# The *magnetostrictive* Position Sensors

**MTS**
®
**SENSORS GROUP**

# Temposonics®

# User's Manual

## Analog Position Sensor System with External Electronic Interface
1. Position Sensor Temposonics-II
2. Analog Board AK 288

CE

**ISO 9001**
C E R T I F I E D

# Temposonics®

## General Safety Instructions

### Preface

The general safety instructions given below are inten-
ded to ensure the personnel safety and to avoid damage.
Temposonics are state-of-the-art position measurement
systems built in accordance with the standard safety
regulations. Nevertheless, hazards to the life and health
of the user or other persons, or impairments of the sensor
or other objects may arise in conjunction with the use of
Temposonics Sensors.

### Application

1. The position measurement systems of all series
Temposonics may be used only for the purposes for
which they were designed, i.e. they may be used
exclusively for measurement tasks in industrial, com-
mercial and laboratory applications. E.g. positions,
displacements and speeds can be measured (more
detailed information is given in the relevant product
documentation). The position sensors are accessories
of an installation and must be connected to a suitable
evaluating unit as included in a PLC, IPC, indicator or
other electronic control unit. Correct use for the inten-
ded purpose implies that all instructions given in the
product documentation are followed. Using sensor
Temposonics beyond these limits is incorrect. MTS
Sensor Technologie GmbH & Co. KG refuse any liability
for damage resulting from incorrect use.

2. The displacement sensors may be used only in safe
condition. In order to maintain this condition and to
ensure safe operation, installation, connection and
service work may be done only by trained and qualified
personnel *), whereby the relevant instructions for
accident prevention and safety as well as the information
given in the product documentation must be followed.

### Functional trouble

Hazards to the safety of persons or risks of damage to
operating facilities due to sensor failure or malfunction
must be avoided by additional safety measures such
as plausibility checks, limit switches, emergency off
systems, protective devices, etc.
In case of trouble, the sensor must be shut down and
protected against accidental operation.

### Repair

Repair of the sensor may be done only by MTS or an
explicitly authorized organization.

### Installation and operation

To ensure perfect functioning, following the informa-
tion given below is indispensable:
1. Protect the sensors against mechanical damage
during installation and operation.
2. Do not open or dismantle the sensors.
3. Connect the sensors with utmost care related to
polarity of connections, supply voltage as well as type
and duration of control pulses.
4. Use only approved power supplies.
5. Meeting the permissible sensor limit values e.g. for
supply voltage, environmental conditions etc. specified
in the product documentation is indispensable.
6. Check the correct function of the position sensors at
regular intervals and provide test documentation.
7. Before switching on the installation, ensure that
the starting machine does not threaten the safety and
health of persons.

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*) Trained personnel means persons who
• related to projecting, are familiar with the safety
  concepts of automation,
• are informed of the electromagnetic compatibility,
• have received a special training for commissioning
  and servicing,
• are familiar with the operation of the unit and
  informed of the specifications for correct operation
  given in the product documentation.

## Analog Board AK 288

### 1. Introduction

The absolute and linear TEMPOSONICS Position Sensing system is an analog measuring device with highest resolution. Consisting of a sensor TEMPOSONICS-II with built-in R-Module in the sensor head and the separate evaluation interface AK 288.

The TEMPOSONICS system measures the time interval between a Start and a Stop signal. In the sensor, a torsional strain pulse is induced in a specially designed magnetostrictive waveguide by the interaction of two magnetic fields under the positioning head.

The running time, proportional to the displacement will be converted into an analog voltage or current output (Fig 1).
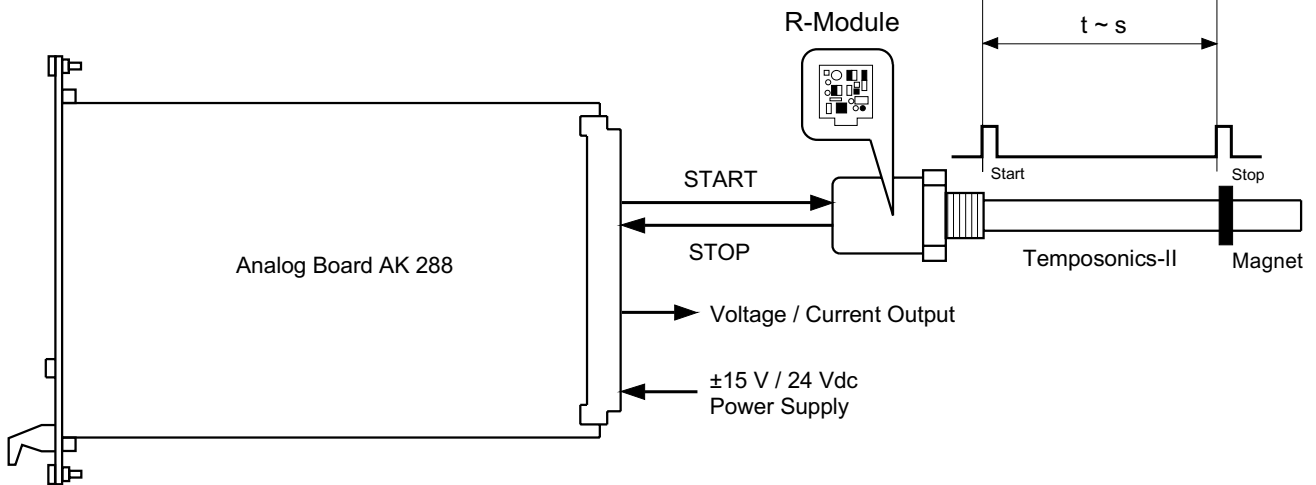
**Fig. 1**



### 2. Analog Board AK 288

#### 2.1 Design and Operations

The AK 288 card in Europe format 100 x 160 mm is suitable for installation in a 19" sub-rack, for 32-pin insert card blocks of structural shape C (DIN 41612) or Snap-in card housing.

The board consists of the following function units:

1. **Control Logic and Start/Stop-pulse processing**
2. **Measuring Length Calibration**
3. **Noise Rejection**
4. **Analog Output with**
   • Reference Voltage
   • Analog Switch
   • Filter and Amplifier for Null and Span
5. **Error Output**

The card generates the measuring repeat frequency and generates a pulse width from the start/stop signal which is proportional to the position of the magnet head. The pulse duration controls a precision analog switch used to switch an internal reference voltage to an active filter. The filter forms an analog voltage from the gate which is directly proportional to the magnet position.

The Error Output of board AK 288 shows " Low " level, if

• the magnet on the sensor is missing
• no sensor is connected
• the power supply of sensor is missing
• the board is defective
• the Error-Input Pin a16 is not connected

The Error Output requires an additional power supply of +15V or +24Vdc on Pin a16. Pin c16 shows that voltage output if the board AK 288 has no fault.
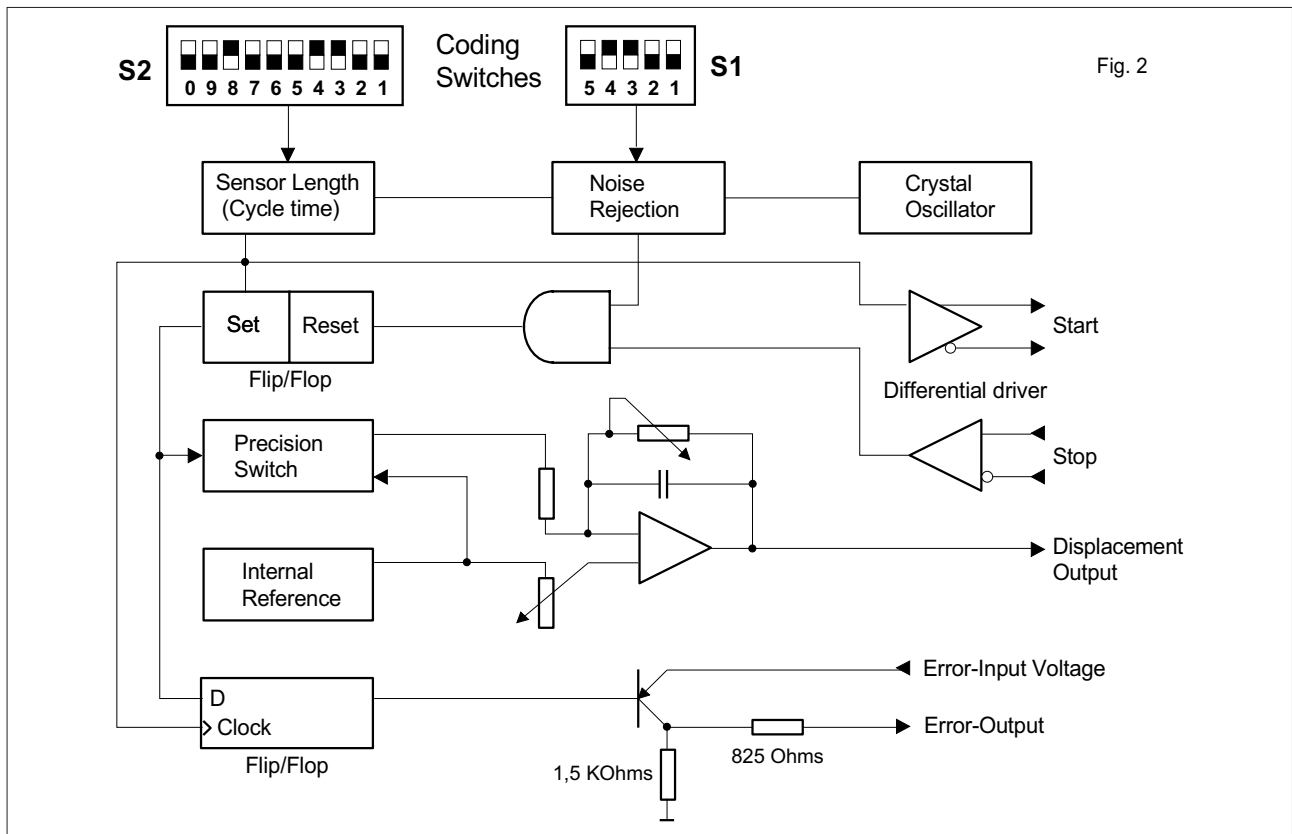
### 2.2  Block Diagram AK 288



Fig. 2

### 3.  Installation

Measuring and control technology as a component of modern production facilities are often surrounded by interference factors which can impair the function of the electronic system. For this reason the measuring technology should be installed very carefully and attention paid to the following items ( see fig 3. )

### 3.1  Installing the Sensor

The sensor has to be mounted to the machine in any position. The measuring point is definated by the position magnet that has to be connected to the moving machine part and it slides over the transducer rod without wearing. For mechanical installation see the below figures illustrating minimum clearances of transducer magnets and note following items for the very best function of the device.
• Use non-ferrous material (screws, supports etc.)
• Using ferromagnetic materials, the magnet needs spaces between the surface of the magnet and material
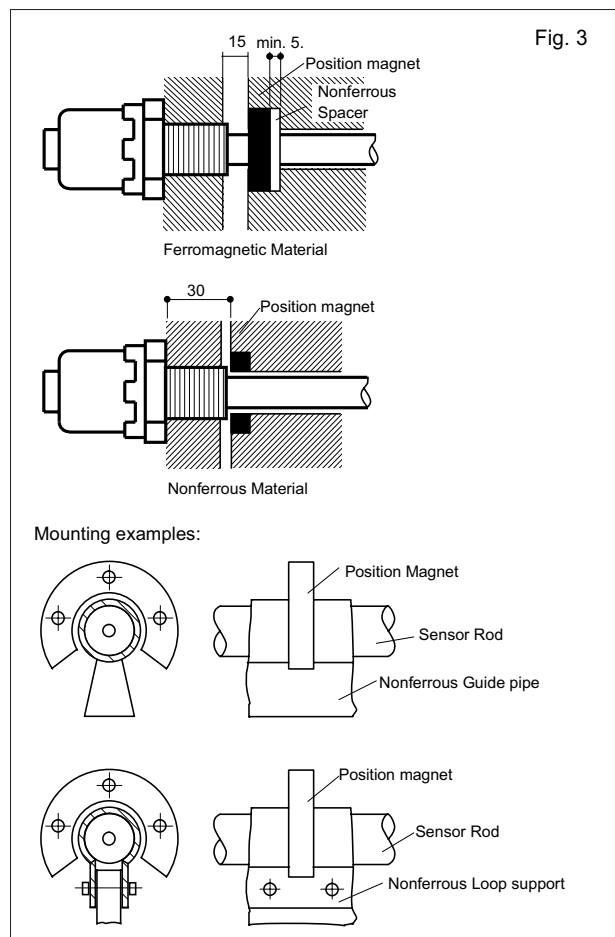• Long Sensors (above 1000 mm measuring stroke) may require mechanical supports



Fig. 3

## 3.2 Installing the Board

The analog displacement board AK 288 has the European standard format 100 x 160 mm for mounting in 19"-racks. For mounting in control cabinets it is also possible to use standard card holders, form C, 32 pins, a + c row. Over the terminal block the sensor interface can be wired directly to the sensor.

Fig. 4

**AK 288**
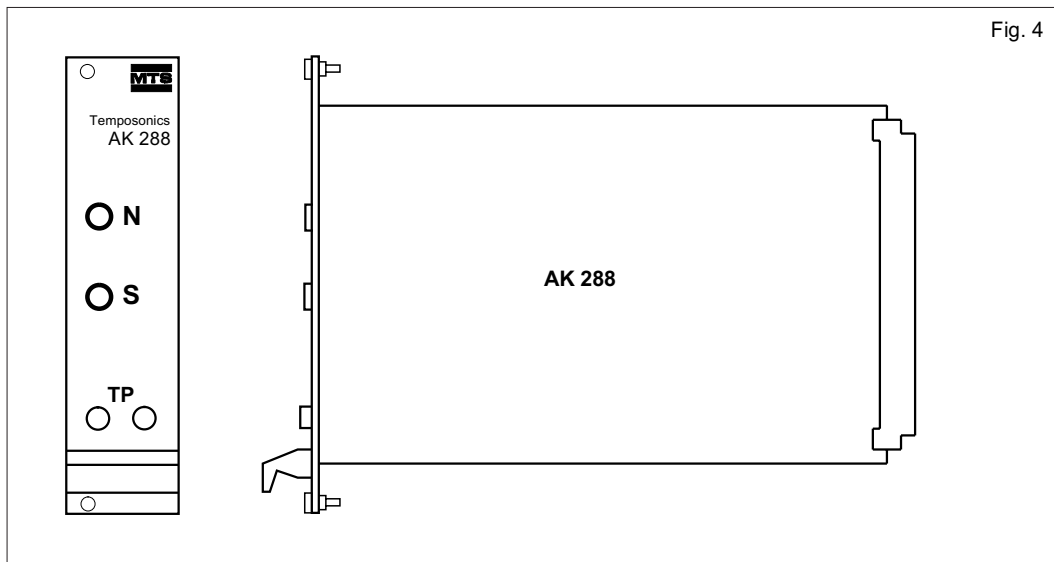
### 3.3 Cable

Electrical faults are often caused by the long data lines with defective and incorrect cable laying. The Start/Stop pulse is transmitted as a differential signal.
Cable connection between sensor and card of 500 meters are possible.

**Attention! All connections are measuring cable and must be treated as such.**

• Do not lay cable near and parallel to sources of interference such as engine lines, frequency converters, valve lines or other lines with high switching inductivity
• Lay low-impedance cable
• Avoid earth circuits
• Use twisted cable with a shield
• The shielding of the sensor feed should be matched to the overall concept of the control.

Possible shields are
• One-sided sheath to machine ground ( standard )
• One-sided sheath to 0 volts
• Two-sided sheath to machine ground
• External sheath to machine ground. Internal shield to 0 V power supply (applies only to double shielded cable of type LiYCY-CY.... )
• We recommended following cable type:
  8 x 0,25 mm² / twisted pairs / shielded
  e.g.   LiYCY 4 x 2 x 0,25 mm²  or
         LiYCY-CY 4 x 2 x 0,25 mm²

### 3.4 Power Supply

Power units can also cause interference to the measuring system. This often happens in facilities on which joint power supplies are used which then transmit interference peaks from other components.
Only stabilized power supplies guarantee trouble-free functioning of the Temposonics measuring device.
Please note the connected loads right.

**Attention! Do not connect other voltages.**
**That can damage electronic components**
**of sensor or board.**

**Input:  ±15 V dc** ( ± 0,5 V )
• **+15 V** current consumption:  250 mV max.
• Ripple:  200 mV max.
• **-15 V** current consumption:  100 mV max.
• Ripple:  200 mA max.

**Input:  24 Vdc** ( ± 1,2V )
• Current consumption:  250 mA max.
• Ripple:  200 mV max.

### 3.5 Connections of Sensor Temposonics-II

| | Connector | Cable color | TEMPOSONICS-II / Series TTA; TTM and TTS |
|---|---|---|---|
| | Connector Pin No. | Cable type K 32 4 x 2 pairs | Type TTA/TTM/TTS-*RB*-M-◻◻◻◻-R (Integral connector) Type TTA/TTM/TTS-*R0*-M-◻◻◻◻-R (Integral cable) |
| | | | *Power Supply* |
| | 1 | white | DC Ground (0V) |
| | 2 | brown | Machine Ground (Frame) |
| | 5 | red | +15V |
| | 6 | blue | -15V |
| | | | *Pulse Transmission* |
| | 3 | gray | Stop ( - ) |
| | 4 | pink | Stop ( + ) |
| | 7 | | |
| | 8 | | |
| | 9 | yellow | Start ( + ) |
| | 10 | green | Start ( - ) |

10-pin MTS-Connector type **RB** (male)

External view

### 3.6 Wiring Sensor - Analog Board

Following TEMPOSONICS components can be connect to an analog sensor system

**Position Sensor**
1. Type TTA; TTM and TTS - RB - M - xxxx- R  (Connector version)
2. Type TTA; TTM and TTS - R0 - M - xxxx - R  (Cable version)

**Analog Board**
1. Type  AK 288 - xx - 0 - xxxx  ( ±15 Vdc Input )
2. Type  AK 288 - xx - 1 - xxxx  ( 24 Vdc Input )

**Do not carry out any connection with power on !**
The Start/Stop pulse transmission between Sensor and Board is a differential signal.
Cable length:   Maximum of 500 meters ( see page 3 )
Cable type:  Shielded Cable with twisted pairs
         e.g.  LiYCY 4 x 2 x 0,25 mm² or
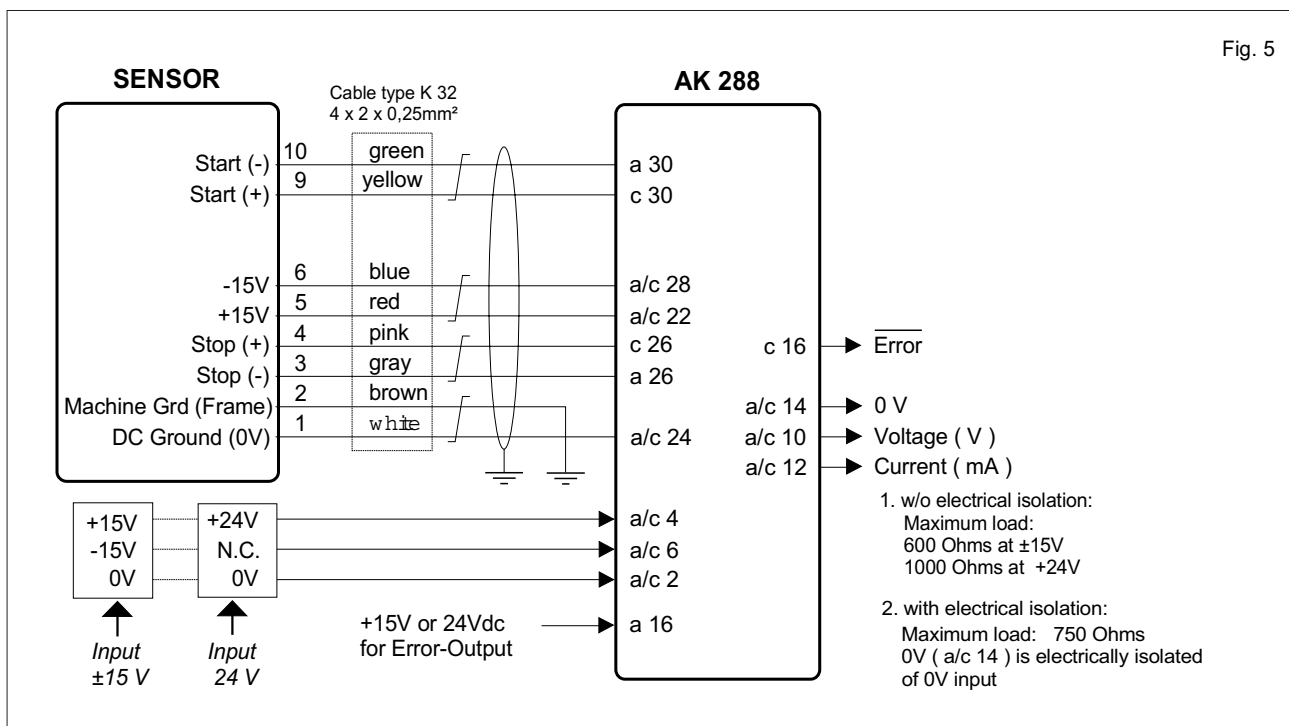          LiYCYCY 4 x 2 x 0,25 mm²



Fig. 5

## 4. Operational Check

### 4.1 Adjustment Start-Position and End-Position

Note: All boards are factory-set to the following customized parameters
• Sensor Length
• Noise rejection
• Measuring direction
• Position of Setpoints SP1 and SP2
• Output
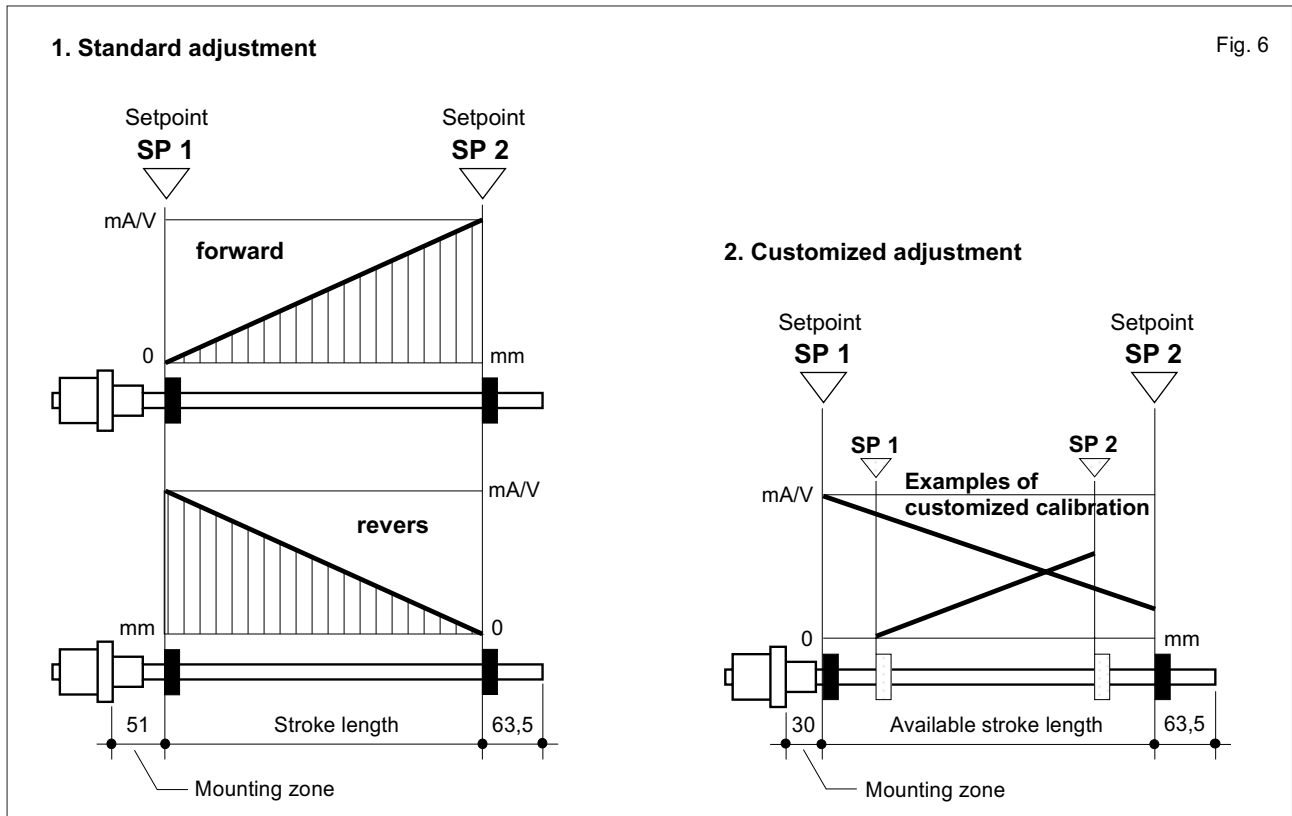A difference is made between standard and customized adjustments.



**1. Standard adjustment** — Fig. 6

**2. Customized adjustment**

Small offsets in the magnet position due to mounting or wear in the moving parts of the mechanical system to which the magnet is attached can be compensate by the adjustments of 2 potentiometers in the card front panel:

1. Bring Position magnet to the factory adjusted **ZERO** and **SPAN** position ( Setpoints SP1 and SP2 ) and check the outputs with help of a digital voltmeter or the connected controller.

2. Adjust **START** position ( NULL ) if necessary by potentiometer **" N "**

3. Adjust **END** position ( SPAN ) if necessary by the potentiometer **" S "**

To guarantee the high accuracy of the TEMPOSONICS analog measuring device, that adjustments of 'N' and 'S' are only possible in the small range of ±1% of full stroke.

**Important!**
Independent of measuring direction, valid is:
The **Start Position** will be adjusted always with pot **'N'**
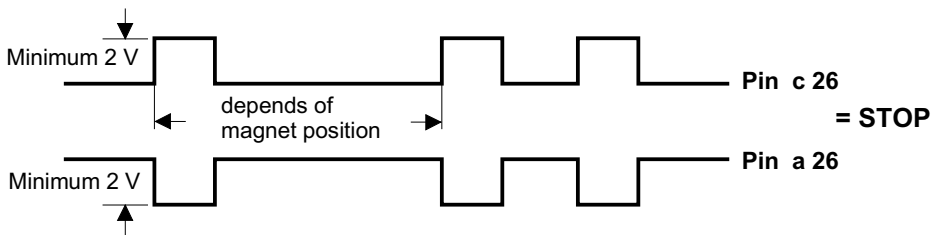The **End Position** will be adjusted always with pot **'S'**

### 4.2 Troubleshooting

Use the troubleshooting procedure in this section when operational problems are encountered. Note, that the following checks are only for general diagnostic purposes.
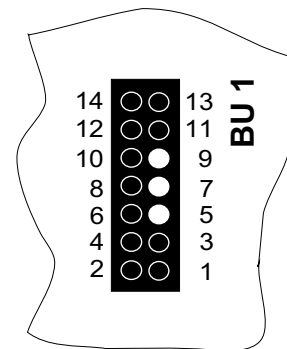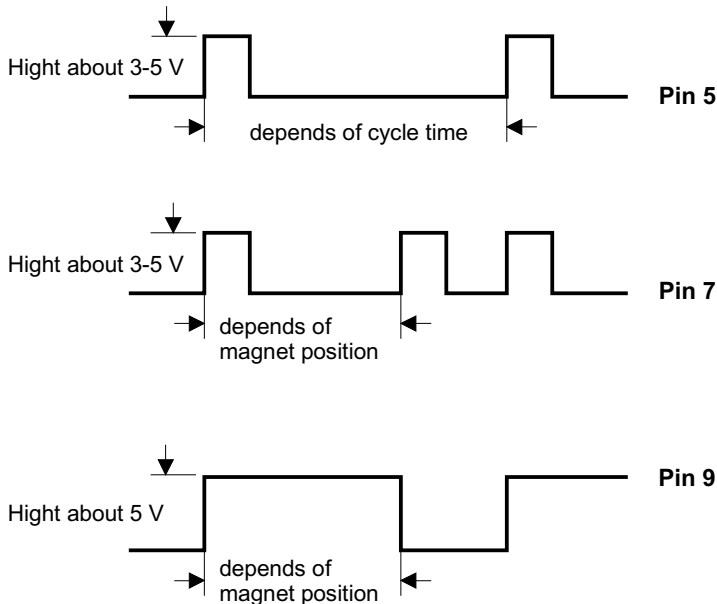
1. Check the cable connections
2. Check the power supply of the board AK 288
3. Check the Power supply board to displacement sensor
4. Check the START - SIGNAL on the multipoint plug of the card with an oscilloscope

Minimum 2,4 V — depends of cycle time — Pin c 30
**= START**
Minimum 2,4 V — Pin a 30
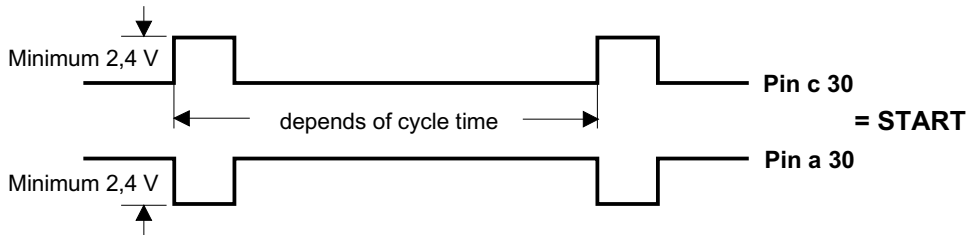
5. Check the STOP - SIGNAL on the card ' s multipoint plug

Minimum 2 V — depends of magnet position — Pin c 26
**= STOP**
Minimum 2 V — Pin a 26

6. The following signals must be measured at the pins of the test socket **" BU 1 "** (see fig. 7 / page 7)

Hight about 3-5 V — depends of cycle time — **Pin 5**

Hight about 3-5 V — depends of magnet position — **Pin 7**

Hight about 5 V — depends of magnet position — **Pin 9**

BU 1

| 14 | 13 |
| 12 | 11 |
| 10 | 9 |
| 8 | 7 |
| 6 | 5 |
| 4 | 3 |
| 2 | 1 |

Test Socket
Component side

7. At the 2 testpoints **" TP "** on the board frontpanel (right) the actual DISPLACEMENT VALUE can be measured as an analog voltage output.

**Please use this signal output for testing only !**

**5. System Calibration**

**ATTENTION!**
**All Boards are factory adjusted. Following**
**detailed instructions are for scaling to altered local conditions**
**only or for a new setting of a neutral spare part board.**

**5.1 Sensor Length and Cycle Time**
**5.2 Noise Rejection**
**5.3 Measuring Direction**
**5.4 Output of Start and End Points**

are variable parameters. For changements of the factory
calibration note the adjustment items on following pages.
Position of calibration components you can find on the
board component side below.



Fig. 7
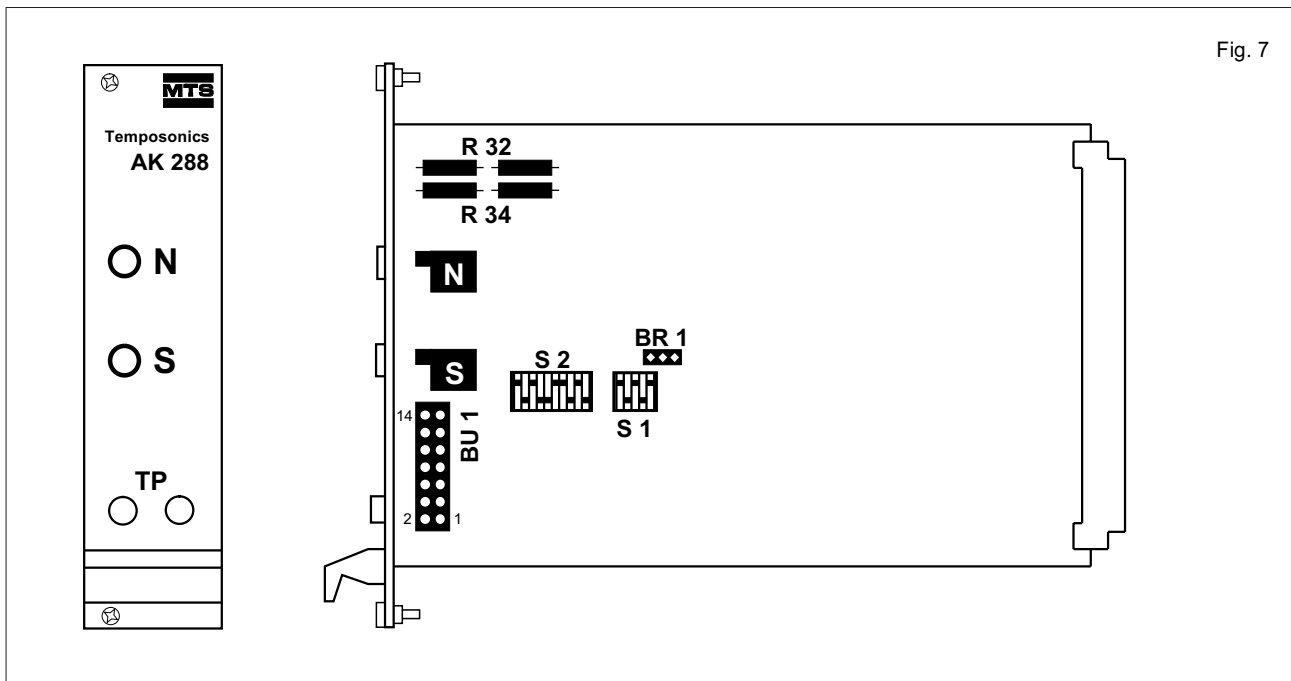
### 5.1 Sensor Length and Cycle Time

To optimize the cycle time (measuring frequency), the AK 288 must always be adjusted to the Sensor Length of the connected Temposonics-II transducer.
**The Sensor Length is the addition of labled stroke length, mounting zone (51 mm) and a fixed value of 46 mm (see below).**



Example Sensor Lable

MTS Sensor Technologie GmbH & Co. KG
Auf dem Schüffel 9
D-58513 Lüdenscheid

**Temposonics**

TTA-RB-M-*0150*-R

| Stroke | 150 mm |
| Scale | 64840 |
| FK | 281972 / A |
| Grd | 9.00805 |
| FN | 93-39065 |

Stroke length

The Sensor Length must be programmed with the dip switches No. 0-9 of the code switch S2 (fig.8) in On/Off position.
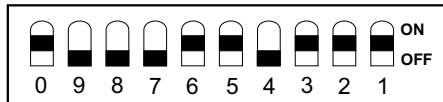


**Fig. 8 - Code switch S2**

### 5.1.1 Calculation of Total Value ( GW ):

$$GW = \frac{\text{Stroke length + 51mm Mounting zone + 46 mm}}{17{,}9 \text{ mm}}$$

Always round up the calculated value !

### 5.1.2 Setup Code switch S 2

• Each of the dip-switches 0 - 9 of code switch S2 has a Single Value ( EW ) as shown in table 1.

• EW (Single Value) which is closest to the calculated GW (Total Value) read from the table 1 and add EW`s until GW is reached.

• Set the slide switches 0 - 9, with the single value ( EW ) to position ON.

• All other switches must be in position OFF.

| Single value (EW) | Dip switch | Cycle time, µsec | Sensor length, mm |
|---|---|---|---|
| 1 | 0 | 6.4 | 17.9 |
| 2 | 9 | 12.8 | 35.8 |
| 4 | 8 | 25.6 | 71.6 |
| 8 | 7 | 51.2 | 143.2 |
| 16 | 6 | 102.4 | 286.4 |
| 32 | 5 | 204.8 | 572.8 |
| 64 | 4 | 409.6 | 1145.6 |
| 128 | 3 | 819.2 | 2291.2 |
| 256 | 2 | 1638.4 | 4582.4 |
| 512 | 1 | 3276.8 | 9164.8 |

Table 1

### 5.1.3 Example of Scaling Sensor Length



SP 1     SP 2

*51*    *300 mm Stroke length*

*Mounting zone*

$$GW = \frac{\text{Stroke length + 51mm mounting zone + 46 mm}}{17{,}9 \text{ mm}}$$

*1) Put in the values of above sketch*

$$GW = \frac{300 + 51 + 46}{17{,}9} = 22{,}18$$

*2) Round up that calculated value to 23*

*3) Add the Single Values from table 1 to that calculated Total Value of 23 and setup the corresponding dip switches (see table 1) in position ON. All others in position OFF.*

**EW   16 + 4 + 2 + 1  = 23**

**Switch #   6    8    9    0  = ON**



*4) Table 1 can also be used to obtain the cycle time or measuring frequency for the individual sensor length. The cylcle time is calculated by the addition of the individual cycle times + 6,2 µs.*

### 5.2 Noise Rejection

TEMPOSONICS sensor device needs a perfect STOP signal. Noises out of interferences on the connecting cable can be rejected on the Analog Board AK 288 with code switch S1 by programming a " time window ". The STOP signal must be within this window.
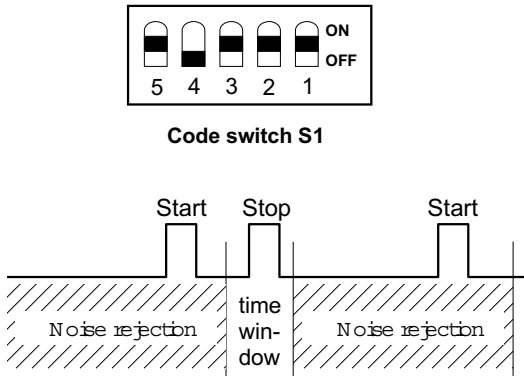
**Code switch S1**

Fig. 9

The pulse duration - measured in µs - is adjusted dynamically to the STOP signal in each case. If a setting other than the factory scaling is desired, the duration must be programmed on starting up in dependence on the maximum speed of the position magnet

**Following noise rejections has been factory set:**

• Stroke length up to 150 mm
( time window = 3,1 µs )

• Stroke length of 150-300 mm
( time window = 4,6 µs )
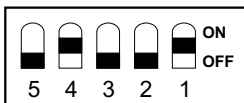
• Stroke length above 300 mm
( time window = 6,2 µs )
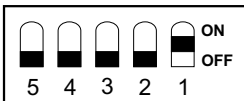
### 5.2.1 Scaling Noise Rejection

The position of the single switches # 1 - 5 of **S1** is determined according to the formula as follows

$$\text{Time Window (µsec)} = \frac{\text{max. speed (m/s) } \times \text{ setup stroke length* + 17}}{7840}$$

*) see page 8; item 5.1

Using this calculated time window, the required programming of **Switch S1**, can read from table below.

| Time window in µs | Switch S1 | Switch S2 |
|---|---|---|
| 1) No noise rejection | | |
| 2) 1.4 µsec | | |
| 3) 1.4 µsec | | |
| 4) Factory preset up to 150 mm | | |
| 6) 3.1 µsec | | |
| 7) Factory preset 150...300 mm | | |
| 8) 4.6 µsec | | |
| 9) Factory preset above 300 mm | | |
| 10) 6.2 µsec | | |
| 11) 8.0 µsec | | |
| 12) 9.6 µsec | | |
| 13) 11.2 µsec | | |
| 14) 12.8 µsec | | |
| **STOP** ATTENTION! Switch positions as right are prohibited ! | | |

Table 2

If the calculated value is below the lowest table 2 value, switch **S1** is set for a time window = 1.4 µs as follows:
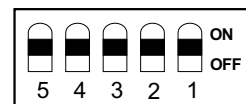
**IMPORTANT!**
**Sliding switch No. 5 of S1 and switch No. 0 of S2 are connected with one other. Both switches must be switched ON or OFF!**

### 5.3  Scaling Measuring Direction

The measuring direction is determined or changed on the
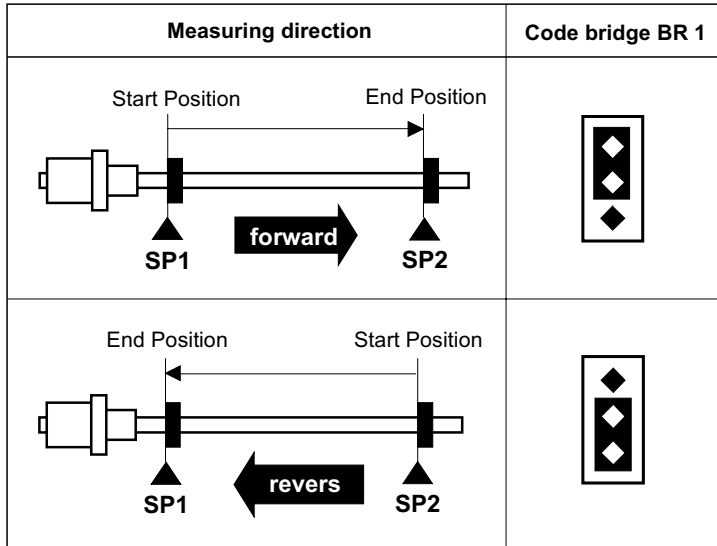analog card using the 3 pin code-bridge BR 1 (see page 7).

| Measuring direction | Code bridge BR 1 |
|---|---|
|  Start Position — End Position — SP1 — **forward** — SP2 |  |
|  End Position — Start Position — SP1 — **revers** — SP2 |  |

Fig. 10

### 5.4  Setpoint Adjustment

**IMPORTANT**
**Independent of measuring direction:**
**Setpoint SP 1 is always at sensor head**
**Setpoint SP 2 is always at sensor rod end**

For calibration of the Start and End position you need
2 decimal resistors or multispeed helical pot. Setups
are done using the resistors **R32** and **R34** (see page 7,
fig. 7) as following:

1. Turn potentiometers NULL **" N "** and SPAN **" S "**
   (page 7, fig 7) to the middle position.

2. For **R32** and **R34** connect compensating resistors  in
   the form of decimal resistors or helical potentiometers.



Start Position Setup

**R 32**    Fig. 11
**R 34**

End Position Setup
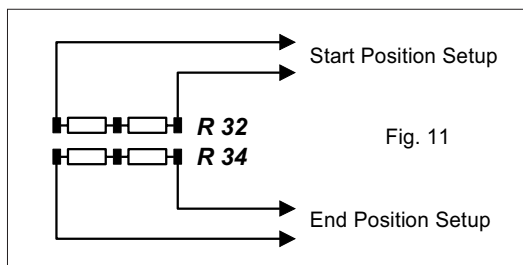
3. Attention!
   It is imperative that **R 34** is wired with a resistor
   (average value appx. 10 KOhms), as the power
   stages otherwise work without feedback.

4. Connect a Digitalmultimeter to the output of the
   analog board.

5. Bring the position magnet to the Start Position **SP1**
   or **SP2** and set the desired output using the decimal
   resistor or helical potentiometer at **R32**.

6. Read the resistance value off or measure the poten-
   tiometer value and connect as fixed resistor for **R32**

7. Check the output by approaching the start point
   from both sides several times, and correct where
   necessary using **" N "**.

8. Bring the position magnet to the End Position **SP1**
   or **SP2** and determine the fixed resistance for **R34** in
   the same manner as described for **R32**.

9. Check the output by approaching the end point
   from both sides several times, and correct where
   necessary using **" S "**.

10. If there is only 1 decimal resistor or 1 helical potentio-
    meter, before **R 32** is set, **R 34** must be provided with
    a **10 KOhms** fixed resistor.

**END**