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 ≤ ±150mV range	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, < 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, > 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 Uio25_28 Out	Channel #29: bank of 4 bits, 0...15 value, scalar input/output, no high speed i/o Channel #30: bank of 4 bits, 0...15 value, scalar input/output, no high speed i/o

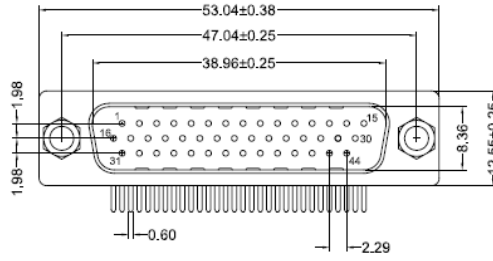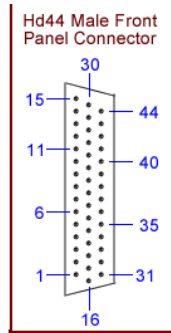| Connector Pins	One pin per bit	Signals are available at Hd44 connector pins: #25...#28[217]
Ground Reference	Hd44 Pins 29/42/43/44	i600 ground is connected to computer ground via USB bus (which is connected to Earth ground via computer power supply plug 3rd prong). Alternatively, i601 ground is electrically 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	"	"	"

Hd44 Male Front Panel Connector

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 the input. For example, if one measures 2Volts and the absolute 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]

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.

○ 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 -210 to -10°C: ±1.15°C	2.56K i423 is faster
	-210 to 1200°C	±80mV	10 to 1200°C: ±0.90°C -210 to 1200°C: ±1.40°C	2.65K
K	-200 to 200°C	±20mV	-10 to 120°C: ±0.87°C ±200°C: ±1.31°C	2.56K
	-200 to 1360°C	±80mV	10 to 1360°C: ±1.16°C -200 to 1360°C: ±1.62°C	2.65K
B	251 to 1820°C	±20mV	251 to 600°C: ±4.75°C 600 to 1300°C: ±2.45°C 251 to 1300°C: ±4.75°C 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 -200 to 125°C: ±1.01°C	2.56K
	-200 to 1K°C	±80mV	10 to 1K°C: ±0.81°C -200 to 1K°C: ±1.20°C	2.65K
G	0 to 500°C	±20mV	0 to 500°C: ±6.30°C 100 to 500°C: ±3.23°C	2.56K
	0 to 2315°C	±40mV	0 to 300°C: ±6.44°C 300 to 2315°C: ±1.86°C	2.56K
N	-200 to 570°C	±20mV	-200 to 0°C: ±1.66°C 0 to 170°C: ±1.01°C -10 to 570°C: ±1.01°C	2.56K
	-200 to 1300°C	±80mV	10 to 1300°C: ±1.17°C -200 to 1300°C: ±2.14°C	2.65K
R	-50 to 800°C	±20mV	-50 to 10°C: ±3.41°C 10 to 800°C: ±2.49°C	2.56K
	-50 to 1768°C	±40mV	10 to 1768°C: ±2.55°C -50 to 1768°C: ±3.48°C	2.56K
S	-50 to 1768°C	±20mV	-50 to -10°C: ±3.17°C -10 to 860°C: ±2.66°C -50 to -10°C: ±3.17°C -10 to 1768°C: ±2.66°C	2.56K
T	-200 to 175°C	±20mV	-200 to -10°C: ±1.27°C -10 to 175°C: ±0.86°C	2.56K
	-200 to 400°C	±40mV	10 to 400°C: ±0.84°C -200 to 400°C: ±1.29°C	2.56K

Thermocouple Specification Conditions, iNet-600 & iNet-601

o The iNet-600 & iNet-601 module supports quantity 8 Thermocouple devices wired

o These specifications assume the thermocouple device is grounded at the instruNet

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.

(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 30 to 70°C: ±0.17°C 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 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	2.02K	10K Ω	0.05%, 5ppm/C	#iNet-R-10K
			150 to 300°C:	±0.74°C	i423 is faster			
	-238 to 850°C	±150mV	-238 to 0°C:	±0.52°C	2.02K	10K Ω	0.05%, 5ppm/C	#iNet-R-10K
			0 to 100°C:	±0.61°C				
			100 to 850°C:	±1.40°C				
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 (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]

○ Single-Ended or Differential Wiring

- 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.

- 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 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 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