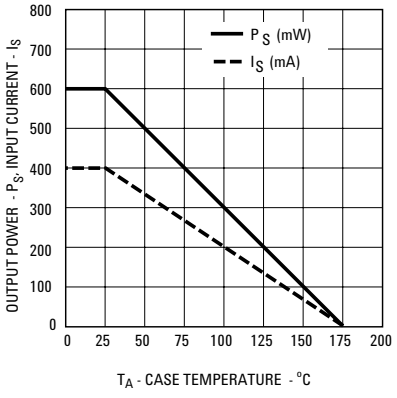
Description	Symbol	Characteristic	Unit
Installation classification per DIN VDE 0110/1.89, Table 1			
for rated mains voltage 300 Vrms		I-IV	
for rated mains voltage 600 Vrms		I-III	
Climatic Classification		55/100/21	
Pollution Degree (DIN VDE 0110/1.89)		2	
Maximum Working Insulation Voltage	V_{IORM}	891	V_{PEAK}
Input to Output Test Voltage, Method b[2]			
V_{IORM} x 1.875 = V_{PR}, 100% Production Test with t_m = 1 sec, Partial discharge < 5 pC	V_{PR}	1670	V_{PEAK}
Input to Output Test Voltage, Method a[2]			
V_{IORM} x 1.5 = V_{PR}, Type and Sample Test, t_m = 60 sec, Partial discharge < 5 pC	V_{PR}	1336	V_{PEAK}
Highest Allowable Overvoltage (Transient Overvoltage t_{ini} = 10 sec)	V_{IOTM}	6000	V_{PEAK}
Safety-limiting values—maximum values allowed in the event of a failure.			
Case Temperature	T_S	175	°C
Input Current[3]	$I_{S,INPUT}$	400	mA
Output Power[3]	$P_{S,OUTPUT}$	600	mW
Insulation Resistance at T_S, V_{IO} = 500 V	R_S	$>10^9$	Ω

Notes:

1. Insulation characteristics are guaranteed only within the safety maximum ratings which must be ensured by protective circuits within the application. Surface Mount Classification is Class A in accordance with CECC00802.

2. Refer to the optocoupler section of the Isolation and Control Components Designer's Catalog, under Product Safety Regulations section, (IEC/EN/DIN EN 60747-5-2) for a detailed description of Method a and Method b partial discharge test profiles.

3. Refer to the following figure for dependence of PS and IS on ambient temperature.



Insulation and Safety Related Specifications

Parameter	Symbol	Value	Unit	Conditions
Minimum External Air Gap (Clearance)	L(101)	7.4	mm	Measured from input terminals to output terminals, shortest distance through air.
Minimum External Tracking (Creepage)	L(102)	8.0	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	>175	Volts	DIN IEC 112/VDE 0303 Part 1
Isolation Group		III a		Material Group (DIN VDE 0110, 1/89, Table 1)

Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Unit	Note
Storage Temperature	T_S	-55	125	°C	
Operating Temperature	T_A	- 40	100		
Supply Voltage	V_{DD1}, V_{DD2}	0	5.5	V	
Steady-State Input Voltage 2 Second Transient Input Voltage	V_{IN+}, V_{IN-}	-2.0 -6.0	V_{DD1} +0.5		
Output Voltage	V_{OUT}	-0.5	V_{DD2} +0.5		
Solder Reflow Temperature Profile	See Maximum Solder Reflow Thermal Profile Section				

Recommended Operating Conditions

Parameter	Symbol	Min.	Max.	Unit	Note
Ambient Operating Temperature	T_A	-40	85	°C	
Supply Voltage	V_{DD1}, V_{DD2}	4.5	5.5	V	
Input Voltage (accurate and linear)	V_{IN+}, V_{IN-}	-200	200	mV	1
Input Voltage (functional)	V_{IN+}, V_{IN-}	-2	2	V	

DC Electrical Specifications

Unless otherwise noted, all typicals and figures are at the nominal operating conditions of V_{IN+} = 0, V_{IN-} = 0 V, V_{DD1} = V_{DD2} = 5 V and T_A = 25°C; all Min./Max. specifications are within the Recommended Operating Conditions.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions	Fig.	Note
Input Offset Voltage	V_{OS}	-2.0	0.3	2.0	mV	T_A = 25°C	1,2	
		-3.0		3.0		-40°C < T_A < +85°C, -4.5 V < (V_{DD1}, V_{DD2}) < 5.5 V		
Magnitude of Input Offset Change vs. Temperature	$\|DV_{OS}/DT_A\|$		3.0	10.0	µV/°C		3	2
Gain (HCPL-7800A)	G_1	7.92	8.00	8.08	V/V	-200 mV < V_{IN+} < 200 mV, T_A = 25°C,	4,5,6	3
Gain (HCPL-7800)	G_3	7.76	8.00	8.24				
Magnitude of V_{OUT} Gain Change vs.Temperature	$\|DG/DT_A\|$		0.00025		V/V/°C			4
V_{OUT} 200 mV Nonlinearity	NL_{200}		0.0037	0.35	%	-200 mV < V_{IN+} < 200 mV	7,8	5
Magnitude of V_{OUT} 200 mV Nonlinearity Change vs. Temperature	$\|dNL_{200}/dT\|$		0.0002		% / °C			
V_{OUT} 100 mV Nonlinearity	NL_{100}		0.0027	0.2	%	-100 mV < V_{IN+} < 100 mV		6
Maximum Input Voltage before V_{OUT} Clipping	$\|V_{IN+}\|MAX$		308.0		mV		9	
Input Supply Current	I_{DD1}		10.86	16.0	mA	V_{IN+} = 400 mV	10	7
Output Supply Current	I_{DD2}		11.56	16.0		V_{IN+} = -400 mV		8
Input Current	I_{IN+}		-0.5	5.0	µA		11	9
Magnitude of Input Bias Current vs. Temperature Coefficient	$\|dI_{IN}/dT\|$		0.45		nA/°C			
Output Low Voltage	V_{OL}		1.29		V			10
Output High Voltage	V_{OH}		3.80		V			
Output Common-Mode Voltage	V_{OCM}	2.2	2.545	2.8	V			
Output Short-Circuit Current	$\|I_{OSC}\|$		18.6		mA			11
Equivalent Input Impedance	R_{IN}		500		kΩ			
V_{OUT} Output Resistance	R_{OUT}		15		Ω			
Input DC Common-Mode Rejection Ratio	$CMRR_{IN}$		76		dB			12

AC Electrical Specifications

Unless otherwise noted, all typicals and figures are at the nominal operating conditions of V_{IN+} = 0, V_{IN-} = 0 V, V_{DD1} = V_{DD2} = 5 V and T_A = 25°C; all Min./Max. specifications are within the Recommended Operating Conditions.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions	Fig.	Note
V_{OUT} Bandwidth (-3 dB) sine wave.	BW	50	100		kHz	V_{IN+} = 200 mV_{pk-pk}	12,13	
V_{OUT} Noise	N_{OUT}		31.5		mVrms	V_{IN+} = 0.0 V		13
V_{IN} to V_{OUT} Signal Delay (50 – 10%)	t_{PD10}		2.03	3.3	µs	V_{IN+} = 0 mV to 150 mV step. Measured at output of MC34081 on Figure 15.	14,15	
V_{IN} to V_{OUT} Signal Delay (50 – 50%)	t_{PD50}		3.47	5.6				
V_{IN} to V_{OUT} Signal Delay (50 – 90%)	t_{PD90}		4.99	9.9				
V_{OUT} Rise/ Fall Time (10 – 90%)	$t_{R/F}$		2.96	6.6				
Common Mode Transient Immunity	CMTI	10.0	15.0		kV/µs	V_{CM} = 1 kV, T_A = 25°C	16	14
Power Supply Rejection	PSR		170		mVrms	With recommended application circuit.		15

Package Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Condition	Fig.	Note
Input-Output Momentary Withstand Voltage	V_{ISO}	3750			Vrms	RH < 50%, t = 1 min. T_A = 25°C		16,17
Resistance (Input-Output)	R_{I-O}		$>10^9$		Ω	V_{I-O} = 500 V_{DC}		18
Capacitance (Input-Output)	C_{I-O}		1.2		pF	f = 1 MHz		18