Welding Force Calibration Transmitter  
Type 9831C...

System for Measuring the Electrode Force in Spot Welding

Measuring system for testing and calibrating the electrode force in spot welding machines (resistance welding).

Quartz Force Sensor
- Minimum electrode distance of only 3,0 mm
- Interchangeable inserts to fit different electrode shapes
- Highest safety standard due to flexibly mounted sensor unit
- Selectable, calibrated measuring ranges: 5 kN, 10 kN or 45 kN
- High repetition accuracy because the centering of the electrodes improves the transmission of force

Measuring System
- The welding process can be improved by means of an optimum electrode force-time curve in combination with the welding current switching signal.
- The force sensor can be combined with Welding & Fastening Monitor Type 5825A2 (mobile hand-held unit)
- Documentation facility via interface RS-232C
- Rugged and overload-proof design of components

Description
The system consists of a quartz force sensor, which can be connected to various evaluation units. The electronic system plots the force-time curve in combination with the welding current switching signal. The ground-isolated sensor design prevents the flow of welding current during the measuring process. The charge amplifier electronics integrated in the sensor provides a calibrated output signal proportional to the force.

Applications
- Monitoring of welding robots in production lines (e.g. in the automotive production lines)
- Maintenance of welding units
- Setup of welding units for new workpieces
- Calibration of spot welding guns
- Optimization of cycle times and welding cycles
- Calibrated test device according to ISO 9001 quality management

Fig. 1: Welding force calibration transmitter Type 9831C111

Fig. 2: Complete mobile measuring system with welding force calibration transmitter Type 9831C111 and measuring set in case Type 9831C0001
Technical Data

<table>
<thead>
<tr>
<th>Welding Force Sensor</th>
<th>Type</th>
<th>9831C1...</th>
<th>9831C2...</th>
<th>9831C3...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring range kN</td>
<td>5</td>
<td>10</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Overload kN</td>
<td>6</td>
<td>12</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Calibrated range kN</td>
<td>5</td>
<td>10</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Response threshold N</td>
<td></td>
<td>≤0,01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity V/kN via charge amplifier</td>
<td></td>
<td>1</td>
<td>0,5</td>
<td>0,1</td>
</tr>
<tr>
<td>Linearity ±% FSO</td>
<td></td>
<td>≤1</td>
<td>≤1</td>
<td>≤2</td>
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<tr>
<td>Welding cap standard (Reference)</td>
<td></td>
<td>ISO5821</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrode distance during the measurement (depending on electrode shape and welding insert type) mm</td>
<td></td>
<td>≥3,0</td>
<td></td>
<td></td>
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<tr>
<td>Operating temperature range °C</td>
<td>0 ... 60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensor connector</td>
<td>8-pole, DIN 45326</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree of protection at the sensor (cable connected) IP65 (EN60529)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (without cables) kg</td>
<td>1,4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compliance with EU directives Safety EN60950</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EMC interference immunity EN61000-6-3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interference immunity EN61000-6-2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Charge Amplifier

| Output voltage VDC | ±5 | ±5 | ±4,5 |
| Output voltage offset mV | ≤±10 | | |
| Output current mA | ±2 | | |
| Output impedance (Output PIN 4) Ω | 100 | | |
| Drift (25 °C) mN/s | ≤±20 | ≤±10 | ≤±2,222 |
| Reset/Operate transition mV | ≤±0,7 | ≤±0,35 | ≤±0,0777 |
| Supply voltage VDC | 10 ... 30 | | |
| Supply current mA | ≤10 | | |

Operate Signal

| Operate input on GND or V | 0 ... 0,8 |
| Reset mA | <0,1 |
| Operate input open or V | >2 |
| Operate/Reset time until signal ms | <20 | <40 | <180 |
| Signal <0,5 % FS at max. Load (FS) | | | |

Welding Current Switching Signal

| Weld Signal VDC | 5,5 ± 10 % |
| Output signal Ω | 2,700 |
| Max. permissible voltage VDC between sensor underside and top side (supply voltage) | 9 |
| Switching threshold VDC | 3 |
| Veff | 4 |
| Signal delay ms | 0,2 |
Pin Allocation

Weld Signal 5
Code 0 3
Code 1 7
1 NC
2 Exct/Signal GND
4 Sensor Signal
6 Operate
8 Exct 10 ... 30VDC

Code 0, Code 1 = Automatic measuring range detection at Welding & Fastening Monitor Type 5825A2 (see data sheet 5825A_000-448)

NC = Not connected

Dimensions

Fig. 3: Welding force sensor Type 9831C... with charge amplifier included and plastic handgrip (removable)
Electrode Inserts
The welding force sensor is equipped with 2 electrode inserts, which must be specified in the order, and is calibrated to these prior to delivery. The design of the welding force sensor makes it very easy to change the electrode inserts. When inserts of the same type are replaced, measuring accuracy is unaffected. If a change is made to a different type of electrode insert, for which the welding force sensor has not been calibrated, the sensitivity will vary within a range of ±2 %. The recalibration of the sensor to a new type of electrode insert, (a service offered by Kistler) improves the accuracy to the value for the measuring range stated in the table under “Technical Data”.

Type 9426B20
max. permissible measuring range 45 kN

Type 9426B25
max. permissible measuring range 10 kN

Application Range
Dummy insert for sensor applications on a flat surface.

Type 9426B10
max. permissible measuring range 10 kN

Type 9426B27
max. permissible measuring range 10 kN

Type 9426B29
max. permissible measuring range 10 kN

Application Range
Electrode contact area is located on the insert base (Index A).

Application Range
Electrode contact area must be located ring-shaped on the cone side (Index B).

Application Range
Electrode contact area is located on the insert base (Index A).

Application Range
Electrode contact area must be located ring-shaped on the cone side (Index B).

Customized electrode inserts are available on request.
Application Examples
A selection of various electrode shapes with matching electrode inserts in the sensor.

Closing force measurement with 30° milled Type B electrodes (ISO 5821) and with top and bottom inserts Type 9426825.

Measuring range: F ≤10 kN
Force transmission ring-shaped via cone wall; minimum electrode distance during the measurement.

\[ e_1 + e_2 = e_3 \cong 3,4 + 3,1 = 6,5 \text{ mm} \]
Approach distance for the pair of electrodes:

\[ a = 11,5 \text{ mm} \]

Closing force measurement with 48° milled Type F electrodes (ISO 5821) and with top and bottom inserts Type 9426825.

Measuring range: F ≤10 kN
Force transmission ring-shaped via cone wall; minimum electrode distance during the measurement.

\[ e_1 + e_2 = e_3 \cong 1,7 + 2,8 = 4,5 \text{ mm} \]
Approach distance for the pair of electrodes:

\[ a = 11,5 \text{ mm} \]

Closing force measurement with modified Type F electrodes (ISO 5821) with ball-shaped tips and with top and bottom inserts Type 9426825.

Measuring range: F ≤10 kN
Force transmission ring-shaped via cone wall; minimum electrode distance during the measurement.

\[ e_1 + e_2 = e_3 \cong 1,5 + 2,6 = 4,1 \text{ mm} \]
Approach distance for the pair of electrodes:

\[ a = 11,5 \text{ mm} \]

Closing force measurement with modified Type F electrodes (ISO 5821) with flat tip and with top and bottom inserts Type 9426825.

Measuring range: F ≤10 kN
Force transmission ring-shaped via cone wall; minimum electrode distance during measurement.

\[ e_1 + e_2 = e_3 \cong 2,1 + 3,2 = 5,3 \text{ mm} \]
Approach distance for the pair of electrodes:

\[ a = 11,5 \text{ mm} \]

Closing force measurement with 30° milled Type B electrodes (ISO 5821) and with top and bottom inserts Type 9426820.

Measuring range: F ≤45 kN
Force transmission via the plane parallel surfaces of base and cover plates; minimum electrode distance during the measurement.

\[ e_1 + e_2 = c \cong 15,5 + 15,5 = 31 \text{ mm} \]
Approach distance for the pair of electrodes:

\[ c = 31 \text{ mm} \]

Closing force measurement with 48° milled Type F electrodes (ISO 5821) and with top and bottom inserts Type 9426820.

Measuring range: F ≤45 kN
Force transmission via the plane parallel surfaces of base and cover plates; minimum electrode distance during the measurement.

\[ e_1 + e_2 = c \cong 15,5 + 15,5 = 31 \text{ mm} \]
Approach distance for the pair of electrodes:

\[ c = 31 \text{ mm} \]
Closing force measurement with 30° milled Type B electrodes (ISO 5821) and with top and bottom inserts Type 9426810.

Measuring range: $F \leq 10$ kN

Force transmission ring-shaped via cone wall; minimum electrode distance during measurement.

$e_1 + e_2 = e_3 \approx 2,4 + 3,3 = 5,7$ mm

Approach distance for the pair of electrodes:

$b = 20,5$ mm

Closing force measurement with 30° milled Type B electrodes (ISO 5821) and with top and bottom inserts Type 9426827.

Measuring range: $F \leq 10$ kN

Force transmission ring-shaped via cone wall; minimum electrode distance during measurement.

$e_1 + e_2 = e_3 \approx 3,5 + 5,1 = 8,1$ mm

Approach distance for the pair of electrodes:

$b = 20,5$ mm

Closing force measurement with 48° milled Type F electrodes (ISO 5821) and with top and bottom inserts Type 9426810.

Measuring range: $F \leq 10$ kN

Force transmission ring-shaped via cone wall; minimum electrode distance during measurement.

$e_1 + e_2 = e_3 \approx 2,2 + 2,2 = 4,4$ mm

Approach distance for the pair of electrodes:

$b = 20,5$ mm

Closing force measurement with 48° milled Type F electrodes (ISO 5821) and with top and bottom inserts Type 9426827.

Measuring range: $F \leq 10$ kN

Force transmission ring-shaped via cone wall; minimum electrode distance during measurement.

$e_1 + e_2 = e_3 \approx 1,7 + 3,2 = 4,9$ mm

Approach distance for the pair of electrodes:

$b = 20,5$ mm

Closing force measurement with modified Type F electrodes (ISO 5821) with ball-shaped tips and with top and bottom inserts Type 9426810.

Measuring range: $F \leq 10$ kN

Force transmission ring-shaped via cone wall; minimum electrode distance during measurement.

$e_1 + e_2 = e_3 \approx 1,7 + 1,7 = 3,4$ mm

Approach distance for the pair of electrodes:

$b = 20,5$ mm

Closing force measurement with modified Type F electrodes (ISO 5821) with ball-shaped tips and with top and bottom inserts Type 9426827.

Measuring range: $F \leq 10$ kN

Force transmission ring-shaped via cone wall; minimum electrode distance during measurement.

$e_1 + e_2 = e_3 \approx 1,5 + 2,7 = 4,2$ mm

Approach distance for the pair of electrodes:

$b = 20,5$ mm

Closing force measurement with modified Type F electrodes (ISO 5821) with flat tip and with top and bottom inserts Type 9426810.

Measuring range: $F \leq 10$ kN

Force transmission ring-shaped via cone wall; minimum electrode distance during measurement.

$e_1 + e_2 = e_3 \approx 1,6 + 2,4 = 4,0$ mm

Approach distance for the pair of electrodes:

$b = 20,5$ mm

Closing force measurement with modified Type F electrodes (ISO 5821) with flat tip and with top and bottom inserts Type 9426827.

Measuring range: $F \leq 10$ kN

Force transmission ring-shaped via cone wall; minimum electrode distance during measurement.

$e_1 + e_2 = e_3 \approx 2,1 + 3,3 = 5,4$ mm

Approach distance for the pair of electrodes:

$b = 20,5$ mm

Closing force measurement with 30° milled Type B electrodes (ISO 5821) and with top and bottom inserts Type 9426810.

Measuring range: $F \leq 10$ kN

Force transmission ring-shaped via cone wall; minimum electrode distance during measurement.

$e_1 + e_2 = e_3 \approx 3,5 + 5,1 = 8,1$ mm

Approach distance for the pair of electrodes:

$b = 20,5$ mm

Closing force measurement with 30° milled Type B electrodes (ISO 5821) and with top and bottom inserts Type 9426827.

Measuring range: $F \leq 10$ kN

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$e_1 + e_2 = e_3 \approx 3,5 + 5,1 = 8,1$ mm

Approach distance for the pair of electrodes:

$b = 20,5$ mm

Closing force measurement with 48° milled Type F electrodes (ISO 5821) and with top and bottom inserts Type 9426810.

Measuring range: $F \leq 10$ kN

Force transmission ring-shaped via cone wall; minimum electrode distance during measurement.

$e_1 + e_2 = e_3 \approx 1,7 + 3,2 = 4,9$ mm

Approach distance for the pair of electrodes:

$b = 20,5$ mm

Closing force measurement with 48° milled Type F electrodes (ISO 5821) and with top and bottom inserts Type 9426827.

Measuring range: $F \leq 10$ kN

Force transmission ring-shaped via cone wall; minimum electrode distance during measurement.

$e_1 + e_2 = e_3 \approx 1,7 + 3,2 = 4,9$ mm

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Closing force measurement with modified Type F electrodes (ISO 5821) with ball-shaped tips and with top and bottom inserts Type 9426810.

Measuring range: $F \leq 10$ kN

Force transmission ring-shaped via cone wall; minimum electrode distance during measurement.

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Approach distance for the pair of electrodes:

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Closing force measurement with modified Type F electrodes (ISO 5821) with ball-shaped tips and with top and bottom inserts Type 9426827.

Measuring range: $F \leq 10$ kN

Force transmission ring-shaped via cone wall; minimum electrode distance during measurement.

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Approach distance for the pair of electrodes:

$b = 20,5$ mm

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$e_1 + e_2 = e_3 \approx 2,1 + 3,3 = 5,4$ mm

Approach distance for the pair of electrodes:

$b = 20,5$ mm

Closing force measurement with modified Type F electrodes (ISO 5821) with flat tip and with top and bottom inserts Type 9426827.

Measuring range: $F \leq 10$ kN

Force transmission ring-shaped via cone wall; minimum electrode distance during measurement.

$e_1 + e_2 = e_3 \approx 2,1 + 3,3 = 5,4$ mm

Approach distance for the pair of electrodes:

$b = 20,5$ mm
## Electrode/Insert Spacing for Different Electrode Shapes and Electrode Inserts

This information corresponds to the current state of knowledge. Kistler reserves the right to make technical changes. Liability for consequential damage resulting from the use of Kistler products is excluded.

### Electrode shape

<table>
<thead>
<tr>
<th>Electrode shape</th>
<th>E-caps according to ISO 5821</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type B</td>
<td></td>
</tr>
<tr>
<td>Type A</td>
<td></td>
</tr>
<tr>
<td>Type C</td>
<td></td>
</tr>
<tr>
<td>Type F</td>
<td></td>
</tr>
</tbody>
</table>

### Electrode/insert spacing between two identical electrode caps and electrode inserts in sensor

<table>
<thead>
<tr>
<th>Electrode shape</th>
<th>Electrodes external ø d1</th>
<th>Electrode/insert spacing e3 = e1 + e2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type B</td>
<td>13</td>
<td>32</td>
</tr>
<tr>
<td>Type A</td>
<td>13</td>
<td>x</td>
</tr>
<tr>
<td>Type C</td>
<td>13</td>
<td>x</td>
</tr>
<tr>
<td>Type F</td>
<td>13</td>
<td>x</td>
</tr>
</tbody>
</table>

### Notes

- Electrode/insert spacing with two identical electrode caps and electrode inserts in sensor: e3(*) = e1 + e2 (where e1 = e2)
- Worked example of electrode/insert spacing with two different electrode caps and/or electrode inserts in sensor:
  - Top electrode insert Type 9426B25 with electrode Type B (d1 ø 16 mm)
  - Bottom electrode insert Type 9426B27 with electrode (round) Type F (d1 ø 16 mm)

### Table

<table>
<thead>
<tr>
<th>Electrode/Insert Spacing</th>
<th>F ≤5 kN</th>
<th>F = 0 ... 10 kN</th>
<th>F ≤45 kN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor Electrode Insert</td>
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<td></td>
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</tr>
<tr>
<td>Type 9426B27</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Type 9426B25</td>
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</tr>
<tr>
<td>Type 9426B29</td>
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</tr>
<tr>
<td>Type 9426B10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type 9426B20</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electrode/insert spacing e3 = e1 + e2 between two identical electrode caps (e1 = e2) and electrode inserts in sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
</tr>
<tr>
<td>13</td>
</tr>
<tr>
<td>16</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>13</td>
</tr>
<tr>
<td>16</td>
</tr>
<tr>
<td>20</td>
</tr>
</tbody>
</table>

![Fig. 4: Electrode/insert spacing between two electrode caps](image)
**System Versions**

**Measuring System for Mobile Application**
The welding force calibration transmitter Type 9831C... combined with the welding force measuring system in a case Type 9831C0001 (available as an option) provides a complete measuring system, which is primarily intended for mobile data acquisition of electrode closing forces using the Welding & Fastening Monitor Type 5825A2.

**Main Characteristics of Welding & Fastening Monitor Type 5825A2**
- Supply and control of the integrated charge amplifier of the welding force sensor
- Storage of up to 100 welding cycle evaluations
- RS-232C interface
- Analog signal outputs for electrode force and welding voltage
- Automatic measuring range detection of the sensor
- Connection for external trigger signal

**Welding Force Measuring System, Stationary**
The welding force sensor Type 9831C... can also be used in a stationary system, e.g. at a fixed location or on a robotic system. For this purpose, the plastic handgrip is simply pulled off and the sensor could be mounted at the tubular charge amplifier housing in a suitable holder.
Explanation of Measurands

- $F_{\text{Inst}}$: Instantaneous value of the welding force $F$ (not stored).
- $F_{\max}$: Maximum electrode force over the entire measuring time $t_{\text{meas}}$ ($F_{\max}$ selectable with peak value or instantaneous value display).
- $F_{\text{won}}$: Electrode force at welding voltage turn on.
- $F_{\text{woff}}$: Electrode force at welding voltage turn off.
- $F_{\text{wav}}$: Mean value of the electrode force during the welding process (application of welding voltage).
- $xx\%F_{\text{wav}}$: $xx\%$ of $F_{\text{wav}}$ (calculated value); recommended set point for the start of the welding process (default value: $xx\%F_{\text{wav}} = 90\%$; $xx$ adjustable from 50 … 95%).
- $F_{\text{wmin}}$: Minimum electrode force during the welding process.
- $F_{\text{wmax}}$: Maximum electrode force during the welding process.
- $F_{\text{wend}}$: Force at the end of total measuring time.

**Fig. 5: Start of welding time late (dt is negative)**

- $td$: Time from the start of the measurement (reaching the set trigger level or external trigger pulse) until $xx\%F_{\text{wav}}$ (calculated value) is reached.
- $dt$: Time difference between reaching $xx\%F_{\text{wav}}$ until the start of the welding process (calculated value); this time should be as short as possible.
- $-dt$: Welding voltage reached late (delayed by time $dt$), i.e. after reaching the $xx\%F_{\text{wav}}$ threshold.
  - Action: Shorten the squeeze time in the welding control unit by time $dt$.
- $+dt$: Welding voltage reached prematurely by time $dt$, i.e. before reaching the $xx\%F_{\text{wav}}$ threshold.
  - Action: Extend the squeeze time in the welding control unit by time $dt$.

- $t_{\text{wv}}$: Duration of the welding process (weld signal); with impulse welding, this is the total time of the individual pulses without pauses.
- $t_{\text{won}}$: Time elapsed to welding voltage turn on (from reaching the trigger level or external trigger).
- $t_{\text{woff}}$: Time elapsed to welding voltage turn off (from reaching the trigger level or external trigger).
- $t_{\text{wse}}$: Total time of the welding process in impulse welding (total time of the individual pulses with pauses).
- $t_{\text{meas}}$: Total measuring time from reaching the trigger level or external trigger pulse.
Ordering Key
For Welding Force Calibration Transmitter without Measuring Case

Welding force calibration transmitter with plastic handgrip, equipped and calibrated with 2 electrode inserts*), incl. calibration certificate, without additional accessories according to the following ordering key:

<table>
<thead>
<tr>
<th>Range</th>
<th>Measuring range 5 kN</th>
<th>Measuring range 10 kN</th>
<th>Measuring range 45 kN*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

The equipment complement of the welding force calibration transmitter with the two electrode inserts can be individually selected.

**Equipment above**
- Type 9426825
- Type 9426820
- Type 9426829
- Type 9426827
- Type 9426810

**Equipment below**
- Type 9426825
- Type 9426820
- Type 9426829
- Type 9426827
- Type 9426810

Description of the available electrode inserts see page 4 et seqq.
Additional special inserts on request.

*) for 45 kN measuring range on both sides only available with electrode inserts Type 9426B20.

Ordering Example

Welding force calibration transmitter equipped and calibrated with 2 electrode inserts

Measuring range: 10 kN
Electrode insert above: Type 9426825
Electrode insert below: Type 9426825

Ordering Key
For Measuring Case without Welding Force Calibration Transmitter

Type 9831C0001

The welding force measuring case consists of:
1. Measuring case with foam inlay
2. Welding & Fastening Monitor (incl. power supply and 9 V battery)
3. Connecting cable, length = 1,5 m
4. Offset screwdriver for internal Torx
5. Countersunk screws ISO14581-M4x8-A4 (4 pcs.)
6. Calibration certificate

Type/Art. No.
- 3.070.281
- 5825A2
- 1500A35
- 5.210.434
- 6.150.120

The welding force measuring case consists of:
- Type 9831C

*Where Type 9831C indicates the order code for the calibration transmitter and the measuring case.

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Tel +41 52 224 11 11, Fax +41 52 224 14 14, info@kistler.com, www.kistler.com
Welding Force Calibration Transmitter – System for Measuring the Electrode Force in Spot Welding, Type 9831C...

Ordering Example
Welding Force Calibration Transmitter with Measuring Case Supplied as a Set

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 1</td>
<td>Welding force calibration transmitter</td>
<td>9831C211</td>
</tr>
<tr>
<td>Item 2</td>
<td>Welding force measuring case</td>
<td>9831C0001</td>
</tr>
<tr>
<td>Item 3</td>
<td>Welding force sensor included in measuring case</td>
<td>9999</td>
</tr>
</tbody>
</table>

Optional Accessories

- Connecting cable between welding force calibration transmitter Type 9831C... and Welding & Fastening Monitor Type 5825A2...:
  Length according to order: 1500A35sp
  \( L_{\text{min}} = 0.5 \text{ m} / L_{\text{max}} = 20 \text{ m} \)
- Connecting cable RS-232C, Length = 5 m: 1200A27
- Connecting cable for Type 5825A2... Length = 1,0 m: 1700A70
- Electrode inserts according to details on page 4: 9426B...