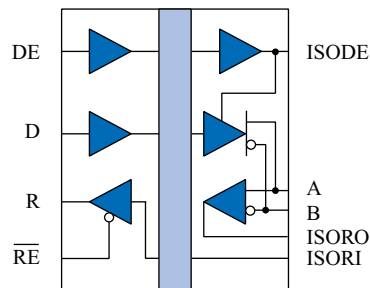
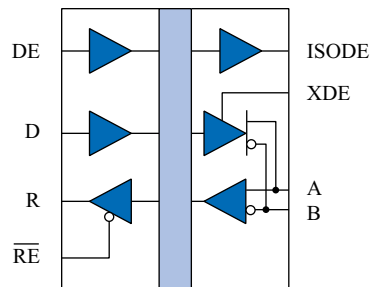


## PROFIBUS-Compatible Isolated RS-485 Transceivers

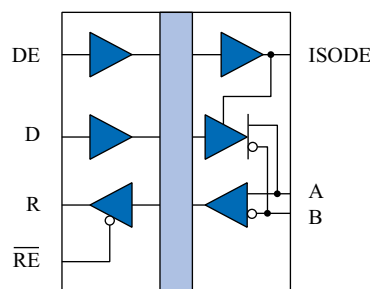
### Functional Diagrams



**IL3685-1**  
(QSOP)



**IL3685-3**  
(narrow-body)

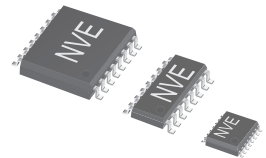


**IL3685**  
(wide-body)

V <sub>id</sub> (A-B)	DE	$\overline{\text{RE}}$	R	D	Mode
≥ 200 mV	L	L	H	X	Receive
≤ -200 mV	L	L	L	X	Receive
≥ 1.5 V	H	L	H	H	Drive
≤ -1.5 V	H	L	L	L	Drive
X	X	H	Z	X	Hi-Z R
Open	L	L	H	X	Receive

### Features

- 40 Mbps data rate
- 3 V to 5 V power supplies
- 20 ns propagation delay
- 5 ns pulse skew
- 50 kV/μs typ.; 30 kV/μs min. common mode transient immunity
- 44000 year barrier life
- 15 kV bus ESD protection
- Low EMC footprint
- Thermal shutdown protection
- -40°C to +85°C temperature range
- Meets or exceeds ANSI RS-485 and ISO 8482:1987(E)
- PROFIBUS compliant
- 6 kV<sub>RMS</sub> Reinforced Isolation/ 12.8 kV surge/ 1 kV<sub>RMS</sub> WV (V-Series)
- VDE V 0884-10 certified; UL 1577 recognized
- QSOP, 0.15", or 0.3" 16-pin packages



### Applications

- PROFIBUS, PROFIBUS DP, and FMS networks
- Factory automation
- Industrial control networks
- Building environmental controls
- Equipment covered under IEC 61010-1 Edition 3

### Description

IL3685-Series galvanically isolated, high-speed differential bus transceivers are designed for bidirectional data communication on balanced transmission lines. The devices use NVE's patented\* IsoLoop spintronic Giant Magnetoresistance (GMR) technology.

The wide-body version provides true 8 mm creepage. Narrow-body and QSOP packages offer unprecedented miniaturization.

IL3685-Series transceivers are fully PROFIBUS compliant, including the rigorous PROFIBUS differential output voltage specifications.

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

The device is compatible with 3 V as well as 5 V input supplies, allowing interface to standard microcontrollers without additional level shifting.

Current limiting and thermal shutdown features protect against output short circuits and bus contention that may cause excessive power dissipation. Receiver inputs feature a "fail-safe if open" design, ensuring a logic high R-output if A/B are floating.



IsoLoop® is a registered trademark of NVE Corporation.

\*U.S. Patent number 5,831,426; 6,300,617 and others.

## Absolute Maximum Ratings<sup>(11)</sup>

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Storage Temperature	$T_S$	-55		150	°C	
Junction Temperature	$T_J$	-55		150	°C	
Ambient Operating Temperature	$T_A$	-40		85	°C	
Voltage Range at A or B Bus Pins		-7		12	V	
Supply Voltage <sup>(1)</sup>	$V_{DD1}, V_{DD2}$	-0.5		7	V	
Digital Input Voltage		-0.5		$V_{DD} + 0.5$	V	
Digital Output Voltage		-0.5		$V_{DD} + 1$	V	
ESD (all bus nodes)		15			kV	HBM

## Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Supply Voltage	$V_{DD1}$ $V_{DD2}$	3.0 4.5		5.5 5.5	V	
Junction Temperature	$T_J$	-40		110	°C	
High-Level Digital Input Voltage	$V_{IH}$	2.4 3.0		$V_{DD1}$	V	$V_{DD1} = 3.3\text{ V}$ $V_{DD1} = 5.0\text{ V}$
Low-Level Digital Input Voltage	$V_{IL}$	0		0.8	V	
Differential Input Voltage <sup>(2)</sup>	$V_{ID}$			+12 / -7	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	Data Rate = 40 Mbps; $R_L = 54\ \Omega$
Digital Input Signal Rise and Fall Times	$t_{IR}, t_{IF}$					DC Stable

## Insulation Specifications

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Creepage Distance (external)	IL3685-1E IL3685-3E IL3685E	3.2 4.0 8.03	8.3		mm	Per IEC 60601
Total Barrier Thickness (internal)		0.013	0.016		mm	
Barrier Resistance	$R_{IO}$		$>10^{14}$		$\Omega$	500 V
Barrier Capacitance	$C_{IO}$		7		pF	f = 1 MHz
Leakage Current			0.2		$\mu\text{A}_{RMS}$	240 $V_{RMS}$ , 60 Hz
Comparative Tracking Index	CTI	$\geq 600$			$V_{RMS}$	Per IEC 60112
High Voltage Endurance (Maximum Barrier Voltage for Indefinite Life)	AC DC	$V_{IO}$	1000 1500		$V_{RMS}$ $V_{DC}$	At maximum operating temperature
Surge Immunity ("V" Version)	$V_{IOSM}$	12.8			$\text{kV}_{PK}$	Per IEC 61000-4-5
Barrier Life			44000		Years	100°C, 1000 $V_{RMS}$ , 60% CL activation energy

## Thermal Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Junction-Ambient Thermal Resistance	$\theta_{JA}$		77 60 43		°C/W	Soldered to double-sided board; free air
Junction-Case (Top) Thermal Resistance	$\theta_{JT}$		41 30 20		°C/W	
Power Dissipation	$P_D$			675 700 800	mW	

## Safety and Approvals

### VDE V 0884-10 (VDE V 0884-11 pending)

V-Series (Reinforced Isolation; VDE File Number 5016933-4880-0002)

- Working Voltage ( $V_{IORM}$ ) 1000  $V_{RMS}$  (1415  $V_{PK}$ ); reinforced insulation; pollution degree 2
- Isolation voltage ( $V_{ISO}$ ) 6000  $V_{RMS}$
- Surge immunity ( $V_{IOSM}$ ) 12.8 k $V_{PK}$
- Surge rating 8 kV
- Transient overvoltage ( $V_{IOTM}$ ) 6000  $V_{PK}$
- Each part tested at 2387  $V_{PK}$  for 1 second, 5 pC partial discharge limit
- Samples tested at 6000  $V_{PK}$  for 60 sec.; then 2122  $V_{PK}$  for 10 sec. with 5 pC partial discharge limit

Standard versions (Basic Isolation; VDE File Number 5016933-4880-0001)

- Working Voltage ( $V_{IORM}$ ) 600  $V_{RMS}$  (848  $V_{PK}$ ); basic insulation; pollution degree 2
- 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

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

### IEC 61010-1 (Edition 2; TUV Certificate Numbers N1502812; N1502812-101)

Reinforced Insulation; Pollution Degree II; Material Group III

Part No. Suffix	Package	Working Voltage
-1	QSOP	150 $V_{RMS}$
-3	SOIC	150 $V_{RMS}$
None	True 8™ Wide-body SOIC	300 $V_{RMS}$

### UL 1577 (Component Recognition Program File Number E207481)

V-Series isolation grade

6 kV rating; tested at 7.2 k $V_{RMS}$  (10.2 k $V_{PK}$ ) for 1 second; each lot sample tested at 6 k $V_{RMS}$  (8485  $V_{PK}$ ) for 1 minute

Standard isolation grade

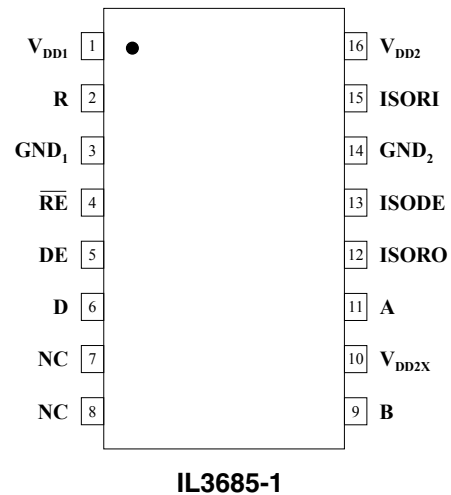
Each part tested at 3000  $V_{RMS}$  (4243  $V_{PK}$ ) for 1 second; each lot sample tested at 2500  $V_{RMS}$  (3536  $V_{PK}$ ) for 1 minute

## Soldering Profile

Per JEDEC J-STD-020C, MSL 1

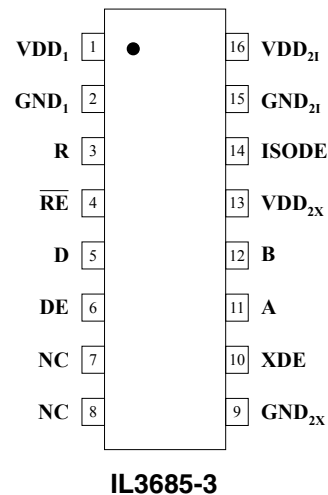
### IL3685-1 (QSOP Package) Pin Connections

1	V <sub>DD1</sub>	Input power supply.
2	R	Output data from bus.
3	GND <sub>1</sub>	Input power supply ground return.
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, 8	NC	No internal connection.
9	B	Inverting bus line.
10	V <sub>DD2X</sub>	Output transceiver power supply (normally connected to pin 16).
11	A	Non-inverting bus line.
12	ISORO	Isolated R output (should be externally connected to pin 15; no other connection should be made).
13	ISODE	Isolated DE output.
14	GND <sub>2</sub>	Output power supply ground return.
15	ISORI	Isolated R input (should be connected to pin 12; no other connection should be made).
16	V <sub>DD2I</sub>	Output isolation power supply (normally connected to pin 10).



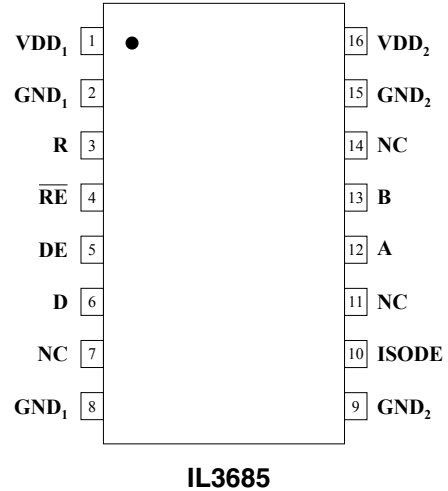
### IL3685-3 (0.15" Narrow-Body SOIC) Pin Connections

1	V <sub>DD1</sub>	Input power supply.
2	GND <sub>1</sub>	Input power supply ground return.
3	R	Output data from bus.
4	$\overline{RE}$	Read data enable (if $\overline{RE}$ is high, R= high impedance).
5	D	Data input to bus.
6	DE	Drive enable.
7, 8	NC	No internal connection.
9	GND <sub>2X</sub>	Output transceiver ground return. (normally connected to pin 15).
10	XDE	Transceiver Device Enable input enables the transceiver from the bus side, or is connected to ISODE to enable the transceiver from the controller-side DE input (this input should not be left unterminated).
11	A	Non-inverting bus line.
12	B	Inverting bus line.
13	V <sub>DD2X</sub>	Output transceiver power supply (normally connected to pin 16).
14	ISODE	Isolated DE output (normally connected to pin 10).
15	GND <sub>2I</sub>	Output isolation power supply ground return. (normally connected to pin 9).
16	V <sub>DD2I</sub>	Output isolation power supply (normally connected to pin 13).



**IL3685 (0.3" SOIC Wide-Body SOIC) Pin Connections**

1	V <sub>DD1</sub>	Input power supply.
2	GND <sub>1</sub>	Input power supply ground return (pin 2 is internally connected to pin 8).
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 <sub>1</sub>	Input power supply ground return (pin 8 is internally connected to pin 2).
9	GND <sub>2</sub>	Output power supply ground return (pin 9 is internally connected to pin 15).
10	ISODE	Isolated DE output for use in PROFIBUS applications where the state of the isolated drive enable node needs to be monitored.
11	NC	No internal connection.
12	A	Non-inverting bus line.
13	B	Inverting bus line.
14	NC	No internal connection.
15	GND <sub>2</sub>	Output power supply ground return (pin 15 is internally connected to pin 9).
16	V <sub>DD2</sub>	Output power supply.



## Driver Section

Electrical Specifications ( $T_{\min}$ to $T_{\max}$ and $V_{DD} = 4.5$ V to $5.5$ V unless otherwise stated)						
Parameter	Symbol	Min.	Typ. <sup>(5)</sup>	Max.	Units	Test Conditions
Output voltage	$V_O$			$V_{DD}$	V	$I_O = 0$
Differential Output Voltage <sup>(2)</sup>	$ V_{OD1} $			$V_{DD}$	V	$I_O = 0$
Differential Output Voltage <sup>(2)</sup>	$ V_{OD2} $	2.1	3	3.5	V	$R_L = 54 \Omega$
Differential Output Voltage <sup>(2)(6)</sup>	$V_{OD3}$	1.9		3.5	V	$R_L = 60 \Omega$
Change in Magnitude of Differential Output Voltage <sup>(7)</sup>	$\Delta V_{OD} $			$\pm 0.2$	V	$R_L = 54 \Omega$ or $100 \Omega$
Common Mode Output Voltage	$V_{OC}$			3	V	$R_L = 54 \Omega$ or $100 \Omega$
Change in Magnitude of Common Mode Output Voltage <sup>(7)</sup>	$\Delta V_{OC} $			$\pm 0.2$	V	$R_L = 54 \Omega$ or $100 \Omega$
High Level Input Current	$I_{IH}$			10	$\mu A$	$V_I = 3.5$ V
Low Level Input Current	$I_{IL}$			-10	$\mu A$	$V_I = 0.4$ V
Absolute  Short-circuit Output Current	$I_{OS}$			250	mA	$-7$ V < $V_O$ < $12$ V
Supply Current	$V_{DD1} = 5$ V $V_{DD1} = 3.3$ V			4 3	6 4	mA No load (Outputs Enabled)

### Notes (apply to both driver and receiver sections):

- All voltages are with respect to network ground except differential I/O bus voltages.
- Differential input/output voltage is measured at the noninverting terminal A with respect to the inverting terminal B.
- Skew limit is the maximum propagation delay difference between any two devices at  $25^\circ C$ .
- All typical values are at  $V_{DD1}, V_{DD2} = 5$  V or  $V_{DD1} = 3.3$  V and  $T_A = 25^\circ C$ .
- $-7$  V <  $V_{CM} < 12$  V;  $4.5$  V <  $V_{DD} < 5.5$  V.
- $\Delta|V_{OD}|$  and  $\Delta|V_{OC}|$  are the changes in magnitude of  $V_{OD}$  and  $V_{OC}$ , respectively, that occur when the input is changed from one logic state to the other.
- 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.
- Includes 10 ns read enable time. Maximum propagation delay is 25 ns after read assertion.
- Pulse skew is defined as  $|t_{PLH} - t_{PHL}|$  of each channel.
- Absolute Maximum specifications mean the device will not be damaged if operated under these conditions. It does not guarantee performance.
- The relevant test and measurement methods are given in the Electromagnetic Compatibility section on p. 6.
- 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. 6).

## Receiver Section

Electrical Specifications ( $T_{min}$ to $T_{max}$ and $V_{DD} = 4.5\text{ V}$ to $5.5\text{ V}$ unless otherwise stated)						
Parameter	Symbol	Min.	Typ. <sup>(5)</sup>	Max.	Units	Test Conditions
Positive-going Input Threshold Voltage	$V_{IT+}$			0.2	V	$-7\text{ V} < V_{CM} < 12\text{ V}$
Negative-going Input Threshold Voltage	$V_{IT-}$	-0.2			V	$-7\text{ V} < V_{CM} < 12\text{ V}$
Hysteresis Voltage ( $V_{IT+} - V_{IT-}$ )	$V_{HYS}$		28		mV	$V_{CM} = 0\text{ V}$ , $T = 25^\circ\text{C}$
Differential Bus Input Capacitance	$C_D$		9	12	pF	
High Level Digital Output Voltage	$V_{OH}$	$V_{DD} - 0.2$	$V_{DD}$		V	$V_{ID} = 200\text{ mV}$ $I_{OH} = -20\text{ }\mu\text{A}$
Low Level Digital Output Voltage	$V_{OL}$			0.2	V	$V_{ID} = -200\text{ mV}$ $I_{OH} = 20\text{ }\mu\text{A}$
High-impedance-state output current	$I_{OZ}$			$\pm 1$	$\mu\text{A}$	$V_O = 0.4$ to $(V_{DD2} - 0.5)\text{ V}$
Line Input Current <sup>(8)</sup>	$I_I$			220	$\mu\text{A}$	$V_I = 12\text{ V}$
				-160	$\mu\text{A}$	$V_I = -7\text{ V}$
Input Resistance	$R_I$	54			k $\Omega$	
Supply Current	$I_{DD2}$		5	16	mA	No load; Outputs Enabled; $V_{DD2X}$ connected to $V_{DD21}$ if applicable

## Switching Characteristics

$V_{DD1} = 5\text{ V}$ , $V_{DD2} = 5\text{ V}$						
Parameter	Symbol	Min.	Typ. <sup>(5)</sup>	Max.	Units	Test Conditions
Data Rate		40			Mbps	$R_I = 54\text{ }\Omega$ , $C_L = 50\text{ pF}$
Propagation Delay <sup>(2, 9)</sup>	$t_{PD}$		20	30	ns	$V_O = -1.5$ to $1.5\text{ V}$ , $C_L = 15\text{ pF}$
Pulse Skew <sup>(2, 10)</sup>	$t_{SK(P)}$		1	5	ns	$V_O = -1.5$ to $1.5\text{ V}$ , $C_L = 15\text{ pF}$
Skew Limit <sup>(3)</sup>	$t_{SK(LIM)}$		2	10	ns	$R_I = 54\text{ }\Omega$ , $C_L = 50\text{ pF}$
Output Enable Time To High Level	$t_{PZH}$		15	30	ns	$C_L = 15\text{ pF}$
Output Enable Time To Low Level	$t_{PZL}$		15	30	ns	$C_L = 15\text{ pF}$
Output Disable Time From High Level	$t_{PHZ}$		15	30	ns	$C_L = 15\text{ pF}$
Output Disable Time From Low Level	$t_{PLZ}$		15	30	ns	$C_L = 15\text{ pF}$
Common Mode Transient Immunity (Output Logic High to Logic Low)	$ CM_{H }, CM_L $	30	50		kV/ $\mu\text{s}$	$V_{CM} = 1500\text{ V}_{DC}$ $t_{TRANSIENT} = 25\text{ ns}$
$V_{DD1} = 3.3\text{ V}$ , $V_{DD2} = 5\text{ V}$						
Parameter	Symbol	Min.	Typ. <sup>(5)</sup>	Max.	Units	Test Conditions
Data Rate		40			Mbps	$R_I = 54\text{ }\Omega$ , $C_L = 50\text{ pF}$
Propagation Delay <sup>(2, 9)</sup>	$t_{PD}$		25	35	ns	$V_O = -1.5$ to $1.5\text{ V}$ , $C_L = 15\text{ pF}$
Pulse Skew <sup>(2, 10)</sup>	$t_{SK(P)}$		2	5	ns	$V_O = -1.5$ to $1.5\text{ V}$ , $C_L = 15\text{ pF}$
Skew Limit <sup>(3)</sup>	$t_{SK(LIM)}$		4	10	ns	$R_I = 54\text{ }\Omega$ , $C_L = 50\text{ pF}$
Output Enable Time To High Level	$t_{PZH}$		17	30	ns	$C_L = 15\text{ pF}$
Output Enable Time To Low Level	$t_{PZL}$		17	30	ns	$C_L = 15\text{ pF}$
Output Disable Time From High Level	$t_{PHZ}$		17	30	ns	$C_L = 15\text{ pF}$
Output Disable Time From Low Level	$t_{PLZ}$		17	30	ns	$C_L = 15\text{ pF}$
Common Mode Transient Immunity (Output Logic High to Logic Low)	$ CM_{H }, CM_L $	30	50		kV/ $\mu\text{s}$	$V_{CM} = 1500\text{ V}_{DC}$ $t_{TRANSIENT} = 25\text{ ns}$

## Magnetic Field Immunity<sup>(12)</sup>

V <sub>DD1</sub> = 5 V, V <sub>DD2</sub> = 5 V						
Power Frequency Magnetic Immunity	H <sub>PF</sub>		3500		A/m	50Hz/60Hz
Pulse Magnetic Field Immunity	H <sub>PM</sub>		4500		A/m	t <sub>p</sub> = 8μs
Damped Oscillatory Magnetic Field	H <sub>OSC</sub>		4500		A/m	0.1Hz – 1MHz
Cross-axis Immunity Multiplier <sup>(13)</sup>	K <sub>X</sub>		2.5			
V <sub>DD1</sub> = 3.3 V, V <sub>DD2</sub> = 5 V						
Power Frequency Magnetic Immunity	H <sub>PF</sub>		1500		A/m	50Hz/60Hz
Pulse Magnetic Field Immunity	H <sub>PM</sub>		2000		A/m	t <sub>p</sub> = 8μs
Damped Oscillatory Magnetic Field	H <sub>OSC</sub>		2000		A/m	0.1Hz – 1MHz
Cross-axis Immunity Multiplier <sup>(13)</sup>	K <sub>X</sub>		2.5			

## 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.

## Pinout Differences Between Packages

The QSOP (IL3685-1E) and narrow-body (IL3685-3E) versions are designed for minimum board area in densely-populated PCAs. Both have pin sets that should be connected externally for normal operation, but that can be used for testing, trouble-shooting, or special purposes. The wide-body version (IL3685E) has redundant ground pins for layout flexibility.

The narrow-body version provides a separate isolated DE output (ISODE) and Transceiver Device Enable (XDE) input. ISODE follows the Device Enable input (DE). XDE can be used to enable and disable the transceiver from the bus side, or connected to ISODE to enable and disable the transceiver from the DE controller-side input. The QSOP and narrow-body versions also provide separate bus-side power supply pins—V<sub>DD2X</sub> for the transceiver module and V<sub>DD2I</sub> for the isolation module. These should be externally connected for normal operation, but can be used separately for testing or troubleshooting. The QSOP version also has an “ISORI” input that can be used to test the controller-side “R” from the bus side. ISORI should be connected externally to “ISORO” for normal operation. ISORI and ISORO can be used for testing.

The wide-body version has internal connections between the isolated DE output and the Transceiver Device Enable input, and well as between the two bus-side power supplies.

## 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.

Data Rate (Mbps)	I <sub>DD1</sub>	I <sub>DD2</sub>
1	150 μA	150 μA
10	1.5 mA	1.5 mA
20	3 mA	3 mA
40	6 mA	6 mA

Table 2. Typical Dynamic Supply Currents.

## Power Supply Decoupling

Both V<sub>DD1</sub> and V<sub>DD2</sub> must be bypassed with 47 nF ceramic capacitors. These should be placed as close as possible to V<sub>DD</sub> pins for proper operation. Additionally, V<sub>DD2</sub> should be bypassed with a 10 μF tantalum capacitor.

## DC Correctness

The IL3685 incorporates a patented refresh circuit to maintain the correct output state with respect to data input. At power up, the bus outputs will follow the Function Table shown on Page 1. The DE input should be held low during power-up to eliminate false drive data pulses from the bus. An external power supply monitor to minimize glitches caused by slow power-up and power-down transients is not required.



### **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.

### **Electromagnetic Compatibility**

IL3685-Series Transceivers are fully compliant with generic EMC standards EN50081, EN50082-1 and the umbrella line-voltage standard for Information Technology Equipment (ITE) EN61000. The IsoLoop Isolator's Wheatstone bridge configuration and differential magnetic field signaling ensure excellent EMC performance against all relevant standards. NVE conducted compliance tests in the categories below:

EN50081-1

Residential, Commercial & Light Industrial

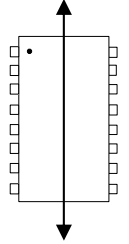
Methods EN55022, EN55014

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

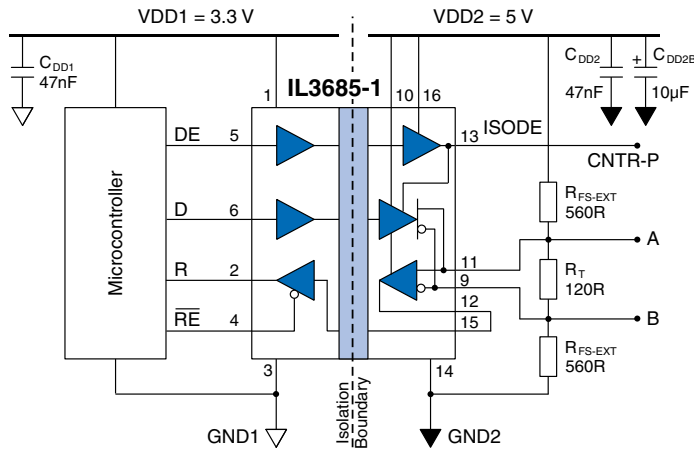
Radiated Field from Digital Telephones (Immunity Test)



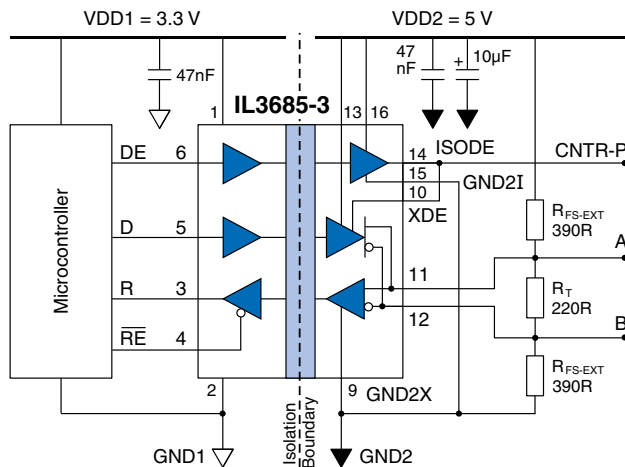
Immunity to external magnetic fields is even higher if the field direction is “end-to-end” (rather than “pin-to-pin”) as shown in the diagram above.

**Application Information**

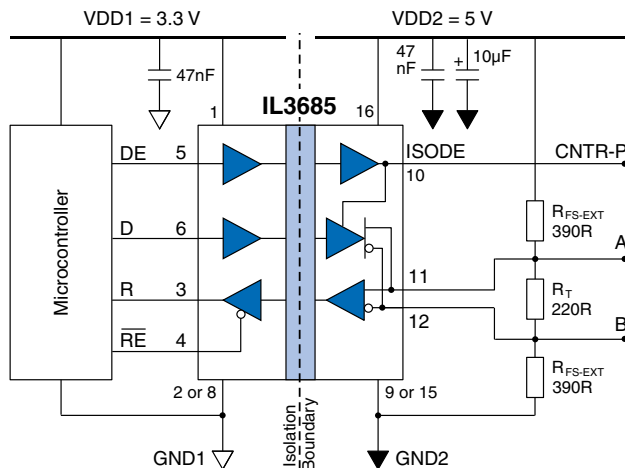
Figures 1a, 1b, and 1c show typical connections to a bus and microcontroller for the three package versions, including external connections required for normal operation. Typical termination resistors, fail-safe resistors, and power supply decoupling capacitors are also included:



**Figure 1a. Typical QSOP transceiver connections.**



**Figure 1b. Typical narrow-body transceiver connections.**



**Figure 1c. Typical wide-body transceiver connections.**

*Receiver Features*

The receiver output “R” has tri-state capability via the active low  $\overline{RE}$  input.

*Driver Features*

The RS-485 driver has a differential output and delivers at least 2.1 V across a 54  $\Omega$  load. In addition, unlike most other transceivers, IL3685-Series transceivers meet stringent PROFIBUS standards for maximum differential output voltage.

Drivers feature low propagation delay skew to maximize bit width and minimize EMI. Drivers have tri-state capability via the active-high DE input.

*Receiver Data Rate, Cables and Terminations*

PROFIBUS Type A bus cable is recommended for high transmission speeds (more than 500 Kbps). Type B should only be used at low baud rates and low requirements on the network distances. IL3685-Series transceivers are intended for networks up to 4,000 feet (1,200 m) with Type A bus cable and proper termination. The maximum data rate decreases as cable length increases.

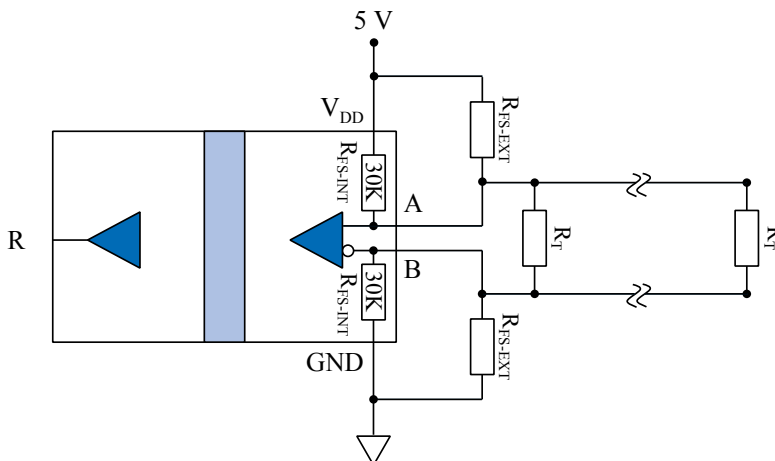
*The ISODE Output*

The unique ISODE output can be used in PROFIBUS applications where the state of the isolated drive enable node needs to be monitored, or for testing or troubleshooting.

**Termination and Fail-Safe Biasing**

*Internal Biasing Resistors*

“Fail-safe biasing” forces a logic high state on “R” in response to an open-circuit condition between the bus “A” and “B” lines, or when no drivers are active on the bus. IL3000-Series Isolated Transceivers include internal pull-up and pull-down resistors of approximately 30 k $\Omega$  in the receiver section (RFS-INT in Figure 2 below):



**Figure 2. Termination and internal and external fail-safe biasing resistors.**

These internal resistors ensure fail-safe operation if there are no termination resistors and up to four RS-485 worst-case Unit Loads of 12 k $\Omega$ .

*Termination Resistors*

Termination resistors should be on both ends of the network to minimize reflections. Values should be selected to match cable impedance; 220  $\Omega$  resistors are typical for PROFIBUS.

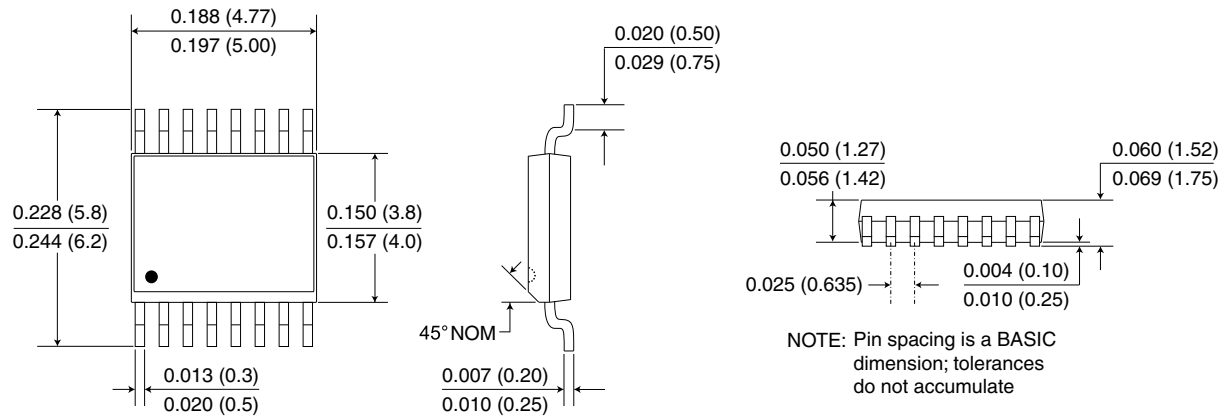
*External Fail-Safe Biasing Resistors*

Termination resistors bring the differential voltage across the conductor pair close to zero with no active drivers. In this case, the idle bus is indeterminate and susceptible to noise. External fail-safe biasing resistors (labeled RFS-EXT in Figure 2) at one end of the bus ensure fail-safe operation with a terminated bus. Biasing should provide at least 200 mV across the conductor pair to meet the RS-485 input sensitivity specification. Fail-safe resistors of 390  $\Omega$  are common for PROFIBUS. They should be on only one node of the network. Using the same value for pull-up and pull-down biasing resistors maintains balance for positive- and negative going transitions.

**Package Drawings**

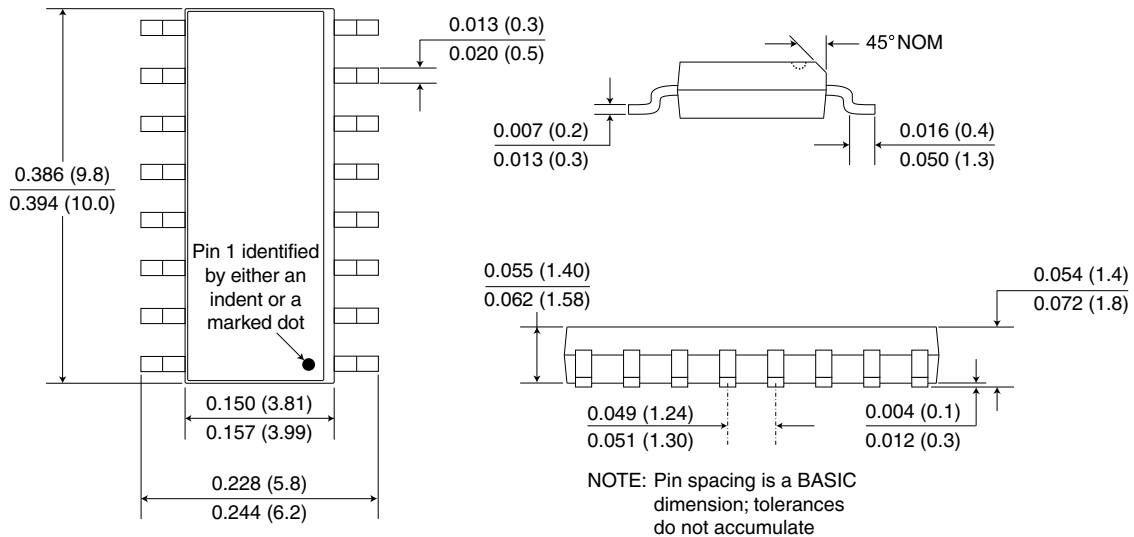
**Ultraminiature 16-pin QSOP Package (-1 suffix)**

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



**0.15" 16-pin Narrow-Body SOIC Package (-3 suffix)**

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

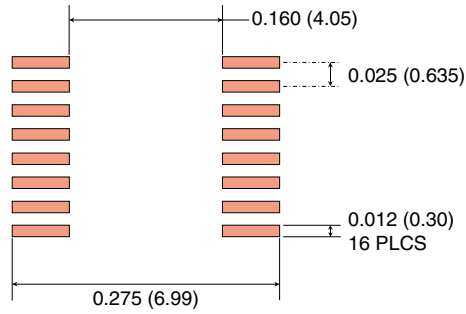




**Recommended Pad Layouts**

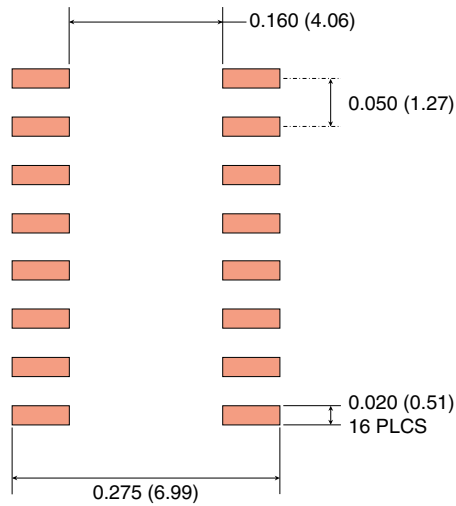
**4 mm x 5 mm 16-pin QSOP Pad Layout**

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



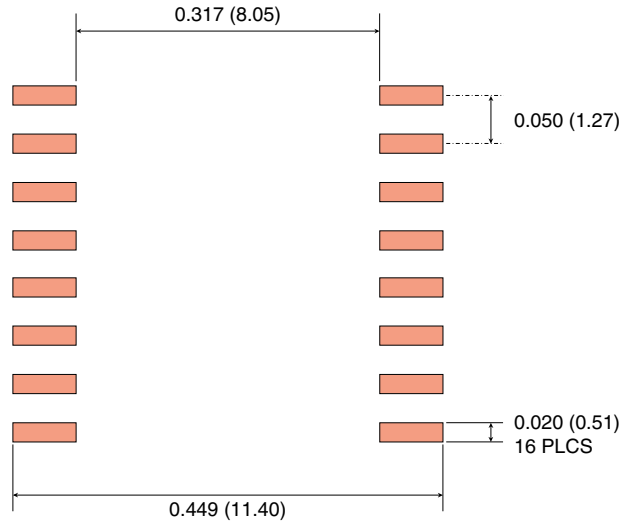
**0.15" Narrow-Body 16-pin SOIC Pad Layout**

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



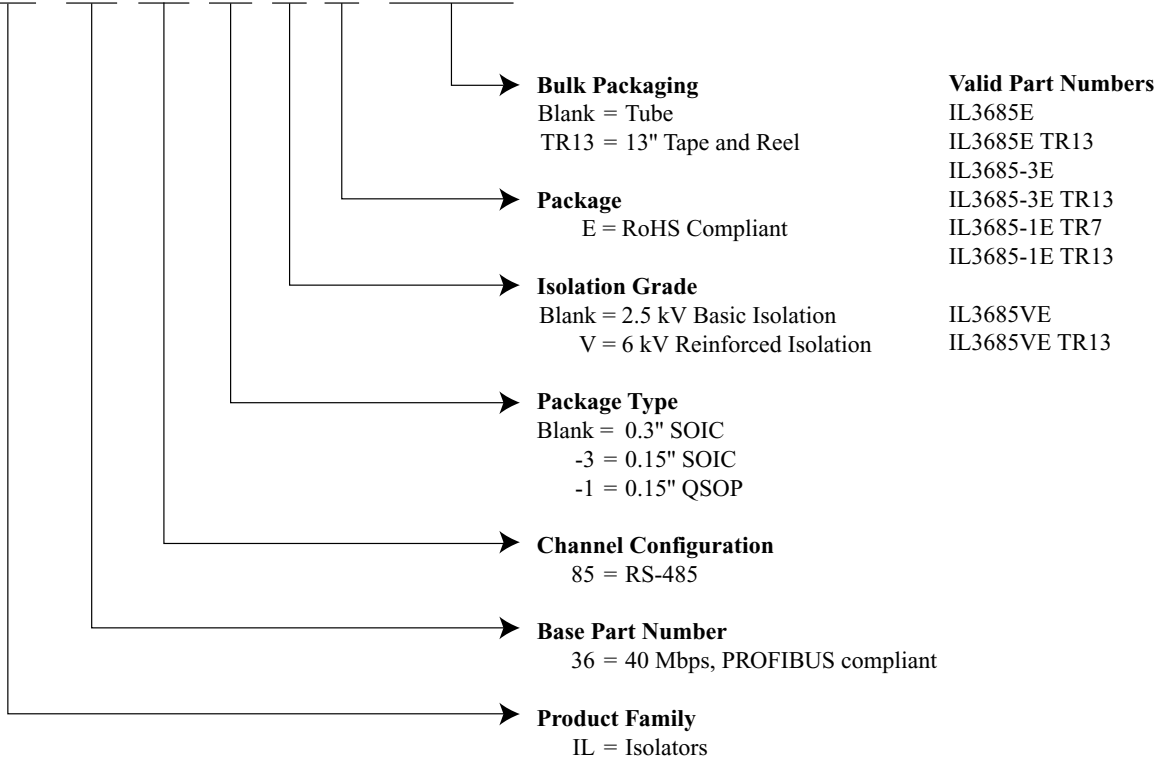
**0.3" 16-pin Wide-Body SOIC Pad Layout**

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



**Ordering Information and Valid Part Numbers**

**IL 36 85 -3 V E TR13**





## Revision History

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**ISB-DS-001-IL3685-V**  
**October 2017**

**Change**

- Added IL3685VE to the list of available parts (p. 16).

**ISB-DS-001-IL3685-U**  
**May 2017**

**Change**

- Refined thermal resistance specifications based on additional test data (p. 2).
- Added worst-case operating conditions to max. ambient operating temperature spec.
- Deleted minimum magnetic field immunity specifications (p. 8) since it is not 100% tested.

**ISB-DS-001-IL3685-T**

**Change**

- Added QSOP version (IL3685-1E).
- VDE certification and UL approval for V-Series version (6 kV reinforced isolation).

**ISB-DS-001-IL3685-S**

**Change**

- Eliminated inconsistent Driver Section output current specification.
- Improved Receiver Section Line Input Current and Input Resistance specifications.

**ISB-DS-001-IL3685-R**

**Change**

- Updated VDE certification standard to VDE V 0884-10.
- Upgraded “V” Version Surge Immunity specification to 12.8 kV.
- Upgraded “V” Version VDE 0884-10 rating to reinforced insulation.

**ISB-DS-001-IL3685-Q**

**Change**

- Increased V-Series isolation voltage to 6 kVrms.
- Increased typ. Total Barrier Thickness specification to 0.016 mm.
- Increased CTI min. specification to  $\geq 600 V_{RMS}$ .

**ISB-DS-001-IL3685-P**

**Change**

- Increase V-Series surge voltage specification to 10 kV.
- Upgraded V-Series safety and approval from IEC 60747-5-5 (VDE 0884) to VDE 0884-10.

**ISB-DS-001-IL3685-O**

**Change**

- Added V-Series versions (5 kVrms isolation / 1000 Vrms working voltage)

**ISB-DS-001-IL3685-N**

**Change**

- Added Differential Bus Input Capacitance specification (p. 6).

**ISB-DS-001-IL3685-M**

**Change**

- IEC 60747-5-5 (VDE 0884) certification.
- Upgraded from MSL 2 to MSL 1.

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An ISO 9001 Certified Company

NVE Corporation  
11409 Valley View Road  
Eden Prairie, MN 55344-3617 USA  
Telephone: (952) 829-9217

[www.nve.com](http://www.nve.com)  
e-mail: [iso-info@nve.com](mailto:iso-info@nve.com)

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ISB-DS-001-IL3685-V

*Oct. 2017*