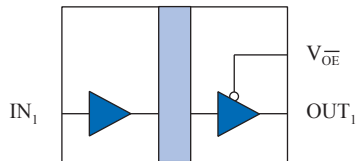
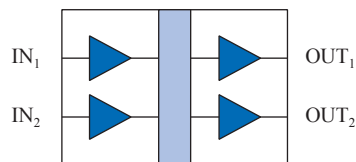


DC-Correct Digital Isolators

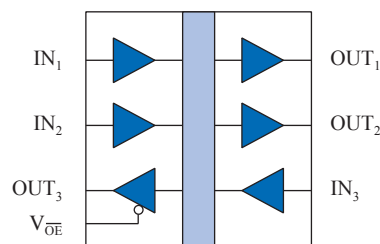
Functional Diagrams



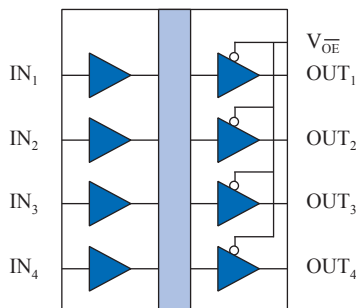
IL510



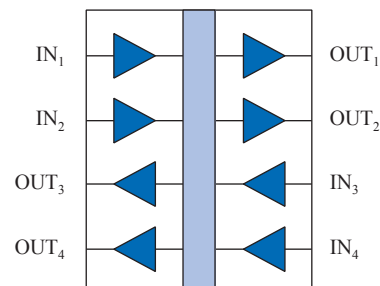
IL511



IL514



IL515



IL516

Features

- 2 Mbps maximum speed
- DC-correct
- 3 V to 5 V power supplies
- -40°C to 85°C operating temperature
- 50 kV/μs typ.; 30 kV/μs min. common mode transient immunity
- 1000 V_{RMS}/1500 V_{DC} high voltage endurance
- 44000 year barrier life
- 10 ns pulse width distortion
- 25 ns propagation delay
- Low EMC footprint
- 8-pin MSOP and SOIC; 0.15", 0.3", and True 8™ mm 16-pin SOIC packages
- UL 1577 recognized; IEC 61010-1 approved; VDE 0884 pending

Applications

- ADCs and DACs
- Digital Fieldbus
- RS-485 and RS-422
- Multiplexed data transmission
- Data interfaces
- Board-to-board communication
- Digital noise reduction
- Ground loop elimination
- Peripheral interfaces
- Parallel bus
- Logic level shifting

Description

IL500-Series isolators are low-cost isolators operating up to 2 Mbps over an operating temperature range of -40°C to 85°C.

The devices use NVE's patented* IsoLoop® spintronic Giant Magnetoresistive (GMR) technology.

A unique ceramic/polymer composite barrier provides excellent isolation and virtually unlimited barrier life.

IsoLoop is a registered trademark of NVE Corporation.
*U.S. Patent numbers 5,831,426; 6,300,617 and others.

Absolute Maximum Ratings⁽¹⁾

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Storage Temperature	T_S	-55		150	°C	
Ambient Operating Temperature	T_A	-40		85	°C	
Supply Voltage	V_{DD1}, V_{DD2}	-0.5		7	V	
Input Voltage	V_I	-0.5		$V_{DD}+0.5$	V	
Output Voltage	V_O	-0.5		$V_{DD}+0.5$	V	
Output Current Drive	I_O			10	mA	
Lead Solder Temperature				260	°C	10 sec.
ESD			2		kV	HBM

Recommended Operating Conditions

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Ambient Operating Temperature	T_A	-40		85	°C	
Supply Voltage	V_{DD1}, V_{DD2}	3.0		5.5	V	
Logic High Input Voltage	V_{IH}	2.4		V_{DD}	V	
Logic Low Input Voltage	V_{IL}	0		0.8	V	
Input Signal Rise and Fall Times ⁽¹⁰⁾	t_{IR}, t_{IF}		DC-Correct			

Insulation Specifications

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Creepage Distance (external)	MSOP 0.15" SOIC (8 or 16 pin) 0.3" SOIC	3.0 4.0 8.03	8.3		mm	Per IEC 60601
Total Barrier Thickness (internal)		0.012	0.013		mm	
Leakage Current			0.2		μA	240 V_{RMS} , 60 Hz
Barrier Impedance			$>10^{14} 3$		Ω pF	
High Voltage Endurance (Maximum Barrier Voltage for Indefinite Life)	AC	1000			V_{RMS}	At maximum operating temperature
	DC	1500			V_{DC}	
Barrier Life			40000		Years	100°C, 1000 V_{RMS} , 60% CL activation energy

Package Characteristics

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Capacitance (Input–Output) ⁽⁵⁾	C_{I-O}		4		pF	f = 1 MHz
Thermal Resistance						
MSOP	θ_{JC}		168		°C/W	Thermocouple at center underside of package
0.15" 8-pin SOIC	θ_{JC}		144		°C/W	
0.15" 16-pin SOIC	θ_{JC}		41		°C/W	
0.3" 16-pin SOIC	θ_{JC}		28		°C/W	
Package Power Dissipation	P_{PD}			150	mW	f = 1 MHz, $V_{DD} = 5$ V

Safety and Approvals

IEC 61010-1 (TUV Certificate Numbers N1502812; N1502812-101)

Classification as Reinforced Insulation; Pollution Degree II; Material Group III

Part No. Suffix	Package	Working Voltage
-1	MSOP	150 V _{RMS}
-3	Narrow-body SOIC	150 V _{RMS}
None	Wide-body SOIC/True 8™	300 V _{RMS}

UL 1577 (Component Recognition Program File Number E207481)

Each part tested at 3000 V_{RMS} (4240 V_{PK}) for 1 second; each lot sample tested at 2500 V_{RMS} (3530 V_{PK}) for 1 minute

VDE 0884-10 (pending)

Working Voltage 600 V_{RMS} (848 V_{PK}); Reinforced Insulation; Pollution Degree 2

4000 V_{PK} transient overvoltage (1500 V_{PK} for MSOP)

Each part tested at 1590 V_{PK} for 1 second, 5 pC partial discharge limit

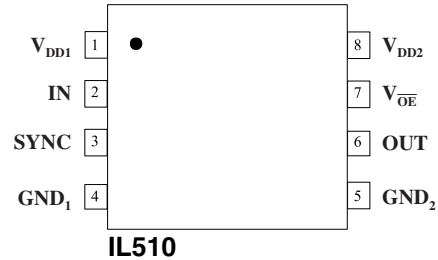
Each lot sample tested at 4000 V_{PK} (1500 V_{PK} for MSOP) for 10 seconds; then 1358 V_{PK} for 1 minute with 5 pC partial discharge limit

Soldering Profile

Per JEDEC J-STD-020C, MSL=2

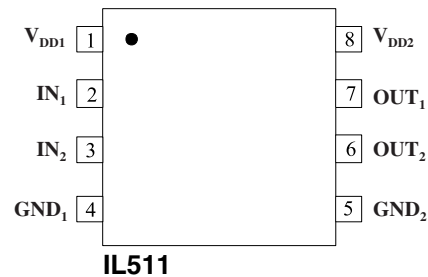
IL510 Pin Connections

1	V _{DD1}	Supply voltage
2	IN	Data in
3	SYNC	Internal refresh clock disable (normally enabled and internally held low with 10 kΩ)
4	GND ₁	Ground return for V _{DD1}
5	GND ₂	Ground return for V _{DD2}
6	OUT	Data out
7	V _{OE}	Output enable (internally held low with 100 kΩ)
8	V _{DD2}	Supply voltage



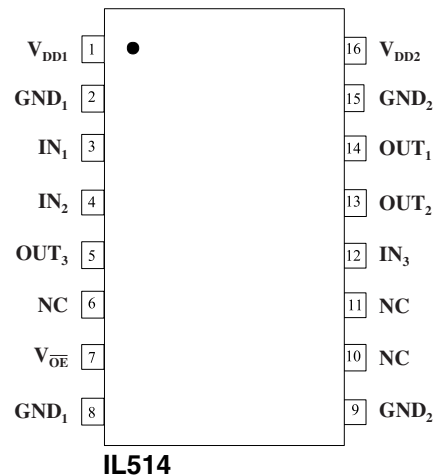
IL511 Pin Connections

1	V _{DD1}	Supply voltage
2	IN ₁	Data in, channel 1
3	IN ₂	Data in, channel 2
4	GND ₁	Ground return for V _{DD1}
5	GND ₂	Ground return for V _{DD2}
6	OUT ₂	Data out, channel 2
7	OUT ₁	Data out, channel 1
8	V _{DD2}	Supply voltage



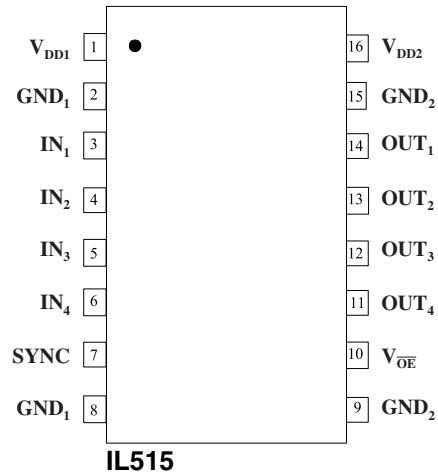
IL514 Pin Connections

1	V _{DD1}	Supply voltage 1
2	GND ₁	Ground return for V _{DD1} (pin 2 internally connected to pin 8)
3	IN ₁	Data in, channel 1
4	IN ₂	Data in, channel 2
5	OUT ₃	Data out, channel 3
6	NC	No connection
7	V _{OE}	Output enable, channel 3 (internally held low with 100 kΩ)
8	GND ₁	Ground return for V _{DD1} (pin 8 internally connected to pin 2)
9	GND ₂	Ground return for V _{DD2} (pin 9 internally connected to pin 15)
10	NC	No connection
11	NC	No connection
12	IN ₃	Data in, channel 3
13	OUT ₂	Data out, channel 2
14	OUT ₁	Data out, channel 1
15	GND ₂	Ground return for V _{DD2} (pin 15 internally connected to pin 9)
16	V _{DD2}	Supply voltage



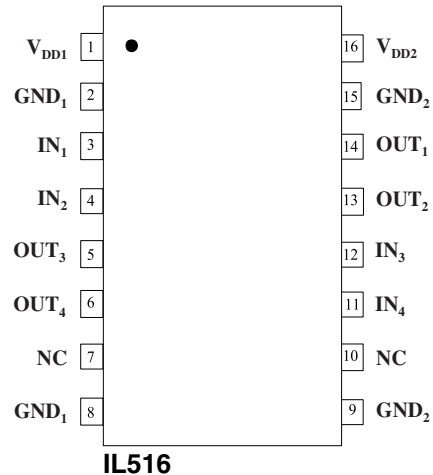
IL515 Pin Connections

1	V _{DD1}	Supply voltage
2	GND ₁	Ground return for V _{DD1} (pin 2 internally connected to pin 8)
3	IN ₁	Data in, channel 1
4	IN ₂	Data in, channel 2
5	IN ₃	Data in, channel 3
6	IN ₄	Data in, channel 4
7	SYNC	Internal refresh clock disable (normally enabled and internally held low with 10 kΩ)
8	GND ₁	Ground return for V _{DD1} (pin 8 internally connected to pin 2)
9	GND ₂	Ground return for V _{DD2} (pin 9 internally connected to pin 15)
10	V _{OE}	Output enable (internally held low with 100 kΩ)
11	OUT ₄	Data out, channel 4
12	OUT ₃	Data out, channel 3
13	OUT ₂	Data out, channel 2
14	OUT ₁	Data out, channel 1
15	GND ₂	Ground return for V _{DD2} (pin 15 internally connected to pin 9)
16	V _{DD2}	Supply voltage

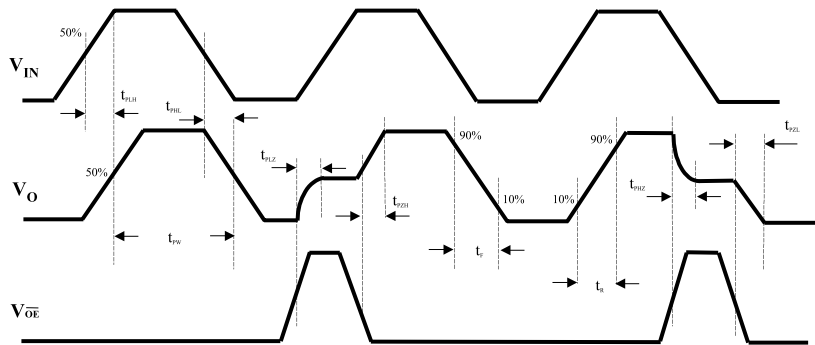


IL516 Pin Connections

1	V _{DD1}	Supply voltage
2	GND ₁	Ground return for V _{DD1} (pin 2 internally connected to pin 8)
3	IN ₁	Data in, channel 1
4	IN ₂	Data in, channel 2
5	OUT ₃	Data out, channel 3
6	OUT ₄	Data out, channel 4
7	NC	No connection
8	GND ₁	Ground return for V _{DD1} (pin 8 internally connected to pin 2)
9	GND ₂	Ground return for V _{DD2} (pin 9 internally connected to pin 15)
10	NC	No connection
11	IN ₄	Data in, channel 4
12	IN ₃	Data in, channel 3
13	OUT ₂	Data out, channel 2
14	OUT ₁	Data out, channel 1
15	GND ₂	Ground return for V _{DD2} (pin 15 internally connected to pin 9)
16	V _{DD2}	Supply voltage



Timing Diagrams



Legend

t_{PLH}	Propagation Delay, Low to High
t_{PHL}	Propagation Delay, High to Low
t_{PW}	Minimum Pulse Width
t_{PLZ}	Propagation Delay, Low to High Impedance
t_{PZH}	Propagation Delay, High Impedance to High
t_{PHZ}	Propagation Delay, High to High Impedance
t_{PZL}	Propagation Delay, High Impedance to Low
t_R	Rise Time
t_F	Fall Time

Truth Tables

Output Enable

V_I	V_{OE}	V_O
L	L	L
H	L	H
L	H	Z
H	H	Z

SYNC

SYNC	Internal Refresh Clock
0	Enabled
1	Disabled

Note: SYNC should be left open or connected to GND to enable the internal refresh clock, or connected to V_{DD} to disable the internal clock.

3.3 Volt Electrical Specifications (T _{min} to T _{max} unless otherwise stated)						
Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Input Quiescent Supply Current						
IL510, IL511, IL515	I _{DD1}		15	30	μA	
IL514			1.7	2	mA	
IL516			3.3	4	mA	
Output Quiescent Supply Current						
IL510	I _{DD2}		1.7	2	mA	
IL511, IL514, IL516			3.3	4	mA	
IL515			6.6	8	mA	
Logic Input Current	I _I	-10		10	μA	
Logic High Output Voltage	V _{OH}	$V_{DD} - 0.1$	V_{DD}		V	I _O = -20 μA, V _I = V _{IH}
		$0.8 \times V_{DD}$	$0.9 \times V_{DD}$			I _O = -4 mA, V _I = V _{IH}
Logic Low Output Voltage	V _{OL}		0	0.1	V	I _O = 20 μA, V _I = V _{IL}
				0.5		0.8

Switching Specifications (V _{DD} = 3.3 V)						
Maximum Data Rate		2			Mbps	C _L = 15 pF
Pulse Width ⁽⁷⁾	PW	20			ns	V _O 50% points; SYNC=0
		25			ns	V _O 50% points; SYNC=1
Propagation Delay Input to Output (High to Low)	t _{PHL}			25	ns	C _L = 15 pF
Propagation Delay Input to Output (Low to High)	t _{PLH}			25	ns	C _L = 15 pF
Propagation Delay Enable to Output (High to High Impedance)	t _{PHZ}			5	ns	C _L = 15 pF
Propagation Delay Enable to Output (Low to High Impedance)	t _{PLZ}			5	ns	C _L = 15 pF
Propagation Delay Enable to Output (High Impedance to High)	t _{PZH}			5	ns	C _L = 15 pF
Propagation Delay Enable to Output (High Impedance to Low)	t _{PZL}			5	ns	C _L = 15 pF
Pulse Width Distortion ⁽²⁾	PWD			10	ns	C _L = 15 pF
Propagation Delay Skew ⁽³⁾	t _{PSK}			10	ns	C _L = 15 pF
Output Rise Time (10%–90%)	t _R		1	3	ns	C _L = 15 pF
Output Fall Time (10%–90%)	t _F		1	3	ns	C _L = 15 pF
Common Mode Transient Immunity (Output Logic High or Logic Low) ⁽⁴⁾	CM _H , CM _L	30	50		kV/μs	V _{CM} = 1500 V _{DC} t _{TRANSIENT} = 25 ns
Channel-to-Channel Skew	t _{CSK}		3	5	ns	C _L = 15 pF
SYNC Internal Clock Off Time ⁽¹¹⁾	t _{OFF}			5	ns	
Dynamic Power Consumption ⁽⁶⁾			140	240	μA/MHz	per channel

Magnetic Field Immunity ⁽⁸⁾ (V _{DD2} = 3V, 3V < V _{DD1} < 5.5V)						
Power Frequency Magnetic Immunity	H _{PF}	1000	1500		A/m	50Hz/60Hz
Pulse Magnetic Field Immunity	H _{PM}	1800	2000		A/m	t _p = 8μs
Damped Oscillatory Magnetic Field	H _{OSC}	1800	2000		A/m	0.1Hz – 1MHz
Cross-axis Immunity Multiplier ⁽⁹⁾	K _X		2.5			

5 Volt Electrical Specifications (T _{min} to T _{max} unless otherwise stated)						
Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Input Quiescent Supply Current						
IL510, IL511, IL515	I _{DD1}		24	40	μA	
IL514			2	3	mA	
IL516			5	6	mA	
Output Quiescent Supply Current						
IL510	I _{DD2}		2	3	mA	
IL511, IL514, IL516			4	6	mA	
IL515			9	12	mA	
Logic Input Current	I _I	-10		10	μA	
Logic High Output Voltage	V _{OH}	$V_{DD} - 0.1$	V_{DD}		V	I _O = -20 μA, V _I = V _{IH}
		$0.8 \times V_{DD}$	$0.9 \times V_{DD}$			I _O = -4 mA, V _I = V _{IH}
Logic Low Output Voltage	V _{OL}		0	0.1	V	I _O = 20 μA, V _I = V _{IL}
			0.5	0.8		I _O = 4 mA, V _I = V _{IL}

Switching Specifications						
Maximum Data Rate		2			Mbps	C _L = 15 pF
Pulse Width ⁽⁷⁾	PW	20			ns	V _O 50% points; SYNC=0
		25			ns	V _O 50% points; SYNC=1
Propagation Delay Input to Output (High to Low)	t _{PHL}			25	ns	C _L = 15 pF
Propagation Delay Input to Output (Low to High)	t _{PLH}			25	ns	C _L = 15 pF
Propagation Delay Enable to Output (High to High Impedance)	t _{PHZ}			5	ns	C _L = 15 pF
Propagation Delay Enable to Output (Low to High Impedance)	t _{PLZ}			5	ns	C _L = 15 pF
Propagation Delay Enable to Output (High Impedance to High)	t _{PZH}			5	ns	C _L = 15 pF
Propagation Delay Enable to Output (High Impedance to Low)	t _{PZL}			5	ns	C _L = 15 pF
Pulse Width Distortion ⁽²⁾	PWD			10	ns	C _L = 15 pF
Propagation Delay Skew ⁽³⁾	t _{PSK}			10	ns	C _L = 15 pF
Output Rise Time (10%–90%)	t _R		1	3	ns	C _L = 15 pF
Output Fall Time (10%–90%)	t _F		1	3	ns	C _L = 15 pF
Common Mode Transient Immunity (Output Logic High or Logic Low) ⁽⁴⁾	CM _H , CM _L	30	50		kV/μs	V _{CM} = 1500 V _{DC} t _{TRANSIENT} = 25 ns
Channel-to-Channel Skew	t _{CSK}		3	5	ns	C _L = 15 pF
SYNC Internal Clock Off Time ⁽¹¹⁾	t _{OFF}			5	ns	
Dynamic Power Consumption ⁽⁶⁾			200	340	μA/MHz	per channel

Magnetic Field Immunity ⁽⁸⁾ (V _{DD2} = 5V, 3V < V _{DD1} < 5.5V)						
Power Frequency Magnetic Immunity	H _{PF}	2,800	3,500		A/m	50Hz/60Hz
Pulse Magnetic Field Immunity	H _{PM}	4,000	4,500		A/m	t _p = 8 μs
Damped Oscillatory Magnetic Field	H _{OSC}	4,000	4,500		A/m	0.1Hz – 1MHz
Cross-axis Immunity Multiplier ⁽⁹⁾	K _X		2.5			

Notes (apply to both 3.3 V and 5 V specifications):

1. Absolute maximum means the device will not be damaged if operated under these conditions. It does not guarantee performance.
2. PWD is defined as $|t_{pHL} - t_{pLH}|$. %PWD is equal to PWD divided by pulse width.
3. t_{psk} is the magnitude of the worst-case difference in t_{pHL} and/or t_{pLH} between devices at 25°C.
4. CM_H is the maximum common mode voltage slew rate that can be sustained while maintaining $V_o > 0.8 V_{DD2}$. CM_L is the maximum common mode input voltage that can be sustained while maintaining $V_o < 0.8 V$. The common mode voltage slew rates apply to both rising and falling common mode voltage edges.
5. Device is considered a two terminal device: pins on each side of the package are shorted.
6. Dynamic power consumption is calculated per channel and is supplied by the channel's input side power supply.
7. Minimum pulse width is the minimum value at which specified PWD is guaranteed.
8. The relevant test and measurement methods are given in the Electromagnetic Compatibility section on p. 9.
9. External magnetic field immunity is improved by this factor if the field direction is "end-to-end" rather than to "pin-to-pin" (see diagram on p. 9).
10. If internal clock is used, devices will respond to DC states on inputs within a maximum of 9 μ s. Outputs may oscillate if the SYNC input slew rate is less than 1 V/ms.
11. t_{off} is the maximum time for the internal refresh clock to shut down.

Application Information

Electrostatic Discharge Sensitivity

This product has been tested for electrostatic sensitivity to the limits stated in the specifications. However, NVE recommends that all integrated circuits be handled with appropriate care to avoid damage. Damage caused by inappropriate handling or storage could range from performance degradation to complete failure.

Electromagnetic Compatibility

IsoLoop Isolators have the lowest EMC footprint of any isolation technology. IsoLoop Isolators' Wheatstone bridge configuration and differential magnetic field signaling ensure excellent EMC performance against all relevant standards.

Additionally, on the IL510 and IL515, the internal clock can be disabled for even better EMC performance.

These isolators are fully compliant with generic EMC standards EN50081, EN50082-1 and the umbrella line-voltage standard for Information Technology Equipment (ITE) EN61000. NVE has completed compliance tests in the categories below:

EN50081-1

Residential, Commercial & Light Industrial
Methods EN55022, EN55014

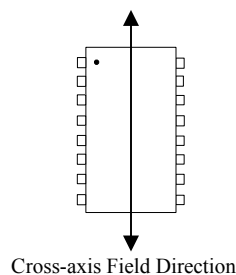
EN50082-2: Industrial Environment

Methods EN61000-4-2 (ESD), EN61000-4-3 (Electromagnetic Field Immunity), EN61000-4-4 (Electrical Transient Immunity), EN61000-4-6 (RFI Immunity), EN61000-4-8 (Power Frequency Magnetic Field Immunity), EN61000-4-9 (Pulsed Magnetic Field), EN61000-4-10 (Damped Oscillatory Magnetic Field)

ENV50204

Radiated Field from Digital Telephones (Immunity Test)

Immunity to external magnetic fields is even higher if the field direction is "end-to-end" rather than to "pin-to-pin" as shown in the diagram below:



Power Supply Decoupling

Both power supplies to these devices should be decoupled with low ESR ceramic capacitors of at least 47 nF. Capacitors must be located as close as possible to the V_{DD} pins.

Maintaining Creepage

Creepage distances are often critical in isolated circuits. In addition to meeting JEDEC standards, NVE isolator packages have unique creepage specifications. Standard pad libraries often extend under the package, compromising creepage and clearance. Similarly, ground planes, if used, should be spaced to avoid compromising clearance. Package drawings and recommended pad layouts are included in this datasheet.

Dynamic Power Consumption

IsoLoop Isolators achieve their low power consumption from the way they transmit data across the isolation barrier. A magnetic field is created around the GMR Wheatstone bridge by detecting the edge transitions of the input logic signal and converting them to narrow current pulses. Depending on the direction of the magnetic field, the bridge causes the output comparator to switch following the input logic signal. Since the current pulses are narrow, about 2.5 ns, the power consumption is independent of mark-to-space ratio and solely dependent on frequency. This has obvious advantages over optocouplers, which have power consumption heavily dependent on mark-to-space ratio.

DC Correctness, EMC, and the SYNC Function

NVE digital isolators have the lowest EMC noise signature of any high-speed digital isolator on the market today because of the dc nature of the GMR sensors used. It is perhaps fair to include optocouplers in that dc category too, but their limited parametric performance, physically large size, and wear-out problems effectively limit side by side comparisons between NVE's isolators and isolators coupled with RF, matched capacitors, or transformers.

IL500-Series isolators has an internal refresh clock which ensure the synchronization of input and output within 9 μ s of the supply passing the 1.5 V threshold. The IL510 and IL515 allow external control of the refresh clock through the SYNC pin thereby further lowering the EMC footprint. This can be advantageous in applications such as hi-fi, motor control and power conversion.

The isolators can be used with Power on Reset (POR) circuits common in microcontroller applications, as the means of ensuring the output of the device is in the same state as the input a short time after power up. Figure 1 shows a practical Power on Reset circuit:

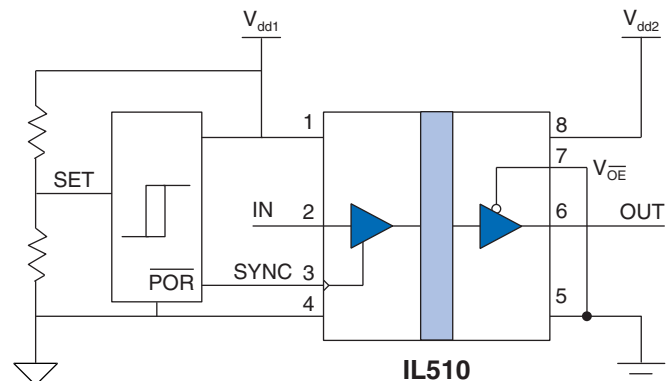
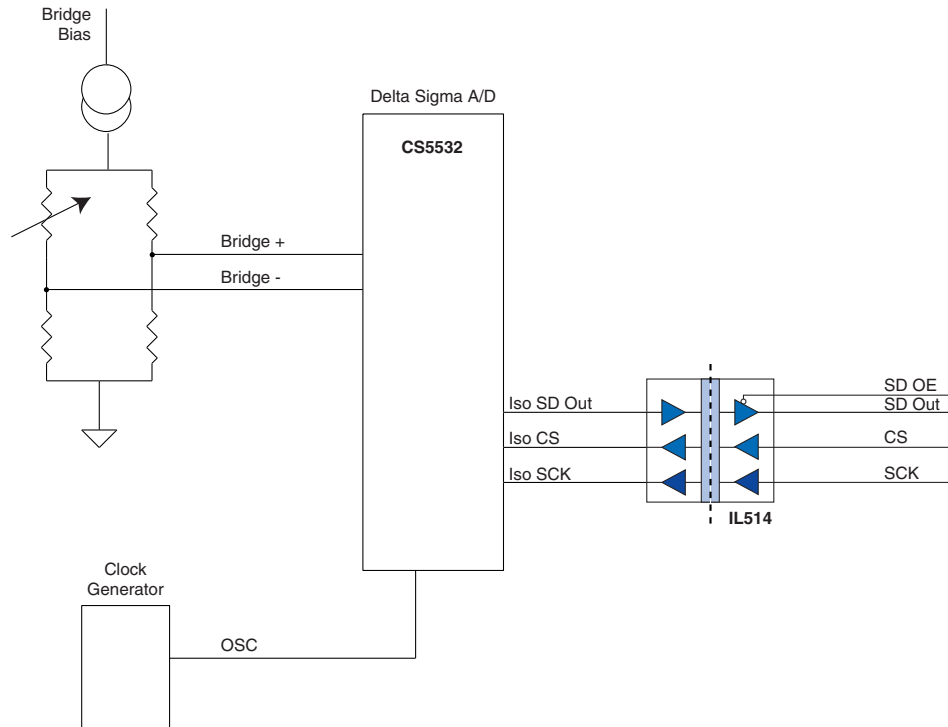


Fig. 1. Typical Power On Reset Circuit for IL510

After POR, the SYNC line goes high, the internal clock is disabled, and the EMC signature is optimized. Decoupling capacitors are omitted for clarity.

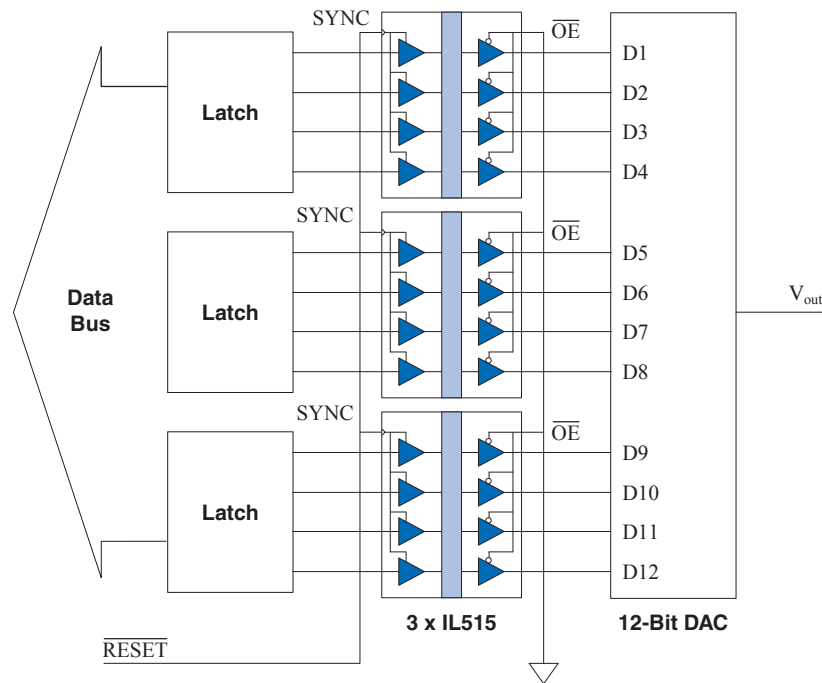
Illustrative Applications

Isolated A/D Converter



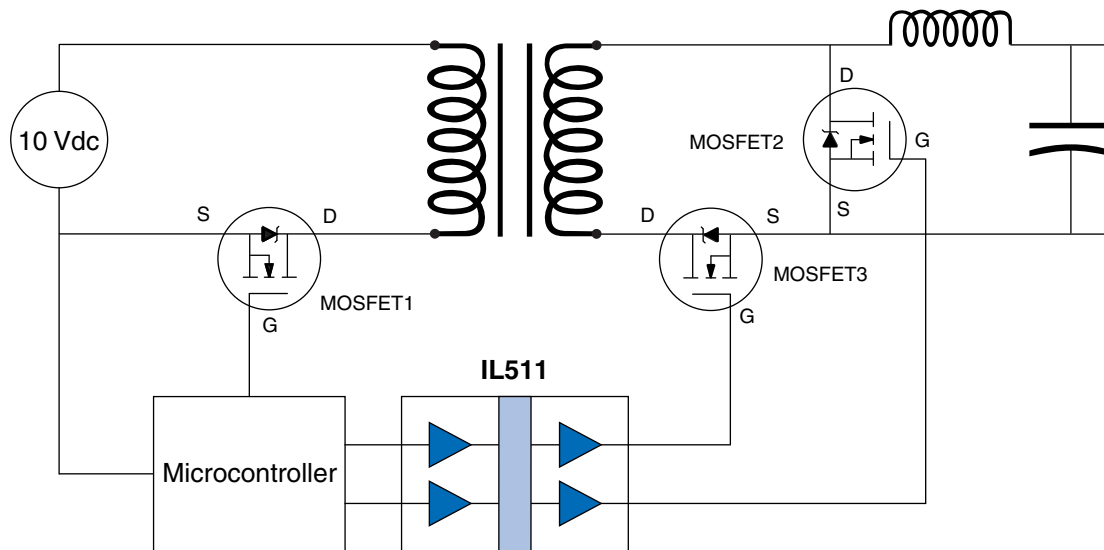
A delta-sigma A-D converter interfaced with the three-channel IL514. Multiple channels can easily be combined using the IL514's output enable function.

12-Bit D/A Converter Isolation



The IL515 four-channel isolator is ideally suited for parallel bus isolation. The circuit above uses three IL515s to isolate a 12-bit DAC. The unique SYNC function automatically synchronizes the outputs to the inputs, ensuring correct data on the isolator outputs. After the reset pulse goes high, data transfer from input to output is initiated by the leading edge of each changing data bit.

Intelligent DC-DC Converter With Synchronous Rectification

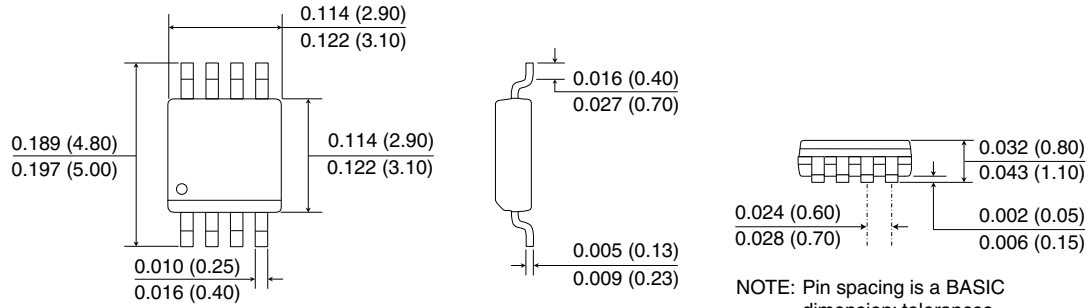


A typical primary-side controller uses the IL511 to drive the synchronous rectification signals from primary side to secondary side. IL511 pulse-width distortion of 10 ns minimizes MOSFET dead time and maximizes efficiency. The ultra-small MSOP package minimizes board area.

Package Drawings

8-pin MSOP (-1 suffix)

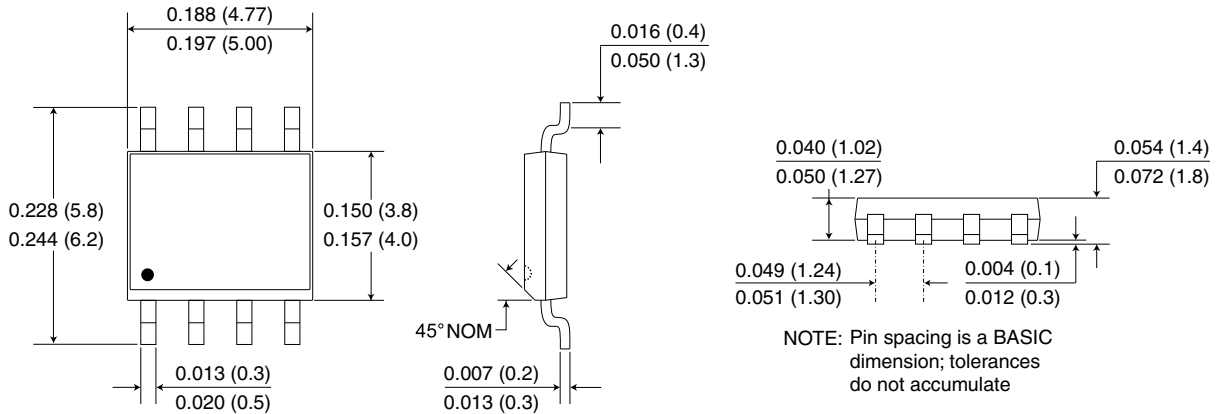
Dimensions in inches (mm); scale = approx. 5X



NOTE: Pin spacing is a BASIC dimension; tolerances do not accumulate

8-pin SOIC Package (-3 suffix)

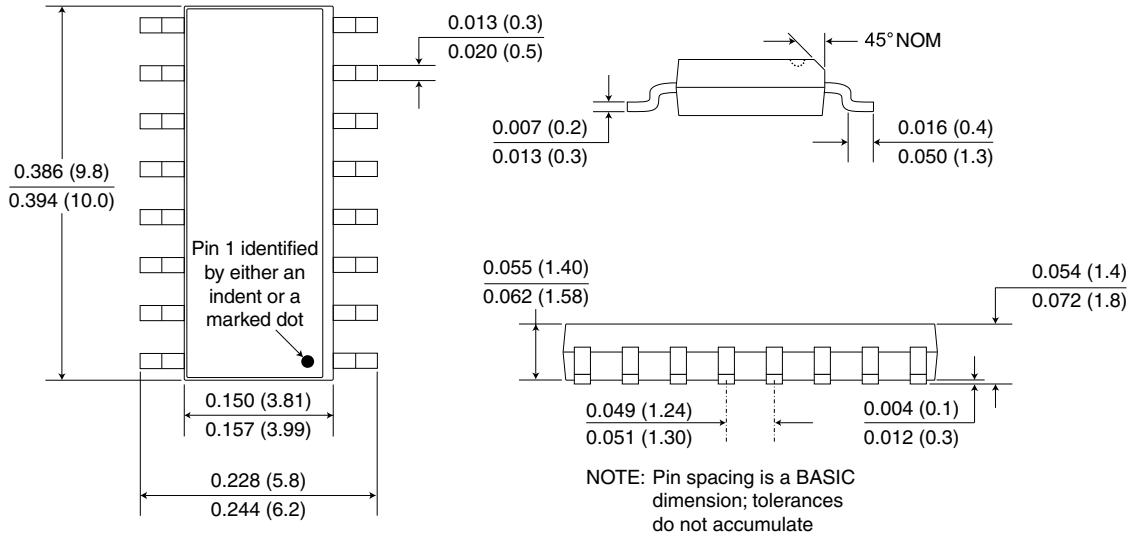
Dimensions in inches (mm); scale = approx. 5X



NOTE: Pin spacing is a BASIC dimension; tolerances do not accumulate

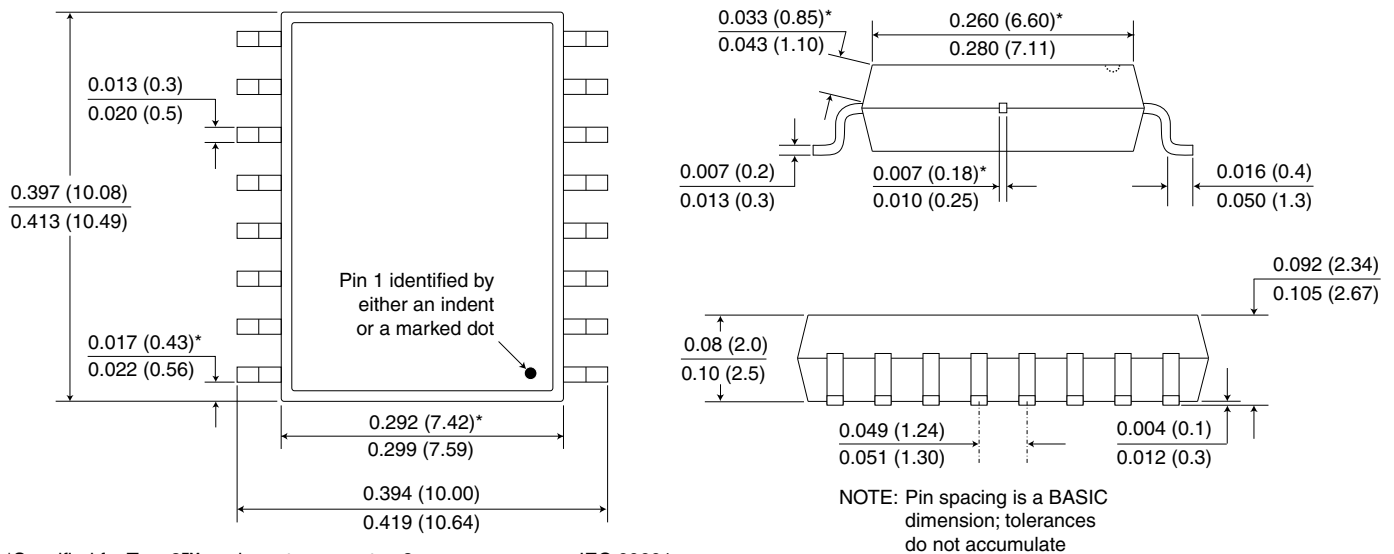
0.15" 16-pin SOIC Package (-3 suffix)

Dimensions in inches (mm); scale = approx. 5X



0.3" 16-pin SOIC Package (no suffix)

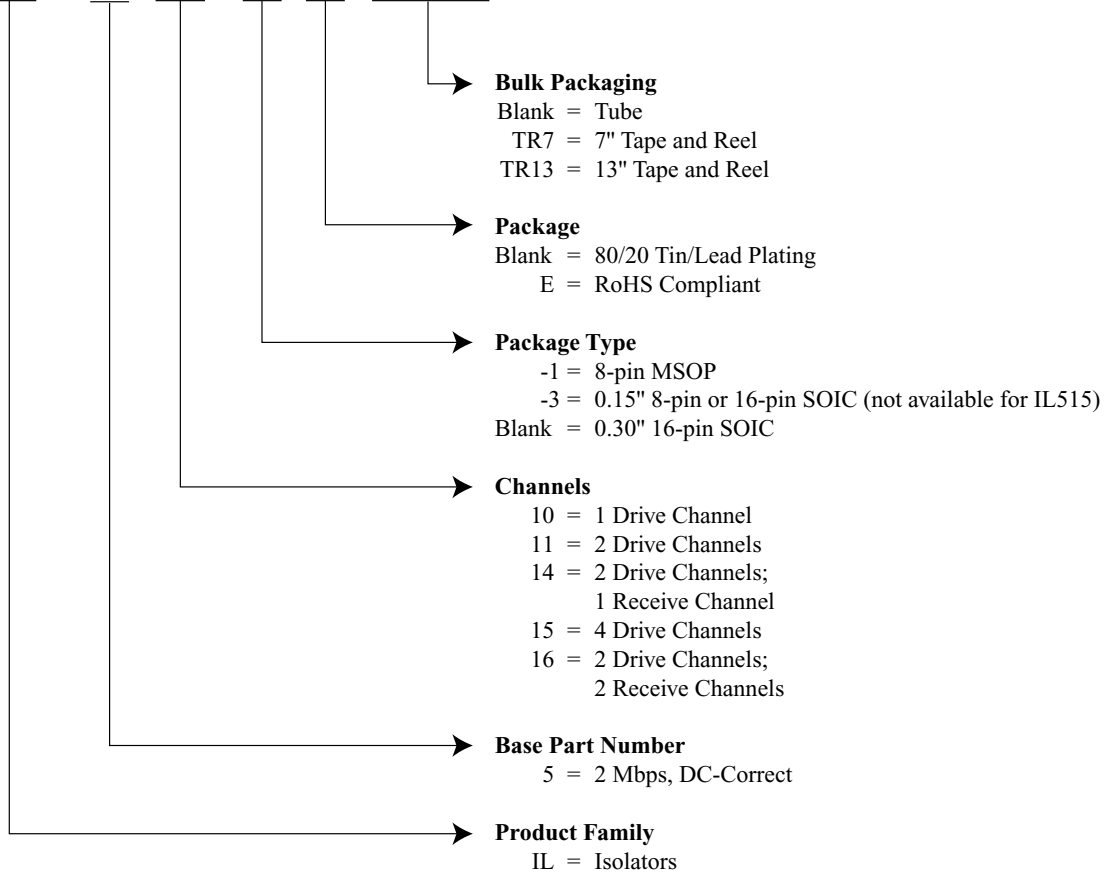
Dimensions in inches (mm); scale = approx. 5X



*Specified for True 8™ package to guarantee 8 mm creepage per IEC 60601.

Ordering Information

IL 5 16 - 3 E TR13



ISB-DS-001-IL500-K
June 2013

Changes:

- Increased transient immunity specifications based on additional data.
- Added VDE 0884 pending.
- Added high voltage endurance specification.
- Increased magnetic immunity specifications.
- Updated package drawings.

ISB-DS-001-IL500-J

Changes:

- Changed title to “DC-Correct Digital Isolator.”
- Detailed isolation and barrier specifications.
- Cosmetic changes.

ISB-DS-001-IL500-I

Changes:

- Update terms and conditions.

ISB-DS-001-IL500-H

Changes:

- Added clarification of internal ground connections (p. 4).

ISB-DS-001-IL500-G

Changes:

- Clarified SYNC function.

ISB-DS-001-IL500-F

Changes:

- Changed pin spacing specification on MSOP drawing.

ISB-DS-001-IL500-E

Changes:

- Added EMC details.

ISB-DS-001-IL500-D

Changes:

- Add Output Enable to IL515.
- IEC 61010-2001 Approval (removed “pending”).
- Added 12-bit DAC illustrative application.

ISB-DS-001-IL500-C

Production release

ISB-DS-001-IL500-B

Initial release

ISB-DS-001-IL500-A

Preliminary release

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ISB-DS-001-IL500-K

June 2013