MEINBERG

Technical Information

Operating Instructions

FDM509

Impressum

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Table of Contents

Generally

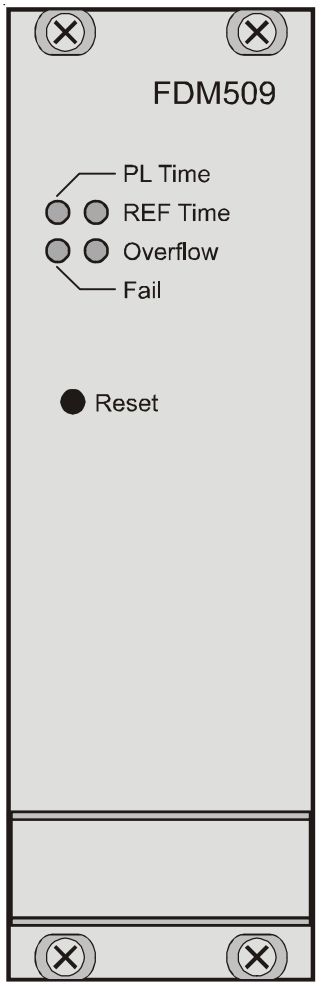
The module FDM509 was designed to calculate and monitor the frequency in 50/60Hz power line networks. A preconnected reference is necessary that provides a high accuracy 10MHz frequency, a serial time string and a PPS (pulse per second). Additional to the frequency the "PLT" (Power Line Time) is calculated that would be displayed by a clock using the mains frequency as its timekeeping reference. The accumulated differece between the drifting power line time and the high accuracy reference time (REF) is called "time deviation". 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 the 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 FDM509, then filtered and transformed. After that the sine-wave signal is converted into a TTL signal using a schmitt trigger. The rising edge of the TTL signal is used to start/stop a counter that is clocked by the high accuracy 10MHz pulse of the reference. Because of that the period length of the mains frequency is measured with a resolution of 100ns and read out by the micro controller of the FDM509. The values are averaged over a period of one second or one minute (selectable) and then the frequency is calculated with a resolution of 1mHz.

Calculation of the PL time occurs by counting the periods of the power line frequency. Depending on the nominal frequency the PL time seconds are incremented after counting 50 or 60 periods. To initialize the PL time it is necessary to get the exact time via the serial interface. The time deviation is calculated once per second or once per minute and is limited to ±100 seconds.

The Front Panel Layout



The 40.6mm wide front panel integrates four LED indicators and a covered push button.

LED PL Time

This LED toggles once per second corresponding to the power line time seconds when the mains frequency is detected correctly. It stops toggling if either the mains frequency or the 10MHz reference is not applied or the REF time could not be read out after reset.

LED REF Time

This LED toggles once per second corresponding to the pulse per second of the reference. It stops toggling if either the PPS or the 10MHz reference is not applied or the REF time could not be read out after reset.

LED Overflow

This LED is switched on when the time deviation (the difference between REF time and PL time) exceeds the limit of ±100 seconds. It is switched off again when either the time deviation is dropped below ±100 seconds or a reset sets the time deviation back to zero.

LED Fail

This LED is switched on if correct operation of the module is not ensured and the results are unusable. Loosing the PPS or the 10MHz from the referenc could be a reason for this as well as an error in reading in the REF time. The serial output of the measure string is stopped when this LED is switched on.

Push Button Reset

The time deviation is set to zero if this covered key is pressed for one second at least. Furthermore the PL time is initialized with the REF time, provided that a time string is applied to the serial port COM1 and the corresponding DIP switch is set. If not, both the PL time and the REF time are set to 00:00:00. Also all error bits are cleared and the analog outputs are set to their initial state (0V). Pressing the reset key has the same effect than causing a hardware power-up reset or sending a serial reset command.

Mains Socket Power Line (optional)

The power line frequency to be monitored may be connected to the module via this optional power socket in the front panel instead of the rear VG edge connector. The power supply for the FDM509 occurs not via this applied mains voltage but via the rear edge connector (+5V). To detect the mains frequency of 45 ... 65 Hz correctly the voltage of the connected mains must be in the range of 70V ... 270V AC. This input is protected by a 200mA slow blowing fuse.

Installation FDM509

Power Supply

FDM509 requests only one single supply voltage of +5V, connected via the rear edge connector of the module. The current consumption is about 180mA.

Input Signals

For operation of the frequency deviation monitor FDM509 the following input signals, provided by a preconnected reference, are necessary:

a) 10MHz oscillator clock, TTL level, rear edge connector pin Z12
b) pulse per second PPS, TTL level, rear edge connector pin D6
c) time string (RS232), rear edge connector pin B10

A GPS receiver GPS167 or a DCF77 radio clock PZF509 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, the system is ready to operate. The Fail LED as well as the REF Time LED and the PL Time LED are switched on after power up reset. FDM509 waits for the incoming serial time string via COM1 to initialize the internal system time (REF time). After this is done the PL time is also initialized with the REF time. 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 REF Time LED and the PL Time LED start toggling once per second corresponding to their time base. The Fail LED is switched off.

Configuration

Configuration occurs via the on board DIL switch. To synchronize the FDM509 it is necessary to set baudrate and framing of the connected reference time string to 19200 baud, 8N1. The module starts sending the measure string as soon as all necessary signals are applied and the Fail LED is switched off.

Power Line Frequency

FDM509 is designed to monitor the frequency in 50Hz mains as well as in 60Hz mains. The corresponding configuration is set via DIL-SW1:

DIL-SW1 (nominal mains frequency)	OFF: 50Hz	ON: 60Hz

Average and Serial Output String

The period length of the mains frequency is measured and then read out by the micro controller of the FDM509. The values are averaged over a period of one second or one minute and then the frequency is calculated with this average value. The serial string is sent once per second or once per minute, too, corresponding to the period of average. Configuration occurs via DIL-SW2:

DIL-SW2 (Average)	OFF: once per second	ON: once per minute

Initialize Power Line Time

The PL time must be initialized at the beginning of the measurement, so it either can be set with the REF time or it starts with 00:00:00. In the first case the REF time is read in via COM1 (19200 baud, 8N1) of the FDM509, PL time and REF time are synchrounous at the beginning of the measurement. Because only the difference between the REF time and the drifting PL time is actually relevant, reading in the REF time string and connecting the serial ports may be omited. In this case both times start with 00:00:00 after reset.

DIL-SW3 (initialialize PL time)	OFF: time string	ON: 00:00:00

Output String

One of two different output strings containing the results of the measurement can be selected to be sent via the serial port COM0. The first string is a sequence of 62 ASCII characters containing the frequency F, the frequency deviation FD, the REF time, the power line time PL and the time deviation TD, seperated by a space character each. The string 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 second string is a sequence of 23 ASCII characters containing only information about frequency deviation FD and time deviation TD, seperated by a space character:

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

Selection of the string type occurs via DIL-SW4:

DIL-SW4 (string type)	OFF: long	ON: short

The meaning of the several values are described below:

F:*49.984* The measured power line frequency with a resolution of 1mHz. The accuracy of the displayed value is ±1mHz.

FD:*-00.016* The frequency deviation is the difference between the measured frequency and the nominal mains frequency (50Hz or 60Hz). This value is signed, it has the same accuracy and resolution as the frequency.

REF:*15:03:30* The time from the preconnected reference. This time is read in via COM1 RxD once after reset (if connected, otherwise set to 00:00:00) and then incremented by the PPS of the referenc. Time jumps, like changeover in daylight saving or leap seconds, will not be executed.

PLT:*15:03:30.378* The power line time is synchronized with the REF time once after reset and then incremented by a certain number of recorded mains frequency periods (50 or 60). In addition the PL time milliseconds are shown, too.

TD:*+00.378* The time deviation is the difference between the drifting PL time and the exact REF time. This value is signed, with a resolution of 1ms. The time deviation is set to 00.000 after reset. It has the long-term accuracy of the PPS from the reference.

The serial RS232 ports

Baudrate and framing of the serial port COM0 can be configured using the DIL-switches SW5 and SW6:

DIL-SW5 (Baudrate)	OFF: 19200 baud	ON: 9600 baud
DIL-SW6 (Framing)	OFF: 8N1	ON: 7E2

COM1 RxD is used to read in the time string of the reference. This serial port is fixed configured to 19200 baud, 8N1. The connected reference must be configured appropriate and send the time string once per second. The TxD line of COM1 is sending the long output string once per second. It can be used to connect a display, for example.

Analog Output

FDM509 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. The full scale range of the analog outputs can be set either to 500mHz or to 5Hz (i.e. 0,2mHz/mV or 2mHz/mV) when the frequency deviation is selected, or, if the time deviation is selected, to 10s or to 100s (i.e. 4ms/mV or 40ms/mV). Configuration regarding the analog outputs occurs via the DIL-switches SW7 to SW10:

DIL-SW7 (source for A1)	OFF: frequency deviation	ON: time deviation
DIL-SW8 (full scale range A1)	OFF: 5Hz/ 100s	ON: 500mHz/10s
DIL-SW9 (source for A2)	OFF: frequency deviation	ON: time deviation
DIL-SW10 (full scale range A2)	OFF: 5Hz/100s	ON: 500mHz/10s

Serial Reset Command

The FDM509 can be reseted to its start values by a serial command. Sending the character '**R**' (ASCII code 52h) via the serial port COM0 causes a reset that has the same effect than powering up the system or pressing the Reset button (refer to chapter "Push Button Reset").

Error Bits

FDM509 provides eight error bits that can be read out via the serial port COM0 by sending the character '**E**' (ASCII code 45h). Any error bit reports a corresponding error event that occurs during operation. The format is:

ERROR:*X*$_8$*X*$_7$*X*$_6$*X*$_5$*X*$_4$*X*$_3$*X*$_2$*X*$_1$**<CR><LF>**

The meaning of the error bits is:

- ***X*$_1$:** **Fail** (equal to LED Fail), an error occured and the serial output is stopped, can be cleared only by a reset
- ***X*$_2$:** **No Time String**, FDM509 waits for the serial time string
- ***X*$_3$:** **No 10MHz**, missing reference clock, can be cleared only by a reset
- ***X*$_4$:** **No PPS**, no pulse per second, can be cleared only by a reset
- ***X*$_5$:** **No Power Line**, a mains frequency can not be detected, can be cleared only by a reset
- ***X*$_6$:** **Time Deviation Overflow** (equal to LED Overflow), time deviation > ±100s
- ***X*$_7$:** **A1 Overflow**, analog output 1 has reached its full scale range
- ***X*$_8$:** **A2 Overflow**, analog output 2 has reached its full scale range

The error bits can be red out during normal operation as well as after an error occurs and the serial output is stopped. In the second case the last measure string before the output was stopped will be sent out once more, additional to the error bits.

Analog Values

The values of the two analog outputs provided by FDM509 can also be red out via the serial port COM0 by sending the character '**A**' (ASCII code 41h). FDM509 sends a string with the following format:

A1:*XXXX*_**A2:***XXXX***<CR><LF>**

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

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 key "Reset" 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 FDM509 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 "Reset" key 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.

Inquiring Serial Number and Software Revision

The serial number and the revision of the loaded software can be read out by sending the three characters "**SN!**" via COM0 to the clock that starts sending the following string:

```
SN:FDM509 9041260  REV:01.10/01
```

The software revision is updated automatically with every update of the firmware. The serial number is fixed in an I^2C bus EEPROM and can not be changed.

CE Label

CE

This device conforms to the directive 89/336/EWG on the approximation of the laws of the Member States of the European Community relating to electromagnetc compatibility.

Technical Specifications FDM509

INPUT SIGNALS:	10MHz oscillator clock (TTL level) pulse per second, activ high (TTL level) serial time string (RS232), 19200 baud, 8N1 (see "Format of the Meinberg Standard Time String") 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, COM1: 19200 baud, 8N1 COM0 configurable via DIL-switch: Baudrate: 9600 or 19200 baud Framing: 7E2 or 8N1 output and average once per second or once per minute output string: one of two different formats selectable, see chapter "Output String"
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, @180mA
PHYSICAL DIMENSIONS:	Eurocard, 100mm x 160mm, 1.5mm Epoxy
FRONT PANEL:	3U / 8HP (128mm high x 40.6mm wide), Aluminium
AMBIENT TEMPERATURE:	0 ... 50°C
HUMIDITY:	max. 85 %
OPTIONS:	power line input via mains socket in the front panel Hardware and software modifications accordding to customer specification

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)

Rear Connector Pin Descriptions

Signal Name	Pin	Description
VCC in (+5V)	B, D+Z2	+5V supply voltage
GND	B, D+Z16	power supply ground
/Reset	Z4	Reset and Boot signal for starting bootstrap loader (pull down while powering-up) signal is parallel wired to push button "Reset"
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 RS232 transmit data output
COM0 RxD in	B8	COM0 RS232 receive data input
COM0 GND	Z6	COM0 ground (=power supply ground)
COM1 TxD out	D10	COM1 RS232 transmit data output
COM1 RxD in	B10	COM1 RS232 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)
SDA	D14	reserved for extensions
SCL	Z14	reserved for extensions
SCL_EN	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	/Reset	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	SCL	SCL_EN	SDA
16	GND	GND	GND
20			
22			
24			
26			
28	L1		
30			N
32	PE		

Component Layout