Symbols Used

This symbol warns of possible danger. Failure to heed this warning may result in personal injury or death, or property damage, including destruction.

This symbol warns the user of a possible fault. Failure to heed this warning can lead to total failure of the device and any other connected equipment.

This symbol draws attention to important information.
Safety Notes

The Frequency Converter with Trip Values must only be operated by trained personnel in accordance with this handbook.

The protection of operating personnel and of the system is only ensured if the devices are used in accordance with their intended purpose. Any other type of operation than that described in this manual places the safety and functionality of the devices and systems connected to them in question.

The devices may only be installed, connected, and adjusted by electrical professionals outside the hazardous area.

If faults cannot be eliminated, the devices must be taken out of operation and protected from being placed in service again inadvertently. Tampering with or making changes to the devices is dangerous and therefore not permitted. They render the warranty void.

The responsibility for the adherence to local safety standards lies with the operator.
Overview

The devices of the Bul. 937C IS Barriers, Isolators and Converters are used to transmit signals between field devices and the process control system or control.

937 products are suitable for connection to field devices in the hazardous area. The field current circuits of these devices are intrinsically safe and are galvanically isolated from the not intrinsically safe circuits. The devices thus represent an electrical isolation between the hazardous area and the secure area.

Devices can be used for signal transmission between field devices in the secure area and the process control system or the control.

Resistance bridges, i.e. strain gauges, load cells, force transducers, pressure transducers, torque shafts or similar devices, can be connected to the input of the converters.

The 937CU-AISTR-DC1 converts the input signal into a proportional output current, which can be forwarded e.g. to a display unit or an analog input of the process control system or control. By means of the two relay outputs.

Two different, freely parameterisable trip values of the input signal can be monitored.

Further information (e.g. certificates and the 937CU-AISTR-DC1 data sheet and the operating instructions for the Bul. 937 family) can be found on our Internet page www.ab.com.
Mounting and Connection

The Strain Gauge Converter can be mounted on a 35 mm standard rail corresponding to DIN EN 60175. The devices must be snapped onto the rail vertically, and never slanted or tipped to the side.

The Strain Gauge Converters are constructed in protection class IP20 and must therefore be protected from undesirable environmental conditions (water, small foreign objects).

Attention

CORRECT: Device snapped on vertically.

INCORRECT: Device snapped on from the side. Can damage the contacts and cause the device to fail.
Connection

The Bul. 937 series' slip-off terminals significantly simplify connection and construction of switching cabinets. They allow quick and error-free exchange of the unit when service is needed.

The terminals can be screwed on, are self-opening, and have generous connection room for a wire diameter of up to 2.5 mm² and coded plugs, so that leads cannot be confused.

The intrinsically safe field circuit is connected to the **blue** terminals 1 to 6 of the Strain Gauge Converters. This may be conducted into the hazardous area using DIN EN 60079-14-compliant leads.

The non-intrinsically safe field circuit is connected to the **black** terminals 1 to 6 of the Strain Gauge Converters.

In both cases you can connect:
- a half bridge (terminals 1, 3, 4, 5, 6)
- a full bridge (terminals 1 to 6)
The remaining green terminals have the following functions:

- Terminals 7/8: current output
- Terminal 9: only for voltage output (see below.)
- Terminals 10 ... 12: relay 1
- Terminals 13/14: binary input 1
- Terminals 15/14: binary input 2
- Terminals 16 ... 18: relay 2
- Terminals 19 ... 21: RS 485 interface (deactivated if plug is in RS 232 interface)
- Terminal 22: not used
- Terminals 23/24: power supply 24 V DC

If you connect terminals 7 and 9 by means of a bridge, a voltage output of -10 V ... +10 V results between this bridge and terminal 8. The built-in shunt resistance is 500 Ω.

The RS 485 interface is galvanically isolated from other circuits. It is deactivated if you plug a connector into the socket of the RS 232 interface on the front panel of the Strain Gauge Converters.

Further information on connecting the Strain Gauge Converters (e.g. on using the Power Rail) can be found in the data sheet and in the operating instructions for the Bul. 937 system on our Internet page www.ab.com.
Front panel

On the front panel of the Strain Gauge Converters you will find:

- LED ERR (red) to indicate
  - a sensor fault (flashes red)
  - the simulation mode (only when using FDT flashes red) - a device fault (steady red)
- PWR LED (green), to indicate the presence of the supply voltage
- LED OUT 1 (yellow), to indicate that relay 1 is active
- LED OUT 2 (yellow), to indicate that relay 2 is active
- serial RS 232 interface to connect to a PC for parameterisation and diagnosis of the Strain Gauge Converter using FDT.
- a display for measured value and error message display and for display during parameterisation mode
- four buttons for parameterisation of the Strain Gauge Converters
  - ▲ (Up)
  - ▼ (Down)
  - ESC (Escape)
  - OK

Display mode and error messages

Measured value display

- In normal operation, the current net value is indicated on the display in the selected unit.
- If you hold down the ▼ key, the current gross value is indicated on the display in the selected unit.
- If you hold down the ▲ key, the mV value actually measured by the Strain Gauge Converters on the terminals 1 and 2 is indicated on the display.
- As usual, the following applies: net value = gross value - tare
Messages during operation

- **Alarm freeze**
- **Hold on error**

Error messages

- **Err INT**: error in the internal communication of the Strain Gauge Converters; may also occur if no sensor is connected
- **Err MEM**: error in the memory of the Strain Gauge Converters
- **Err SIM**: Strain Gauge Converter in simulation mode (only when using FDT)
- **Err CELL**: cell breakage or no cell connected; for information on selecting the check for sensor breakage

If you cannot solve the problem by checking the cell and the cell cables and by switching the Strain Gauge Converters off/on, please contact Rockwell Automation.

In the case of a fault, the relays switch into a state with no current, unless you have selected the function **Hold on error**.

Editing device data

**WARNING**: A change in device data will change the operation of the device!

**WARNING**: Before entering new data into the device, you should therefore ascertain that no danger to the installation will result.

FDT Interface

This manual describes Parameterization mode of the universal frequency converter using the control panel. Parameterization mode for the universal frequency converter is more convenient with a PC using Field Device Tool (FDT) software.

Some specialized functions can only be selected using the FDT, for instance, pulse suppression as an alternative to the start-up override.

The FDT interface is the specification describing the standardized data exchange between devices and control system or engineering or asset management tools. Examples include: PACTware™, FieldCare, FactoryTalk AssetCentre, and Process Device Configuration. FDT frame software can be downloaded from the web: www.pactware.com www.fdtgroup.org.

PACTware™ is trademark of PACTware Consortium
Parameterization mode control panel

Programming

You can return to display mode from any point in the menu in parameterization mode by pressing the ESC key (possibly multiple times). If you do not press any key for 10 minutes in parameterization mode, the device automatically switches back into display mode.
Password

You can protect the current configuration from unauthorized changes by using a password (See Service; inactive when Strain Gauge Converter is delivered).

If password protection is active, the various settings in parameterization mode are visible before entry of the password, but may not be changed. The first time an attempt is made to change a setting, the device automatically displays a window for entering the password.

- You must enter the password **once each time** after switching from display mode to parameterization mode.
- The password cannot be changed and is **1234**.

How to enter the password:

![Password Entry Diagram]

*If the ▲ or ▼ keys are pressed, the value changes stepwise; if the ▲ or ▼ keys are held down for a longer period, the value "rolls" to higher or lower values.*
Navigation Method

The following illustration shows the navigation method in parameterization mode using the ▲, ▼, OK, and ESC keys:
Lowest menu level

Choose Values, Enter Numbers

At the lowest level of the menus, you can either choose between particular possible values for individual parameters, or enter a numeric value.

When entering numeric values, please note:
- If you press the ▲ or ▼ key, the value changes stepwise.
- If you hold the ▲ or ▼ key for a longer time, the value "rolls" to higher or lower values.
- The sign switches automatically.
- The decimal point is moved automatically.

Units are automatically converted to higher units, e.g. kg to t, or a factor is displayed, e.g. factor 10 for numbers \( \geq 10000 \).
Unit

The following figure shows the menu for the unit. The menu options of the lowest menu level are surrounded by a bold box. The unit is used for the measured value display (net and gross) and for all respective settings in the parameterisation mode.

* If more than 9999 kg are entered, the unit changes automatically from kg on t! The Strain Gauge Converter makes measurements in mV.
Sensor

The following figures show the menus for the input parameters. The menu options of the lowest menu level are surrounded by a bold box. Menu options that are only displayed if you have selected certain parameter values elsewhere are highlighted in grey.

- **Input**
- **Sensor**
- **Excitation**
  - 1 V
  - 2 V
  - 3 V
  - 4 V
  - 5 V

- **Sensitivity**
  - 0.001 to 60.00 mV/V

- **Cell rating**
  - 0.001 kg to 999.9 t

- **Rate**
  - normal
  - fast
Bul. 937C Strain Gauge Converter Installation Instructions

- Calibration
  - Trigger 1
  - Trigger 2

- Cell detect:
  - On
  - Off

- Smoothing:
  - 0 sec to 10 sec
Excitation, Sensitivity, Cell rating

- For the values of these parameters, please refer to the technical data of the sensor.
- The supply voltage exists between terminals 3 and 4.
- When connecting several measuring cells in parallel, the supply voltage and sensitivity must be transferred, the cell data are to be totalled. Only cells of the same design and with identical cell data may be connected in parallel.
- For a resulting total sensor resistance of \( R < 100 \, \Omega \) the supply voltage 5 V must not be selected. The maximum permitted supply voltage is calculated as follows:

\[
\text{Supply voltage} = 49 \, \text{mA} \times \text{total resistance of the measuring cells}
\]

- For the *Cell data* parameter, the maximum cell load must be set in kg (even if a different unit has been selected).

The cell data can be set up without a measuring cell being connected. The Strain Gauge Converter can then be connected to the weighing cell and is basically ready for operation. The voltage created by the weighing cell due to the load is converted linear into the corresponding gross weight.

**Note**

*If you want to use the Strain Gauge Converter without calibration yet take into account an existing empty weight (e. g. an empty tank or a weighing platform) when measuring, do not use the function "Zero point" but the function "Tare".*

Please note that mechanical influences have not yet been taken into account (e. g. acting of forces on the weighing cell other than perfectly vertically) so that the weighing device does not achieve its optimum accuracy.

**Note**

*To take into account mechanical influences a calibration of the fully installed weighing device using defined loads is unavoidable.*
**Without adjustment**, the gross value is calculated as follows:

\[
\text{Gross value} = \frac{\text{Measured value in mV}}{\text{Sensitivity} \times \text{Excitation voltage}} \times \frac{\text{Cell rating}}{\text{kg/unit}}
\]

This results in the following assignment: 0 mV is converted into 0 unit, the maximum sensor signal (= sensitivity x excitation voltage) is converted into the maximum cell load of the selected unit, interim values are converted proportionally.

**Rate, Cell error, Smoothing**

- If you have selected the *fast* setting for *Rate*, the *Sensor failure* and *Smoothing* menu options are not displayed. In this case, a check for sensor breakage and smoothing is not possible.

- If you have selected the *On* setting for *Sensor failure*, a check for sensor breakage is performed after each measurement (terminals 1 and 2). Possibly, the Strain Gauge Converter returns the error message *Err CELL*. Unless this check is enabled the Strain Gauge Converter might process uncontrolled input values until the sensor failure has been detected.
• The settings influence the measuring cycle time:

<table>
<thead>
<tr>
<th>Rate</th>
<th>Sensor failure</th>
<th>Measuring cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td>fast</td>
<td>–</td>
<td>approx. 300 ms</td>
</tr>
<tr>
<td>normal</td>
<td>Off</td>
<td>approx. 750 ms</td>
</tr>
<tr>
<td>normal</td>
<td>On</td>
<td>approx. 850 ms</td>
</tr>
</tbody>
</table>

• By means of *Smoothing*, you influence the reaction of the Strain Gauge Converter to strongly fluctuating measured values.

The Strain Gauge Converter processes the smoothed value instead of the current measured value. With an adjusted smoothing time of 0 sec, the input value is processed directly. The largest smoothing is reached with the attitude 10 sec. Note please that with increasing smoothing also the response time of the Strain Gauge Converter is reduced.

Smoothing is designed as a first-order low-pass filter. The smoothing time is the time required by the output signal to get from 10 % to 90 % after a jump stimulation.
Calibration

The following figure shows the menu levels following the Calibration menu option. The menu options of the lowest menu level are surrounded by a bold box. Menu options that are only displayed if you have selected certain parameter values elsewhere are highlighted in grey.

```
Calibration —— Zero —— Set —— -100 to +100 mV

          Execute
                yes
                    no

Adjust —— Weight —— Execute

          0.001 kg to 999.9 t

          yes
                    no

Range —— Set —— see zero point & adjust

          Execute
                yes
                    no

          kg/unit —— 0.001 kg/unit to 999.9 t/unit
```
Zero point

For installations where a signal of 0 mV does not correspond to the measured value 0 in the selected unit, a zero offset can be stored.

- If the zero offset is known from the data of the installation, please enter the value under Set displays.
- If you select (after appropriate measures in the installation, e. g. removing all weights) Execute and then Yes, the current mV measured value is stored as zero point. The gross value, the net value and the tare are set to 0.

For storing the zero point by means of the triggers, i. e. without using the control panel keys.

Adjust without mechanical load

The easiest calibration method. However, not all links in the measuring chain will be considered resulting in some inaccuracies.

- A trigger input must be parameterized as zare
- After installation and connection of the Strain Gauge Converter the corresponding input must be short-circuited with the measuring cell free from loads.

Adjust with mechanical load

This is the more accurate calibration method because the whole measuring chain is included. It does, however, require a high effort.

Adjust

The adjust is an exact defined excitation of the cell, e. g. by an exactly known weight. The Strain Gauge Converter requires both the value of the adjust in the selected unit and the generated input signal in mV:

- First enter the adjust value in the selected unit kg, N, cbm or pcs under Weight. If you have selected the unit %, the adjust value must be entered in the unit that was selected before the unit was set to %.
- After excitation of the sensor (applying the weight), select Execute and then Yes. This determines the adjust value in mV. The tare is set to 0, gross value and net value correspond to the adjust value in the selected unit.

For determining the adjust value in mV by means of the triggers, i. e. without using the control panel keys, see Triggers section.
Notes on Zero point and Adjust

- For the result of the adjust it does not matter whether you determine the zero point or the adjust value first.
- Zero point and adjust value must be determined in the same unit (do not change the unit before both operations have been performed).
- If you perform the adjust in a unit other than kg, a new adjust is required after changing the value kg/unit.
- If you change one of the Excitation voltage, Sensitivity or Cell rating parameters, a new adjust is required.

After an adjust, the gross value is calculated as follows:

\[
\text{Gross value} = \frac{\text{Measured value in mV} - \text{Zero point}}{\text{Adjust in mV} - \text{Zero point}} \times \text{Adjust in unit}
\]

This results in the following assignment: The zero point (in mV) is converted into 0 unit, the adjust value in mV is converted into the adjust value of the selected unit, intermediate values and values beyond the adjust value are converted proportionally.
Range

This parameter is required for evaluations in the unit %.

- Under Set displays, enter the value that is to correspond to the gross value 100 % in the (before selecting %) selected unit kg, N, cbm or pcs (see section 7.2). Values between 0 and the maximum cell load are possible.

- Alternatively, you can select Execute and then Yes after excitation of the cell (e.g. after applying a corresponding weight). This stores the current measured value as Range.

After a change to the unit %, the gross value is calculated as follows:

\[
\text{Gross value in } \% = \frac{\text{Gross value without change to } \%}{\text{Range}} \times 100 \%
\]

kg/unit

- This menu option is only displayed if N, cbm or pcs has been selected as unit (see section 7.2) or if % has been selected as unit and N, cbm or pcs has been selected previously.

- The entered value determines the conversion of kg into
  - N (approx. 1/9.81 = 0.102)
  - cbm (known from the application or to be determined by weighing)
  - pcs (known from the application or to be determined by weighing).

- If % has been selected as unit, the factor for converting kg into the previously selected unit must be entered.

- If an adjust into a unit other than kg is performed, the value kg/unit must be entered before the adjust. After changing the value kg/unit, a new adjust is required.
7.5 Triggers

The following figure shows the menus for trigger 1 and trigger 2. The menu options of the lowest menu level are surrounded by a bold box. For information on the binary inputs, see Connection section.

- In the case of the Tare setting, a signal of at least 100 ms at the binary input results in the current measured value of the Strain Gauge Converter being stored as the (new) value for the tare. As usual, the following applies:
  \[ \text{net value} = \text{gross value} - \text{tare} \]
- In the case of the Adjust setting, a signal of at least 100 ms at the binary input results in the current measured value of the Strain Gauge Converter being adopted as the value for the adjust.
- In the case of the Zero setting, a signal of at least 100 ms at the binary input results in the current measured value of the Strain Gauge Converter being adopted as the value for the zero point.

Storing the adjust and the zero point by means of the triggers only makes sense, for example, if you want to avoid operational actions on the Strain Gauge Converter.
Relays

The following figure shows the menus for the output parameters.

From the Relay 1 and Relay 2 menu options, you can use the OK key to get to a menu in which you can enter individual parameters for the selected relay. Both menus are structured in the same way and are thus only described once.

The activated function of a relay (Trip alarm or Fault indication) is marked by On. If you want to activate a different function, first call this function using the ▲ and ▼ keys. Then press the OK key twice. After the first OK you can cancel with ESC.
Trip alarm

The following figures show the menu levels following the Trip alarm menu option. The menu options of the lowest menu level are surrounded by a bold box.

If the Trip alarm function is activated (On), use the OK key to get from the Trip alarm menu option to the Min/Max menu option. If you reactivate the Trip alarm function, pressing the OK key twice takes you directly to the Min/Max menu option.

Trip alarm (On) —— Min/Max —— Trip —— Trip point & Hysteresis —— Hysteresis —— Trip point & Hysteresis —— Mode —— Passive —— Active —— Gross/Net —— Gross —— Net

continued on next page
Operating behavior

As the trip mode *Max* or *Min* are possible, as the operating mode *Active* or *Passive* are possible. Areas of application:

- Trip mode *Max*, operating mode *Active*: alarm if the signal is above the trip value, e. g. horn on; protection against overfilling, e. g. open drain in capacity tank
- Trip mode *Max*, operating mode *Passive*: protection against overfilling, e. g. conveyor belt/pump off; for a large hysteresis Min-Max operation, e. g. conveyor belt/pump on/off
- Trip mode *Min*, operating mode *Active*: alarm if the signal is below the trip value, e. g. horn on; protection against shortfalls in security reserves, e. g. conveyor belt/pump on
- Trip mode *Min*, operating mode *Passive*: Protection against shortfalls in security reserves, e. g. pumping out off; for a large hysteresis Min-Max operation

The exact operating behavior of the Strain Gauge Converter is illustrated in the following figure:
Trip point and Hysteresis

When entering the values for the trip point and hysteresis, please observe the following:

- By means of the Gross/Net parameter, you determine whether the value for the trip point is a gross value or a net value (gross value minus current tare).

- The trip point and hysteresis must be entered in the selected unit.
  - The minimum value for the trip point is 0, the minimum value for the hysteresis is 0.1.
  - If you have selected Gross, the maximum cell load is the maximum value for the trip point and hysteresis.
  - If you have selected Net, the value of the maximum cell load minus the current tare is the maximum value for the trip point and hysteresis.
As the representation of the operating behavior in section 7.6.2 shows, the following must apply:

- for the trip mode \(\text{Max}\): trip point - hysteresis \(\geq 0\)
- for the trip mode \(\text{Min}\): trip point + hysteresis \(\leq\) upper limit of the trip point

The limits are automatically determined by the Strain Gauge Converter being.

- The hysteresis should be \(> 1\%\) of the trip point in order to prevent rapid switching of the relay.

**Delay**

If you set a time \(> 0\) sec, you prevent short-time violations of the trip value from triggering an alarm.

- The relay only switches if the trip point is exceeded/fallen short of for a period that is longer than the delay time.

- The relay only switches back if the trip point \(-/+\) hysteresis is fallen short of/exceeded for a period that is longer than the delay time.

- If the trip point is exceeded/fallen short of for a short time, this does not have any effects.

The following figure shows the operating behavior for the trip mode \(\text{Max}\), operating mode \(\text{Active}\).
Alarm freeze and Hold on error

- By means of the **Alarm freeze** you ensure that the operating personnel notices if the trip value is temporarily violated.
  
  If *Alarm freeze On* has been selected, the new condition is maintained after switching the relay, until the ESC key is pressed or the device is restarted. These actions reset the relay, unless the trip value is still exceeded.

- The **Hold on error** function prevents the relay from de-energising in the case of a fault.
  
  If *Hold on error On* has been selected, the condition of the relay is maintained in the case of a fault, until the error message is cleared. Afterwards, the relay takes up its normal function again.

Fault indication

The following figure shows the menu levels following the *Fault indication* menu option. The menu options of the lowest menu level are surrounded by a bold box.

If the Fault indication function is activated (*On*), use the OK key to get from the *Fault indication* menu option to the *Alarm freeze* menu option. If you reactivate the Fault indication function, pressing the OK key twice takes you directly to the *Alarm freeze* menu option.

```
Fault indication (On) ─────────── Alarm freeze ─── On
          ────── Off
```

A relay with the function **Fault indication** is energised in normal operation. If the device detects a fault, the relay is de-energised.
Current output

The following figures show the menu levels following the \(I_{out}\) menu option. The menu options of the lowest menu level are surrounded by a bold box.

\[
\begin{align*}
\text{I}_{out} & \quad \text{Characteristic} & \quad 20.20 \text{ -/+mA} \\
& & \quad 4 \text{ - 20 NE 43} \\
& & \quad 12.20 \text{ -/+mA} \\
& & \quad 0 \text{ - 20 mA (b)} \\
\end{align*}
\]

\[
\begin{align*}
\text{Gross/Net} & \quad \text{Gross} \\
& & \quad \text{Net} \\
\text{Span} & \quad \text{Gross/Net,Span,Inv} \\
\end{align*}
\]

continued on next page
Gross/Net, Span, Inverted

- By means of the *Gross/Net* parameter, you determine whether the value for the *Span* is a gross value or a net value (gross value minus current tare).
- By means of the *Span* parameter, you determine the measured value range which is represented by the current output.
  - The span must be entered in the selected unit.
  - If you have selected *Gross*, you can enter values between 1 % and 100 % of the maximum cell load.
  - If you have selected *Net*, you can enter values between 1 % of the maximum cell load and the value of the maximum cell load minus the current tare.
- If you select *Inverted → normal*, the measured value 0 is converted into the start value of the current output and the *Span* is converted into the end value (for the Strain Gauge Converter always +20 mA). If you select *Inverted → inverted*, the *Span* is converted into the start value of the current output and the measured value 0 is converted into the end value.
Characteristic

The settings have the following meaning (for Inverted → normal)

**Selected setting 20.20 -/+mA**

This setting converts the measured value 0 into -20 mA (i.e. into 20 mA in the case of changed polarity at the terminals 7 and 8), the span is converted into +20 mA (terminal 7 -, terminal 8 +), interim values are calculated proportionally.

For values below the measured value 0, the output current decreases linearly to a minimum of -20.5 mA (-1.25 % of the measurement range). Further underflows cannot be evaluated (output -20.5 mA). If the span is exceeded, the output current increases linearly to a maximum of +20.5 mA (101.25 % of the measurement range). Further increases cannot be evaluated (output +20.5 mA).

**Selected setting 4 - 20 NE 43**
This setting converts the measured value 0 into 4 mA, the span is converted into 20 mA, interim values are calculated proportionally.

For values below the measured value 0, the output current decreases linearly to a minimum of 3.8 mA (-1.25 % of the measurement range). Further underflows cannot be evaluated (output 3.8 mA). If the span is exceeded, the output current increases linearly to a maximum of 20.5 mA (approx. 103 % of the measurement range). Further increases cannot be evaluated (output 20.5 mA).

**Selected setting 12.20 +/-mA**

This setting converts the measured value 0 into -12 mA (i.e. into 12 mA in the case of changed polarity at the terminals 7 and 8), the span is converted into +20 mA (terminal 7 -, terminal 8 +), interim values are calculated proportionally.

For values below the measured value 0, the output current decreases linearly to a minimum of -12.5 mA (approx. -1.6 % of the measurement range). Further underflows cannot be evaluated (output 12.5 mA). If the span is exceeded, the output current increases linearly to a maximum of 20.5 mA (approx. 102 % of the measurement range). Further increases cannot be evaluated (output 20.5 mA).
Selected setting 0 - 20 mA (b)

This setting converts the measured value 0 into 0, the span (see section 7.7.1) is converted into 20 mA, interim values are calculated proportionally.

Values below the measured value 0 cannot be evaluated (output 0 mA). If the span is exceeded, the output current increases linearly to a maximum of 20.5 mA (102.5 % of the measurement range). Further increases cannot be evaluated (output 20.5 mA).

Fault current

The following table shows what the current output is during a fault, depending on the selected setting:

<table>
<thead>
<tr>
<th>Setting</th>
<th>Characteristic 20.20 -/+mA</th>
<th>Characteristic 4 - 20 NE 43</th>
<th>Characteristic 12.20 -/+mA</th>
<th>Characteristic 0 - 20 mA (b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min (downscale)</td>
<td>-21.5 mA</td>
<td>2.0 mA</td>
<td>-21.5 mA</td>
<td>0 mA (cannot be distinguished from measurement ≤ 0)</td>
</tr>
<tr>
<td>Max (upscale)</td>
<td>+21.5 mA</td>
<td>21.5 mA</td>
<td>+21.5 mA</td>
<td>21.5 mA</td>
</tr>
<tr>
<td>Hold</td>
<td></td>
<td>last value before the fault</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up/down</td>
<td></td>
<td>in the case of Err Cell: downscale; in all other cases: upscale</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Service

The following figure shows the menus for the service parameters. The menu options of the lowest menu level are surrounded by a bold box.

RS 485: Set the address of the Strain Gauge Converter for communication via the RS 485 interface here.

Reset: If yes is flashing and you press the OK key, all settings of the Strain Gauge Converter will be reset to factory settings (see exceptions: language and password activation). All entries which you have ever made in parameterisation mode and the adjust will be lost.
# Factory settings

<table>
<thead>
<tr>
<th>Menu</th>
<th>Parameter</th>
<th>Factory setting</th>
<th>Local setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main menu</td>
<td>Unit</td>
<td>kg</td>
<td></td>
</tr>
<tr>
<td>Input sensor</td>
<td>Excitation voltage</td>
<td>5 V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sensitivity</td>
<td>2,000 mV/V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cell rating</td>
<td>1000 kg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rate</td>
<td>Normal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cell error</td>
<td>On</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Smoothing</td>
<td>0 sec.</td>
<td></td>
</tr>
<tr>
<td>Input adjustment</td>
<td>Zero point</td>
<td>0.000 mV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adjust</td>
<td>1000 kg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>1000 kg</td>
<td></td>
</tr>
<tr>
<td>Input</td>
<td>Trigger 1</td>
<td>Zero</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trigger 2</td>
<td>Zero</td>
<td></td>
</tr>
<tr>
<td>Output relay 1</td>
<td>Trip alarm</td>
<td>On (= selected)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MIN/Max (= Trip mode)</td>
<td>Max</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trip point</td>
<td>10.00 kg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hysteresis</td>
<td>10.00 kg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mode</td>
<td>Passive</td>
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</tr>
<tr>
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<td>Net/Gross</td>
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</tr>
<tr>
<td></td>
<td>Delay</td>
<td>0 sec.</td>
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</tr>
<tr>
<td></td>
<td>Alarm freeze</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Hold on error</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fault indication</td>
<td>not selected</td>
<td></td>
</tr>
<tr>
<td>Parameter</td>
<td>Parameter</td>
<td>Factory setting</td>
<td>Local setting</td>
</tr>
<tr>
<td>---------------------------</td>
<td>---------------------------</td>
<td>-----------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Output relay 2</td>
<td>Trip alarm</td>
<td>On (= selected)</td>
<td></td>
</tr>
<tr>
<td>MIN/Max</td>
<td></td>
<td>Max</td>
<td></td>
</tr>
<tr>
<td>(= Trip mode)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trip point</td>
<td>10.00 kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hysteresis</td>
<td>10.00 kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mode</td>
<td>Passive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net/Gross</td>
<td>Net</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delay</td>
<td>0 sec.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alarm freeze</td>
<td>Off</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hold on error</td>
<td>Off</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fault indication</td>
<td>not selected</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output I&lt;sub&gt;out&lt;/sub&gt;</td>
<td>Characteristic</td>
<td>20.20 -/+mA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Net</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Span</td>
<td>20.00 kg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fault current</td>
<td>Max</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inverted</td>
<td>Normal</td>
<td></td>
</tr>
<tr>
<td>Service</td>
<td>Password</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Language</td>
<td>Eng</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RS 485</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reset</td>
<td>no</td>
<td></td>
</tr>
</tbody>
</table>
**RS 485 interface**

The Strain Gauge Converter can be connected to an RS 485 2-wire bus via the terminals 19 ... 21 or via the Power Rail. In principle, such a bus is structured as follows:

Ensure that the polarity of the connection is correct! An incorrect polarity causes inverted data signals and thus prevents the bus from working properly.

Characteristics of the RS 485 interface of the Strain Gauge Converter:
- Baud rate 9600
- 1 start bit, 8 data bits, no parity bit, 1 stop bit
Requests via the RS 485 interface are **not** suitable for time-critical or safety-critical applications.

The Strain Gauge Converter can request the following information via the RS 485 interface e.g. from a PC or a PLC (with 3 decimal places each):

- Net measured value (in the set unit)
- Gross measured value (in the set unit)
- mV measured value (in the set unit)
- Output value current output (in mA)

The following commands are available for the requests:

- **Null**: delete the receive buffer of the requesting device
- **Check_1**: checks whether Strain Gauge Converter (with the respective address) is connected
- **Get_value_ch1**: requests the net measured value
- **Get_value_ch2**: requests the gross measured value
- **Get_value_ch3**: requests the mV measured value
- **Get_current**: requests the output value current output

At the beginning of each RS 485 communication, send the request **Check_1**.

The RS 485 interface is deactivated if a connector is plugged into the programming jack (RS 232 interface).

When the connector is removed, the request **Check_1** is required to switch to RS 485 communication.
The commands must be encoded as follows:

<table>
<thead>
<tr>
<th>Command</th>
<th>1st byte</th>
<th>2nd byte</th>
<th>3rd byte</th>
<th>4th byte</th>
<th>5th byte</th>
<th>6th byte</th>
</tr>
</thead>
<tbody>
<tr>
<td>Null</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Check_1</td>
<td>Address 1</td>
<td>1</td>
<td>Checksum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Get_value_ch1</td>
<td>Address  $B_{Hex}$</td>
<td>Checksum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Get_value_ch2</td>
<td>Address  $C_{Hex}$</td>
<td>Checksum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Get_value_ch3</td>
<td>Address  $10_{Hex}$</td>
<td>Checksum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Get_current</td>
<td>Address  $D_{Hex}$</td>
<td>Checksum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Strain Gauge Converter returns the following responses:

<table>
<thead>
<tr>
<th>Command</th>
<th>1st byte</th>
<th>2nd byte</th>
<th>3rd byte</th>
<th>4th byte</th>
<th>5th byte</th>
<th>6th byte</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check_1</td>
<td>Address 9</td>
<td></td>
<td>Checksum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Get_value_ch1</td>
<td>Address</td>
<td>Value</td>
<td>Checksum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Get_value_ch2</td>
<td>Address</td>
<td>Value</td>
<td>Checksum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Get_value_ch3</td>
<td>Address</td>
<td>Value</td>
<td>Checksum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Get_current</td>
<td>Address</td>
<td>Value</td>
<td>Checksum</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Explanations:
- **Address**: The address must be calculated as follows: 128 + setting under *Service → RS 485* (see section 7.8). Values from 128 + 0 to 128 + 31, i.e. from $10000000_{Bin}$ to $10011111_{Bin}$, are possible.
- **Checksum**: The checksum is calculated as follows: $100_{Hex} - (1^{st} \text{ byte} + ... + \text{penultimate byte of the code})$, e.g. for Check_1 for address 17: $100_{Hex} - (91_{Hex} + 1) = 6E_{Hex} = 01101110_{Bin}$
- **The figure 9 in the response to Check_1 refers to the device type Strain Gauge Converter.**
- **Value**: in the signed long data format (4 bytes or 2 bytes)
**Example**

The weight of a truck load is to be calculated. The empty weight of the truck can be between 7.5 t and 15 t, the load to be measured can be up to 20 t. To prevent an overloading of the truck an alarm is to be triggered at a weight above 20.5 t.

The truck rests on 4 weighing cells which have been connected in parallel at the input of the Strain Gauge Converter. Each weighing cell has the following data:

- Supply voltage 5 V
- Sensitivity 2 mV/V
- Maximum load: 15 t
- Internal resistance: 350 Ω

The mass of the truck weighing scales is 10 t.

**Unit**

The weight is to be displayed in the unit tons. In the menu **Unit** kg must be set. If the weight reaches 1000 kg the device automatically switches to t.
Sensor data

Because the truck scale rests on 4 measuring cells the parameters of each individual measuring cell must be combined: The following entries must be made in the menu Sensor:

- **Supply voltage:**
  Here the resulting total resistance of the parallel connection of the 4 sensors must be taken into account. If the resulting resistance of the sensors connected in parallel falls below 100 Ω, a lower supply voltage must be selected due to the maximum available current. The maximum permitted supply voltage is calculated as follows:
  
  Total resistance x 49 mA = maximum supply voltage
  
  - 4 measuring cells with each 350 Ω = 87.5 Ω
  - 87.5 Ω x 49 mA = 4.2875 V

  Set the supply voltage to 4 V.
  
  The maximum permitted total resistance of the sensors is 10 kΩ.

- **Sensitivity:**
  The sensitivity of the individual cells can be accepted 1:1.

  **Example:**
  
  4 cells with 2 mV/V each, entry in Sensitivity = 2 mV/V

- **Cell data:**
  
  Max. cell load: The cell load of the individual sensor must be multiplied by the number of sensors.

  **Example:**
  
  4 sensors with 15 t each, entry in Cell load = 60 tons).

  **Explanation:**
  
  If e. g. only one cell is loaded at its individual maximum load it will output its maximum voltage. The other 3 sensors are connected to this voltage and become consumers; this puts a load on the voltage source and results in a voltage drop. Only if all 4 cells are loaded at their respective maximum loads will they output their respective maximum voltages equally which is then measured in parallel by the Strain Gauge Converter. All uneven loads between those two extremes behave linear, therefore the parallel connection can be considered as a single measuring cell.
**Trigger inputs**

One trigger input must be parameterized as "Tare" to enable a subsequent zero point setup.

**Calibration**

The calibration can be carried out offline or online.

**Offline**

Calibration without mechanical load is the simplest way of calibrating the Strain Gauge Converter. However, inaccuracies are to be expected because the whole measuring chain is not included in the calibration process.

With an empty weighing device setting a zero point for the whole system is possible via the input parameterized as tare under "Trigger input". The characteristic of the weighing cell is retained and only the origin is adjusted.

The Strain Gauge Converter is then calibrated. Because the measuring cells are normally calibrated at factory and are very strongly linear, the measuring values are calculated with great accuracy.

**Online**

The online calibration is more accurate than the offline calibration because it involves the whole measuring chain 100%. The measuring cell is put under a defined load and the Strain Gauge Converter calibrated to these points.

The cell returns with an empty weighing platform 1.43 mV. In the menu item Input > Calibration > Adjust > Zero point > Execute a zero point calibration is carried out, i. e. the 1.43 mV are allocated to 0 kg which is now also displayed by the Strain Gauge Converter.

A defined weight must then be placed on the cell, e. g. 5 t.

Under the menu item Input > Calibration > Adjust > Weight the applied weight must now be entered (5 t) and the calibration be carried out via Execute. The Strain Gauge Converter now displays 5 t.

The processes **Zero point calibration** and **Adjust** must always be carried out together, but the sequence described above does not have to be adhered to (it is possible to calibrate **Adjust** and then **Zero point**.
However, because the total mass to be measured is greater, the range must also be entered. Under Input > Calibration > Range > Set the weight to be measured must be entered, in the example 35 t. With this setting the value 100 % will be displayed at 35 t if the unit is changed to %.

The Strain Gauge Converter has now been calibrated including the whole measuring chain.

Outputs

Current output
The current output must only represent the net value (the weight of the load). In the menu Output > I_{out} > Gross/Net the option Net must therefore be selected.

The adjustable range relates to the maximum cell load. Because the maximum cell load is not reached with a full tank (full truck = 20 t, maximum cell load = 60 t) the value 20 t must be entered here.

Relay outputs
To prevent overloading a relay must be triggered as a limit value relay if 20.5 t is exceeded. This means that the relay must be parameterized as a limit value switch with the switching direction "Max"; as a switching point the 20.5 t must be entered. As hysteresis a value of approx. 1 % of the range is recommended, i.e. 250 kg (0.25 t). The relay must energise once the switching point has been exceeded, the direction of action must therefore be entered as "active".

To prevent the relay from switching during the truck entering the scales a time of 60 s can be entered under the menu item Relay > Trip alarm > Delay. Limit overruns of less than 60 s duration will then be ignored.

Operation

An empty truck enters the scales. After short-circuiting the inputs of the trigger input previously parameterized as "Tare" a zero point calibration is carried out. The truck is then loaded and the Strain Gauge Converter displays only the weight of the load.

At the current output the weight of the load is represented by 4 mA for the empty truck and 20 mA for the fully loaded truck.

Via the RS 485 interface the weight of the load (net weight) can be queried by a PLS via the command Get_value_ch_1 and be processed numerically.