

# Operating Instructions

## VRZ 402, VRZ 403, VRZ 404 HEIDENHAIN Counters



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### 1. Items supplied

HEIDENHAIN counter VRZ 40X (type as ordered)  
Fuse 0.16A/slow-blow, incorporated (for 200 ... 240 V)  
Fuse 0.315A/slow-blow, in package (for 100 ... 140 V)  
Connector for "external operation", 12-pole (Ident-No. 228 56114),  
Connector for BCD-data output, 36-poles (Id.-No. 200732 03) (VRZ 402)  
Mains cable  
Operating instructions and certificate of inspection

### 2. Brief description – Outline

**Counters VRZ 402 ... 404** in conjunction with **gauges MT 12/25/60/101** constitute a HEIDENHAIN-METRO digital length measuring unit.

In addition to the gauges, other **HEIDENHAIN linear encoders** with 10 µm or 20 µm grating pitch (e. g. LID 300, LS 703/704, LS 403/404, ULS 300, etc.) as well as **HEIDENHAIN rotary encoders** with sinusoidal output signals are also suitable for connection.

The output signals of the gauges are amplified, interpolated within the counter and subsequently counted in accordance with the sign. The measured value is displayed via a seven-digit 7-segment digital display.

The counters are provided with the following **functions**:

	<b>VRZ 402</b>	<b>VRZ 403</b>	<b>VRZ 404</b>
Data output	BCD	V.24/RS-232-C	IEEE 488
Functions	Zero reset Datum set Reference mark evaluation REF mm/inch calculator selectable display step selectable counting direction Classifying with 2 limit values Minimum/Maximum acquisition Subtraction of Maximum and Minimum (difference) Display stop External operation Output for classifying state		

### 3. Notes

Counters VRZ 402 ... 404 correspond to protection class I of the German VDE provisions VDE 0411 and have been built and checked in accordance with DIN 57411 part 1/VDE 0411 part 1 "protective measures for electronic measuring units". In order to maintain this condition and to assure safe operation please adhere to the **notes and instructions** as contained herein.

### Maintenance

These instructions contain all details required for commissioning and operation of the counters. The units are maintenance-free. In the case of any fault or failure we recommend return of the counter to our works Traunreut or to your local supplier.

### Caution!

Do not engage or disengage any connectors whilst under power.

### Manufacturer's certificate

We hereby certify that the above unit is radioshielded in accordance with the German official register decree 1046/1984. The German postal authorities have been notified of the issuance of this unit and have been granted admission for examination of the series regarding compliance with the regulations.

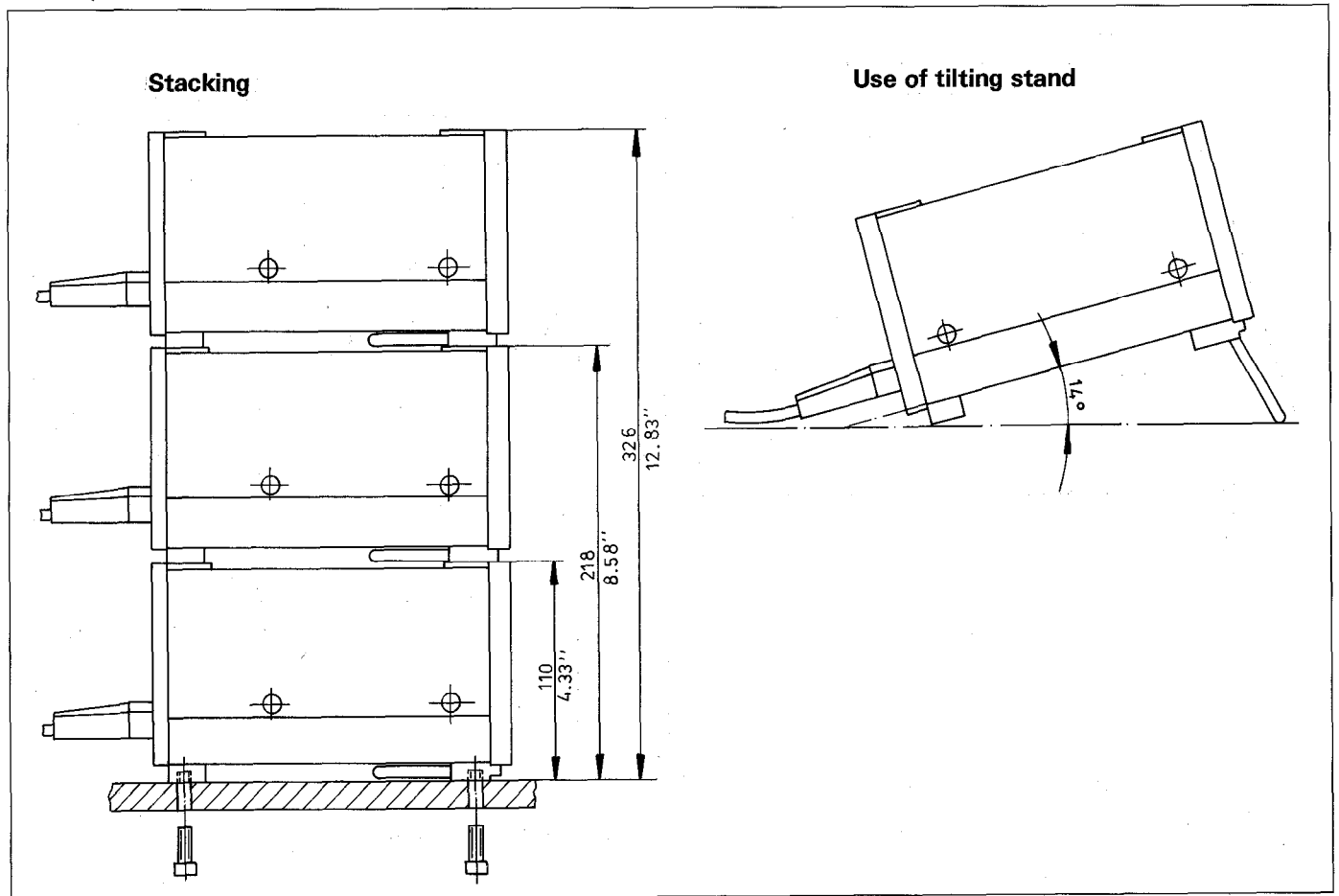
Information:

If the unit is incorporated by the user into an installation then the complete installation must comply with the above requirements.

#### 4. Installation of counter

The counter is designed as a desk-top unit.

For easier readings it can be tilted by approx.  $14^\circ$  by means of a collapsible stand. The feet of the unit are provided with M5 tapped holes for fixing to a base plate. Several counters can be **stacked** by simply putting one on top of the other. Slipping of stacked counters is prevented by the housing rim as well as by small protrusions in the housing cover.

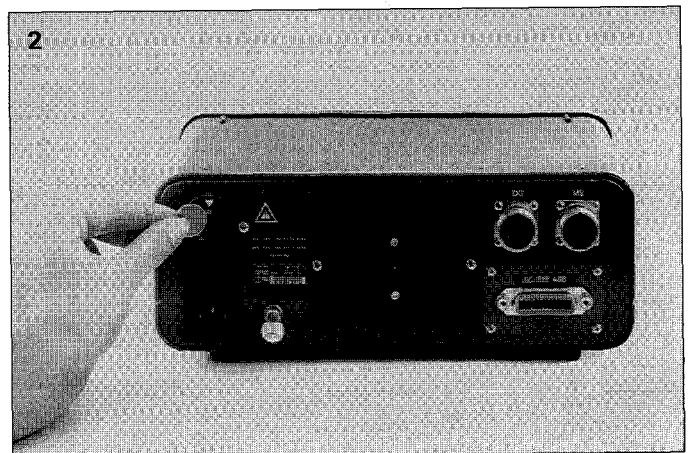
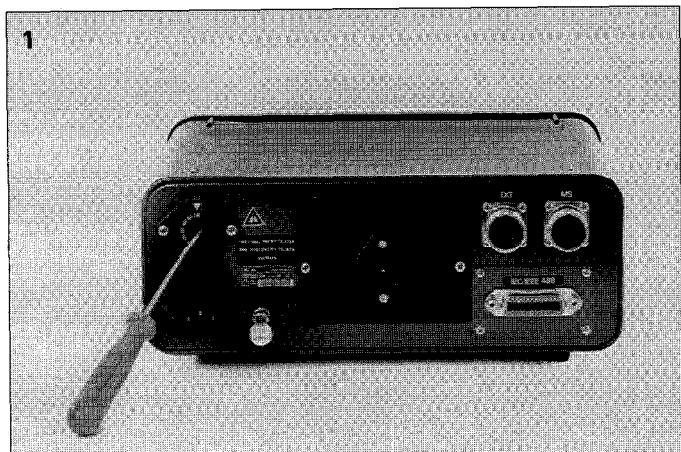


#### 5. Selection of mains voltage

Counters VRZ 40X are set to 220 V operation when supplied. This may be changed to 100, 120, 200, 240 V as follows: Remove mains fuse holder (Fig. 1) and set voltage selector to the required rating by means of a coin (Fig. 2). Replace mains fuse holder with correct fuse.

Fuse for 200 ... 240 V 0.16 A slow-blow

Fuse for 100 ... 140 V 0.315 A slow-blow



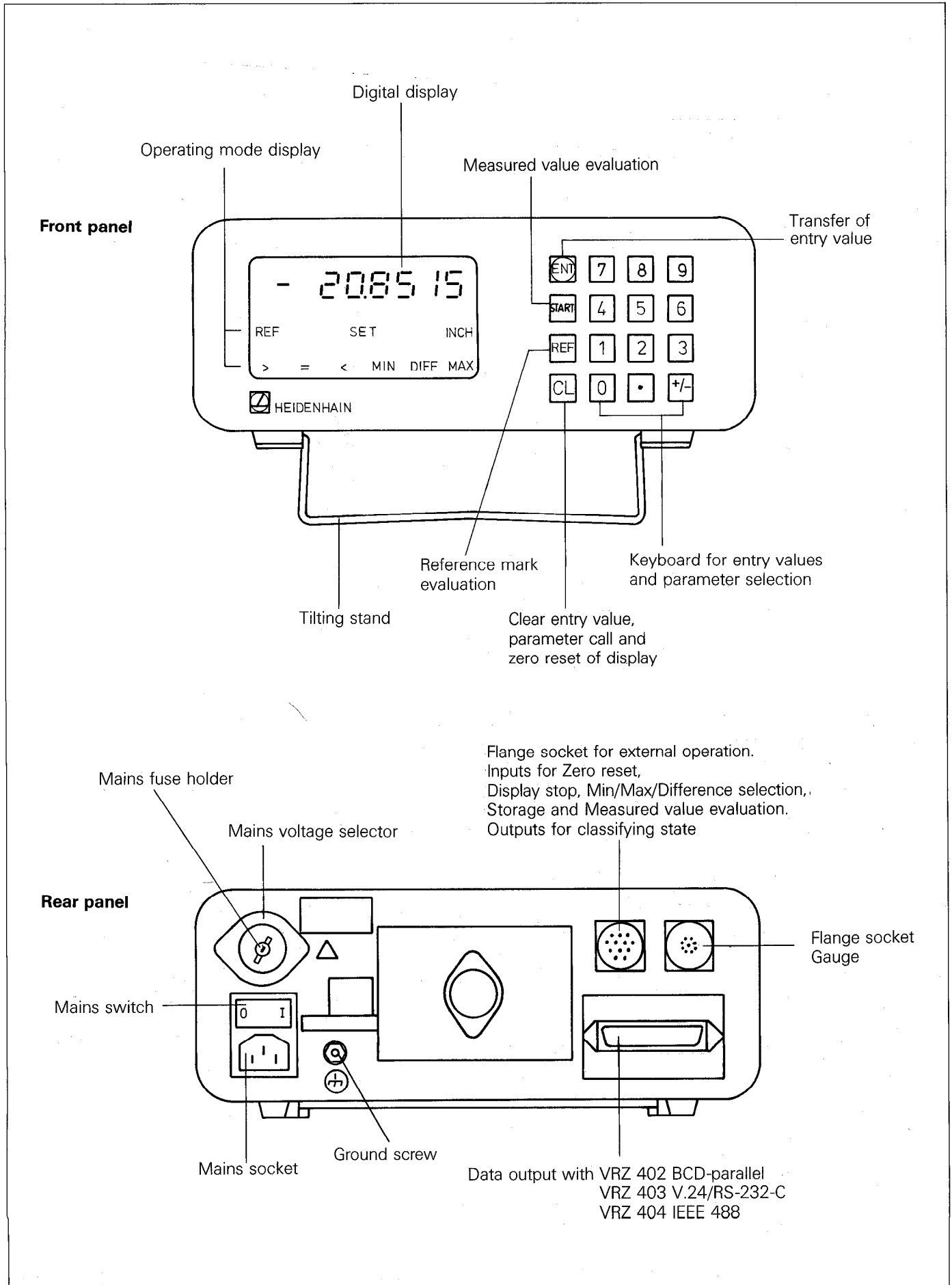
##### 5.1

#### Ground screw

To ensure error free operation when using the external operation connector the ground screw should be connected to the ground of the external unit.

## 6. Starting procedure

### 6.1 Controls



## 6.2

### Switch-on of counter

The digital display flashes after switch-on (mains switch at counter rear). This signals that the displayed value does not correspond to the last selected datum value due to the preceding power interruption.

- With **initial activation** the flashing of the display can be cancelled by pressing the **REF**-key twice. The counter is now ready for setting the operating mode (see item 6.3).
- With any **further activation** press **REF**-key once. The digital display illuminates; flashing of the **REF** display field requests traversing the reference mark of the encoder for retrieval of the last selected correlation between encoder position and display value (see item 7.3.2). If this correlation is effected via zero reset or datum set after probing of a mechanical limit stop (reference surface), the **REF**-key is to be pressed twice (see 7.3.3).

## 6.3

### Setup functions

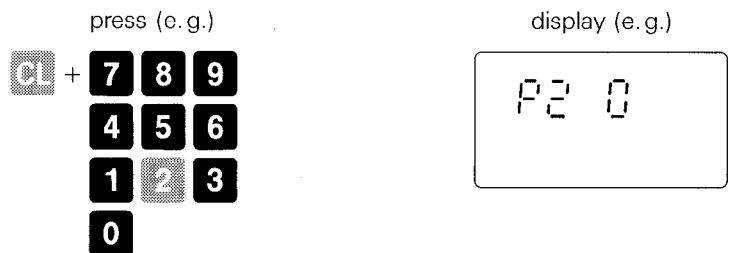
VRZ 40X is provided with a number of selectable functions (see tables as of page 6). The required operating mode is determined by entry of parameter values.

#### 6.3.1

##### Parameter-entry

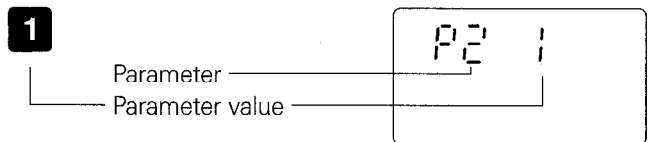
###### Parameter call-up

Simultaneous pressing of **CL** and of the number of the selected parameter. The parameter value last entered is displayed.



###### Enter parameter value

Enter value for required operating mode.



###### Storing parameter value

By pressing **ENT** the selected parameter value is stored. The required operating mode is now set.



**Non-volatile** storage of entered parameter values. When resuming operation the counter operates in the last entered mode.

### 6.3.2

#### Parameter Overview

**Caution!** Different functions are allocated to certain parameters for the various counters. The functions are described in detail under 6.3.3

### 6.3.2.1

#### VRZ 402



Keys	Function	Parameter	Entry value																													
<b>CL</b> + <b>0</b>	Level of sign at BCD output	P0	<b>0</b> negative sign at data interface $\hat{=}$ LOW level <b>1</b> negative sign at data interface $\hat{=}$ HIGH level																													
<b>CL</b> + <b>1</b>	Counting direction	P1	<b>0</b> positive counting mode with <b>retracting</b> plunger <b>1</b> positive counting mode with <b>extending</b> plunger																													
<b>CL</b> + <b>2</b>	mm/inch conversion	P2	<b>0</b> display in mm <b>1</b> display in inch (INCH lights up)																													
<b>CL</b> + <b>3</b>	Display step	P3	<table border="1"> <thead> <tr> <th></th> <th>display in mm</th> <th>display in inch</th> <th>Parameter P4</th> </tr> </thead> <tbody> <tr> <td><b>0</b></td> <td>X.XXX5 X.XX1</td> <td>X.XXXX2 X.XXXX5</td> <td>0 1</td> </tr> <tr> <td><b>1</b></td> <td>X.XX1</td> <td>X.XXXX5</td> <td>0</td> </tr> </tbody> </table>		display in mm	display in inch	Parameter P4	<b>0</b>	X.XXX5 X.XX1	X.XXXX2 X.XXXX5	0 1	<b>1</b>	X.XX1	X.XXXX5	0																	
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<b>1</b>	X.XX1	X.XXXX5	0																													
<b>CL</b> + <b>4</b>	Grating period	P4	<b>0</b> for encoders with 10 $\mu$ m grating period <b>1</b> for encoders with 20 $\mu$ m grating period																													
<b>CL</b> + <b>5</b>	Blinking display – function of the <b>CL</b> key	P5	<table border="1"> <thead> <tr> <th rowspan="2">Function of the <b>CL</b> key</th> <th colspan="2">Display blinks after</th> </tr> <tr> <th>switch-on</th> <th>fault</th> </tr> </thead> <tbody> <tr> <td><b>0</b> clears the display and recalls the previous value</td> <td>● yes</td> <td>● yes</td> </tr> <tr> <td><b>1</b> sets the display to "0"</td> <td>● yes</td> <td>● yes</td> </tr> <tr> <td><b>2</b> clears the display and recalls the previous value</td> <td>● yes</td> <td>○ no</td> </tr> <tr> <td><b>3</b> sets the display to "0"</td> <td>● yes</td> <td>○ no</td> </tr> <tr> <td><b>4</b> clears the display and recalls the previous value</td> <td>○ no</td> <td>● yes</td> </tr> <tr> <td><b>5</b> sets the display to "0"</td> <td>○ no</td> <td>● yes</td> </tr> <tr> <td><b>6</b> clears the display and recalls the previous value</td> <td>○ no</td> <td>○ no</td> </tr> <tr> <td><b>7</b> sets the display to "0"</td> <td>○ no</td> <td>○ no</td> </tr> </tbody> </table>	Function of the <b>CL</b> key	Display blinks after		switch-on	fault	<b>0</b> clears the display and recalls the previous value	● yes	● yes	<b>1</b> sets the display to "0"	● yes	● yes	<b>2</b> clears the display and recalls the previous value	● yes	○ no	<b>3</b> sets the display to "0"	● yes	○ no	<b>4</b> clears the display and recalls the previous value	○ no	● yes	<b>5</b> sets the display to "0"	○ no	● yes	<b>6</b> clears the display and recalls the previous value	○ no	○ no	<b>7</b> sets the display to "0"	○ no	○ no
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<b>CL</b> + <b>7</b>	Operating mode	P7	<b>0</b> display of nominal value (normal counter operation) <b>1</b> display of smallest value (minimum) of a measurement series, after pressing <b>START</b> ( <b>MIN</b> lights up) <b>2</b> display of largest value (maximum) of a measurement series, after pressing <b>START</b> ( <b>MAX</b> lights up) <b>3</b> display of difference between max. and min. of a measurement series, after pressing <b>START</b> ( <b>DIFF</b> lights up) <b>4</b> display stop <b>5</b> classification (enter limit values in param. P8 and P9) <b>6</b> display stop/concurrent display <b>7</b> display stop until next storage command and classification (enter limit values in parameters P8 and P9) <b>8</b> display stop/concurrent display and classification (enter limit values in parameters P8 and P9)																													
<b>CL</b> + <b>8</b>	Lower limit value	P8	enter numerical value including sign; must be smaller than upper limit value																													
<b>CL</b> + <b>9</b>	Upper limit value	P9	enter numerical value including sign; must be larger than lower limit value																													

6.3.2.2  
VRZ 403



Keys	Function	Parameter	Entry value																													
<b>CL</b> + <b>0</b>	Outputs additional <b>line feeds</b> to the data interface between measuring values	P0	Enter number of additional line feeds																													
<b>CL</b> + <b>1</b>	<b>Counting direction</b>	P1	<b>0</b> positive counting mode with <b>retracting</b> plunger <b>1</b> positive counting mode with <b>extending</b> plunger																													
<b>CL</b> + <b>2</b>	<b>mm/inch conversion</b>	P2	<b>0</b> display in mm <b>1</b> display in inch (INCH lights up)																													
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<b>CL</b> + <b>6</b>	<b>Baud rate</b>	P6	<b>0</b> 110 baud <b>1</b> 150 baud <b>2</b> 300 baud <b>3</b> 600 baud <b>4</b> 1200 baud <b>5</b> 2400 baud																													
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<b>1</b>	X.XX1 X.X1 *	X.XXX5 X.XXX5	0 1																													
<b>CL</b> + <b>4</b>	Grating period	P4	<b>0</b> for encoders with 10 µm grating period <b>1</b> for encoders with 20 µm grating period																													
<b>CL</b> + <b>5</b>	Blinking display – function of the <b>CL</b> key	P5	<table border="1"> <thead> <tr> <th rowspan="2">Function of the <b>CL</b> key</th> <th colspan="2">Display blinks after</th> </tr> <tr> <th>switch-on</th> <th>fault</th> </tr> </thead> <tbody> <tr> <td><b>0</b> clears the display and recalls the previous value</td> <td><input type="radio"/> yes</td> <td><input type="radio"/> yes</td> </tr> <tr> <td><b>1</b> sets the display to "0"</td> <td><input type="radio"/> yes</td> <td><input type="radio"/> yes</td> </tr> <tr> <td><b>2</b> clears the display and recalls the previous value</td> <td><input type="radio"/> yes</td> <td><input type="radio"/> no</td> </tr> <tr> <td><b>3</b> sets the display to "0"</td> <td><input type="radio"/> yes</td> <td><input type="radio"/> no</td> </tr> <tr> <td><b>4</b> clears the display and recalls the previous value</td> <td><input type="radio"/> no</td> <td><input type="radio"/> yes</td> </tr> <tr> <td><b>5</b> sets the display to "0"</td> <td><input type="radio"/> no</td> <td><input type="radio"/> yes</td> </tr> <tr> <td><b>6</b> clears the display and recalls the previous value</td> <td><input type="radio"/> no</td> <td><input type="radio"/> no</td> </tr> <tr> <td><b>7</b> sets the display to "0"</td> <td><input type="radio"/> no</td> <td><input type="radio"/> no</td> </tr> </tbody> </table>	Function of the <b>CL</b> key	Display blinks after		switch-on	fault	<b>0</b> clears the display and recalls the previous value	<input type="radio"/> yes	<input type="radio"/> yes	<b>1</b> sets the display to "0"	<input type="radio"/> yes	<input type="radio"/> yes	<b>2</b> clears the display and recalls the previous value	<input type="radio"/> yes	<input type="radio"/> no	<b>3</b> sets the display to "0"	<input type="radio"/> yes	<input type="radio"/> no	<b>4</b> clears the display and recalls the previous value	<input type="radio"/> no	<input type="radio"/> yes	<b>5</b> sets the display to "0"	<input type="radio"/> no	<input type="radio"/> yes	<b>6</b> clears the display and recalls the previous value	<input type="radio"/> no	<input type="radio"/> no	<b>7</b> sets the display to "0"	<input type="radio"/> no	<input type="radio"/> no
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	switch-on	fault																														
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<b>1</b> sets the display to "0"	<input type="radio"/> yes	<input type="radio"/> yes																														
<b>2</b> clears the display and recalls the previous value	<input type="radio"/> yes	<input type="radio"/> no																														
<b>3</b> sets the display to "0"	<input type="radio"/> yes	<input type="radio"/> no																														
<b>4</b> clears the display and recalls the previous value	<input type="radio"/> no	<input type="radio"/> yes																														
<b>5</b> sets the display to "0"	<input type="radio"/> no	<input type="radio"/> yes																														
<b>6</b> clears the display and recalls the previous value	<input type="radio"/> no	<input type="radio"/> no																														
<b>7</b> sets the display to "0"	<input type="radio"/> no	<input type="radio"/> no																														
<b>CL</b> + <b>6</b>	Device address	P6	Enter the device address when connecting to an IEEE 488 bus. Entry values 0 to 30 possible																													
<b>CL</b> + <b>7</b>	Operating mode	P7	<b>0</b> display of nominal value (normal counter operation) <b>1</b> display of smallest value (minimum) of a measurement series, after pressing <b>START</b> ( <b>MIN</b> lights up) <b>2</b> display of largest value (maximum) of a measurement series, after pressing <b>START</b> ( <b>MAX</b> lights up) <b>3</b> display of difference between max. and min. of a measurement series, after pressing <b>START</b> ( <b>DIFF</b> lights up) <b>4</b> display stop <b>5</b> classification (enter limit values in param. P8 and P9) <b>6</b> display stop/concurrent display																													
<b>CL</b> + <b>8</b>	Lower limit value	P8	enter numerical value including sign; must be smaller than upper limit value																													
<b>CL</b> + <b>9</b>	Upper limit value	P9	enter numerical value including sign; must be larger than lower limit value																													

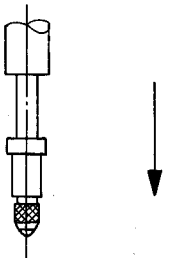
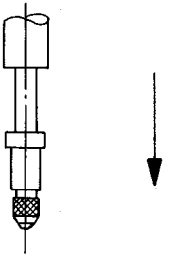
Store the selected parameter value with

\* only with rotary and angle encoders

**6.3.3 Functions/Operating modes**

**6.3.3.1 Counting direction**

The positive counting mode may be allocated either to the retracting or the extending plunger. Switch-over is effected via entry of parameter value P1.

Parameter	Parameter value	Plunger movement	Counting mode
P1	0		0.0010 mm 0.0005 mm 0.0000 mm - 0.0005 mm - 0.0010 mm
P1	1		- 0.0010 mm - 0.0005 mm 0.0000 mm 0.0005 mm 0.0010 mm etc.

**6.3.3.2 mm/inch display**

Optional display of measured value in either "mm" or "inch". Selection effected via value entry in parameter P2. This is also possible during measuring.

Parameter	Parameter value	Display	Unit
P2	0	25.4000	mm
P2	1	1.00000 <b>INCH</b> illuminates	inch

**6.3.3.3**  
**Display step with linear encoders and length gauges**

Measuring system	Signal period	Display step		Parameter setup	
		mm	inch	P3	P4
Metro length gauge ULS 300, LID 311, LID 351, LS 101, LS 405	10 µm	0.0005 0.001	0.00002 0.00005	0 1	0 0
LS 303, LS 603, LS 403, LS 406, LS 704, LS 107	20 µm	0.001	0.00005	0	1

**6.3.3.4**  
**Display step with rotary and angle encoders**

Rotary encoder	Line number	Display step	Parameter setup		
			P2	P3	P4
ROD 700/800 ERO 725/815	36000	0.0005° 0.001°	0 0	0 1	0 0
ROD 250/700 RON 255/705 ERO 725/815	18000	0.001°	0	0	1
ROD 450/456* MINIROD 450	1800*	0.01°*	0	1	1

\* only possible with VRZ 404

Rotary and angle encoders can also be used to determine lengths, travels and feedrates. For this purpose, the transmission ratio (rack/pinion), lead screw or friction wheel must be taken into account in addition to parameters P3 and P4.

### 6.3.3.5

#### Function of **CL**-key

Various functions can be assigned to the **CL**-key via parameter P1: Parameter call and clearing of the entry value or zeroing the display.

Parameter P1 also permits a deactivation of display blinking after interruption in power and/or switch-on or due to malfunction.

Parameter	Parameter value	Function of the CL key	Display blinks after	
			switch-on	fault
P5	0	clears the display and recalls the previous value	● yes	● yes
	1	sets the display to "0"	● yes	● yes
	2	clears the display and recalls the previous value	● yes	○ no
	3	sets the display to "0"	● yes	○ no
	4	clears the display and recalls the previous value	○ no	● yes
	5	sets the display to "0"	○ no	● yes
	6	clears the display and recalls the previous value	○ no	○ no
	7	sets the display to "0"	○ no	○ no

### 6.3.3.6

#### Operating mode Nominal value (NOM)/Maximum (MAX)/Minimum (MIN)/Difference (DIFF) display.

##### Measured value evaluation not started:

In this operating mode (parameter value P7 = 0/1/2/3/4) the counter display is simultaneous with each plunger position.

##### Measured value evaluation started:

From any number of measured values, the largest (Maximum) and the smallest (Minimum) value is determined and the difference then calculated.

These values can be transferred into the display in succession via parameter switch-over or external operation. After the next starting of the measured value evaluation a new maximum and minimum is determined.

The maximum and minimum acquisition is carried out every 520  $\mu$ s. Intermediate Maxima/Minima are not recognized. The test piece therefore must be moved at such a slow rate that the measured value change within the 520  $\mu$ s is smaller than the required accuracy, e.g. with a required accuracy of  $\pm 0.5 \mu$ m the maximum plunger movement must not exceed 1 mm/s.

##### Start of measured value evaluation:

The measured value evaluation is started either by pressing the Start-key or via external operation (see item 8) by TTL pulse trigger or make contact.

**Caution:** with started measured value evaluation the data output is delayed (see item 9 signal diagrams)

Measured value evaluation can be cleared by:

- mains off/on
- switching INT/EXT (see item 8.2)
- switching to operating mode classification or display stop
- IEEE bus commands DCL/SDC with VRZ 404

##### Selection of display:

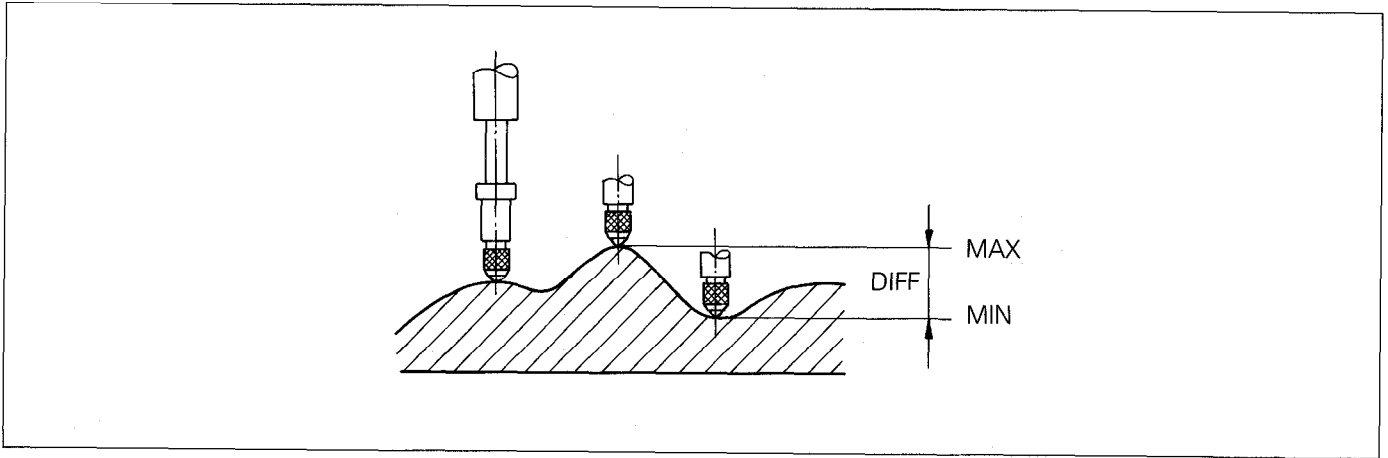
Selection between display of Nominal/Maximum/Minimum and Difference value is effected either by entry of the parameter value or via external operation by TTL pulse trigger (LOW level) or make contact (also see item 8.2).

Selection of display via	NOM	MIN	MAX	DIFF
entry of parameter value in Parameter P7	P7 = 0	P7 = 1	P7 = 2	P7 = 3
external operation (LOW level/0 V) at	PIN 1	PIN 1+ PIN 6	PIN 1+ PIN 8	PIN 1+ PIN 7

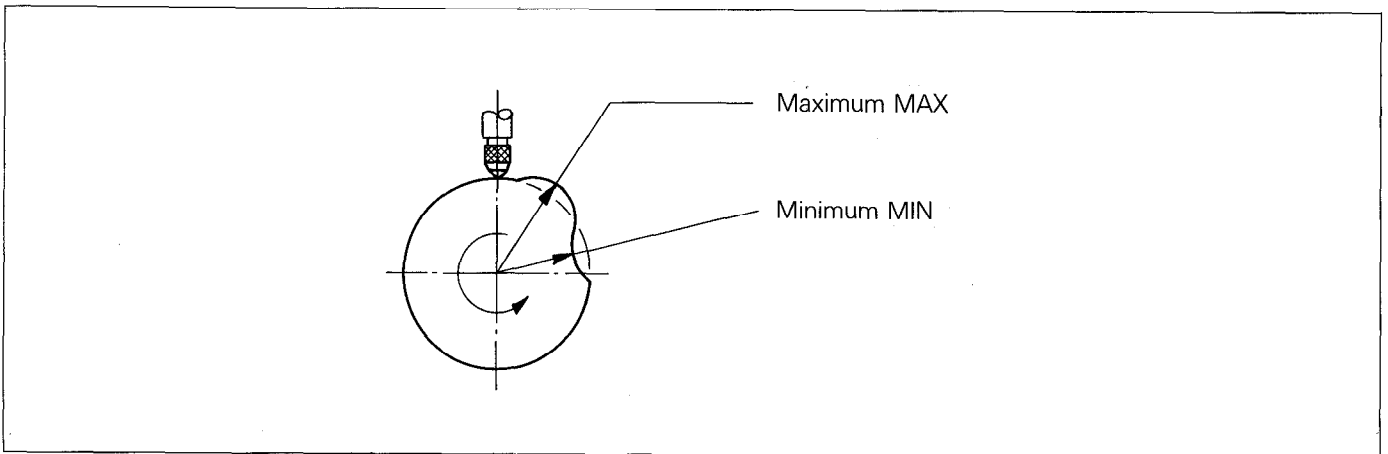
### Application examples

A random number of points may be probed on the measuring object. Subsequently, the Maximum (MAX), the Minimum (MIN) and the Difference between both values (DIFF) can be displayed and output.

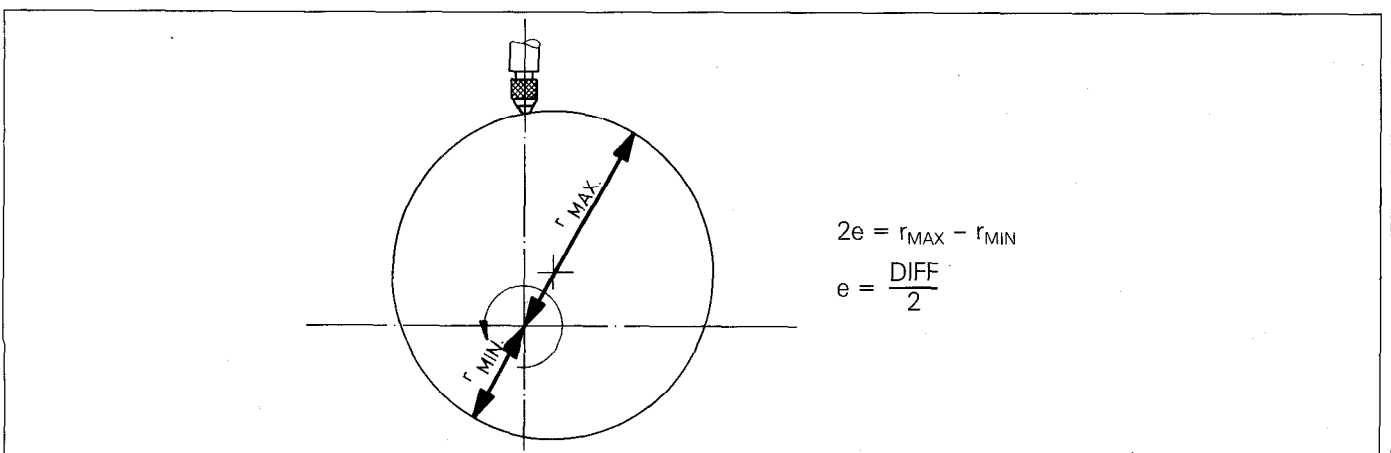
**Straightness**   
**Flatness** 



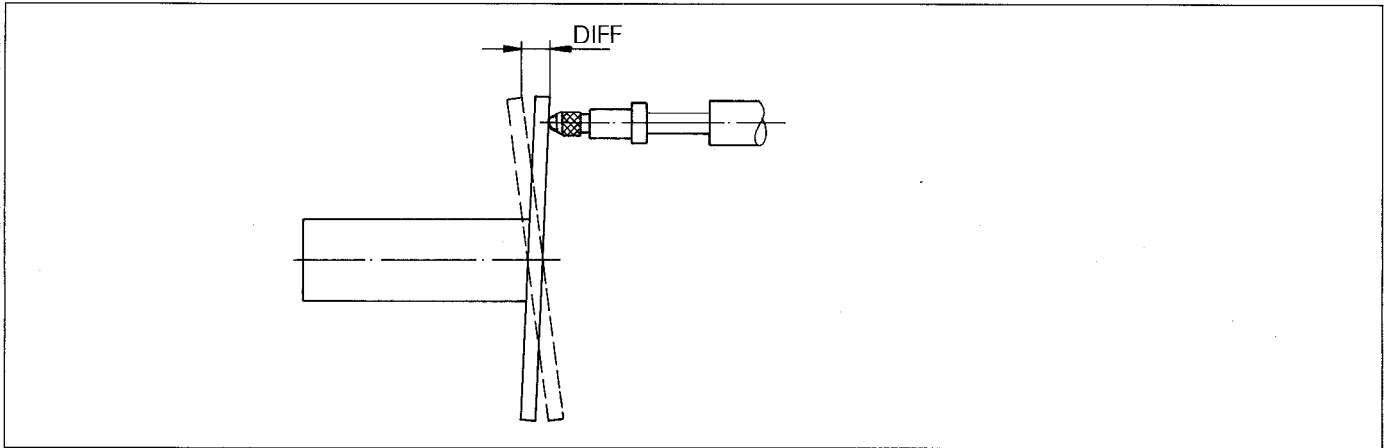
**Roundness** 



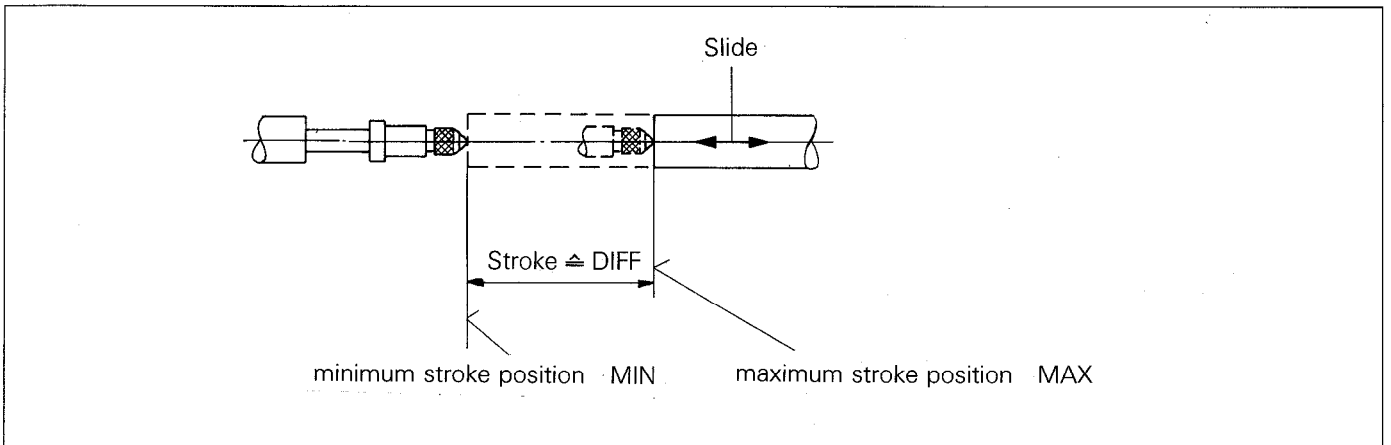
**Concetricity**   
**Eccentricity**



### Wobble

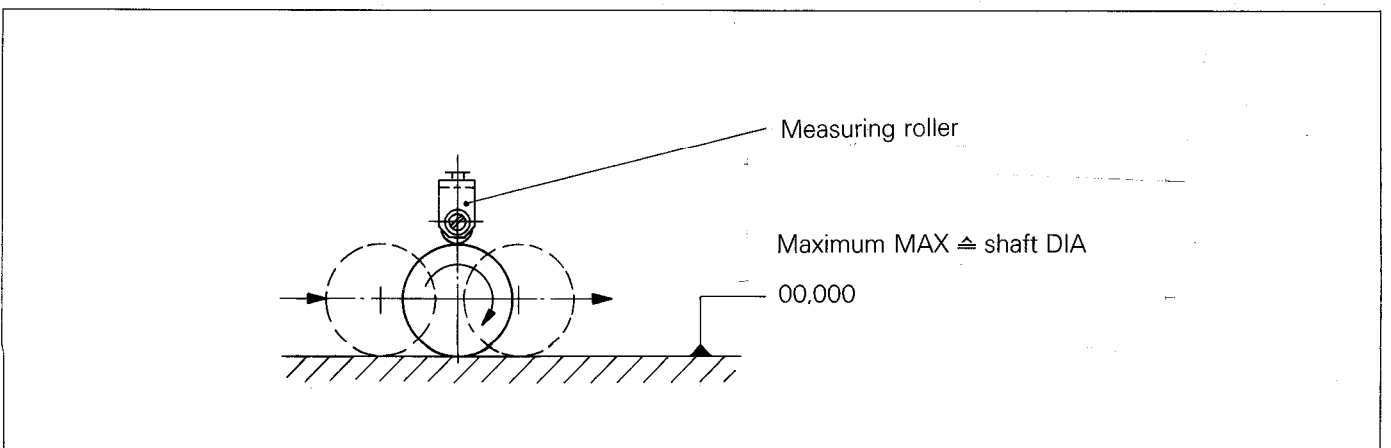


### Stroke measurement



### Shaft diameter measurement

When pushing the round test piece through, the display stops (without the usual back and forth trials) at the maximum value (operating mode Maximum display) which corresponds to the diameter.



### 6.3.3.7

#### Operating mode Display Stop

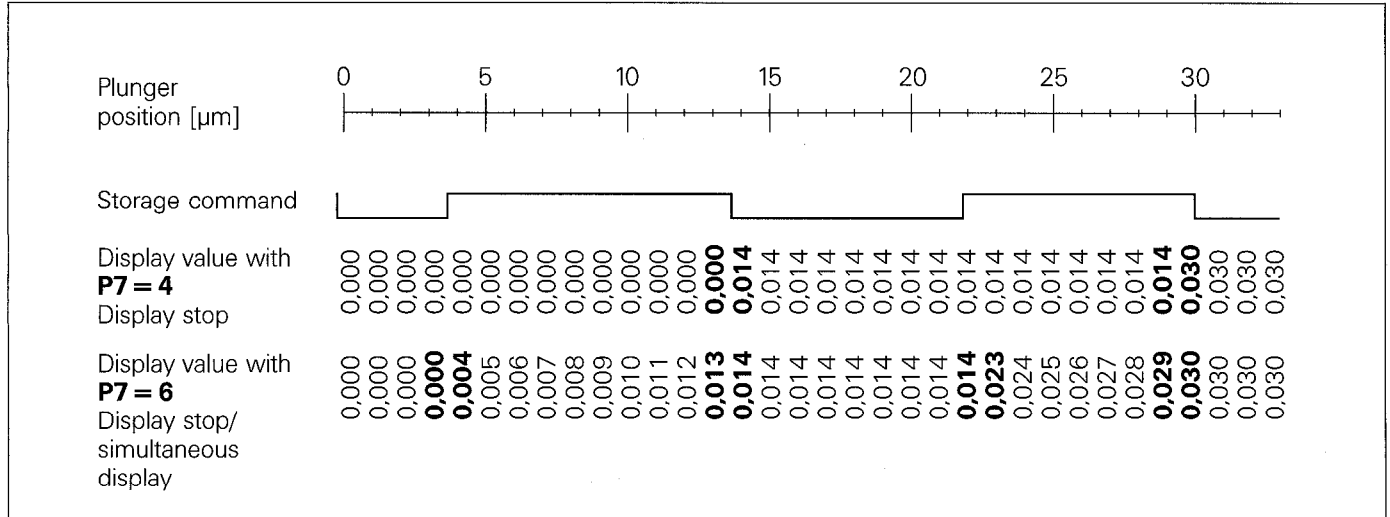
In operating modes Display Stop, the display may be stopped for any length of time. The internal counter continues operation. The Display Stop is activated by applying a storage command (see 8.3). Data output is initiated simultaneously.

#### Caution!

If no data are called up with counters VRZ 403 and VRZ 404 (e.g. no subsequent electronics unit connected), error message Error 2 is indicated (see item 10). This error message may be cleared by pressing **CL** until the counter is switched on once again.

#### Display stop

In operating mode Display Stop (Parameter P7 = 4), the display is always set to the updated measured value via a storage command. Display remains stopped until the next storage command updates the display once again. A clocked display can be realized via connection of an external clock generator.



#### Display Stop/concurrent display

If Parameter value P7 = 6 is entered, display is stopped for the duration of the storage command (see item 8.3). At the end of the storage command the display continues again with the updated measured value.

### 6.3.3.8

#### Operating mode Classification

In operating mode Classification (Parameter value P7 = 5) two limit values can be entered via Parameter P8 and P9.

Parameter	Description	Example 1	Example 2
P8	lower limit value	25.9920	- 14.0035
P9	upper limit value	26.0130	- 13.9955

The classifying state, i.e. whether the updated measured value falls within the stored limit values or exceeds these, is indicated via symbols and output via 2 lines (flange socket for external operation, see item 8).

The max. lag time between exceeding the preset limit values and the output of the corresponding signals at Pin 4/5 is for  
mm-display: 8 ms  
inch-display: 20 ms

Symbol	Output signal		Classifying state
	PIN 4	PIN 5	
=	HIGH-level	HIGH-level	Measured value within tolerance
<	HIGH-level	<b>LOW</b> -level	Measured value smaller than lower limit value
>	<b>LOW</b> -level	HIGH-level	Measured value larger than upper limit value

The levels of the output signals correspond to TTL (Low Power Schottky)

LOW-level: = 0.4 V at  $I_{\text{sink}} = 12 \text{ mA}$

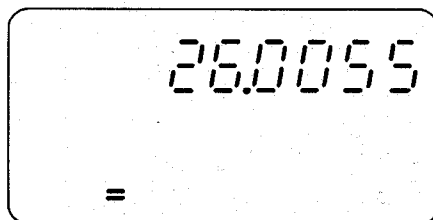
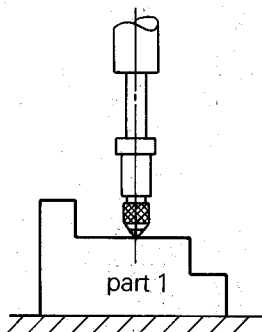
HIGH-level: = 2.4 V at  $I_{\text{source}} = -2.6 \text{ mA}$

Load capacity:  $I_{\text{sink}} = 12 \text{ mA}$   $I_{\text{source}} = -2.6 \text{ mA}$

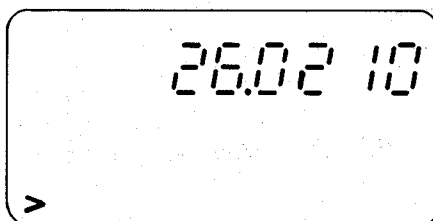
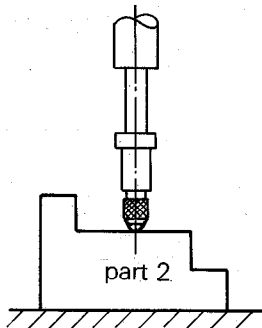
Application examples:  
Classifying/Sorting

Nominal dimension **26**  $+0.012$   
 $-0.008$  **1.0236**  $+ .0005''$   
 $- .0003''$

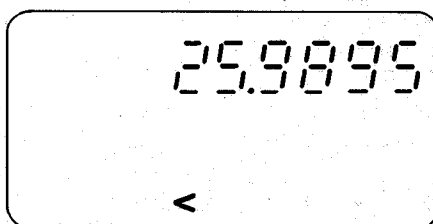
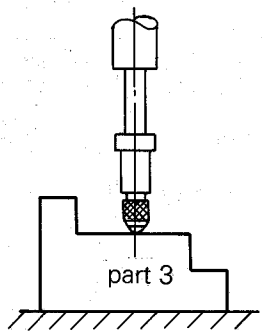
Actual dimension.



within tolerance  
(good)



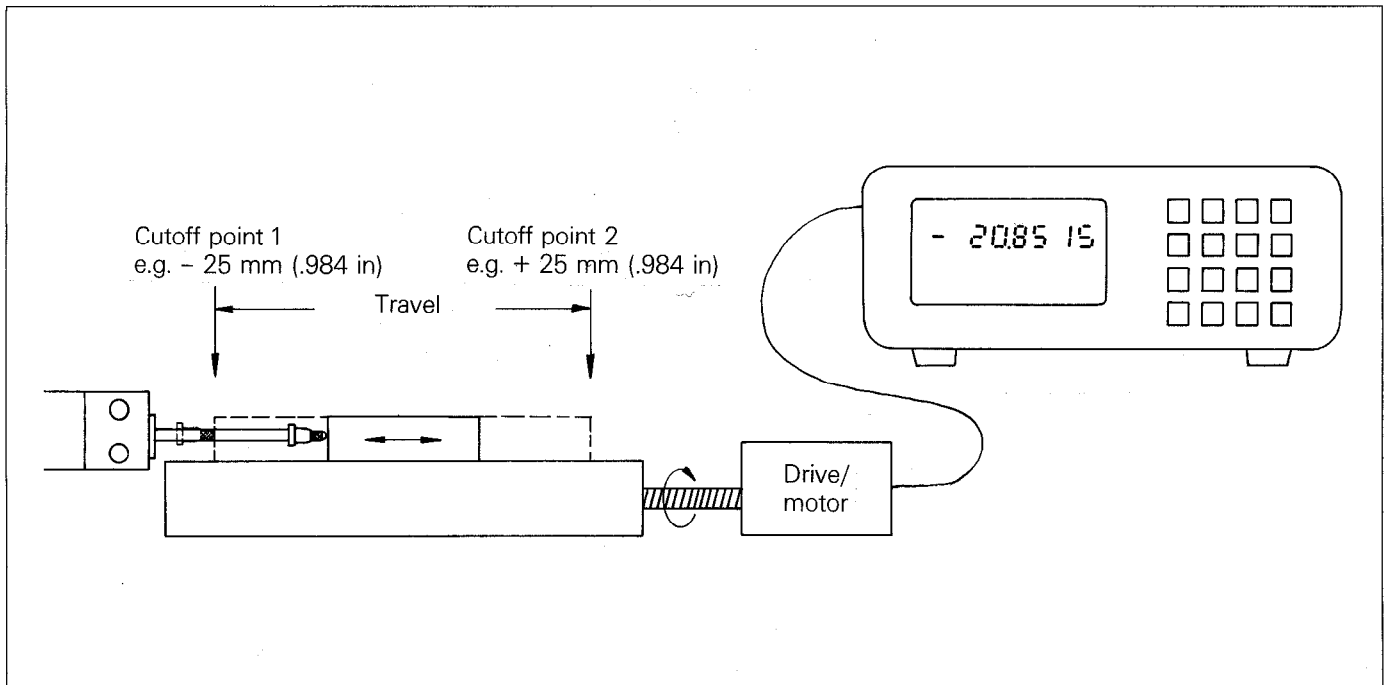
oversized  
(rework)



undersized  
(reject)

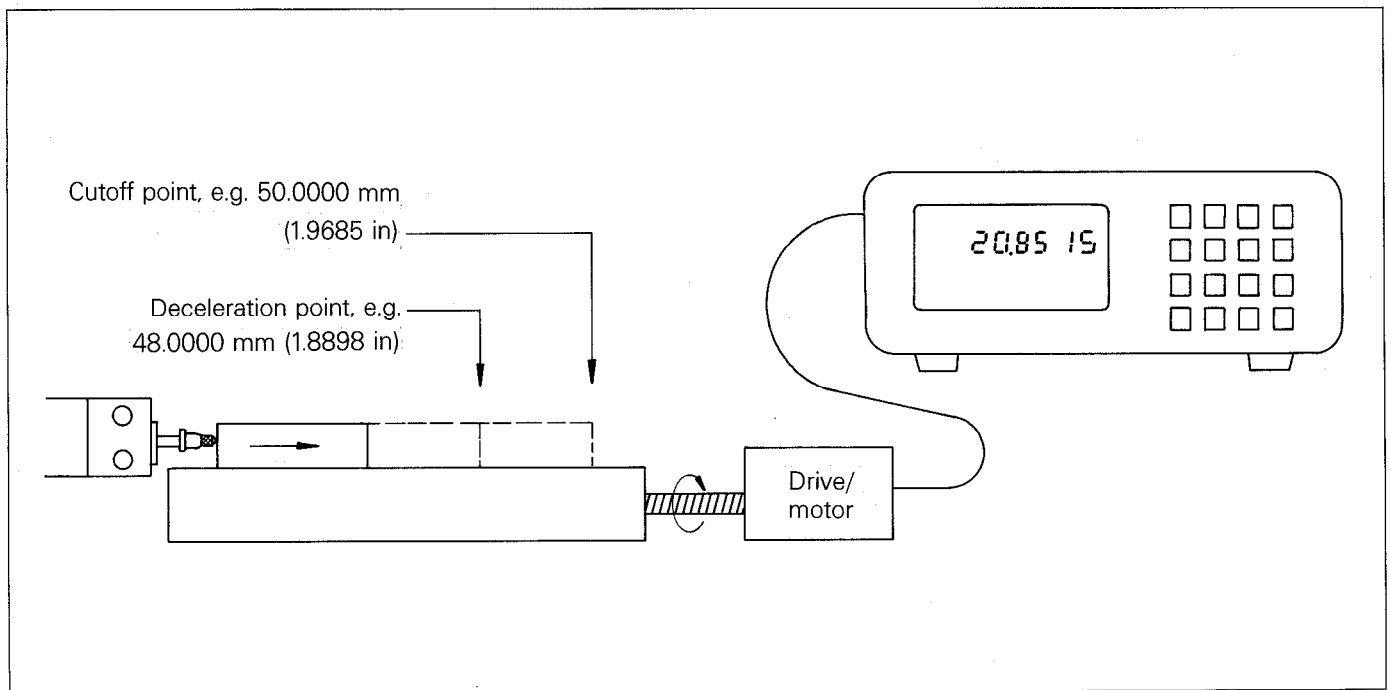


## Counter with 2 cutoff points



The gauge serves as linear encoder. The values of cutoff points 1 and 2 are to be entered into Parameter P8 and P9 of the counter in the correct correlation. Via a customer-specific control electronics unit the drive of the carriage is switched off upon reaching one of the cutoff points.

## Counter with deceleration point and cutoff point

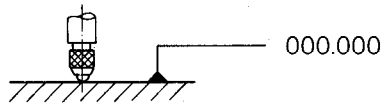


Feed rate is reduced upon reaching the deceleration point in order to assure safe stopping at the cutoff point.

## 7. Operation

### 7.1

#### Zero reset



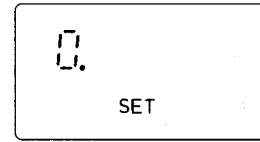
Counter can be reset to zero at any random location of the travel.

Press

**0**

0-key

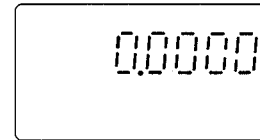
▶ SET on  
Zero appears on left of display.



**ENT**

Transfer key

▶ SET off  
Zero as datum appears on right of display.

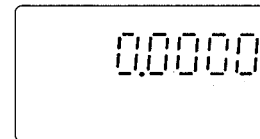


or, if Parameter P5 = 1/3/5/7 has been addressed.

**CL**

Clear key

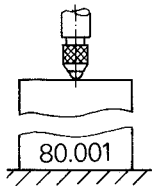
▶ Zero appears in display upon release of key.



Counters VRZ 402/403/404 may also be zeroed via external operation (see item 8). With VRZ 404 zeroing can also be effected via the IEEE bus.

### 7.2

#### Datum set



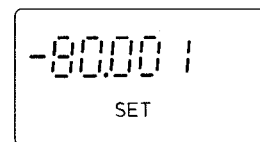
Any random number (e.g. the Nominal dimensions) can be set as reference datum (initial value).

Press

**7 8 9**  
**4 5 6**  
**1 2 3**

Enter datum  
e.g. 80.001 mm  
(3.150 in)

▶ SET on  
Value appears on left of display



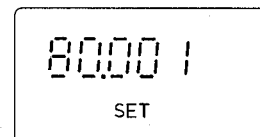
**0**

**CL**

Clear key for wrong entry

**+/-**

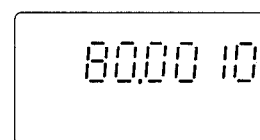
Entry of neg. sign after datum set, if reqd.



**ENT**

Transfer key

▶ SET off  
Datum value e.g. 80.001 mm (3.150 in) appears on right of display



The datum value is rounded off in accordance with selected display step and mm or inch display.

entered datum value (last decade)	transferred datum value (last decade) with display step			
	0.0005 mm	0.001 mm	0.00002 inch	0.00005 inch
0	0	0	0	0
1	0	1	0	0
2	0	2	2	0
3	0	3	2	0
4	0	4	4	0
5	5	5	4	5
6	5	6	6	5
7	5	7	6	5
8	5	8	8	5
9	5	9	8	5

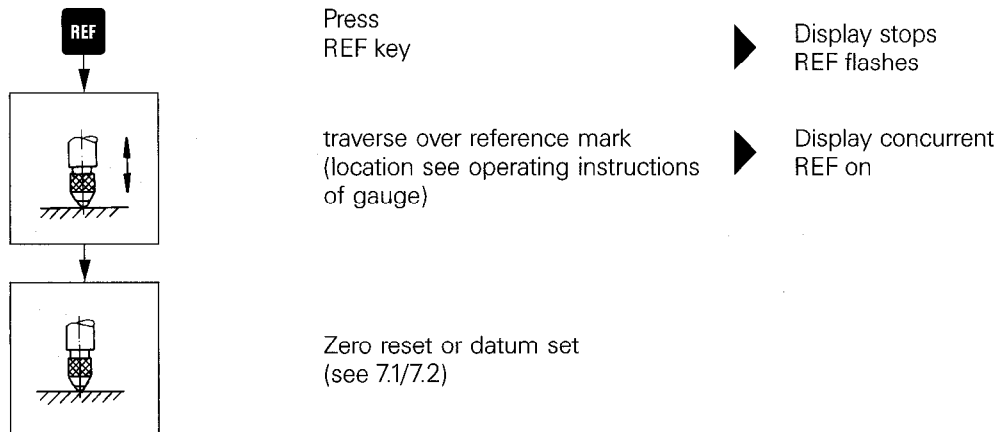
### 7.3

#### Reference mark evaluation REF

The correlation between plunger position and display value last effected by means of zeroing or datum set in function REF (REF illuminates), can be easily retrieved after power failure with the reference mark evaluation REF by passing over the gauge reference mark. The reference mark evaluation REF is not possible in operating modes Maximum, Minimum and Difference display (Parameter P7 = 1/2/3).

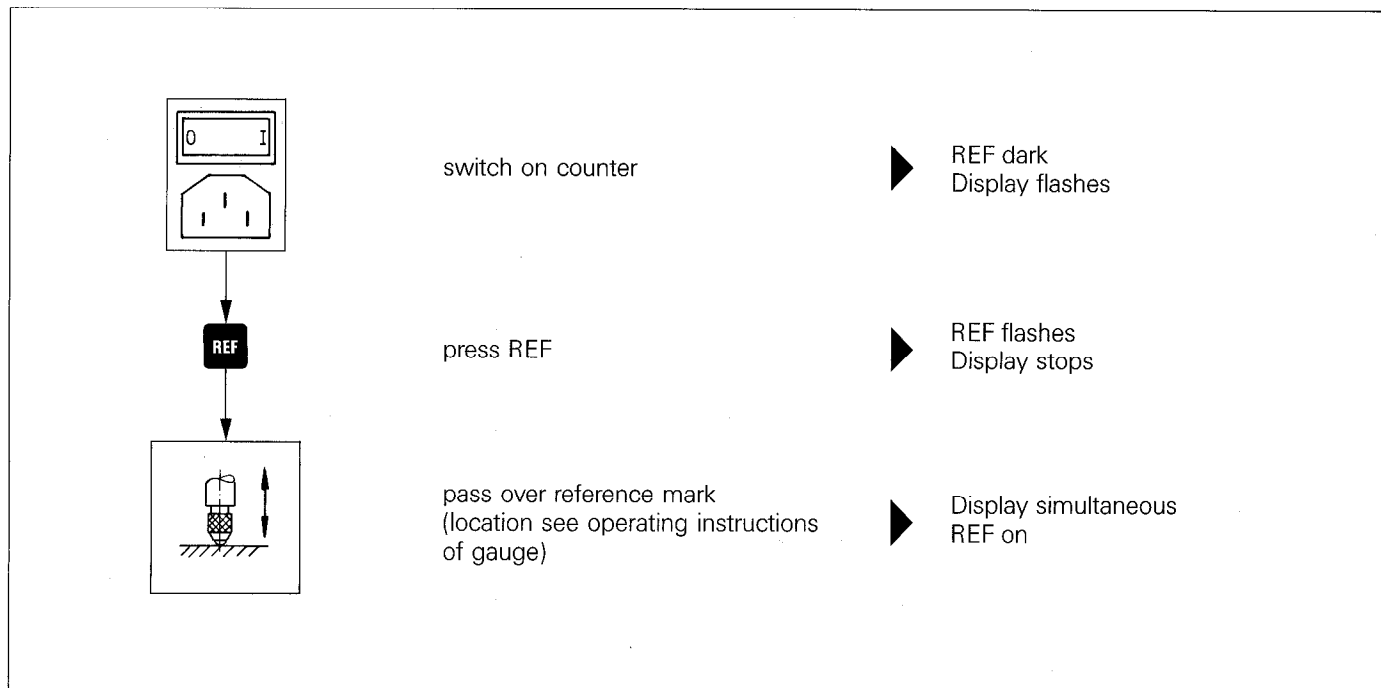
#### 7.3.1

##### Storage of datum point



### 7.3.2

#### Retrieval of correlation Plunger position/Display value



Display value is now referenced to the last datum set in REF operation.

### 7.3.3

#### Working without reference mark evaluation REF

Some applications provide a fixed mechanical limit stop as reference plane. In these cases the reference mark evaluation is not required. It can easily be disabled by pressing the REF-key **twice** after counter switch-on. The reference system can be retrieved by probing the measuring table surface, a master piece, and zeroing or datum set.

## 8. External operation/Outputs

The 12-pole flange socket at counter rear serves for external operation and for output of classifying signals.

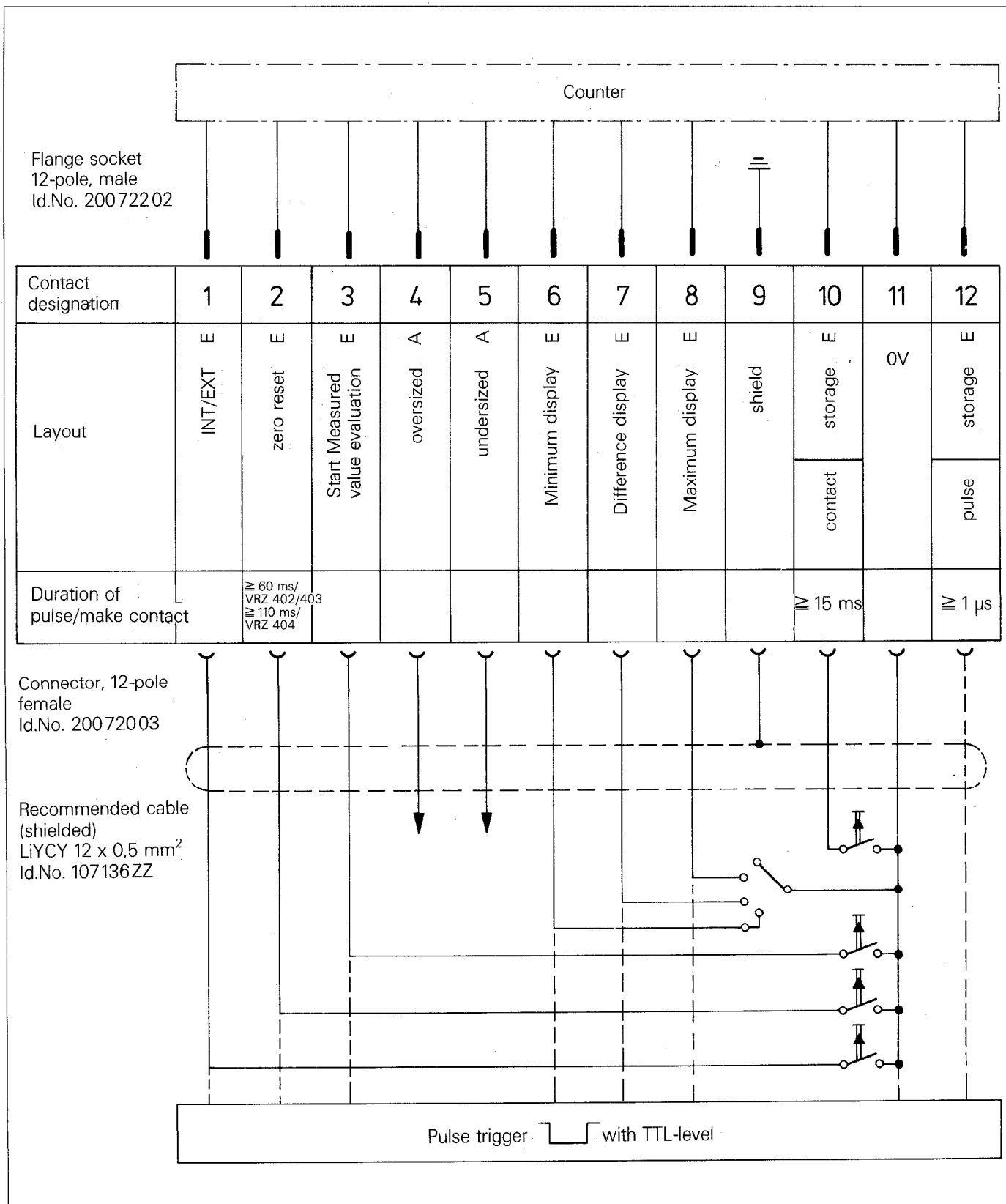
The following functions can be operated externally:

- Zero reset (see item 7.1)
- Display stop (see item 6.3.3.7)
- Storage/Data output (see item 8.3)
- Minimum display (see item 6.3.3.6)
- Maximum display (see item 6.3.3.6)
- Difference display (see item 6.3.3.6)
- Start Measured value evaluation (see item 6.3.3.6)

External operation is also possible via make contact or TTL pulse trigger. The connection cable must be shielded. A broad surface contact between connector and shield should be ensured.

In the following diagram, inputs of the counter are designated with "E", outputs with "A".

### 8.1 Connector layout



## 8.2

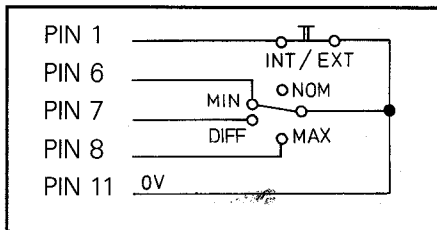
### External selection of NOM, MAX, MIN and DIFF

Display of Nominal value (NOM), Maximum (MAX), Minimum (MIN) or Difference (DIFF) can be selected via Parameter entry (Parameter value P7 = 0/1/2/3) or via external operation. Selection via external operation is only possible if the counter is set to one of those four operating modes. Via PIN 1 it is determined whether selection is effected via Parameter entry (INT) or external operation (EXT).

Input	Wiring	Designation
PIN 1	LOW-level/0V	External operation (EXT)
	HIGH-level/open	Parameter entry (INT)

With PIN 1 on LOW-level/0 V, display of NOM, MAX, MIN or DIFF value can be externally operated.

### Display selection with 4-step switch



### Display selection with TTL level

Function	PIN			
	1	6	7	8
Parameter entry INT possible	H	x	x	x
External operation INT possible				
Nominal value NOM	L	H	H	H
Minimum MIN	L	L	H	H
Maximum MAX	L	H	H	L
Difference DIFF	L	H	L	H

## 8.3

### Storage command

At PIN 10 and PIN 12 the storage commands can be entered via make contact or pulse trigger for activation of the data output.

In operating mode "Display stop" (Parameter value P7 = 4/6) the storage command is simultaneously used for "freezing" of the display and setting to updated measured value.

Connection	Function	Level	Duration
PIN 10	Storage via make contact	active LOW	≥ 15 ms
PIN 12	Storage via pulse trigger		≥ 1 μs

## 8.4

### Signal description of inputs and outputs

**Inputs** (PIN 1/2/3/6/7/8/10/12), LOW active

LOW-level  $U_{eL} \leq 0,4 \text{ V}$  at  $I_{\text{sink}} = 0,2 \text{ mA}$

HIGH-level  $U_{eH} \geq 2,7 \text{ V}$  at  $I_{\text{source}} = 20 \mu\text{A}$

**Outputs** (PIN 4/5) (TTL compatible)

LOW-level  $U_{oL} \leq 0,4 \text{ V}$

HIGH-level  $U_{oH} \geq 2,4 \text{ V}$

load capacity  $I_{aL} = 12 \text{ mA}$

$I_{aH} = -2,5 \text{ mA}$

### Note:

Inputs and outputs may only be connected to circuits with protective low voltage as per German standard VDE 0100/5.73 § 8.

## 9. Data output

The counters are provided with different data outputs:

- VRZ 402 BCD data output
- VRZ 403 V.24/RS-232-C-interface
- VRZ 404 IEEE 488-interface

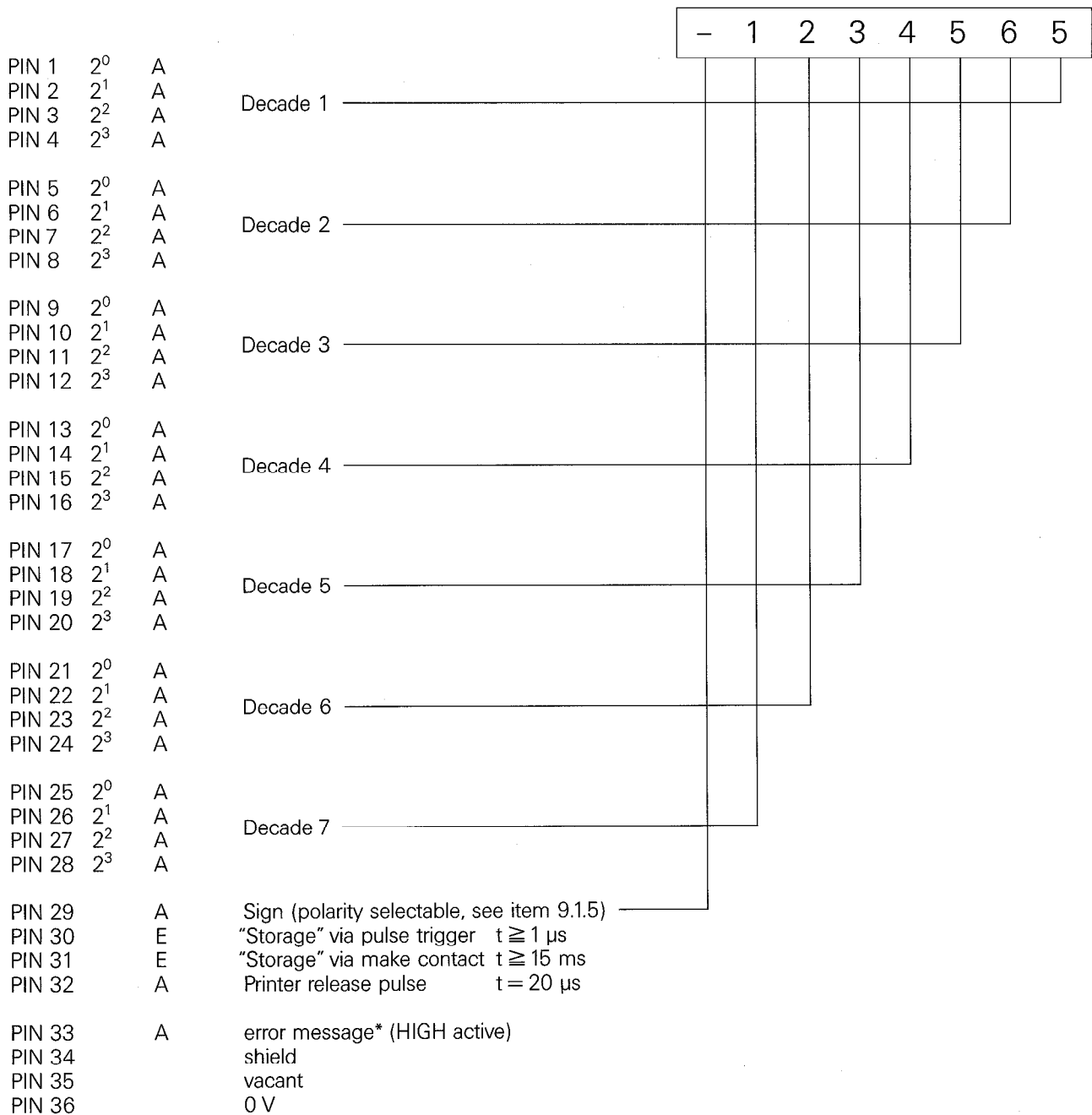
### 9.1

#### BCD-data output (VRZ 402)

Parallel data output in 8-4-2-1-BCD-Code (TTL-level) at 36-pole Amphenol-Tuchel-socket.

#### 9.1.1

##### Connector layout



\* in case of power interruption, contamination of scale, Error 1, character overflow, or if maximum input frequency was exceeded

### 9.1.2

#### Connection cable

A shielded cable is to be used for connection to the BCD-output (e.g. cable LiYCY 40 x 0.14 mm<sup>2</sup>, Id.-No. 202420 01). The max. cable length should not exceed 10 m (32.89 ft). The mating connector Id.-No. 200732 03 (Amphenol Tuchel 57-30360) is included in delivery.

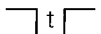
### 9.1.3

#### Signal description of inputs and outputs

**Inputs** (negative logic)

**Storage** via pulse trigger

TTL-level

  $t \geq 1 \mu\text{s}$

**Storage** via make contact

Make contact  $t \geq 15 \text{ ms}$

**Outputs** (TTL compatible)

Decade 1...7 and **sign** (positive logic)

LOW-level  $U_{aL} \leq 0,4 \text{ V}$  at  $I_{\text{sink}} = 12 \text{ mA}$  (max.)

HIGH-level  $U_{aH} \geq 2,4 \text{ V}$  at  $I_{\text{source}} = -2,6 \text{ mA}$  (max.)

**Printer release pulse/Error message:**

LOW-level  $U_{aL} \leq 0,4 \text{ V}$  at  $I_{\text{sink}} = 4 \text{ mA}$

HIGH-level  $U_{aH} \geq 2,4 \text{ V}$  at  $I_{\text{source}} = -0,4 \text{ mA}$

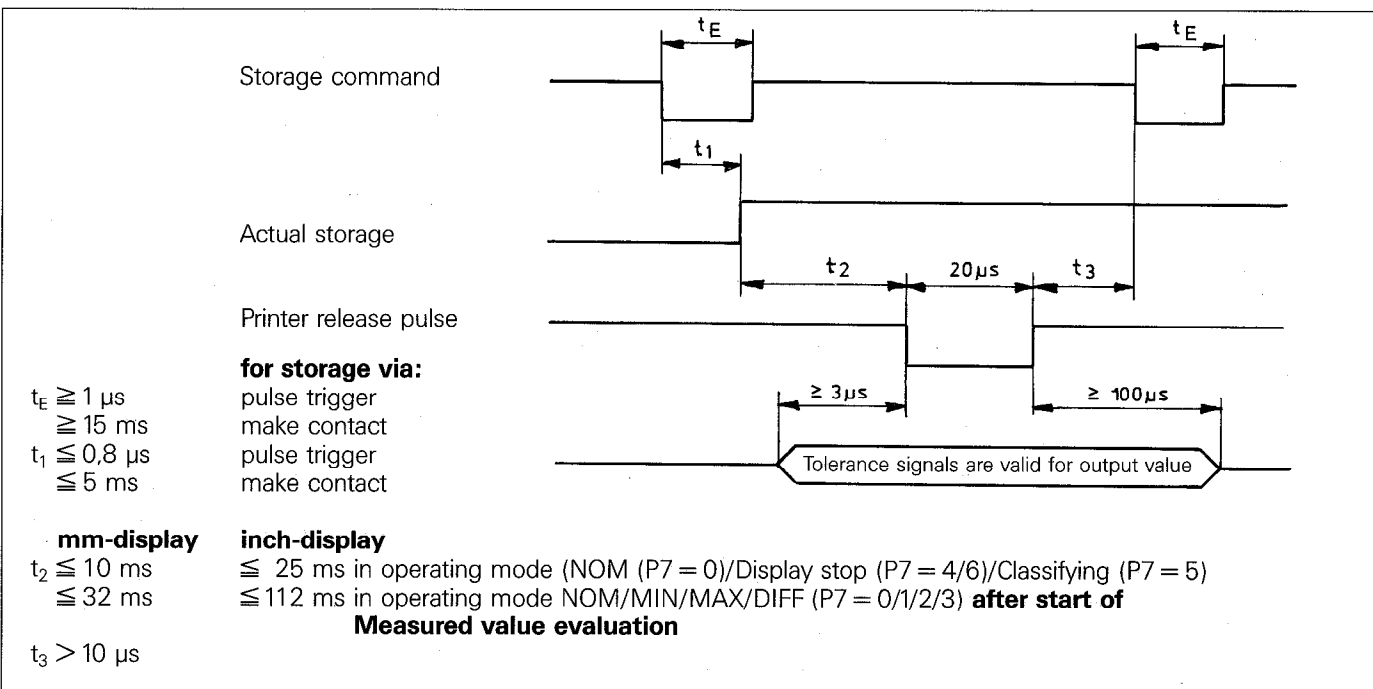
Load capacity  $I_{aL} = 8 \text{ mA}$   $I_{aH} = -0,4 \text{ mA}$

### 9.1.4

#### Data inquiry

Data output is parallel in 8-4-2-1-BCD-Code via incorporated intermediate memory. When applying a storage command (leading edge) via external operation or to the BCD data output, the updated display value (Nominal measured value, Minimum, Maximum or Difference) is transferred into the intermediate memory after a max. delay of  $t_1$ . After the data have been registered in this buffer memory, the VRZ 402 issues a printer release pulse (Ready-message). This pulse indicates counter at standby for data output to the subsequent electronics (printer, calculator etc.).

The printer release pulse has a fixed duration of  $20 \mu\text{s}$ . Even after expiration of this pulse the data are retained in the buffer memory until the next storage command. A new storage command can be entered immediately after the trailing edge of the printer release pulse.



### 9.1.5

#### Sign

The signal level corresponding to the negative sign can be converted via parameter entry.

Parameter	Parameter value	Sign	Level
P0	0	– (negative sign)	LOW-level
P0	1	– (negative sign)	HIGH-level



## 9.2

### V.24/RS-232-C-interface (VRZ 403)

VRZ 403 is provided with a standard interface "V.24" as per CCITT recommendation or RS-232-C as per EIA-Standard.

#### 9.2.1

##### Definition of V.24-interface

The following important criteria are provided because units with different signal levels, connector layouts etc. are on the market as „V.24-compatible systems“.

##### Voltage-compatible interface

The V.24 interface processes signals with voltage levels. Current interfaces (e. g. 20 mA) cannot be connected!

##### Signal designations and levels

Signal		Meaning
Data signals:	TXD* RXD*	Transmit Data Receive Data
Control signals:	DTR RTS	Data Terminal Ready Request to Send
Verification signals:	DSR CTS	Data Set Ready Clear to Send

Logic-level	Operating level
"1": - 3 V... - 15 V	- 5 V... - 15 V
"0": + 3 V... + 15 V	+ 5 V... + 15 V

\* Designations "TXD, RXD" are derived through negative level for "1".

##### Series data transfer

The V.24-interface of VRZ 403 transmits data in series. Units with parallel interfaces cannot be connected!

##### Transfer code

The code being used is ASCII with additional "Even parity bit". This corresponds to the ISO-Code with the following exceptions.

SXT: start of data transfer

DC3: interruption of data transfer

DC1: continuation of data transfer

#### 9.2.2

##### Transfer rate (baud-rate)

The baud-rate signifies the number of bits which can be transmitted every second. The V.24-interface of VRZ 403 permits the following baud rates: 110, 150, 300, 600, 1200, 2400.

Peripheral units must be able to process the selected baud-rate without limitations in order to prevent data transmission errors.

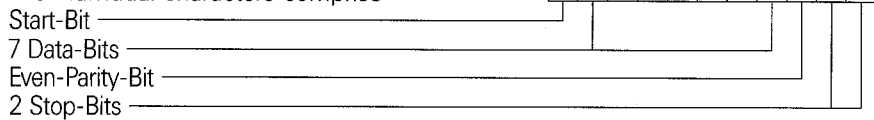
The baud-rate can be selected via Parameter entry.

Parameter	Parameter value	Baud-rate
P6	0	110 baud
P6	1	150 baud
P6	2	300 baud
P6	3	600 baud
P6	4	1200 baud
P6	5	2400 baud

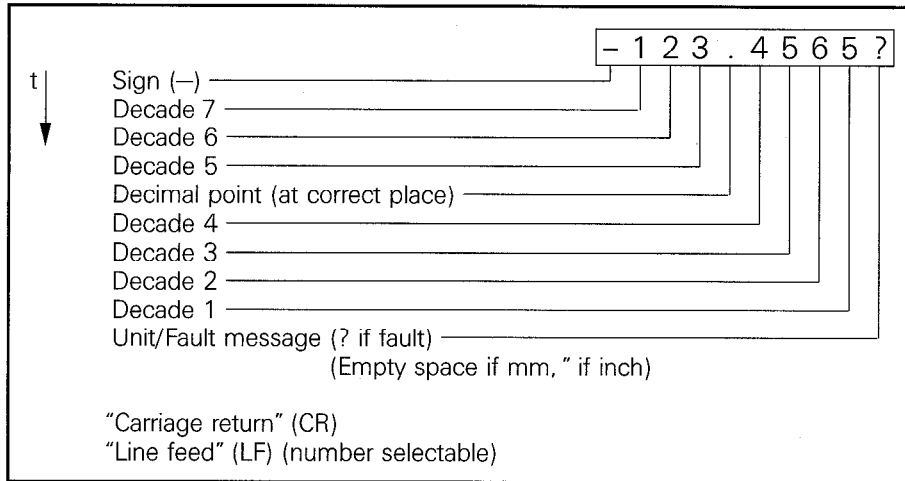
### 9.2.3

#### Data format

The individual characters comprise



#### Sequence of character output



The number of additional "line feed" commands (blank lines) is selectable between 0 and 99 via Parameter entry.

Parameter	Parameter value	Description
PO	x	x = number of additional blank lines LF
e. g. PO	1	one additional line feed between 2 printouts (2xLF)
PO	5	five additional line feeds between 2 printouts (6xLF)

### 9.2.4

#### Interruption of data transfer

With normal commercially available data receivers (e. g. printers) it is possible that data transfer has to be interrupted from time to time (e. g. printing procedure or "overflow" of character memory). Therefore, a signal is produced for interruption/continuation of data transfer. The technical features vary depending on the make.

##### a) Start/Stop signals via interface input RXD

The data receiver controls the VRZ 403 via the ASCII characters DC3 and DC1;

DC3 = XOFF = CTRL S: interruption of data transfer,

DC1 = XON = CTRL Q: continuation of data transfer.

Owing to the signal switching times, up to four characters can be transmitted after output of the Stop character DC3.

##### b) Start/Stop signals via the interface input CTS

In this case the data receiver converts the level of the verification input CTS of the transmitter interface, whereby the level depends on the make.

### 9.2.5

#### Data output

Data output is effected via a built-in intermediate (buffer) memory.

When a storage command is given (leading edge) via external operation or control character Control B (= STX) to the V.24/RS-232-C interface, the updated display value (Nominal measured value, Minimum, Maximum or Difference) is transferred to the intermediate memory.

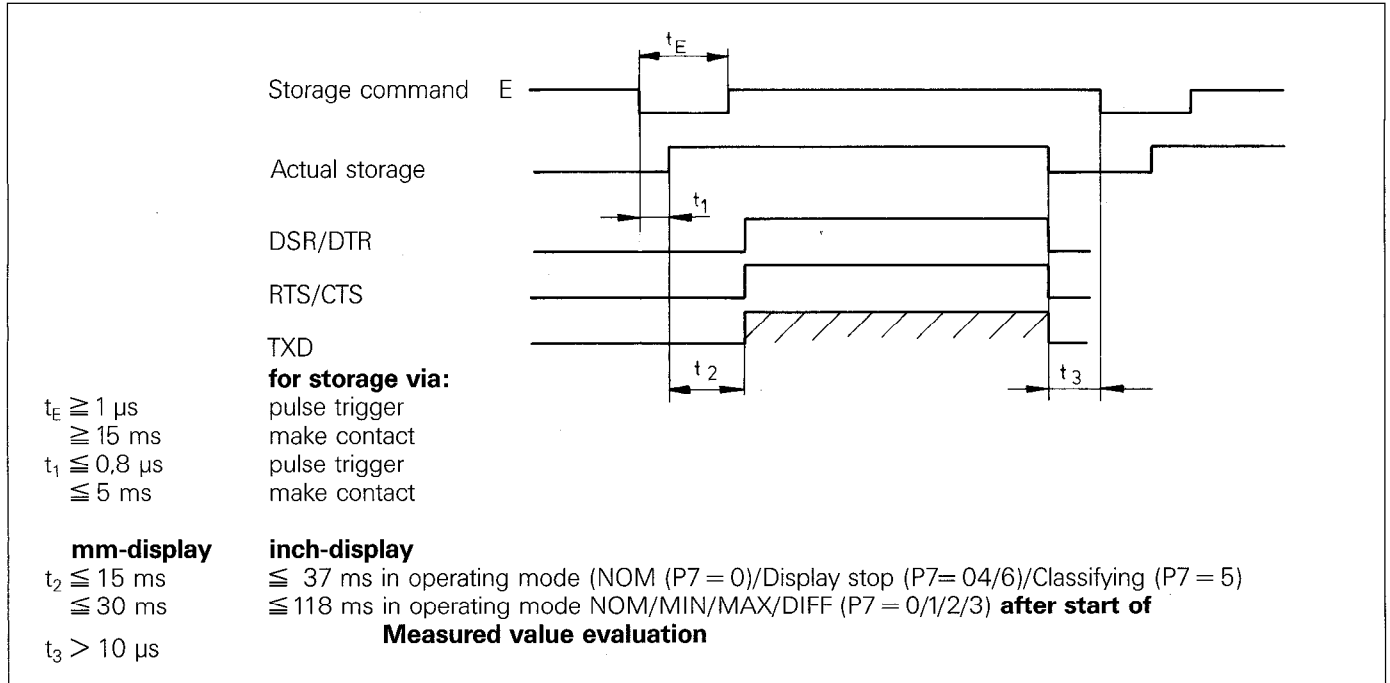
After a delay  $t_2$  the data are provided at the interface output TXD. The duration of data transfer is dependent on the selected baud rate and the required number of line feeds (LF).

#### Caution:

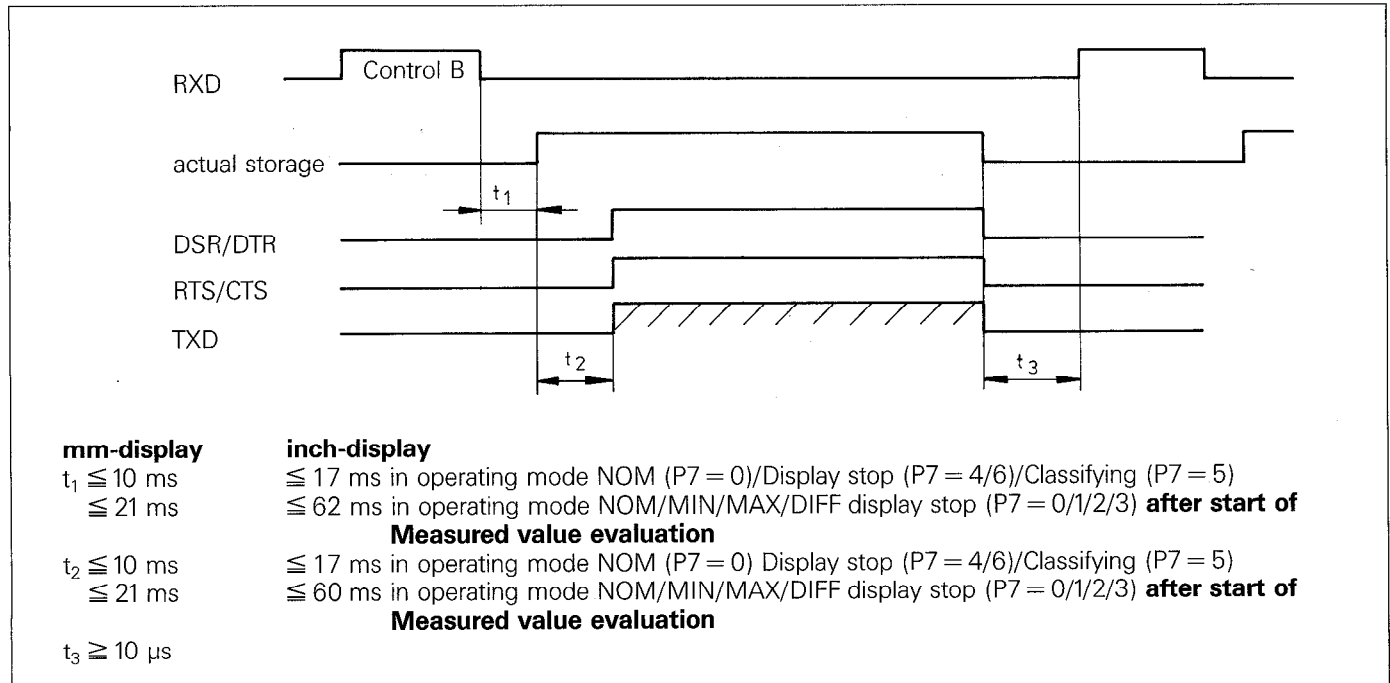
For the storage command via external operation, **TTL-level** is valid, not V.24-level!

## Signal diagrams for the simplified connector layout

### Storage via external operation



### Storage via V.24/RS 232-C-interface



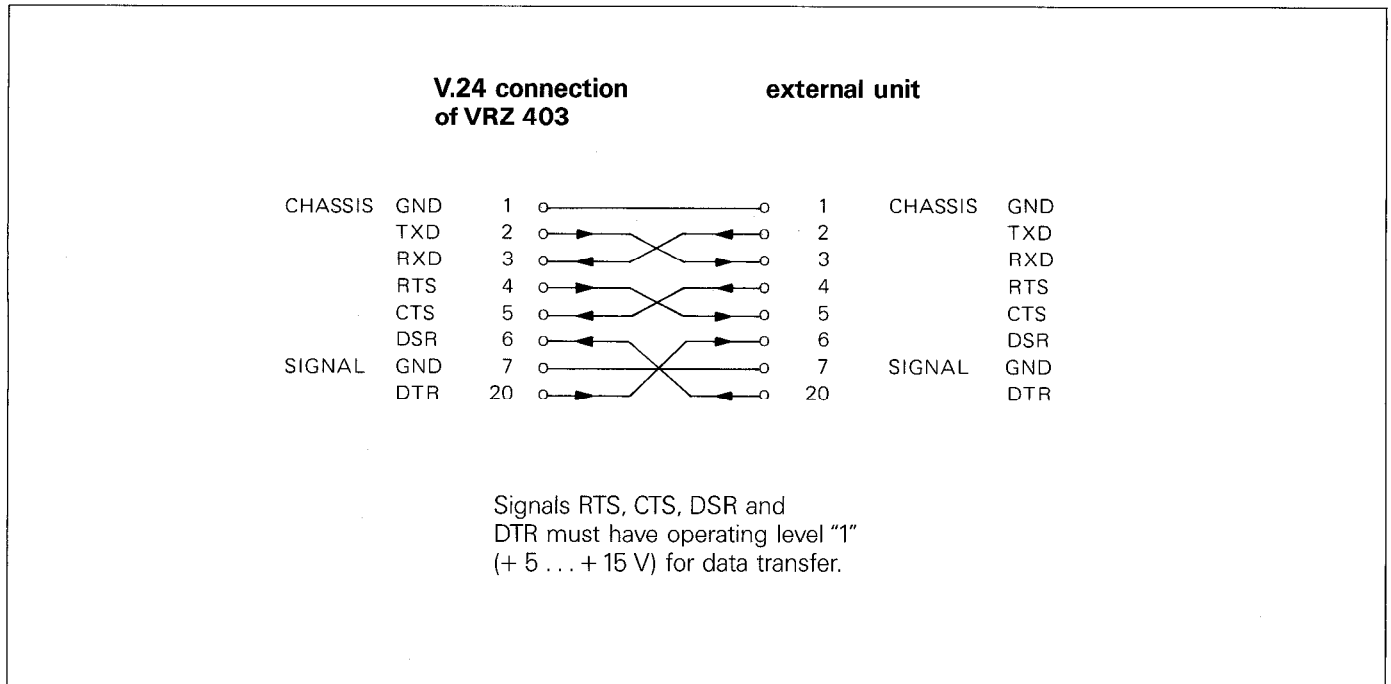
### 9.2.6

#### Connection of external units (wiring)

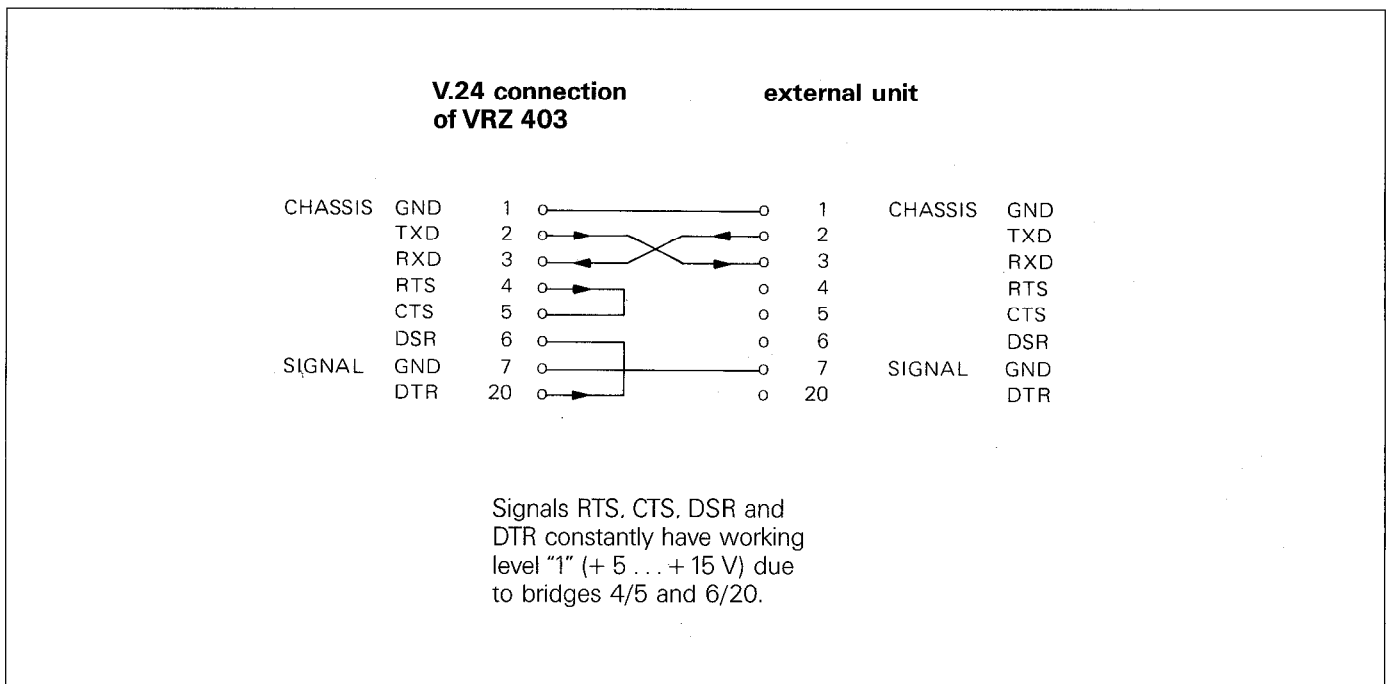
Depending on the type of the employed data units, different wiring of the connection cables might be required. Some non-standard connector layouts are being used.

#### Commonly used wiring:

#### Complete wiring



#### Simplified wiring



### 9.2.7

#### Connection cable

To ensure error free data transmission we recommend you use the HEIDENHAIN data transmission cable with 25 pin Sub-Min-D connectors, Id.-No. 242869...

**9.3**

**IEEE 488-interface (VRZ 404)**

Data output of VRZ 404 corresponds to "IEEE 488" and the "ANSI-Standard MC 1.1". It is identical to the IEC 625 Standard with the exception of the different connector system.

**9.3.1**

**Definition**

**Level**

The levels of the interface lines correspond to IEEE 488/ANSI-Standard MC 1.1/IEC 625

HIGH-level UH ≥ 2.0 V

LOW-level UH ≤ 0.8 V

**Output stage**

The output stage consists of Open-Collector-Drivers

**Interface functions**

The VRZ 404 is a "Listener/Talker", i.e. it can transmit data and also receive commands. It has the following interface functions.

<b>T6</b>	Talker Serial Polling Automatic Address Clear when My Listener Address (MLA) is set
<b>L4</b>	Listener Automatic Address Clear when My Talker Address (MTA) is set
<b>SH 1</b>	Talker Handshake function provided
<b>AH 1</b>	Listener Handshake function provided
<b>SR 1</b>	Service Request function provided
<b>DC 1</b>	Device Clear and Selected Device Clear provided
<b>DT 1</b>	Trigger facility with Group Execute Trigger (GET)
<b>E 1</b>	Open-Collector-Drivers

With **Group Execute Trigger (GET)** the updated display value is transferred into the incorporated buffer memory and at standby for polling.

The interface functions **Device Clear (DCL)** and **Selected Device Clear (SDC)** operate identical to Zero reset or External zero reset.

**Caution:**

The Talker function T6 indicates that the VRZ 404 cannot operate in mode "Talker only". A Controller must always be provided in the system. Connection of **only** one printer to VRZ 404 is therefore **not** possible.

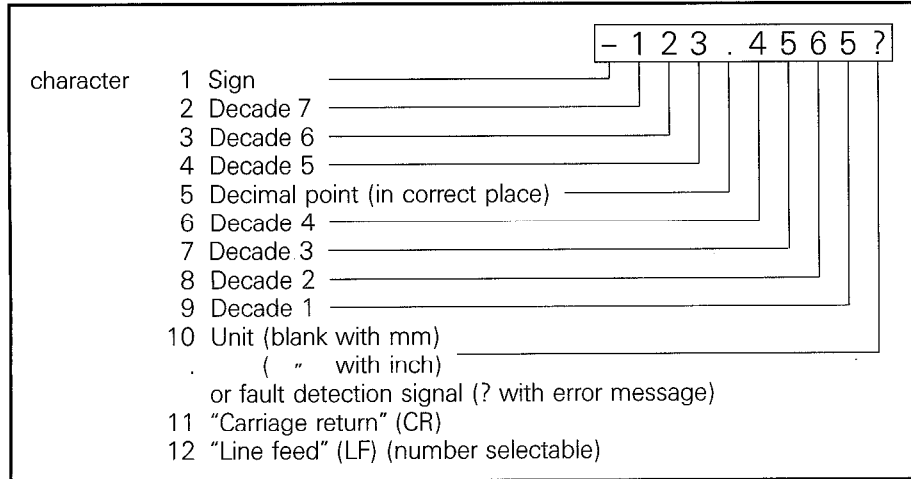
**Transfer Code**

ASCII code is used for data transfer.

**9.3.2**

**Data format**

Transfer of the indicated value is effected bit-parallel/byte-serial. The VRZ provides 12 characters in sequence:



With the last character the control command EOI (End Or Identify) is simultaneously output.

### 9.3.3

#### **Control commands** (Management-Bus)

VRZ 404 can process or generate the following control commands:

**ATN** (Attention)

**IFC** (Interface Clear)

**EOI** (End Or Identify)

**SRQ** (Service Request)

The control command

**REN** (Remote Enable)

is not recognized by VRZ 404.

### 9.3.4

#### **Data transfer**

Data transfer is carried out via 3-Line-Handshake process. The 3 Handshake lines have the following meaning

**DAV** Data Valid;  
operated via Talker or Controller and indicates in active state  
(LOW) that data are at standby.

**NRFD** Not Ready for Data  
operated via all active Listeners

**NDAC** Not Data Accepted  
operated via all active  
Listeners.

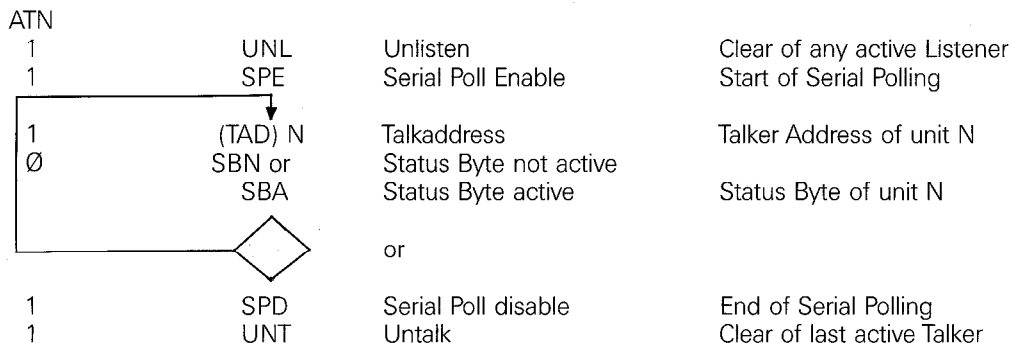
### 9.3.5 Data output

Data output is effected via the incorporated intermediate memory.

The updated display value is transferred into intermediate memory after:

#### a) Entering a storage command

The storage command (TTL pulse trigger or make contact) is applied at the input for external operation (see item 8.3). The counter stores the value after a delay  $t_1$  and then immediately (delay  $t_2$ ) provides the control command Service Request (SRQ). For the subsequently carried out Serial Polling of the Controller, the following sequence of the interface messages is required (see IEEE 488/IEC 625):



Caution: the interface message Serial Polling (SPE) must be provided prior to setting of the Talker Address (TAD).

The VRZ 404 emits the following status character SBA

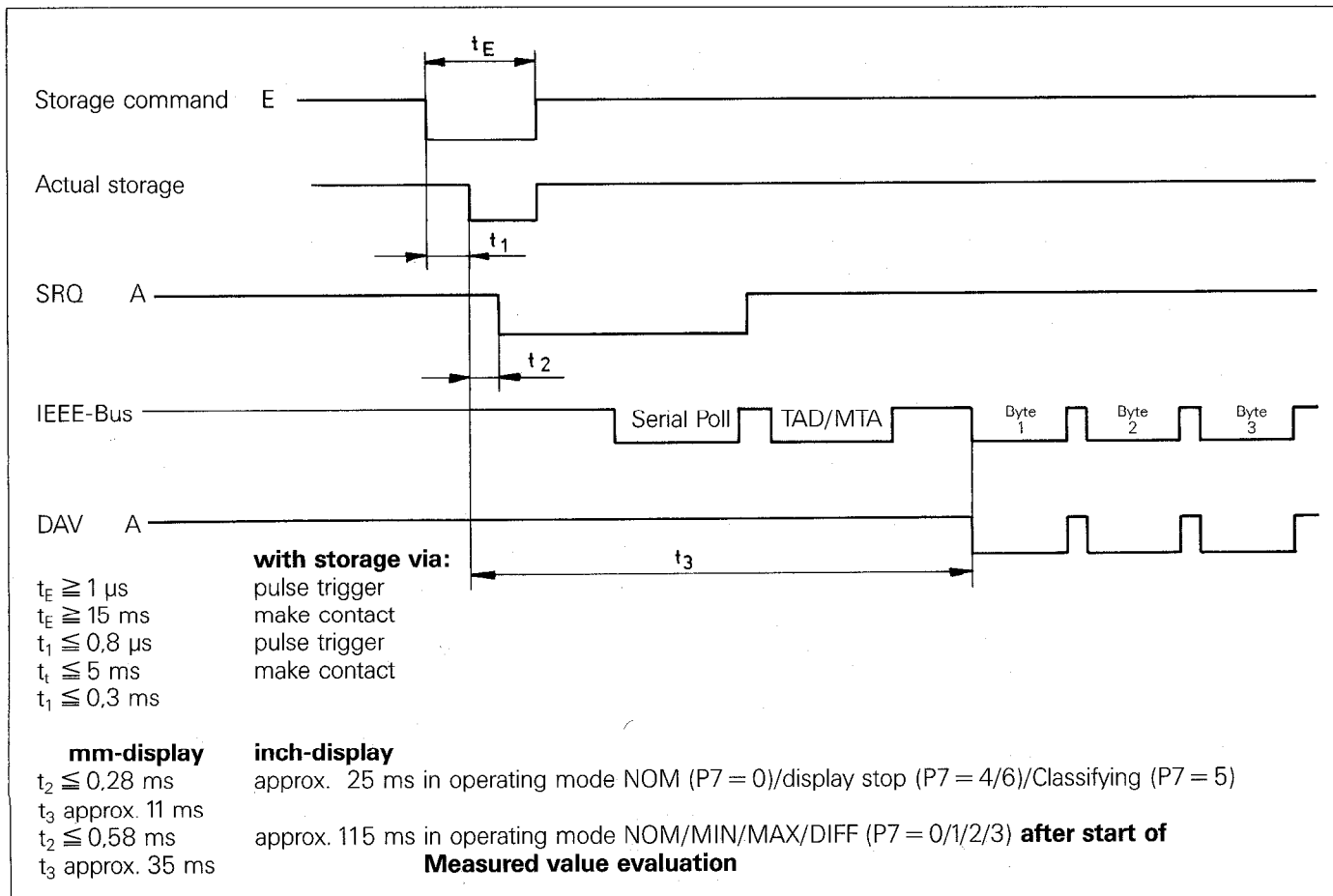
Bit pattern	01000001
hex	41
dec	65

Service Request is only reset after Serial Polling.

VRZ 404 commences data output with a delay  $t_4$  after recognition of My Talker Address (TAD = MTA).

Between Service Request SRQ and standby of data at the interface, a max. delay  $t_3$  passes. If in the meantime the Serial Polling has been completed and the Talker Address set, the line DAV (Data Valid) will subsequently become active.

### Signal diagram

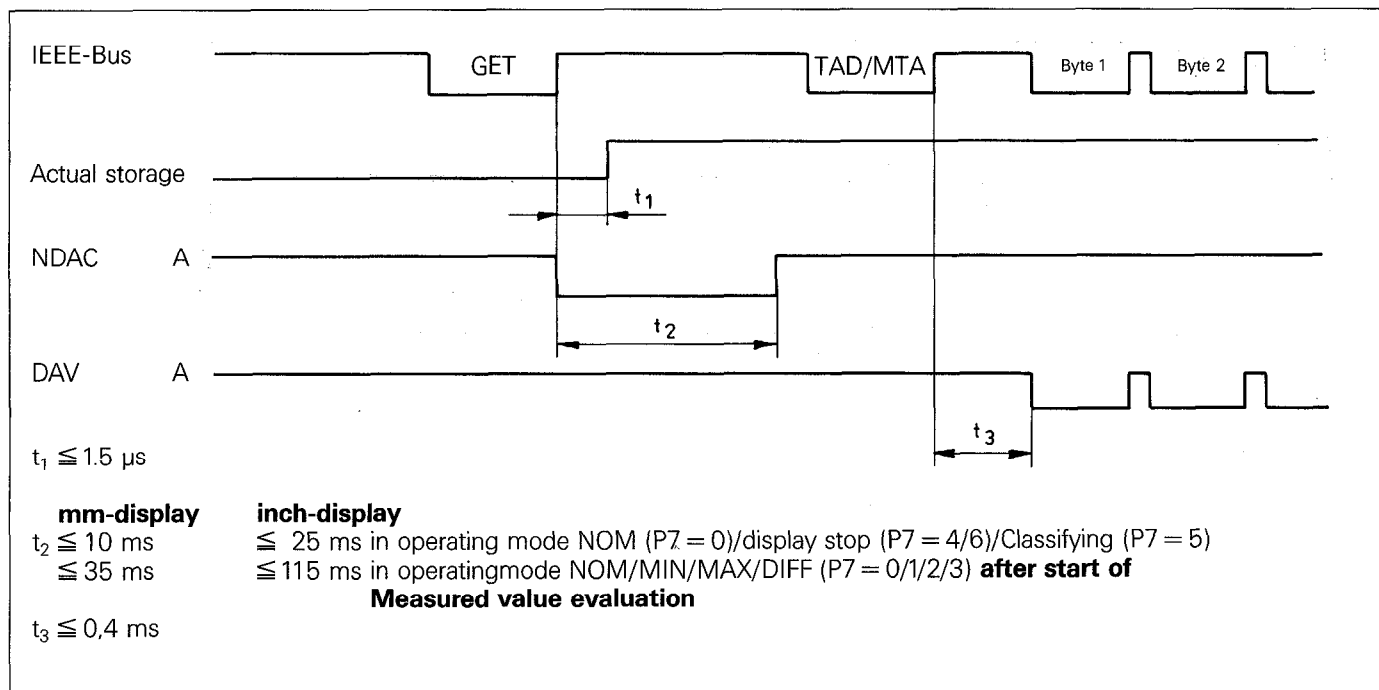


**b) Bus Command GET**

The Bus Command GET effects simultaneous storage with all VRZ 404 addressed. With recognition of GET the Handshake line NDAC is activated until the data are at standby for output ( $t_2$ ). Only then can the appropriate Talker Address TAD be set.

VRZ 404 commences data output with the delay  $t_3$  after recognition of My Talker Address (TAD = MTA).

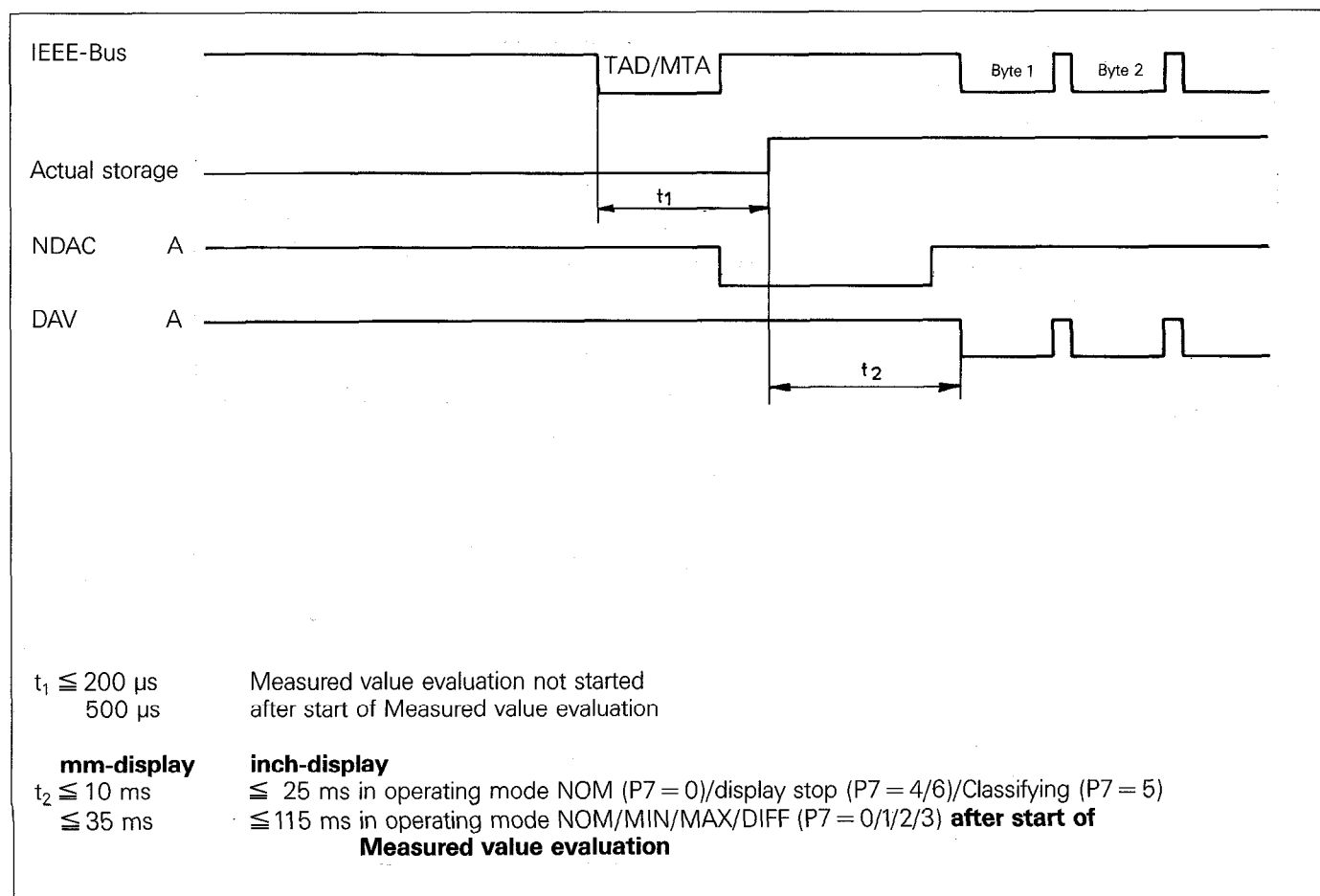
**Signal diagram**



**c) Receipt of My Talker Address (MTA)**

After recognition of My Talker Address (MTA), the updated value will be stored unless the counter has received a prior storage command or GET command. VRZ 404 commences data output with the delay  $t_2$  following actual storage.

**Signal diagram**





### 9.3.6

#### Addressing

In order to enable controlled data exchange between several units, the units connected to the IEEE 488 bus must be provided with addresses.

Determination of the unit address of VRZ 404 is carried out via entry of the parameter value in Parameter P6.

Parameter	Parameter value	Description
P6	x	x = unit address (0 to 30 possible)
e.g. P6	5	VRZ 404 has address 5
P6	21	VRZ 404 has address 21

### 9.3.7

#### Connection cable, interface cards

In order to ensure failsafe operation use a shielded cable with metallic connector housing. In addition to PIN 12 the shield should also be connected to the connector housing. The total length of the connection cables of all units (max. 15) connected to the IEEE 488-bus may not exceed 20 m. The max. cable length between two units is 2 m. Remote distances require the use of so-called bus extenders (modem operation, if reqd.). A number of companies, e.g. Hewlett Packard, which specialize in interface accessories, offer suitable units and completely wired connection cables.

### 9.3.8

#### Connector layout

Connector layout is standardized as per IEEE 488/ANSI-Standard MC 1.1. By means of a regular adapter connector/cable, connection to IEC-625-bus systems is also possible.

PIN 1 DIO 1 Data input/output 1	PIN 9 IFC Interface Clear	PIN 17 REN Remote Enable
PIN 2 DIO 2 Data input/output 2	PIN 10 SRQ Service Request	PIN 18 Ground 0V twisted with PIN 6
PIN 3 DIO 3 Data input/output 3	PIN 11 ATN Attention	PIN 19 Ground 0V twisted with PIN 7
PIN 4 DIO 4 Data input/output 4	PIN 12 Shield	PIN 20 Ground 0V twisted with PIN 8
PIN 5 EO1 End Or Identify	PIN 13 DIO 5 Data input/output 5	PIN 21 Ground 0V twisted with PIN 9
PIN 6 DAV Data Valid	PIN 14 DIO 6 Data input/output 6	PIN 22 Ground 0V twisted with PIN 10
PIN 7 NRFD Not Ready for Data	PIN 15 DIO 7 Data input/output 7	PIN 23 Ground 0V twisted with PIN 11
PIN 8 NDAC Not Data Accepted	PIN 16 DIO 8 Data input/output 8	PIN 24 Logic Ground 0V

### 9.3.9

#### Program examples for HP 85

The program examples for HP 85 are in Basic. For VRZ 404 the unit address "6" or with two connected VRZ 404 the addresses "5" and "6" have been selected.

The Select Code for the HP-IB Interface is "7".

#### Interface messages (Bus commands)

Interface Clear (IFC)	ABORTIO 7
Device Clear (DCL)	CLEAR 7
Selected Device Clear (SDC)	CLEAR 706
Group Execute Trigger (GET)	TRIGGER 706

#### Data inquiry

##### a) by setting the Talker Address

ENTER 706 ; A\$	VRZ 404 (Address 6) is addressed as Talker; value stored and transferred.
DISP A\$	value is displayed

##### b) with Group Execute Trigger (GET)

**one** VRZ 404 connected

TRIGGER 706	storage with GET
ENTER 706 ; A\$	addressing, data inquiry and display
DISP A\$	

**two** VRZ 404 connected

TRIGGER 705, 706 @ RESUME 7	storage from unit 5 and 6 with GET
DISP "VRZ 404 5/6"	
ENTER 705 ; A\$	addressing, data inquiry and display unit 5
DISP A\$	
ENTER 706 ; A\$	addressing, data inquiry and display unit 6
DISP A\$	

If more than two units are connected, then the program can be amended accordingly.

##### c) with storage via external operation

With Serial Polling to be carried out following Service Request (SRQ), the interface message SPE must be effected before setting of the Talker Address (TAD) (see item 9.3.6). The Basic command SPOLL (6) is therefore not suitable for Serial Polling with HP 85. Serial Polling must thus be formulated by the user, e.g. as subprogram "SUB 100".

100 SEND 7 ; UNL MLA	Unlisten, HP 85 becomes Listener
110 SEND 7 ; CMD CHR\$ (24)	SPE (start of Serial Polling)
120 SEND 7 ; TALK 6	unit with Address 6 becomes Talker
130 RESUME 7	ATN inactive
140 ENTER 7 USING "#, B"; S6	Status Byte is read
150 SEND 7 ; CMD CHR\$(25)	SPD (end of Serial Polling)
160 SEND 7 ; UNT	Untalk
170 RESUME 7	
180 RETURN	

If several units are to be operated via Serial Polling, the program block line 120, 130 and 140 must be provided with the appropriate unit address and repeated before line 150.

#### Cyclical polling of Service Request (SQR)-Line:

200 STATUS 7,2 ; S	Status of SQR-Line polled (Interface Status Register)
210 IF BIT (S,5) = 1 THEN 230	
220 GOTO 200	
230 GOSUB 100	Subprogram for Serial Polling
240 ENTER 706 ; A\$	
250 DISP A\$	
260 GOTO 200	

#### Service Request releases Interrupt in HP 85:

300 ON INTR 7 GOSUB 350	
310 ENABLE INTR 7 ; 8	SRQ Interrupt is released
320 GOTO 320	infinite loop up to Interrupt
350 STATUS 7,1 ; S	Interface-Status Register 1
360 GOSUB 100	
370 ENTER 706 ; A\$	
380 DISP A\$	
390 ENABLE INTR 7 ; 8 @ RETURN	

If several units are connected, insert the following in place of lines 370 and 380:

```
370 IF NOT BIT (SN, 6) THEN 390
375 DISP "VRZ 404/N"
380 ENTER 70N ; A$
385 DISP A$
```

Insert the appropriate unit address in place of N. The program part can be repeated independent of the number of connected units. Of course in this case the subprogram "SUB 100" must also have provisions for several units.

## 10. Error messages

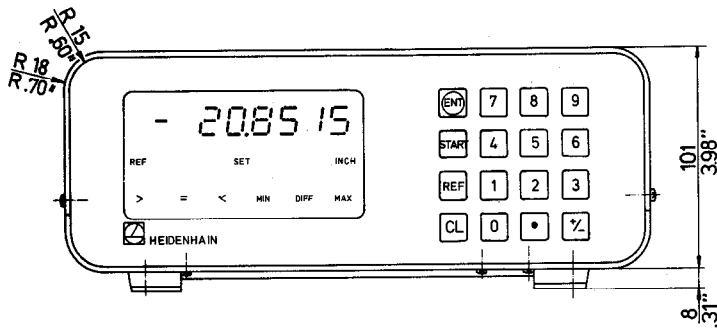
The counter monitors a series of functions. Failures are indicated to the user by means of error messages.

Error message	Trouble shooting	Remedy
Display flashes	a) no gauge connected b) break in connection cable c) gauge defective d) max. permissible measuring velocity e) mains interruption depending on parameter P5 (also briefly)	a) connect gauge b) check cable and connection c) return gauge for repairs d) reduce measuring velocity The error message can be cleared by pressing the REF key once or twice. The correlation to plunger position and display value must then be retrieved (REF, Zero reset or Datum set; see item 7.)
All decimal points illuminated	max. display capacity exceeded mm-display: $\pm 999.9995$ inch-display: $\pm 99.99998$	select datum such that display capacity with full travel is not exceeded
ERROR 1	counter has received a second storage command (via external operator or interface), before the data following the first command are output	extend spacing between storage commands  error message clear by pressing <b>CL</b>
ERROR 2	with VRZ 403 external unit not ready	connect external unit or check connection; switch external unit on or activate to ready state
	with VRZ 404 a) IEEE 488-Bus not ready (no Controller present) b) error in the Handshake-lines (NCDA <b>and</b> NRFD inactive/ HIGH at start of Handshakes). c) all Handshake-lines active/ LOW (Controller interface reset by Controller and simultaneous storage via external operation).	a) connect Controller or check connection and switch on. b) check Handshake-lines and unit in Bus (Extender)  c) change program sequence
		error message ERROR 2 cleared by pressing <b>CL</b> . Error message is only reactivated after counter is switched off/on or bus commands DCL or SDC (with VRZ 404; effects simultaneous zero reset!) are received!

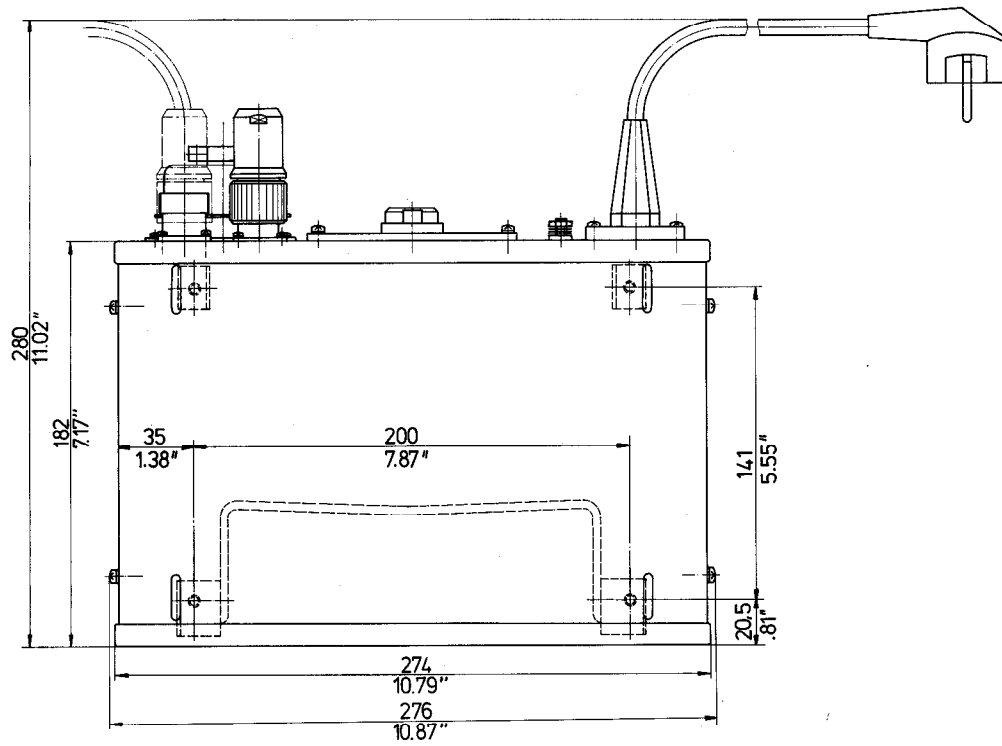
## 11. Technical specifications

	Housing	desk-top model, for stacking with tilting stand
	Dimensions (wxdxh)	276x109x182 mm (10.87 x 4.29 x 7.17 in) (without connector)
	Weight	ca. 3.7 kg
	Operating temperature	0 ... 45° C
	Storage temperature	- 30 ... + 70° C
	permissible rel. humidity	75 % annual average 90 % on rare occasions
	Protection	IP 40 (front panel IP 54)
Electrical data	Display	7 decades and sign
	Display step	selectable 0.0005/0.001 mm or 0.00002/0.00005 inch (0.01 mm/ 0.00005 inch only VRZ 404)
	Zero reset	· via keyboard · via external operation pulse trigger or make contact · via bus command DCL or SDC (VRZ 404)
	Datum set	via keyboard
	Reference signal evaluation	automatic with REF
	Counting direction	selectable
	mm/inch calculator	standard feature
	Operating modes	· Nominal display NOM · MAXIMUM display MAX · MINIMUM display MIN · Subtraction, DIFF of MIN and MAX · Display stop · Tolerance check
	Data output/data interface	BCD-parallel with VRZ 402 V.24/RS-232-C with VRZ 403 IEEE 488 with VRZ 404
	max. scanning frequency	25 kHz
	Nominal mains voltage (selectable)	100, 120, 140, 200, 220, 240 V
	Mains voltage tolerance	- 15 % ... + 10 %
	Mains frequency	48 ... 62 Hz
	Mains fuse	0.16A slow-blow for 200/220/240 V 0.315A slow-blow for 100/120/140 V
	Power consumption	ca. 14 W

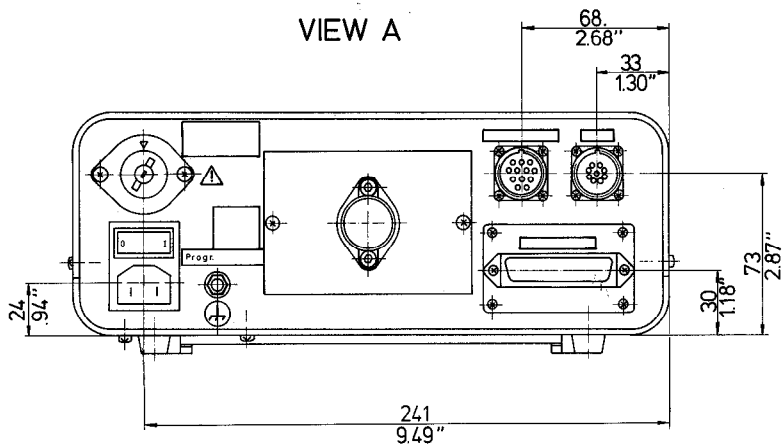
12. Dimensions mm/inch



A  
↓



VIEW A





**HEIDENHAIN**

