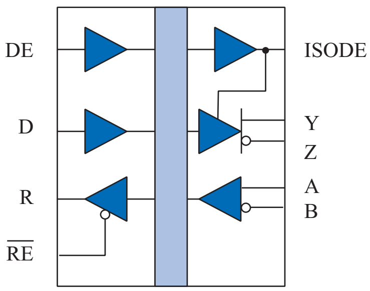
Isolated RS422/RS485 Interface

Functional Diagram



IL422

IL422 Receiver

$\overline{RE}$	R	$V_{(A-B)}$
H	Z	X
L	H	≥ 200 mV
L	L	≤–200 mV
L	I	Open

IL422 Driver

DE	D	$V_{(Y-Z)}$
L	X	Z
H	H	≥ 1.5 V
H	L	≤–1.5 V

H = High Level, L = Low Level
I = Indeterminate, X = Irrelevant, Z = High Impedance

Features

- 3.3 V Input Supply Compatible
- 25 ns Maximum Propagation Delay
- 25 Mbps Data Rate
- 1 ns Pulse Skew (typ.)
- ±60 mA Driver Output Capability
- Thermal Shutdown Protection
- Meets or Exceeds ANSI 422-B, EIA 485-A and ITU Recommended V11
- Low EMC Footprint
- –40 °C to +85 °C Operating Temperature
- PROFIBUS Compliant
- 2500 V_{rms} Isolation
- IEC 60747-17 (VDE 0884-17):2021-10 certified; UL 1577 recognized
- 16-pin Wide-Body SOIC Package

Applications

Multi-point or multi-drop transmission on long bus lines in noisy environments.

Description

The IL422 is a galvanically isolated, high-speed differential bus transceiver, designed for bidirectional data communication on balanced transmission lines. The devices use NVE's patented* spintronic Giant Magnetoresistance (GMR) technology. The IL422 was the first isolated RS-422 interface in a standard 16-pin SOIC package to meet the ANSI Standards EIA/TIA-422-B and RS-485.

The IL422 has current limiting and thermal shutdown features to protect against output short circuits and bus contention situations that could cause excessive power dissipation.

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

REV. S

Absolute Maximum Ratings[11]

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Storage Temperature	T_S	–65		150	°C	
Junction Temperature	T_J	–65		150	°C	
Voltage Range at A or B Bus Pins		–7		12	V	
Supply Voltage[1]	V_{DD1}, V_{DD2}	–0.5		7	V	
Digital Input Voltage		–0.5		5.5	V	
Digital Output Voltage		–0.5		V_{DD} + 1	V	
Continuous Total Power Dissipation				725 377	mW	25°C 85°C
Maximum Output Current	I_O			95	mA	
Lead Solder Temperature				260	°C	10 sec.
ESD			2		kV	HBM

Recommended Operating Conditions

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Supply Voltage	V_{DD1} V_{DD2}	3.0 4.5		5.5 5.5	V	
Input Voltage at any Bus Terminal (separately or common mode)	V_I V_{IC}			12 –7	V	
High-Level Digital Input Voltage	V_{IH}	2.4 3.0		V_{DD1}	V	V_{DD1} = 3.3 V V_{DD1} = 5.0 V
Low-Level Digital Input Voltage	V_{IL}	0		0.8	V	
Differential Input Voltage[2]	V_{ID}			±12	V	
High-Level Output Current (Driver)	I_{OH}			60	mA	
High-Level Digital Output Current (Receiver)	I_{OH}			8	mA	
Low-Level Output Current (Driver)	I_{OL}	–60			mA	
Low-Level Digital Output Current (Receiver)	I_{OL}	–8			mA	
Ambient Operating Temperature	T_A	–40		85	°C	
Junction Temperature	T_J	–40		100	°C	
Transient Immunity		20			kV/μs	
Digital Input Signal Rise and Fall Times	t_{IR},t_{IF}	DC Stable				

Safety and Approvals

IEC 60747-17 (VDE 0884-17):2021-10 (Basic Isolation; VDE File Number 5016933-4880-0001)

- Isolation voltage (V_{ISO}): 2500 V_{RMS}
- Transient overvoltage (V_{IOTM}): 4000 V_{PK}
- Surge rating: 4000 V
- Each part tested at 1590 V_{PK} for 1 second, 5 pC partial discharge limit.
- Samples tested at 4000 V_{PK} for 60 sec.; then 1358 V_{PK} for 10 sec. with 5 pC partial discharge limit.
- Working Voltage (V_{IORM}) 600 V_{RMS} (848 V_{PK}); basic insulation; pollution degree 2

Safety-Limiting Values	Symbol	Value	Units
Safety rating ambient temperature	T_S	180	°C
Safety rating power (180 °C)	P_S	270	mW
Supply current safety rating (total of supplies)	I_S	54	mA

UL 1577 (Component Recognition Program File Number E207481)

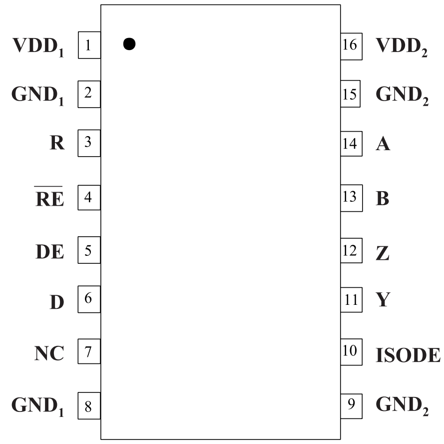
- 2500 V rating
- Each part tested at 3000 V_{RMS} (4243 V_{PK}) for 1 second
- Each lot sample tested at 2500 V_{RMS} (3536 V_{PK}) for 1 minute

Soldering Profile

Per JEDEC J-STD-020C, MSL-1

IL422 Pin Connections

1	V_{DD1}	Input Power Supply
2	GND_1	Input Power Supply Ground*
3	R	Output Data from Bus
4	$\overline{RE}$	Read Data Enable (if $\overline{RE}$ is high, R = high impedance)
5	DE	Drive Enable
6	D	Data Input to Bus
7	NC	No Internal Connection
8	GND_1	Input Power Supply Ground*
9	GND_2	Output Power Supply Ground*
10	ISODE	Isolated DE Output for use in Profibus applications where the state of the isolated drive enable node needs to be monitored
11	Y	Y Bus (Drive – True)
12	Z	Z Bus (Drive – Inverse)
13	B	B Bus (Receive – Inverse)
14	A	A Bus (Receive – True)
15	GND_2	Output Power Supply Ground*
16	V_{DD2}	Output Power Supply



IL422

***NOTE:** Pins 2 and 8 are internally connected, as are pins 9 and 15.

Driver Section

Electrical specifications are T_{min} to T_{max} and V_{DD} = 4.5 V to 5.5 V unless otherwise stated.

Parameters	Symbol	Min.	Typ.(5)	Max.	Units	Test Conditions
Input Clamp Voltage	V_{IK}			−1.5	V	I_L = −18 mA
Output voltage	V_O	0		6	V	I_O = 0
Differential Output Voltage(2)	$\lvert V_{OD1}\rvert$	1.5		6	V	I_O = 0
Differential Output Voltage(2)	$\lvert V_{OD2}\rvert$	1.5	2.5	5	V	R_L = 54 Ω, V_{DD} = 5 V
Differential Output Voltage(2)(6)	V_{OD3}	1.5		5	V	R_L = 54 Ω, V_{DD} = 4.5 V
Change in Magnitude of Differential Output Voltage(7)	$\Delta\lvert V_{OD}\rvert$			±0.2	V	R_L = 54 Ω or 100 Ω
Common Mode Output Voltage	V_{OC}			3 −1	V	R_L = 54 Ω or 100 Ω
Change in Magnitude of Common Mode Output Voltage(7)	$\Delta\lvert V_{OC}\rvert$			±0.2	V	R_L = 54 Ω or 100 Ω
Output Current(4) *Output Disabled*	I_O			1 −0.8	mA	V_O = 12 V V_O = −7 V
High Level Input Current	I_{IH}			10	μA	V_I = 3.5 V
Low Level Input Current	I_{IL}			−10	μA	V_I = 0.4 V
Short-circuit Output Current	I_{OS}			250 −150 −250	mA	V_O = −6 V V_O = 0 V V_O = 8 V
Supply Current V_{DD1} = +5 V V_{DD1} = +3.3 V	I_{DD1} I_{DD1}		4 3	6 3	mA	No Load (Outputs Enabled)
Switching Specifications						
Parameters	**Symbol**	**Min.**	**Typ.(5)**	**Max.**	**Units**	**Test Conditions**
Maximum Data Rate		25			Mbps	R_L = 54 Ω, C_L = 50 pF
Differential Output Prop Delay	t_D(OD)		16	25	ns	R_L = 54 Ω, C_L = 50 pF
Pulse Skew(10)	t_S(P)		1	6	ns	R_L = 54 Ω, C_L = 50 pF
Differential Output Rise & Fall Time	t_T(OD)		8	10	ns	R_L = 54 Ω, C_L = 50 pF
Output Enable Time to High Level	t_{PZH}		31	65	ns	R_L = 54 Ω, C_L = 50 pF
Output Enable Time to Low Level	t_{PZL}		22	35	ns	R_L = 54 Ω, C_L = 50 pF
Output Disable Time from High Level	t_{PHZ}		28	50	ns	R_L = 54 Ω, C_L = 50 pF
Output Disable Time from Low Level	t_{PLZ}		16	32	ns	R_L = 54 Ω, C_L = 50 pF
Skew Limit(3)	t_{SK}(LIM)		2	8	ns	R_L = 54 Ω, C_L = 50 pF

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Receiver Section

Electrical specifications are T_{min} to T_{max} and V_{DD} = 4.5 V to 5.5 V unless otherwise stated.

Parameters	Symbol	Min.	Typ.[5]	Max.	Units	Test Conditions
Positive-going Input Threshold Voltage	V_{IT+}			0.2	V	V_O = 2.7 V, I_O = −0.4 mA
Negative-going Input Threshold Voltage	V_{IT-}	−0.2			V	V_O = 0.5 V, I_O = 8 mA
Hysteresis Voltage ($V_{IT+} - V_{IT-}$)	V_{HYS}		60		mV	
High Level Digital Output Voltage	V_{OH}	V_{DD} − 0.2			V	V_{ID} = 200 mV I_{OH} = −20 µA
Low Level Digital Output Voltage	V_{OL}			0.2	V	V_{ID} = −200 mV I_{OH} = 20 µA
High-impedance-state output current	I_{OZ}			±10	µA	V_O = 0.4 to (V_{DD2}−0.5) V
Line Input Current[8]	I_I			1 −0.8	mA	V_I = 12 V V_I = −7 V Other Input[11] = 0 V
Input Resistance	r_I	12	20		kΩ	
Supply Current	I_{DD2}		27	34	mA	No load Outputs Enabled
Switching Characteristics at 5 V						
Parameters	**Symbol**	**Min.**	**Typ.[5]**	**Max.**	**Units**	**Test Conditions**
Maximum Data Rate		25			Mbps	R_L = 54 Ω, C_L = 50 pF
Propagation Delay[9]	t_{PD}		24	32	ns	V_O = −1.5 V to 1.5 V, C_L = 15 pF
Pulse Skew[10]	$t_{SK}(P)$		1	6	ns	V_O = −1.5 V to 1.5 V, C_L = 15 pF
Skew Limit[3]	$t_{SK}(LIM)$		2	8	ns	R_L = 54 Ω, C_L = 50 pF
Output Enable Time To High Level	t_{PZH}		17	24	ns	C_L = 15 pF
Output Enable Time To Low Level	t_{PZL}		30	45	ns	C_L = 15 pF
Output Disable Time From High Level	t_{PHZ}		30	45	ns	C_L = 15 pF
Output Disable Time From Low Level	t_{PLZ}		18	27	ns	C_L = 15 pF
Switching Characteristics at 3.3 V						
Parameters	**Symbol**	**Min.**	**Typ.[5]**	**Max.**	**Units**	**Test Conditions**
Maximum Data Rate		25			Mbps	R_L = 54 Ω, C_L = 50 pF
Propagation Delay[9]	t_{PD}		27	32	ns	V_O = −1.5 V to 1.5 V, C_L = 15 pF
Pulse Skew[10]	$t_{SK}(P)$		2	6	ns	V_O = −1.5 V to 1.5 V, C_L = 15 pF
Skew Limit[3]	$t_{SK}(LIM)$		4	8	ns	R_L = 54 Ω, C_L = 50 pF
Output Enable Time To High Level	t_{PZH}		20	24	ns	C_L = 15 pF
Output Enable Time To Low Level	t_{PZL}		33	45	ns	C_L = 15 pF
Output Disable Time From High Level	t_{PHZ}		33	45	ns	C_L = 15 pF
Output Disable Time From Low Level	t_{PLZ}		20	27	ns	C_L = 15 pF

Magnetic Field Immunity[11]

Magnetic Field Immunity at 5 V						
Power Frequency Magnetic Immunity	H_{PF}		3500		A/m	50Hz/60Hz
Pulse Magnetic Field Immunity	H_{PM}		4500		A/m	t_p = 8µs
Damped Oscillatory Magnetic Field	H_{OSC}		4500		A/m	0.1Hz – 1MHz
Cross-axis Immunity Multiplier[12]	K_X		2.5			
Magnetic Field Immunity at 3.3 V						
Power Frequency Magnetic Immunity	H_{PF}		1500		A/m	50Hz/60Hz
Pulse Magnetic Field Immunity	H_{PM}		2000		A/m	t_p = 8µs
Damped Oscillatory Magnetic Field	H_{OSC}		2000		A/m	0.1Hz – 1MHz
Cross-axis Immunity Multiplier[12]	K_X		2.5			

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Insulation Specifications

Parameters	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Creepage Distance		8.08				mm
Barrier Impedance			$>10^{14} \| 7$			Ω ǁ pF
Leakage Current			0.2		μA	240 V_{RMS}, 60 Hz

Thermal Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Junction–Ambient Thermal Resistance	θ_{JA}		67		°C/W	Double-sided PCB in free air
Junction–Case (Top) Thermal Resistance	θ_{JC}		12			
Junction–Ambient Thermal Resistance	θ_{JA}		46			2s2p PCB in free air per JESD51
Junction–Case (Top) Thermal Resistance	θ_{JC}		9			
Power Dissipation	P_D			1500	mW	

Notes:

1. All voltage values are with respect to network ground except differential I/O bus voltages.
2. Differential input/output voltage is measured at the noninverting terminal A with respect to the inverting terminal B.
3. Skew limit is the maximum propagation delay difference between any two devices at 25°C.
4. The power-off measurement in ANSI Standard EIA/TIA-422-B applies to disabled outputs only and is not applied to combined inputs and outputs.
5. All typical values are at V_{DD1}= 3.3 V or 5 V and V_{DD2} = 5 V, and T_A = 25°C.
6. The minimum V_{OD2} with a 100 Ω load is either ½ V_{OD1} or 2 V, whichever is greater.
7. $\Delta|V_{OD}|$ and $\Delta|V_{OC}|$ are the changes in magnitude of V_{OD} and V_{OC}, respectively, that occur when the input is changed form one logic state to the other.
8. This applies for both power on and power off, refer to ANSI standard RS-485 for exact condition. The EIA/TIA-422-B limit does not apply for a combined driver and receiver terminal.
9. Includes 8 ns read enable time. Maximum propagation delay is 25 ns after read assertion.
10. Pulse skew is defined as $|t_{PLH} - t_{PHL}|$ of each channel.
11. The relevant test and measurement methods are given in the Electromagnetic Compatibility section.
12. External magnetic field immunity is improved by this factor if the field direction is “end-to-end” rather than to “pin-to-pin.”

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Application Information

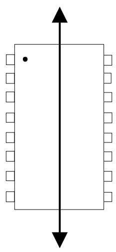
Electrostatic Discharge Sensitivity

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

The IL422 is fully compliant with IEC 61000-6-1 and IEC 61000-6-2 standards for immunity, and IEC 61000-6-3, IEC 61000-6-4, CISPR, and FCC Class A standards for emissions.

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:



Cross-axis Field Direction

Dynamic Power Consumption

IsoLoop Isolators achieve their low power consumption from the way they transmit data across the isolation barrier. By detecting the edge transitions of the input logic signal and converting these to narrow current pulses, a magnetic field is created around the GMR Wheatstone bridge. 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 frequency and time.

The approximate power supply current per channel is:

$$I_{IN} = 40 \text{ x } \frac{f}{f_{MAX}} \text{ x } \frac{1}{4} \text{ mA}$$

Where f = operating frequency

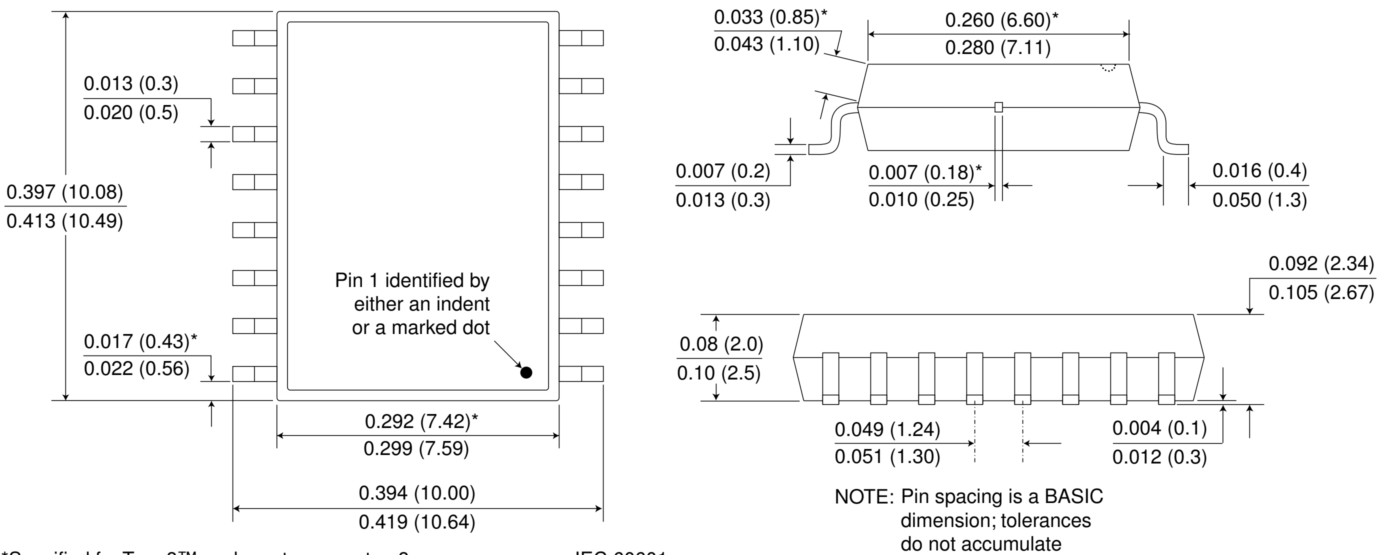
f_{MAX} = 50 MHz

Power Supply Decoupling

V_{DD1} and V_{DD2} should be bypassed with 0.1 μF typical (0.047 μF minimum) capacitors as close as possible to the V_{DD} pins.

0.3" 16-pin SOIC Package

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



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

Ordering Information and Valid Part Numbers

IL 422 E TR13

Bulk Packaging
Blank = Tube
TR = 13" Tape and Reel

Package
Blank = 80/20 Tin/Lead Plating
E = RoHS Compliant

Base Part Number
422 = RS-422 Transceiver

Product Family
IL = Isolators

Valid Part Numbers
IL422
IL422E

All IL422 part types are available on tape and reel.

RoHS COMPLIANT

ISB-DS-001-IL422-S **October 2022**	**Changes** • Upgrade to VDE 0884-17 (p. 3). • Updated EMC standards. • Deleted minimum magnetic field immunity specifications (p. 6) since it is not 100% tested. • Added thermal characteristics (p. 7).
ISB-DS-001-IL422-R	**Change** • Updated MSL, agency approvals, magnetic immunity, and other specifications.
ISB-DS-001-IL422-Q	**Change** • Update terms and conditions.
ISB-DS-001-IL422-P	**Change** • Added clarification of internal ground connections.
ISB-DS-001-IL422-O	**Change** • Added low EMC footprint.
ISB-DS-001-IL422-N	**Changes** • Added magnetic field immunity and electromagnetic compatibility specifications. • Added note on package drawing that pin-spacing tolerances are non-accumulating.
ISB-DS-001-IL422-M	**Change** • Changed ordering information to reflect that devices are now fully RoHS compliant with no exemptions.
ISB-DS-001-IL422-L	**Change** • Reorganized supply current specifications; misc. minor changes
ISB-DS-001-IL422-K	**Change** • Eliminated soldering profile chart
ISB-DS-001-IL422-J	**Change** • Updated open input state in truth table
ISB-DS-001-IL422-I	**Change** • Updated package drawing; misc.
ISB-DS-001-IL422-H	**Change** • Updated UL and IEC approvals
ISB-DS-001-IL422-G	**Changes** • Revision letter added. • Ordering Information Removed. • IEC 61010-1 Classification: “Reinforced Insulation” added. • Notes added. • IR Soldering Profile added • Ordering Information added.

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