MFL 300 / 500 / 800-B

Operator's Manual
Repair and Maintenance

MF

Precision testing of linear strain

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Manufacturer's Declaration

This measuring system is not a "stand-alone operating instrument", to be attached to a tensile and compression testing machine.
Its operation is not allowed as long as the testing machine setup complies with the applicable EG–regulations. These rules have to be strictly obeyed by the manufacturer or Service Company of the test instrument to which this system will be connected.

General Safety Instructions

1. Caution when mounting the MFL to the testing instrument!
   The MFL is very heavy (30 kg) and of quite tall design (830/1030 mm), therefore please take all precautions that it will neither topple nor be dropped on the floor!
2. Be careful not to touch the measuring knife edges when handling with the measuring arms! They are very sharp edges and are apt to cause injuries if treated with too little care.
3. The MFL has to be fixed securely at any operation to prevent falling over or dropping down.
4. When operated care has to be taken that the measuring arms can move freely and without danger of hitting mechanical obstructions.
5. It is generally not permissible to interfere "manually" into the work area of the measuring arms during a measuring sequence!
6. Beyond this, for the entire test unit all safety instructions of the manufacturer of the whole test system must be strictly obeyed.

Please note:

This user's manual is separated into the two chapters A **User's Instructions of the MFL 300/500/800-B-Electronics,** and B **Repair and Maintenance**.

Chapter A

Chapter A: User's Instructions of the MFL 300-B/500-B-Electronics

Contents:

List of Sketches and Graphs

1 General Functions

The MFL300-B / 500-B /800-B is designed to detect the elongation on specimen during a tensile test used in materials testing. Controlling and interpretation of the materials characteristics by the tensile tester are not the task of the MFL controller.
Die system's internal Software of the MFL-electronics controls just the extensometer respectively the recording and transfer of the measured readings. The controller's tasks are: To convert the incoming parameters for the position (lower gauge head) and the initial gauge length (difference between the two gauge heads) into a well-defined movement, to attach the gauge heads on the specimen upon an incoming instruction and to relay the recorded elongation via the selected interface. The controller must also recognise and display operating faults or mechanical / electronics errors.

1.1 Description of the MFL

This device represents a measuring instrument to measure all changes in elongation on the specimen during a tensile or compression test.
At detecting the elongation very low clamping respectively activating forces affects the specimen. The extensometer (called MFL in the following) detects the elongation of the sample using a measuring spring sensor. For this purpose, two gauge heads are brought in contact with the sample. If the specimen will now be stretched, two incorporated measuring springs detect each position change at the tips of the arms. In cases of crooked specimen or an alignment cause's different movements an averaging is carried out at each one of the arms. The elongation is measured indirectly by recording the movement of the gauge heads on an opto-incremental glas scale. The resulting relative changes (recognised as electrical impulses) are recorded by a counter, and then fed to the processor as binary values. The processor will then relay these values to the connected host computer (PC).

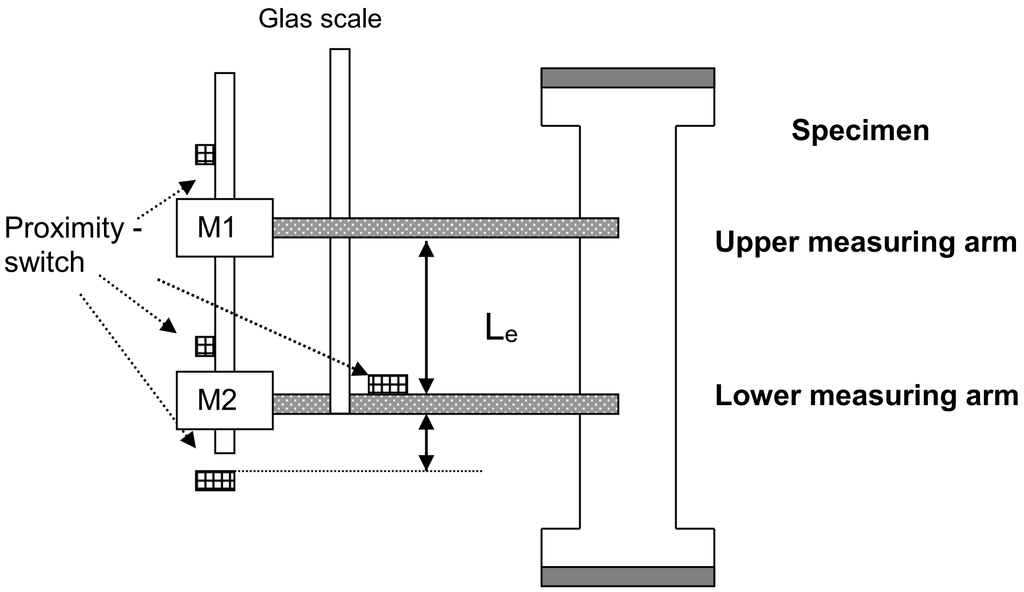


Fig. 1: Sketch of the MFL

The glas scale of the MFL is attached directly to the lower measuring arm and it follows the movements of it.
Fig. 1 shows that during a measurement with the MFL only the upper measuring arm moves relative to the glas scale. The readings issued by the connected electronics directly represents the true measuring distance, because this is the real length change towards the lower arm.

In addition to the above described extensometer, there is also a devices available to measure the transverse strain of the specimen (Type MFQ-A). It can be attached or removed as required, by the software. This software however does not take any recordings of the measured readings.

1.2 The Measurement Process

The MFL will be mounted on a tensile testing machine. It determines the elongation of a test specimen due a tensile test. The load measurement readings taken by a load cell are then brought into relation with the readings taken from the MFL. Receiving and synchronisation of the readings supplied by the load cell should be done at the serial interface via handshake lines.

The measurement sequence works as described below:

1. The parameters must be entered with the command e.g. **:sep10,50** (see para. 5.2.).
2. Now, the MFL can be calibrated with the command ***cal** . To do this, the lower pair of arms in our example will now move to position 10 mm, and the upper pair will follow. As soon as the lower pair of arms arrive its position, the upper pair of arms will continue to move until it will activate the proximity switch that is attached to the lower arm. The upper pair of arms will then move a certain amount upwards, passing the reference mark on the glas scale. When passing this mark, the pre-set value (can be modified on the controller board at S3 and S4) will be recognised by the internal counter. The pairs of measurement arms will stop at the position reading 10 mm, and at the calibration position e.g. gauge length approx. 10.5 mm.
3. Following this step, the initial gauge length L_0 must be reached using the command **:mov** . This is the distance of the arms representing their initial gauge length, from where the measurement will begin. This distance should be found with maximum precision (in our example: position value 10 mm and gauge length L_0=50 mm). The lower pair of measuring arms already rests at this position, so that only the upper pair of arms will move to its L_0=50 mm. Make sure, this position is oriented symmetrically with reference to the specimen centre. The position value relates from known geometrical dimensions, such as the orientation of the lower clamping holder, position of the lower pair of measuring arms of the MFL and the specimen length. Approximately $^{1}/_{10}$ mm accuracy is sufficient for the position value.
4. The measuring arms will now be attached slowly on sample using the command **:mst1** .
5. At this point in time, the actual elongation measurement starts. The measurement readings will now be transferred by sending the character **$** (see para. 5.2, command **:mst**). In most cases, the RS422 output will be used to collect the measurement readings.
6. The command **<** terminates the measurement, the arms will swiftly open, and the motors in the tensile direction will be blocked.

If the next measurement needs to be carried out at the same position, resp. gauge length, no new parameters need to be entered to the MFL. → repeat 3. to 6.

2 Program In- / Outputs

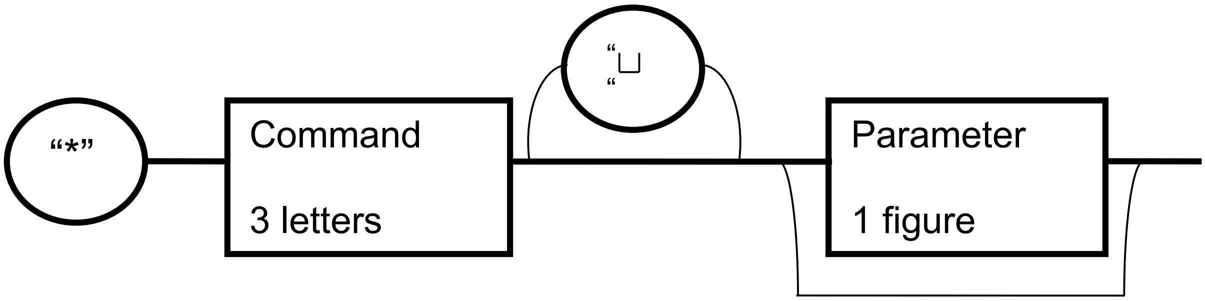


Fig. 2.1: Syntax graph of the main IEEE 488.2 commands

All IEEE 488.2 commands begin with the character “*”. Three letters must follow, representing the command itself. No additional characters are allowed between the command characters and the command word. These commands can contain maximum one parameter. The parameter may (does not strictly need to) be separated from the command itself, using the space key once or several times. Figures are allowed that can be shown as ASCII decimal figures. The question mark is a special parameter. It generates an inquiry when using certain commands, to read and show the associated register or condition. This may (should however better not) be separated from the command word itself by a space key. All characters may be used as upper or lower case letters.

2.1 Syntax graph of the special commands

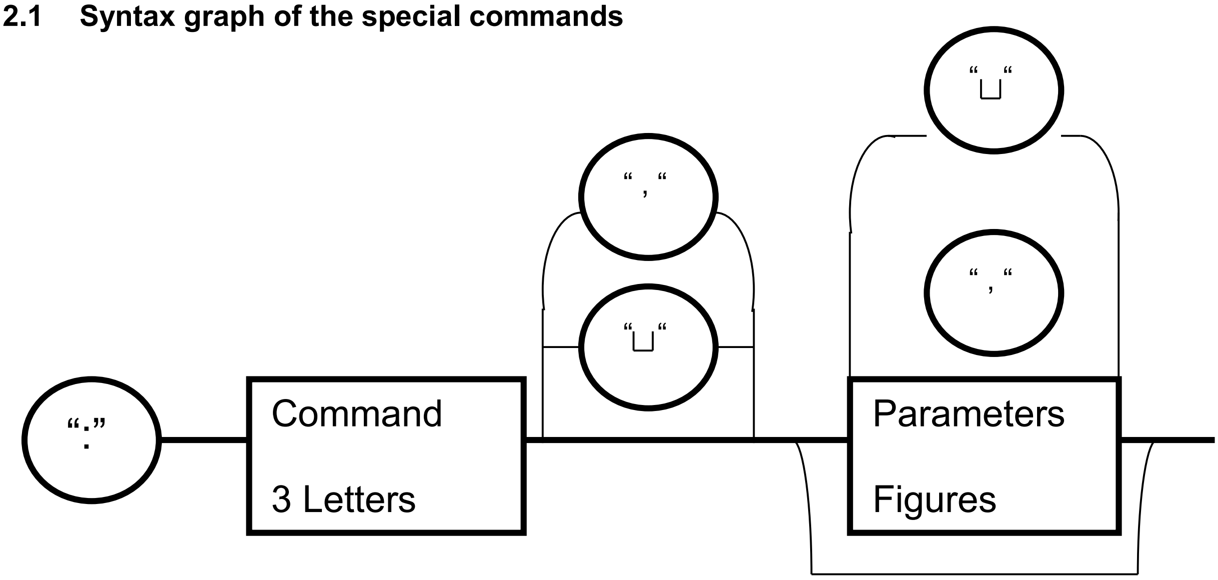


Fig. 2.2: Syntax graph of the special commands

The commands for the MFL controller are set up in a similar structure also. The first key of a command is the sign “:”. This marks the command group clearly right away. Next to follow is the command word. There are no additional characters allowed between the command keys and the command word. Different from the above shown commands, here may also be inserted several parameters. The individual parameters are separated by a comma or a space. Here too, all characters are shown in ASCII code. Generally, provisions are made for a maximum of 7 parameters. The parameters are always composed of figures (ASCII-code-decimal values). All characters may be used as upper or lower case letters.

2.2 Program messages

All error messages are shown in the IEEE 488.2 structure.
Generally, it is composed of several registers, where there are status markers placed, according to the momentary instrument status. These markers can be reached by their appropriate data queries. An error message will be remain until it was explicitly queried or visited, even if the real cause for the error has already been eliminated at the time up to the query. Program messages are generally shown in ASCII-format. Only the measurement readings are an exception to this rule. They may also be transferred in packed BCD-format, or as true binary values.
(See command: **FMT**).

3 The Status Report System

The status structure of the software serves to coordinate the various events and error messages of the instrument setup, and to inform the connected PC.

For this, a structure similar to IEEE 488.2 was chosen.

It contains a status byte, which is connected to the Service Request Enable-Register. As soon as an event occurs, (or when the according messages arrive in the “output queue” or “error queue”), a certain bit is placed in the status byte register. Depending upon whether or not the equivalent bit has been placed in the “service request enable register”, a service request will be triggered at the IEEE bus interface. The master will then generate a serial poll for the IEEE bus, which will initiate the return of the status byte. The master can now decide which one of the connected devices has triggered a service request. It is part of the application programmer’s work, to set bits in the service request enable register, and thus determine, which event will admit the release of a service request.

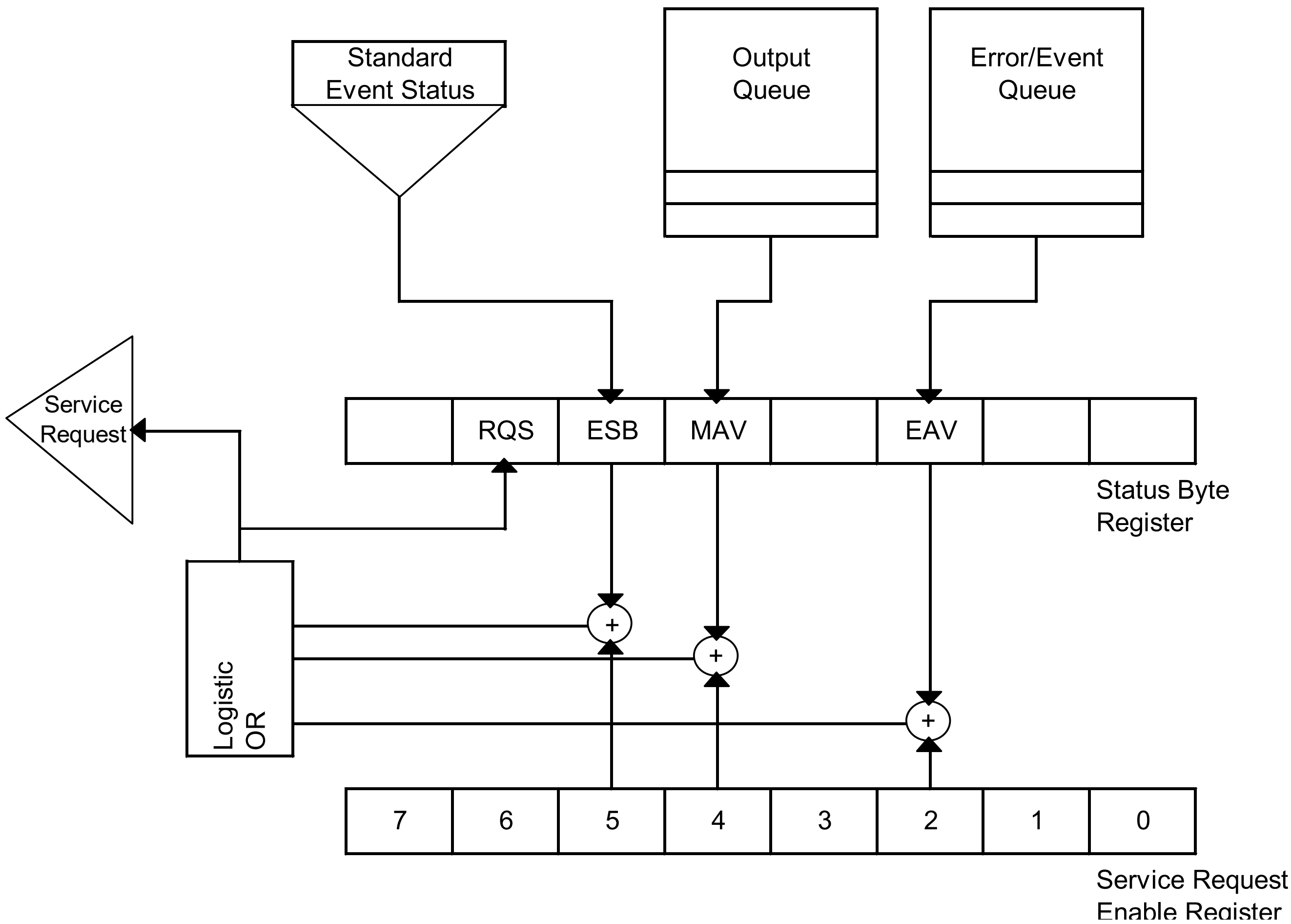


Fig. 3.1: **Status report system**

3.1 The Status Byte Register

Bit 0		
Bit 1		
Bit 2	EAV	Event/Error available, “1”, if an error is present in the error/event queue.
Bit 3		
Bit 4	MAV	Message available , “1”, if data are present in the output queue.
Bit 5	ESB	Event Status Bit, “1”, if a status bit was set in the event register.
Bit 6	RQS / MSS	Request Service IEEE 488 generates service request RS 232 returns prompt with “!”, 1, if a non-masked status occurred.
Bit 7		

This register mirrors the internal status of the instrument. For this purpose, several bits are assigned firmly in the IEEE 488.2.
Part of the status byte register is the “service request enable register”. This is a register (ir “list”), in which you may determine which bit in the status byte will release a service request (IEC Bus) or an error message (RS232). If the figure “1” shows at the same bit position in the SRQ register, and also in the status byte register, then a service request announcement will be generated.

3.2 The Standard Event Status Register

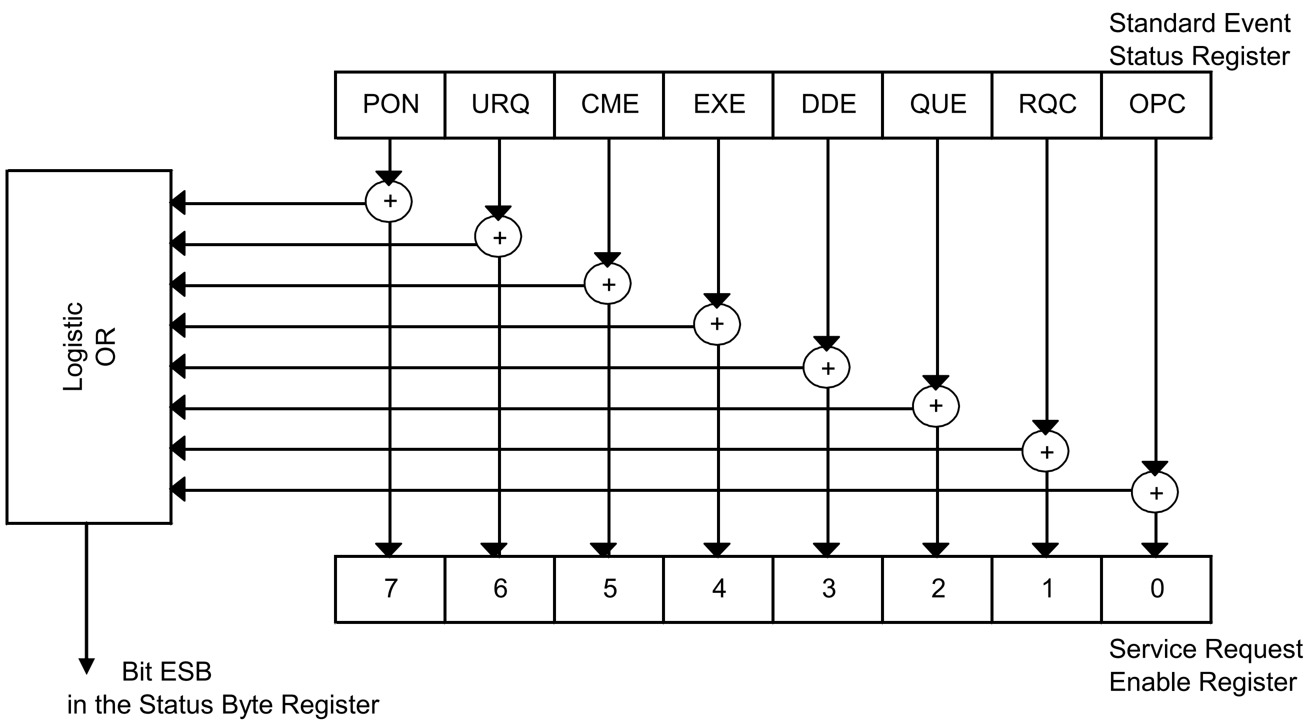


Fig. 3.2: Standard Event Status-Register

The “Standard Event Register” contains bits, informing you about the error status of the instrument.

Bit 0	OPC	Operation complete. This bit is set to 1, until all arrived orders will have been completed.
Bit 1	RQC	Request Control, always “0”
Bit 2	QYE	Query Error. This error is set to 1, if the “timeout” between the characters of a query has expired, or if characters were lost.
Bit 3	DDE	Device Dependent Error. The DDE-bit is set, if the measurement data transfer becomes unstable or unreliable, for example because a command has arrived via interface, which will not prepare for the end of the measurement.
Bit 4	EXE	Execution Error. Here the bit is set to “1”, if parameters were entered that exceed the operation limits, or if a command cannot be completed for other reasons.
Bit 5	CME	Command Error. This bit represents syntax errors in the command transfer. (Example :*CAL 50 (Wrong Parameter!))
Bit 6	URQ	Not occupied, always “0”
Bit 7	PON	Power On. This bit is set to “1” as soon as the instrument is switched on. Not occupied.

For this register also, there is a standard event enable register, similar to the service request enable register. Here the “1” is set at the appropriate bit position if an error is supposed to set the “event status bit” in the “status byte register”.

The error bits remain active until either:

- the command ***ESR?** arrives, thus having read the content of the register,
or
- an error message was set automatically by the service request.
or
- by sequential reading of the “error event queue” by the command **:EST**, thus erasing the “error event queue”. (Caution: *All* error messages must have been read, befor the bits can be erased.),
or
- the “standard event enable Register” was programmed new using the command ***ESE**,
or
- by erasing all status register entries using the command ***CLS**.

The error bits remain set, until the command ***CLS** will have erased all entries in the status register.

3.3 Converting the Structure to an RS 232-Interface

The RS 232 C-interface allows neither to generate a service request, nor a serial poll-call up. To adapt the above described structure to the requirements of the serial interface, the following agreement may be implemented:

If an IEEE 488.2 instrument would generate a “service request signal”, then the according error message will be displayed in plain English. The error message will then be erased from the “error/event queue”.
If an error occurs without fulfilling the conditions for a “service request”, then *no* error message will be issued. Instead, the prompt which always is sent after completing or cancelling a command, will be changed. The following prompts are defined:

#>	No error occurred. Will also be returned, if an error occurred and the error messages are activated.
?>	Command not understood. Implemented if an IEEE488.2 command error or query error was generated by the command.
!>	The command was analysed successfully, but it could not be executed for other reasons. Implemented if an IEEE 488.2 instrument would generate an execution error or a “device dependent error”.

In addition to the returning of a prompt, the error messages are stored in the “error event queue”. If the “error/”event queue” is full, no additional error messages will be stored there, but only the error message “350 Queue Exceeded” will be created. A “device dependent error” will show. If any of the above described error prompts occurs, the PC can read the “error event queue” using the command :EST .
The following relation between the bits EAV and ESB of the status bytes is a result of the status report system:

ESB	EAV	Reaction
0	0	The error message is stored in the ”error event queue”. A prompt will be generated
0	1	The error message is stored in the ”error event queue”. Because this is now full, and EAV=1, an error message is sent. Only the string will be sent.
1	0	The error message is stored in the ”error event queue”. A short message, containing the error number only will be sent.
1	1	The error message is *not* stored in the ”error event queue”. The error message will be sent as a string and number.

The bit **MAV** is responsible for the suppression of other messages from the program, except for the error messages and measurement readings. If the bit 4 of the service request enable registers equals “0”, then no messages will be issued at all, even if the command would require them. Example: ***IDN** does not generate any message, but is shown as “completed successfully”. However, this message will be stored in the “output queue”. It can be shown using the command **:MSE** (**M**essage **Se**nd). Please note that both, the “standard output queue”, and also the “error/event queue” are FIFO-stores. The error messages will be treated like “first come, first send”.

The bit **RQS** is not required for the serial interface.

4 Error Messages

4.1 Errors and Error Numbers

Command error	- 100 – 199 Bit 5 – CME
Executing error	- 200 – 299 Bit 4 – EXE
Device dependent error	- 300 – 399 Bit 3 – DDE
Query error	- 400 – 499 Bit 2 – QYE

4.2 Command Error

Error number	Error description
0	no Error
-100	command error
-101	invalid character
-102	syntax error
-103	invalid space
-104	data type error
-108	parameter not acceptable
-109	missing parameter
-110	command-header error
-111	header space error
-113	undefined header
-114	header suffix out of range
-120	numeric data error
-121	invalid character in figures
-124	too many characters
-128	incorrect numeric data

4.3 Execution Error

-200	execution error
-201	reached upper limit switch
-202	reached lower limit switch
-203	arm movement error
-204	calibration not done
-205	cannot reach position (timeout, or similar)
-206	cannot reach initial instrument measuring length (timeout, or similar)
-207	MFQ-A – no response
-208	cannot calibrate instrument
-209	external limit switch
-220	parameter error
-221	setup conflict
-222	off range data
-223	too many data
-224	invalid parameter value
-225	initial instrument measuring length too low (central limit switch)
-226	command abort
-230	data disrupted or useless
-231	disturbance at linear gauge
-240	hardware error
-241	hardware not available

4.4 Device Specific Errors

-300	device specific error
-301	upper measurement spring misalignment
-302	lower measurement spring misalignment

-310	system error
-311	storage error
-313	calibration store lost
-315	configuration store lost
-330	self test failed
-350	queue overflow
-351	input queue overflow
-352	output queue overflow

4.5 Error Query

-400	query error
-410	query interrupted
-420	query not terminated
-430	query blocked
-440	query not terminated after undefined response

5 Command List

5.1 IEEE 488.2 Commands

*CAL

Instrument **CAL**ibration

Syntax:

*CAL

*CAL?

Parameters: none

Use:
This command initiates the instrument calibration, or a query is released to determine if the calibration was done before.

Example:
*CAL
#>

Command	Send	MFL Prompt	
*cal	Enter	..#>	After calibration done
2A 63 61 6C	0D	0D 0A 23 3E	

The lower measuring head of the MFL moves to its last used position readings, and the upper measuring head follows. As soon as the lower measuring head has reached its position, the upper one approaches the lower one until arriving at the approximation switch. At this moment, the initial instrument measuring length L_e is written into the counter. The MFL will now stop at the L_0 reading of approximately 10.5 mm.

Example:

*CAL?	or	*CAL?
#>0		#>1
#>		#>

Command	Send	MFL Prompt
*cal?	Enter	..#>0..#>
2A 63 61 6C 3F	0D	0D 0A 23 3E 30 0D 0A 23 3E
Or		
*cal?	Enter	..#>1..#>
2A 63 61 6C 3F	0D	0D 0A 23 3E 31 0D 0A 23 3E

Query:
The response is relayed in form of a figure. If “1” shows, this indicates that the calibration was completed successfully. The figure “0” indicates that the instrument is not calibrated (calibration required). During calibration, the bit 0 is changed to 1, to indicate that the process is under way. The query can only be released after completing the calibration process.

Error sources:
The message "Error – 204 calibration not done“ is generated if no parameter for position L_e was entered after switching on the instrument.
The message "Error – 208 cannot calibrate instrument“ is generated if the linear encoder signal of the MFL does not fall within the standard range, or if it cannot be recognised.

Please note:
If required at the end of the test indicated by “<“, the command :MOV will send the MFL right away to a parking position. A new calibration, initiated by *CAL is required only, if the linear encoder detector has lost some impulses due to strong vibrations. Such loss of impulses is rather unlikely in practical work, therefore it is not necessary to run a calibration after every tensile test. It is recommended to go through the calibration process once a day, or after testing approximately 100 specimens, entering ***cal**.

*CLS

CLear **S**tatus data structures

Syntax:

*CLS

Parameters: none

Use:
This command will erase all status data structures by:
a) Erasing all event registers, that are listed in the status byte register.

b) Erasing all queues, that are listed in the status byte register, except for the output queue listed in the MAV-Bit.
-Error/Event Queue

Example:
*CLS
#>

Command	Send	MFL Prompt
*cls	Enter	..#>
2A 63 6C 73	0D	0D 0A 23 3E

*IDN?

Instrument **ID**e**N**tification

Syntax:

*IDN?

Parameters: none

Use:
This query will identify the instrument maker and type. The response will deliver a string, containing information about the manufacturer, the model and its serial number together with its firmware.

Example:
#>*IDN?
MF Extensometer V1.41 Serial No: 07020001
#>

5.2 Special Commands for the MFL - Controller

:DOL

Display **O**riginal **L**ength

Syntax:

:DOL

Parameters: none

Use:
The reply will show the momentary L_e – value once, with the measurement arms open. It will be delivered only with 3 command interfaces via RS232.
This command is suitable for checking the L_e value before moving the arms into position.

Example:
:DOL
#>50.002
#>

Command	Send	MFL Prompt
:dol	Enter	..#>0020.000..#>
3A 64 6F 6C	0D	0D 0A 23 3E 30 30 32 30 2E 30 30 30 0D 0A 23 3E

Error sources:
After switching on, the MFL must first be calibrated using the commands :sep and *cal, because otherwise an undefined figure for the measuring value will be delivered.

:POS

Syntax:

:POS

Parameters: none

Use:
Sends one-off the actual position and gange length when the measuring arms are open via RS232. These values are only indicated with three decimal places.
This command is suitable to control the actual position and gange length of the MFL.

Example:
:POS
 POS= 0030.00 L0= 0050.000 OK
#>

:FMT

For**M**a**T**

Syntax:

:FMT <Format type>

Parameter: 1,2 or 3

Use:
Selects the output format of the measurement readings according to the following list:
1: Measurement reading as binary value.
2: Measurement reading as packed BCD.
3: Measurement reading as ASCII BCD.
This is valid only for the serial interface. This way, the data output speed can be increased considerably. The formats 1 and 2 however, can only be used with an evaluating receiving program.
After switching on the controller mains, or after pressing the reset-button the output format is always in the condition: FMT3 (Measurement reading as ASCII BCD).

Example:
:FMT3
#>
Error sources:
Data format is set wrong, if for example the format Packed BCD was selected for a terminal program. This format cannot be implemented.

:MOV

MOVe

Syntax:

:MOV <Position Anfangsgerätemesslänge >

Parameter: figures without units as ASCII BCD

Use:
Will take over the parameter values for position and L_e. The instrument will move to these values, and the arms will be held constant at these readings.
If the command is used without parameters, then the last set parameters will be addressed to.

Example:
:MOV120.5,50.000
#>

<table>
<tr><td>Command</td><td>Send</td><td colspan="2">MFL Prompt</td></tr>
<tr><td>:mov</td><td>Enter</td><td>..#></td><td rowspan="2">After reaching the position</td></tr>
<tr><td>3A 6D 6F 76</td><td>0D</td><td>0D 0A 23 3E</td></tr>
</table>

Error Sources:
Invalid Ranges.

:MSE

Message **SE**nd

Syntax:

:MSE

Parameters: none

Use:
The standard output queue will be displayed completely. Next, the bit MAV in the status byte register will be erased.

Beispiel:
:MSE ; retrieve message

Error sources:
Incomplete reading of the output queue. Reading attempt, although output on the interface is busy.

:MST

Measurement **S**tar**T**:

Syntax:

:MST

Parameters: 0; 1, or none
Use:
The measurement arms move into contact, and the MFL goes to the measuring process.

Example:

:MST	The MFL-controller sends (0D) Return after closing of the measurement arms.
50.012	Continuous output of the measurement readings
:MST0	The MFL-controller sends (0D) Return after closing of the measurement arms.
50.0120	Continuous output of the measurement reading
:MST1	The MFL-controller sends (0D) Return after closing of the measurement arms. No automatic output of measuring readings. With sending of a "$" one measurement reading will be put out
$	
50.0120	Only one measurement reading output of the measurement readings after sending $

Command	Send	MFL Prompt
$	**no** Enter	0050.0120..
24		30 30 35 30 2E 30 31 32 30 0D 00

Error Possibilities:
The command :MST will be sent, if the correct values and positions for L_e were not addressed to, using the command :MOV.

:SEP

SEt **P**arameter

Syntax:

:SEP <Position, initial instrument measurement length>

Parameter: figures without units as ASCII BCD

Use:
Will take over the values for position as parameters (this is the distance of the lower measurement head as seen from the lower mechanical stop in mm) and L_e into the internal memory. No calibration will be done. The instrument will not drive to these values.
Figures to be used may also contain digits after the decimal point, like position value 20.6 mm / L_e 80,3 mm :sep20.6,80.3, .

Example:
:SEP10,50 ; addressing to position 10 mm and L_0 50 mm
#>

Command	Send	MFL Prompt
:sep10,50	Enter	..#>
3A 73 65 70 31 30 2C 35 30	0D	0D 0A 23 3E

Error sources:
Entering figures beyond the limit. Incomplete parameters.
The position value 0 and the activating point of the end-of-travel switch are close to each other. To be on the safe side, make sure you chose a value larger than 0. (Recommended: 5 mm; see Fig. 1).

Q

mf**Q** on:

Syntax:

Q

Parameters: none

Use:
Will create the signal to move the automatic MFQ-A respectively its sled into the measuring position (MFQ-Start).

Example:
Q

Command	Send	MFL Prompt	
Q	**no** Enter	..#>	Confirmation of the received command
51		0D 0A 23 3E	

A status query can be started with the command :MFQ? :
Reply 1 → MFQ-A moved in
Reply 0 → MFQ-A moved out

:MFQ?
#>1
#>

Command	Send	MFL Prompt
:mfq?	Enter	..0..#>
3A 6D 66 71 3F	0D	0D 0A 30 0D 0A 23 3E
Or		
:mfq?	Enter	..1..#>
3A 6D 66 71 3F	0D	0D 0A 31 0D 0A 23 3E

q

mf**q** off:

Syntax:

q

Parameters: none

Use:
Will create the signal to move the automatic MFQ-A respectively its sled out

Example:
q

Command	Send	MFL Prompt	
Q	**no** Enter	..#>	Confirmation of the received command
71		0D 0A 23 3E	

<

Syntax:

<

Parameter: none

Use:
Command: "<" Measurement ends

The arms will move out immediately. The Motors will be blocked.

Example:
<
#>
#>

Command	Send	MFL Prompt	
<	**no** Enter	..#>..#>	After arms have opened
3C		0D 0A 23 3E 0A 23 3E	

Error sources:
The measurement arms **must never** be disturbed while opening. A force sensor will cut off the motor

supply current that opens the arms motor if a mechanicaldisturbance is detected. Work can only be continued after switching the controller mains OFF and ON again.

#

General Abort

Syntax:

#

Parameters: none

Use:
General abort: all commands will be cancelled, the measuring arms move to their “out” poisition.
Reaction: the Input-Queue will be erased, no additional commands will be executed. The parameters "initial instrument length" und "position" remain intact. An error message will be sent.

Example:
#
?>Error 226 Command abort
#>

5.3 Special Command

!

Special command: Software-Reset "!"

Use:
This command is handled directly in the interrupt routine, and it will cause the resetting of all queues. Be very careful when using it. This is however safe, if all commands were completed before.
It is wise to send the command #, before the command**!**

Example:
!
#>

Command	Send	MFL Prompt
!	Enter	..#>
21	0D	0D 0A 23 3E

Note
The commands #, <, q and Q need no ENTER for sending them.
For every sended ENTER the prompt is received..#>(0D 0A 23 3E) from MFL300-B.

6 The Program Output Structure

All program outputs are done by the standard output queue. Among this for example, are the prompts to the command queries. When using the serial interface, the outputs of prompts are not done by the standard output queue. Also, the measurement readings will not be sent via the output queue.
The standard output queue is a FIFO (First In First Out) memory, that can be called up or sent when required. In some cases, several program messages may have accumulated, and these will then be sent one after the other. All program messages will be returned via the command interface.
The measurement value output is a standardised procedure running via X13 / RS422 or also via X11 / RS232 or X14 / USB. No measurement readings will be accumulated while a measurement is under way. The momentary measurement reading will always taken as the set of data that will be sent first. In case this set of data cannot be sent, then it will be overwritten by the next arriving measurement package of data. The result of this is, that no more than **one** measurement value is waiting in the output queue. This ensures, that always the last arrived measuring value will be sent, even if the data transfer was disabled for a period of time. This rule applies to both, the RS232 – interface, as well as for the USB - interface.

6.1 Principal Use of the Commands

The use of the commands depends mainly upon the type of host computer being used. Here it is essential, which interface is being utilised, and in what form the incoming signals and data from the MFL will be used. The simplest way is, to use just one terminal, or a computer with a terminal program software (such as HyperTerminal / Windows).

The commands : e.g. :SEP10,50 *CAL :MOV :DOL :MST1 $ und < can fully control the MFL.

Error messages will be returned immediately in plain language, and the measurement readings can be taken directly from the screen in ASCII BCD. Such plain language error messages are however not very practical if a computer program needs to be employed. Then this form of language error messages mixed with ASCII BCD is much too slow. At this point however, the MFL controller can be configured in such a way, that for example the measurement results are conveyed in binary form, and the error messages must be called up by the computer. The command :FMT will show the various possibilities.

6.2 Special Hints

A zero-modem cable is required for connecting the serial interface RS232 (cable X11 with two 9-pin - sockets; 3 m of cable are part of the shipment volume). To control the system via USB a USB 2.0-cable type A to type B.

Please make sure also, that the hardware handshake of the host computer is indeed active.

Settings for the serial interface:

RS232	USB
8 data bit	8 data bit
OFF Parity	OFF Parity
1 stop bit	1 stop bit
XON / XOF	XON / XOF
9600 Baud Standard 19200 Baud adjustable 38400 Baud adjustable	921600 Baud receiving Sending commands max. 1 character / ms

Many terminal- or test programs initialise the serial interface by writing a defined character into it. This can result in the fact that when switching on the instrument mains in the sequence MFL controller followed by the host computer, a single character was written into the MFL controller. therefore it may happen, that the first incoming command will be cancelled with the message "Error 113 undefined header". We recommend entering a “return” after switching on, thus provocating a possible error message.

In principle, all cables required for the basic operations must be connected **before** switching on the MFL. These are

1. Mains cable
2. Cable X11 for the serial connection of the RS232 to the customer’s computer.
   or
   Cable X14 for the connection of the USB port to the user’s computer
3. Cable X13 measurement output RS422

7 Momentary Status

At present, there is no timeout error recognition implemented to the system (we recommend that the user does this by himself). This leads to the situation that no error will be shown if the positions are not reached in case of a failure. The controller does not respond with the prompt (#>). If such failure occurs, briefly switch off the mains voltage, or bridge (short) the reset contact X8 for a short moment.

8 Controlling and Data Recording

The controlling via two interfaces of the MFL has proven to be most effective and the easiest way to use.

The input, and respectively the operating of the MFL must always be done using the RS 232 (or USB). Data recording can be done by different methods.

1. <u>MFL controlling via RS232 only:</u>
   Controlling of the MFL is done via serial interface RS232, and the data recording can be done via RS232 / X11. The synchronization of the readings delivered by the load cell works via the handshake-lines. We recommend using the command :MST1.
2. <u>MFL controlling via RS232 and RS422: (Standard):</u>
   Controlling of the MFL is done via serial interface RS232, and the data recording can be done via RS232 **and** the simultaneous data output X13 / RS422 together. We recommend using the command :MST1.
3. As an alternative to the RS232, you may also use the USB-interface.

Data Recording

1. You can work with the absolute reading, recording the first value via RS232 using the $-character, and then analyze the elongation via RS422.
2. You can calibrate the L_e-value yourself, by taking the reference mark (via RS422) from the glass graticule displacement gauge during the calibrating movement, and then analyze the elongation via the RS422 interface.
3. A relative measurement is also possible, taking the elongation only via RS422, **after** touching down on the specimen.

Two grades of resolution (1 µm or 0.1 µm) can be selected at the MFL 300-B/500-B (item number 08 200). The operator can modify the resolution setting himself!

Chapter
B

Chapter B

Contents

Checking the Measurement Heads

Both measuring heads are identical to each other, and they may be exchanged against each other. No setup change is required when exchanging the measurement heads.

1. The lower edge of the upper measuring head, and the upper edge of the lower measureing head must both be perpendicular to the MFL–housing. The smallest mechanically possible distance between these two measuring heads will show a parallel clearance of approximately 0.3 to 0.5 mm. If this is not the case, then the measuring heads have been bent by mechanical force. They must then be exchanged or repaired.
2. The measuring springs together with the measuring blades must be freely movable. There must not be any dirt or tinder dust in that area, which may hamper the movement of the measuring springs.
3. The clearance in which the springs can move must be almost equal in both directions (up and down).
4. While not in operation, the measuring blades are lined up exactly opposite to each other. Their alignment is done using the T10 screw (spring fixation) and the M3 x 3 (DIN 916) set screw (lining up the blade position), to which there is access through a small hole in the measuring arm.
5. The spring that draws the measuring arms towards each other must not be overstretched. In case of doubt, it ought to be renewed.
6. When the measuring arms are attached and in their "open" position, they should be placed symmetrically to the instrument and stand exactly vertical above each other. Minor misalignments can be adjusted for, using the pressure pads that press against the eccentric tubes.
7. To remove the measurement heads, use the Allen hex wrench (5 mm, to be found in the shipment volume). Before doing so, take off the measure arm's tension spring.

1 Setting the opening width

In their "open" position the measuring arms must always stand symmetrically to the MFL 300-B/500-B. The opening width and closing of the measuring arms can be set by two micro switches *(item number E08 707)*. They are located at the bottom side of the housing cover of the MFL 300-B/500-B, and together with the holder they can be shifted a small amount after slackening the retaining screws.

1.1 Closing the Measurement arms

1. Usually, this alignment does not need to be changed!
2. The micro switch cuts off the motor **M3** after closing the measurement arms.
3. Line up the micro switch in such a way, that upon closing the measurement arms, the motor will always be cut off, and cannot move until hitting a "blocking".
4. Make sure, that all <u>four</u> measuring arms touch down on the specimen quite equally → this means, that between the pressure pads of the measuring arms (at the rear of each arm) and the eccentric tubes a small clearance is created.

1.2 Opening the Measurement arms

1. After opening the measurement arms, the micro switch cuts off the motor **M3**.
2. The opening width was set to 80 mm (measured between the blades) by the manufacturer. It may be modified if required – for example if for spatial reasons larger or smaller openings must be created. The width however must never exceed 100 mm!

2 Setting up the Control Electronics

Any work or modification at the MFL-Electronics may only be carried out by trained employees of the MF GmbH! The control electronics is located inside the MFL-housing.

Caution:
All cables of the MFL must be connected properly, and the housing must be closed. The measurement arms must have sufficient clearance to move in all directions, and they must not rest at either one of the two movement limit positions (up or down travel)!
Make sure to pull the mains cable before opening the MFL-housing.

The now following descriptions imply the “UPWARDS measuring direction”. In the “DOWNWARDS measuring direction, the mechanics of the MFL 300-B/500-B is principally turned around 180° in the measuring direction.

2.1 Cable connection combinations

1.	Mains cable	
2.	X8	External reset possible
3.	X9	Controlling a MFQ-A made by MF GmbH company
4.	X10	JOG → in preparation
5.	X11 cable	To connect the RS232 leading to the user’s Computer
6.	X12	No function / must not be taken into the circuitry
7.	X13 cable	Measuring output RS422 (A -/B-signals 90°)
8.	X14 cable	To connect the USB with the user’s computer

2.2 Mains connections

Power: 85… 250V AC / 40… 60 Hz
Fuse: 5 x 20: 2x 1 A / TG

3 Tuning the control electronics

3.1 Tuning potentiometers

All tuning elements were tuned by the manufacturer before delivery, and they must never be changed, because their setting was trimmed relatively among each other according to each individual system! Any change in this tuning setup requires the exchange of the entire control board!

3.2 Strain gauge - sensors

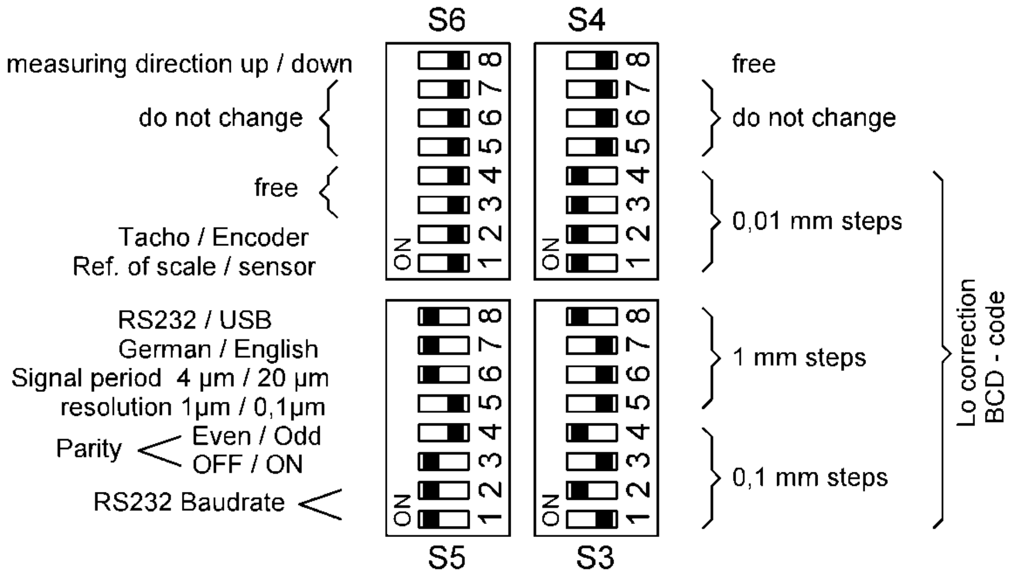
No tuning of the strain gauge sensors is required, this is taken care of automatically by the MFL-electronics.

3.3 Power supply

The power supply RS-50-24 is set to 24 VDC. This voltage can be adjusted at the trimming element SVR1. It must deliver from 23.9 to 24.1 V.
The working voltage 24 VDC is fused in the control electronics input with 5 x 20 = 1 A / T.

3.4 DIP-switches

The selection of the interface, language setting, L_e-correktion and Baud rate can be addressed according to the prevailing requirements. No other changes should be taken by the user or operator without the manufacturer‘s consent.



<u>DIP-switch S3:</u>

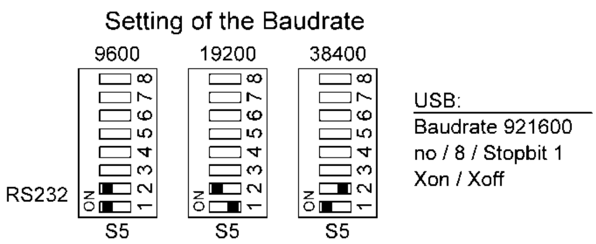
S3/1	L_e – correction 0.1 mm digit / 2^0 - binary code	ON = 0 / OFF = 1
S3/2	L_e – correction 0.1 mm digit / 2^1 - binary code	ON = 0 / OFF = 1
S3/3	L_e – correction 0.1 mm digit / 2^2 - binary code	ON = 0 / OFF = 1
S3/4	L_e – correction 0.1 mm digit / 2^3 - binary code	ON = 0 / OFF = 1
S3/5	L_e – correction 1 mm digit / 2^0 - binary code	ON = 0 / OFF = 1
S3/6	L_e – correction 1 mm digit / 2^1 - binary code	ON = 0 / OFF = 1
S3/7	L_e – correction 1 mm digit / 2^2 - binary code	ON = 0 / OFF = 1
S3/8	L_e – correction 1 mm digit / 2^3 - binary code	ON = 0 / OFF = 1

<u>DIP-switch S4:</u>

S4/1	L_e – correction 0.01 mm digit / 2^0 - binary code	ON = 0 / OFF = 1
S4/2	L_e – correction 0.01 mm digit / 2^1 - binary code	ON = 0 / OFF = 1
S4/3	L_e – correction 0.01 mm digit / 2^2 - binary code	ON = 0 / OFF = 1
S4/4	L_e – correction 0.01 mm digit / 2^3 - binary code	ON = 0 / OFF = 1
S4/5	preset by manufacturer – must not be changed	
S4/6	preset by manufacturer – must not be changed	
S4/7	preset by manufacturer – must not be changed	
S4/8	not occupied	

<u>DIP-switch S5:</u>

S5/1	RS232 / Baud rate	see drawing
S5/2	RS232 / Baud rate	see drawing



S5/3	Parity OFF / ON	
S5/4	Parity Even / Odd	
S5/5	Measurement resolution	ON = 1 µm / OFF = 0.1 µm
S5/6	Encoder grid increments	ON = 4 µm / OFF = 20 µm
S5/7	Language of error messages	ON = German / OFF = English
S5/8	Interface selection	ON = RS232 / OFF = USB

<u>DIP-switch S6:</u>

S6/1 Encoder reference / approximation switch

S6/2 selection ON = tacho generator / OFF = Encoder
S6/3 not occupied
S6/4 not occupied
S6/5 preset by manufacturer – must not be changed
S6/6 preset by manufacturer – must not be changed
S6/7 preset by manufacturer – must not be changed
S6/8 measurement direction ON = DOWN / OFF = UP

3.5 L_e Alignment

Adjustments will become necessary, if the L_e to which the instrument was instructed to move, does not match the displayed value. The DIP-switches S3 and S4 on the control board allows to determine a reset value in binary code from 0.00 to 9.99 mm. The reset value is a value that will betaken into account during the calibration process. All selected L_e values will be influenced similarly if the reset value is modified.
→ Example: a change of the reset value of 1.3 mm will change L_e for 1.3 mm.
→ Approximately 7.5 mm is a typical setting.

<u>Causes for L_e-value deviation:</u>

1. the measuring arm was bent → frequently caused by accidental movement of the clamping chuck.
2. overloaded strain gauge measuring sensors → if this occurs, check if there is sufficient movement clearance for the strain gauge sensors, and make sure the measuring blades are lined up accurately in line opposite to each other.

The measuring blades must be lined up accurately, so that they will be oriented opposite and in line with each other, before setting L_e. This adjustment is done using an M3x3 set screw directly at the front end of the individual measurement arm, and it is accessible through a small hole (also see auch para. "1 Checking the measuring heads").

- Go to a required L_e value
- Measure he addressed L_e–values (for this, we recommend to use a F20–OP).
- Calculate the difference relative to the addressed L_e–value.
- Change the setting of the DIP switches using this amount.

<u>Binary Digits:</u>

1 mm				
S3	**8**	**7**	**6**	**5**
Zahl	2^3	2^2	2^1	2^0
	8	4	2	1
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	0

0,1 mm				
S3	**4**	**3**	**2**	**1**
Zahl	2^3	2^2	2^1	2^0
	8	4	2	1
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	0

0,01 mm				
S4	**4**	**3**	**2**	**1**
Zahl	2^3	2^2	2^1	2^0
	8	4	2	1
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	0

<u>In this example → 7, 5 0 mm</u>

	7				/		5					0			
	8	**7**	**6**	**5**			**4**	**3**	**2**	**1**		**4**	**3**	**2**	**1**
S3	2^3	2^2	2^1	2^0		**S3**	2^3	2^2	2^1	2^0	**S4**	2^3	2^2	2^1	2^0
	0	1	1	1			1	0	0	1		0	0	0	0

4 Exchanging the Control Electronics

1. Shut off mains at MFL- mains switch.
2. Remove mains cable.
3. Remove all connected cables X8 to X14.
4. Take off top and both side cover sheets, using Allen Hex wrench (3 mm).
5. Disconnect power line for 24 VDC from the control electronics. Caution: note the cable colour codes.
6. Carefully pull off all plugged in cables from the control electronics. Caution: note pin sequence!
7. Take out the fixation screws (6 screws M3 x 8 DIN 912) of the board, using a 2.5 mm Allen Hex wrench. The standoffs must remain attached to the board. Do not undo the red marked screws! Caution: hold the control electronics firmly in your hands!
8. Change the settings of the DIP-switches, entering the settings as they show in the “old” board (just taken out), and transfer it to the “new” board!
9. Attach the "new“ electronics firmly again.
10. Carefully re-connect all cables in the same sequence as before removed from the old board. Caution: Make sure, the sequence is exactly duplicated!
11. Re-connect the für 24 VDC line. Caution: make sure, the colour code is well observed.
12. Put top and side covers back into place, using the Allen Hex wrench (3 mm).
13. Put all cables X8 to X14 back in place, the same way they were connected before.
14. Connect mains cable again.
15. Switch on at MFL- mains cable.

5 Measuring Outputs at the Control Electronics

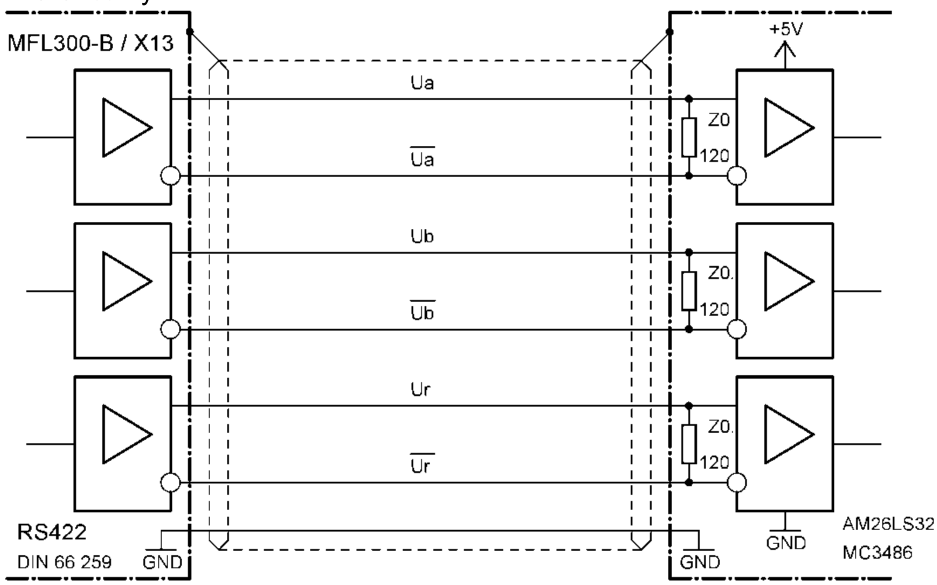
5.1 RS232 / (USB in preparation)

See also: command :MST

5.2 Measurement reading output X13 / RS422 (Standard)

The output X13 is a 15 pin- sub–D-connector (a socket X13 is part of the shipping volume). This output delivers two square signals shifted by 90° (Ua, Ub), a reference impulse (Ur), and their inverted signals. These signals must be counted and further processed by the user's computer.

X13 Circuitry



The circuitry must be able to recognise all signals, and these must have a terminating resistor Z_0.
If only Ua and Ub are used for counting, then counting errors could occur.
Please keep the connection cable X13 as short as possible, and make sure the shielding is connected at both sides to of the plug housings.
Connection pin sequence at measuring output X13

Pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Signal	Ua	GND	Ub	free			$\overline{Ur}$	free	$\overline{Ua}$	GND	$\overline{Ub}$	free		Ur	free

Sub - D 15 pin socket

6 Fault Finding at the MFL 300-B/500-B

6.1 MFL 300-B/500-B does not move

1. Check, if all cables are properly connected.
2. The measurement arms must have sufficient movement clearance to all directions, and they must not rest on the limit of one of the movement freedoms!
3. If the green LED of the power source is not lit up, then check power voltage of the power source, 230 V/AC, and fuses (2x 1A).
4. The MFL- controller receives meaningless commands!
5. Check motors in the MFL 300-B/500-B. The motor shafts must be free to turn by hand while the voltage is switched off. If one of the motors cannot be turned manually, it is defective and should be exchanged *(see instructions)*. It is possible, that its board also has a defect. This could make it necessary to exchange the board also *(see instructions)*.
6. Possible malfunction of the board, exchange as shown in the instruction.

6.2 Measuring blades are not in line, opposite to each other

- For alignment, see para. "1 Checking the measurement heads“.

6.3 L_e- value not reached correctly

A sudden change of the arrival at L_e indicates that a rough shake or another mechanical intrusion has happened to the traverse frame (measuring arms bent).

- For alignment see para. "1 Checking the measuring heads“ and "Aligning L_0- ".

6.4 Measuring blades glide on specimen surface

1. Turn or exchange blunt or worn blades → Measuring blades!
2. The MFL is not oriented symmetrically to the specimen centre, and/or opening hardware has become misaligned. One or two measuring arms do not touch the specimen during the measuring process (thin specimens will reveal this program more pronouncedly). → For alignment, refer to para. "3 Aligning the opening width“.
3. The tensile spring, which draws the measuring arms towards each other must not be over-stretched, because this may result in a too low clamping force.
    a. The standard value for the original MFL tensile springs is 50 cN.
    b. Maximum clamping force of 100 cN <u>must not</u> be exceeded!

6.5 Defects at the motor opening/closing the measurement arms

Motor Nr.: 110125 / Gear Nr. 134158

1. Take of top and side covers, using 3 mm Allen Hex wrench.
2. Take of the holding screws of both measuring heads, using 5 mm Allen Hex wrench (in toolkit), then pull off measuring heads. Unhinge the tensile spring at the measuring arm.
3. If the motor shaft at the opening mechanics can still be turned manuallyt:
    - Turn shaft until both set screws M3x3 / DIN 916 are accessible, then separate the drive shaft from the motor.
    - Pull shaft and guide out towards front side.
    - Unsolder motor supply cable.
    - Exchange defective motor against a new one.
    - Put shaft and guide back in place. Caution: make sure not to bend the micro switch!
    - Attach drive shaft to motor shaft using the M3x3 / DIN 916 set screws.
    - Solder motor contact cable in place → watch for correct polarity.

4. If the motor shaft of the opening mechanics cannot be turned manually, and no access can be gained to the M3x3 / DIN 916 set screws:
    - Slacken the shaft nut of the opening mechanics using the (2.5 mm) Allen Hex wrench.

- ➢ Undo the M6x45 / DIN 912 screws of the motor flange plate.
- ➢ Detach both micro switch adapters, and carefully bend them towards the rear.
- ➢ Lift the motor flange plate and separate the shaft of the opening mechanics from the motor (M3x3 / DIN 916 set screws).
- ➢ Unsolder motor cable
- ➢ Exchange the defective motor against a new one.
- ➢ Put micro switch adapters with their switches back into place and attach well.
- ➢ Put back tooth belt wheels on the driving shafts. Allow about 0.5 mm of clearance between tooth belt wheel and upper end plate of the instrument.
- ➢ Undo strain gauge amplifier, and shift it to the rear.
- ➢ Slacken the two screws of the motor plate (M5x12 / DIN 912) to set the tooth belt wheel tension.
- ➢ Adjust and fix motor flange plate with respect to the upper device plate in parallel manner.
- ➢ Fix the spindle with hexagon screws M3x3 / Din 916 to the motor shaft.
- ➢ Adjust and fix spindle nut of the opening mechanic with respect to the motor spindle.
- ➢ Solder motor connecting cable – note the polarity.

5. Place both measuring heads, and tighten using the Allen Hex wrench (5 mm).
6. Mount top and side covers in place.

6.6 Defective drive motor for the measuring heads

Motor Nr.: 220 432 / Gear Nr. 143 974 / Encoder Nr. 201 937

1. Remove top and side covers using the 3 mm Allen Hex wrench.
2. Slacken both measuring heads with the 5 mm Allen Hex wrench, and pull them off. Make sure to unhinge the tensile spring at the measuring arm before this step.
3. Carefully pull off the motor voltage cable from the board.
    - Take off tooth belt.
    - Slacken and carefully remove tooth belt wheel from the defective drive motor.
    - Remove motor from the motor plate, and exchange against a new one.
    - Put toothed belt wheel back in place and attach. Allow about 0.5 mm of clearance between tooth belt wheel and upper end plate of the instrument.
    - Roll the toothed belt back, beginning with the toothed belt wheel, and the side cover disks.
    - Check belt tension / the belt should be bended 2 mm under gentle pressure.
    - To adjust belt tension slacken 2 screws of motor flange plate (M5x12 / Din 912)
    - Adjust belt tension by moving the motor flange plate, so that the belt can be bended about 2 mm under gentle pressure.
4. Make sure to re-connect the voltage able with its right polarity.
5. Put both measurement heads back in place and tighten them using the Allen Hex wrench (5mm).
6. Attach top and both side covers again.

6.7 Defective bellow

1. Remove top and side covers using the 3mm Allen Hex wrench.
2. Slacken both measuring heads using the 5 mm Allen Hex wrench, and pull them off.
3. Undo and remove the four attaching screws (M3x6 / DIN 912) of theder U–profiles for the bellows guide, using 2.5 mm Allen Hex wrench.
4. Pull off downwards both U–profiles and remove them.
5. Now, slacken and turn out the two attachment screws for the bellows, and remove too. Exchange the defective part of the bellow.
6. Put bellow back in place, and attach them at the end plates of the instrument.
7. Guide the U–profiles from below, into its place, and line the bellow up evenly.
8. Attach U–profiles at the end plates of the instrument with their screws.
9. Attach measuring heads, side and top covers again.

7 Maintenance

Once a year, or after 4000 hours of operation, the elongation sensor should be serviced. These intervals should be kept shorter if some very high contamination level prevails.

1. Clean both **drive shafts** of the measuring heads using a lint-free tissue, slightly moistened in ethyl alcohol or petroleum ether. Allow the shafts to dry for a moment, and then gently apply the special lubricant ISOFLEX NBU 15 or similar. A clean brush may be used for re-greasing, but make sure, that no particles can enter the shaft nut.

2. The **shaft of the opening mechanics** (open / close measurement arms) should be maintained in a similar way.

3. The **guide rails** should be cleaned and re-lubricated in a similar way.

The measuring springs and blades should be cleaned more or less frequently, depending upon the amount of tinder or dust contamination. Only the clearance between the spring and the body of the measuring arm will be cleaned of debris (for example, using pressurised air).

8 Additional Schematics

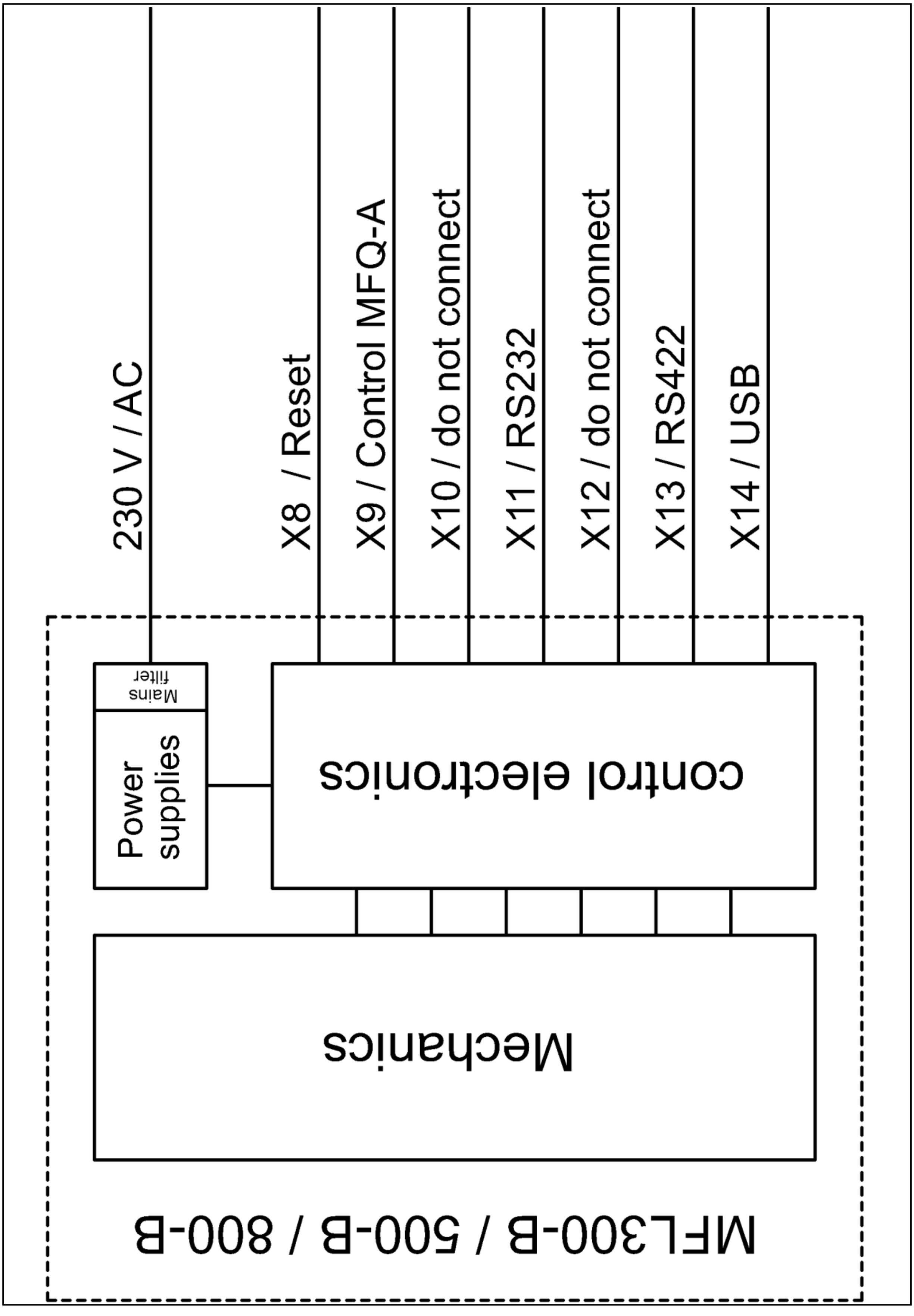


Fig. 1: Circuit Block Diagram