High-Precision Temperature and Voltage Loggers

NI 4350, NI 4351 Series

Precision Temperature Inputs
6 or 14 thermocouples
±0.42 °C accuracy
Up to 60 readings/s
Autozero
Cold-junction compensation
Open-thermocouple detection

Precision Voltage Inputs
8 or 16 differential
24-bit ADC resolution
±15 V input range
Up to 60 readings/s

Digital I/O
Up to 8 TTL lines

Application Software
LabVIEW
BridgeVIEW
LabWindows/CVI
VirtualBench
NI-Dlog Instrument driver

Solutions
Temperature measurements
DC voltage measurements
Resistance measurements
Automotive measurements
Portable data logging
Chromatography

Calibration certificate included

Bus	Operating Systems
PCI, PXI/CompactPCI, ISA, PCMCIA, USB	Windows NT/98/95

Overview

The National Instruments NI 4350 and NI 4351 Series are computer-based precision instruments designed specifically for temperature measurements (with thermocouples, RTDs, thermistors), chromatography measurements, and for low-frequency analog signals within ±15 V. The instruments are available for PCI, PXI/CompactPCI, ISA, PCMCIA, and USB.

The instruments feature ±0.42 °C, J-type thermocouple accuracy, 5½ digit voltage measurements, power-line noise rejection filters, and precision current excitation for RTD and thermistor excitation. The NI 4350/4351 instruments combine the functionality of stand-alone temperature and voltage meters and chromatographs with the flexibility and benefits of your computer, so you can build highly capable computer-based data loggers that leverage off Pentium processing power and the Internet.

Hardware

Precision Analog Input

The NI 4350 for PCMCIA has eight differential analog inputs; the NI 4350 for USB and ISA and the NI 4351 Series have 16 differential analog inputs. Each instrument has a 24-bit ADC and six possible reading rates – 10, 50, and 60 readings/s in single channel acquisition mode and 2.8, 8.8, and 9.7 readings/s in multiple channel acquisition mode. Digital filters reject 50, 60, and 400 Hz noise, based on the reading rate. The input circuitry delivers ±42 V overvoltage protection and per-channel lowpass, antialiasing filters.

The NI 4350 and NI 4351 instruments feature software-selectable ground-referencing on a channel-by-channel basis, so you can measure both floating and ground-referenced signals together, and per- channel open-thermocouple detection. When open thermocouple detection is enabled, the input channel is connected to +2.5 VDC through a 10 MΩ resistor. When a thermocouple breaks or is disconnected, the reading rapidly increases to 100 mV or more, indicating an open-circuit condition.

Precision Current Excitation

The NI 4350 and NI 4351 feature a 25 µA precision current source for excitation of RTDs, thermistors, or other resistive devices. The source excites total system resistance of up to 600 kΩ.

Digital I/O and Alarm Outputs

The NI 4350 for PCMCIA has four TTL digital lines; the NI 4350 for USB and ISA and NI 4351 Series have eight lines. You can individually configure each line as an input or an output. The lines are used as general-purpose digital I/O or as control lines for alarms. Each line sinks or sources 8 mA.

USB Cables and Power for the USB-Based NI 4350

A standard USB cable, with Series A and Series B plugs, connects the NI 4350 for USB to your computer. The Series B plug connects to the NI 4350 and the Series A plug connects to the USB host.

The NI 4350 for USB uses power from the USB bus. An external power supply is not needed.

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Measurement Type	NI 4350/4351 Platform for	Accessory
Thermocouple Only	PCMCIA	PSH32-TC6 cable with miniconnector
	USB, ISA, PCI, PXI/CompactPCI	TC-2190 and SH6868 cable
Voltage,	PCMCIA	CB-27 and PSH32-30F cable
Chromatography Only	USB, ISA, PCI, PXI/CompactPCI	TBX-68 and SH6868 cable
Temperature, Voltage,	PCMCIA	CB-27T and PSH32-30F cable
Chromatography	USB, ISA, PCI, PXI/CompactPCI	TBX-68T and SH6868 cable

Table 1. Accessory Selection Table

I/O Connector

The NI 4350 for PCMCIA I/O connector is a 32-pin shielded female connector featuring active latches to ensure reliable connections. The NI 4350 for USB and ISA and NI 4351 Series I/O connectors are a 68-pin shielded male connector with active latches. ACH±<0..7/15> are the 8/16 differential analog input channels. AGND is the analog ground. IEX± are for the current excitation. DIO<0..3/7> are the TTL lines and are referenced to DGND.

Signal Connections and Accessories

Different accessories are required to measure temperature or voltage. Table 1 lists the type of accessory needed for temperature or voltage measurements. Refer to page 625 for detailed accessory descriptions.

Software

Instrument Driver

If you want to build an automated test application or to integrate the NI 4350/4351 in your test software, use the NI-Dlog instrument driver. The instrument driver works with

- *LabVIEW*
- *BridgeVIEW*
- *LabWindows/CVI*
- *Microsoft Visual C/C++*
- *Borland C++*
- *Visual Basic*

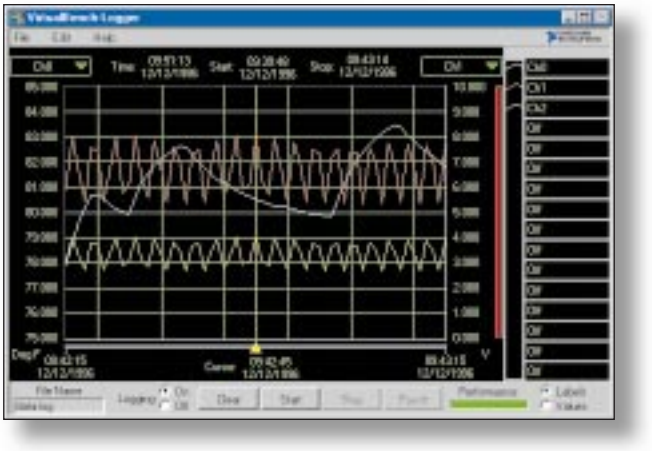

Figure 1. VirtualBench-Logger Soft Front Panel for All NI 4350/4351 High-Precision Temperature and Voltage Meters.

Interactive Control for Temperature and Voltage Measurement

VirtualBench-Logger software, shown in Figure 1, is shipped with all NI 4350/4351 meters. VirtualBench-Logger is a multichannel data logger for recording and displaying low-frequency signals, such as temperature, pressure, and voltage. The software operates as a soft front panel that controls the NI 4350/4351s with no programming required. All hardware features of the NI 4350/4351s are accessible by the software. You use VirtualBench-Logger just as you use a stand-alone data logger, but you benefit from the processing, display, and storage capabilities of your computer.

Chromatography

The LCC-100, which uses the National Instruments NI 4350/4351, is a four-channel integrator for LC, GC,or HPLC instruments. Data analysis is performed via semiautomatic peak detection. The user identifies the noise, minimum peak, and the corrected baseline. The LCC-100 comes complete with integrator, computer interface, cable, and LabVIEW executable software. Contact Analytical Instrument Systems at (908) 788-7022 or, visit their Web site at ***www.aishome.com***

Ordering Information

NI 4350 *for*

PCMCIA

including PSH32-TC6 cable.....777221-03

without cable and accessories.....777221-01

ISA (XT bus).....777222-01

USB 777225-01*

** Includes 1 m USB cable.*

NI 4351 *for*

PCI 777789-01

PXI/CompactPCI.....777790-01

NI 4350 kits include the NI 4350 hardware, NI-Dlog instrument driver, VirtualBench-Logger, and VirtualBench-DIO.

Refer to page 625 for other accessories.

Specifications

Accuracy Tables[1,2]

Thermocouple Accuracy[3]

TC Type	°C	Error (°C) 10 Hz	50 Hz	60 Hz	Temperature coefficient (°C/°C)	Accessory error[2] (°C)
J	-100	0.53	0.61	0.74	0.02	0.25
	0	0.42	0.49	0.59		
	760	0.42	0.47	0.55		
K	-100	0.60	0.72	0.89	0.03	0.27
	0	0.45	0.54	0.67		
	1000	0.60	0.69	0.81		
	1372	0.74	0.84	0.99		
N	-100	0.68	0.84	1.08	0.03	0.26
	0	0.54	0.67	0.86		
	400	0.42	0.51	0.65		
	1300	0.57	0.66	0.80		
E	-100	0.55	0.62	0.74	0.02	0.28
	0	0.41	0.46	0.55		
	500	0.35	0.40	0.46		
	1000	0.46	0.50	0.57		
T	-150	0.81	0.96	1.17	0.03	0.36
	0	0.46	0.55	0.68		
	400	0.33	0.39	0.47		
R	250	0.82	1.16	1.65	0.06	0.12
	1000	0.72	0.99	1.37		
	1767	0.91	1.19	1.60		
S	250	0.91	1.28	1.83	0.07	0.13
	1000	0.77	1.05	1.47		
	1767	0.96	1.27	1.72		
B	600	1.08	1.64	2.47	0.11	0.00
	1000	0.76	1.14	1.69		
	1820	0.74	1.05	1.50		

RTD Accuracy[4]

°C	Error (°C) 10 Hz	50 Hz	60 Hz	Temperature coefficient (°C/°C)
-200	1.00	1.33	1.81	0.01
0	1.14	1.49	2.00	
100	1.22	1.58	2.10	
300	1.38	1.76	2.32	
600	1.66	2.08	2.69	

** With 100 Ω RTD*

Thermistor Accuracy[5†]

°C	Error (°C)	Temperature coefficient (°C/°C)
0-50	0.03	0.001

† With 5,000 Ω thermistor

Settling time for full-scale step

Accuracy	Time (s)
±0.1%	0.3
±0.01%	0.5
±0.0015%	2.4
±0.001%	3
±0.0004%	7

DC Voltage Accuracy[6]

Range (Volts DC)	% of Reading 24 Hour	90 Day	1 Year	Additional error with auto-zero (µV) 10 Hz	50 Hz	60 Hz	Additional error without auto-zero (µV) 10 Hz	50 Hz	60 Hz	Temperature coefficient % Reading/°C	µV/°C
15	0.0146	0.0175	0.0205	28	117	141	130	193	210	0.0009	5
7.5	0.0152	0.0181	0.0211	21	71	106	125	160	185	0.0009	5
3.75	0.0164	0.0193	0.0223	14	30	42	120	131	140	0.0010	5
2.5	0.0066	0.0095	0.0125	5	17	24	24	32	37	0.0004	1
1.25	0.0072	0.0101	0.0131	3	12	18	22	29	33	0.0004	1
0.625	0.0084	0.0113	0.0143	2	6	11	22	24	28	0.0005	1

Resistance Accuracy[7]

Range (Ω)	% of Reading 24 Hour	90 Day	1 Year	Additional error with auto-zero (Ω) 10 Hz	50 Hz	60 Hz	Additional error without auto-zero (Ω) 10 Hz	50 Hz	60 Hz	Temperature coefficient % Reading/°C
600000	0.0400	0.0429	0.0459	20.11	23.64	24.63	24.17	26.67	27.37	0.0013
300000	0.0406	0.0435	0.0465	19.82	21.80	23.22	23.97	25.37	26.37	0.0013
150000	0.0418	0.0447	0.0477	19.54	20.16	20.67	23.77	24.21	24.57	0.0013
100000	0.0320	0.0349	0.0379	0.51	1.00	1.28	1.26	1.60	1.80	0.0013
50000	0.0326	0.0355	0.0385	0.45	0.80	1.02	1.21	1.46	1.62	0.0013
25000	0.0338	0.0367	0.0397	0.41	0.54	0.74	1.18	1.28	1.42	0.0013

[1] All specifications are for the NI 4350/4351 instruments between 15 °C and 35 °C and for 1 year unless otherwise noted. All specifications are relative to calibration standards and require a 30 minute warm-up period. Specifications do not include transducer error.

[2] Temperature coefficient is applicable for 0 to 15 °C and 35 to 55 °C. For thermocouples, add the accessory error in °C only if the accessory (TC-2190, PSH32-TC6, CB-27T, TBX-68T) is in the 0 to 15 °C and 35 to 55 °C temperature range.

[3] Thermocouple measurement specifications include cold-junction compensation error (with sensor between 15 and 35 °C), isothermal accuracy and system noise. The specifications assume that the 0.625 V range is used and that ground-referencing and open-thermocouple detection are enabled for a floating thermocouple. Specifications improve with ground-referencing enabled and open-thermocouple detection disabled for a floating thermocouple. The specifications also assume that the cold-junction sensor is between 15 and 35 °C.

[4] RTD specifications assume that the 25 kΩ range (with a 25 µA current excitation) is used and worst case common mode voltage for this range is present. Specifications improve if actual common mode voltage is less than worst case. Specifications improve for a 1,000 Ω RTD.

[5] Thermistor accuracy is valid for all filter settings. Specifications assume that the 25 kΩ range is used and worst case common mode voltage for this range is present. Specifications improve if actual common mode voltage is less than worst case.

[6] Voltage specifications do not include errors resulting from common mode voltages. Calculate additional error because of common mode voltages as: (common mode voltage)/10CMR specification in dB/20.

[7] Resistance specifications assume worst case common mode voltage for the given range. Specifications improve if actual common mode voltage is less than worst case. Measurement accuracy is affected by source impedance. Resistances > 25 kΩ may require 1 s settling time.

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Specifications

Analog Input

Input Characteristics

Number of channels for bus options
- *PCMCIA* ..... *8 differential or 6 thermocouple*
- *PCI, PXI/CompactPCI, USB, ISA (XT)* ..... *16 differential or 14 thermocouple*

Digits *51/2*
Type of ADC ..... *Sigma-delta*
ADC Resolution ..... *24-bits, no missing codes*
Calibration cycle ..... *One year*

Reading Rates

Mode	Reading rate (readings/s)		Power-line noise rejection
Single channel	10		50, 60, 400 Hz
	50		50, 400 Hz
	60		60 Hz
Multiple channel scanning	2.8	1.4*	50, 60, 400 Hz
	8.8	2.1*	50, 400 Hz
	9.7	2.1*	60 Hz

**Resistance ranges >– 50 k Ω*

Input Coupling ..... *DC*
Maximum working voltage (signal + common mode)
- *Range > 2.5 V* ..... *Each input should remain within ±15 V of ground*
- *Range ≤ 2.5 V* ..... *Each input should remain within ±2.5 V of ground*

Over-voltage protection
- *(ACH<0..8/15>, IEX±)* ..... *±42 V powered on, ±17 V powered off*

Data transfers ..... *Interrupts, programmed I/O*
Warm-up time ..... *30 minutes*

Amplifier Characteristics

Input impedance
- *Normal powered on* ..... *>1 GΩ in parallel with 0.39 µF*
- *Powered off* ..... *10 kΩ*
- *Overload* ..... *10 kΩ*

Open-thermocouple detection ..... *10 MΩ between CH+ and +2.5 V (software selectable)*
Ground-referencing ..... *10 MΩ between CH- and ground (software selectable)*
Input bias current ..... *<500 pA*
CMR (DC, 50 Hz, 60 Hz, 400 Hz)
- *Range ≥ 2.5 V* ..... *80 dB*
- *Range < 2.5 V* ..... *100 dB*

NMR (50 Hz, 60 Hz, 400 Hz) ..... *>100 dB*

Dynamic Characteristics

Bandwidth ..... *20 Hz*

Excitation

Number of channels *1*
Level ..... *25 µA*
Maximum load resistance ..... *600 kΩ*
Temperature coefficient ..... *±15 ppm/°C*

Digital I/O and Alarm Outputs

Number of lines for bus options
- *PCMCIA* *4*
- *PCI, PXI/CompactPCI, USB, ISA* *8*

Compatibility ..... *TTL*

Digital Logic Levels

Level	Minimum	Maximum
Input low voltage	0.0 V	0.8 V
Input high voltage	2.0 V	5.0 V (Vcc)
Input low current (V_{in} = 0 V)	–	-10 µA
Input high current (V_{in} = 5 V)	–	10 µA
Output low voltage (I_{out} = 8 mA)	–	0.4 V
Output high voltage (I_{out} = 8 mA)	3.8 V	–

Power-on state ..... *Tristate (weak pull-up)*
Data transfers ..... *Programmed I/O*

Bus Interface ..... *ISA, PCMCIA, PCI, PXI/CompactPCI, USB*

Power Requirements

PCI ..... *480 mA at 5 V*
PXI/CompactPCI ..... *480 mA at 5 V*
PCMCIA ..... *130 mA at +5 V*
ISA ..... *160 mA at +5 V*
USB ..... *High power, USB powered peripheral (500 mA)*

Physical

Dimensions

PCI ..... *PCI (half size)*
PXI/CompactPCI ..... *10.0 x 16.0 cm (3.9 x 6.3 in), 3U*
PCMCIA ..... *Type II PC Card*
ISA ..... *ISA (half size)*
USB ..... *14.6 by 21.3 by 3.8 cm (5.8 by 8.4 by 1.5 in.)*

I/O connector

PCMCIA ..... *32-pin female, shielded and latched*
USB, PCI, PXI/CompactPCI, and ISA ..... *68-pin male, shielded and latched*

Environment

Operating temperature ..... *0 to 55 °C*
Storage temperature ..... *-20 to 70 °C*

Certifications and compliances

CE Mark Compliance

Accuracy Calculation Examples:

1. *Measurement of 760 °C using J type thermocouple at 28 °C ambient temperature; filter setting of 10 Hz: accuracy is 0.42 °C [read directly from table].*
2. *Measurement of 760 °C using J type thermocouple with 4350 at 38 °C and accessory (cold-junction sensor) at 23 °C; filter setting of 10 Hz: accuracy is 0.48 °C as a result of [0.42 °C + (38 °C - 35 °C) x 0.02].*
3. *Measurement of 760 °C using J type thermocouple with 4350 and accessory (cold-junction sensor) at 38 °C ; filter setting of 10 Hz: accuracy is 0.73 °C as a result of [0.42 °C + (38 °C - 35 °C) x 0.02 + 0.25 °C].*
4. *Measurement of 1 V using 1.25 V range, filter setting of 60 Hz at 28 °C ambient temperature, after 90 days of calibration, with auto-zero; at 0 V common mode voltage: accuracy is 119 µV as a result of [1 V x 0.0101% + 18 µV].*
5. *Measurement of 1 V using 1.25 V range, filter setting of 60 Hz at 38 °C ambient temperature after 90 days of calibration, with auto-zero; at 0.5 V common mode voltage: accuracy is 139 µV as a result of [1 V x 0.0101% + 18 µV + (38 °C - 35 °C) x {1 V x 0.0004%/°C + 1 µV/°C} + (0.5 V/10100/20)].*