# Current Transducer ITZ 10000-SB FLEX ULTRASTAB $I_{PM}$ = 10000 A

For ultra-high precision measurement of current: DC, AC, pulsed..., with galvanic separation between primary and secondary. Separate magnetic head and measuring electronics provides high flexibility.

## Features

- ±10 V voltage output
- Closed loop fluxgate
- Split design - separate head and rack electronics.
- Analog output on 15-pin D-sub female output connector
- Status/interlock port on 9-pin D-sub male output connector
- Secondary current monitoring on BNC connector
- 4 mm banana sockets for secondary current output
- Full-featured indicator panel.

## Advantages

- Very high accuracy
- Excellent linearity
- Extremely low temperature drift
- Wide frequency bandwidth
- High immunity to external fields
- No insertion losses
- Low noise on output signal
- Low noise feedback to primary conductor.

## Applications

- Feedback element in high-precision, high-stability power supplies
- Calibration unit
- Absolute current standard reference
- Test and calibration of current sources
- Current extender for power systems
- Differential current measurement on power line
- Metrology applications.

## Standards

EMC:

- EN 61000-6-2: 2019
- EN 61000-6-3: 2007 + A1 (2011)
- EN 61326-1: 2013

Safety:

- IEC 61010-1: 2010/AMD1: 2016.

## Application Domains

- Industrial
- Laboratory
- Medical.



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## Safety

This transducer must be used in limited-energy secondary circuits according to IEC 61010-1.

Caution

This transducer must be used in electric/electronic equipment with respect to applicable standards and safety requirements in accordance with the manufacturer's operating instructions.
If the device is used in a way that is not specified by the manufacturer, the protection provided by the device may be compromised. Always inspect the electronics unit and connecting cable before using this product and do not use it if damaged.
Mounting assembly shall guarantee the maximum primary conductor temperature, fulfill clearance and creepage distance, minimize electric and magnetic coupling.

Caution, risk of electrical shock

Use caution during installation and use of this product; certain parts of the module can carry hazardous voltages and high currents (e.g. primary conductor).
Ignoring this warning can lead to injury and/or cause serious damage.
De-energize all circuits and hazardous live parts before installing the product.
All installations, servicing operations and use must be carried out by trained and qualified personnel practicing applicable safety precautions.
This transducer is a built-in device, no maintenance required; cleaning by dry compressed air is authorized.

This transducer is a build-in device, whose hazardous live parts must be inaccessible after installation.
This transducer must be mounted in a suitable end-enclosure.
Besides make sure to have a distance of minimum 30 mm between the primary conductor (return bar) and the transducer and other neighboring components.

Main supply must be able to be disconnected.
Always inspect the current transducer for damage before using this product.
Never connect or disconnect the power while the primary circuit is connected to live parts.
Never connect the output to any equipment with a common mode voltage to earth greater than 30 V.
Always wear protective clothing and gloves if hazardous live parts are present in the installation where the measurement is carried out.
Safe and trouble-free operation of this transducer can only be guaranteed if transport, storage and installation are carried out correctly and are carried out with care.
The current transducer shall not be opened or modified.
If not working, the current transducer shall be replaced by an equivalent device.

In case of main supply cable replacement, make sure to use similar cable to guaranty the safety; please refer to the user manual for more information.

ESD susceptibility
The product is susceptible to ESD damage if secondary connectors pins are touched without being properly grounded.

## Remark

Installation of the transducer must be done unless otherwise specified on the datasheet, according to LEM Transducer Generic Mounting Rules. Please refer to LEM document N°ANE120504 available on our Web site:
https://www.lem.com/en/file/3137/download/.



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## Mains INPUT

| Parameter | Symbol | Unit | Value | Comment |
|---|---|---|---|---|
| Mains input voltage | $U_C$ | V | 100-240 V AC (±10 %) | IEC-type inlet socket OVCII and PD2 |
| Mains input frequency | $f$ | Hz | 50/60 | |
| Fuses | | At | 2.5/240 V AC | Internal fuses, not user-replaceable |
| Power consumption | $P_C$ | W | 76 | ITZ 2000-S; ITZ 2000-SB;<br>ITZ 2000-SPR;<br>ITZ 2000-SBPR;<br>ITZ 5000-S; ITZ 5000-SB |
| | | | 163 | ITZ 6100-S |
| | | | 137 | ITZ 10000-S; ITZ 10000-SB |
| | | | 202 | ITZ 16000-S; ITZ 16000-SB |
| | | | 300 | ITZ 24000-S; ITZ 24000-SB |

## Insulation coordination

| Parameter | Symbol | Unit | Value | Comment |
|---|---|---|---|---|
| Rated insulation RMS voltage, basic insulation | $U_{Nm}$ | V | 4000 | IEC 61010-1 conditions<br>- over voltage cat III<br>- pollution degree 2 |
| Rated insulation RMS voltage, reinforced insulation | $U_{Nm}$ | V | 2000 | IEC 61010-1 conditions<br>- over voltage cat III<br>- pollution degree 2 |
| RMS voltage for AC insulation test, 50/60 Hz, 1 min | $U_d$ | kV | 16.2 | |
| Impulse withstand voltage 1.2/50 µs | $U_{Ni}$ | kV | 29.8 | |
| Clearance (pri. - sec.) | $d_{Cl}$ | mm | 40 | Shortest distance through air |
| Creepage distance (pri. - sec.) | $d_{Cp}$ | mm | 40 | Shortest path along device body |
| Comparative tracking index | $CTI$ | V | 100 | |

## Environmental and mechanical characteristics

| Parameter | Symbol | Unit | Min | Typ | Max | Comment |
|---|---|---|---|---|---|---|
| Ambient operating temperature HEAD | $T_A$ | °C | 0 | | 55 | |
| Ambient operating temperature ELECTRONICS | $T_A$ | °C | 10 | | 40 | |
| Ambient storage temperature HEAD and ELECTRONICS | $T_{A\,st}$ | °C | −20 | | 85 | |
| Maximum primary conductor temperature | $T_{B\,max}$ | °C | | | 100 | |
| Relative humidity | $RH$ | % | 20 | | 80 | Non-condensing |
| Environmental conditions | | | | | | Indoor |
| Cooling conditions | | | | | | Natural convection |
| Dimensions ELECTRONICS | | mm | | | | 482 × 88 × 430<br>see drawing (page 13) |
| Dimensions HEAD | | | | | | see drawing (page 13) |
| Altitude | | m | | | 2000 [1)] | |
| Mass rack electronics | $m$ | kg | | 9.4 | | |
| Mass head | $m$ | kg | | 20 | | |

Note: [1)] Insulation coordination at 2000 m.



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## Electrical data

At $T_A$ = 25 °C unless otherwise noted.

| Parameter | Symbol | Unit | Min | Typ | Max | Comment |
|---|---|---|---|---|---|---|
| Primary continuous direct current | $I_{P\,N\,DC}$ | A | −10000 | | 10000 | |
| Primary nominal RMS current | $I_{P\,N}$ | A | | | 7070 | |
| Primary current, measuring range | $I_{P\,M}$ | A | −10000 | | 10000 | |
| Measuring resistance (option) | $R_M$ | Ω | 0 | | 0.5 | |
| Secondary current | $I_S$ | A | −2 | | 2 | |
| (Analog) secondary voltage | $U_S$ | V | −10 | | 10 | |
| Sensitivity | $S$ | V/A | | 1/1000 | | |
| Resistance of secondary winding | $R_S$ | Ω | | 11 | | |
| Primary withstand peak current (max) [1] | $\hat{I}_{P\,max}$ | kA | | | 30 | |
| Mains supply RMS voltage | | V | 100 | | 240 | |
| Rated power supply frequency | $f$ | Hz | | 50/60 | | |
| Power consumption $I_P$ = 0 A<br>@ Mains supply = 230 V RMS | $P_C$ | W<br>VA | | 70<br>157 | | Average<br>Peak |
| Power consumption $I_P = I_{P\,N\,DC}$ (10000 A)<br>@ Mains supply = 230 V RMS | $P_C$ | W<br>VA | | 137<br>203 | | Average<br>Peak |
| RMS noise current 0 … 10 Hz [2] | $U_{no}$ | ppm | | | 0.1 | |
| RMS noise current 0 … 10 kHz [2] | | | | | 8 | |
| RMS noise current 0 … 100 kHz [2] | | | | | 60 | |
| Re-injected RMS noise on primary bus bar 0 ... 100 kHz | | µV | | | 2 | |
| Temperature coefficient of $S$ [2] | $TCS$ | ppm/K | −2 | | 2 | 10 °C .. 40 °C |
| Temperature coefficient of $U_{O\,E}$ [2] | $TCU_{O\,E}$ | ppm/K | −0.3 | | 0.3 | 10 °C .. 40 °C |
| Electrical offset voltage [2] | $U_{O\,E}$ | ppm | −3 | | 3 | |
| Offset stability [2] | | ppm/month | −1.5 | | 1.5 | |
| Sensitivity stability [2] | | ppm/month | −2 | | 2 | |
| Linearity error [2] | $\varepsilon_L$ | ppm | −12 | | 12 | |
| Sensitivity error [2] | $\varepsilon_G$ | ppm | −50 | | 50 | |
| Delay time @ 90 % of the final output value $I_{P\,N\,DC}$ step | $t_{D\,90}$ | µs | | | 2 | With a $di/dt \geq 100$ A/µs |
| Frequency bandwidth (±3 dB) | $BW$ | kHz | 0 | 20 | | Small-signal bandwidth, 1 % of $I_{P\,N\,DC}$ |
| $di/dt$ accurately followed | $di/dt$ | A/µs | 100 | | | |

Notes: [1] Single pulse of 100 ms only, not AC. The transducer may require a few seconds to return to normal operation when autoreset system is running.
[2] All ppm figures refer to full-scale which corresponds to an analog secondary voltage ($U_S$) of 10 V.



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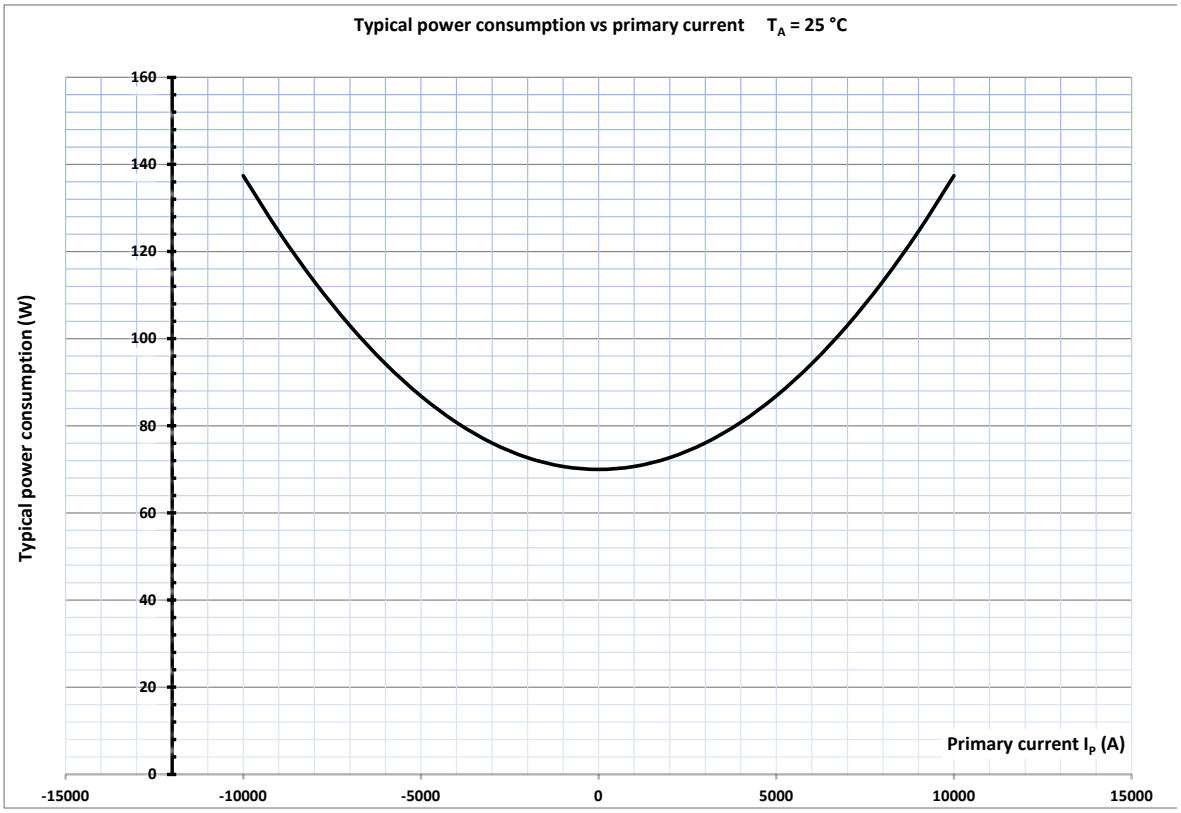
## Typical power consumption





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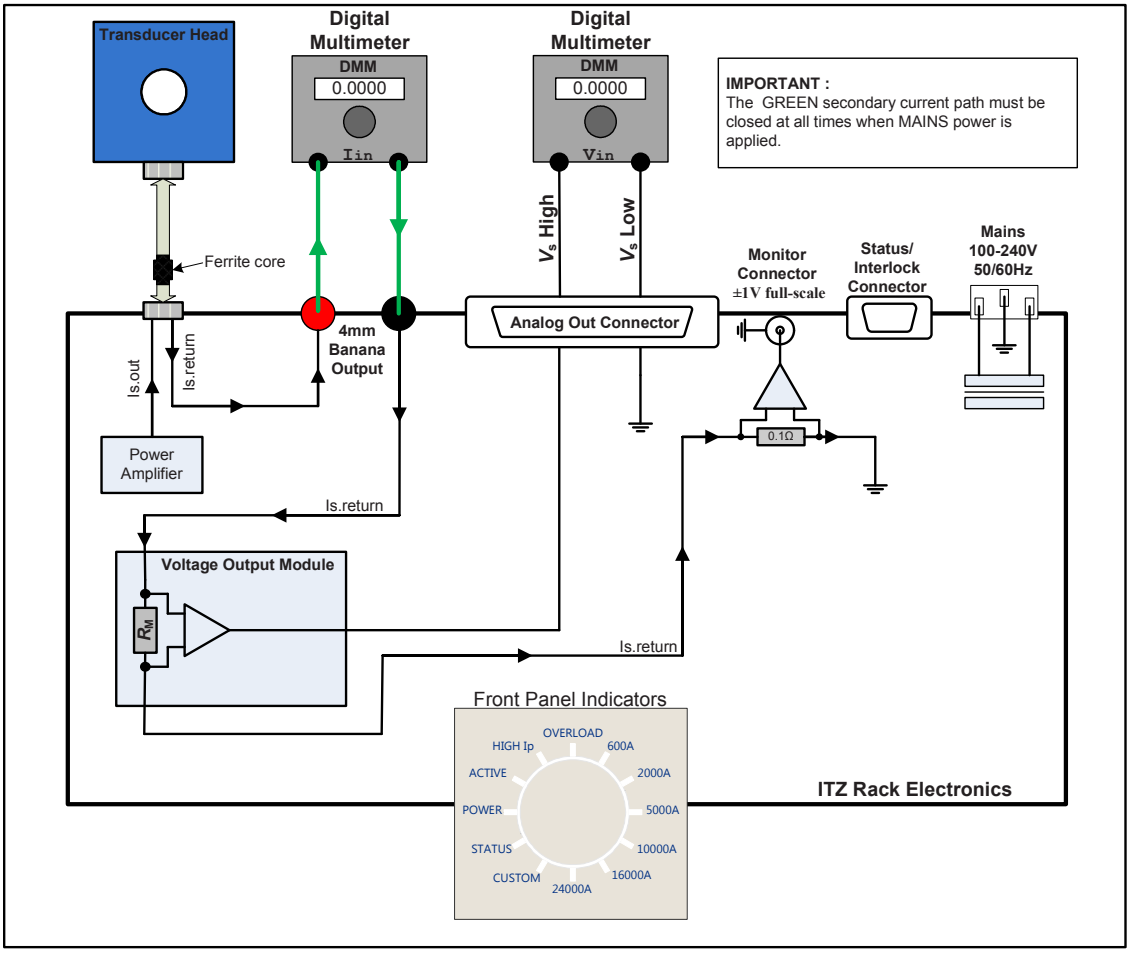
## System overview




## Front panel indicators

When the mains supply voltage is set up, the rack electronics starts and initializes itself.
After this process, the LEDs POWER, STATUS and 10000 A light up.
The LEDs present on this panel display information about conditions which affect the operation of the transducer.
They are defined in the following table:

| LED | Description |
|---|---|
| POWER (blue LED) | This LED is lit when the mains supply voltage is present |
| ACTIVE (yellow LED) | This LED is lit when $I_P$ is higher than approximately 1 % of $I_{P\,N\,DC}$ |
| HIGH $I_P$ (yellow LED) | This LED is lit when $I_P$ is higher than approximately 105 % of $I_{P\,N\,DC}$ |
| OVERLOAD (red LED) | This LED is lit when the transducer head saturates due to excessive primary current. |
| 600 A ... 24000 A (yellow LED) | These LEDs are lit when a transducer head with the corresponding full-scale range is connected to the rack electronics. For ITZ 10000-SB, only LED 10000 A is lit, and the others may be ignored. |
| CUSTOM (yellow LED) | Reserved for a custom head configuration. |
| STATUS (green LED) | This LED is lit when the unit status is OK (Normal operation). |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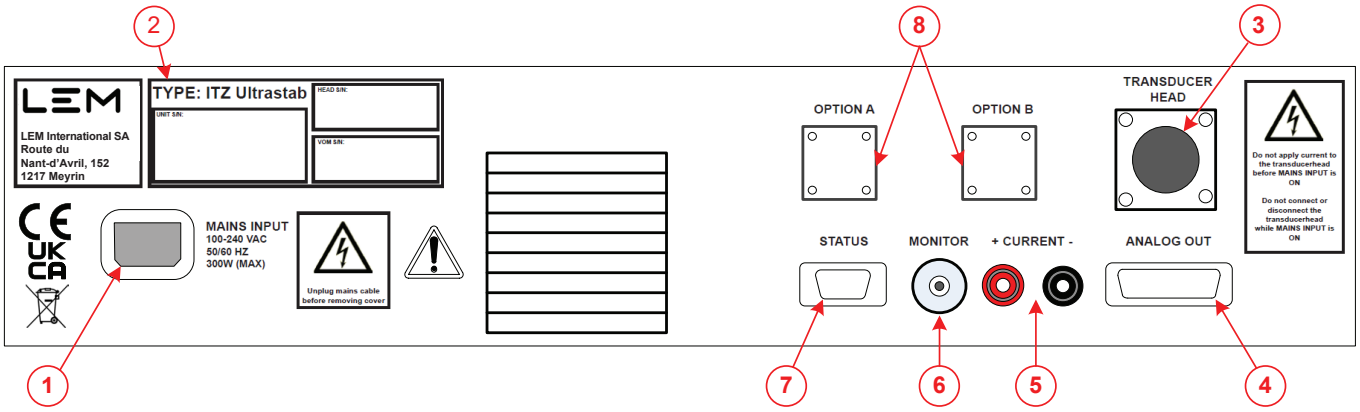
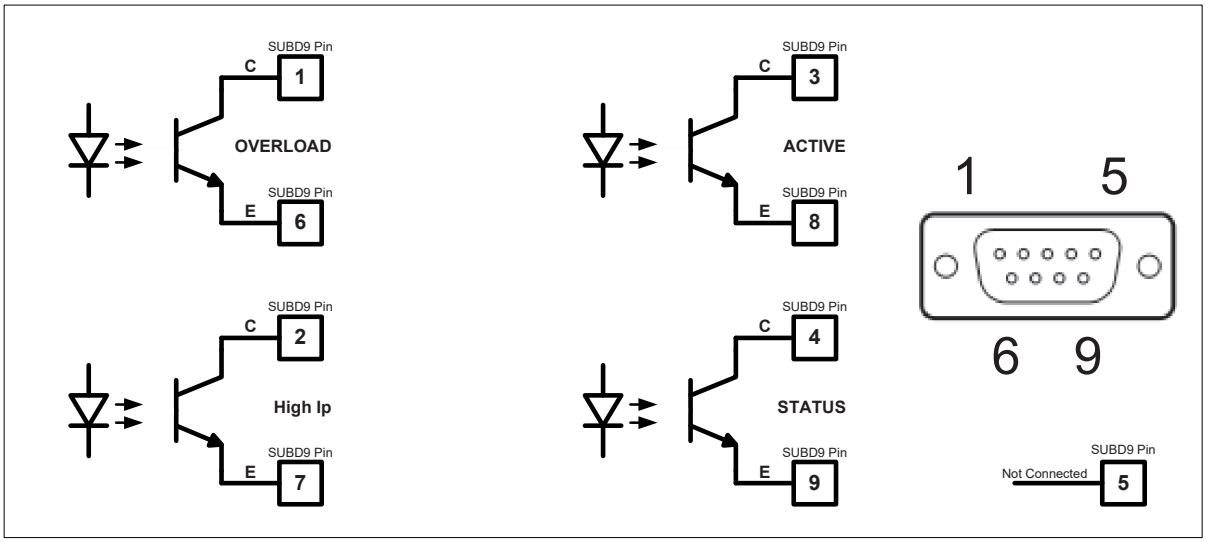
## Back panel




| Reference | Description |
|---|---|
| 1 | IEC power inlet: This connector accepts a standard IEC power cord (supplied) |
| 2 | Type / Serial number plate. Three individual S/Ns may be listed here: One for the ITZ electronics, one for the matching head and one for the installed voltage output module |
| 3 | Transducer head: Connection to the transducer head |
| 4 | Analog out: Output connection to a DMM or other equipment, 15-pin D-Sub female UNC 4-40 screw lock |
| 5 | Current ±: Secondary current output |
| 6 | Monitor: Voltage output with a buffered replica of the secondary current |
| 7 | Status/Interlock signal outputs, 9-pin D-Sub male UNC 4-40 screw lock |
| 8 | Option A+B: These positions are for future expansion or customization (not used) |

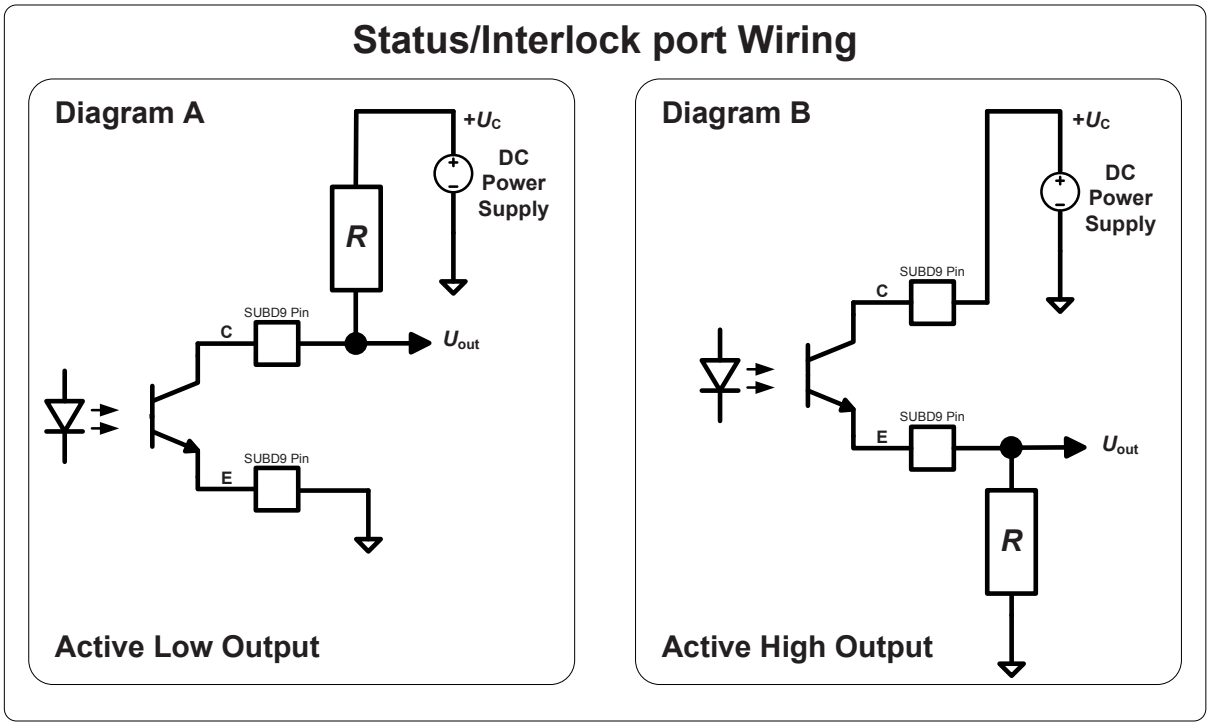
## Status /Interlock Port - electrical specification

All signals on the Status/Interlock port are optically isolated, Photocouplers type, floating Collector and Emitter.
Four signals are present on the port, each having two dedicated floating pins in the SUBD9 Male connector:
. Collector (C)
and
. Emitter (E)




## Status /Interlock port wiring

Depending on how each signal is wired, it can be “Active Low” or “Active High” as shown below:




In the Diagram A Active Low Output, the output signal $U_{out}$ switches to GND when the corresponding LED is ON.
In the Diagram B Active High Output, the output signal $U_{out}$ switches to +$U_C$ when the corresponding LED is ON.
When the output signal $U_{out}$ is switched to GND, its value is lower than 0.2 V.
When the output signal $U_{out}$ is switched to +$U_C$, its value is equal to +$U_C$.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In case diagram A, the following table shows how each individual output signal acts:

| Output signal | $U_{out}$ | Description |
|---|---|---|
| OVERLOAD | < 0.2 V | The transducer head is saturated due to excessive primary current |
| | $+U_C$ | The transducer head is not saturated |
| High $I_P$ | < 0.2 V | The primary current is higher than 105 % of nominal full-scale output |
| | $+U_C$ | The primary current is lower than 105 % of nominal full-scale output |
| ACTIVE | < 0.2 V | The primary current is higher than approximately 1 % of nominal full-scale output |
| | $+U_C$ | The primary current is lower than approximately 1 % of nominal full-scale output |
| STATUS | < 0.2 V | When the unit status is OK (Normal operation) |
| | $+U_C$ | When the unit status is not OK (Supply fault, over-temperature conditions and Current overloads or No detected head) |

In case diagram B, the following table shows how each individual output signal acts:

| Output signal | $U_{out}$ | Description |
|---|---|---|
| OVERLOAD | $+U_C$ | The transducer head is saturated due to excessive primary current |
| | < 0.2 V | The transducer head is not saturated |
| High $I_P$ | $+U_C$ | The primary current is higher than 105 % of nominal full-scale output |
| | < 0.2 V | The primary current is lower than 105 % of nominal full-scale output |
| ACTIVE | $+U_C$ | The primary current is higher than approximately 1 % of nominal full-scale output |
| | < 0.2 V | The primary current is lower than approximately 1 % of nominal full-scale output |
| STATUS | $+U_C$ | When the unit status is OK (Normal operation) |
| | < 0.2 V | When the unit status is not OK (Supply fault, over-temperature conditions and Current overloads or No detected head) |

The power supply voltage $+U_C$ must be between 4 V and 60 V DC and the resistor value must be chosen between a minimum value $R_{min}$ and a maximum value $R_{max}$ calculated by using the following equations:

$$R_{min}\,(k\Omega) = \frac{+U_C}{3.4} \quad \text{and} \quad R_{max}\,(k\Omega) = \frac{+U_C}{1.7}$$

Some recommended standard values of $R$ are given in the following table:

| Power supply voltage $+U_C$ | $R_{min}$ (kΩ) | $R_{max}$ (kΩ) | $R$ Standards values ± 5 % |
|---|---|---|---|
| 5 V | 1.5 | 3 | 1.8 kΩ or 2.2 kΩ |
| 12 V | 3.5 | 7 | 4.7 kΩ or 6.8 kΩ |
| 24 V | 7 | 14 | 10 kΩ or 12 kΩ |

## Absolute maximum ratings

| Parameter | Symbol | Specification | Unit |
|---|---|---|---|
| Power supply voltage | $+U_C$ | 60 | V |
| Maximum Collector-Emitter Voltage, Off-state | $U_{C\,E\,off\,max}$ | 60 | V |
| Maximum reverse Collector-Emitter Voltage, Off-state | $U_{C\,E\,off\,max}$ | 5 | V |
| Maximum Collector-Emitter Current, On-state | $I_{C\,E\,ON\,max}$ | 10 | mA |

Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the status/interlock signal outputs.



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## Sweep function during overload status

The overload occurs when the primary current $I_P$ exceeds a trip level such that the fluxgate detector becomes completely saturated and, consequently, the transducer will switch from normal operation to overload mode.
This trip level is guaranteed to be greater than 110 % of $I_{P\,N\,DC}$ and its actual value depends on operating conditions such as temperature and measuring resistance.
When this happens, the ITZ rack electronics will automatically begin to sweep in order to lock on to the primary current again and the measuring can resume when the primary current returns in the nominal range between $-I_{P\,N\,DC}$ and $+I_{P\,N\,DC}$.
In sweep mode, the secondary current will be a slope between −2 A and +2 A.

## Thermal protection

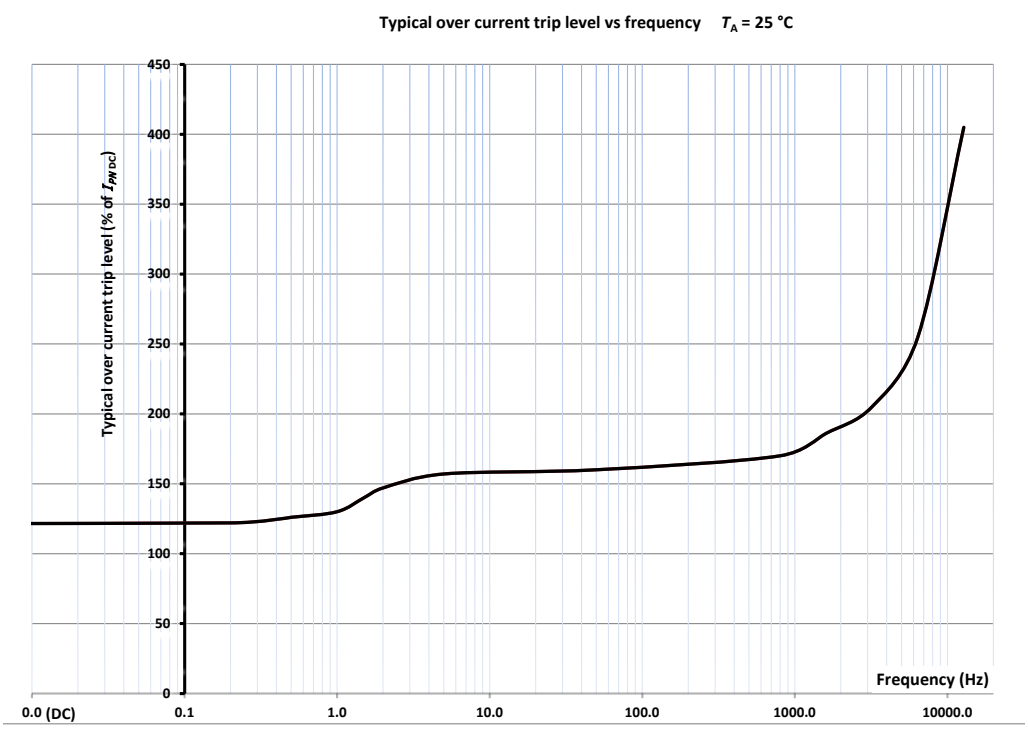
The ITZ 10000-SB has thermal shutdown circuitry that protects the electronics from damage.
The thermal protection circuitry disables the measuring circuit when the rack electronics temperature reaches approximately 65 °C and allows the transducer to cool. When this occurs, the status LED is switched off.
When the rack electronics temperature cools to approximately 60 °C, the measuring circuit is automatically re-enabled and the status LED is again lit.

## Over current protection - Electrical specifications

The over current occurs when the primary current exceeds 120 % of $I_{P\,N\,DC}$.
To detect the over current with primary AC, the secondary current is full-wave rectified and is time-averaged by a low-pass filter. Depending on the frequency range of the primary current, two cases appear:

- Low frequency range: DC – 1.6 Hz (over current slow)
  In this case, the over current trip level is set to 120 % of $I_{P\,N\,DC}$.
  The secondary current is tracked until the primary AC peak exceeds this trip level.Then, the rack electronics shut down the measuring circuit and wait until the primary AC peak becomes lower than the set trip level.
- High frequency range: 1.6 Hz – 1.6 KHz (over current fast)
  In this case, the over current trip level is set to 160 % of $I_{P\,N\,DC}$.
  The secondary current is tracked until the primary AC peak exceeds this trip level. Then, the rack electronics shut down the measuring circuit and wait until the primary AC peak becomes lower than the set trip level.

The frequency response characteristics of the over current trip level with a sine-wave primary AC is illustrated by the following curve:





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The table shown below summarizes various frequency values and the typical value of over current trip level to detect over current state:

| Primary current frequency (Hz) | Typical over current trip level to detect over current state |
|---|---|
| DC (0 Hz)) | 120 % of $I_{P\,N\,DC}$ |
| 1 | 130 % of $I_{P\,N\,DC}$ |
| 1.5 | 140 % of $I_{P\,N\,DC}$ |
| 50 | 160 % of $I_{P\,N\,DC}$ |
| 800 | 170 % of $I_{P\,N\,DC}$ |
| 1600 | 186 % of $I_{P\,N\,DC}$ |

Under these conditions:

- The signal Status (Contact between Pin 4:C and Pin 9:E) switches off, this signal becomes open (No current from collector to emitter) to indicate that the unit is not OK.
- The status green LED located on the front panel switches off (fault state)
- The transducer is protected against damage that the over current primary AC may cause to the electronics.

The transducer will automatically starts again to work when the primary AC peak becomes lower than the trip level indicated in the table above.

## Transducer head description

Connect the transducer head to the electronics rack using the supplied transducer head cable.
The side of cable where there is the ferrite must be connected to the rack electronics.
The transducer head cable is available in three lengths: 10, 20 and 30 meters.

For more information, see section “ITZ mandatory accessories” on page 12.



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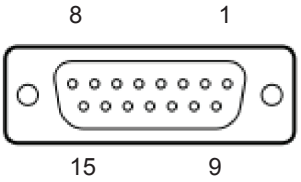
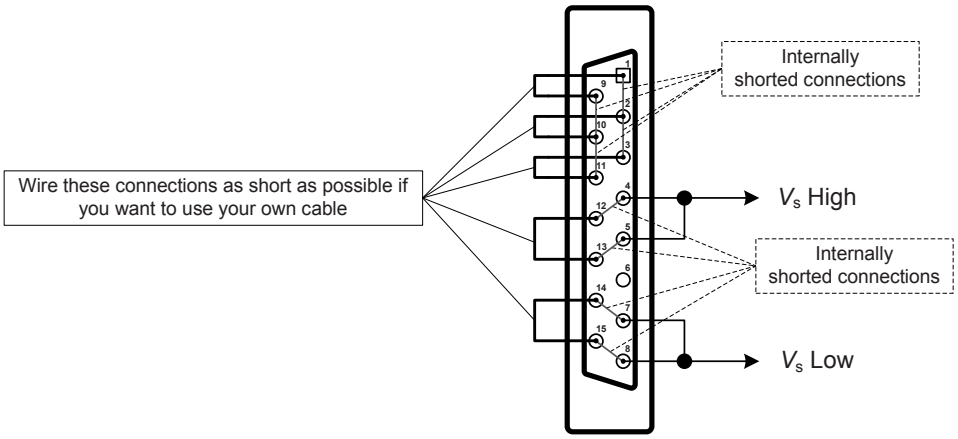
## Analog output connector

Normally the provided analog output cable should be used.
It is also possible to configure your own output cable, bearing the following description in mind.
The female 15-pin D-Sub connector Analog out connector contains the following signals:

1. Current return
2. Current return
3. Current return
4. $U_S$ High Sense
5. $U_S$ High Out
6. Ground
7. $U_S$ Low Sense
8. $U_S$ Low Out
9. Current out
10. Current out
11. Current out
12. $U_S$ High Sense
13. $U_S$ High Out
14. $U_S$ Low Sense
15. $U_S$ Low Out




Connect both pins 1 and 9, pins 2 and 10, pins 3 and 11.This will loop the current output to the voltage output module.
The sense pins $U_S$ High Sense at pins 4 and 12, $U_S$ Low Sense at pins 7 and 14 and the voltage output pins $U_S$ High Out at pins 5 and 13, $U_S$ Low Out at pins 8 and 15 are internally shorted by rack electronics.
Be sure to connect both pins 12 and 13, pins 14 and 15.
The output signal $U_S$ High is then present at pins 4 and 5 and the output signal $U_S$ Low is then present at pins 7 and 8.
The connections described above are illustrated by the following figure:




Details of further considerations relating to connect the analog output connector directly to a current measuring device can be found in the ITZ FLEX ULTRASTAB user guide.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## Secondary current monitoring

The rack electronics incorporates a 0.1 Ω resistance in series with the measuring resistance for the monitoring of the secondary current.
A BNC connector located on the rear panel provides a low-precision voltage output ±1 V full-scale which indicates a secondary current flowing through the measuring resistance and the 0.1 Ω resistance.
The voltage on this connector is equal to:

$$\frac{U_S(V)}{10} = \frac{N_P / N_S(V/A) \cdot I_P(A)}{10}(Volt) \qquad N_P / N_S = \frac{1}{1000} V/A$$

As one example, if $I_P$ is 10000 A, the voltage on this connector is 1 V.

Similarly, if $I_P$ is −10000 A, the voltage on this connector is −1 V.

As another example, if $I_P$ is 5000 A, the voltage on this connector is 0.5 V.

Similarly, if $I_P$ is −5000 A, the voltage on this connector is −0.5 V.

## Delivery package

The LEM ITZ 10000-SB FLEX ULTRASTAB package contains by default:

- 19-inch rack-mount ITZ FLEX ULTRASTAB electronics
- Transducer head
- European (Schuko CEE 7/7) and US/Japanese mains cables, 2 m each (with three-pole IEC C13 female connector).
- Short-plug for 4 mm banana terminals and 15-pin D-Sub short-plug for analog output connector (back panel of electronics rack)

## Mandatory accessories

The 2 following accessories have to be separately ordered as per the table hereafter, otherwise the ITZ FLEX ULTRASTAB can not operate without them:

- Transducer head cable (interconnecting cable between transducer head and electronics rack)
- Analog output cable

| ITZ mandatory accessories | Available material | Available length | Part number |
|---|---|---|---|
| Transducer HEAD cable | Non-Halogeneous | 10 m | 71.16.13.001.0 |
| | Non-Halogeneous | 20 m | 71.16.17.001.0 |
| | Non-Halogeneous | 30 m | 71.16.20.001.0 |
| | Halogeneous | 10 m | 71.16.13.000.0 |
| | Halogeneous | 15 m | 71.16.15.000.0 |
| | Halogeneous | 20 m | 71.16.17.000.0 |
| | Halogeneous | 25 m | 71.16.19.000.0 |
| | Halogeneous | 30 m | 71.16.20.000.0 |
| Analog output cable | Non-Halogeneous | 1.5 m | 71.17.E7.002.0 |

* Other values might be possible upon request to LEM.

## Optional

Calibration can be separately ordered as per the table hereafter:

- Calibration with certificate in ISO 17025 certificated laboratory

| ITZ option | Available calibration* | Part number |
|---|---|---|
| Calibration | 5 points | X-CAL-LAB-02 |
| | 11 points | X-CAL-LAB-03 |

* Other values might be possible upon request to LEM.



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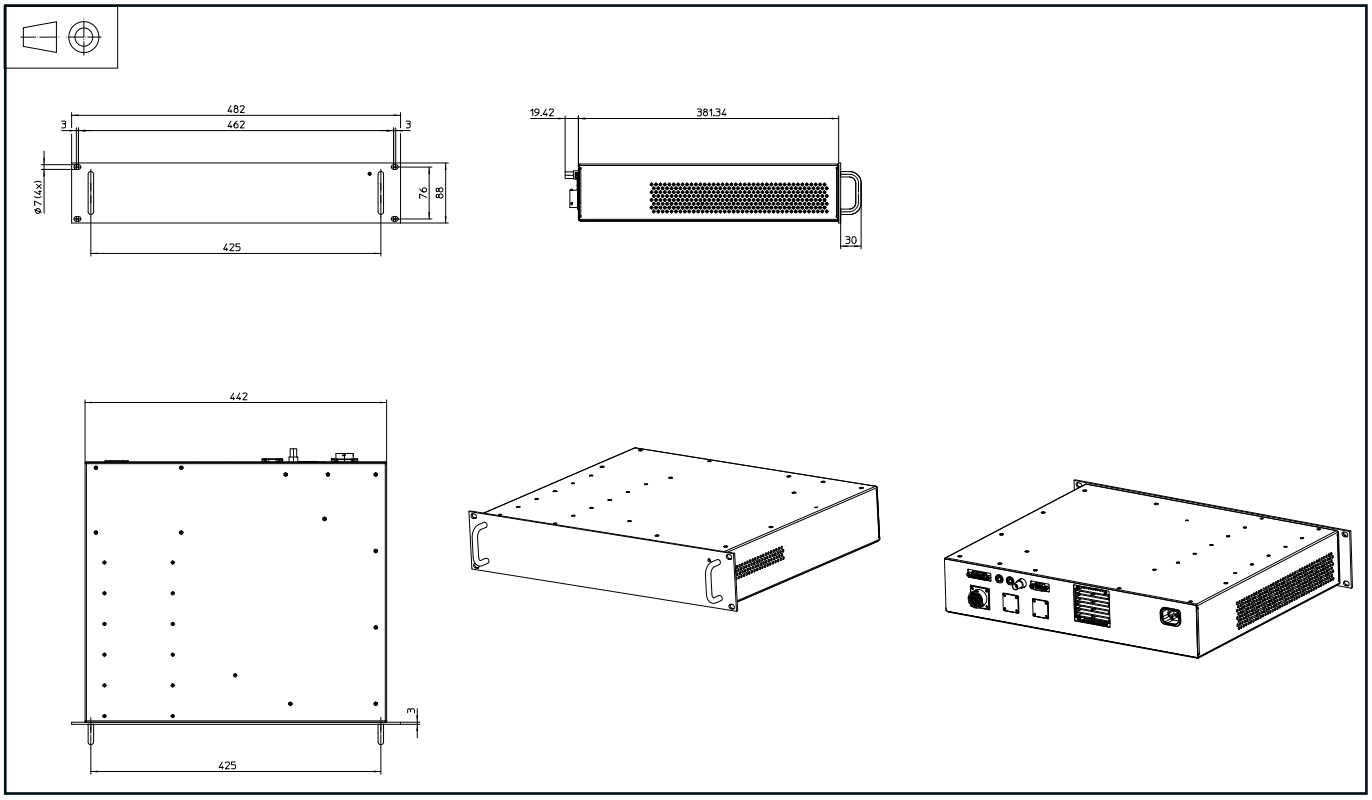
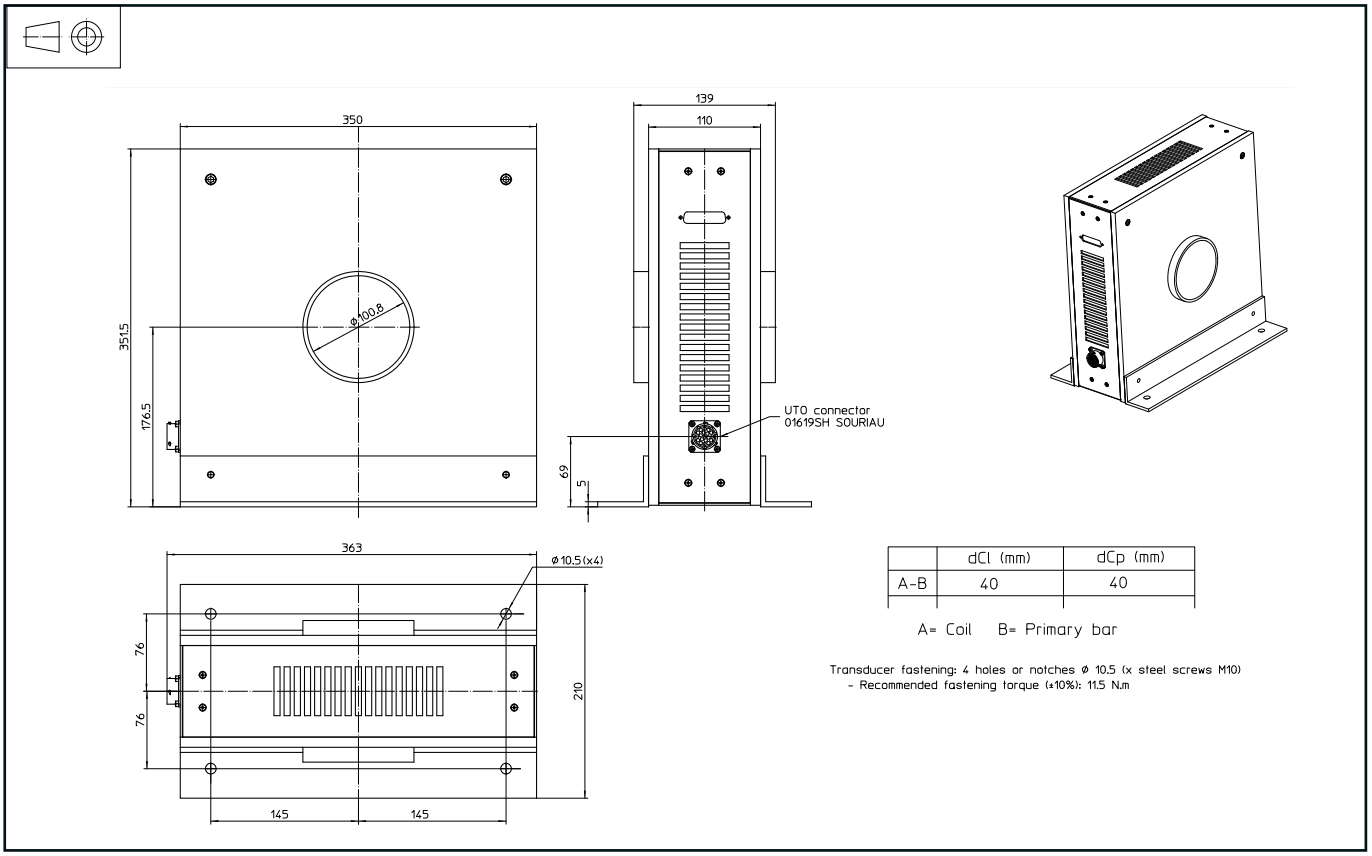
## Dimensions - Rack electronics (in mm, general tolerance ±1.5 mm)




## Dimensions - Measuring head (in mm, general tolerance ±1.5 mm)




| | dCl (mm) | dCp (mm) |
|---|---|---|
| A-B | 40 | 40 |

A= Coil B= Primary bar

Transducer fastening: 4 holes or notches ø 10.5 (x steel screws M10)
- Recommended fastening torque (±10%): 11.5 N.m



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