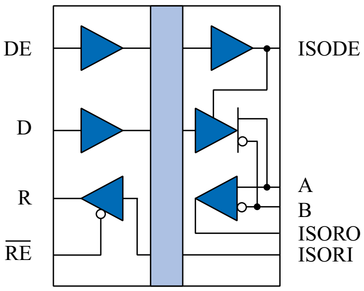
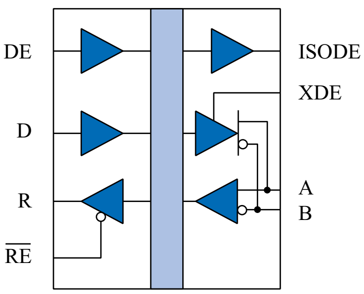
Advanced Isolated RS-485 Transceivers

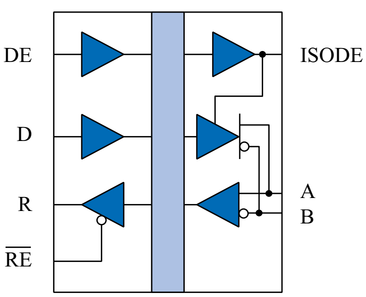
Functional Diagrams



IL3685-1
(QSOP)



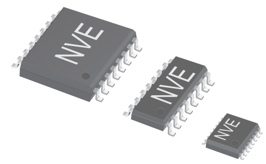
IL3685-3
(narrow-body)



IL3685
(wide-body)

V_{ID} (A-B)	DE	$\overline{RE}$	R	D	Mode	Notes
≥ 200 mV	L	L	H	X	Receive	
≤−200mV	L	L	L	X		
Open	L	L	H	X		A/B failsafe
≥ 1.5 V	H	L	H	H	Drive	R reads back D information
≤−1.5 V	H	L	L	L		
≥ 1.5 V	H	H	Z	H		R tri-state (no output)
≤−1.5 V	H	H	Z	L		
X	L	H	Z	X	Disabled	R tri-state; A/B failsafe

Features



- 40 Mbps data rate
- 3 V to 5 V power supplies
- 20 ns propagation delay
- Hot-plug capable
- 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
- PROFIBUS compliant
- 6 kV_{RMS} Reinforced Isolation; 1.2 kV_{RMS} Working Voltage (IL3685VE)
- IEC 60747-17 (VDE 0884-17):2021-10 certified; UL 1577 recognized
- ATEX / IECEx certified for IS-to-IS intrinsically safe applications
- 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 are second-generation isolated, high-speed differential bus transceivers. The devices use NVE's patented* spintronic Giant Magnetoresistance (GMR) technology and have advanced features such as hot-plug capability and PROFIBUS compliance.

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

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.

PROFI®
PROCESS FIELD BUS
BUS

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

REV. Z

Absolute Maximum Ratings[7]

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Storage Temperature	T_S	–55		150	°C	
Junction Temperature	T_J	–55		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		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	
Ambient Operating Temperature	T_A	–40		85	°C	
Junction Temperature	T_J	–40		100	°C	
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 / –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	
Digital Input Signal Rise and Fall Times	t_{IR}, t_{IF}	DC Stable				

NVE Corporation 11409 Valley View Road, Eden Prairie, MN 55344-3617(952) 829-9217 www.nve.com YouTube.com/NveCorporation iso-apps@nve.com

Safety and Approvals

IEC 60747-17 (VDE 0884-17):2021-10:

IL3685VE version (Reinforced Isolation; VDE File Number 5016933-4880-0002)

- Working Voltage (V_{IORM}): 1200 V_{RMS} (1700 V_{PK}) with 20% Safety Factor; pollution degree 2
- Isolation voltage (V_{ISO}): 6000 V_{RMS}
- Surge immunity (V_{IOSM}): 12.8 kV_{PK}
- Surge rating: 8000 V
- 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)

- 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}; pollution degree 2):

Package	Part No. Suffix	Working Voltage
QSOP16	-1	600 V_{RMS}
Narrow-body SOIC16	-3	700 V_{RMS}
Wide-body SOIC16/True 8™	None	600 V_{RMS}

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)

Standard isolation grade

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.

V-Series isolation grade

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

Intrinsically Safe Certification

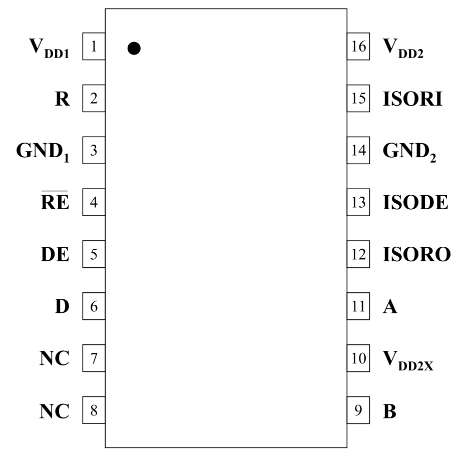
- IL3685VE is ATEX / IEC 60079-0 / 60079-11 certified Intrinsically Safe (IS) for use in IS to IS applications.
- 500 V_{RMS} rating.

Soldering Profile

Per JEDEC J-STD-020C, MSL 1

IL3685-1 (QSOP Package) Pin Connections

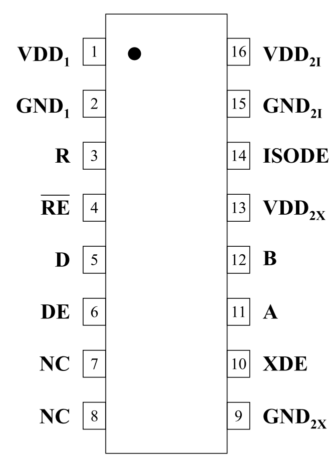
1	V_{DD1}	Input power supply.
2	R	Output data from bus.
3	GND_1	Input power supply ground return.
4	$\overline{RE}$	Read data enable (if $\overline{RE}$ is high, R= high impedance).
5	DE	Drive enable (HIGH if left unconnected).
6	D	Data input to bus.
7, 8	NC	No internal connection.
9	B	Inverting bus line.
10	V_{DD2X}	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_2	Output power supply ground return.
15	ISORI	Isolated R input (should be connected to pin 12; no other connection should be made).
16	V_{DD2I}	Output isolation power supply (normally connected to pin 10).



IL3685-1

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

1	V_{DD1}	Input power supply.
2	GND_1	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 (HIGH if left unconnected).
7, 8	NC	No internal connection.
9	GND_{2X}	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 trans-ceiver 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_{DD2X}	Output transceiver power supply (normally connected to pin 16).
14	ISODE	Isolated DE output (normally connected to pin 10).
15	GND_{2I}	Output isolation power supply ground return. (normally connected to pin 9).
16	V_{DD2I}	Output isolation power supply (normally connected to pin 13).

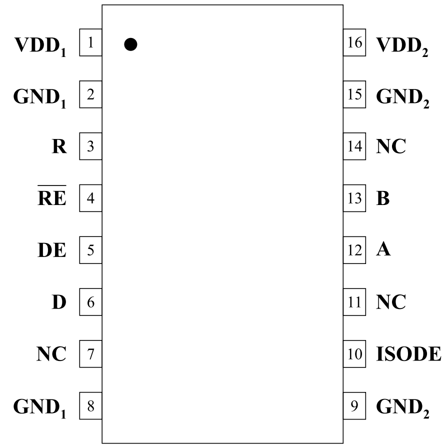


IL3685-3

NVE Corporation 11409 Valley View Road, Eden Prairie, MN 55344-3617(952) 829-9217 www.nve.com YouTube.com/NveCorporation iso-apps@nve.com

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

1	V_{DD1}	Input power supply.
2	GND_1	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 (HIGH if left unconnected).
6	D	Data input to bus.
7	NC	No internal connection.
8	GND_1	Input power supply ground return (pin 8 is internally connected to pin 2).
9	GND_2	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_2	Output power supply ground return (pin 15 is internally connected to pin 9).
16	V_{DD2}	Output power supply.



IL3685

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.**	**Max.**	**Units**	**Test Conditions**
Output voltage	V_O			V_{DD}	V	$I_O = 0$
Differential Output Voltage(2)	$\|V_{OD1}\|$			V_{DD}	V	$I_O = 0$
Differential Output Voltage(2)	$\|V_{OD2}\|$	2.1	3	3.5	V	R_L = 54 Ω
Differential Output Voltage(2)	V_{OD3}	1.9		3.5	V	−7 V < V_{CM} < 12 V; R_L = 60 Ω
Change in Magnitude of Differential Output Voltage(4)	$\Delta\|V_{OD}\|$			±0.2	V	R_L = 54 Ω or 100 Ω
Common Mode Output Voltage	V_{OC}			3	V	R_L = 54 Ω or 100 Ω
Change in Magnitude of Common Mode Output Voltage(4)	$\Delta\|V_{OC}\|$			±0.2	V	R_L = 54 Ω or 100 Ω
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
Absolute |Short-circuit Output Current|	I_{OS}			250	mA	−7 V < V_O < 12 V

Receiver 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.**	**Max.**	**Units**	**Test Conditions**
Positive-going Input Threshold Voltage	V_{IT+}			0.2	V	−7 V < V_{CM} < 12 V
Negative-going Input Threshold Voltage	V_{IT-}	−0.2			V	−7 V < V_{CM} < 12 V
Hysteresis Voltage ($V_{IT+} - V_{IT-}$)	V_{HYS}		28		mV	V_{CM} = 0 V, T = 25°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 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}			±1	μA	V_O = 0.4 to (V_{DD2}–0.5) V
Line Input Current	I_I			220	μA	V_I = 12 V
				−160	μA	V_I = −7 V
Input Resistance	R_I	54			kΩ	
Bus-Side Supply Current	I_{DD2}		5	16	mA	
Bus-Side Dynamic Supply Current	$\Delta I_{DD2}/\Delta f_{IN}$		1			$R_T = \infty$
			0.8			R_T = 60 Ω

Power Consumption

T_{min} to T_{max} and V_{DD2} = 5 V unless otherwise stated						
Parameter	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Conditions**
Controller-Side Quiescent Current V_{DD1} = 3.3 V V_{DD1} = 5 V	I_{DD1}		3 4	4 6	mA	f_{IN} = 0 Hz
Bus-Side Quiescent Supply Current	I_{DD2}		5	16	mA	Outputs Enabled; $R_T = \infty$; f_{IN} = 0 Hz ; V_{DD2x} connected to V_{DD2I} if applicable
Controller-Side Dynamic Supply Current	I_{DD1}		0.22		mA/Mbps	V_{DD1} = 3.3 V
Bus-Side Dynamic Supply Current	$\Delta I_{DD2}/\Delta f_{IN}$		1			$R_T = \infty$
			0.8			R_T = 60 Ω

Switching Characteristics

V_{DD1} = 5 V, V_{DD2} = 5 V						
Parameter	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Conditions**
Data Rate		40			Mbps	R_L = 54 Ω, C_L = 50 pF
Propagation Delay(5)	t_{PD}		20	30	ns	V_O = −1.5 to 1.5 V, C_L = 15 pF
Pulse Skew(6)	$t_{SK}(P)$		1	5	ns	V_O = −1.5 to 1.5 V, C_L = 15 pF
Skew Limit(3)	$t_{SK}(LIM)$		2	10	ns	R_L = 54 Ω, C_L = 50 pF
Output Enable Time To High Level	t_{PZH}		15	30	ns	C_L = 15 pF
Output Enable Time To Low Level	t_{PZL}		15	30	ns	C_L= 15 pF
Output Disable Time From High Level	t_{PHZ}		15	30	ns	C_L = 15 pF
Output Disable Time From Low Level	t_{PLZ}		15	30	ns	C_L = 15 pF
Common Mode Transient Immunity (Output Logic High to Logic Low)	$\|CM_H\|,\|CM_L\|$	30	50		kV/µs	V_{CM} = 1500 V_{DC} $t_{TRANSIENT}$ = 25 ns
V_{DD1} = 3.3 V, V_{DD2} = 5 V						
Parameter	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Conditions**
Data Rate		40			Mbps	R_L = 54 Ω, C_L = 50 pF
Propagation Delay(5)	t_{PD}		25	35	ns	V_O = −1.5 to 1.5 V, C_L = 15 pF
Pulse Skew(6)	$t_{SK}(P)$		2	5	ns	V_O = −1.5 to 1.5 V, C_L = 15 pF
Skew Limit(3)	$t_{SK}(LIM)$		4	10	ns	R_L = 54 Ω, C_L = 50 pF
Output Enable Time To High Level	t_{PZH}		17	30	ns	C_L = 15 pF
Output Enable Time To Low Level	t_{PZL}		17	30	ns	C_L= 15 pF
Output Disable Time From High Level	t_{PHZ}		17	30	ns	C_L = 15 pF
Output Disable Time From Low Level	t_{PLZ}		17	30	ns	C_L = 15 pF
Common Mode Transient Immunity (Output Logic High to Logic Low)	$\|CM_H\|,\|CM_L\|$	30	50		kV/µs	V_{CM} = 1500 V_{DC} $t_{TRANSIENT}$ = 25 ns

Magnetic Field Immunity(8)

V_{DD1} = 5 V, V_{DD2} = 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(9)	K_X		2.5			
V_{DD1} = 3.3 V, V_{DD2} = 5 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(9)	K_X		2.5			

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}		Ω	500 V
Barrier Capacitance		C_{IO}		7		pF	f = 1 MHz
Leakage Current				0.2		μA_{RMS}	240 V_{RMS}, 60 Hz
Comparative Tracking Index		CTI	≥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			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	QSOP 0.15" SOIC 0.3" SOIC	θ_{JA}		100 82 67		°C/W	Double-sided PCB in free air
Junction–Case (Top) Thermal Resistance	QSOP 0.15" SOIC 0.3" SOIC	θ_{JC}		9 8 12		°C/W	Double-sided PCB in free air
Junction–Ambient Thermal Resistance	0.3" SOIC	θ_{JA}		46		°C/W	2s2p PCB in free air per JESD51
Junction–Case (Top) Thermal Resistance	0.3" SOIC	θ_{JC}		9		°C/W	2s2p PCB in free air per JESD51
Power Dissipation	QSOP 0.15" SOIC 0.3" SOIC	P_D			675 700 1500	mW	

Notes:

1. All voltages 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. $\Delta|V_{OD}|$ 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.
5. Includes 10 ns read enable time. Maximum propagation delay is 25 ns after read assertion.
6. Pulse skew is defined as $|t_{PLH} - t_{PHL}|$ of each channel.
7. Absolute Maximum specifications mean the device will not be damaged if operated under these conditions. It does not guarantee performance.
8. The relevant test and measurement methods are given in the Electromagnetic Compatibility section.
9. External magnetic field immunity is improved by this factor if the field direction is "end-to-end" rather than to "pin-to-pin."

NVE Corporation 11409 Valley View Road, Eden Prairie, MN 55344-3617 (952) 829-9217 www.nve.com YouTube.com/NveCorporation iso-apps@nve.com

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_{DD2X} for the transceiver module and V_{DD2I} 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.

Power Supply Decoupling

V_{DD1} and V_{DD2} should be bypassed with 0.1 µF typical (47 nF minimum) capacitors as close as possible to the V_{DD} pins.

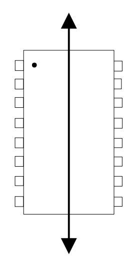
Maintaining Creepage

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.

Electromagnetic Compatibility

IL3685-Series Transceivers are 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.

The IsoLoop Isolator's Wheatstone bridge configuration and differential magnetic field signaling ensure excellent EM immunity. Immunity to external magnetic fields is even higher if the field direction is "end-to-end" (rather than to "pin-to-pin") as shown at right.



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:

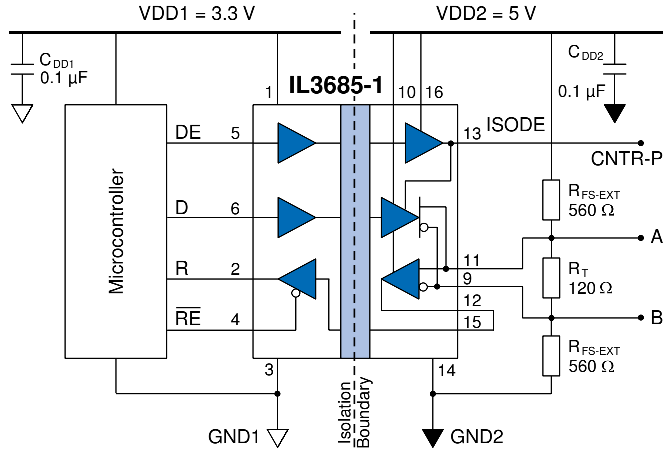


Figure 1a. Typical QSOP transceiver connections.

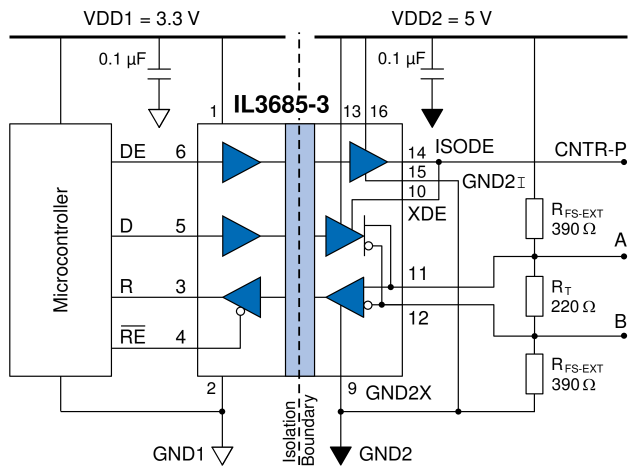


Figure 1b. Typical narrow-body transceiver connections.

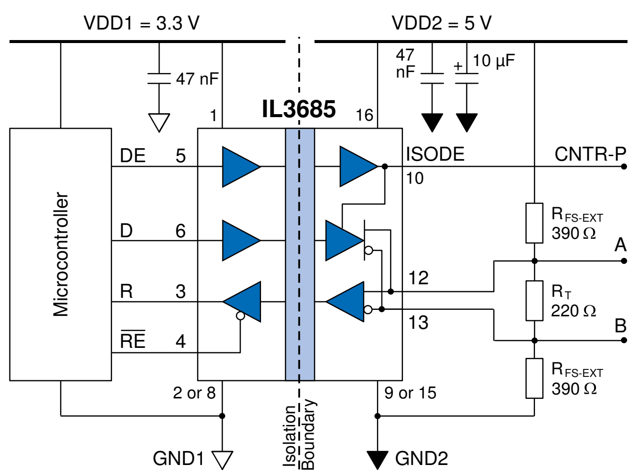


Figure 1c. Typical wide-body transceiver connections.

Transceiver Operation

The transceiver block diagram is shown below:

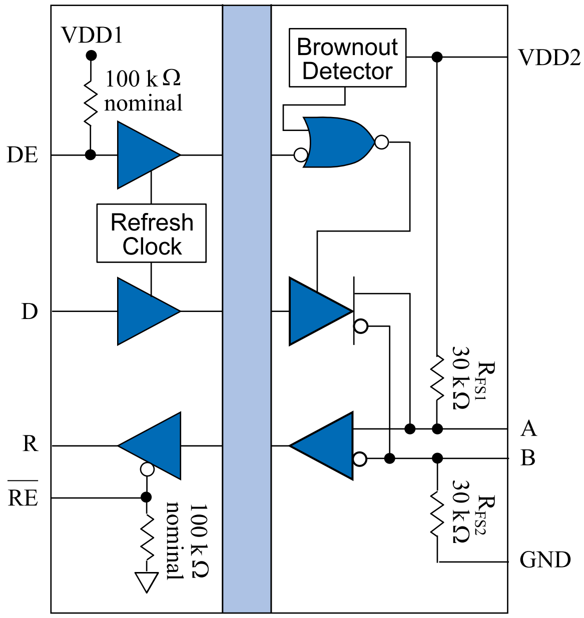


Figure 2. Detailed transceiver block diagram.

Receiver Features
The receiver output "R" has tri-state capability via the active low $\overline{\text{RE}}$ input.

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

Deterministic Power Up and Brownout Detection
IL3685 parts have circuitry to disable the bus driver until the driver-side voltage (VDD2) reaches approximately 3.3 volts on power-up. The transceiver is disabled when the voltage drops below approximately 3.1 volts on power-down. This brownout circuitry ensures the transceiver does not "crash" the bus on power up, power down, or brownout, and eliminates the need for external power supply monitors. In addition, a patented refresh circuit maintains the correct transceiver output state with respect to data input (DC correctness). The refresh circuit ensures the bus outputs will follow the Function Table shown on Page 1 after power up.

Hot Plug Operation
Deterministic power-up allows IL3685 nodes to "hot plug" into the bus, since the bus driver will be in a high-impedance state until the bus supply is enough for the bus driver to operate.

Unpowered Nodes
Unpowered nodes (i.e., either no VDD1 or VDD2 power) result in high impedances on the "A" and "B" bus lines , so the unpowered node will not disturb bus operation.

Internal Fail-Safe Biasing Resistors
Internal "fail-safe biasing" forces a logic high state on "R" with an open-circuit between the bus "A" and "B" lines, or when no drivers are active on the bus.

Rigorous PROFIBUS Compatibility
Unlike most other transceivers, IL3685E transceivers meet stringent PROFIBUS standards for maximum differential output voltage as well as other PROFIBUS requirements.

Thermal Shutdown
The bus driver is disabled when the driver die temperature exceeds approximately 150 °C, and re-enabled when the die temperature drops below approximately 135 °C. The receiver section continues to operate during thermal shutdown.

NVE Corporation 11409 Valley View Road, Eden Prairie, MN 55344-3617 (952) 829-9217 www.nve.com YouTube.com/NveCorporation iso-apps@nve.com

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 kΩ in the receiver section (RFS-INT in Figure 3 below):

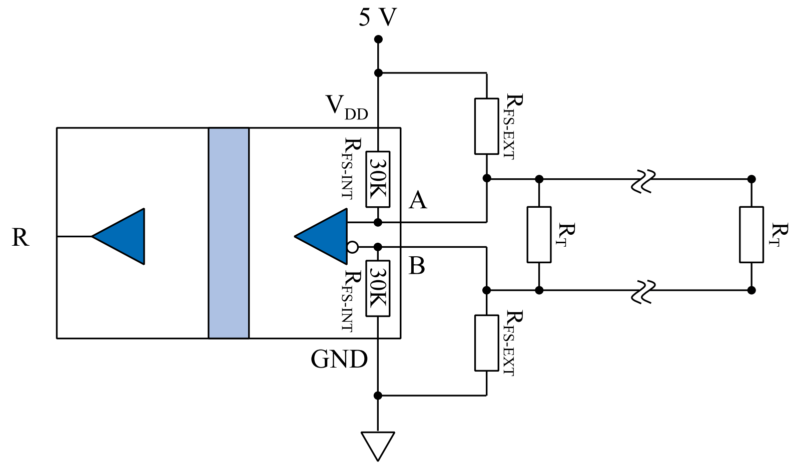


Figure 3. Termination and internal and external fail-safe biasing resistors.

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 kΩ.

Termination Resistors

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

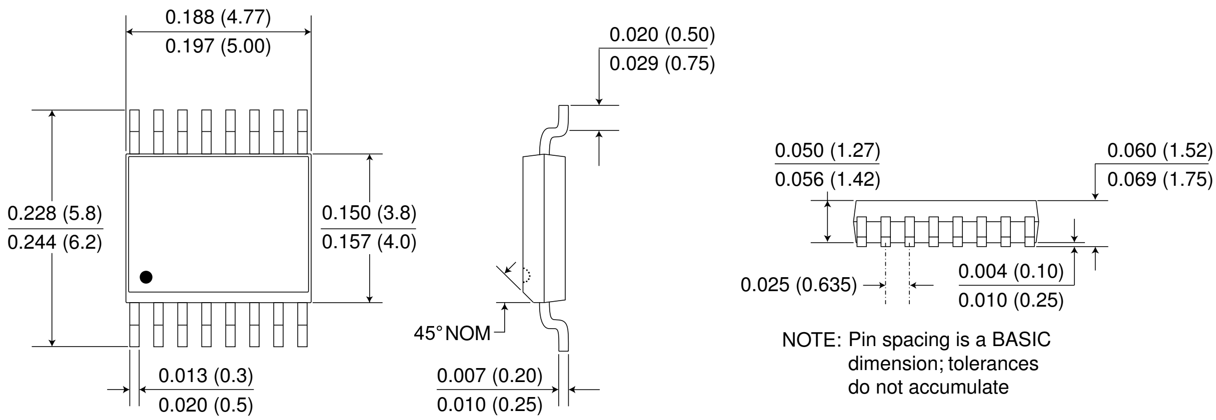
External Fail-Safe Biasing Resistors

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 3) 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 Ω 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

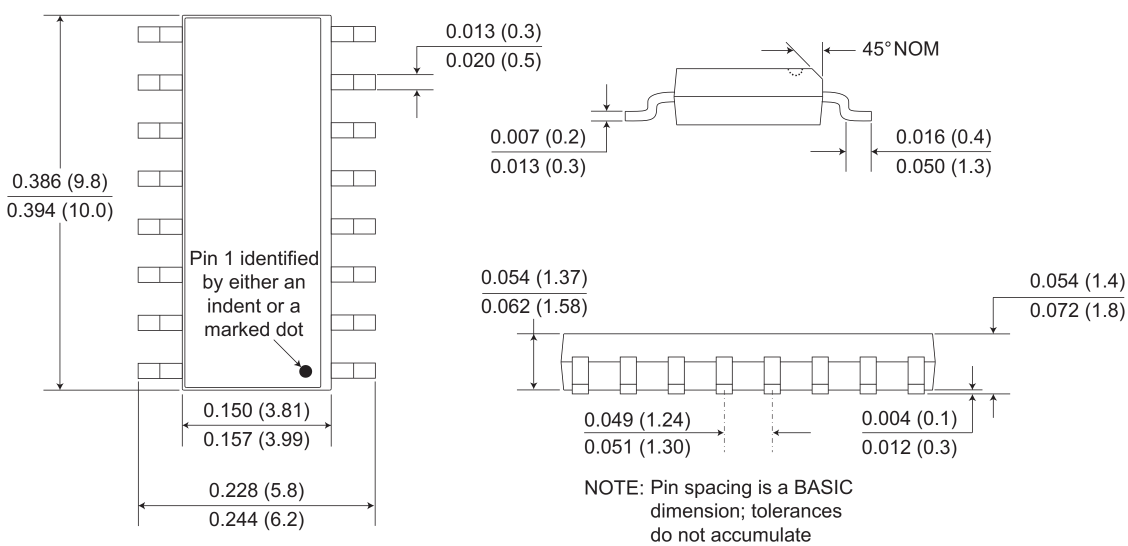
Ultraminiature 16-pin QSOP Package (-1 suffix)

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



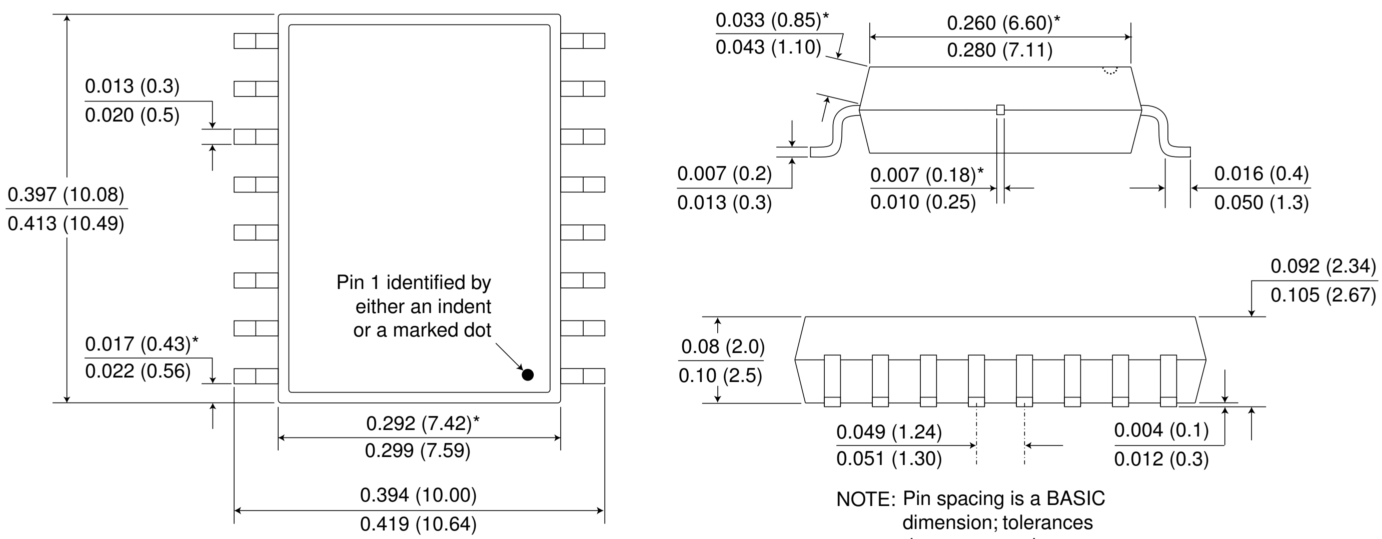
0.15" 16-pin Narrow-Body SOIC Package (-3 suffix)

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



0.3" 16-pin Wide-Body SOIC Package (no suffix)

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

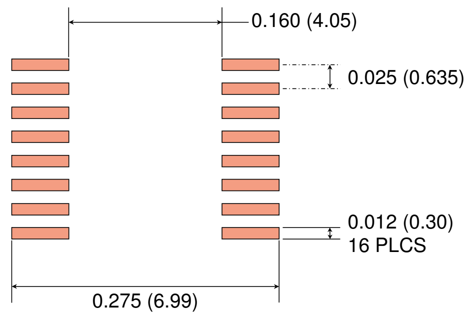


*Specified for True 8™ package to guarantee 8 mm creepage per IEC 60601.

Recommended Pad Layouts

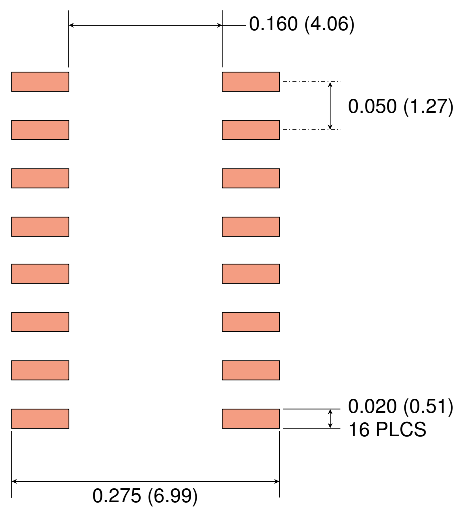
4 mm x 5 mm 16-pin QSOP Pad Layout

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



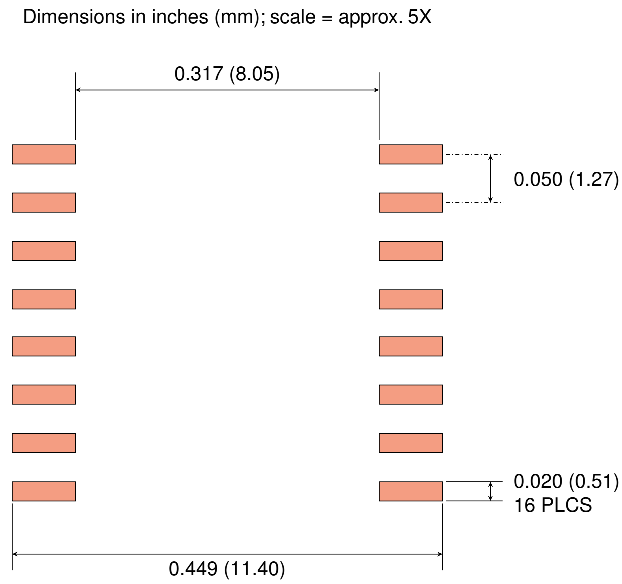
0.15" Narrow-Body 16-pin SOIC Pad Layout

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



NVE Corporation 11409 Valley View Road, Eden Prairie, MN 55344-3617 (952) 829-9217 www.nve.com YouTube.com/NveCorporation iso-apps@nve.com

0.3" 16-pin Wide-Body SOIC Pad Layout



NVE Corporation 11409 Valley View Road, Eden Prairie, MN 55344-3617 (952) 829-9217 www.nve.com YouTube.com/NveCorporation iso-apps@nve.com

Ordering Information and Valid Part Numbers

IL 36 85 -3 V E TR13

Bulk Packaging
Blank = Tube
TR13 = 13" Tape and Reel

Package
E = RoHS Compliant

Isolation Grade
Blank = 2.5 kV Basic Isolation
V = 6 kV Reinforced Isolation

Package Type
Blank = 0.3" SOIC
-3 = 0.15" SOIC
-1 = 0.15" QSOP

Channel Configuration
85 = RS-485

Base Part Number
36 = 40 Mbps, PROFIBUS compliant

Product Family
IL = Isolators

Valid Part Numbers
IL3685E
IL3685E TR13
IL3685-3E
IL3685-3E TR13
IL3685-1E TR7
IL3685-1E TR13

IL3685VE
IL3685VE TR13

RoHS
COMPLIANT

NVE Corporation 11409 Valley View Road, Eden Prairie, MN 55344-3617 (952) 829-9217 www.nve.com YouTube.com/NveCorporation iso-apps@nve.com

Revision History

ISB-DS-001-IL3685-Z
August 2022

Changes

- Clarified truth table (p. 1).
- Upgraded VDE approval to IEC 60747-17 (VDE 0884-17):2021-10 (p. 3).
- Increased Working Voltage ratings based on latest VDE testing (p. 3).
- Added IL3685VE ATEX / IEC 60079 certification for intrinsically safe applications (p. 3).

ISB-DS-001-IL3685-Y

Changes

- Upgrade from VDE V 0884-10 to VDE V 0884-11 / IEC 60747-17 (p. 3).
- Separate power consumption specifications section; added dynamic power consumption (p. 6).
- Revised thermal specifications (p. 8).
- More details on power up, hot plug, brownout detection, and unpowered nodes (p. 12).
- Updated EMC standards.

ISB-DS-001-IL3685-X

Change

- Improved thermal specifications based on new test data (p. 2).

ISB-DS-001-IL3685-W

Change

- Dropped 10 µF tantalum capacitor recommendation (p. 8).

ISB-DS-001-IL3685-V

Change

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

ISB-DS-001-IL3685-U

Changes

- 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

Changes

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

ISB-DS-001-IL3685-S

Changes

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

ISB-DS-001-IL3685-R

Changes

- 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

Changes

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

Datasheet Limitations
The information and data provided in datasheets shall define the specification of the product as agreed between NVE and its customer, unless NVE and customer have explicitly agreed otherwise in writing. All specifications are based on NVE test protocols. In no event however, shall an agreement be valid in which the NVE product is deemed to offer functions and qualities beyond those described in the datasheet.

Limited Warranty and Liability
Information in this document is believed to be accurate and reliable. However, NVE does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information.

In no event shall NVE be liable for any indirect, incidental, punitive, special or consequential damages (including, without limitation, lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Right to Make Changes
NVE reserves the right to make changes to information published in this document including, without limitation, specifications and product descriptions at any time and without notice. This document supersedes and replaces all information supplied prior to its publication.

Use in Life-Critical or Safety-Critical Applications
Unless NVE and a customer explicitly agree otherwise in writing, NVE products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical devices or equipment. NVE accepts no liability for inclusion or use of NVE products in such applications and such inclusion or use is at the customer's own risk. Should the customer use NVE products for such application whether authorized by NVE or not, the customer shall indemnify and hold NVE harmless against all claims and damages.

Applications
Applications described in this datasheet are illustrative only. NVE makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using NVE products, and NVE accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the NVE product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customers. Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NVE does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customers. The customer is responsible for all necessary testing for the customer's applications and products using NVE products in order to avoid a default of the applications and the products or of the application or use by customer's third party customers. NVE accepts no liability in this respect.

Limiting Values
Stress above one or more limiting values (as defined in the Absolute Maximum Ratings System of IEC 60134) will cause permanent damage to the device. Limiting values are stress ratings only and operation of the device at these or any other conditions above those given in the recommended operating conditions of the datasheet is not warranted. Constant or repeated exposure to limiting values will permanently and irreversibly affect the quality and reliability of the device.

Terms and Conditions of Sale
In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. NVE hereby expressly objects to applying the customer's general terms and conditions with regard to the purchase of NVE products by customer.

No Offer to Sell or License
Nothing in this document may be interpreted or construed as an offer to sell products that is open for acceptance or the grant, conveyance or implication of any license under any copyrights, patents or other industrial or intellectual property rights.

Export Control
This document as well as the items described herein may be subject to export control regulations. Export might require a prior authorization from national authorities.

Automotive Qualified Products
Unless the datasheet expressly states that a specific NVE product is automotive qualified, the product is not suitable for automotive use. It is neither qualified nor tested in accordance with automotive testing or application requirements. NVE accepts no liability for inclusion or use of non-automotive qualified products in automotive equipment or applications.

In the event that customer uses the product for design-in and use in automotive applications to automotive specifications and standards, customer (a) shall use the product without NVE's warranty of the product for such automotive applications, use and specifications, and (b) whenever customer uses the product for automotive applications beyond NVE's specifications such use shall be solely at customer's own risk, and (c) customer fully indemnifies NVE for any liability, damages or failed product claims resulting from customer design and use of the product for automotive applications beyond NVE's standard warranty and NVE's product specifications.

NVE Corporation 11409 Valley View Road, Eden Prairie, MN 55344-3617 (952) 829-9217 www.nve.com YouTube.com/NveCorporation iso-apps@nve.com

An ISO 9001 Certified Company

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

www.nve.com
e-mail: iso-info@nve.com

ISB-DS-001-IL3685-Z

August 2022