MEINBERG

Technical Information
Operating Instructions

FDM511

Impressum

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Features of the Frequency Deviation Monitor FDM511

The module FDM511 was designed to calculate and monitor the frequency in 50/60Hz power line networks. A preconnected reference is necessary that provides a high accuracy 10MHz clock, a serial time string and a PPS (pulse per second). In addition to the frequency, the time is calculated that would be displayed by a clock using the mains frequency as its timekeeping reference (PLT = Power Line Time). The accumulated differece between the drifting power line time PLT and the high accuracy reference time REF is called the time deviation (TD). Because the time deviation has the long-term accuracy of the reference, it is suitable to supervise the frequency stability. The time deviation can be read out either via serial interface or via one of the two integrated analog outputs for further evaluation or regulation.

Functional Principle

The power line frequency to be monitored is applied via the rear VG edge connector (optional: via a mains socket in the frontpanel) of the FDM511, then filtered and transformed. After that the sine-wave signal is converted into a TTL signal using a schmitt trigger. The rising edge of this TTL signal is used to start/stop a counter that is clocked by the high accuracy 10MHz pulse of the reference. Due to this, the period length of the mains frequency is measured with a resolution of 100ns and read out by the micro controller of the FDM511. The values are averaged over a period of one second and then the frequency is calculated with a resolution of 1mHz.

Calculation of the power line time PLT occurs by counting the periods of the mains frequency. Depending on the nominal frequency, the PLT seconds are incremented after counting 50 or 60 periods. To initialize the PLT, it is necessary to get the exact time via the serial interface (REF) and the pulse per second (PPS) from the preconnected reference. The time deviation TD is calculated once per second and is limited to ±100 seconds.

The Front Panel Layout

The 61mm wide front panel contains four LED indicators, two push buttons and a 8-digit alphanumerical LED display.

LED PL Time

This LED toggles once per second when the mains frequency is detected correctly. It stops toggling as soon as the mains frequency fails.

LED REF Time

This LED toggles once per second corresponding to the pulse per second of the reference. It stops toggling as soon as the PPS is not applied any longer.

LED Fail

This LED is switched on whenever a correct operation of the module is not ensured and the results are useless. Loss of the PPS, the mains frequency or the serial time string can cause this. The reason for the fault can be found out by reading the Error-Bits.

LED Overflow

This LED is switched on whenever one of the measurements exceeds its limits:

- Time Deviation is more than ±100 seconds
- Frequency is below 45Hz or above 65Hz
- Analog Output exceeds ±2,5V

The LED is switched off again as soon as all values are back within their limits.

Push Buttons

Measurement and status information can be selected to be shown on the display using the two push buttons. The **Menu** button is used to skip to several sub menus while the **Set** button is used to select the corresponding item and display its content. In the setup menu the push buttons are also used to change the configuration of the FDM511 or to enter parameters.

Display

The 8-digit alphanumerical LED display shows the measurements of the FDM511 like frequency and time deviation. Furthermore, in the setup menu the display is used to show configuration parameters and status information.

Analog Outputs

FDM511 provides two analog outputs for longtime-recording. These outputs have a range of -2.5V ... +2.5V, divided in 65536 steps. Either the frequency deviation or the time deviation can be selected for monitoring via one of these analog outputs.

Serial COM Ports

The frequency deviation monitor provides two serial RS-232 interfaces, COM0 and COM1. Both ports are able to spread the calculated measurements of the FDM511 once per second, the format of the string can be selected. In addition, COM0 is used for some serial commands sent to the module, e.g. for setting a time deviation preset value. Firmware updates are also possible using this port. The serial input of COM1 is used to read in the time information of the preconnected reference.

EEPROM

The non-volatile EEPROM is used to store the settings of the FDM511. This ensures a proper restart without any new configuration after the module was switched off for a certain time. The two push bottons in the front panel and the LED display are used to set the parameters (see "Menu SETUP").

Installation

Power Supply

FDM511 needs a single supply voltage of +5V/150mA. As soon as the power supply and the requested input signals are applied, the module starts operation.

Input Signals

The following input signals, provided by a preconnected reference, are necessary for operation of the frequency deviation monitor FDM511:

a) 10MHz oscillator clock, TTL level, rear edge connector pin Z12
b) pulse per second, TTL level (active-high), rear edge connector pin D6
c) time string, RS-232, rear edge connector pin B10 (RxD1)

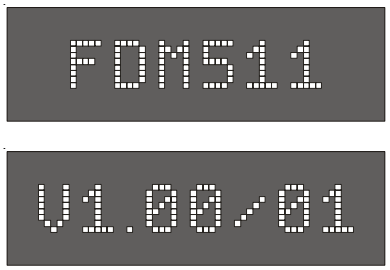
A GPS receiver GPS170 or a DCF77 radio clock PZF511 can be used as a reference, for example.

Powering Up the System

If all the input signals, the power supply and the power line to be monitored have been connected to the FDM511, the system is ready to operate. The "Fail"-LED as well as the "Overflow"-LED are switched on after power up reset. FDM511 waits for the incoming serial time string via COM1 to initialize the internal system time (REF time). When this is done, the PL time is also initialized with the REF time and consequently, the time deviation TD is set to +00.000s. From now on the REF time is incremented with the PPS applied while the PL time is incremented by a certain number of recorded mains frequency periods (50 or 60). The "PL" and "REF"-LEDs start toggling once per second, corresponding to their time base. The Fail LED is switched off.

The Menus in Detail

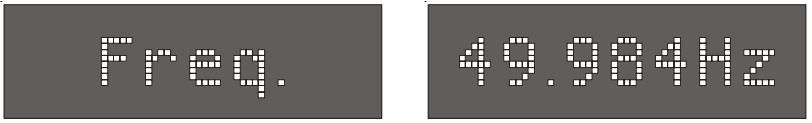
After power-up, the type of the module and the firmware revision is displayed for a short time. Successively, the following items appear before the display begins to shows the mains frequency automatically:



Knowledge of the firmware revision is helpful whenever technical support from Meinberg is needed. The **Menu** button is used to skip to the menus described in the following. The corresponding content of the menu is displayed after selection is done with the **Set** button.

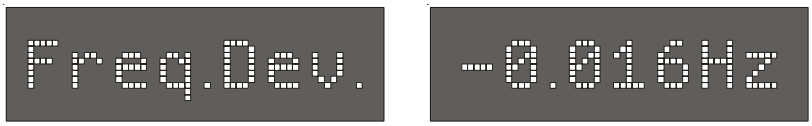
Menu Frequency

The actual calculated mains frequency is displayed with a resolution of 0.001Hz. This is the default content of the display after powering-up the module.



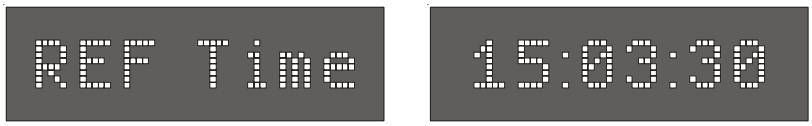
Menu Frequency Deviation

This menu, choosen with the **Set** button, shows the deviation of the mains frequency from the nominal frequency (50 of 60Hz). The frequency deviation is a signed value with the same resolution and accuracy of the mains frequency.



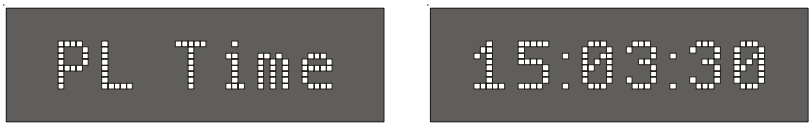
Menu REF Time

The time, provided by the reference, is shown in this menu.



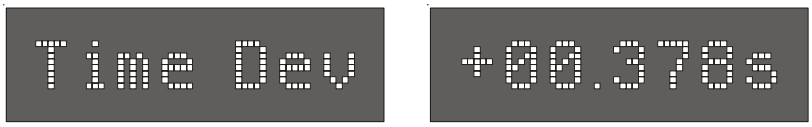
Menu PL Time

The power line time is displayed when this menu is selected. The PL time is set to the REF time after a power-up reset and thereafter is clocked with the mains frequency as its timekeeping reference. Therefore, time jumps, like changeover in daylight saving or leap seconds, will not be executed!



Menu Time Deviation

The time deviation is the difference between the exact REF time and the drifting PL time. The displayed value is signed, has a resolution of 1ms and is limited to its maximum of ±99.999s. If this limit is exceeded, an error bit is set (see "Error Bits") and the "Overflow"-LED is switched on. The time deviation is set to +00.000s after power-up reset, but can be set to any preset value via the Setup Menu "TD Init". The long-term accuracy of the time deviation is equal to the pulse per second from the reference.



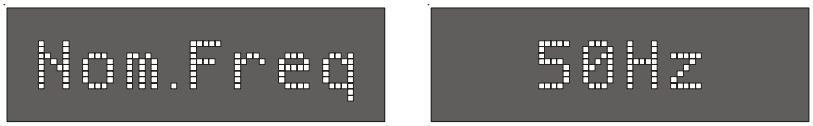
Menu SETUP

The setup menu allows the configuration of the FDM511. To avoid the erroneous change of these parameters, it is not possible to skip to the submenus by pressing the **Menu** button. Rather than before, the setup submenus will be released not before the **Set** button is pressed for at least one second and the character '*' appears behind the text "SETUP".

Thereafter, the **Menu** button is used to show all available setup submenus that can be entered for configuration with the **Set** button as descibed before. Successively the following setup menus appear when pressing **Menu**.

Menu Nominal Frequency

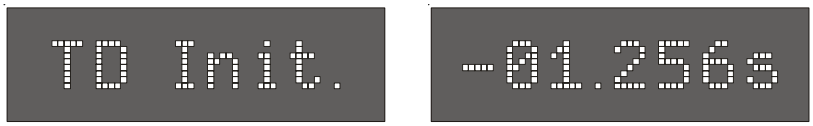
The frequency deviation monitor FDM511 is suitable for 50Hz power networks and for 60Hz networks as well. Selection is made in this submenu.



After entering the menu with the **Set** button, the currently stored parameter is shown. To change the nominal frequency, the **Set** button must be pushed once. The content of the display starts flashing and can be altered by pressing **Set** again. When the designated parameter appears, the configuration is stored and the submenu is left by pressing the **Menu** button for at least one second. **Menu** must be pressed again to skip to the next menu.

Menu Time Deviation Init

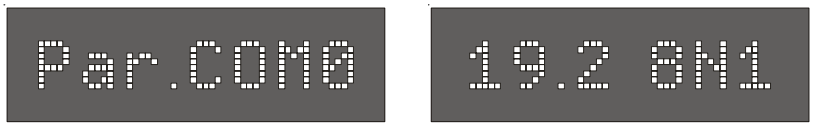
After power-up, the PL time is reset to the REF time and therefore the time deviation is set to +00.000s. However, if a different start value is required because of any reason, a time deviation preset value in the rage between -99.999s and +99.999s can be entered in this menu. The PL time is calculated according to the new value of the time deviation.



After pressing the **Set** button once, the actual time deviation is displayed. The first digit of the time deviation value starts flashing when the **Set** button is pressed once more. This digit can be changed by using the **Set** button again. After the first digit has been changed successfully, the **Mode** button is to press shortly to skip to the next digit that can be changed in the same manner. After all digits are set and the designated value for the time deviation is entered, the configuration is stored and the submenu is left by pressing the **Menu** button for at least one second. FDM511 calculates the corresponding PL time, this causes the "Fail"-LED to be switched on for a short time before normal operation is started again. **Menu** must be pressed again to skip to the next menu.

Menu COM Parameter

The two setup menus PAR.COM0 and PAR.COM1 allow the configuration of the serial RS232 ports COM0 and COM1.



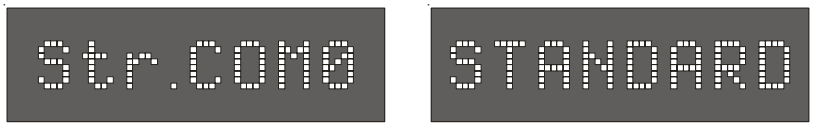
Changing the COM Port parameters occurs by using the buttons **Menu** and **Set**, as described already. The following settings are possible:

Baudrate: 0.6 / 1.2 / 2.4 / 4.8 / 9.6 and 19.2 kBaud
Framing: 7N2 / 7E1 / 7E2 / 8N1 / 8N2 / 8E1 / 7O2 and 8O1

Note: Make sure that the configuration of COM1 corresponds with the COM parameters of the preconnected reference clock! This is mandatory, because the input of COM1 is used to read in the REF time. The output sends a serial output string once per second, this applies for COM1 as well as for COM0. The format can be selected in the next sub menu.

Menu Output String

The two setup menus Str.COM0 and Str.COM1 allow the selection of the serial output strings for COM0 and COM1.



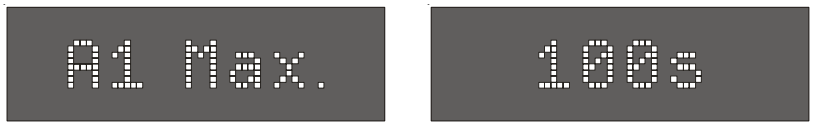
Selection is done with the push buttons **Menu** and **Set**. The following strings are available:

- Standard FDM String
- Short FDM String
- AREVA String

The format of the output strings is described in chapter "Serial Output Strings".

Menu Analog Outputs

FDM511 provides two independent analog outputs, A1 and A2. These outputs have a voltage range of -2.5V to +2.5V, divided in 65536 steps. The value that causes a full scale deflection of the corresponding analog output, can be defined in this menus (A1 Max. and A2 Max.). Either the frequency deviation or the time deviation can be selected for monitoring via one of these analog outputs.



The following values can be defined for a full scale deflection:

Frequency Deviation:
- 500mHz (which corresponds with a frequency deviation of 0,2mHz/mV)
- 5Hz (which corresponds with a frequency deviation of 2mHz/mV)

Time Deviation:
- 10s (which corresponds with a time deviation of 4ms/mV)
- 100s (which corresponds with a time deviation of 40ms/mV)

If the full scale deflection of ±2,5V is reached while the corresponding value raises forward, error bits are set (see "Error Bits") and the "Overflow"-LED is switched on.

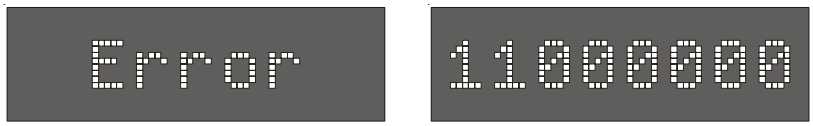
The values of the two analog outputs can also be red out via the serial port COM0 by sending the character '**A**' (ASCII code 41h). FDM511 sends a string in the following format:

A1:*XXXX*_A2:*XXXX*<CR><LF>

The values are given in hex code (0000h ... FFFFh). The initial state is 8000h.

Menu Error Bits

FDM511 recognizes fail and overflow events and sets or clears eight error bits accordingly. These bits are shown in this menu. Reading this bits, the user is able to understand why the "Fail"-LED or the "Overflow"-LED is switched on.



Each error bit represents a certain source of fault that occurs during the normal operation. The format of the displayed bits is: $X_8X_7X_6X_5X_4X_3X_2X_1$. The single bits have the following meaning:

- X_8: **A2 Overflow**, analog output 2 has reached its full scale deflection
- X_7: **A1 Overflow**, analog output 1 has reached its full scale deflection
- X_6: **Time Deviation Overflow**, the time deviation exceeds ±99.999s
- X_5: **Frequency Overflow**, the frequency deviation exceeds ±9.999Hz or the frequency is < 45Hz or > 65Hz
- X_4: **REF Free**, no pulse per second (PPS) from the reference
- X_3: **PL Free**, no power line detected (PL time runs free)
- X_2: **No Time String**, no serial time string from the reference
- X_1: **No PL Init**, the PL time has not been initialized (yet)

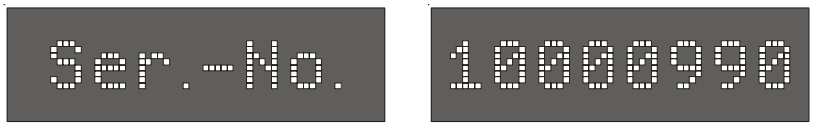
The "Fail"-LED is on whenever one of the error bits X_1 to X_4 is set whereas the "Overflow"-LED is switched on by one of the error bits X_5 to X_8.

The error bits can be red out via the serial port COM0 by sending the character '**E**' (ASCII code 45h). The format of the return string is:

ERROR:$X_8X_7X_6X_5X_4X_3X_2X_1$**<CR><LF>**

Menu Serial Number

The serial number of the FDM511 is displayed in this menu. This number may be helpful to know if the user asks Meinberg for support. The most significant eight digits of the serial number are displayed first, after pressing the **Set** button the next digits are shown.



The serial number and the firmware revision of the FDM511 can be red out by sending the three characters "**SN!**" via COM0 to the module that returns the following string:

SN: 041110000990 REV:01.00/01<CR><LF>

Serial Output Strings

Several output strings are available with the FDM511. Selection is made in the setup menu "Str.COM0" and "Str.COM1". The format of the output strings as well as related input strings or commands are described in the following.

Standard FDM String

The STANDARD string is a sequence of 62 ASCII characters containing the frequency F, the frequency deviation FD, the REF time, the power line time PLT and the time deviation TD, each item seperated by a space character. The string is send out at the beginning of every new REF time second and ends with the characters Carriage-Return (ASCII code 0Dh) and Line-Feed (ASCII code 0Ah). The letters displayed in ***italics*** are replaced by the calculated values whereas the other characters are part of the string:

F:***49.984***_FD:***-00.016***_REF:***15:03:30***_PLT:***15:03:30.378***_TD:***+00.378***<CR><LF>

The meaning of the several values is described below:

F:*49.984* The measured power line frequency with a resolution of 1mHz

FD:*-00.016* The frequency deviation between calculated and nominal frequency, with sign character (+/-), resolution: 1mHz, maximum: ±09.999Hz

REF:*15:03:30* The reference time from the preconnected clock, (hours:minutes:seconds)

PLT:*15:03:30.378* The power line time, based on the mains frequency, (hours:minutes:seconds.milliseconds)
Time jumps, like changeover in daylight saving or leap seconds, will not be executed by the PL time!

TD:*+00.378* The time deviation between REF time and PL time, with sign character (+/-), resolution: 1ms, maximum: ±99.999s

Short FDM String

The SHORT string is a sequence of 23 ASCII characters containing simply information about frequency deviation FD and time deviation TD, seperated by a space character. The string is send out at the beginning of every new REF time second and ends with the characters Carriage-Return (ASCII code 0Dh) and Line-Feed (ASCII code 0Ah). The letters displayed in ***italics*** are replaced by the calculated values whereas the other characters are part of the string:

FD:***-00.016***_TD:***+00.378***<CR><LF>

The meaning of the several values is described below:

FD:*-00.016* The frequency deviation between calculated and nominal frequency, with sign character (+/-), resolution: 1mHz, maximum: ±09.999Hz

TD:*+00.378* The time deviation between REF time and PL time, with sign character (+/-), resolution: 1ms, maximum: ±99.999s

Time Deviation Preset String

The time deviation TD can be preset to a value between -99.999s and +99.999s. This can be done in the setup menu "Time Deviation Init" and also via the serial interface COM0. Sending the following string to the FDM511 causes the module to set the time deviation and the PL time is recalculated according to this new value:

TD:*+05.873*<CR><LF>

This serial method can be used to reset the time deviation back to +00.000s. This is also caused by pulling down the /Reset input (see rear VG-Edge connector pin assignment) or by a power-up reset.

Note: The described time deviation preset method is available via COM0, only, and **not** with COM1! Furthermore, the output string STANDARD or SHORT has to be choosen for COM0.

Areva FDM String

The AREVA string is a sequence of 71 ASCII characters containing the frequency F, the frequency deviation FD, the time deviation TD, the power line time PLT and the reference time REF (preceded by the 3 digit day-of-the year), each item seperated by the characters Carriage-Return (ASCII code 0Dh) and Line-Feed (ASCII code 0Ah). Each of the five data items is preceded by a fixed 3 digit address (020 ... 024). The string starts with the STX character (start-of-text, ASCII code 02h) and ends with a terminating ETX character (end-of-text, ASCII code 03h) on time with the change of the REF time seconds. The letters displayed in ***italics*** are replaced by the calculated values whereas the other characters are part of the string:

<STX> 020***49.984***<CR><LF>
021***-0.016***<CR><LF>
022***+00.378***<CR><LF>
023***15_03_30.378***<CR><LF>
024***068_15_03_30_***<CR><LF>
<ETX>

The meaning of the several values is described below:

49.984	The measured power line frequency with a resolution of 1mHz
-0.016	The frequency deviation between calculated and nominal frequency, with sign character (+/-), resolution: 1mHz, maximum: ±09.999Hz
+00.378	The time deviation between REF time and PL time, with sign character (+/-), resolution: 1ms, maximum: ±99.999s
15_03_30.378	The power line time, based on the mains frequency, (hours_minutes_seconds.milliseconds) Time jumps, like changeover in daylight saving or leap seconds, will <u>not</u> be executed by the PL time!
068_15_03_30	The reference time from the preconnected clock, (day-of-the-year_hours_minutes_seconds)

Over Range Condition

Whenever the frequency deviation or the time deviation exceeds its allowable limit (±9.999Hz or ±99.999 seconds), an over range condition occurs. In this case the corresponding value is sent out as a sign character (+ or -) followed by 9_ _ _ _ , where the <_> character represents a space, e.g.: '+9 ' would follow +9.999 when incremented by 0.001. Furthermore, this condition is indicated bythe Overflow LED.

Time Deviation Preset

A time deviation preset value in the range of -99.999 to +99.999 seconds can be set by a serial ASCII command via the serial interface COM0. Sending the following string to the FDM511 causes the module to set the time deviation and the PL time is recalculated according to this new value. All previously accumulated time deviation is lost.

The ASCII command to set the preset value starts with the characters "F27PS" and ends with the Carriage-Return (ASCII code 0Dh) and Line-Feed (ASCII code 0Ah). The numbers displayed in ***italics*** are replaced by the time deviation preset value whereas the other characters are part of the string. Examples:

send Preset Value +10.553:	
F27PS+***10.553***<CR><LF>	(string sent to FDM511)
OK<CR><LF>	(response from FDM511)
send Preset Value -08.68:	
F27PS-***08.68***<CR><LF>	(string sent to FDM511)
OK<CR><LF>	(response from FDM511)
read out the Preset Value:	
F27PS<CR><LF>	(string sent to FDM511)
F27PS=-*08.680*<CR><LF>	(response from FDM511)

The preset value **must** be entered with the sign (+ or -), two digits as integer (01 to 99), a dot as separatror (.) and two or three following decimal places. FDM511 returns the **OK** acknowledge and recalculates the corresponding PL time. This causes the "Fail"-LED to be switched on for a short time before normal operation is started again.

Note: The described time deviation preset method is available via COM0, only, and **not** with COM1! Furthermore, the output string AREVA has to be choosen for COM0.

Firmware Updates

Whenever the on-board software must be upgraded or modified, the new firmware can be downloaded to the internal flash memory via the serial port COM0.

If the **Menu** button in the front panel is pushed down while the system is powered up, a bootstrap-loader will be activated that waits for instructions from the serial port COM0. The new firmware can be sent to the FDM511 from any standard PC with serial interface. A loader program will be shipped together with the file containing the image of the new firmware.

The contents of the program memory will not be modified until the loader program has sent the command to erase the flash memory. So if the **Menu** button is pushed down unintentionally while the system is powered up, the firmware will not be changed accidentially. After the next power-up, the system will be ready to operate again.

CE Label

CE

This device conforms to the directive 2004/108/EG on the approximation of the laws of the Member States of the European Community relating to electromagnetc compatibility.

Technical Specifications FDM511

DISPLAY:	8-digit alpha-numerical LED Display for showing the FDM511 results as well as status information. Character height: 5mm
INPUT SIGNALS:	10MHz oscillator clock (TTL level) pulse per second, activ high (TTL level) serial time string (RS232), Meinberg Standard Time String or Uni-Erlangen Time String (see "Time Strings") mains voltage, 70V... 270V, 45Hz ... 65Hz (protected with 200mA fuse, slow blowing)
OUTPUTS:	2 analog outputs: -2,5V ... 2,5V, resolution: 16 bit fail output (TTL level) overflow output (TTL level)
SERIAL RS232 PORTS:	2 serial RS232 ports (COM0, COM1), configurable: Baudrate: 600, 1200, 2400, 4800, 9600 or 19200 Baud Framing: 7N2, 7E1, 7E2, 8N1, 8N2, 8E1, 7O2 or 8O1 output and average once per second output string selectable (see chapter "Serial Output Strings")
ACCURACY OF MEASUREMENT:	frequency: accuracy of reference (10MHz) ±1mHz time deviation: accuracy of reference (PPS) ±1ms
CONNECTORS:	rear VG edge connector, mixed F/H, DIN 41612 Type F: 24 poles, type H: 7 poles optional: mains socket in the front panel
POWER REQUIREMENTS:	+5V, 150mA
PHYSICAL DIMENSIONS:	Eurocard, 100mm x 160mm, 1.5mm Epoxy
FRONT PANEL:	3U / 12HP (128mm high x 61mm wide), Aluminium
AMBIENT TEMPERATURE:	0 ... 50°C
HUMIDITY:	max. 85 %
OPTIONS:	power line input via mains socket in the front panel RJ45 ethernet connection for monitoring the results via network

Time Strings

Format of the Meinberg Standard Time String

The Meinberg Standard Time String is a sequence of 32 ASCII characters starting with the STX (start-of-text) character and ending with the ETX (end-of-text) character. The format is:

<STX>D:*dd.mm.yy*;T:*w*;U:*hh.mm.ss*;*uvxy*<ETX>

The letters printed in *italics* are replaced by ASCII numbers whereas the other characters are part of the time string. The groups of characters as defined below:

<STX> Start-Of-Text (ASCII code 02h)

dd.mm.yy the current date:

dd	day of month	(01..31)
mm	month	(01..12)
yy	year of the century	(00..99)

w the day of the week (1..7, 1 = Monday)

hh.mm.ss the current time:

hh	hours	(00..23)
mm	minutes	(00..59)
ss	seconds	(00..59, or 60 while leap second)

uv clock status characters (depending on clock type):

u:
- '#' GPS: clock is running free (without exact synchr.)
  PZF: time frame not synchronized
  DCF77: clock has not synchronized after reset
- ' ' (space, 20h)
  GPS: clock is synchronous (base accuracy is reached)
  PZF: time frame is synchronized
  DCF77: clock has synchronized after reset

v:
- '*' GPS: receiver has not checked its position
  PZF/DCF77: clock currently runs on XTAL
- ' ' (space, 20h)
  GPS: receiver has determined its position
  PZF/DCF77: clock is syncronized with transmitter

x time zone indicator:

'U'	UTC	Universal Time Coordinated, formerly GMT
' '	MEZ	European Standard Time, daylight saving disabled
'S'	MESZ	European Summertime, daylight saving enabled

y anouncement of discontinuity of time, enabled during last hour before discontinuity comes in effect:
- '!' announcement of start or end of daylight saving time
- 'A' announcement of leap second insertion
- ' ' (space, 20h) nothing announced

<ETX> End-Of-Text (ASCII code 03h)

Format of the Uni Erlangen Time String

The time string Uni Erlangen (NTP) of a **GPS clock** is a sequence of 66 ASCII characters starting with the STX (start-of-text) character and ending with the ETX (end-of-text) character. The format is:

<STX>tt.mm.jj; w; hh:mm:ss; voo:oo; acdfg i;bbb.bbbbn lll.llle hhhh*m*<ETX>

The letters printed in *italics* are replaced by ASCII numbers whereas the other characters are part of the time string. The groups of characters as defined below:

<STX> Start-Of-Text, ASCII Code 02h
sending with one bit occuracy at change of second

dd.mm.yy the current date:

dd	day of month	(01..31)
mm	month	(01..12)
yy	year of the century	(00..99)

w the day of the week (1..7, 1 = Monday)

hh.mm.ss the current time:

hh	hours	(00..23)
mm	minutes	(00..59)
ss	seconds	(00..59, or 60 while leap second)

v sign of the offset of local timezone related to UTC

oo:oo offset of local timezone related to UTC in hours and minutes

ac clock status characters:

a:
- '#' clock has not synchronized after reset
- ' ' (space, 20h) clock has synchronized after reset

c:
- '*' GPS receiver has not checked its position
- ' ' (space, 20h) GPS receiver has determined its position

d time zone indicator:

'S'	MESZ	European Summertime, daylight saving enabled
' '	MEZ	European Standard Time, daylight saving disabled

f anouncement of discontinuity of time, enabled during last hour before discontinuity comes in effect:
- '!' announcement of start or end of daylight saving time
- ' ' (space, 20h) nothing announced

g anouncement of discontinuity of time, enabled during last hour before discontinuity comes in effect:
- 'A' announcement of leap second insertion
- ' ' (space, 20h) nothing announced

i	leap second insertion 'L' leap second is actually inserted (active only in 60th sec.) ' ' (space, 20h) no leap second is inserted
bbb.bbbb	latitude of receiver position in degrees leading signs are replaced by a space character (20h)
n	latitude, the following characters are possible: 'N' north of equator 'S' south d. equator
lll.llll	longitude of receiver position in degrees leading signs are replaced by a space character (20h)
e	longitude, the following characters are possible: 'E' east of Greenwich 'W' west of Greenwich
hhhh	altitude above sea level in meters leading signs are replaced by a space character (20h)
<ETX>	End-Of-Text, ASCII Code 03h

Rear Connector Pin Descriptions

Signal Name	Pin	Description
VCC in (+5V)	B, D+Z2	+5V supply voltage
GND	B, D+Z16	power supply ground
/BSL (/RESET)	Z4	TD Reset (reset time deviation to +00.000s), Boot signal for starting bootstrap loader (pull down while powering-up)
P_SEC in	D6	pulse per second input, TTL level, active high
10 MHz in	Z12	10 MHz oscillator clock input, TTL-Pegel
COM0 TxD out	D8	COM0 RS-232 transmit data output
COM0 RxD in	B8	COM0 RS-232 receive data input
COM0 GND	Z6	COM0 ground (=power supply ground)
COM1 TxD out	D10	COM1 RS-232 transmit data output
COM1 RxD in	B10	COM1 RS-232 receive data input
COM1 GND	B12	COM1 ground (=power supply ground)
A1 out	B4	analog output no. 1
A2 out	B6	analog output no. 2
A_out GND	D4	analog output ground (=power supply ground)
+USB	D14	reserved for extensions
-USB	B14	reserved for extensions
Fail out	Z8	fail output (Fail LED), TTL level
Overflow out	D12	overflow output (Overflow LED), TTL level
Reserve in	Z10	input, reserved for extensions
L1	Z28	L, mains voltage
N	D30	N, mains voltage
PE	Z32	PE, protective earth conductor

Rear Connector Pin Descriptions

	Z	B	D
2	VCC in (+5V)	VCC in (+5V)	VCC in (+5V)
4	/BSL	A1 out	GND
6	GND	A2 out	P_SEC in
8	Fail out	RxD0	TxD0
10	Reserve in	RxD1	TxD1
12	10MHz in	GND	Overflow out
14		-USB (optional)	+USB (optional)
16	GND	GND	GND
20			
22			
24			
26			
28	L1		
30			N
32	PE