



# IPAQ<sup>®</sup>-H PLUS / IPAQ<sup>®</sup>-HX PLUS

## High-performance Intelligent 2-wire In-head Transmitters

Actual size

IPAQ-H<sup>PLUS</sup> is a *high-performance*, universal and intelligent 2-wire In-head transmitter for temperature and other measurement applications.

IPAQ-HX<sup>PLUS</sup> is the Intrinsic Safe version for use in Ex-applications.

The outstanding combination of *excellent specifications, high functionality and simple configuration* makes IPAQ-H<sup>PLUS</sup> and IPAQ-HX<sup>PLUS</sup> the obvious choice in *demanding applications*.

The Windows based and user friendly software, IPRO 4, is used for transmitter configuration, documentation, monitoring and calibration purposes.



### Performance and design:

#### Precision accuracy

- Linearity 0.05 % for RTD.
- Reduced temperature influence. Each transmitter is individually temperature compensated.
- Long-term stability 0.05 %/year.

#### Fast response

- Update time down to 170 ms, i.e. a measuring frequency of appr. 6 per second.

#### Enhanced total system accuracy

- Sensor error correction (for known sensor errors).
- System error correction (against known temperatures).

#### NAMUR-compliant

- Output limitations and fail currents adjustable according to NAMUR recommendations.

#### Smart Filter

- Short response time combined with high noise immunity.

#### Input-Output isolation 3750 VAC

- Excellent filtering of voltage spikes and elimination of ground loops.

#### High load capacity

- Only 6.5 V voltage drop over the transmitter (IPAQ-H<sup>PLUS</sup>) allows for high loads.

#### Designed for harsh conditions

- Operation temperature up to 85 °C / 185 °F (105 °C / 221 °F on request).
- Excellent EMC performance.
- Durable, shockproof design.

#### 5 year limited warranty

### Functions:

#### Input for RTDs, T/Cs, mV and resistance

- Reduced inventory costs.
- Simplified plant engineering.

#### True on-line communication

- Full access to all features while in operation.

#### Configuration without external power

- Editing or reading a configuration is possible also without external power supply.

#### Display connection

- Direct connection of an Inor digital display to the communication port.

#### Efficient customized 40-point linearization

- Any sensor characteristics can be matched.

#### Sensor diagnostics

- SmartSense detects low sensor isolation (essential for correct measurements).
- Selectable sensor break action.

#### Simplified loop check-up

- The transmitter works as an accurate current generator with user defined action.

#### On-screen indications and line recording

- Valuable tools for temporary measurements.

#### Improved QA with data storage

- Vital information, such as TAG-No., maintenance record etc. can be stored in the nonvolatile memory.

## Main features of IPAQ-H<sup>PLUS</sup> and IPAQ-HX<sup>PLUS</sup>

### Accuracy and stability

IPAQ-H<sup>PLUS</sup>/IPAQ-HX<sup>PLUS</sup> are designed for applications with the highest demands on accuracy, also under severe operating conditions. To reach these demands, the following factors are essential:

**Low linearity and calibration errors** -The combination of a high-efficient 40-point linearization and the use of quality components and precision calibration equipment reduce these errors to a minimum, e.g.  $\pm 0.05\%$  of span for RTD inputs.

**Low ambient temperature influence** -Each transmitter in the IPAQ<sup>PLUS</sup> family is individually compensated at different temperatures within the operating range. This procedure minimizes the ambient influence to a minimum.

**High long-term stability** -Internal "self calibration", by means of continuous adjustment of important parameters after comparison with accurate built-in references, contributes to a stability better than  $\pm 0.05\%$ /year.

### Measurements with RTDs and other resistances

IPAQ-H<sup>PLUS</sup>/IPAQ-HX<sup>PLUS</sup> accept inputs from standardized Platinum and Nickel RTDs like Pt10...Pt1000 acc. to IEC 751 ( $\alpha=0.00385$ ), Pt100 acc. to JIS 1604 ( $\alpha=0.003916$ ) and Ni100/Ni1000 acc. to DIN 43760, as well as inputs from plain resistance sensors such as potentiometers. 3- or 4-wire connection can be chosen.

### Measurements with thermocouples and plain voltage

IPAQ-H<sup>PLUS</sup>/IPAQ-HX<sup>PLUS</sup> accept inputs from 11 types of standardized thermocouples as well as plain mV input. For T/C input, the CJC (Cold Junction Compensation) is fully automatic, by means of an accurate measurement of the terminal temperature. Alternatively, an external CJ temperature can be entered.

### Digital output for display

Direct connection to external Inor display through the communication port. The information on the display is defined when programming the transmitter. *Request display information.*

### Customized linearization and Engineering units

The accurate and versatile 40-point *Customized linearization* can be used to create any type of linearization curve for RTD, T/C, resistance and mV inputs. By combining *Customized linearization* with the use of *Engineering units*, the transmitters can be programmed to give a linear output corresponding to a specific measuring range expressed in the primary process value. The sensor characteristics are described by either up to 40 data pairs or 8 polynomials. *Fig. 1a and 1b.*

Fig.1a

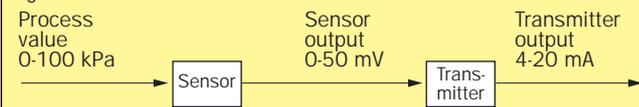
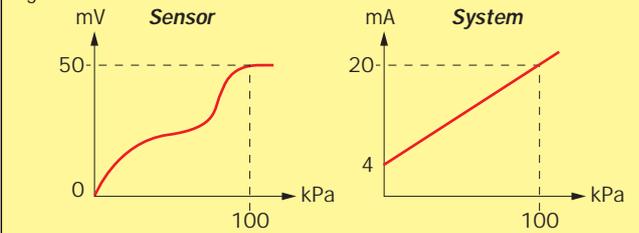


Fig.1b



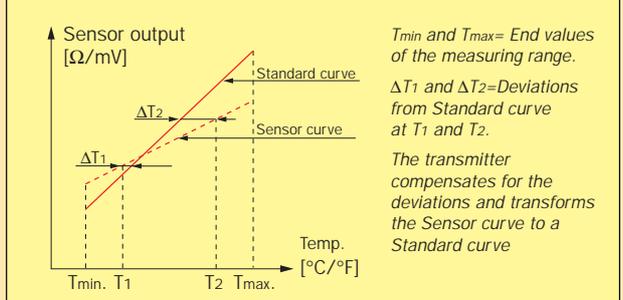
Example of a system (sensor + transmitter) with an output linear to the process value, in spite of a **non-linear** sensor.

### Sensor or System error correction

IPAQ-H<sup>PLUS</sup>/IPAQ-HX<sup>PLUS</sup> offer two ways of improving the measurement with temperature sensors:

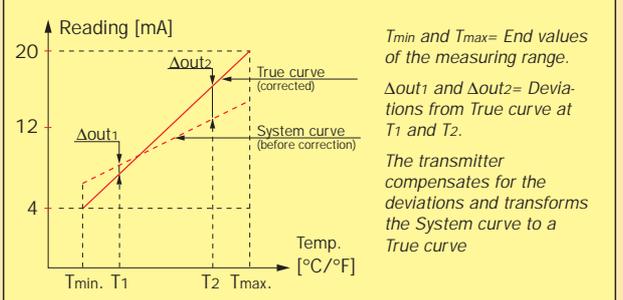
**Sensor error correction** - Known sensor errors compared to the standard curve, e.g. for a calibrated sensor, are entered, and the transmitter automatically corrects for the sensor errors. *Fig. 2.*

Fig.2 Sensor error correction



**System error correction** -This method is used to correct the system error (sensor + transmitter error) by exposing the sensor to one (one-point correction) or two (two-point correction) accurately measured temperatures (true temperatures). The true temperature(s) and the corresponding transmitter reading(s) are entered, and the transmitter automatically corrects for the system errors. *Fig. 3.*

Fig.3 Two-point System error correction



### SmartSense - Sensor isolation monitoring

SmartSense continuously monitors the isolation resistance of thermocouples and 3-wire connected RTDs as well as the cabling between sensor and transmitter. The transmitter will react by forcing the output to a user defined level if the isolation is below a preset level. SmartSense requires an extra lead inside the thermocouple or RTD. *Fig. 4.*

For detailed information, see section *Theory and Facts.*

### Sensor break monitoring

IPAQ-H<sup>PLUS</sup>/IPAQ-HX<sup>PLUS</sup> monitor sensor break and force the output signal to a user defined level, when *any* sensor lead is broken or disconnected. The sensor break monitoring can be switched off. The monitoring is furnished with a *pulsed excitation current*. This eliminates the voltage drop in the lead wires (giving a measuring error), caused by a standard DC excitation current.

### Controlled output for instrument calibration

IPAQ-H<sup>PLUS</sup>/IPAQ-HX<sup>PLUS</sup> can be set to automatically provide fixed or recurring output current regardless of the input signal. The time periods in recurring mode are selectable.

**Smart Filter**

The Smart Filter detects the difference between fast signal changes and electrical noise, e.g. ripple and spikes, on the input. The smart filter offers a superior combination of very short response time for the input signal and high noise immunity.

**Adjustable dampening**

The dampening function can be used to dampen undesired instabilities on the input signal. The dampening time can be set between 0 and 10 seconds in intervals of 1 second. The dampening time is the time required, in addition to the update time, for the output to reach 90% of its final value after a step change has been applied to the input.

**NAMUR-compliant**

The output can be limited to high and low selectable values, i.e.  $3.8 \leq I \leq 20.5$  mA for NAMUR compliance. This function is overridden by the Sensor break monitoring and SmartSense.

**Power supply**

IPAQ-H<sup>PLUS</sup>/IPAQ-HX<sup>PLUS</sup> are loop-powered and will work on voltages down to 6.5 VDC (8 VDC for IPAQ-HX<sup>PLUS</sup>), thus allowing for high loads in the current loop. Reversed polarity will not damage the transmitter. Fig. 5

**Mounting**

IPAQ-H<sup>PLUS</sup>/IPAQ-HX<sup>PLUS</sup> are designed to fit inside connection heads type DIN B or larger. The 7mm/0.28 inch center hole facilitates the mounting procedure.

**IPRO 4 - The user friendly software for all transmitters of the IPAQ family**

IPRO 4, which is used with all IPAQ-transmitters, is the tool to utilize all the versatile functions of the IPAQ-H<sup>PLUS</sup> and IPAQ-HX<sup>PLUS</sup> such as:

- Measurement configuration: Sensor type, range, sensor or system error correction, linearization, engineering units, output settings, filter activation, etc.
- Monitoring of sensor status: Sensor break and sensor isolation (SmartSense).
- On-screen real time presentation of measured values and output signal in the form of numericals, meters, bar graphs and line recorder.
- Transmitter calibration: Field calibration in one or two points and basic calibration.
- Documentation: Configuration files can be saved for future use and configuration protocols can easily be printed.

The communication with the transmitter can be performed on line, i.e. with transmitter in operation.

**IPAQ-H<sup>PLUS</sup>/IPAQ-HX<sup>PLUS</sup> can also be configured without connecting a power supply.**

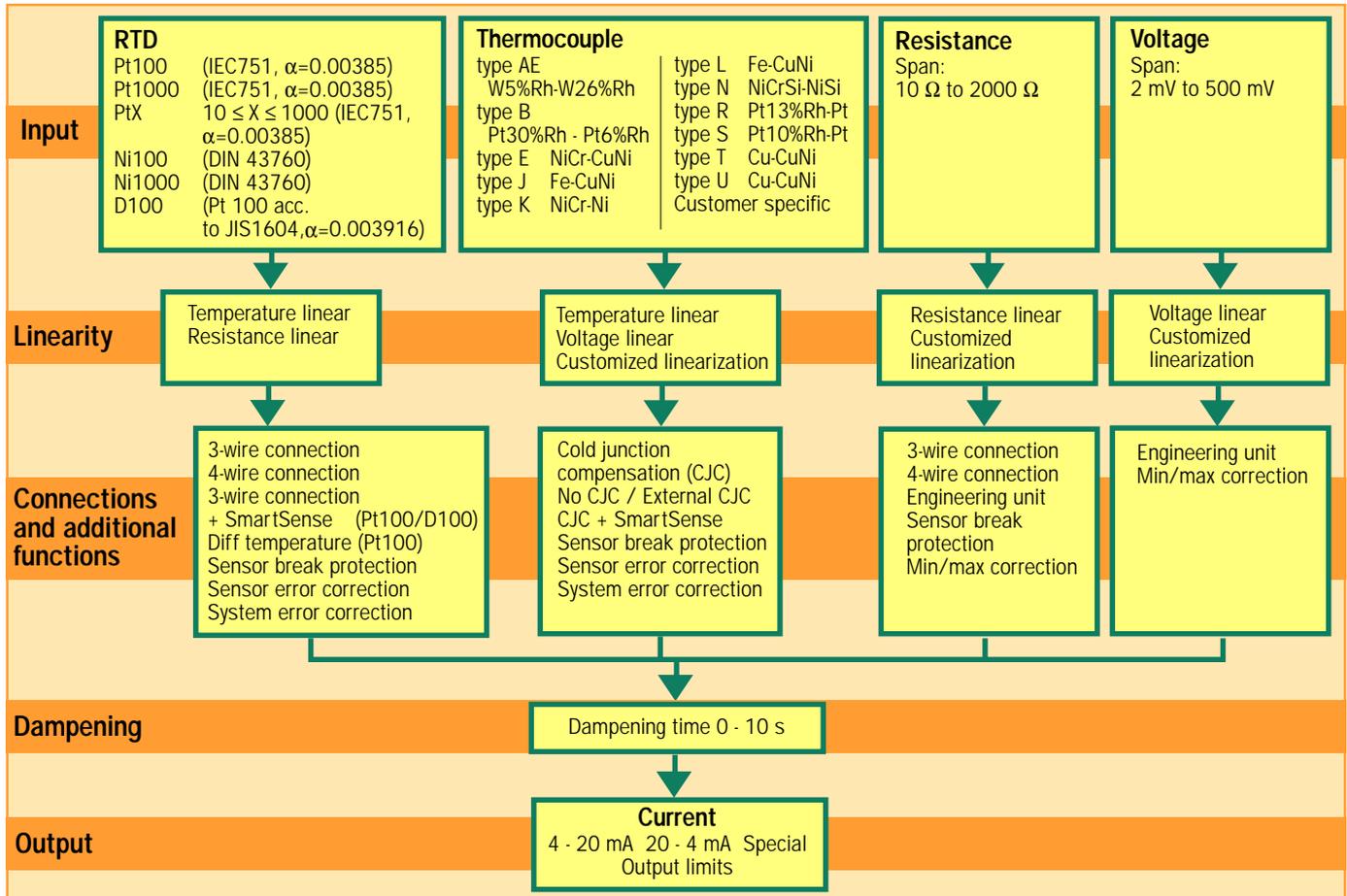
An isolated and Ex-approved communication cable is included in the software kit, IPRO-X.

IPRO 4 is compatible with Windows 3.1, Windows 3.11, Windows 95 and Windows NT Workstation 4.0. The program is menu-driven and easy to learn. On-line help is an effective tool for the user.

**Warranty**

IPAQ-H<sup>PLUS</sup>/IPAQ-HX<sup>PLUS</sup> are covered by a 5 year limited warranty.

**IPAQ-H<sup>PLUS</sup>/IPAQ-HX<sup>PLUS</sup> Configuration scheme**



## Specifications

<b>Input</b>		
<b>RTD's and Resistance</b>		
Pt100 (IEC751, $\alpha=0.00385$ )	3-, 4-wire connection	-200 to +1000 °C / -328 to +1832 °F
Pt1000 (IEC751, $\alpha=0.00385$ )	3-, 4-wire connection	-200 to +200 °C / -328 to +392 °F
PtX $10 \leq X \leq 1000$ (IEC751, $\alpha=0.00385$ )	3-, 4-wire connection	Upper range depending on X-value
Ni100 (DIN 43760)	3-, 4-wire connection	-60 to +250 °C / -76 to +482 °F
Ni1000 (DIN 43760)	3-, 4-wire connection	-60 to +150 °C / -76 to +302 °F
D100 (Pt 100 acc.to JIS1604, $\alpha=0.003916$ )	3-, 4-wire connection	-200 to +1000 °C / -328 to +1832 °F
Potentiometer/resistance	3-, 4-wire connection	0 to 2000 $\Omega$
Sensor current		~ 0.4 mA
Maximum sensor wire resistance		25 $\Omega$ /wire
<b>Thermocouples and Voltage</b>		
T/C	Type: AE, B, E, J, K, L, N, R, S, T, U	Ranges according to users manual
Voltage input		-10 to +500 mV
Input impedance		>10 M $\Omega$
Maximum sensor wire resistance		500 $\Omega$ (total loop)
<b>Monitoring</b>		
Sensor break monitoring	User definable output	3.5 to 22.8 mA <sup>1)</sup>
SmartSense, sensor isolation monitoring	User definable output	3.5 to 22.8 mA <sup>1)</sup>
<b>Adjustments</b>		
Zero adjustment	All inputs	Any value within range limits
Minimum spans	Pt100, Pt1000, Ni100, Ni1000	10 °C / 18 °F
	Potentiometer	10 $\Omega$
	T/C, mV	2 mV
<b>Output</b>		
Straight,reversed or any intermediate value		4-20/20-4 mA
Resolution		5 $\mu$ A
Minimum output signal	Adjustable	$\geq 3.5$ mA
Maximum output signal	Adjustable	$\leq 22.8$ mA
Permissible load, <i>see fig.5</i>	IPAQ-H <sup>PLUS</sup>	760 $\Omega$ @ 24 VDC, 23 mA
	IPAQ-HX <sup>PLUS</sup>	695 $\Omega$ @ 24 VDC, 23 mA <sup>2)</sup>
<b>Temperature</b>		
Ambient, storage		-40 to +85 °C / -40 to +185 °F <sup>4)</sup>
Ambient, operation	IPAQ-H <sup>PLUS</sup>	-40 to +85 °C / -40 to +185 °F <sup>4)</sup>
	IPAQ-HX <sup>PLUS</sup>	Acc. to Ex-approval (pending)
<b>General data</b>		
Adjustable dampening time		0 to 10 s
Update time		~170 ms <sup>3)</sup>
Isolation In - Out		3750 VAC, 1 min
Humidity (non-condensing)		0 to 95 %RH
Intrinsic safety	IPAQ-HX <sup>PLUS</sup> , Cenelec	Approval pending
	FM	Approval pending
<b>Power supply, polarity protected</b>		
Supply voltage	IPAQ-H <sup>PLUS</sup>	6.5 to 36 VDC 2-wire
	IPAQ-HX <sup>PLUS</sup>	8.0 to 30 VDC <sup>2)</sup> 2-wire
Permissible ripple		4 V p-p @ 50/60 Hz

<sup>1)</sup> Independent of output limitation

<sup>2)</sup> Preliminary data

<sup>3)</sup> ~300 ms with Sensor Break Monitoring activated

<sup>4)</sup> Up to 105 °C/221 °F available on request

Accuracy		
Linearity	RTD Potentiometer, mV	±0.05 % <sup>1)</sup>
	T/C	±0.1 % <sup>1)</sup>
Calibration	RTD	Max. of ±0.1 °C / ±0.2 °F or ±0.05 % <sup>1)</sup>
	Potentiometer	Max. of ±0.1 Ω or ±0.05 % <sup>1)</sup>
	mV, T/C	Max. of ±20 μV or ±0.05 % <sup>1)</sup>
Cold Junction Compensation (CJC)	T/C	±0.5 °C / ±0.9 °F
Temperature influence <sup>4)</sup>	All inputs	Max. of ±0.125 °C/25 °C or ±0.125%/25 °C <sup>1)3)</sup>
		Max. of ±0.25 °F/50 °F or ± 0.14%/50 °F <sup>1)3)</sup>
Temperature influence CJC <sup>4)</sup>	T/C	±0.5 °C/25 °C / ±1.0 °F/50 °F
Instrument calibration output	4-20 mA	±4.5 μA
Sensor wire resistance influence	RTD, Potentiometer, 3-wire	Negligible <sup>2)</sup>
	RTD, Potentiometer, 4-wire	Negligible
	mV, T/C	Negligible
Load influence		Negligible
Power supply influence		Negligible
RFI influence, 0.15-1000 MHz, 10 V or V/m		±0.1 % <sup>1)</sup> (typical)
Long-term stability		±0.05 % <sup>1)</sup> /year
Housing		
Material / Flammability (UL)		PC + ABS/V0, Polyamide/V2
Mounting		DIN B-head or larger, DIN rail (with mounting kit)
Connection	Single/stranded wires	≤1.5 mm <sup>2</sup> , AWG 16
Weight		50 g
Protection, housing / terminals		IP 50 / IP 10

<sup>1)</sup> Of input span

<sup>2)</sup> With equal wire resistance

<sup>3)</sup> If zero-deflection > 100% of input span:  
add 0.125% of input span/25 °C or 0.14%  
of input span/50 °F per 100% zero-deflection

<sup>4)</sup> Reference temperature 23 °C/73 °F

**The User Instructions must be read prior to adjustment and/or installation.**

## Accuracy examples

Applications	Partial accuracies (°C)					Total statistical accuracy	
	Linearity	Calibration	CJC	Temperature influence	Temperature influence CJC	°C <sup>5)</sup>	% of span
Pt100, 0-200 °C, T <sub>Amb</sub> = 25°C	±0.1	±0.1	–	±0.02	–	±0.14	±0.07
Pt100, 0-200 °C, T <sub>Amb</sub> = 50°C	±0.1	±0.1	–	±0.27	–	±0.30	±0.15
T/C K, 0-600 °C, T <sub>Amb</sub> = 25°C	±0.6	±0.3	±0.5	±0.06	±0.04	±0.84	±0.14
T/C K, 0-600 °C, T <sub>Amb</sub> = 50°C	±0.6	±0.3	±0.5	±0.81	±0.54	±1.28	±0.21

Reference temperature: T<sub>Amb</sub> = 23 °C

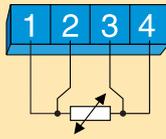
<sup>5)</sup> Total statistical accuracy (Δ<sub>Tot</sub>) is calculated as the "Root Mean Square" of the partial accuracies (Δ<sub>1</sub>...Δ<sub>n</sub>)

$$\Delta_{Tot} = \sqrt{\Delta_1^2 + \Delta_2^2 + \dots + \Delta_n^2}$$

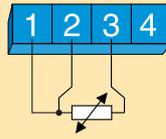
INPUTS

RTD

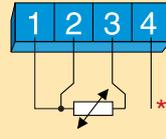
Pt100, Pt1000, Ni100, Ni1000, PtX, D100  
4-wire connection



3-wire connection

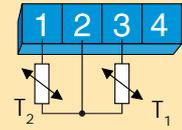


Pt100, D100  
3-wire connection



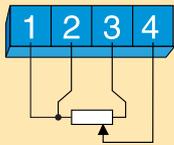
\*SmartSense lead

Pt100  
Diff temperature  $T_1 > T_2$

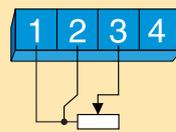


Potentiometer

4-wire connection

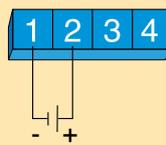


3-wire connection



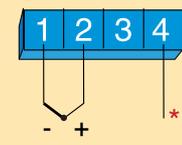
Voltage

millivolt



Thermocouple

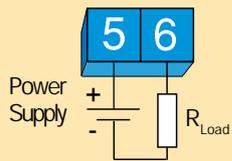
AE,B,E,J,K,L,N,R,S,T,U  
or customer specific



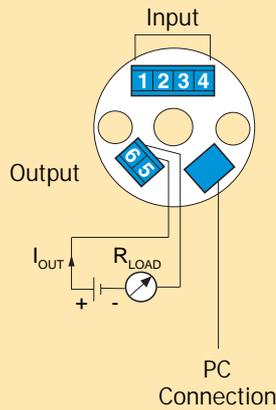
\*SmartSense lead

OUTPUT

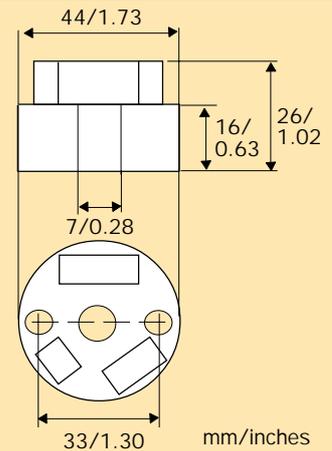
4-20 mA Output



Connections

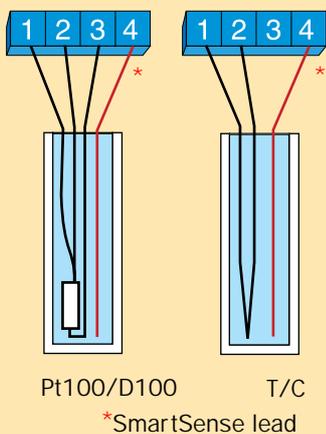


Dimensions



SmartSense

Fig.4

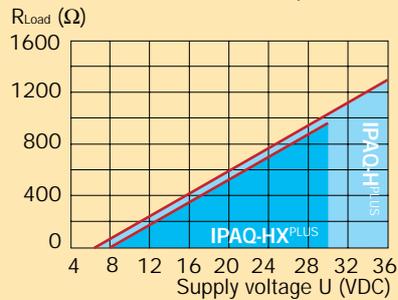


Pt100/D100 T/C  
\*SmartSense lead

Output load diagram

Fig.5

Permissible  $R_{Load}$  at 23 mA output



$$R_{Load} = (U - 6.5) / 0.023 \text{ (IPAQ-H}^{PLUS}\text{)}$$

$$R_{Load} = (U - 8.0) / 0.023 \text{ (IPAQ-HX}^{PLUS}\text{)}$$

Ordering table

Item	Part No.
<b>Transmitter</b>	
IPAQ-H <sup>PLUS</sup>	70IHPH0001
IPAQ-HX <sup>PLUS</sup> (Cenelec)	70IHPHX001
IPAQ-HX <sup>PLUS</sup> (FM)	70IHPHX101
<b>Options</b>	
Configuration	70CAL00001
Configuration with 5-point calibration certificate	70CAL00051
<b>Software and cable</b>	
IPRO-X (IPRO with cable)	70IPRX0001
Software IPRO upgrade	70IPRS0001
<b>Accessories</b>	
Surface mounting box	70ADA00008
Rail mounting box	70ADA00009
Head mounting kit	70ADA00012
Rail mounting kit	70ADA00013