MIKROELEKTRONIK GMBH
intelligent sensors & measuring systems

M2DF-ISA

M2D-Laser-Scanner
with ISA-plug-in board

Manual

Version 3.01

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Contents

M2DF Laser Scanners

The M2DF Laser Scanners extend MEL's product range of Laser Line Scanners to higher image capture rate of 100 Hz with full resolution. For general guidelines see MEL Laser-Scanner catalog!

M2-PCF-LaserScanner

The M2-PCF Laser Scanner system is a ISA-board with 1 or 2 controller add-on boards for connection of the scanner heads. The ISA-board covers 1 ISA slot in a PC. The board takes power from the computers bus : no external power supply!

System Components

- ✓ ISA back plane, Controller module with Linearisation Eprom Alternative: MEL Blue-Box version2
- ✓ Scanner head
- ✓ Scanner head connecting cable, Optional: Scanner head extension cable

Hardware requirement 1 free ISA slot

CPU recommendation 200 MHz-Pentium or AMD Processor for one Scanner
300 … 400 MHz- Pentium or AMD Processor for 2 Scanners

software base address Factory defaults* 300 hex scanner connector 1 (upper)
* = no jumper set 304 hex scanner connector 2 (lower)

Operating systems and compatible Software

The ISA card Version 2 works on 9.x and Windows-2K/XP operating systems. Installation of a special driver is required for Windows NT, 2000 or XP. Special installation guideline is available from the MEL support team.

Use of Interrupt handling

The MEL M2-PCF-ISA card does not require Interrupt handling. IRQ handler can be turned on, when needed.
IRQ-numbers supported: 5, 7, 9 , 10, 11, 12

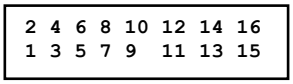
Jumper settings

X = Jumper set = no Jumper set **bold** = default settings

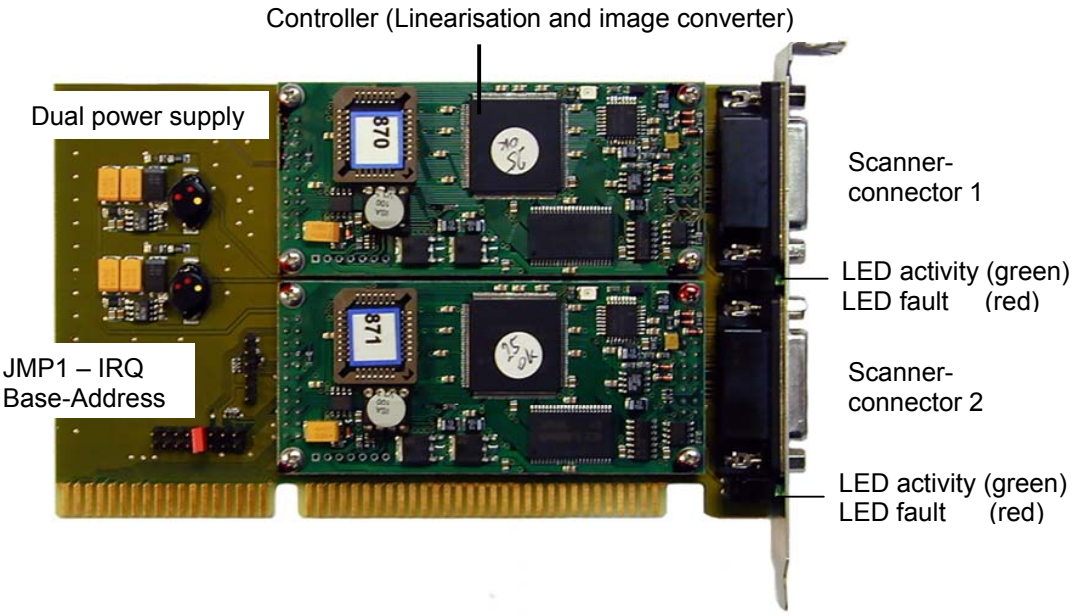
Description	**JMP 1**							
	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16
no Interrupt								
Interrupt 5						**X**		
Interrupt 7					**X**			
Interrupt 9				**X**				
Interrupt 10			**X**					
Interrupt 11		**X**						
Interrupt 12	**X**							
Base address = 300 / 304 Hex								
Base address = 308 / 30C Hex								**X**
Base address = 310 / 314 Hex							**X**	
Base address = 318 / 31C Hex							**X**	**X**

Base address of Scanner connector 2 = Base address of Scanner-connector 1 + 4 [Hexadecimal]

Jumper block 1:

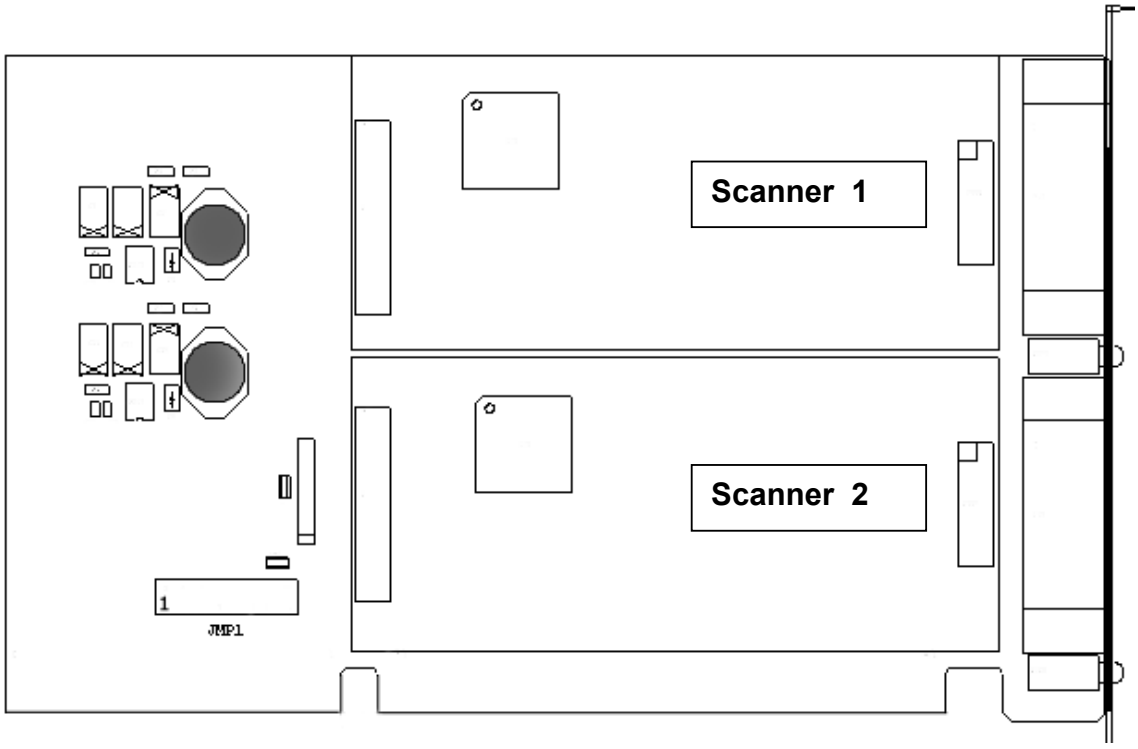


Board Layout



Operation Indicator LED's

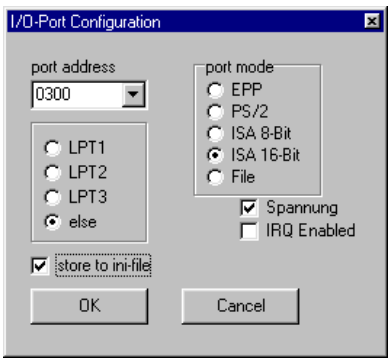
green LED blinking = normal operation.
red Led off = normal operation on = hardware fault condition.



Software Configuration-Tool

The MEL configuration Tool provides the following functions

- set base address for application software
- define port + port mode
- switch on /off power for Laser diode
- save parameter to ini file
- activate IRQ



When you have not set jumpers for IRQ, leave the checkbox „IRQ enabled“ unchecked.

Use of two M2D-Scanner heads on ISA card

make sure, that your application software starts a independent “threads” for each base address, port set to ISA 16-Bit and respective base addresses.

Parameter adjustments

All parameters of the Scanner head are set with software according to the register definition listing. The ISA-card has no Dip-Switches.

Automatic dynamic shutter time

In auto mode the electronic system determines and adjusts the amount of light from the cameras video signal. For low light condition as on “dark targets” - the camera automatically adjusts shutter speed (time) to a slower (longer) value.
For bright light, shutter time is decreased (shorter). Video gain can be raised and thus compensate for slowing down shutter time on black or dark targets,- yet noise will then increase due to the increase of video gain.

Synchronisation

Jumper 5-6 defines sync mode. Master/Slave detection is automatic. After switching on, the Sync mode is always synchronous, this means, profile scans are taken simultaneously, at the same time. Register 15 (0Fh) defines, which sync mode will be active.

Software routines compatible to ISA-card Version 2

Windows	M2D-Show ISA M2D DLL Test (V2.36) Config.exe Scan-Recorder
DOS, Linux	Software examples are available on request.

Parameter adjustments

All parameters of the application software and data communication from and to the scanner head are set in the software configuration. There are no jumpers or dip switches except the settings for synchronization and IRQ / Base address on the ISA board. Communicating to previous generations of MEL demo software could result in broken profile data due to erroneous set up of data format definition in these software releases. The work around is to call the configuration screen and execute a hardware reset. This hardware reset can be called by software command (see register & data format description page ….).

Data Format

Register-Addresses

Base Address Example: 0300h	Bit's	Function	Status
+ 0	0..15	Sensor1 (Bit 0..7= 1.Data bit Bit 8..15=2.Data bit) Sensor1 (Bit 0..7= Sensor command Bit 8..15=n. used)	Read [Byte*] write[Byte*]
+ 2	0 1 2..15 0..15	Sensor_Power_on with 1 Sensor1 Interrupt activate with 1 NC reserved	Write [word*] Read [word*]
+ 4	0..15	Sensor2 (Bit 0..7= 1.Data bit Bit 8..15=2.Databit) Sensor2 (Bit 0..7= Sensor command Bit 8..15 = not used)	Read Byte*] Write [Byte*]
+ 6	0 1 2..15 0..15	Sensor_Power_on with 1 Sensor2 Interrupt activate with 1 NC reserved	Write [word*] Read [word*]

* Byte = 8 bit word = 16 bit

1. Sensors Controls

When the highest Bit is 0, the Byte is interpreted by the Sensor as a command or Register number.
Register contents must be indicated by a 1 in the MSB. For changing a value send first the register number, and then the value to be set. Registers can not be queried. For dual registers, the value is transferred only when the higher register is written.

Register HEX/DEZ		Bit	Function	Remarks	
0	0	6..0	Shutter time Low	Shutter time 0 = max 1022 = min 1023 = Laser off	Manual control
1	1	2..0	Shutter time High		
2	2	6..0	Maximum shutter time Low	Value defines the limit for max. shutter time 0 = max 1022 = min	Automatic control
3	3	6..0	Maximum shutter time High		
4	4	6..0	Begin read out Pixels	Value range is 0 to 127. 1 Bit corresponds 8 Pixels Condition: (Begin < End) Max is limited automatically	
5	5	6..0	End read out Pixels		
6	6	6..0	Video gain Low	<256 = 27dB 1023 = 0dB (default = 768 = 9dB) value is set after sending high byte	
7	7	2..0	Video gain high		
8	8				
9	9				
A	10				
B	11	0	FPGA OK LED	0 = on 1 = off	
C	12				
D	13				
E	14		Reset Position encoder electronic system		
F	15	0	Function of Trigger output	0=simultaneous meas. 1=alternating measurement	
10	16	0	set Scan, image	0=Scan data, 1=complete image (see No. 4)	
11	17	5..0	set Sensor Status messages	0 = Sensor temperature 1 = Register contents 2 = Version number electronic system 3 = Version number camera 4,5,6,7,8 = hours counter in 0,25 seconds 9,10,11 = on counter 31..12 = inputs 1 +2 63..32 = NC = 32 Byte Eprom-Data (siehe unten)	
12	18	0	set Software version	0 = Version1 / 1 = Version2 / 2 = Version3	
13	19		Reset camera chip	Bildzähler und Kamera werden zurückgesetzt	
14	20	2..0 3	Do not use! Measurement control	Dip-Switch adjustments of previous versions*. 0 = continuous 1 = single shot with Trigger	
15	21	0	Shutter time control	0=automatic, 1=extern (Register 0 & 1)	
16	22	0	Linearisation	0=off, 1=on; Start value 1	
1C	28		Reset FIFO	All values in FIFO will be cleared	
1D	29		Single shot in Trigger mode		
1E	30		Reset Sensor	All register values will be reset	

* reserved for incompatible parameters of previous versions – do not use these registers!

2. Data format

Synch signal Status info and Incremental encoder data (Softw.-vers. 3 and higher)

ByteNr	Value	Bit Nr.	Meaning	
1-8	0	8 mal 00 for Synchronisation		
9	1	7... 0	Version number	
10	Status Register 1	0	0=not linear, 1=linear	
		6..1	contents Register 17	
		7	always 0 **	
11	image number	Fortlaufend, 0..253		
12	Status Register 2	**The contents of the status registers is selected by Register 17.** On all values made by 2 or more Bytes, Bit 7 is always 0.		
13	Position encoder Reg.1	6..0	Position encoder Bit 6..0	always 0 **
14	Position encoder Reg.2	6..0	Position encoder Bit 13..7	always 0 **
15	Position encoder Reg.3	6..0	Position encoder Bit 20..14	always 0 **
16	Position encoder Reg.4	5..0 6	Position encoder Bit 26..21 Direction of Position encoder	always 0 ** always 0 **

** these registers are not supported by the ISA-board hardware.

Register [0] : Sensor Temperature

Reg.Nr.	Temperature	value (Hex)	value (Bin)	
0	+126 C°	7E	1111 1110	In steps of 1 degree from -55 to +126 C°. Bit 7 is the sign
	+ 85 C°	55	1101 0101	
	+ 25 C°	19	1001 1001	
	+ 0 C°	00	0000 0000	
	- 1 C°	FF	0000 0001	
	- 25 C°	E7	0001 1001	
	- 55 C°	C9	0011 0111	

Register [1] : Register contents

Reg.Nr.	Bit.Nr	meaning
1	0	0=not linear, 1=linear
	1	0=Register contents as after Reset, 1=after write to register
	2	0=Scan data, 1=complete image
	3	Laser 0 = on 1 = off
	4	Measurement control 0 = continuous 1 = single shot with trigger
	5	Lasers control 0=automatic, 1=extern (Register 0 & 1)
	6	NC
	7	0

Register [2, 3] : Version number electronic system and camera

Reg.Nr.	Bit.Nr	meaning
2	7..0	Example: value 21 corresponds to Version 2.1
3		

Register [4, 5, 6, 7, 8] : Hours counter (Bit 7 always 0) every 250msec one count

Reg.Nr.	Bit.Nr	meaning
4	6..0	Hours counter Bit 6..0
5	6..0	Hours counter Bit 13..7
6	6..0	Hours counter Bit 20..14
7	6..0	Hours counter Bit 27..21
8	3..0	Hours counter Bit 31..28

Register [9, 10, 11] : On timer (Bit 7 always 0) maximum counter value = 131072

Reg.Nr.	BitNr	meaning
9	6..0	On counter Bit 6..0
10	6..0	On counter Bit 13..7
11	2..0	On counter Bit 16..14

Register [12] : Digital inputs

Reg.Nr.	BitNr	meaning	
12	0	input 1	always 0 **
	1	input 2	always 0 **
	7..2	NC always 0	always 0 **

** these Registers are not supported by the hardware.

Register [32 … 63] : 32 Byte Eprom-Data Register (EPROM Addresses 18000h - 1801Fh)

Bit 7 of the Register is not used and always 0. All dimensions 0,1 or 1 mm steps *

Register	BitNr	meaning
32 33	6..0 = LB 6..0 = HB	Pixels of camera horizontal
34 35	6..0 = LB 6..0 = HB	Pixels of camera vertical
36 37 38 39	6..0 = LB 6..0 = LMB 6..0 = HMB 6..0 = HB	Serial number
40 41	6..0 = LB 6..0 = HB	Begin of range *
42 43	6..0 = LB 6..0 = HB	Range *
44 45	6..0 = LB 6..0 = HB	Scan width at begin of range *
46 47	6..0 = LB 6..0 = HB	Scan width at end of range *
48 49	6..0 = LB 6..0 = HB	Max value for measurement range linear
50 51	6..0 = LB 6..0 = HB	Max value for scan range linear
52 53	6..0 = LB 6..0 = HB	Min value for the measurement range (z) not linear
54 55	6..0 = LB 6..0 = HB	Min value for the scan range (x) not linear
56 57	6..0 = LB 6..0 = HB	Max value for measurement range not linear
58 59	6..0 = LB 6..0 = HB	Max value for scan range not linear
60	0 1 2 3 6..4	0 = camera in field mode, 1 = camera in full frame mode 0 = normal, 1 = camera image mirrored 0 = normal, 1 = camera image rotated by 90° 0 = dimensions in 0,1mm steps 1 = dimensions in 1mm steps NC
61 62		Not used Not used
63	6..0	Data format Version

3. Structure of Scanner image data

Software Version 1 linearised:

Each measurement delivers 283 pixels each 4 Bytes with the coordinates X, Z and Intensity
X and Z are given with 12 Bit, Intensity with 4 Bit.

Byte Nr.	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
1	0	**X6**	**X5**	**X4**	**X3**	**X2**	**X1**	**X0**
2	0	**X8**	**X7**	**Z11**	**Z10**	**Z9**	**Z8**	**Z7**
3	0	**Z6**	**Z5**	**Z4**	**Z3**	**Z2**	**Z1**	**Z0**
4	0	**I7**	**I6**	**I5**	**I4**	**X11**	**X10**	**X9**

Distance Z: 0 ... 4095
Scan range X: 0 …4095
Intensity I: 0 ... 14
Bytes could never be 255 (FFh) – Bytes with FF indicate, that the FIFO is empty.

Software Version 1 not linearised:

Each measurement delivers 283 pixels each 2 Bytes with the coordinates X, Z and Intensity
X and Z are given with 10 or 11 Bit, Intensity with 7 Bit.

Byte Nr.	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
1	0	**X6**	**X5**	**X4**	**X3**	**X2**	**X1**	**X0**
2	0	**X9**	**X8**	**X7**	**Z10**	**Z9**	**Z8**	**Z7**
3	0	**Z6**	**Z5**	**Z4**	**Z3**	**Z2**	**Z1**	**Z0**
4	0	**I7**	**I6**	**I5**	**I4**	**I3**	**I2**	**I1**

Distance Z: 0..Pixelzahl horizontal maximal 2048
Scan range X: 0..vertikal/2 maximal 1024
Intensity I: 0..127
Bytes could never be 255 (FFh) – Bytes with FF indicate, that the FIFO is empty.

Software Version 2 and higher linearised and not linearised

Each field delivers as many measurement values as the number of pixels of the CCD divided by 2.
Each line is transformed into 5 Bytes with the coordinates X, Z and Intensity.
X and Z are transferred with 14 Bit, Intensity I with 8 Bit.

Byte Nr.	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
1	0	**X6**	**X5**	**X4**	**X3**	**X2**	**X1**	**X0**
2	0	**X13**	**X12**	**X11**	**X10**	**X9**	**X8**	**X7**
3	0	**Z6**	**Z5**	**Z4**	**Z3**	**Z2**	**Z1**	**Z0**
4	0	**Z13**	**Z12**	**Z11**	**Z10**	**Z9**	**Z8**	**Z7**
5	**I7**	**I6**	**I5**	**I4**	**I3**	**I2**	**I1**	**I0**

	Values not linearized	Values linearized
Distance Z	0…number of Pixels horizontal	0..max 16384 according to linearisation table
Scan range X	0…number of Pixels vertikal/2	0..max 16384 according to linearisation table
Intensity I	1..254	1..254

Bytes could never be 255 (FFh) – Bytes with FF indicate, that the FIFO is empty.

4. Read out complete image

The complete camera image can be read out. This means, there is no internal qualification algorithm of the scan line profile, and the image pixel data is sent out without any further data processing with a resolution of 8 bit.

When the register 16 is set to “1”, the sensor writes two fields to the FIFO. After each field, 8 Byte Synchron Zeros and 4 Byte status information are sent.
Then the sensor waits until the FIFO is emptied, only then, the next two fields are written to the FIFO.

We recommend, to empty the FIFO before activating the video mode, because only then the read-in process of the image data starts. Intensity of the pixels is from 1 to 254. Intensity 255 (FFh) means, that the sensor is busy writing data or FIFO is empty.

5. Synchronizing Scanners

Synchronization means the simultaneous or alternating capture of profile information. For synchron operation of the scanners, jumper 5-6 on jumper block 2 on the ISA base board must be set. In sync mode, both scanner heads operate absolutely synchronous. The phase error is max. 10 µsec.

When register 15 is set to “on”, the scanner heads measure alternating. Shutter time must then be limited by register 2 and 3 to the value 400h, to avoid overlapping of open shutter.

External Synchronization

Extern Sync is accomplished by a *external sync signal* at Sync-input / Pin 4.
The Sync-input reacts on the leading edge of the sync pulse. Threshold is approx. 3 V. This allows operation with TTL logic as well as 24 V logic (PLC) circuits.

Trigger and synchronization is almost the same operation mode.
Please note: when the first image is read in, the first field may contain rubbish (old or corrupted data). The picture information contained in this first field have been created before the sync / trigger impulse has arrived.
Throw away this data! After the first field, two fields with correct data will be read. Each sync pulse resets the image counter to zero.
When no sync pulse is received, the scanners run from their built-in crystal oscillators. External sync could be used in a way, to keep the both scanners running from their built-in oscillators, sending from time to time a sync pulse. This will phase difference very low. The drift of the oscillators is specified 100 x 10^{-6}.

6. Trigger Mode (Board-Version 3.4 and higher)

Trigger mode must be set in the register 20 with a "1" .
Software-Trigger and Hardware-Trigger provide the same functionality.
Both trigger modes react on a leading edge of the trigger input signal on pin 4. The camera starts 65 µsec after the trigger event. The image counter is reset with each trigger pulse and 2 fields are sent.

7. Calculation of shutter time

The camera works with 100 fields per second. Time frame is 10 msec.
Maximum shutter time is shorter, because of the time necessary for erasing the previous image.

Max shutter time = 10 msec * 286 / 256 = 11,17 msec

This max shutter time is divided into 16.384 steps. Light sensitivity of the camera is not linear, therefore the regulation parameter is linearized using 8 “supporting points” (see register 0 … 3).
The calculation of the shutter time using the regulation parameter (0 = shortest ; 1022 = longest shutter time) is given by the following formula:

$$\text{Shutter time} = \text{max shutter time} \times \frac{16384 - \sqrt[4]{\text{reg.parameter} \times 2897}}{16384}$$

D-Sub-15pin Scanner Connector pin out (cable connector is male!)

Pin DSub-15	Signal	Colour	Level	Remarks	Pin Code round binder connector
1	Video Signal		1 V	Coax cable 75 Ω	M
2	nc				nc
3	+ 50 MHz				C
4	Sync-Input		2 mA	Extern Trigger *	D
5	GND, 0V		0 V	screen	A
6	- 50 MHz		V		B
7	nc				nc
8	+ 10V		+ 10 V	Max. 2 mV ripple	K
9	GND Video		0 V	Black coax shield	L
10	GND		0 V	Grey coax	H
11	GND		0 V	Grey coax shield	J
12	nc				nc
13	nc				F
14	SerKO_data		V		E
15	Syn_data		V		G

* from hardware version 3.5