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Find the *National Instruments USB-8451* at our website: ***Click HERE***

SPECIFICATIONS

USB-8451 OEM

This user guide describes how to use the National Instruments USB-8451 OEM I^2C/SPI communication device.

The NI USB-8451 OEM is a full-speed USB 2.0 device that provides I^2C and SPI connectivity with eight SPI chip selects and eight general-purpose DIO channels.

Dimensional Drawings

Figure 1 shows a top view of the USB-8451 OEM. Figure 2 shows the front and rear dimensions.

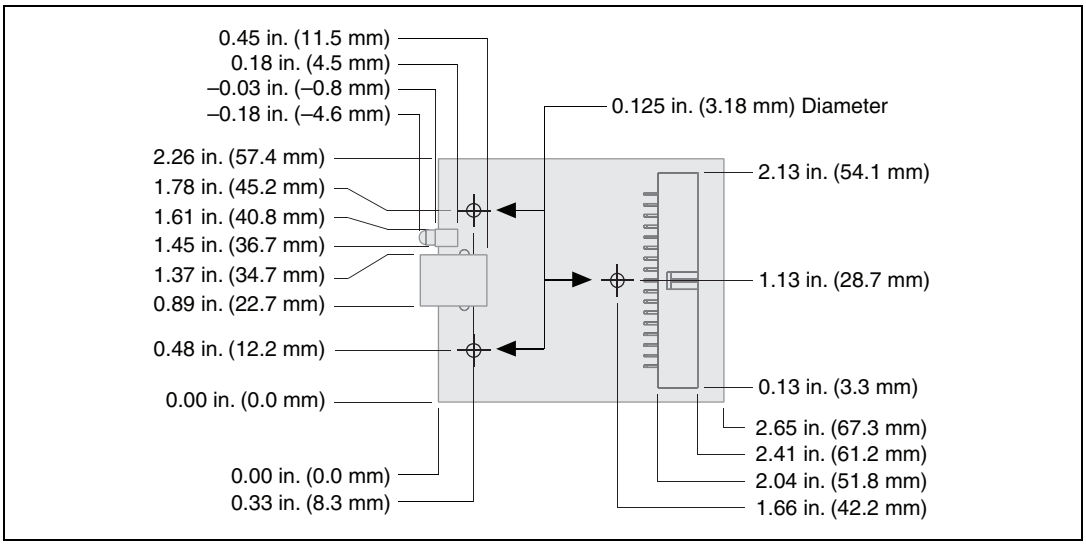


Figure 1. USB-8451 OEM Dimensions (Top View)

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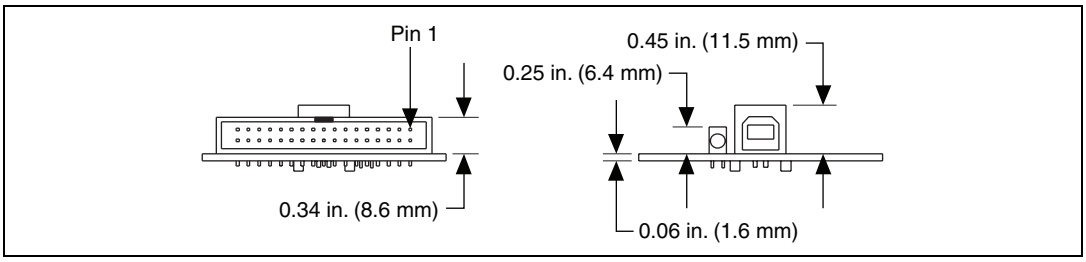


Figure 2. USB-8451 OEM Dimensions (Front and Rear Views)

Block Diagram

Figure 3 shows key functional components of the USB-8451 OEM.

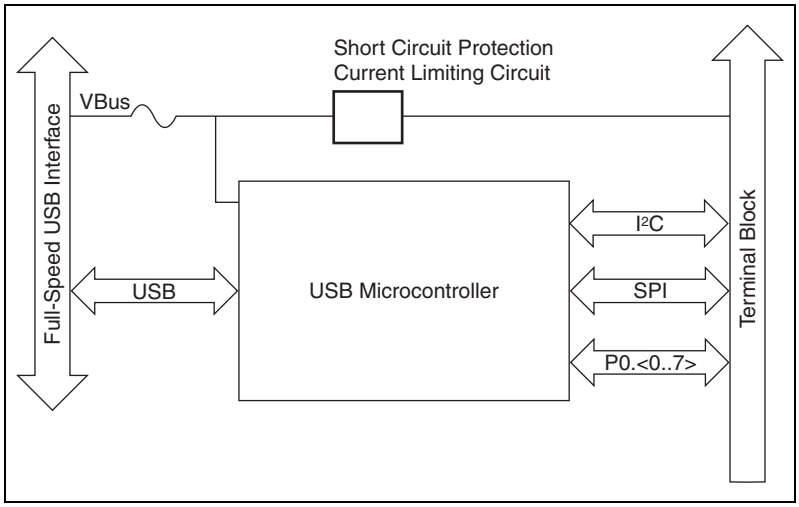


Figure 3. Device Block Diagram

Refer to the *Safety Guidelines* section of this document for important safety information.

Installing Software and Hardware

Install the software provided with the USB-8451 OEM. Install the USB device and cables. Refer to the *NI-845x Software and Hardware Installation Guide* for more information.

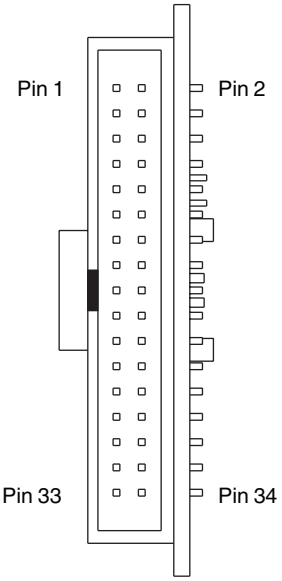
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I/O Connector and Cable

Use any 34-pin female IDC (ribbon) cable to connect to the IDC connector on the USB-8451 OEM.

Table 1 lists the pin assignments and signal names for the IDC connector.

Table 1. Pin Assignments

Signal	Pin	Connector	Pin	Signal
NC	1		2	GND
NC	3		4	SCLK
SDA	5		6	GND
SCL	7		8	MISO
NC	9		10	GND
CS5	11		12	MOSI
CS6	13		14	GND
CS7	15		16	CS0
P0.0	17		18	GND
P0.1	19		20	CS1
P0.2	21		22	GND
P0.3	23		24	CS2
P0.4	25		26	GND
P0.5	27		28	CS3
P0.6	29		30	GND
P0.7	31		32	CS4
+5V	33		34	+5V

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Signal Descriptions

Table 2 describes the signals available on the I/O connectors.

Table 2. Signal Descriptions

Signal Name	Direction	Description
SPI CS <0..7>	Output	**Chip Select Signals**—Outputs used to select the desired SPI peripheral device.
SPI MOSI (SDO)	Output	**Master Output Slave Input**—SPI communication signal to slave device.
SPI MISO (SDI)	Input	**Master Input Slave Output**—SPI communication signal from slave device.
SPI CLK (SCLK)	Output	**SPI Clock**—SPI output clock signal to slave devices capable of clock rates up to 12 MHz.
I^2C SDA	Input or Output	**I^2C Serial Data**—Data signal for I^2C communication.
I^2C SCL	Output	**I^2C Clock**—I^2C clock signal to slave devices capable of clock rates up to 250 kHz.
P0.<0..7>	Input or Output	**Digital I/O Signals**—You can individually configure each signal as an input or output. You can configure the port for open-drain or push-pull output.*
+5 V	Output	**+5 V**—The voltage source provided by the USB host. The voltage is nominally 5 V, but varies from system to system.
GND	—	**Ground**—The reference for the digital signals and the +5 VDC supply.
NC	—	**No Connect**—Do not connect any signals to this terminal.

* If you configure the DIO port for open-drain output, you must supply pull-up resistors to V_{cc} (3.3 or 5 V). The resistor value must not be lower than 1 kΩ.

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Digital I/O

The USB-8451 OEM has eight single-ended digital lines, P0.<0..7>.

Static DIO

Each USB-8451 OEM DIO line can be individually programmed as a static DI or DO line. You can use static DIO lines to monitor or control digital signals. All samples of static DI lines and updates of DO lines are software timed.

Digital Output Information

The default configuration of the USB-8451 OEM DIO port is push-pull, allowing 3.3 V operation. You can add an external pull-up resistor (Rp) to achieve 5 V operation, as shown in Figure 4. Do not use a pull-up resistor of less than 1 kΩ.

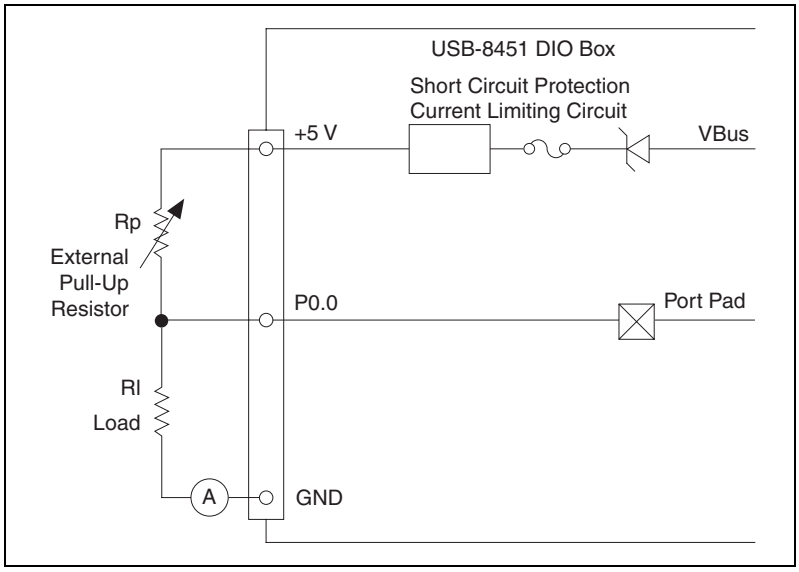
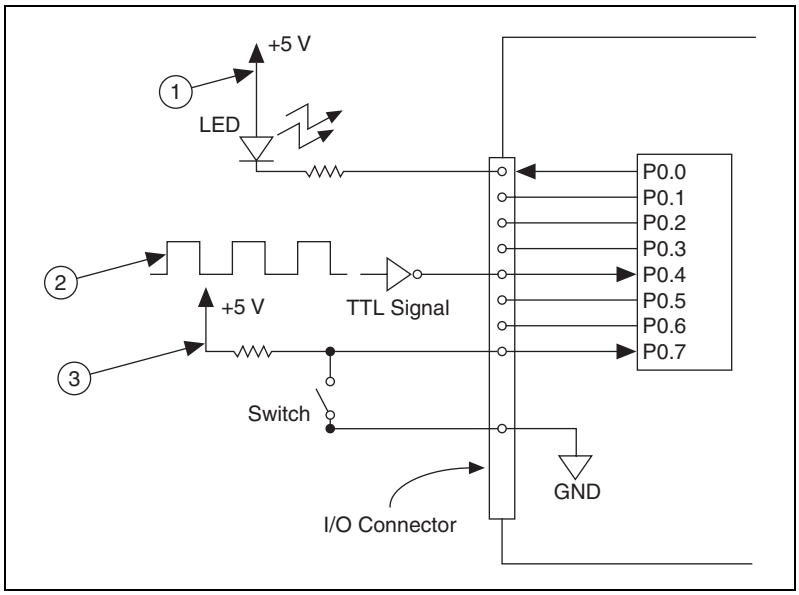


Figure 4. Example of Connecting External User-Provided Resistor

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Digital I/O Circuitry

Figure 5 shows P0.<0..7> connected to example signals configured as digital inputs and digital outputs. Refer to Figure 5 for some common examples of connections of DIO lines with standard circuits.



1 P0.0 configured as an open-drain digital output driving a LED
2 P0.4 configured as a digital input receiving a TTL signal from a gated invertor
3 P0.7 configured as a digital input receiving a 0 V or 5 V signal from a switch

Figure 5. Example of Connecting a Load

Caution Exceeding the maximum input voltage ratings or maximum output ratings, which are listed in the *Specifications* section, can damage the USB device and the computer. National Instruments is *not* liable for any damage resulting from such signal connections.

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SPI Circuitry

Figure 6 shows a typical SPI interface to three peripherals. All devices share the SPI MISO, SPI MOSI, and SPI CLK signals. Each peripheral has its own CS signal for addressing it.

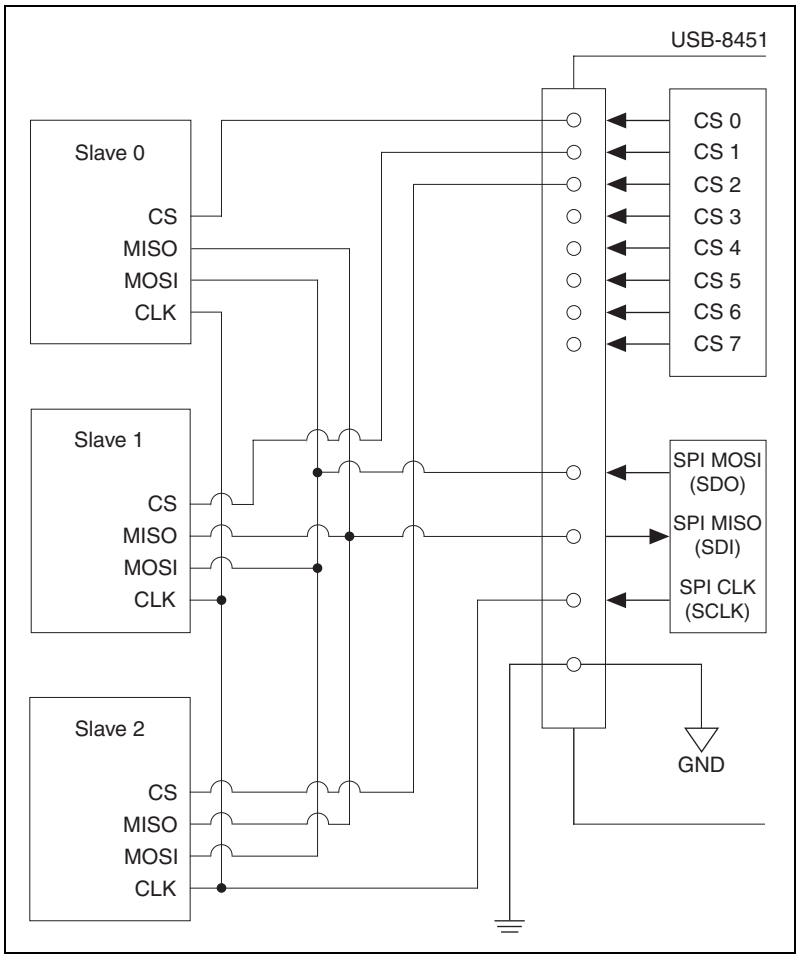


Figure 6. SPI Interface to Three Peripherals

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I²C Circuitry

Figure 7 shows a typical I²C interface to two peripherals. All devices on the I²C bus share the SDA and SCL signals. SDA and SCL must be pulled up externally. Refer to the I²C specification to select the correct resistor values for your bus.

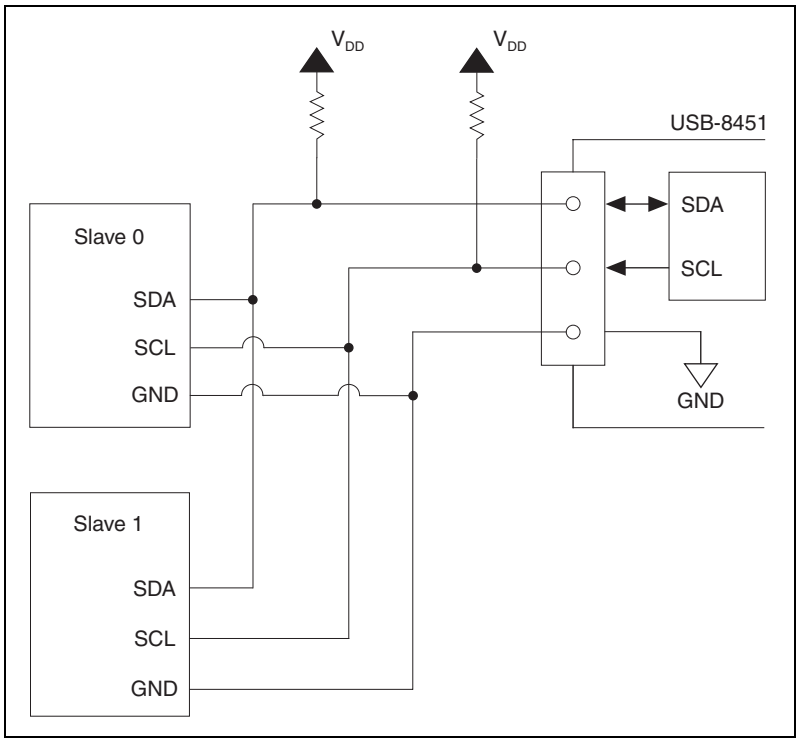


Figure 7. I²C Interface to Two Peripherals

I/O Protection

Each DIO, SPI, and SPI CS signal is protected against overvoltage, undervoltage, and overcurrent conditions, as well as ESD events. However, you should avoid these fault conditions by using the following guidelines:

- If you configure a line as an output, do not connect it to any external signal source, ground signal, or power supply.
- If you configure a line as an output, understand the current requirements of the load connected to these signals. Do not exceed the specified current output limits of the USB-8451 OEM.
- If you configure a line as an input, do not drive the line with voltages outside of its normal operating range.

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- Treat the USB-8451 OEM as you would treat any static sensitive device. Always properly ground yourself and the equipment when handling the USB device or connecting to it.

Caution Take special care with respect to the I^2C SDA and SCL lines. To allow for external pull-ups, the circuit protection has been removed. Do not exceed the specified voltages for these signals.

Power-On States

At system startup and reset, the hardware sets all DIO lines to high-impedance inputs. The USB-8451 OEM does not drive the signal high or low.

+5 V Power Source

The USB-8451 OEM supplies a nominal 5 V from two pins, one on each screw terminal block. The voltage source is provided by the USB host. The voltage is nominally 5 V, but varies from system to system. Refer to the *Specifications* section for more information about USB bus power specifications. This source can be used to power external components.

Note While the device is in USB suspend, the output is disabled.

Caution When using the 5 V source, understand the current requirements of the load connected. Do *not* exceed the specified current output limits of the USB Vbus.

Specifications

The following specifications are typical at 25 °C, unless otherwise noted.

Digital I/O and Chip Selects

Number of lines

P0.<0..7> 8

CS <0..7> 8

Direction control ..... Input or output, software selectable

Output driver type ..... Push-pull (active drive) or open-drain (DIO only), software selectable

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Absolute voltage range .....–0.5 to 5.8 V with respect to GND

Power-on state .....Input (high impedance)

Digital logic levels

Level	Min	Max	Units
Input			
Input low voltage	–0.3	0.8	V
Input high voltage	2.0	5.8	V
Input leakage current	—	50	µA
Output			
Output low voltage (I = 8.5 mA)	—	0.8	V
Output high voltage			
Push-pull (active drive), I = –8.5 mA	2.0	3.5	V
Open-drain (DIO only)	V_{cc}*	V_{cc}*	V

* V_{cc} refers to the pull-up voltage you select.

SPI Interface

Signals

SPI MOSI (SDO).....Output

SPI MISO (SDI) .....Input

SPI CLK (SCLK) .....Output (12 MHz max)

Supported clock rates.....48 kHz, 50 kHz, 60 kHz, 75 kHz, 80 kHz, 96 kHz, 100 kHz, 120 kHz, 125 kHz, 150 kHz, 160 kHz, 200 kHz, 240 kHz, 250 kHz, 300 kHz, 375 kHz, 400 kHz, 480 kHz, 500 kHz, 600 kHz, 750 kHz, 800 kHz, 1 MHz, 1.2 MHz, 1.5 MHz, 2 MHz, 2.4 MHz, 3 MHz, 4 MHz, 6 MHz, 12 MHz

Output driver type.....Push-pull (active drive)

Absolute voltage range .....–0.5 to 5.8 V with respect to GND

Power-on state .....Input (high impedance)

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Digital logic levels

Level	Min	Max	Units
Input			
Input low voltage	–0.3	0.8	V
Input high voltage	2.0	5.8	V
Input leakage current	—	50	µA
Output			
Output low voltage (I = 8.5 mA)	—	0.8	V
Output high voltage			
Push-pull (active drive), I = –8.5 mA	2.0	3.5	V

I²C Interface

Signals

SDA ..... Output/Input

SCL ..... Output (250 kHz max)

Supported clock rates ..... 32 kHz, 40 kHz, 50 kHz, 64 kHz, 80 kHz, 100 kHz, 125 kHz, 160 kHz, 200 kHz, 250 kHz

Output driver type ..... Open-drain

Absolute voltage range..... –0.5 to 5.8 V with respect to GND

Power-on state..... Input (high impedance)

Digital logic levels

Level	Min	Max	Units
Output			
Output low voltage (I = 8.5 mA)	—	0.8	V
Output high voltage			
Open-drain with external pull-up resistor	2.0	—	V

Note This interface is compatible with both I²C and SMBus devices.

Bus Interface

USB specification ..... Full-speed (12 Mb/s)

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External Voltage

+5 V output

Voltage .....4.10 V min, 5.25 V max

Current.....230 mA max

Power Requirements

USB

4.10 to 5.25 VDC.....80 mA typical, 500 mA max

USB Suspend.....300 µA standby mode, 500 µA max

Physical Characteristics

Dimensions

Without connectors.....6.35 cm × 8.51 cm × 2.31 cm (2.50 in. × 3.35 in. × 0.91 in.)

With connectors.....8.18 cm × 8.51 cm × 2.31 cm (3.22 in. × 3.35 in. × 0.91 in.)

I/O connectors.....USB series B receptacle, (2) 16 position (screw terminal) plug headers

Screw-terminal wiring .....16 AWG to 28 AWG copper conductor wire with 10 mm (0.39 in.) of insulation stripped from the end

Torque for screw terminals.....0.22 to 0.25 N · m (2.0 to 2.2 lb · in.)

Weight .....84 g (3 oz)

Safety

Standards

The USB-8451 OEM is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1
- CAN/CSA-C22.2 No. 61010-1

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Note For UL and other safety certifications, refer to the product label, or visit `ni.com/certification`, search by model number or product line, and click the appropriate link in the Certification column.

Overvoltage Protection

Connect only voltages that are within these limits.

Channel-to-COM (one channel)..... ±30 V max,
Measurement Category I

Channels-to-COM
(one port, all channels)..... ±8.9 V max,
Measurement Category I

Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as *MAINS* voltage. MAINS is a hazardous live electrical supply system that powers equipment. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.

Caution Do *not* use this module for connection to signals or for measurements within Measurement Categories II, III, or IV.

Hazardous Locations

The USB-8451 OEM is not certified for use in hazardous locations.

Environmental

The USB-8451 OEM device is intended for indoor use only.

Operating temperature
(IEC 60068-2-1 and IEC 60068-2-2)..... 0 to 45 °C

Operating humidity
(IEC 60068-2-56)..... 10 to 90% RH, noncondensing

Maximum altitude..... 2,000 m (at 25°C ambient temperature)

Storage temperature
(IEC 60068-2-1 and IEC 60068-2-2)..... –40 to 85 °C

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Storage humidity
(IEC 60068-2-56) .....5 to 90% RH, noncondensing

Pollution Degree (IEC 60664).....2

Electromagnetic Compatibility

Emissions.....EN 55011 Class A at 10 m
FCC Part 15A above 1 GHz

Immunity .....Industrial levels per
EN 61326:1997 + A2:2001,
Table 1

EMC/EMI .....CE, C-Tick, and FCC Part 15
(Class A) Compliant

Note For EMC compliance, operate this device with shielded cabling.

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

Low-Voltage Directive (safety).....73/23/EEC

Electromagnetic Compatibility
Directive (EMC) 89/336/EEC

Note Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, visit `ni.com/certification`, search by model number or product line, and click the appropriate link in the Certification column.

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Safety Guidelines

Caution Operate the hardware only as described in these operating instructions.

The following section contains important safety information that you must follow when installing and using the USB-8451 OEM.

Do not operate the USB-8451 OEM in a manner not specified in this document. Misuse of the device can result in a hazard. You can compromise the safety protection built into the device if the device is damaged in any way. If the device is damaged, contact National Instruments for repair.

Do not substitute parts or modify the device except as described in this document. Use the device only with the chassis, modules, accessories, and cables specified in the installation instructions. You must have all covers and filler panels installed during operation of the device.

Do not operate the device in an explosive atmosphere or where there may be flammable gases or fumes. If you must operate the device in such an environment, it must be in a suitably rated enclosure.

If you need to clean the device, use a dry cloth. Make sure that the device is completely dry and free from contaminants before returning it to service.

Operate the device only at or below Pollution Degree 2. Pollution is foreign matter in a solid, liquid, or gaseous state that can reduce dielectric strength or surface resistivity. The following is a description of pollution degrees:

- Pollution Degree 1 means no pollution or only dry, nonconductive pollution occurs. The pollution has no influence.
- Pollution Degree 2 means that only nonconductive pollution occurs in most cases. Occasionally, however, a temporary conductivity caused by condensation must be expected.
- Pollution Degree 3 means that conductive pollution occurs, or dry, nonconductive pollution occurs that becomes conductive due to condensation.

You must insulate signal connections for the maximum voltage for which the device is rated. Do not exceed the maximum ratings for the device. Do not install wiring while the device is live with electrical signals. Do not remove or add connector blocks when power is connected to the system. Avoid contact between your body and the connector block signal when hot swapping modules. Remove power from signal lines before connecting them to or disconnecting them from the device.

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Operate the device at or below the Measurement Category I[1]. Measurement circuits are subjected to working voltages[2] and transient stresses (overvoltage) from the circuit to which they are connected during measurement or test. Measurement categories establish standard impulse withstand voltage levels that commonly occur in electrical distribution systems. The following is a description of measurement categories:

- Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as MAINS[3] voltage. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.
- Measurement Category II is for measurements performed on circuits directly connected to the electrical distribution system. This category refers to local-level electrical distribution, such as that provided by a standard wall outlet (for example, 115 V for U.S. or 230 V for Europe). Examples of Measurement Category II are measurements performed on household appliances, portable tools, and similar E Series devices.
- Measurement Category III is for measurements performed in the building installation at the distribution level. This category refers to measurements on hard-wired equipment such as equipment in fixed installations, distribution boards, and circuit breakers. Other examples are wiring, including cables, bus-bars, junction boxes, switches, socket-outlets in the fixed installation, and stationary motors with permanent connections to fixed installations.

Measurement Category IV is for measurements performed at the primary electrical supply installation (<1,000 V). Examples include electricity meters and measurements on primary overcurrent protection devices and on ripple control units.

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[1] Measurement Category as defined in electrical safety standard IEC 61010-1. Measurement Category is also referred to as Installation Category.

[2] Working Voltage is the highest rms value of an AC or DC voltage that can occur across any particular insulation.

[3] MAINS is defined as a hazardous live electrical supply system that powers equipment. Suitably rated measuring circuits may be connected to the MAINS for measuring purposes.

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Where to Go for Support

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Portugal 351 210 311 210, Russia 7 095 783 68 51,
Singapore 1800 226 5886, Slovenia 386 3 425 4200,
South Africa 27 0 11 805 8197, Spain 34 91 640 0085,
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