novotechnik

MAX 100

Measuring Device for Digital Transducers

Operating Manual

Version 1.01

SUMMARY

1. Overview

Short Description

MAX 100 is a multi-functional measuring and display device for digital transducers. It supports all common digital point-to-point transducer interfaces like SSI24, SSI25, SSI48 and Start/Stop.

A power supply with America plug is also available.

	Article No.
MAX 100	055 036
Power Supply Europe Z-MAX-EU	055 037
Power Supply USA Z-MAX-US	055 038

Additionally there is a software on the Novotechnik website for configuration and data acquisition with the MAX 100 for free download. The LabVIEW source code is available on request.

Features

- Read and display data via SSI24/25/48 and Start/Stop interface
- Display of 1 or 2 interfaces separately in SSI48 mode
- Display of system data in SSI48 mode
- Support of up to 3 position markers in Start/Stop mode
- Fixed resolution of 5 µm in SSI24/25/48 mode
- Display of positions up to 5 m
- Variable velocity resolution in SSI48 mode
- Clock Frequency and clock rate selectable
- Changing between Binary- and Gray-Coding
- Resolution 1µm / 5µm
- Settings for processed data display
- Display language selectable between German or English
- 4 x 20 character LCD with backlight illumination
- very simple one-button operation
- RS-232 interface for reading the received SSI data and for remote control of the MAX 100 (115200 kBit/s, 8, N, 1)
- Read and modifiy the configuration settings via RS-232 interface
- all settings are preserved after power off

2. Getting Started

The MAX 100 is provided with an external power supply and two 8 pin transducer conntector cables with 2.5 m length each. The cables can adapt transducers with IEC 130-9 and M12x1 connections. The RS-232 cable is not part of delivery.

1. Connect power supply
2. Connect transducer
3. Switch on MAX 100
4. Check configuration if no or wrong data is displayed

Competitor products can be principally connected. But pin layout must be verified before linking to prevent the MAX 100 or the transducer from malfunction or destruction!

2.1. SSI24

Display of the position with a resolution of 5µm or 1µm per increment.

The values are displayed with a positive or negative prefix.

The actual value of the clock frequency (Cf) and clock rate (Cr) is displayed additionally.

```
SSI24
Cf=1MHz     Cr=1ms

Pos :   274.935 mm
```

2.2. SSI25

Display of the position with a resolution of 5µm or 1µm per increment.

The values are displayed with a positive or negative prefix.

The actual value of the clock frequency (Cf) and clock rate (Cr) is displayed additionally.

```
SSI25
Cf=1MHz     Cr=1ms

Pos :  1926.110 mm
```

2.3. SSI48 / DyMoS®

Position and Velocity Data

Display of the position with a resolution of 5µm or 1µm per increment. The values are displayed with sign in two's complement.

The velocity resolution depends on the transducer's internal cycle time. The MAX 100 can be adapted to this cycle time with a configuration parameter. Velocity data is displayed positively without sign independent of the direction of motion.

Two different display modes are selectable from the configuration menu: 1 or 2 pages.

In the two page display the data of SSI1 and SSI2 is shown separately. Thereby the configured clock frequency (Cf) and clock rate (Cr) as well as the corresponding error bits are displayed additionally. The second page and the following two pages for the system data display can be obtained by turning the button to the right.

In one page mode the position and velocity data from both SSI interfaces are displayed simultaneously. In this mode errors are only signaled acoustically by the beeper. The beeper can be switched off in the configuration menu.

first page in 2 page mode

```
SSI48          SSI1
Cf=500kHz    Cr=1ms
Pos1:  165.530 mm
Vel1:  320.0   mm/s
```

second page in 2 page mode

```
SSI48          SSI2
Cf=500kHz    Cr=1ms
Pos2:  426.655 mm
Vel2:  173.0   mm/s
```

1 page mode

```
Pos1:  165.530 mm
Vel1:  320.0   mm/s
Pos2:  426.655 mm
Vel2:  173.0   mm/s
```

System Data

The system data pages according to the SSI48 / DyMoS® specification are located directly behind the user data page(s). They are shown with the text *Sys1* bzw. *Sys2* in the upper right display edge.

Page *Sys1* shows the company name, measurement resolution and length sent by the transducer:

```
SSI48          Sys1
Company: Novotechnik
Resol. : 5 äm
Length : 1300 mm
```

Page *Sys2* shows the SSI1 and SSI2 interface mapping, calendar week of production, production year and a consecutive production number within the calendar week:

```
SSI48          Sys2
Map SSI1: Pos1/Vel1
Map SSI2: Pos2/Vel2
No: 0087  Wk:38 Y:03
```

The possible value ranges for the system data are described in chapter 4.

If no system data has been received after power on or if a CRC error of the system data has been detected, the following error message will be displayed on the two system data pages:

```
SSI48          Sys1

  No System Data
    available!
```

Error bits

Error bits only exist in SSI48 interface mode. In SSI24 and SSI25 mode the error state could only be detected by considering a certain data value e.g. 00000 or FFFFFF hex as the error value. But as both values can also be existing position values, the MAX 100 does not count it as an error.

Five different error will be detected:

1. Error bit received via SSI1 *)
   (an "E" with one dot below)

2. Error bit received via SSI2 *)
   (an "E" with two dots below)

3. CRC error on SSI1 user data detected
   (a "C" with one dot below)

4. CRC error on SSI2 user data detected
   (a "C" with two dots below)

5. CRC error on system data detected
   (a "C" with a horizontal dash below)

*) The error bit is the second bit in the SSI48 protocol.

The error bits are displayed depending on the selected page *(SSI1, SSI2, Sys1, Sys2)* in the middle of the first display line. On each page only the error bits assigned to the appropriate data channel (user data via SSI1, user data via SSI2, system data) are visible. This means that on page *SSI1* only error 1, 3 and 5 is visible, on page *SSI2* only error 2, 4 and 5 is shown and on page *Sys1/2* only error 5 is visible.

If the MAX 100 did not receive any system data after power on an error message in plain text will be displayed on the system data pages independent of the error bits.

The error events can be accompanied by a beep tone optionally. In one page mode there is not enough space available for the error display, so only acoustic signaling is possible.

The CRC error on interface SSI1 or SSI2 means the received data is invalid as well as the error bits 1 and 2. In this case the SSI error bits are reset (if they are present) until the CRC error has disappeared.

If the MAX 100 operates in SSI48 mode without a transducer connected to it, a CRC error for the system data will be displayed. The reason for this behaviour is that the SSI interfaces have a logic 1 level in their inactive state meaning that all bits in the SSI48 protocol are ones. But if the third bit of the protocol is set to 1, system data will be recognized. All bits of the CRC are high bits (1), too, so the CRC will be detected as erroneous. MAX 100 expects the system data on line SSI1, so a CRC error for the SSI1 user data cannot occur at the same time.

2.4. Start/Stop

Display of 1-3 positions with a display resolution of 1 µm. The built-in TDC (Time to Digital Converter) has a substantially higher resolution.

The maximum number of detectable stops can be set in the configuration menu. See chapter 3 for further details.

Due to the measurement of a time difference between the start and stop events only positive position values can occur.

The transducer's specific ultrasonic speed can be set in the configuration menu for fine adjustment of the position gradient. The specific ultrasonic speed is placed on the product label of transducers with a Start/Stop interface.

Novotechnik transducers with a Start/Stop interface always have a standardized ultrasonic speed of 2800 m/s.

StartStop
Pos3: 1624.000 mm
Pos2: 230.998 mm
Pos1: 97.281 mm

If position markers are withdrawn oder another markers are put on, the position display is restored after each newly detected stop signal. *Pos1* is always the position of the magnet which is next to the the transducer's connector.

Further position markers which are put after the third marker or disturbing signals that occur after the third stop signal will be ignored.

3. Configuration

In configuration mode different settings for the digital interfaces, display parameters etc. can be modified.

Modification of parameters or changes of the configuration page can be made by turning the button to the right (increment) or to the left (decrement). If the button is pressed, the mode can be toggled between parameter change and page change.

In parameter change mode an *E* (edit) is shown in the upper right corner of the display. If the letter *E* is not present, the configuration page can be changed by turning the button.

The configuration mode is entered by holding the button down for two seconds. After a security inquiry that has to be answered with *Yes*, the configuration parameters can be verified or changed:

Configuration E
Sure? Yes

The configuration mode is left if the button is pressed on the last page for confirmation:

Configuration
Save and exit?
Press button

Depending on the selected interface on the first configuration page, only the relevant parameters for this interface are visible, e.g. the mapping and cycle time is only used in SSI48 mode and can only be modified in this mode. If the configuration parameters are accessed via the RS-232 diagnostic interface they are all modifiable at the same time. Invalid combinations are acknowledged by a negative response.

The following pages show a detailed description of all configuration parameters:

Interface

Configuration
Interface
SSI48

The interface for the connected transducer is set.

Value range:
SSI24, *SSI25*, *SSI48* and *Start/Stop*

Mapping

Configuration
Mapping
D1: P1/V1 D2: P2/V2

Setting of the user data organisation in SSI48 mode on the differential data lines SSI1 (D1) and SSI2 (D2). This is called mapping. For further information on the mapping see chapter 4.
In the above example the position and velocity of the first magnet will be transmitted over the SSI1 interface. The position and velocity of the second magnet will be sent via SSI2.

Value range:
D1: P1/V1 D2: P2/V2 and
D1: P1/P2 D2: V1/V2

Display Mode

Configuration
Display Mode
2 Pages

Setting of the display mode for position and velocity data when the MAX 100 communicates with a SSI48 transducer. In one-page mode the position and velocitiy data of both SSI interfaces is displayed at the same time. In two-page mode the user data is separated in SSI1 one the first page and SSI2 on the second page.

Value range:
1 page, *2 pages*

Coding

Configuration
Coding
Binary

Only for SSI24/25: Changing the Coding-Style for the received data between Binary and Gray.

Value range:
Binary, *Gray*

Resolution

Configuration
Resolution
1 um

For SSI24/25 and SSI48 without SystemData: Changing the resolution for the received data between 1µm/Inc and 5µm/Inc.

For SSI48 with SystemData the resolution is automaticaly set by the resolution-bit.

Value range:
1 µm, *5 µm*

Cycle Time and Velocity Resolution

Configuration	
tcyc	V-Aufl.
1 ms	5 mm/s

Setting of the cycle time (t_{cyc}) i.e. the resolution of velocity data. Unfortunately these two parameters are anticyclic for magnetostrictive transducers due to the acquisition principle. This means that a small cycle time has a coarse velocity resolution and vice versa.

The cycle time is defined as the time between two measuring cycles. It cannot be reduced to any desired value as the ultrasonic wave needs a certain time to get back from the magnet to the reception unit. On longer transducers where the position marker is at the other end, the wave would not have enough time before the next acquisiton cycle begins.

The cycle time must not be confused with the update rate at the SSI interface with which the user data is updated. The update rate normally is a multiple time faster than the cycle time.

This parameter must correspond with the transducer's internal cycle time and can be requested from the manufacturer.

Value range for 5µm i.e. 1µm resolution:
500 µs at *10 mm/s* i.e. *2 mm/s*
1 ms at *5 mm/s* i.e. *1 mm/s*
2 ms at *2.5 mm/s* i.e. *0.5 mm/s*
4 ms at *1.25 mm/s* i.e. *0.25 mm/s*

Clock Frequency

Configuration
Clock Frequency
1 MHz

Setting of the clock frequency in SSI24/25/48 mode. This is the frequency of the clock pulses within the SSI clock burst.

Value range:
250 kHz, *500 kHz* and *1 MHz*

See also the additional information in the following section.

Clock Rate

Configuration
Clock Rate
1 ms

Setting of the SSI clock burst repeat rate. The parameter is used in SSI24/25/28 mode only.

Value range:
100 µs and *1 ms*

The combination possibilities of the clock frequency and the clock rate are limited. For example, if the clock repeat rate is very short (100 µs) and the clock frequency is slower (250 or 500 kHz) it could happen that the clock burst cannot be transmitted completely and that the next clock burst will overlap with the last burst. In this case, any data acquisition is impossible.

So the combinations of the interface mode, the clock frequency and the clock rate are limited.

The following table shows all combinations of clock frequency and clock rate:

Clock Frequency	Clock Rate	Remarks
250 kHz	1 ms	possible in all cases
500 kHz	1 ms	possible in all cases
1 MHz	1 ms	possible in all cases
250 kHz	100 µs	not possible
500 kHz	100 µs	possible on SSI24/25, not possible on SSI48
1 MHz	100 µs	possible in all cases

Not admissible parameter combinations that will lead to a malfunction during data acquisition are automatically corrected by the MAX 100.

Examples:
250 kHz and 1 ms are set. Now if the clock rate is lowered to 100 µs, the clock frequency is changed in the background at the same time to get a valid combination. If the clock frequency is lowered having the 1 MHz / 100 µs combination, the clock rate will be adjusted.

Wrong combinations received via the diagnostic interface will be acknowledged by a negative response.

Number of Position Markers

Configuration
No. Pos. Markers 3

Setting of the maximum number of position markers to be captured in start/stop mode.

After the MAX 100 has detected the defined number of stops, the acquisition of further stop pulses will be blocked until the next start pulse is generated. Hereby, an occurence of transmission line based glitches is suppressed and does not lead to any false data acquisition.

Value range:
1...3

Ultrasonic Speed

Configuration
Ultrasonic Speed 2800,0 m/s

The specific ultrasonic speed is set in start/stop mode.

The setting must correspond to the information printed on the transducer's label to get exact position data. This value is responsible for a fine adjustment of the gradient.

Novotechnik transducers with Start/Stop interface are always standardized to 2800 m/s.

Value range:
2790,0...2830,0 m/s

Language

Configuration
Language English

Setting for the display language in configuration and measuring mode.

If the language is set to *English*, all numbers are displayed with a decimal point instead of a comma.

Value range:
German and *English*

Display Average

Configuration
Display Average 1

Setting of a floating average calculation over *n* values. This parameter has influence on the display only to get a smoother output on intensive changing data.

If a highly dynamic data display without time lag is desired, this parameter should be set to 1.

Value range:
1...255

Display Update Rate

Configuration
Display Update Rate 160 ms

Setting of the update rate for data display. If the data values change very fast and the display is updated quickly, the values seem to float and can hardly be read due to the inertial of the human eyes and the LCD display.

With this parameter the display can be made slower to get readable results. The display for data values is updated every *n* ms. A setting between 160...200 ms is recommended for fast and readable data updates.

Value range:
20 ms...1000 ms in steps of 20 ms

Beeper

Configuration
Beeper On

The beeper for key press and acoustic error signaling in SSI48 mode can be switched on or off here.

Value range:
On and *Off*

For a better overview in configuration mode there are only those parameters accessible which are necessary for the interface set. The other parameters are not visible until the interface setting is changed. The following table shows the availbility of the parameters in different interface configurations:

Parameter	SSI24	SSI25	SSI48	St/Sp
Mapping	–	–	✓	–
Display Mode	–	–	✓	–
Cycle Time	–	–	✓	–
Clock Frequency	✓	✓	✓	–
Clock Rate	✓	✓	✓	–
Coding	✓	✓	–	–
Resolution	✓	✓	✓ –	–
No. Position Markers	–	–	–	✓
Ultrasonic Speed	–	–	–	✓
Language	✓	✓	✓	✓
Display Average	✓	✓	✓	✓
Display Update Rate	✓	✓	✓	✓
Beeper	✓	✓	✓	✓

4. SSI Interfaces

SSI stands for Serial Synchronous Interface and describes a synchronous interface with a differential clock line pair and a differential data line pair. The clock signal is sent by a control unit (e.g. the MAX 100) to the transducer. With each rising edge of the clock signal the transducer puts a data bit on the data line. The SSI48/DyMoS interface supports one or two data interfaces depending on the transducer option (SSI1 with DATA1/DATA1N and SSI2 with DATA2/DATA2N).

The inactive state of the clock and data lines is logical 1 and corresponds to a positive voltage between DATAx and DATAxN.

In SSI24/25/48 mode all position data has a + or - prefix, negative values are output in two's complement. Thereby care has to be taken that the value 0 as well as the value (F)FFFFF hex can be a valid position. So the control unit has to process the position data as values with a + or - prefix if the magnets can be placed close to the index point.

The clock and data lines are logical high in inactive state. The output data word will be latched in the transducer with the first falling edge of the clock to ensure data consistence. Data transmission begins with the first rising edge of the clock where the transducer puts a bit on the data line and continues to put further bits on the data line with each rising edge until the whole data has been transmitted. The control unit has to consider line capacities and driver delays when sampling the bits on the data line. After receiving the complete data word the data line will rest on logical low level until the the time t_m has expired. The transducer's t_m timer is started with the next falling edge of the clock signal after a complete data output. If the clock is interrupted or too slow, the serial data transmission is reset after the time t_o has expired.

SSI24

The position of a magnet is output with a resolution of 24 bits on SSI1. The MSB (most significant bit) is transmitted first.

SSI25

The position of a magnet is output with a resolution of 24 bits on SSI1. The first bit is a dummy bit that is always 0. The MSB (most significant bit) is transmitted first.

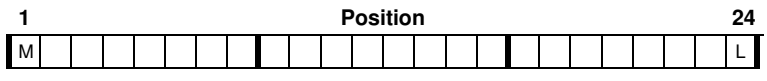
SSI48 / DyMoS®

The data frame is identical for both physical data lines SSI1 (DATA1) and SSI2 (DATA2). Only the contents of the user data vary depending on the mapping bit. The mapping bit is not used if system data is processed. When user data (position or velocity data) is transmitted, the LSB (least significant bit) is transmitted first for each data value.

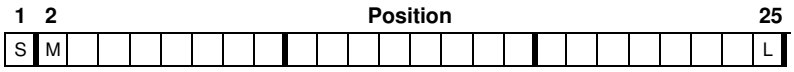
With the SSI48 interface it is possible to get system data information during the first four messages after power on of the transducer. The system data are usually sent via SSI1 and SSI2 simultaneously. The content of the system data is written during production and can not be modified by the user.

Velocity data does not have a sign bit. So it is always transmitted as a positive value independent of the direction of motion.

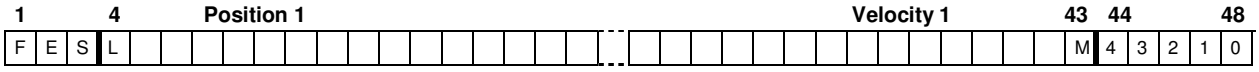
SSI 24



SSI 25



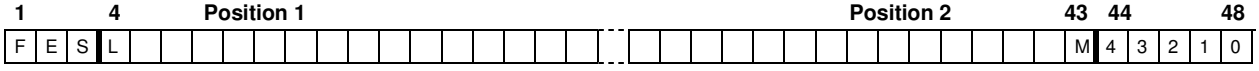
SSI48 *SSI1 Measurement Data, type 1*



F function bit (always 1)
E error bit (0 = no error, 1 = error)
S system bit (0 = user data, 1 = system data)

bit 4...23 position 1 (LSB...MSB)
bit 24...43 velocity 1 (LSB...MSB)
4...0 bit 4...0 of CRC

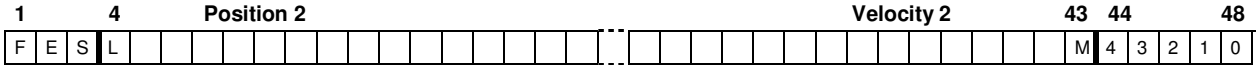
SSI 48 *SSI1 Measurement Data, Type 2*



F function bit (always 1)
E error bit (0 = no error, 1 = error)
S system bit (0 = user data, 1 = system data)

bit 4...23 position 1 (LSB...MSB)
bit 24...43 position 2 (LSB...MSB)
4...0 bit 4...0 of CRC

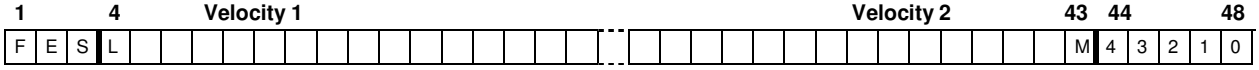
SSI48 *SSI2 Measuring data, type 1*



F function bit (always 1)
E error bit (0 = no error, 1 = error)
S system bit (0 = user data, 1 = system data)

bit 4...23 position 2 (LSB...MSB)
bit 24...43 velocity 2 (LSB...MSB)
4...0 bit 4...0 of CRC

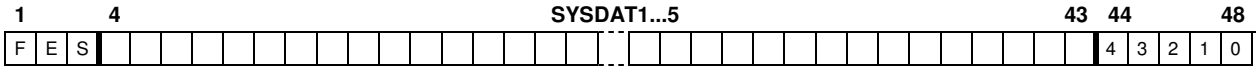
SSI48 *SSI2 Measuring data, type 2*



F function bit (always 1)
E error bit (0 = no error, 1 = error)
S system bit (0 = user data, 1 = system data)

bit 4...23 velocity 1 (LSB...MSB)
bit 24...43 velocity 2 (LSB...MSB)
4...0 bit 4...0 of CRC

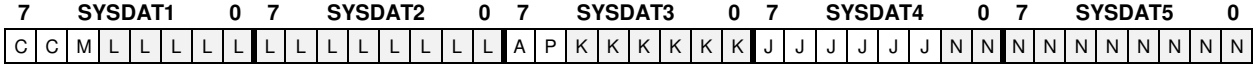
SSI48 *System data via SSI1 and SSI2*



F function bit (always 1)
E error bit (always 0 in system data mode)
S system bit (always 1 in system data mode)

4...0 bit 4...0 of CRC

Die Aufteilung der Systemdaten ist wie folgt:



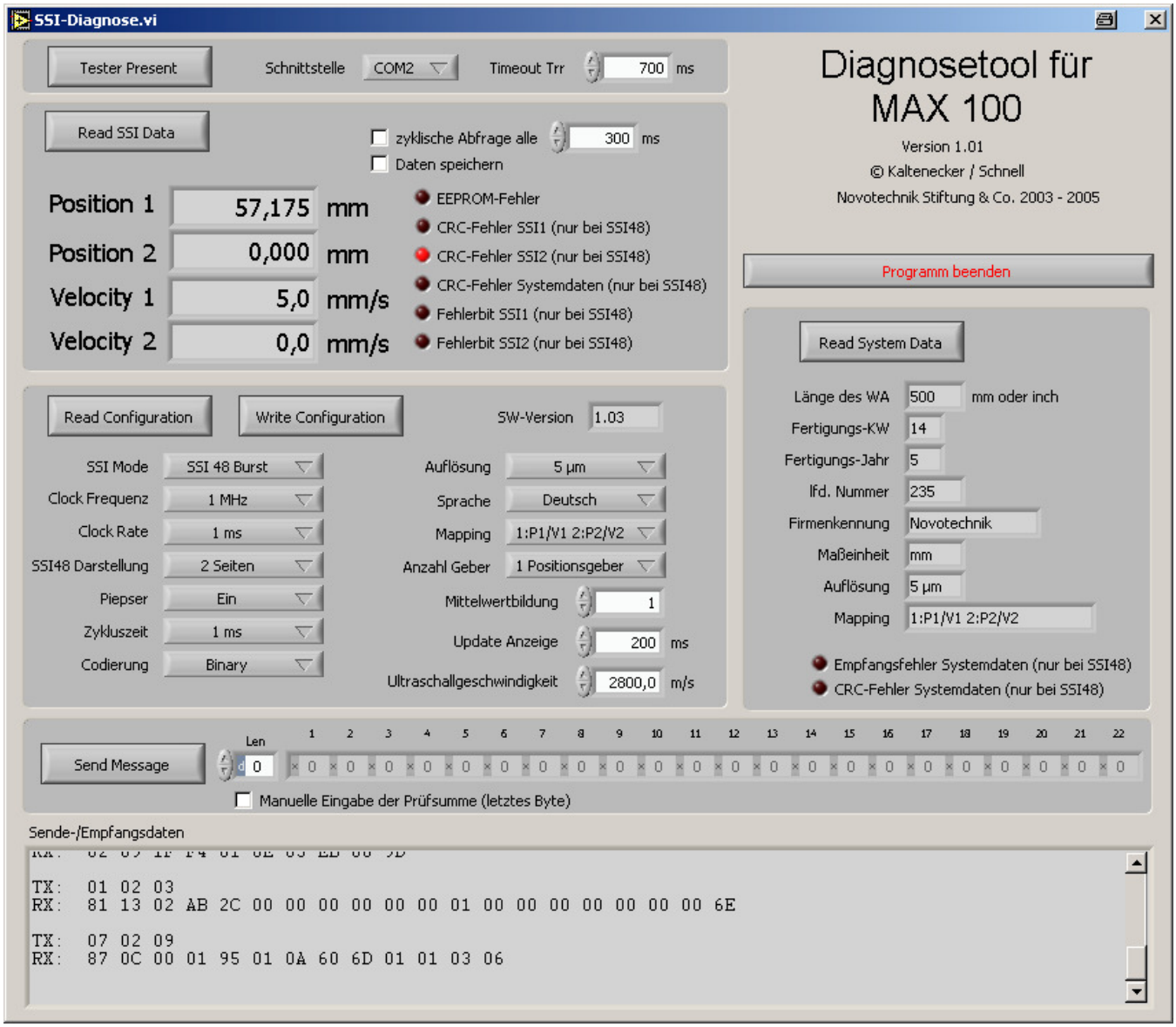
C company name (00/ 01/ 10 = reserved, 11 = Novotechnik)
M scale unit (0 = inch, 1 = mm)
L transducer length (1...8191 mm)
A resolution (0 = 1 µm, 1 = 5 µm)
P mapping for user data (0 = SSI1:Pos1/Pos2 and SSI2:Vel1/Vel2, 1 = SSI1:Pos1/Vel1 and SSI2:Pos2/Vel2)
K calendar week of production (1...52)
J year of production (1...63)
N identification number (0...1023)

5. Remote Control via RS-232

Measurement data and configuration parameters can be processed and controlled via the RS-232 interface of the MAX 100. A diagnostic tool for configuration and measurement and the serial interface protocol specification can be downloaded free of charge from the Novotechnik website.

A serial 1:1 cable with 9 pin SUB-D connector is necessary for the diagnostic communication. At least the lines RXD, TXD and GND must be connected.

An english version of the MAX 100 diagnostic tool is available on request.



6. Technical Data

6.1. MAX 100

Parameter	Remarks	Symbol	Value			Unit
			min	typ	max	
Supply Voltage		U_S	19,2	24	28,8	V
Supply Current		I_S			0,4	A
Operating Temperature		ϑ_B	0	–	+50	°C
Storage Temperature		ϑ_L	-10	–	+60	°C
Case Dimensions	241 x 195 x 55 (L x W x H)					mm
Case Color	black with dark blue foil					
LCD Type	4 x 20 characters, STN					
LCD Backlight Color	yellow / green					
LCD Backlight Illumination	yellow LED area					
LCD Character Height	2,95 x 4,75 (W x H)					mm

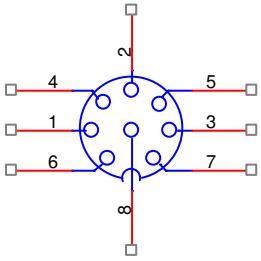
6.2. External Power Supply

Two different versions of the power supply are available. The only difference is the mains plug (Euro / U.S.).

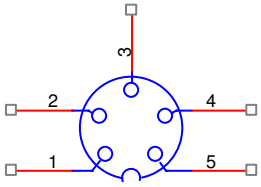
Parameter	Remarks	Symbol	Value			Unit
			min	typ	max	
Europe Type	Z-MAX-EU (L15D24M-P1J)					
USA Type	Z-MAX-US (L15D24B-P1J)					
Supply Voltage			100		240	VAC
Supply Frequency			50		60	Hz
Output Voltage	protected against short-circuits and overload			24		VDC
Supply Current					0,5	A
Power Dissipation					12	W
Dimensions	80 x 55 x 30,5 (L x W x H)					mm
Weight				190		g

6.3. Connector Pin Assignments

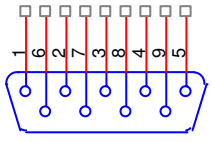
ON / OFF — Power Supply +24 V — RS-232 — Transducer Connection



Pin	Pulse (Start/Stop)	SSI without 331	SSI 331 only
1	INIT	CLK	CLK
2	STSP	DATA1	DATA1
3	INITN	CLKN	CLKN
4	—	—	DATA2N
5	STSPN	DATA1N	DATA1N
6	GND	GND	GND
7	24 V	24 V	24 V
8	—	—	DATA2



Pin	Function
1	GND
2	—
3	Case
4	—
5	24 V



RS-232

Pin	Function
1	—
2	TXD
3	RXD
4	—
5	GND
6	—
7	—
8	—

The assignment of the pin numbering and function is identical between the MAX 100 and the adapter cables.

7. Revision History

Version	Modifications	Date	Name
1.0	First edition	11/11/2003	Hahn
1.01	Binary-/Gray-Coding Resolution 1/5 µm for SSI24/25, automaticuly for SSI48 Resolution for reading Data over RS232 to 1µm i.e. 0.01mm/s	04/25/2005	Schnell

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