MF/HF Frequency converter for
induction heating systems

Translation

Operations Manual

PLUS POINT THERM

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Company Information

Operation Manual TNX Compact, TNX Standard, TNX Industry

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Important Information

All information contained in this operation manual have been compiled with best possible accuracy and to the best knowledge. Nevertheless, it cannot be ruled out that this manual contains errors. In such cases we apologize and appreciate notification.
The delivered induction heating system will be referred to simply as “system” in the following pages.
Some pictures or drawings in this manual serve as additional explanation of the system, as a picture can help to clarify a situation.
We cannot be held liable for any damage caused to any person or device in connection with the use of this manual.

Legal Notice

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KONFORMITÄTSERKLÄRUNG/DECLARATION OF CONFORMITY

CE

Der Hersteller und der Inverkehrbringer in der Schweiz
Manufacturer and distributor in Switzerland

Plustherm Point GmbH
erklärt hiermit, dass die nachfolgend bezeichnete Maschine aufgrund Ihrer Auslegung und Bauart sowie in der von uns in Verkehr gebrachten Ausführung den einschlägigen grundlegenden Sicherheits- und Gesundheitsanforderungen der EG-Richtlinie entspricht. Bei einer nicht mit uns abgestimmten Änderung der Maschine verliert diese Erklärung Ihre Gültigkeit.

Plustherm Point Ltd
Hereby declares that the named machine is by design, construction and implementation in compliance with relevant EU-directives concerning the essential safety and health requirements. Any alteration of the named machine not verified from our side results with validity cancellation of this declaration.

"xxx"steht für ("xxx" applies for): 1, 5, 10, 15, 20, 30, 40, 50, 60, 70, 80, 100, 120, 150, 200, 250, 300, 350, 400, 500, 600

Maschinentyp: *Machine description*:	TNXxxx, TNXxxx Compact, TNXxxx Standard, TNXxxx Industrie
Einschlägige EG-Richtlinien: *Relevant EU-directives:*	Niederspannungsrichtlinie 2006/95/EG EMV- Richtlinie 2004/108/EG *Low Voltage Directive 2006/95/EC* *EMC Directive 2004/108/EC*
Angewandte harmonisierte Normen: *Applied harmonized standards:*	EN 60204-1 EN 60519-1 EN 60519-3 EN 55011 EN 61922
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Wettingen, 14.03.2014

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Änderungen vorbehalten. Subject to alterations

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1 Introduction

Who should read this?	The information herein concerns every person which may install, operate, and/or maintain these induction heating machines.
Content	- General information about the system - Description of functions

1.1 Purpose

This manual contains all the information needed for the proper installation, commissioning and programming of the system and its trouble-free operation.

1.2 Coverage

This manual applies to all MF-Generators of the types: TNX Compact, TNX Standard und TNX Industry.

1.3 Target audience

This operating manual is intended for use by qualified personnel and properly trained users.

1.4 Description of Operation

The principle of induction heating itself has been used commercially for more than 50 years. Yet it is still largely unknown to a wider audience. Thanks to modern technology, today's equipment weighs 1/10 compared to earlier devices. The compact design, low weight, flexibility of applications, and reasonable price enable a broad application of induction heating.

Induction heating is fundamentally different from most other types of heating. The heat is generated in the work-piece itself and there is no heat-transfer medium (eg. with air or any conductive mechanical connection). The electrical energy is transferred to the work-piece to be heated via a magnetic field.

An alternating current flows through the induction coil which generates a magnetic field. This magnetic field then induces a specific pre-determined current in the work-piece. Through the induction coil, electrical energy is converted into magnetic energy afterwards the work-piece transforms it into heat.

High-frequency currents flow, in contrast to low-frequency currents, only in a very thin surface layer (this phenomenon is called the skin-effect). The heat is only generated in this thin layer (penetration depth), which is only a few fractions of a mm. This property has opened up the broad field of surface hardening of high-frequency heating. Through heating by induction is not a problem provided the time taken for the heat conduction is considered. The heat can then be distributed in the interior of the piece.

Inductors can be produced in any form. Because of this, a partial heating can be achieved with high frequency and a very short heating time. This can’t be achieved with any other method.

1.5 Guarantee

The details of the warranty period are in our general delivery terms. Specific agreed services are mentioned in the order confirmation.

1.6 Symbols

	**Dangerous voltage warning** This symbol warns of high voltage which can lead to injury or death and / or damage to equipment.
	**General warning** This symbol warns against non-electrical dangers that can lead to injury or death and / or damage to equipment.
	**Important notice** Designates a general, useful tip. When observed, operation of the systems are facilitated and malfunctions are prevented.
	**Warning: dangerous situation possible** Non-observance of this warning can lead to damage and/or inoperability of the equipment.
	**Warning: non-ionizing radiation** This symbol serves as a warning for those with active implanted devices and metal prostheses. Such individuals must stay away from the system.

	**Warning: magnetic field** This symbol serves as a warning for individuals with active implanted devices and metal prostheses. These individuals must stay away from the complex.
	**Warning: hot surfaces** Burns possible from touching or handling of device.
	**No access for people with metallic implants** The symbol indicates that access for people with metal implants is extremely dangerous and therefore prohibited. This sign is used to avoid the risk of heating of metal implants by HF radiation.
	**No access for people with pacemakers** Pacemakers may fail when exposed to electromagnetic radiation. This is extremely dangerous and can be life threatening for the individuals concerned.

Chart 1: Overview symbols

2 System Overview

Who should read this section?	All personnel who install, operate, and/or maintain this equipment.
Content of this section	System overview

The system overview shows how and where the individual components are connected to the system.
A detailed system overview is presented on page 92 (Appendix 1: System overview, Specifications, Test report, Software-defaults)

3 Specifications

Who should read this section?	System installation, planning, and implementation personnel.
Content of this section	- Specifications - Electrical Data - Electric supply - Cooling

3.1 General

The following information applies to all standard equipment.
Project specific parameters can be found on page 92 (Appendix 1: System overview, Specifications, Test report, Software-defaults.)

MF-Generator: TNX Compact	
MF-Generator: TNX Standard	

MF-Generator: TNX Industry (with built-in oscillating circuit)	
MF-Generator: TNX Industry (with external oscillating circuit)	
MF-Generator: TNX Industry (mobile version)	

Chart 2: Overview MF-Generators

3.1.1 Technical Data

Operating temperature / ambient temperature	5°C -30°C (non-condensing) **Optional up to 40°C**
Storage temperature range	0°C -50°C
Installation	System should be installed only on a vibration-free platform that is grounded.
Humidity	80% relative humidity (non-condensing) **Optional: up to 95%**
Operating altitude	Up to 1000 m above sea level

Chart 3: Technical Data

3.1.2 Cooling

The high energy system components are water-cooled. The cooling water used (fresh water cooling system) must satisfy the conditions set out in the following specifications, otherwise the function and performance of the system is affected and will ultimately lead to total failure.

Water required	5kW system -> 3 l/min 10kW system -> 6 l/min 15kW system -> 8 l/min 20kW system -> 10l/min 30kW system -> 14 l/min 40kW system -> 19 l/min 50kW system -> 24 l/min 60kW system -> 29 l/min 100kW system -> 48 l/min 150kW system -> 71 l/min 200kW system -> 95 l/min 300kW system -> 143 l/min 600kW system -> 286 l/min (The specified amount of water is considered as a guide only, for it is highly dependent on the application)
At a pressure of	4 bar dynamic
Max. allowed pressure	6 bar
Water inlet temperature	20°C < T < 28 °C T must not reach the dew-point.
Water quality	- Fresh clean water or purified, filtered industry water - Filter max. 150um - Conductivity 100-600uS/cm - PH-field 7.0-8.5 - Hardness < 8.4°dH

Water hardness	- See page 92 (Appendix 4: Cooling Circuit) - See page 92 (Appendix 5: Device Details, Photos)

Chart 4: Cooling water conditions

Further note that the connection elements may consist solely of copper, stainless steel or plastic. The use of iron compound can affect the function and performance of the system and will ultimately lead to a total failure.

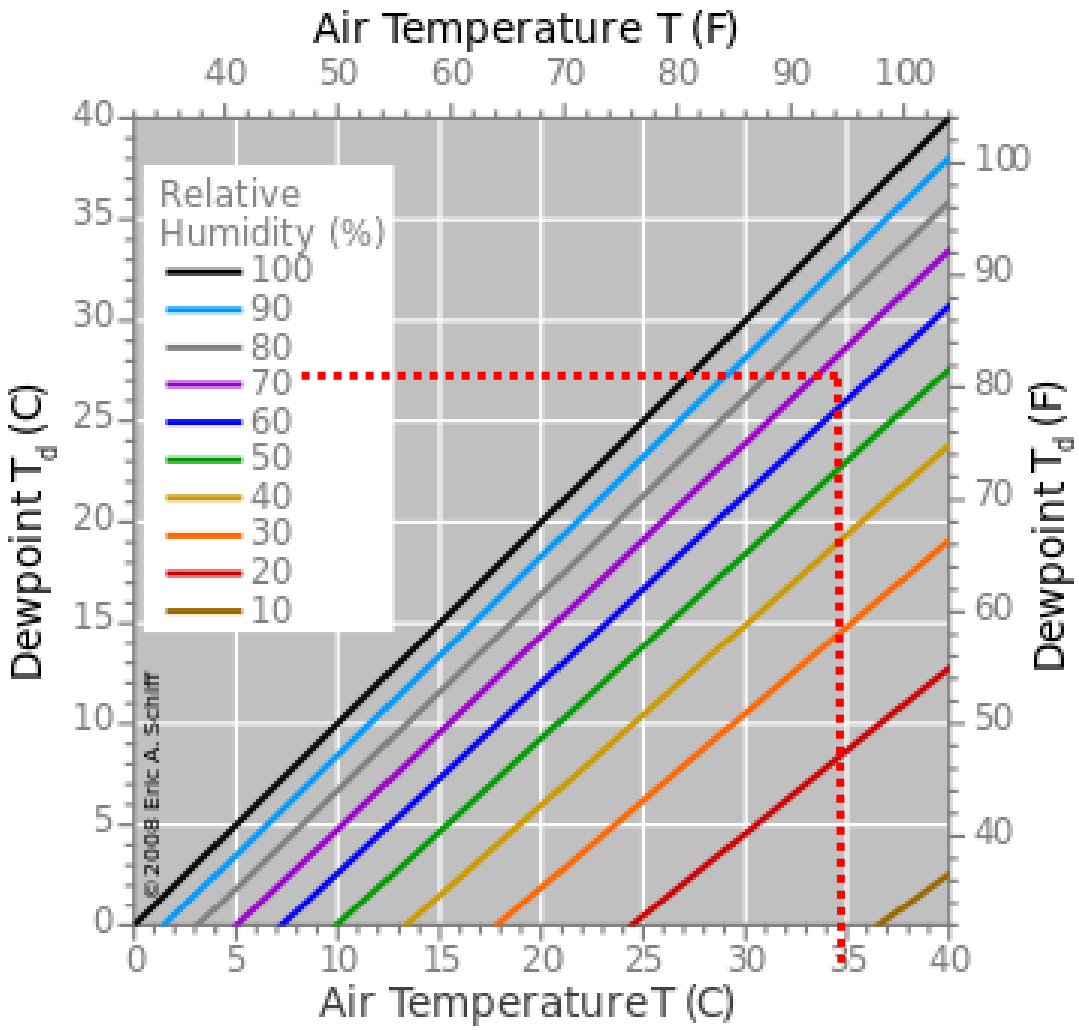
For trouble-free and long-term operation the cooling water must be checked regularly according to the maintenance plan (page 82).

It is important to ensure that the water inlet temperature won't get too low, otherwise under unfavourable conditions, the formation of condensation in the generator can occur. Condensation on the power components can result in total failure.

The following dew point curve shows what minimum cooling water temperature (Dew - point) in which air temperature (air temperature) and humidity (Relative Humidity) must be set.

Example:
Air = 35°C; Humidity = 70%

-> Minimum cooling water temperature is approximately 28°C.



Graphic 1: Dew-point curve (Source Wikipedia)

3.2 MF-Generator “TNX Compact“

3.2.1 Electrical Data

	TNX5 Compact	TNX10 Compact	TNX15 Compact	TNX20 Compact
HF-power at the inductor terminals in the nominal operating point at continuous operation	*5 kW*	*10 kW*	*15 kW*	*20 kW*
Frequency at full load	*10-150 kHz*			
MF-voltage (rms.)	*600 V*			
HF-current in the inductor	*500-1500 A*			

Chart 5: TNX Compact, electrical Data

3.2.2 Electric Supply

	TNX5 Compact	TNX10 Compact	TNX15 Compact	TNX20 Compact
Voltage	*3 x 400 V + N + E*			
Frequency	*50/60Hz Hz*			
Permissible voltage fluctuations	*+/- 5 %*			
Power Consumption when HF is switched off	*100 W*			
Power consumption at rated load	*6 kVA*	*11 kVA*	*16 kVA*	*23 kVA*
Power factor cos at rated load	*0,94*			
Current per phase (400 V) at rated load	*ca. 10 A*	*Ca. 16 A*	*Ca. 24 A*	*Ca. 32 A*
Required protection	*400V, 16AT*	*400V, 25AT*	*400V, 40 AT*	*400V, 50AT*
Control voltage	*24 VDC*			
External power control	Local potentiometer, *Tacho Input ref. 0 - 10 V VDC,* fieldbus			

Chart 6: TNX Compact Electric supply

3.3 MF-Generator "TNX Standard"

3.3.1 Electrical Data

	TNX10 Standard	TNX15 Standard	TNX20 Standard	TNX30 Standard	TNX40 Standard
HF-power at the inductor terminals in the nominal operating point at continuous operation	*10 kW*	*15 kW*	*20 kW*	*30 kW*	*40 kW*
Frequency at full load	*10-150 kHz*				
MF-Voltage (rms.)	*600 V*				
HF-Current in inductor	*500-1500 A*				

Chart 7: TNX Standard, electrical Data

3.3.2 Electric Supply

	TNX10 Standard	TNX15 Standard	TNX20 Standard	TNX30 Standard	TNX40 Standard
Voltage	*3 x 400 V + E*				
Frequency	*50/60Hz Hz*				
Permissible voltage fluctuations	*+/- 5 %*				
Power Consumption when HF is switched off	*150 W*				
Power consumption at rated load	*11 kVA*	*16 kVA*	*23 kVA*	*32 kVA*	*45 kVA*
Power factor cos at rated load	*0.94*				
Current per phase (400 V) at rated load	*Ca. 16 A*	*Ca. 24 A*	*Ca. 32 A*	*Ca. 46 A*	*Ca. 62 A*
Required protection	*400V, 25AT*	*400V, 40AT*	*400V, 50AT*	*400V, 80AT*	*400V, 100AT*

Control voltage	*24 VDC*
External power control	Local potentiometer, *Tacho Input ref. 0 - 10 V VDC,* fieldbus

Chart 8: TNX Standard, Electric Supply

3.4 MF-Generator "TNX Industrie"

3.4.1 Electrical Data

	TNX60 Industrie	TNX100 Industrie	TNX150 Industrie	TNX200 Industrie	TNX300 Industrie	TNX600 Industrie
HF-power at the inductor terminals in the nominal operating point at continuous operation	*60 kW*	*100 kW*	*150 kW*	*200 kW*	*300 kW*	*600 kW*
Frequency at full load	*1-20 kHz*					
MF-Current (rms.)	*600 V*					
HF-Current in inductor	*500-3500 A*					

Chart 9: TNX Industry, electrical data

3.4.2 Electric Supply

	TNX60 Industrie	TNX100 Industrie	TNX150 Industrie	TNX200 Industrie	TNX300 Industrie	TNX600 Industrie
Voltage	*3 x 400 V + E*					
Frequency	*50Hz* *(Optional 60Hz)*					
Permissible voltage fluctuations	*+/- 5 %*					
Power Consumption when HF is switched off	*150 W*					
Power consumption at rated load	*68 kVA*	*114 kVA*	*175 kVA*	*235kVA*	*350 kVA*	*700 kVA*
Power factor cos at rated load	*0.94*					

Current per phase (400 V) at rated load	*Ca. 92 A*	*Ca. 154 A*	*Ca. 231 A*	*Ca. 308 A*	*Ca.462 A*	*Ca. 925 A*
Required protection	*400V, 160AT*	*400V, 250AT*	*400V, 355AT*	*400V, 425AT*	*400V, 700AT*	*400V, 1000AT*
Control voltage	*24 VDC*					
External power control	Local potentiometer, *Tacho Input ref. 0 - 10 V VDC,* fieldbus					

Chart 10: TNX Industry, electrical data

4 Safety

Who should read this section?	This section is aimed at all personnel who install, operate, plan, and implement this induction heating equipment.
Content of this section	- Notes on Personnel Qualification - Consequences of unauthorized modification - hazard analysis - safety Precautions

Physiological effects of high frequency

Contact with pure radio-frequency is not necessarily fatal since radio-frequency currents flow only on the surface of the body due to the "skin effect". Depending on the magnitude of the voltage, unpleasant and painful burns are possible. This occurs if arcs are struck by direct contact with the body: If the contact is established in such a manner that the person touches a live part whilst holding something metal, an arc crosses to the metal and a warm feeling (depending on voltage) is noticeable. Therefore:
C A U T I O N !

Do not touch any parts which are under radio-frequency voltage because of burn danger!

4.1 Fundamentals

Knowledge about the biological impact of low-frequency electromagnetic fields (1-150kHz) is still relatively low. Most of the available studies refer to a constant load of continuously 24 hours. Secured on the other hand, is the discovery that the intensity of an electromagnetic field with increasing distance from the source of the field potentially decreases and that the exposure time is essential for potential effects on the human organism.

4.2 General

This operating manual contains basic instructions that must be followed during the commissioning, operation and maintenance. It is therefore essential that the technician as well as the operating personnel read this operating manual. It must be available at the installation time. It is not only to follow the safety messages that follow this section, but also the instructions contained in the other sections, special safety instructions and local regulations.

4.3 Personnel qualification and training

The personnel responsible for the operation, maintenance, inspection and assembly must be fully qualified for this work. Responsibilities, competence and supervision must be clearly defined by the operator.

4.4 Dangers due to non-observance of safety measures

Ignoring the safety instructions can cause harm to persons as well as for the environment and machine failure. Failure to follow the safety instructions results in the loss of any claims for damages.

4.5 Unauthorized modification and reproduction of spare parts

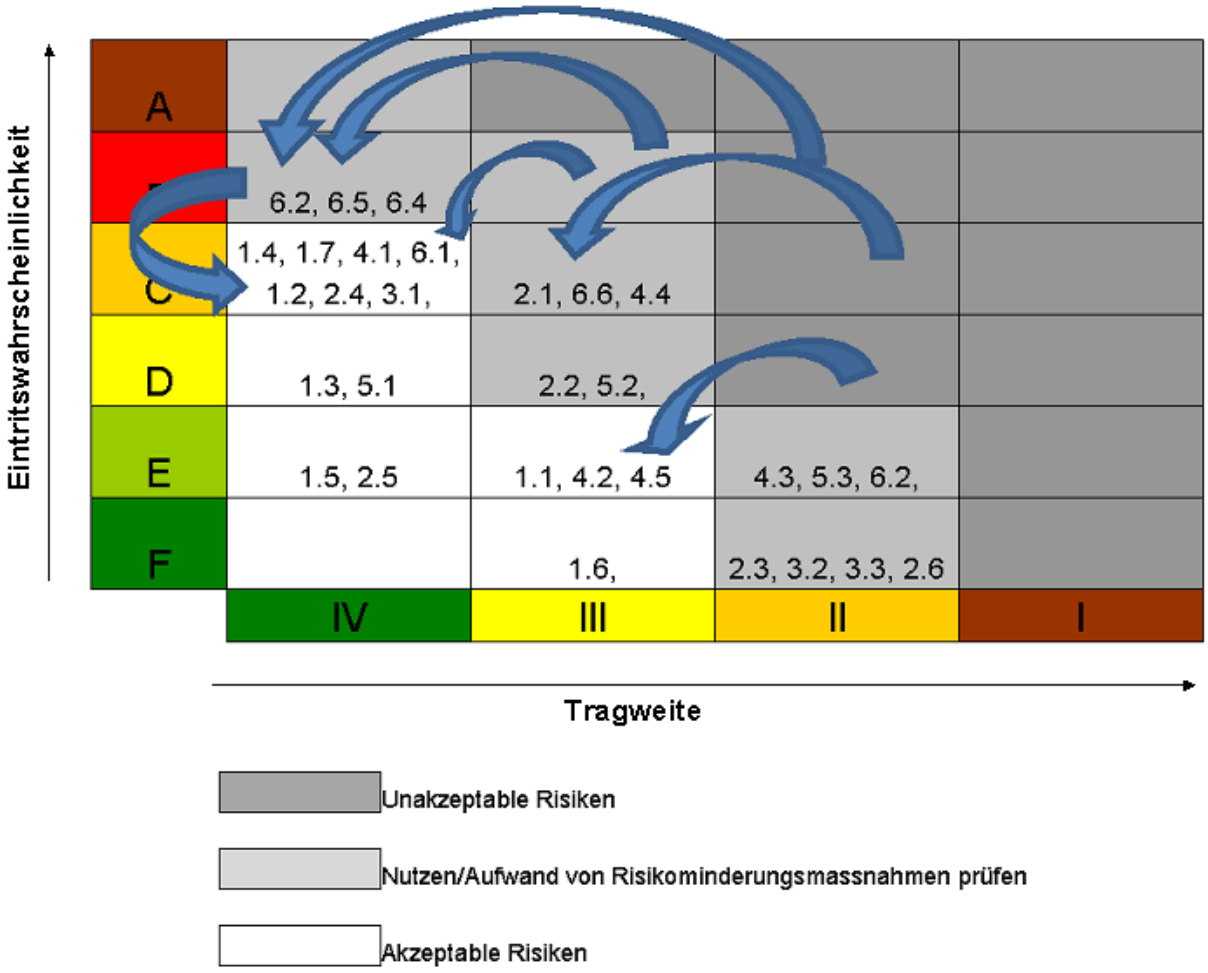
Modifications or changes to the system are only permitted after consultation with the manufacturer. Original spare parts and accessories authorized by the manufacturer help to ensure a safe working environment. Use of parts that are not approved by Plustherm will invalidate liability for every occurance.

4.6 Unauthorized modes of operation

The operational safety of the system is only guaranteed when used as directed. The limits given in the technical data must not be exceeded under any circumstance.

4.7 Hazard analysis

Excerpt from the risk and hazard analysis. The complete analysis can be found in the headquarters of the company Plustherm Point GmbH.



Graphic 2: Extract hazard analysis

4.8 Safety Precautions

Nr.	Activity	Result
1	Operator touches the inductor at one point.	Nothing happens and the system is running normally because: 1: the HF circuit is isolated from the net. 2: the inductor is insulated by a coating.
2	The operator causes a short circuit between the inductor with a metal object (e.g.: screwdriver).	Nothing happens to the operator but the system detects the short circuit and turns off the high power circuit.
3	The operator turns on the system without a mounted inductor.	The system detected an open inductor and switches off the high power circuit.
4	A water leak develops while operating.	The water-flow measurement device notices a difference between input and output and therefore turns off power to the system.

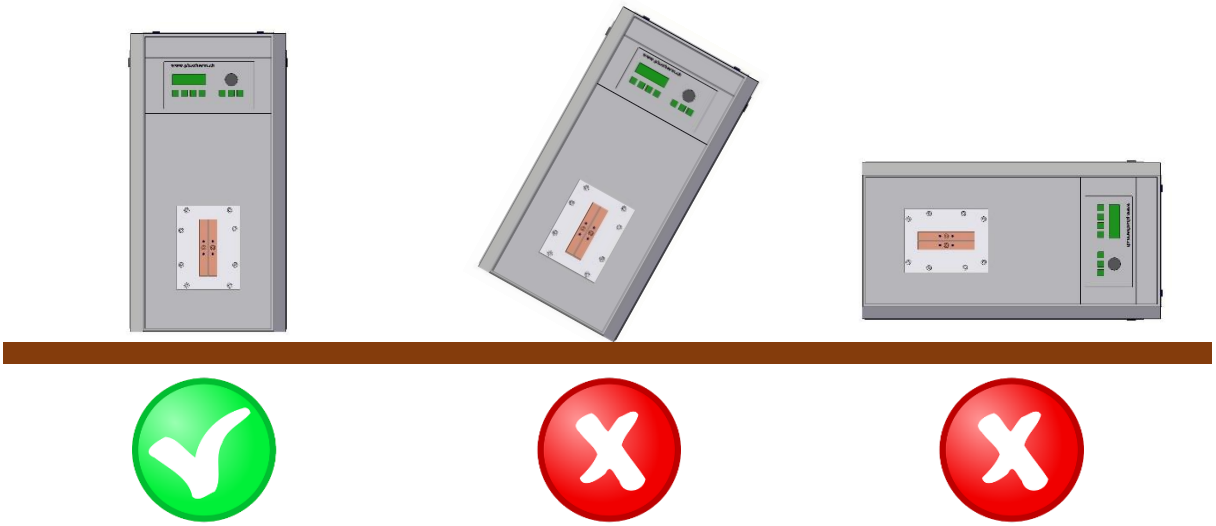
5	The system works with dirty water.	The particulates gradually accumulate in the water cooling system causing overtemp or water-flow errors. The system cannot run properly until the cooling system is cleaned and/or replaced.
6	Fan malfunctioning or has a clogged filter.	System detects a temperature rise and turns off after reaching the temperature threshold.
7	The operator pressed the emergency stop button.	All high power modules are turned off immediately.
8	No water in the inductor.	Error message (Flow coil). The system will not turn on.

Chart 11: Important safety attributes

5 Transport / Storage

Who should read this section?	This section is intended for all persons who need to transport or store induction heating equipment with the help of this manual.
Content of this section	- Transport advice

It should be noted that the facility may be transported only in initial position. Otherwise there is a risk that solve parts of the bracket become loose.



The system should only be stored in the original packaging material.

Detailed transport and storage conditions are detailed on page 15 (Technical Dat).

Transport and storage conditions for all of the accessory items should also be adhered to (Page 92; Appendix 6: Accessories).

6 Installation / Removal

Who should read this section?	This section is intended for all persons using this manual to plan and install induction heating equipment.
Content of section	- Schedule installation - Disposal

6.1 Installation Flow-chart

Task	See
Planung of the installation. Check the ambient conditions, ratings, required cooling capacity, power connector and the fuse	- Appendix 1: System overview, Specifications, Test report, Software-defaults - Specification (page 13) - Appendix 2: Electrical Circuit Diagrams - Appendix 3: Mechanical Drawings
Unpack and check the system if all components are present and undamaged	- Appendix 1: System overview, Specifications, Test report, Software-defaults
Installation of the equipment on site	- Appendix 3: Mechanical Drawings
Connection of water, electricity and communication	- Appendix 2: Electrical Circuit Diagrams - Appendix 5
Operating unit and pyrometer connection (if available)	- Appendix 2: Electrical Circuit Diagrams - Appendix 5: Device Details, Photos
Connect the inductor to C-Box. Note that O-rings are used. Only use brass or stainless screws, since other materials may be heated by the high-frequency	- Appendix 5: Device Details, Photos Checklist before turn on (Page 30)

Chart 12: Schedule Installation

6.2 Previous System Removal

The operator is responsible for ensuring that the system is handed over to applicable collection points at the end of its useful life.
For any questions, the manufacturer can be contacted.

6.3 Packing Material

The packaging materials are recyclable. Dispose of the packaging materials in the appropriate waste disposal center.

7 Commissioning

Who should read this section?	This section is aimed at all persons who plan, maintain and operate induction heating equipment with the help of this manual.
Content of this section	- Explanation of the controls. - Matching impedance with capacitors - Approach first commissioning

Work on the system may only be performed by qualified personnel who are trained in the setup, installation, commissioning and operation.

- ➔ Plustherm devices work with high voltages.
- ➔ During operation, certain parts of the device are at hazardous voltage.
- ➔ In cases where short circuits in the system may result in significant material damage or even grievous bodily injury, additional external measures or means must be provided to ensure safe operation or to force, even if a fault occurs (e.g.: independent limit switches, mechanical interlocks, etc.).
- ➔ Certain parameter settings may cause the system to restart automatically after a power failure.

7.1 Pre-powerup Checklist

Check the mechanical and electrical installation of the equipment prior to commissioning. Go through the checklist below together with another person.

Check
Mechanic: All parameters of the environment are within design specifications (see ○ Specification page 13). ○ The system is properly installed. ○ There is enough space for air around the ventilation inlets and outlets to allow circulation. ○ The access to the parts and components can be guaranteed in case of failure. Electric: ○ The system is properly grounded. The net voltage and frequency meet specifications (see ○ Specifications page 13). ○ Power cables and control cables are routed separately. ○ There are no loose parts or debris in the inductor. ○ The system is in test mode.

Chart 13: Checklist before switch-on

7.2 Controls and Display

TNX generators are typically supplied as follows:

TNX Compact: Remote-Panel
TNX Standard: Front-panel (Optional Remote-Panel)
TNX Industrie: Front-panel (Optional Remote-Panel)

Remote-panel	
Front-panel	

Chart 14: Overview controls

7.2.1 Definitions

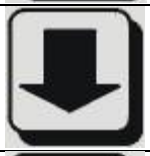
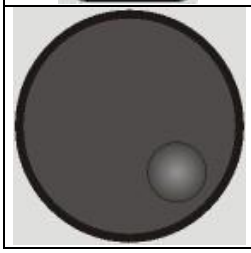
Key	Definition
	UP Key
	DOWN Key
	Menu - Key
	MS-Key
	HF-Key
	Reset-Key
	Potentiometer, set-point indicator

Chart 15: Overview controls

7.2.2 Start-up

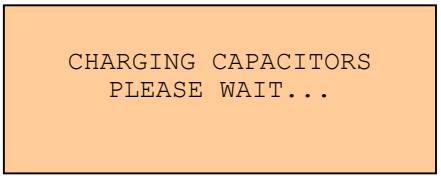
```
Plustherm Point GmbH
www.plustherm.ch
S/N: P1154 S/V: V2.70
TNX30 P1154
```

When you turn on the generator, the start up message is displayed for several seconds.

When error messages occur see page 88 (

Error Messages /Warnings).

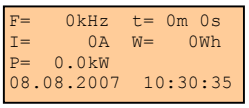
7.2.3 Charge Capacitor-Battery



After initial power-up, the power module must load. This process takes about 15 seconds.

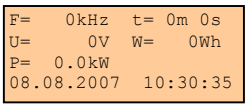
7.2.4 Main Display

This screen is displayed after start-up. It is also referred to as the standby screen.

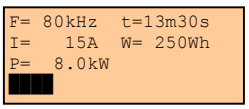


Bedeutung der Anzeigen:

F : Work frequency
t : Switch-on time of HF
I : Current in A [eff.]
U : Voltage in VDC {eff.]
W : Work in Wh



U and I are displayed alternately



With active high-frequency P is shown graphically. The date is hidden there.

Wh-counter (W) and HF-On timer (t) will be set to 0 after every switch-on of the HF.

7.3 Main Switch

By default all TNX generators are supplied with a main switch which interrupts the power and the control circuits when abnormalities are detected.

In the appendix on page 92 is a photo showing the exact position of the main switch (Appendix 5: Device Details, Photos).

7.4 Initial System Commissioning

In test mode, the power is drastically reduced and the machine operates in local mode.

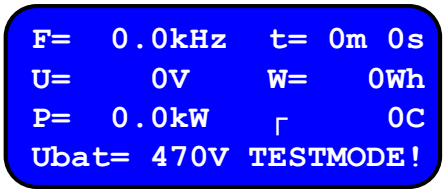
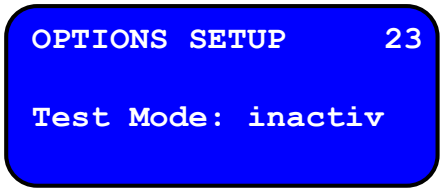
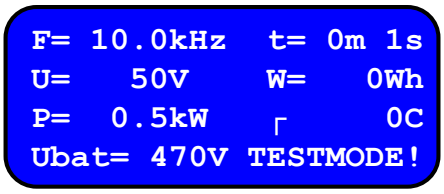
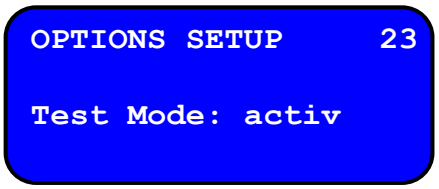
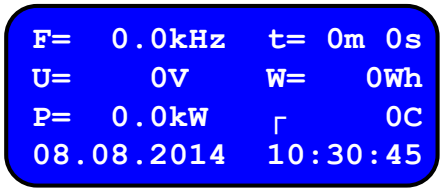
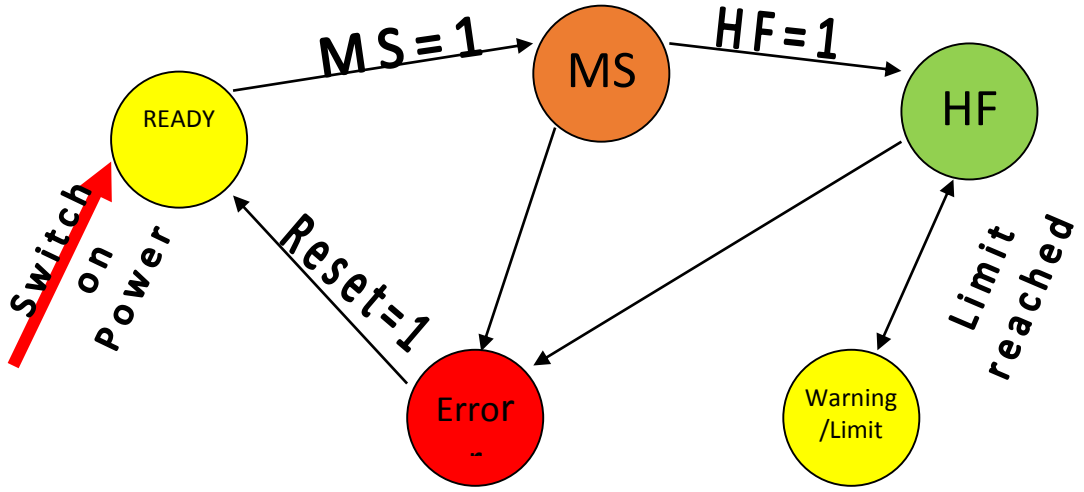
Task	See
Check whether the is nductor without load ↓ Turn on main switch. ↓ Wait until the display shows the message "TEST MODE" is displayed. Perhaps the system must be switchedto "TEST MODE". OPTIONS SETUP -> No.23 Test mode activ = (password = Arrowdown - Menu - Arrow Up - Arrow Down - Enter Arrow Up) ↓ Reduce power with the rotary knob to the minimum ↓ Press the "MS" button. LED next to the "MS" button should be lit ↓ Press the "HF" button for 1-2 seconds. During this time, a frequency value which corresponds to the Test Report has to be seen on display, ↓ Parameter no. 23 in menu "OPTIONS SETUP" switch from activ to inactiv. (Password = Arrow Down -Menu-Arrow Up - Arrow Down-Enter - Arrow Up) ↓ In normal view "TEST MODE" should no longer be seen. The system is now ready for normal operation	See page 92 (Appendix 5: Device Details, Photos)   **Performance test** No. | P [kW] | U [V] | I [A] | f [kHz] | C [uF] | Coil | Load 1 | 90.5 | 453 | 200 | 10.8 | 40 | 11-18mm | 18mmCU 2 | 46 | 500 | 92 | 9.1 | 40 | 11-18mm | No 3 | 84.5 | 420 | 200 | 11.3 | 42 | 6-10mm | 10mmCU 4   

Chart 16: Schedule first commission

7.5 Operating Conditions

As soon as the operator turns MS on, the system starts in the state "MS" (Main Switch). You can hear the switching of the main contactors. (See 57, MS Control)
If the MS state is reached, this means for the operator or the master control that the system is operational.
By setting the state of HF or press the HF button, the heating is started.



Graphic 3: Operating conditions

The permissions for the startup process and the set-point can be defined in the USER MENU. (See page 41)

7.6 Adjusting Capacitance

To enable a best possible adaptation of the system, the capacitors must be adjusted. Especially when working with different coils with different inductances, these adjustments must be made.

Case 1, voltage (U) too high:
If the generator runs in the voltage limitation ((500V) / "Current Limit" flashes), an additional capacitor can be installed. This reduces the voltage and the frequency.

Case 2, current (I) too high:
The generator in the current limitation ("Current Limit" is flashing), a capacitor can be removed. Wherein the voltage and frequency is increased.

When changing the adjustment / C, the system must be in "stand-by" mode. (MS=Off, HF=Off)
In no case the maximum frequency in accordance with specifications may exceed. (See page 13)
Only original capacitors from the manufacturer may be used for the adjustment of the system. Incorrect capacitors cause interference and can cause a total failure.

Generally:
Capacitor removed: U ↑ - I ↓- f ↑

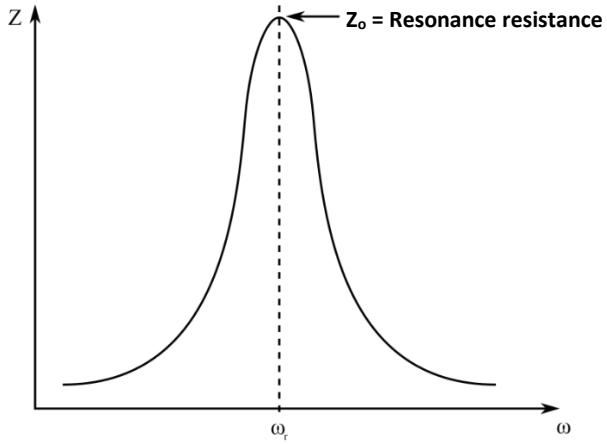
Capacitor installed: I ↑ - U ↓- f ↓

[U= voltage; I=current; f=frequency]

Generally:

$$f_0 = \frac{1}{2\pi\sqrt{LC}}.$$

The system runs always at highest impedance in parallel resonance:



Resonance angular frequency

8 Generator Operation

Who should read this section?	This section is aimed at all persons who plan, maintain, operate and write manuals with the help of this manual induction heating equipment.
Content of this section	- Description of controls - Setting / interface parameters - Programming power / temperature curves

8.1 Main Display

This is the normal display.

```
F=    0kHz  t= 0m 0s
I=      0A  W=    0Wh
P=   0.0kW
08.08.2007  10:30:35
```

Meaning of the display text:

```
F    :   Work frequency
t    :   Running cycle of the HF
I    :   Current in A [eff.]
U    :   Voltage in VDC (eff.]
W    :   Work in Wh
```

```
F=    0kHz  t= 0m 0s
U=      0V  W=    0Wh
P=   0.0kW
08.08.2007  10:30:35
```

```
U and I are displayed
alternately
```

```
F= 80kHz  t=13m30s
I=   15A  W= 250Wh
P=   8.0kW
```

```
With active high-frequency P is
shown graphically. The date is
hidden.
```

Wh-counter (W) and HF-On timer (t) will be set to 0 after every switch-on of the HF.

8.2 Key Functions:

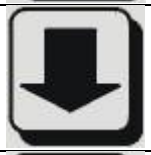
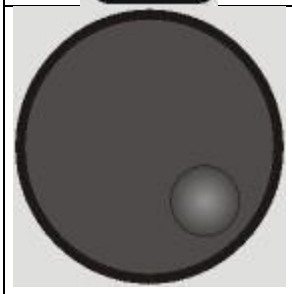
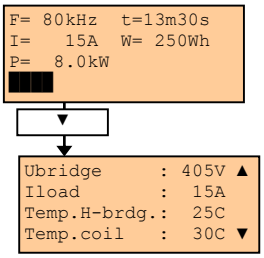
Key	Function
	Switching to reference display (Reference mode (Type of external setpoint) on page 53)
	Switching to System Parameters display (page 40)
	Switching to display Main Display(page33)
	Turns the power unit on and off
	Turns the high frequency on and off when the power supply is turned on
	Power set-point (display changes to Reference mode (type of external reference), if the corresponding option is enabled in the User Menu (page 59)

Chart 17: Key functions

8.3 System Parameters

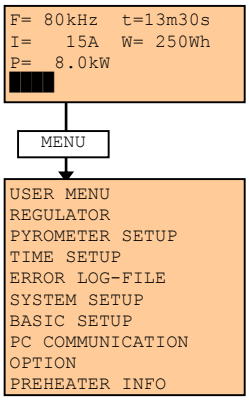


General information about the system is displayed here.

For some values, it is necessary that the built-in capacity of the resonant circuit capacitors is entered correctly.
Details see page 58.

Display text	Meaning
Pmax	Maximal generator performance (with poor adjustment <capacity rating)
U Bridge	Voltage over H-Bridge
I Load	Current in H-Bridge
R Load	Load resistance
L Load	Load inductivity
Q	Q Factor
W total	Total output work
Hour meter	Operating hours counter total
HF hour	Total heating time
Piece count.	Piece counter. Can be set to 0 in the User Setup
Temp.H-brdg.	Cooling water temperature of the H-Bridge
Temp.coil	Cooling water temperature of the inductor
Temp.chopper	Cooling water temperature of the choppers (Option)
Temp.C-bank	Cooling water temperature of the resonant circuit capacitors (Option)
Temp.busbar	Cooling water temperature of the external busbar (Option)
Temp.CPU	Microprocessor temperature (room temperature)
Water flow	Flow rate of cooling water
+15V supply	+15VDC power supply
-15V supply	-15VDC power supply
+5VA supply	+5VDC power supply
-5VA supply	-5VDC power supply
UBAT	Voltage of the battery for the chopper
PWM	Pulse-width modulation control method (Chopper)
Icoil	Current in the inductor (calculated from capacitance / voltage and frequency in the resonant circuit)

8.4 Main Menu

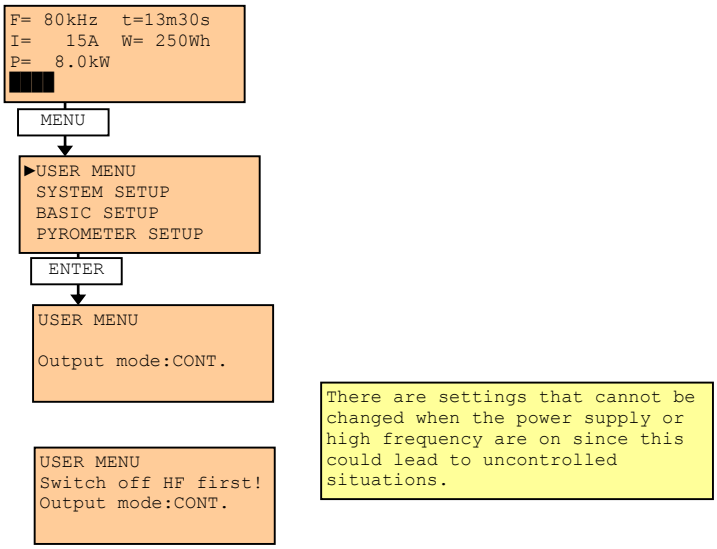


From here you get into the various sub-menus.

The System and Basic Setup menus are password-protected. Within them are settings that cannot be changed!

8.5 User Menu

Here the user can set the generator to his needs.

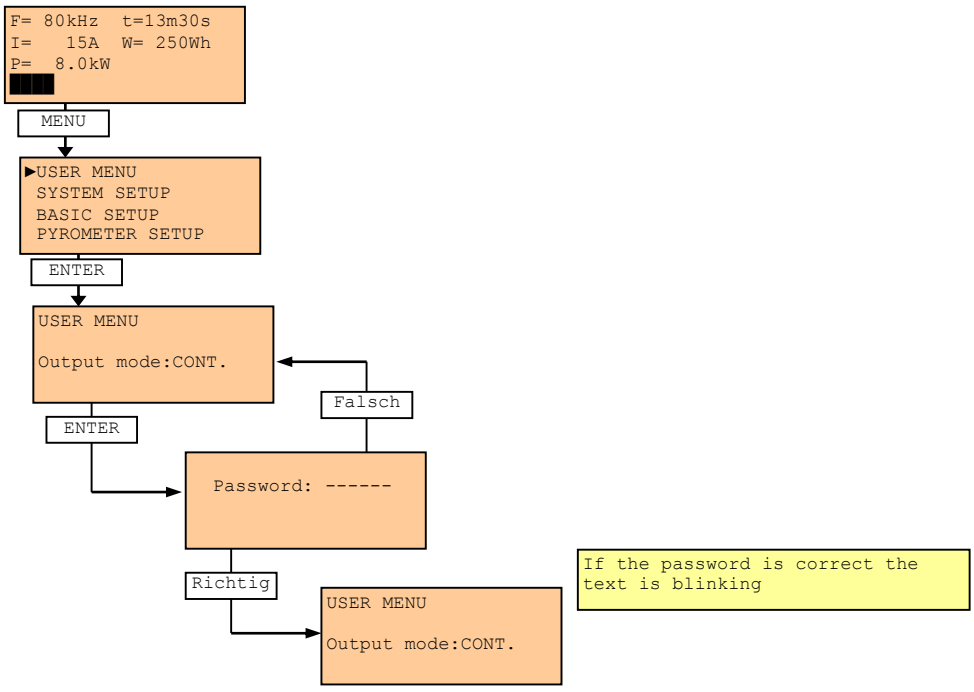


8.5.1 Password protection

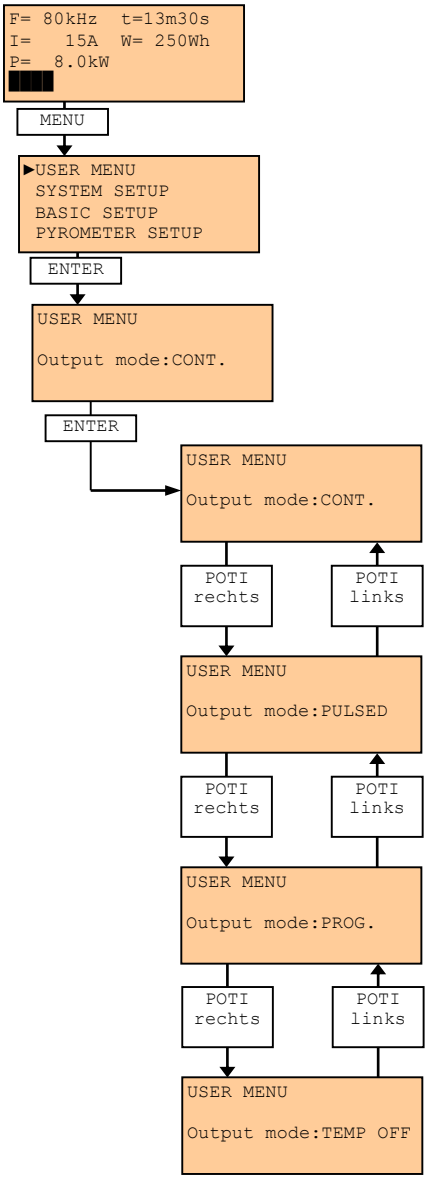
All items in this menu can only be modified when the correct password has been entered. The password allows an input value only for 2 minutes, then the menu will be reset in order to exclude misuse.
Das Passwort für das USER-Menu befindet sich auf Seite 92 (Appendix 1: System overview, Specifications, Test report, Software-defaults)

In the following documentation will no longer be referred to the appearance of the password.

8.5.1.1 Example



8.5.2 Output Mode



8.5.2.1 Cont. (continuous operation)

The generator is operated in continuous mode, that is, until the high frequency is turned turn-off (repeatedly pressing the HF key in local mode or open the external HF-On contact).

8.5.2.2 Pulsed (pulse operation)

The generator is operated in pulsed mode, ie the high-frequency switched off after the time that is set in the menu option "Pulse duration" is reached.

If HF is operational, it can be cancelled during any pulse duration by repeatedly pushing the HF-On button.

In HF Remote mode, the pulse will also be stopped by a pressing HF-On, if this option has been activated.

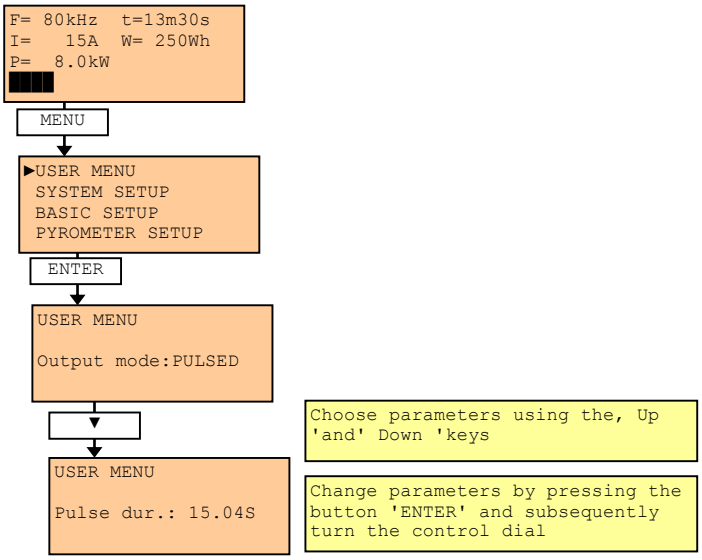
8.5.2.3 Prog. (Programmed curve)

In this mode, a pre-programmed set-point curve is traced. (See page 43)

8.5.2.4 Temp Off (Turning off when temperature is reached.)

In this mode, the power is turned off when a set temperature has been reached. It will turn off when temperature is reached (see page 49).

8.5.3 Pulse dur. (Pulse Duration)



Here, the pulse duration for pulse operation is determined.

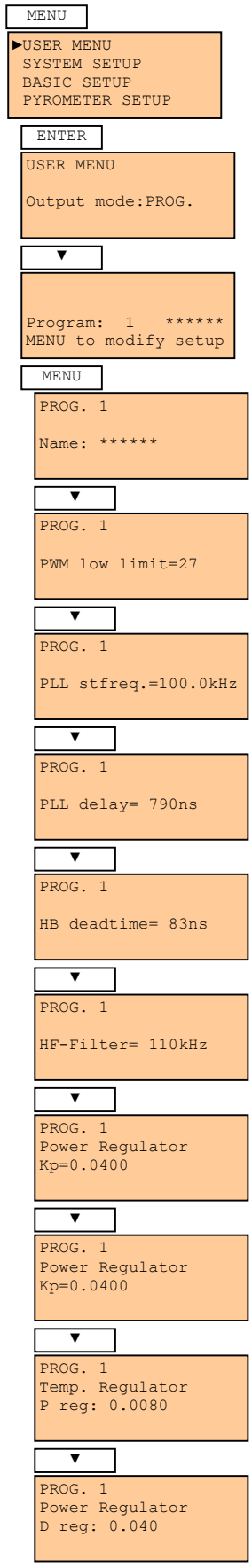
For the pulse duration to be set, "Pulsed" has to be set in the menu point "Output Mode" first.

For details see chapter: Pulsed (pulse mode) page 42.

8.5.4 Program (Programs)

Here the program mode is set.
In program mode, different sets can be saved with power / temperature curves, as well as associated operating parameters.

A maximum of 80 programs can be stored, in addition240 programmable segments (points). i.e.: 1 Defined program with 240 segments, or 80 programs with 3 segments per.



Freely selectable program name (6 characters)
Setting: Activate by pressing Enter, select location with up / down, with Adjust characters with knob

Lower PWM limits. Affects starting (minimum power)

PLL Start Frequency: Affects start behavior should be optimally adjusted to the operating frequency of the system

PLL delay: Influenced frequency control must be set using an oscilloscope

HB deadtime: Affects frequency control must be set using an oscilloscope

HF filters: Affects frequency control should be set above the operating frequency (about 5-10kHz)

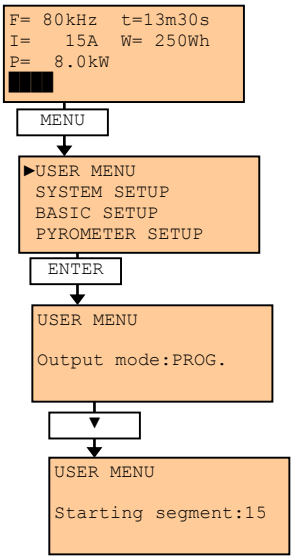
Kp: P-factor for power regulator

Td: D-factor for power regulator

P reg: P-Faktor für Temperaturregler

D reg: D-Faktor für Temperaturregler

8.5.4.1 Starting segment



Here you can set which segment with a programmed power curve should be started.

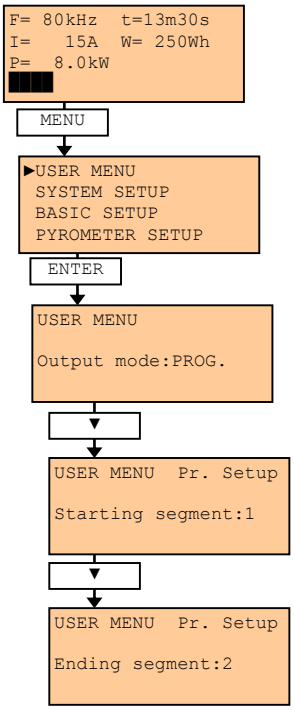
Before a choice can be made, output mode 'PROG. have been set in the menu point.

Details see page 41.

Choose parameter with ‚UP' and ‚DOWN' keys

Change parameters by pressing the button 'ENTER' and subsequently turn the control dial

8.5.4.2 Ending segment



Here you can set which segment with a programmed power curve is to be terminated.

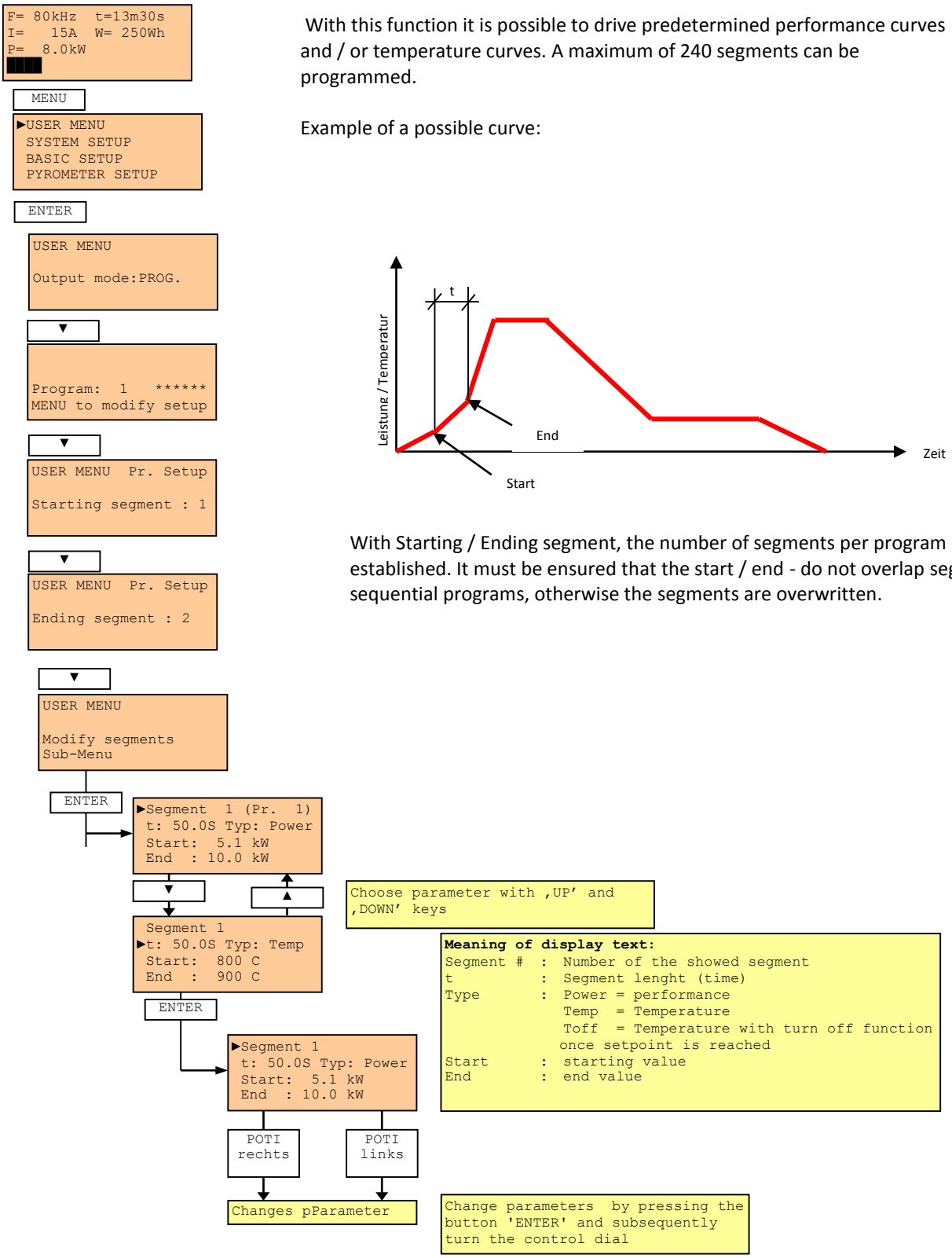
Before a choice can be made, output mode PROG. Must be set in the menu point.

Details see page 41.

Choose parameter with ‚UP' and ‚DOWN' keys

Change parameters by pressing the button 'ENTER' and subsequently turn the control dial

8.5.4.3 Modify Segment



With this function it is possible to drive predetermined performance curves and / or temperature curves. A maximum of 240 segments can be programmed.

Example of a possible curve:

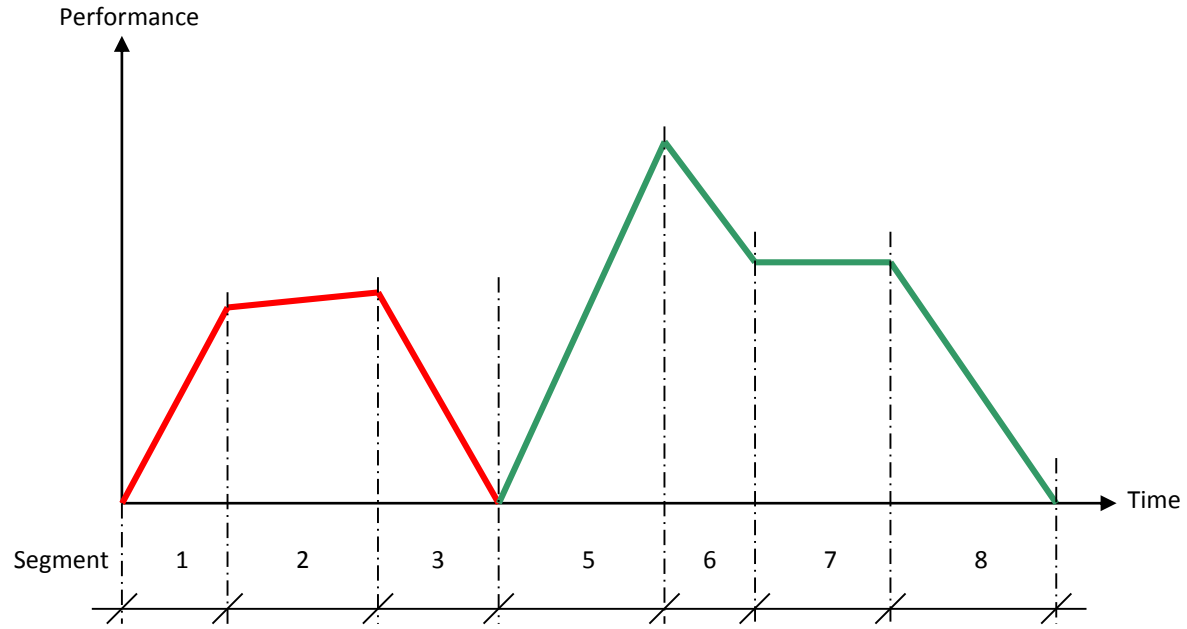
With Starting / Ending segment, the number of segments per program can be established. It must be ensured that the start / end - do not overlap segments of sequential programs, otherwise the segments are overwritten.

It is possible to specify for each segment, whether it is a power or temperature setting. This makes it possible to grope underneath the pyrometer reading area with constant power curves at this value and then to control the temperature.

If the segment time is set to 0, the power curve ends in the segment. This also makes it possible to store a plurality of curves and to select them each have the function of "starting segment". If the segment time is set to ∞ (1 level greater than 0), this segment is driven continuously until a new HF-ON signal is set (HF-control, set to "remote with time off (hold)") (See

HF Control (High Frequency), page 57.

8.5.4.4 Example of two independent curves



Segment #	t [sec]	Type	Start [kW]	End [kW]
1	5	Power	0	5
2	10	Power	5	7
3	7	Power	7	0
4	0	--	--	--
5	10	Power	0	15
6	4	Power	15	10
7	8	Power	10	10
8	12	Power	10	0
9	0	--	--	--

Power curve work-piece 1

Power curve work-piece 2

In the table above you can see an example of performance curves for two different work-pieces.

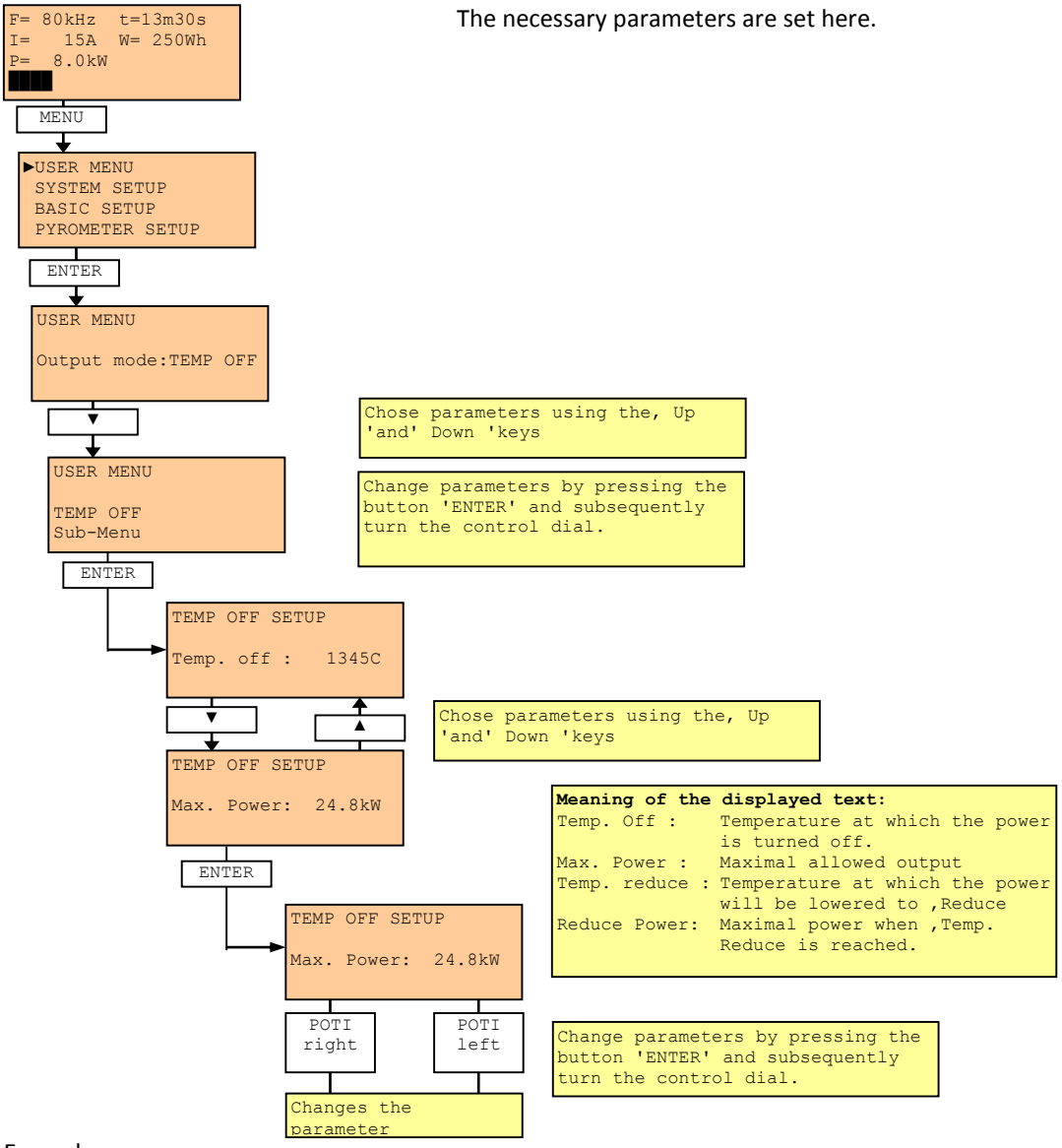
If work-piece 1 is heated, the power curve starts with segment # 1 (starting segment = 1 (see Section8.5.4.1) and ends with the segment No. 4

If work-piece 2 is heated so the power curve starts with segment No. 5 (starting segment = 5 (see Section 8.5.4.1) and ends with the segment No. 9

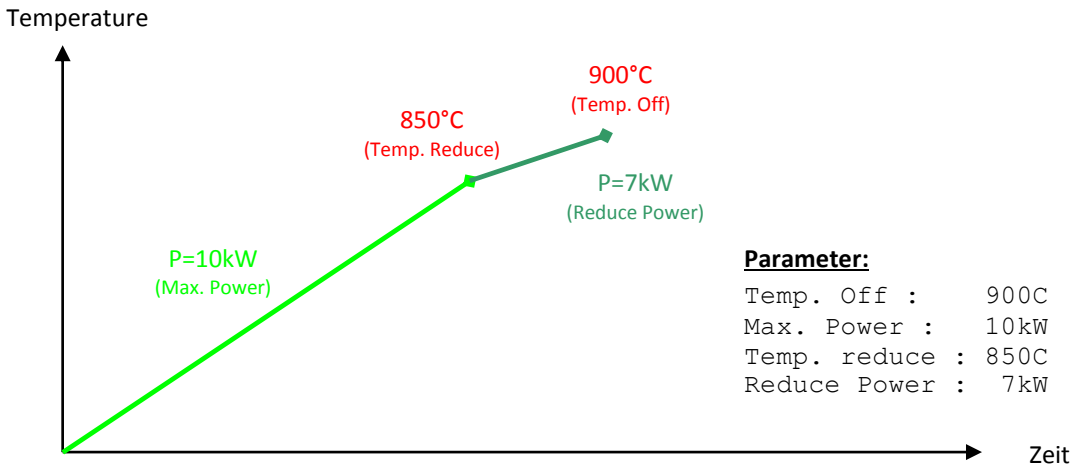
Thus one has the possibility performance curves for different work-pieces to save. The only limit the maximum number of segments (240) is taken into account.

8.5.5 TEMP OFF (Power off when temperature reached)

The necessary parameters are set here.

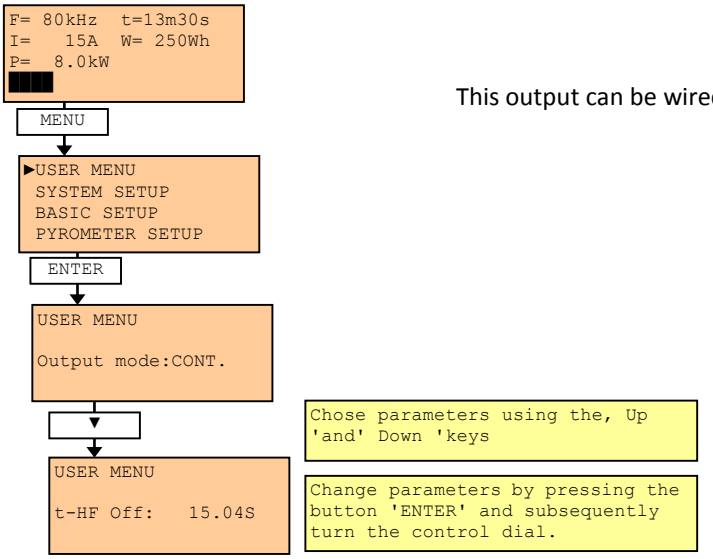


Example:



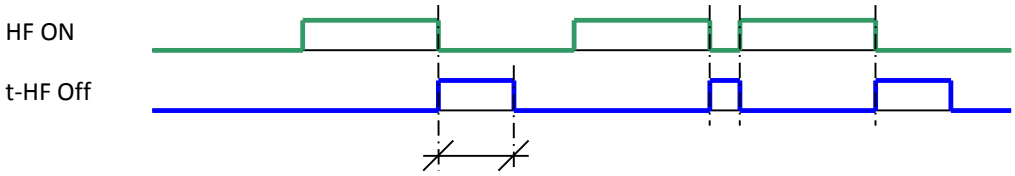
8.5.6 t-HF Off (Timer after HF-Off)

The controller has a relay contact which can remain for a time after turning off HF. This can, for example, be used as quenching device.



This output can be wired to the user interface X2.

8.5.6.1 Signal flow diagram:

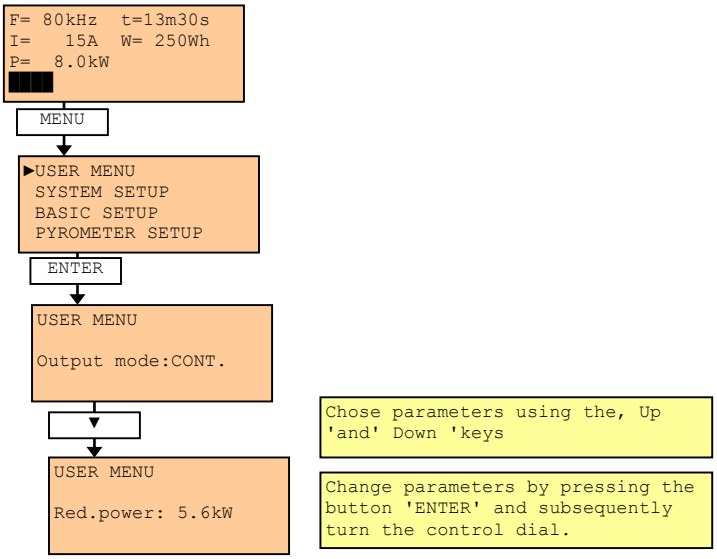


t-HF Off

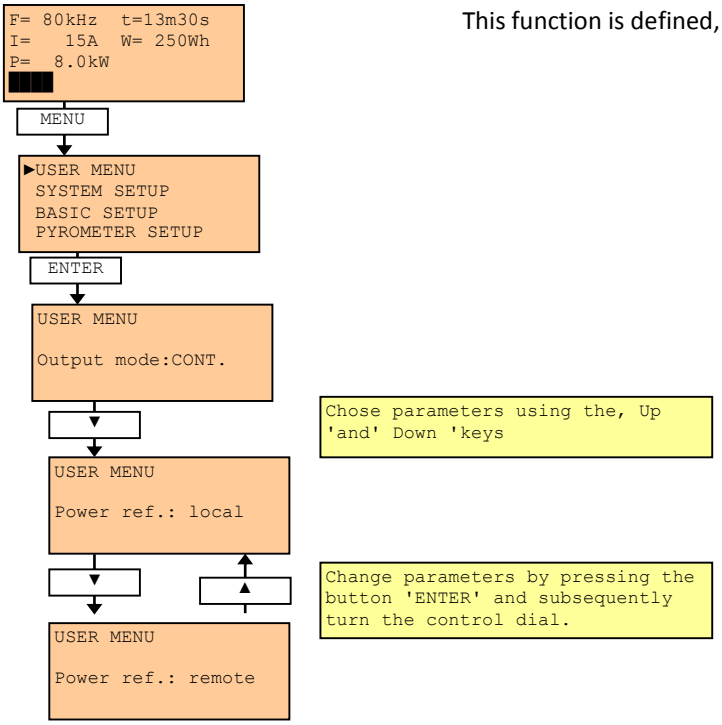
The high frequency cannot be operated when t-HF Off has a signal.

8.5.7 Reduced Power

About the external input "Reduced Power", the generator power is set to the value set here. However this only works if the reference value is controlled locally.



8.5.8 Setpoint reference



This function is defined, where the power setpoint is to come.

8.5.8.1 Local

The power setpoint is set using the setpoint front or remote panel's potentiometer.

8.5.8.2 Remote

The power setpoint is set externally via the interface X2.
In this mode, the function Reference Mode 'can be adjusted to the type of input signal it is.
Details see page53. (Reference mode (Type of external setpoint))

8.5.8.3 Profibus Resolution 100W

The power setpoint is set externally via the Profibus interface.
In this mode to the type of input signal must be set in the "Reference mode". Resolution in 100W steps, that is, e.g. Profibus value 10 corresponds 10x100W = 1kW.
Details see page 53. (Reference mode (Type of external setpoint))

8.5.8.4 PB % Resolution 1/1000

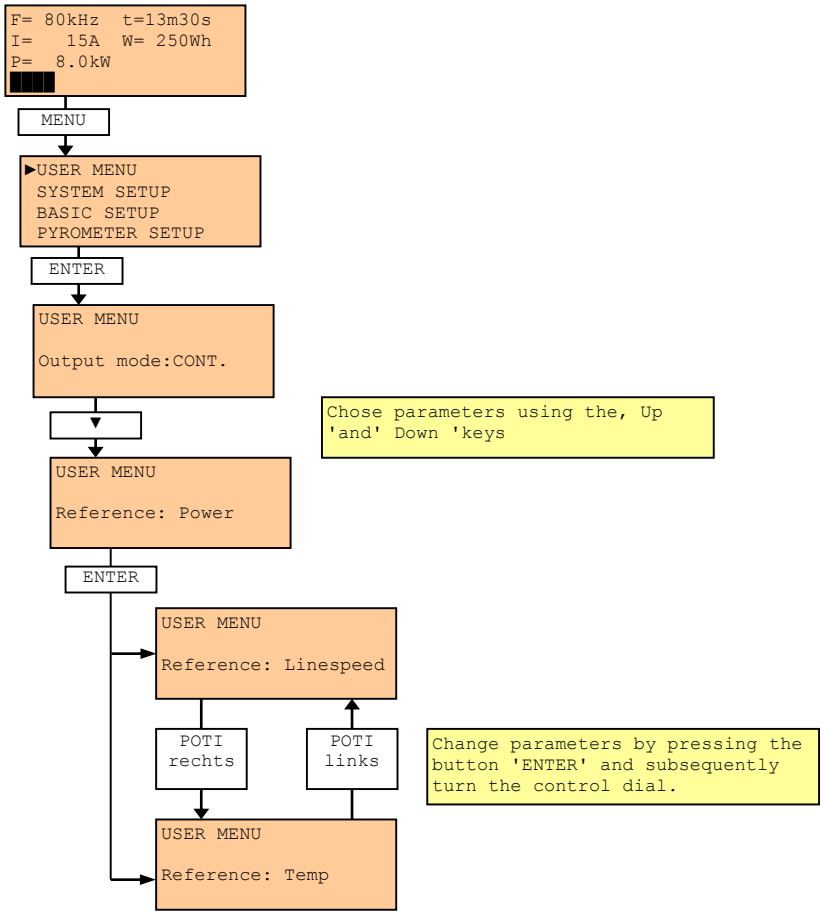
The power setpoint is set externally via the Profibus interface. .
In this mode to the type of input signal must be set in the "Reference mode". Resolution in Promille (1/1000) steps according reference. E.g. Profibus value 100 corresponds 100/1000=1/10. E.g. with reference „Volt“ (Umax=500V, 500*1/10=50V).
Details see page 53. (Reference mode (Type of external setpoint))

8.5.8.5 Profibus Resolution 10W

The power setpoint is set externally via the Profibus interface. .
In this mode to the type of input signal must be set in the "Reference mode". Resolution in 10W steps, that means Profibus value 10 corresponds 10x10W=0.1kW.
Details see page 53. (Reference mode (Type of external setpoint))

8.5.9 Reference mode (Type of external setpoint)

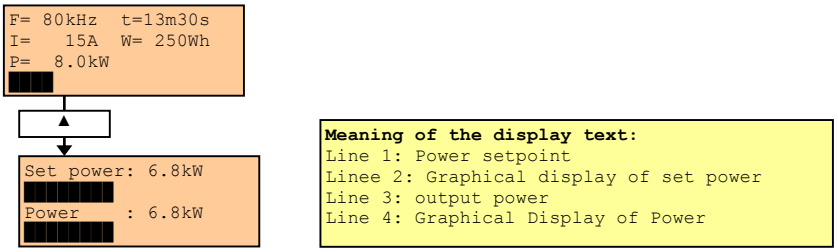
Here is set how the analog input signal 1 is to be interpreted.



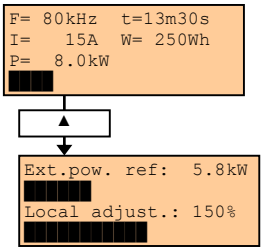
8.5.9.1 Power

The input signal is interpreted as a power setpoint. 0 – 10VDC equal 0-100% output.

8.5.9.1.1 Reference display in local mode



8.5.9.1.2 Reference display in remote mode



Meaning of display text:
Line 1: External setpoint output
Line 2: Graphical display Ext.pow.
Line 3: correction factor
Line 4: Graphical display of Local adjust

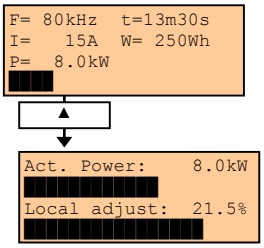
With the correction factor, which is adjusted with the setpoint wheel, the external setpoint signal can be amplified or attenuated.
Possible corrections are possible in the range of 0-200%. A correction of 100% corresponds to no correction, ie, the signal is transferred 1:1.

8.5.9.2 Line-speed

The input signal corresponds to the speed of the manufacturing. This can be used, for example, in the process of cable heating, so long that the Start-Parameter is active under the User Menu (see page 55 - Start Level (Line Speed)).

With the correction factor, the external setpoint signal can be amplified or reduced. A 0-200% correction factor is possible. A factor of 100% corresponds to no change in signal (1:1).

8.5.9.2.1 Reference Display

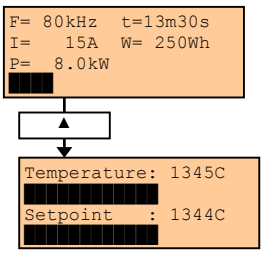


Understanding the display:
Line 1: Actual Power
Line 2: Graphical indicator of power
Line 3: Correction factor for reference signal
Line 4: Graphical indicator for adjusted output

8.5.9.3 Temp (Temperature Mode)

The input signal (actual value) is interpreted as a specific temperature. In this case, the necessary parameters must be adjusted (See page 64 - Pyrometer Setup).

8.5.9.3.1 Reference Display



Understanding the display:
Line 1: Measured temperature
Line 2: Graphical display of temperature
Line 3: Temperature set point value
Line 4: Graphical display of set point

8.5.9.4 Voltage

The input signal of 0-10VDC is interpreted as a percentage point 0-100% output voltage. This reference type is particularly helpful for automatic adjustments under full to partial loads in order to prevent overheating of the work-piece.

8.5.9.5 Temp 2 (Temperature Mode 2)

These input signals as interpreted as both Actual Temp (input 1) and Set Point Temp (input 2). The temperature value is made externally instead of locally on the display panel.

The Actual Value via Pyromter:

- Analog input 1 (Ext. Ref. 1)
- Pin59/60 on the mainboard
- Pin 12/13 on the X2 communications port

0.0VDC is interpreted as the minimal temperature possible by the specific pyrometer (i.e.: 300°C)
10.0VDC is interpreted as the maximal temperature possible by the specific pyrometer (i.e.: 1300°C)

The Set Point value for the 0-10VCD analog input:

- Analog input 2 (Ext. Ref. 2)
- Pin61/62 on the mainboard

0.0VDC is interpreted as the minimal temperature possible by the specific pyrometer (i.e.: 300°C)
10.0VDC is interpreted as the maximal temperature possible by the specific pyrometer (i.e.: 1300°C)

8.5.10 Start Level (Line Speed)

With this parameter, the power is regulated by the speed of the manufacturing line.

With this parameter active, HF only turns on when the input signal is greater than 0VDC. If a value of more than 0VDC is not reached, a message is displayed stating „Line speed low. No HF!" accompanied by a flashing red LED.

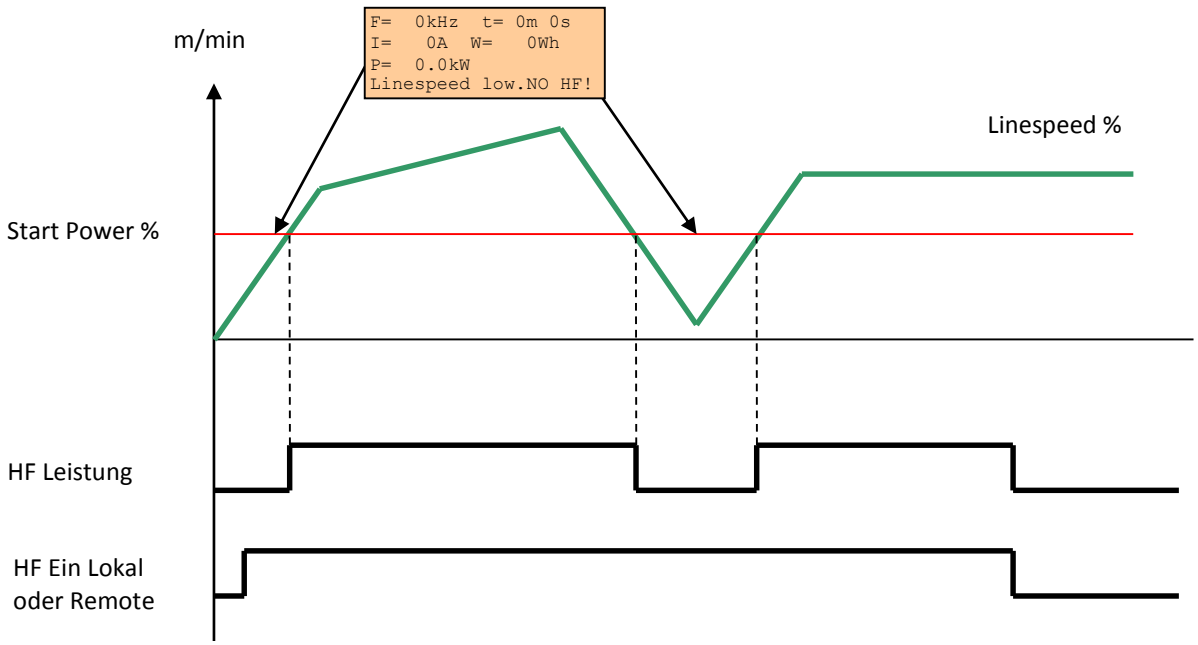
Example:

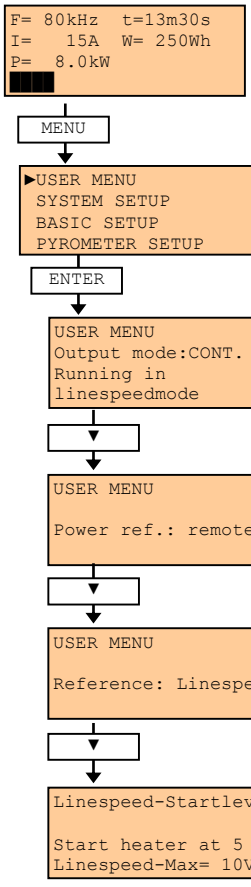
Requirements:
Max. Linespeed = 8m/min
Actual Linespeed = 5m/min
HF activation point = from 1m/min

Settings:
Max. Linespeed = 8 m/min = 10 Vdc by generator input.

1m/min= 12.5% from Max-Linespeed (8m/min)

That start level is 12.5% -> Power balance (0-200%) is adjusted with the front panel potentiometer.





Required parameters for utilizing Linespeed feature

Activation of HF is not possible whilst this menu is activated. Also, altering these values is not possible while HF is active.

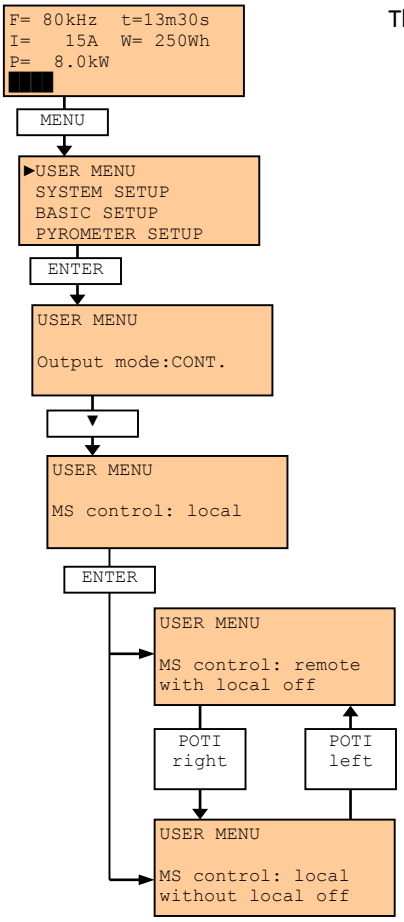
Output Mode must be set to continuous.

Power reference must be set to remote.

Reference must be set to Linespeed.

Understanding this display:
Starting level for HF in relation to the 0-10VDC input.

8.5.11 MS Control



This function is defined as the power unit to be switched on.

To change parameter: Press enter key while parameter is selected, then adjust potentiometer.

Understanding this display

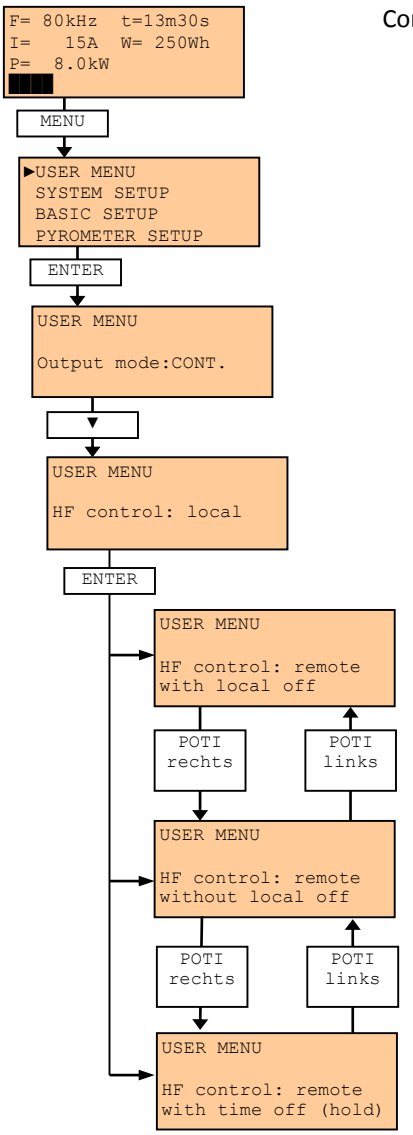
local:
MS is turned on and off using the front/remote panel

Remote with local off:
MS is controlled remotely but the ability to turn off locally is reserved.

Remote without local off:
MS is controlled only remotely.

AUTO:
The main contactor is automatically activated when the system is turned on. This condition can also be queried on the digital interface and via the Profibus.

8.5.12 HF Control (High Frequency)



Control parameters by which HF is activated.

To change parameter: Press enter key while parameter is selected, then adjust potentiometer.

Understanding this display

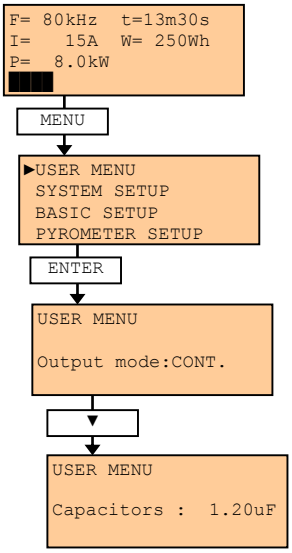
local:
HF is turned on and off using the front/remote panel

Remote with local off:
HF is controlled remotely but the ability to turn off locally is reserved.

Remote without local off:
HF is controlled only remotely.

Remote with time off:
The high frequency is externally turned on via the interface X2 (pulse). The generator runs with the preset pulse width.
Only for Operating Mode "pulsed".

8.5.13 Capacitors (Oscillating circuit capacitors)

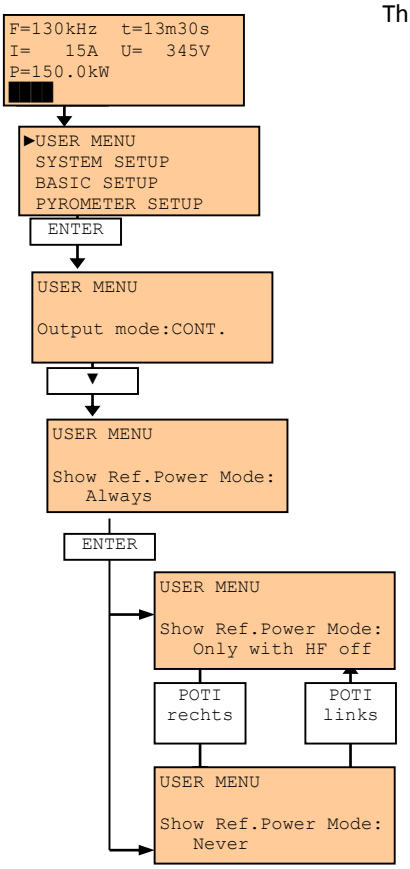


The total value of the installed oscillating circuit capacitors must be entered here. Various system parameters are calculated using this value (see page 40 - System Parameters).

To change parameter: Press enter key while parameter is selected, then adjust potentiometer.

8.5.14 Show ref. (Setpoint display)

This function determines when the reference display is presented.



To change parameter: Press enter key while parameter is selected, then adjust potentiometer.

Understanding this display

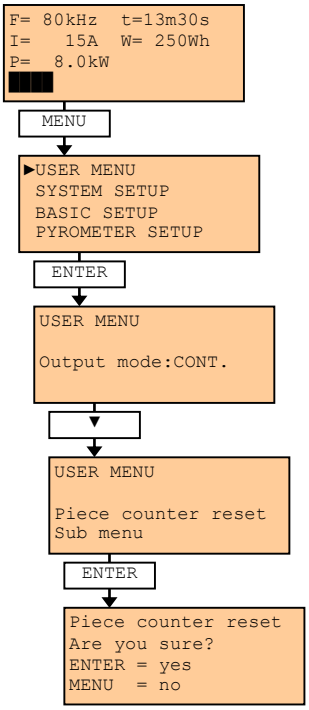
Normal (adjustable):
The reference indicator displays whenever in the main menu and the potentiometer is rotated.

Only if HF=OFF:
The reference is only displayed while HF is off and the potentiometer is rotated.

Locked:
The reference is not displayed. However, this value can still be seen by pressing the "up" arrow whilst at the home screen.

Protected (passwrd.):
Protected by password (user menu password).

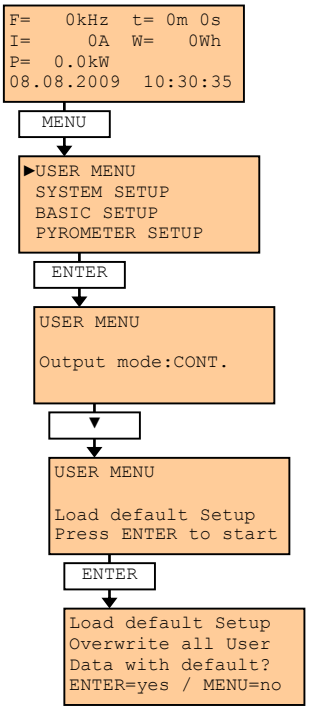
8.5.15 Piece counter reset



With this function the piece counter can be set to zero. It is normally incremented by 1 each time HF is activated.

The resetting of this value must be confirmed by one more press of the „Enter“ button, and can also be aborted by pressing the „Menu“ button.

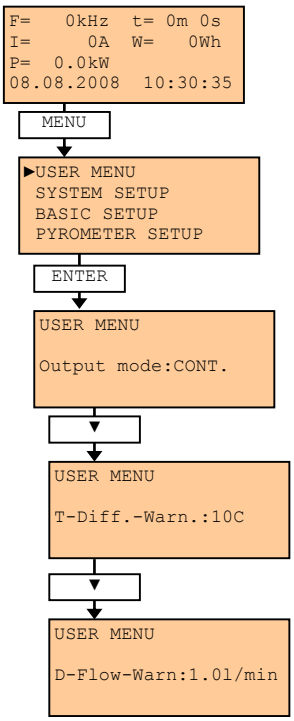
8.5.16 Load Default Setup



With this function, the default settings can be loaded.

The resetting of this value must be confirmed by one more press of the „Enter“ button, and can also be aborted by pressing the „Menu“ button.

8.5.17 Warning (Optional)



With this function, the warning limits for water-flow and temperature can be set.

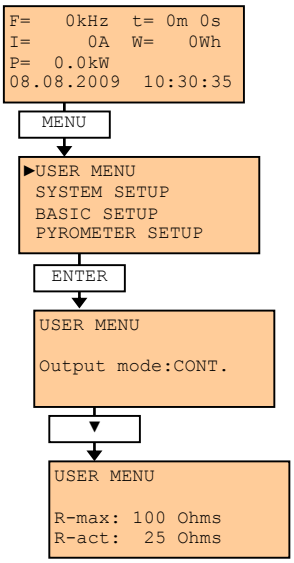
Warning messages come from a relay output and also the display unit (see 8.15.1.14, page 77).

Warnings can be deactivated when User Menu Nr. 19 is set to zero.

```
Limit at which a warning is issued, a set amount
of degrees before temperature reaches Max. Temp.
```

```
Limit at which a warning is issued, a set amount
of flow before waterflow reaches Min. Flow.
```

8.5.18 Impedance Monitoring (Optional)



With this function the power can be reduced if the impedance is higher than the set value. In the case of exceeding the threshold, the system automatically reduces the power of the value which is set at "reduce power". (See page 51 - Reduced Power)

This function is mainly used when working with large changes of load and when it is not desired for HF to be turned off during heating periods.

```
R max is the threshold at which the power is
reduced. In operation, the actual measured value
is displayed (R-act).
```

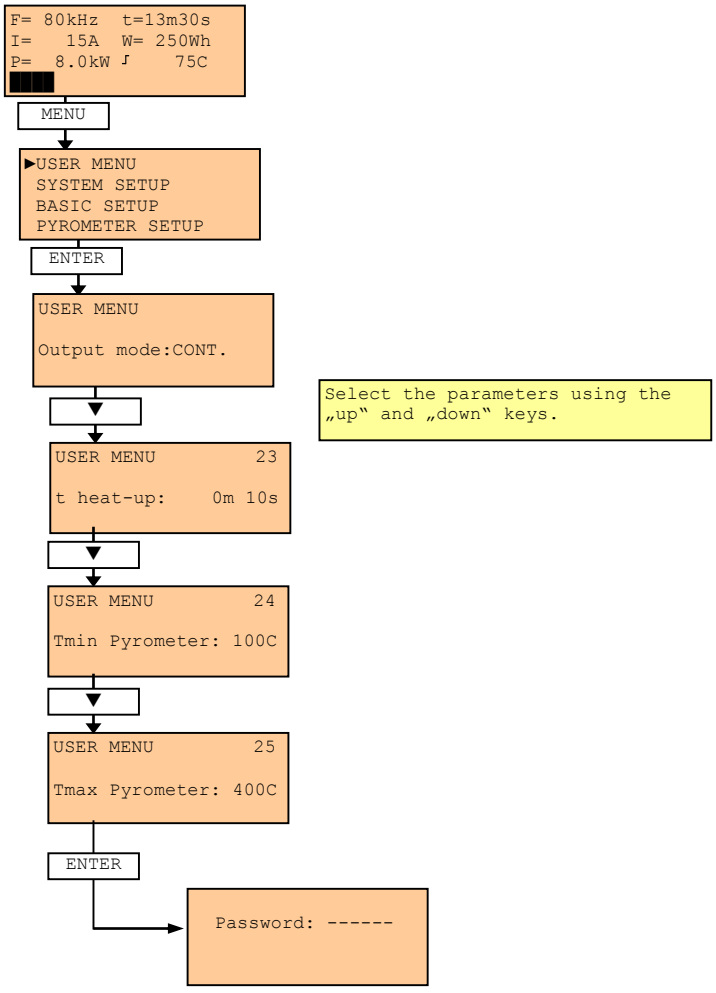
8.5.19 Pyrometer Monitoring (optional)

For pyrometer monitoring, the following parameters in the User Menu can be set:

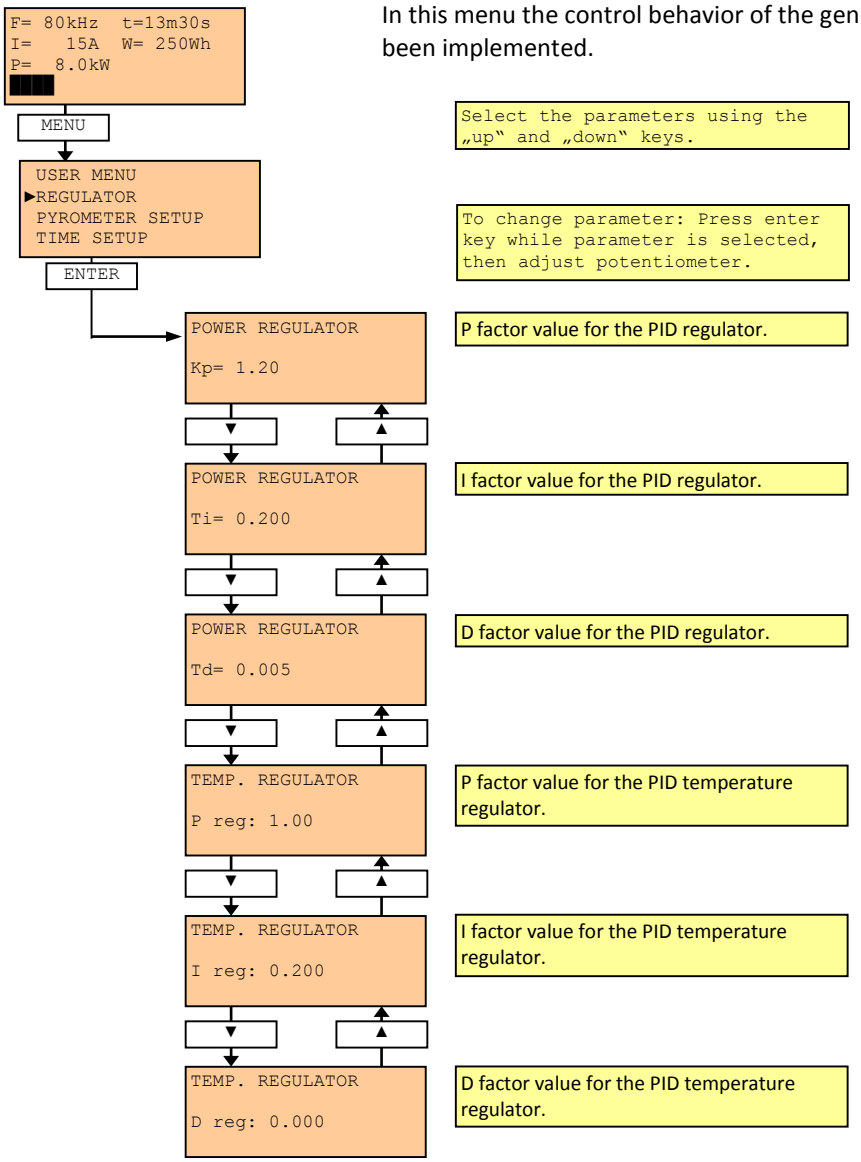
- **t heat-up:** Heat up time, after which pyrometer monitoring is activated
- **Tmin Pyrometer:** Minimum temperature measurement point.
- **Tmax Pyrometer:** Maximim temperature measurement point.

When these set limit values are exceeded, HF is turned off and an error is logged.

Settings:



8.6 Regulator Setup



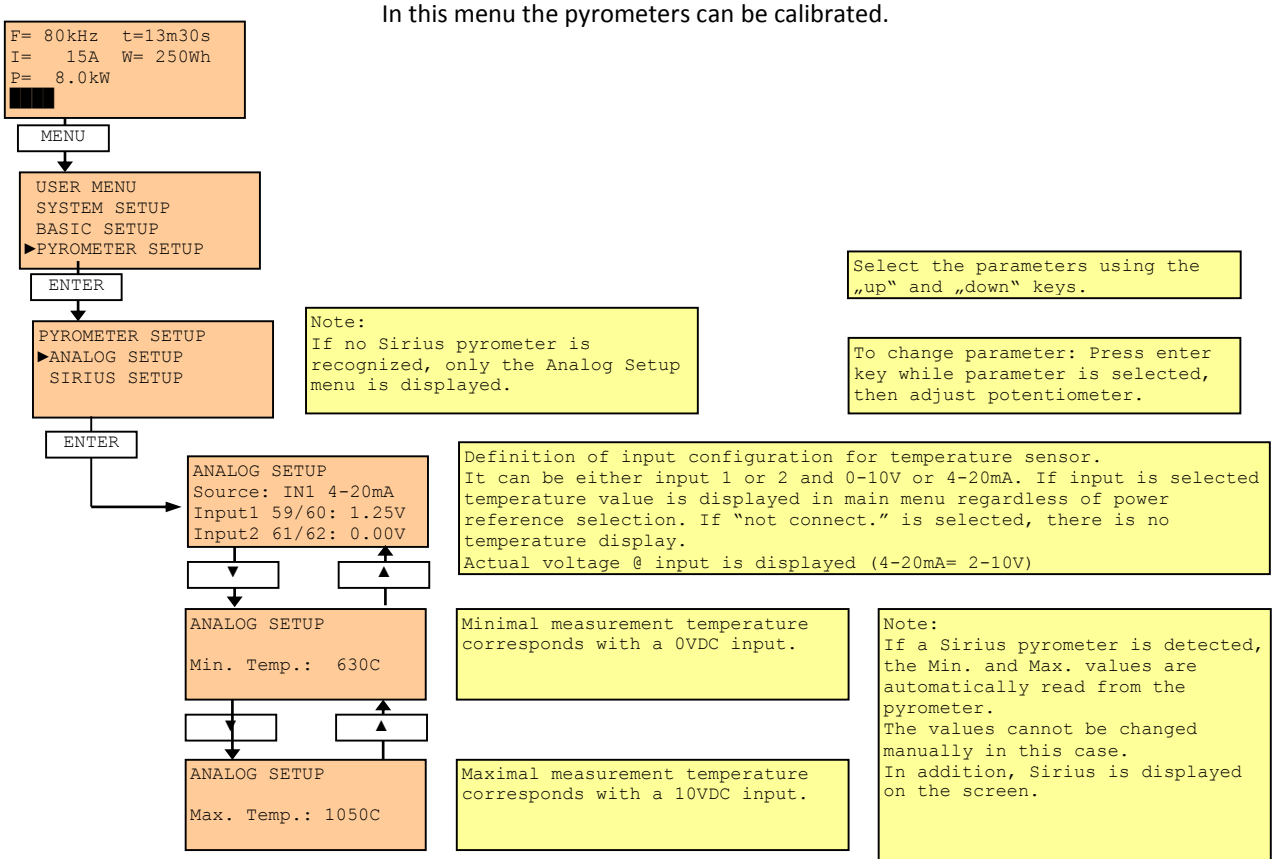
In this menu the control behavior of the generator is set if a controller has been implemented.

Important:
The temperature regulator is only correct whilst properly calibrated and when Reference = Temperature (see page 54). This requires calibration of the analog input (see page 64 - Pyrometer Setup).

8.7 Pyrometer Setup

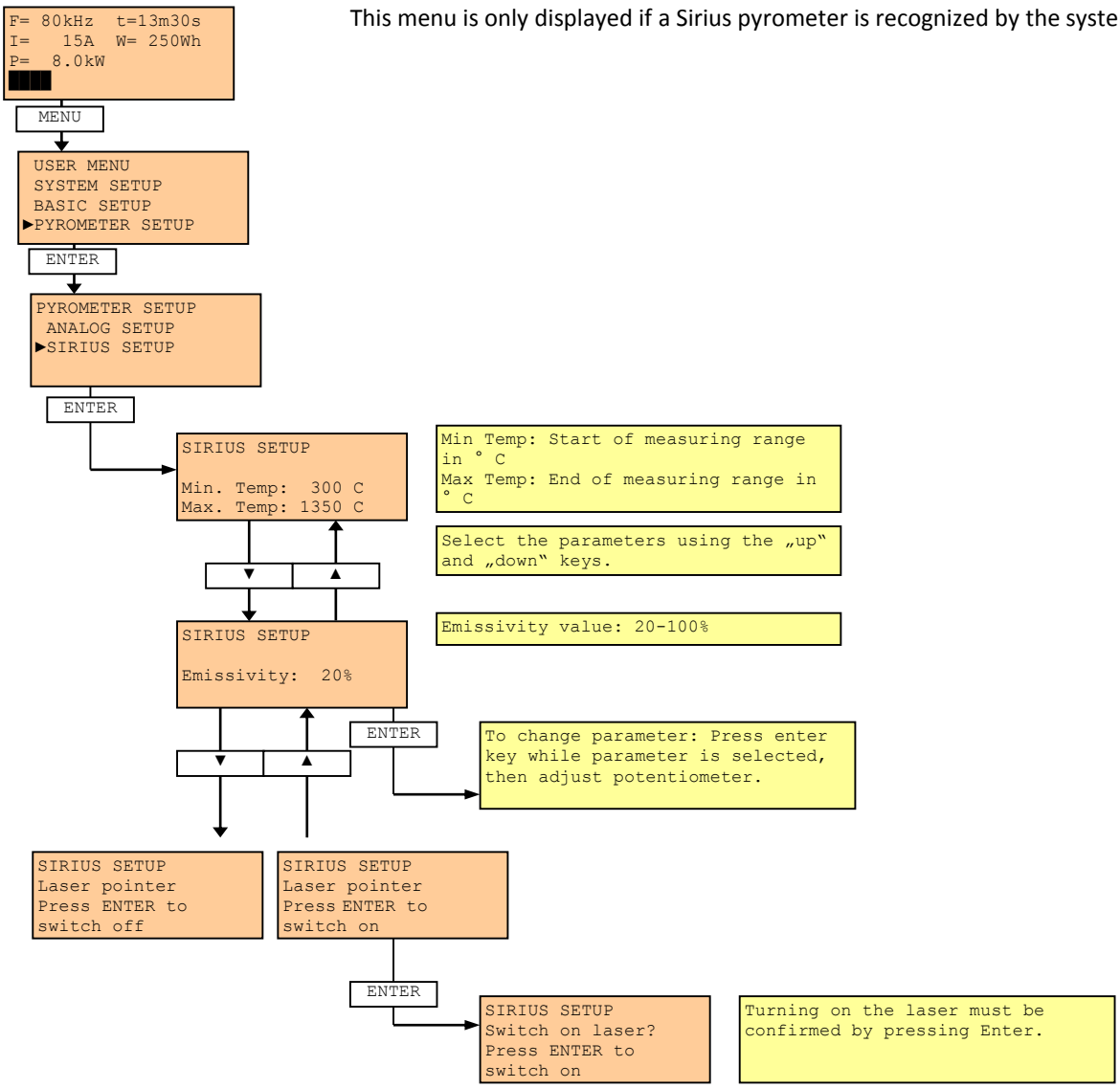
8.7.1 Analog Setup

In this menu the pyrometers can be calibrated.



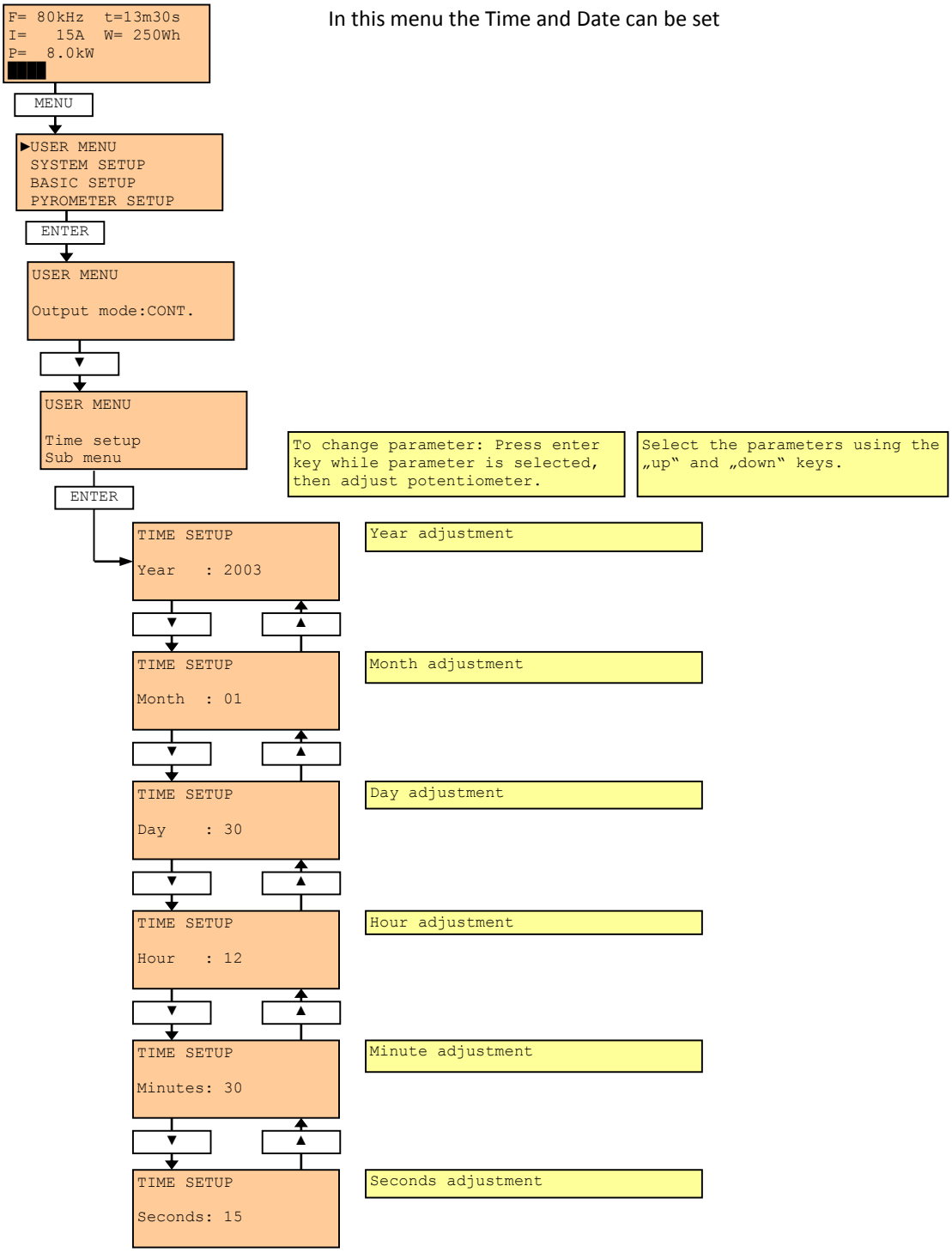
8.7.2 Sirius Setup

This menu is only displayed if a Sirius pyrometer is recognized by the system.

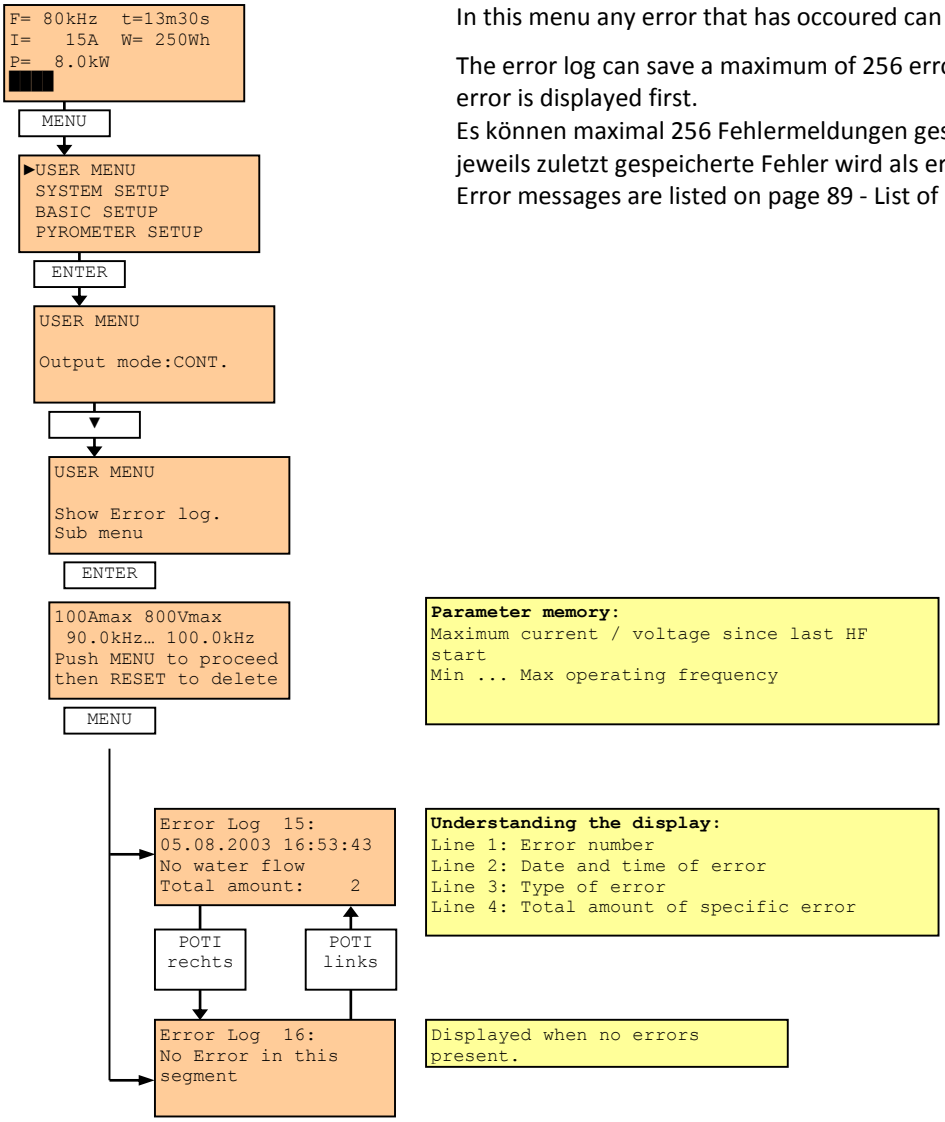


8.8 Time Setup

In this menu the Time and Date can be set



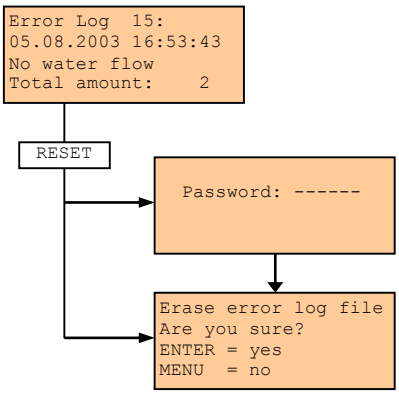
8.9 Show Error Log



In this menu any error that has occoured can be seen.

The error log can save a maximum of 256 errors. The most recent error is displayed first.
Es können maximal 256 Fehlermeldungen gespeichert werden. Der jeweils zuletzt gespeicherte Fehler wird als erstes angezeigt.
Error messages are listed on page 89 - List of Errors.

8.9.1 Clearing Error Log



Pressing the „Reset“ button while in the error log will prompt to clear error log.

A password must be entered before the log can be cleared.
The authorization will be automatically revoked after 2 minutes.

After entering the correct password, deletion of the error log must be confirmed.

8.10 System Setup

The system setup includes settings for each type of generator. These settings will be set at the factory and cannot be changed by the customer.

8.11 Basic Setup

The basic setup includes settings for each type of generator. These settings will be set at the factory and cannot be changed by the customer.

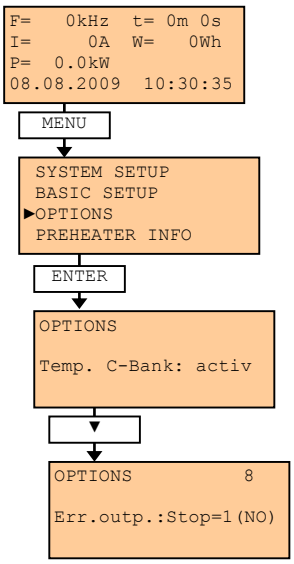
8.12 PC Communication

This menu includes functions for testing purposes only.

8.13 Options Setup

In this menu sensors or additional components can be enabled or disabled.

8.13.1 Error Output Polarity



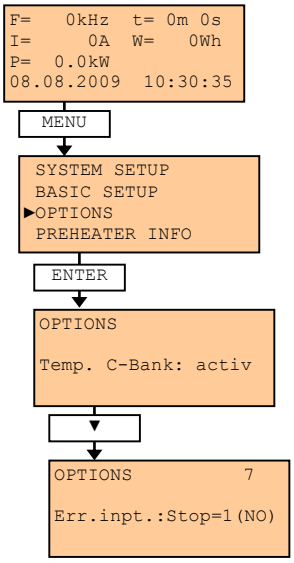
With this function, the error output signal can be inverted (see page 76 - Output: Error message (Relay No. 2)).

Stop= 1 (NO, closer, „normally open“):
When error occurs, relay closes.

Stop= 0 (NC, opener, “normally closed“):
When error occurs, relay opens.

Error output can be changed to a high or low output.

8.13.2 Error Input Polarity



With this function, the polarity of the error input can be inverted (see page 74 - Input: External Error).

Err.inpt.: 0= Stop (NC, opener, “normally closed“):
Error occurs when input is high.

Err.inpt.: 1= Stop (NO, closer, “normally open“):
Error occurs when input is low.

Error output can be changed to a high or low input.

8.13.3 Options setup parameter table

Parameter No.	Description
1-6	Internal temperature sensors configuration, can be “n.c.” (not connected), “NTC1” or “NTC2”
7	Error input configuration: can be NC (normally closed, standard) or NO (normally open)
8	Error output configuration: can be NC (normally closed, standard) or NO (normally open)
9	Phase voltage monitoring: enabled by default (“active”)
10	Error flow: additional flow switch monitor, setting project specific
11	UBatt: enabled by default, monitors battery (DC capacitor bank)
12	Error CHOP.: enabled by default: monitor of chopper driver error feedback
13	Error HBDRV: project specific, monitor can be set for local or external H-bridge driver monitoring
14	IN8 (P33): project specific error monitor for external device/ sensor
15-18	Optional temperature sensor inputs selection
19/20	Analog output 1/2: configuration for monitor value: 0) Inactive (no output for this channel) 1) “HB-U”: Output voltage (H-bridge-voltage) 2) “CH-I”: Output current (chopper current) 3) “HB-F”: Output frequency 4) “P-out”: Output power 5) “P-user”: Power set value 6) “Setpoint”: Power set value, can be calculated e.g. in temperature regulation mode 7) “Flow”: Actual cooling water flow 1 8) “Pyrometer”: Actual temperature measured by pyrometer/ external temperature sensor 9) “Temp HB”: Actual H-bridge heat sink temperature 10) “Temp coil”: Actual coil cooling water temperature (return) 11) “PWM-CH”: Actual PWM value (Chopper) 12) “Temp. error”: actual temperature error in temperature regulator task 13) “Analog 1 in”: Actual input @ analog 1 input 14) “Analog 2 in”: Actual input @ analog 2 input 15) “Bandspeed”: optional control output for conveyor speed
22	I/O state: status monitor sub-menu for commissioning/ troubleshooting I/O state 1/2 – inputs: display actual status of digital and analog inputs I/O state 3 – outputs: display actual state of digital/ relay outputs I/O state 4 – Profibus: display Profibus control bits/ parameters I/O state 5 – Profibus: display actual power reference setting I/O state 6 – Linespeed: display actual linespeed parameters I/O state 7 –Linetemp: display actual Linetemp parameters
23	Testmode: disabled by default, can be set for commissioning/ troubleshooting (run generator w/o direct mains power connected, mainswitch disabled)
24	Warning LED: selection for warnings indication: 1) OFF: no LED action in case warnings is present 2) RESET: in case warnings is activated red error LED (reset button) is flashing 3) MS: in case warnings is activated green MS LED (MS button) is flashing

Tabelle 18: Overview Options

8.14 Preheater Info

In this menu, general data about the generator and its manufacturer is displayed.

8.15 Communication Interface

8.15.1 Interface X2

Customer interface description. The exact port numbers are shown in the wiring diagrams. (See page 92 - Appendix 2: Electrical Circuit Diagrams)

Risk of coupling with extraneous noise.
Only use shielded cables!

Function Pin 1-16		
+24V DC Internal	+24V DC	1
Digital input DI1 [MS activation] *Depends on setup this state will achieved automatically or manually (See page 57 - MS Control)*	DI1	2
Digital input DI2 [HF activation]	DI2	3
Digital input DI3 [External reset]	DI3	4
Digital input DI4 [External error 1 / Disruption 1]	DI4	5
Relay output [MS feedback active] 24VDC / 500mA *Je nach Einstellung wird dieser Zustand automatisch oder Manuell erreicht.* *(Siehe **Fehler! Textmarke nicht definiert., Fehler! Verweisquelle konnte nicht gefunden werden.**)*	RO1	6
	RO1	7
Relay output [HF feedback active] 24VDC / 500mA	RO2	8
	RO2	9
Relay output [Internal error] 24VDC / 500mA	RO3	10
	RO3	11
Analog input AI1 / External reference-	AI1-	12
	AI1+	13
Analog output AO1 Ausgangsparameter kann im Menu “OPTIONS” eingestellt werden.	AO1-	14
	AO1+	15
Digital input GND/0VDC	DIGND	16

@ MF-Generator „TNX Compact“ Pin17-24

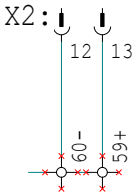
*Device specific		A	17
		B	18
		C	19
		D	20
		E	21
		F	22
Relay output [Internal warning]		RO4	23
		RO4	24

@ MF-Generator „TNX Standard“ & „TNX Industrie“ Pin 17-24

Digital Input DI6 [Error module]		DI6	17
Digital input DI5 [External error 2/disturbance 2]		DI5	18
Emergency stop contact 1 from generator		C	19
		D	20
Emergency stop contact 2 from generator		E	21
		F	22
Relay output [Internal warning]		RO4	23
		RO4	24

Chart 19: Client Communication

8.15.1.1 Input: Analog 1 (0-10VDC/ 0-20mA)



External Reference 1 Input

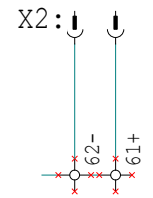
This input is used as a reference input for determining the output power.

It can be used as:
- Power Setpoint (0-100%)
- Line speed value (0-100%))
- Temperature value (° C)

The actual configuration is performed in the User Menu (See page 41).

This input is by default routed to the remote connector X2
(12 = 0-10V, 13 = 0V). Electrically isolated, internal resistance Ri> 20 kOhm.

8.15.1.2 Input: Analog 2 (0-10VDC/ 0-20mA)



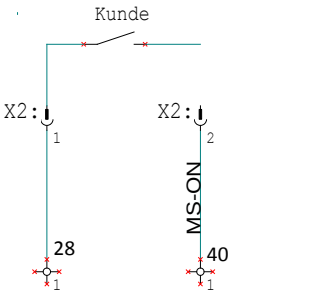
External Reference 2 Input

This input is available as a reserve for special customer requests.

Electrically isolated, internal resistance Ri> 20 kOhm.

It is used in the "Temp2" mode as temperature setpoint setting (° C).

8.15.1.3 Input: Activate main contactor (MS-ON) – DI1



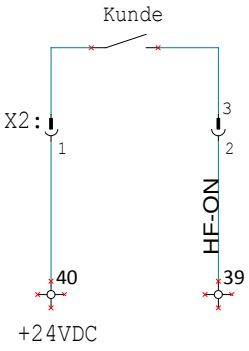
Turns on the power supply, if the controller to remote operation is set (See page 57 - MS Control).

It is a permanent contact. If the contact is closed, the power supply is turned on. When off, the contact is open.

This input is by default routed to the remote connector X2
(1 = 24VDC, 2 = switching signal).

Can also be used as a "ready signal".

8.15.1.4 Input: Activate High Frequency (HF-ON) – DI2



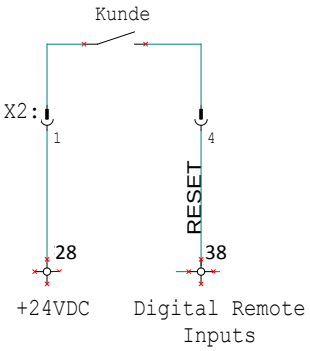
Turns on the high frequency, provided that the control on remote operation is set (See page 58 - HF Control (High Frequency)).

In continuous operation, it is a permanent contact. The contact is closed, the high frequency is turned on. When the contact is open it is off.

In pulsed operation, the high frequency is turned on at the rising edge of the signal.

This input is by default routed to the remote connector X2
(1 = 24VDC, 3 = switching signal).

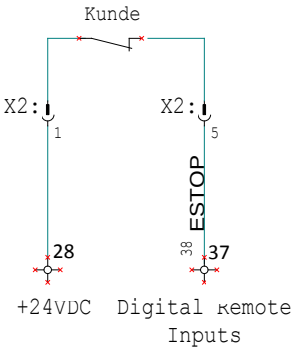
8.15.1.5 Input: Reset – DI3



Used to acknowledge a pending error message. The controller responds to the rising edge of the signal.

This input is by default routed to the remote connector X2
(1 = 24VDC, 4 = switching signal).

8.15.1.6 Input: External Error 1 – DI4 @ MF-Generator "Compact"

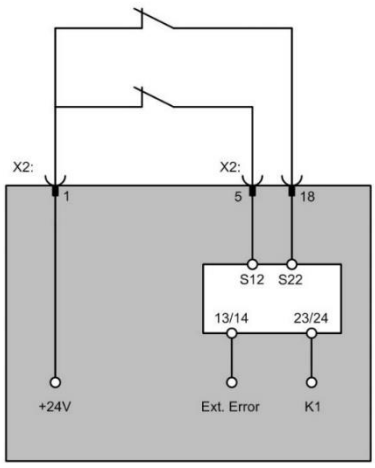


This signal is used as an external error. On opening, the high frequency and the power module are turned off.

This input is by default routed to the remote connector X2
(1 = 24VDC, 5 = switching signal).

The polarity of the input can be modified under "OPTIONS" (See page 69 - Error Input Polarity).

8.15.1.7 Input: External error 1+2 – DI4/DI5 @MF-Generator „Standard" & „Industrie"

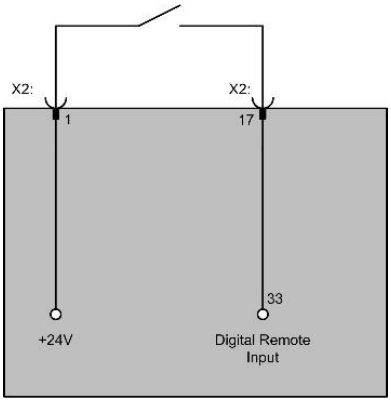


This signal is used as an external error and the wiring should be wired in double. (EN 14121-1)

On opening the high frequency and the power module are turned off and the system is in state of malfunction. -> Relay output [Error message]

Those inputs are by default routed to the remote connector X2.
(1=24VDC, 5=switching signal 1, 18=switching signal 2).

8.15.1.8 Input Error internal module – DI6 @MF-Generator „Standard“ & „Industrie“

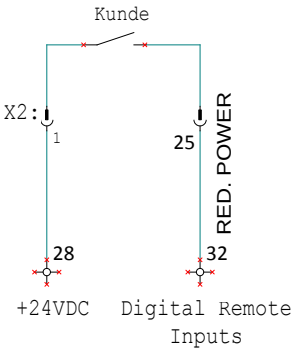


This signal is used as an internal module error such as cooling equipment, sensors, photoelectric sensors, drive units, etc.

The function of the input can be modified under “OPTIONS” as a warning or a fault.

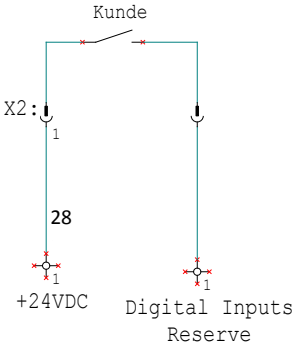
When the contact is close/open the system generate an error or a warning. (Depends on definition)

8.15.1.9 Input: Reduced Power (optional)



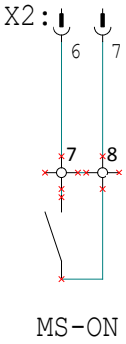
If the contact is closed, the power is reduced to the value in the menu item 'Red. Power' (See page 51 - Reduced Power).
(Terminal 32 on the motherboard / Terminal 25 on X2)

8.15.1.10 Input: Reserve



Depending on requirements, the digital inputs can be configured for special applications (optional).

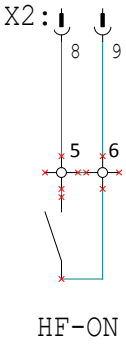
8.15.1.11 Output: MS activated



This contact is closed when the power supply is turned on. Once this feedback is active, the system is ready for heating or "HF On".

This input is by default routed to the remote connector X2
(6 & 7, potential-free relay contact).

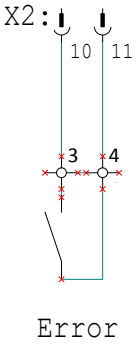
8.15.1.12 Output: HF activated



This contact is closed when HF is turned on.

This input is by default routed to the remote connector X2
(8 & 9, potential-free relay contact).

8.15.1.13 Output: Error message (Relay No. 2)

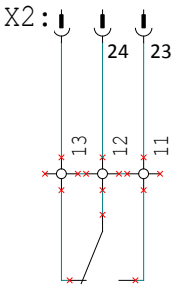


This contact is open when an error is present.

This output is normally through the X2 communications port.

The polarity of the relay (NC or NO) can be changed under "OPTIONS" (See page 68 - Error Output Polarity).

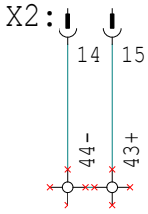
8.15.1.14 Output: Warning (optional) (Relay No. 6)



Reserve

Depending on the requirements, relay outputs can be configured for special applications. A warning is activated when an alarm threshold is exceeded / (eg T> (Tmax "T-diff-warning") or flow <Flowmin + "D-Flow Warning")

8.15.1.15 Output: Analog 1 (0-10VDC/ 0-20mA)

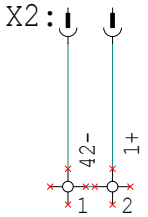


Analog Output 1

This output, according to the Options Setup (No. 19), adjusts parameters from a signal of 0-10VDC.
The signal is isolated.

This input is by default routed to the remote connector X2
(14 = 0 VDC, 15 = 0-10VDC, RLmin: 1kOhm (10mA max)..

8.15.1.16 Ausgang: Analog 2 (0-10VDC/ 0-20mA, optional)

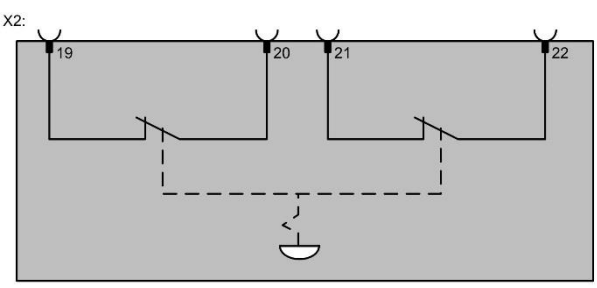


Analog Output 2

This output, according to the Options Setup (No. 20), adjusts parameters from a signal of 0-10VDC.

The signal is electrically isolated (RLmin: 1kOhm (10mA max).

8.15.1.17 Output Emergency stop contact 1+2 – C/D & E/F @MF-Generator „Standard“ & „Industrie“



The emergency stop contact of the system is activated when someone bush the emergency stop button on the unit.
In this case, both normally closed contacts are active and there is an emergency shout down of the system. Thereby the complete power part would be disconnected from the mains.

The 2 channel controlled floating contacts can pick up at custom interface X2 between pins 19&20 and 21&22.

8.15.2 Profibus (Optional)

The system can be specifically designed (upon wish) with a Profibus system. The Profibus connection is located on the rear of the system.

For details please refer to the separate Profibus Interface Manual on page 92 (Appendix 6: Accessories).

The exact port numbers are shown in the wiring diagrams. (See page 92 - Appendix 2: Electrical Circuit Diagrams)

8.15.3 Serial Communications Port (Optional)

The system has a serial interface port (RS232 / RS422) which can be adapted for any desire. Further it can be used for communication with external components (pyrometer, TNX monitor, etc.).

For details, refer to the description on page 92 (Appendix 6: Accessories).

The exact port numbers are shown in the wiring diagrams.
(See page 92 - Appendix 2: Electrical Circuit Diagrams)

9 Accessories / Variants

Who should read this section?	This section is aimed at all persons who plan and entertain induction heating equipment with the help of this manual and write manuals.
Content of this section	-List of accessories

Plustherm systems can, upon wish, be equipped with almost every periphery. For example:

	Cooling units for the independent operation of 1-160kW cooling capacity.
	Pyrometer with variations for all materials and temperature ranges from 0-2000 ° C.
	Connection to field bus systems such as Profibus or Profinet.
	Additional visualization with Tablets / panels or recording of operating data for quality assurance.
	Matching transformers for impedance matching specific to the application. Up to 1000kVA.

Chart 20: Excerpt List of accessories

Details on the accessories available for order can be seen on page 92 (Appendix 6: Accessories).

Details for installation and configuration of the peripheral components are on page 92 (Appendix 1: System overview, Specifications, Test report, Software-defaults).

10 Schematic Diagrams

Who should read this section?	This section is aimed at all persons who plan and maintain an induction heating system with the help of this manual.
Content of this section	- Electrical drawings - Mechanical drawings - Cooling circuits

10.1 Electrical Drawings

The electrical drawings are project-based and visible on page 92 - Appendix 2: Electrical Circuit Diagrams.

10.2 Mechanical Drawings

The electrical drawings are project-based and visible on page 92 - Appendix 3: Mechanical Drawings

10.3 Cooling Circuit

Cooling of the power-carrying components in the generator is normally carried out with fresh water from mains. The water must meet the conditions listed in the specifications, in the other case, a closed circuit with the given conditions matched rear cooling should be provided.

It is important to ensure that the water inlet is not too low, otherwise condensation in the generator may occur.
The cooling circuits are both temperature and through-flow monitored.

Cooling system specifications can be seen on page 15 - Cooling.
Technical drawings can be seen on page 92 - Appendix 4: Cooling Circuit.

10.4 List of spare parts

The mechanical and electrical spare parts lists can be seen directly in the corresponding schematics.

-Page 92 -> Appendix 2: Electrical Circuit Diagrams
-Page 92 -> Appendix 3: Mechanical Drawings
-Page 92 -> Appendix 4: Cooling Circuit

A project-specific spare parts list is on page 92 - Appendix 7: Troubleshooting & Spare Parts List.

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11 Test Report

Who should read this section?	This section is aimed at all persons who take the help of this manual induction heating system is in operation and entertained.
Content of this section	- Plustherm Test Report - Acceptance Certificate

All test reports and inspection logs are located on page 92 - Appendix 1: System overview, Specifications, Test report, Software-defaults.

12 Software Parameters

Who should read this section?	This section is aimed at all persons who take the help of this manual induction heating system is in operation and maintain.
Content of this section	-Software parameters

All software parameter information is located on page 92 - Appendix 1: System overview, Specifications, Test report, Software-defaults.

13 Maintenance

Who should read this section?	This section is aimed at all persons who entertain induction heating system with the help of this manual and write manuals.
Content of this section	- System cleaning - General maintenance - Cleaning schedule

13.1 Cleaning

If irregularities apear in the mechanical working components, or if unusual noises occur, the system must be switched off immediately. The generator itself is maintenance free by design. However, strict attention must be paid to the following:

Dirty inductor terminals ask for trouble! Keep connection heads clean. From time to time check that all screws are securely tightened.

Depending on the work environment, exhaust fan filters must be cleaned regularly.

13.2 Maintenance

To ensure trouble-free operation, scheduled maintenance must be performed. This maintenance includes the cleaning and oversight for the electrical and mechanical components. It is most important to keep the machine clean and free of debris.

A vacuum cleaner is best used to remove as much debris as possible. This prevents a short circuit hazard.

Suitable measures must be taken in case of lime, calcium, and/or accumulation of dirt in the cooling system.

For maintenance and cleaning principles:
-Voltages existing within the generator are lethal.
-Ensure the generator is completely discharged of all voltages before performing any maintenance duties.

13.3 Maintenance Duties

Component	Task	Period
Coil	Visual check the following points require special attention: - Discoloration of components due to overheating - Water leaks - Loose parts or connections	Monthly
Bus-bars	Visual check the following points require special attention: - Discoloration of components due to overheating - Water leaks - Loose parts or connections	Monthly
Cooling system	Visual check the following points require special attention: - Discoloration of components due to overheating - Water leaks - Loose parts or connections Control of water treatment plant (separate manual) Check the transparent water pipes on deposits of lime or dirt Check the flow switch: interrupt water flow, Flow Error trigger must Refrigeration equipment must be checked by an expert for leaks.	Monthly Yearly
Chassis	-Visual check -Discharge with compressed air	Monthly
Control	-Visual check of the control panels -Discharge with compressed air	Monthly
C-Bank	Visual check of the capacitors (A slight leakage of oil on the bottom side is normal)	Monthly
Emergency Off	Functionality test	3 Months
Auxiliary switch off	Test the external shutdown (via the interface)	3 Months

Tabelle 21: Maintenance schedule

13.4 Wear parts

Fans:
The life of the fans used for cooling the power components depends on the operating and environmental conditions (temperature, dust).

Capacitors:
Inside the unit there are DC electrolytic capacitors which lose the effect by increasingly wear.
The life time depends on work capacity and ambient/case temperature.

Back-up battery internal storage:
The life time depends on downtime of the system. The longer the unit stays without mains, the sooner the back-up battery for the internal storage has to be changed.
See page 91 (Chapter 14.3.3.3, User data corrupt)

Risks:
- Overheating due to fan fails.
- Capacitor overheating, if prolonged over time, could cause a sudden breakdown with fumes and noise disturbance, and could also damage other parts of the unit.
- Higher total expenditure than with normal preventive replacement, due to having to restore the system to working order (cost of changing capacitors + cost of repairing other damaged parts).
- Financial loss due to unscheduled machine downtime.

When a replacement is recommended?
The preventive replacement is recommended by the following years of operation:*

Fan -> 4 Years
DC capacitor -> 5 Years
Back-up battery -> 10 Years

Fans and capacitors must be replaced by qualified personnel only. Only PLUSTHERM personnel are authorized to make recommendations for any replacement parts.

** based on operation of the unit within the manufacturer's specification. Capacitor & Fan lifespan is subject to change if environmental conditions (premises, usage or load type) are abnormal or harsh for the equipment.*

14 Error Diagnostics

Who should read this section?	This section is aimed at all persons who entertain induction heating equipment with the help of this manual and write manuals.
Content of this section	- List of instruments for troubleshooting

14.1 Plustherm Test Equipment

For efficient troubleshooting, we recommend the procurement of suitable testing equipment. We recommend the following products which are available on our web-shop.

www.induction-heating-shop.com

	**Multi-meter** Multi-meter with RMS-Measuring and insulation test up to 1000V. This multi-meter is required for fast and efficient troubleshooting. Art.Nr. X101373
	**Oscilloscope** The oscilloscope is required in order to diagnose faults that occur during operation. It is often necessary to measure very fine signals and/or voltages up to 1000V. Art.Nr. X100227
	**LC-Measuring device** The LC meter is required to configure the HF generator's components efficiently and precisely. Art. Nr. X100334

	**Programming adapter Altera** This programming tool is required to perform a software update. It can be connected to any computer with Win7 and USB interface. Art. Nr. X100337
	**Programming Cygnal adapter** This programming tool is required to perform a software update. It can be connected to any computer with Win7 and USB interface. Art. Nr. X100335

Chart 22: Measuring instruments for troubleshooting

14.2 List of Spare Parts

The mechanical and electrical spare parts lists can be seen in the following locations:

-Page 92 -> Appendix 1: System overview, Specifications, Test report, Software-defaults
-Page 92 -> Appendix 2: Electrical Circuit Diagrams
-Page 92 -> Appendix 3: Mechanical Drawings
-Page 92 -> Appendix 4: Cooling Circuit

A project-specific spare parts list can be seen on page 92.

14.3 Error Messages /Warnings

14.3.1 Warnings

If the LED on the reset button is blinking, then the system operates in a critical condition. The system is still fully functional. It should serve as an indication for the operator to do something about the warning.

The limits for the appearance of the warning can be disabled. (See page61 - Warning (Optional))

Warning List:

Warning	Cause	Solution
Flow coil	Flow through the coil must be increased or water lines are clogged.	- Higher differential pressure - Enlarge hose cross-section
T coil	Too hot / cold water in the supply line or lines in the inductor are clogged.	- Increase flow - Reduce the cooling water temperature
Power lim. AMPS	Reaches current limit of the device. Adjustment is not correct.	- Increase distance between coil and work-piece. - Resonant circuit capacitors: Reduce capacitance. - Use better adapted inductor
Power lim. VOLT	Reached voltage limit of the device. Adjustment is not correct.	- Increase distance between coil and work-piece - Resonant circuit capacitors: Reduce capacitance. - Use better adapted inductor
Power lim. PWM	Reached pulse width limits of the device. Adjustment is not correct.	- Increase distance between coil and work-piece - Resonant circuit capacitors: Reduce capacitance. - Use better adapted inductor
Power lim. USER-MAX	Reached user-specified power max.	- Increase limits - Better adjustment
Power lim. R>RMAX	Impedance monitoring has responded. Possibly adjust limits.	- Increase limits - Better adjustment - Increase distance between coil and work-piece - Resonant circuit capacitors: Reduce capacitance. - Use better adapted inductor

Tabelle 23: Overview Warning messages

14.3.2 General Errors

```
FAULT        (2)*
Output overcurrent
```

* Error number, the errors are binary coded (displayed in decimal), with multiple errors at the same time the total value (sum decimal) is displayed.

14.3.2.1 List of Errors

No.	Error message on display	Description	Solution
1	"E-Stop remote"	External emergency stop	Find interruption in emergency-chain.
2	"Output overcurrent"	Detects overvoltage	Check inductor for short circuit, clean inductor.
3	"Output overvoltage",	Detects overvoltage	Check inductor / leads to bad connections. Possibly open connection.
4	"Frequency abnormal"	Frequency out of the normal range	Inductor and capacitors control number according to test report.
5	"One phase missing"	Phase error (400V supply)	Check the fuses on the transformer and line voltage.
6	"Battery voltage low"	Low voltage capacitor bank	Check all 3 mains voltage, check fuses.
7	"CH-Driver fault"	Chopper-Driver-Error	Check fuse and connection cable drivers on the chopper board.
8	"HB-driver #1 fault"	HB- Driver stage # 1 error	Check the operating frequency. If the error cannot be reset, the driver must be checked.
9	"HB-Driver #2 fault"	HB- Driver stage # 2 error	Check the operating frequency. If the error cannot be reset, the driver must be checked.
10	"HB-Driver #3 fault"	HB- Driver stage # 3 error	Check the operating frequency. If the error cannot be reset, the driver must be checked.
11	"HB-Driver #4 fault"	HB- Driver stage # 4 error	Check the operating frequency. If the error cannot be reset, the driver must be checked.
12	"+15V supply failure"	Supply voltage error (Mainboard)	Turn off machine and contact Plustherm.
13	"-15V supply failure"	Supply voltage error (Mainboard)	Turn off machine and contact Plustherm.
14	"+5VA supply failure"	Supply voltage error (Mainboard)	Turn off machine and contact Plustherm.
15	"-5VA supply failure"	Supply voltage error (Mainboard)	Turn off machine and contact Plustherm.
16	"Overtemp Chopper "	T1- overtemperature (optional)	Increase flow, clogged lines -> clean.
17	"Overtemp HBridge"	T2- overtemperature	Increase flow, clogged lines -> clean.
18	"Overtemp H2O int. "	T3- overtemperature (optional)	Increase flow, clogged lines -> clean.
19	"Overtemp Busbar "	T4- overtemperature (optional)	Increase flow, clogged lines -> clean.

20	"Overtemp Coil"	T5- overtemperature	Increase flow, clogged lines -> clean.
21	"Overtemp C-Bank"	T6- overtemperature (optional)	Increase flow, clogged lines -> clean.
22	--- (optional temp 7)	T7- overtemperature (optional)	Increase flow, clogged lines -> clean.
23	--- (optional temp 8)	T8- overtemperature (optional)	Increase flow, clogged lines -> clean.
24	--- (optional temp 9)	T9- overtemperature (optional)	Increase flow, clogged lines -> clean.
25	--- (optional temp 10)	T10- overtemperature (optional)	Increase flow, clogged lines -> clean.
26	"No water coil"	Cooling water flow 1 is too low	Increase flow, clogged lines -> clean.
27	"No water int"	Cooling water flow 2 is too low	Increase flow, clogged lines -> clean.
28	--- (optional flow 3)	Cooling water flow 3 is too low	Increase flow, clogged lines -> clean.
29	--- (optional flow 4)	Cooling water flow 4 is too low	Increase flow, clogged lines -> clean.
30	THS too low (Twater)	Diff. Temperature environment / point number too large (optional)	Increase water temperature.
31	Powerlimit reached	Warning that system runs in limitation (optional)	Turn off machine and contact Plustherm.
32	"Profibus conn. lost"	Profibus connection timeout (1s)	Check connectors, re-establish connection. Check cables from chassis to motherboard.
33	Water leakage (optional)	Water leak detected.	Water damage in the device.

Tabelle 24: Overview error messages

If it is not possible to clear the fault please contact Plustherm.

14.3.3 Special Errors

14.3.3.1 Not Connected

```
Plustherm Point GmbH
  www.plustherm.ch
    Version  1.2
   NOT  CONNECTED
```

This message appears briefly when first switching on the generator. The controller attempts to synchronize with the generator. During this time, the message “NOT CONNECTED “ appears. Once synchronization is complete this message will disappear.

14.3.3.2 Setup Data Corrupt

```
Setup data corrupt
  Defaults loaded
Push RESET to cont.
```

In this case, user data has been lost. The basic settings are applied by pressing the reset button.
Should this error message re-appear, try replacing the backup battery (normal service life is 10 years).

14.3.3.3 User data corrupt

```
  User data corrupt
   Defaults loaded
Push RESET to cont.
```

In this case, user data is lost. The basic settings are applied by pressing the reset button.
Should this error message re-appear, try replacing the backup battery (normal service life is 10 years).

	**Bat-Fix** The control of TNX-generator has a RAM battery for data retention and clock-time buffering in case of power interruption / disconnection from the main power supply. The battery has a limited life which naturally decreases with time. To prevent data loss during battery replacement, there is the Bat-Fix tool available in our spare parts inventory. Art.Nr. X101384

15 Appendix

15.1 Appendix 1: System overview, Specifications, Test report, Software-defaults

-System overview
-Specifications
-Test rapport
-Acceptance protocol
-Software Default Settings
-USER-Password

15.2 Appendix 2: Electrical Circuit Diagrams

-Electrical circuit diagrams
-Object list

15.3 Appendix 3: Mechanical Drawings

-Mechanical circuit diagrams
-Object list

15.4 Appendix 4: Cooling Circuit

-Schematic diagrams
-Object list

15.5 Appendix 5: Device Details, Photos

Pictures say more than words. Critical remarks are explained and enhanced with photos in this appendix.

15.6 Appendix 6: Accessories

Documentation of peripheral components.

15.7 Appendix 7: Troubleshooting & Spare Parts List

-Troubleshooting instructions
-Spare parts list