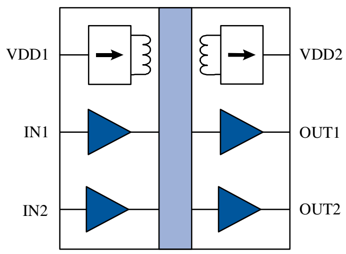
NVE CORPORATION

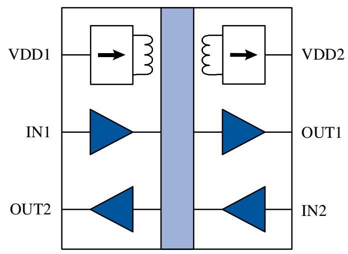
IL761xV / IL781xV

High-Speed Data Couplers with Integrated DC-to-DC Convertors

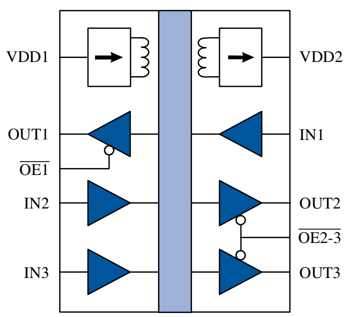
Block Diagrams



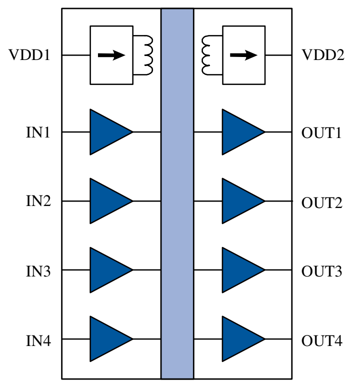
IL7611V / IL7811V



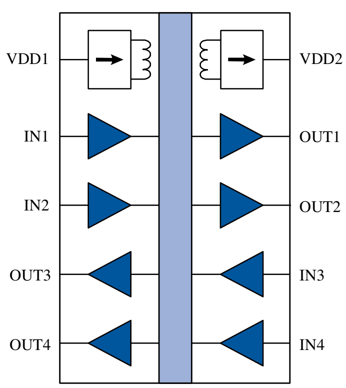
IL7612V / IL7812V



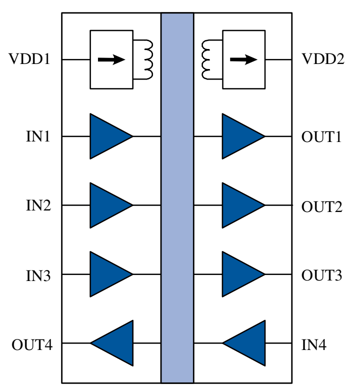
IL7614V / IL7814V



IL7615V / IL7815V



IL7616V / IL7816V



IL7617V / IL7817V

Features

- 110 Mbps
- Integrated 3.3-to-3.3 V or 3.3-to-5 V DC-DC convertors
- Ultralow output ripple
- −40 °C to 125 °C temperature range
- Overcurrent and thermal shutdown protection
- EN 55032 CISPR 32 Class B compliant
- 6 kV_{RMS} isolation
- UL 1577 approved
- EU Declaration of Conformity (CE mark)
- 0.3″ True 8™ mm 16-pin SOIC JEDEC-standard package

Applications

- Industrial automation
- 2xMOPP medical instrumentation
- Grid infrastructure
- Test and measurement
- Two-and three-wire serial interfaces
- Isolated ADCs and DACs

Description

The IL761x- and IL781x-Series are high-speed, fully-isolated, data couplers with integrated, one-quarter watt DC-to-DC convertors. This level of integration dramatically reduces chip count and board area.

The IL761xV-Series has 3.3-to-3.3 V DC-to-DC convertors, and the and IL781xV-Series has 3.3-to-5 V DC-to-DC convertors.

The devices use NVE’s proven, patented* spintronic Giant Magnetoresistance (GMR) isolation technology and IsoLoop® high-efficiency micro-scale isolation transformers.

Internal shielding and DC-to-DC convertor frequency hopping minimize EMI. Parts are EN 55032 CISPR 32 Class B compliant with just a small amount of stitching capacitance.

A unique ceramic/polymer composite barrier provides best-in-class 6 kV_{RMS} isolation and virtually unlimited barrier life.

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

Rev. F

Absolute Maximum Ratings[1]

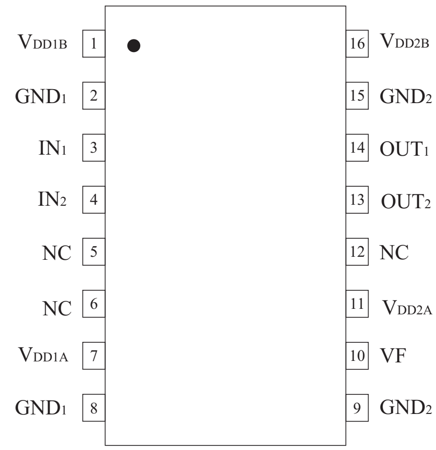
Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Storage temperature	T_S	–55		150	°C	
Junction temperature	T_J	–55		150	°C	
Supply voltage	V_{DD1}	–0.5		6	V	
Digital input voltage		–0.5		V_{DD} + 0.5	V	
Digital output voltage		–0.5		V_{DD} + 1	V	
Coupler output current drive	Io			10	mA	
Lead solder temperature				260	°C	10 sec.
ESD			2		kV	HBM

Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Input-side supply voltage	V_{DD1}	3	3.3	3.6	V	
Isolated-side power supply input	V_{DD2B}	2.7	3.3	5.5	V	
Ambient operating temperature	T_{min}; T_{max}	–40		125	°C	
Junction temperature	T_J	–40		150	°C	
High-level digital input voltage	V_{IH}	2.4		V_{DD1}	V	V_{DD1} = 3.3 V
Low-level digital input voltage	V_{IL}	0		0.8	V	

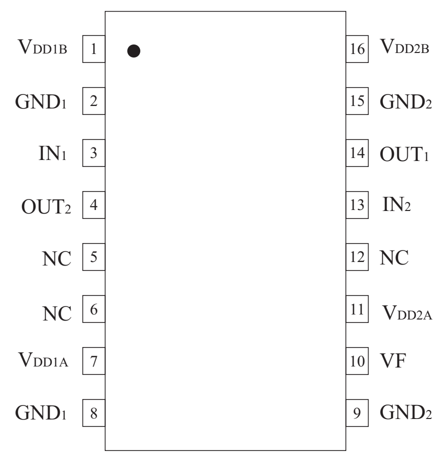
IL7611V / IL7811V Pin Connections

1	V_{DD1B}	Coupler controller-side power supply input (3.3 V nominal).
2	GND_1	Ground return for V_{DD1} (pins 2 and 8 internally connected).
3	IN_1	Data in, channel 1
4	IN_2	Data in, channel 2
5	NC	No internal connection
6	NC	No internal connection
7	V_{DD1A}	DC-DC convertor input voltage (3.3 V nominal); bypass with 0.1 µF.
8	GND_1	Ground return for V_{DD1} (pins 2 and 8 internally connected).
9	GND_2	Ground return for V_{DD2} (pins 9 and 15 internally connected).
10	VF	Output-side rectifier output / regulator input; connect to a 0.1 µF/16 V external filter capacitor.
11	V_{DD2A}	Isolated DC-DC convertor output
12	NC	No internal connection
13	OUT_2	Data out, channel 1
14	OUT_1	Data out, channel 2
15	GND_2	Ground return for V_{DD2} (pins 9 and 15 internally connected).
16	V_{DD2B}	Isolated-side power supply input (connect to pin 11 and bypass with 10 µF for normal operation).



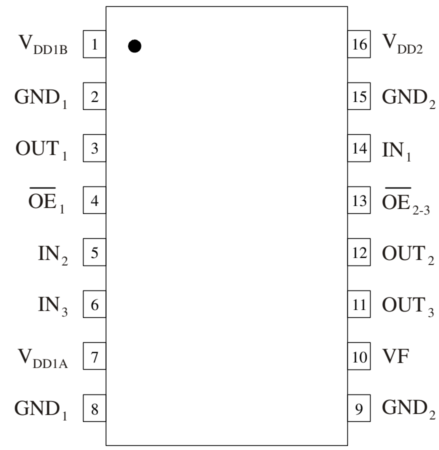
IL7612V / IL7812V Pin Connections

1	V_{DD1B}	Coupler controller-side power supply input (3.3 V nominal).
2	GND_1	Ground return for V_{DD1} (pins 2 and 8 internally connected).
3	IN_1	Data in, channel 1
4	OUT_2	Data out, channel 2
5	NC	No internal connection
6	NC	No internal connection
7	V_{DD1A}	DC-DC convertor input voltage (3.3 V nominal); bypass with 0.1 µF.
8	GND_1	Ground return for V_{DD1} (pins 2 and 8 internally connected).
9	GND_2	Ground return for V_{DD2} (pins 9 and 15 internally connected).
10	VF	Output-side rectifier output / regulator input; connect to a 0.1 µF/16 V external filter capacitor.
11	V_{DD2A}	Isolated DC-DC convertor output
12	NC	No internal connection
13	IN_2	Data out, channel 1
14	OUT_1	Data in, channel 2
15	GND_2	Ground return for V_{DD2} (pins 9 and 15 internally connected).
16	V_{DD2B}	Isolated-side power supply input (connect to pin 11 and bypass with 10 µF for normal operation).



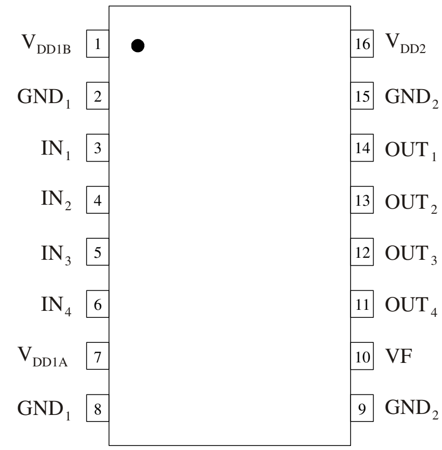
IL7614V / IL7814V Pin Connections

1	V_{DD1B}	Coupler controller-side power supply input (3.3 V nominal).
2	GND_1	Ground return for V_{DD1} (pins 2 and 8 internally connected)
3	OUT_1	Data out, channel 1
4	$\overline{OE}_1$	Channel 1 output enable (if high, OUT_1 = high impedance; has a 500 kΩ nominal internal pulldown)
5	IN_2	Data in, channel 2
6	IN_3	Data in, channel 3
7	V_{DD1A}	DC-DC convertor input voltage (3.3 V nominal); bypass with 0.1 µF.
8	GND_1	Ground return for V_{DD1} (pins 2 and 8 internally connected)
9	GND_2	Ground return for V_{DD2} (pins 9 and 15 internally connected)
10	VF	Output-side rectifier output / regulator input; connect to a 0.1 µF/16 V external filter capacitor.
11	OUT_3	Data out, channel 3
12	OUT_2	Data out, channel 2
13	$\overline{OE}_{2\text{-}3}$	Channel 2 and 3 output enable (if high, OUT_2 and OUT_3 are high impedance; has a 500 kΩ nominal internal pulldown)
14	IN_1	Data in, channel 1
15	GND_2	Ground return for V_{DD2} (pins 9 and 15 internally connected)
16	V_{DD2}	Isolated supply voltage (bypass with 10 µF).



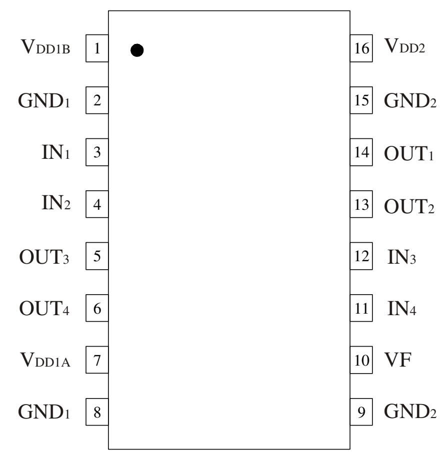
IL7615V / IL7815V Pin Connections

1	V_{DD1B}	Coupler controller-side power supply input (3.3 V nominal).
2	GND_1	Ground return for V_{DD1} (pins 2 and 8 internally connected).
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	V_{DD1A}	DC-DC convertor input voltage (3.3 V nominal); bypass with 0.1 µF.
8	GND_1	Ground return for V_{DD1} (pins 2 and 8 internally connected).
9	GND_2	Ground return for V_{DD2} (pins 9 and 15 internally connected).
10	VF	Output-side rectifier output / regulator input; connect to a 0.1 µF/16 V external filter capacitor.
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} (pins 9 and 15 internally connected).
16	V_{DD2}	Isolated supply voltage (bypass with 10 µF).



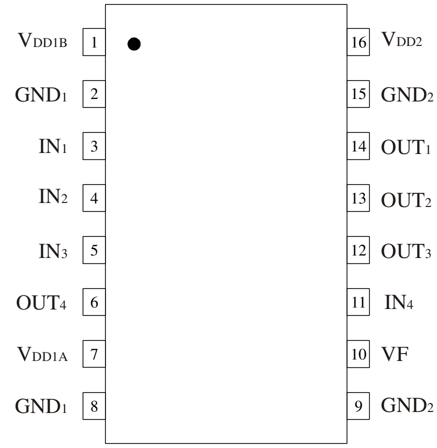
IL7616V / IL7816V Pin Connections

1	V_{DD1B}	Coupler controller-side power supply input (3.3 V nominal).
2	GND_1	Ground return for V_{DD1} (pins 2 and 8 internally connected).
3	IN_1	Data in, channel 1
4	IN_2	Data in, channel 2
5	OUT_3	Data out, channel 4
6	OUT4	Data out, channel 4
7	V_{DD1A}	DC-DC convertor input voltage (3.3 V nominal); bypass with 0.1 µF.
8	GND_1	Ground return for V_{DD1} (pins 2 and 8 internally connected).
9	GND_2	Ground return for V_{DD2} (pins 9 and 15 internally connected).
10	VF	Output-side rectifier output / regulator input; connect to a 0.1 µF/16 V external filter capacitor.
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} (pins 9 and 15 internally connected).
16	V_{DD2}	Isolated supply voltage (bypass with 10 µF).



IL7617V / IL7817V Pin Connections

1	V_{DD1B}	Coupler controller-side power supply input (3.3 V nominal).
2	GND_1	Ground return for V_{DD1} (pins 2 and 8 internally connected).
3	IN_1	Data in, channel 1
4	IN_2	Data in, channel 2
5	IN_3	Data in, channel 3
6	OUT_4	Data out, channel 4
7	V_{DD1A}	DC-DC convertor input voltage (3.3 V nominal); bypass with 0.1 μF.
8	GND_1	Ground return for V_{DD1} (pins 2 and 8 internally connected).
9	GND_2	Ground return for V_{DD2} (pins 9 and 15 internally connected).
10	VF	Output-side rectifier output / regulator input; connect to a 0.1 μF/16 V external filter capacitor.
11	IN_4	Data in, 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} (pins 9 and 15 internally connected).
16	V_{DD2}	Isolated supply voltage (bypass with 10 μF)



Coupler Specifications (V_{DD1B} = 3.3 V; T_{min} to T_{max} unless otherwise stated)

Electrical Specifications						
Parameters	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Conditions**
Controller-side coupler quiescent supply current						
IL7611V / IL7811V	I_{DD1B}		0.01	0.015	mA	
IL7612V / IL7812V			1.2	1.75		
IL7614V / IL7814V			1.2	1.75		
IL7615V / IL7815V			0.3	0.4		
IL7616V / IL7816V			2.4	3.5		
IL7617V / IL7817V			1.2	1.75		
Isolated-side quiescent supply current						
IL7611V / IL7811V	I_{DD2}		2.4	3.5	mA	
IL7612V / IL7812V			1.2	1.75		
IL7614V / IL7814V			2.4	3.5		
IL7615V / IL7815V			4.8	7		
IL7616V / IL7816V			2.4	3.5		
IL7617V / IL7817V			3.6	5.25		
Controller-side dynamic supply current						
IL7611V / IL7811V	I_{DD1B}		0.3	0.5	mA/Mbps	All channels switching
IL7612V / IL7812V			0.15	0.25		
IL7614V / IL7814V			0.3	0.5		
IL7615V / IL7815V			0.6	1		
IL7616V / IL7816V			0.3	0.5		
IL7617V / IL7817V			0.45	0.75		
Isolated-side dynamic supply current						
IL7611V / IL7811V	I_{DD2}		0.02	0.04	mA/Mbps	All channels switching
IL7612V / IL7812V			0.15	0.25		
IL7614V / IL7814V			0.15	0.25		
IL7615V / IL7815V			0.02	0.04		
IL7616V / IL7816V			0.3	0.5		
IL7617V / IL7817V			0.15	0.25		
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 x V_{DD}	0.9 x 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, $V_I = V_{IL}$

Coupler Switching Specifications						
Maximum data rate		100	110		Mbps	C_L = 15 pF
Pulse width[(6)]	PW	10			ns	50% Points, V_O
Propagation delay input to output (high to low)	t_{PHL}		12	18	ns	C_L = 15 pF
Propagation delay input to output (low to high)	t_{PLH}		12	18	ns	C_L = 15 pF
Pulse width distortion[(2)]	PWD		2	3	ns	C_L = 15 pF
Propagation Delay difference between any two parts[(3)]	t_{PSK}		4	6	ns	C_L = 15 pF
Output rise time (10%–90%)	t_R		2	4	ns	C_L = 15 pF
Output fall time (10%–90%)	t_F		2	4	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}		2	3	ns	C_L = 15 pF

Coupler Magnetic Field Immunity[(7)]						
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[(8)]	K_X		2.5			

DC-DC Convertor Specifications

T_{min} to T_{max} and V_{DD1} = 3.0 V to 3.6 V unless otherwise stated						
Parameter	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Conditions**
Output voltage IL761xV	V_{DD2A}	2.7	3.3	3.45	V	I_{DD2A} < 80 mA
IL781xV		4.5	5	5.5		I_{DD2A} < 50 mA
Output current (total available to internal transceiver and external load) IL761xV IL781xV	I_{DD2A}	80 50			mA	
Overcurrent threshold	I_{DD2A}		150		mA	Disable
			145			Re-enable
Short-circuit protection limited current		115	125	135	mA	
Controller-side quiescent supply current	I_{DD1AQ}		200	240	mA	No external load on V_{DD2}
Controller-side supply current	I_{DD1A}		380	440	mA	Maximum DC-DC convertor load
Line regulation	$\Delta V_{DD2}/\Delta V_{DD1A}$		32	40	mV/V	25 °C
			16			125 °C
Load regulation	$\Delta V_{DD2}/V_{DD2}$		5	6	%	I_{DD2} = 0 to max.
Output voltage temperature coefficient	$(\Delta V_{DD2}/V_{DD2}) / \Delta T$		0.017 0.03		%/C	I_{DD2} = 10 mA I_{DD2} = 50 mA
Capacitive load	C_{DD2}			1000	µF	
Output voltage ripple	$V_{DD2\text{-}RIPPLE}$			5	$mV_{P\text{-}P}$	20 MHz bandwidth; I_{DD2} = max.
			1			1 kHz bandwidth; I_{DD2} = max.
Start-up time	t_{SU}	2			ms	I_{DD2} = 0
				6		I_{DD2} = max.
Convertor frequency	f_{OSC}	105	113	120	MHz	

Isolation Specifications

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Isolation voltage*	V_{ISO}	6000			V_{RMS}	Per VDE 0884-17
Working Voltage	V_{IORM}	600			V_{RMS}	
Transient overvoltage	V_{IOTM}	6000			V_{PK}	
Surge immunity		6400			V_{PK}	
Creepage distance (external)		8.03	8.3		mm	Per IEC 60601
Total barrier thickness (internal)		0.012	0.016		mm	
Barrier resistance	R_{IO}		$>10^{14}$		Ω	500 V_{RMS}
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
Barrier life			44000		Years	100°C, 1000 V_{RMS}, 60% CL activation energy

* VDE 0884-17 Basic Isolation certified under VDE File Number 5016933-4880-0001.
UL 1577 approved under Component Recognition Program File Number E207481.
Parts 100% tested at 7.2 kV_{RMS} (10.2 kV_{PK}) for 1 second, 5 pC partial discharge limit under the stringent IEC60747-17 standard.
Each lot sample tested at 6 kV_{RMS} (8.5 kV_{PK}) for 1 minute.

- 2xMOPP compliant under IEC 60601-1 for medical systems (isolation voltage ≥4 kV_{RMS}; creepage ≥8 mm).
- Compliant with IEC 60950-1 and IEC 62368-1 end equipment standards.

Thermal Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Junction–ambient thermal resistance	θ_{JA}		67		°C/W	Double-sided PCB with thermal vias in free air
Junction–case (top) thermal resistance	θ_{JC}		12			
Junction–ambient thermal resistance	θ_{JA}		46			2s2p PCB with thermal vias per JESD51 with thermal vias in free air
Junction–case (top) thermal resistance	θ_{JC}		9			
Power dissipation	P_D			1.6	W	

Notes:

1. Absolute Maximum specifications mean 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 1–8 shorted and pins 9–16 shorted.
6. Minimum pulse width is the minimum value at which specified PWD is guaranteed.
7. The relevant test and measurement methods are given in the Electromagnetic Compatibility section.
8. 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 in the Electromagnetic Compatibility section).

Device Operation

DC-DC Convertor Operation

The DC-DC convertor block diagram is shown in Figure 1:

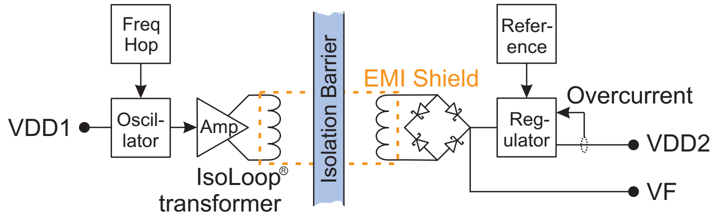


Figure 1. DC-DC convertor block diagram.

A 113 MHz oscillator drives a high-frequency power amplifier, which in turn drives an IsoLoop® microtransformer primary. Frequency hopping reduces EMI peak amplitudes, and embedded magnetic shielding further reduces radiated EMI.

A unique ceramic/polymer composite barrier provides best-in-class 5 kV isolation with virtually unlimited barrier life.

On the other side of the isolation barrier, the transformer secondary output is filtered, rectified, and regulated by a low-EMI low drop-out regulator with a precision bandgap voltage reference.

Simple Capacitive Decoupling

The only external parts required are a 0.1 µF capacitor placed as close as possible to the V_{DD1B} supply pin, a 10 µF ceramic capacitor for the V_{DD2} pin, and a 0.1 µF/16 V filter capacitor near the V_F pin. The low external parts count reduces board area and cost.

Soft Start-up

The two millisecond minimum startup time of allows control electronics stabilize before powering isolated-side electronics.

Short-Circuit Protection

The output current is internally limited to approximately 125 mA. This provides short-circuit protection and eliminates the need for external protection circuitry.

Optional External Regulation

An external regulator can be used in place of the parts' internal low drop-out regulator for voltages up to approximately 8 volts. The maximum output current decreases at higher regulator output voltages, but the output power capacity remains approximately 250 milliwatts.

GMR Isolator Operation

An equivalent circuit for each of the Giant Magnetoresistor (GMR) isolator channels is shown in Figure 2:

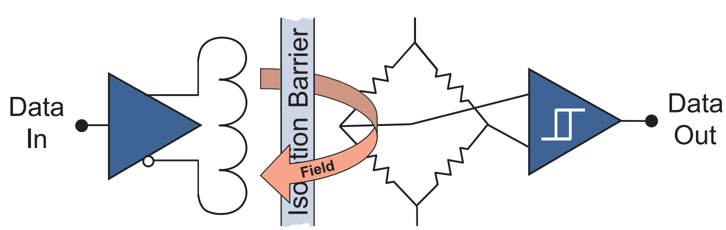


Figure 2. Isolator model signal path.

The GMR isolator signal path starts with a buffered input signal that is driven through an ultraminiature coil. This generates a small magnetic field that changes the electron spin polarization of GMR resistors, which are configured as a Wheatstone bridge. The change in spin polarization of the resistors creates a bridge voltage which drives an output comparator to construct an isolated version of the input signal. GMR is inherently high speed and low distortion.

Dynamic Power Consumption
NVE 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 mark-to-space ratio.

Power consumption increases with frequency for the input side of each channel, but output-side power consumption is constant for a particular isolator channel. For channels with inputs on the V_{DD2} side, the dynamic power consumption must be provided by the DC-DC convertor, so V_{DD1B} supply current increases with the frequency of that channel.

Coupler Status on Start-up and Shut Down
To minimize power dissipation, coupler input signals are differentiated and then latched on the output side of the isolation barrier to reconstruct the signal. This could result in an ambiguous output state depending on power up, shutdown and power loss sequencing. Therefore, the designer should consider including an initialization signal in the start-up circuit. Initialization consists of toggling the input either high then low, or low then high.

Current Drawn from the Output of the DC-DC Convertor by the Coupler Section
The current drawn from the output of the DC-to-DC convertor by the coupler section consists of the coupler's isolated-side quiescent current, plus, in the case of the IL7614V, isolated-side dynamic current. So, for example, for an IL7614V, the isolated-side quiescent current is 3.5 mA, the dynamic current is 0.24 mA/Mbps, so if the coupler is running at 100 Mbps, the dynamic current is 24 mA and the total current is 27.5 mA. Since the DC-DC convertor can supply up to 80 mA, the IL7614 can therefore supply up to 52.5 mA to external loads. Of course, the DC-DC convertor can supply more if the coupler channels are running below full speed.

Overall Operation

EMI Mitigation
Electromagnetic compatibility is regulated by international standards such as IEC 61000-4-x and CISPR 32. Although system-level performance depends on board design and layout, IL761xV and IL781xV parts incorporate embedded magnetic shielding to reduce radiated EMI and frequency hopping to reduce EMI peak amplitudes. This inherently low EMI eliminates the need for shielding or external mitigation components such as ferrite beads. The parts are fully EN 55032 CISPR 32 Class B compliant with no EMI mitigation components and only 12 pF of input-to-output stitching capacitance. The capacitance can be created in a four-layer PCB by extending the GND1 and GND2 ground planes into the PCB isolation area. External stitching capacitor components are generally not recommended due to parasitic inductance above one gigahertz. See Fig. 13 for a typical schematic, and Application Bulletin AB-29 for a recommended PCB layout.

Power and Thermal Management
Note that self-heating generated by the quiescent current of the DC-to-DC convertor generally limits the ambient operating temperature to less than 125 °C to avoid exceeding the 150 °C Absolute Maximum junction temperature. The isolator section will operate at 125 °C, however, if the DC-to-DC convertor is not used or is duty cycled.

IL761xV and IL781xV parts typically operate well within the current limits of the DC-DC convertor unless the coupler is operating at high speed or there are external loads on the DC-DC convertor. Internal thermal management circuitry gradually limits the output voltage and power output as the junction temperature increases to avoid thermal overload. The coupler section is guaranteed to operate at the 2.7 volt minimum DC-DC convertor output voltage with 250 mW output power.

Board Thermal Optimization
Board layout can be optimized for thermal performance if necessary. A double-sided, double buried power plane (“2s2p”) board maximizes thermal performance. Thermal vias should be used between the power plane and the board surfaces. All of the IC ground pins should be connected, with wide traces to help cool the leadframe.

Ideal for Medical Systems
Patient-applied parts electrically connected to the patient in body-floating medical systems generally require two means of patient protection (2xMOPP). IL761xV and IL781xV parts meet the 2xMOPP requirements of 4 kV_{RMS} isolation and true 8 mm creepage.

2xMOPP AC/DC power supplies are difficult to find and expensive. An inexpensive 2xMOOP power supply can supply the operator interface, while a 2xMOPP compliant IL761xV or IL781xV DC-to-DC converter can power the patient-applied electronics. The power requirements of the patient-applied electronics are generally low and can be satisfied with the internal DC-to-DC converter. Figure 18 shows a typical circuit.

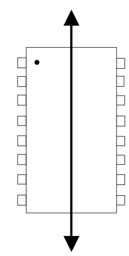
Maintaining Creepage
Creepage distances are often critical in isolated circuits. In addition to meeting JEDEC standards, NVE isolator packages have unique creepage specifications. Standard pad libraries often extend under the package, compromising creepage and clearance. Similarly, ground planes, if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

Inherently Low EMI
IL761xV and IL781xV parts are designed for compliance with IEC 61000-6-3, IEC 61000-6-4, CISPR, and FCC Class B standards for emissions. The DC-DC convertor oscillator operates above 88 MHz, where emission limits are higher since there is less risk of interference with common commercial radio and television broadcasting.

Frequency-hopping technology dramatically reduces peak EMI, and synchronous rectification and PWM control are avoided, resulting in inherently low EMI.

This inherently low EMI allows CISPR and FCC compliance without shielding or external components such as ferrite beads. The parts are fully compliant with EN 55032 CISPR 32 Class B with just a small amount of stitching capacitance.

High Magnetic Immunity
These parts are fully compliant with IEC 61000-6-1 and IEC 61000-6-2 magnetic immunity standards. The coupler'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.



Typical Performance Graphs

The following graphs show typical performance:

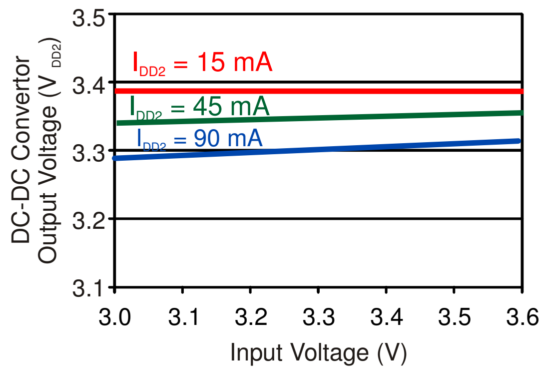


Figure 3. Typical DC-DC convertor line regulation.

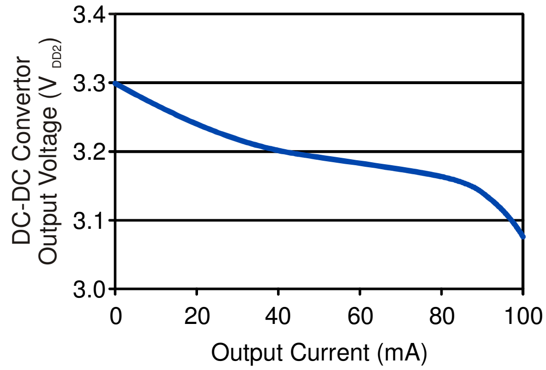


Figure 4. Typical DC-DC convertor load regulation (IL76xx; V_{DD1} = 3.3 V).

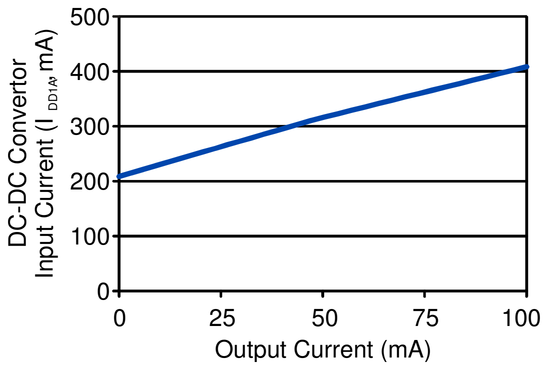


Figure 5. Typical DC-DC convertor supply current versus output current (V_{DD1} = 3.3 V).

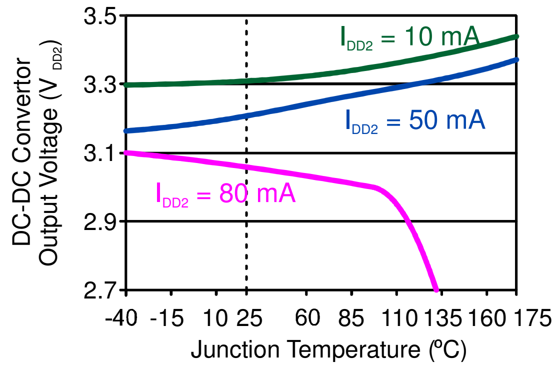


Figure 6. Typical DC-DC convertor output versus temperature (IL76xx; V_{DD1A} = 3.3 V).

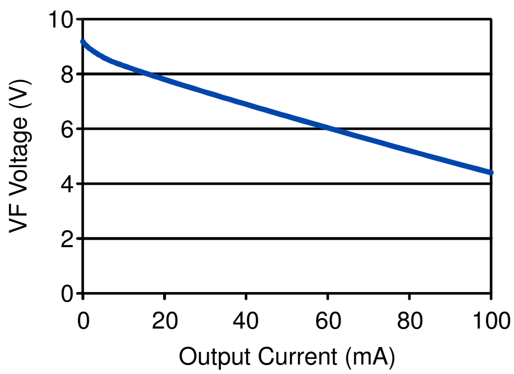


Figure 7. Typ. unregulated output vs. output current (V_{DD1A} = 3.3 V; 25 °C).

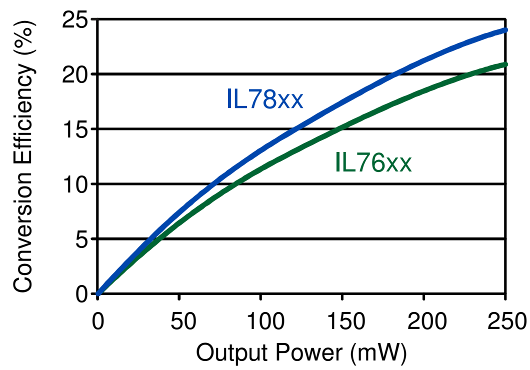


Figure 8. Typical DC-to-DC convertor power efficiency (V_{DD1A} = 3.3 V; 25 °C).

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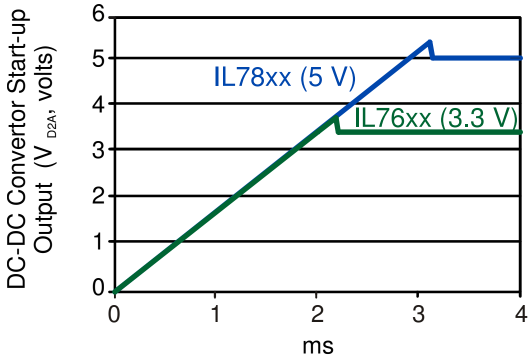

Figure 9. Typical DC-to-DC convertor start-up voltage (no load).

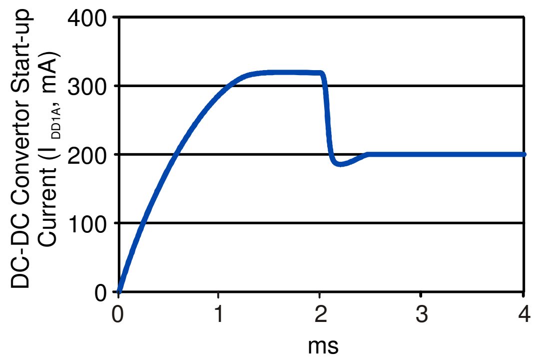

Figure 10. Typical DC-to-DC convertor start-up current (no load).

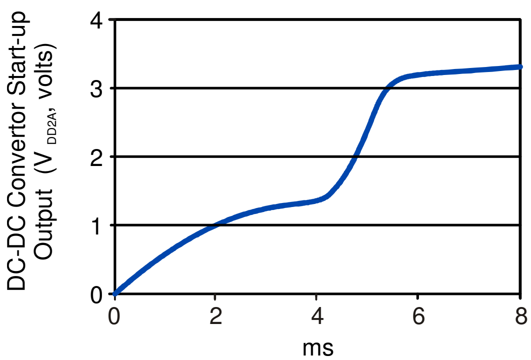

Figure 11. Typical DC-to-DC convertor start-up voltage (IL76xx; maximum load).

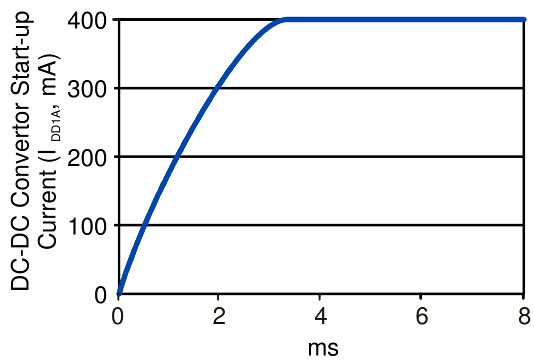

Figure 12. Typical DC-to-DC convertor start-up current (maximum load).

Application Circuits

Basic recommended circuit:

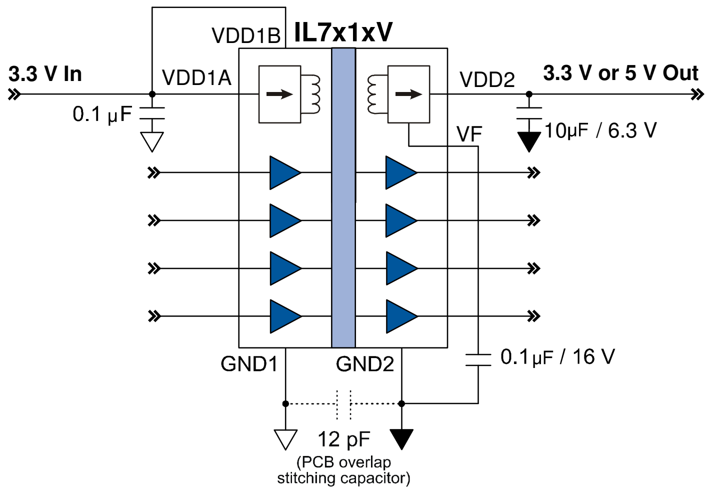

Figure 13. Typical IL7x1xV circuit.

Bypass capacitors are required on the VDD1, VDD2, and VF pins as shown. The small input-to-output ground stitching capacitance is recommended for EMI mitigation. It can be a discrete capacitor or created using PCB ground-plane overlap.

Isolated SPI interface to ADC:

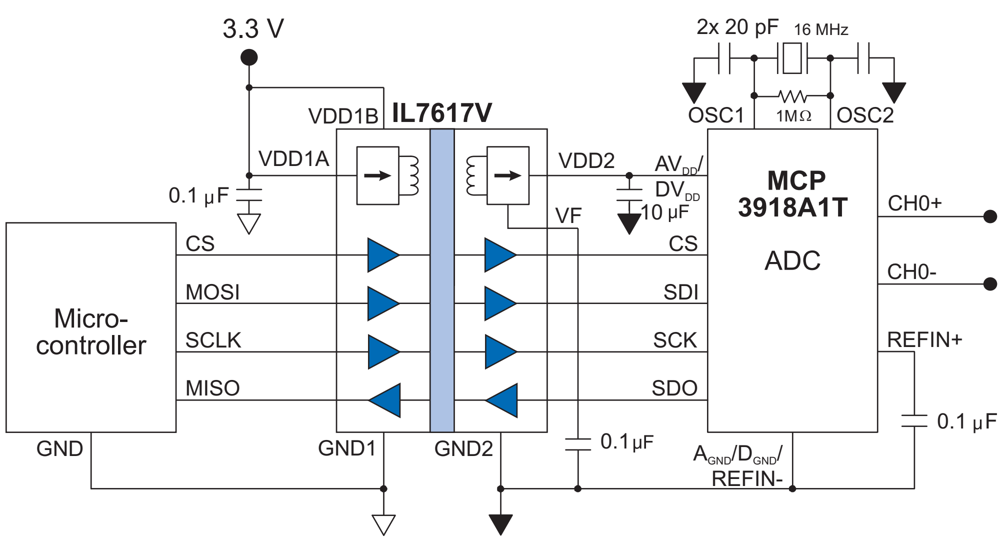

Figure 14. Isolated bidirectional SPI ADC interface.

The IL7617V provides three transmit and one receive channel, making it ideal for isolating ubiquitous bidirectional SPI peripherals such as ADCs. The isolation allows safe connections to line voltage, and the isolated power supply prevents microcontroller noise from affecting the ADC.

Isolated SPI sensor interface:

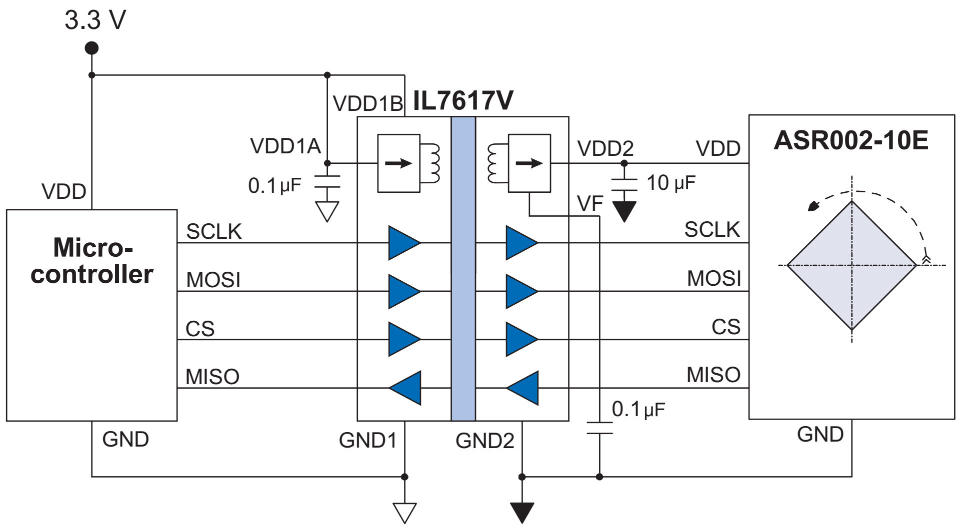

Figure 15. Isolated SPI sensor interface.

The IL7617VE provides three transmit and one receive channel, making it ideal for isolating classic SPI sensors. The isolated power supply prevents noise from the microcontroller from affecting the sensor.

Isolated SPI / MICROWIRE interface to transmit-only ADC:

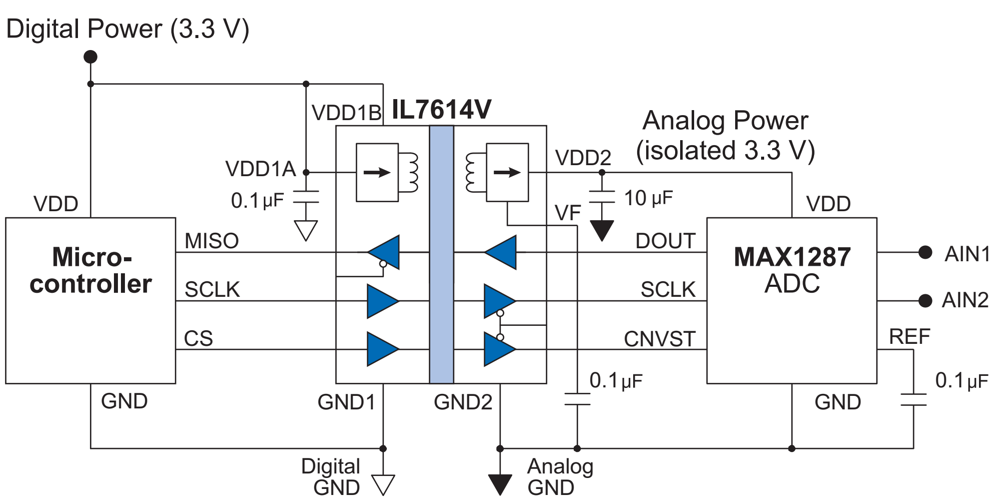

Figure 16. Isolated ADC serial interface.

Only three channels of isolation are required for transmit-only SPI peripherals such as ADCs or sensors. The IL7614V provides an isolated analog power supply to significantly improve the noise performance of a successive-approximation ADC, and also isolates the serial interface.

Isolated shunt-based electric meter interface:

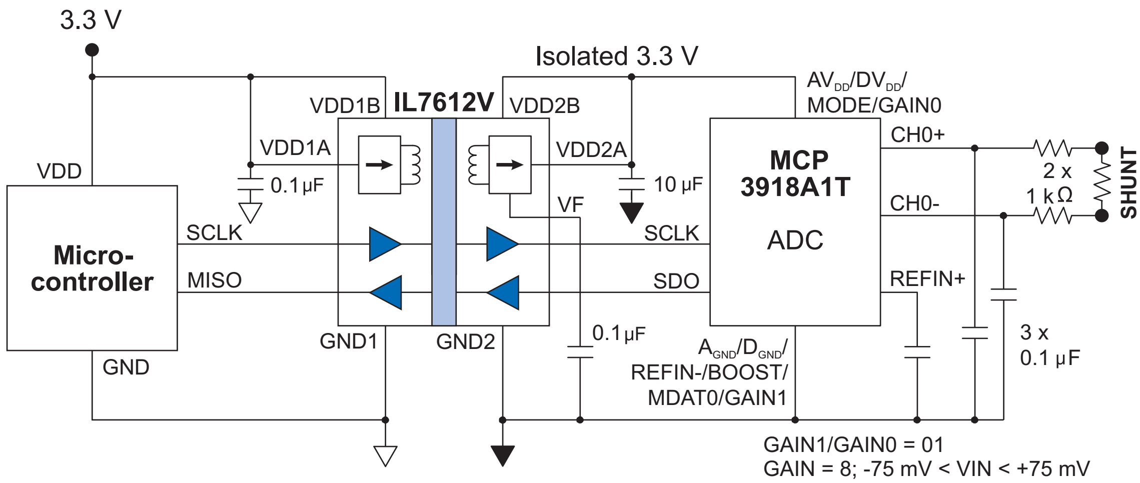

Figure 17. Isolated shunt-based current sensing.

Just two channels are needed for ADCs with two-wire serial interfaces and no chip-selects or other interface lines. The IL7812V's boost convertor can power classic five-volt ADCs such as the ADS1252U, and allows analog inputs above the 3.3-volt system supply for 3.3 to 5-volt ADCs such as the LTC2400-series.

Isolated shunt-based electric meter interface:

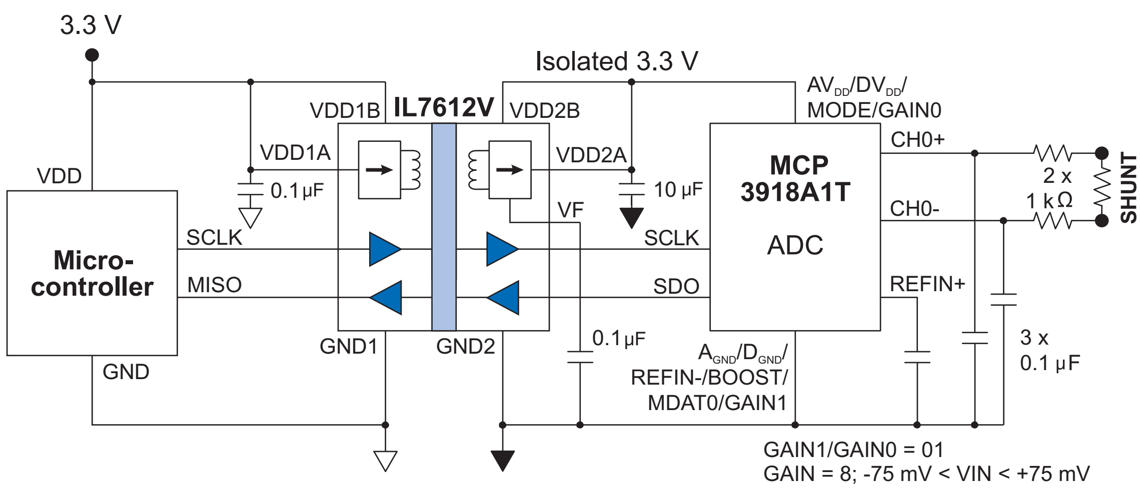

Figure 18. Isolated shunt-based current sensing.

The circuit above takes advantage of the "two-wire interface mode" of an MCP3918 analog front end for shunt-based current sensing. Unlike most optocouplers, the IL7612V isolator section is fast enough for the front-end's 20 MHz high-speed SPI.

Isolated SPI for receive-only DACs:

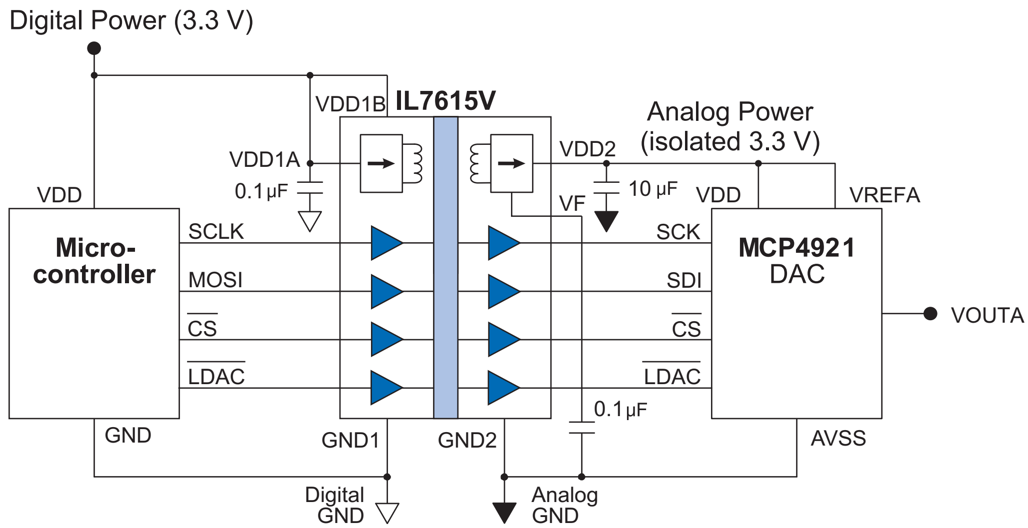

Figure 19. Isolated four-channel DAC interface.

The IL7615V provides four transmit channels of isolation for receive-only DACs with SPI plus additional lines. In the example above, the LDAC synchronization line is isolated, which transfers data from the serial interface latches to the output latches, as well as the SPI lines (SCLK, MOSI, and CS).

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Double-isolated asynchronous parallel DAC interface:

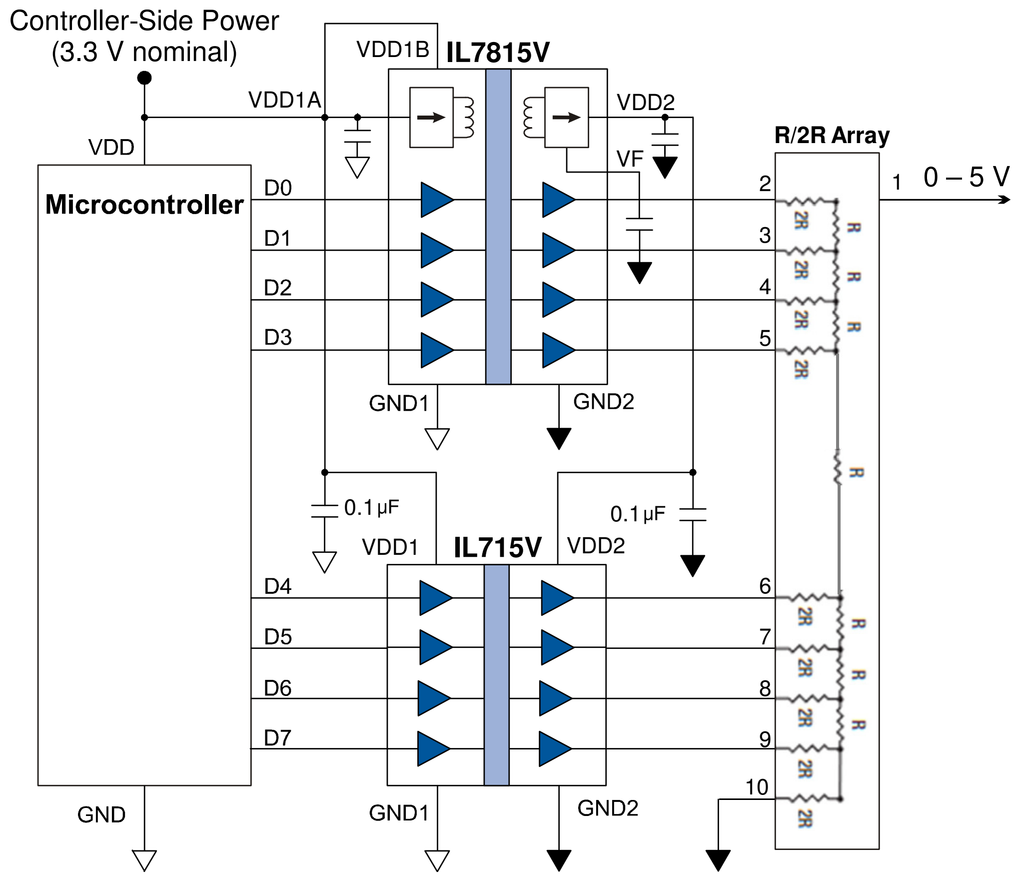


Figure 20. Double-isolated asynchronous parallel DAC interface.

The IL7615V plus an IL715V provide isolated power and a full byte of isolation. Since the IL7815V and IL715V have rail-to-rail outputs and the IL7815V's integrated DC-to-DC convertor has extremely low output ripple, an inexpensive R/2R network can be used as a DAC. Alternatively, the IL7815V's boost convertor can power a classic five-volt DAC such as an AD557.

Double-isolated parallel DAC interface:

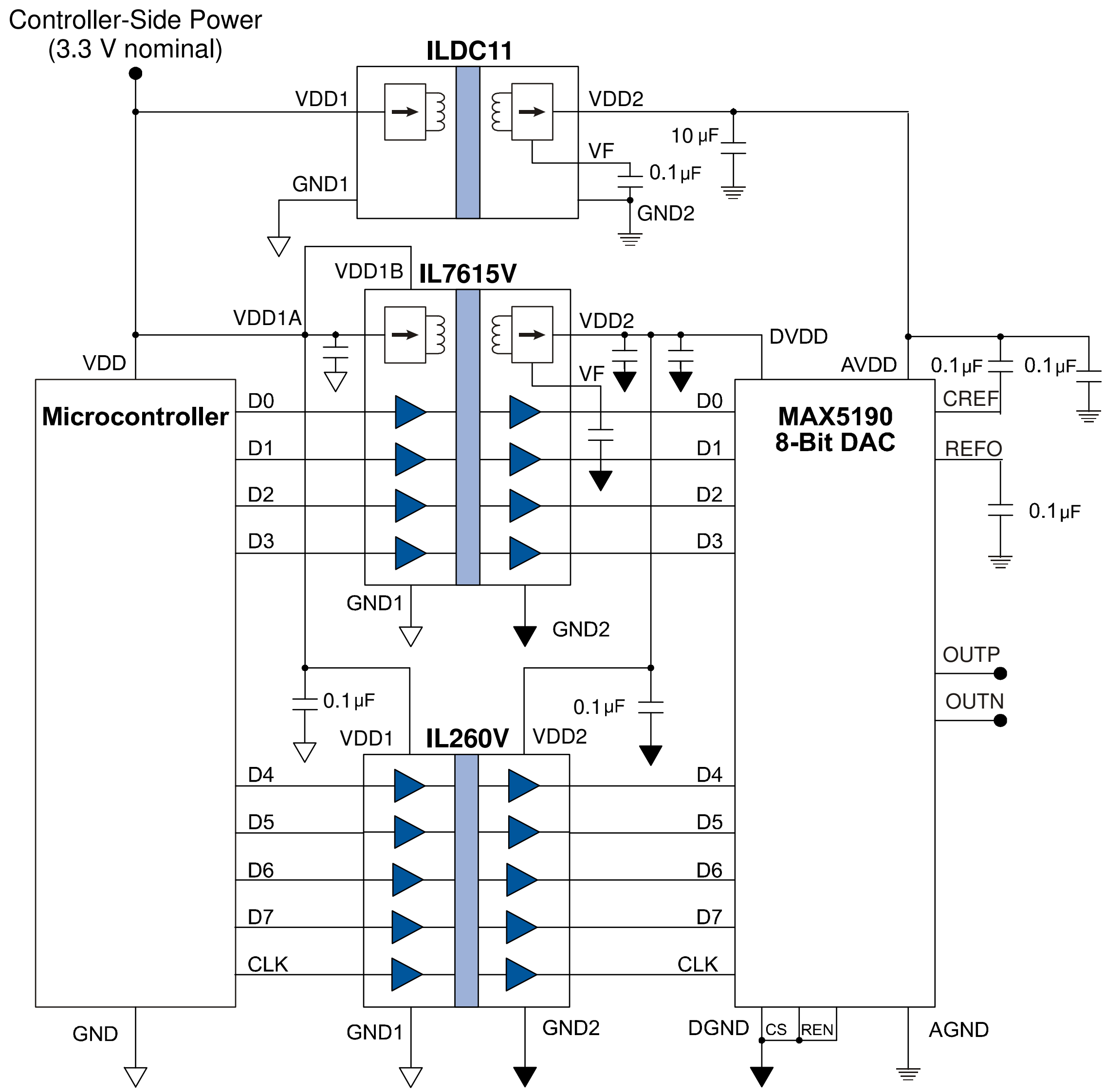


Figure 21. Double-isolated parallel DAC interface.

The IL7615V plus an IL260V provide isolated digital power and nine channels of isolation. This allows isolation of an eight-bit parallel peripheral such as a high-speed digital-to-analog convertor. The 110 Mbps speed of the IL7615V and IL260V couplers support the 40 MHz DAC used in this circuit. A separate ILDC11 DC-DC convertor provides an isolated analog power supply to improve noise performance by preventing digital noise from affecting the analog section of the DAC. The ILDC11's extremely low ripple also enhances the DAC's noise performance.

Isolated interface to multiple SPI sensors:

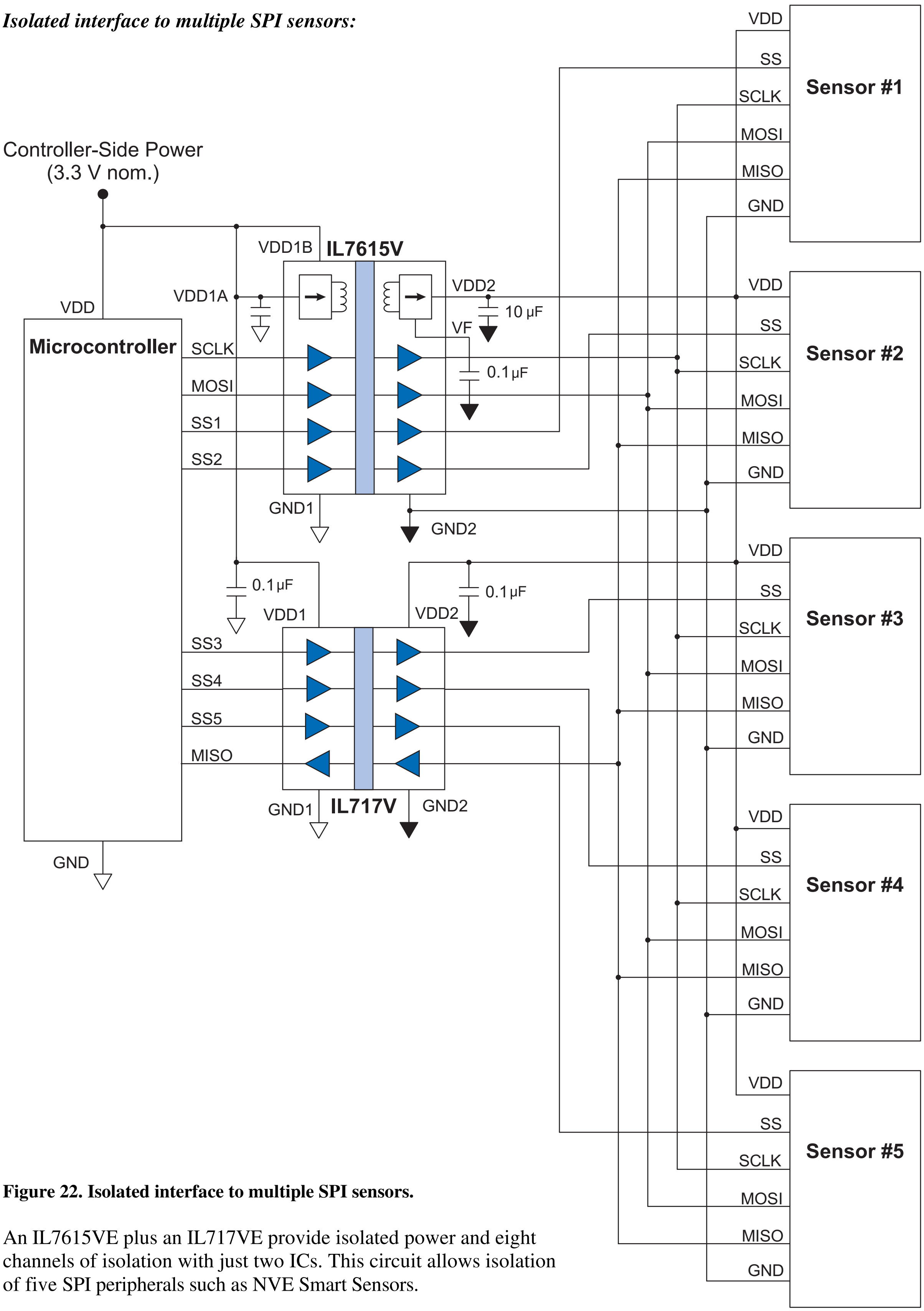


Figure 22. Isolated interface to multiple SPI sensors.

An IL7615VE plus an IL717VE provide isolated power and eight channels of isolation with just two ICs. This circuit allows isolation of five SPI peripherals such as NVE Smart Sensors.

Medical System Isolation:

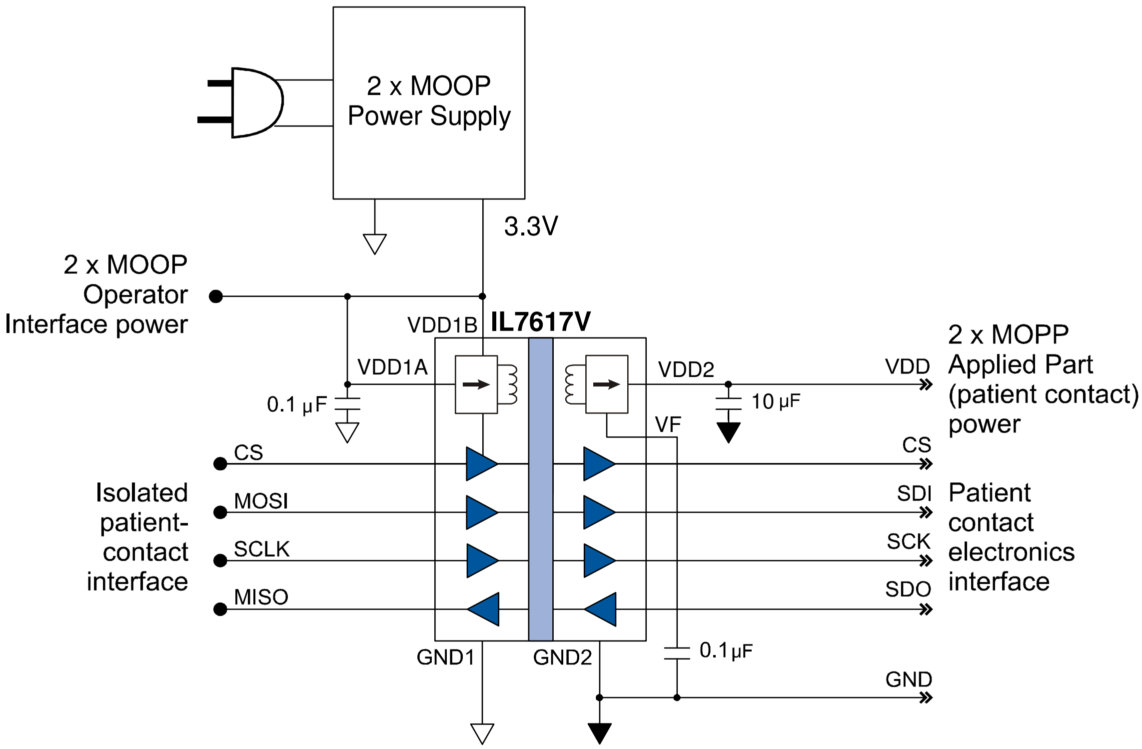


Figure 23. Medical system isolation.

Combining a double Means of Operator Protection (2 x MOOP) power supply with a double Means of Patient Protection (2xMOPP) IL761xV or IL781xV provides cost-effective compliance with IEC 60601 for body-floating medical systems. The power requirements of the patient-applied electronics are generally low and can be satisfied with the IL761xV / IL781xV DC-to-DC convertor. The data coupler section can transfer data between the operator interface electronics and the patient-contact electronics (via SPI in the example above).

16 mm Creepage:

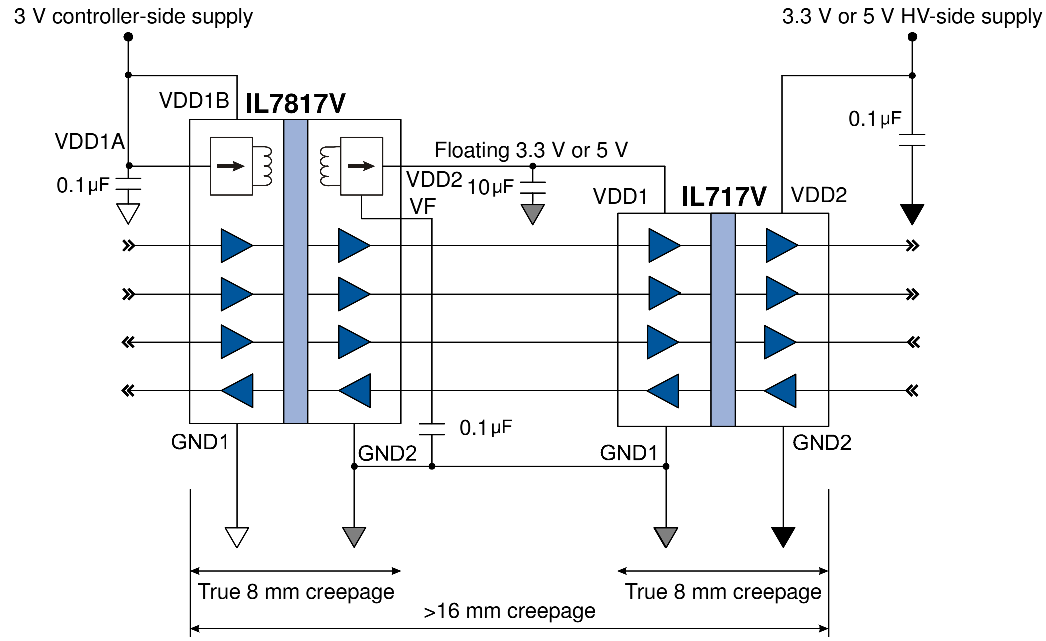


Figure 24. 16 mm creepage with two isolators.

Combining two guaranteed eight-millimeter creepage packages in series provides more than 16 millimeter creepage in a small, convenient form factor. This meets the requirements for 500 V_{RMS} working voltage under IEC 60601.

5-volt to 3.3-volt isolation:

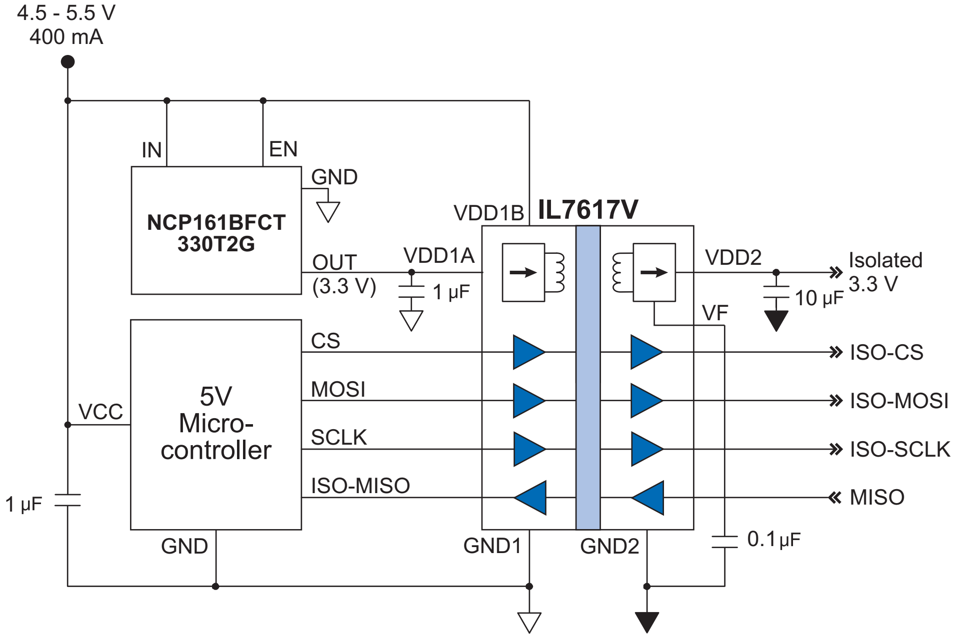
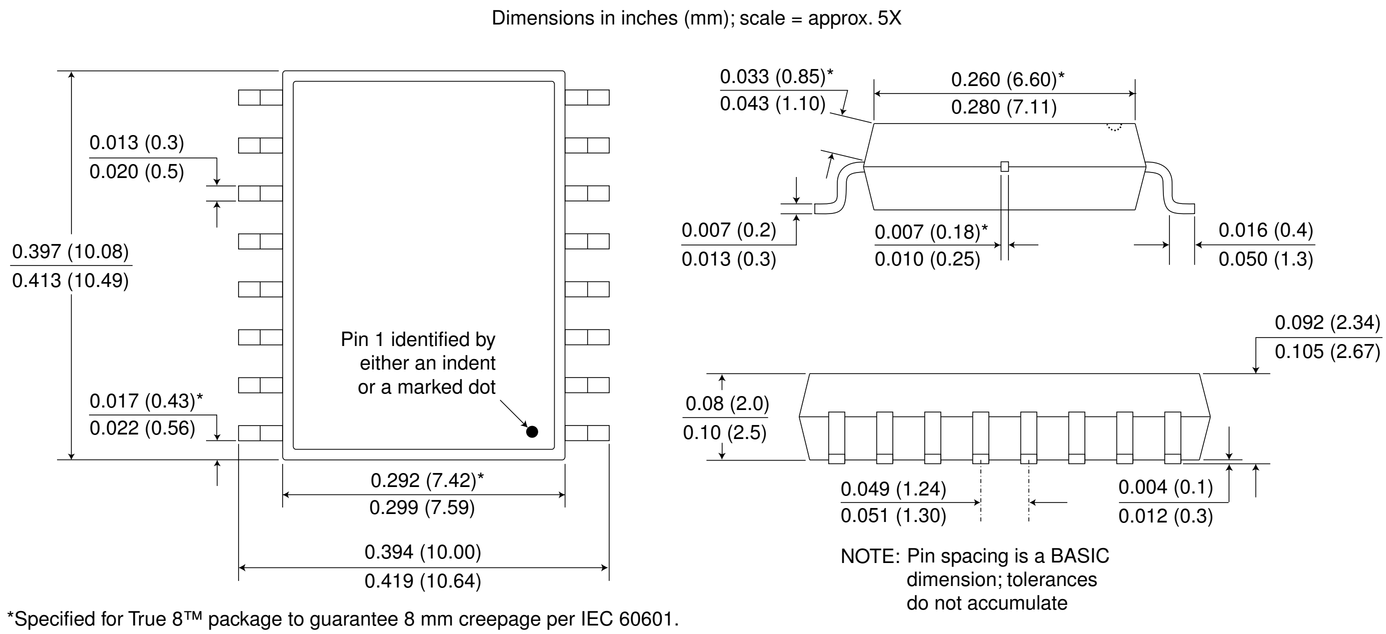


Figure 25. 5-volt to 3.3-volt isolation.

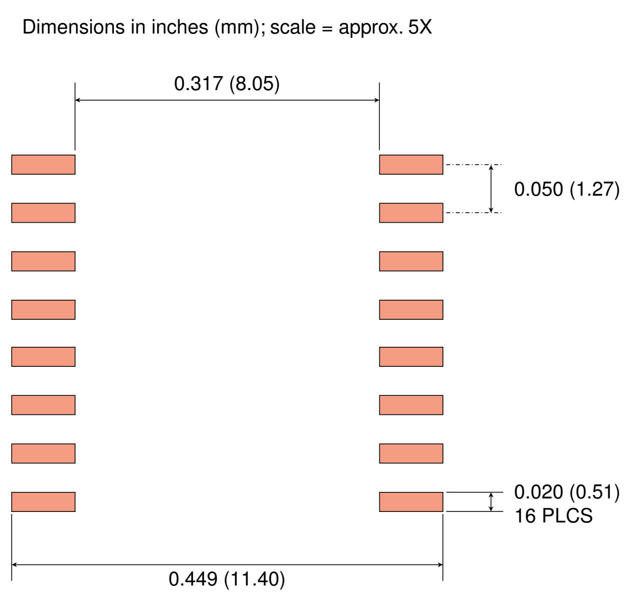
An inexpensive external regulator can be used to accommodate a five-volt input to the DC-DC convertor. For higher efficiency, a buck switching regulator such as a LM3691-3.3 can be used.

Package Drawing



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

Recommended Pad Layout



Available Part Numbers (IL761xV)

Part Number	Bus Voltage	Channels (transmit/receive)	Bulk Packaging	RoHS?
IL7611VE	3.3 V	2 / 0	Tubes (50 pcs.)	RoHS
IL7612VE		1 / 1		
IL7614VE		2 / 1		
IL7615VE		4 / 0		
IL7616VE		2 / 2		
IL7617VE		3 / 1		
IL7611VE-TR7		2 / 0	7-inch reels (up to 450 pcs.)	
IL7612VE-TR7		1 / 1		
IL7614VE-TR7		2 / 1		
IL7615VE-TR7		4 / 0		
IL7616VE-TR7		2 / 2		
IL7617VE-TR7		3 / 1		
IL7612VE-TR13		1 / 1	13-inch reels (up to 1500 pcs.)	
IL7614VE-TR13		2 / 1		
IL7614VE-TR13		2 / 1		
IL7615VE-TR13		4 / 0		
IL7616VE-TR13		2 / 2		
IL7617VE-TR13		3 / 1		
IL7611V		2 / 0	Tubes (50 pcs.)	SnPb finish (non-RoHS; Special Order)
IL7612V		1 / 1		
IL7614V		2 / 1		
IL7615V		4 / 0		
IL7616V		2 / 2		
IL7617V		3 / 1		
IL7611V-TR7		2 / 0	7-inch reels (up to 450 pcs.)	
IL7612V-TR7		1 / 1		
IL7614V-TR7		2 / 1		
IL7615V-TR7		4 / 0		
IL7616V-TR7		2 / 2		
IL7617V-TR7		3 / 1		
IL7611V-TR13		2 / 0	13-inch reels (up to 1500 pcs.)	
IL7612V-TR13		1 / 1		
IL7614V-TR13		2 / 1		
IL7615V-TR13		4 / 0		
IL7616V-TR13		2 / 2		
IL7617V-TR13		3 / 1		

Available Part Numbers (IL781xVE)

Part Number	Bus Voltage	Channels (transmit/receive)	Bulk Packaging	RoHS?
IL7811VE	5 V	2 / 0	Tubes (50 pcs.)	RoHS
IL7812VE		1 / 1		
IL7814VE		2 / 1		
IL7815VE		4 / 0		
IL7816VE		2 / 2		
IL7817VE		3 / 1		
IL7811VE-TR7		2 / 0	7-inch reels (up to 450 pcs.)	
IL7812VE-TR7		1 / 1		
IL7814VE-TR7		2 / 1		
IL7815VE-TR7		4 / 0		
IL7816VE-TR7		2 / 2		
IL7817VE-TR7		3 / 1		
IL7812VE-TR13		1 / 1	13-inch reels (up to 1500 pcs.)	
IL7814VE-TR13		2 / 1		
IL7814VE-TR13		2 / 1		
IL7815VE-TR13		4 / 0		
IL7816VE-TR13		2 / 2		
IL7817VE-TR13		3 / 1		
IL7811V		2 / 0	Tubes (50 pcs.)	SnPb finish (non-RoHS; Special Order)
IL7812V		1 / 1		
IL7814V		2 / 1		
IL7815V		4 / 0		
IL7816V		2 / 2		
IL7817V		3 / 1		
IL7811V-TR7		2 / 0	7-inch reels (up to 450 pcs.)	
IL7812V-TR7		1 / 1		
IL7814V-TR7		2 / 1		
IL7815V-TR7		4 / 0		
IL7816V-TR7		2 / 2		
IL7817V-TR7		3 / 1		
IL7811V-TR13		2 / 0	13-inch reels (up to 1500 pcs.)	
IL7812V-TR13		1 / 1		
IL7814V-TR13		2 / 1		
IL7815V-TR13		4 / 0		
IL7816V-TR13		2 / 2		
IL7817V-TR13		3 / 1		

Revision History

ISB-DS-001-IL761xV-IL781xV-Rev. F
April 2024

Change
- Increased V-Series isolation specification from 4 kV_{RMS} to 6 kV_{RMS} (8.5 kV_{PK}), lot codes ≥240000.

ISB-DS-001-IL761xV-IL781xV-Rev. E
Feb. 2024

Change
- Added two-wire ADC application circuit (Fig. 17), asynchronous parallel application circuit (Fig. 20), and 16 mm creepage (Fig. 24).

ISB-DS-001-IL761xV-IL781xV-Rev. D
Sept. 2023

Change
- Added CISPR 32 Class B compliance and stitching capacitor recommendation (p. 11).
- Added basic application circuit (Fig. 13, p. 15).

ISB-DS-001-IL761xV-IL781xV-Rev. C
October 2022

Changes
- Added and IL781xV-Series (3.3-to-5 V DC-to-DC convertors).
- Eliminated startup current specification with soft-start on lots 22xxxx and higher (p. 2).
- Added IEC 60601 medical equipment standards (p. 3).
- Added equipment-level safety standards such as IEC 62368-1 (p. 3).
- Upgraded to VDE 0884-17 certification (p. 9).
- Changed isolation and working voltages under the more stringent standard (p. 9).
- Added section on EMI mitigation (p. 11).
- Added section on medical systems (p. 11).
- Replaced DC-to-DC convertor “Start-up Current” paragraph with soft start-up description.
- Changed typical performance graphs with addition of soft-start (Figs. 9 – 12).
- Changed isolation and working voltages under the more stringent standard (p. 9).
- Added diagram for medical system isolation (Fig. 20).

ISB-DS-001-IL76xx-Rev. B
September 2021

Changes
- Corrected IL7616V (p. 5) and IL7617V (p. 6) pin-out diagrams.
- Changed isolation voltage to 4 kV under the more stringent IEC60747-17 standard.

ISB-DS-001-IL76xx-Rev. A
April 2021

Changes
- Added IL7611V and IL7612V.
- Changed Absolute Maximum storage and junction temperatures to 150 °C.
- Added VF vs. output current typical performance graph.
- Added descriptions of external regulator options.
- Added IL7617V / ADC application circuit (Figure 11).
- Added IL7612V / ADC application circuit (Figure 14).
- Added IL7615V / DAC application circuit (Figure 15).

ISB-DS-001-IL76xx-PRELIM3
August 2020

Changes
- Added thermal shutdown protection (p. 9) and graph (Figure 6).
- Added start-up current specification (p. 6) and typical graph (Figure 9).

ISB-DS-001-IL76xx-PRELIM2
July 2020

Change
- Added IL7616 and IL7617.

ISB-DS-001-IL76xx-PRELIM
July 2020

Change
- Preliminary release.

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