Original Instructions

Digital Measuring Unit

MG3 Hot Bar

OPERATING INSTRUCTIONS

AMADA®

76609576EN-MG3-HB-V1.0a

Annex:
- Safety Regulations
- General References on Resistance Welding
- Contact Addresses

Version	Date	Revision notification
1.0	2013-04	New
1.0a	2015-10	Changed company name

Table of Contents

1 General Information 5
1.1 Preface 5
1.2 Copyrights, Proprietary Rights 5
1.3 Definition of Symbols Used 6
1.3.1 Prohibition and Warning Symbols 6
1.3.2 Further Symbols 7
2 Technical Description 8
2.1 Mode of Action 8
2.2 Technical Data 8
3 Commissioning 9
3.1 Connecting the Components 10
3.1.1 Description of the Connectors 10
3.1.2 Connector Pin Assignment of Inputs & Outputs 11
3.1.2.1 Connector X54 (Outputs) 11
3.1.2.2 Connector X55 (Inputs) 12
3.1.2.3 Connector X38 (I/O Outputs) 13
3.1.2.4 Connector X38 (I/O Inputs) 14
3.1.2.5 Connector X51 (RS232) / Baud rate 14
3.1.2.6 Connector X60 and X61 (CANopen) 15
3.1.3 Connecting Temperature Sensor 15
3.1.4 Connecting Displacement Sensor (optional) 15
3.1.5 Connecting Force or Pressure Sensor (optional) 15
3.1.6 WK-Adapter (optional) 16
3.2 Initial Commissioning 16
3.2.1 Preconditions 16
3.2.2 Starting-up 16
4 Operation 17
4.1 Toggle Wheel 17
4.2 LED Status Display 18
4.3 Screen (Display) 18
4.3.1 Display Windows – Quadrant 1 to 4 19
4.3.2 Menu Bar 19
4.3.3 Program Display 19
4.3.4 Measuring Mode 19
4.3.5 Status Bar 19
4.4 USB Port 20
4.5 UNDO Function 20
5 How to ...? 21
5.1 Make General Settings 21
5.2 Measure Temperature 24
5.3 Switch between Single and Multiple Measurement 26
5.4 Configure the Display Windows (Quadrants) 27
5.5 Measure Displacement 29
5.5.1 Configure Displacement Measurement 29
5.5.2 Configure Part Detection 30

5.6 Measure Pressure or Force 32
5.7 Set Limit Values 33
5.8 Copy, Save and Load Programs and Parameters 34
5.9 Count Measurements 35
5.10 View and Save Measuring Waveforms 36
5.11 Print Measured Values 38
5.12 Set and Change Password 39
5.13 Configure the Logger 40
5.14 Display the Parameter Overview 42
5.15 Analyze Accept-Reject Ratio 43
5.16 Monitor Statistical Values 44
5.17 Determine Limit Values Statistically 45
5.18 Transfer Data to PC/Laptop 46
5.19 Make a Screenshot of the Current Display 46
5.20 Register the Device 46
6 Integration in Automated Installations 47
6.1 Connection to field bus system 47
7 Appendix 48
7.1 Error messages 48
8 Indexes 49
8.1 Figures 49
8.2 Headwords 49

1 General Information

1.1 Preface

	Information about safety regulations, usage location conditions, copyrights, protection rights, symbols, and notes on resistance welding can be found in the annex of the operating instructions. Please read this information carefully before using this unit.

These **operating instructions** shall help you to familiarize yourself with the unit and take advantage of its application possibilities when used as directed.

The operating instructions contain important notes to help operate the unit safely, properly, and economically.
Observing the notes will help avoid risks, decrease repair costs and down times, and enhance reliability and the service life of the unit.

The operating instructions should **always** be accessible at the unit operating site. It should be read, understood and utilized by any person assigned to work on or with the unit. This applies in particular to the notes on safety, notes concerning safety regulations as well as safety and warning notes.

Warning	The fundamental principle applies**:** **Safety first!** **Always carry out a function test before the first weld!**
	Do not operate the unit before reading these operating instructions!

1.2 Copyrights, Proprietary Rights

The copyright of these operating instructions remains the property of our company.

These operating instructions are only meant for the internal use of the operator of resistance welding units (hereafter called “unit”) and his/her personnel.

It contains descriptions, technical drawings, regulations and instructions which should not be copied, distributed, passed on to others or use without permission for competitive purposes, whether completely or in part. In the event of competitors endeavoring to see these operating instructions, we expect the same fairness from you that you, in turn, would expect from your customers in such cases.

All rights are reserved, particularly in cases of patent granting or other registrations. We reserve the right to make technical alterations.

1.3 Definition of Symbols Used

1.3.1 Prohibition and Warning Symbols

 **Danger**	This symbol indicates an **imminent danger**. Failure to heed these instructions will lead to irreversible or even life-threatening injuries, grave adverse effects on health or considerable material damage.
 **Warning**	This symbol indicates a **potentially imminent danger**. Failure to heed these instructions can lead to irreversible or even life-threatening injuries, grave adverse effects on health or considerable material damage.
 **Warning**	This symbol **warns of hazards emanating from electrical voltage**. Failure to heed these instructions can lead to grave, irreversible or even life-threatening injuries caused by electric shocks.
 **Caution**	This symbol indicates **a potentially harmful situation**. Failure to heed these instructions can lead to product damage or damage to objects in its near vicinity.
 **Attention**	This symbol indicates **possibly harmful situations**. Failure to heed these instructions can lead to work delays or light damage to the product.
	**Crush hazard**
	**Magnetic field hazard**
	**Tipping over hazard**
	**Prohibition for wearers of cardiac pacemakers**
	**Prohibition for wearers of metallic implants**

1.3.2 Further Symbols

	**Wear eye protection**
	**Disconnect power plug**
	**Wear protection gloves**
	**Pay attention to Operating Instructions**
	**Information** **This symbol indicates operator tips and other useful information for optimum utilization of the machine.**

2 Technical Description

2.1 Mode of Action

The MG3 Hot Bar is a digital measuring and monitoring instrument for Hot Bar installations.
You can adjust up to 99 programs with different parameters for monitoring. Choose one of these programs for monitoring the welding process.

The values of the last welds (up to 2500) are stored in a buffer.
If this buffer is full (or the set number of welds to be stored is reached), the complete measurement data packet is written as a log file onto the USB-stick.

You can print selected parameters of each welding on a printer with serial interface.
Individual operator configurations remain stored even when the device has been switched off.
The MG3 is operated by a toggle wheel.

2.2 Technical Data

Program monitoring	99 programs, internal or external program selection
Measuring functions	2 temperatures with temperature peak, temperature integral, temperature average, temperature gradient, temperature difference, heat time (s) Optional: displacement and force or pressure
Counter	Up and down counter with prewarn and final value signal-output
Measuring range temperature	Temperature 1 (T1): 25 to 600 °C Temperature 2 (T2): 25 to 600 °C
Measuring accuracy	± 1.5 % of upper range value for temperature
Graphic resolution	Sample rate 100 ms
Measuring interval	Variable Note: The more graphics are displayed, data through RS232 and limit values are monitored, the longer the measuring interval.
Limit value setting	Upper and lower limit value, independently from each other
Prewarn setting	Upper and lower prewarn value, independently from each other
Graphic display	VGA, 640 x 480 pixel
Optical indications	8 front LEDs
Inputs / outputs	See chap. 3.1.1
Mains voltage and frequency	110 - 240 Volt AC; 50-60 Hz, switching power supply
Power consumption	60 W
Ambient temperature	0 °C to 40 °C
Relative humidity	max 70 %
Dimensions	½ 19“: (W x H x D) 280 x 140 x 340 mm
Weight	approx. 5.4 kg, (approx. 11.9 lbs)

3 Commissioning

The MG3 Hot Bar is supplied with an adjustable support stand.
To have a non-dazzling reading of the screen adjust the tilt angle with this stand.

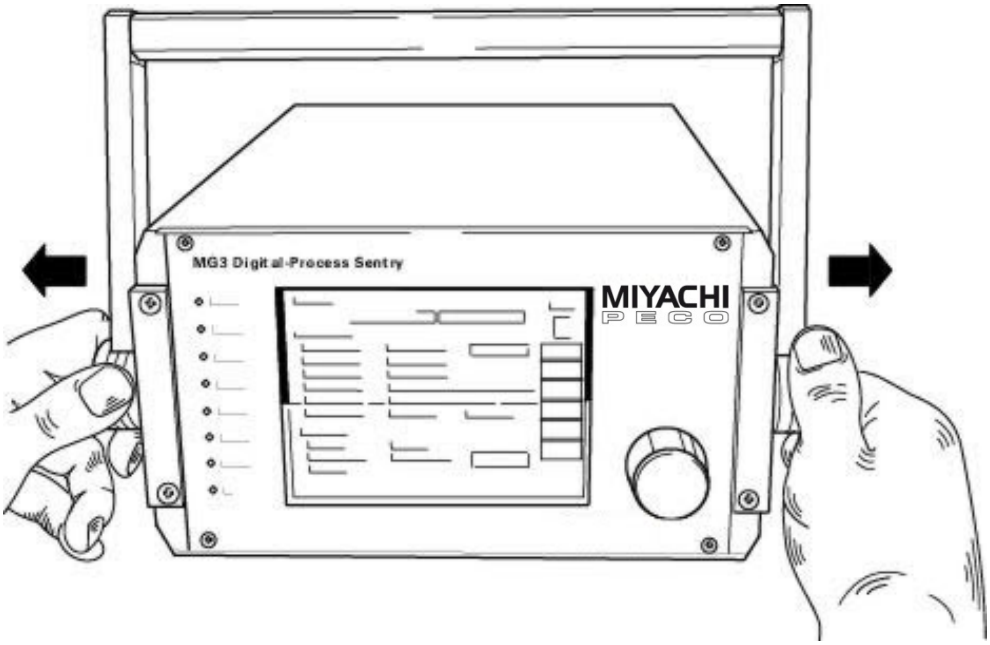


Fig. 1: MG3 with support stand

Remove the MG3 Hot Bar from the packing and set it up at the designated place.
Pull apart both caps at the stand's pivot points and adjust the desired position.

3.1 Connecting the Components

3.1.1 Description of the Connectors

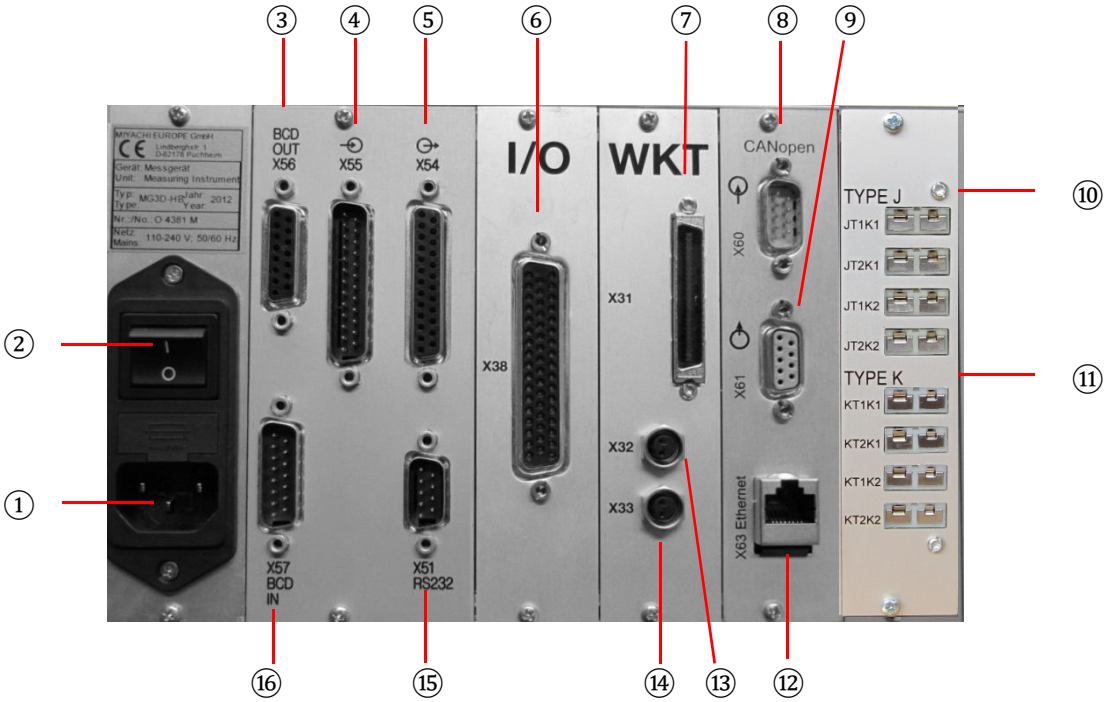


Fig. 2: Connectors on the housing rear side

No.	Connector	Function
①	**Mains**	Connector for mains cable. Check **mains voltage** on type **designation plate**.
②		On/off switch
③	**X56**	Outputs for program number (set BCD or binary code accordingly, 1...99)
④	**X55**	Control inputs from peripheral equipment
⑤	**X54**	Control outputs to peripheral equipment
⑥	**X38**	Inputs and outputs extended I/O
⑦	**X31**	Connector for displacement measuring or WK-Adapter (for displacement and force or pressure measuring)
⑧	**X60**	CANopen IN
⑨	**X61**	CANopen Out
⑩	**TYPE J**	Connectors for thermocouples of thermode J
⑪	**TYPE K**	Connectors for thermocouples of thermode K
⑫	**X63**	Ethernet
⑬	**X32**	Not used
⑭	**X33**	Not used
⑮	**X51**	RS232 interface (e.g. to serial printer)
⑯	**X57**	Inputs for program number (set BCD or binary code accordingly, 1...99)

3.1.2 Connector Pin Assignment of Inputs & Outputs

The outputs always represent the last measurement.
They will be set or cleared only after a new measurement.
In the following tables means
High = voltage level +24 V and **Low = voltage level 0 V**

3.1.2.1 Connector X54 (Outputs)

Pin	Name	Chan.	Function
1	**Ready**	1 and 2	Control unit ready to receive data. Ready flag does not apply during counter or measured value reset, during boot procedure or by HIGH signal at control input NOT READY, measurement reset, data transfer
2	**Temperature**	1	Signalizes the superior control that measurement is started by an external trigger signal. Signal remains until manually set measuring time ends.
3	**WARN min.**	1 and 2	Monitoring of minimum prewarn value.
4	**WARN max.**	1 and 2	Monitoring of maximum prewarn value.
5	**Limit value min.**	1 and 2	Monitoring of minimum limit value.
6	**Counter limit**	1 and 2	Signal waiting when counter reached final value, until counter reset.
7	**REJECT**	2	Signal waiting as soon as monitored parameter is out of limits.
8	**Temperature**	2	Signalizes the superior control that measurement is started by an external trigger signal. Signal remains until manually set measuring time ends.
14	**ACCEPT**	1	Signal waiting as long as parameters monitored with limit values are within the limit.
15	**REJECT**	1	Signal waiting as soon as monitored parameter is out of limits.
16	**Overflow**	1 and 2	Signal waiting if a set measuring range is exceeded by the measured parameter.
17	**No temperature**	1	Signal is activated (High): a) after external trigger signal if no temperature is measured during this. b) after valid part detection c) if trigger source “0 penetration“ or “Force trigger“ is activated and no temperature is measured. Signal is deactivated (low): a) at beginning of measurement b) with signal at input reset measuring value
18	**Limit value max.**	1 and 2	Monitoring of maximum limit value.
19	**Counter WARN**	1 and 2	Signal waiting when counter reached prewarn value, until counter reset.
20	**ACCEPT**	2	Signal waiting as long as parameters monitored with limit values are within the limits.

Pin	Name	Chan.	Function
21	**No temperature**	2	Signal is activated (High): a) after external trigger signal if no temperature is measured during this. b) after valid part detection c) if trigger source “0 penetration“ or “Force trigger“ is activated and no temperature is measured. Signal is deactivated (low): a) at beginning of measurement b) with signal at input reset measuring value

3.1.2.2 Connector X55 (Inputs)

Pin	Name	Chan.	Function
5	**Clear ACCEPT outputs, set faults**	1 and 2	Disables all ACCEPT outputs; all limit, REJECT and prewarn (WARN) outputs (fault outputs) are set.
8	**Save log-file**	2	
9	**Counter reset**	1	Resets counter to its initial value.
10	**Measurement reset and outputs cleared**	2	Displayed measured values are set to zero and outputs are cleared.
12	**Hold**	1	High: measured values of a succeeding welding are not accepted. With falling edge measured values are read in again starting with a new welding.
13	**Trigger**	1	High: - if no measuring signal is detected a ‘no temperature error’ is set with falling edge. - only the last measuring before falling edge is evaluated.
17	**Not ready**	1 and 2	Disables parameter value acquisition; ready output at X54 pin 1 goes to LOW.
18	**Set ACCEPT outputs, clear faults**	1 and 2	Disables all REJECT and limit value outputs; all ACCEPT outputs are set.
21	**Save log-file**	1	
22	**Counter reset**	2	Resets counter to its initial value.
23	**Measurement reset and outputs cleared.**	1	Displayed measured values are set to zero and outputs are cleared.
24	**Hold**	2	High: measured values of a succeeding welding are not accepted. With falling edge measured values are read in again starting with a new welding.
25	**Trigger**	2	High: - if no measuring signal is detected a ‘no temperature error’ is set with falling edge. - only the last measuring before falling edge is evaluated.

3.1.2.3 Connector X38 (I/O Outputs)

Pin	Name	Chan.	Function
3	**Displacement min.**	1	High: currently measured displacement is outside the set limits
4	**Displacement max.**	1	
5	**Displacement min.**	2	High: currently measured displacement is outside the set limits
6	**Displacement max.**	2	
7	**Prewarn Dist. S3**	1	High: prewarn value is exceeded
8	**Prewarn Dist. S6**	2	
9	**Sinking 2 Accept 2**	2	Output enabled if sinking 2/1 is ACCEPT
10	**Sinking 1 Accept 1**	1	
11	**Pressure/Force reject**	1	
12	**Pressure/Force accept**	1	
13	**Pressure/Force reject**	2	
14	**Pressure/Force accept**	2	
17	**Path Abort Temperature High**	2	High: cutoff value is exceeded.
31	**Path Abort Temperature Low**	2	Low: cutoff value is exceeded.
18, 21	**Plus terminal (+)**		Common plus terminal (+) for PIN: 14, 13, 11, 12, 10, 9, 8, 7, 6, 5, 4, 3, 30, 29, 28, 27, 26, 25, 24, 23
19	**Common (+) 1**	1	Common plus terminal 10 – 30 V for PIN 16 and 20.
20	**Path Abort Temperature High**	1	High: cutoff value is exceeded.
16	**Path Abort Temperature Low**	1	Low: cutoff value is exceeded.
25	**Parts Detection Low active**	1	Low: limit values are not reached or exceeded, (pressure switch control unit).
26	**Parts Detection Low active**	2	
27	**Path Parts Detection min.**	1	Depending on setup default; becomes active if the currently measured parts control path min./max. is exceeded or remains under.
28	**Path Parts Detection max.**	1	
29	**Path Parts Detection min.**	2	High: currently measured parts detection path min/max is exceeded or remains under.
30	**Path Parts Detection max.**	2	
34	**Common (+)**	2	Common plus terminal 10 – 30 V for PIN 17 and 34.

3.1.2.4 Connector X38 (I/O Inputs)

Pin	Name	Chan.	Function
22	Ground connection		Common connection of the inputs.
35	n/c		
36	n/c		
37	n/c		
38	n/c		
39	Reference run part detection	1 and 2	High: part detection without inserted part for reference run (can also be actuated with the reference button on the display)
41	n/c		
42	n/c		
43	n/c		
44	n/c		
45	Null Sinking	2	Triggers with rising edge, cooling time with falling edge.
46	Null Sinking	1	Triggers with rising edge, cooling time with falling edge.
47	Parts Detection	2	Set parts detection = HWScan. Measured value is evaluated and part min. 2 – max. 2 is set.
48	Parts Detection	1	Set parts detection = HWScan. Measured value is evaluated and part min. 1 – max. 1 is set.
49	Start Measure	2	Starts part detection 2 for sensor 2.
50	Start Measure	1	Starts part detection 1 for sensor 1.

3.1.2.5 Connector X51 (RS232) / Baud rate

Pin	Name	Pin	Name
1	free	6	free
2	TxD	7	CTS
3	RxD	8	RTS
4	5V	9	free
5	GND		

Baud rates (bit/s)	9600; 19200; 38400; 57600; 115200
Data bits	8
Start bits	1
Stop bits	1
Parity	none
Busy Control	no/off

3.1.2.6 Connector X60 and X61 (CANopen)

Connection with standard RS232 extension cable (1:1)

Pin	Name	Function
1	Free	
2	CAN_L	Low-level
3	CAN_GND	Ground
4	Free	
5	CAN_SHLD	Circuit shield
6	Free	
7	CAN_H	High-level
8		
9		

CAN-Baud rates	1 MB/s; 800 kB/s; 500 kB/s; 250 kB/s; 125 kB/s; 50 kB/s; 20 kB/s; 10 kB/s

3.1.3 Connecting Temperature Sensor

For the mounting of the thermocouples on the Hot Bar head please see the operating instructions of the Hot Bar system.

Connect the plug of the thermocouples with the corresponding socket on the rear side of the MG3 (see chap. 3.1.1).
Note: Switch off the MG3 Hot Bar before connecting.

3.1.4 Connecting Displacement Sensor (optional)

For displacement measurement you need an optional available displacement sensor and the corresponding mounting kit.

For the mounting of the displacement sensor on the Hot Bar head please see the operating instructions of the Hot Bar system.

Connect the plug of the displacement sensor with the supplied sensor cable adapter and then connect the adapter with the corresponding socket (X31) on the rear side of the MG3 (see chap. 3.1.1).
Note: Switch off the MG3 Hot Bar before connecting.

If a WK-adapter is used (necessary for force or pressure measurement), connect the plug of the displacement sensor directly to the WK-adapter.

3.1.5 Connecting Force or Pressure Sensor (optional)

For force or pressure measurement you need optional available force or pressure sensor, the corresponding mounting kit and the WK-adapter.

For the mounting of the respective sensor on the Hot Bar head please see the operating instructions of the Hot Bar system.

Connect the plug of the sensor to the WK-adapter and then connect the adapter with the corresponding socket (X31) on the rear side of the MG3 (see chap. 3.1.1).
Note: Switch off the MG3 Hot Bar before connecting.

3.1.6 WK-Adapter (optional)

Fig. 3: WK-Adapter

For force or pressure measurement you need an optional available force or pressure sensor, the corresponding mounting kit and the WK-adapter.

For the mounting of the respective sensor on the Hot Bar head please see the operating instructions of the Hot Bar system.

Connect the plug of the sensor to the WK-adapter and then connect the adapter with the corresponding socket (X31) on the rear side of the MG3 (see chap. 3.1.1).
Note: Switch off the MG3 Hot Bar before connecting.

3.2 Initial Commissioning

3.2.1 Preconditions

- Check whether the MG3 Hot Bar is switched off. The main switch must be in position 0.
  See chap. 3.1.1.
- Check mains voltage and frequency at place of installation. See chap. 2.2.
- Plug in power supply cord to the corresponding connector at the rear of the MG3 Hot Bar.
- Check whether the USB stick is plugged in.

3.2.2 Starting-up

Switch on the main switch on the rear side of the MG3 Hot Bar.
After initialization - lasting for approx. 30 seconds - you can configure the MG3 Hot Bar.

4 Operation

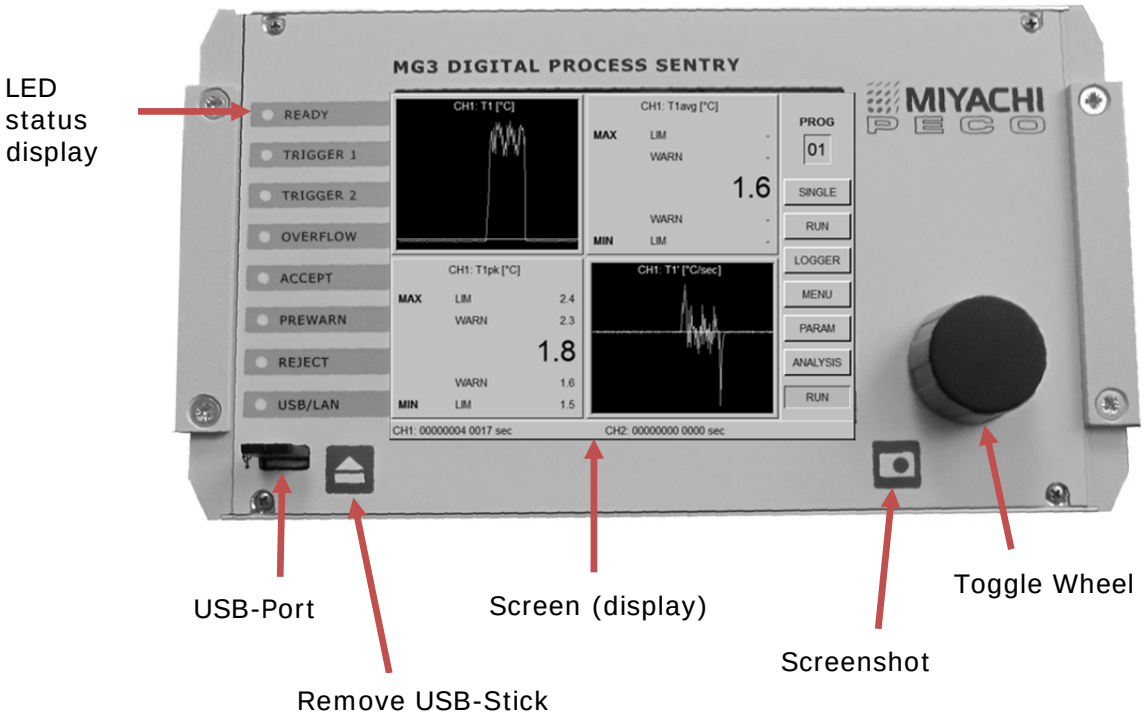


Fig. 4: Control panel MG3 Hot Bar

4.1 Toggle Wheel

The toggle wheel is the central operating element of the MG3 Hot Bar.
You can carry out all settings with the toggle wheel:

- Select by turning the toggle wheel. The selected item changes to red.
- By pushing the toggle wheel (hereinafter called clicking) you can enable resp. activate/deactivate the selected item (button, check box, list box, quadrant, etc.).
- Grayed items are disabled and cannot be selected.

Input fields are:

- Buttons which trigger a certain action when clicked
- Check boxes which have two switching conditions (black = on/active; gray = off/inactive)
- List boxes which allow you to select from a list of options.
- Edit boxes which allow the input of numbers.
  Click once to get to the quick-edit mode where you can change the whole number (by turning the toggle wheel).
  Click twice to get to the precision editing mode where you can change each digit separately.

  Click again to get back to the edit box.

4.2 LED Status Display

READY	🟢	MG3 Hot Bar ready for measurement
TRIGGER1	🟢	Measurement activity on channel 1
TRIGGER2	🟢	Measurement activity on channel 2
OVERFLOW	🔴	MG3 Hot Bar overflow measuring range
ACCEPT	🟢	Measurement within set limits
PREWARN	🟡	Measurement outside set prewarn limits
REJECT	🔴	Measurement outside set limits
USB	🟢	USB stick missing (blinking) or access to USB stick (on steady)

4.3 Screen (Display)

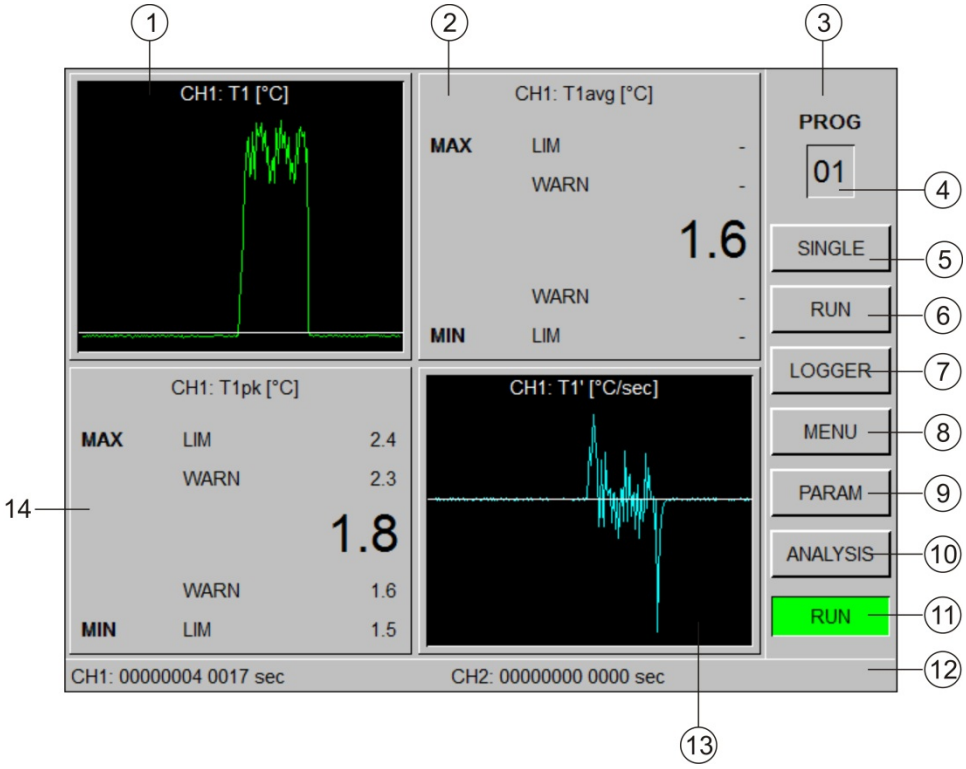


Fig. 5: Screen (Display)

1. Display window quadrant 1 (Q1)
2. Display window quadrant 2 (Q2)
3. Menu bar
4. Program number selection
5. Button for single measurement (SINGLE)
6. Button for permanent measurement (RUN)
7. Button for logging (LOGGER)
8. Button for configuration menu (MENU)
9. Button for parameter overview (PARAM)
10. Button for analysis (LIMITS)
11. Shows current measuring mode (SINGLE/RUN)
12. Status bar for status, help and fault messages
13. Display window quadrant 4 (Q4)
14. Display window quadrant 3 (Q3)

4.3.1 Display Windows – Quadrant 1 to 4

The measured values can be shown in four fully configurable display windows (quadrants).
Each quadrant can show the values in one of the following display modes:

- numeric
- graphical
- SPC*-Chart
- SPC*-Values

* SPC: Statistical Process Control

Select the quadrant by turning the toggle wheel.

Click on one quadrant to see an enlarged and more detailed view of this quadrant with additional setting possibilities.
To get back to the previous display click to the main display field in this screen.

Special feature of the numeric display mode:
After a measurement the measured value can flash colored or gray.
This means:

- yellow: the measured value is outside the set prewarn limits
- red: the measured value is outside the set limits
- gray: invalid measurement (range overflow)

4.3.2 Menu Bar

The menu bar comprises the following controls:

- Display/setting of the current program number (1…99)
- Display of the current measuring mode (SINGLE/RUN)
- Buttons for selecting displays and measuring mode

4.3.3 Program Display

Shows the number of the currently active measuring program.
Range: 1 to 99.
Program selection by the toggle wheel.

4.3.4 Measuring Mode

You can switch between the two measuring modes by clicking on it:

- Single measurement (SINGLE) or
- Multiple measurement (RUN)

The currently active measuring mode is shown in the last field below.

4.3.5 Status Bar

Depending on the selected controls the status bar shows:

- Information on the last measurement (channel 1/2)
- Details on the meaning of the selected controls
- Information on the condition of the selected function
- Fault messages

4.4 USB Port

Caution	**Loss of data !** Disable the USB stick before you remove it from the notebook or PC. Press the ‘remove USB stick’ button on the front of the MG3 Hot Bar before you remove the USB stick (see chap.4, fig. 4).

4.5 UNDO Function

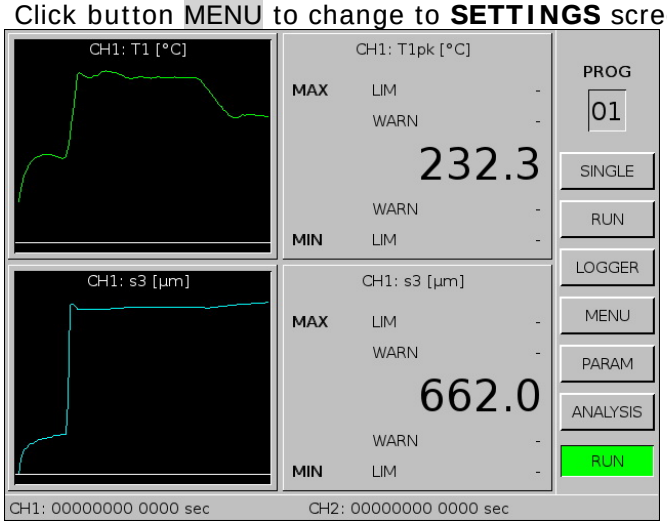
The menu bar offers the button UNDO for all screens where parameters can be set or changed.
With this button you can undo the last (up to 50) settings in this screen one by one.

5 How to ...?

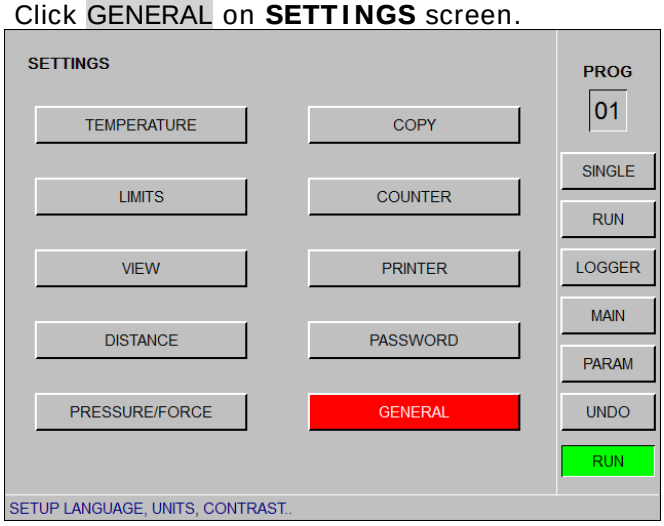
5.1 Make General Settings

After starting-up and initialization, the MG3 Hot Bar is in measuring mode ‘Multiple Measurement’ (RUN). First you have to make the basic settings.

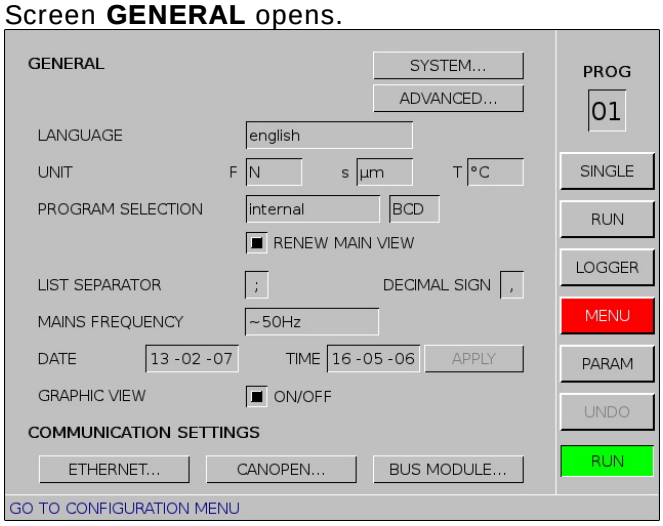
Click button MENU to change to **SETTINGS** screen.



Click GENERAL on **SETTINGS** screen.



Screen **GENERAL** opens.



LANGUAGE
Choose your language.

UNIT
Choose units of measure:

- for force measurement **F**: **N** or **lbs**
  for pressure measurement **p:** **bar** or **psi**
  (choose between force and pressure measurement on the screen PRESSURE/FORCE, see chap. 5.6)
- for displacement measurement **s**: **µm** or **th**“ (thousandth inch)
- for temperature measurement **T**: **°C** (Celsius) or **°F** (Fahrenheit)

PROGRAM SELECTION
Choose the measuring program selection:

- **internal** (default) means with the toggle wheel (necessary when working with bus systems)
- **external** means by external hardware input at connector X57.

Choose the coding for the program number input/output:

- **BCD** (binary-coded decimal) or
- **BIN** (binary).

RENEW MAIN VIEW
Refreshing the main view takes time, so if you use external program selection deactivate this feature in order to speed up the program changeover.

Also deactivate this feature if you configure quadrant windows for SPC (see chap. 5.4). These SPC quadrant windows have to be configured the same for each program, otherwise the SPC chart will be reset.
Deactivation of this option is therefore advantageous when rapidly switching programs and using the SPC charts, as the main display need only be configured once.

LIST SEPARATOR, DECIMAL SIGN
The MG3 Hot Bar stores its data in a CSV (comma separated value) compatible format.
So the used sign for the list separator and the decimal sign on the MG3 Hot Bar must be the same as the one used on your PC.
Choose between semicolon (;) and colon (,) for the list separator and between point (.) and colon (,) for the decimal sign.
Note:
You find the used signs on your PC in the system settings by the point regional settings.

MAINS FREQUENCY
Select the used mains frequency: **~50 Hz** or **~60 Hz**.

Caution

Wrong settings will cause wrong measurements!

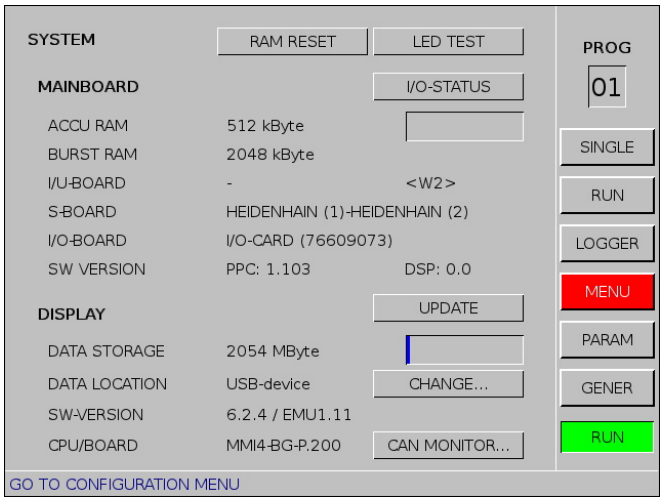
DATE
Set the current date in the format YY-MM-DD (year-month-day)

TIME
Set the current time in the format HH:MM:SS (hour:minute:second)

GRAPHIC VIEW
Enables graphic viewing (ON/OFF). If you disable this check box, no graphics will be shown.

COMMUNICATION SETTINGS
Adjust the settings for communication via Ethernet, CANopen or Bus modules.

Click SYSTEM to change to **SYSTEM** screen.



The **SYSTEM** screen displays general system information. E.g. about:

- **MAINBOARD**
  (RAM assignment, built-in plug-in cards, hardware version, software version PPC and DSP)
- **DISPLAY**
  (RAM assignment, USB stick memory capacity, display software version)

For a function check of the LEDs click LED TEST.
All LEDs on the front panel will light shortly.

For a complete reset of all parameters click RAM RESET.

Use **RAM RESET** only if there is no other possibility.
Before you confirm the reset, save all set parameters to the USB stick.

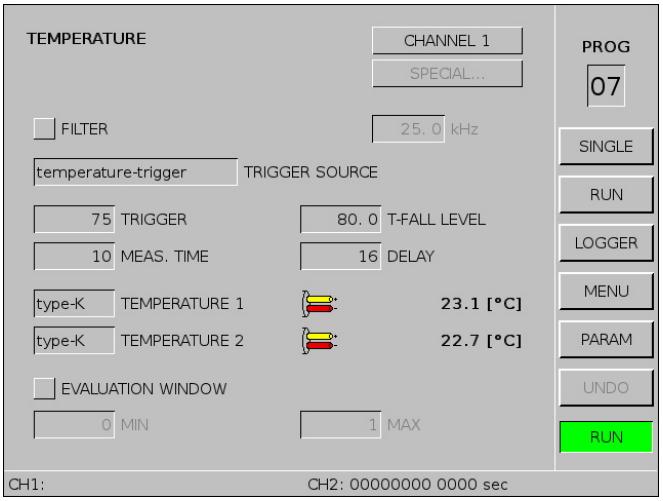
Caution

Loss of data!
If you perform RAM RESET, all set parameters will be lost!

ADVANCED
Shows advanced information about the MG3 Hot Bar.

5.2 Measure Temperature

Go to **TEMPERATURE** screen via MENU - TEMPERATURE.



CHANNEL
Click CHANNEL 1 to change to CHANNEL 2 and vice versa.

FILTER
Set an interference filter for the input signal (for temperature 1 and temperature 2).

TRIGGER SOURCE
Choose which value shall trigger the measuring:

- temperature-trigger:
  measuring is started when the temperature set in the field TRIGGER is reached.
- force-trigger:
  measuring is started when the force/pressure set in the field TRIGGER is reached.
- 0-displacement: triggers if a signal is active at input (X38) “Zero penetration 1 or 2”.

TRIGGER
Set the temperature, force or pressure value which must be reached to start the measuring.
Setting range: 0 – 500 °C or N or bar

T-FALL LEVEL
Set the falling temperature limit (in % of T1pk) for the heating time counting (Th).

MEAS. TIME
For single weld measurement you need to set the measuring time bigger than the total heat time of the Hot Bar system.
Setting range**:** 0 to 100 sec.

DELAY
The delay time set here prevents the start of a new measuring directly after the end of a measuring.
Setting range**:** 0 to 100 sec.

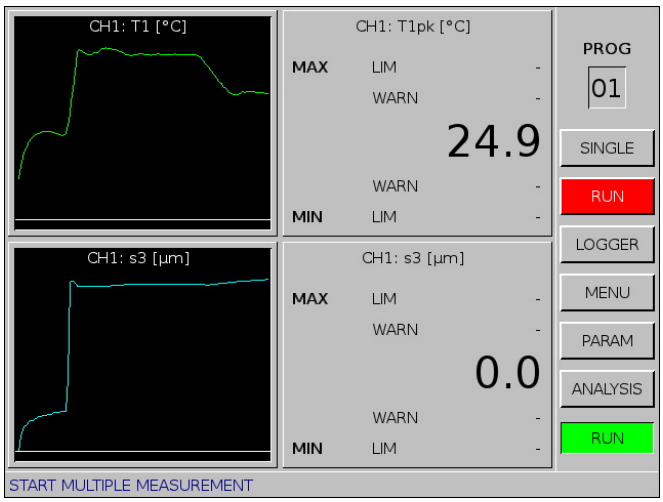
TEMPERATURE 1 / 2
Set the used type of thermo couples:
type-K or type-J

EVALUATION WINDOW
Activate and set a time slot (MIN / MAX) in which measuring value monitoring shall happen.
Setting range**:** 0 to 1030 sec.

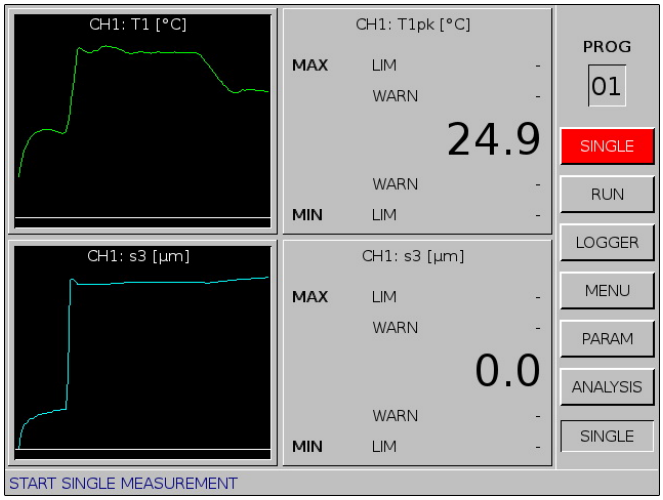
SPECIAL
Adjust the hysteresis for the trigger.

5.3 Switch between Single and Multiple Measurement

After system start the MG3 Hot Bar is in multiple measurement mode.
This is indicated in the last box of the menu bar (shows RUN).
That means that a measurement is performed and logged at every valid triggering.



To switch to single measurement mode click button SINGLE.
The last box in the menu bar changes to SINGLE and the MG3 Hot Bar is now in single measurement mode.



To switch back to multiple measurement mode click button RUN.

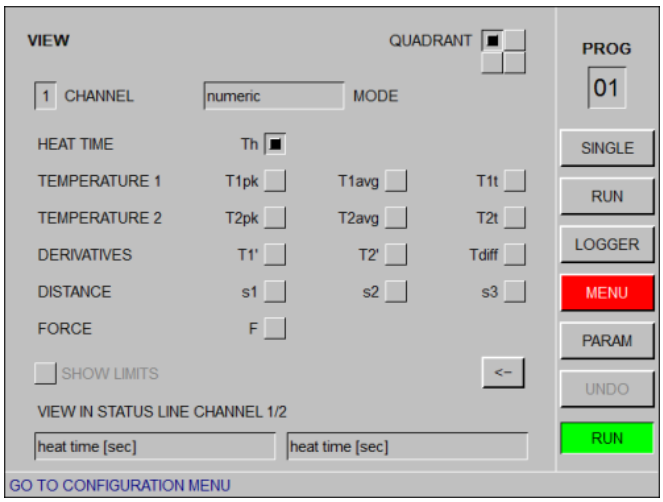
In **single measurement** mode the MG3 Hot Bar switches to hold after triggering.
The box SINGLE is grayed. To enable next measurement click button SINGLE again.

In **multiple measurement** mode the MG3 Hot Bar is always ready for measurement.

5.4 Configure the Display Windows (Quadrants)

The measured values can be displayed in four configurable display windows (quadrants).
Each quadrant can be operated in four different display modes.

Go to screen **VIEW** via MENU - VIEW.



QUADRANT
Select the quadrant 1…4 to be configured.
Each quadrant can show only one measured variable.

CHANNEL
Select the channel for this quadrant.

MODE
Select how the measured variable shall be displayed in this quadrant:

- numeric
- graphic
  (here you can also select the color of the graphs)
- SPC*-Chart
- SPC*-Values

SPC: **S**tatistical **P**rocess **C**ontrol

Select the measured variable for this quadrant:

HEAT TIME:	**Th**
TEMPERATURE 1, TEMPERATURE 2:	**Txpk** (peak) **Txavg** (average) **Txt** (integral)
DERIVATIVES:	**T1'** (gradient) **T2'** (gradient) **Tdiff** (difference between T1 and T2)
DISTANCE:	Only during active displacement and/or part detection (see chap. 5.5)

Channel 1:	Channel 2:
s1 = Part detection	**s4** = Part detection
s2 = Switch off value	**s5** = Switch off value
s3 = Displacement value	**s6** = Displacement value

FORCE/PRESSURE: Only if active

Button <-
Click here to switch to the next quadrant.

SHOW LIMITS
Activate this check box to show the set limits.

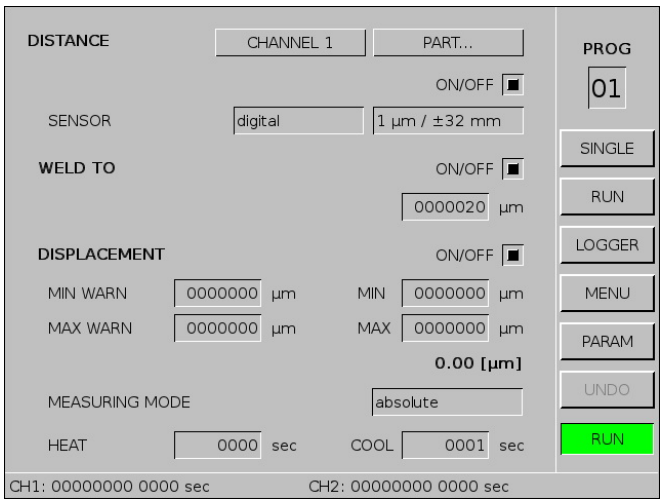
VIEW IN STATUS LINE CHANNEL 1/2
Choose heat time or program name to be shown in the status line below.

5.5 Measure Displacement

Connect the optional available displacement sensor as described in chap. 3.1.4.
Note: switch off the MG3 Hot Bar before connecting.

Go to screen **DISTANCE** via MENU - DISTANCE.

5.5.1 Configure Displacement Measurement



CHANNEL
Shows the currently selected channel, to which the displacement sensor is connected. To change the channel click on it.

PART... / DISPLACEMENT...
Switch between part detection and displacement measuring.

ON/OFF
Enables/disables the main function 'DISTANCE'.

SENSOR
Choose the signal form and the resolution of the displacement sensor connected.
In case of digital displacement sensor, you can also choose the maximum measurable stroke.

WELD TO
When enabled (ON/OFF), the welding current is switched off as soon as the welding head has reached the displacement preset in the corresponding input field.

DISPLACEMENT
When enabled (ON/OFF), the displacement measuring is active.

MIN WARN/MAX WARN
Set the minimum and maximum prewarn value for monitoring.
If both values are zero, prewarn monitoring is disabled.

MIN/MAX
Set the minimum and maximum value for displacement monitoring.
If both values are zero, the evaluation of displacement monitoring is disabled.

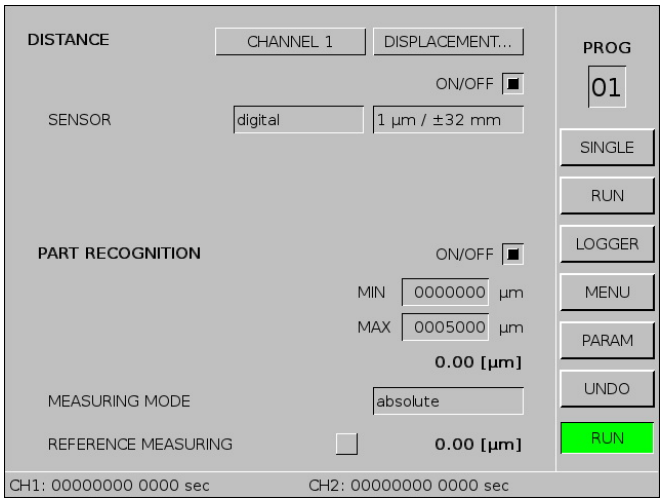
MEASURING MODE
Select the measuring mode for the part detection.

- **absolute**
  measures the way the welding head actually covers.
- **reference**
  the distance between both electrodes is determined.
  Note: reference should only be used with part detection.

HEAT
Set a minimum waiting time (heat up time) before an evaluation or a breakdown is carried out.
Setting range: 0 – 9999 sec.

COOL
Set a minimum waiting time (cool down time) before the displacement value (S3/S6) is calculated.
Setting range: 0 – 9999 sec.

5.5.2 Configure Part Detection



CHANNEL
Shows the currently selected channel, to which the displacement sensor is connected. To change the channel click on it.

PART... / DISPLACEMENT...
Switch between part detection and displacement measuring.

ON/OFF
Enables/disables the main function ‘DISTANCE’.

SENSOR
Choose the signal form and the resolution of the displacement sensor connected.
In case of digital displacement sensor, you can also choose the maximum measurable stroke.

PART RECOGNITION
When enabled (ON/OFF), the part detection is active.

MIN/MAX
Set the minimum or maximum value for the part detection monitoring.
If both values are zero, the part detection monitoring is disabled.

MEASURING MODE
Select the measuring mode for the part detection.

- **absolute**
  measures the way the welding head actually covers.
- **reference**
  the distance between both electrodes is determined.
  Note: reference should only be used with part detection.

REFERENCE MEASURING
Enabling the button will start the reference measuring.
If the reference measuring is completed, disable the button. Now the determined reference value is shown right beside the button.

Caution

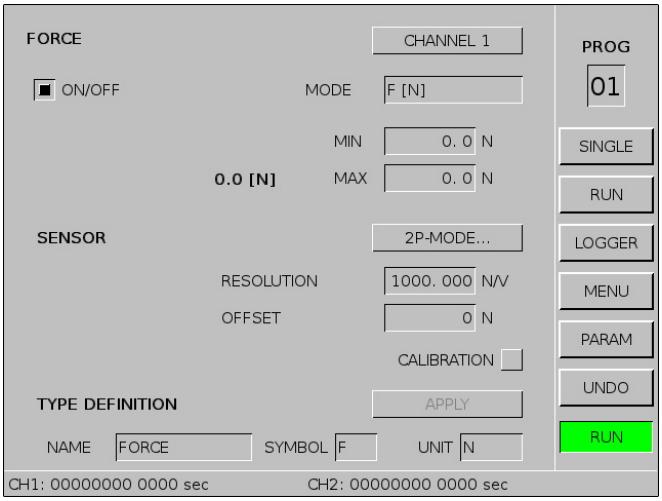
To avoid damage to electrodes and welding installation, a reference run has to be done:

- prior to first measurement
- after any change on the electrodes
- after any change on the welding head

5.6 Measure Pressure or Force

Connect the optional available force or pressure sensor as described in chap. 3.1.4.
Note: switch off the MG3 Hot Bar before connecting

Go to screen **PRESSURE / FORCE** via MENU – PRESSURE/FORCE.



Configure pressure / force measurement
ON/OFF
Enables/disables pressure/force measurement.

MODE
Select force F[N] or pressure p[bar] measurement. The screen changes after clicking.

MIN/MAX
Set the permissible minimum/maximum values for the pressure or force.
If both values are zero, the monitoring is deactivated.

SENSOR

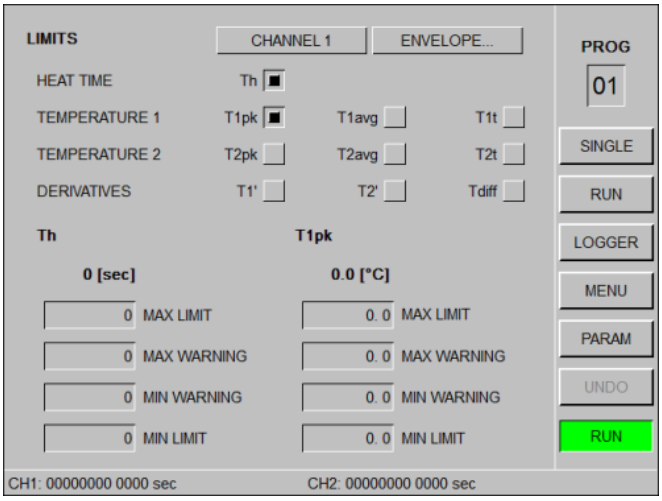
STANDARD / 2P-MODE
Change between Standard and 2P-Mode (explanation see CALIBRATION)
Pressure sensor
A pressure sensor with a linear curve should be used. The no-load measured value for the sensor is entered in the OFFSET field. Input in the SENSOR RESOLUTION field is realized in bar/V or psi/V.
The maximum possible resolution is 10 bar/V.
Force sensor
A force sensor with a linear curve should be used. The no-load measured value for the sensor is entered in the OFFSET field. Input in the SENSOR RESOLUTION field is realized in N/V or lbs/V.
The maximum possible resolution is 1000 N/V.

CALIBRATION:
Shows the current pressure/force real-values if activated.
For STANDARD calibration adjust resolution and offset.
For 2 point calibration (2P-MODE) proceed as follows:

- Set RESOLUTION = 1 and OFFSET = 0 and activate CALIBRATION. Then change to 2P-MODE.
- Make two measurements with an external load cell: one at low force and one at high force.
- The measured voltage value is shown in the display of the MG3. Set this value in the field INPUT 1 (measuring at low force) resp. INPUT 2 (measuring at high force).
- The measured force value is shown at the load cell. Set this value in the field VALUE1 resp. VALUE2.
- Now deactivate CALIBRATION.

5.7 Set Limit Values

Go to screen **LIMITS** via MENU – LIMITS.



Select up to two indicators to be monitored per channel.

Notes

- The limit value monitoring is analyzed after each measurement.

The evaluation result is:

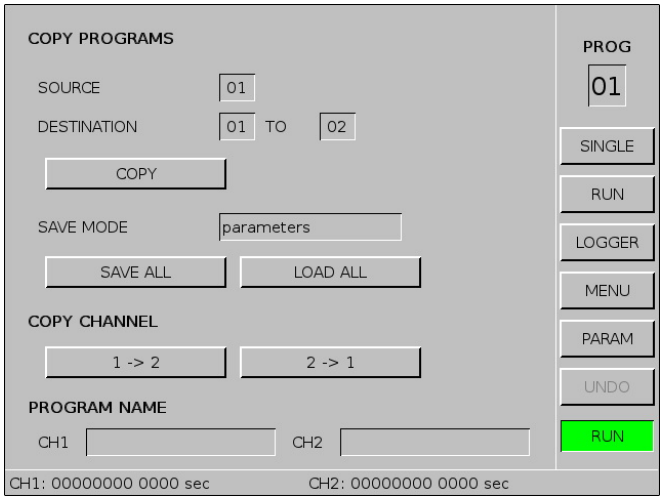
- shown by the LEDs on the front side.
- logged.
- available at the digital output on the rear side.
- If both channels are monitored and the measurements are simultaneously, the evaluation result is formed by a logical disjunction.

Defining limits

MAX LIMIT, MAX WARNING, MIN WARNING, MIN LIMIT
Set the minimum and maximum prewarn and limit values.
The limit value monitoring is deactivated if the min and max values are set to zero. The same applies for the prewarn values.

5.8 Copy, Save and Load Programs and Parameters

Copy programs and parameters
Go to screen COPY PROGRAMS via MENU – COPY.



SOURCE
Enter the number of the program you want to copy.

DESTINATION
Enter the number of the target programs (first and last), where the source program and its parameters shall be copied to.

COPY
Start the copy process.

Save all programs and parameters
You can choose between 4 different modes:

- parameters
  save all program parameters (PROG 1..99) and all global parameters
- parameters/env.
  see above and additionally all reference and envelope waveforms
- protocol
  used only for internal diagnose
- clearup
  clear the internal memory

Select the wanted and click SAVE ALL.

A popup opens where you can set the name for the backup file.

Click OK to start the saving process.

Backup files have the file extension **.par** .
Protocol files have the extension **.txt** .

Load programs and parameters
Click LOAD ALL, choose the file you want to upload and confirm with OK.

Copy a channel
Copy the settings of channel 1 to channel 2 (1 → 2) or vice versa (2 → 1) of the currently active program by clicking the respective button.

PROGRAM NAME
Set a program name for each channel of the currently active program.

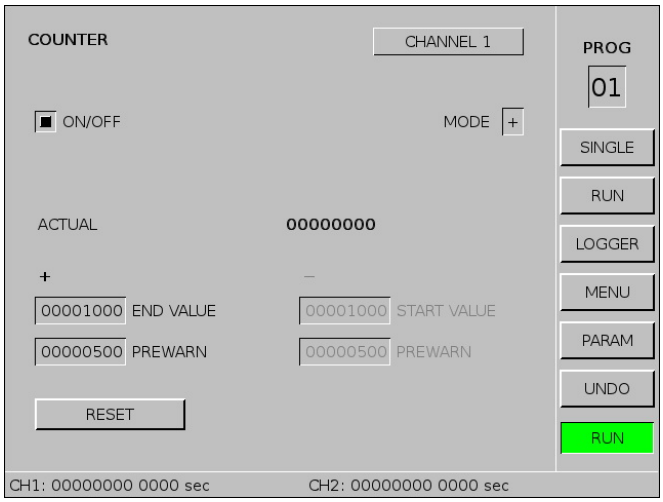
5.9 Count Measurements

Here you can make adjustments for the welding counter for channel 1 and 2.

When the set prewarn value is reached, a signal is set at the corresponding output.

When the end value (counting direction +) or zero (counting direction -) is reached, a signal is set at the corresponding output.

Go to screen COUNTER via MENU – COUNTER.



ON/OFF
Enables/disables the counter for the respective channel.

MODE
Choose the counting direction:
Plus (+) counts forward, starting from zero to set END VALUE.
Minus (-) counts backward, starting from set START VALUE.

END VALUE
End value for the plus counter.

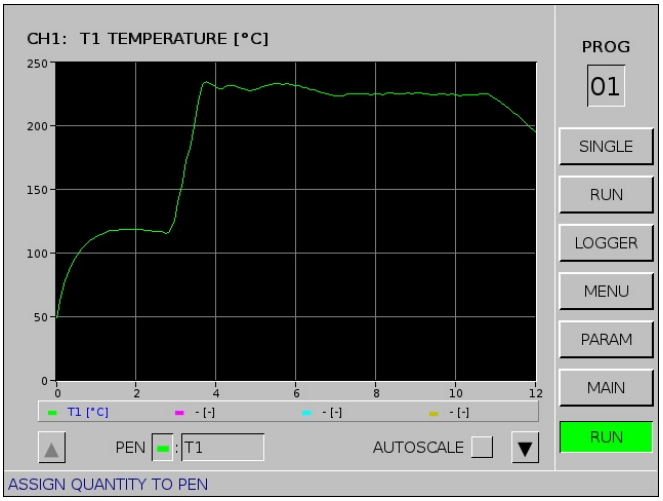
START VALUE
Start value for the minus counter.

PREWARN
Prewarn value of active counter.

RESET
Reset the counter.

5.10 View and Save Measuring Waveforms

Click on the desired quadrant to open the full screen.



AUTOSCALE
Activate this check box to get an automatic scaled view mode.
Now the current primary measured variable of this quadrant is automatically and optimally adapted to fit in the diagram (choose the primary variable in the field right beside PEN; the name of the primary measured variable is then also shown in the head line).

Use this function also to get back to a clear diagram.

Deactivate the AUTOSCALE check box in order to activate the **view, zoom** and **save menu**. Now the arrow pointing down right beside the check box is activated.

▲ or ▼ (arrows)
Click on the arrow pointing down ▼ right beside the check box to move one level down to the **zoom** menu.
Click again to move forward to the **view** (=cursor) menu and again for the **save** menu.

To get back to previous menus click on the arrow pointing up ▲ on the left side of the display.

PEN
Choose the color for each graph (pink, blue, green and brown).
In the adjacent selection field you can choose the corresponding measured variable.

The **last measured variable** you enter **becomes** the **primary measured variable** to which the Y-axis scaling relates to.
The primary measured variable is also shown in the head line and is marked in blue letters in the legend.

Zoom menu
YMAX / YMIN
Click YMAX or YMIN to adjust the upper or lower Y-axis scale value for the **primary measured variable** (selection see above).

XMAX / XMIN
Click XMAX or XMIN to adjust the upper or lower scale value of the X-axis for **all** displayed measured variables.

▲▼ and ◄►
You can zoom in with ▲▼ and ◄►.

If you click on one of these buttons a white line appears which you can move with the toogle wheel to the wanted position. Click to set this first limit.
Now a second white line appears on the first line. Move it with the toggle wheel to the wanted position and click to set this second limit.

The diagram shows now the enlarged version.

Click ▲ to get back to previous menus.

Cursor menu
Click ▼ to change to CURSOR menu.

Choose one of the four measured variables by clicking on it.

A crosshairs (cursor) appears in the color of the measured variable. You can move the crosshairs with the toggle wheel.
The measured values belonging to the respective measuring point are displayed below the legend.

Click again to exit the crosshairs mode.

Click ▲ to get back to previous menus.

Save menu
Click again ▼ to change to SAVE menu.

Here you can save all measured values of one single or all measuring waveforms on the USB stick.

Choose one measured variable by clicking on it.

Enter a number for the filename.

The files are saved with the suffix .crv in the folder “waveform”. The respective formula symbol of the measured variable precedes the file name.
Click ▲ to get back to previous menus.

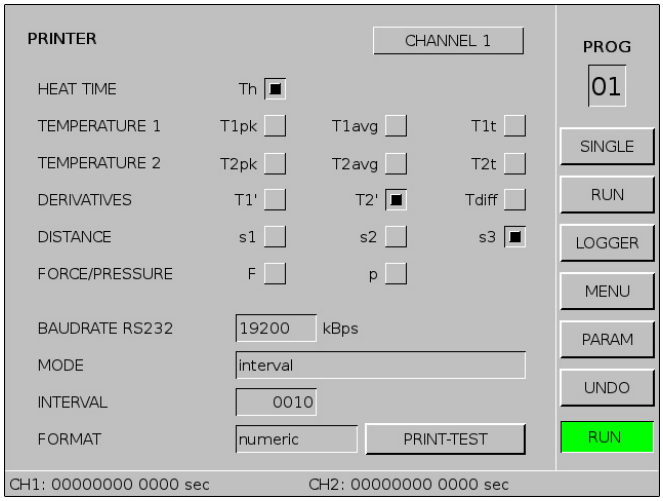
Click on the diagram or use the MAIN button to get back to main screen.

5.11 Print Measured Values

Here you can adjust the settings for the printing mode.

A printer can be connected to the serial interface X51 (RS232).

You can choose different values for channel 1 and 2.



Go to screen PRINTER via MENU – PRINTER.

Choose any number of values to be printed.

BAUDRATE RS232
Select the baud rate for the RS232 interface.

MODE
Select the printing mode.

Possible printing modes are:

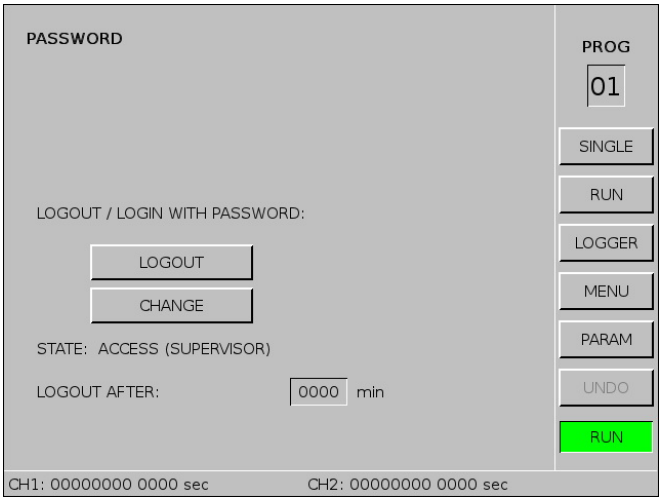
- off — function deactivated
- all — all measurements
- reject — rejected measurements
- prewarning — measurements with active prewarning
- Interval — measurements with an interval from 1..9999
- Interval/reject — measurements with an interval from 1..9999 and rejected measurements

FORMAT
Set to **numeric** to transmit the data to the printer (**graphic** is only for internal use).

PRINT-TEST
Test the connection.

5.12 Set and Change Password

Go to screen **PASSWORD** via MENU - PASSWORD



LOGIN / LOGOUT
Click here to login / logout.

Note:
For all settings you need to be logged in.

CHANGE
Change the password (only possible after correct login).

STATE
Indicates whether you are authorized for access or not.

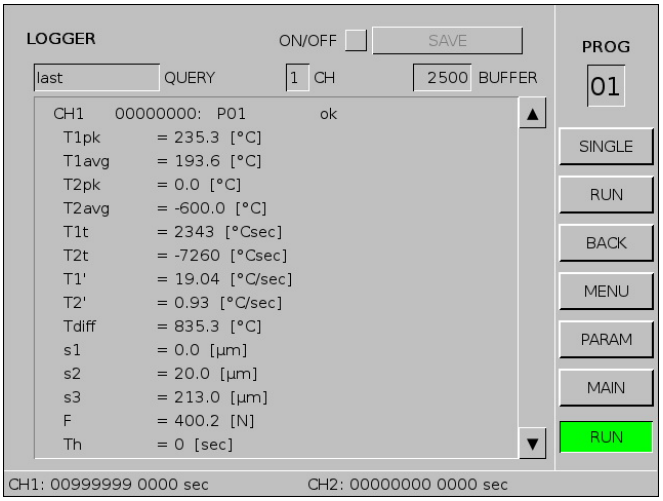
Note:
Password on delivery: 0000
If you don't remember your password, please contact our service department.

LOGOUT AFTER
Choose a time from 0 to 9999 minutes after which an automatic logout is carried out.

If a time is set, the value in brackets shows the remaining time to automatic logout.

5.13 Configure the Logger

Click on the button LOGGER in the menu bar.



ON/OFF
Activate/deactivate the data logging for the channel set below.

SAVE
Save all values logged until now on the USB stick.
If the stick is nearly full you will be asked to change it.

QUERY
Choose the display mode:

- all measurements
- rejected measurements
- last measurement (detailed view)

CH
Choose between channel 1, 2 or 1/2 (1/2 only for last measurement mode)

VALUE
Select the value to be displayed.

Note:
The overall state of a measurement is illustrated with the following colors:

- Gray letters
  = invalid measurement (range overflow)
- Yellow background
  = beyond the prewarn values
- Red background
  = exceeded limit value

With ▲ and ▼ you can scroll forward and backward through the logging history.

last measurement mode shows additional information of the last measurement:

- which measured variable has exceeded the limits/prewarn values.
- the direction of the exceeding:
  +: exceeded upwards
  -: exceeded downwards
  ±: exceeded in both directions

HK: if the last measurement is completely or partially outside the active envelope waveform

BUFFER (only in last measurement mode)
Set the number of measurements to be stored in the buffer before a log file is written.

Note:
The logger buffers up to 2500 measurements per channel. Then the buffer is saved in a log file on the USB stick and starts new.
The log file has the file suffix .**log** and is .csv compatible (time, date, counter number, program number, measured values and status information of the measurement are saved in the form of a table).

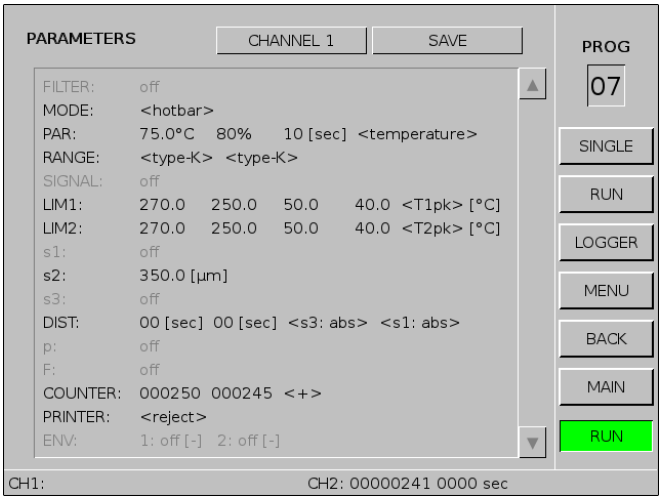
In the log file the result of the measurement is indicated with the following symbols:
V...positive measurement, no pre-warning
X...negative measurement
!... positive measurement, but pre-warning active
%..invalid measurement (range exceeded,...)
O...negative measurement (zero current)

The details indicate the direction in which the limit value was exceeded with **+** and **-**.
( ) indicates exceeded pre-warning limits, while **{ }** indicates the exceeding of a limit determined by an envelope waveform.

5.14 Display the Parameter Overview

Click on the button PARAM in the menu bar.

An overview of the most important parameters for the selected program channel is displayed.



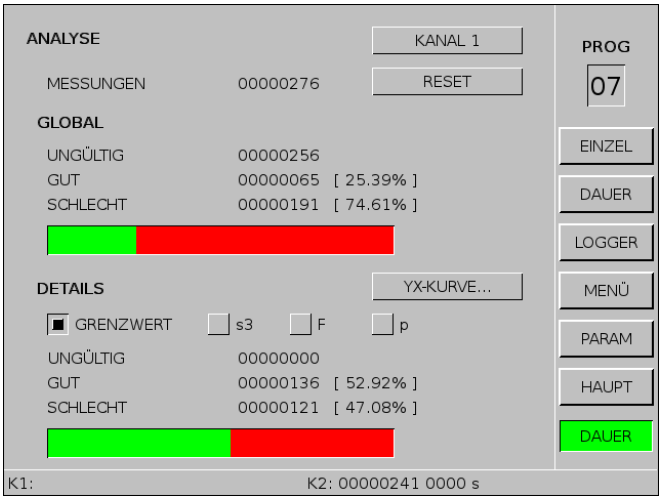
CHANNEL 1
Change to channel 2. Click again to change back to channel 1.

SAVE
Save the parameters as text file on the USB stick. The text file has the extension **.txt** .

Note
The text file is readable only in languages with an ANSI-compatible syntax.

5.15 Analyze Accept-Reject Ratio

Go to **MAIN** screen via MENU – MAIN and click on the button ANALYSIS in the menu bar.



RESET
Reset all counters for the selected channel.

DETAILS
Select for which measured value the accept-reject ratio shall be displayed separately.

- **LIMIT**
  Limit value monitoring for freely-adjustable variables.
- **s3**
  Limit value monitoring for displacement.
- **F**
  Limit value monitoring for force.
- **p**
  Limit value monitoring for pressure.

5.16 Monitor Statistical Values

Requirements for statistical process control (SPC)

- The **limit values** for the requested measured variable must be set. If they are zero, they are not active..
- The values should be reasonable. If you don't have exact values estimate them generously..
- One quadrant has to be in **display mode SPC-chart** (for configuration see chap. 5.4).
- Evaluation of the measured value starts when one quadrant is in SPC-chart mode. Evaluation ends when this quadrant is reconfigured
- The SPC-chart displays and calculates within sequential measurement intervals.

Procedure

Configure a quadrant for the SPC-chart mode (see chap. 5.4).

Click in this quadrant and screen **SPC-chart** opens.

Click HISTOGRAM and screen HISTOGRAM opens.

SAMPLES

Set the number of samples (measurements) which shall be used for the calculation interval.
The value must be ≥ 1.

Note

The SPC-chart shows average value (green) and standard deviation (3 Sigma, blue) for the set number of samples.

Colors

The colors in the histogram have the following meaning:

- GREEN LINE
  = average value (Xavg)
- YELLOW LINES
  = warning limits
- RED LINE
  = limits
- BLUE LINE
  = standard deviation S (+/-3 sigma)

5.17 Determine Limit Values Statistically

Requirements for determining limit values statistically:

- The limit monitoring for the respective measured value must be enabled (limit values must be set, see chap. 5.7).
- A large number of measurements must be recorded with the statistical evaluation enabled

The more measurements have been recorded and the larger the number of samples, the more precise the result of the limit value determination will be.

The histogram shows average and standard deviation values calculated of all measured values.

Click HISTOGRAM on the screen SPC-chart.

DEFINE LIMITS
Click to calculate new limit values.
A popup shows the calculated limit values and asks if you want to overwrite the previous limits. Confirm with YES.

CALCULATION LIMITS
Select the limit value calculation mode.
Choose between:

±2S / ±1S
±3S / ±2S
±4S / ±3S
±5S / ±4S
±6S / ±5S
99% / ±95%

The first value is standard deviation S and the second value is the deviation of the warning limits.

RESCALE
Adapts graphic to screen.

RESET
Reset the statistical calculation.

5.18 Transfer Data to PC/Laptop

Caution

Disable the USB stick before you remove it from the PC.

File structure
Data on the USB stick is stored in four directories.

DATA contains files with the file name extensions:
*.bmp (screenshots)
*.txt (text file of the parameters)
*.par (parameter file)

LOGGING contains files with the file name extensions:
*.log (log file)

UPDATE contains update files with the file name extension:
*.gz (Update-File)
*.mot (Update-File for mainboard)

WAVEFORM contains files with the file name extensions:
*.crv (measured curve)

Note:
Files with file name extensions *.log and *.crv are saved as CSV format (Comma Separated Value format) and can be further processed with Excel for instance.

5.19 Make a Screenshot of the Current Display

To make a screenshot of the current display, press the screenshot button on the front of the MG3 (see chap. 4, fig. 4).
It is automatically saved on the USB stick as a .bmp file with the prefix "SSH_xxx" (xxx means a consecutive number).

The LED on the USB stick illuminates for a few seconds for each successful screenshot and a message is generated in the status line.

5.20 Register the Device

Depending on delivery it may be necessary to register the device for unlimited use.

The **MG3 Hot Bar** can be supplied as a 30 day test version or as full version. Check your version at screen PASSWORD.
In case of the 30 day test version you find there a serial number and a “Register” button and also the remaining days left.
In the test version all full version functions can be used for max 30 days. When this test time period expires, all operating elements are blocked and you are asked for a password to activate the full version.

Request the password by e-mail or telephone from Amada Miyachi Europe GmbH. For this you need the identification number (S/N) shown on the PASSWORD screen.

After entering the password the MG3 Hot Bar is enabled for unlimited use.

6 Integration in Automated Installations

ⓘ	Integrating the MG3 Hot Bar in an automated installation, take care to have the MG3 Hot Bar ready signal always co-evaluated by a higher-level stored-program controller (SPC). There must be no triggering as long as the ready signal is “low” (measuring interval). During this measuring interval, data is calculated, compared, and transferred to the display and further interfaces.

6.1 Connection to field bus system

The MG3 Hot Bar can communicate with a control or master computer via CAN-Bus.
For this purpose the CANopen log is used and the MG3 Hot Bar acts as a CANopen slave.

Detailed instructions on request..

7 Appendix

7.1 Error messages

No.	Error	Cause
4002	OPEN FILE	USB stick or file damaged
4003	SAVE FILE	USB stick or file damaged
4004	WRONG FILE TYPE OR CORRUPT FILE	xxx is wrong or faulty file header
4005	ACTUALIZE GRAPHIC	
4006	ACCU-RAM ACCESS	Battery exhausted
4007	LOAD FILE	USB stick or file damaged
4008	FILE ALREADY EXISTING OR READ-ONLY	Write-protected file
4011	INSTALLING DATA CACHE FAILED!	
4020	CAN: TIME-OUT READ DATA	Data transfer overloaded, possible causes: measuring interval too short too intensive rotary transducer Actuation during highly frequented measurements
4021	CAN: TIME-OUT WRITE DATA	Data transfer overloaded, possible causes: measuring interval too short too intensive rotary transducer Actuation during highly frequented measurements
4022	CAN: TIME-OUT RECEIVE REQUEST	
4023	CAN: TIME-OUT SEND REQUEST	
4024	CAN: OVERFLOW BUFFER	Bottleneck executing several tasks, possible cause: display of too many graphics during strongly frequented measurements
4030	ERROR ETHERNET: IP-ADDRESS IS IN RESERVED RANGE!	

8 Indexes

8.1 Figures

Fig. 1: MG3 with support stand 9
Fig. 2: Connectors on the housing rear side 10
Fig. 3: WK-Adapter 16
Fig. 4: Control panel MG3 Hot Bar 17
Fig. 5: Screen (Display) 18

8.2 Headwords

A

Analyze Accept-Reject Ratio 43
Appendix 48

B

Baud rate 14

C

CANopen 15
Commissioning 9
Configure Displacement Measurement 29
Configure Part Detection 30
Configure the Display Windows (Quadrants) 27
Configure the Logger 40
Connecting Displacement Sensor 15
Connecting Force or Pressure Sensor 15
Connecting Temperature Sensor 15
Connecting the Components 10
Connection to field bus system 47
Connector Pin Assignment of Inputs & Outputs 11
Connectors 10
Copy Programs and Parameters 34
Copyrights, Proprietary Rights 5
Count Measurements 35

D

Definition of Symbols Used 6
Determine Limit Values Statistically 45
Display the Parameter Overview 42
Display Windows – Quadrant 1 to 4 19

E

Error messages 48

F

Further Symbols 7

G

General Information 5
General settings 21

H

How to … ? 21

I

Initial Commissioning 16
Integration in Automated Installations 47

L

LED Status Display 18
Load Programs and Parameters 34

M

Measure Displacement 29
Measure Pressure or Force 32
Measure Temperature 24
Measuring Mode 19
Menu Bar 19
Mode of Action 8
Monitor Statistical Values 44

O

Operation 17

P

Password 39
Preconditions 16
Preface 5
Print Measured Values 38
Program Display 19
Prohibition and Warning Symbols 6

R

Register the Device 46
RS232 14

S

Save Programs and Parameters 34
Screen (Display) 18
Screenshot 46
Set and Change Password 39
Set Limit Values 33
Starting-up 16
Status Bar 19
Switch between Single and Multiple Measurement 26

T

Technical Data 8
Technical Description 8
Toggle Wheel 17
Transfer Data to PC/Laptop 46

U

UNDO Function 20
USB Port 20

V

View and Save Measuring Waveforms 36

W

WK-Adapter 16

X

X38 (I/O Inputs) 14
X38 (I/O Outputs) 13
X51 14
X54 11
X55 12
X60 and X61 15