# instruNet i60x Datasheet

*Miniature USB Data Acquisition System Attaches Directly to Sensors*

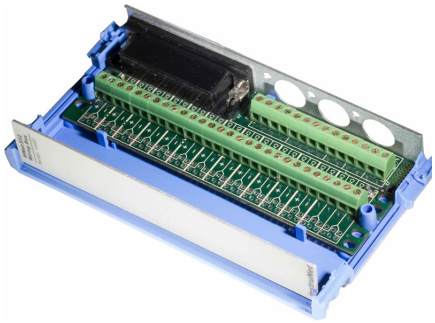
## Features


- The i600/i601 USB Data Acquisition device connects a Windows computer to sensors and controls via analog inputs, digital inputs and digital outputs.
- The i601 product provides ±36V bank electrical isolation; whereas the less costly i600 connects I/O signal ground to computer ground. i60x receives power from USB bus.
- 16se/8di Voltage Input Channels with extremely accurate 24-bit A/D Converter[29]
- 4x Digital I/O (4mA sink/source, 0 to 3.3V)
- Connect Directly To Sensors: Voltage, Thermocouple, Thermistor, RTD, Load Cell[30], Strain Gage[30], Potentiometer, Current, Resistance

## Summary

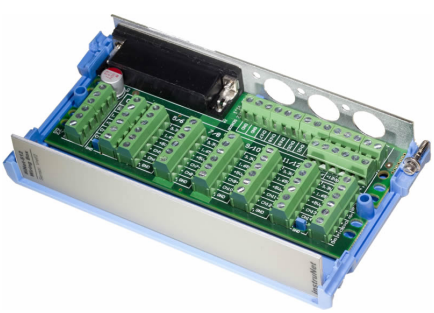
- This A/D module provides 16se/8di voltage input channels (Ch#1...#16)[40] , each of which are independently software programmable with Windows software that support the direct connection to many common sensor types
- Voltage input range on each channel is independently software programmable to one of: ±20mV, ±40mV, ±80mV, ±150mV, ±300mV, ±600mV, ±1.2V, ±2.5V, ±5V, ±10V
- Included is a mating Hd44 Female Connector & Cover. Alternatively, one can attach i600/i601 to the following optional wiring boxes: i510, i511, i512. If one is working with thermocouples, an i510 wiring box is required due to it's internal cold junction compensation.
- i600 and i601 are stand-alone USB data acquisition systems. No additional components, such as external power supply, are required. Included in the box: i60x Hardware Device, USB Cable, Software on CD, Mating Hd44 Female Connector & Hd44 Cover. For details, see the i60x Installation Guide.
- Digitize at a maximum sample rate of 160K sample/sec for 1 channel, 12Ks/sec/ch for 2 channels, 6Ks/sec/ch for 4 channels, and 3Ks/sec/ch for 8 channels. For more details, see Voltage Accuracy.
- Each channel provides the following software programmable parameters: A/D Signal-Averaging-Per-Point (0 ... 100mSec)[3] , Sample-Rate (samples-per-second-per-channel)[17] , Digital IIR Filter (LowPass, HighPass, BandPass, or BandStop)[55] , Voltage Measurement Range (±20mV...±10V)[1] , Sensor Type[13] , and Single-Ended or Differential Wiring
- Excitation power (+3.3V ±0.2V, <80mA, 28mA per sensor max) is provided for sensors[30], along with other End User Power voltages. This 3.3V, which is referenced to instruNet Ground, is automatically readback by A/D when calculating sensor values.
- The 4mA sink/source digital I/O port consists of 4 individual TTL-compatible lines (Ch#25...#28), each of which can be configured as: input or output bit[45] . When configured as an input, a channel can be used to sense a digital high (2 to 5.5 Volts) or digital low (0V to 0.8Volts). When configured as an output, a channel can be set high (e.g. >2V) or low (e.g. <0.8V). These I/O pins are short-circuit protected against high voltages up to 6.0V and down to -6.0V.

## Optional i51x Wiring Box



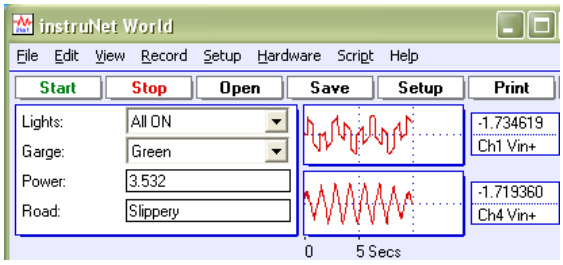
i510 Low Cost Wiring Box

i511 BNC Wiring Box



i512 Wiring Box

## Optional Accessories

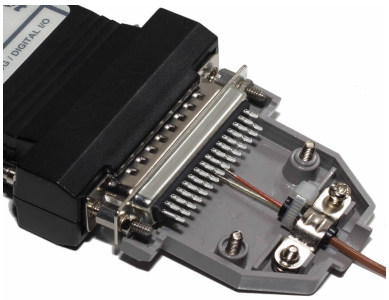



instruNet World PLUS Software (iW+)

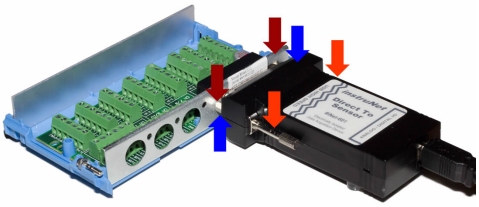

Application Software

Shunt Resistors

## How to Connect Sensors



Attach Directly to Hd44 Connector



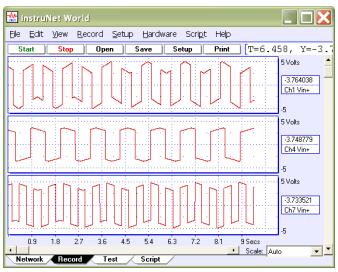
Attach i60x to i51x Wiring Box

Attach to i511 BNC Wiring Box

## What's Included in the Box?


i60x Device

i60x hardware Kit




instruNet World Software CD

10ft (3m) USB Cable

## Subjects Discussed in this Datasheet, iNet-600 & iNet-601

## Analog Voltage Input (A/D), iNet-600 & iNet-601

| Parameter | Specifications[19] | Notes |
|---|---|---|
| Description | 16se/8di Voltage Input Channels with extremely accurate 24-bit A/D Converter[29] | This A/D module provides 16se/8di voltage input channels (Ch#1...#16), each of which are independently software programmable with Windows software that support the direct connection to many common sensor types |
| Absolute Accuracy | Specified | Error components (i.e. INL, DNL, linearity, noise, temperature drift[66] , time stability) are summed and specified as "Absolute Accuracy" with the following supported sensors (click for accuracy and maximum sample rate): Voltage, Thermocouple, Thermistor, RTD, Load Cell[30], Strain Gage[30], Potentiometer, Current, Resistance |
| Voltage Ranges | ±20mV ... ±10V | Voltage input range on each channel is independently software programmable to one of: ±20mV, ±40mV, ±80mV, ±150mV, ±300mV, ±600mV, ±1.2V, ±2.5V, ±5V, ±10V |
| Internal A/D | 24-bit | Internal 24-bit A/D Converter[29] resolves voltage input range to ±8.4M digital value. |
| Sensors | Direct Connect | Each of the 8 differential channels support the direct connection to the following sensor types (click for Wiring Diagram and Setup Instructions): Voltage, Thermocouple, Thermistor, RTD, Load Cell[30], Strain Gage[30], Potentiometer, Current, Resistance |
| Channel Amplifiers | Software Programmable | Each channel provides the following software programmable parameters: A/D Signal-Averaging-Per-Point (0 ... 100mSec)[3] , Sample-Rate (samples-per-second-per-channel)[17] , Digital IIR Filter (LowPass, HighPass, BandPass, or BandStop)[55] , Voltage Measurement Range (±20mV...±10V)[1] , Sensor Type[13] , and Single-Ended or Differential Wiring |
| Wiring | Single-Ended or Differential | Single-ended (SE) wiring involves measuring the voltage between the input pin and instruNet Ground; whereas Differential (DI) wiring involves measuring the voltage between two input pins |
| Protected Voltage | -30 to +30V | Short any combination of voltage input channels to external -30 to +30V power source (i.e. capable of high current), instruNet power on or off, any duration, without damage |
| Bandwidth | Depends on Voltage Range | See absolute accuracy specification tables below (e.g. Voltage Accuracy) for bandwidth details |
| RFI Filter | 13 KHz RFI filter on ≤ ±150mVrange | RFI filter is a low pass filter that rejects high frequencies that could cause small measurement errors if left unfiltered |
| Digital Filter | LowPass, HighPass, BandPass, or BandStop | Each channel provides optional digital IIR lowpass, highpass, bandpass and bandstop filters with independent software programmable cut-off frequency, minimum dB stopband attenuation, maximum dB passband attenuation, and filter type (e.g. Elliptic, Chebyshev B, Chebyshev S, and Butterworth). Number of poles/zeros (i.e. "filter order") is programmable between 2 and 32[55] . |
| Maximum Sample Rate[17] | 160Ks/sec/aggregate | Digitize[70] at a maximum sample rate of 160K sample/sec for 1 channel on largest voltage input range. More channels at same voltage input range involves slower rates, e.g. 12Ks/sec per channel for 2 channels, 6Ks/sec/ch for 4 channels, and 3Ks/sec/ch for 8 channels. For a details on maximum sample rate and bandwidth with different voltage input ranges, sensor types, and a/d averaging[61] ; see absolute accuracy specification tables below (e.g. Voltage Accuracy). Sample rate is set accurate to 50 ppm (e.g. user specifies 20000 s/sec yet system actually digitizes at 20001 s/sec). Minimum sample rate is 0.015 samples/sec/ch. |
| Sensor Excitation | Included | Excitation power (+3.3V ±0.2V, <80mA, 28mA per sensor max) is provided for sensors[30], along with other End User Power voltages. This 3.3V, which is referenced to instruNet Ground, is automatically readback by A/D when calculating sensor values. |

Electrical Specifications, Analog Voltage Input, iNet-600 & iNet-601

| Parameter | Specifications[19] | Notes |
|---|---|---|
| Common Mode Voltage | -10 to +10V | All voltage input pins must be driven with a voltage between -10 and +10V, with respect to instruNet ground. i600 ground is connected to computer ground via USB |

| | | |
|---|---|---|
| | | bus (which is connected to Earth ground via computer power supply plug 3rd prong). Alternatively, i601 ground is electrically isolated from computer ground. |
| Crosstalk | < -80dB typ | Crosstalk from one channel to another depends on sample rate and frequency of applied signal, and is typically < -80dB; i.e. -80dB = 20 * log (1 / 10000). For example, one can apply a 10Hz 10Vpp sinewave to Ch1 on the ±5Vrange, apply 0 Volts DC to Ch3 on the ±2.5Vrange, digitize both at the maximum sample rate, and see < 1mVpp sinewave on Ch3, in a typical case. The amplitude of this sinewave would decrease with slower sample rates, and increase with higher sinewave frequencies. |
| Input Coupling | DC | Measure constant DC voltage or dynamic AC waveform with absolute voltage accuracy |
| Input Impedance | 100MΩ | Internal 100MΩ resistor (5% accuracy) between input pin and instruNet ground reduces fluctuating measurements when input pin is left unconnected |
| Current Pump | 35 pC max | Internal multiplexors pump a small amount of current out voltage measurement pin and into the end user circuit when channels switch. This is normal for multiplexors (they all do this), and is automatically mitigated when doing sensor measurements by waiting for current to dissipate before taking the measurement. If you don't like multiplexors, or need fast sample rates with low level signals; please see i423 which routes inputs to instrumentation amplifiers instead of multiplexors. |
| Input leakage current | 4.5 nA max at 37°C | This is a small current that flows out the voltage input pin and into the end user circuit. It has little effect unless measuring small voltages (e.g. expecting accuracy better than ±100uV) with a high source impedance (e.g. > 2K Ω). Maximum leakage is 4.5 nA at 37°C, and 2.3 nA at 25°C. |
| Input Circuit | Multiplexer | Voltage input pin connects directly to internal protected multiplexer IC |
| Common Mode Rejection Ratio | ≥ 110dB | CMRR is the amount of rejection of a common signal that is present on both inputs of a differential measurement. Theoretically, it should not be measured because the differential measurement looks at the voltage between two pins; however small internal imbalances cause a small error, which is specified here with a DC to 60Hz common mode signal. |
| Calibration | Software Control | instruNet hardware is calibrated[66] when the system is reset (i.e. press RESET button, load .prf configuration file, or start instruNet software), and when the system is software calibrated (i.e. press CALIBRATE button, issue software calibrate command, or set up software to calibrate every X minutes[59] ). |
| Front End Schematics | Published | Schematics: i60x Hd44 Schematic, i60x Multiplexer Schematic |

Software Interface, Analog Voltage Input, iNet-600 & iNet-601

| Parameter | Specifications[19] | Notes |
|---|---|---|
| Software Interface | Windows Compatible | instruNet Scalar I/O and High Speed I/O[60] interface subroutines execute on Windows Computer via instruNet World, Visual Basic, C, Labview, or DasyLab software. Scalar I/O reads or writes 1 value at a time; whereas High Speed I/O reads or writes multiple values (i.e. a waveform) at a fixed rate (i.e. sample rate). |
| Maximum # of Channels | Up to 256 | instruNet system (iNet32/64.dll ≥ v3.0) supports simultaneous high speed I/O to/from computer with 1 to 256 I/O channels[70] |
| Maximum Waveform Size | Limited by Computer | Continuously digitize into Windows computer RAM or into file on Windows computer hard disk[62] . Maximum file size is limited by available space on hard disk. Data consumes 4 bytes per point. |
| Scalar I/O Benchmark | 50 to 300uSec typ | Scalar I/O[60] typically requires 50 to 300uSec to read 1 value from 1 voltage input channel with 0 mSec of a/d averaging. This increases by the amount of a/d averaging (e.g. 1050 to 1300uSec for 1mSec of a/d averaging) |
| Software Channels | Ch1 Vin+ ... Ch16 Vin- | Channels #1...#16: SE/DI voltage inputs, ±20mV...±10V |
| Connector Pins | One pin per bit | Signals are available at Hd44 connector pins: #1...#16[217] |
| Ground Reference | Hd44 Pins 29/42/43/44 | i600 ground is connected to computer ground via USB bus (which is connected to Earth ground via computer power supply plug 3rd prong). Alternatively, i601 ground is electrically isolated from computer ground. |

## 4x Digital I/O, 4mA sink/source, iNet-600 & iNet-601

| Parameter | Specifications[19] | Notes |
|---|---|---|
| Description | 4 Bidirectional Digital I/O | The 4mA sink/source digital I/O port consists of 4 individual TTL-compatible lines (Ch#25...#28), each of which can be configured as: input or output bit. When configured as an input, a channel can be used to sense a digital high (2 to 5.5 Volts) or digital low (0V to 0.8Volts). When configured as an output, a channel can be set high (e.g. >2V) or low (e.g. <0.8V). These I/O pins are short-circuit protected against high voltages up to 6.0V and down to -6.0V. |
| Function | input or output bit | Each bit is independently software programmed as an input or output |
| TTL Compatible | Yes | Supports 0.8V for logic 0 and 2V for logic 1, which is typical for TTL |
| 3.3V CMOS Compatible | " | Supports 1.1V (3.3V*.35) for logic 0 and 2.3V (3.3V*.7) for logic 1, which is typical for digital Cmos powered by 3.3V |
| Drive Relay Directly | " | Wire one side of external relay coil to power supply (e.g. 5V), wire other side to I/O pin, and output logic 0 to turn on relay |
| Detect Switch Closure | " | Wire one side of external switch to gnd, wire other side to I/O pin, input logic 0 when switch is closed, and input logic 1 when switch is open |

Electrical Specifications, Digital I/O, iNet-600 & iNet-601

| Parameter | Specifications[19] | Notes |
|---|---|---|
| Working Voltage | 0 to +5.5V | Functions properly when working with 0 to +5.5V between the I/O pin and instruNet gnd, where each bit is set up as an input or output |
| Protected Voltage | -6 to +6V | Short any combination of I/O pins to external -6 to +6V power source (i.e. capable of high current), set up as input or output (0 or 1), instruNet power on or off, without damage |
| Fuse | Auto-Reset, 4 Milliamp | Internal fuse on each I/O pin opens during > 4mA over-current condition, and automatically closes otherwise |
| "0" Input Voltage | 0 to +0.8V | Applying 0 to +0.8V is read as logic 0 when I/O pin is configured as input |
| "0" Input Current | Amps = Vin / 50K | External signal must pull up internal 50.0K resistor (which is connected to GND). |
| "1" Input Voltage | 2V to +5.5V | Applying 2V to 5.5V is read as logic 1 when I/O pin is configured as input. If left unconnected this pin floats to 0V. |
| "0" Output Voltage | < 0.7V @ 2mA,<br>< 0.9V @ 4mA | I/O pin configured as an output sinks current low to 0.3V...0.7V with 0 to 2mA load; or sinks low to 0.3V...0.9V with 0 to 4mA load |
| "1" Output Voltage | > 2.4V @ 2mA,<br>> 2.2V @ 4mA | I/O pin configured as an output sources current high to 2V...3.3V with 0 to 4mA load. |

Software Interface, Digital I/O, iNet-600 & iNet-601

| Parameter | Specifications[19] | Notes |
|---|---|---|
| Software Interface | Windows Compatible | instruNet Scalar I/O and High Speed I/O[60] interface subroutines execute on Windows Computer via instruNet World, Visual Basic, C, Labview, or DasyLab software. Scalar I/O reads or writes 1 value at a time; whereas High Speed I/O reads or writes multiple values (i.e. a waveform) at a fixed rate (i.e. sample rate). |
| Maximum # of Channels | Up to 256 | instruNet system (iNet32/64.dll ≥ v3.0) supports simultaneous high speed I/O to/from computer with 1 to 256 I/O channels[70] |
| Scalar I/O Benchmark | 50 to 300uSec typ | Scalar I/O[60] typically requires 50 to 300uSec to R/W 1 value to/from 1 bit or a bank of multiple I/O bits |
| Bit or Bank Control | Yes | Either R/W one bit (0 or 1 value) at a time, or R/W multiple bits within one bank (e.g. 0...255 value with one 8bit bank) |
| Latching I/O | " | Internal register reads all input bits within one bank at same time, and updates all output bits within one bank at same time |
| Bit Software Channels | Ch25 Dio ... Ch28 Dio | Channels #25...#28: digital I/O bits, 0 or 1 value, scalar input/output, no high speed i/o, 4mA sink/source |
| Bank Software Channels | Uio25_28 In | Channel #29: bank of 4 bits, 0...15 value, scalar input/output, no high speed i/o |

| | | |
|---|---|---|
| | Uio25_28 Out | Channel #30: bank of 4 bits, 0...15 value, scalar input/output, no high speed i/o |
| Connector Pins | One pin per bit | Signals are available at Hd44 connector pins: #25...#28[217] |
| Ground Reference | Hd44 Pins 29/42/43/44 | i600 ground is connected to computer ground via USB bus (which is connected to Earth ground via computer power supply plug 3rd prong). Alternatively, i601 ground is electrically isolated from computer ground. |

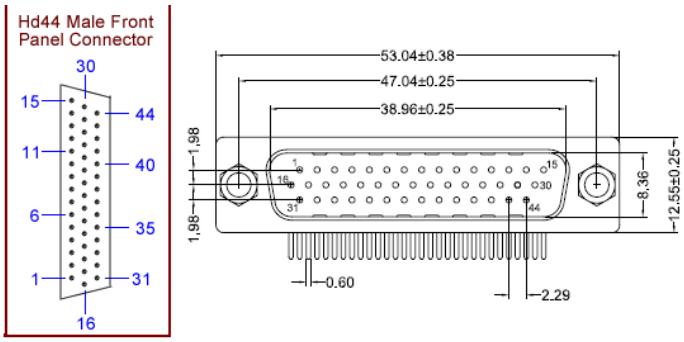
## I/O Software Channels, iNet-600 & iNet-601

| ChNum | Name | Channel Type | Hd44 Pin(s) | Description | Scalar I/O Support | High Speed Digitize Support |
|---|---|---|---|---|---|---|
| #1 | Ch1 Vin+ | SE/DI Voltage Input | 1, 2 | ±20mV...±10V | input | input |
| #2 | Ch2 Vin- | SE Voltage Input | 2 | " | " | " |
| #3 | Ch3 Vin+ | SE/DI Voltage Input | 3, 4 | " | " | " |
| #4 | Ch4 Vin- | SE Voltage Input | 4 | " | " | " |
| #5 | Ch5 Vin+ | SE/DI Voltage Input | 5, 6 | " | " | " |
| #6 | Ch6 Vin- | SE Voltage Input | 6 | " | " | " |
| #7 | Ch7 Vin+ | SE/DI Voltage Input | 7, 8 | " | " | " |
| #8 | Ch8 Vin- | SE Voltage Input | 8 | " | " | " |
| #9 | Ch9 Vin+ | SE/DI Voltage Input | 9, 10 | " | " | " |
| #10 | Ch10 Vin- | SE Voltage Input | 10 | " | " | " |
| #11 | Ch11 Vin+ | SE/DI Voltage Input | 11, 12 | " | " | " |
| #12 | Ch12 Vin- | SE Voltage Input | 12 | " | " | " |
| #13 | Ch13 Vin+ | SE/DI Voltage Input | 13, 14 | " | " | " |
| #14 | Ch14 Vin- | SE Voltage Input | 14 | " | " | " |
| #15 | Ch15 Vin+ | SE/DI Voltage Input | 15, 16 | " | " | " |
| #16 | Ch16 Vin- | SE Voltage Input | 16 | " | " | " |
| #25 | Ch25 Dio | One Dio Bit | 25 | 0 or 1, 4mA sink/source | input/output | no high speed i/o |
| #26 | Ch26 Dio | " | 26 | " | " | " |
| #27 | Ch27 Dio | " | 27 | " | " | " |
| #28 | Ch28 Dio | " | 28 | " | " | " |
| #29 | Uio25_28 In | Group of Dio Bits | 25...28 | 0...15 | " | " |
| #30 | Uio25_28 Out | " | " | " | " | " |

## Hd44 Connector Pins, iNet-600 & iNet-601

| Hd44 Pin# | Pin Name | Pin Type | Description |
|---|---|---|---|
| #1 | Ch1 Vin+ | SE/DI+ Voltage In | Supported Sensors: Voltage, Thermocouple, Thermistor, RTD, Load Cell[30], Strain Gage[30], Potentiometer, Current, Resistance |
| #2 | Ch2 Vin- | SE/DI- Voltage In | " |
| #3 | Ch3 Vin+ | SE/DI+ Voltage In | " |
| #4 | Ch4 Vin- | SE/DI- Voltage In | " |
| #5 | Ch5 Vin+ | SE/DI+ Voltage In | " |
| #6 | Ch6 Vin- | SE/DI- Voltage In | " |
| #7 | Ch7 Vin+ | SE/DI+ Voltage In | " |
| #8 | Ch8 Vin- | SE/DI- Voltage In | " |
| #9 | Ch9 Vin+ | SE/DI+ Voltage In | " |
| #10 | Ch10 Vin- | SE/DI- Voltage In | " |
| #11 | Ch11 Vin+ | SE/DI+ Voltage In | " |
| #12 | Ch12 Vin- | SE/DI- Voltage In | " |
| #13 | Ch13 Vin+ | SE/DI+ Voltage In | " |
| #14 | Ch14 Vin- | SE/DI- Voltage In | " |
| #15 | Ch15 Vin+ | SE/DI+ Voltage In | " |
| #16 | Ch16 Vin- | SE/DI- Voltage In | " |
| #17 | Not Used | Not Used | |
| #18 | " | " | " |
| #19 | " | " | " |
| #20 | " | " | " |
| #21 | " | " | " |
| #22 | " | " | " |
| #23 | " | " | " |
| #24 | " | " | " |
| #25 | Ch25 Dio | One Dio Bit | digital I/O bits, 0 or 1 value, scalar input/output, no high speed i/o, 4mA sink/source, 0 to 3.3V |
| #26 | Ch26 Dio | " | " |
| #27 | Ch27 Dio | " | " |
| #28 | Ch28 Dio | " | " |
| #29 | Gnd | instruNet Ground | i600 ground is connected to computer ground via USB bus (which is connected to Earth ground via computer power supply plug 3rd prong). Alternatively, i601 ground is electrically isolated from computer ground. |
| #30 | Internal_30 | Internal Use Only | Pin is used by manufacturer for product testing, please do not touch |
| #31 | Internal_31 | " | " |
| #32 | Internal_32 | " | " |
| #33 | Internal_33 | " | " |
| #34 | 3.3Vref | +3.3V ±0.2V, <80mA | Power Available to End User |
| #35 | " | " | " |
| #36 | 5Vpwr | +5V ±0.6V, <8mA | Power Available to End User |
| #37 | " | " | " |
| #38 | 12Vpwr | +15V ±1.2V, <4mA | Power Available to End User |
| #39 | " | " | " |
| #40 | -12Vpwr | -15V ±1.2V, <4mA | Power Available to End User |
| #41 | " | " | " |
| #42 | Gnd | instruNet Ground | i600 ground is connected to computer ground via USB bus (which is connected to |

| | | | |
|---|---|---|---|
| | | | Earth ground via computer power supply plug 3rd prong). Alternatively, i601 ground is electrically isolated from computer ground. |
| #43 | " | " | " |
| #44 | " | " | " |



## Power Available to End User, iNet-600 & iNet-601

| Parameter | Specifications[19] | Notes |
|---|---|---|
| Description | External Power | +3.3V, +5V, +15V, and -15V power (< 80mA) is available to the end user at several Hd44 Connector[217] pins. |
| +3.3V Reference Pwr | +3.3V ±0.2V, <80mA[30] | +3.3Vdc power available to end user at Hd44 connector pins 34 and 35 |
| +5V End User Pwr | +5V ±0.6V, <8mA | +5Vdc power available to end user at Hd44 connector pins 36 and 37 |
| +15V End User Pwr | +15V ±1.2V, <4mA | +15Vdc power available to end user at Hd44 connector pins 38 and 39 |
| -15V End User Pwr | -15V ±1.2V, <4mA | -15Vdc power available to end user at Hd44 connector pins 40 and 41 |
| Fuse | Auto-Reset | Internal fuse on each power voltage opens during over-current condition, and automatically closes otherwise. 3.3Vref has 0.25A fuse, 5Vpwr has 15mA/100Ω fuse, and ±15Vpwr has 7mA/470ohmΩ fuse. |

## Physical/Environmental Specifications, iNet-600 & iNet-601

| Parameter | Specifications[19] | Notes |
|---|---|---|
| I/O Connector | HD44 male | High density 44 pin male connector[217] (e.g. Astron #HD6C-44-AMAN-1G[213] , click footnote for datasheet, outer shell is same size as DB25) |
| Wiring Box | Compatible | Compatible with the following optional wiring boxes: i510, i511, i512 |
| Physical Dimensions | 3.784" x 0.924" x 2.286" | For details, see i60x Mechanical Drawing |
| Operating Temp. | 1 to 70°C | Operate in temperature between 1°C and 70°C, no condensation |
| Storage Temperature | -20 to 70°C | Store in ambient temperature between -20°C and +70°C |
| Relative Humidity | ≤ 90% | Operate in humidity less than 90%, no condensation |
| Hot Plug & Play | Yes | One can attach device with power on or off, without damage |
| USB Interface | 2.0 | Transfer data to/from device at 480Mbits/sec |
| Safety | IEC, EN, UL, CSA | Designed to meet IEC 61010-1, EN 61010-1, UL 61010-1, CSA 61010-1 |
| Emissions | EN, CE, FCC | Designed to meet EN 61326 EMC Min Immunity, EN 55011 Emissions Group 1 Class A, CE, C-tick, ICES, and FCC Part 15 Emissions Class A |
| CE Compliance | Yes | Meets 73/23/EEC low-voltage safety, and 89/336/EEC electromagnetic compatibility |
| Specifications | Subject to change | All specifications are subject to change without notice |
| +5V USB Power, Max | +5V ±0.4V, ~433mA | Power drawn from USB bus, with max load from end user sensors |
| +5V USB Power, Typ | +5V ±0.4V, ~255mA | Power drawn from USB bus, with no load from end user sensors |

# Voltage Measurement
## Absolute Accuracy Specifications, iNet-600 & iNet-601

| Voltage Range [1] | Signal Averaging Per Point (mSec) [3] | Absolute Accuracy (Max Gain + Offset Error) [38a] | Max Multi-Channel Aggregate Sample Rate (s/sec/agg) [18] | Channel Switching Acquisition Time (uSec) [4] | Analog Amplifier Bandwidth (KHz) [5] |
|---|---|---|---|---|---|
| ±10V | 0 mSec | ±(0.005% + 1569.9µV) | 33.40K | 29.9 | 315 |
| | 0.1 mSec | ±(0.005% + 973.2µV) | 4.52K | 29.9 | 315 |
| | 1.0 mSec | ±(0.005% + 271.8µV) | 0.77K | 29.9 | 315 |
| ±5V | 0 mSec | ±(0.005% + 709.4µV) | 33.40K | 29.9 | 315 |
| | 0.1 mSec | ±(0.005% + 443.8µV) | 4.52K | 29.9 | 315 |
| | 1.0 mSec | ±(0.005% + 131.6µV) | 0.77K | 29.9 | 315 |
| ±2.5V | 0 mSec | ±(0.005% + 374.2µV) | 25.49K | 39.2 | 315 |
| | 0.1 mSec | ±(0.005% + 234.0µV) | 4.52K | 39.2 | 315 |
| | 1.0 mSec | ±(0.005% + 69.2µV) | 0.76K | 39.2 | 315 |
| ±1.2V | 0 mSec | ±(0.005% + 197.3µV) | 25.26K | 39.6 | 315 |
| | 0.1 mSec | ±(0.005% + 123.7µV) | 4.52K | 39.6 | 315 |
| | 1.0 mSec | ±(0.005% + 37.2µV) | 0.76K | 39.6 | 315 |
| ±600mV | 0 mSec | ±(0.005% + 123.9µV) | 20.86K | 47.9 | 315 |
| | 0.1 mSec | ±(0.005% + 91.5µV) | 4.27K | 47.9 | 315 |
| | 1.0 mSec | ±(0.005% + 22.4µV) | 0.75K | 47.9 | 315 |
| ±300mV | 0 mSec | ±(0.005% + 90.9µV) | 20.71K | 48.3 | 315 |
| | 0.1 mSec | ±(0.005% + 66.8µV) | 4.27K | 48.3 | 315 |
| | 1.0 mSec | ±(0.005% + 15.3µV) | 0.75K | 48.3 | 315 |
| ±150mV | 0 mSec | ±(0.005% + 70.4µV) | 3.75K | 187.7 | 21 |
| | 0.1 mSec | ±(0.005% + 22.8µV) | 2.65K | 187.7 | 21 |
| | 1.0 mSec | ±(0.005% + 11.4µV) | 0.69K | 187.7 | 21 |
| ±80mV | 0 mSec | ±(0.005% + 49.3µV) | 3.75K | 193.6 | 21 |
| | 0.1 mSec | ±(0.005% + 16.5µV) | 2.65K | 193.6 | 21 |
| | 1.0 mSec | ±(0.005% + 8.6µV) | 0.68K | 193.6 | 21 |
| ±40mV | 0 mSec | ±(0.005% + 32.8µV) | 3.58K | 199.1 | 21 |
| | 0.1 mSec | ±(0.005% + 11.7µV) | 2.56K | 199.1 | 21 |
| | 1.0 mSec | ±(0.005% + 6.7µV) | 0.68K | 199.1 | 21 |
| ±20mV | 0 mSec | ±(0.006% + 32.1µV) | 3.58K | 198.3 | 21 |
| | 0.1 mSec | ±(0.006% + 11.4µV) | 2.56K | 198.3 | 21 |
| | 1.0 mSec | ±(0.006% + 6.5µV) | 0.68K | 198.3 | 21 |

### Voltage Specification Conditions, iNet-600 & iNet-601

- The iNet-600 & iNet-601 module supports quantity 8 Voltage devices wired Differential or 16 wired Single-Ended.
- **Absolute Accuracy** is specified as a percentage of measured value PLUS a fixed offset. It is the sum of the following errors components, each in their worst case (we are conservative): Intergal Nonlinearity (INL), Differential Nonlinearity (DNL), system noise (ground input, digitize, and see noise), gain/offset temperature drift, gain/offset time stability drift, gain/offset initial offset error, 4.5nA max leakage current (at 37°C) times 50Ω user source impedance error, and voltage reference temperature/time drift [66]. Noise offset error is modeled as 3 times the Noise RMS value (99.7%). Absolute Accuracy is the same as Maximum Worst Case error. For Typical error, divide maximum by 2.
- Absolute accuracy is shown with both a gain and offset component, where the offset error is independent of the input voltage, and the gain error is porportional to
- Calibration: These specifications assume 1 year since Factory Calibration, instruNet hardware ambient temperature is between 13 and 33 °C, and instruNet hardware temperature changed 1°C since its last self-calibration [59].

**Software Programmable Parameters**
Each channel provides the following independently programmable parameters:

- A/D Signal-Averaging-Per-Point (0 ... 100mSec) [3]
- Sample-Rate (samples-per-second-per-channel) [17]
- Digital IIR Filter (LowPass, HighPass, BandPass, or BandStop) [55]
- Voltage Measurement Range (±20mV...±10V) [1]

the the input. For example, if one measures 2Volts and the absolute accuracy specification is ±(1% + 3mV), then one could expect ±(1% * 2V + 3mV) = ±23mV accuracy.

- These specifications assume the external end user source resistance is <50 Ω (op amp source); and the external end user source capacitance to GND is < 1000 pF.

- Sensor Type [13]
- Single-Ended or Differential Wiring

**More Information**

- Voltage Wiring Diagram and Setup
- instruNet i600/i601 Product Description
- Model i600/i601 Voltage Measurement Error Components
- Electrical Specifications
- I/O Software Channels
- Hd44 Connector Pins

## Voltage Measurement
## Drift Errors, iNet-600 & iNet-601

| Voltage Range [1] | Absolute Accuracy (Max Gain + Offset Error) [38a] | Additional Error Per °C If Operate Hardware at >33°C or <13°C [7] | Additional Error Per Year if Not Factory Calibrate Hardware After 1Yr [9] | Additional Error per °C if not AutoCal after 1°C Hardware Change Since last AutoCal [8] |
|---|---|---|---|---|
| ±10V | ±(0.005% + 271.8µV) | ±0.0003%/°C | ±0.0012%/yr | ±(0.0003% + 1.8µV)/°C |
| ±5V | ±(0.005% + 131.6µV) | ±0.0003%/°C | ±0.0012%/yr | ±(0.0003% + 1.0µV)/°C |
| ±2.5V | ±(0.005% + 69.2µV) | ±0.0003%/°C | ±0.0012%/yr | ±(0.0003% + 0.7µV)/°C |
| ±1.2V | ±(0.005% + 37.2µV) | ±0.0003%/°C | ±0.0012%/yr | ±(0.0003% + 0.4µV)/°C |
| ±600mV | ±(0.005% + 22.4µV) | ±0.0003%/°C | ±0.0012%/yr | ±(0.0003% + 0.3µV)/°C |
| ±300mV | ±(0.005% + 15.3µV) | ±0.0003%/°C | ±0.0012%/yr | ±(0.0003% + 0.2µV)/°C |
| ±150mV | ±(0.005% + 11.4µV) | ±0.0003%/°C | ±0.0012%/yr | ±(0.0003% + 0.2µV)/°C |
| ±80mV | ±(0.005% + 8.6µV) | ±0.0003%/°C | ±0.0012%/yr | ±(0.0003% + 0.1µV)/°C |
| ±40mV | ±(0.005% + 6.7µV) | ±0.0003%/°C | ±0.0012%/yr | ±(0.0003% + 0.1µV)/°C |
| ±20mV | ±(0.006% + 6.5µV) | ±0.0004%/°C | ±0.0012%/yr | ±0.0004%/°C |

## Thermocouple Measurement
## Absolute Accuracy Specifications, iNet-600 & iNet-601

| TC Type [13] | Measurement Range [11] | Voltage Range [1] | Absolute Accuracy (±Max Error) [38w] | Max Multi-Channel Aggregate Sample Rate (s/sec/agg) [18] |
|---|---|---|---|---|
| J | -210 to 150°C | ±20mV | -10 to 150°C: ±0.79°C<br>-210 to -10°C: ±1.15°C | 2.56K<br>i423 is faster |
| | -210 to 1200°C | ±80mV | 10 to 1200°C: ±0.90°C<br>-210 to 1200°C: ±1.40°C | 2.65K |
| K | -200 to 200°C | ±20mV | -10 to 120°C: ±0.87°C<br>±200°C: ±1.31°C | 2.56K |
| | -200 to 1360°C | ±80mV | 10 to 1360°C: ±1.16°C<br>-200 to 1360°C: ±1.62°C | 2.65K |
| B | 251 to 1820°C | ±20mV | 251 to 600°C: ±4.75°C<br>600 to 1300°C: ±2.45°C<br>251 to 1300°C: ±4.75°C<br>1300 to 1820°C: ±1.63°C | 2.56K |
| C | 0 to 1K°C | ±20mV | ±1.84°C | 2.56K |
| | 0 to 2315°C | ±40mV | ±2.48°C | 2.56K |
| D | 0 to 1K°C | ±20mV | ±2.14°C | 2.56K |
| | 0 to 2315°C | ±40mV | ±2.48°C | 2.56K |
| E | -200 to 125°C | ±20mV | -90 to 80°C: ±0.80°C<br>-200 to 125°C: ±1.01°C | 2.56K |
| | -200 to 1K°C | ±80mV | 10 to 1K°C: ±0.81°C<br>-200 to 1K°C: ±1.20°C | 2.65K |
| G | 0 to 500°C | ±20mV | 0 to 500°C: ±6.30°C<br>100 to 500°C: ±3.23°C | 2.56K |
| | 0 to 2315°C | ±40mV | 0 to 300°C: ±6.44°C<br>300 to 2315°C: ±1.86°C | 2.56K |
| N | -200 to 570°C | ±20mV | -200 to 0°C: ±1.66°C<br>0 to 170°C: ±1.01°C<br>-10 to 570°C: ±1.01°C | 2.56K |
| | -200 to 1300°C | ±80mV | 10 to 1300°C: ±1.17°C<br>-200 to 1300°C: ±2.14°C | 2.65K |
| R | -50 to 800°C | ±20mV | -50 to 10°C: ±3.41°C<br>10 to 800°C: ±2.49°C | 2.56K |
| | -50 to 1768°C | ±40mV | 10 to 1768°C: ±2.55°C<br>-50 to 1768°C: ±3.48°C | 2.56K |
| S | -50 to 1768°C | ±20mV | -50 to -10°C: ±3.17°C<br>-10 to 860°C: ±2.66°C<br>-50 to -10°C: ±3.17°C<br>-10 to 1768°C: ±2.66°C | 2.56K |
| T | -200 to 175°C | ±20mV | -200 to -10°C: ±1.27°C<br>-10 to 175°C: ±0.86°C | 2.56K |
| | -200 to 400°C | ±40mV | 10 to 400°C: ±0.84°C<br>-200 to 400°C: ±1.29°C | 2.56K |

Thermocouple Specification Conditions, iNet-600 & iNet-601

- The iNet-600 & iNet-601 module supports quantity 8 Thermocouple devices wired Differential (not SE).
- **Absolute Accuracy** is specified as a percentage of measured value PLUS a fixed offset. It is the sum of the following errors components, each in their worst case (we are conservative): voltage measurement errors as described above, cold junction compensation (supplied automatically by instrunet) error, polynomial linearization error, 0.2°C instrunet screw terminal temperature change since last autocalibration, multiplexor current pump error. Absolute Accuracy does Not include errors from the actual Thermocouple device. Absolute Accuracy is the same as Maximum Worst Case error. For Typical error, divide maximum by 2.
- These specifications assume signal averaging per point is 0.1mSec Integ for all rows[3] .
- Measurement of thermocouples Requires that an i51x Wiring Box be attached to the i4xx Module, and that the thermocouple leads are attached directly to the i51x screw terminals (for automatic Cold Junction Compensation).
- The measured thermocouple temperature is a function of the instruNet hardware screw terminal temperature and the voltage measured across the thermocouple. Therefore, an additional temperature measurement error of 1°C occurs for each 1°C change of the instruNet screw terminal temperature since the last instruNet auto-calibration (where it measures screw terminal temperature) [59] . For example, if the instruNet hardware auto-calibrates when it's screw terminals are at 23°C, and they then heat up 3°C before another auto-calibration, then all thermcouple measurements will return a temperature that is 3°C higher than expected. One can program the instruNet to auto-calibrate once every 1 to 1000 minutes.
- These specifications assume the thermocouple device is grounded at the instruNet (e.g. the end user connects an external wire between the i51x Vin Minus (Vin-) and GND screw terminals).
- Calibration: These specifications assume 1 year since Factory Calibration, instruNet hardware ambient temperature is between 13 and 33 °C [59] .

**Software Programmable Parameters**
Each channel provides the following independently programmable parameters:

- A/D Signal-Averaging-Per-Point (0 ... 100mSec) [3]
- Sample-Rate (samples-per-second-per-channel) [17]
- Digital IIR Filter (LowPass, HighPass, BandPass, or BandStop) [55]
- Voltage Measurement Range (±20mV ... ±80mV) [1]
- Sensor Type [13]
- Min/Max °C Range [11]

**More Information**

- Thermocouple Wiring Diagram and Setup
- instruNet i600/i601 Product Description
- Model i600/i601 Thermocouple Measurement Error Components
- Electrical Specifications

# Thermistor Measurement
## Absolute Accuracy Specifications, iNet-600 & iNet-601

| Thermistor Type (Ω @ 25°C) [23] | Measurement Range [11] | Voltage Range [1] | Absolute Accuracy (±Max Error) [38n] | Max Multi-Channel Aggregate Sample Rate (s/sec/agg) [18] | External Shunt Resistor (Ω) [15] | Shunt Resistor Initial Accuracy (%) and Temp Drift (ppm/C) [16] | Example Shunt Resistor Product [100] |
|---|---|---|---|---|---|---|---|
| **2252 Ω** eg #44004 | 10 to 130°C i423 has more range | ±1.2V | 10 to 30°C: ±0.25°C<br>30 to 70°C: ±0.17°C<br>70 to 130°C: ±0.21°C | 4.27K i423 is faster | 10K Ω | 0.05%, 5ppm/C | #iNet-R-10K |
| | 0 to 70°C | ±2.5V | ±0.30°C | 4.27K | 10K Ω | 0.05%, 5ppm/C | #iNet-R-10K |
| | 90 to 250°C | ±80mV | ±1.43°C | 2.02K | 10K Ω | 0.05%, 5ppm/C | #iNet-R-10K |
| | 30 to 250°C | ±600mV | 30 to 170°C: ±0.48°C<br>170 to 250°C: ±2.24°C | 4.27K | 10K Ω | 0.05%, 5ppm/C | #iNet-R-10K |
| | 30 to 70°C | ±1.2V | ±0.16°C | 4.27K | 10K Ω | 0.01%, 5ppm/C | contact disti |

### Thermistor Specification Conditions, iNet-600 & iNet-601

- The iNet-600 & iNet-601 module supports quantity 8 Thermistor devices wired Differential or 16 wired Single-Ended.
- **Absolute Accuracy** is specified as a percentage of measured value PLUS a fixed offset. It is the sum of the following errors components, each in their worst case (we are conservative): voltage measurement errors as described above, readback of excitation voltage error, sensor self heating error, external shunt resistor self heating error, external shunt resistor initial accuracy error, instruNet input impedance variation error, 4.5nA max leakage current (at 37°C) times user source impedance error, polynomial linearization error, multiplexor current pump error. Absolute Accuracy does Not include errors from the actual Thermistor device. Absolute Accuracy is the same as Maximum Worst Case error. For Typical error, divide maximum by 2.
- These specifications assume signal averaging per point is 0.1mSec Integ for all rows[3] .
- instruNet connects directly to all types of Thermistor's.
- The end user must supply one external shunt resistor per channel (i.e. this resistor is not included with i4xx or i51x products).
- The end user must supply Steinhart a/b/c coefficients, unless working with YSI/Omega 4xx or 4xxxx series thermistors [23] .
- These specifications assume that less than 1000 pF of external capacitance is between the end user source and GND.
- instruNet provides a fixed 3.3V excitation voltage which is accurately readback in order to calculate °C.
- These specifications assume an i51x Wiring Box is attached to the i4xx Module, and that the device leads are attached to the i51x screw terminals (for accurate readback of 3.3Vref). The i51x can be attached directly to the i4xx front panel; or a cable can be placed between the i4xx and i51x wiring box (e.g. ≤ 5meters, 44 wire, point-to-point) without degradation of accuracy.
- Calibration: These specifications assume 1 year since Factory Calibration, instruNet hardware ambient temperature is between 13 and 33 °C, and instruNet hardware temperature changed 1°C since its last self-calibration [59] .

**Software Programmable Parameters**
Each channel provides the following independently programmable parameters:

- A/D Signal-Averaging-Per-Point (0 ... 100mSec) [3]
- Sample-Rate (samples-per-second-per-channel) [17]
- Digital IIR Filter (LowPass, HighPass, BandPass, or BandStop) [55]
- Voltage Measurement Range (±20mV ... ±10V) [1]
- Sensor Type [23]
- Min/Max °C Range [11]
- Single-Ended or Differential Wiring
- External End-User-Supplied Shunt Resistor resistance (Ω) [15]
- Device Steinhart-Hart a/b/c coefficients

**More Information**

- Thermistor Wiring Diagram and Setup
- instruNet i600/i601 Product Description
- Model i600/i601 Thermistor Measurement Error Components
- Electrical Specifications

# RTD Measurement

## Absolute Accuracy Specifications, iNet-600 & iNet-601

| RTD Type (Ω @ 0°C) [13] | Measurement Range [11] | Voltage Range [1] | Absolute Accuracy (±Max Error) [38e] | Max Multi-Channel Aggregate Sample Rate (s/sec/agg) [18] | External Shunt Resistor (Ω) [15] | Shunt Resistor Initial Accuracy (%) and Temp Drift (ppm/C) [16] | Example Shunt Resistor Product [100] |
|---|---|---|---|---|---|---|---|
| 100 Ω | ±50°C | ±40mV | ±0.48°C | 2.02K | 10K Ω | 0.05%, 5ppm/C | #iNet-R-10K |
| | -100 to 300°C | ±80mV | -100 to 150°C: ±0.61°C<br>150 to 300°C: ±0.74°C | 2.02K<br>i423 is faster | 10K Ω | 0.05%, 5ppm/C | #iNet-R-10K |
| | -238 to 850°C | ±150mV | -238 to 0°C: ±0.52°C<br>0 to 100°C: ±0.61°C<br>100 to 850°C: ±1.40°C | 2.02K | 10K Ω | 0.05%, 5ppm/C | #iNet-R-10K |
| 500 Ω | -100 to 300°C | ±600mV | ±0.62°C | 4.27K | 10K Ω | 0.05%, 5ppm/C | #iNet-R-10K |
| 1K Ω | -100 to 300°C | ±600mV | ±0.64°C | 4.27K | 10K Ω | 0.05%, 5ppm/C | #iNet-R-10K |
| 100 Ω | -100 to 150°C | ±80mV | ±0.44°C | 2.02K | 10K Ω | 0.01%, 5ppm/C | contact disti |

### RTD Specification Conditions, iNet-600 & iNet-601

- The iNet-600 & iNet-601 module supports quantity 8 RTD devices wired Differential or 16 wired Single-Ended.
- **Absolute Accuracy** is specified as a percentage of measured value PLUS a fixed offset. It is the sum of the following errors components, each in their worst case (we are conservative): voltage measurement errors as described above, readback of excitation voltage error, sensor self heating error, external shunt resistor self heating error, external shunt resistor initial accuracy error, instruNet input impedance variation error, 4.5nA max leakage current (at 37°C) times user source impedance error, multiplexor current pump error. Absolute Accuracy does Not include errors from the actual RTD device. Absolute Accuracy is the same as Maximum Worst Case error. For Typical error, divide maximum by 2.
- These specifications assume signal averaging per point is 0.1mSec Integ for all rows[3] .
- instruNet connects directly to all types of RTD's.
- The end user must supply one external shunt resistor per channel (i.e. this resistor is not included with i4xx or i51x products).
- These specifications assume that less than 1000 pF of external capacitance is between the end user source and GND.
- instruNet provides a fixed 3.3V excitation voltage which is accurately readback in order to calculate °C.
- These specifications assume an i51x Wiring Box is attached to the i4xx Module, and that the device leads are attached to the i51x screw terminals (for accurate readback of 3.3Vref). The i51x can be attached directly to the i4xx front panel; or a cable can be placed between the i4xx and i51x wiring box (e.g. ≤ 5meters, 44 wire, point-to-point) without degradation of accuracy.
- Calibration: These specifications assume 1 year since Factory Calibration, instruNet hardware ambient temperature is between 13 and 33 °C, and instruNet hardware temperature changed 1°C since its last self-calibration [59] .

**Software Programmable Parameters**
Each channel provides the following independently programmable parameters:

- A/D Signal-Averaging-Per-Point (0 ... 100mSec) [3]
- Sample-Rate (samples-per-second-per-channel) [17]
- Digital IIR Filter (LowPass, HighPass, BandPass, or BandStop) [55]
- Voltage Measurement Range (±20mV ... ±10V) [1]
- Sensor Type [13]
- Min/Max °C Range [11]
- Single-Ended or Differential Wiring
- External End-User-Supplied Shunt Resistor resistance (Ω) [15]
- RTD alpha (e.g. 0.0038) and delta (e.g. 1.492) coefficients
- RTD beta (e.g. 0.11) coefficient when working with temperatures < 0°C

**More Information**

- RTD Wiring Diagram and Setup
- instruNet i600/i601 Product Description
- Model i600/i601 RTD Measurement Error Components
- Electrical Specifications

# Load Cell Measurement
## Absolute Accuracy Specifications, iNet-600 & iNet-601

| Load Cell (Max Kg) [13] | Measurement Range [11] | Absolute Accuracy (±Max Error) [38p] | Max Multi-Channel Aggregate Sample Rate (s/sec/agg) [18] | Voltage Range [1] | Signal Averaging Per Point (mSec) [3] |
|---|---|---|---|---|---|
| **10 Kg**, 350Ω, 2mV/V @ MaxKg | 0 to 10 Kg | ±0.014 Kg | 1.97K, i423 is faster | ±20mV | 0.1 mSec |
| | | ±0.006 Kg | 0.62K | | 1.0 mSec |
| **25 Kg**, 350Ω, 2mV/V @ MaxKg | 0 to 25 Kg | ±0.034 Kg | 1.97K | ±20mV | 0.1 mSec |
| | | ±0.015 Kg | 0.62K | | 1.0 mSec |
| **100 Kg**, 350Ω, 2mV/V @ MaxKg | 0 to 100 Kg | ±0.136 Kg | 1.97K | ±20mV | 0.1 mSec |
| | | ±0.061 Kg | 0.62K | | 1.0 mSec |
| **250 Kg**, 350Ω, 2mV/V @ MaxKg | 0 to 250 Kg | ±0.339 Kg | 1.97K | ±20mV | 0.1 mSec |
| | | ±0.152 Kg | 0.62K | | 1.0 mSec |
| **1000 Kg**, 350Ω, 2mV/V @ MaxKg | 0 to 1K Kg | ±1.356 Kg | 1.97K | ±20mV | 0.1 mSec |
| | | ±0.607 Kg | 0.62K | | 1.0 mSec |
| **5000 Kg**, 350Ω, 2mV/V @ MaxKg | 0 to 5K Kg | ±6.779 Kg | 1.97K | ±20mV | 0.1 mSec |
| | | ±3.037 Kg | 0.62K | | 1.0 mSec |
| **100 Kg**, 500Ω, 2mV/V @ MaxKg | 0 to 100 Kg | ±0.141 Kg | 1.97K | ±20mV | 0.1 mSec |
| | | ±0.066 Kg | 0.62K | | 1.0 mSec |
| **100 Kg**, 1000Ω, 2mV/V @ MaxKg | 0 to 100 Kg | ±0.158 Kg | 1.88K | ±20mV | 0.1 mSec |
| | | ±0.083 Kg | 0.61K | | 1.0 mSec |

### Load Cell Specification Conditions, iNet-600 & iNet-601

- The iNet-600 & iNet-601 module supports quantity 8 Load Cell devices wired Differential (not SE) [30].
- **Absolute Accuracy** is specified as a percentage of measured value PLUS a fixed offset. It is the sum of the following errors components, each in their worst case (we are conservative): voltage measurement errors as described above, readback of excitation voltage error, 4.5nA max leakage current (at 37°C) times user source impedance error, multiplexor current pump error. Absolute Accuracy does Not include errors from the actual Load Cell device. Absolute Accuracy is the same as Maximum Worst Case error. For Typical error, divide maximum by 2.
- instruNet connects directly to all types of Load Cell's.
- These specifications assume the device has been calibrated at the 0 point. This "balancing" involves appling 0 force and then telling instruNet to "balance bridges" via a software command. Subsequently, instruNet automatically subtracts this voltage from future measurements.
- 120Ω devices are typically not used due to excess heating at the device (3.3V / 120Ω = 27mA, 90 mWatts). ≥ 350Ω devices are preferred (3.3V / 350Ω = 9mA, 31 mWatts).
- These specifications assume that less than 1000 pF of external capacitance is between the end user source and GND.
- instruNet provides a fixed 3.3V excitation voltage which is accurately readback in order to calculate Kg.
- These specifications assume an i51x Wiring Box is attached to the i4xx Module, and that the device leads are attached to the i51x screw terminals (for accurate readback of 3.3Vref). The i51x can be attached directly to the i4xx front panel; or a cable can be placed between the i4xx and i51x wiring box (e.g. ≤ 5meters, 44 wire, point-to-point) without degradation of accuracy.
- Calibration: These specifications assume 1 year since Factory Calibration, instruNet hardware ambient temperature is between 13 and 33 °C, and instruNet hardware temperature changed 1°C since its last self-calibration [59].

**Software Programmable Parameters**
Each channel provides the following independently programmable parameters:

- A/D Signal-Averaging-Per-Point (0 ... 100mSec) [3]
- Sample-Rate (samples-per-second-per-channel) [17]
- Digital IIR Filter (LowPass, HighPass, BandPass, or BandStop) [55]
- Voltage Measurement Range (±20mV ... ±80mV) [1]
- Sensor Type [13]
- Min/Max Kg Range [11]
- Device maximum-Kg-force and mV/V-sensitivity-at-max-force coefficients

**More Information**

- Load Cell Wiring Diagram and Setup
- instruNet i600/i601 Product Description
- Model i600/i601 Load Cell Measurement Error Components
- Electrical Specifications

# Strain Gage Measurement
## Absolute Accuracy Specifications, iNet-600 & iNet-601

| Strain Gage (ohms) [13] | Measurement Range [11] | Absolute Accuracy (±Max Error) 38d | Max Multi-Channel Aggregate Sample Rate (s/sec/agg) [18] | External Ro Resistor (Ω, temp drift) [15] | Example Shunt Resistor Product [100] | Voltage Range [1] | Signal Averaging Per Point (mSec) [3] |
|---|---|---|---|---|---|---|---|
| **350 Ω**, ¼ Bridge | ±11875 µS | ±13.5 µS | 1.97K, i423 is faster | 350 Ω, 5ppm/C | #iNet-R-350 | ±20mV | 0.1 mSec |
| | ±24035 µS | ±15.5 µS | 1.97K | 350 Ω, 5ppm/C | #iNet-R-350 | ±40mV | |
| | ±49258 µS | ±22.3 µS | 2.02K | 350 Ω, 5ppm/C | #iNet-R-350 | ±80mV | |
| **350 Ω**, ½ Bridge Bend | ±5868 µS | ±5.6 µS | 1.97K | 350 Ω, 5ppm/C | #iNet-R-350 | ±20mV | |
| **350 Ω**, ½ Bridge Axial | ±8945 µS | ±8.5 µS | 1.97K | 350 Ω, 5ppm/C | #iNet-R-350 | ±20mV | |
| **350 Ω**, Full Br Bend | ±2934 µS | ±1.6 µS | 1.97K | (no ext Ro) | | ±20mV | |
| | | ±0.9 µS | 0.62K | | | | 1.0 mSec |
| **350 Ω**, Full Br Axial I | ±4445 µS | ±2.5 µS | 1.97K | (no ext Ro) | | ±20mV | 0.1 mSec |
| | | ±1.4 µS | 0.62K | | | | 1.0 mSec |
| **350 Ω**, Full Br Axial II | ±4459 µS | ±2.5 µS | 1.97K | (no ext Ro) | | ±20mV | 0.1 mSec |
| | | ±1.4 µS | 0.62K | | | | 1.0 mSec |
| **1K Ω**, ¼ Bridge | ±11876 µS | ±10.0 µS | 1.88K | 1K Ω, 5ppm/C | #iNet-R-1K | ±20mV | 0.1 mSec |

### Strain Gage Specification Conditions, iNet-600 & iNet-601

- The iNet-600 & iNet-601 module supports quantity 8 Strain Gage devices wired Differential (not SE) [30].
- **Absolute Accuracy** is specified as a percentage of measured value PLUS a fixed offset. It is the sum of the following errors components, each in their worst case (we are conservative): voltage measurement errors as described above, readback of excitation voltage error, external shunt resistor self heating error, 4.5nA max leakage current (at 37°C) times user source impedance error, multiplexor current pump error. Absolute Accuracy does Not include errors from the actual Strain Gage device. Absolute Accuracy is the same as Maximum Worst Case error. For Typical error, divide maximum by 2.
- instruNet connects directly to all types of Strain Gage's.
- The end user must supply 2 external shunt resistors if working with a half bridge and 3 external resistors if working with a quarter bridge (i.e. these resistors are not included with i4xx or products).
- These specifications assume the device has been calibrated at the 0 point. This "balancing" involves appling 0 force and then telling instruNet to "balance bridges" via a software command. Subsequently, instruNet automatically subtracts this voltage from future measurements.
- 120Ω devices are typically not used due to excess heating at the device (3.3V / 120Ω = 27mA, 90 mWatts). ≥ 350Ω devices are preferred (3.3V / 350Ω = 9mA, 31 mWatts).
- These specifications assume that less than 1000 pF of external capacitance is between the end user source and GND.
- instruNet provides a fixed 3.3V excitation voltage which is accurately readback in order to calculate µS.
- These specifications assume an i51x Wiring Box is attached to the i4xx Module, and that the device leads are attached to the i51x screw terminals (for accurate readback of 3.3Vref). The i51x can be attached directly to the i4xx front panel; or a cable can be placed between the i4xx and i51x wiring box (e.g. ≤ 5meters, 44 wire, point-to-point) without degradation of accuracy.
- Calibration: These specifications assume 1 year since Factory Calibration, instruNet hardware ambient temperature is between 13 and 33 °C, and instruNet hardware temperature changed 1°C since its last self-calibration [59].

**Software Programmable Parameters**
Each channel provides the following independently programmable parameters:

- A/D Signal-Averaging-Per-Point (0 ... 100mSec) [3]
- Sample-Rate (samples-per-second-per-channel) [17]
- Digital IIR Filter (LowPass, HighPass, BandPass, or BandStop) [55]
- Voltage Measurement Range (±20mV ... ±80mV) [1]
- Sensor Type [13]
- Min/Max µS Range [11]
- External End-User-Supplied Shunt Resistor resistance (Ω) [15]
- Device GF (e.g. 2) and Poisson (e.g. 0.32) coefficients
- Device to instruNet lead resistance (Ω)

**More Information**

- Strain Gage Wiring Diagram and Setup
- instruNet i600/i601 Product Description
- Model i600/i601 Strain Gage Measurement Error Components
- Electrical Specifications

# Potentiometer Measurement
# Absolute Accuracy Specifications, iNet-600 & iNet-601

| POT Type (ohms) [13] | Measurement Range [11] | Signal Averaging Per Point (mSec) [3] | Absolute Accuracy (±Max Error) [38q] | Max Multi-Channel Aggregate Sample Rate (s/sec/agg) [18] | Voltage Range [1] |
|---|---|---|---|---|---|
| 10K Ω | 0 to 1.0Eu | 0.1 mSec | ±0.000227Eu | 2.48K, i423 is faster | ±5V |
| 50K Ω | 0 to 1.0Eu | | ±0.000254Eu | 0.78K | ±5V |

### Potentiometer Specification Conditions, iNet-600 & iNet-601

- The iNet-600 & iNet-601 module supports quantity 8 Potentiometer devices wired Differential (not SE).
- **Absolute Accuracy** is specified as a percentage of measured value PLUS a fixed offset. It is the sum of the following errors components, each in their worst case (we are conservative): voltage measurement errors as described above, readback of excitation voltage error, instruNet input impedance variation error, 4.5nA max leakage current (at 37°C) times user source impedance error, multiplexor current pump error. Absolute Accuracy does Not include errors from the actual Potentiometer device. Absolute Accuracy is the same as Maximum Worst Case error. For Typical error, divide maximum by 2.
- instruNet connects directly to all types of Potentiometer's.
- These specifications assume that less than 1000 pF of external capacitance is between the end user source and GND.
- instruNet provides a fixed 3.3V excitation voltage which is accurately readback in order to calculate Eu.
- These specifications assume an i51x Wiring Box is attached to the i4xx Module, and that the device leads are attached to the i51x screw terminals (for accurate readback of 3.3Vref). The i51x can be attached directly to the i4xx front panel; or a cable can be placed between the i4xx and i51x wiring box (e.g. ≤ 5meters, 44 wire, point-to-point) without degradation of accuracy.
- Calibration: These specifications assume 1 year since Factory Calibration, instruNet hardware ambient temperature is between 13 and 33 °C, and instruNet hardware temperature changed 1°C since its last self-calibration [59].

**Software Programmable Parameters**
Each channel provides the following independently programmable parameters:

- A/D Signal-Averaging-Per-Point (0 ... 100mSec) [3]
- Sample-Rate (samples-per-second-per-channel) [17]
- Digital IIR Filter (LowPass, HighPass, BandPass, or BandStop) [55]
- Voltage Measurement Range (±20mV ... ±10V) [1]
- Sensor Type [13]

**More Information**

- Potentiometer Wiring Diagram and Setup
- instruNet i600/i601 Product Description
- Model i600/i601 Potentiometer Measurement Error Components
- Electrical Specifications

# Current Measurement

## Absolute Accuracy Specifications, iNet-600 & iNet-601

| Measurement Range [11] | Signal Averaging Per Point (mSec) [3] | Absolute Accuracy (Max Gain + Offset Error) [38b] | Max Multi-Channel Aggregate Sample Rate (s/sec/agg) [18] | External Shunt Resistor (Ω) [15] | Shunt Resistor Initial Accuracy (%) and Temp Drift (ppm/C) [16] | Example Shunt Resistor Product [100] | Voltage Range [1] |
|---|---|---|---|---|---|---|---|
| 0 to 24mA | 0 mSec | ±(0.056% + 6.0uA) | 24.70K | 33 Ω | 0.05%, 5ppm/C | #iNet-R-33 | ±1.2V |
| | 1.0 mSec | ±(0.056% + 1.1uA) | 0.76K | | | | |
| ±24mA | 0 mSec | ±(0.056% + 6.0uA) | 24.70K | | | | |
| | 1.0 mSec | ±(0.056% + 1.1uA) | 0.76K | | | | |
| ±12mA | 0 mSec | ±(0.056% + 3.1uA) | 23.98K | 120 Ω | 0.05%, 5ppm/C | #iNet-R-120 | ±2.5V |
| | 0.1 mSec | ±(0.056% + 1.1uA) | 4.27K | | | | |
| | 1.0 mSec | ±(0.056% + 0.6uA) | 0.75K | | | | |
| ±2.5mA | 0 mSec | ±(0.056% + 0.4uA) | 17.28K | 1K Ω | 0.05%, 5ppm/C | #iNet-R-1K | ±2.5V |
| | 0.1 mSec | ±(0.056% + 0.1uA) | 4.05K | | | | |
| | 1.0 mSec | ±(0.056% + 0.1uA) | 0.74K | | | | |
| ±1.2mA | 0 mSec | ±(0.055% + 0.20uA) | 17.17K | 1K Ω | 0.05%, 5ppm/C | #iNet-R-1K | ±1.2V |
| | 1.0 mSec | ±(0.055% + 0.04uA) | 0.74K | | | | |
| ±500uA | 0.1 mSec | ±(0.056% + 0.02uA) | 2.48K | 10K Ω | 0.05%, 5ppm/C | #iNet-R-10K | ±5V |
| | 1.0 mSec | ±(0.056% + 0.01uA) | 0.67K | | | | |
| ±600uA | 0 mSec | ±(0.056% + 0.12uA) | 15.02K | 1K Ω | 0.05%, 5ppm/C | #iNet-R-1K | ±600mV |
| | 0.1 mSec | ±(0.056% + 0.04uA) | 3.85K | | | | |
| | 1.0 mSec | ±(0.056% + 0.02uA) | 0.73K | | | | |
| ±800uA | 0.1 mSec | ±(0.055% + 0.19uA) | 2.08K | 120 Ω | 0.05%, 5ppm/C | #iNet-R-120 | ±150mV |
| | 1.0 mSec | ±(0.055% + 0.09uA) | 0.63K | | | | |
| ±120uA | 0.1 mSec | ±(0.058% + 0.007uA) | 2.40K | 10K Ω | 0.05%, 5ppm/C | #iNet-R-10K | ±1.2V |
| | 1.0 mSec | ±(0.058% + 0.004uA) | 0.67K | | | | |
| ±80uA | 0.1 mSec | ±(0.058% + 0.016uA) | 1.92K | 1K Ω | 0.05%, 5ppm/C | #iNet-R-1K | ±80mV |
| | 1.0 mSec | ±(0.058% + 0.008uA) | 0.61K | | | | |
| 0 to 24mA | 0 mSec | ±(0.016% + 6.0uA) | 24.70K | 33 Ω | 0.01%, 5ppm/C | contact disti | ±1.2V |
| | 1.0 mSec | ±(0.016% + 1.1uA) | 0.76K | | | | |

### Current Specification Conditions, iNet-600 & iNet-601

- The iNet-600 & iNet-601 module supports quantity 8 Current devices wired Differential or 16 wired Single-Ended.
- **Absolute Accuracy** is specified as a percentage of measured value PLUS a fixed offset. It is the sum of the following errors components, each in their worst case (we are conservative): voltage measurement errors as described above, readback of excitation voltage error, external shunt resistor self heating error, external shunt resistor initial accuracy error, instruNet input impedance variation error, 4.5nA max leakage current (at 37°C) times user source impedance error, multiplexor current pump error. Absolute Accuracy is the same as Maximum Worst Case error. For Typical error, divide maximum by 2.
- Absolute accuracy is shown with both a gain and offset component, where the offset error is independent of the input voltage, and the gain error is porportional to the the input. For example, if one measures 2Volts and the absolute accuracy specification is ±(1% + 3mV), then one could expect ±(1% * 2V + 3mV) = ±23mV accuracy.
- The end user must supply one external shunt resistor per channel (i.e. this resistor is not included with i4xx or i51x products).
- These specifications assume that less than 1000 pF of external capacitance is between the end user source and GND.
- Calibration: These specifications assume 1 year since Factory Calibration, instruNet hardware ambient temperature is between 13 and 33 °C, and instruNet hardware temperature changed 1°C since its last self-calibration [59].

**Software Programmable Parameters**

Each channel provides the following independently programmable parameters:

- A/D Signal-Averaging-Per-Point (0 ... 100mSec) [3]
- Sample-Rate (samples-per-second-per-channel) [17]
- Digital IIR Filter (LowPass, HighPass, BandPass, or BandStop) [55]
- Voltage Measurement Range (±20mV ... ±10V) [1]
- Sensor Type [13]
- Min/Max uA Range [11]

- instruNet hardware measures the voltage across an external current shunt resistor. Both sides of this resistor must be within ±5 Volts of instruNet GND at all times.

- Single-Ended or Differential Wiring
- External End-User-Supplied Shunt Resistor resistance (Ω) [15]

**More Information**

- Current Wiring Diagram and Setup
- instruNet i600/i601 Product Description
- Model i600/i601 Current Measurement Error Components
- Electrical Specifications

# Resistance Measurement
## Absolute Accuracy Specifications, iNet-600 & iNet-601

| Measurement Range [11] | Signal Averaging Per Point (mSec) [3] | Absolute Accuracy (Max Gain + Offset Error) 38c | Max Multi-Channel Aggregate Sample Rate (s/sec/agg) [18] | External Shunt Resistor (Ω) [15] | Shunt Resistor Initial Accuracy (%) and Temp Drift (ppm/C) [16] | Example Shunt Resistor Product [100] | Voltage Range [1] |
|---|---|---|---|---|---|---|---|
| 0 to 33 Ω | 0.1 mSec | ±(0.067% + 0.008 Ω) | 2.08K, i423 is faster | 1K Ω | 0.05%, 5ppm/C | #iNet-R-1K | ±150mV |
| | 1.0 mSec | ±(0.066% + 0.004 Ω) | 0.63K | | | | |
| 0 to 100 Ω | 0 mSec | ±(0.072% + 0.028 Ω) | 20.20K | 1K Ω | 0.05%, 5ppm/C | #iNet-R-1K | ±300mV |
| | 0.1 mSec | ±(0.068% + 0.010 Ω) | 4.27K | | | | |
| | 1.0 mSec | ±(0.067% + 0.005 Ω) | 0.75K | | | | |
| 0 to 330 Ω | 0 mSec | ±(0.083% + 0.06 Ω) | 24.51K | 1K Ω | 0.05%, 5ppm/C | #iNet-R-1K | ±1.2V |
| | 0.1 mSec | ±(0.074% + 0.02 Ω) | 4.27K | | | | |
| | 1.0 mSec | ±(0.072% + 0.01 Ω) | 0.76K | | | | |
| 0 to 1K Ω | 0 mSec | ±(0.113% + 0.11 Ω) | 24.74K | 1K Ω | 0.05%, 5ppm/C | #iNet-R-1K | ±2.5V |
| | 0.1 mSec | ±(0.091% + 0.04 Ω) | 4.27K | | | | |
| | 1.0 mSec | ±(0.085% + 0.02 Ω) | 0.76K | | | | |
| 0 to 3300 Ω | 0 mSec | ±(0.114% + 0.4 Ω) | 24.74K | 3.3K Ω | 0.05%, 5ppm/C | #iNet-R-3300 | ±2.5V |
| | 1.0 mSec | ±(0.091% + 0.1 Ω) | 0.76K | | | | |
| 0 to 10K Ω | 0.1 mSec | ±(0.131% + 0.1 Ω) | 4.27K | 3.3K Ω | 0.05%, 5ppm/C | #iNet-R-3300 | ±2.5V |
| | 1.0 mSec | ±(0.122% + 0.1 Ω) | 0.76K | | | | |
| 0 to 100 Ω | 0 mSec | ±(0.032% + 0.028 Ω) | 20.20K | 1K Ω | 0.01%, 5ppm/C | contact disti | ±300mV |
| | 0.1 mSec | ±(0.028% + 0.010 Ω) | 4.27K | | | | |
| | 1.0 mSec | ±(0.027% + 0.005 Ω) | 0.75K | | | | |

### Resistance Specification Conditions, iNet-600 & iNet-601

- The iNet-600 & iNet-601 module supports quantity 8 Resistance devices wired Differential or 16 wired Single-Ended.
- **Absolute Accuracy** is specified as a percentage of measured value PLUS a fixed offset. It is the sum of the following errors components, each in their worst case (we are conservative): voltage measurement errors as described above, readback of excitation voltage error, external shunt resistor self heating error, external shunt resistor initial accuracy error, instruNet input impedance variation error, 4.5nA max leakage current (at 37°C) times user source impedance error, multiplexor current pump error. Absolute Accuracy is the same as Maximum Worst Case error. For Typical error, divide maximum by 2.
- Absolute accuracy is shown with both a gain and offset component, where the offset error is independent of the input voltage, and the gain error is porportional to the the input. For example, if one measures 2Volts and the absolute accuracy specification is ±(1% + 3mV), then one could expect ±(1% * 2V + 3mV) = ±23mV accuracy.
- The end user must supply one external shunt resistor per channel (i.e. this resistor is not included with i4xx or i51x products).
- These specifications assume that less than 1000 pF of external capacitance is between the end user source and GND.
- instruNet provides a fixed 3.3V excitation voltage which is accurately readback in order to calculate Ω.
- These specifications assume an i51x Wiring Box is attached to the i4xx Module, and that the device leads are attached to the i51x screw terminals (for accurate readback of 3.3Vref). The i51x can be attached directly to the i4xx front panel; or a
- Calibration: These specifications assume 1 year since Factory Calibration, instruNet hardware ambient temperature is between 13 and 33 °C, and instruNet hardware temperature changed 1°C since its last self-calibration [59].

**Software Programmable Parameters**
Each channel provides the following independently programmable parameters:

- A/D Signal-Averaging-Per-Point (0 ... 100mSec) [3]
- Sample-Rate (samples-per-second-per-channel) [17]
- Digital IIR Filter (LowPass, HighPass, BandPass, or BandStop) [55]
- Voltage Measurement Range (±20mV ... ±10V) [1]
- Sensor Type [13]
- Min/Max Ω Range [11]
- Single-Ended or Differential Wiring
- External End-User-Supplied Shunt Resistor resistance (Ω) [15]

**More Information**

- Resistance Wiring Diagram and Setup
- instruNet i600/i601 Product Description
- Model i600/i601 Resistance Measurement Error Components
- Electrical Specifications

cable can be placed between the i4xx and i51x wiring box (e.g. ≤ 5meters, 44 wire, point-to-point) without degradation of accuracy.