Operator's manual

TruPlasma RF 1001 to 1003 (G2/13)

Technical specifications and operator's manual

TRUMPF

Operator's manual

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Technical specifications and operator's manual

Original operator's manual

Edition **2017-06-26**

Order Information

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For "partly completed machinery" in accordance with the EC Machinery Directive, this document corresponds to the assembly instructions.

Before you proceed ...

Need help?

Provide the **serial number** when you contact the Service department. The serial number can be found on the name plate of the device.

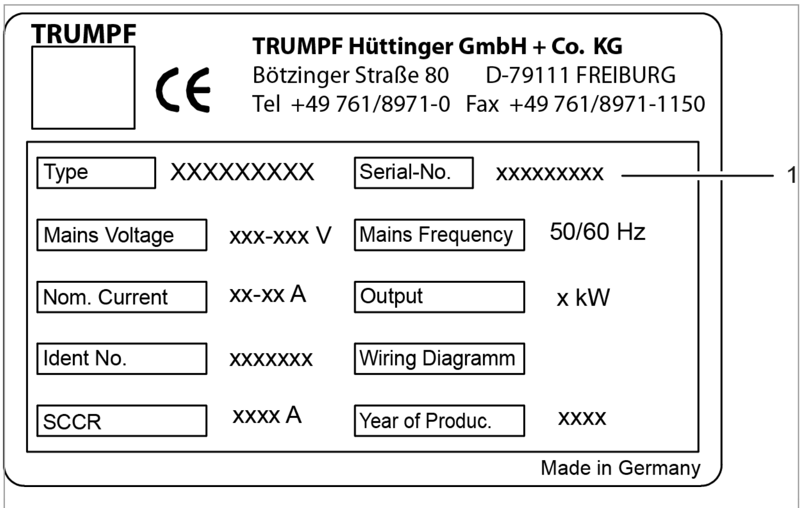
How to reach our Service department:

Telephone **+49 761 8971-2170**

Fax **+49 761 8971-1178**

E-mail **Service.Elektronik@de.trumpf.com**

Position of the serial number



1 Serial number

Name plate of the generator Fig. 10520

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Chapter 1

Safety

1. Safety

1.1 For your own safety

This chapter points out measures for avoiding potential dangers. The overview of residual dangers includes measures the operator is to take to reduce residual dangers.

Note

The operator must comply with the valid safety and accident-prevention laws of the delivery country and of the local government!

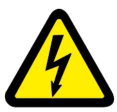
1.2 Warning signs and danger signs

Certain activities can cause danger during operation. Corresponding warning signs concerning the dangers should precede instructions concerning the activities. Danger signs are located on the generator.

A warning sign contains signal words which are explained in the following table:

Signal word	Description
DANGER	Indicates a major danger. If it is not avoided, serious injuries or death will result.
WARNING	Indicates a dangerous situation. If it is not avoided, it may lead to serious injuries.
CAUTION	Indicates a potentially dangerous situation. If it is not avoided, injuries may occur.
NOTICE	If such a situation is ignored, material damage may result.

Description of the signal words Tab. 1-1

Symbol	Description
	Warning: Risk of electric shock.
	Warning: Non-ionizing electromagnetic radiation.

Symbol	Description
	Warning: Read operating instructions prior to use.

Description of the symbols Tab. 1-2

2. Using the generator

Typical fields of application

The generator was conceived as an energy source for plasma excitation.

Typical fields of application are:

- Plasma-activated CVD processes (PECVD).
- Reactive ion etching (RIE).
- Sputter-etching (SE).
- Magnetron sputtering (PVD).
- Photoresist ashing
- Etch: silicon, dielectric, metal and strip
- Deposition: PECVD; PVD HDP-CVD. PEALD

Liability exclusion

Any use not listed under "Typical fields of application" contravenes the intended purpose. TRUMPF is not liable for any ensuing damages, in particular for property damage, personal injury and loss of production. The operator bears all risks. The warranty is rendered null and void.

Impermissible uses

Impermissible uses include, for example:

- For medical purposes.
- For radio communication purposes.
- In environments where a danger of explosion exists.
- Above protection type IP 40.

3. Authorized personnel

Installation, operation, configuration and maintenance work may only be performed by authorized, trained and instructed personnel.

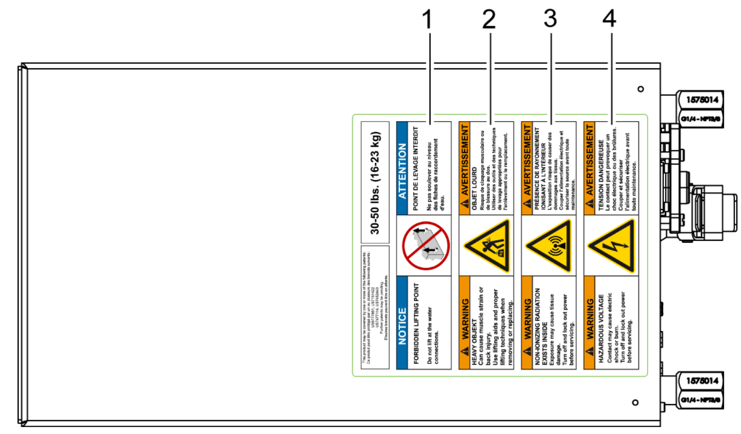
Authorized persons must be capable of understanding their tasks and recognizing potential dangers. Therefore, authorized persons must be trained and be familiar with the standards and regulations relevant to their tasks.

It is the duty and responsibility of the operator to maintain the qualifications of the authorized personnel. The authorized personnel must therefore be trained at regular intervals.

The following activities may only be performed by authorized persons:

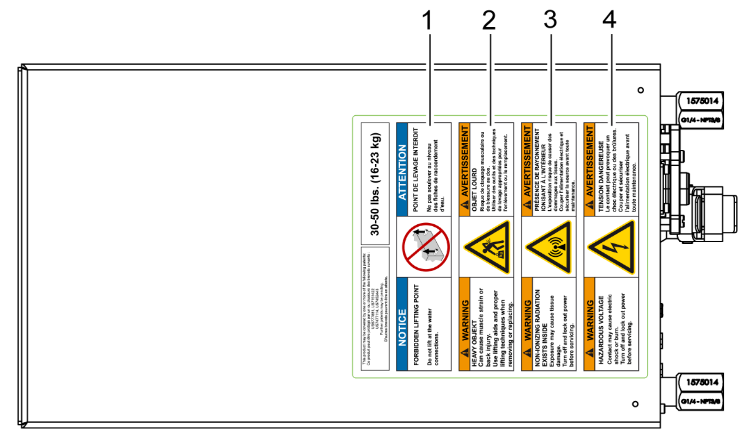
- Setting up the generator.
- Connecting the generator.
- Dismantling the generator.
- Operating the generator.

4. Warning signs on the generator



1	Not a lifting point	3	Electromagnetic fields
2	Weight	4	Dangerous voltage

Warning signs on the generator Fig. 10581



1	Pas de point de levage	3	Champs électromagnétiques
2	Poids	4	Tension dangereuse

Avertissements sur le générateur Fig. 10581

5. What you must know as an operator

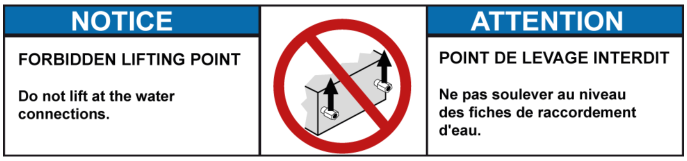
All warning signs must be present and legible.

If one or more of these warning signs is missing or not legible, contact TRUMPF to request new warning signs.

Ce que vous devez savoir en tant qu'exploitant

Tous les panneaux d'avertissement doivent être présents et lisibles.

Si un ou plusieurs panneaux d'avertissement manque ou n'est pas lisible, adressez-vous à TRUMPF pour en demander de nouveaux.

Warning sign Panneau d'avertissement	Meaning signification
	Sign warns against improper lifting (see "Hazard from weight", pg. 1-12). Panneau d'avertissement de soulèvement non conforme.
	Sign warns of hazardous voltage (see "Dangers from high voltages", pg. 1-9). Panneau d'avertissement de tension dangereuse.
	This sign warns of dangers that arise from the weight of the generator (see "Hazard from weight", pg. 1-12). Panneau d'avertissement de danger pouvant survenir en raison du poids du générateur..
	Sign warns of electromagnetic fields (see "Dangers from electromagnetic fields", pg. 1-10). Panneau d'avertissement de champs électromagnétiques.

Meaning of the warning signs
Signification des panneaux d'avertissement
Tab. 1-3

6. Dangers from high voltages

DANGER

Life threatening voltage!

The voltages present at the generator are life-threatening.

➢ Only have work on the generator performed by trained personnel.

The generator produces voltages that can endanger human life and health. These voltages are present both inside the generator and at the power output of the generator.

The lines for the generator's voltage supply carry voltages that are life-threatening.

A person who comes into contact with live generator parts may be killed or severely injured.

Dangers liés à la tension électrique

DANGER

Risque d'électrocution !

Les tensions présentes sur le générateur peuvent être mortelles !

➢ Seul un personnel formé est habilité à effectuer des travaux sur le générateur.

Le générateur produit des tensions qui peuvent représenter un risque pour la vie ou la santé des personnes. Ces tensions surviennent non seulement dans le générateur, mais aussi à la sortie de puissance du générateur.

Les câbles d'alimentation en tension du générateur véhiculent également des tensions mortelles.

Une personne entrant en contact avec les parties sous tension du générateur risque de mourir ou de souffrir de graves blessures.

6.1 Protective measures taken by the manufacturer

The generator is installed in an enclosed metal casing.

Mesures de protection du fabricant

Le générateur est intégré dans un boîtier métallique fermé.

7. Dangers from electromagnetic fields

⚠ DANGER

Danger due to electromagnetic fields!

Potentially harmful high-frequency electromagnetic fields occur close to the generator.

- Only have work on the generator performed by trained personnel.

Electromagnetic fields are present both inside the generator and at the power output of the generator.

Electromagnetic fields can interfere with the environment. For example, strong electromagnetic fields can have an effect on electrical devices (e.g., pacemakers or other electronic aids in the human body).

Implants used in the human body could be damaged through heating.

Dangers liés aux champs électromagnétiques

⚠ DANGER

Danger lié aux champs électromagnétiques !

Des champs électromagnétiques de haute fréquence et dangereux pour la santé surviennent dans le secteur du générateur.

- Seul un personnel formé est habilité à effectuer des travaux sur le générateur.

Des champs électromagnétiques surviennent non seulement dans le générateur, mais aussi à la sortie de puissance du générateur.

Les champs électromagnétiques peuvent avoir des effets gênants pour l'environnement. Des champs électromagnétiques puissants peuvent ainsi influer sur les appareils électriques, p. ex. les stimulateurs cardiaques ou autres appareils électroniques dans le corps humain.

Les implants à l'intérieur d'un corps humain risquent d'être endommagés par l'échauffement.

7.1 Protective measures taken by the manufacturer

The generator is installed in an enclosed metal casing.

However, this measure cannot prevent strong electromagnetic fields from occurring on the load side, e.g. at the plasma chamber.

The effective mitigation of this danger is the responsibility of the operator, i.e., **yours**.

Mesures de protection du fabricant

Le générateur est intégré dans un boîtier métallique fermé.

Toutefois, cette mesure n'empêche pas l'apparition de champs magnétiques élevés du côté de la charge, p. ex. dans la chambre à plasma. La responsabilité d'une limitation efficace de ce danger incombe à l'exploitant, c'est-à-dire **à vous-même**.

8. Hazard from weight

CAUTION

The generator may cause injuries if carried!

- Do not carry or lift the generator **alone**.

Always use a transport aid for carrying and lifting the generator.

Components on the rear side of the generator, e.g., water connections, must not be used as lifting points.

Porter et soulever

ATTENTION

Le fait de porter le générateur risque de générer des blessures !

- Ne **pas** porter ni soulever le générateur seul.

Utilisez toujours un outil d'aide au transport pour porter et soulever le générateur.

Les composants situés au dos du générateur, p. ex. les raccordements d'eau, ne doivent pas être utilisés comme point de levage.

9. Hazard from aggressive cooling water

WARNING

Cooling water is aggressive

Injuries to skin and eyes are possible.

- Avoid direct skin contact with cooling water and cooling water additives.
- Wear protective gloves and safety glasses when working with cooling water and cooling water additives.

Easy-Kits

Observe all of the safety specifications included in the material safety data sheets (MSDS) of the manufacturer of the cooling water additives. The emergency telephone number is listed under Item 16. The safety data sheets can be found on the CD which is enclosed with the cooling water additives. (see "Overview of cooling water additives", pg. 6-19)

Danger lié à l'eau de refroidissement agressive

AVERTISSEMENT

Eau de refroidissement agressive

Risque de blessures de la peau et des yeux

- Éviter tout contact direct de la peau avec l'eau de refroidissement et les additifs d'eau de refroidissement.
- Lors de la manipulation de l'eau de refroidissement et des additifs d'eau de refroidissement, porter des gants de protection et des lunettes de protection.

Respecter toutes les consignes de sécurité des fiches de données de sécurité (MSDS - Material safety data sheet) du fabricant des additifs d'eau de refroidissement. Le numéro d'appel d'urgence y est fourni à la section 16. Les fiches de données de sécurité se trouvent sur le CD fourni avec les additifs d'eau de refroidissement.

10. What you must note as an operator:

10.1 Ensuring safe operation of the generator

1. Only operate the generator within the conditions described in chapter "Technical specifications".
2. The generator must not be opened.
3. Only operating personnel **without** pacemaker or implants may work in the operational site.
4. Use only fault-free RF cables to connect the RF output.
5. RF cables must be properly connected on both ends.
6. Shielding must be grounded on both ends.
7. The generator housing must be grounded.
8. Within the generator, there is double / reinforced insulation between the control interfaces and the circuits that are dangerous to touch.
   Only equipment that satisfies the same insulation requirements may be connected to the control interfaces.

10.2 Safety inspection in accordance with IEC 61010-1

A safety inspection in accordance with IEC 61010-1 was performed on this TRUMPF device.

Performing a high-voltage test of the customer system

1. Disconnect all electrical connections to the TRUMPF device.
2. Perform high-voltage test.

11. Emergency measures

11.1 In the event of an emergency, immediately take the following measures

1. Switch off external mains separation device of the generator.
2. Shut off the cooling water supply for the generator.

Chapter 2

Description

1. Fields of application

1.1 Typical fields of application

The generator is designed as a power supply for plasma excitation.

Typical fields of application are:

- Plasma-activated CVD processes (PECVD).
- Reactive ion etching (RIE).
- Sputter-etching (SE).
- Magnetron sputtering (PVD).
- Photoresist ashing
- Etch: silicon, dielectric, metal and strip
- Deposition: PECVD; PVD HDP-CVD. PEALD

2. Property rights

The generator is protected by the following patents:

- US6777881
- JP3641785
- DE10257147
- DE10262286
- US7477114
- US7151422

Further patents are pending.

3. Function description

The generator delivers an adjustable RF output power at a frequency of 13.56 MHz to a 50 Ω load.
If a matchbox from TRUMPF is connected to the generator, the matchbox can be controlled from the generator.

The output frequency can be changed in the range of 13.56 MHz ±5%. The power can be set in steps of 1 W.

The generator must be supplied with cooling water to cool the power components (copper circuit).

Operation modes

- Continuous operation.
- Pulse mode:

  Setting the pulse frequency: internal or external.

  The generator has a pulse output, which can feed into the pulse input of an additional generator.
- Common-wave operation:

  Frequency at RF output is phase-coupled to the signal at the clock input.
- Operation with phase shift:

  Frequency at the RF output is phase-shifted to the signal at the clock input.

  The generator has a clock output with a 13.56 MHz signal which can feed into the clock input of an additional generator. As a result, multiple generators can operate in common-wave operation.
- Frequency agility (optional):

  In this operation mode, the frequency is automatically set so that optimum load matching is achieved.
- Operation with arc management (optional).

Regulation parameters

For controlling the output power, the following regulation parameters can be selected:

- Forward power P_i.
- Load power P_L.
- Reflected power P_r.

3.1 Operation options

- The generator can be operated using the **TruControl Power** operating software. For this purpose, a computer must be connected via one of the following interfaces:
- Digital data communication with a system controller via:
  - RS-232/RS-485 interface (ASIP protocol)
  - Profibus (optional).
  - EtherCAT (optional).
  - DeviceNet (optional).
- Analog/digital data communication via:
  - AD interface.

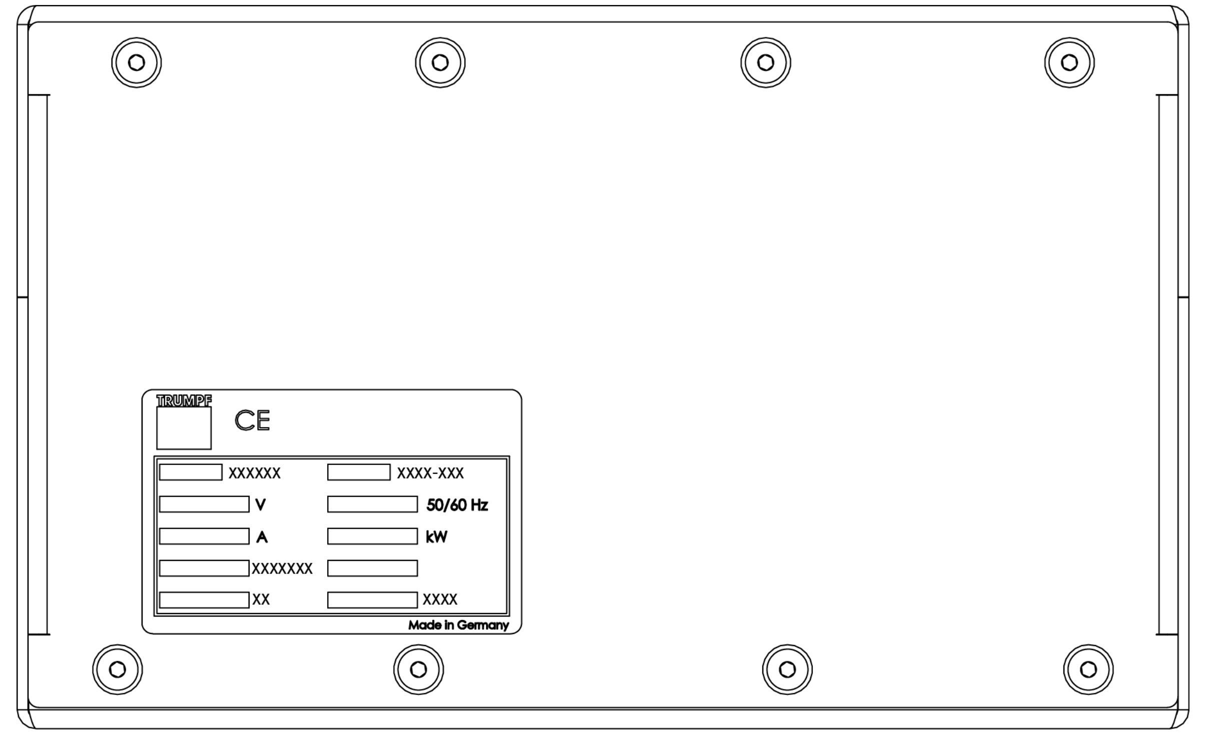
3.2 Interlock

The generator is equipped with an interlock circuit (control current circuit) that switches off the output voltage as soon as at least one contact of the circuit is open.

The interlock satisfies no safety requirements.

4. Construction of the generator

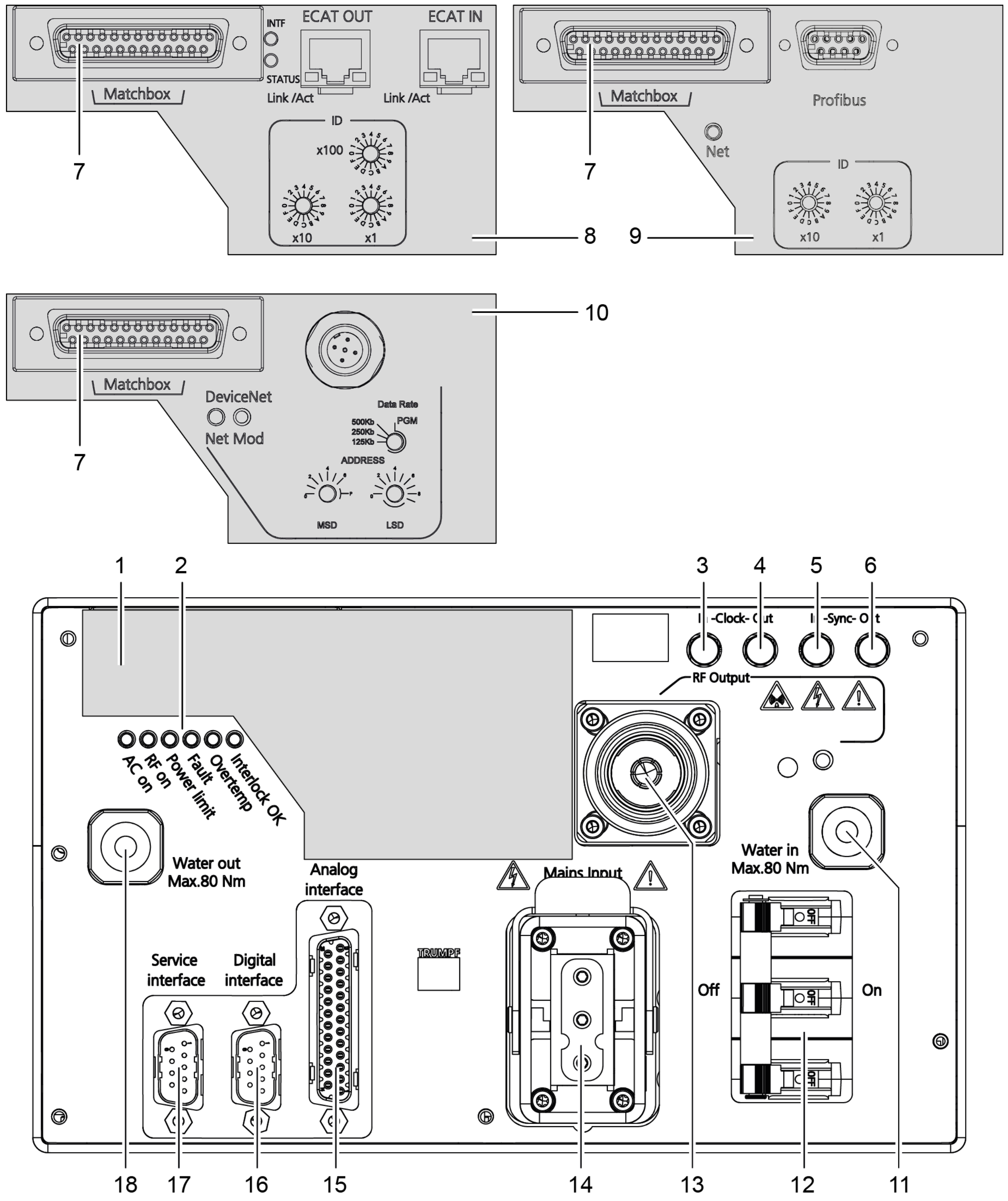
4.1 Front



Front Fig. 10344

4.2 Rear side

The generator is built into a closed metal housing. All connection elements, indicator elements and operating elements are located on the rear side.



1 Interface variants

2 LEDs Generator status

3 Clock input

4 Clock output

5 Sync/pulse input

6 Sync/pulse output

7 Matchbox connection (System-Port) (optional)

8 EtherCAT variant

9 Profibus variant

10 DeviceNet variant

11 Cooling water inflow

12 Protection switch

13 RF output

14 Mains connection

15 AD interface

16 Digital interface (RS-232/ RS-485)

17 Service interface

18 Cooling water outflow

Rear side

Fig. 10656

5. Device variants, options, accessories

5.1 Device variants

Device name	Nominal power	Supply voltage
TruPlasma RF 1001	1 kW	200 to 480 V
TruPlasma RF 1002	2 kW	200 to 480 V
TruPlasma RF 1003	3 kW	200 to 480 V

Device variants Tab. 2-1

5.2 Options

Device name	Options
Functions	▪ Arc management. ▪ Frequency agility.
RF output	▪ HN female connector. ▪ 7/16 socket.
Communication interfaces	▪ Profibus. ▪ EtherCAT. ▪ DeviceNet. ▪ Matchbox.
Adapter for cooling water connection (internal thread G 1/4")	▪ Parker NSS 3/8" socket and plug. ▪ Swagelok Tube Fitting 1/2". ▪ Swagelok Tube Fitting 3/8". ▪ Swagelok QC8 socket and plug.

Options Tab. 2-2

5.3 Accessories

- RF cable
- Cooling water connection:
  - Screw-in quick connector for ∅ 10 mm tube.
  - Screw-in adapter to NPT 3/8".
  - Plug-in adapter to NPT 3/8".
  - Adapter G1/4"-G3/8" VA with O-ring.

- Mains connector coupling:
  - Harting HAN C (40 A) suitable for Harting HAN Q7, 3 strands for phase and 1 strand for protective earth.
- Interface cable:
  - Null modem cable for connecting a computer or a process control system to the RS-232/RS-485 interface.
  - SystemPort cable for connecting a matchbox from TRUMPF.

Please contact TRUMPF to obtain more detailed information on the accessories.

6. Identifying the generator features

"Variant-configured" generators only:
to identify all present generator features, a 25-character "configuration word" is stored in the generator. Each code of the configuration word represents a generator feature.

Displaying the configuration word

Displaying the configuration word with TruControl Power:

- >*Diagnostics* >"Identification"

Structure of the configuration word (example):

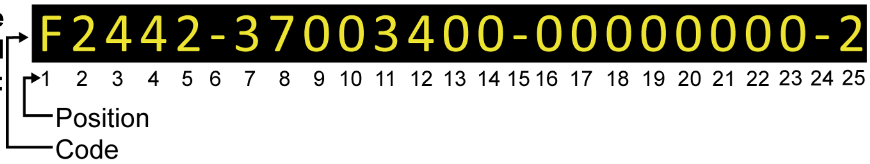


Fig. 10549

Codes of the configuration word

Position	Code	Feature	Feature group
1	A	TruPlasma RF 1000/3000 Series	Product family
2 to 3	01	1 kW	Output power
	02	2 kW	
	03	3 kW	
	06	6 kW	
4	4	13.56 MHz	Output frequency
5	2	200 to 220 V	Supply voltage
	U	200 to 480 V	
6	—		
7 to 10	TRUMPF internal		
11	0 2 4 6 8 A	LEDs on the rear side	Status LEDs
	1 3 5 7 9 B	LEDs on the rear side and front panel	
12 to 14	TRUMPF internal		
15	—		
16 to 21	see following tables		

Position	Code	Feature	Feature group
22 to 25	TRUMPF internal		

Codes of the configuration word Tab. 2-3

Interface equipment
(EtherCAT, see position 18)

Posi-tion	Code	RS-232	RS-485	DeviceNet	Profibus
16	1				•
	2			•	
	4		•		
	5		•		•
	6		•	•	
	8	•			
	9	•			•
	A	•		•	
	C	•	•		
	D	•	•		•
	E	•	•	•	

Codes position 16 Tab. 2-4

Functions

Posi-tion	Code	Interlock autorest	Specification of the AD interface: fast analog	Arc management	P_i/P_L selection for regulation
17	0				
	1				•
	2				
	3				•
	4			•	
	5			•	•
	6			•	
	7			•	•
	8		•		
	9		•		•
	A		•		
	B		•		•
	C		•	•	
	D		•	•	•
	E		•	•	
	F		•	•	•
	G	•			
	H	•			•
	I	•			
	J	•			•
	K	•		•	
	L	•		•	•
	M	•		•	
	N	•		•	•
	O	•	•		
	P	•	•		•
	Q	•	•		
	R	•	•		•
	S	•	•	•	
	T	•	•	•	•
	U	•	•	•	
	V	•	•	•	•

Codes position 17 Tab. 2-5

Functions

Posi-tion	Code	EtherCAT EGT	EtherCAT customer profile	Control range of the output frequency ±1%	Control range of the output frequency ±5%
18	0				
	1				
	2			•	
	3			•	
	4				•
	5				•
	6		•		
	7		•		
	8		•	•	
	9		•	•	
	A		•		•
	B		•		•
	C	•			
	D	•			
	E	•		•	
	F	•		•	
	G	•			•
	H	•			•

Codes position 18 Tab. 2-6

AD interface

Posi-tion	Code	Standard version	Variant 1	Variant 2	Variant 3
19	0	•			
	1			•	
	2		•		
	3				•

Codes position 19 Tab. 2-7

Functions

Posi-tion	Code	Pulse increase	Mixed mode	Frequency agil-ity	Triggered pulse mode	Simmer mode
20	0					
	1					•
	2				•	
	3				•	•
	4			•		
	5			•		•
	6			•	•	
	7			•	•	•
	8		•			
	9		•			•
	A		•		•	
	B		•		•	•
	C		•	•		
	D		•	•		•
	E		•	•	•	
	F		•	•	•	•
	G	•				
	H	•				•
	I	•			•	
	J	•			•	•
	K	•		•		
	L	•		•		•
	M	•		•	•	
	N	•		•	•	•
	O	•	•			
	P	•	•			•
	Q	•	•		•	
	R	•	•		•	•
	S	•	•	•		
	T	•	•	•		•
	U	•	•	•	•	
	V	•	•	•	•	•

Code position 20 Tab. 2-8

Matchbox connection

Posi-tion	Code	SysPort interface for matchbox	DC_{Bias} regulation
21	0		
	1		•
	2	•	
	3	•	•

Codes position 21 Tab. 2-9

Chapter 3

Technical specifications

1. RF output

Description	TruPlasma RF		
	1001	**1002**	**1003**
Full nominal power at 50 Ω load	1 000 W	2 000 W	3 000 W
Nominal power range	10 to 1 000 W	10 to 2 000 W	10 to 3 000 W
Selectable power range	0 to 1 000 W	0 to 2 000 W	0 to 3 000 W
Output power (forward power) with VSWR 1.1 : 1	100% of the nominal power		
Output power (forward power) with VSWR 1.5 : 1	100% of the nominal power		95% of the nominal power
Output power (forward power) with VSWR 2.0 : 1	100% of the nominal power		66% of the nominal power
Output power (forward power) with VSWR 3.0 : 1	100% of the nominal power	75% of the nominal power	50% of the nominal power
Output power (forward power) with unlimited VSWR	60% of the nominal power	30% of the nominal power	20% of the nominal power
Maximum reflected power	600 W		
Nominal load impedance	50 Ω		
Nominal operating frequency	13.56 MHz ±0.005%		
Harmonic signals at full nominal output power at 50 Ω non-reactive load	< -40 dBc		
Spurious signals at full nominal output power at 50 Ω non-reactive load	< -50 dBc		
Connection	Optional: ▪ HN female connector ▪ 7/16 socket		

RF output Tab. 3-1

2. Accuracy of the output power

2.1 Accuracy of the output power for digital control

Description	Value
Power measurement (suppression of interfering frequencies during measurement of the power)	Power measuring setup (suppression for forward and reflected power) ≤ -26 dB for frequencies above 27.0 MHz ≤ -26 dB for frequencies below 7.0 MHz
Power accuracy at 50 Ω load	±1 W or ±1% of set value [1]
With TruPlasma RF 1001: fluctuation on a 50 Ω load with 1000 W (short-term stability within 60 s measurement period)	±1 W
With TruPlasma RF 1001: drift into 50 Ω load with 1000 W (long-term stability during continuous 30 min of operation)	±1 W
With TruPlasma RF 1002, 1003: fluctuation on a 50 Ω load with 2000 W (short-term stability within 60 s measurement period)	±1 W
With TruPlasma RF 1002, 1003: drift into 50 Ω load with 2000 W (long-term stability during continuous 15 min of operation)	±1 W
Repeatability of the output power at 50 Ω load (device to device)	2 W or 2% of set value [1]
All listed values apply only within the recommended calibration period of 12 months.	

Accuracy of the output power for digital control Tab. 3-2

2.2 Accuracy of the output power for analog control

Description	Value
Power measurement (suppression of interfering frequencies during measurement of the power)	Power measuring setup (suppression for forward and reflected power) ≤ -26 dB for frequencies above 27.0 MHz ≤ -26 dB for frequencies below 7.0 MHz
Power accuracy at 50 Ω load	±2 W or ±1% of set value[1]
All listed values apply only within the recommended calibration period of 12 months.	

Accuracy of the output power for analog control Tab. 3-3

1 The larger of the values is valid

3. Dynamic behavior of the power signal at 50 Ω load

Description	Value
Rise time[2] of the power from 10 to 90% of the nominal power after power-on command.	< 1 ms
Rise time[2] of the power from 10 to 90% of the nominal power after a set value change of 200 W.	< 10 ms
Turn-off time upon power-off command from 100% to 1% of nominal power	< 10 µs
Overshoot at 50 Ω load	< 5% of set value
Set value delay from the reception of the analog set value signal until 10% of the set value has been reached.	< 10 ms 5 ms ±4 ms (typ.)
Set value delay from the reception of the analog set value signal until 90% of the set value has been reached.	< 15 ms 10 ms (typ.)
Set value delay from the reception of the digital set value signal until 10% of the set value has been reached	< 30 ms via EtherCAT interface < 30 ms via DeviceNet interface < 30 ms via Profibus interface < 30 ms via RS-232/RS-485 interface
Boot time	< 7 s

Dynamic behavior of the power signal at 50 Ω load Tab. 3-4

2 Prerequisites: 1. "Softstart" set to off. 2. The set value must be passed 50 ms before the power-on command.

4. Mains connection data

Description	TruPlasma RF		
	1001	1002	1003
Mains voltage	3/PE AC 200 to 480 V ±10%		
Mains frequency	50/60 Hz ±3 Hz		
Current consumption per phase with 50 Ω load	6 A at 200 V 3 A at 400 V 2.5 A at 480 V	9.5 A at 200 V 4.7 A at 400 V 4.0 A at 480 V	11.4 A at 200 V 5.7 A at 400 V 4.7 A at 480 V
Mains power consumption at full nominal power at 50 Ω load	1.6 kVA	3.1 kVA	4.1 kVA
Overall efficiency at nominal power at 50 Ω load; at 480 V	72% (typ.)	80% (typ.)	80% (typ.)
Power factor at nominal power at 50 Ω load; at 480 V	0.95		
Ground leakage current	> 3.0 mA		
Internal fuse	20 A		
Short-circuit current rating	2 kA		
Recommended fuse protection of the supply line	16 A gG		
Overvoltage category	II		
Connection	Harting HAN C (40 A)		

Mains connection data Tab. 3-5

5. Clock

5.1 Clock mode

Description	Value
Clock mode	Phase: In this mode, the RF output power signal is phase-locked to the selected clock signal. Frequency: The RF output power deviates in frequency from the clock signal. The phase of the RF output power is not phase-locked.
Clock source	Internal (default setting) External
Accuracy of internal clock	13.56 MHz ±0.005%

Clock mode Tab. 3-6

5.2 Clock input

Description	Value
Input level	0.5 to 5 Vss square wave or sine wave
Frequency	13.56 MHz ±1%
Impedance	50 Ω, VSWR ≤ 1.5 : 1
Connection	Lemo #EPL.00.250.NTN (socket)

Clock input Tab. 3-7

5.3 Clock output

Description	Value
Output level	▪ 2.4 Vss square-wave signal at high impedance ▪ 0.8 Vss square-wave signal at 50 Ω
Frequency (internal clock source)	13.56 MHz ±0.005%
Frequency (external clock source)	13.56 MHz ±1%
Impedance	100 Ω
Connection	Lemo #EPL.00.250.NTN (female connector)

Clock output Tab. 3-8

6. Clock offset mode

6.1 Phase coupling of the output power at the internal or external clock signal (CEX)

Description	Value
Adjustment range of the phase shift of the output power	0 to 359.9°
Phase shifter function resolution	0.1°
Maximum phase error (between clock and RF output)	±5°
Influence of the clock output	No

Phase coupling of the power output at the internal or external clock signal (CEX) Tab. 3-9

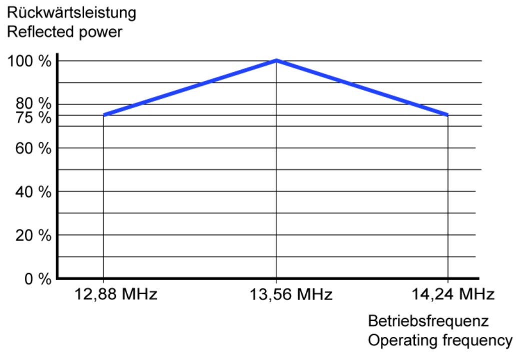
6.2 Frequency offset

Description	Value
Adjustable frequency range	±5% (±678 kHz) Optional: ±1% (±135.6 kHz)
Frequency resolution	1 Hz
Frequency resolution with the TruControl Power operating software	0.1 kHz
Phase coupling between clock and RF output at 0 Hz frequency offset	No
Influence of the clock output	No

Frequency offset mode Tab. 3-10

7. Frequency agility (optional)

Automatic regulation of the output frequency.

Description	Value
Covered frequency range	±678 kHz (±5%)
Reference input	Reflected power P_r
Operation modes	▪ Continuous operation (CW) ▪ Pulse
Adaptive regulation speed (dependent on the reflected power)	yes
Update time	60 µs per step
Adjustable ignition period (measurement delay)	▪ off ▪ 8 µs to 1 ms
Range of the fixed frequency during the ignition period	±678 kHz (±5%)
Adjustable reset force towards a preferred frequency (to give a mechanical matchbox incentive for renewed tuning).	yes
Adjustable regulation threshold	yes
Restriction of the permissible reflected power	

Frequency agility Tab. 3-11

8. Pulse

8.1 Pulse mode

Description	Value
Pulse frequency	10 to 50 000 Hz
Duty cycle	1 to 99% in steps of 1%
Pulse signal source	Internal (default setting) External (Sync in)
Min. pulse on time	10 µs
Min. pulse off time	10 µs
Pulse rise time	< 1 µs
Pulse fall time	< 1 µs
Delay time of the pulse signal between pulse input and pulse output	< 1 µs
Delay time of the pulse signal between pulse input and power output	< 2.5 µs

Pulse mode Tab. 3-12

8.2 Pulse input

Description	Value
Pulse input (Sync in)	TTL input
High-level of input voltage	2 V to 5.5 V
Low level of input voltage	-0.3 V to 0.8 V
Impedance	2 kΩ, 220 pF
Connection	Lemo #EPL.00.250.NTN (female connector)

Pulse input Tab. 3-13

8.3 Pulse output

Description	Value
Pulse output (Sync out)	TTL output
High-level of output voltage	2.4 V to 3.5 V
Low level of output voltage	0 V to 0.4 V
Max. output current	2 mA
Impedance	100 Ω
Connection	Lemo #EPL.00.250.NTN (female connector)

Pulse output Tab. 3-14

9. Arc synchronization

9.1 Arc synchronization input

Description	Value
Input level	TTL input
Frequency	13.56 MHz ±0.005%
Impedance	50 Ω, VSWR ≤ 1.5 : 1
Connector	Lemo #EPL.00.250.NTN (female connector)

Arc synchronization input Tab. 3-15

9.2 Arc synchronization output

Description	Value
Output level	TTL output
Frequency	13.56 MHz ±0.005%
Impedance	50 Ω, VSWR ≤ 1.5 : 1
Connector	Lemo #EPL.00.250.NTN (female connector)

Arc synchronization output Tab. 3-16

10. Communication interfaces

Description	Value
RS-232 service interface	9-pin sub-D male connector Connection to the TruControl Power operating software
RS-232/RS-485 interface	9-pin sub-D male connector Connection to the system master or the TruControl Power operating software
RS-232-interface (customer variant)	9-pin sub-D female connector
AD interface	25-pin sub D female connector
Profibus (option)	9-pin sub-D male connector
EtherCAT (option)	CAT5 RJ-45 female connector
DeviceNet (option)	5-pin M12 male connector
Matchbox (option)	25-pin sub D female connector

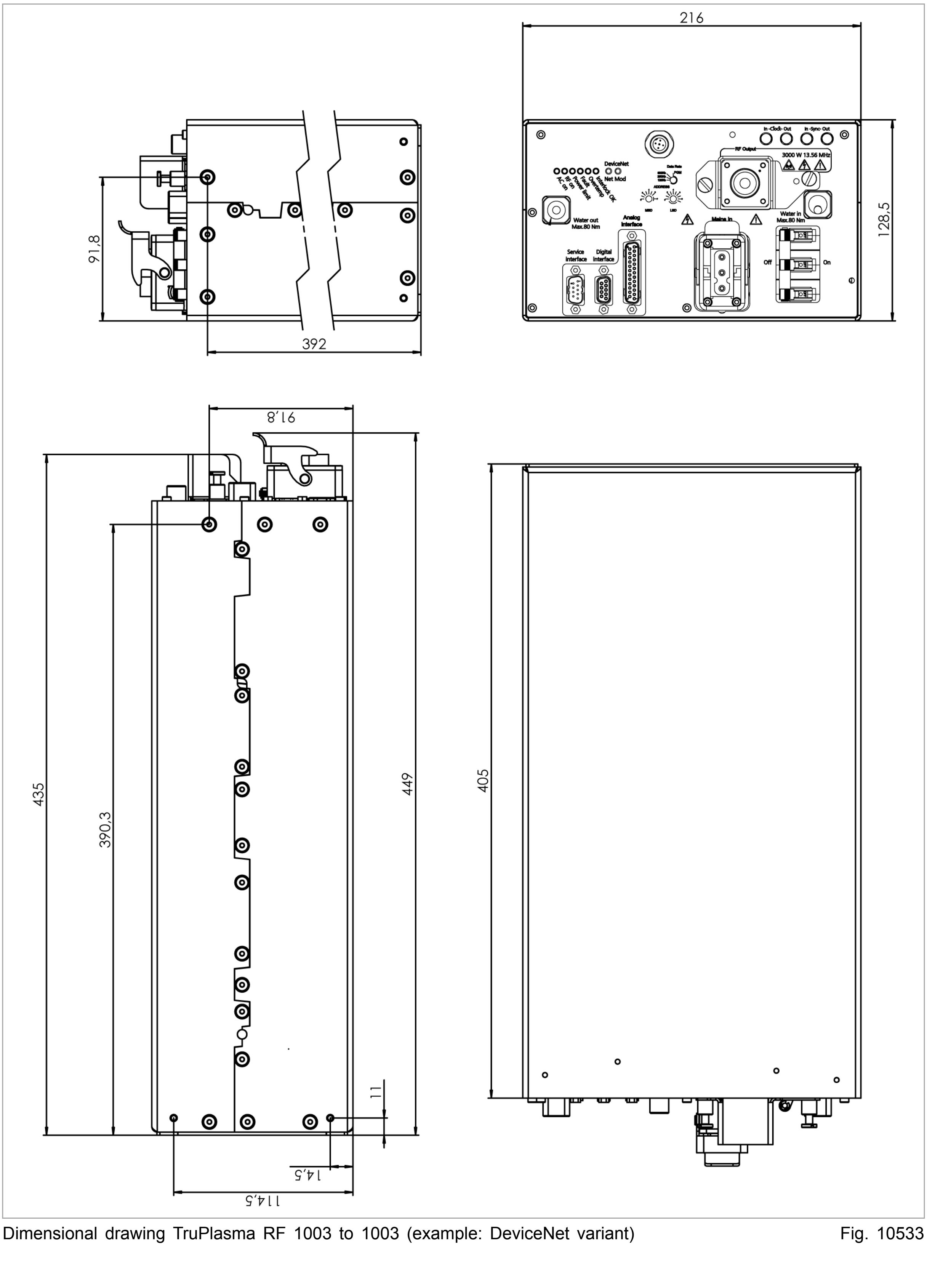
Communication interfaces Tab. 3-17

11. Housing

Description	Value
Dimensions (without con-nectors) W x H x D	216 x 128.5 x 405 mm
Weight	18 kg
Housing color	RAL 9006
Protection class	IP 30

Housing Tab. 3-18

12. Dimensional drawing



Dimensional drawing TruPlasma RF 1003 to 1003 (example: DeviceNet variant) Fig. 10533

13. Environmental conditions

Condition	Temperature	Humidity	Air pressure
Operation	+5 … +40°C	Relative: 5 to 85% [3] Absolute: 1 g/m^3 to 25 g/m^3	79.5 to 106 KPa [4]
Storage	-25 … +55°C [5]	Relative: 5 to 95% Absolute: 1 g/m^3 to 29 g/m^3	79.5 to 106 KPa [4]
Transport	-25 to +70 °C [5]	Relative: < 95% [6] Absolute: < 60 g/m^3[7]	70 to 106 KPa

Environmental conditions Tab. 3-19

Description	Value
Micro-environment according to IEC 61010-1	Degree of soiling 2

Micro-environment Tab. 3-20

3 No condensation or icing.

4 Corresponds to a maximum elevation of 2000 m above sea level.

5 Present cooling water circuits must be completely drained and blown out.

6 Max. relative air humidity if the device temperature increases slowly by 40°C or if the device temperature increases directly from -25 to +30°C.

7 Max. absolute air humidity if the device temperature decreases directly from +70 to +15°C.

14. Cooling requirements

Description	Value
Max. water pressure	7 bar
Max. pressure difference between cooling water inflow and cooling water outflow	1.1 bar
Min. throughput	4 l/min. Check external cooling water flow. Generator is protected against excessive temperature.
Min. throughput during automatic frequency regulation	6 l/min.
Cooling water temperature	5 to 35°C
Air cooling	Not necessary
Conductivity range	20 to 1000 µS/cm

Cooling requirements Tab. 3-21

14.1 Cooling water specification

Requirements for a functioning cooling circuit

- In the cooling water inflow, contamination traps with a fine sieve with a mesh size of 0.25 mm must be installed.
- Materials that should not come into contact with the cooling water:
  - Aluminum.
  - Carbon steel, galvanized and hot-dip galvanized steel.

Preparing cooling water

In operation

During operation, the cooling water must have a pH-value that is between 6 and 9. The conductivity must remain in the specified range and iron and copper values must be below the specified values (see cooling water parameters). Sulfate reducers must not be detectable and the microbiological colony count must be less than 1000 cfu/ml.

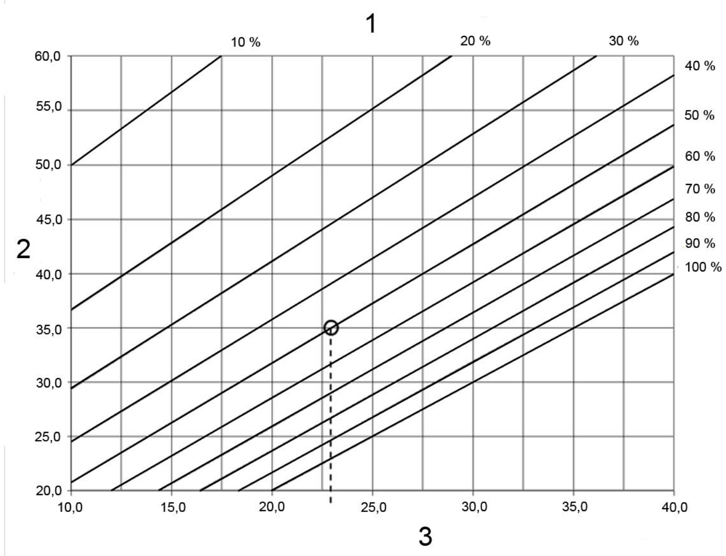
Cooling water parameter

Parameter		Unit	Limit value (Cu cooling circuit)
pH-value		—	6 to 9
Conductivity range		µS/cm	(see "Cooling requirements", pg. 3-16)
Iron		mg/l	< 0.5
Copper		mg/l	< 0.2
Microbiology:	Colony count	KBE/ml	< 1000
	Sulfate reducer	—	Not detectable
Suspended solids		—	Not detectable

Requirements for the cooling water Tab. 3-22

Air pressure value, dew point diagram

The dew point diagram shows the minimum water temperature at which no condensed water forms as a function of the room temperature and the relative humidity of air.



1 Relative air humidity
2 Room temperature in °C
3 Cooling water temperature in °C

Dew point diagram Fig. 10022

Air pressure An air pressure of 1013 mbar was used as the basis for preparing the dew point diagram.

Example A room temperature of 35°C and a relative humidity of air of 50% yield a minimum permissible temperature of 23°C for the cooling water (small circle at the intersection of the 35°C and 50% lines).

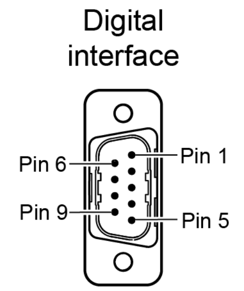
Chapter 4

Interfaces

1. RS-232/RS-485 interface

1.1 RS-232/RS-485 standard interface

View standard interface



View of RS-232/RS-485 interface Fig. 10706

Standard connection

- On the generator: 9-pin sub-D plug.
- Necessary counterpart: 9-pin sub-D female connector.

Standard pin assignment

Pin assignment: 9-pin sub-D male connector

Pin	Function
1	—
2	RS-232 TX
3	RS-232 RX
4	—
5	GND
6	RS-485 A
7	RS-485 B
8	—
9	—

RS-232/RS-485 interface pin assignment Tab. 4-1

Cable requirement sub-D RS-232/RS-485 connection cable

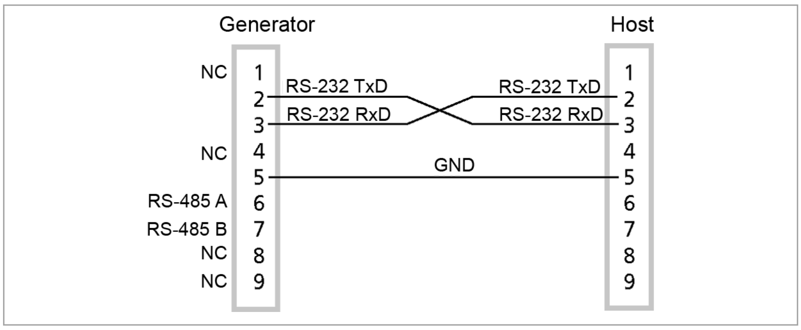
Use a shielded cable with a maximum of 3 strands. A cable with more than 3 strands may cause errors.

Length of the RS-232 connection cable

The lower the set baud rate, the longer the cable may be. Guide values:

- 9600 baud: max. 20 m.
- 57600 baud: max. 5 m.
- 115200 baud: shorter than 2 m.

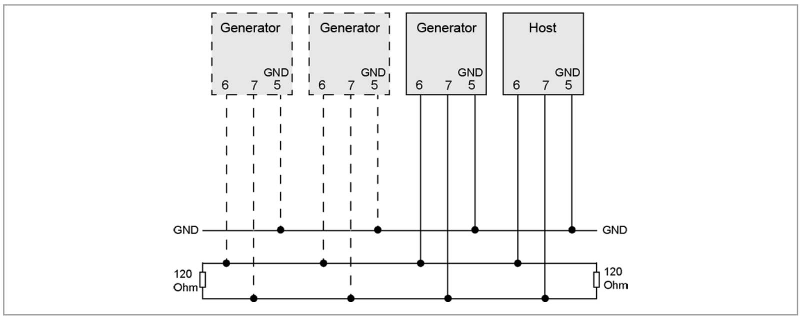
RS-232 null modem cable



RS-232 null modem cable Fig. 10061

For the generator variant with **Sub-D male connector**, a null modem cable must be used.

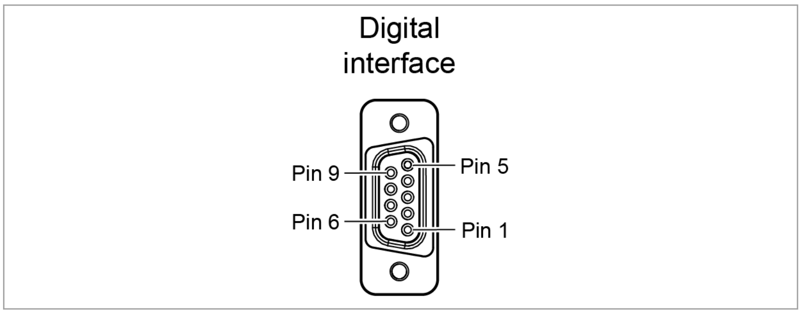
RS-485 connection cable



RS-485 interface cable Fig. 10062

1.2 RS-232 interface customer variant

View customer variant



View of RS-232 interface Fig. 10707

Connection customer variant

9-pin sub-D female connector

Customer variant pin assignment

Pin assignment: 9-pin sub-D female connector

Pin	Function
1	—
2	RS-232 RX
3	RS-232 TX
4	—
5	GND
6	—
7	RS-232 RTS
8	RS-232 CTS
9	—

RS-232 interface pin assignment Tab. 4-2

Cable requirement Sub-D RS-232 connection cable

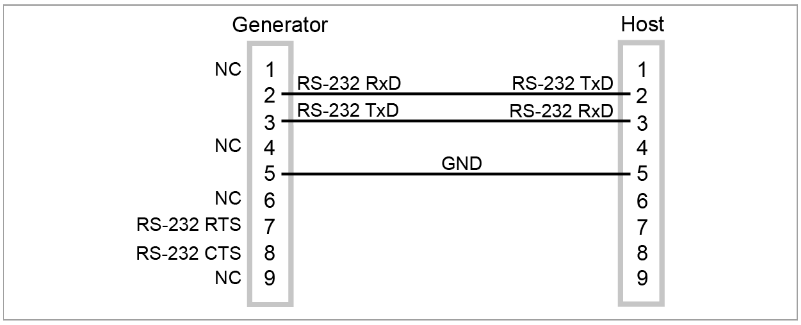
Use a shielded cable with a maximum of 3 strands. A cable with more than 3 strands may cause errors.

Length of the RS-232 connection cable

The lower the set baud rate, the longer the cable may be. Guide values:

- 9600 baud: max. 20 m.
- 57600 baud: max. 5 m.
- 115200 baud: shorter than 2 m.

RS-232 standard cable



RS-232 standard cable Fig. 10463

For the generator variant with **Sub-D female connector**, a standard cable must be used.

1.3 Description of the communication

Description of the communication

ASIP (Advanced serial interface protocol) (see "ASIP (Advanced Serial Interface Protocol)", pg. 4-116).

RS-232/RS-485 commands (see "Parameters of the RS-232/ RS-485 interface", pg. 4-9).

1.4 Parameters of the RS-232/RS-485 interface

General control parameters

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
77	0x4D	1	SINT32	RO	Pending alarm messages.	Number of pending alarm messages.
77	0x4D	1	SINT32	W	Reset alarm messages.	Reset pending alarm messages.
79	0x4F	1	SINT32	RO	Pending warning messages.	Number of pending warning messages.
79	0x4F	1	SINT32	W	Reset warning messages.	Reset pending warning messages.
111	0x6F	1	UINT32	RW	Power output.	■ 0 = Power off. ■ 1 = Power on.

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
220	0xDC	1	UINT32	RO	LED Mod yellow.	▪ 0 = LED off. ▪ 1 = LED on.
221	0xDD	1	UINT32	RO	LED Mod green.	▪ 0 = LED off. ▪ 1 = LED on.
222	0xDE	1	UINT32	RO	LED Net yellow.	▪ 0 = LED off. ▪ 1 = LED on.
223	0xDF	1	UINT32	RO	LED Net green.	▪ 0 = LED off. ▪ 1 = LED on.
334	0x14E	1	SINT32	RO	P_i	Frozen actual value P_i.
335	0x14F	1	SINT32	RO	P_r	Frozen actual value P_r.
336	0x150	1	SINT32	RO	P_L	Frozen actual value P_L.
366	0x16E	1	SINT32	RW	Freeze condition.	The parameter value has a bit field as value. Actual values P_i, P_r and P_L can be requested separately or together via the following bits: ▪ P_i = Forward power. ▪ P_L = Load power. ▪ P_r = Reflected power. ▪ 0x01 = Actual value P_i. ▪ 0x02 = Actual value P_r. ▪ 0x04 = Actual value P_L ▪ 0x07 = Actual value P_i , P_r, P_L.
377	0x179	1	SINT32	RW	State of data logging.	▪ 0 = Stopped. ▪ 1 = Started – stop in case of alarm. ▪ 2 = Started – stop only manually.
378	0x17A	1	SINT32	RW	Interval of data logging.	Resolution 1 ms. ▪ Min. value: 20 ms. ▪ Max. value: 1000 ms.

General control parameters Tab. 4-3

Power regulation

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
6	0x6	1	SINT32	RW	P_i	Set value P_i
7	0x7	1	SINT32	RW	P_L	Set value P_L
8	0x8	1	SINT32	RW	P_r	Limit value P_r
10	0xA	1	SINT32	RW	U_{dc}	Set value U_{DC}
18	0x12	1	SINT32	RO	P_i	Actual value P_i
19	0x13	1	SINT32	RO	P_L	Actual value P_L
20	0x14	1	SINT32	RO	P_r	Actual value P_r
24	0x18	1	SINT32	RO	U_{dc}	Actual value U_{dc}

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
117	0x75	1	UINT32	RO	Process status	▪ 0x00000001 = Internal detection – voltage on. ▪ 0x00000010 = Power output on. ▪ 0x00000020 = Device is calibrated. ▪ 0x00000040 = Warning pending. ▪ 0x00000080 = Alarm pending. ▪ 0x00000200 = Device ready. ▪ 0x00001000 = Pulse mode active. ▪ 0x00008000 = Temperature alarm pending. ▪ 0x00040000 = Limiting by VSWR regulation. ▪ 0x00080000 = Limiting by P_r regulation. ▪ 0x00100000 = Limiting by P_L regulation. ▪ 0x00200000 = Limiting by P_i regulation.

Power regulation Tab. 4-4

External current and voltage regulation (for matchbox control)

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
10	0xA	1	SINT32	RW	Set value for DC_{bias}	Unit is determined by parameter 0x2C8. See matchbox manual for maximum value.
24	0x18	1	SINT32	RO	Actual value of DC_{bias}	
712	0x2C8	1	SINT32	RO	DC_{bias} unit	▪ 0 = This value is not measured in the connected matchbox. ▪ 1 = 1 V. ▪ 10 = 0.1 V.
11	0xB	1	SINT32	RW	Set value for U_{rf}	Unit is determined by parameter 0x02CC. See matchbox manual for maximum value. Whether Urf-peak or Urf-rms is measured and used for the power regulation is also dependent on the matchbox.
25	0x19	1	SINT32	RO	Actual value of U_{rf}	
716	0x2CC	1	SINT32	RO	U_{rf} unit	▪ 0 = This value is not measured in the connected matchbox. ▪ 1 = 1 V. ▪ 10 = 0.1 V.
12	0xC	1	SINT32	RW	Set value for I_{rf}	Unit is determined by parameter 0x02CB. See matchbox manual for maximum value.
26	0x1A	1	SINT32	RO	Actual value of I_{rf}	
715	0x2CB	1	SINT32	RO	I_{rf} unit	▪ 0 = This value is not measured in the connected matchbox. ▪ 1 = A. ▪ 10 = 0.1 A.

External current and voltage regulation (for matchbox control) Tab. 4-5

Generic regulation channel (GRC)

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
776	0x308	1	SINT32	RW	Set value GRC	—
777	0x309	1	SINT32	RO	Actual value GRC	—

Generic regulation channel (GRC) Tab. 4-6

Matchbox control

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
434	0x1B2	1	SINT32	RW	Matchbox mode.	▪ 0 = Automatic mode. ▪ 1 = DC auto mode. ▪ 2 = Recipe control.
702	0x2BE	1	SINT32	RO	Available match-boxes.	▪ 0 = No matchbox found. ▪ 1 = Matchbox found.
703	0x2BF	1	SINT32	RW	Selection of the matchbox.	If only one SystemPort matchbox is connected to the generator, "1" must be selected.
704	0x2C0	1	SINT32	RW	Activation of the matchbox.	▪ 0 = Off. ▪ 1 = Active.
705	0x2C1	1	SINT32	RW	Start matchbox.	▪ 0 = Off. ▪ 1 = Start.
706	0x2C2	1	SINT32	RW	Start automatic regulation.	▪ 0 = Off. ▪ 1 = Start.
707	0x2C3	1	SINT32	RW	Freeze condition.	▪ 0 = Off. ▪ 1 = Freeze.
708	0x2C4	1	SINT32	RW	Recipe number.	0 to 32.
709	0x2C5	1	SINT32	RO	Ready status of the matchbox.	Parameter indicates whether the match-box was found and correctly config-ured.
432	0x1B0	1	SINT32	RW	Set value of the tune capaci-tor/"Plasma-on" position.	Position C_T ▪ Range: 0 to 1000.
430	0x1AE	1	SINT32	RW	Set value of the tune capacitor/ ignition position.	Description as in index 432
27	0x1B	1	SINT32	RO	Actual value of the tune capacitor.	Description as in index 432
433	0x1B1	1	SINT32	RW	Set value of the load capaci-tor/"Plasma-on" position.	Position C_L ▪ Range: 0 to 1000.
431	0x1AF	1	SINT32	RW	Set value of the load capacitor/igni-tion position.	Description as in index 433
28	0x1C	1	SINT32	RO	Actual value of the load capacitor.	Description as in index 433
710	0x2C6	1	SINT32	RO	Actual value of "Z".	Range: 0 to 1000.

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
711	0x2C7	1	SINT32	RO	Actual value of phase.	Range: 0 to 1000.
717	0x2CD	1	SINT32	RO	Status of the matchbox.	▪ Bit 0. – 0 = No alarm. – 1 = Alarm. ▪ Bit 1. – 0 = No warning. – 1 = Warning. ▪ Bit 2. – 0 = Plasma off. – 1 = Plasma on. ▪ Bit 3. – 0 = System not ready. – 1 = System ready. ▪ Bit 4. – 0 = Interlock circuit closed. – 1 = Interlock circuit open. ▪ Bit 5. – 0 = Recipe stopped. – 1 = Recipe is performed. Note: While a recipe is running, no other recipe can be selected. ▪ Bits 6 to 8 not used. ▪ Bit 9. – 0 = State of stepper motor ok. – 1 = Overcurrent at stepper motor. ▪ Bit 10. – 0 = Cooling water ok. – 1 = Cooling water alarm. ▪ Bit 11. – 0 = $U_{dc\ bias}$ ok. – 1 = $U_{dc\ bias}$ too high. ▪ Bit 12. – 0 = AC voltage ok. – 1 = AC voltage too high. ▪ Bit 13. – 0 = AC current ok. – 1 = AC current too high. ▪ Bit 14. – 0 = Matchbox closed. – 1 = Open matchbox cover. ▪ Bit 15. – 0 = SystemPort has only read permission. – 1 = SystemPort has write permission.

Matchbox control Tab. 4-7

Clock and pulse mode

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
360	0x168	1	SINT32	RW	Pulse signal source.	▪ 0 = Internal. ▪ 1 = External.
361	0x169	1	SINT32	RW	Clock source.	Read clock source: ▪ 1 = Internal. ▪ 3 = External.
362	0x16A	1	SINT32	RW	Pulse mode.	▪ 0 = Continuous operation. ▪ 1 = Pulse mode.
364	0x16C	1	SINT32	RW	Pulse frequency.	Resolution 1 Hz.
365	0x16D	1	SINT32	RW	Duty cycle.	1 to 99% in steps of 1%.
384	0x180	1	SINT32	RW	Phase shift.	The phase shift defines the shift between clock source and output signal. Requirement: ▪ Clock offset mode = Phase offset. ▪ 1 digit = 0.1°. ▪ Min. = 0. ▪ Max. = 3600.
456	0x1C8	1	SINT32	RW	Power measurement delay.	Write delay of power measurement relative to the start of the pulse: ▪ 263 = min. delay (0.007 ms). ▪ 37500 = max. delay (1 ms).
457	0x1C9	1	SINT32	RW	Frequency offset.	Availability and range of this parameter depend on the configuration of the generator. To use the frequency offset for the clock source, the "clock offset mode" must be set to "frequency": ▪ 1 digit = 1 Hz. ▪ Min. = -678000. ▪ Max. = +678000. Optional: ▪ Min. = -135600. ▪ Max. = 135600.
516	0x204	1	SINT32	RW	Clock offset mode.	▪ 0 = Phase offset. ▪ 1 = Frequency offset.
519	0x207	1	SINT32	RO	Frequency actual value.	▪ 1 digit = 1 kHz.
593	0x251	1	SINT32	RW	Simmer mode.	Activating simmer mode: ▪ 0 = Inactive. ▪ 1 = Active.
594	0x252	1	SINT32	RW	Low level time.	Duration of the pulse pause in simmer mode in µs.
595	0x253	1	SINT32	RW	High level time.	Duration of a simmer pulse in µs.

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
596	0x254	1	SINT32	RW	Triggered pulse mode.	Rising voltage edge activates the pulse mode: ▪ 0 = Inactive. ▪ 1 = Active.
597	0x255	1	SINT32	RW	Switch on delay.	Time span between detection of the trigger signal and output of the pulse signal in µs.
598	0x256	1	SINT32	RW	Pulse duration.	Time span in which the pulse signal is output in µs.
658	0x292	1	SINT32	RW	Pulse boost.	Activating Pulse boost: ▪ 0 = Inactive. ▪ 1 = Active.

Clock and pulse mode Tab. 4-8

Regulation characteristic

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
454	0x1C6	1	SINT32	RW	Soft start.	▪ 0 = Softstart inactive, normal startup. ▪ 1 = Softstart active.
455	0x1C7	1	SINT32	RW	Regulation speed.	▪ 0 = Standard RF regulation speed. ▪ 1 = Slow RF regulation speed.

Regulation characteristic Tab. 4-9

Timer

Dec index	Hex index.	Sub-index	Data type	Access	Meaning	Description
479	0x1DF	1	SINT32	RW	Timer.	Time after which the power is switched off.
480	0x1E0	1	SINT32	RO	Remaining time - power on.	Remaining time in s after which the output power is switched off.

Timer Tab. 4-10

Joule mode

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
603	0x25B	1	UINT32	RO	Consumed energy.	Consumed energy in kWh
641	0x281	1	SINT32	RO	Remaining energy.	Remaining energy in Ws after which the output power is switched off.
642	0x282	1	SINT32	RO	Energy since power on.	Consumed energy in kWh since the last power-on command.
643	0x283	1	SINT32	RW	Joule mode limit value.	Energy limit value in Ws

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
644	0x284	1	SINT32	RW	Joule mode.	Activating Joule mode: ▪ 0 = Inactive. ▪ 1 = Active.

Joule mode Tab. 4-11

Ramp

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
372	0x174	1	SINT32	RW	Control channel for ramp.	▪ 0 = P_i regulation. ▪ 1 = P_L regulation.
463	0x1CF	1	SINT32	RW	Set value change with rising ramp.	Resolution 1 W/s or 1 V/s or 1 ms (dependent on the ramp type). ▪ Min. value: 1.
464	0x1D0	1	SINT32	RW	Set value change with falling ramp.	Resolution 1 W/s or 1 V/s or 1 ms (dependent on the ramp type). ▪ Min. value: 1.
574	0x23E	1	SINT32	RW	Ramp mode.	▪ 0 = Ramp not active. ▪ 1 = Power on ramp (ramp active when switching on the power). ▪ 3 = Power on ramp and set value ramp (ramp active when switching on the power and on set value change).
575	0x23F	1	SINT32	RW	Ramp type.	Defines the response of the ramp: ▪ 0 = Ramp duration in ms. ▪ 1 = Ramp slope/ramp gradient in W/s.

Ramp Tab. 4-12

Arc management

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
504	0x1F8	1	SINT32	RW	Arc detection.	▪ 0 = Inactive. ▪ 1 = Active.
499	0x1F3	1	SINT32	RO	Arc counter.	—
511	0x1FF	1	SINT32	RW	Reset Arc counter.	▪ 0 = no action. ▪ 1 = Reset.
799	0x31F	1	SINT32	RW	Arc counter auto reset.	Automatic resetting of the arc counter at every power-on command. ▪ 0 = Inactive. ▪ 1 = Active.
509	0x1FD	1	SINT32	RW	Arc handling.	▪ 0 = Inactive. ▪ 1 = Active.

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
496	0x1F0	1	SINT32	RW	Maximum P_r to start.	Resolution 1 W. Example: 421 ≙ 421 W. ▪ Min. value: 10 W. ▪ Max. value: Prmax.
497	0x1F1	1	SINT32	RW	Minimum Pi to start.	Resolution 1 W. Example: 985 ≙ 985 W. ▪ Min value: 30 W. ▪ Max. value: Pimax.
495	0x1EF	1	SINT32	RW	Arc-management delay.	Resolution 1 ms. Example: 235 ≙ 235 ms. ▪ Min. value: 0 ms. ▪ Max. value: 10000 ms.
798	0x31E	1	SINT32	RW	Restart delay.	▪ 0 = no action. ▪ 1 = Restart of the "Arc-management delay" time. Note: With this restart, the Arc handling is immediately inactive.
507	0x1FB	1	SINT32	RW	Detection mode.	▪ 0 = External. ▪ 1 = P_r Threshold. ▪ 2 = P_r Slope. ▪ 3 = P_r/P_i Threshold. ▪ 4 = P_r/P_i Slope. ▪ 5 = Extern + P_r Threshold. ▪ 6 = Extern + P_r Slope. ▪ 7 = Extern + P_r/P_i Threshold. ▪ 8 = Extern + P_r/P_i Slope.
491	0x1EB	1	SINT32	RW	Threshold P_r	Resolution 1 W. Example: 421 ≙ 421 W. ▪ Min. value: 10 W. ▪ Max. value: P_r max.
493	0x1ED	1	SINT32	RW	Slope P_r	Slope $P_r = \Delta P_r/(n \bullet T_{sample})$ n = Sample count (Value set with index 0x1F2) T_{sample} ≈ 100 ns (see "Fig. 10201", pg. 7-48) Resolution 1 W/µs. Example: 123 ≙ 123 W/µs. ▪ Min. value: 10 W/µs. ▪ Max. value: Prmax W/µs.
790	0x316	1	SINT32	RO	Slope P_r max.	Display of the maximum value Slope P_r max since the last time the output power was switched on (data-hold function). Only with Detection mode P_r Slope or Extern + P_r Slope.
666	0x29A	1	SINT32	RW	Arc sync output.	▪ 0 = Inactive. ▪ 1 = Active.

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
492	0x1EC	1	SINT32	RW	Threshold P_r/P_i	Resolution 1 % Example: 45 ≙ 45%. ▪ Min. value: 1 %. ▪ Max. value: 100 %.
494	0x1EE	1	SINT32	RW	Slope P_r/P_i	Resolution 1 %/µs. Example: 45 ≙ %/µs. ▪ Min. value: 1 %/µs. ▪ Max. value: 100 %/µs.
498	0x1F2	1	SINT32	RW	Sample count.	Resolution 1. Example: 45 ≙ 45 samples. ▪ Min. value: 1. ▪ Max. value: 511.
522	0x20A	1	SINT32	RO	Arc rate.	Resolution 1 arc/s.
523	0x20B	1	SINT32	RW	Arc rate limit.	Resolution 1 arc/s. Example: 812 ≙ 812 arc/s. ▪ Min. value: 0.
508	0x1FC	1	SINT32	RW	Handling mode.	▪ 0 = Power off. ▪ 1 = Cut arc activeley.
501	0x1F5	1	SINT32	RW	Arc handling delay.	Resolution 1 µs. Example: 123 ≙ 123 µs. ▪ Min. value: 0 µs. ▪ Max. value: 1000 µs.
502	0x1F6	1	SINT32	RW	Arc suppression time.	Resolution 1 µs. Example: 85 ≙ 85 µs. ▪ Min. value: 5 µs. ▪ Max. value: 500 µs.
500	0x1F4	1	SINT32	RW	Burst pulse on time.	Resolution 1 µs. Example: 85 ≙ 85 µs. ▪ Min. value: 10 µs. ▪ Max. value: 500 µs.
506	0x1FA	1	SINT32	RW	Arc detection delay time.	Resolution 1 µs. Example: 485 ≙ 485 µs. ▪ Min. value: 0 µs. ▪ Max. value: 1000 µs.
503	0x1F7	1	SINT32	RW	Pulse count in burst.	Resolution 1 pulse. Example: 485 ≙ 485 pulses. ▪ Min. value: 0. ▪ Max. value: 10000.
505	0x1F9	1	SINT32	RW	Arc retry count.	Resolution 1 repetition. Example: 5 ≙ 5 repetitions. ▪ Min. value: 0 (no limit, infinite number of pulse packet repetitions).

Arc management Tab. 4-13

Frequency agility

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
516	0x204	1	SINT32	RW	Activate clock modes/frequency agility.	■ 0 = Phase offset. ■ 1 = Frequency offset. ■ 2 = Frequency agility.
582	0x246	1	SINT32	RW	Tuning start offset.	Frequency offset with which automatic frequency tuning begins. ■ Min. value: -678 kHz (13.560 MHz - 678 kHz = 12.882 MHz). ■ Default value: 0 kHz. ■ Max. value: 678 kHz (13.560 MHz + 678 kHz = 14.238 MHz).
583	0x247	1	SINT32	RW	Max. tuning offset.	Upper limit value for the frequency agility algorithm. ■ Min. value: -678 kHz. ■ Max. value: 678 kHz (default value).
584	0x248	1	SINT32	RW	Min. tuning offset.	Lower limit value for the frequency agility algorithm. ■ Min. value: -678 kHz (default value). ■ Max. value: 678 kHz.
585	0x249	1	SINT32	RW	Tuning delay.	Frequency tuning delay after power switched on. ■ Min. value: 0 ms (default value). ■ Max. value: 1500 ms.
456	0x1C8	1	SINT32	RW	Regulation delay.	Delay of the frequency tuning after start of pulse (only relevant for pulse mode). ■ Min. value: 7 µs (default value). ■ Max. value: 1000 µs.
586	0x24A	1	SINT32	RW	Retuning threshold.	If this threshold is not met, automatic frequency tuning is activated again. ■ Min. value: 0 (default value). ■ Max. value: 1000.
587	0x24B	1	SINT32	RW	Modulation period.	Time span for frequency modulation. ■ Min. value: 0 (default value). ■ Max. value: 1000.
588	0x24C	1	SINT32	RW	Gain.	Fixed value for the amplification of the feedback loop of the frequency agility algorithm. ■ Min. value: 0. ■ Default value: 50. ■ Max. value: 1000.

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
589	0x24D	1	SINT32	RW	Relative gain.	Gamma-dependent value for the amplification of the feedback loop of the frequency agility algorithm. ▪ Min. value: 0. ▪ Default value: 50. ▪ Max. value: 1000.
590	0x24E	1	SINT32	RW	Modulation deviation.	Fixed value for the frequency modulation deviation. ▪ Min. value: 0. ▪ Default value: 50. ▪ Max. value: 1000.
591	0x24F	1	SINT32	RW	Relative modulation deviation.	Gamma-dependent value for the frequency modulation deviation. ▪ Min. value: 0. ▪ Default value: 50. ▪ Max. value: 1000.
592	0x250	1	SINT32	RW	Pullback to start frequency.	Shift of the operating frequency towards the starting frequency (corresponds to index 0x246). ▪ Min. value: 0 (no shift, default). ▪ Max. value: 1000 (large shift).
652	0x28C	1	SINT32	RW	Frequency sweep.	Frequency sweep between minimum and maximum tuning offset. ▪ 1 = Start frequency sweep.
804	0x324	1	SINT32	RW	Skip frequency window.	▪ 0 = Inactive. ▪ 1 = Active.
805	0x325	1	SINT32	RW	Center frequency offset.	Distance between the excluded frequency range and the starting frequency (Tuning start offset). ▪ Min. value: -678 kHz. ▪ Default value: 0 kHz. ▪ Max. value: 678 kHz.
806	0x326	1	SINT32	RW	Bandwidth.	Bandwidth of the excluded frequency range. ▪ Min. value: 1 kHz (default value). ▪ Max. value: 1000 kHz.

Frequency agility Tab. 4-14

Interfaces

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
3	0x3	1	SINT32	RO	Standard interface.	—
115	0x73	1	SINT32	RW	Watchdog.	Write watchdog/timeout value: ▪ 0 = Watchdog disabled. ▪ 30000 = 30000 ms. Maximum value: 30000 ms. After each switch-on of the generator, the timeout value is 3000 ms. A changed value is only valid while the generator is switched-on. If the generator does not receive a monitoring signal within the set time, the generator switches the output power off and outputs an error message.
338	0x152	1	SINT32	RO	Active interface.	▪ 0 = No interface active. ▪ 1 = RS-232 interface. ▪ 2 = Service interface. ▪ 3 = DeviceNet. ▪ 4 = AD interface. ▪ 5 = RS-485 interface.
422	0x1A6	1	SINT32	RW	Watchdog service.	Watchdog service interface.

Interfaces Tab. 4-15

User-defined limit values

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
600	0x258	1	SINT32	RW	Limit value P_i	User-defined limit value for P_i.
601	0x259	1	SINT32	RW	Limit value P_L	User-defined limit value for P_L.
602	0x25A	1	SINT32	RW	Limit value P_r	User-defined limit value for P_r.
795	0x31B	1	SINT32	RW	AV P_r clamping threshold.	Threshold of the actual P_r value up to which "0" is displayed on the analog output of the AD interface.

User-defined limit values Tab. 4-16

Mixed mode

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
636	0x27C	1	SINT32	RW	Activate mixed mode.	▪ 0 = Off. ▪ 1 = On.
657	0x291	1	SINT32	RW	Configuration of the analog input.	▪ 0 = Not used. ▪ 1 = Power set value. ▪ 2 = current value of the generic regulation channel (GRC).

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
638	0x27E	1	SINT32	RW	Configuration of the analog outputs AO_1 to AO_3.	▪ Bit 0 = 1: Output AO_1 active. ▪ Bit 1 = 1: Output AO_2 active. ▪ Bit 2 = 1: Output AO_3 active.
639	0x27F	1	SINT32	RW	Configuration of the digital inputs DI_0 to DI_3.	▪ Bit 0 = 1: Input DI_0 active. ▪ Bit 1 = 1: Input DI_1 active. ▪ Bit 2 = 1: Input DI_2 active. ▪ Bit 3 = 1: Input DI_3 active.
640	0x280	1	SINT32	RW	Configuration of the digital outputs DO_0 to DO_2.	▪ Bit 0 = 1: Output DO_0 active. ▪ Bit 1 = 1: Output DO_1 active. ▪ Bit 2 = 1: Output DO_2 active.
797	0x31D	1	SINT32	RW	Digital output DO_2.	▪ 0 = Output shows temperature error. ▪ 1 = Output shows alarm message.
142	0x8E	1	SINT32	RO	Display of the configuration of the analog input.	▪ 0 = Not used. ▪ 1 = Power set value. ▪ 2 = current value of the generic regulation channel (GRC).
578	0x242	1	SINT32	RO	Current voltage at the analog input in mV.	Example: 2750 ≙ 2.75 V.

Mixed mode — Tab. 4-17

Analog I/O scaling

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
570	0x23A	1	SINT32	RW	Scaling for GRC at the analog input.	Power value in W if 10 V is applied at the analog input.
655	0x28F	1	SINT32	RW	Scaling for U_{DC} at the analog input.	Power value P_i / P_L in W if 10 V is applied at the analog input. Example: With a value of 850, P_i / P_L is 850 W if 10 V is applied at the analog input. ▪ Min. value: 1. ▪ Max. value: 10000. ▪ Factory setting: 5000.
571	0x23B	1	SINT32	RW	Scaling factor for analog output P_i.	With the set value in W, the voltage at the analog output is 10 V. Example: With a value of 1725, 10 V is present at the analog output if P_i is 1725 W. ▪ Min. value: 100. ▪ Max. value: 65535. ▪ Factory setting: 32817.

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
572	0x23C	1	SINT32	RW	Scaling factor for analog output P_L.	With the set value in W, the voltage at the analog output is 10 V. Example: With a value of 742, 10 V is present at the analog output if P_L is 742 W. ▪ Min. value: 100. ▪ Max. value: 65535. ▪ Factory setting: 32817.
573	0x23D	1	SINT32	RW	Scaling factor for analog output P_r.	With the set value in W, the voltage at the analog output is 10 V. Example: With a value of 418, 10 V is present at the analog output if P_L is 418 W. ▪ Min. value: 100. ▪ Max. value: 65535. ▪ Factory setting: 32817.
576	0x240	1	SINT32	RW	Analog limit.	Signals at the analog input that are smaller than the configured value in mV are not interpreted as the set value. This function prevents signal noise from being interpreted as the set value. ▪ Min. value: 0. ▪ Max. value: 1000. ▪ Factory setting: 500.
578	0x242	1	SINT32	RO	Current voltage at the analog input in mV.	Example: 2750 ≙ 2.75 V.
514	0x202	1	SINT32	RW	Scaling the voltage values at the analog inputs and analog outputs to 10%. **This function is only possible with customer variants.**	▪ 10 = Default values: 0 to 10 V on analog inputs and analog outputs corresponds to 0 to 100% of the nominal power. ▪ 1 = Values are reduced by a factor of 10: 0 to 10 V on analog inputs and analog outputs corresponds to 0 to 10% of the nominal power.
796	0x31C	1	SINT32	RW	Analog output voltage filter.	Signals at the analog outputs are smoothed. ▪ 0 = Inactive. ▪ 1 = Active.

Analog I/O scaling Tab. 4-18

Device settings

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
99	0x63	—	SINT32	RW	Restore factory settings.	Reset generator to state on delivery.
104	0x68	—	SINT32	RO	EEPROM initial state.	▪ Value = 0 : Writing was successful. ▪ Value ≠ 0: EEPROM was reset to original values.
337	0x151	1	SINT32	RW	Time synchronization.	System time in Linux format.
653	0x28D	1	SINT32	RW	Standby.	Activate standby.

Device settings Tab. 4-19

Monitoring

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
85	0x55	1	SINT32	RO	Counter - mains on.	Time - mains on in s.
86	0x56	1	SINT32	RO	Counter - power on.	Time - power on in s.
323	0x143	1	SINT32	RO	Temperature - control.	Temperature of the regulator circuit board.
383	0x17F	1	SINT32	RO	Temperature - RF detector.	Temperature of the RF detector.
409	0x199	1	SINT32	RO	Temperature - ambient air 1.	Ambient temperature 1.
410	0x19A	1	SINT32	RO	Temperature - RF power stage 1.	Temperature of power stage 1.
411	0x19B	1	SINT32	RO	Temperature - RF power stage 2.	Temperature of power stage 2.
415	0x19F	1	SINT32	RO	Temperature - ambient air 2.	Ambient temperature 2.
416	0x1A0	1	SINT32	RO	Temperature - RF power stage 3.	Temperature of power stage 3.
417	0x1A1	1	SINT32	RO	Temperature - RF power stage 4.	Temperature of power stage 4.
561	0x231	1	SINT32	RO	Rectified mains voltage.	Rectified mains voltage.
561						
604	0x25C	1	SINT32	RO	Counter - power on.	Number of power-on commands.
605	0x25D	1	UINT32	RO	Counter - over temperature.	Number of over temperatures that have occurred.
606	0x25E	1	SINT32	RO	Counter - AC on.	Number of AC power-on events.
607	0x25F	1	SINT32	RO	Counter - alarm messages.	Number of alarm messages that have occurred.

Monitoring Tab. 4-20

Identification

Dec index	Hex index	Sub-index	Data type	Access	Meaning	Description
15	0xF	1	SINT32	RO	Integration level.	Software version of the entire software package.
105	0x69	1	SINT32	RO	Device model.	—
106	0x6A	1	SINT32	RO	Serial number.	—
435	0x1B3	1	vector	RO	Regulator software version.	Software version of the regulator.
436	0x1B4	1	vector	RO	Regulator transfer date.	Date on which the software for the regulator was installed.
439	0x1B7	1	vector	RO	Control software version.	Software version of the control.
442	0x1BA	1	vector	RO	Control transfer date.	Date on which the software for the control was installed.
445	0x1BD	1	vector	RO	Calibration status.	—
447	0x1BF	1	vector	RO	Calibration date.	—
472	0x1D8	1	vector	RO	FPGA software version.	Software version of the FPGA.
550	0x226	1	UINT32	RO	HVPS software version.	Software version of the internal power supply unit.
569	0x239	1	vector		Configuration word.	Configuration of the device.

Identification Tab. 4-21

1.5 Telegram examples

Listed in the following are a number of telegrams that are frequently used during practical work with the generator.

Get control (RS-232/RS-485 should be active interface). **(see "Telegram: Get control", pg. 4-26)**

- **Master to generator**
  [0xAA][0x02][0x06][0x00][0x05][0x01][0x00][0x00][0xFF][0x34][0x8A][0x55]
- **Generator to master**
  [0x06]
- **Generator to master**
  [0xAA][0x01][0x06][0x08][0x05][0x01][0x00][0x00][0xFF][0x03][0x4F][0x55]

Preset set value (P_i = 600 kW). **(see "Telegram: Preset Pi value (600 W)", pg. 4-27)**

- **Master to generator**
  [0xAA][0x02][0x0B][0x00][0x02][0x06][0x00][0x01][0x00][0x04][0x58][0x02][0x00][0x00][0x7E][0xC1][0x55]
- **Generator to master**
  [0x06]
- **Generator to master**
  [0xAA][0x01][0x06][0x08][0x02][0x06][0x00][0x01][0xFF][0xCB][0x4A][0x55]

Read current P_i value. **(see "Telegram: Read Pi value", pg. 4-29)**

- **Master to generator**
  [0xAA][0x02][0x06][0x00][0x01][0x12][0x00][0x01][0xFF][0xCC][0xC6][0x55]
- **Generator to master**
  [0x06]
- **Generator to master**
  [0xAA][0x01][0x0B][0x08][0x01][0x12][0x00][0x01][0x00][0x04][0x58][0x02][0x00][0x00][0x8B][0xD2][0x55]

Release control. **(see "Telegram: Release control", pg. 4-30)**

- **Master to generator**
  [0xAA][0x02][0x06][0x00][0x05][0x02][0x00][0x00][0xFF][0xE8][0x11][0x55]
- **Generator to master**
  [0x06]
- **Generator to master**
  [0xAA][0x01][0x06][0x00][0x05][0x02][0x00][0x00][0xFF][0x9D][0xD9][0x55]

Telegram: Get control

RS-232/RS-485 should be active interface.

Byte no.	Value	Meaning	Other information	
Master to generator				
1	0xAA	Start byte	—	—
2	0x02	Address byte, always 0x02 with RS-232.	—	—
3	0x06	Number of bytes in the following data unit.	—	—
4	0x00	[GS] Generator status, always 0x00 if it is sent by the master.	(see "Generator status [GS]", pg. 4-121)	[DTA] Data unit (see "Data unit type A", pg. 4-125)
5	0x05	[CMD] Get control.	(see "Command (Command) [CMD]", pg. 4-122)	
6	0x01	[IDX] Index	(see "Controlling the active interfaces [0x05]", pg. 4-146)	
7	0x00			
8	0x00	[SUBIDX] Subindex		
9	0xFF	[STAT] Status value	(see "Status values [STAT]", pg. 4-123)	
10	0x34	Checksum	(see "CRC calculation", pg. 4-150)	—
11	0x8A			—
12	0x55	Stop byte	—	—
Generator to master				
1	0x06	[ACK] Acknowledgment from the generator	—	—
Generator to master				
1	0xAA	Start byte	—	—

Byte no.	Value	Meaning	Other information	
2	0x01	Address byte, master address is always 0x01.	—	—
3	0x06	Number of bytes in the following data unit.	—	—
4	0x08	[GS] Generator status: RS-232/RS-485 is active interface.	(see "Generator status [GS]", pg. 4-121)	[DTA] Data unit (see "Data unit type A", pg. 4-125)
5	0x05	[CMD] Repetition of command: "Get control".	(see "Command (Command) [CMD]", pg. 4-122)	
6	0x01	[IDX] Index	(see "Controlling the active interfaces [0x05]", pg. 4-146)	
7	0x00			
8	0x00	[SUBIDX] Subindex		
9	0xFF	[STAT] Status value	(see "Status values [STAT]", pg. 4-123)	
10	0x03	Checksum	(see "CRC calculation", pg. 4-150)	—
11	0x4F			—
12	0x55	Stop byte	—	—

Get control Tab. 4-22

Telegram: Preset P_i value (600 W)

P_i should be set to 600 W

Byte no.	Value	Meaning	Other information	
Master to generator				
1	0xAA	Start byte	—	—
2	0x02	Address byte, always 0x02 with RS-232.	—	—
3	0x0B	Number of bytes in the following data unit.	—	—

Byte no.	Value	Meaning	Other information	
4	0x00	[GS] Generator status, always 0x00 if it is sent by the master.	(see "Generator status [GS]", pg. 4-121)	[DTA] Data unit (see "Data unit type A", pg. 4-125)
5	0x02	[CMD] Write parameter.	(see "Command (Command) [CMD]", pg. 4-122)	
6	0x06	[IDX] Index Parameter: set value P_i	(see "Parameters of the RS-232/RS-485 interface", pg. 4-9)	
7	0x00			
8	0x01	[SUBIDX] Subindex		
9	0x00	[STAT] Status value	(see "Status values [STAT]", pg. 4-123)	
10	0x04	[TYP] Byte defines that data type SINT32 is used for the display of the following value.	(see "Data types [Typ]", pg. 4-124)	
11	0x58	Set value: 600	—	
12	0x02			
13	0x00			
14	0x00			
15	0x7E	Checksum	(see "CRC calculation", pg. 4-150)	—
16	0xC1			—
17	0x55	Stop byte	—	—
Generator to master				
1	0x06	[ACK] Acknowledgment from the genera-tor	—	—
Generator to master				
1	0xAA	Start byte	—	—
2	0x01	Address byte, master address is always 0x01.	—	—
3	0x06	Number of bytes in the following data unit.	—	—
4	0x08	[GS] Generator status: RS-232/RS-485 is active interface.	(see "Generator status [GS]", pg. 4-121)	[DTA] Data unit (see "Data unit type A", pg. 4-125)
5	0x02	[CMD] Repetition of command: "Write parameter".	(see "Command (Command) [CMD]", pg. 4-122)	
6	0x06	[IDX] Index Repetition of the parameter.	(see "Parameters of the RS-232/RS-485 interface", pg. 4-9)	
7	0x00			
8	0x01	[SUBIDX] Subindex		
9	0xFF	[STAT] Status value	(see "Status values [STAT]", pg. 4-123)	
10	0xCB	Checksum	(see "CRC calculation", pg. 4-150)	—
11	0x4A			—
12	0x55	Stop byte	—	—

Preset P_i value (600 W) Tab. 4-23

Telegram: Read P_i value

Example: P_i = 600 W

Byte no.	Value	Meaning	Other information	
Master to generator				
1	0xAA	Start byte	—	—
2	0x02	Address byte, always 0x02 with RS-232.	—	—
3	0x06	Number of bytes in the following data unit.	—	—
4	0x00	[GS] Generator status, always 0x00 if it is sent by the master.	(see "Generator status [GS]", pg. 4-121)	[DTA] Data unit (see "Data unit type A", pg. 4-125)
5	0x01	[CMD] Read parameter.	(see "Command (Command) [CMD]", pg. 4-122)	
6	0x12	[IDX] Index		
7	0x00	Parameter: Actual value P_i		
8	0x01	[SUBIDX] Subindex		
9	0xFF	[STAT] Status value	(see "Status values [STAT]", pg. 4-123)	
10	0xCC	Checksum	(see "CRC calculation", pg. 4-150)	—
11	0xC6			—
12	0x55	Stop byte	—	—
Generator to master				
1	0x06	[ACK] Acknowledgment from the generator	—	—
Generator to master				
1	0xAA	Start byte	—	—
2	0x01	Address byte, master address is always 0x01.	—	—
3	0x0B	Number of bytes in the following data unit.	—	—
4	0x08	[GS] Generator status: RS-232/RS-485 is active interface.	(see "Generator status [GS]", pg. 4-121)	[DTA] Data unit (see "Data unit type A", pg. 4-125)
5	0x01	[CMD] Repetition of command: "Read parameters".	(see "Command (Command) [CMD]", pg. 4-122)	
6	0x12	[IDX] Index repetition		
7	0x00			
8	0x01	[SUBIDX] Subindex		
9	0x00	[STAT] Status value	(see "Status values [STAT]", pg. 4-123)	
10	0x04	[TYP] Byte defines that data type SINT32 is used for the display of the following value.	(see "Data types [Typ]", pg. 4-124)	
11	0x58	Actual value: 600	—	
12	0x02			
13	0x00			
14	0x00			

Byte no.	Value	Meaning	Other information	
15	0x8B	Checksum	(see "CRC calculation", pg. 4-150)	—
16	0xD2			—
17	0x55	Stop byte	—	—

Read current P_i value Tab. 4-24

Telegram: Release control

RS-232/RS-485 should no longer be the active interface.

Byte no.	Value	Meaning	Other information	
Master to generator				
1	0xAA	Start byte	—	—
2	0x02	Address byte, always 0x02 with RS-232.	—	—
3	0x06	Number of bytes in the following data unit.	—	—
4	0x00	[GS] Generator status, always 0x00 if sent from the master to the generator.	(see "Generator status [GS]", pg. 4-121)	[DTA] Data unit (see "Data unit type A", pg. 4-125)
5	0x05	[CMD] Control of interface activity.	(see "Command (Command) [CMD]", pg. 4-122)	
6	0x02	[IDX] Index	(see "Controlling the active interfaces [0x05]", pg. 4-146)	
7	0x00			
8	0x00	[SUBIDX] Subindex		
9	0xFF	[STAT] Status value	(see "Status values [STAT]", pg. 4-123)	
10	0xE8	Checksum	(see "CRC calculation", pg. 4-150)	—
11	0x11			—
12	0x55	Stop byte	—	—
Generator to master				
1	0x06	[ACK] Acknowledgment from the generator	—	—
Generator to master				
1	0xAA	Start byte	—	—
2	0x01	Address byte, master address is always 0x01.	—	—
3	0x06	Number of bytes in the following data unit.	—	—

Byte no.	Value	Meaning	Other information	
4	0x00	[GS] Generator status: RS-232/RS-485 is not the active interface.	(see "Generator status [GS]", pg. 4-121)	[DTA] Data unit (see "Data unit type A", pg. 4-125)
5	0x05	[CMD] Repetition of command: "Control of interface activity".	(see "Command (Command) [CMD]", pg. 4-122)	
6	0x02	[IDX] Index	(see "Controlling the active interfaces [0x05]", pg. 4-146)	
7	0x00			
8	0x00	[SUBIDX] Subindex		
9	0xFF	[STAT] Status value	(see "Status values [STAT]", pg. 4-123)	
10	0x9D	Checksum	(see "CRC calculation", pg. 4-150)	—
11	0xD9			—
12	0x55	Stop byte	—	—

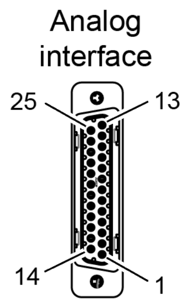
Release control Tab. 4-25

2. AD interface

Note

To determine with which interface variant your generator is equipped:(see "Identifying the generator features", pg. 2-11).

2.1 View



View of 25-pin AD interface Fig. 10477

2.2 Cable requirement

The male connectors and cables must be shielded. The shielding must be connected with the casing ground. Use a suitable male connector that connects the shielding with the generator casing.

2.3 Connection

- On the generator: 25-pin sub-D female connector.
- Necessary counterpart: 25-pin sub-D male connector.

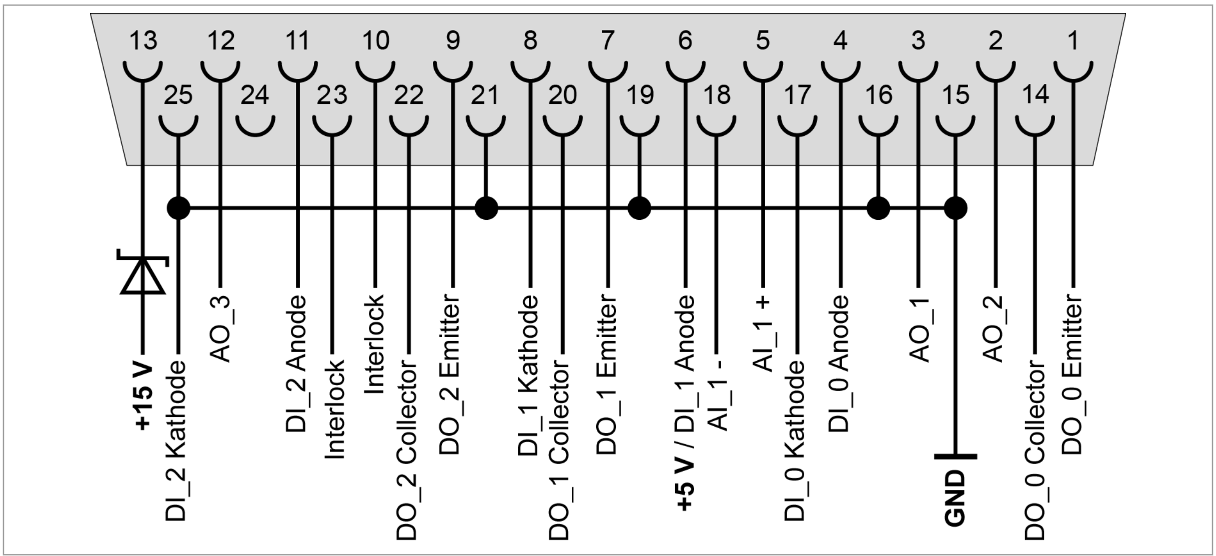
2.4 Meaning of the signals

- DI: digital input.
- DO: digital output.
- AI: analog input.
- AO: analog output.

The following table describes the signals assigned to the inputs and outputs of the AD interface.

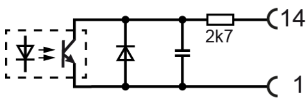
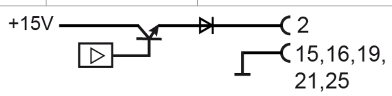
2.5 AD interface – standard version

Pin assignment

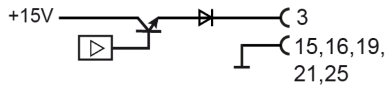
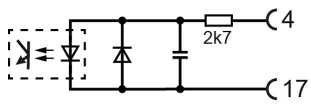
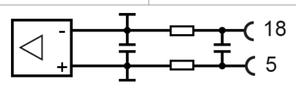
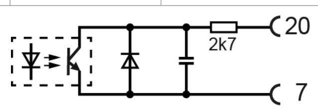


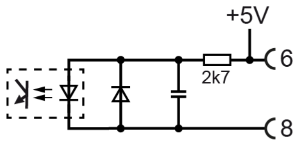
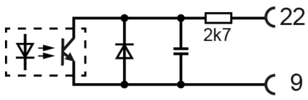
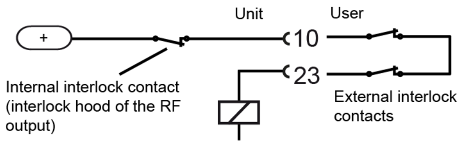
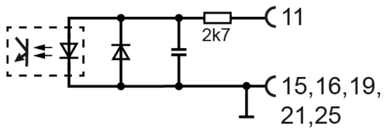
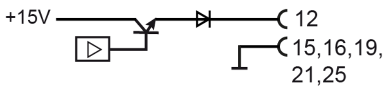
AD interface pin assignment Fig. 10324

Signal description of the AD interface

Pin	Reference pin	Type	Signal name	Description
1	14	DO_0	Power limit-ing	Output shows whether the maximum power is reached. ▪ Transistor conductive = Limit value reached, output power limited by regulator. ▪ Transistor blocked = Limit value not reached.
				
2	15, 16, 19, 21, 25	AO_2	P_r	Output shows actual value P_r[8]. ▪ 0 to 10 V ≙ 0 to 100%.
				

8 P_i = forward power, P_L = load power, P_r = reflected power

<table>
<tr><th>Pin</th><th>Reference pin</th><th>Type</th><th>Signal name</th><th>Description</th></tr>
<tr><td>3</td><td>15, 16, 19, 21, 25</td><td>AO_1</td><td>P_i or P_L</td><td>Output shows either actual value P_i or actual value P_L. Depending on the wiring of digital input DI_1 (pins 6 and 8), the following value is displayed:
▪ Low to DI_1 → Actual value P_i is displayed.
▪ High to DI_1 → Actual value P_L is displayed.
▪ 0 to 10 V ≙ 0 to 100%.</td></tr>
<tr><td colspan="5">
</td></tr>
<tr><td>4</td><td>17</td><td>DI_0</td><td>Power on/off</td><td>Connection of a DC voltage switches on the power.
▪ High → Power on.
▪ Low → Power off.
▪ Falling edge → All alarm and warning messages are reset.
WARNING! Use pulse mode to switch output power on and off with frequency > 1 Hz. Pulsing by rapidly switching power on and off is not an intended use.</td></tr>
<tr><td colspan="5">
</td></tr>
<tr><td>5</td><td>18</td><td>AI_1</td><td>RF set value</td><td>A DC voltage between 0 and 10 V at this input specifies either set value P_i or set value P_L. Depending on the wiring of digital input DI_1 (pins 6 and 8), the following value is displayed:
▪ Low to DI_1 → Set value P_i is preset.
▪ High to DI_1 → Set value P_L is preset.
▪ 0 to 10 V ≙ 0 to 100% (factory setting).
The preset value (0 to 10 V) can be scaled by the factor 0.001 to 1.200.
− Example with the factor 0.850:
0 to 8.50 V ≙ 0 to 100%.
− Example with the factor 1.200:
0 to 12.00 V ≙ 0 to 100%.</td></tr>
<tr><td colspan="5">
</td></tr>
<tr><td>7</td><td>20</td><td>DO_1</td><td>Power on</td><td>Output shows the status of the RF output.
▪ Transistor conductive → Power on.
▪ Transistor blocked → Power off.</td></tr>
<tr><td colspan="5">
</td></tr>
<tr><td>8</td><td>6</td><td>DI_1</td><td>P_i/P_L selection</td><td>The wiring at this input determines whether set value P_i or set value P_L is preset at analog input AI_1.
▪ Low (pin 8 to ground) → Set value P_L.
▪ High (pin 8 high or open) → Set value P_i.</td></tr>
</table>

Pin	Reference pin	Type	Signal name	Description
				
9	22	DO_2	Over temperature	Output shows temperature error. ▪ Transistor conductive → Temperature error. ▪ Transistor blocked → Temperature OK. Note: DO_2 can be configured with TruControl Power in such a way that an existing alarm message (combined alarm) is shown instead of a temperature error.
				
10	23	—	Interlock	Interlock circuit for switching RF power on and off. ▪ Contacts open → Power off. ▪ Contacts connected → Power on. The connection can consist of several external interlock contacts (N.C. contacts) connected in series. As soon as at least one of the contacts is open, the generator switches the output power off. **WARNING!** It is not sufficient to switch off the output power via interlock. When working on the RF output or on the load, you must disconnect the generator from the mains.
				
11	15, 16, 19, 21, 25	DI_2	Pulse mode selection	Connection of a DC voltage activates pulse mode. ▪ Low → Pulse mode off. ▪ High → Pulse mode on.
				
12	15, 16, 19, 21, 25	AO_3	P_i or P_L	Output shows either actual value P_i or actual value P_L. Depending on the wiring of digital input DI_1 (pins 6 and 8), the following value is displayed: ▪ Low to DI_1 → Actual value P_L is displayed. ▪ High to DI_1 → Actual value P_i is displayed. ▪ 0 to 10 V ≙ 0 to 100%.
				
6	—	+5 V DC		
13	—	+15 V DC		

Pin	Reference pin	Type	Signal name	Description
15, 16, 19, 21, 25	—	GND		
24	—	Not assigned		

Signal description of the 25-pin AD interface Tab. 4-26

Specification of inputs and outputs

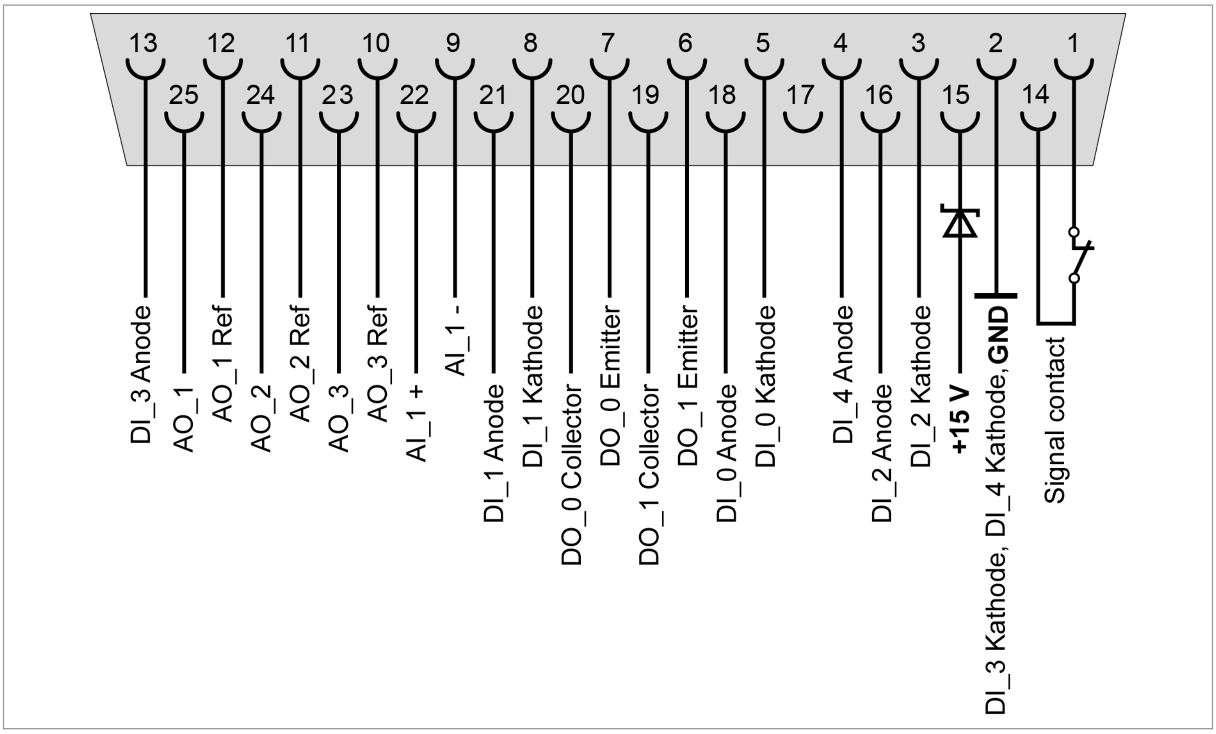
Variant fast analog

Data	Digital inputs			Digital outputs	Analog inputs	Analog outputs	Interlock
	DI_0	DI_1	DI_2				
Number	3			3	1	3	1
Level	+5 to +24 V DC	+5 V DC internally con-nected, open LED cathode	+5 to +24 V DC	+5 to +24 V DC	Standard: 0 to +10 V DC Maximum: 0 to +12.5 V DC	Standard: 0 to +10 V DC Maximum: 0 to +12.5 V DC	≈ 8 V DC
Signal current	–			Max. 9 mA DC	–	0 to 10 mA DC	< 500 mA DC
Input / output resistance	2700 Ω			2700 Ω	100 kΩ	Dynamic	–
External voltage protection / overvoltage protection	±30 V DC	–	±30 V DC	±30 V DC	±30 V DC	±30 V DC	–

Specification of inputs and outputs (25-pin AD interface) Tab. 4-27

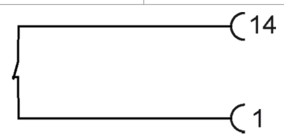
2.6 AD interface – variant 1

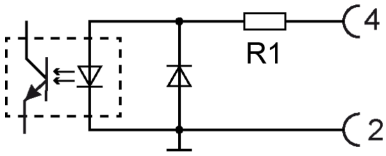
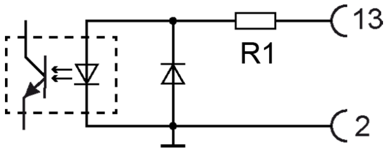
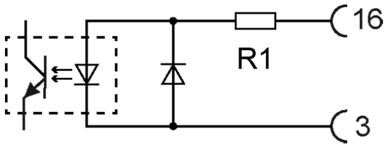
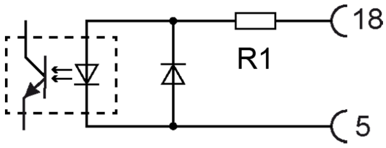
Pin assignment



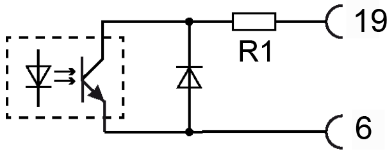
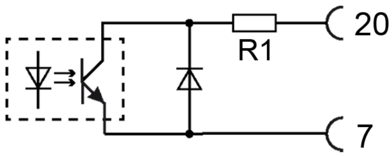
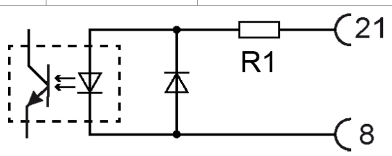
AD interface pin assignment Fig. 10421

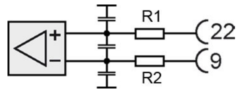
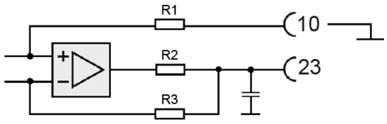
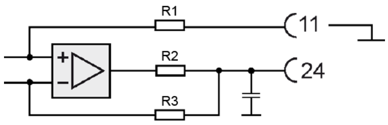
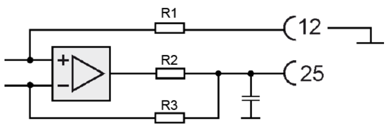
Signal description of the AD interface

Pin	Reference pin	Type	Signal name	Description
1	14	Signal con-tact	—	This contact can be integrated in an interlock circuit by the user. ▪ Signal contact open = RF cable / flange of the RF cable **not** connected. ▪ Signal contact closed = RF cable / flange of the RF cable connected. **WARNING!** This contact offers no safety level and must not be used for external safety devices.
				
2	—	GND	—	Ground

Pin	Reference pin	Type	Signal name	Description
4	2	DI_4	Frequency agility on	Reserved for operation mode AFT (AutoFrequencyTuning / frequency agility). Connection of a DC voltage of 15 V activates operation mode AFT. ▪ Low = AFT off. ▪ High = AFT on.
				
13	2	DI_3	Pulse mode selection	Pulse mode can be enabled at this input: ▪ Low → Pulse mode off, continuous operation on. ▪ High → Pulse mode on. ▪ R1 = 940 Ω.
				
15	2	+15 V	+VDC	Customer auxiliary voltage (+15 V DC, max. 100 mA), ground reference: GND_D **Note:** Only if customer auxiliary voltage is present are the displayed states of digital outputs applicable.
16	3	DI_2	Power regulation mode	The wiring of this input defines how digital input DI 2 is used. ▪ Low = P_i can be specified at DI_2[9] are preset. ▪ High= P_L can be specified at DI_2. ▪ If the pin is not connected, a low-level is preset. ▪ R1 = 940 Ω.
				
17	—	—	—	Not assigned.
18	5	DI_0	Power on	Connection of a DC voltage switches on the output power of the generator. ▪ Low = Power off. ▪ High = Power on. ▪ R1 = 940 Ω.
				

9 P_i = forward power, P_L = load power, P_r = reflected power

Pin	Reference pin	Type	Signal name	Description
19	6	DO_1	Power-on status	Output shows the status of the RF output. ▪ Transistor blocked = No power at output. ▪ Transistor conductive = Power at output. ▪ R1 = 940 Ω.
				
20	7	DO_0	Alarm status	Output shows whether alarm messages are currently pending. ▪ Transistor blocked = Generator ready for use. ▪ Transistor conductive = Alarm message pending, power operation not possible. ▪ R1 = 940 Ω.
				
21	8	DI_1	Scaling the voltage values at the analog inputs and analog outputs to 10%	The values of the analog outputs and the analog input can be scaled at this input. ▪ Low = Default values: 0 to 10 V on analog inputs and analog outputs corresponds to 0 to 100% of the nominal power. ▪ High = Values are reduced by a factor of 10: 0 to 10 V on analog inputs and analog outputs corresponds to 0 to 10% of the nominal power. ▪ If the pin is not connected, a low-level is preset. ▪ R1 = 940 Ω.
				
22	9	AI_1	P_i / P_L	A DC voltage between 0 V and 10 V at this input specifies set value P_i or set value P_L (depending on wiring at digital input DI_2). ▪ 0 to 10 V ≙ 0 to 100% of the nominal power (default scaling). ▪ 0 to 10 V ≙ 0 to 10% of the nominal power (lower scaling). (see pin 21). ▪ The scaling of which value corresponds to 0% of the nominal power and which value corresponds to 100% can be set between 0 and 12 V using the TruControl Power operating software or digital interface (user-defined scaling). ▪ R1 = 50 kΩ, R2 = 50 kΩ.

Pin	Reference pin	Type	Signal name	Description
				
23	10	AO_3	Actual value P_L	Output shows actual value P_L. ▪ 0 to 10 V ≙ 0 to 100% of the nominal power (default scaling). ▪ 0 to 10 V ≙ 0 to 10% of the nominal power (lower scaling). (see pin 21). ▪ R1 = 10 kΩ, R2 = 22 Ω, R3 = 10 kΩ. **Note:** Pin 10 must be connected to GND by the user.
				
24	11	AO_2	Actual value P_r	Output shows actual value P_r. ▪ 0 to 10 V ≙ 0 to 100% of the nominal power (default scaling). ▪ 0 to 10 V ≙ 0 to 10% of the nominal power (lower scaling). (see pin 21). ▪ R1 = 10 kΩ, R2 = 22 Ω, R3 = 10 kΩ. **Note:** Pin 11 must be connected to GND by the user.
				
25	12	AO_1	Actual value P_i	Output shows actual value P_i. ▪ 0 to 10 V ≙ 0 to 100% of the nominal power (default scaling). ▪ 0 to 10 V ≙ 0 to 10% of the nominal power (lower scaling). (see pin 21). ▪ R1 = 10 kΩ, R2 = 22 Ω, R3 = 10 kΩ. **Note:** Pin 12 must be connected to GND by the user.
				

Signal description of the 25-pin AD interface Tab. 4-28

Specification of inputs and outputs

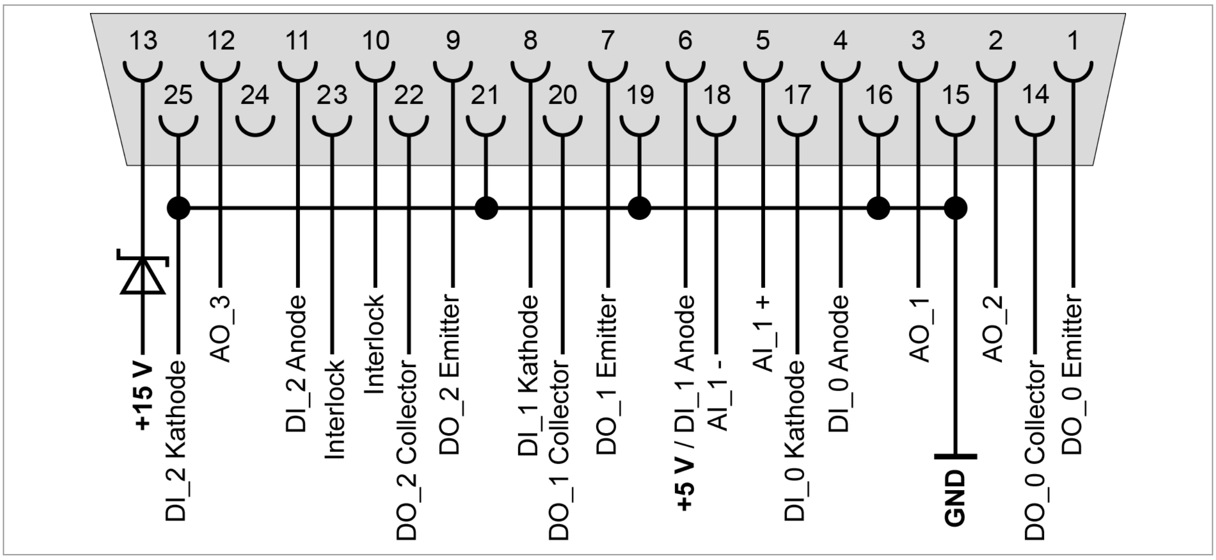
Variant fast analog

Data	Digital inputs	Digital outputs	Analog inputs	Analog outputs	Signal contact
Number	4	2	1	3	1
Level	+5 to +15 V DC +5 to +24 V DC with additional 1000-Ω protective resistor	+5 to +15 V DC +5 to +24 V DC with additional 1000-Ω protective resistor	Standard: 0 to +10 V DC Maximum: 0 to +12.5 V DC	Standard: 0 to +10 V DC Maximum: 0 to +12.5 V DC	30 V AC/DC
Signal current	4 mA to 15 mA DC	Max. 15 mA DC	–	Standard: 0 to +10 mA DC	0.5 A AC/DC
Input / output resistance	1000 Ω	1000 Ω	100 kΩ	Dynamic	–
External voltage protection / overvoltage protection	–	–	±30 V DC	–	–

Specification of inputs and outputs (25-pin AD interface) Tab. 4-29

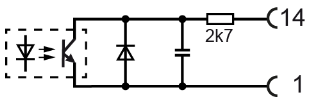
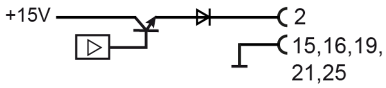
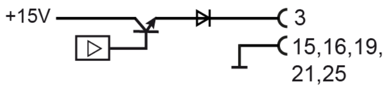
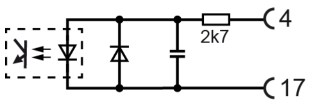
2.7 AD interface – variant 2

Pin assignment

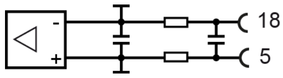
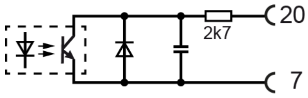
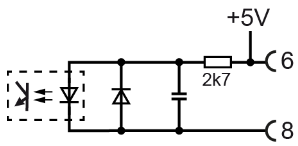
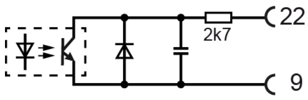


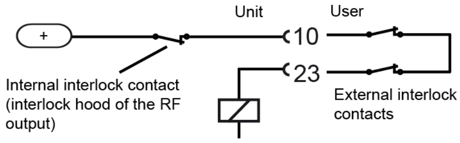
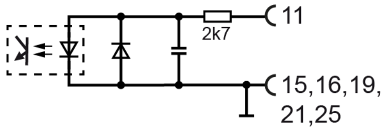
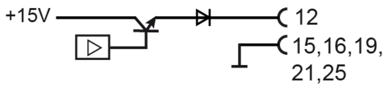
AD interface pin assignment Fig. 10324

Signal description of the AD interface

Pin	Reference pin	Type	Signal name	Description
1	14	DO_0	Power limit-ing	Output shows whether the maximum power is reached. ■ Transistor conductive = Limit value reached, output power limited by regulator. ■ Transistor blocked = Limit value not reached.
				
2	15, 16, 19, 21, 25	AO_2	P_r	Output shows actual value P_r[10]. ■ 0 to 10 V ≙ 0 to 100%.
				
3	15, 16, 19, 21, 25	AO_1	P_i or P_L	Output shows either actual value P_i or actual value P_L. Depending on the wiring of digital input DI_2 (pins 11 and 25), the following value is displayed: ■ Low to DI_2 → Actual value P_L is displayed. ■ High to DI_2 → Actual value P_i is displayed. ■ 0 to 10 V ≙ 0 to 100%.
				
4	17	DI_0	Power on/off	Connection of a DC voltage switches on the power. ■ High → Power on. ■ Low → Power off. ■ Falling edge → All alarm and warning messages are reset. **WARNING!** Use pulse mode to switch output power on and off with frequency > 1 Hz. Pulsing by rapidly switching power on and off is not an intended use.
				

10 P_i = forward power, P_L = load power, P_r = reflected power

Pin	Reference pin	Type	Signal name	Description
5	18	AI_1	RF set value	A DC voltage between 0 and 10 V at this input specifies either set value P_i or set value P_L. Depending on the wiring of digital input DI_2 (pins 11 and 15), the following value is displayed: ▪ Low to DI_2 → set value P_L is preset. ▪ High to DI_2 → set value P_i is preset. ▪ 0 to 10 V ≙ 0 to 100% (factory setting). The preset value (0 to 10 V) can be scaled by the factor 0.001 to 1.200. – Example with the factor 0.850: 0 to 8.50 V ≙ 0 to 100%. – Example with the factor 1.200: 0 to 12.00 V ≙ 0 to 100%.
				
7	20	DO_1	Power on	Output shows the status of the RF output. ▪ Transistor conductive → Power on. ▪ Transistor blocked → Power off.
				
8	6	DI_1	Pulse mode selection	Connection of a DC voltage activates pulse mode. ▪ Low (pin 8 to ground) → Pulse mode on. ▪ High (pin 8 high or open) → Pulse mode off.
				
9	22	DO_2	Over temperature	Output shows temperature error. ▪ Transistor conductive → Temperature error. ▪ Transistor blocked → Temperature OK. **Note** Note: DO_2 can be configured with TruControl Power so that the generator outputs an error message in the event of over temperature.
				

Pin	Reference pin	Type	Signal name	Description
10	23	—	Interlock	Interlock circuit for switching RF power on and off. ▪ Contacts open → Power off. ▪ Contacts connected → Power on. The connection can consist of several external interlock contacts (N.C. contacts) connected in series. As soon as at least one of the contacts is open, the generator switches the output power off. **WARNING!** It is not sufficient to switch off the output power via interlock. When working on the RF output or on the load, you must disconnect the generator from the mains.
				
11	15, 16, 19, 21, 25	DI_2	P_i/P_L selection	The wiring at this input determines whether set value P_i or set value P_L is preset at analog input AI_1. ▪ High → Set value P_i ▪ Low → Set value P_L
				
12	15, 16, 19, 21, 25	AO_3	P_i or P_L	Output shows either actual value P_i or actual value P_L. Depending on the wiring of digital input DI_2 (pins 11 and 15), the following value is displayed: ▪ Low to DI_2 → Actual value P_i is displayed. ▪ High to DI_2 → Actual value P_L is displayed. ▪ 0 to 10 V ≙ 0 to 100%.
				
6	—	+5 V DC		
13	—	+15 V DC		
15, 16, 19, 21, 25	—	GND		
24	—	Not assigned		

Signal description of the 25-pin AD interface Tab. 4-30

Specification of inputs and outputs

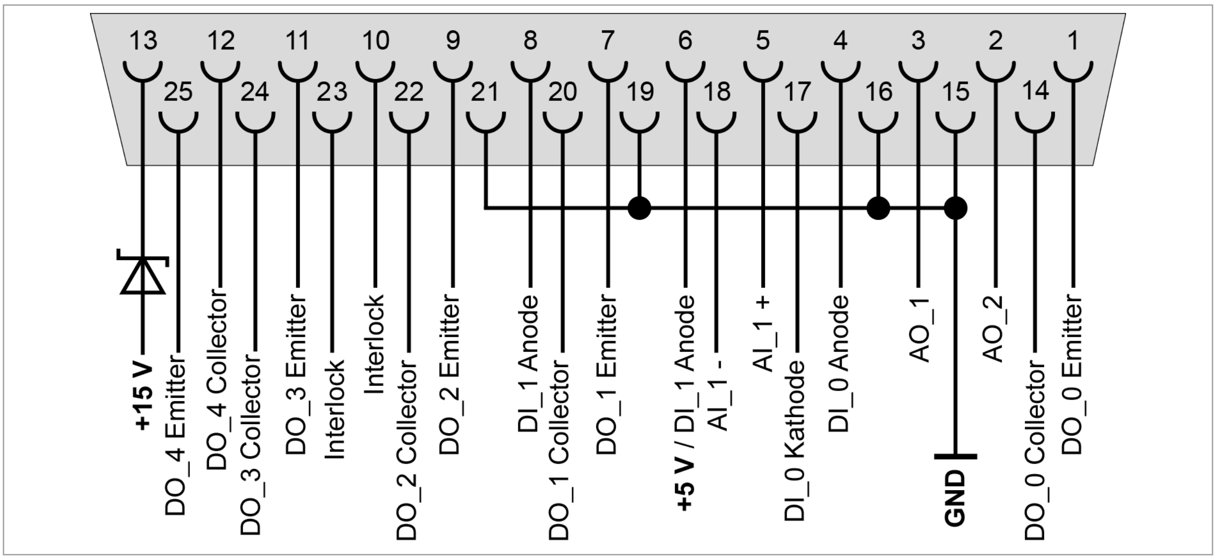
Variant fast analog

Data	Digital inputs			Digital outputs	Analog inputs	Analog outputs	Interlock
	DI_0	DI_1	DI_2				
Number	3			3	1	3	1
Level	+5 to +24 V DC	+5 V DC internally con-nected, open LED cathode	+5 to +24 V DC	+5 to +24 V DC	Standard: 0 to +10 V DC Maximum: 0 to +12.5 V DC	Standard: 0 to +10 V DC Maximum: 0 to +12.5 V DC	≈ 8 V DC
Signal current	–			Max. 9 mA DC	–	0 to 10 mA DC	< 500 mA DC
Input / output resist-ance	2700 Ω			2700 Ω	100 kΩ	Dynamic	–
External voltage pro-tection / overvoltage protection	±30 V DC	–	±30 V DC	±30 V DC	±30 V DC	±30 V DC	–

Specification of inputs and outputs (25-pin AD interface) Tab. 4-31

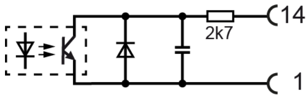
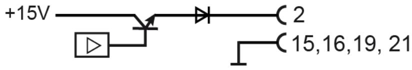
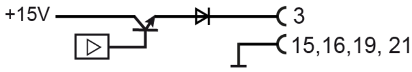
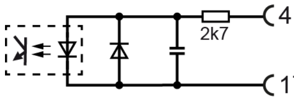
2.8 AD interface – variant 3

Pin assignment

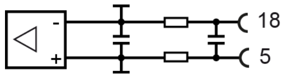
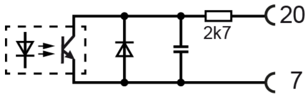
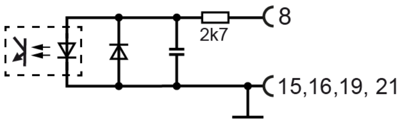
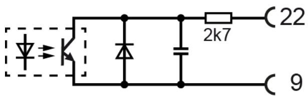


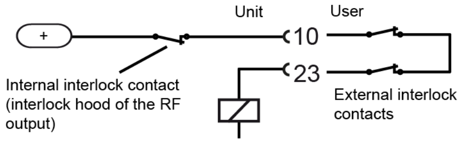
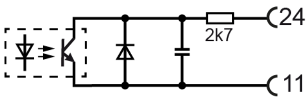
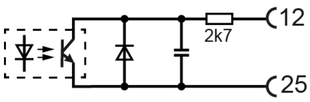
AD interface pin assignment Fig. 10736

Signal description of the AD interface

Pin	Reference pin	Type	Signal name	Description
1	14	DO_0	Power limiting	Output shows whether the maximum power is reached. ▪ Transistor conductive = Limit value reached, output power limited by regulator. ▪ Transistor blocked = Limit value not reached.
				
2	15, 16, 19, 21	AO_2	P_r	Output shows actual value P_r[11]. ▪ 0 to 10 V ≙ 0 to 100%.
				
3	15, 16, 19, 21	AO_1	P_i or P_L	Output shows either actual value P_i or actual value P_L. Depending on the wiring of digital input DI_1 (pins 6 and 8), the following value is displayed: ▪ Low to DI_1 → Actual value P_i is displayed. ▪ High to DI_1 → Actual value P_L is displayed. ▪ 0 to 10 V ≙ 0 to 100%.
				
4	17	DI_0	Power on/off	Connection of a DC voltage switches on the power. ▪ High → Power on. ▪ Low → Power off. ▪ Falling edge → All alarm and warning messages are reset. **WARNING!** Use pulse mode to switch output power on and off with frequency > 1 Hz. Pulsing by rapidly switching power on and off is not an intended use.
				

11 P_i = forward power, P_L = load power, P_r = reflected power

Pin	Reference pin	Type	Signal name	Description
5	18	AI_1	RF set value	A DC voltage between 0 and 10 V at this input specifies either set value P_i or set value P_L. Depending on the wiring of digital input DI_1 (pins 6 and 8), the following value is displayed: ▪ Low to DI_1 → Set value P_i is preset. ▪ High to DI_1 → Set value P_L is preset. ▪ 0 to 10 V ≙ 0 to 100% (factory setting). The preset value (0 to 10 V) can be scaled by the factor 0.001 to 1.200. − Example with the factor 0.850: 0 to 8.50 V ≙ 0 to 100%. − Example with the factor 1.200: 0 to 12.00 V ≙ 0 to 100%.
				
7	20	DO_1	Power on	Output shows the status of the RF output. ▪ Transistor conductive → Power on. ▪ Transistor blocked → Power off.
				
8	15, 16, 19, 21	DI_1	P_i/P_L selection	The wiring at this input determines whether set value P_i or set value P_L is preset at analog input AI_1. ▪ High → Set value P_L. ▪ Low → Set value P_i.
				
9	22	DO_2	Over temperature	Output shows temperature error. ▪ Transistor conductive → Temperature error. ▪ Transistor blocked → Temperature OK. Note: DO_2 can be configured with TruControl Power in such a way that an existing alarm message (combined alarm) is shown instead of a temperature error.
				

Pin	Reference pin	Type	Signal name	Description
10	23	—	Interlock	Interlock circuit for switching RF power on and off. ▪ Contacts open → Power off. ▪ Contacts connected → Power on. The connection can consist of several external interlock contacts (N.C. contacts) connected in series. As soon as at least one of the contacts is open, the generator switches the output power off. **WARNING!** It is not sufficient to switch off the output power via interlock. When working on the RF output or on the load, you must disconnect the generator from the mains.
				
11	24	DO_3	Generator status	Output shows the generator status. ▪ Transistor conductive → Interlock closed and mains voltage ok. ▪ Transistor locked → Interlock open or fault in the mains voltage.
				
12	25	DO_4	CEX-Mode	Output shows CEX-Mode. ▪ Transistor conductive → Output signal of the generator has defined phase shift in relation to clock signal at the generator clock input. ▪ Transistor locked → No defined phase shift.
				
6	—	+5 V DC		
13	—	+15 V DC		
15, 16, 19, 21	—	GND		

Signal description of the 25-pin AD interface — Tab. 4-32

Specification of inputs and outputs

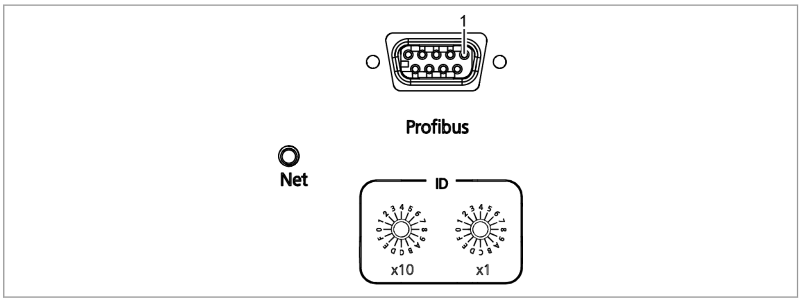
Variant fast analog

Data	Digital inputs		Digital outputs	Analog inputs	Analog outputs	Interlock
	DI_0	DI_1				
Number	2		5	1	2	1
Level	+5 to +24 V DC	GND internally connected, open LED anode	+5 to +24 V DC	Standard: 0 to +10 V DC Maximum: 0 to +12.5 V DC	Standard: 0 to +10 V DC Maximum: 0 to +12.5 V DC	≈ 8 V DC
Signal current	–		Max. 9 mA DC	–	0 to 10 mA DC	< 500 mA DC
Input / output resistance	2700 Ω		2700 Ω	100 kΩ	Dynamic	–
External voltage protection / overvoltage protection	±30 V DC		±30 V DC	±30 V DC	±30 V DC	–

Specification of inputs and outputs (25-pin AD interface) Tab. 4-33

3. Profibus (optional)

3.1 View



Profibus view Fig. 10655

3.2 Connection

- On the generator: 9-pin sub-D female connector.
- Necessary counterpart: 9-pin sub-D male connector.

3.3 Pin assignment

Pin	Assignment
3	$D_{in/out}$ + (positive data line)
4	RTS (ready to send)
5	GND (ground)
6	+5 V
8	$D_{in/out}$ - (negative data line)

Profibus interface pin assignment Tab. 4-34

3.4 Profibus features of the generator

- DPV0 slave.
- The PNO-Ident number is 0x0D35.

3.5 Configuration with the Profibus master

Note

See supplied GSD file.

In the parameter telegram, 17 user-specific parameters are expected. The following parameters must be created:

- Response time of the participant watchdog.
- Format toggle Intel — Motorola.

  For all analog inputs and outputs (byte type AI and AO) with bit width 16, the format must be defined.

  Define format in the user parameter area of the Set Parameter telegram.

  - Byte 3 = 0: Intel format (low-byte first, little endian).
  - Byte 3 = 1: Motorola format (high-byte first, big endian).
- Module selection.

  Four different modules are available for the communication between Profibus master and generator. Before establishing communication, a module must be selected. The following tables show the structure of the modules. By means of the configuration bytes, the Profibus master and the generator can check the number of pieces of data that are to be transmitted and thereby identify the selected module.

  - Configuration bytes for module 1:

    0x57, 0x13, 0x67, 0x23 (20 bytes input/20 bytes output)
  - Configuration bytes for module 2:

    0x97, 0x13, 0xA5 (12 bytes input/6 bytes output)
  - Configuration bytes for module 3:

    0x97, 0x13, 0x57, A5 (28 bytes input/6 bytes output)
  - Configuration bytes for module 4:

    0x57, 0x13, 0x97, 0x67, 0x23, 0xA5 (28 bytes input/ 26 bytes output)
- Synchronous and freeze operation are not provided.

3.6 Module overview

Take control of generator

To be able to set Profibus commands, it is necessary to first take control of the generator.

Conditions

- Power is off.
- No other interface is active, e.g., control unit or TruControl Power.
- Exception: mixed mode of the AD interface is permitted.
- Parameters that are configured in the AD interface as input signal have priority over other interfaces.

➢ Via bit-coded commands: set the bit value to 1 in bit 0.

or

➢ Via Profibus commands: set command word 1 with data 7.

Profibus is now the active interface.

Further steps are necessary before the generator can deliver power .

Module 1

The module includes:

- Transfer of the set values (power) to the generator.
- Reading of actual values and of the generator status.
- The most important commands for generator control in bit-coded form.

Module 2

The module has been optimized with respect to the byte length to keep the cycle period in the Profibus network short.

The module includes:

- A command word in byte-coded form. A generator function can be triggered with each command word (see "Profibus commands", pg. 4-59).

  For command words, the differentiation between write and read commands occurs by means of the sign/the value range:
  - Write commands: 1 to 32767 (0x0001 to 0x7FFF).
  - Read commands: -1 to -32767 (0xFFFF to 0x8001).
- Data for the command word.
- The response of the generator to the command word and the generator status.

Module 3

The module has the same structure as module 2 and also contains the actual values as in module 1.

Module 4

The module is a combination of modules 1 and 2.

Communication for module 2 and module 3

Data from the master to the generator (modules 2 and 3): A data packet, consisting of command word and data for the command word (see "Profibus commands", pg. 4-59) must be completely defined if it is transmitted. If this is not ensured, the command word should first be set to "0" (=no action), the data entered and then the desired command word used.

Data from the generator to the master (modules 2 and 3): The response to the command word, the response data and the "return code" together form a unit and provide information on whether the write/read command was accepted and correctly executed by the generator.

Response to the command word Copy of the command word as feedback (handshake). For the master, this information means that the command word was processed by the generator.

Response data Copy of the data for the command word as feedback (handshake). For the master, this information means that the command word was processed by the generator.

Return code If the read/write commands were processed error-free, a 0 is sent back as return code. In the event of an error, -1 is returned.

Handshake A handshake is achieved by the reflection of the input data (command word and data sent by the master) in the output data (command word and data sent by the generator).

Communication for module 4

Communication behaves as with modules 2 and 3. Only the command words that do not appear in the bit-coded commands and not in the set values are processed, however. Bit-coded commands and set values always have priority over the command words.

3.7 Structure of the modules

The following tables show the structure of the modules according to the configuration bytes in the GSD file.

Module 1

The left side of the table shows the data packet from master to generator. The right side of the table shows the response from the generator.

		Data from the master to the generator			Data from the generator to the master		
Byte	**Bit width**	**Meaning**	**Value**	**Byte type**	**Meaning**	**Value**	**Byte type**
0	16	Set value P_i in W	Example: 980 = 980 W	AO	Actual value P_i in W	Example: 980 = 980 W	AI
1							
2	16	Set value P_L in W	**Note** Specify a value for all 3 variables (see "Regulating power", pg. 7-21).	AO	Actual value P_L in W	Example: 980 = 980 W	AI
3							
4	16	Set value P_r in W		AO	Actual value P_r in W	Example: 427 = 427 W	AI
5							
6	16	Set value $U_{DC\ Bias}$ in V	Example: 277 = 277 V	AO	Actual value $U_{DC\ Bias}$ in V	Example: 277 = 277 V	AI
7							
8	16	Set value U_{RF} in V	Example: 2730 = 2730 V	AO	Actual value U_{RF} in V	Example: 2730 = 2730 V	AI
9							
10	16	Set value I_{RF} in A	Example: 166 = 166 A	AO	Actual value I_{RF} in A	Example: 166 = 166 A	AI
11							
12	16	Not used (byte value = 0)	—	AO	Not used (byte value = 0)	—	AI
13							
14	16	Not used (byte value = 0)	—	AO	Arc counter	—	AI
15							
16(A)	8	Bit-coded commands	(see "Bit-coded commands", pg. 4-58)	DO	Status bytes	(see "Status bytes", pg. 4-58)	DI
17(B)	8			DO			DI
18(C)	8			DO			DI
19(D)	8			DO			DI

Module 1/master to generator/generator to master Tab. 4-35

Module 2

The left side of the table shows the data packet from master to generator. The right side of the table shows the response from the generator.

		Data from the master to the generator			Data from generator to master		
Byte	**Bit width**	**Meaning**	**Value**	**Byte type**	**Meaning**	**Value**	**Byte type**
0	8	Command word (LSB)	(see "Profibus commands", pg. 4-59)	DO	Command word (LSB)	(see "Profibus commands", pg. 4-59)	DI
1	8	Command word (MSB)		DO	Command word (MSB)		DI
2	8	Data for the command word (LSB)		DO	Response to command word (LSB)		DI
3	8	Data for the command word		DO	Response to command word		DI
4	8	Data for the command word		DO	Response to command word		DI
5	8	Data for the command word (MSB)		DO	Response to command word (LSB)		DI
6(A)	8	—			Return Code (LSB)	(see "Return code", pg. 4-59)	DI
7(B)	8	—			Return Code (MSB)		DI
8(A)	8	—			Status bytes	(see "Status bytes", pg. 4-58)	DI
9(B)	8	—					DI
10(C)	8	—					DI
11(D)	8	—					DI

Module 2: data packet master to generator/generator to master Tab. 4-36

Module 3

The left side of the table shows the data packet from master to generator. The right side of the table shows the response from the generator.

		Data from the master to the generator			Data from the generator to the master		
Byte	**Bit width**	**Meaning**	**Value**	**Byte type**	**Meaning**	**Value**	**Byte type**
0	8	Command word (LSB)	(see "Profibus commands", pg. 4-59).	DO	Command word (LSB)	(see "Profibus commands", pg. 4-59).	DI
1	8	Command word (MSB)		DO	Command word (MSB)		DI
2	8	Data for the command word (LSB)		DO	Data for the command word (LSB)		DI
3	8	Data for the command word		DO	Data for the command word		DI
4	8	Data for the command word		DO	Data for the command word		DI
5	8	Data for the command word (MSB)		DO	Data for the command word (MSB)		DI
6(A)	8	—			Return Code (LSB)	(see "Return code", pg. 4-59).	DI
7(B)	8	—			Return Code (MSB)		DI
8(A)	8	—			Status bytes	(see "Status bytes", pg. 4-58).	DI
9(B)	8	—					DI
10(C)	16	—					DI
11(D)	8	—					DI
12	16	—			Actual value P_i in W	Example: 980 = 980 W	AI
13							
14	16	—			Actual value P_L in W	Example: 980 = 980 W	AI
15							
16	16	—			Actual value P_r in W	Example: 427 = 427 W	AI
17							
18	16	—			Not used (byte value = 0)	—	AI
19							
20	16	—			Arc counter	—	AI
21							
22	16	—			Not used (byte value = 0)	—	AI
23							
24	16	—			Not used (byte value = 0)	—	AI
25							
26	16	—			Not used (byte value = 0)	—	AI
27							

Module 3/master to generator/generator to master Tab. 4-37

Module 4

The left side of the table shows the data packet from master to generator. The right side of the table shows the response from the generator.

		Data from the master to the generator			Data from the generator to the master		
Byte	**Bit width**	**Meaning**	**Value**	**Byte type**	**Meaning**	**Value**	**Byte type**
0	16	Set value P_i in W	Example: 980 = 980 W	AO	Actual value P_i in W	Example: 980 = 980 W	AI
1							
2	16	Set value P_L in W	**Note** Specify a value for all 3 variables (see "Regulating power", pg. 7-21).	AO	Actual value P_L in W	Example: 980 = 980 W	AI
3							
4	16	Set value P_r in W		AO	Actual value P_r in W	Example: 427 = 427 W	AI
5							
6	16	Set value $U_{DC\ Bias}$ in V	Example: 277 = 277 V	AO	Actual value $U_{DC\ Bias}$ in V	Example: 277 = 277 V	AI
7							
8	8	Set value U_{rf} in V	Example: 2730 = 2730 V	AO	Actual value U_{rf} in V	Example: 2730 = 2730 V	AI
9							
10	16	Set value I_{rf} in A	Example: 166 = 166 A	AO	Actual value I_{rf} in A	Example: 166 = 166 A	AI
11							
12	16	Not used (byte value = 0)	—	AO	Not used (byte value = 0)	—	AI
13							
14	16	Not used (byte value = 0)	—	AO	Arc counter	—	AI
15							
16(A)	8	Bit-coded commands	(see "Bit-coded commands", pg. 4-58).	DO	Status bytes	(see "Status bytes", pg. 4-58).	DI
17(B)	8			DO			DI
18(C)	8			DO			DI
19(D)	8			DO			DI
20	8	Command word (LSB)	(see "Profibus commands", pg. 4-59).	DO	Command word (LSB)	(see "Profibus commands", pg. 4-59).	DI
21	8	Command word (MSB)		DO	Command word (MSB)		DI
22	8	Data for the command word (LSB)		DO	Data for the command word (LSB)		DI
23	8	Data for the command word		DO	Data for the command word		DI
24	8	Data for the command word		DO	Data for the command word		DI
25	8	Data for the command word (MSB)		DO	Data for the command word (MSB)		DI
26(A)	8	—			Return-Code (LSB)	(see "Return code", pg. 4-59).	DI
27(A)	8	—			Return-Code (MSB)		DI

Module 4/master to generator/generator to master Tab. 4-38

Bit-coded commands

<table>
<tr><th>Byte</th><th>Bit</th><th colspan="3">Meaning</th></tr>
<tr><td rowspan="8">A</td><td>0</td><td colspan="3">1 = Profibus is the active interface</td></tr>
<tr><td>1</td><td colspan="3">1 = Power on (command only active if no alarm message pending)</td></tr>
<tr><td>2</td><td colspan="3">Not used (bit value = 0)</td></tr>
<tr><td>3</td><td colspan="3">Not used (bit value = 0)</td></tr>
<tr><td>4</td><td colspan="3">1 = Reset of all alarm messages</td></tr>
<tr><td>5</td><td colspan="3">1 = Reset of all warning messages</td></tr>
<tr><td>6</td><td colspan="3">Not used (bit value = 0)</td></tr>
<tr><td>7</td><td colspan="3">Not used (bit value = 0)</td></tr>
<tr><td rowspan="11">B</td><td>0</td><td colspan="3">0 = Continuous operation, 1 = Pulsed operation</td></tr>
<tr><td>1</td><td colspan="3">0 = Internal pulse source, 1 = External pulse source</td></tr>
<tr><td rowspan="5">2 , 3</td><td>Bit 3</td><td>Bit 2</td><td>—</td></tr>
<tr><td>0</td><td>0</td><td>Not permitted</td></tr>
<tr><td>0</td><td>1</td><td>Permanently set internal frequency</td></tr>
<tr><td>1</td><td>0</td><td>Not permitted</td></tr>
<tr><td>1</td><td>1</td><td>Generator uses external synchronization signal</td></tr>
<tr><td>4</td><td colspan="3">Not used (bit value = 0)</td></tr>
<tr><td>5</td><td colspan="3">Not used (bit value = 0)</td></tr>
<tr><td>6</td><td colspan="3">Not used (bit value = 0)</td></tr>
<tr><td>7</td><td colspan="3">Not used (bit value = 0)</td></tr>
<tr><td>C</td><td>—</td><td colspan="3">Not used (byte value = 0)</td></tr>
<tr><td>D</td><td>—</td><td colspan="3">Not used (byte value = 0)</td></tr>
</table>

Bit-coded commands Tab. 4-39

3.8 Status bytes

Byte	Bit	Meaning
A	0	1 = Generator is controlled by the Profibus interface
	1	1 = Power on
	2	not used
	3	1 = Supply voltage on
	4	1 = At least one alarm message pending
	5	1 = At least one warning message pending
	6	1 = Alarm message - temperature
	7	Not used

Byte	Bit	Meaning
B	0	Not used
	1	Not used
	2	1 = Clock signal synchronized
	3	Not used
	4	1 = Interlock closed
	5	Not used
	6	Not used
	7	Not used
C	—	Not used
D	0	Not used
	1	Not used
	2	Arc suppression not possible
	3	Not used
	4	Not used
	5	Not used
	6	Not used
	7	Not used

Status bytes Tab. 4-40

3.9 Return code

Byte	Meaning
A	▪ -1 = error ▪ 0 = No error. ▪ 3 = Unknown command.
B	

Return code Tab. 4-41

3.10 Profibus commands

Commands for power regulation

Command word (2 bytes)		Data type	Meaning	Data for the command word (4 bytes)
write	read			
0	0	—	No action	—
1	—	—	Active interface	▪ 0 = Profibus is not the active interface. ▪ 7 = Profibus is the active interface.

Command word (2 bytes)		Data type	Meaning	Data for the command word (4 bytes)
write	read			
—	-1	—	Active interface	▪ 1 = RS-232 interface. ▪ 2 = Service interface. ▪ 3 = DeviceNet. ▪ 4 = AD interface. ▪ 5 = RS-485 interface. ▪ 6 = Ethernet. ▪ 7 = Profibus. ▪ 8 = EtherCAT.
2	-2	—	Set value P_i	Resolution 1 W. Example: 980 = 980 W.
3	-3	—	Set value P_L	
4	-4	—	Set value P_r (max. 600 W)	
—	-5	—	Actual value P_i	
—	-6	—	Actual value P_L	
—	-7	—	Actual value P_r	
8	—	—	Reset pending alarm mes-sages	Contents of the data not relevant.
—	-8	—	Number of pending alarm messages	—
9	—	—	Reset pending warning mes-sages	Contents of the data not relevant.
—	-9	—	Number of pending warning messages	—
10	-10	—	Power on/off	▪ 0 = Off. ▪ 1 = On.
12	-12	—	Pulse source	▪ 0 = Internal. ▪ 1 = External.
13	-13	—	Clock source	▪ 1 = Internal permanent frequency. ▪ 3 = External synchronization signal.
14	-14	—	Pulse mode	▪ 0 = Continuous operation. ▪ 1 = Pulse mode.
15	-15	—	Pulse frequency	Resolution 1 Hz. Example: 1000 = 1000 Hz.
16	-16	—	Duty cycle (pulse mode)	Resolution 1 % to 99 % Example: 35 = 35 %.
—	-17	—	Cooling plate temperature, position 1	Resolution 1 °C. Example: 47 = 47 °C.
—	-18	—	Cooling plate temperature, position 2	
—	-19	—	Internal power supply tem-perature	
—	-20	—	Temperature of regulator cir-cuit board	
—	-21	—	Temperature - RF detector	
22	-22	—	Phase synchronization	Phase shift 0 – 355.9°, resolution: 1/10 degree. Example: 485 = 48.5 degrees.

Command word (2 bytes)		Data type	Meaning	Data for the command word (4 bytes)
write	read			
23	-23	—	Mode selection - phase offset/frequency offset	▪ 0 = Phase offset. ▪ 1 = Frequency offset.
24	-24	—	Frequency (deviation from 13.56 MHz)	▪ -678 to +678 kHz. ▪ Optional: -135.6 to +135.6 kHz. Resolution: 1 Hz.
26	-26	—	Rising ramp	Resolution 1 W/s or 1 V/s or 1 ms (dependent on the ramp type, see command word 29). ▪ Min. value: 1.
27	-27	—	Falling ramp	Resolution 1 W/s or 1 V/s or 1 ms (dependent on the ramp type, see command word 29). ▪ Min. value: 1.
28	-28	—	Ramp mode	▪ 0 = Ramp not active. ▪ 1 = Power on ramp (ramp active when switching on the power). ▪ 3 = Power on ramp and set value ramp (ramp active when switching on the power and on set value change).
29	-29	—	Ramp type	Defines the response of the ramp that was written with command word 26 or 27. ▪ 0 = Ramp duration in ms. ▪ 1 = Ramp slope/ramp gradient in W/s.
—	-400 to -419	—	Alarm messages	If alarm messages are pending, they can be read out with these command words.
—	-420 to -439	—	Warning messages	If warning messages are pending, they can be read out with these command words.

Commands for power regulation Tab. 4-42

Commands for matchbox

Command word (2 bytes)		Data type	Meaning	Data for the command word (4 bytes)
write	read			
—	-348	UINT8	Ready status of the matchbox.	Parameter indicates whether the matchbox was found and correctly configured.
450	-450	UINT8	Matchbox mode.	▪ 0 = Automatic. ▪ 1 = DC automatic. ▪ 2 = Recipe.
—	-451	UINT16	Matchbox found on SystemPort.	▪ 0 = No matchbox found. ▪ 1 = Matchbox found.
452	-452	UINT8	Selection of the matchbox.	If only one SystemPort matchbox is connected to the generator, "1" must be selected.
453	-453	UINT8	Activity control.	▪ 0 = Off. ▪ 1 = Active.
455	-455	UINT16	Recipe number.	0 to 32.

<table>
<tr><th colspan="2">Command word (2 bytes)</th><th rowspan="2">Data type</th><th rowspan="2">Meaning</th><th rowspan="2">Data for the command word (4 bytes)</th></tr>
<tr><th>write</th><th>read</th></tr>
<tr><td>—</td><td>-456</td><td>UINT16</td><td>Status display of the match-box.</td><td>▪ Bit 0.
− 0 = No alarm.
− 1 = Alarm.
▪ Bit 1.
− 0 = No warning.
− 1 = Warning.
▪ Bit 2.
− 0 = Plasma off.
− 1 = Plasma on.
▪ Bit 3.
− 0 = System not ready.
− 1 = System ready.
▪ Bit 4.
− 0 = Interlock circuit closed.
− 1 = Interlock circuit open.
▪ Bit 5.
− 0 = Recipe stopped.
− 1 = Recipe is performed. Note: While a recipe is running, no other recipe can be selected.
▪ Bits 6 to 8 not used.
▪ Bit 9.
− 0 = Status of stepper motor ok.
− 1 = Overcurrent at stepper motor.
▪ Bit 10.
− 0 = Cooling water ok.
− 1 = Cooling water alarm.
▪ Bit 11.
− 0 = $U_{dc\ bias}$ ok.
− 1 = $U_{dc\ bias}$ too high.
▪ Bit 12.
− 0 = AC voltage ok.
− 1 = AC voltage too high.
▪ Bit 13.
− 0 = AC current ok.
− 1 = AC current too high.
▪ Bit 14.
− 0 = Matchbox closed.
− 1 = Open matchbox cover.
▪ Bit 15.
− 0 = SystemPort has only read permission.
− 1 = SystemPort has write permission.</td></tr>
<tr><td>—</td><td>-457</td><td>UINT16</td><td>Actual value of the tune capacitor/ignition position.</td><td>Position C_T
▪ Range: 0 to 1000.</td></tr>
<tr><td>—</td><td>-458</td><td>UINT16</td><td>Actual value of the load capacitor/ignition position.</td><td>Position C_L
▪ Range: 0 to 1000.</td></tr>
</table>

Command word (2 bytes)		Data type	Meaning	Data for the command word (4 bytes)
write	read			
459	-459	UINT16	Set value of the tune capacitor/ignition position.	Position C_T. ▪ Range: 0 to 1000.
460	-460	UINT16	Set value of the load capacitor/ignition position.	Position C_L. ▪ Range: 0 to 1000.
—	-461	UINT16	Actual value of "Z".	Range: 0 to 1000.
—	-462	UINT16	Actual value of phase.	Range: 0 to 1000.
463	-463	UINT16	Set value of the tune capacitor/"Plasma-on" position.	Position C_T. ▪ Range: 0 to 1000
464	-464	UINT16	Set value of the load capacitor/"Plasma-on" position.	Position C_L. ▪ Range: 0 to 1000.
465	-465	UINT8	Start matchbox.	▪ 0 = Off. ▪ 1 = Start.
466	-466	UINT8	Start Automatic mode.	▪ 0 = Off ▪ 1 = Start
467	-467	UINT8	Freeze condition.	▪ 0 = Off. ▪ 1 = Freeze.
—	-468	UINT16	DC_{bias} max.	[V] Max. value depends on matchbox connected.
—	-469	UINT16	U_{rf} peak max.	[V] Max. value depends on matchbox connected.
—	-470	UINT16	U_{rf} rms max.	[V] Max. value depends on matchbox connected.
—	-471	UINT16	I_{rf} max.	[A] Max. value depends on matchbox connected.
95	-95	UINT16	Set value U_{dc} (DC_{bias}).	[V] Max. value depends on matchbox connected.
96	-96	UINT16	Set value U_{rf}	[V] Max. value depends on matchbox connected.
97	-97	UINT16	Set value I_{rf}	[A] Max. value depends on matchbox connected.
—	-98	UINT16	Actual value U_{dc} (DC_{bias}).	[V] Max. value depends on matchbox connected.
—	-99	UINT16	Actual value U_{rf}	[V] Max. value depends on matchbox connected.
—	-100	UINT16	Actual value I_{rf}	[A] Max. value depends on matchbox connected.
—	-115	UINT8	Unit of I_{rf}	▪ 0 = This value is not measured in the connected matchbox. ▪ 1 = A. ▪ 10 = 0.1 A.
—	-116	UINT8	Unit of U_{rf}	▪ 0 = This value is not measured in the connected matchbox. ▪ 1 = V. ▪ 10 = 0.1 V.
—	-117	UINT8	DC_{bias} unit	▪ 0 = This value is not measured in the connected matchbox. ▪ 1 = V. ▪ 10 = 0.1 V.

Commands for matchbox Tab. 4-43

Commands for arc management

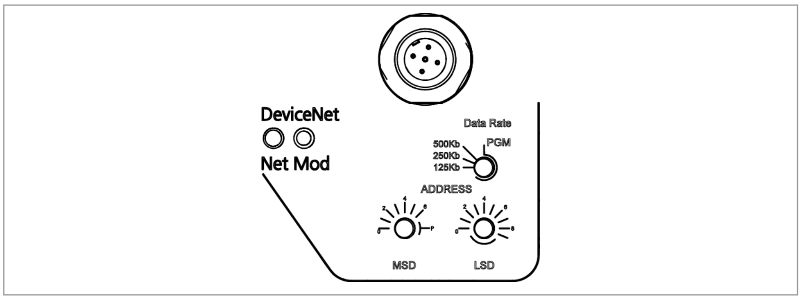
Command word (2 bytes)		Data type	Meaning	Data for the command word (4 bytes)
write	read			
290	-290	SINT32	Arc detection.	▪ 0 = Inactive. ▪ 1 = Active.
—	-110	SINT32	Arc counter.	
111	-111	SINT32	Reset Arc counter.	▪ 0 = no action. ▪ 1 = Reset.
291	-291	SINT32	Arc handling.	▪ 0 = Inactive. ▪ 1 = Active.
310	-310	SINT32	Maximum P_r to start.	Resolution 1 W. Example: 421 ≙ 421 W. ▪ Min. value: 10 W. ▪ Max. value: Prmax.
311	-311	SINT32	Minimum P_i to start.	Resolution 1 W. Example: 985 ≙ 985 W. ▪ Min value: 30 W. ▪ Max. value: Pimax.
302	-302	SINT32	Arc-management delay.	Resolution 1 ms. Example: 235 ≙ 235 ms. ▪ Min. value: 0 ms. ▪ Max. value: 10000 ms.
300	-300	SINT32	Detection mode.	▪ 0 = External. ▪ 1 = P_r Threshold. ▪ 2 = P_r Slope. ▪ 3 = P_r/P_i Threshold. ▪ 4 = P_r/P_i Slope. ▪ 5 = Extern + P_r Threshold. ▪ 6 = Extern + P_r Slope. ▪ 7 = Extern + P_r/P_i Threshold. ▪ 8 = Extern + P_r/P_i Slope.
299	-299	SINT32	Threshold P_r	Resolution 1 W. Example: 421 ≙ 421 W. ▪ Min. value: 10 W. ▪ Max. value: Prmax.
298	-298	SINT32	Slope P_r	Resolution 1 W/µs. Example: 123 ≙ 123 W/µs. ▪ Min. value: 10 W/µs. ▪ Max. value: Prmax W/µs.
315	-315	SINT32	Arc sync output.	▪ 0 = Inactive. ▪ 1 = Active.
297	-297	SINT32	Threshold P_r/P_i	Resolution 1 % Example: 45 ≙ 45%. ▪ Min. value: 1 %. ▪ Max. value: 100 %.

Command word (2 bytes)		Data type	Meaning	Data for the command word (4 bytes)
write	read			
296	-296	SINT32	Slope P_r/P_i	Resolution 1 %/µs. Example: 45 ≙ 45 %/µs. ▪ Min. value: 1 %/µs. ▪ Max. value: 100 %/µs.
312	-312	SINT32	Sample count.	Resolution 1. Example: 45 ≙ 45 samples. ▪ Min. value: 1. ▪ Max. value: 511.
—	-295	SINT32	Arc rate.	Resolution 1 arc/s.
294	-294	SINT32	Arc rate limit.	Resolution 1 arc/s. Example: 812 ≙ 812 arc/s. ▪ Min. value: 0.
293	-293	SINT32	Handling mode.	▪ 0 = Power off. ▪ 1 = Cut arc activeley.
305	-305	SINT32	Arc handling delay.	Resolution 1 µs. Example: 123 ≙ 123 µs. ▪ Min. value: 0 µs. ▪ Max. value: 1000 µs.
306	-306	SINT32	Arc suppression time.	Resolution 1 µs. Example: 85 ≙ 85 µs. ▪ Min. value: 5 µs. ▪ Max. value: 500 µs.
304	-304	SINT32	Burst pulse on time.	Resolution 1 µs. Example: 85 ≙ 85 µs. ▪ Min. value: 10 µs. ▪ Max. value: 500 µs.
313	-313	SINT32	Arc detection delay time.	Resolution 1 µs. Example: 485 ≙ 485 µs. ▪ Min. value: 0 µs. ▪ Max. value: 1000 µs.
308	-308	SINT32	Pulse count in burst.	Resolution 1 pulse. Example: 485 ≙ 485 pulses. ▪ Min. value: 0. ▪ Max. value: 10000.
307	-307	SINT32	Arc retry count.	Resolution 1 repetition. Example: 5 ≙ 5 repetitions. ▪ Min. value: 0 (no limit, infinite number of pulse packet repetitions).

Commands for arc management Tab. 4-44

4. DeviceNet (optional)

4.1 Position



DeviceNet view Fig. 10484

4.2 Connection

- On the generator: 5-pin M12 SPEEDCON male connector, A-coded.
- Necessary counterpart: 5-pin M12 SPEEDCON coupling, A-coded.
  Part numbers (Phoenix Contact):
  - 1432664 - straight
  - 1432677 - angled

4.3 Pin assignment

Pin	Assignment
1	Shielding
2	V+
3	V-
4	CAN_high
5	CAN_low

DeviceNet pin assignment Tab. 4-45

4.4 Status LEDs

The two LED indicators, **Net** and **Mod**, are multi-color LEDs displaying multiple operating states.

LED Net DeviceNet: network status

The LED Net indicator displays bus activity during DeviceNet operation.

Status	Description
Off	▪ The generator has no supply voltage. ▪ The device is not switched on, please observe status LED. ▪ No network voltage present. ▪ "Duplicate MAC identity test" not yet completed.
Green, flashing	The generator is online and has completed the "Duplicate MAC Identity Test". A complete connection setup could not be performed, however. The generator can not yet be operated in the network.
Green, steady	The generator has established the connection to the master. It is online and can be operated in the network.
Yellow, flashing	At least one I/O connection is in time-out state.
Yellow, steady	Error prevents communication with the network, e.g., duplicate DeviceNet ID, bus is offline.
Yellow-green, flashing	Network access fault.

DeviceNet LED Net Tab. 4-46

DeviceNet LED Mod: module status

The LED Mod indicator displays the generator's status.

Status	Description
Off	Generator has no supply voltage.
Green, steady	Generator is in normal operating mode.
Green, flashing	Generator is: ▪ in standby mode ▪ is not or is incorrectly configured.
Yellow, flashing	Fault which can be reset.
Yellow, steady	Fault which cannot be reset; module may be defective.
Yellow-green, flashing	Self-test

DeviceNet LED Mod Tab. 4-47

4.5 ODVA DeviceNet

The DeviceNet interface corresponds to ODVA DeviceNet specification Release 2.0 Errata 5. The specification is obtained from ODVA (www.odva.org). Generator profile 0x20 was implemented in this context.

- Vendor name: Huettinger Elektronik GmbH + Co. KG.
- Vendor ID: 464.

4.6 Protocol

- Both explicit and poll messages may be sent.
- The generator operates as a Group 2 only server in accordance with the RF power generator device profile.
- Device type 0x20 (see DeviceNet specification volume II, chapter 3, section 3-30)
- All DeviceNet objects were implemented in accordance with the ODVA specification:
  - Volume 1: Common industrial protocol (CIP) edition 3.11.
  - Volume 3: DeviceNet adaption of CIP edition 3.11.
- The following objects were implemented (according to CIP RF-power generator profile):
  - Identify
  - Message router
  - DeviceNet
  - Connection
  - Assembly
  - S-Device supervisor (see "Device supervisor / Class 0x30", pg. 4-68)
  - S-Analog sensor (see "Analog sensor / Class 0x31", pg. 4-69)
  - S-Single stage controller (see "Single stage controller / Class 0x33", pg. 4-70)
  - S-Analog actuator (see "Analog actuator / Class 0x32", pg. 4-71)
  - Selection (see "Selection / Class 0x2E", pg. 4-72)
  - Register (see "Register / Class 0x07", pg. 4-72)
  - Bit coded values (see "Bit coded values / Class 0x65", pg. 4-73)

4.7 Explicit messages

Device supervisor / Class 0x30

Name	No.	Data length in bytes	Access rule
Instances			
Instance 1	1		
Class Attributes			

Name	No.	Data length in bytes	Access rule
Revision	1	2	Get
Max Instance	2	2	Get
Instance Attributes			
DeviceType	3	8	Get
SEMI Standard Revision Level	4	20	Get
Manufacturer's Name	5	20	Get
Manufacturer's Model Number	6	20	Get
Software Revision Level	7	6	Get
Hardware Revision Level	8	6	Get
State of the instance	11	1	Get
Alarm Enable Bit	12	1	Get
Exception detail Alarm	13	0	Get
Exception detail Warning	14	0	Get
Alarm Enable	15	1	Get/Set
Warning Enable Bit	16	1	Get/Set
Output Power Enable	96	1	Get/Set
Subclass	99	2	Get
Services			
Get_Attributes_Single	0x0E		
Set_Attributes_Single	0x10		
Reset	0x05		
Start	0x06		
Stop	0x07		
Abort	0x4B		
Recover	0x4C		
Perform_Diagnostics	0x4E		

Device supervisor Tab. 4-48

Analog sensor / Class 0x31

Name	No.	Data length in bytes	Access rule
Instances			
Forward Power	1		
Reflected Power	2		
Delivered Power	3		
Frequency	6		
CT Position	102		
CL Position	103		
Udcbias from matchbox	104		
Urf from matchbox	105		
Irf from matchbox	106		

Name	No.	Data length in bytes	Access rule
Forward Power in percent	107		
Reflected Power in percent	108		
Delivered Power in percent	109		
Class Attributes			
Revision	1	2	Get
Max Instance	2	2	Get
Instance Attributes			
Data type	3	1	See spec.
Data Units	4	2	See spec.
Reading Valid	5	1	Get
Value	6	2/4	Get
Status	7	1	
Services			
Get_Attributes_Single	0x0E		
Set_Attributes_Single	0x10		

Analog sensor Tab. 4-49

Single stage controller / Class 0x33

Name	No.	Data length in bytes	Access rule
Instances			
Output Forward Power Regulation	1		
Output Delivered Power Regulation	2		
Output Frequency Regulation	3		
Pulse Period	92		
Pulse DutyCycle	93		
Output Reflected Power Regulation	100		
Output Udcbias Regulation	101		
Output Urf Regulation	102		
Output Irf Regulation	103		
Class Attributes			
Revision	1	2	Get
Max Instance	2	2	Get
Instance Attributes			
Data type	3	1	Get/Set
Data Units	4	2	Get/Set
Setpoint	6	2/4	Get/Set
Status	10	1	Get
Pulse Enable	90	1	Get/Set
Second Setpoint	91	4	Get
Pulse Period	92	4	Get/Set

Name	No.	Data length in bytes	Access rule
Pulse DutyCycle	93	2	Get/Set
Sync Enable / Pulse Source	94	1	Get/Set
Ramp State	96	2	Get/Set
Subclass	99	2	Get
Services			
Get_Attributes_Single	0x0E		
Set_Attributes_Single	0x10		

Single stage controller Tab. 4-50

Analog actuator / Class 0x32

Name	No.	Data length in bytes	Access rule
Instances			
Output Power	1		
Output Frequency	2		
CT Ignition Position	3		
CL Ignition Position	4		
CT Plasma On Position	102		
CL Plasma On Position	103		
Matchbox Channel Select	105		
Matchbox Recipe Number	106		
Class Attributes			
Revision	1	2	Get
Max Instance	2	2	Get
Instance Attributes			
Data type	3	1	See spec.
Data Units	4	2	See spec.
Reading Valid	5	1	Get
Value	6	1/2/4	Set
Status	7	1	Get
Services			
Get_Attributes_Single	0x0E		
Set_Attributes_Single	0x10		

Analog actuator Tab. 4-51

Selection / Class 0x2E

Name	No.	Data length in bytes	Access rule
Instances			
Instance 1	1		
Class Attributes			
Revision	1	2	Get
Max Instance	2	2	Get
Instance Attributes			
Status	1	1	Get
Max_destinations	2	2	Get
Number_of_destinations	3	2	Get
Destination_list	4	14	Get
Max_sources	5	2	Get
Number_of_sources	6	2	Get
Source_used	8	2	Get/Set
Algorithm type	10	1	Get
Object_source_list	13	1	Get
Destination_used	14	2	Get/Set
Input_data_value	15	2/4	Get/Set
Services			
Get_Attributes_Single	0x0E		
Set_Attributes_Single	0x10		

Selection Tab. 4-52

Register / Class 0x07

No.	Name	Data length in bytes	Access rule
Instances			
Operational Status	1		
Interlock Status	2		
Class Attributes			
Revision	1	2	Get
Max Instance	2	2	Get
Instance Attributes			
Bad Flag	1	1	Get
Direction	2	1	Get
Size	3	2	Get
Data	4	1/2	Get
Services			
Get_Attributes_Single	0x0E		

No.	Name	Data length in bytes	Access rule
Set_Attributes_Single	0x10		

Register Tab. 4-53

Bit coded values / Class 0x65

Name	No.	Data length in bytes	Access rule
Instances			
Operational Control	1	1	Get/Set
Operational Status	2	1	Get
Pulse Duty Cycle	3	1	Get/Set
Pulse Frequency	4	1	Get/Set
Extended Control	5	1	Get/Set
Extenden Status	6	1	Get
Control for Assembly 125	7	1	Get/Set
Matchbox Control	8	1	Get/Set
State for Assembly 126	9	1	Get
Generator State	10	1	Get
Warning Message	11	2	Get
Warning Function	12	2	Get
Alarm Message	13	2	Get
Alarm Function	14	2	Get
RF on time	15	2	Get
Class Attributes			
Revision	1	2	Get
Max Instance	2	2	Get
Instance Attributes			
Bad flag	1	1	Get
Direction	2	2	Get
Size	3	1	Get
Data array of bits	4	1/2	Get/Set
Services			
Get_Attributes_Single	0x0E		
Set_Attributes_Single	0x10		

Bit coded values Tab. 4-54

4.8 Poll messages

Instance overview

Assembly	Data direction (master view)	Number of bytes	Type	Data specification
Instance 1	Output	5	Necessary	For type and range, see also ODVA DeviceNet Specification Volume 1, Edition 3.11.
Instance 2	Input	9	Necessary	
Instance 3	Output	1	Necessary	
Instance 17	Input	1	Necessary	
Instance 18	Input	8	Necessary	
Instance 19	Input	8	Necessary	
Instance 117	Output	5	Optional	—
Instance 118	Input	9	Optional	—
Instance 121	Output	5	Optional	—
Instance 122	Input	9	Optional	—
Instance 123	Output	5	Optional	—
Instance 124	Input	9	Optional	—
Instance 125	Output	31	Optional	—
Instance 126	Input	28	Optional	—

Instance overview Tab. 4-55

Assembly instance 1 (default output)

Byte	Bit	Function
0	0 to 7	Forward power out 12 (P_i)
1	0 to 3	
	4 to 7	not used
2 to 3	—	not used
4	0 to 7	Power on

Assembly instance 1 Tab. 4-56

Assembly instance 2 (default input)

Byte	Bit	Function
0	0 to 7	Forward power out 12 (P_i)
1	0 to 3	
	4 to 7	not used
2	0 to 7	Reflected power in 12 (P_r)
3	0 to 3	
	4 to 7	not used

Byte	Bit	Function
4 to 7	—	not used
8	0 to 7	Power on

Assembly instance 2 Tab. 4-57

Assembly instance 3 (output)

Byte	Bit	Function
0	0 to 7	power on

Assembly instance 3 Tab. 4-58

Assembly instance 17 (input)

Byte	Bit	Function
0	0	Alarm Device Common
	1	Alarm Device Specific
	2	Alarm Manufacturer Specific
	3	not used
	4	Warning Device Common
	5	Warning Device Specific
	6	Warning Manufacturer Specific
	7	Expanded Method

Assembly instance 17 Tab. 4-59

Assembly instance 18 (input)

Byte	Bit	Function	
0	0	Value always 0	Exception Detail Alarm 0 (size, common = 2)
	1	Value always 1	
	2 to 7	Value always 0	
1	0	1 = Internal diagnostic exception	Exception Detail Alarm 1 (common 0)
	1 to 7	not used	
2	0 to 2	not used	Exception Detail Alarm 2 (common 1)
	3	1 = Power supply input voltage	
	4 to 7	not used	
3	0 to 1	Value always 0	Exception Detail Alarm 3 (size, device = 4)
	2	Value always 1	
	3 to 7	Value always 0	

Byte	Bit	Function	
4	0	not used	Exception Detail Alarm 4 (device 0)
	1	1 = Interlock open	
	2	1 = Device temp high	
	3 to 7	not used	
5	0 to 7	not used	Exception Detail Alarm 5 (device 1)
6	0 to 7	not used	Exception Detail Alarm 6 (device 2)
7	0 to 7	not used	Exception Detail Alarm 7 (device 3)

Assembly instance 18 Tab. 4-60

Assembly instance 19 (input)

Byte	Bit	Function	
0	0	Value always 0	Exception Detail Warning 0 (size, common = 2)
	1	Value always 1	
	2 to 7	Value always 0	
1	0	1 = Internal diagnostic exception	Exception Detail Warning 1 (common = 0)
	1 to 7	not used	
2	0 to 7	not used	Exception Detail Warning 2 (common = 1)
3	0 to 1	Value always 0	Exception Detail Warning 3 (size, device = 4)
	2	Value always 1	
	3 to 7	Value always 0	
4	0 to 7	not used	Exception Detail Warning 4 (device 0)
5	0 to 7	not used	Exception Detail Warning 5 (device 1)
6	0 to 7	not used	Exception Detail Warning 6 (device 2)
7	0 to 7	not used	Exception Detail Warning 5 (device 3)

Assembly instance 19 Tab. 4-61

Assembly instance 117 (output)

Byte	Bit	Function
0	0 to 7	Power out 12:
1	0 to 3	▪ Forward power or load power, depending on value of byte 4, bit 6. ▪ 0x0000 to 0xFFF ≙ 0% to 100%.
	4 to 7	not used

Byte	Bit	Function
2	0 to 6	Depending on value of byte 4 / bit 7: ▪ With regular pulse mode: Duty cycle. – 0x01 to 0x63 ≙ 1% to 99%. – Example: 0x32 ≙ 50 % ▪ With triggered pulse mode: Pulse delay. Values: (see "Tab. 4-64", pg. 4-78).
	7	Pulse mode on/off: ▪ 1 = Pulse mode on. ▪ 0 = Pulse mode off. Switching off pulse mode while power is on results in a warning message.
3	0 to 7	Depending on value of byte 4 / bit 7: ▪ With regular pulse mode: Pulse frequency. – Adjustable in 50 Hz increments, minimum value is 50 Hz. – 0x01 to 0xFF ≙ 50 Hz to 12 750 Hz. – Example: 0xC8 = 10 000 Hz. ▪ With triggered pulse mode: Pulse duration. Values: (see "Tab. 4-64", pg. 4-78).
4	0	Power on/off: ▪ 1 = Power on. ▪ 0 = Power off.
	1 to 2	not used
	3	Frequency offset and frequency agility: ▪ 0 = Frequency offset on. ▪ 1 = Frequency agility on (optional).
	4	Clock: ▪ 0 = Clock signal produced in the generator (frequency offset according to bit 3). ▪ 1 = Clock signal from an external source (phase offset).
	5	Pulse input: ▪ 0 = Internal pulse input. ▪ 1 = External pulse input. Switching to another pulse input is only possible while the power is off.
	6	Power type on byte 0 to 1: ▪ 0 = Forward power. ▪ 1 = Load power.
	7	Pulse mode: ▪ 0 = Regular pulse mode. ▪ 1 = Triggered pulse mode.

Assembly instance 117 Tab. 4-62

CEX combinations

Byte 4		Result
Bit 4	**Bit 3**	
0	0	Internal clock signal and frequency offset on.
0	1	Internal clock signal and frequency agility on.
1	0	External clock signal and phase offset on.
1	1	External clock signal and phase offset on.

CEX combinations Tab. 4-63

Value calculation Pulse delay and Pulse duration

The calculation method for values Pulse delay and Pulse duration is identical.

Calculate value:

- Pulse delay in µs = *Factor* x *Value*
- Pulse duration in µs = *Factor* x *Value*

Bit 6	Bit 5	Bit 4	*Factor*	Bit 3	Bit 2	Bit 1	Bit 0	*Value*
0	0	0	1	0	0	0	0	1
0	0	1	10	0	0	0	1	2
0	1	0	100	0	0	1	0	3
0	1	1	1 000	0	0	1	1	4
1	0	0	10 000	0	1	0	0	5
1	0	1	100 000	0	1	0	1	6
				0	1	1	0	7
				0	1	1	1	8
				1	0	0	0	9
				1	0	0	1	10
				1	0	1	0	11
				1	0	1	1	12
				1	1	0	0	13
				1	1	0	1	14
				1	1	1	0	15
				1	1	1	1	16

Tab. 4-64

Note

If value that is too high is specified, the generator sets the maximum value.

If a value that is too low is specified, the generator sets the minimum value.

Read values (instance 118): the actual value is rounded down until it fits into the schema of this table.

Assembly instance 118 (input)

Byte	Bit	Function
0	0 to 7	Power in 12::
1	0 to 3	▪ Display of the forward power or load power, depending on value of byte 8, bit 6. ▪ 0x0000 to 0xFFF ≙ 0% to 100%.
	4 to 7	not used
2	0 to 7	Reflected power in 12::
	0 to 3	▪ Display of the reflected power. ▪ 0x0000 to 0xFFF ≙ 0% to 100%.
	4 to 7	not used
4	0 to 7	Arc rate (arcs/s) LSB, only with active arc detection.
5	0 to 7	Arc rate (arcs/s) MSB, only with active arc detection.
6	0 to 6	Depending on value of byte 8 / bit 7: ▪ With regular pulse mode: Display Duty cycle. – 0x01 to 0x63 ≙ 1% to 99%. – Example: 0x32 ≙ 50 % – 0x00 ≙ Pulse mode not active. ▪ With triggered pulse mode: Display Pulse delay. Values: (see "Tab. 4-64", pg. 4-78).
	7	Pulse mode message: ▪ 1 = Pulse mode on. ▪ 0 = Pulse mode off.
7	0 to 7	Depending on value of byte 8 / bit 7: ▪ With regular pulse mode: Display of the pulse frequency. – Resolution in 50 Hz increments. – 0x01 to 0xFF ≙ 50 Hz to 12 750 Hz. – Example: 0xC8 = 10 000 Hz. ▪ With triggered pulse mode: Display Pulse duration. Values: (see "Tab. 4-64", pg. 4-78).

Byte	Bit	Function
8	0	Power on/off message: ▪ 1 = Power on. ▪ 0 = Power off.
	1	Set value message: ▪ 1 = Set value reached. ▪ 0 = Set value not reached.
	2	Error status: ▪ 1 = No error. ▪ 0 = Alarm.
	3	Pulse error or CEX error message: ▪ 0 = ok. ▪ 1 = Error.
	4	Interlock status: ▪ 1 = Interlock circuit closed. ▪ 0 = Interlock circuit open.
	5	Pulse source: ▪ 0 = Internal pulse source. ▪ 1 = External pulse source.
	6	Power type on byte 0 to 1: ▪ 0 = Forward power. ▪ 1 = Load power.
	7	Pulse mode: ▪ 0 = Regular pulse mode. ▪ 1 = Triggered pulse mode.

Assembly instance 118 Tab. 4-65

Assembly instance 121 (output)

Byte	Bit	Function
0	0 to 7	Forward power out 12 (P_i): ▪ 0x0000 to 0xFFF ≙ 0% to 100%.
1	0 to 3	
	4 to 7	not used
2	0 to 6	Pulse width in percent: ▪ 0x01 to 0x63 ≙ 1% to 99%. ▪ Example: 0x32 = Pulse mode with 50% of the pulse width.
	7	Pulse mode on/off: ▪ 1 = Pulse mode on ▪ 0 = Pulse mode off Switching off pulse mode while power is on results in a warning message.

Byte	Bit	Function
3	0 to 7	Pulse frequency: ▪ Adjustable in 50 Hz increments, minimum value is 50 Hz. ▪ 0x01 to 0xFF ≙ 50 Hz to 12 750 Hz. ▪ Example: 0xC8 = 10 000 Hz.
4	0	Power on/off: ▪ 1 = Power on. ▪ 0 = Power off.
	1 to 3	not used
	4	Pulse input: ▪ 0 = Internal pulse input. ▪ 1 = External pulse input. Switching to another pulse input is only possible while the power is off.
	5 to 7	not used

Assembly instance 121 Tab. 4-66

Assembly instance 122 (input)

Byte	Bit	Function
0	0 to 7	Forward power in 12: ▪ Display (P_i). ▪ 0x0000 to 0xFFF ≙ 0% to 100%.
1	0 to 3	
	4 to 7	not used
2	0 to 7	Reflected power in 12: ▪ Display (P_r). ▪ 0x0000 to 0xFFF ≙ 0% to 100%.
3	0 to 3	
	4 to 7	not used
4 to 5	—	not used
6	0 to 6	Display of the pulse width in percent: ▪ 0x01 to 0x63 ≙ 1% to 99%.
	7	Pulse mode message: ▪ 1 = Pulse mode on. ▪ 0 = Pulse mode off.
7	0 to 7	Display of the pulse frequency: ▪ Resolution in 50 Hz increments. ▪ 0x01 to 0xFF ≙ 50 Hz to 12 750 Hz. ▪ Example: 0xC8 = 10 000 Hz.

Byte	Bit	Function
8	0	Power on/off message: ▪ 1 = Power on. ▪ 0 = Power off.
	1	Set value message: ▪ 1 = Set value reached. ▪ 0 = Set value not reached.
	2	Temperature message: ▪ 1 = Temperature ok. ▪ 0 = Excessive temperature.
	3	Pulse error message: ▪ 0 = ok. ▪ 1 = Error.
	4	Interlock status: ▪ 1 = Interlock circuit closed. ▪ 0 = Interlock circuit open.
	5	Pulse source message: ▪ 0 = Internal pulse source. ▪ 1 = External pulse source.
	6 to 7	not used

Assembly instance 122 Tab. 4-67

Assembly instance 123 (output)

Byte	Bit	Function
0	0 to 7	Power out 12: ▪ Display of the forward power or load power, dependent on the selected power type in byte 4, bit 5. ▪ 0x0000 to 0xFFF ≙ 0% to 100%.
1	0 to 3	
	4 to 7	not used
2	0 to 6	Pulse width in percent: ▪ 0x01 to 0x63 ≙ 1% to 99%. ▪ Example: 0x32 = Pulse mode with 50% of the pulse width.
	7	Pulse mode on/off: ▪ 1 = Pulse mode on. ▪ 0 = Pulse mode off. Switching off pulse mode while power is on results in a warning message.
3	0 to 7	Pulse frequency: ▪ Adjustable in 50 Hz increments, minimum value is 50 Hz. ▪ 0x01 to 0xFF ≙ 50 Hz to 12 750 Hz. ▪ Example: 0xC8 = 10 000 Hz.

Byte	Bit	Function
4	0	Power on/off: ▪ 1 = Power on. ▪ 0 = Power off.
	1 to 3	not used
	4	Pulse input: ▪ 0 = Internal pulse input. ▪ 1 = External pulse input. Switching to another pulse input is only possible while the power is off.
	5	Power type on byte 0 to 1: ▪ 0 = Forward power. ▪ 1 = Load power.
	6 to 7	not used

Assembly instance 123 Tab. 4-68

Assembly instance 124 (input)

Byte	Bit	Function
0	0 to 7	Power in 12: ▪ Display of the forward power or load power, dependent on the selected power type in byte 8, bit 6. ▪ 0x0000 to 0xFFF ≙ 0% to 100%.
1	0 to 3	
	4 to 7	not used
2	0 to 7	Reflected power in 12: ▪ Display of the reflected power. ▪ 0x0000 to 0xFFF ≙ 0% to 100%.
	0 to 3	
	4 to 7	not used
4 to 5	—	not used
6	0 to 6	Display of the pulse width in percent: ▪ 0x01 to 0x63 ≙ 1% to 99%.
	7	Pulse mode message: ▪ 1 = Pulse mode on. ▪ 0 = Pulse mode off.
7	0 to 7	Display of the pulse frequency: ▪ Resolution in 50 Hz increments. ▪ 0x01 to 0xFF ≙ 50 Hz to 12 750 Hz. ▪ Example: 0xC8 = 10 000 Hz.

Byte	Bit	Function
8	0	Power on/off message: ▪ 1 = Power on. ▪ 0 = Power off.
	1	Set value message: ▪ 1 = Set value reached. ▪ 0 = Set value not reached.
	2	Temperature message: ▪ 1 = Temperature ok. ▪ 0 = Excessive temperature.
	3	Pulse error message: ▪ 0 = ok. ▪ 1 = Error.
	4	Interlock status: ▪ 1 = Interlock circuit closed. ▪ 0 = Interlock circuit open.
	5	Pulse source message: ▪ 0 = Internal pulse source. ▪ 1 = External pulse source.
	6	Power type on byte 0 to 1: ▪ 0 = Forward power. ▪ 1 = Load power.
	7	not used

Assembly instance 124 Tab. 4-69

Assembly instance 125 (output)

Byte	Bit	Meaning
0	0	Power on/off ▪ 0 = Power off ▪ 0→1 (edge) = Power on
	1	Vacuum tube filament (only relevant for generators with tubes) ▪ 0 = Off ▪ 1 = on
	2	Reset alarm and warning messages ▪ 0 = no action ▪ 0→1 (edge) = Reset messages
	3 to 5	not used
	6	Pulse mode ▪ 0 = Off ▪ 1 = on
	7	Active interface ▪ 0 = Release control ▪ 1 = Get control (DeviceNet becomes active interface)

Byte	Bit	Meaning
1	Low Byte	Set value P_i in W ▪ 0 to 4095 ≙ 0% to 100% ▪ Bits 4 to 7 of the high byte are not used.
2	High Byte	
3	Low Byte	Set value P_L in W ▪ 0 to 4095 ≙ 0% to 100% ▪ Bits 4 to 7 of the high byte are not used.
4	High Byte	
5	Low Byte	Set value P_r in W ▪ 0 to 4095 ≙ 0% to 100% ▪ Bits 4 to 7 of the high byte are not used.
6	High Byte	
7	Low Byte	Set value U_{dc} in V (maximum value dependent on connected SystemPort matchbox). ▪ 0 to 4095 ≙ 0% to 100% ▪ Bits 4 to 7 of the high byte are not used.
8	High Byte	
9	Low Byte	Set value U_{rf} in V (maximum value dependent on the connected SystemPort matchbox). ▪ 0 to 4095 ≙ 0% to 100% ▪ Bits 4 to 7 of the high byte are not used.
10	High Byte	
11	Low Byte	Set value U_{dc} in V (maximum value dependent on the connected SystemPort matchbox). ▪ 0 to 4095 ≙ 0% to 100% ▪ Bits 4 to 7 of the high byte are not used.
12	High Byte	
13	LSB	Period duration in µs (with pulse mode) ▪ 20 to 100,000 ≙ 20 µs to 100,000 µs ▪ 20 µs ≙ 50 kHz, 100,000 µs ≙ 10 Hz
14		
15		
16	MSB	
17	Low Byte	Duty cycle ▪ 41 to 4054 ≙ 1% to 99%
18	High Byte	
19	Low Byte	Ignition position C_T. The capacitor takes this position if the SystemPort matchbox is in "Manual" or "Automatic" mode and no plasma is present. ▪ 0 to 4095 ≙ 0 to 1000 ▪ Bits 4 to 7 of the high byte are not used.
20	High Byte	
21	Low Byte	Ignition position C_L. The capacitor takes this position if the SystemPort matchbox is in "Manual" or "Automatic" mode and no plasma is present. ▪ 0 to 4095 ≙ 0 to 1000 ▪ Bits 4 to 7 of the high byte are not used.
22	High Byte	
23	Low Byte	"Plasma on" position C_T. If the SystemPort matchbox is in "Automatic" mode, the capacitor takes this position as soon as an ignition has been detected. ▪ 0 to 4095 ≙ 0 to 1000 ▪ Bits 4 to 7 of the high byte are not used.
24	High Byte	
25	Low Byte	"Plasma on" position C_L. If the SystemPort matchbox is in "Automatic" mode, the capacitor takes this position as soon as an ignition has been detected. ▪ 0 to 4095 ≙ 0 to 1000 ▪ Bits 4 to 7 of the high byte are not used.
26	High Byte	
27	Low Byte	Selection of the SystemPort matchbox ▪ If only one SystemPort matchbox is connected to the generator, "1" must be selected.
28	High Byte	

Byte	Bit	Meaning
29	0	Bit 1-0 = Mode of the SystemPort matchbox
	1	▪ 0-0 = Automatic ▪ 0-1 = DC Automatic ▪ 1-0 = Recipe ▪ 1-1 = Not used
	2 to 3	not used
	4	Activity control ▪ 0 = Off ▪ 1 = Active
	5	Start SystemPort matchbox ▪ 0 = Off ▪ 1 = Start
	6	Start Automatic mode ▪ 0 = Off ▪ 1 = Start
	7	Freeze mode ▪ 0 = Off ▪ 1 = Freeze
30	Low Byte	Recipe number

Assembly instance 125 Tab. 4-70

Assembly instance 126 (input)

Byte	Bit	Meaning
0	Low Byte	Actual value P_i in W.
1	High Byte	▪ 0 to 4095 ≙ 0% to 100% ▪ Bits 4 to 7 of the high byte are not used.
2	Low Byte	Actual value P_L in W.
3	High Byte	▪ 0 to 4095 ≙ 0% to 100% ▪ Bits 4 to 7 of the high byte are not used.
4	Low Byte	Actual value P_r in W.
5	High Byte	▪ 0 to 4095 ≙ 0% to 100% ▪ Bits 4 to 7 of the high byte are not used.
6	Low Byte	Actual value U_{dc} in V. Value is dependent on the connected matchbox.
7	High Byte	▪ 0 to 4095 ≙ 0% to 100% ▪ Bits 4 to 7 of the high byte are not used.
8	Low Byte	Actual value U_{rf} in V. Value is dependent on the connected SystemPort matchbox.
9	High Byte	▪ 0 to 4095 ≙ 0% to 100% ▪ Bits 4 to 7 of the high byte are not used.
10	Low Byte	Actual value I_{rf} in A. Value is dependent on the connected SystemPort matchbox.
11	High Byte	▪ 0 to 4095 ≙ 0% to 100% ▪ Bits 4 to 7 of the high byte are not used.

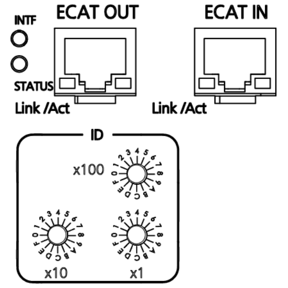
<table>
<tr><th>Byte</th><th>Bit</th><th>Meaning</th></tr>
<tr><td>12</td><td>Low Byte</td><td rowspan="2">Position C_T. Value is dependent on the connected SystemPort matchbox.
▪ 0 to 4095 ≙ 0% to 100%
▪ Bits 4 to 7 of the high byte are not used.</td></tr>
<tr><td>13</td><td>High Byte</td></tr>
<tr><td>14</td><td>Low Byte</td><td rowspan="2">Position C_L. Value is dependent on the connected SystemPort matchbox.
▪ 0 to 4095 ≙ 0% to 100%
▪ Bits 4 to 7 of the high byte are not used.</td></tr>
<tr><td>15</td><td>High Byte</td></tr>
<tr><td rowspan="8">16</td><td>0</td><td>Output power
▪ 0 = Off
▪ 1 = on</td></tr>
<tr><td>1</td><td>Set value
▪ 0 = Not reached
▪ 1 = Reached</td></tr>
<tr><td>2</td><td>Temperature state
▪ 0 = Excessive temperature
▪ 1 = ok</td></tr>
<tr><td>3</td><td>not used</td></tr>
<tr><td>4</td><td>Interlock state
▪ 0 = Open
▪ 1 = Closed</td></tr>
<tr><td>5</td><td rowspan="3">Bits 7-6-5 = Current regulator
▪ 0-0-0 = P_i
▪ 0-0-1 = P_L
▪ 0-1-0 = P_r
▪ 0-1-1 = U_{dc}
▪ 1-0-0 = U_{rf}
▪ 1-0-1 = I_{rf}
▪ 1-1-0 = Other regulation parameter
▪ 1-1-1 = Not used</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td></tr>
</table>

Byte	Bit	Meaning
17	0	Output power ▪ 0 = Off ▪ 1 = on
	1	Vacuum tube filament (only relevant for generators with tubes; for generators without tubes, the value is always "1"). ▪ 0 = Off ▪ 1 = on
	2	Warning messages ▪ 0 = No warning message ▪ 1 = At least one warning message
	3	Alarm messages ▪ 0 = No alarm message ▪ 1 = At least one alarm message
	4	Plasma state ▪ 0 = No plasma, dependent on the U_{DC} of the SystemPort matchbox ▪ 1 = Plasma present
	5	not used
	6	Mode of the SystemPort matchbox ▪ 0 = Different from recipe ▪ 1 = Recipe
	7	Active interface ▪ 0 = DeviceNet is not the active interface. ▪ 1 = DeviceNet is the active interface.
18	Low Byte	Warning messages (error number)
19	High Byte	
20	Low Byte	Warning messages (function number)
21	High Byte	
22	Low Byte	Alarm messages (error number)
23	High Byte	
24	Low Byte	Alarm messages (function number)
25	High Byte	
26	Low Byte	Power-on time in hours
27	High Byte	

Assembly instance 126 Tab. 4-71

5. EtherCAT (optional)

5.1 View



EtherCAT view Fig. 10492

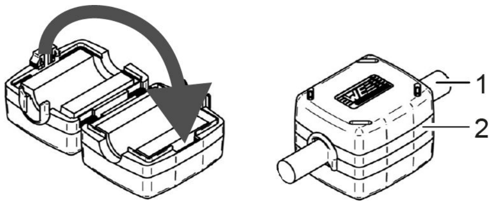
5.2 Connection

RJ-45 connector for EtherCAT input and EtherCAT output

5.3 Cable requirement

The RJ-45 plugs are properly shielded. Shielded cables should be used. Standard Beckhoff EtherCAT plugs and cables are supported.

In order to satisfy the EMC requirement, each EtherCAT cable must be equipped with a ferrite core (see "Fig. 10659", pg. 4-89). The cores should be placed as close as possible to the plug.
The ferrite cores are supplied with the generator.



1 EtherCAT cable 2 Ferrite core

Ferrite core Fig. 10659

Note

The maximum permissible cable length is **30 m**. If longer cables are needed, select optical transmission.

5.4 EtherCAT objects

The object definition corresponds to the „EtherCAT semiconductor specific device profile“ of the RF generator. The exact object description can be found further below.

5.5 Vendor ID and ESI file

The device uses a valid vendor ID to identify the device on the bus.

TRUMPF's vendor ID is **0x00000260**.

TRUMPF provides a valid ESI file describing the functionality and capabilities of TRUMPF generators.

Product code for the generator that is described in these operating instructions:

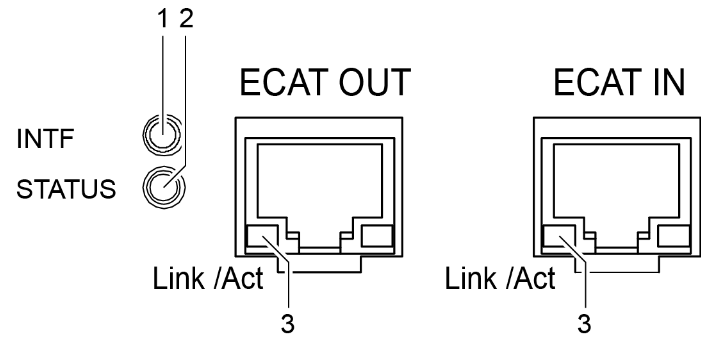
- **0x00007002**
- Revision **0x00000004**

5.6 Data communication

Definition of reaction time:

- In order to have fast and repeatable reaction times for the process data, the cyclic data – the so-called process data objects (PDO) – is sent with a latency time of < 3 ms. The latency-time deviation of this value is < 2 ms.
  - Definition of latency time: Time from the end of the command word to the center of the reaction time distribution.
  - Definition of latency time jitter: Maximum deviation from the center of the reaction time distribution
- The reaction time for the acyclic data is < 50 ms, which is sufficient for transmission of the Service Data Objects (SDO).

5.7 Meaning of EtherCAT indicator elements (LEDs)



1 INTF
2 Status LED
3 Activity display

LEDs EtherCAT Fig. 10303

INTF EtherCAT is powered up and operational.

Status EtherCAT bus status:

Display	Description
Off	Initialization
Flashing green	Not yet operational
Brief green flash	Ready for safe operation
Steady green	Device in operation
Flashing red	Bus error

Indicator of EtherCAT bus status Tab. 4-72

Activity display

Display	Description
Flashing green	Active
Off	No connection established

Indicator of EtherCAT link activity Tab. 4-73

5.8 Objects

Identification area

Index	Sub-index	Name	DT[12]	Z[13]	Data size in bytes
0x1000	—	Device type	UDINT	RO	4
0x1008	—	Device name	STR	RO	variable
0x1009	—	Hardware version	STR	RO	variable
0x100A	—	Software version	STR	RO	variable
0x1018	0x01	Vendor ID	UDINT	RO	4
	0x02	Product code	UDINT	RO	4
	0x03	Revision number	UDINT	RO	4
	0x04	Serial number	UDINT	RO	4
0x10F8	—	Time stamp (local time)	ULINT	RO	8

Identification area Tab. 4-74

PDO mapping

Transmit Process Data Objects (TPDO)

PDO index	PDO SI	Index	SI	Description
TPDO 0x1A00	0x01	0x6000	0x01	Display of RF on
	0x02		0x02	Display of RF on requested
	0x03		0x03	EtherCAT is not active control
	0x04		0x04	Control value not in permissible range
	0x05		0x05	Error present
	0x06		0x06	Warning present
	0x07	0x6002	0x01	Interlock open
	0x08		0x02	Overtemperature error
	0x09	0x6004	0x01	Display of the regulation/control mode
	0x0A	0x6005	0x01	Current set value
	0x0B	0x6006	0x01	Current forward power
	0x0C		0x02	Current reflected power
	0x0D		0x03	Current delivered power

12 Data type.

13 Access: RO = Read only.

TPDO 0x1B00	0x01	0x6001	0x01	Pulse mode activation
	0x02		0x02	Ramp operation status
	0x03		0x05	CEX activated
	0x04		0x06	CEX disabled
	0x05		0x09	Process timer: End of process timer
	0x06	0x6002	0x04	AC supply error
	0x07	0x6003	0x04	AC supply warning
	0x08		0x07	Warning "power limit exceeded"
	0x09	0x600B	0x01	Frequency actual value
TXPDO 0x1B01	0x01	0x6001	0x03	Arc detection activated
	0x03		0x04	Arc reaction activated
	0x05	0x600A	0x01	Arc counter since RF on
TPDO 0x1B02	0x01	0xF380	0x00	Active exception status
	0x02	0xF383	0x01	Active device error, details
	0x03	0xF384	0x01	Active manufacturer error, details
	0x04	0xF381	0x01	Active device warning, details
	0x05	0xF382	0x01	Active manufacturer warning, details

Transmit Process Data Objects (TPDO) Tab. 4-75

Receive Process Data Objects (RPDO)

PDO index	**PDO SI**	**Index**	**SI**	**Description**
RPDO 0x1600	0x01	0x7000	0x01	RF on request
	0x02		0x02	Error reset
	0x03	0x7004	0x01	Regulation/control mode
	0x04	0x7005	0x01	Set value
RPDO 0x1700	0x01	0x7001	0x01	Pulse mode ON
	0x03		0x05	CEX on
	0x04	0x7006	0x01	Set value for forward power
	0x05		0x02	Set value for reflected power
	0x06		0x03	Set value for delivered power
	0x07	0x7008	0x01	Pulse frequency
	0x08		0x02	Pulse duty cycle
	0x09	0x7009	0x01	CEX phase offset
	0x0A	0x2002	0x01	Offset mode
	0x0B	0x8002	0x01	Ramp mode
	0x0C		0x02	Ramp unit
	0x0D		0x03	Ramp-up parameter
	0x0E		0x04	Ramp dropout parameter

RPDO 0x1701	0x01	0x7001	0x02	Arc detection on
	0x02		0x03	Arc reaction on
	0x03		0x04	Arc counter reset
	0x05	0x2001	0x04	Arc threshold value P_r
	0x06		0x05	Arc gradient P_r
	0x07		0x06	Arc threshold value P_r/P_i
	0x08		0x07	Arc gradient P_r/P_i
	0x09		0x01	Arc management time delay
	0x0A		0x03	Arc min. start value P_i

Receive Process Data Objects (RPDO) Tab. 4-76

Input area (generator → master control)

Index	SI	Name	Description	DT[14]	Z[15]	Size	Default value
0x6000	—	Device status					
	0x01	Display power on	▪ 0 = Power off. ▪ 1 = Power on.	BOOL	RO P	1 bit	0
	0x02	Display of power on requested	1 = Power on requested	BOOL	RO P	1 bit	0
	0x03	EtherCAT is not active control	1 = EtherCAT is not active/ does not have control	BOOL	RO P	1 bit	0
	0x04	Control value not in permissible range	1 = A control value (in 0x7nnX) lies outside of the permissible range or tolerance (i.e., a control value is too high or too low and was limited to its maximum or minimum value).	BOOL	RO P	1 bit	0
	0x05	Error present	1 = Error present	BOOL	RO P	1 bit	0
	0x06	Warning present	1 = Warning present	BOOL	RO P	1 bit	0
0x6001	—	Device status configuration					
	0x01	Pulse mode status	1 = Pulse mode active	BOOL	RO P	1 bit	0
	0x02	Ramp operation status	1 = Ramp operation active	BOOL	RO P	1 bit	0
	0x03	Arc detection status	1 = Arc detection activated	BOOL	RO P	1 bit	0
	0x04	Arc reaction status	1 = Arc reaction activated	BOOL	RO P	1 bit	0
	0x05	CEX activated	1 = CEX activated	BOOL	RO P	1 bit	0
	0x06	CEX disabled	1 = CEX disabled	BOOL	RO P	1 bit	0
	0x08	Joule mode: Energy limit reached	1 = Energy limit reached	BOOL	RO P	1 bit	0
	0x09	Process timer: End of process time	1 = End of process time	BOOL	RO P	1 bit	0

14 Data type.

15 Access: RO = Read only. P = PDO.

Index	SI	Name	Description	DT[14]	Z[15]	Size	Defa ult value
0x6002	—	Device status error					
	0x01	Interlock open	1 = Interlock open	BOOL	RO P	1 bit	0
	0x02	Overtemperature error	1 = Overtemperature error	BOOL	RO P	1 bit	0
	0x04	AC supply error	1 = AC supply error	BOOL	RO P	1 bit	0
0x6003	—	Device status warnings					
	0x04	AC supply warning	1 = AC supply error	BOOL	RO P	1 bit	0
	0x07	Warning "power limit exceeded"	1 = Warning "power limit exceeded"	BOOL	RO P	1 bit	0
0x6004	—	Display of the regulation/control mode					
	0x01	Display of the regula-tion/control mode	Display of the currently set control mode: ▪ 0 = Forward power opera-tion ▪ 1 = Power delivery / load operation Optional: ▪ 2 = Automatic operation ▪ 4 ...7 = Reserved	USINT	RO P	1 byte	0
0x6005	—	Current set value					
	0x01	Current set value	Set value for regulating the output power in watts	REAL	RO P	4 byte s	0
0x6006	—	Actual values					
	0x01	Current forward power	Current value of the forward power in watts	REAL	RO P	4 byte s	0
	0x02	Current reflected power	Current value of the reflected power in watts	REAL	RO P	4 byte s	0
	0x03	Current delivered power	Current value of the delivered output power in watts	REAL	RO P	4 byte s	0
0x6008	—	Internal device temperatures					
	0x01	Water temperature	Most important water tempera-ture in °C	REAL	RO P	4 byte s	0
	0x02	Air temperature	Most important air temperature in °C	REAL	RO P	4 byte s	0
0x6009	—	Pulse width					
	0x01	Pulse width	Recalculated pulse width (see pulse frequency and pulse duty cycle) in microseconds	REAL	RO P	4 byte s	0
0x600A	—	Arc counter					
	0x01	Arc counter since power on	Arc counter since the last time the RF voltage was switched on (is automatically reset with "Power on requested"= 1)	UDINT	RO P	4 byte s	0

14 Data type.

15 Access: RO = Read only. P = PDO.

Index	SI	Name	Description	DT[14]	Z[15]	Size	Default value
0x600B	—	Frequency actual value					
	0x01	Frequency actual value	Actual output frequency, in kHz	REAL	RO P	4 bytes	0

Input area

Tab. 4-77

Output area (master control → generator)

Index	SI	Name	Description	DT[16]	Z[17]	Size	Default value
0x7000	—	Generator control					
	0x01	Power on request	▪ 0 = Power off. ▪ 0 → 1 = Power on request (edge triggered).	BOOL	RW P	1 bit	0
	0x02	Error reset	0 → 1 = Error reset* (edge triggered)	BOOL	RW P	1 bit	0
0x7001	—	Device control configuration					
	0x01	Pulse mode	1 = Pulse mode on	BOOL	RW P	1 bit	0
	0x02	Arc detection	1 = Arc detection on	BOOL	RW P	1 bit	0
	0x03	Arc reaction	1 = Arc reaction on	BOOL	RW P	1 bit	0
	0x04	Arc counter reset	0 → 1 = Arc counter reset (edge triggered) (an arc reset can be triggered while the process is running)	BOOL	RW P	1 bit	0
	0x05	CEX	1 = CEX on	BOOL	RW P	1 bit	0
	0x06	Frequency mode	▪ 0 = Fixed frequency. ▪ 1 = Automatic frequency (only for generators with supply voltage 200 to 480 V).	BOOL	RW P	1 bit	0
0x7004	—	Regulation/control mode					
	0x01	Regulation/control mode	Request to set the regulation/ control mode: ▪ 0 = Forward power operation. ▪ 1 = Power delivery / load operation. ▪ 2 = Automatic operation. ▪ 3...7 = Reserved.	USINT	RW P	1 byte	0

14 Data type.

15 Access: RO = Read only. P = PDO.

16 Data type.

17 Access: RW = Read and write. P = PDO.

Index	SI	Name	Description	DT[16]	Z[17]	Size	Defa ult value
0x7005	—	Set value					
	0x01	Set value	For 0x7004 = 0.1: The current power set value in watts	REAL	RW P	4 byte s	0
0x7006	—	Set value for automatic mode					
	0x01	Set value for forward power	Set value for forward power in watts	REAL	RW P	4 byte s	0
	0x02	Set value for reflected power	Set value for reflected power in watts	REAL	RW P	4 byte s	0
	0x03	Set value for delivered power	Set value for delivered power in watts	REAL	RW P	4 byte s	0
0x7008	—	Pulse settings					
	0x01	Pulse frequency	Pulse frequency in Hz	REAL	RW P	4 byte s	0
	0x02	Pulse duty cycle	Pulse-duty factor in percent (on time / pulse duration)	REAL	RW P	4 byte s	0
0x7009	—	CEX phase settings					
	0x01	CEX phase offset	Shared exciter/phase setting: sets the phase offset in CEX mode (CEX on = 1) in degrees (0 to 360°)	REAL	RW P	4 byte s	0

Output area Tab. 4-78

Configuration area

Index	SI	Name	Description	DT[18]	Z[19]	Gr[20]	Defa ult value
0x8000	—	Device limit configuration					
	0x01	Forward power - soft-ware limit value	Maximum permissible set value in watts	REAL	RW	4	3000
	0x02	Reflected power - soft-ware limit value	Maximum limit value of the reflected power in watts	REAL	RW	4	600

16 Data type.

17 Access: RW = Read and write. P = PDO.

18 Data type.

19 Access: RO = Read only, RW = Read and write. P = PDO.

20 Size (bytes)

Index	SI	Name	Description	DT[18]	Z[19]	Gr[20]	Default value
0x8001	—	Pulse configuration					
	0x01	Pulse mode	Current pulse mode, defined as follows: ▪ 0 = Master/internal. ▪ 1 = Slave/external. ▪ 2 = Reserved (for triggered slave). ▪ 3...7 = Reserved.	UDINT	RW P	4	—
	02	Pulse delay	Pulse delay of input, in micro-seconds.	UDINT	RW P	4	—
	03	Pulse duration	Pulse duration, in microsec-onds	UDINT	RW P	4	—
0x8002	—	Ramping configuration					
	0x01	Ramp mode	Current ramp mode, defined as follows: ▪ 0 = Ramp function disabled. ▪ 1 = Power-on ramp. ▪ 2 = Set value change ramp. ▪ 3 = Power-on ramp and set value change ramp. ▪ 4...7 = Reserved.	USINT	RW P	1	—
	0x02	Ramp unit	For 0x8002 SI1 = 1, 2, 3: the actual ramp unit, defined as follows: ▪ 0 = Time; in milliseconds. ▪ 1 = Slope, in watts per sec-ond.	USINT	RW P	1	—
	0x03	Ramp-up parameter: power	If the ramp unit ▪ is 0 = time, this unit is ms. ▪ is 1 = slope, this unit is W/s D2.	UDINT	RW P	4	—
	0x04	Ramp dropout param-eter: power	If the ramp unit ▪ is 0 = time, this unit is ms. ▪ is 1 = slope, this unit is W/s D2.	UDINT	RW P	4	—

18 Data type.

19 Access: RO = Read only, RW = Read and write. P = PDO.

20 Size (bytes)

Index	SI	Name	Description	DT[18]	Z[19]	Gr[20]	Default value
0x8003	—	Arc management configuration					
	0x01	Arc detection mode	The current arc detection mode is defined as the manufacturer-specific mode SSM EtherCAT: ▪ 0 = External detection. ▪ 1 = P_r threshold detection. ▪ 2 = P_r gradient detection. ▪ 3 = P_r/P_i threshold detection. ▪ 4 = P_r/P_i gradient detection. ▪ 5 = External + P_r threshold detection. ▪ 6 = External + P_r gradient detection. ▪ 7 = External + P_r/P_i threshold detection. ▪ 8 = External + P_r/P_i gradient detection.	USINT	RW	1	0
	0x02	Arc reaction mode	The current arc reaction mode is defined as the manufacturer-specific mode SSM EtherCAT: ▪ 0 = RF-output power off. ▪ 1 = CutArcActively.	USINT	RW	1	1
	0x03	Arc synchronization (not supported, function can be executed with sub-index 0x01)	Arc synchronization: ▪ 0 = Sync mode off. ▪ 1 = Sync mode on.	USINT	RW	1	1
0x8004	—	Auto Frequency Tuning / AFT					
	0x01	Fixed Frequency	Nominal frequency, in kHz	SINT32	RW	4	13 560 kHz
	0x02	Tuning start offset	Starting frequency offset in kHz	SINT32	RW	4	0 kHz
	0x03	Min. tuning offset	Lower frequency offset for the control range in kHz.	SINT32	RW	4	-678 kHz
	0x04	Max. tuning offset	Upper frequency offset for the control range in kHz.	SINT32	RW	4	678 kHz
0x8006	—	Release configuration					
	0x01	Joule mode on	1 = Joule mode enabled	BOOL	RW	1 bit	—
0x8007	—	Joule mode configuration					
	0x01	Joule mode: energy limit	Energy limit for Joule mode in kJ	REAL	RW	4	—

18 Data type.

19 Access: RO = Read only, RW = Read and write. P = PDO.

20 Size (bytes)

Index	SI	Name	Description	DT[18]	Z[19]	Gr[20]	Default value
0x8008	—	Process timer configuration					
	0x01	Process timer: timeout	Process timer timeout, in seconds. If the timeout is 0, the process timer is disabled	REAL	RW	4	—
0x9000	—	Device rating					
	0x01	Max. forward nominal power	Maximum forward nominal power in W(see "RF output", pg. 3-3).	REAL	RO	4	—
	0x02	Max. reflected nominal power	Maximum reflected nominal power in watts (see "RF output", pg. 3-3).	REAL	RO	4	—
0x9001	—	Frequency rating					
	0x01	Nominal frequency	Nominal frequency, in kHz = 13560	REAL	RO	4	—
0x9002	—	Nominal pulse values					
	0x01	Min. pulse frequency	Minimum frequency of pulse generation in Hz = 10	REAL	RO	4	—
	0x02	Max. pulse frequency	Maximum frequency of pulse generation in Hz = 5000	REAL	RO	4	—
	0x03	Minimum pulse duty cycle	Minimum pulse duty cycle; the value is the percentage of the pulse switch-on time = 1	REAL	RO	4	—
	0x04	Maximum pulse duty cycle	Maximum pulse duty cycle; the value is the percentage of the pulse switch-on time = 99	REAL	RO	4	—

18 Data type.

19 Access: RO = Read only, RW = Read and write. P = PDO.

20 Size (bytes)

Index	SI	Name	Description	DT[18]	Z[19]	Gr[20]	Default value
0x9003	—	Device temperatures					
	0x01	Power stage 1	Temperature of power stage 1 in °C	REAL	RO	4	—
	0x02	Power stage 2	Temperature of power stage 2 in °C	REAL	RO	4	—
	0x03	Ambient temperature 1	Ambient temperature 1 in °C	REAL	RO	4	—
	0x04	Power stage 3 (only with TruPlasma RF 3006)	Temperature of power stage 3 in °C	REAL	RO	4	—
	0x05	Power stage 4 (only with TruPlasma RF 3006)	Temperature of power stage 4 in °C	REAL	RO	4	—
	0x06	Ambient temperature 2 (only with TruPlasma RF 3006)	Ambient temperature 2 in °C	REAL	RO	4	—
	0x07	Regulation	Temperature of the regulator circuit board in °C	REAL	RO	4	—
	0x08	RF detector	Temperature of the RF detector in °C	REAL	RO	4	—
0x9004	—	Device counters					
	0x01	Power-on time	Total number of seconds RF output power has been turned on	UDINT	RO	4	—
	0x02	Delivered energy	Total energy output in kWh	UDINT	RO	4	—
	0x03	Power-on phases	Total number of power-on phases	UDINT	RO	4	—
	0x04	Over-temperature events	Total number of over-temperature events	UDINT	RO	4	—
	0x05	Mains-on phases	Total number of mains-on phases	UDINT	RO	4	—
	0x06	Error numbers	Total number of error numbers that have occurred	UDINT	RO	4	—
0x9006	—	Activation info					
	0x01	Joule mode activation	1 = Joule mode enabled	BOOL	RO	1 bit	—
0x9007	—	Joule mode info					
	0x01	Current remaining energy in Joule mode	Current remaining energy in Joule mode, in kJ	REAL	RO	4	—
0x9008	—	Process timer info					
	0x01	Current remaining process time	Current remaining process time, in seconds	REAL	RO	4	—

Configuration area Tab. 4-79

18 Data type.

19 Access: RO = Read only, RW = Read and write. P = PDO.

20 Size (bytes)

Exception handling

Index	SI	Name	Description	DT[21]	Z[22]	Gr[23]	Default value
0xF380	—	Active Exception Status	An abbreviated summary byte that describes the detection of active device exceptions. ▪ Bit 0 Device warning ▪ Bit 1 Manufacturer warning ▪ Bit 2 Device error ▪ Bit 3 Manufacturer error	USINT	RO P	1	0
0xF381	—	Active Device Warning Details					
	0x01	Module 1	▪ Bit 0 - Warning present.	UDINT	RO P	4	0
0xF382	—	Active Manufacture Warning Details					
	0x01	Module 1	▪ Bit 0 - Warning present ▪ Bit 1 - Arc retry limit reached.	UDINT	RO P	4	0
0xF383	—	Active Device Error Details					
	0x01	Module 1	▪ Bit 0 Error present. ▪ Bit 1 Interlock open. ▪ Bit 2: Error: excessive temperature. ▪ Bit 3: Error: cooling / ventilator. ▪ Bit 4: Error: AC supply. ▪ Bit 5-31 Reserved.	UDINT	RO P	4	0
0xF384	—	Active Manufacture Error Details					
	0x01		▪ Bit 0 - Error present. ▪ Bit 1 - 15 Reserved.	UDINT	RO P	4	0
0xF390	Structure corresponds to 0xF380						
0xF391	Structure corresponds to 0xF381						
0xF392	Structure corresponds to 0xF382						
0xF393	Structure corresponds to 0xF383						
0xF394	Structure corresponds to 0xF384						

Exception handling Tab. 4-80

21 Data type.

22 Access: RO = Read only. P = PDO.

23 Size (bytes)

Manufacturer-specific objects

Index	SI	Name	Min. Value	Max. value	Default value	Unit	DT[24]	Z[25]	Gr [26]
0x2001	—	Arc management parameters							
0x2001	0x01	Arc management time delay	0	10000	100	ms	UINT	RW P	2
0x2001	0x02	Arc max. start value P_r	0	Max. P_r	10	W	UINT	RW P	2
0x2001	0x03	Arc min. start value P_i	1	Max. P_i	1% of max. P_r	W	UINT	RW P	2
0x2001	0x04	Arc threshold value P_r	0	Max. P_r	100	W	UINT	RW P	2
0x2001	0x05	Arc gradient P_r	1	Max. P_r	20	W/ sample values	UINT	RW P	2
0x2001	0x06	Arc threshold value P_r/P_i	0	100	50	%	UINT	RW P	2
0x2001	0x07	Arc gradient P_r/P_i	1	100	50	% / sample values	UINT	RW P	2
0x2001	0x08	Number of arc sample values (prev. shift-register length)	1	500	1	—	UINT	RW P	2
0x2001	0x09	Delay in arc handling	0	1000	0	µs	UINT	RW P	2
0x2001	0x0A	Arc suppression time	5	500	10	µs	UINT	RW P	2
0x2001	0x0B	Arc burst-pulse on time	10	500	10	µs	UINT	RW P	2
0x2001	0x0C	Delay time during arc detection	0	1000	0	µs	UINT	RW P	2
0x2001	0x0D	Arc handling pulse number per burst	0	1000	0	Number of burst pulses	UINT	RW P	2
0x2001	0x0E	Arc handling - number of new attempts	0	65535	0	Number of bursts	UINT	RW P	2
0x2001	0x0F	Arc self-prolonging suppression pulse on	—	—	—	—	UINT	RW P	2
0x2001	0x10	Arc rate	0	65535	0	Arcs/ second	UINT	RW P	2
0x2001	0x11	Arc rate limit	0	65535	0	Arcs/ second	UINT	RW P	2
0x2002	—	Clock configuration							
0x2002	0x01	Clock offset mode	0	2	0	—	USINT	RW P	1

24 Data type.

Index	SI	Name	Min. Value	Max. value	Default value	Unit	DT[24]	Z[25]	Gr [26]
0x2002	0x02	Frequency offset mode	-5000	5000	0	Hz	REAL	RW P	4
0x2003	—	Ramping configuration							
0x2003	0x01	Ramp channel	0	2	0	—	USINT	RW P	1
0x2004	—	Device configuration							
0x2004	0x01	Configured station address	0	0xFFFF	0	—	UINT	RO	2
0x2016	—	—							
0x2016	0x01	Software limit value of the load power	0	3000	3000	W	REAL	RW	4

Manufacturer-specific area Tab. 4-81

Matchbox objects

Index	SI	Name	Description	DT[27]	Z[28]
0x2011	—	Power regulation with matchbox values			
	0x01	Set value Udc (DC bias)	[V] Max. value depends on matchbox connected.	DINT32	RW
	0x02	Set value Urf	[V] Max. value depends on matchbox connected.	DINT32	RW
	0x03	Set value Irf	[A] Max. value depends on matchbox connected.	DINT32	RW
0x2012	—	Current matchbox values			
	0x01	Actual value Udc (DC bias)	[V] Max. value depends on matchbox connected.	DINT32	RO
	0x02	Actual value Urf	[V] Max. value depends on matchbox connected.	DINT32	RO
	0x03	Actual value Irf	[A] Max. value depends on matchbox connected.	DINT32	RO

24 Data type.

25 Access: RO = Read only, RW = Read and write. P = PDO.

26 Size (bytes)

25 Access: RO = Read only, RW = Read and write. P = PDO.

26 Size (bytes)

27 Data type.

28 Access: RO = Read only, RW = Read and write. P = PDO.

Index	SI	Name	Description	DT[27]	Z[28]
0x2013	—	Units for matchbox values			
	0x01	DC bias unit	▪ 0 = This value is not measured in the connected matchbox. ▪ 1 = V. ▪ 10 = 0.1 V.	DINT32	RO
	0x02	Urf unit	▪ 0 = This value is not measured in the connected matchbox. ▪ 1 = V. ▪ 10 = 0.1 V.	DINT32	RO
	0x03	Irf unit	▪ 0 = This value is not measured in the connected matchbox. ▪ 1 = A. ▪ 10 = 0.1 A.	DINT32	RO
0x2028	—	Matchbox set values			
	0x01	Matchbox mode	▪ 0 = Automatic. ▪ 1 = DC automatic. ▪ 2 = Recipe.	DINT32	RW
	0x02	Selection of the matchbox	If only one SystemPort matchbox is connected to the generator, "1" must be selected.	DINT32	RW
	0x03	Activity control	▪ 0 = Off ▪ 1 = Active	DINT32	RW
	0x04	Start matchbox	▪ 0 = Off ▪ 1 = Start	DINT32	RW
	0x05	Start Automatic mode	▪ 0 = Off ▪ 1 = Start	DINT32	RW
	0x06	Freeze condition	▪ 0 = Off ▪ 1 = Freeze	DINT32	RW
	0x07	Recipe number	0 to 32	DINT32	RW
	0x08	Set value of the tune capacitor / "plasma-on" position	Position C_T. ▪ Range: 0 to 1000	DINT32	
	0x09	Set value of the tune capacitor / ignition position	Position C_T. ▪ Range: 0 to 1000	DINT32	RW
	0x0A	Set value of the load capacitor / "plasma-on" position	Position C_L. ▪ Range: 0 to 1000	DINT32	RW
	0x0B	Set value of the load capacitor / ignition position	Position C_L. ▪ Range: 0 to 1000	DINT32	RW

27 Data type.

28 Access: RO = Read only, RW = Read and write. P = PDO.

Index	SI	Name	Description	DT[27]	Z[28]
0x2029	—	Current matchbox values			
	0x01	Matchbox found on SystemPort	▪ 0 = No matchbox found. ▪ 1 = Matchbox found.	DINT32	RO
	0x02	Ready status of the matchbox	Parameter indicates whether the matchbox was found and correctly configured.	DINT32	RO
	0x03	Actual value of the tune capacitor / ignition position	Position C_T ▪ Range: 0 to 1000	DINT32	RO
	0x04	Actual value of the load capacitor / ignition position	Position C_L ▪ Range: 0 to 1000	DINT32	RO
	0x05	Actual value of "Z"	Range: 0 to 1000	DINT32	RO
	0x06	Actual value of phase	Range: 0 to 1000	DINT32	RO
	0x07	Status display of the matchbox	▪ Bit 0: Error. ▪ Bit 1: Matchbox alarm. ▪ Bit 2: Plasma on. ▪ Bit 3: Matchbox values are valid.	DINT32	RO
	0x08	DC bias max	Range: 0 to 65 535	DINT32	RO
	0x09	Urf peak max	Range: 0 to 65 535	DINT32	RO
	0x0A	Urf rms max	Range: 0 to 65 535	DINT32	RO
	0x0B	Irf max	Range: 0 to 65 535	DINT32	RO
	0x0C	Software version of the matchbox		DINT32	RO
	0x0D	Serial number of the matchbox		DINT32	RO

Matchbox objects Tab. 4-82

27 Data type.

28 Access: RO = Read only, RW = Read and write. P = PDO.

AFT objects

Index	SI	Name	Description	DT[29]	Z[30]
0x2024	—	AFT adjustment parameters			
	0x01	Modulation deviation	(see "Description of the frequency agility function", pg. 7-30)	UINT32	RW
	0x02	Rel. mod. deviation		UINT32	RW
	0x03	Modulation period		UINT32	RW
	0x04	Gain		UINT32	RW
	0x05	Rel. gain		UINT32	RW
	0x06	Pullback to start freq.		UINT32	RW
	0x07	Retuning threshold		UINT32	RW
	0x08	Regulation delay		UINT32	RW
	0x09	Auxilliary		UINT32	RW
	0x0A	Pulse shaping mode		UINT32	RW
	0x0B	Pulse overdrive		UINT32	RW

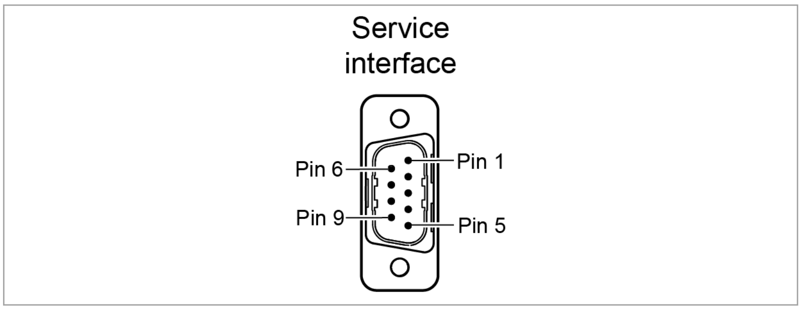
AFT objects Tab. 4-83

29 Data type.

30 Access: RO = Read only, RW = Read and write. P = PDO.

6. Service interface

6.1 View



View of service interface Fig. 10476

6.2 Connection

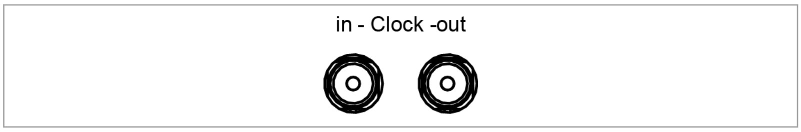
- On the generator: 9-pin sub-D plug.
- Necessary counterpart: 9-pin sub-D female connector.

6.3 Description

Interface for device configuration and service functions.

7. Clock input/clock output (phase synchronization)

7.1 View



View of clock input / clock output Fig. 10640

7.2 Connection

Lemo #EPL.00.250.NTN sockets

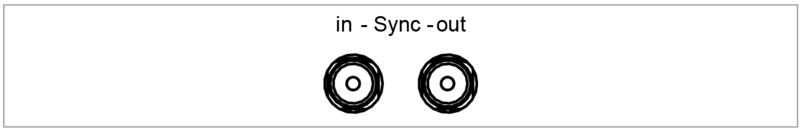
7.3 Cable requirement

Coaxial cable with 50 Ω characteristic impedance.

The maximum length is dependent on the attenuation of the selected cable. The maximum length is to be selected so that the specification of the input level is maintained (see "Clock input", pg. 3-7).

8. Sync input/sync output (arc synchronization or pulse mode)

8.1 View



View of sync input/sync output Fig. 10639

8.2 Connection

Lemo #EPL.00.250.NTN sockets

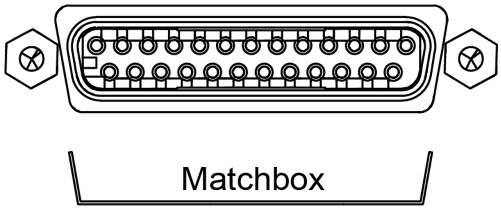
8.3 Cable requirement

Coaxial cable with 50 Ω characteristic impedance.

The maximum length is dependent on the attenuation of the selected cable. The maximum length is to be selected so that the specification of the input level is maintained (see "Pulse input", pg. 3-10).

9. Matchbox connection (optional)

9.1 View



Matchbox connection view Fig. 10652

9.2 Connection

- On the generator: 25-pin sub-D female connector.
- Necessary counterpart: 25-pin sub-D male connector.

9.3 Description

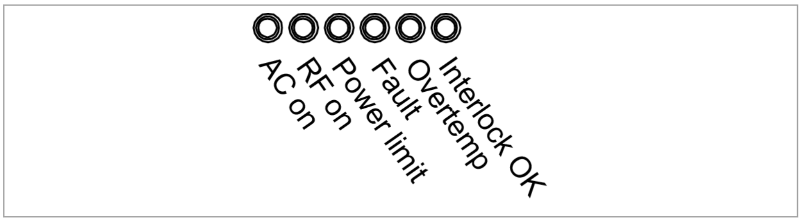
A matchbox from TRUMPF can be controlled via this interface.

9.4 Cable requirement

SystemPort cable from TRUMPF.

10. LEDs Device status

10.1 View



View of device status LEDs — Fig. 10493

For visual control of the generator modes and operation state, the generator has 6 LED indicators.

10.2 Description of LEDs Device status

Description	Color
AC on	green
RF on	green
Power limit	yellow
Fault	yellow
Overtemp	yellow
Interlock OK	green

LEDs Device status — Tab. 4-84

AC on Supply voltage present

RF on RF output active

Power limit Power limiting is active

RF output active/forward power is limited due to excessive reflected power.

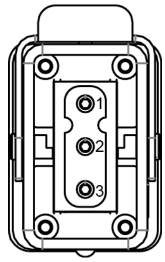
Fault Alarm message present

Overtemp Excessive temperature

Interlock ok Interlock circuit closed

11. Mains input

11.1 View



View of mains input for TruPlasma RF 1001 to 1003 Fig. 10485

11.2 Connection

TruPlasma RF 1001 to 1003: 3-pin Harting male connector HAN C-modular (40 A)

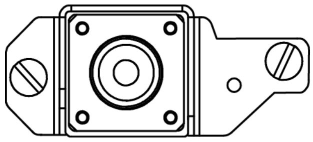
11.3 Pin assignment

Pin	Assignment
1	L1
2	L2
3	L3
PE	PE

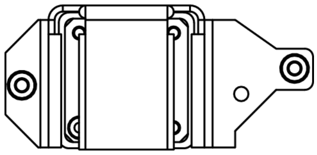
Pin assignment of mains input Tab. 4-85

12. RF output

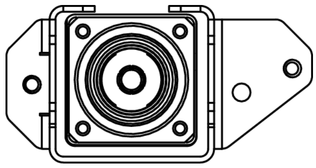
12.1 View



View of RF output HN socket Fig. 10488



View of RF output HN socket 90° Fig. 10489



View of RF output 7/16 Fig. 10490

12.2 Connection

7/16

HN socket

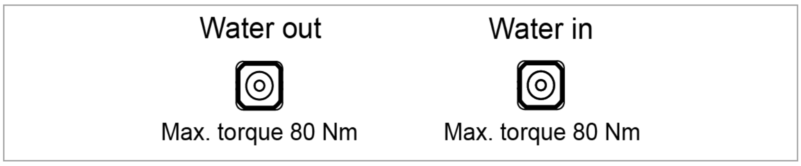
12.3 Cable requirement

RF cable from TRUMPF.

Please contact TRUMPF to obtain more detailed information about selecting the appropriate RF cable.

13. Cooling water

13.1 View



View of cooling water inflow/cooling water outflow Fig. 10658

Cooling water connections for inflow and outflow are located on the rear side.

13.2 Connection

Screw-in thread G 1/4"

14. ASIP (Advanced Serial Interface Protocol)

14.1 Introduction

This chapter defines the protocol for the communication between the user (e.g. via an operating tool) and the generator. The protocol is designed as a half duplex master/slave protocol, where the generator acts as slave.

ASIP is available on RS-232, RS-485 and Ethernet interfaces.

14.2 RS-232/RS-485 interfaces

Bit transmission (physical layer)

The serial signal is structured according to the following diagram:

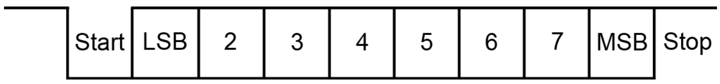


Fig. 10121

Automatic baud rate adaptation or fixed baud rate:

When operated with baud rate adaptation, the generator (slave) can adjust its baud rate to that of the master. When operated with fixed baud rate, the baud rate can be set from flexible to fixed operation by means of the parameter. This option was provided to avoid problems with the adaptation.

For baud rate adaptation, only data rates of 9,600, 57,600, and 115,200 baud are permitted. After the system starts, the generator begins searching at 115200 baud. If the master telegrams are valid and there is a good connection, the search algorithm takes at most three attempts to find the baud rate prescribed by the master and responds at the latest to the fourth request from the master. More attempts may be necessary if there are connection problems. In the worst case, no connection can be established.

If the master has made seven attempts without detecting the baud rate (no response telegram from the generator), it must be assumed that there is a significant connection problem with bit errors. It may be possible to rectify the problem by using a low fixed baud rate.

Important: Even if automatic baud rate detection is active, the timeouts must be observed.

The fixed baud rate is not limited and must be consistent with the master hardware and generator that is used (at a minimum, baud rates 9,600, 57,600, and 115,200 should be supported).

Settings/standards

RS-232 operation

- 1 start bit, 8 data bits, no parity, 1 stop bit, without direction switching.
- Single slave function/addressing (connection between 1 master and 1 slave).
- Two operating modes are available for the baud rate (automatic baud rate adaptation or fixed baud rate).
- Connection: 9-pin sub-D plug with screw-type locking (recommended).
- Cable: shielded null modem cable.

Baud rate	Maximum cable length Depending on the cable's capacitance
9 600	20 m
57 600	5 m
115 200	< 2 m

Baud rate and maximum cable length for RS-232 Tab. 4-86

RS-485 operation

- 1 start bit, 8 data bits, no parity, 1 stop bit, RTS for direction switching.
- 120 Ω terminating resistors must be used at the ends of the cables.
- Multiple slave function/addressing available (connection between 1 master and n slaves).
- As with RS-232 operation, two operating modes are available for the baud rate:

  Automatic baud rate adaptation or fixed baud rate.
- Connection: 9-pin sub-D plug with screw-type locking (recommended).
- Cable: shielded 1:1 cable.

Note

The maximum permissible cable length is **30 m**. If longer cables are needed, select optical transmission.

Framing (data link layer)

To match the data format of Intel processor-based master systems (i.e., the majority of all master systems), the data is transmitted in little endian format.

Addressing for RS-232 and RS-485 operation:

- The address consists of one byte contained in the data link layer.
- Address 0x00 is reserved for broadcasts (broadcasts are not followed by a response).
- The master is always addressed via the master address 0x01.
- For RS-232 operation (single slave addressing), the slave is addressed via the slave address 0x02.
- For RS-485 operation (multi slave addressing), the slaves can be addressed according to project requirements between 0x02 (default) and 0x7F. Ensure unique addressing.

Note

The address byte is protected by a parity bit at the data link layer level. The parity is created and removed by the data link layer (the application layer is not informed of this). The lower seven bits yield the target address and the top bit is calculated (as odd parity) of the lower seven bits.

Example: A slave has received address 0x05 for RS-485. The address byte on the link layer results in 0x85 (including parity).

0x05 => even parity sum => parity bit (odd parity) equals 1.

Odd parity	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	LSB
1	0	0	0	0	1	0	1

Tab. 4-87

On this layer, it is possible to distinguish between the following three telegram architectures.

Structure of a Type I Telegram

[Start byte]	(1 byte) The start byte is always [0xAA]
[Address]	(1 byte) Target address
[Length]	(1 byte) This byte contains the number of data bytes (1 … 255) without checksum.
[Data]	(1 … 255 bytes) Data that is to be passed to the application.

[Checksum]	(2 bytes) The checksum is calculated as a 16-bit-CRC (CRC-CCITT 0xFFFF, non-reflected) of all bytes before the checksum itself (from the start byte to the last data byte).
[Stop byte]	(1 byte) The stop byte is always [0x55]

Structure of a Type I Telegram Tab. 4-88

Note

For this type of telegram, the minimum length is 6 bytes (0 bytes of application data) and the maximum is 261 bytes.

Structure of a Type II Telegram

[ACK]	(1 byte) If the telegram of type I has successfully been sent from the master (sender) to the generator (slave/receiver), the generator always responds with direct acknowledgment [0x06] of the telegram. A telegram type I may then follow from the slave system.

Structure of a Type II Telegram Tab. 4-89

Structure of a Type III Telegram

[NAK]	(1 byte) If the telegram of type I has been sent from the master (sender) to the generator (slave/receiver) with errors, the generator always responds with direct non-acknowledgment [0x15] of the telegram.
[RSN]	(1 byte) Additional byte: this contains the reason for rejection. Possible detected problems are: ▪ Faulty length: Cause [0x02]. ▪ Faulty checksum: Cause [0x03]. ▪ Timeout (or insufficient data): Cause [0x04].

Structure of a Type III Telegram Tab. 4-90

Note

The master does not acknowledge with ACK/NAK. If the master does not understand the generator's response, it must repeat the most recent request.

Timeout behavior

There is a granted latency of 150 milliseconds ($T_{Latency}$) which may elapse between a telegram type I being sent by the master (sender) and the generator acknowledgment with ACK or NAK. This latency is extended by the transmission time. If the resulting data link layer timeout ($T_{DLLtimeout}$) is expired, the master will assume that the generator did not detect the telegram and restarts the transmission.

$T_{DLLtimeout} = T_{Latency} + n * (Sym_{Norm}/Baud + T_{InterChar})$.

- n: number of bytes in the telegram to be sent.
- Baud: Set baud rate of the master interface (in [symbols/s]).

- Sym_{Norm}: Normalized symbols for 1 start bit, 8 data bits and 1 stop bit, resulting in 10 - [unit: symbols]).
- $T_{InterChar}$: Maximum delay time between two bytes (limited to 0.025 - unit 1/s).

- Ex: The master application sends a telegram with a length of 12 bytes (e.g., controlling the activity of the interface) at a baud rate of 9600 baud:

  $T_{DLLdelay}$ = 0.150 + 12 * (10/9600 + 0.025) = 0.4625 s.

  The master calculates 462.5 ms as the timeout for the response (ACK/NAK) of the generator's data link layer.

Notes

- $T_{DLLtimeout}$ must be measured after the complete transmission, i.e., the master application must also consider the transmission time. The transmission time depends on the number of bytes and the baud rate.
- The inter-character interval ($T_{InterChar}$) may vary in value; in the example, the calculated timeout is barely reached.

Name	Value [s]	Description
$T_{InterChar}$	0,025	Inter character timeout
$T_{Latency}$	0,150	Response latency

Time constants of the data link layer Tab. 4-91

14.3 Data transmission (application layer)

The application layer describes the structure of the [Data] item on the data link layer.

In the [data] section of a telegram, several data objects may be located under one command. Each data object triggers an action that is executed in the same sequence as in the request. The responses are given in the same order and are chained in the data section of the response telegram. Different commands cannot be mixed.

As the ASIP protocol is designed in half duplex mode, after a request the master has to wait for a response before another request can be issued.

Note

The data link layer limits the data section of a response telegram to a maximum of 255 bytes. Thus the master system must limit the number of chained requests so that the response fits into the response telegram in its entirety.

Timeout behavior

The generator requires at most one second ($T_{ALtimeout}$) to respond the master's request.

If the master does not pass any requests over five seconds ($T_{ALtimeoutConn}$), which were recognized as valid by the generator, the generator will close the associated connection. E.g. open file handles are closed and a new connection attempt of the master is expected by the generator.

Name	Value [s]	Description
$T_{ALtimeout}$	1.000	Application layer timeout
$T_{ALtimeoutConn}$	5.000	Application layer connection time-out

Time constants of the application layer Tab. 4-92

Structure of the data unit

There are two types of [data] units. Data unit type A is a sequence of complete data objects in one telegram, and data unit type B streams a data object over one or more telegrams.

Which data unit is used depends on the command and is uniquely specified in the description of the command. For example, the parameter read and parameter write commands use type A, whereas the file transfer and message transfer commands use type B. Both types have an identical structure which differs in the fine structure of the data object [DOB] only.

[GS]	(1 byte) The first byte represents the generator status. A master request will always set this byte to [0x00].
[CMD]	(1 byte) Command (queried by the master or executed by the generator slave).
[DOB]	(1 … n) Data objects - depending on type.

Structure of the data unit Tab. 4-93

Generator status [GS]

The generator status consists of one byte which is interpreted as a bit field. The generator status must be [0x00] when sent from master to generator (= slave), otherwise the slave responds with an error telegram. In the opposite direction, the slave sends the generator status with the following meaning:

MSB 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	LSB 0
Alm	Msg	Resv	Pwr	ActIfc	Rdy2	Rdy1	Resv

Status byte Tab. 4-94

Bit is 1	Meaning
Alm	Alarms or error messages are pending, read error list.
Msg	Alarms, warnings and/or information pending.
Resv	Reserved for future extensions.
Pwr	Power is currently supplied.
ActIfc	Interface is currently active.
Rdy2	Ready, power can be delivered (even calibrated)
Rdy1	Ready, boot process complete.
Resv	Reserved for future extensions.

Meaning of the bits Tab. 4-95

Command (Command) [CMD]

Command is a category under which one or more data objects of the same data unit can be arranged.

For example, the master requests one or more parameter values from the slave via the command "Parameter Read". The slave responds with the command "Parameter Read" and writes the parameter values into the data objects. More information may be found in chapter "Parameter Read".

The following table contains an overview of the defined commands:

ID	Command
[0xFE]	Telegram error (as response of a generator, if the telegram structure is not correct).
[0x01]	Parameter Read (reading of parameters).
[0x02]	Parameter Write (writing of parameters).
[0x03]	File Transfer (reading/writing of files).
[0x04]	Message Read (reading of messages)
[0x05]	Control of interface activity.
[0x1A]	Read lower parameter limit.
[0x1B]	Read upper parameter limit.

Commands (Commands) Tab. 4-96

Data objects [DOB]

Data objects encapsulate the data to be transferred into an information layer that makes them unequivocal for the communication partners. One can put as many data objects into a telegram as the maximum telegram length permits. The information layer is structured and is explained below.

Index [IDX]	The index is an abstract designator that may designate a parameter index but also, for example, a sub-command.
Sub-index [SUBIDX]	The sub-index extends the index by a further structural level. It is used for reading or writing parameter arrays.

Tab. 4-97

Notes

- An array could be used, e.g., for a cluster of parameters with similar style or structure, or to determine the limits of the value range, step intervals, etc. in addition to the value itself. But this parameter definition is implementation-specific and is not a part of this specification.
- A special case is sub-index [0x00], where a read process returns the number of elements contained in a structure. Parameters that are not a structure behave alike and return the value 1. The value can then be accessed via sub-index 1. Writing to sub-index 0 leads to error "unknown sub-index".

For commands different from Parameter Read/Write, the sub-index may also carry other information, such as, e.g., file handle.

Status values [STAT]

ID	Description
0x00	No error, data follows.
0x05	Unknown parameter index / forbidden parameter index.
0x16	This command is not accepted. Example: writing parameters/data but interface is not "active". Example: activating the interface when interface is already active.
0x23	Current user role has no access (e.g. reading parameters is not permitted when parameter read was requested).
0x24	The parameter is not initialized correctly.
0x25	A parameter specific check has failed -> see parameter specific information.
0x26	The parameter can only be written in case of "power off".
0x27	Parameter dependency check failed. Example: pulse frequency and duty cycle must match.

ID	Description
0x33	Insufficient space available in the response telegram.
0x34	No free file handle available.
0x35	Unknown / incorrect file handle. Example: access after a timeout of 5000 ms.
0x36	Unknown file / unknown file name.
0x37	Illegal file attribute (e.g. attempt to write/read a file when file may only be read/written to; or write access if maximum file size is exceeded).
0x38	Unknown sub-index, e.g. in the case of "Parameter write to sub-index 0".
0x40	Activation of the interface not possible.
0x41	File could not be written after transfer (e.g., incorrect file size or insufficient memory available).
0x42	File could not be retrieved: either it is in use (invalid file handle) or being created (valid file handle), ("busy status").
0xFF	No data, no error.

Status values [STAT] Tab. 4-98

Note

ASIP defines a pool of status values. Which of these are supported is generator specific (i.e., status values [0x26] and [0x27] are not supported by every generator).

Data types [Typ]

ID	Abbreviation	Description
0x01	IND	1 byte, bit value LSB on | off [0x01|0x00]
0x02	SINT8	1 byte, signed integer [-128 to 127]
0x05	UINT8	1 byte, unsigned integer [0 to 255]
0x03	SINT16	2 bytes, signed integer [-32768 to 32767]
0x06	UINT16	2 bytes, unsigned integer [0 to 65535]
0x04	SINT32	4 bytes, signed integer [-2147483648 to 2147483647]
0x07	UINT32	4 byte, unsigned integer [0 to 4294967295]
0x08	FLT32	4 bytes, floating point IEEE
0x11	FLT64	8 bytes, floating point IEEE
0x40	FSIZE	4 bytes, unsigned integer [0 to 4294967295], file size in bytes
0x41	TIM96	12 bytes, time stamp (8 bytes seconds since Jan. 1st 1970, followed by 4 bytes microseconds) **Notice:** If this type is written, the slave may not respond because of invalid time intervals!
0x42	SINT16_TIM96	2 bytes, signed integer [-32768 to 32767] and 12 bytes time stamp
0x43	UINT16_TIM96	2 bytes, unsigned integer [0 to 65535] and 12 bytes time stamp
0x50	STRUC_INDICATION	(see "Structure definition", pg. 4-149)
0x51	STRUC_IND_SHORT	(see "Structure definition", pg. 4-149)
0x52	STRUC_EVENT	(see "Structure definition", pg. 4-149)

ID	Abbreviation	Description
0x53	STRUC_PARAM_LOG	(see "Structure definition", pg. 4-149)
0x5F	VECT	1 to 248 bytes of vector data; data field with length of 1 byte followed by up to 247 bytes of data

Data types [TYP] Tab. 4-99

Note

Other data types are not supported. They have to be handled as "Specific vector files", cf. "File name list".

Data [DTA]

Data is an abstract designator that must be interpreted according to data type. It differs in composition and structure.

Data unit type A

This describes the chaining of complete data objects. Here, the data object is repeated in its entirety if more than one data object is used in the telegram.

If an error is reported, it is entered into the status field for the respective current data object.

[GS] (1 byte) The first byte represents the generator status. A master request will always set this byte to [0x00].

[CMD] (1 byte) Command - queried by the master or executed by the generator (Slave).

[DOB] (1 to n) Data objects with the following structure:

- [IDX] (2 bytes) Index.
- [SUBIDX] (1 byte) Sub-index.
- [STAT] (1 byte) Status, only if followed by [0x00].
- [TYP] (1 byte) Data type.
- [DTA] (1 to 248 bytes) Data with the data type specified above.

Note

In this context, it must be considered that the master must never query too many parameters in a single telegram, as the slave can only respond with a single telegram with a payload of 255 bytes.

Data unit type B

This describes the chaining within a data object. Only one data object may be used in the telegram. A variant list is created below respective the index / sub-index selection. The list elements form a sequence of status, data type and data.

If an error is reported, it must be entered globally for the entire data object in the first status field directly after the index / sub-index section.

Note

This global status applies across all list elements.

[GS] (1 byte) The first byte represents the generator status. A master request will always set this byte to [0x00].

[CMD] (1 byte) Command (queried by the master or executed by the generator slave).

[DOB] 1 Data objects with the following structure:

- [IDX] (2 bytes) Index.
- [SUBIDX] (1 byte) Sub-index.
- (1 … n) Variant list elements.
  - [STAT] (1 byte) Status, only if followed by [0x00]:
  - [TYP] (1 byte) Data type.
  - [DTA] (1 to 248 bytes) Data with the data type specified above.

Note

For both data unit types, the minimum length is 6 bytes and the maximum 255 bytes.

Specific commands of the application

Telegram error [0xFE]

If an error is detected in the application, the entire telegram must be discarded. A partial execution must not take place as a precise cause for the error cannot be determined and commands are not context-free. These telegrams can only be transmitted by the generator.

For telegram errors, the data unit type A is used.

- [GS] (1 byte) The first byte always represents the generator status.
- [CMD] (1 byte) Telegram error [0xFE].
- [DOB] 1 data object with the following structure:
  - [IDX] (2 bytes)
    Unknown command [0x01] or
    Parsing error [0x02] or
    Generator status error [0x03] or
    Telegram length error [0x04] or
  - [SUBIDX] (1 byte) Sub-index, not used [0x00].
  - [STAT] (1 byte) Status [0xFF].

For telegram errors, the data unit type A is used.

- [GS] (1 byte) The first byte always represents the generator status.
- [CMD] (1 byte) Telegram error [0xFE].
- [DOB] 1 data object with the following structure:
  - [IDX] (2 bytes) Unknown command [0x01] or Parsing error [0x02] or Generator status error [0x03] or Telegram length error [0x04].
  - [SUBIDX] (1 byte) Sub-index, not used [0x01].
  - [STAT] (1 byte) Status [0xFF].

Parameter read [0x01]

Reading of parameter values.

For reading parameters, the data unit type A is used.

[GS] (1 byte) The first byte always represents the generator status.

[CMD] (1 byte) Parameter Read [0x01].

[DOB] (1 to n) Data objects with the following structure:

- [IDX] (2 bytes) Index.
- [SUBIDX] (1 byte) Sub-index.
- [STAT] (1 byte) Status, only if [0x00]:
- [TYP] (1 byte) Data type.
- [DTA] (1 to 248 bytes) Data with the data type specified above.

For reading parameters, the data unit type A is used.

[GS] (1 byte) The first byte always represents the generator status.

[CMD] (1 byte) Parameter Read [0x01].

[DOB] (1 to n) Data objects with the following structure:

- [IDX] (2 bytes) Index.
- [SUBIDX] (1 byte) Sub-index.
- [STAT] (1 byte) Status, only if [0x00]:
- [TYP] (1 byte) Data type.
- [DTA] (1 to 248 bytes) Data with the data type specified above.

Example for reading a parameter (success case):

Read parameters 0x0001, 0x0005 and 0x2534 (assuming that sub-index 1 reads the value of the parameter).

The master requests the following parameters:

[GS] [0x00]

[CMD] [0x01]

[DOB] 3 Data objects with the following structure:

- [IDX] (1 byte) LO [0x01], (1 byte) HI [0x00].
- [SUBIDX] (1 byte) Sub-index [0x01].
- [STAT] (1 byte) Status [0xFF].
- [IDX] (1 byte) LO [0x05], (1 byte) HI [0x00].
- [SUBIDX] (1 byte) Sub-index [0x01].
- [STAT] (1 byte) Status [0xFF].
- [IDX] (1 byte) LO [0x34], (1 byte) HI [0x25].
- [SUBIDX] (1 byte) Sub-index [0x01].
- [STAT] (1 byte) Status [0xFF].

The generator responds:

[GS] [0x00]

[CMD] [0x01]

[DOB] 3 Data objects with the following structure:

- [IDX] (1 byte) LO [0x01], (1 byte) HI [0x00].
- [SUBIDX] (1 byte) Sub-index [0x01].
- [STAT] (1 byte) Status [0x00].
- [TYP] (1 byte) Data type [0x06].
- [DTA] (2 bytes) Data [0x00] [0x00].
- [IDX] (1 byte) LO [0x05], (1 byte) HI [0x00].
- [SUBIDX] (1 byte) Sub-index [0x01].
- [STAT] (1 byte) Status [0x00].
- [TYP] (1 byte) Data type [0x05].
- [DTA] (1 byte) Data [0xE3].
- [IDX] (1 byte) LO [0x34], (1 byte) HI [0x25].

- [SUBIDX] (1 byte) Sub-index [0x01].
- [STAT] (1 byte) Status [0x00].
- [TYP] (1 byte) Data type [0x07].
- [DTA] (4 bytes) Data [0x00] [0x02] [0x05] [0xFF].

The parameter 0x0001 is of type UINT16 and has the value 0x0000.

The parameter 0x0005 is of type UINT8 and has the value 0xE3.

The parameter 0x2534 is of type UINT32 and has the value 0xFF050200.

Example for reading a parameter (error case):

Read parameters 0x0001, 0x0005 and 0x2534 (assuming that sub-index 1 reads the value of the parameter).

The master requests the following parameters:

[GS] [0x00]

[CMD] [0x01]

[DOB] 3 Data objects with the following structure:

- [IDX] (1 byte) LO [0x01], (1 byte) HI [0x00].
- [SUBIDX] (1 byte) Sub-index [0x01].
- [STAT] (1 byte) Status [0xFF].
- [IDX] (1 byte) LO [0x05], (1 byte) HI [0x00].
- [SUBIDX] (1 byte) Sub-index [0x01].
- [STAT] (1 byte) Status [0xFF].
- [IDX] (1 byte) LO [0x34], (1 byte) HI [0x25].
- [SUBIDX] (1 byte) Sub-index [0x01].
- [STAT] (1 byte) Status [0xFF].

The generator responds:

[GS] [0x00]

[CMD] [0x01]

[DOB] 3 Data objects with the following structure:

- [IDX] (1 byte) LO [0x01], (1 byte) HI [0x00].
- [SUBIDX] (1 byte) Sub-index [0x01].
- [STAT] (1 byte) Status [0x23].
- [IDX] (1 byte) LO [0x05], (1 byte) HI [0x00].
- [SUBIDX] (1 byte) Sub-index [0x01].
- [STAT] (1 byte) Status [0x00].
- [TYP] (1 byte) Data type [0x05].
- [DTA] (1 byte) Data [0xE3].
- [IDX] (1 byte) LO [0x34], (1 byte) HI [0x25].
- [SUBIDX] (1 byte) Sub-index [0x01].

- [STAT] (1 byte) Status [0x00].
- [TYP] (1 byte) Data type [0x07].
- [DTA] (4 bytes) Data [0x00] [0x02] [0x05] [0xFF].

The parameter 0x0001 could not be read because the user role does not have read permission for this parameter.

The other parameters were read successfully.

The parameter 0x0005 is of type UINT8 and has the value 0xE3.

The parameter 0x2534 is of type UINT32 and has the value 0xFF050200.

Parameter Write [0x02]

Writing of parameter values.

Note

Only the active interface is able to write parameter values (cf. Controlling the active state of the interface).

For writing parameters, the data unit type A is used.

[GS] (1 byte) The first byte always represents the generator status.

[CMD] (1 byte) Parameter Write [0x02].

[DOB] (1 to n) Data objects with the following structure:

- [IDX] (2 bytes) Index.
- [SUBIDX] (1 byte) Sub-index.
- [STAT] (1 byte) Status, only if a [0x0] follows:
- [TYP] (1 byte) Data type.
- [STA] (1 to 248 bytes] Data with the data type specified above.

For writing parameters, the data unit type A is used.

[GS] (1 byte) The first byte always represents the generator status.

[CMD] (1 byte) Parameter Write [0x02].

[DOB] (1 to n) Data objects with the following structure:

- [IDX] (2 bytes) Index.
- [SUBIDX] (1 byte) Sub index.
- [STAT] (1 byte) Status, only if followed by [0x0]:
- [TYP] (1 byte) Data type.
- [STA] (1 to 248 bytes] Data with the data type specified above.

Example for writing a parameter (success case):

Write parameters 0x0001, 0x0005 and 0x2534 (assuming that sub-index 1 writes the value of the parameter).

The master writes the following parameters:

[GS] [0x00]

[CMD] [0x02]

[DOB] 3 Data objects with the following structure:

- [IDX] (1 byte) LO [0x01], (1 byte) HI [0x00].
- [SUBIDX] (1 byte) Sub-index [0x01].
- [STAT] (1 byte) Status [0x00].
- [TYP] (1 byte) Data type [0x06].
- [DTA] (2 bytes) Data [0x00] [0x00].
- [IDX] (1 byte) LO [0x05], (1 byte) HI [0x00].
- [SUBIDX] (1 byte) Sub-index [0x01].
- [STAT] (1 byte) Status [0x00].
- [TYP] (1 byte) Data type [0x05].
- [DTA] (1 byte) Data [0xE3].
- [IDX] (1 byte) LO [0x34], (1 byte) HI [0x25].
- [SUBIDX] (1 byte) Sub-index [0x01].
- [STAT] (1 byte) Status [0x00].
- [TYP] (1 byte) Data type [0x07].
- [DTA] (4 bytes) Data [0x00] [0x02] [0x05] [0xFF].

The parameter 0x0001 is of type UINT16 and is to be set to the value 0x0000.

The parameter 0x0005 is of type UINT8 and is to be set to the value 0xE3.

The parameter 0x2534 is of type UINT32 and is to be set to the value 0xFF050200.

The generator responds:

[GS] [0x00]

[CMD] [0x02]

[DOB] 3 Data objects with the following structure:

- [IDX] (1 byte) LO [0x01], (1 byte) HI [0x00].
- [SUBIDX] (1 byte) Sub-index [0x01].
- [STAT] (1 byte) Status [0xFF].
- [IDX] (1 byte) LO [0x34], (1 byte) HI [0x25].
- [SUBIDX] (1 byte) Sub-index [0x01].
- [STAT] (1 byte) Status [0xFF].

The parameters were written successfully.

Example for writing a parameter (error case):

Write parameters 0x0001, 0x0005 and 0x2534 (assuming that sub-index 1 writes the value of the parameter).

The master writes the following parameters:

[GS] [0x00]

[CMD] [0x02]

[DOB] 3 Data objects with the following structure:

- [IDX] (1 byte) LO [0x01], (1 byte) HI [0x00].
- [SUBIDX] (1 byte) Sub-index [0x01].
- [STAT] (1 byte) Status [0x00].
- [TYP] (1 byte) Data type [0x06].
- [DTA] (2 bytes) Data [0x00] [0x00].
- [IDX] (1 byte) LO [0x05], (1 byte) HI [0x00].
- [SUBIDX] (1 byte) Sub-index [0x01].
- [STAT] (1 byte) Status [0x00].
- [TYP] (1 byte) Data type [0x05].
- [DTA] (1 byte) Data [0xE3].
- [IDX] (1 byte) LO [0x34], (1 byte) HI [0x25].
- [SUBIDX] (1 byte) Sub-index [0x01].
- [STAT] (1 byte) Status [0x00].
- [TYP] (1 byte) Data type [0x07].
- [DTA] (4 bytes) Data [0x00] [0x02] [0x05] [0xFF].

The parameter 0x0001 is of type UINT16 and is to be set to the value 0x0000.

The parameter 0x0005 is of type UINT8 and is to be set to the value 0xE3.

The parameter 0x2534 is of type UINT32 and is to be set to the value 0xFF050200.

The generator responds:

[GS] [0x00]

[CMD] [0x02]

[DOB] 3 Data objects with the following structure:

- [IDX] (1 byte) LO [0x01], (1 byte) HI [0x00].
- [SUBIDX] (1 byte) Sub-index [0x01].
- [STAT] (1 byte) Status [0x23].
- [IDX] (1 byte) LO [0x05], (1 byte) HI [0x00].
- [SUBIDX] (1 byte) Sub-index [0x01].
- [STAT] (1 byte) Status [0xFF].
- [IDX] (1 byte) LO [0x34], (1 byte) HI [0x25].

- [SUBIDX] (1 byte) Sub-index [0x01].
- [STAT] (1 byte) Status [0xFF].

The parameter 0x0001 could not be written because the user role does not have write permission for the parameter. The other parameters were written successfully.

File transfer [0x03]

The transfer direction of the file from the generator to the master is defined as **read file transfer** and from the master to the generator as **write file transfer**.

The master always initiates the file transfer with an invalid file handle [0x0] and receives a valid handle from the generator in return. The file transfer consists of the selection of the (virtual) file to be transferred and the query of the individual data blocks up to the defined end of file.

Note

Important: In this protocol version, only a single file handle per interface is supported for file transfer, which may be used for either "Select read" or "Select write". At any given time there is thus only one file in transfer per interface. (This does not affect the possibility to interrupt the file transfer at any time, e.g. to query and update actual values during a longer data transmission.)

If the master does not pass any requests, regardless of their nature - i.e. any command - to the application layer within 5,000 ms (cf. $T_{ALtimeoutConn}$), the generator regards the connection as closed, resulting in a new connection attempt. Open file handles in particular are closed in this context.

For file transfers, the data unit type B is used.

[GS] (1 byte) The first byte always represents the generator status.

[CMD] (1 byte) File transfer [0x02].

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Read mode selection [0x01] or
  Write mode selection [0x02] or
  First block [0x03] or
  Next block [0x04] or
  Repeat block [0x05] or
  Close [0x06]
  (1 byte) Not used [0x00] or
  Last data [0x01] or
  More data [0x02].
- [SUBIDX] (1 byte) File handle [0x00…0xFF].
- (1 to n) Variant list elements
  - [STAT] (1 byte) Status, only if followed by [0x0]:
  - [TYP] (1 byte) Data type
  - [DTA] (1 - 248 bytes) Data with the data type specified above.

For file transfers, the data unit type B is used.

[GS] (1 byte) The first byte always represents the generator status.

[CMD] (1 byte) File transfer [0x02].

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Read mode selection [0x01] or
  Write mode selection [0x02] or
  First block [0x03] or
  Next block [0x04] or
  Repeat block [0x05] or
  Close [0x06]
  (1 byte) not used [0x00] or
  Last data [0x01] or
  More data [0x02].
- [SUBIDX] (1 byte) File handle [0x00…0xFF].
- (1 to n) Variant list elements
  - [STAT] (1 byte) Status, only if followed by [0x0]:
  - [TYP] (1 byte) Data type
  - [DTA] (1 - 248 bytes) Data with the data type specified above.

Reading file transfer

A reading file transfer should create a snapshot of the data to be transferred whenever a valid file handle is issued and should destroy the snapshot upon a close.

Opening the file

The master determines the reading file transfer via the transfer direction using "Select read" and the defined file name, as specified in the file name list.

The generator transmits the file size to the master and subsequently acknowledges the selection. This response also includes the file handle that only can be set to "valid" by the generator. When the master receives a valid handle, it is the master's responsibility to close this handle in order to end the transfer in a controlled fashion. Any file handle other than [0x0] is a valid handle.

Data transmission

After the file selection, the data transfer starts with the request for the first block. Requests for further data blocks (Next Block) follow until the generator no longer transmits any data. For this purpose, the generator must set the second byte of the index to inform the master whether further data is pending: if further data exists, the generator sets the "More data" byte. If no data follows, i.e., the file has been completely transferred, it sets the "Last data" byte.

In the case of a transfer error, the master can re-request the data block to be repeated an arbitrary number of times by sending a repeat request (Repeat Block).

A data transmission can be interrupted by other requests from the master and can be continued by placing further data transmission requests. The file handle uniquely identifies a data transmission.

If a change in the user role reduces the permissions and thus prevents the reading of a file to be continued, the handle becomes invalid and the file transfer is aborted.

Closing the file

The master can actively close the data transmission at any time via the "Close" command. The generator does not release a file handle automatically. After the last successfully received telegram, the master must actively dispatch a "Close" command. The generator acknowledges the received "Close" telegram.

Only an extraordinary operation state (e.g., PowerFail) forces the generator to close all open file handles of a connection.

- Initially and after a new connection attempt, all handles are closed.
- If a change in the user role reduces the permissions and thus prevents the reading of a file to be continued, the handle becomes invalid and the file transfer is aborted.

Example for a reading file transfer (success case):

"/Test.txt" is transferred from the generator to the master without error

The master requests write access to the "/Test.txt" file:

[GS] [0x00]

[CMD] [0x03]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Write mode selection [0x02], (1 byte) [0x00] not used.
- [SUBIDX] (1 byte) File handle [0x00] not valid.
- 1 variant list element.
  - [STAT] (1 byte) Status [0x00].
  - [Typ] (1 byte) Vector [0x5F].
  - [DTA] (10 bytes) Data [0x09, 0x2F, 0x54, 0x65, 0x73, 0x74, 0x2E, 0x74, 0x78, 0x74].
  - [STAT] (1 byte) Status [0x00].
  - [TYP](1 byte) FSIZE [0x40].
  - [DTA] (4 bytes) Data […].

If the file can be written, the generator responds with:

[GS] [0x00]

[CMD] [0x03]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Write mode selection [0x02], (1 byte) [0x00] not used.
- [SUBIDX] (1 byte) File handle [0x01] valid.
- 1 variant list element.
  - [STAT] (1 byte) Status [0xFF].

The master writes the first block:

[GS] [0x00]

[CMD] [0x03]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) First block [0x03], (1 byte) More data [0x02].
- [SUBIDX] (1 byte) File handle [0x01] valid.
- 1 variant list element.
  - [STAT] (1 byte) Status [0x00].
  - [Typ] (1 byte) Vector [0x5F].
  - [DTA] (248 bytes) Data [0xF7, 0x41, …; 0x41) (The vector defines its length with F7 byte, resulting in a data length of 248 bytes).

The generator acknowledges this first block with:

[GS] [0x00]

[CMD] [0x03]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) First block [0x03], (1 byte) [0x00] not used.
- [SUBIDX] (1 byte) File handle [0x01] valid.
- 1 variant list element.
  - [STAT] (1 byte) Status [0xFF].
  - [Typ] (1 byte) Vector [0x5F].

The master writes subsequent blocks until the last block:

[GS] [0x00]

[CMD] [0x03]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Next block [0x04], (1 byte) [0x00] not used.
- [SUBIDX] (1 byte) File handle [0x01] valid.
- 1 variant list element.
  - [STAT] (1 byte) Status [0xFF].

The generator responds with the "Last data" byte that there is no further data after this block:

[GS] [0x00]

[CMD] [0x03]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Next block [0x04], (1 byte) Last data [0x01].
- [SUBIDX] (1 byte) File handle [0x01] valid.
- 1 variant list element.
  - [STAT] (1 byte) Status [0x00].
  - [Typ] (1 byte) Vector [0x5F].
  - [DTA] (1 byte) Data [0x01, 0x41].

The master closes the file transfer with:

[GS] [0x00]

[CMD] [0x03]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Close [0x06], (1 byte) [0x00] not used.
- [SUBIDX] (1 byte) File handle [0x01] valid.
- 1 variant list element.
  - [STAT] (1 byte) Status [0xFF].

The generator acknowledges:

[GS] [0x00]

[CMD] [0x03]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Close [0x06], (1 byte) [0x00] not used.
- [SUBIDX] (1 byte) File handle [0x01] File handle is no longer valid.
- 1 variant list element.
  - [STAT] (1 byte) Status [0xFF].

Example for a reading file transfer (error case):

"/Test.txt" does not exist

The master requests the file "/Test.txt" for reading:

[GS] [0x00]

[CMD] [0x03]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Read mode selection [0x01], (1 byte) [0x00] not used.
- [SUBIDX] (1 byte) File handle [0x00] not valid.
- 1 variant list element.
  - [STAT] (1 byte) Status [0x00].
  - [Typ] (1 byte) Vector [0x5F].
  - [DTA] (10 bytes) Data [0x09, 0x2F, 0x54, 0x65, 0x73, 0x74, 0x2E, 0x74, 0x78, 0x74].

If the file is not present, the generator responds with:

[GS] [0x00]

[CMD] [0x03]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Read mode selection [0x01], (1 byte) [0x00] not used.
- 1 variant list element.
  - [STAT] (1 byte) Status [0x36] File does not exist, global status.

Writing file transfer

If possible, a "Writing file transfer" is based on a transaction model, i.e., a possibility to roll back incomplete write operations.

Note

Only the active interface can initiate and execute a writing file transfer.

Opening the file

The master defines the writing file transfer using the transfer direction "Select write" and the selected file name as specified in the file name list that follows. In addition to the file name, the file size is transmitted to the generator. The generator's response includes the file handle that only can be set to "valid" by the generator. When the master receives a valid handle, it is the master's responsibility to close this handle in order to end the transfer in a controlled fashion. Any file handle other than [0x0] is a valid handle.

Data transmission

After selecting the file, the master starts the data transfer by writing the data blocks, beginning with a "First block" sub-command followed by subsequent "Next block" sub-commands. The generator acknowledges each block. For this purpose, the master must set the second byte of the index in order to inform the generator of whether further data is pending. If there is still more data, the master sets the "More data" byte. If no data follows, i.e., the file has been completely transferred, the master sets the "Last data" byte. The generator waits for the master's close request to close the file transfer in a controlled fashion.

In the case of a transfer error or even a timeout event, detected and reported by the data link layer, the master can repeat the data block an arbitrary number of times by sending the same data block with a "Next block" sub-command. If the generator reports an error by the global error state of the application layer, the master must also repeat the last telegram, but now with the "Repeat block" sub-command.

In the case of a severe error, the generator can declare the handle as invalid, unexpectedly closing the file transfer.

A data transmission can be interrupted by other requests from the master and can be continued by placing further data transmission requests. The file handle uniquely identifies a data transmission.

Closing the file

The master can actively close the data transmission at any time via the "Close" command. The generator does not release a handle automatically. After the last successfully received telegram, the master must actively dispatch a "Close" command. The generator acknowledges the received "Close" telegram. The state includes information as to whether the file could be written correctly.

The following operation states force the generator to close open file handles of a connection:

- Initially (even in the case of a mains failure) and after a new connection attempt, all file handles are closed.
- The change of the interface property from active to inactive closes all writing file handles of the connection. This means that the handle used for writing is revoked and becomes invalid when the interface relinquishes its activity.

- If a change in the user role reduces the permissions and thus prevents the writing of a file to be continued, the handle becomes invalid and the file transfer is aborted.
- 5,000 ms command timeout.

Example for a writing file transfer via an active interface (success case)

"/Test.txt" is transferred from the generator to the master without error

The master requests the file "/Test.txt" for reading:

[GS] [0x00]

[CMD] [0x03]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Write mode selection [0x02], (1 byte) [0x00] not used.
- [SUBIDX] (1 byte) File handle [0x00] not valid.
- 1 variant list element.
  - [STAT] (1 byte) Status [0x00].
  - [Typ] (1 byte) Vector [0x5F].
  - [DTA] (10 bytes) Data [0x09, 0x2F, 0x54, 0x65, 0x73, 0x74, 0x2E, 0x74, 0x78, 0x74].
  - [STAT] (1 byte) Status [0x00].
  - [TYP](1 byte) FSIZE [0x40].
  - [DTA] (4 bytes) Data […].

If the file can be written, the generator responds with:

[GS] [0x08]

[CMD] [0x03]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Write mode selection [0x02], (1 byte) [0x00] not used.
- [SUBIDX] (1 byte) File handle [0x01] valid.
- 1 variant list element.
  - [STAT] (1 byte) Status [0xFF].
  - [TYP](1 byte) FSIZE [0x40].
  - [DTA] (4 bytes) Data […].

The master writes the first block:

[GS] [0x00]

[CMD] [0x03]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) First block [0x03], (1 byte) More data [0x02].
- [SUBIDX] (1 byte) File handle [0x01] valid.
- 1 variant list element.
  - [STAT] (1 byte) Status [0x00].
  - [Typ] (1 byte) Vector [0x5F].
  - [DTA] (248 bytes) Data [0xF7, 0x41, …; 0x41) (The vector defines its length with F7 byte, resulting in a data length of 248 bytes).

The generator acknowledges this first block with:

[GS] [0x08]

[CMD] [0x03]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) First block [0x03], (1 byte) More data [0x00] not used.
- [SUBIDX] (1 byte) File handle [0x01] valid.
- 1 variant list element.
  - [STAT] (1 byte) Status [0xFF].

The master writes subsequent blocks until the last block:

[GS] [0x00]

[CMD] [0x03]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Next block [0x04], (1 byte) Last data [0x01].
- [SUBIDX] (1 byte) File handle [0x01] valid.
- 1 variant list element.
  - [STAT] (1 byte) Status [0x00].
  - [Typ] (1 byte) Vector [0x5F].
  - [DTA] (1 byte) Data [0x01, 0x41].

The generator acknowledges this last block with:

[GS] [0x08]

[CMD] [0x03]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Last block [0x04], (1 byte) [0x00] not used.
- [SUBIDX] (1 byte) File handle [0x01] valid.
- 1 variant list element.
  - [STAT] (1 byte) Status [0xFF].

The master closes the file transfer with:

[GS] [0x00]

[CMD] [0x03]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Close [0x06], (1 byte) [0x00] not used.
- [SUBIDX] (1 byte) File handle [0x01] valid.
- 1 variant list element.
  - [STAT] (1 byte) Status [0xFF].

The generator acknowledges:

[GS] [0x08]

[CMD] [0x03]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Close [0x06], (1 byte) [0x00] not used.
- [SUBIDX] (1 byte) File handle [0x01] is no longer valid.
- 1 variant list element.
  - [STAT] (1 byte) Status [0xFF].

Example for a writing file transfer via an active interface (error case)

"/Test.txt" does not exist

The master requests write access to the "/Test.txt" file:

[GS] [0x00]

[CMD] [0x03]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Write mode selection [0x02], (1 byte) [0x00] not used.
- [SUBIDX] (1 byte) File handle [0x00] not valid.
- 1 variant list element.
  - [STAT] (1 byte) Status [0x00].
  - [Typ] (1 byte) Vector [0x5F].
  - [DTA] (10 bytes) Data [0x09, 0x2F, 0x54, 0x65, 0x73, 0x74, 0x2E, 0x74, 0x78, 0x74].
  - [STAT] (1 byte) Status [0x00].
  - [TYP](1 byte) FSIZE [0x40].
  - [DTA] (4 bytes) Data […].

If the file cannot be written, the generator responds with:

[GS] [0x08]

[CMD] [0x03]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Write mode selection [0x02], (1 byte) [0x00] not used.
- [SUBIDX] (1 byte) File handle [0x00] not valid.
- 1 variant list element.
  - [STAT] (1 byte) Status [0x37] (Illegal file attribute. File cannot be written, global status).

File name list

Each file is defined by its name, its attributes and its data type/ structure. The file name list is part of the specific information of the generator. It is a configuration list, that is processed identically by master and generator. It makes the file names known to the master and the generator; as a result, only associated files can be read and/or written.

File name

File names are case sensitive and consist of alphanumeric characters from ([a to z], [A to Z], [0 to 9]). The dot [.] is to be used as category delimiter and is the only special character allowed. The length of the file name is limited by the maximum length of the vector data type minus 6 bytes for the length information used in "Select write" requests.

File names, selected by the master, that are not included in the generator's list cause a defined error [0x36]. The error [0x37] is caused if the required file attribute does not match the defined file attribute.

Files may be categorized by historic lists "Histo" and logged lists "Log". A historic list has an independent time stamp for each value. A logged list has a defined interval that is incremented uniformly for each value. Files with bus logging data can be categorized with "Bus", configuration files are categorized with "Config" and pure binary files with "Bin". This categorization is optional.

File attributes

In addition, the files may have attributes (r, w, rw from the master's perspective). These attributes are internally represented by a 32 bit word. The lower 24 bits are reserved for general protocol purposes. In this protocol version only attributes for read/write are defined (r=0x01 for read only, r=0x02 for write only, rw=0x03 for read and write). The 8 high bits may be extended by generator specific purposes. The definition of these extended file attributes can be found in the specific information of the generator.

File type/structure

Files are defined by their type/structure. Beyond the generic binary format, ASIP supports special types defined in the appendix of this document. The generator specific file name list defines which type matches to a file (for generic files a vector type should be used as default).

Message read [0x04]

This command reads the lists of pending messages. The reading process follows the file transfer, except without Select and Close - and with special data types.

Reading a list using "Message read" must not be interrupted. If another request is placed before the "Message read" sequence is completed, the sequence is discarded. This means on the other hand, that the master can abort a "Message read" sequence in a controlled manner.

The data structure of "Message read" is provided in a short and in a long form (STRUC_INDICATION and STRUC_IND_SHORT), depending on the generator's implementation. The type of structure is provided in the response message.

For a "Message read" the data unit type B is used

[GS] (1 byte) The first byte always represents the generator status.

[CMD] (1 byte) Message Read [0x04]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) First block [0x03] or
  Next block [0x04] or
  Repeat block [0x05]
  (1 byte) Last data [0x01] or
  More data [0x02].
- [SUBIDX] (1 byte) Not used [0x00] or
  Warnings [0x01] or
  Alarms [0x02] or
  Info [0x03] or
  Messages [0x04].
- (1 to n) Variant list elements
  - [STAT] (1 byte) Status, only if followed by [0x0]:
  - [TYP] (1 byte) Data type
  - [DTA] (1 to 248 bytes) Data with the data type specified above.

For a "Message read" the data unit type B is used

[GS] (1 byte) The first byte always represents the generator status.

[CMD] (1 byte) Message Read [0x04]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) First block [0x03] or
  Next block [0x04] or
  Repeat block [0x05]
  (1 byte) Last data [0x01] or
  More data [0x02].
- [SUBIDX] (1 byte) Not used [0x00] or
  Warnings [0x01] or
  Alarms [0x02] or
  Info [0x03] or
  Messages [0x04].
- (1 to n) Variant list elements
  - [STAT] (1 byte) Status, only if followed by [0x0]:
  - [TYP] (1 byte) Data type
  - [DTA] (1 to 248 bytes) Data with the data type specified above.

Example for reading a message (success case)

The short structure elements for message transfer are used here.

The master requests the list of alarms:

[GS] [0x00]

[CMD] [0x04]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) First block [0x03], (1 byte) [0x00] not used.
- [SUBIDX] (1 byte) Alarms [0x02] valid.
- 1 variant list element
  [STAT] (1 byte) Status [0xFF].

The generator supplies the alarms (provided that the generator status shows pending alarms) with:

[GS] [0x80]

[CMD] [0x04]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) First block [0x03], (1 byte) More data [0x02].
- [SUBIDX] (1 byte) Alarms [0x02].
- 1 … 62 variant list elements with identical data type.
  - [STAT] (1 byte) Status [0x00].
  - [TYP] (1 byte) Structure [0x51].
  - [DTA] (24 bytes) Data […].
  - ...
  - [STAT] (1 byte) Status [0x00].

- [TYP] (1 byte) Structure [0x50].
- [DTA] (24 bytes) Data […].

Remark: For this data type, a maximum of 62 messages fit into a telegram:

255 - 1 [GS] - 1 [CMD] - 2 [IDX] - 1 [SUBIDX] = 250;

250 / (1 [STAT] + 1 [TYP] + 2 [DTA]) => 62 messages (remainder: 2 bytes);

Controlling the active interfaces [0x05]

In this context an active interface does not mean that the interface is without function. It is common use to request the internal states of a generator via an inactive interface. An active interface can, however, be used to change the internal states of the generator. This command can be used to switch the activity status of an interface. The request to change the status from inactive to active will be rejected by the generator if a different interface is already active. Because only one interface can be active at a time, each interface should change the activity status to inactive on request. The only exception is defined by having service privileges. In this case, it is possible to set another interface to inactive and explicitly activate an interface.

The generator reports the activity status of an interface via the generator status with each response telegram. This bit is only set in the generator status for an active interface.

For controlling the interface activity status, data unit type A is used.

[GS] (1 byte) The first byte always represents the generator status.

[CMD] (1 byte) Interface activity [0x05].

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Request activity [0x01] or
  Cancel activity [0x02]
  (1 byte) Not used [0x00].
- [SUBIDX] (1 byte) Not used [0x00].
- 1 variant list element.
  - [STAT] (1 byte) Status [0xFF].

For controlling the interface activity status, data unit type A is used.

[GS] (1 byte) The first byte always represents the generator status.

[CMD] (1 byte) Interface activity [0x05].

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Request activity [0x01] or
  Cancel activity [0x02]
  (1 byte) Not used [0x00].
- [SUBIDX] (1 byte) Not used [0x00].
- 1 variant list element.
  - [STAT] (1 byte) Status [0xFF].

Example: Activating and deactivating interfaces (confirmed)

...

The master activates the interface:

[GS] [0x00]

[CMD] [0x05]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Activate [0x01], (1 byte) [0x00].
- [SUBIDX] (1 byte) not used [0x00].
- 1 variant list element.
  - [STAT] (1 byte) Status [0xFF].

The generator can activate this serial interface and expresses this in the generator status:

[GS] [0x08]

[CMD] [0x05]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Activate [0x01], (1 byte) [0x00].
- [SUBIDX] (1 byte) not used [0x00].
- 1 variant list element.
  - [STAT] (1 byte) Status [0xFF].

The master deactivates the interface again:

[GS] [0x00]

[CMD] [0x05]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Deactivate [0x02], (1 byte) [0x00].
- [SUBIDX] (1 byte) not used [0x00].
- 1 variant list element.
  - [STAT] (1 byte) Status [0xFF].

The generator deactivates this serial interface and expresses this in the generator status:

[GS] [0x00]

[CMD] [0x05]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Deactivate [0x02], (1 byte) [0x00].
- [SUBIDX] (1 byte) not used [0x00].
- 1 variant list element.
  - [STAT] (1 byte) Status [0xFF].

Example: Activating interfaces (rejected)

…

The master activates the interface:

[GS] [0x00]

[CMD] [0x05]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Activate [0x01], (1 byte) [0x00].
- [SUBIDX] (1 byte) not used [0x00].
- 1 variant list element.
  - [STAT] (1 byte) Status [0xFF].

The generator can not activate this serial interface and expresses this in the generator status:

[GS] [0x00]

[CMD] [0x05]

[DOB] 1 data object with the following structure:

- [IDX] (1 byte) Activate [0x01], (1 byte) [0x00].
- [SUBIDX] (1 byte) not used [0x00].
- 1 variant list element.
  - [STAT] (1 byte) Status [0x40].

Note

The global status is set to **[0x40]**, this means activation of interface is currently not possible.

Lower limit read [0x1A]

For reading lower parameter limits, the data unit type A is used.

[GS] (1 byte) For queries by the master, the first byte is always the generator status [0x00].

[CMD] (1 byte) Command (dispatched by the master or executed by the slave).

[DOB] (1 to n) Data objects with the following structure:

- [IDX] (2 bytes) Index.
- [SUBIDX] (1 byte) Sub-index.
- [STAT] (1 byte) Status, only if followed by [0x00]:
- [TYP] (1 byte) Data type.
- [DTA] (1 to 248 bytes) Data with the data type specified above.

Upper limit read [0x1B]

For reading upper parameter limits, the data unit type A is used.

[GS] (1 byte) For queries by the master, the first byte is always the generator status, [0x00].

[CMD] (1 byte) Command (dispatched by the master or executed by the slave).

[DOB] (1 to n) Data objects with the following structure:

- [IDX] (2 bytes) Index.
- [SUBIDX] (1 byte) Sub-index.
- [STAT] (1 byte) Status, only if followed by [0x00]:
- [TYP] (1 byte) Data type.
- [DTA] (1 to 248 bytes) Data with the data type specified above.

Appendix

Structure definition

Data type	**Length (bytes)**	**Description**	**Description**
STRUC_INDICATION			
TIM96	12	Time stamp	—
UINT32	4	Code	▪ 12*1,000,000 + type * 100,000 + number ▪ 12: = TRUMPF generator designator ▪ Type: = 0->Warning, 1->Alarm, 3->Info ▪ Number: = [0 … 99999]
UINT32	4	Module ID	—
UINT32	4	Additional parameters	—
STRUC_IND_SHORT			
UINT16	2	ID	Any message number
STRUC_EVENT			
TIM96	12	Time stamp	—
UINT32	4	Event ID	—
UINT32	4	Module ID	—

Data type	Length (bytes)	Description	Description
UINT32	4	Function ID	—
STRUC_PARAM_LOG[31]			
TIM96	12	Time stamp	—
UINT32	4	Interface - written	—
UINT32	4	User level	—
UINT32	4	ParamIndex	—
UINT32	4	SubIndex	—
UINT32	4	DataType	—

Structure definition Tab. 4-100

Timeout table

Name	Time (s)	Description
$T_{DLLtimeout}$	0.15	Data Link Layer timeout
$T_{DLLdelay}$	Byte * (1 ÷ baud rate) * bit factor	Data Link Layer delay
$T_{DLLdelayIntChar}$	Byte * (1 ÷ baud rate) * 10 + delays	Data Link Layer delay Inter Character
$T_{DLLIntChar}$	≤ 0.025	Data Link Layer Inter Character
$T_{ALtimeout}$	1	Application Layer timeout
$T_{ALtimeoutFile}$	5	Application Layer timeout File

Timeout table Tab. 4-101

CRC calculation

This protocol uses a 16 bit CRC (CRC-CCITT (0xFFFF), non-reflected).

The CRC calculation can be implemented as follows:

31 This STRUC_PARAM_LOG defines a "paramHeader" and after this header the "paramValue" should follow in the same or in the following telegram!

```
#define POLY 0x1021

// Definition of CRC:
//   width=16 poly=0x1021 init=0xffff refin=false
//   refout=false xorout=0x0000 check=0x29b1
//   name="CRC-16/CCITT-FALSE"
unsigned short crc16ccitt(unsigned char *data_p,
                          unsigned short length)
{
        unsigned short crc;
        int n, i;
        unsigned char byte;

        crc = 0xFFFF;

        for (i = 0; i < length; i++) {
                byte = data_p[i];
                crc = crc ^ (byte << 8);
                for (n = 1; n <= 8; n++) {
                        if ((crc & 0x8000) > 0)
                                crc = (crc << 1) ^ POLY;
                        else
                                crc = (crc << 1);
                }
        }

        return crc;
}
```

Fig. 10525

Checking implementation:

Calculation of the checksum using the string "123456789" must result in 0x29B1. Note that the string "123456789" is displayed in the byte format {0x31, 0x32, 0x33, …, 0x39}. The CRC in the telegram is displayed in little endian format.

Chapter 5

Standards and directives

1. CE certification

EU directives:

- 2014/35/EU
- 2014/30/EU

Standards taken into account:

- EN 61000-6-2:2005/AC:2005
- EN 55011:2009/A1:2010 Group 2 Class A
- EN 61010-1:2010

Important notes:

- The products listed in the declaration of conformity are not independently operating products in the sense of the EMC directive. The EMC situation cannot be evaluated until the product has been incorporated in a complete system. The evaluation was verified for a typical system configuration, but not for the individual product.
- All technical safety requirements in the product-specific documentation (operating instructions, manual, etc.) must be adhered to throughout the entire product lifecycle.

1.1 EU declaration of conformity

TruPlasma RF 1001 to 1003

TRUMPF

EU Declaration of Conformity

in accordance with
Low Voltage Directive 2014/35/EU
Directive relating to electromagnetic compatibility 2014/30/EU

We hereby declare that the following device complies with all the relevant requirements of the EU directives listed above.

Device:	**TruPlasma RF 1001 (G2/13) 200-480V** **TruPlasma RF 1002 (G2/13) 200-480V** **TruPlasma RF 1003 (G2/13) 200-480V**
Serial number:	≥ 201889281
Applied harmonized standards, in particular:	EN 61000-6-2:2005/AC:2005, EN 55011:2009/A1:2010 Group 2 Class A, EN 61010-1:2010
Party authorized to compile the technical file:	Clemens Rehbein

Town / Date / Signature Freiburg im Breisgau, 19.04.2016 i.V.

Clemens Rehbein
Quality Director

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TE172sc
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en

EC declaration of conformity TruPlasma RF 1001 to 1003 Fig. 10645

2. Classification according to EN 55011

The EN 55011 standard groups ISM devices (industrial, scientific and medical high-frequency devices) into various classes.

This generator is a device of **Group 2, Class A**.

Class A devices are intended for operation in an industrial environment. The electromagnetic compatibility in other environments (e.g. residential areas) may not be guaranteed due to the interference factors that occur.

Group 2 includes all ISM-RF applications in which RF energy in the radio frequency range from 9 kHz to 40 GHz is intentionally produced and/or used as electromagnetic radiation for the treatment of material or for testing or analysis purposes.

3. SEMI standards

3.1 SEMI S2

During development of the generator the requirements acc. to SEMI S2 "Environmental, health, and safety guideline for semiconductor manufacturing equipment" were taken into account. Certification on request.

3.2 SEMI S8

During development of the generator the requirements acc. to SEMI S8 "Safety guidelines for ergonomics engineering of semiconductor" were taken into account. Certification on request.

3.3 SEMI S9

During development of the generator the requirements acc. to SEMI S9 "Safety guideline for electrical design verification tests for semiconductor manufacturing equipment" were taken into account. Certification on request.

3.4 SEMI S10

During development of the generator the requirements acc. to SEMI S10 - "Safety guideline for risk assessment and risk evaluation process" were taken into account. Certification on request.

3.5 SEMI F47

The generator was developed and manufactured in compliance with the requirements specified by SEMI F47 "Specification for semiconductor processing equipment voltage sag immunity".

Tested by the TRUMPF test and qualification center and/or by an independent testing laboratory.

4. NRTL safety certification

The product was certified by an accredited testing laboratory.

Standards taken into account:

- UL 61010-1 3rd. Ed. May 2012.
- IEC 61010-1 June 2010.
- DIN EN 61010-1 July 2011.

5. FCC 47 CFR Part 18

The product satisfies the requirements from "47 CFR part 18, Federal Communications Commision (FCC) rules".

Tested by the TRUMPF EMC Test Center and/or by an independent testing laboratory.

TRUMPF

Certificate of Conformity

in accordance with

47 CFR part 18 Code of Federal Regulations - Limits and methods of measurements of radio interference characteristics of industrial, scientific, and medical equipment

We hereby declare that the following device complies with all the relevant requirements of the Federal Communication Commision (FCC) rules listed above.

Device:	**TruPlasma RF 1001 (G2/13) 200-480V** **TruPlasma RF 1002 (G2/13) 200-480V** **TruPlasma RF 1003 (G2/13) 200-480V** **TruPlasma RF 3006 (G2/13) 200-480V**
Serial number:	≥ 201889281
Applied standards, in particular:	47 CFR part 18
Party authorized to compile the technical file:	Clemens Rehbein

Town / Date / Signature Freiburg im Breisgau, 19.04.2016

i.V.

Clemens Rehbein / Quality Director

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V 2016 - 04

en

FCC conformity certificate Fig. 10759

6. Radio Wave Act (South Korea)

Certification on request.

Chapter 6

Installation

1. After receiving the generator

1.1 Inspecting the delivery

1. Check the generator immediately as soon as it is delivered for completeness in accordance with the delivery note and also for visible damages incurred during transport.
2. In order to retain the right of recourse, report any shipping damages immediately in writing to the forwarding agent, the insurance company and TRUMPF.

2. Unpacking

2.1 Disposing of packaging material

If you do not want to keep the packaging material for a subsequent transport:

➢ Dispose of all packaging materials in compliance with the relevant regional waste disposal regulations.

3. Transport, storage

3.1 Transport

CAUTION

Risk of injury due to the weight of the generator

- Do not carry or lift the generator **alone**.
- Do not lift the generator by the components on the rear side, e.g., water connections.

3.2 Storage conditions

If you do not install the generator immediately following delivery:

1. Store the generator in original packaging.
2. Ensure that the specified environmental conditions are maintained.

4. Requirements for the site

4.1 Installing external mains separation device

➢ To be able to completely disconnect the generator from voltage, an external mains separation device must be installed in the supply line to the generator.

The external mains separation device must:

- Be directly assigned to and located near generator.
- Be easily identifiable.
- Be easily accessible.

4.2 Selecting a suitable location

➢ When selecting the location, please observe the following criteria.

- Access to the external mains separation device must not be obstructed by the generator.
- Keep generator away from magnetic fields. Strong magnetic fields in the direct vicinity can damage the generator.

4.3 Position during operation

The generator is designed for installation and operation in any position.

Note

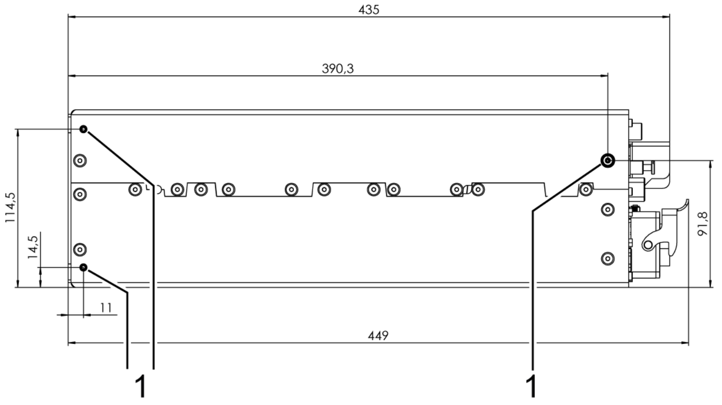
TRUMPF recommends an installation position in which the water connections are **not** at the top.

5. Installation

5.1 Module fastening

Located on the sides of the generator are threads that can be used for fastening.

- M4 thread
- Thread depth 8 mm
- Torque 1.5 Nm



1 Thread for fastening

Installing the generator Fig. 10548

6. Connection order

6.1 Connecting the generator

When connecting the generator, observe the following sequential order:

1. Connect the cooling water.
2. Connect control lines (interfaces and interlock).
3. Connect the power output.
4. Connecting the supply voltage.

7. Cooling water

7.1 Connecting the cooling water

NOTICE

The generator's cooling water circuit consists of copper components.

The use of cooling water from aluminum systems damages the generator.

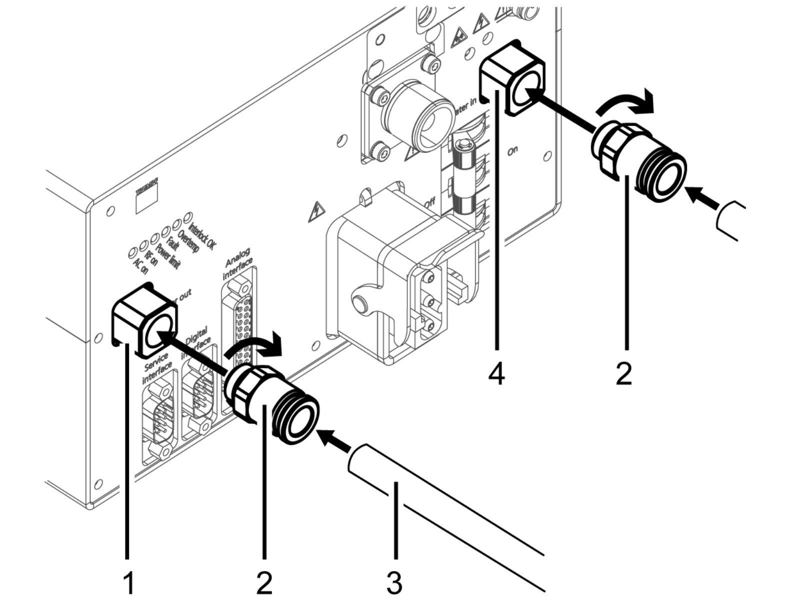
➢ Take care to separate the generator cooling water strictly from cooling water from aluminum systems.

7.2 Connecting cooling water pipes

The connection for the cooling water pipes consists of connection ports with 1/4" internal thread.
Various adapters can be mounted to these. The following example shows the mounting of Römer quick connectors.

Means, Tools, Materials

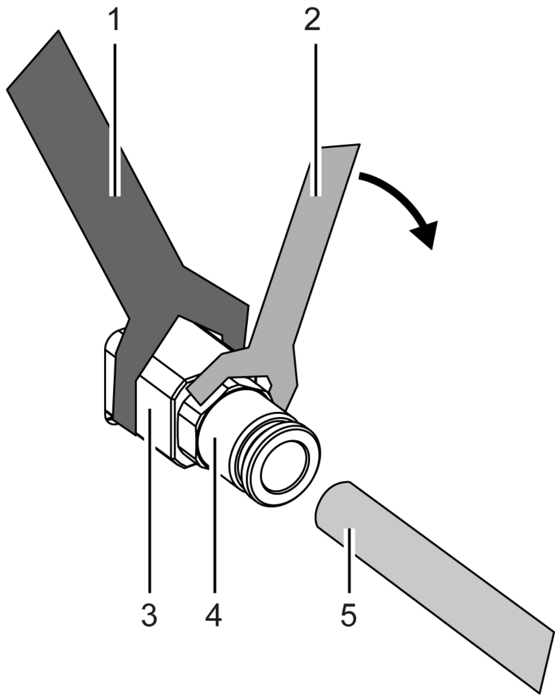
- For generators with angular-shaped connection port: one open-end wrench for securing the connection port on the generator.
- Two Römer quick connectors.
- One open-end wrench, WAF suitable for the Römer quick connectors.
- Hose with suitable diameter for the Römer quick connectors.



1	Connection with 1/4" internal thread for water return.	3	Water hose.
2	Römer quick connector.	4	Connection with 1/4" external thread for water inlet.

Cooling water connection Fig. 10447

1. For generators with angular-shaped connection port: secure port with open-end wrench.
2. Screw Römer quick connector to the connection port. **Observe torque indicated on the generator!**
3. Plug cooling water hose into Römer quick connector.

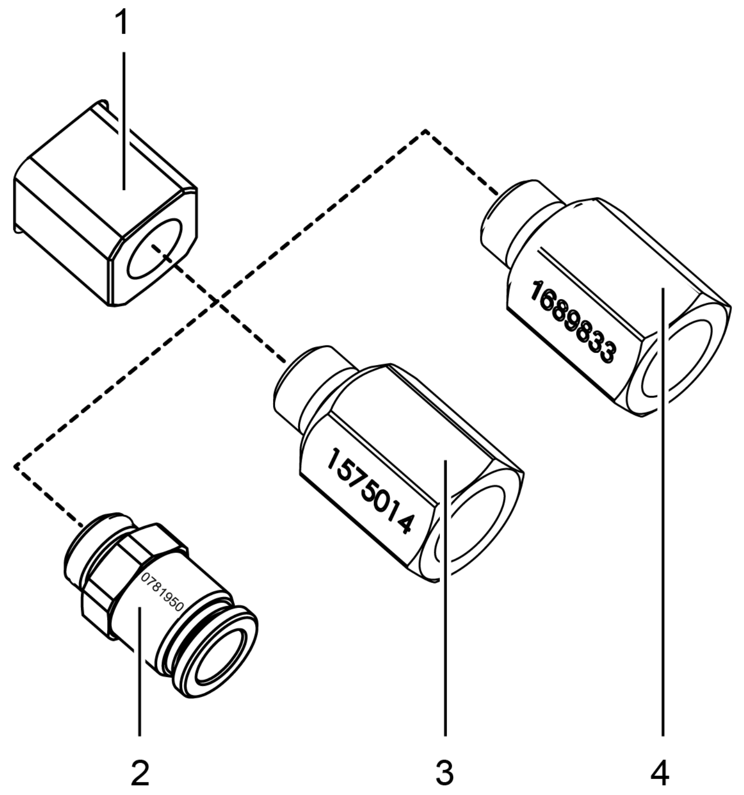


1	Open-end wrench for securing	4	Römer quick connector
2	Open-end wrench for tightening	5	Hose
3	Connection port on the generator		

Fastening quick connector Fig. 10445

7.3 Connecting an adapter

Various adapters are available for the cooling water connection.



1 Connection port on the generator with 1/4" internal thread
2 Römer quick connector
3 Adapter G1/4 - NPT3/8
4 Adapter G1/4A - G3/8

Adapter variants Fig. 10446

➢ Observe the torque indication when screwing on the adapter. Do not exceed the torque indication provided on the front panel of the generator.

7.4 Checking for leaks

1. **Carefully** switch on the cooling water supply.
2. Avoid pressure surges.
3. Check pipes and plugs for leaks.
4. Switch off cooling water supply.
5. Do not switch the cooling water supply back on again until just before commissioning.

7.5 Definition of open/closed system

Open system

A cooling circuit is referred to as an "open system" if the cooling water within the cooling circuit comes into contact with the surrounding atmosphere or with external water from another cooling circuit. Through the contact with the surrounding atmosphere or with external water, the water parameters could change.

Example

- Cooling tower.
- Cooling water basin.
- Central cooling water circuits within plants.

Closed system

A cooling circuit is referred to as a "closed system" if the cooling water circulates in a sealed circuit and, as a result, does not come into contact with the surrounding atmosphere or with external water from other cooling water circuits. Thus, it is not possible for the cooling water parameters to be changed by the atmosphere or external water.

7.6 Requirements for a functioning cooling water circuit

- For open routing, do not use transparent hose connections, as light promotes algae growth.

  Tip
  Use opaque coverings to protect transparent cooling water hoses from the incidence of light.
- The closed system must not be connected to external cooling water circuits.

Note

In the event of questions regarding the design and dimensioning of open and closed systems, please contact your plumbing specialist.

7.7 Preparing cooling water

The system operator is to ensure the quality of the cooling water

The quality of the cooling water is the responsibility of the system operator. A cooling water quality that prevents the formation of corrosion is to be ensured.

Within the framework of the legal regulations, TRUMPF shall only be liable for damage which has been caused by faults in the devices or components supplied by TRUMPF. TRUMPF shall not accept liability for damage caused by third-party products.

- TRUMPF recommends the use of a closed cooling water circuit.
- To ensure the cooling water properties, we recommend the use of a recooling system.
- The sales team at TRUMPF will gladly assist you in making the appropriate selection.

Initial filling

For the initial filling of the generator in a closed cooling water circuit, the cooling water must have the quality of a demineralized, deionized or distilled water and be filled together with the appropriate corrosion inhibitor. Any additional water added to compensate for evaporation losses must also be fully demineralized and be added to the cooling water circuit together with a corresponding corrosion inhibitor.

7.8 Cooling water parameter

Check cooling water for the following cooling water parameters.

Parameter		Unit	Limit value (Cu cooling circuit)
pH-value		—	6 to 9
Conductivity range		µS/cm	(see "Cooling requirements", pg. 3-16)
Iron		mg/l	< 0.5
Copper		mg/l	< 0.2
Microbiology:	Colony count	KBE/ml	< 1000
	Sulfate reducer	—	Not detectable
Suspended solids		—	Not detectable

Requirements for the cooling water Tab. 6-1

If the inspection reveals deviations from the specified cooling water parameters, the cooling water must be topped up with fresh water and the appropriate apportionment of corrosion inhibitor with the following quality:

Parameter	Unit	Limit value
Conductivity	µS/cm	< 20
Microbiology	KBE/ml	< 100

Cooling water parameters for additional water Tab. 6-2

Cooling water additives for the chemical treatment of additional water and cooling water

Description	Apportionment
Copper corrosion inhibitor for closed systems	Water Care-Copper For concentration, see Easy-Kits Cu
Copper corrosion inhibitor for open systems	Use suitable copper corrosion inhibitor.
Oxidizing biocides (halogens)	< 0.3 mg/l (as Cl2), only in combination with copper corrosion inhibitor

Cooling water additives for the chemical treatment of additional water and cooling water Tab. 6-3

7.9 Cooling water additives

Perfect cooling is an important prerequisite for the reliable functioning of the generators. To ensure the long-term proper functioning of the cooling system, only the cooling water additives described here are permitted to be used.

- **Water Care-Copper** acts as an anticorrosive agent specifically for copper parts and should only be used in the copper cooling circuit.
- **The biocide** is used in the copper cooling circuits for disinfection purposes. The biocide is applied for 2 hours during the cleaning cycle prior to commissioning and when cleaning the cooling circuits. Different biocides are utilized due to variations in local laws.

Color code

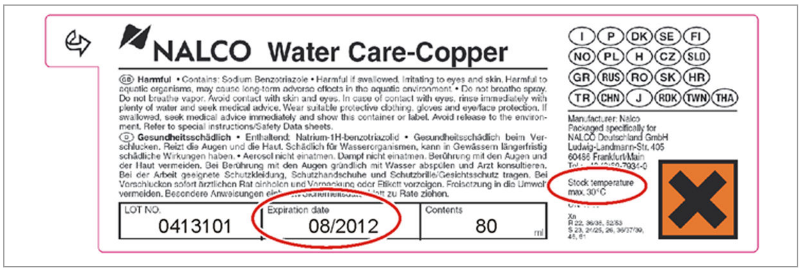
A color code is used in order to make it easier to identify the different cooling water additives. The bottles of the various cooling water additives have different colored bottle caps.

Cooling water additive	Color
Water Care-Copper	Yellow
Cleaning biocide	Red

Color code Tab. 6-4

Shelf life and storage temperature

The cooling water additives are limited in terms of shelf life and are marked with expiration dates. The expiration date can be found on the labels of the bottles and on the packaging label. The maximum storage temperature is also specified there ("Stock temperature").



Label with expiration date Fig. 10019

7.10 Easy-Kits

Cooling water additives are available in **Easy-Kits**.

Easy-Kits

Easy-Kits are easy to use because the apportionment of the cooling water additive is accomplished by the bottle and the volume required does not need to be calculated and measured.

Easy-Kits can be used for all cooling circuits on TRUMPF generators and systems. Each Easy-Kit contains a bottle with biocide and a bottle with anticorrosive agent. The bottles are filled in such a way that the respective contents are sufficient for one cleaning cycle and one water change. Because of the different filling volumes in the bottles, each Easy-Kit may only be used for a specific cooling water quantity.

Easy-Kits in different sizes

Because of the different water volumes in the cooling water circuits, Easy-Kits are available in a variety of sizes. Easy-Kits for copper cooling water circuits can be obtained in 5 sizes: Easy-Kit Cu-1 to Easy-Kit Cu-5. The water volume in the cooling water circuits (tank contents + hose volume) is to be determined and the appropriate Easy-Kit is to be selected.

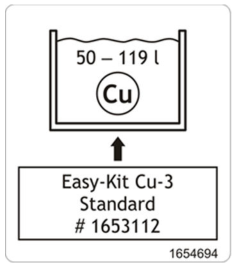
Cooling circuit	Cooling water quantity = tank filling + hose volume	Easy-Kit
Copper	5 … 14 l	Easy-Kit Cu-1
Copper	15 … 49 l	Easy-Kit Cu-2
Copper	50 … 119 l	Easy-Kit Cu-3
Copper	120 … 359 l	Easy-Kit Cu-4
Copper	360 … 999 l	Easy-Kit Cu-5

Overview of Easy-Kits Tab. 6-5

Each Easy-Kit is available in 5 country-specific variants (Netherlands (NE), Belgium (BE), USA (US), Canada (CA) and Standard), because the cleaning biocides they contain vary, depending on the country. The material numbers of all of the Easy-Kits can be found at the end of the chapter (see "Overview of cooling water additives", pg. 6-19).

Allocating Easy-Kit

Different Easy-Kits are used in the cooling water circuits. Allocating the correct Easy-Kit to be used in a cooling water circuit is dependent on cooling water volume. Each Easy-Kit comes packaged with a label which identifies the Easy-Kit. This label can, for example, be mounted on the chiller or on the cooling water tank.



Label for Easy-Kits (example) Fig. 10020

The label indicates the cooling water circuit (Cu) and the water volume (above) in addition to the size, the country-specific variant and the material number of the Easy-Kit (below).

7.11 Utilization and apportionment

Cooling water additives are used for:

- Commissioning of the cooling water circuits with new systems.
- Maintenance of the cooling water circuits.
- Topping up cooling water.

NOTICE

Corrosion and microbial contamination of the cooling water circuits!

Damage to generators and systems.

- ➢ Use fresh, clean, demineralized water only.
- ➢ Flush cooling water circuits thoroughly after cleaning.
- ➢ Do not operate cooling water circuits without anticorrosive agents.
- ➢ Do not use biocide on a continuous basis, but only for cleaning.

Apportionment with Easy-Kits

Apportionment with Easy-Kits is accomplished by the bottle. That is the reason that the sizes and the filling volumes of the bottles in the various Easy-Kits are different.

- Use the correct Easy-Kit, based on the cooling water circuit (Cu) and on the water volume.
- Bottle with biocide (red):

  Use for the cleaning cycle. Open the bottle and carefully add the entire contents to the tank of the cooling water circuit. Circulate the cooling water immediately.
- Bottle with anticorrosive agent (Cu = yellow):

  Use after the water has been replaced and the tank is filled with fresh cooling water. Open the bottle and carefully add the entire contents to the tank of the cooling water circuit. Circulate water immediately.

7.12 Cleaning and care

Closed system

- The devices as well as external areas (basins, lines, hoses) must be cleaned with the biocide from Easy-Kit Cu for approximately 2 hours prior to the initial commissioning and flushed with water in the quality specified for additional water. These products are available from TRUMPF.

7.13 Overview of cooling water additives

Cooling water additives	**Water Care-Copper**			**STABREX ST40** **STABREX ST70** **STABREX ST70 FOR KITS** **NALCO 93033B** **NALCO 93033**	
Function	Anticorrosive agent for copper parts			Biocide	
Where to use them?	In copper cooling circuit			In copper cooling circuit	
When to use them?	Continuously in operation			During the cleaning cycle for 2 hours	
Color code	Yellow			Red	
—	Easy-Kit Material number for reordering				
—	Standard	USA	Canada	Belgium	Netherlands
Easy-Kit Cu-1 (5 … 14 l)	1652981	1652991	1652992	1652993	1652994
Easy-Kit Cu-2 (15 … 49 l)	1652995	1653088	1653089	1653090	1653111
Easy-Kit Cu-3 (50 … 119 l)	1653112	1653113	1653114	1653119	1653120
Easy-Kit Cu-4 (120 … 359 l)	1653107	1653108	1653109	1653130	1653131
Easy-Kit Cu-5 (360 … 999 l)	1653132	1653124	1653125	1653126	1653127
Apportionment	By the bottle: The entire contents of the bottle are poured into the tank.				

Overview of cooling water additives Tab. 6-6

8. Control lines

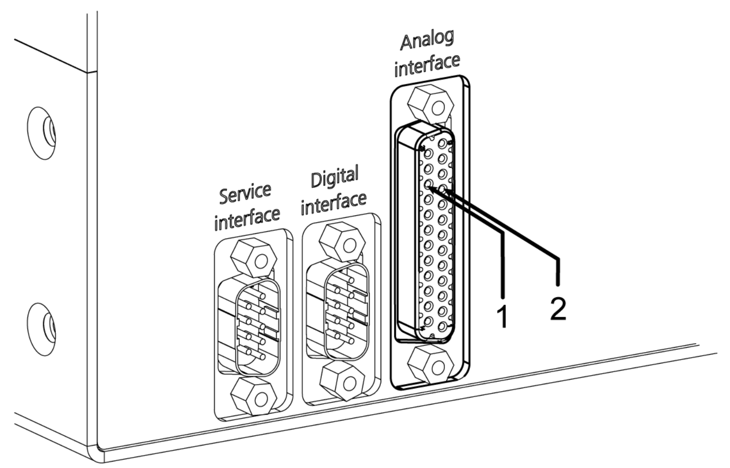
8.1 Connecting the control lines

Condition

- The generator can only output power if the interlock circuit of the AD interface is closed.
  Connection of the interlock circuit: pin 23 and pin 10 of the AD interface.

1. Connect pin 23 and pin 10 of the AD interface.
   The connection can consist of:
   - a bridge
   - multiple N.C. contacts connected in series.

   Connection of the interlock circuit (see "Fig. 10515", pg. 6-20).



1 Pin 23 2 Pin 10

Interlock contacts on AD interface Fig. 10515

2. Connecting other desired interfaces:
   - Other inputs and outputs of the AD interface (see "Signal description of the AD interface", pg. 4-33).
   - RS-232/RS-485 interface (connection of the TruControl Power operating software or operation via ASIP serial data transmission).

   Dependent on generator variant:

   - EtherCAT.
   - DeviceNet.
   - Profibus.
   - Matchbox.

9. RF output

9.1 Connecting RF output

⚠ DANGER

Life threatening voltage!

Contact with live parts is life-threatening.

➢ Only connect RF output if the generator is disconnected from mains.

⚠ DANGER

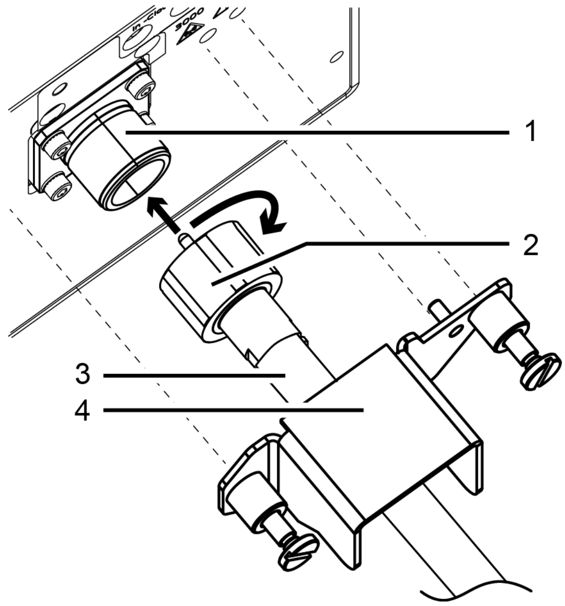
Electromagnetic fields!

Electromagnetic fields can be harmful to health.

➢ Only connect RF output if the generator is disconnected from mains.

1. First connect RF cable to the load.
2. Screw RF plug to generator.
3. Mount interlock hood (see "Fig. 10451", pg. 6-21).

- The interlock contact prevents power from being present at an unconnected output. The output power is automatically switched off if the interlock contact is opened.



1	Connection thread for RF plug	3	RF cable
2	RF plug	4	Interlock hood

RF output with interlock hood — Fig. 10451

10. Supply voltage

DANGER

Life Threatening Voltage!

Contact with live parts is life-threatening.

- ➢ Open external mains separation device.
- ➢ Check mains cables for absence of voltage.

Note

The device is a device of protection class I and requires a PE protective earth connection for safety.

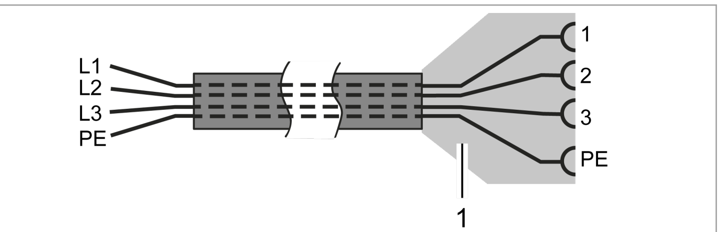
10.1 Connecting the mains cable

Conditions

- The mains cable satisfies:
  - Local and national regulations.
  - Requirements for current-carrying capacity, etc. (see "Mains connection data", pg. 3-6).
  - Requirements on environmental conditions (see "Environmental conditions", pg. 3-15).
- The supply voltage satisfies the specifications in chapter "Technical Specification" (see "Mains connection data", pg. 3-6).

Means, Tools, Materials

- Mains cable with mains connector coupling (see "Mains connection data", pg. 3-6).



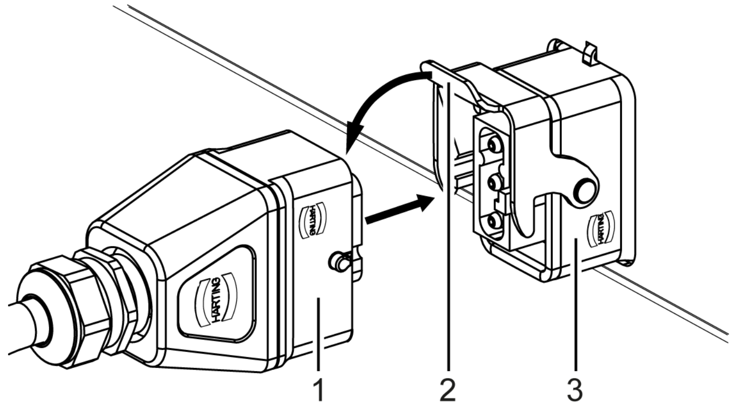
1 Mains connector coupling

Mains cable Fig. 10443

1. Make certain that the supply voltage corresponds to the details given in chapter "Technical Specification" (see "Mains connection data", pg. 3-6).
2. Check mains cable for absence of voltage.

3. Set protection switch on generator to the Off position.
4. Plug the mains connector coupling with the mains cable into the panel connector for the mains connection.
5. Close interlock (see "Fig. 10439", pg. 6-23).

10.2 Mains connection for TruPlasma RF 1001 to 1003



1	Mains connector coupling	3	Panel connector
2	Locking mechanism		

Mains connection TruPlasma RF 1001 to 1003 Fig. 10439

11. Matchbox (optional)

A matchbox from TRUMPF is connected between generator and load. The matchbox thereby forms the load for the generator.

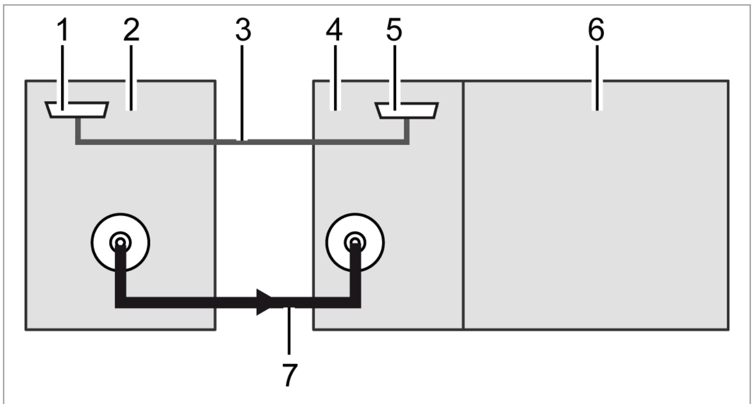
11.1 Connection principle of a matchbox

For more exact details on the matchbox: see operating instructions for the matchbox.

1. Connect generator to matchbox by means of Sub-D cable.

   Only use cables from TRUMPF!
2. Connect RF output of the generator with the RF input of the matchbox.

   RF cable available from TRUMPF.
3. Connect the matchbox to the load. Observe operating instructions for the matchbox.



1	Control connection for the matchbox	5	SystemPort of the matchbox
2	Generator	6	Load
3	Sub_D cable	7	RF cable
4	Matchbox		

Connection of a matchbox Fig. 10552

12. Dismantling

12.1 Dismantling the generator

WARNING

RF output carries life threatening voltage!

➢ Before unfastening the RF cable, switch off the generator and disconnect mains cables from mains.

NOTICE

The generator's cooling water circuit consists of copper components

The use of cooling water from aluminum systems damages the generator.

➢ Take care to separate the generator cooling water strictly from cooling water from aluminum systems.

Note

When dismantling the generator, adhere to the following order:

1. Switch off the power supply at the external mains separation device.
2. Remove mains cables.
3. Remove all other electric lines from the generator:
   - RF cable.
   - Control cable.
4. Switch off cooling water supply.
5. Remove the cooling water pipes.
6. Allow the cooling water circuit of the generator to run until empty.
7. Save the cooling water to conserve resources.
8. Drain the cooling water circuit of the generator by blowing it out with compressed air.
9. Dry all cooling water residues.
10. Clean the generator with a dry ESD cloth.
11. Seal water connections with plugs

13. Shipping

13.1 Packing the generator

➢ Use suitable packaging material for shipping the generator (as for delivery).

14. Disposal

14.1 Disposal of generator

- Observe the local regulations when disposing of the generator.

Chapter 7

Operation

1. Activating interface and changing active interface

1.1 Activating interface

The generator can be operated and controlled via various interfaces.

The generator can only be controlled from the **active** interface. Only **one** interface can be active. Monitoring of values and error messages can be done simultaneously via multiple interfaces.

After switching the generator on, the **AD interface** is active. Each digital interface, including the TruControl Power operating software, can take control and thereby become the active interface. As soon as a different interface takes control, the AD interface is no longer the active interface. If the active interface releases control, the AD interface automatically becomes the active interface again.

➢ To activate the desired interface after switching on the generator:
  - In the TruControl Power operating software, press *Get control*.
  - For other interfaces: take control via a command or bit (see chapter 4).

1.2 Changing active interface

1. Either
   ➢ In the TruControl Power operating software, press *Release control*.

   or

   ➢ For other interfaces: release control via a command or bit (see chapter 4).
2. Activate the desired interface.

1.3 Displaying the active interface

1. Select >*Configuration* >*Interfaces*.
2. Read the currently active interface under "Active interface""Status".

3. Read the default interface under "Active interface""Main interface".

   After the generator is switched on, the default interface is automatically the active interface.

2. Operation with TruControl Power

The **TruControl Power** software permits easy operation of the generator. The software is supplied on a CD. The computer can be connected to the generator via the Ethernet interface or RS-232 interface.

The software package must first be installed on a computer.

System requirements:

- 2 GHz processor.
- 1 GB RAM, 3 GB free hard drive memory.
- Operating system: Windows XP or higher.
- CD drive.
- Ethernet or serial interface (RS-232).
- Screen resolution 1024 x 768 minimum.

2.1 Installing TruControl Power

1. Insert the CD into the CD drive of the computer.
2. Double-click on the file 'TruControl_Power_setup_[Release-Datum].exe'.
3. Follow the instructions displayed on the screen.

2.2 Setting up connection via RS-232 interface

1. Connect the computer to the generator via the RS-232 interface.
2. Switch on the generator.
3. Start TruControl Power on the computer.
4. Select Select >*Connection settings* >*Serial port-settings*.
5. Under "COM port", select the used COM port of the computer.
6.

   under "Baud rate" select the baud rate appropriate for the RS-232 cable length:
   - 115200 (with max. RS-232 cable length of 2 m).
   - 57600 (with max. RS-232 cable length of 5 m).
   - 9600 (with max. RS-232 cable length of 20 m).
7. Under "Protocol"*, select ASIP*.
8. Click on *Ok*.

9. Click on *Connect* .

10. Select *Operator* and click on *Ok*.

The software establishes contact with the connected generator.

2.3 Disconnecting

➢ Click on *Disconnect*.

The start screen then opens and the connection can again be established.

2.4 Taking and releasing control

To control a generator using TruControl Power, the generator interface to which the computer is connected must first be activated.

1. Click on *Get control*.

   The connection status is displayed (see "Connection status", pg. 7-8).

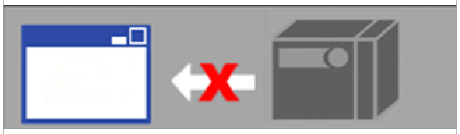
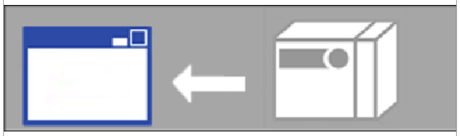
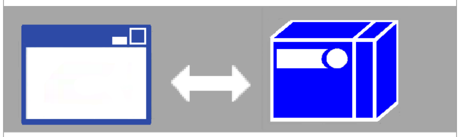
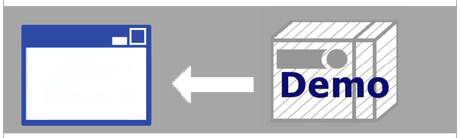
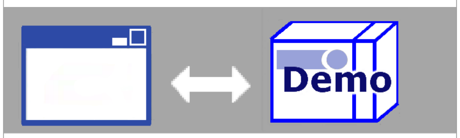
   The generator can be controlled using TruControl Power.

2. Click on *Release control* to deactivate the interface.

   The generator can no longer be controlled using TruControl Power. The data can be read only.

2.5 Connection status

The symbols on the left part of the window indicate the current connection status of the software to the generator.

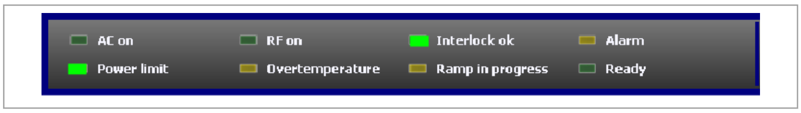
Symbol	Connec-tion	Control	Description
	No	No	▪ Generator is not connected. ▪ Generator is switched off.
	Yes	No	▪ Data from the generator can only be read. ▪ Required generator interface is not activated. ▪ To activate the RS-232 interface: Press *Take control*.
	Yes	Yes	Connection is set up. Generator can be controlled using the TruControl Power operating software.
	Simulated connection	No	Demo mode
	Simulated connection	No (simu-lated con-trol)	Demo mode The demo mode can be controlled using the TruControl Power operating software (values can be changed).

Connection status Tab. 7-1

2.6 Status display

Indicators in the status bar

If a connection to the generator exists, multiple status indicators are visible in the status bar (upper area) that indicate the status of the generator. Number and contents of the indicators are dependent on the connected generator.



Status bar Fig. 10501

2.7 Messages

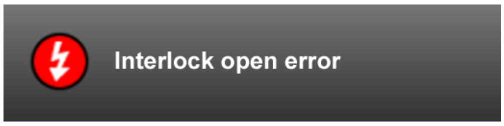
Three types of message can appear on the right in the status bar:

Icon	Message type	Priority
	Current alarm	1
	Current warning	2
	Current information	3

Message types Tab. 7-2

If one or more messages are pending, the current alarm is always displayed. If no alarm is pending, the pending warning is always displayed. If no warning is present either, the pending info is displayed. And, if this, too, is not the case, the field remains empty.

Example for an alarm



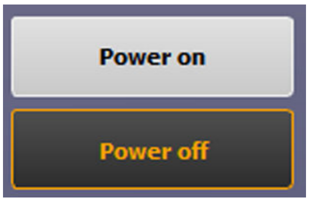
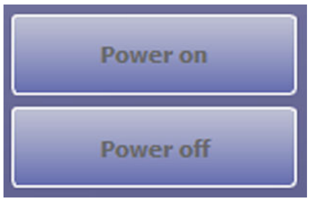
Example for an alarm Fig. 10725

2.8 Switching power on and off

Use *Power on* and *Power off* to switch the power of the generator on and off.

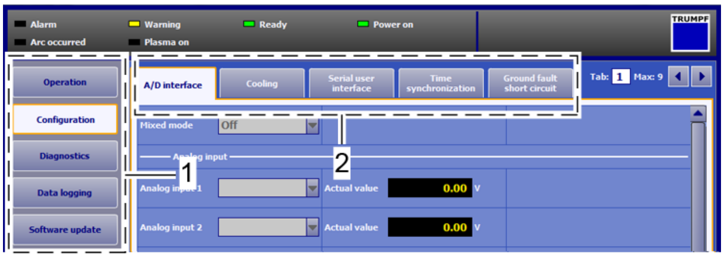
1. Click on *Get control*.

   The *Power on* and *Power off* buttons are now active.
2. To switch the generator on and off: click on *Power on* or *Power off*.

Buttons active	Buttons passive
	

Power on and Power off buttons Tab. 7-3

2.9 Main menu and submenu



1 Main menu 2 Submenu

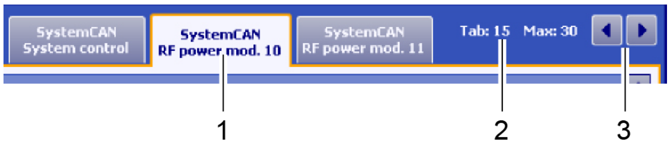
Position of main menu and submenu Fig. 10015

The user interface is divided into a main menu and a submenu. The buttons for the main menu are on the left side of the window and cover the following 5 areas:

- Operation
- Configuration
- Diagnostics
- Data logging
- Software update

The submenu items are functionally assigned to the main menu items. Depending on which main menu item is selected, different submenu items are offered.

Selecting submenu items



1 Tab
2 Number of tab
3 Arrow buttons

Changing tab Fig. 10014

➢ To select a submenu item:
 ➢ Click on the tab of the submenu item (1).

or

 ➢ Clicking on the arrows to scroll forward or backward (3).

or

 ➢ At "Tab:", highlight the number with the left mouse button. Enter the number of the desired tab. Press <Enter> (2).

2.10 TruControl Power menu structure

Main menu	Submenu	Description
>*Operation*	Power regulation	Set and actual values (see "Power regulation", pg. 7-21).
	Generic regulation channel	(see "Generic regulation channel (GRC)", pg. 7-23)
	External current / voltage regulation (matchbox)	(see "External current / voltage regulation", pg. 7-24)
	Clock and pulse mode	(see "Phase offset (CEX mode)", pg. 7-25) (see "Pulse mode", pg. 7-35)
	Control characteristic	(see "Regulation characteristic", pg. 7-38) (see "Timer", pg. 7-40)
	Ramp function	(see "Ramp function", pg. 7-42)
	Arc management	(see "Arc management (optional)", pg. 7-44)
	Frequency agility	(see "Description of the frequency agility function", pg. 7-30)
Configuration	Interfaces	(see "Setting the watchdog", pg. 7-15)(see "Displaying EtherCAT states", pg. 7-19) (see "Displaying the active interface", pg. 7-5)
	User limit configuration	Setting power limit values (see "User limit configuration", pg. 7-60).
	Analog I/O scaling	(see "Scaling analog inputs and outputs", pg. 7-16)
	Factory settings	(see "Factory setting", pg. 7-63)
	Time synchronization	(see "Time synchronization", pg. 7-67)

Main menu	Submenu	Description
Diagnostics	Pending messages	(see "Diagnostics", pg. 7-68)
	Message history	(see "Diagnostics", pg. 7-68)
	Monitoring	(see "Monitoring", pg. 7-69)
	Identification	(see "Identification", pg. 7-69)
Data logging	Trending	(see "Performing trending", pg. 7-70)
	Configuration	(see "Setting trigger conditions for oscillo-scope", pg. 7-70)
	Oscilloscope	(see "Operating the oscilloscope", pg. 7-71)
Software update	—	(see "Performing software updates", pg. 8-2)

TruControl Power menu structure Tab. 7-4

3. Operating via RS-232/RS-485 interface

The generator can be controlled by means of serial data transmission via the RS-232/RS-485 interface. This way, the generator can be integrated into a complex system and controlled via a system controller.

Pin assignment, function description and serial protocol .

3.1 Switching between RS-232 and RS-485

Because the same physical interface is used for serial data transmission by way of RS-232 and RS-485, the interface must be selected prior to beginning communication.

1. In TruControl Power, select >*Configuration* >*Interfaces*.
2. Select one of the available interfaces:
   - ➢ To specify the baud rate of the master: Under "Interface" in the "RS-232 / RS-485" area, select the item with the extension **flex**.

     The baud rate setting in TruControl Power is ignored.

   or

   - ➢ To specify the baud rate in TruControl Power: Under "Interface" in the "RS-232 / RS-485" area, select the item with the extension **fix**.
   - ➢ In TruControl Power, select >*Connection settings* >*Serial port settings*.
   - ➢ Under "Baud rate", select the desired baud rate.

3.2 Setting slave address for RS-485

Note

In order to operate multiple generators together on one RS-485 bus, all generators must use the ASIP protocol.

1. In TruControl Power, select >*Configuration* >*Serial user interface*.

   "Slave address" shows the currently set slave address. "RS-485: Maximum slave address" shows the maximum value to which the slave address can be set.
2. Set the desired slave address under "Slave Address".

3. Select >*Configuration* >*Parameter handling* and press *Save parameters*.

3.3 Setting the watchdog

1. Select >*Configuration* >*Interfaces*.
2. Enter the time under "Service" "Watchdog".

   If no valid command is transferred within the entered time, the generator switches off the power and outputs an alarm message.

4. Operation via AD interface

The AD interface is a combined interface consisting of analog inputs and outputs as well as digital inputs and outputs (I/O lines):

- Digital inputs
- Digital outputs
- Analog input.
- Analog outputs.

The inputs of the AD interface can be used to control the generator. Prerequisite: Mixed mode is active (see "Mixed Mode", pg. 7-61).

Pin assignment, function description and level: (see "Interfaces_AD interface_25-pin (SSM).")

4.1 Scaling analog inputs and outputs

1. Select >*Configuration* >*Analog I/O scaling*.
2. Under "Scaling of analog input 10 V", enter the value for "Pi/PL" that is to correspond to the 10 V at the analog input.

   Because either P_i or P_L can be specified via the analog interface, this setting applies for the selected value.
3. Only if mixed mode was enabled and "Analog input function > Udc actual value" was selected:
   Under "Scaling of analog input 10 V", enter the value for"Udc" that is to correspond to the 10 V at the analog input.

   Because P_i, P_L or U_{DC} can be specified via the analog interface with mixed mode activated, this setting applies for the selected value.
4. Under "Scaling of analog output 10 V", enter the values that are to correspond to the 10 V on the analog outputs:
   - "Pi"
   - "PL"
   - "Pr"
5. Enter a limit value under "Low voltage limit". Signals that are smaller than the configured value are not interpreted as the set value. This function prevents signal noise from being interpreted as the set value.
6. Under "Analog output voltage filter", select "Active" if the voltage is to be smoothed at the analog outputs.

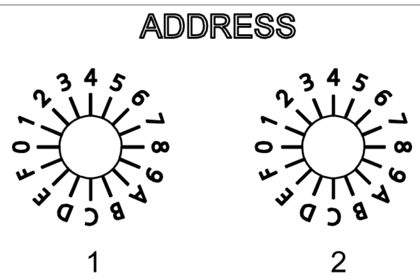
5. Operation via Profibus interface (optional)

The generator features an interface for Profibus communication (optional).

Pin assignment and function description (see "Profibus (optional)", pg. 4-50).

5.1 Setting Profibus address

1. Switch off the generator using the main switch.
2. Set rotary switch for **Profibus** to desired address.
   - MSD switch: first digit of the hexadecimal number.
   - LSD switch: second digit of the hexadecimal number.
   - Permitted address range: 0x00 to 0x7D (≙ 0 to 126).



1 MSD switch 2 LSD switch

Rotary switches for Profibus Fig. 10531

3. Switch on the generator using the main switch.

The generator adopts the set address.

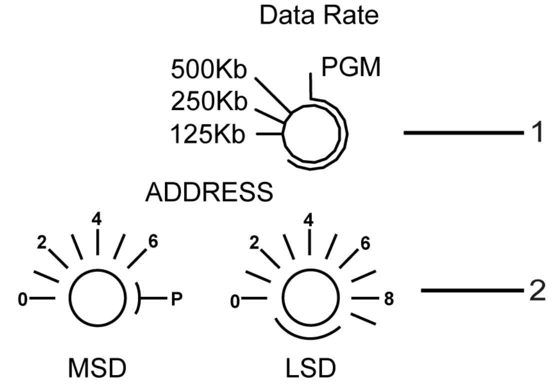
6. Operation via DeviceNet interface (optional)

The generator features an interface for DeviceNet communication (optional).

Pin assignment and function description (see "DeviceNet (optional)", pg. 4-66).

6.1 Setting the baud rate and node address

1. Switch off the generator using the main switch.
2. Setting the rotary switch for node address:
   - MSD: tens digit
   - LSD: ones digit
   - Permitted address range: 00 to 63
   - Factory setting: 63
   - MSD switch on position P: setting of the node address by means of TruControl Power. In this case, the position of the LSD switch is not relevant.
3. Setting the rotary switch for data rate:
   - 125 kbit/s
   - 250 kbit/s
   - 500 kbit/s
   - Position PGM: setting of the data rate by means of Tru-Control Power.



1 Rotary switch for data rate
2 Rotary switch for node address

Rotary switch for DeviceNet

Fig. 10530

4. Switch on the generator using the main switch.

The generator applies the settings when restarted.

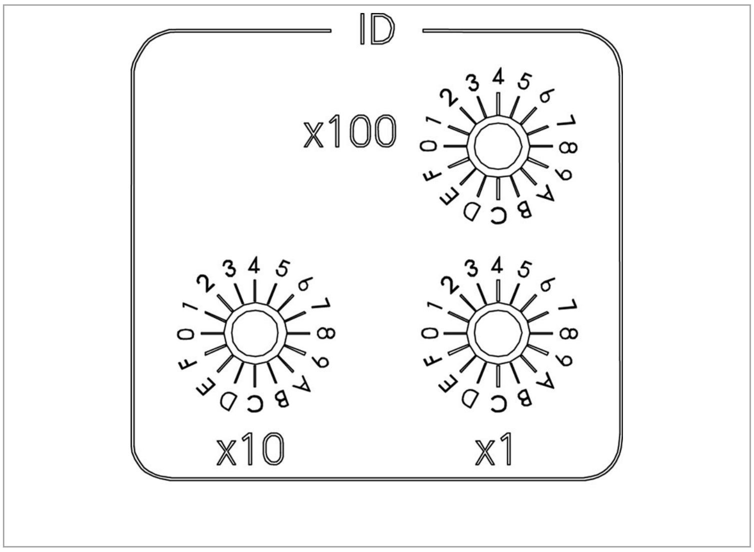
7. Operation via EtherCAT interface (optional)

The generator features an interface for EtherCAT communication (optional).

Pin assignment and function description (see "EtherCAT (optional)", pg. 4-89).

7.1 Setting node address

1. Switch off the generator using the main switch.
2. Use the rotary switch on the rear side of the generator to set the desired node address:
   - x1: first digit of the hexadecimal number.
   - x10: second digit of the hexadecimal number.
   - x100: third digit of the hexadecimal number.
   - Permitted address range: 0x000 to 0xFFF (≙ 0 to 4095).
   - Factory setting: 0x000.



Rotary switch for setting the node address Fig. 10289

3. Switch on the generator using the main switch.

The generator applies the settings when restarted.

7.2 Displaying EtherCAT states

1. Select >*Configuration* >*Interfaces*.

2. Read the current status under "EtherCAT device state".

   There are four states corresponding to the EtherCAT definition: Init, Pre-op, Safe-op and op.

3. Read the time stamp under "Time stamp EtherCAT".

8. Power regulation

8.1 Switching power on

Conditions

- Interlock circuit is closed.
- On the AD interface, the two pins for the interlock circuit are connected to an external contact for this purpose (see "Connecting the control lines", pg. 6-20).
- RF output cable is correctly mounted (see "Connecting RF output", pg. 6-21).

NOTICE

Pulsing by quickly switching on and off.

The generator will be damaged if it is switched on and off with a frequency greater than 1 Hz (power on, power off).

➢ Use pulse mode.

1. Switch on the generator using the main switch.

   While the generator starts up, all LEDs are switched on. After a few seconds, only the green LEDs remain illuminated. The generator is ready for operation.

2. To activate the desired interface after switching on the generator:
   - In the TruControl Power operating software, press *Take control*.
   - For other interfaces: take control via a command or bit (see chapter 4).
3. To switch on the output power:

   ➢ TruControl Power: Click on *Power on*.

   or

   ➢ For other interfaces: switch on power via a command (see chapter 4).

8.2 Regulating power

The regulation mode (P_i-, P_L-, P_r- or U_{DC}-regulation) is automatically determined from the lowest applicable set-value difference.

Perform settings

1. Select >*Operation* >*Power regulation*.

Note

Observe the useful range for P_i set values: $P_i \leq P_L + P_r$.

2. Enter set value for forward power (P_i), load power (P_L), reflected power (P_r) and DC bias (U_{DC}).

   Which regulator is currently active is displayed under "Active regulator / ramping state" while power is on. The status indicators can take the following values:  gray = off or  white = on.

   Set values cannot be changed.

   Set values are controlled via the AD interface. Access to the set values is therefore disabled.

   ➢ Select >*Configuration* >*AD interface*.

   ➢ In order to change the set values on the control unit or in TruControl Power: select "Mixed mode"*off*.

Using pure Pi regulation

3. Under "Forward Power (Pi)", enter set value for P_i.
4. For set values P_L and P_r, enter upper limits. The values should be selected so that they offer protective function.

   For a P_i set value of 1000 W and a P_L set value of 3000 W, the difference between P_i set value and P_i actual value is always less than the difference between P_L set value and P_L actual value. Thus, P_i regulation always intervenes.

Using pure PL regulation

5. Enter the set value for P_L under "Load power (PL)":
6. For set values P_i and P_r, enter upper limits. The values should be selected so that they offer protective function.

   For a PL set value of 1000 W and a P_i set value of 3000 W, the difference between P_L set value and P_L actual value is always less than the difference between P_i set value and P_i actual value. Thus, P_L regulation always intervenes.

Combined P_i-P_L regulation

7. Enter set values for P_i and P_L:
   - Under "Forward Power (Pi)", enter set value for P_i.
   - Under "Load power (PL)", enter set value for P_L.
   - P_i set value must lie in the following range: $P_i \leq P_L + P_r$.
8. Under "Reflected power (Pr)", enter set value for P_r.

Tips

- Do not set the P_r limit value too low; this may reduce the regulation speed. It then takes longer for the desired set value to be reached.
- Interfaces that can control either the P_i set value or the P_L set value have a choice of regulation (P_i/P_L selection). If the generator is switched on via the interface or if the "P_i/P_L

selection" signal is changed, the unneeded set value is automatically set to its maximum value. The P_r set value remains unchanged. The unneeded set value as well as the P_r set value can be controlled via one of the digital interfaces at any time.

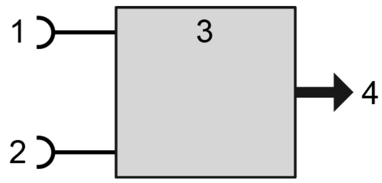
8.3 Generic regulation channel (GRC)

This regulation channel offers the possibility to use an arbitrary external measured variable as regulation parameter.

Requirement:

- The generator must receive a set value via the digital interface.
- At the analog input of the AD interface, the generator must receive an actual value from the external measuring equipment.

The value range for set value and actual value is from 0 to 10,000.



1	Digital interface (set value)	3	Generator
2	Analog input (actual value)	4	RF output

Principle of the generic regulation channel Fig. 10673

Use generic regulation channel

1. Apply external voltage to the analog input of the AD interface.
2. TruControl Power: Click on >*Operation* >*Generic regulation channel*. Enter the limit value.
3. Click on >*Configuration* >*Mixed mode*. Select *Mixed mode on*
4. Under , select *Analog input functionGRC actual value*.
5. Scale analog input: Click on >*Configuration* >*Analog I/O scaling*. Under *Grc*, set a value that is to correspond to 10 V on the analog input.

8.4 External current / voltage regulation

This regulation allows measurement values from a matchbox to be used as regulation parameters.

Note

External current / voltage regulation is only possible if a matchbox from TRUMPF is connected to the generator (see "Matchbox (optional)", pg. 6-24).

Use external current / voltage regulation

1. Select >*Operation* >*External current / voltage regulation*.
2. Enter set values for DC bias (U_{dc}), U_{rf} and I_{rf}.

9. Clock modes

Three clock modes are available:

- Phase offset (CEX mode)

  Here, the clock signal and the RF output signal are coupled phase-locked. The phase shift can be set by the user.
- Frequency offset

  In this mode, a frequency deviation can be set by the user in a range around the nominal frequency.
- Frequency agility (optional)

  In this mode, an internal algorithm sets the frequency with the best impedance matching (Auto Frequency Tuning / AFT). The frequency that was set in frequency offset mode can be used as ignition frequency.

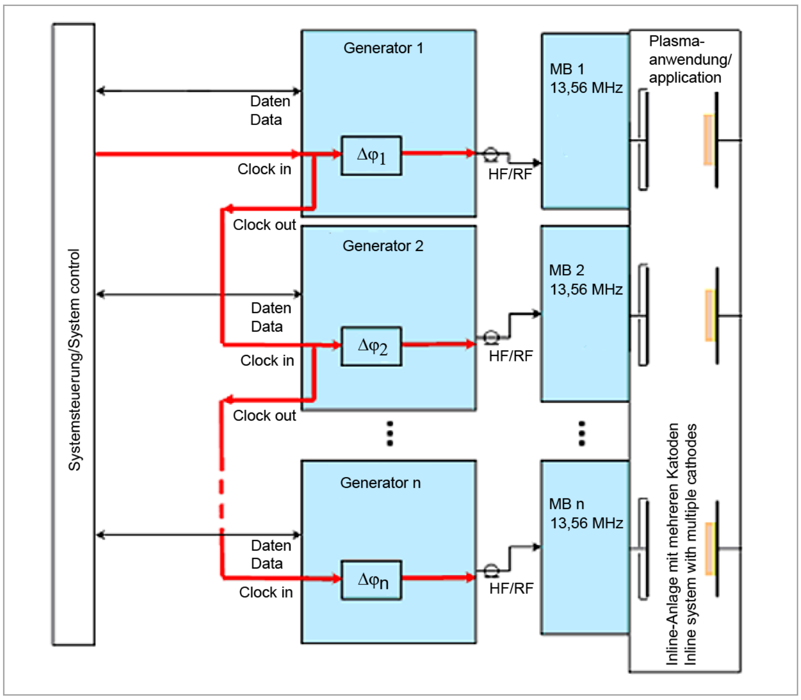
9.1 Phase offset (CEX mode)

For applications with several plasma sources within one plasma chamber, it may be necessary to control the individual cathodes with RF signals that operate in phase or whose phase angles are exactly defined.

For this purpose, the generator provides an input (Clock in) and an output (Clock out) for a 13.56 MHz signal that defines the phase angle relative to the RF output signal.

For the generator, the phase angle of the RF output signal can be specified relative to the clock signal via the $\Delta\varphi_n$ parameter by means of software. The $\Delta\varphi_n$ parameter is controlled via the digital or the DeviceNet interface. The value can be set within a range of 0° and 360° for each generator. Adjustment of phase angle offset $\Delta\varphi_n$ is done in steps of 0.1°.

9.2 Clock signal from an external source



Clock signal from an external source Fig. 10208

Note

For an external clock signal to be accepted, the generator must be set to Clock - source *External*.

(>*Operation*"Clock and pulse mode""Source"*External*).

This setting can only be activated when the RF output power is switched off.

Making settings for clock signal from external source

Condition

- Sinusoidal clock signal, no phase jumps

1. Press *Power off*.
2. Select >*Operation* >*Clock and pulse mode*.
3. Under "Source", select *External*.
4. Under "Clock offset mode", select *Phase offset* and enter a value under "Phase shift".

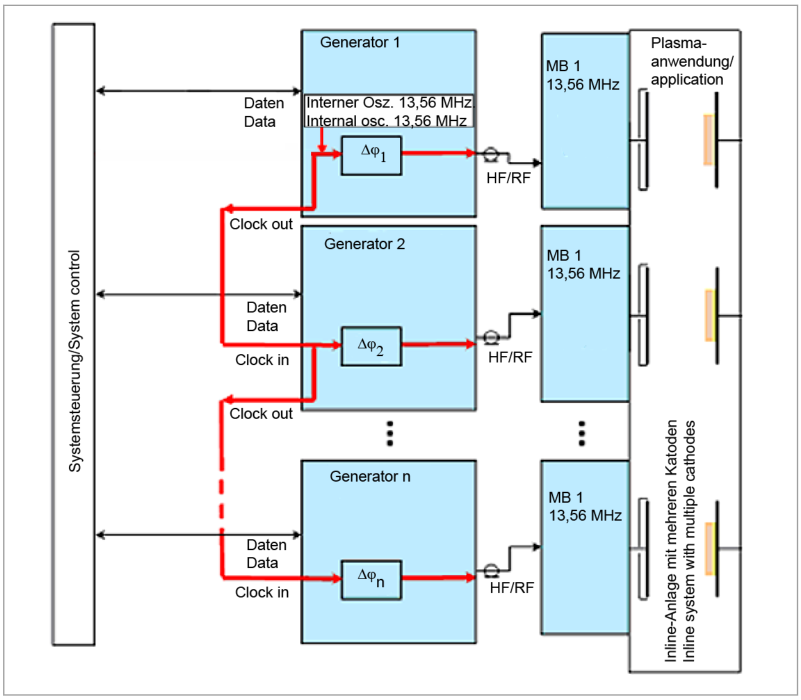
   The phase shift between clock signal and power delivery can be between 0.0 and 360.0°.

Tip

If the value set for the phase shift is too large, the generator outputs an alarm message.

9.3 Clock signal generated internally in the generator

A generator can operate as a clock signal master. The internal oscillator generates the 13.56 MHz signal which can be fed to other RF generators, which shall have a defined phase angle relative to the common clock signal.



Clock signal from an internal source Fig. 10209

Making settings for generator-internal clock signal

1. Select >*Operation* >*Clock and pulse mode*.
2. Under "Source", select *Internal*.
3. Under "Clock offset mode", select *Phase offset* and enter a value under "Phase shift".

   The phase shift between clock signal and RF power output can be between 0.0 and 360.0°.

4. Feed in the clock signal of other generators (see "Clock signal from an external source", pg. 7-26) and make settings for an external clock signal .

9.4 Frequency offset

Note

Clock signal and RF output power are not phase synchronous in the "clock offset mode" *frequency*, not even with a frequency deviation of *0 Hz*. The clock output signal has the same frequency as the clock source (internal or external) and does not include the set frequency deviation.

Select frequency deviation

1. Select >*Operation* >*Clock and pulse mode*.
2. Under "Source", select *Internal*.

   Operation with an external source is also possible but does not have any advantages with frequency offset.
3. Under "Clock offset mode", select *Frequency*.

   The frequency deviation to the clock signal can be selected between -5 and +5 kHz (optionally between -135.6 and +135.6 kHz or between -567 and +567 kHz).
4. Under "Frequency deviation", enter a value.

Tip

If the >*Clock and pulse mode* tab contains no selection field for the "Clock offset mode", the mode is selected in the following way: (see "Choosing between frequency offset and phase shift without the "Clock offset mode" selection field", pg. 7-28).

9.5 Choosing between frequency offset and phase shift without the "Clock offset mode" selection field

In certain software versions, no selection field is provided for choosing between phase shift and frequency offset. In this case, the choice is made as follows.

Selecting frequency-offset mode

1. Enter the desired value under "Frequency offset".

2. Switch on output power with *Power on*.

   The generator now switches to frequency-offset mode. A value entered under "Phase shift" is generally ignored.

Selecting phase shift mode

3. To select the phase shift mode: enter the desired value under "Phase shift".
4. Under "Frequency offset", enter the value *0*.
5. Switch on output power with *Power on*.

   The generator now switches to phase shift mode. If a value is subsequently entered under "Frequency offset", it is ignored. When the power is switched on again, however, the generator switches to frequency-offset mode if a value other than *0* is entered there at the moment power is switched on.

10. Frequency agility (optional)

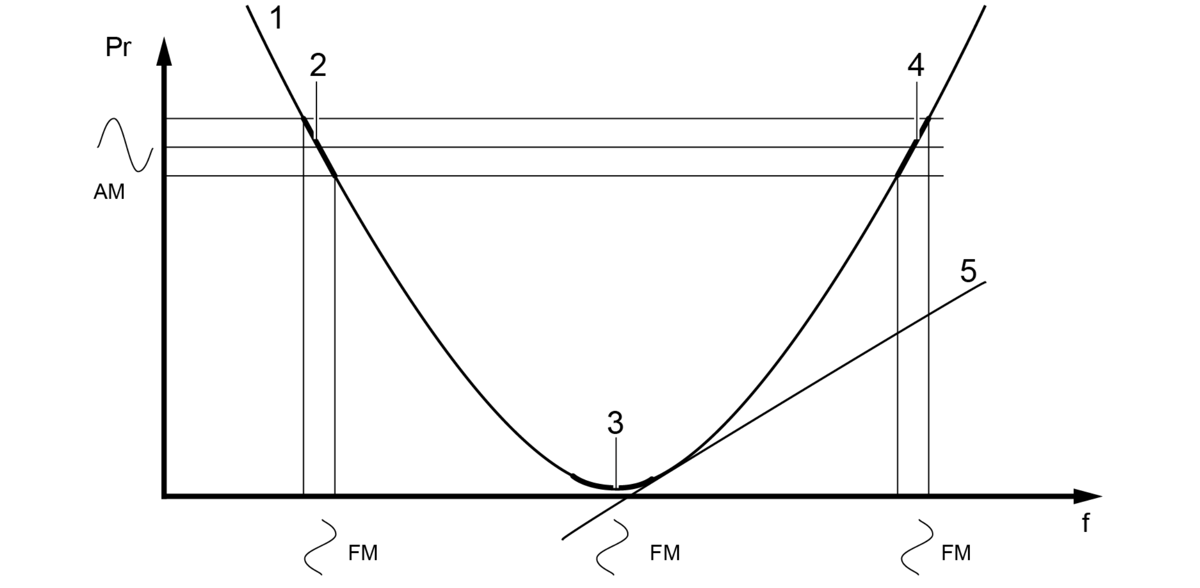
10.1 Activate frequency agility

1. Press *Power off*.
2. Select >*Operation* >*Frequency agility*.
3. Select >*Mode* >*Frequency agility*.

10.2 Description of the frequency agility function

Auto Frequency Tuning / AFT (optional)

In "Frequency agility" mode, the generator automatically changes its operating frequency and tries to achieve optimum matching. By means of specially developed signal processing, more direct tuning is possible, unlike the otherwise typical trial-and-error methods.



1	Matching curve	3	No slope	5	First derivative of the matching curve
2	Slope	4	Opposing slope		

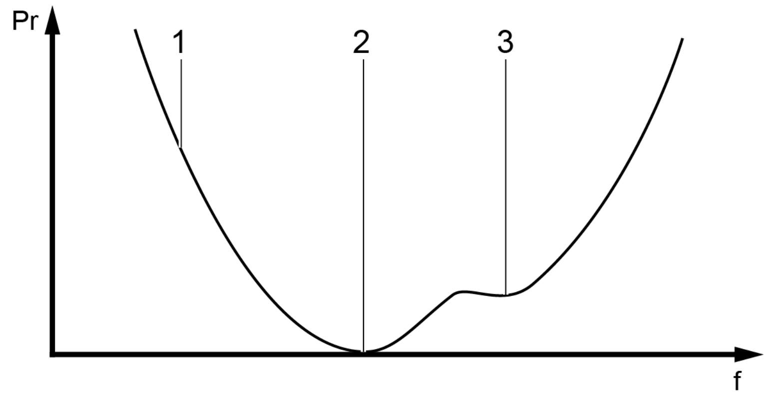
Matching curve

Fig. 10611

The most important parameters are "Modulation" and the gain factor "gain", which is used to change the working frequency. Each of these parameters is divided into a constant part and a part that is dependent on the mismatching (gamma Γ).
The "Modulation" parameter can be used to ensure that the generator regulates over and beyond a "local minimum" (see "Fig. 10615", pg. 7-31). In addition, this parameter influences the regulation speed (see formula for matching speed).

The Γ-dependent part of the modulation "Rel. mod. deviation" causes the modulation to become very small near the optimum matching (lowest-possible reflected power Pr). If frequency regulation is also to take place even with very low reflection, parameter "Modulation deviation" must be increased somewhat.
The Γ-dependent regulation amplification "Rel. gain" is likewise large outside of the matching, but very small near the matching. As a result, automatic frequency regulation is initially very fast, is stable and functions robustly once a match is achieved. If regulation of the frequency is also to take place even with very low regulation, the constant regulation amplification "Gain" must be increased somewhat.

"Local minimum"

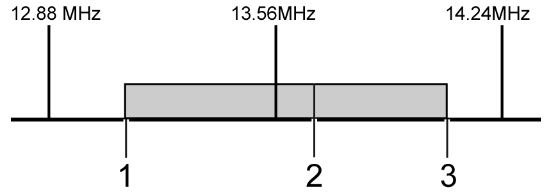


1 Matching curve
2 Optimum matching
3 Local minimum

Local minimum Fig. 10615

With the modulation deviation and regulation amplification set to small values, there is a risk that the working frequency will not level out at the optimum match, but rather at a local minimum. Increasing the modulation parameters helps to overcome a local minimum.

Starting frequency, frequency range

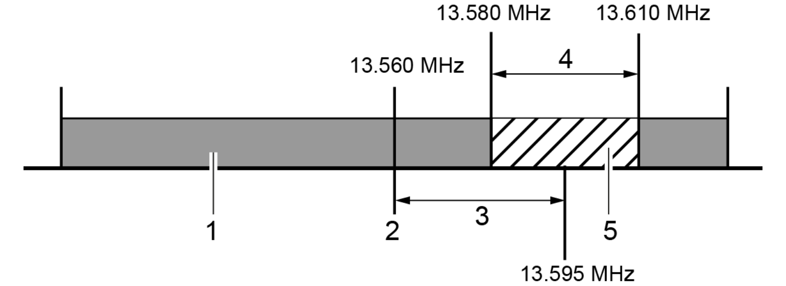


1 "Min. tuning offset"
2 "Tuning start offset"
3 "Max. tuning offset"

AFT range Fig. 10565

The starting frequency is defined with "Tuning start offset". After switching on the RF power, the frequency switches from the ignition frequency (see "Fig. 10634", pg. 7-33)to the starting frequency, after which automatic frequency regulation begins. The range for automatic frequency regulation can also be limited to application-specific values with parameters "Min. tuning offset" and "Max. tuning offset".

Excluded frequency range



1 AFT range
2 Nominal operating frequency (13.56 MHz)
3 "Center frequency offset" (Example: 35 kHz)
4 "Bandwidth"(Example: 30 kHz)
5 Excluded frequency range

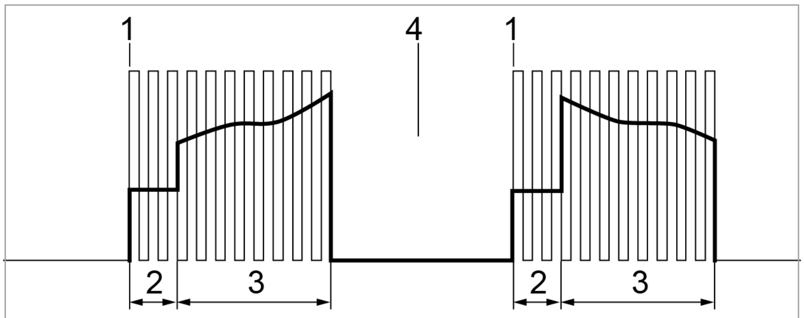
Excluded range Fig. 10755

With the function "Skip frequency window", a frequency range from the AFT can be ruled out. This means that the working frequency can only accept values outside of this range.

Pullback

With this function, the reproducibility of the RF matching is improved through the support of an external automatic matching network when searching for its optimum.
With parameter "Pullback to start frequency", the operating frequency is intentionally pulled towards the starting frequency "Tuning start offset" after the matching point is reached. The matching network is thereby slightly mismatched and, as a result, remains motivated to complete its tuning operation.

AFT with pulse mode



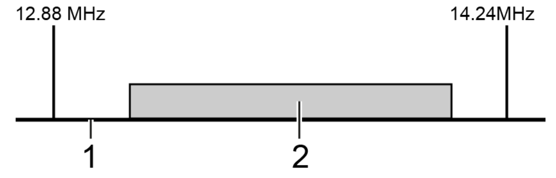
1 Start of pulse
2 "Regulation delay"
3 Tuning operation
4 Pulse pause

AFT with pulse mode Fig. 10614

ATF is also possible in pulse mode. The tuning operation is interrupted during pulse pauses and resumes at the start of the pulse.
Frequency tuning can be delayed somewhat with adjustment parameter *Regulation delay* to allow external processes, such as

an ignition process or plasma propagation to complete.
If *Ignition Frquenecy mode* is active, the generator starts the first pulse from the ignition position (ignition frequency). The next pulse begins with frequency 13.56 MHz + offset and continues after the *Regulation delay* has elapsed with the working frequency that was used up to the end of the previous pulse.
Through an appropriate choice of parameters (both modulations and both regulation amplifications at zero), the working frequency can also remain unregulated (fixed). One thereby has two fixed and independent frequencies for pulse mode.

Ignition position



1 Possible ignition position 2 AFT range

Ignition position Fig. 10634

As ignition position, a frequency can be set at which the best ignition performance is achieved (highest Urf voltage). To do this, the ignition mode ("Mode") is set to *Frequency*. The constant ignition frequency can be defined with parameter "Frequency offset"; it remains valid during the regulation delay.

Frequency Sweep

With the "Frequency Sweep" command, an automatic frequency sweep can be triggered. The generator sweeps through the complete working frequency range once in steps. This function serves as an aid during commissioning or when determining the ignition position and the tuned operating frequency.

Retuning Threshold

With this value, the sensitivity of the readjustment following successful tuning is set.

Tuning delay

With the function "Tuning delay", using the AFT after switching the power on can be delayed. This time can be used for the tuning operation for a connected matchbox.

Modulation period

"Modulation period" is a factor for the AFT frequency modulation. This value can be used to change the standard modulation of 16 kHz.

AFT adjustment parameters

AFT settings Fig. 10756

Size	Default	Min.	Max.
"Frequency offset"	0 kHz	-5000 kHz	5000 kHz
"Tuning start offset"	0 kHz	-678 kHz	678 kHz
"Min. tuning offset"	-678 kHz	-678 kHz	678 kHz
"Max. tuning offset"	678 kHz	-678 kHz	678 kHz
"Modulation deviation"	50	0	1000
"Rel. mod. deviation"	50	0	1000
"Modulation period"	1 µs	1 µs	10 µs
"Gain"	50	0	1000
"Rel. gain"	50	0	1000
"Pullback to start freq."	0	0	1000
"Retuning threshold"	0	0	1000
"Regulation delay"	7 µs	7 µs	1000 µs
"Tuning delay"	0 ms	0 ms	1500 ms
"Center requency offset"	0 kHz	-678 kHz	678 kHz
"Bandwidth"	1 kHz	1 kHz	1000 kHz

AFT adjustment parameters Tab. 7-5

11. Pulse mode

As an alternative to continuous operation, the RF power can be pulsed cyclically. The relevant variables for pulse mode, such as frequency and duty cycle, can be produced in the generator or externally.

During the pulse (high level), the generator delivers power. During the pulse pause (low level), no power is delivered, but all components remain ready for power delivery.

11.1 Setting pulse mode

1. Press *Power off*.
2. Select >*Operation* >*Clock and pulse mode*.
3. To switch on pulse mode: select *Pulse* under "Mode".
4. Selecting the "source" for the pulse signal:
   - *Internal*: The pulse generator of the generator is used.
   - *External*: Pulse signal is fed in via the Pulse in/out interface.
5. Under "Measurement delay", enter the time by which the internal power measurement is to be delayed relative to the start of the pulse.

   Limit values for the measurement delay:

   - 7 µs (≙ 263) to 1 ms (≙ 37500).
   - Maximum 1/2 pulse duration.

   The measurement delay prevents power regulation from responding to the ignition response of the plasma on the start of each pulse.
6. If the pulse signal is generated internally:
   - Enter the "frequency".
   - Enter the "duty cycle".

   The internal pulse generator starts on *power on* with a high level.

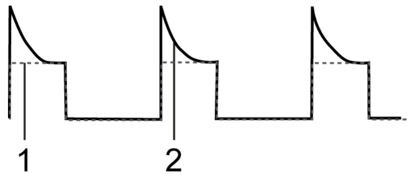
Tip

It is possible to switch between pulse mode and continuous operation during running operation (*power on*).

11.2 Pulse increase

With activated pulse increase, all pulses (high level) have a higher amplitude, comparable to switching on the power with the

Power on command. With the help of the pulse increase in pulse mode, a much higher switch-on/switch-off frequency with increased pulses can be achieved than with the *Power on* and *Power off* commands.



1 Power curve without pulse increase

2 Power curve with pulse increase

Pulse increase Fig. 10455

11.3 External pulse source

The pulse signal can only come from an external source. A TTL signal supplied to the sync input causes the RF output power to switch on and off. Please note the limit values in the technical specifications (see "Pulse", pg. 3-10). For an external pulse signal to be accepted, the generator must be set to pulse mode: *Pulse* and source: *External*.

Note

The sync input can also be used for external arc detection; the sync output can also be used as an arc sync output. To use the sync input and sync output as a pulse input and pulse output, the external arc detection and the arc sync output must be deactivated.

11.4 Pulse output

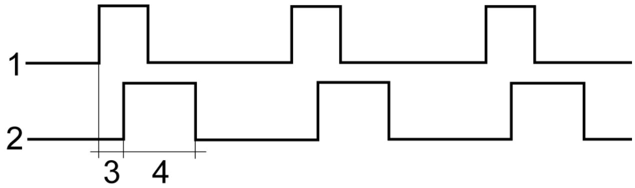
The generator can also be operated as a pulse generator for other generators. According to the pulse frequency and duty cycle settings, a pulse signal is generated which is available for pulsing other generators via the pulse out connector.

11.5 Triggered pulse mode

This function can be used to trigger an internal pulse signal through an external pulse signal.

The "Pulse delay" is the time between the rising edge of the external pulse signal until the application of the internal pulse signal. The "Pulse duration" defines the duration of the internal pulse signal.

To use this function, the pulse source must be set to *external* ("Pulse mode" "Source" *External*).

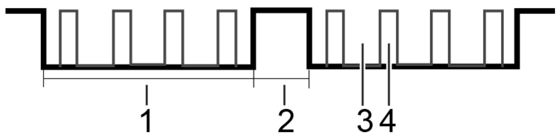


1	External pulse signal	3	"Pulse delay" in µs
2	Internal pulse signal	4	"Puls duration" in µs

Triggered pulse mode Fig. 10545

11.6 Simmer operation

In simmer operation, the generator also delivers a defined power during the pulse pauses in the form of brief pulses. The variables "Low time" and "High time" define these pulses.



1	Pulse pause	3	"Low time"
2	Pulse	4	"High time"

Simmer mode Fig. 10543

12. Regulation characteristic

Soft start

With the "soft start" start behavior, a slow, controlled start behavior can be achieved.

The "soft start" ensures that, when switched on, the generator is always adjusted from 0 W to the entered set value.

This prevents the occurrence of a sudden, high reflected power, since the regulation has sufficient time to intervene once the entered P_r limit value or the generator-internal, maximum-permissible P_r value is reached.

Normal start

In contrast, on a normal start ("soft start" disabled), the intermediate circuit is precharged so that regulation starts with a power value near the entered set value following the "Power on" command. Prerequisite for this is that all power set values are transfered to the generator prior to the "Power on" switching signal. This facilitates power rise times to the desired set value within microseconds. In this way, it is possible to ignite a plasma even under difficult conditions. The disadvantage can be that, in the event of mismatching, a sudden, high reflected power occurs and the generator turns down if the generator-internal, maximum-permissible P_r value is exceeded.

Normal start via analog interface

If the analog control voltage for the target power is set together with the "Power on" command, this command can be delayed internally by 5 ms to allow the intermediate circuit to precharge to the required voltage and thereby achieve the desired short power rise time.

Matching the precharger

In normal operation, the precharger makes available an intermediate circuit voltage that allows the output power to jump to approx. 90% of the target power upon executing the "Power on" command. The remaining power difference is compensated for by the regulation. If it is desired that the power precisely reach its target value – or even a value somewhat higher – after switching on, the "Precharge extension" parameter can be used to increase precharging to 110% of the target power.

Limiting the output power when switching on the power

If a high reflected power occurred that forced the generator to regulate the output power from power value A to a lower power value B, precharging is limited to B first. Within < 10 s, however, the precharge value for A is again available

Regulation speed

To keep even critical plasma processes stable, the speed for power regulation can be set. With the *Slow* setting, regulation can be reduced to approx. 25% of the normal dynamics. The *Expert* setting is available as an option. It is thereby possible to vary the regulation speed between *1* and *500*. *280* corresponds approximately to the setting *Normal*; *70* corresponds approximately to setting *Slow*.

12.1 Setting the regulation characteristic

1. Select *Operation Regulation characteristic*.
2. To activate "soft start", select: *Active*.
3. To increase the time constants of the regulation during unsteady operating conditions: select *Slow* or *Expert* under "Regulation speed"; if necessary, set a different value for the regulation speed.

13. Timer

13.1 Setting timer

1. Select >*Operation* >*Regulation characteristic*.
2. Under "RF off timer", enter the time after which the output power is switched off.
   Adjustment range: 0 to 999999 seconds.

   Tip

   With setting *0 s*, the timer is not active.

3. To activate the timer: press *Power on*.

   or

   ➢ The *Power on* commands of interfaces also activate the timer (e.g., RS-232/RS-485 interface).

Under "Remaining operating time RF", the remaining time is displayed after which the output power is switched off.

14. Joule mode

In Joule mode, a limit value is specified for energy transfer to the load. The power is switched off after the energy value has been reached.

- "Joule mode limit": limit value specification in Ws.
- "Total energy output": display of the consumed energy in kWh.
- "Remaining output energy": display of the remaining energy in Ws after which the output power is switched off.
- "Energy output since power on": display of the consumed energy in kWh since the last power-on command.

15. Ramp function

The ramp function can be used to set the output power to a new value with a defined speed in W/s or within a defined period in ms.

Depending on the choice of reference input (Regulation type), the ramp acts on P_i or on P_L. With power switched on, the ramp starts immediately; otherwise, it starts the next time the power is switched on.

If a new set value is entered, the ramp function is started if power is switched on.

The new set value must deviate from the currently set set value by more than 3 W in order for the ramp to start.

If a new set value is entered during a running ramp, the currently active ramp continues unaffected. The new parameter setting is saved. Immediately after the current ramp is ended, the new ramp is started.

When the output power (*Power on*) is switched on, the ramp starts at 0 W with the set set value for P_i or P_L as target value.

When the output power (*Power off*) is switched off, the output power is immediately switched off; any ramp settings are ignored. To execute a power-off ramp, set the set value for P_i or P_L to 0 W.

15.1 Setting the ramp function

1. Select >*Operation* >*Ramp function*.
2.

   Under "Ramp mode", select the desired ramp mode:
   - *Disabled*: ramp mode is not active.
   - *RF on*: ramp is performed once on *power on*.
   - *RF on and set value change*: ramp is performed on *power on* and on every subsequent set value change.
3. Under "Ramp unit", select time ramp (*Time ramp*) or power ramp (*Power ramp*).
4. Under "Set value ramp up", set the value for the upward ramp.
5. Under "Set value ramp down", set the value for the downward ramp.
6. Under "Reference input", select: *Pi* or *PL*.

   The ramp acts on the selected reference input.
7. To start the ramp, switch on power (*power on*).

   Ramp with reference input P_L is not started.

The P_i set value may be set too low. The P_i regulator intervenes even before the ramp can increase to the P_L set value.

- In TruControl Power, select >*Operation* >*Power regulation*.
- Check set values for P_i and P_L and change if necessary.

15.2 Regulate power to 0 W with downward ramp

1. Select >*Operation* >*Ramp function*.
2. Making settings(see "Setting the ramp function", pg. 7-42):
   - Under "Ramp mode", select *RF on and Set value change*.
   - Under "Ramp unit", select *Time ramp* or *Power ramp*.
   - Under "Set value ramp down", set the value for the downward ramp.
   - Under "Reference input", select: *Pi* or *PL*.
3. Select >*Operation* >*Power regulation*.
4. Setting the set value for P_i or P_L:
   - With selected reference input P_i, set the set value for P_i to 0 W.

   or

   - With selected reference input P_L, set the set value for P_L to 0 W.

The downward ramp from the current actual value to the target value of 0 W is started.

16. Arc management (optional)

Arc management operates in two levels:

- Detection
- Reaction

If arc detection is active, all arcs are counted. The arc counter can be reset.

External arc detection

Arc detection is performed by an external measuring device. This measuring device can be a second generator.

Arc synchronization input

The Arc-Sync in input can be used to trigger an arc reaction in the generator if arc detection originates from an external generator.
To use this function, external arc detection must be enabled (see "Arc detection modes", pg. 7-45).

Arc synchronization output

The Arc-Sync out output can be used to notify an external generator about an arc treatment of this generator.
To use this function, external arc detection and arc treatment of the external generator must be activated(see "Arc detection modes", pg. 7-45).

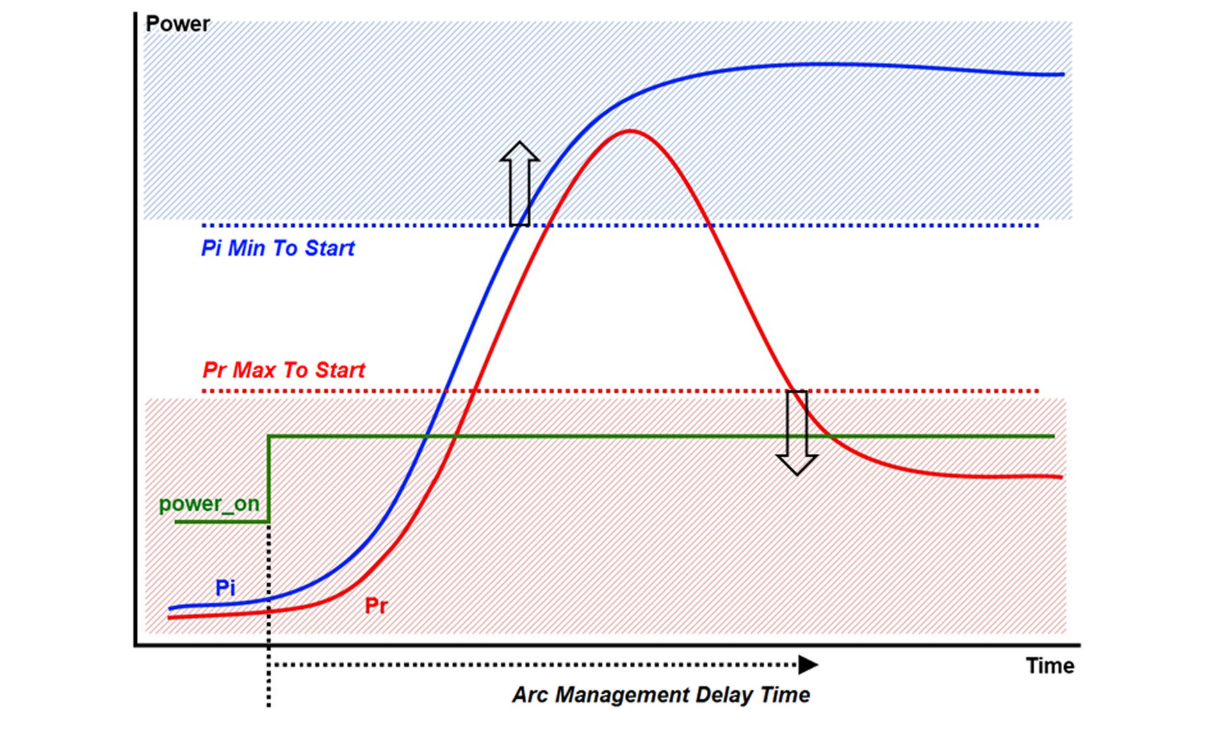
16.1 Condition for arc detection

For arc detection to intervene if a plasma is present, the following conditions must be met:

- P_i is larger than the set parameter "Minimum Pi to start".
- P_r is smaller than the set parameter "Maximum Pr to start".
- The "arc management delay" time has elapsed.
  This is the wait time until activation of the arc management after the plasma has ignited.

Note

In the event of process changes or other changes, the "Arc management delay" time can be restarted (Restart delay). With this restart, the Arc handling is immediately inactive.



Condition for arc detection

Fig. 10198

16.2 Arc detection modes

There are various ways to detect arcs:

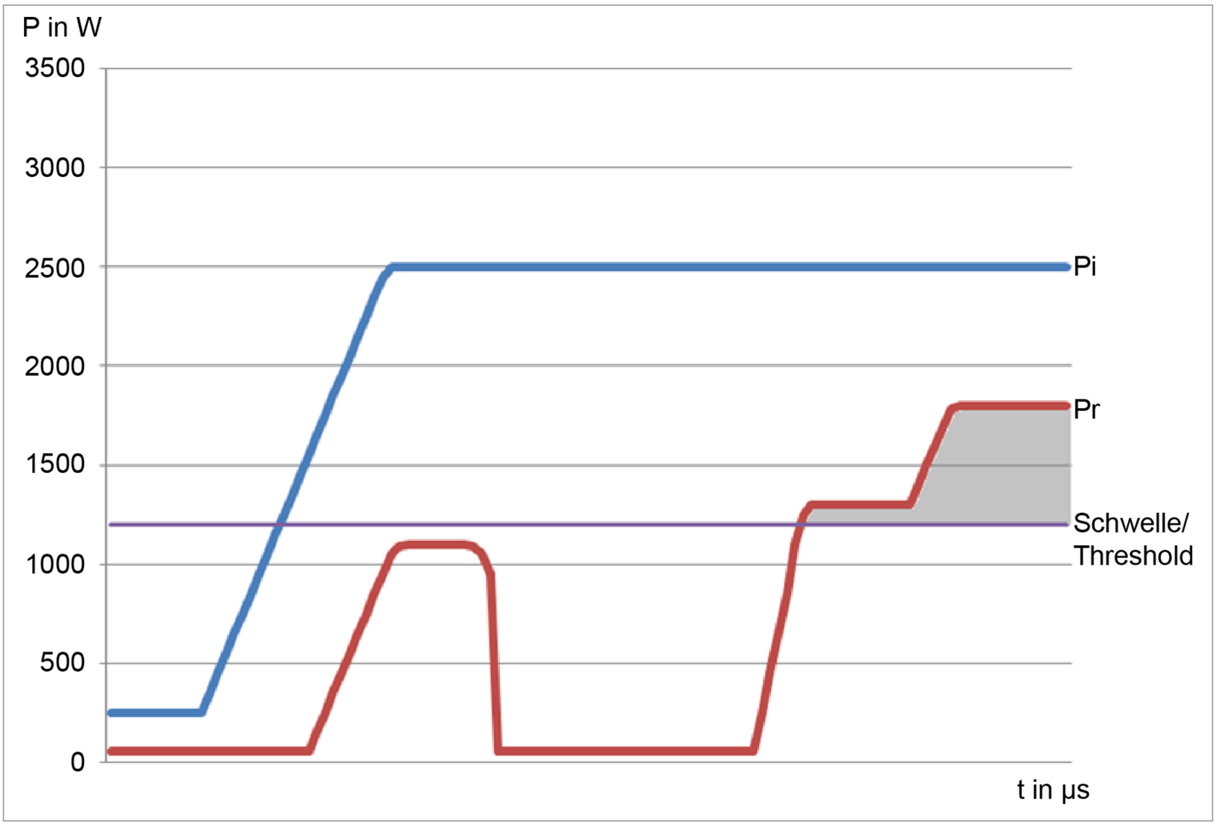
- "Pr Threshold":
  - P_r limit value in W.
  - An arc is detected if the P_r value exceeds the set P_r limit value.
  - (see "Fig. 10199", pg. 7-47).
- "Pr/Pi Threshold":
  - Ratio P_r/P_i in %.
  - An arc is detected if ratio P_r/P_i has exceeded the set value "Threshold Pr/Pi".
  - (see "Fig. 10200", pg. 7-48)
- "Pr Slope":
  - Slope $\Delta P_r/(n * T_{sample})$ in W/µs.
  - An arc is detected if P_r rises faster than the set value "Slope Pr".
  - (see "Fig. 10201", pg. 7-48).
  - Under "Slope Pr max", the highest value that occurred for Slope Pr since switching on of the output power is displayed (data-hold function).

- "Pr/Pi Slope":
  - Slope $\Delta(P_r/P_i)/(n * T_{sample})$ in %/µs.
  - An arc is detected if P_r/P_i rises faster than the set value "Slope Pr/Pi".
  - (see "Fig. 10202", pg. 7-49).
- "External":

  An arc is detected by an external measuring device. In the event of an arc, this device supplies a signal to the arc-syn in interface in the generator (see "Fig. 10628", pg. 7-49).
  "External" arc detection can be combined with all other arc detection modes (see "Fig. 10629", pg. 7-50):
  - "Extern + Pr Threshold".
  - "Extern + Pr/Pi Threshold".
  - "Extern + Pr Slope".
  - "Extern + Pr/Pi Slope".

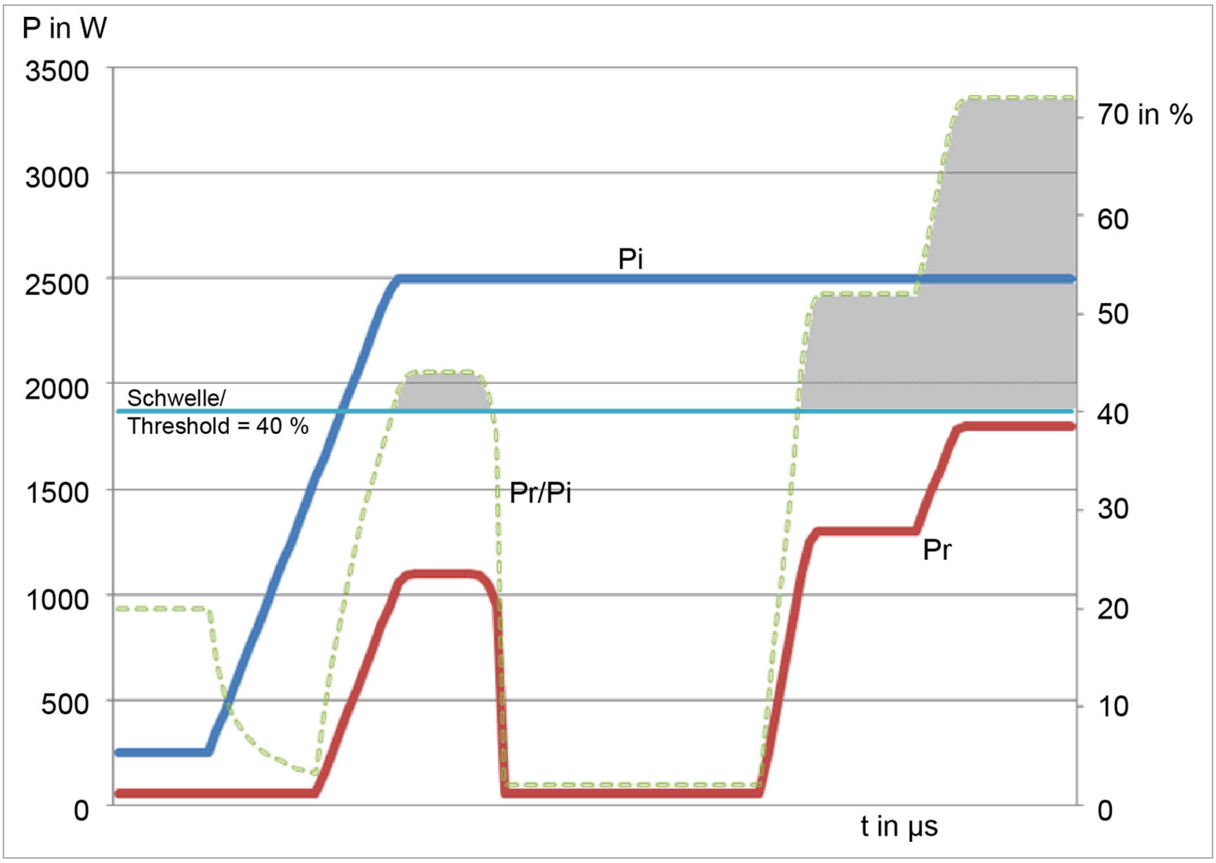
- Calculation of the values for "Pr Slope" and "Pr/Pi Slope":

  The time unit for the slope calculation is formed from the T_{sample} (= 100 ms) and the number of time intervals ("Sample count"). The examples in the following figures (see "Fig. 10201", pg. 7-48), (see "Fig. 10202", pg. 7-49) calculate with "Sample count" = 1. In the case of slower power changes it makes sense to increase the "Sample count". Example: At "Sample count" = 25 the power change is calculated within 2500 µs.



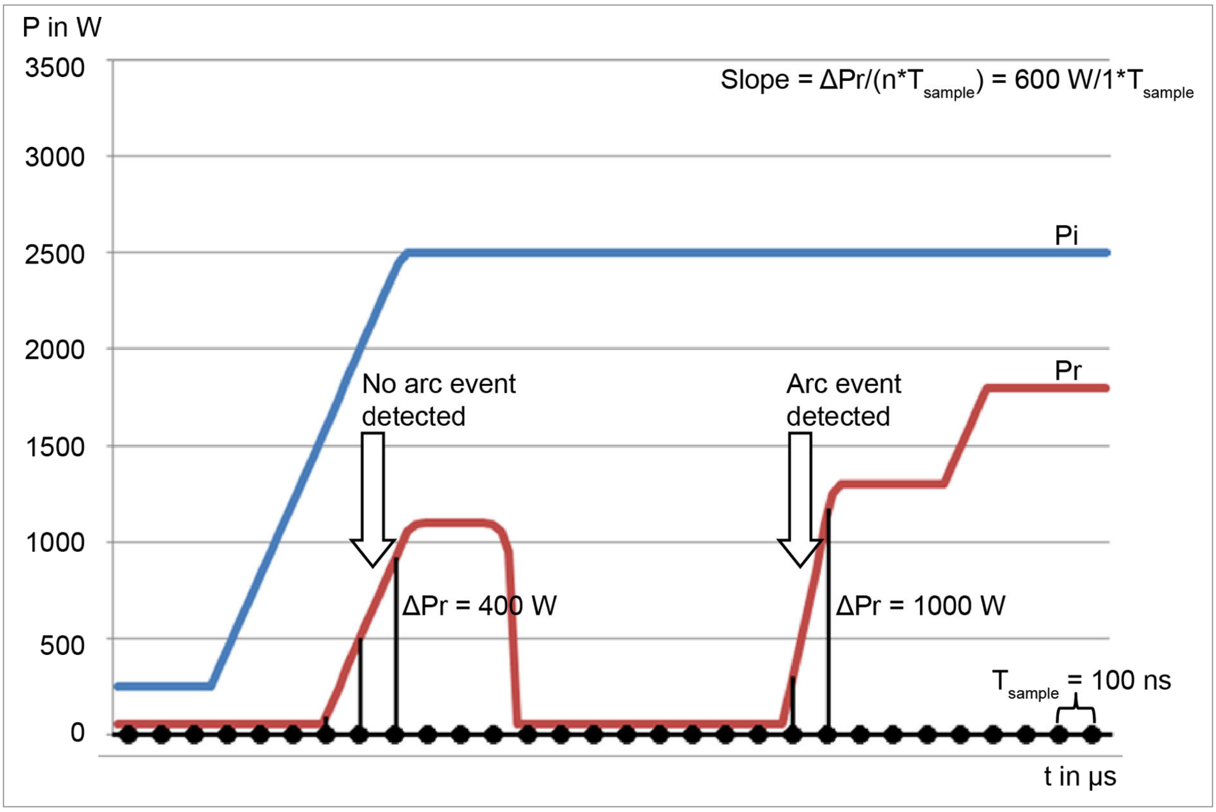
Arc detection P_r threshold

Fig. 10199



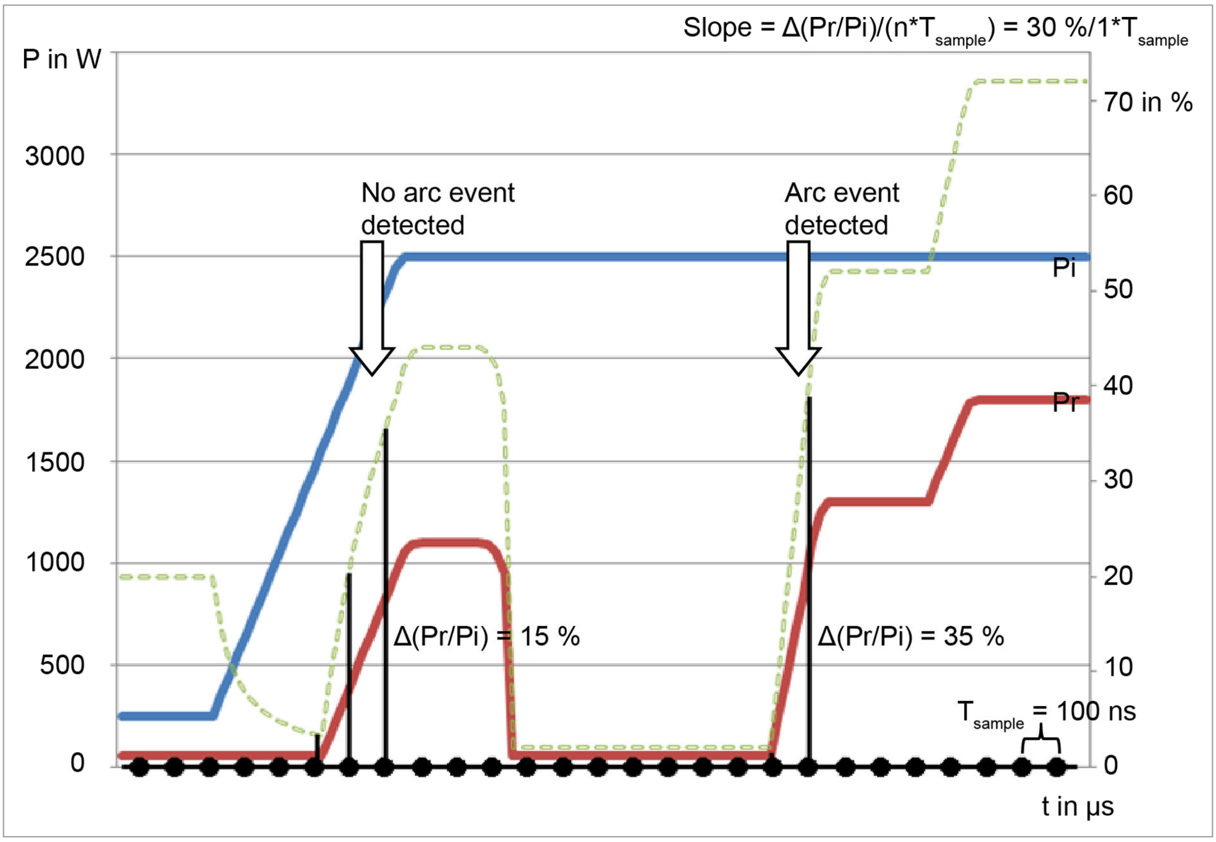
Arc detection P_r/P_i threshold

Fig. 10200



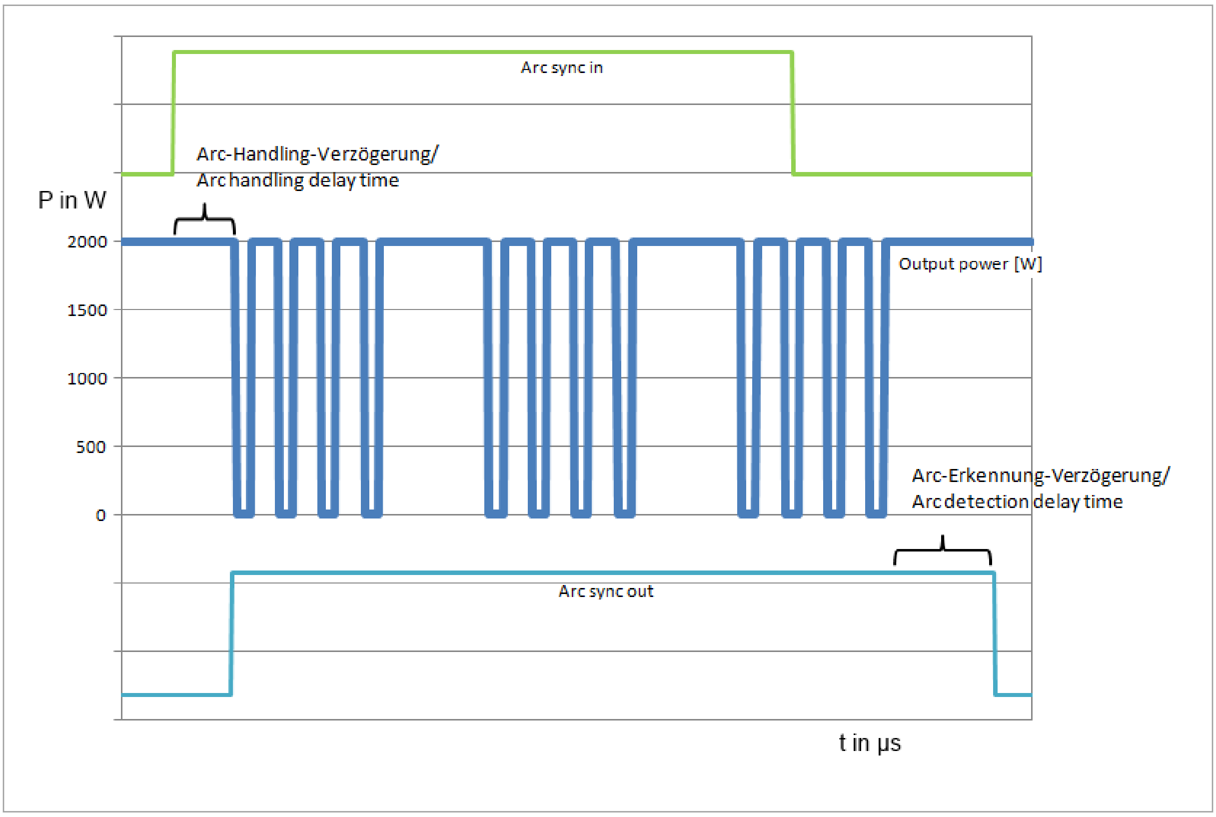
Arc detection P_r slope

Fig. 10201



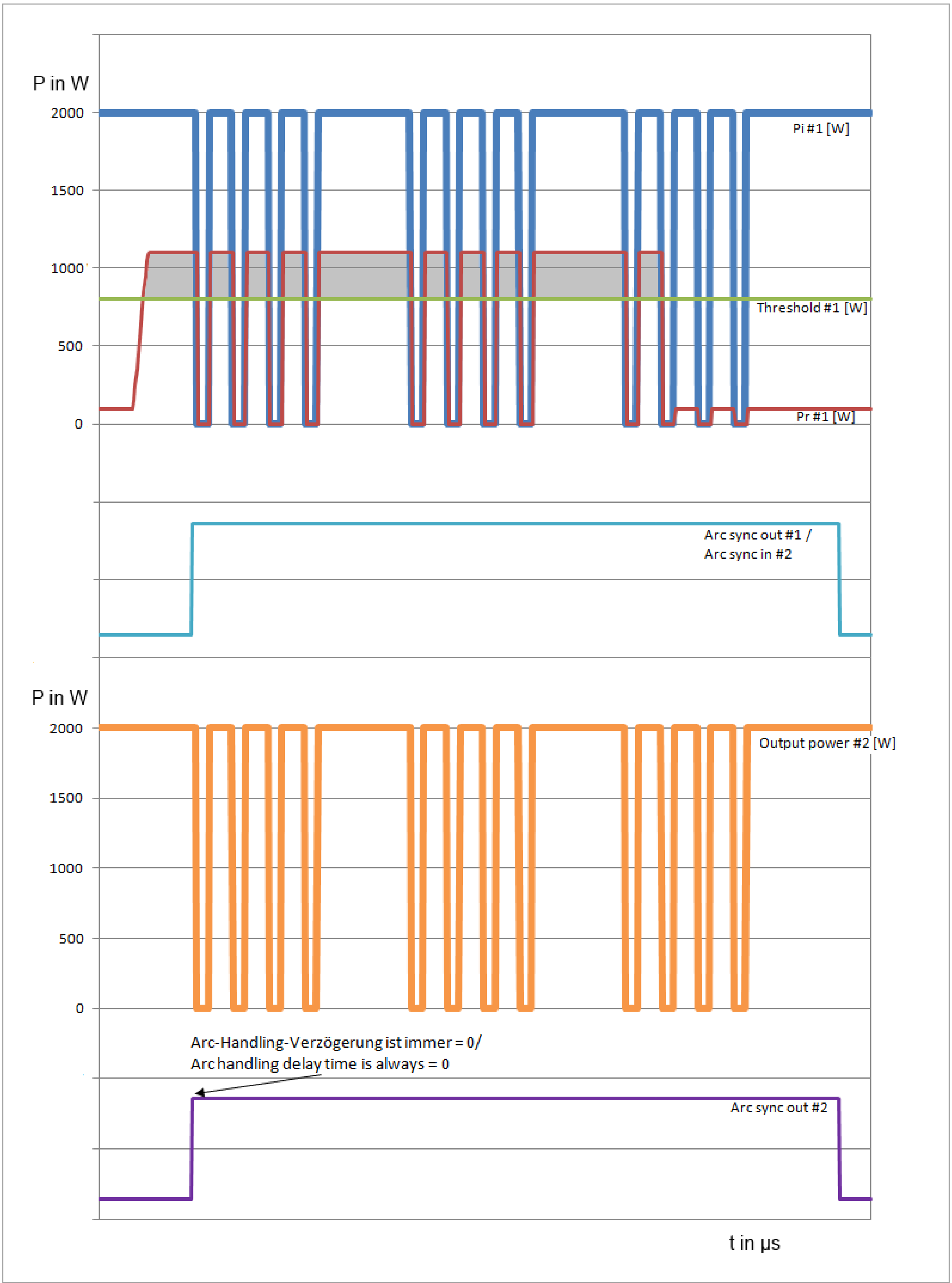
Arc detection P_r/P_i slope

Fig. 10202



External arc detection

Fig. 10628



Combined arc detection - external - internal Fig. 10629

16.3 Arc handling

There are two different types of arc treatment:

- Power off:

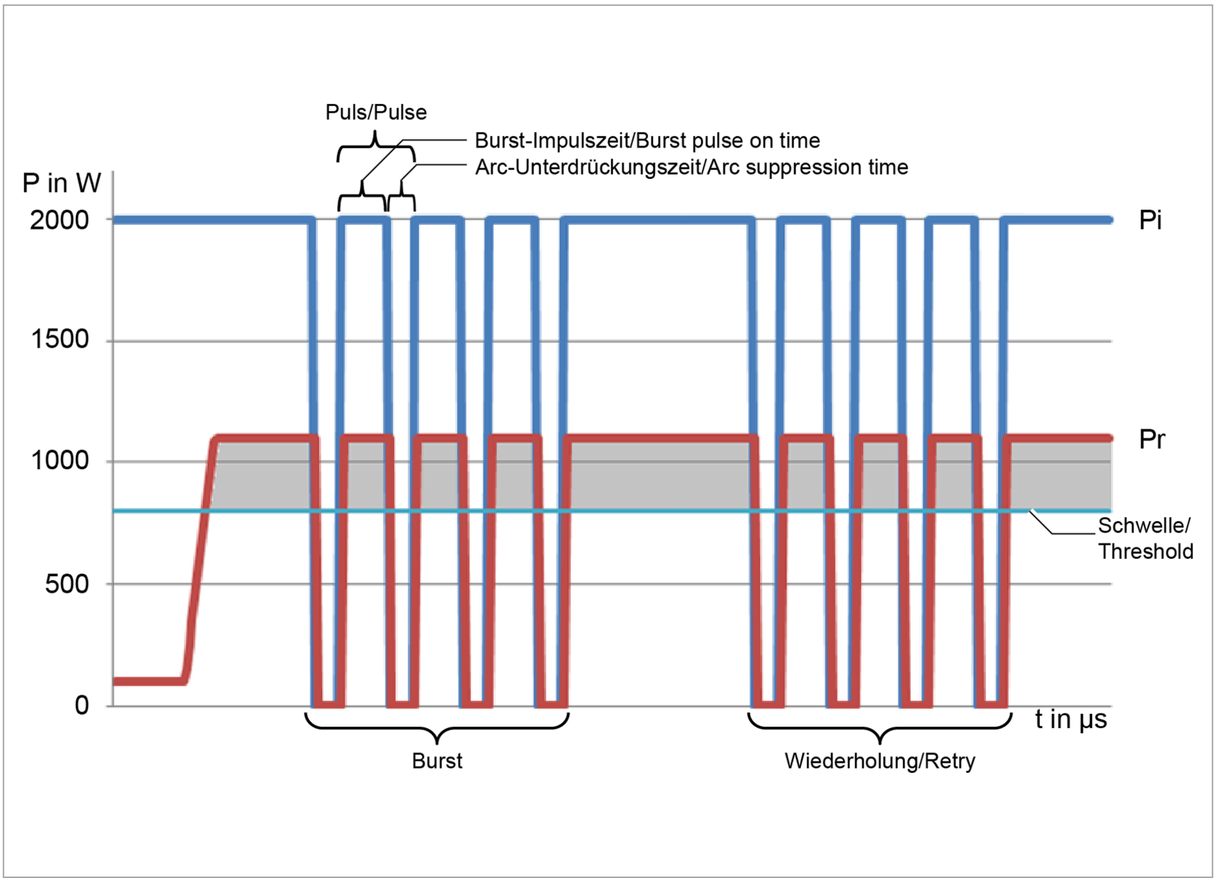
  In the event of an arc, the generator switches off the output power and generates an alarm message.
- Cut arc actively (active interruption of the arc):

  The generator responds according to the arc treatment settings.

16.4 Arc handling settings

The main variables which can be used to change the reactions to arcs:

- "Handling mode": Power off or reaction according to the following points.
- "Arc handling delay": Arc handling delay time in µs. If an arc was detected with the help of the combined arc detection (external + internal arc detection), this time is always «0».
- "Arc suppression time": Blanking time in µs.
- "Burst-pulse-on time": Keying time in µs.
- "Arc detection delay": Arc detection delay time in µs.
- "Pulse count in burst": Pulse packet with defined number of pulses.
- "Arc retry count": Repetition of the pulse packet.



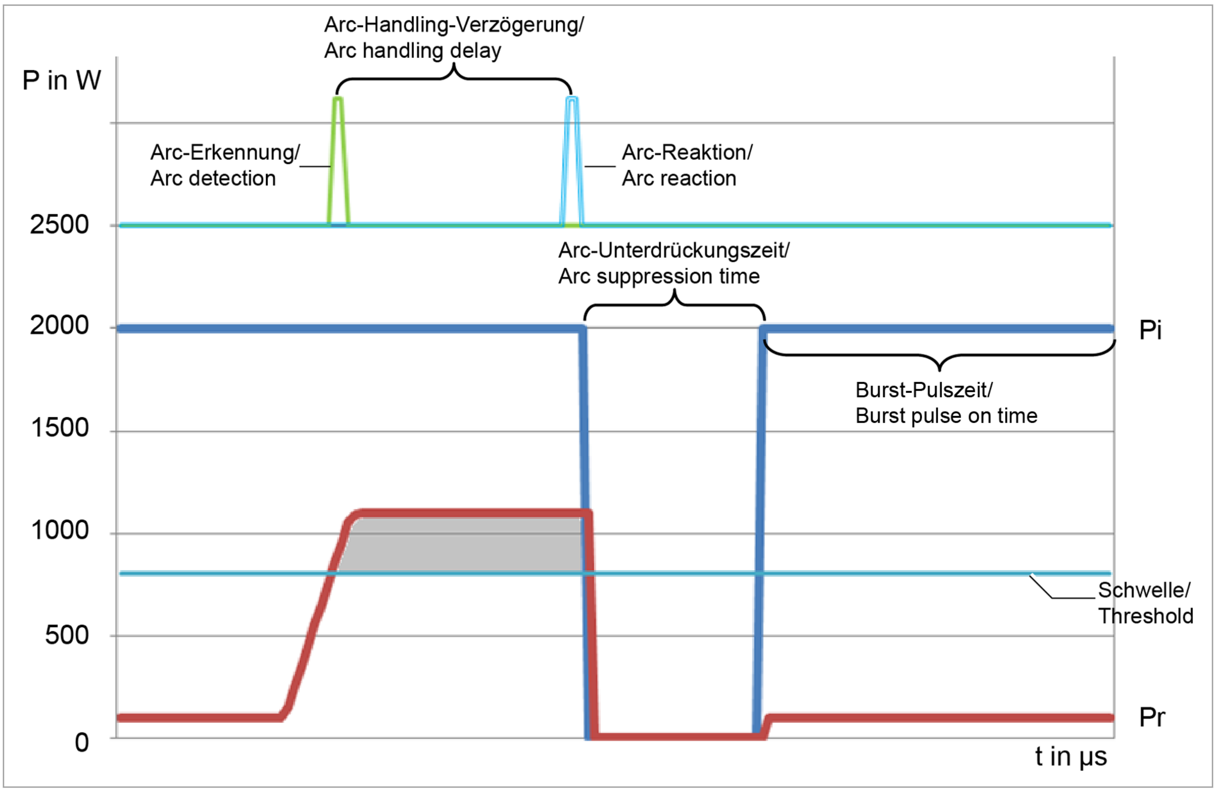
Process and parameter combinations

Fig. 10203

16.5 Single pulse

To extinguish an arc with a single pulse, the following parameters must be set:

- "Pulse count in burst = 1."
- "Arc suppression time = n µs."
- "Burst-pulse-on time = n µs."



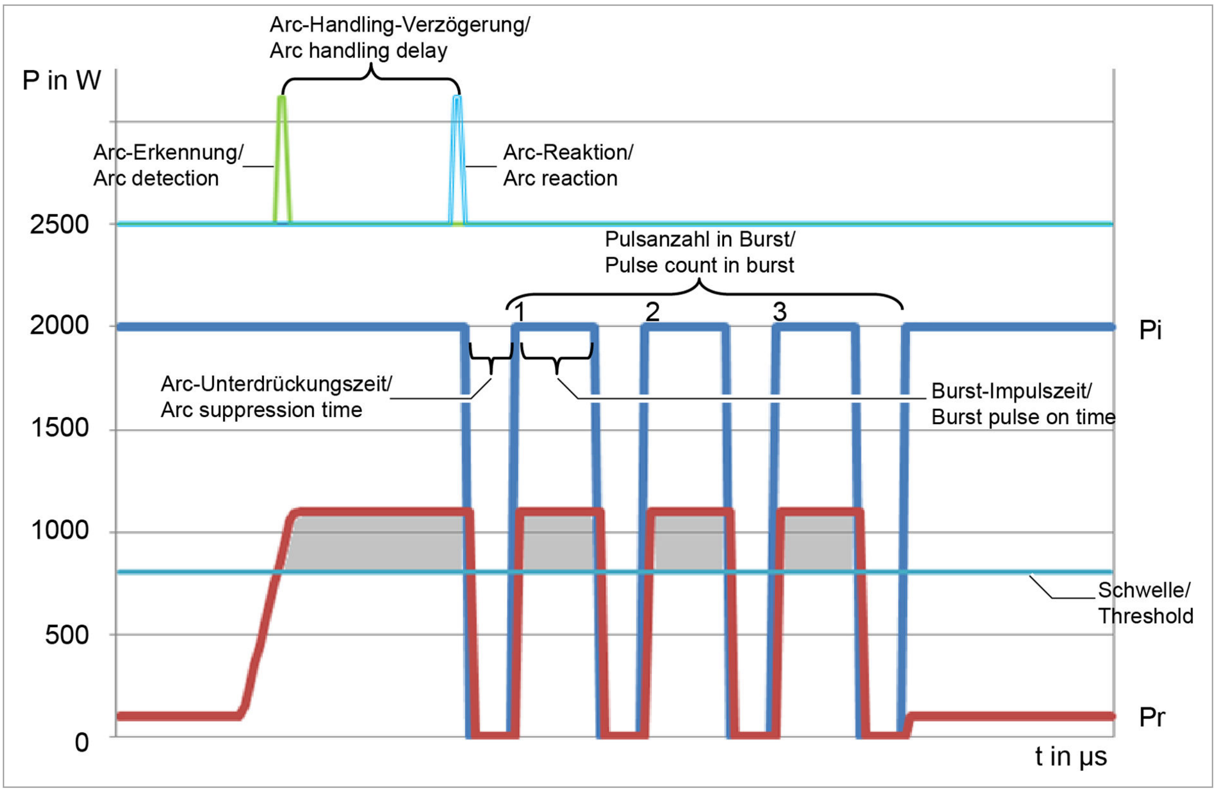
Single pulse

Fig. 10204

16.6 Pulse packet

To extinguish an arc with a defined number of pulses, the following parameters must be set:

- "Pulse count in burst "= number of pulses. Even if 0 is set, the following applies: With active arc handling, a single arc suppression is performed (see "Fig. 10205", pg. 7-54).
- "Arc suppression time "= time in µs.
- "Burst pulse on time "= time in µs.



Pulse packet

Fig. 10205

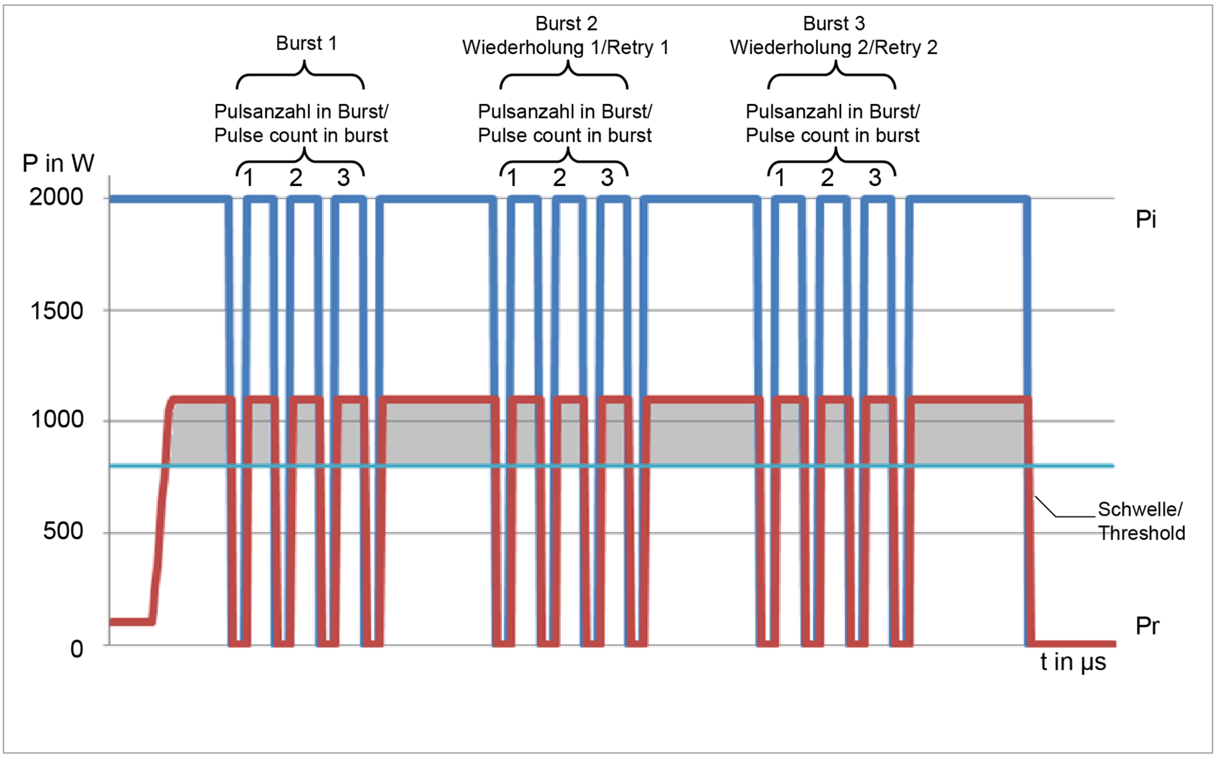
16.7 Limiting repetition of the pulse packet

If an arc cannot be extinguished in spite of pulse packet, the pulse packet is repeated continuously.

To limit the number of repetitions, the "Arc retry count" parameter must be set:

- x = number of pulse packet repetitions (see "Fig. 10206", pg. 7-55).
- 0 = unlimited number of pulse packet repetitions.

If an arc is still present after a defined number of pulse packets, the generator switches off power and generates an alarm message.



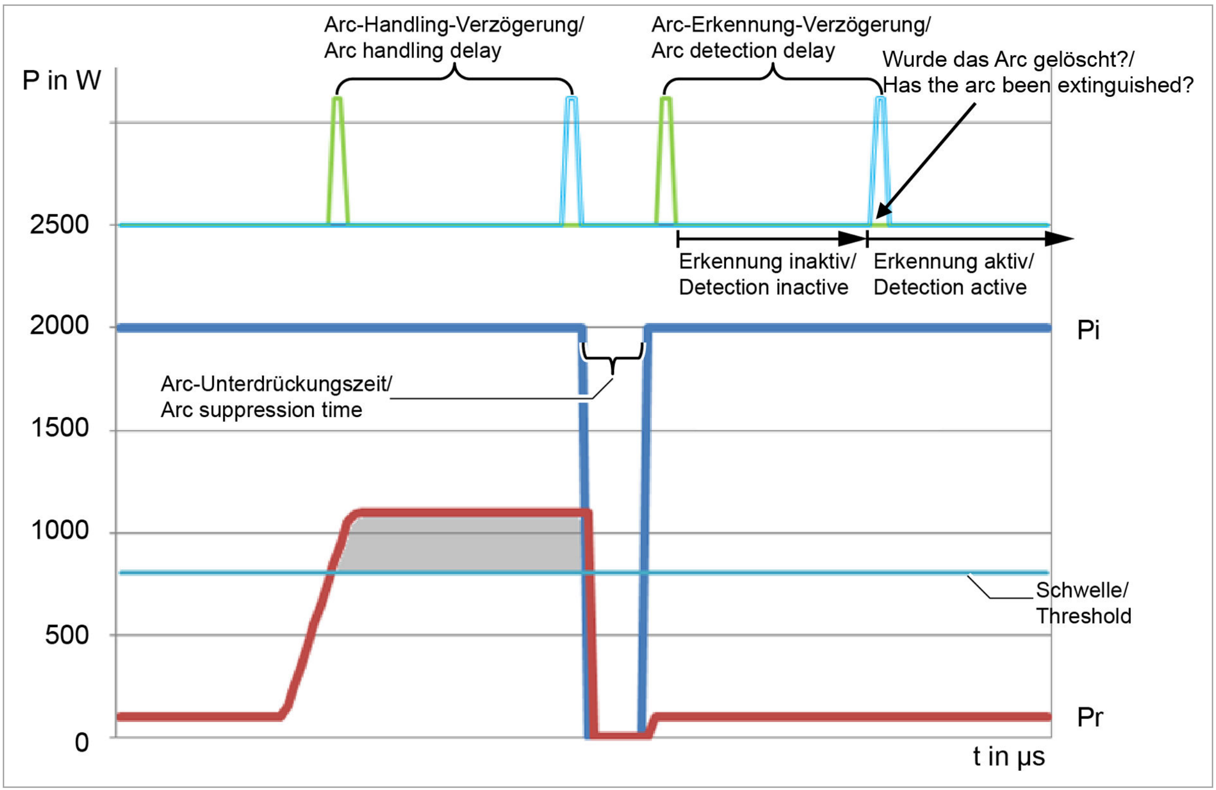
Repetition of pulse packets/retry count = 2

Fig. 10206

16.8 Behavior after an arc

To define the time between power on and reactivation of arc detection following an arc, the following parameter must be set:

- "Arc detection delay" = time in µs (see "Fig. 10207", pg. 7-56).



Arc detection delay (number of burst pulses = 0) Fig. 10207

17. Run-time monitoring (watchdog)

Each active interface is subject to run-time monitoring. If no valid command is transmitted within a specified time (timeout 500 to 30,000 ms), the generator switches off power and generates an alarm message. This prevents the generator from discharging power in an uncontrolled manner should the interface cable be interrupted.

Note

If the generator is controlled via the TruControl Power operating software, set the watchdog time ≥ 2,000 ms.

With a shorter watchdog time, communication via TruControl Power is not stable and connection interruptions will occur.

18. Matchbox operation

NOTICE

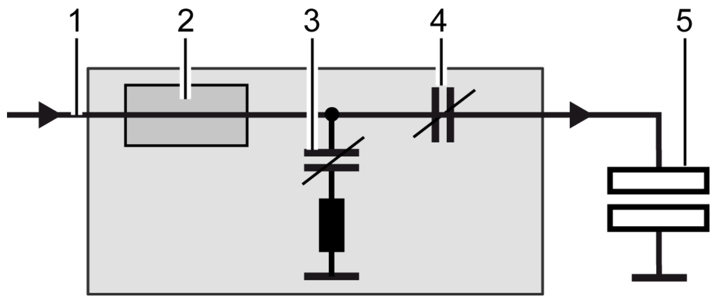
Operation of the matchbox via different interfaces can cause errors.

➢ Do not operate the matchbox simultaneously with TruControl Power and another operating tool.

A matchbox from TRUMPF can be connected to the generator by means of a 25-pin Sub-D cable. The current matchbox measurement values are transmitted to the generator via this cable. The control commands from the generator to the matchbox are likewise transmitted to the matchbox via the Sub-D cable. The matchbox can thereby be directly operated from the generator.

Note

The connected matchbox influences the regulation speed of the generator.



1	Power from the generator	4	Load capacitor
2	Z phi detector	5	Load
3	Tune capacitor		

Schematic diagram of a matchbox — Fig. 10591

For basic matchbox settings: in TruControl Power, select >*Configuration* >*SysPort matchbox*.

For power regulation of the matchbox: in TruControl Power select >*Operation* >*External current voltage regulation*.

Adjustment parameters of the matchbox:

- "Mode" (*Automatic*, *DC-Automatic*, *Recipe Control*).
  - With *Automatic*, the positions of the capacitors automatically adjust to the optimum value. The reflected power Pr is used as regulation parameter.
  - *DC-Automatic* and *Recipe Control*: see operating instructions of the matchbox.
- "Selected matchbox". To use the matchbox: select *1*.
- "Activity control" (*Inactive*, *Active*).

- "Matchbox" (*Start*, *Stop*).
- "Start automatic control" (*Manual*, *Automatic*).
- "Freeze" (*Unfreeze*, *Freeze*).
- "Recipe number" (*0* to *32*).
- ""Plasma-on" position" and "ignition position" of the tune capacitor.
- ""Plasma-on" position" and "ignition position" of the load capacitor.

Measurement values of the matchbox:

- Capacitor positions, "Z" (size of the load-power vector), "phi" (phase angle of the load-power vector), "DC bias", "RF current", "RF voltage".

See also operating instructions of the matchbox.

19. User limit configuration

The user can define limit values for Pi, Pl and Pr that are not exceeded during operation.

Example:

For a generator with 3 kW output power, a limit value of PLmax = 2500 W was set. If a set value of 3000 W is entered, this pre-set value is cut to 2500 W. No alarm or warning message is output. If a value of 10 V is preset via the analog input of the AD interface in order to obtain an output power PL of 100%, the generator discharges 2500 W at the output.

If a limit value is defined by the user that is below the current value, the generator generates a warning message.

Under *AV Pr clamping threshold*, the actual Pr value up to which “0” is displayed at the analog output of the AD interface can also be defined for Pr. With setting 0 W, this function is deactivated.

20. Mixed Mode

If mixed mode is not active, the generator can only be controlled from the **active** interface. Only **one** interface can be active.

In mixed mode, one of the digital interfaces is the main interface (active interface); individual commands can, however, be transmitted via AD interface. These commands are then disabled via the active interface.

Mixed mode can be enabled with the TruControl Power operating software or via serial data transmission.

Possible uses for mixed mode:

- An external voltage on the analog input, e.g., DC bias, set value for Pi, set value for PL, serves as regulation parameter
- Digital output 2 can be configured so that the generator outputs an alarm message in the event of over temperature.
- Other possibilities (see "AD interface", pg. 4-32).

20.1 Activate mixed mode

1. Switch off output power.
2. Select >*Configuration* >*Mixed Mode*.

   or

   ➢ Configure mixed mode via other active interface.
3. Configure, if necessary, inputs and outputs of the AD interface.

1	Analog input	3	Digital inputs
2	Analog outputs	4	Digital outputs

Configure mixed mode Fig. 10660

Description of the inputs and outputs (see "AD interface", pg. 4-32).

4. If analog inputs and analog outputs are used, scale these as necessary (see "Scaling analog inputs and outputs", pg. 7-16).
5. Under "Mixed Interface Mode", select *On* to accept the configuration and activate mixed mode.

21. Factory setting

21.1 Resetting to factory settings

1. Select >*Configuration* >*Device settings*.
2. Press *Factory settings*.
3. Switch generator off and back on again.

All settings made in main menu >*Configuration* are reset to the factory settings.

21.2 Default values

Default values operation

Parameter number dec.	Parameter number hex.	Feature	Value
Power regulation			
6	0x6	Set value of forward power (Pi)	0 W
7	0x7	Set value of load power (PL)	Same as User limit PL
8	0x8	Limit value of reflected power (Pr)	Same as User limit Pr
External current / voltage regulation			
10	0xA	Set value of DC bias (Udc)	0 W
11	0xB	Set value of RF voltage (Urf)	0 W
12	0xC	Set value of RF current (Irf)	0 W
Generic regulation channel			
776	0x308	Limit value	0
Clock and pulse mode			
361	0x169	Clock source	Internal
516	0x204	Clock offset mode	Phase offset
384	0x180	Phase shift	0°
457	0x1C9	Frequency offset	0 kHz
362	0x16A	Pulse mode	Continuous
360	0x168	Pulse source	Internal
658	0x166	Pulse boost	Inactive
456	0x1C8	Measurement delay	0 µs
364	0x16C	Frequency (internal pulse source)	1000 Hz
365	0x16D	Duty cycle (internal pulse source)	50%
596	0x254	Triggered pulse mode	Inactive
597	0x255	Pulse delay (triggered pulse mode)	0 µs
598	0x256	Pulse duration (triggered pulse mode)	10 µs
593	0x251	Simmer mode	Inactive
594	0x252	Low time (simmer mode)	10 µs

Parame-ter num-ber dec.	Parame-ter num-ber hex.	Feature	Value
595	0x253	High time (simmer mode)	1 µs
Regulation characteristic			
454	0x1C6	Soft start	Inactive
455	0x1C7	Regulation mode	Normal
745	0x2E9	Expert settings	70
479	0x1DF	Timer	0 s (timer not active)
644	0x284	Joule mode	Inactive
643	0x283	Joule limit value	0 Ws
Ramp function			
574	0x23E	Ramp mode	Ramp not active
575	0x23F	Ramp unit	Time ramp
463	0x1CF	Set value ramp up	1 ms
464	0x1D0	Set value ramp down	1 ms
372	0x174	Reference input	Pr
Arc management			
504	0x1F8	Arc detection	Inactive
509	0x1FD	Arc reaction	Inactive
496	0x1F0	Maximum Pr to start	10 W
497	0x1F1	Minimum Pi to start	30 W
495	0x1EF	Arc-Management delay	100 ms
507	0x1FB	Detection mode	Pr Threshold
491	0x1EB	Pr limit value	100 W
493	0x1ED	Slope Pr	20 W/µs
492	0x1EC	Threshold Pr/Pi	50%
494	0x1EE	Slope Pr/Pi	50%/µs
498	0x1F2	Number of measurement values	1
523	0x20B	Arc rate warning threshold	0 arc/s
508	0x1FC	Handling mode	Cut arc activeley
501	0x1F5	Arc handling delay	0 µs
502	0x1F6	Arc suppression time	10 µs
500	0x1F4	Burst-pulse-on time	10 µs
506	0x1FA	Arc detection delay	0 µs
503	0x1F7	Pulse count in burst	0
505	0x1F9	Arc retry count	0
Frequency agility			
361	0x169	Source	Internal
516	0x204	Mode	Phase offset
384	0x180	Phase offset	0°
457	0x1C9	Frequency offset	0 kHz
582	0x246	Tuning start offset	0 kHz
584	0x248	Min. tuning offset	-678 kHz
583	0x247	Max. tuning offset	678 kHz
590	0x24E	Modulation deviation	50

Parameter number dec.	Parameter number hex.	Feature	Value
591	0x24F	Rel. mod. deviation	50
587	0x24B	Modulation period	1 µs
588	0x24C	Gain	50
589	0x24D	Rel. gain	50
592	0x250	Pullback to start freq.	0
586	0x24A	Retuning threshold	0
456	0x1C8	Regulation delay	7 µs
585	0x249	Auxillary	0 µs
671	0x29F	Pulse shapping mode	Off
672	0x2A0	Pulse overdrive	0%

Default values operation Tab. 7-6

Default values configuration

Parameter number dec.	Parameter number hex.	Feature	Value
Interfaces			
375	0x177	Mode	RS-232
115	0x73	Watchdog RS-232/RS-485	3000 ms
422	0x1A6	Watchdog service	3000 ms
230	0xE6	DeviceNet Mac-ID	Setting of the rotary switch on the rear side of the generator
231	0xE7	DeviceNet baud rate	
233	0xE9	Produced path	2 (is defined by the DeviceNet stack)
234	0xEA	Consumed path	1 (is defined by the DeviceNet stack)
670	0x29E	DNET regulation mode for path 1+2	Forward power
Limit values			
600	0x258	User limit Pi	3-kW generator: 3000 W 6-kW generator: 6000 W
601	0x259	User limit PL	3-kW generator: 3000 W 6-kW generator: 6000 W
602	0x25A	User limit Pr	With 3-kW generator: 600 W With 6-kW generator: 1200 W
795	0x31B	AV Pr clamping threshold	0 W
Mixed mode			
636	0x27C	Mode	Off
657	0x291	Analog input function	Power setpoint

Parame-ter num-ber dec.	Parame-ter num-ber hex.	Feature	Value
638	0x27E	Active analog outputs	Output 1 active Output 2 active Output 3 active
639	0x27F	Active digital inputs	Input 0 active Input 1 active Input 2 active Input 3 active
640	0x280	Active digital outputs	Output 0 active Output 1 active Output 2 active
797	0x31D	DO 2 Alarm	Temperature error
Analog I/O scaling			
655	0x28F	GRC	1
570	0x23A	Pi/PL	Nominal power acc. to specification (see "RF output", pg. 3-3)
571	0x23B	Pi	
572	0x23C	PL	
573	0x23D	Pr	
576	0x240	Analog limit	10 mV
796	0x242	Analog output voltage filter	Inactive
Matchbox			
434	0x1B2	Mode	Automatic
703	0x2BF	Selected matchbox	0
704	0x2C0	Activity control	Active
705	0x2C1	Matchbox operation	Start
706	0x2C2	Start automatic control	Automatic
707	0x2C3	Freeze	Off
708	0x2C4	Recipe number	0
432	0x1B0	"Plasma-on" position of tune capacitor	500
430	0x1AE	Ignition position of tune capacitor	500
433	0x1B1	"Plasma-on" position of load capacitor	500
431	0x1AF	Ignition position of load capacitor	500

Default values configuration Tab. 7-7

22. Time synchronization

The time used within the generator is UTC time. UTC stands for Universal Time Clock and is also frequently referred to as Greenwich Mean Time.

The operating panel on the generator also uses UTC time. The UTC time can be set via the operating panel.

In TruControl Power, the local time is used. All time stamps, e.g., for the warning messages, are given in local time. With the aid of time synchronization, the local time of the computer is transferred to TruControl Power and the UTC time automatically calculated.

During the summer in Central Europe (CET), the local time may differ from the UTC time, e.g., by 2 hours, due to daylight savings time.

22.1 Synchronizing time

1. Select >*Configuration* >*Time synchronization*.
2. To transfer the local time from the computer to the generator: press *Time synchronization*.

   The current local time is displayed under "Device time".

23. Diagnostics

Pending messages, a message history, temperatures, operating time and values for identifying the generator can be displayed in TruControl Power.

23.1 Displaying messages in TruControl Power

Displaying current messages

1. Select >*Diagnostics* >*Pending messages*.

   The currently pending messages are displayed.

2. To display additional information about a message: double-click on the message.
3. To save the current messages to a CSV file: press *Save*.
4. To reset the current messages on the generator: press *Reset*.

Displaying the message history

5. Select >*Diagnostics* >*Message history*.

   The last 1000 messages are displayed in a list.

6. To display or hide the messages according to message type: select or deselect the checkbox in front of the symbols for alarm, warning or information.

Zeitstempel	Id	Typ	Beschreibung	Module-Id	Zusätzliche Informationen
2014-01-29 08:35:38	1111		Errorcode: 457	25	1
2014-01-29 08:35:38	1116		Errorcode: 45c	25	6
2014-01-29 08:35:38	1117		Errorcode: 45d	25	7

Message history with alarm messages; warning messages and information are hidden from view Fig. 10113

7. To display additional information about a message: double-click on the message.
8. To update the message history: press *Update*.
9. To save the message history to a CSV file: press *Save*.

Tip

If malfunctions occur, it is helpful if you send the CSV files with the current message and the message history to our service employees via e-mail. Using the message numbers, malfunctions can be traced and rectified more quickly.

23.2 Monitoring

Displaying the temperature

➢ Select >*Diagnostics* >*Monitoring*.

The values of the temperature sensors are displayed under "Temperature".

Displaying the operating time

➢ Select >*Diagnostics* >*Monitoring*.

The operating times are displayed under "Operating time".

Generator on: time span during which the generator was switched on.

Power on: time span during which the generator delivered power.

23.3 Identification

Displaying identification

➢ Select >*Diagnostics* >*Identification*.

All important values on the topic of generator identification are displayed: device ID, version, serial number and integration level, other hardware and software versions of individual components as well as the configuration word.

The configuration word can only be displayed in TruControl Power.

24. Data logging

Note

This function is not available on the operating panel.

24.1 Performing trending

1. Select >*Data Logging* >*Trending*.
2. Under "Channel", select a signal from the drop-down list.
3. To start the display of signals: press *Start* under "Trending options".
4. To stop the display of the signals: press *Stop* under "Trending options".
5. Set the desired sampling interval under "Interval".
6. To specify a recording time:
   - Activate Limit under "Trending options".
   - Enter the time in the following format: hours:minutes:seconds.
   - Press *Start*.

   The signals are recorded during the specified recording time. Displayed under "Remaining" is how much longer recording will be performed.
7. To change the display of the curves, under "Plotter options":
   - Activate/deactivate "Show sampling points".
   - Activate/deactivate "Show lines".
   - Press *View*.
8. To shift the curves:
   - Under "Plotter options", press *Scaling cor.*
   - Under "Channel", set the "Gain" and the "Offset".
9. To save the recorded data in a CSV file: press *Save* under "Plotter options".

Tip

Before changing the channel settings: save the data of the running recording as CSV file. Otherwise, the previously recorded data is lost.

24.2 Setting trigger conditions for oscilloscope

1. Select >*Data logging* >*Configuration*.

2. To start trigger monitoring every time an alarm occurs: activate "Triggering on every alarm".
3. Set the desired sampling interval under "Interval".

24.3 Operating the oscilloscope

1. Select *>Data logging >Oscilloscope*.
2. Under "Channel", select a signal from the drop-down list.
3. To start the display of the signals: press *Activate* under "Trigger".

   The button is highlighted and the text changes to *Deactivate*.

   The trigger state changes from *Deactivated* to *Wait for trigger*. As soon as the trigger conditions are satisfied, Triggered is displayed. The data is captured by the generator and transferred to TruControl Power; *Transferring data* is displayed. The transferred data is then displayed on the screen.
4. To stop display of the signals: press *Deactivate* under "Trigger".

   The trigger state changes to *Deactivated*.

   The data record is deleted and can no longer be displayed in TruControl Power.
5. To change the display of the curves, under "Plotter options":
   - Activate/deactivate "Show sampling points".
   - Activate/deactivate "Show lines".
   - Press *View*.
6. To shift the curves:
   - Under "Plotter options", press *Scaling cor.*
   - Under "Channel", set "Gain" and "Offset".
7. To save the recorded data in a CSV file: press *Save* under "Plotter options".

Chapter 8

Maintenance

1. Maintenance work

1.1 Performing software updates

Software updates can be performed via the RS-232 service interface.

➢ Only have software updates for the generator performed by TRUMPF personnel.

1.2 Checking cooling water circuit

➢ Regularly check all connected water lines for wear and tear and aging.

1.3 Cooling water parameter

Check cooling water for the following cooling water parameters.

Parameter		Unit	Limit value (Cu cooling circuit)
pH-value		—	6 to 9
Conductivity range		µS/cm	(see "Cooling requirements", pg. 3-16)
Iron		mg/l	< 0.5
Copper		mg/l	< 0.2
Microbiology:	Colony count	KBE/ml	< 1000
	Sulfate reducer	—	Not detectable
Suspended solids		—	Not detectable

Requirements for the cooling water Tab. 8-1

If the inspection reveals deviations from the specified cooling water parameters, the cooling water must be topped up with fresh water and the appropriate apportionment of corrosion inhibitor with the following quality:

Parameter	Unit	Limit value
Conductivity	µS/cm	< 20
Microbiology	KBE/ml	< 100

Cooling water parameters for additional water Tab. 8-2

Cooling water additives for the chemical treatment of additional water and cooling water

Description	Apportionment
Copper corrosion inhibitor for closed systems	Water Care-Copper For concentration, see Easy-Kits Cu
Copper corrosion inhibitor for open systems	Use suitable copper corrosion inhibitor.
Oxidizing biocides (halogens)	< 0.3 mg/l (as Cl2), only in combination with copper corrosion inhibitor

Cooling water additives for the chemical treatment of additional water and cooling water Tab. 8-3

1.4 Utilization and apportionment

Cooling water additives are used for:

- Commissioning of the cooling water circuits with new systems.
- Maintenance of the cooling water circuits.
- Topping up cooling water.

NOTICE

Corrosion and microbial contamination of the cooling water circuits!

Damage to generators and systems.

- ➢ Use fresh, clean, demineralized water only.
- ➢ Flush cooling water circuits thoroughly after cleaning.
- ➢ Do not operate cooling water circuits without anticorrosive agents.
- ➢ Do not use biocide on a continuous basis, but only for cleaning.

Apportionment with Easy-Kits

Apportionment with Easy-Kits is accomplished by the bottle. That is the reason that the sizes and the filling volumes of the bottles in the various Easy-Kits are different.

- Use the correct Easy-Kit, based on the cooling water circuit (Cu) and on the water volume.
- Bottle with biocide (red):

  Use for the cleaning cycle. Open the bottle and carefully add the entire contents to the tank of the cooling water circuit. Circulate the cooling water immediately.
- Bottle with anticorrosive agent (Cu = yellow):

  Use after the water has been replaced and the tank is filled with fresh cooling water. Open the bottle and carefully add the entire contents to the tank of the cooling water circuit. Circulate water immediately.

1.5 Cleaning and care

Closed system

- The inspection interval of the cooling water should be approximately 6 months. The test parameters are:
  - Clear appearance, without suspended solids.
  - No odor - perhaps slightly of copper inhibitor.
  - pH-value.
  - Conductivity.
  - Colony count.
  - In the case of abnormalities, have a sample of the cooling water analyzed.

Every 12 months

- The cooling circuit must be cleaned and the cooling water replaced once per year.
- If the limit values of the test parameters were exceeded at the inspection interval, the cooling circuit is to be cleaned and the cooling water replaced.

Open system

- Cleaning and care should be performed in accordance with directives or standards VDI 6022, DIN 3803 or other valid, legal specifications.

Disposal

- The local and national wastewater regulations at the installation site of the generator must be adhered to during disposal of the cooling water.

1.6 Overview of cooling water additives

Cooling water additives	**Water Care-Copper**	**STABREX ST40** **STABREX ST70** **STABREX ST70 FOR KITS** **NALCO 93033B** **NALCO 93033**
Function	Anticorrosive agent for copper parts	Biocide
Where to use them?	In copper cooling circuit	In copper cooling circuit
When to use them?	Continuously in operation	During the cleaning cycle for 2 hours
Color code	Yellow	Red
—	Easy-Kit Material number for reordering	

Cooling water additives	**Water Care-Copper**			**STABREX ST40** **STABREX ST70** **STABREX ST70 FOR KITS** **NALCO 93033B** **NALCO 93033**	
—	Standard	USA	Canada	Belgium	Netherlands
Easy-Kit Cu-1 (5 … 14 l)	1652981	1652991	1652992	1652993	1652994
Easy-Kit Cu-2 (15 … 49 l)	1652995	1653088	1653089	1653090	1653111
Easy-Kit Cu-3 (50 … 119 l)	1653112	1653113	1653114	1653119	1653120
Easy-Kit Cu-4 (120 … 359 l)	1653107	1653108	1653109	1653130	1653131
Easy-Kit Cu-5 (360 … 999 l)	1653132	1653124	1653125	1653126	1653127
Apportionment	By the bottle: The entire contents of the bottle are poured into the tank.				

Overview of cooling water additives Tab. 8-4

Chapter 9

Troubleshooting

1. Warning and alarm messages

Fault indication

The "ALARM" LED on the control unit indicates whether a fault has occurred.

Alarm message

In case of severe faults, power output is automatically interrupted and an alarm message is issued. Power operation can only be restarted after the cause of the alarm has been removed and the alarm message has been reset.

Warning message

In case of less severe faults, the power operation is not interrupted, but a warning message is issued.

Display of alarm and warning messages

The messages that are output always consists of an alarm or warning number and a message text.

When operating the generator with the control unit or TruControl Power, the alarm and warning numbers are displayed together with the message text. In case of serial data transmission, only the numbers and no text are transmitted.

Resetting alarm and warning messages

Several options are available for resetting alarm or warning messages:

- If the generator is controlled by means of the **Control unit**, the alarm and warning messages can be reset with the *Reset* button.
- If the generator is controlled by means of the **TruControl Power** operating software, the alarm and warning messages can be reset with the *Reset* button.
- If the generator is controlled via **serial data transmission**, the reset command will delete alarm and warning messages.
- If the generator is controlled via **AD interface**, the "Reset message" signal causes the alarm and warning messages to be deleted at the corresponding pins.

List of alarm and warning messages

The following tables show the most important alarm and warning messages, with notes on error causes and how to correct them.

If a message reappears repeatedly after resetting and restarting the generator, please contact TRUMPF Service.

2. Messages

Dec. no.	Hex. no.	Type 32	Message texts	Effect	Cause	Measure
17002	426A	A	Invalid error number.	—	Missing error number (not defined yet).	—
17003	426B	A	NULL pointer assignment.	—	Uninitialized pointer in software.	—
17004	426C	A	Software initialization error.	—	Runtime problems during initialization or defective hardware.	—
17005	426D	A	Initialization error error handler.	—	Runtime problems during initialization or defective hardware.	—
17006	426E	A	Initialization error error control.	—	Runtime problems during initialization or defective hardware.	—
17007	426F	A	Initialization error timer control.	—	Runtime problems during initialization or defective hardware.	—
17008	4270	A	Initialization error ESPIIO.	—	Runtime problems during initialization or defective hardware.	—
17009	4271	A	Initialization error DSP1.	—	Runtime problems during initialization or defective hardware.	—
17010	4272	A	Initialization error DSP2.	—	Runtime problems during initialization or defective hardware.	—
17011	4273	A	Initialization error parameter.	—	Runtime problems during initialization or defective hardware.	—
17017	4279	A	Parameter error.	—	Unknown parameter or parameter not initialized.	—
17018	427A	A	Timeout.	—	Error code prepared for future use.	—
17019	427B	A	Reset by hardware watchdog occured.	—	Error code prepared for future use.	—
18001	4651	A	RAM error.	—	Error code prepared for future use.	—
18002	4652	A	Checksum error ROM.	—	Error code prepared for future use.	—

32 Message type: A = Alarm, W = Warning, I = Information.

Dec. no.	Hex. no.	Type [32]	Message texts	Effect	Cause	Measure
18003	4653	A	Error CPLD.	—	Error code prepared for future use.	—
18004	4654	A	DSP error.	—	Error code prepared for future use.	—
18005	4655	A	EEPROM check-sum error.	—	Wrong checksum when reading EEPROM page. Maybe uninitialized.	—
18006	4656	A	EEPROM verifi-cation error.	—	EEPROM page faulty after writing.	—
18007	4657	A	Customer inter-face watchdog event.	—	No valid protocol frame within the set watchdog time for customer interface.	—
18008	4658	A	Service interface watchdog event.	—	No valid protocol frame within the set watchdog time for service interface.	—
18009	4659	A	Serial interface can not be initial-ized.	Serial interface does not work properly.	Serial interface is disabled or hardware is defect.	—
18012	465C	A	CANopen bus overrun.	—	Too high traffic on internal can bus.	—
18013	465D	A	CANopen PDO length.	—	Definition of process data object of inter-nal can bus is faulty.	—
18017	4661	A	CANopen stack initialization faulty.	—	Wrong parameters are used while initi-alizing the CANopen stack.	—
19000	4A38	A	Value exceeded upper limit.	—	Value acceded the upper error limit.	—
20000	4E20	A	Value underran lower limit.	—	Value underran the lower error limit.	—
21000	5208	A	Internal error.	—	Error code prepared for future use.	—
24000	5DC0	A	Interlock voltage error.	—	Voltage supply for interlock broken, or RF cable not con-nected.	—
24001	5DC1	A	Interlock open error.	—	Customer interlock is opened.	—
24002	5DC2	A	Mains was switched off while rf was still on.	—	Interface unit has detected low voltage on mains during rf on.	—
24016	5DD0	A	DeviceNet slave reset.	—	DeviceNet slave applikation has been reset.	—
24017	5DD1	A	DeviceNet bus sense error.	—	Power was lost through DevcieNet bus connector.	—

32 Message type: A = Alarm, W = Warning, I = Information.

Dec. no.	Hex. no.	Type [32]	Message texts	Effect	Cause	Measure
24018	5DD2	A	DeviceNet duplicate MAC-ID error.	—	Duplicate MAC ID check failed.	—
24019	5DD3	A	DeviceNet Rx queue overrun.	—	The interface unit did not empty the receive queue in time.	—
24020	5DD4	A	DeviceNet Tx queue overrun.	—	The can controller did not send the data in time.	—
24021	5DD5	A	DeviceNet I/O send error.	—	I/O message could not be sent.	—
24022	5DD6	A	DeviceNet CAN bus off event.	—	There were to many transmission errors on the bus.	—
24023	5DD7	A	DeviceNet CAN bus overrun.	—	The can register was written twice before it was cleared.	—
24024	5DD8	A	DN - CAN Tx passive or Rx passive.	DeviceNet communication can not be established.	No other CAN node available.	—
24575	5FFF	A	Power module system error.	—	Error code prepared for future use.	—
24576	6000	A	Power module error.	—	Supplemental error message from control unit.	—
24577	6001	A	Power module mains voltage fault.	—	Control unit has detected low voltage on mains.	—
24578	6002	A	Power module mains line fault.	—	Phase missing on mains voltage.	—
24579	6003	A	Masterclock conditions out of range.	—	Clock signal for generator frequency is outside the specified range.	—
24580	6004	A	Temperature of cooling plate 1 is out of range.	—	Generator temperature is out of the allowed range.	—
24581	6005	A	Temperature of cooling plate 2 is out of range.	—	Generator temperature is out of the allowed range.	—
24582	6006	A	Temperature of ambient air is out of range.	—	Generator temperature is out of the allowed range.	—
24583	6007	A	Temperature of temperature control is out of range.	—	Generator temperature is out of the allowed range.	—

32 Message type: A = Alarm, W = Warning, I = Information.

Dec. no.	Hex. no.	Type [32]	Message texts	Effect	Cause	Measure
24584	6008	A	Temperature of RF-Detector is out of range.	—	Generator temperature is out of the allowed range.	—
24585	6009	A	Power module ADC gain error.	—	Calibration is faulty.	—
24586	600A	A	Power module ADC offset error.	—	Calibration of internal meassurement tool faulty.	—
24587	600B	A	Power module general controller error.	—	Error code prepared for future use.	—
24588	600C	A	System not ready.	—	Error code prepared for future use.	—
24589	600D	A	Pulse conditions out of range.	—	External attached pulse source is outside the specified range.	—
24590	600E	A	RF module not calibrated.	—	Calibration of generator faulty or not done.	—
24591	600F	A	RF clock not synchronised.	—	External clock input could not be synchronised to the output sygnal.	—
24592	6010	A	Control unit detects interlock.	—	Supplemental interlock message of control unit.	—
24593	6011	A	Error reading digital inputs on analog interface.	—	The data read from the analog interface where faulty.	—
24594	6012	A	RF switched OFF due to Arc Management settings.	—	FPGA reports an error in ARC management.	—
24595	6013	A	Analog RF pin is still on while control interface has been changed.	RF is switched off.	—	—
24596	6014	A	Can not switch RF on because Analog RF pin is low.	—	RFon is not cleared by the analog interface.	—
24597	6015	A	Plausibility check in DSP fails.	—	Internal supply voltage is not matching the desired output power.	—
24598	6016	A	DSP reports a problem initialising canbus.	—	CANbus stack starts up with a wrong initialization.	—
24599	6017	A	DSP reports a problem with the EtherCAT module.	—	DSP can't access the process data objects.	—

32 Message type: A = Alarm, W = Warning, I = Information.

Dec. no.	Hex. no.	Type [32]	Message texts	Effect	Cause	Measure
24600	6018	A	Gate synchronisation failed.	—	RF output frequency is not synchronised with clock input.	—
24601	6019	A	Extension temperature sensor 1 out of range.	—	Generator temperature is out of the allowed range.	—
24602	601A	A	Extension temperature sensor 2 out of range.	—	Generator temperature is out of the allowed range.	—
24603	601B	A	EtherCAT module error is detected.	—	Control unit got error events from the EtherCAT stack on the module.	—
24604	601C	A	Fatal error in EtherCAT module is detected. Module is to be reset.	—	EtherCAT module has an unsolvable error and has been hard reset.	—
24605	601D	A	Error in HVPS module 1.	—	Temperature error is detected.	—
24606	601E	A	Error in HVPS module 2.	—	Temperature error is detected.	—
24607	601F	A	Temperature sensor of HVPS ambient air is defective.	—	Value not feasible. Sensor error is detected by control module.	—
24608	6020	A	Temperature sensor of HVPS cooling plate 1 is defective.	—	Value not feasible. Sensor error is detected by control module.	—
24609	6021	A	Temperature sensor of HVPS cooling plate 2 is defective.	—	Value not feasible. Sensor error is detected by control module.	—
24610	6022	A	Temperature sensor of HVPS DC Module 1 is defective.	—	Value not feasible. Sensor error is detected by control module.	—
24611	6023	A	Temperature sensor of HVPS DC Module 2 is defective.	—	Value not feasible. Sensor error is detected by control module.	—
24612	6024	A	Temperature sensor of HVPS DC Module 3 is defective.	—	Value not feasible. Sensor error is detected by control module.	—
24613	6025	A	Temperature of HVPS ambient air is out of range.	—	Temperature error is detected by power module.	—
24614	6026	A	Temperature of HVPS cooling plate 1 is out of range.	—	Temperature error is detected by power module.	—

32 Message type: A = Alarm, W = Warning, I = Information.

Dec. no.	Hex. no.	Type [32]	Message texts	Effect	Cause	Measure
24615	6027	A	Temperature of HVPS cooling plate 2 is out of range.	—	Temperature error is detected by power module.	—
24616	6028	A	Temperature of HVPS DC Mod-ule 1 is out of range.	—	Temperature error is detected by power module.	—
24617	6029	A	Temperature of HVPS DC Mod-ule 2 is out of range.	—	Temperature error is detected by power module.	—
24618	602A	A	Temperature of HVPS DC Mod-ule 3 is out of range.	—	Temperature error is detected by power module.	—
24619	602B	A	Number of HVPS Module is invalid.	—	Inconsistant module numer is detected.	—
24620	602C	A	DC Alarm.	—	Power module detected DC alarm in HPVS module.	—
24621	602D	A	Temperature of control is out of range.	—	Power module detected temperature alarm.	—
24622	602E	A	Temperature of RF-Detector is out of range.	—	Power module detected temperature alarm.	—
24623	602F	A	Temperature of ambient air is out of range.	—	Power module detected temperature alarm.	—
24624	6030	A	Temperature of cooling plate 1 is out of range.	—	Power module detected temperature alarm.	—
24625	6031	A	Temperature of cooling plate 2 is out of range.	—	Power module detected temperature alarm.	—
24626	6032	A	HVPS Module 1: Temperature of ambient air is out of range.	—	Power module detected temperature alarm.	—
24627	6033	A	HVPS Module 1: Temperature of cooling plate 1 is out of range.	—	Power module detected temperature alarm.	—
24628	6034	A	HVPS Module 1: Temperature of cooling plate 2 is out of range.	—	Power module detected temperature alarm.	—
24629	6035	A	HVPS Module 1: Temperature of DC Module 1 is out of range.	—	Power module detected temperature alarm.	—

32 Message type: A = Alarm, W = Warning, I = Information.

Dec. no.	Hex. no.	Type [32]	Message texts	Effect	Cause	Measure
24630	6036	A	HVPS Module 1: Temperature of DC Module 2 is out of range.	—	Power module detected temperature alarm.	—
24631	6037	A	HVPS Module 1: Temperature of DC Module 3 is out of range.	—	Power module detected temperature alarm.	—
24632	6038	A	HVPS Module 2: Temperature of ambient air is out of range.	—	Power module detected temperature alarm.	—
24633	6039	A	HVPS Module 2: Temperature of cooling plate 1 is out of range.	—	Power module detected temperature alarm.	—
24634	603A	A	HVPS Module 2: Temperature of cooling plate 2 is out of range.	—	Power module detected temperature alarm.	—
24635	603B	A	HVPS Module 2: Temperature of DC Module 1 is out of range.	—	Power module detected temperature alarm.	—
24636	603C	A	HVPS Module 2: Temperature of DC Module 2 is out of range.	—	Power module detected temperature alarm.	—
24637	603D	A	HVPS Module 2: Temperature of DC Module 3 is out of range.	—	Power module detected temperature alarm.	—
24638	603E	A	EtherCAT module can't be initialized properly. Profile data is missing	EtherCAT communication is stopped	EtherCAT Profile is missing, or device configuration data is incorrect.	—
24640	6040	A	Error not in use.	—	—	—
24641	6041	A	DC module firmware fault.	DC module may not work.	DC may have wrong firmware.	—
24642	6042	A	Error not in use (Regulation unit error bit 12/31).	—	—	—
24643	6043	A	Plausibility error type 2.	DC module may not work properly.	Power module detected alarm.	—
24656	6050	A	HVPS Module 1: EEPROM Checksum does not match	—	Power module detected alarm	—
24657	6051	A	HVPS Module 1: EEPROM access denied	—	Power module detected alarm	—

32 Message type: A = Alarm, W = Warning, I = Information.

Dec. no.	Hex. no.	Type [32]	Message texts	Effect	Cause	Measure
24658	6052	A	HVPS Module 1: AC line voltage too low	—	Power module detected alarm	—
24659	6053	A	HVPS Module 1: AC line voltage too high	—	Power module detected alarm	—
24660	6054	A	HVPS Module 1: U800 voltage too low	—	Power module detected alarm	—
24661	6055	A	HVPS Module 1: U800 voltage too high	—	Power module detected alarm	—
24662	6056	A	HVPS Module 1: U800_init voltage too high	—	Power module detected alarm	—
24663	6057	A	HVPS Module 1: Communication between master and slave got lost	—	Power module detected alarm	—
24664	6058	A	HVPS Module 1: Communication lost with host	—	Power module detected alarm	—
24665	6059	A	HVPS Module 1: Ambient tempera-ture above the alarm limit	—	Power module detected alarm	—
24666	605A	A	HVPS Module 1: Cooling plate 1 temperature above the alarm limit	—	Power module detected alarm	—
24667	605B	A	HVPS Module 1: Cooling plate 2 temperature above the alarm limit	—	Power module detected alarm	—
24668	605C	A	HVPS Module 1: DC module 1 temperature above the alarm limit	—	Power module detected alarm	—
24669	605D	A	HVPS Module 1: DC module 2 temperature above the alarm limit	—	Power module detected alarm	—
24670	605E	A	HVPS Module 1: DC module 3 temperature above the alarm limit	—	Power module detected alarm	—

32 Message type: A = Alarm, W = Warning, I = Information.

Dec. no.	Hex. no.	Type [32]	Message texts	Effect	Cause	Measure
24671	605F	A	HVPS Module 1: IPS 6V PREDRV failed	—	Power module detected alarm	—
24672	6060	A	HVPS Module 1: IPS +6V MEAS failed	—	Power module detected alarm	—
24673	6061	A	HVPS Module 1: IPS -6V MEAS failed	—	Power module detected alarm	—
24674	6062	A	HVPS Module 1: IPS 24V W failed	—	Power module detected alarm	—
24675	6063	A	HVPS Module 1: IPS 24V CI failed	—	Power module detected alarm	—
24676	6064	A	HVPS Module 1: IPS 15V Heat failed	—	Power module detected alarm	—
24677	6065	A	HVPS Module 1: IPS 9V INT failed	—	Power module detected alarm	—
24678	6066	A	HVPS Module 1: IPS 4V UC failed	—	Power module detected alarm	—
24679	6067	A	HVPS Module 1: IPS 10.5-1 (GPS) failed	—	Power module detected alarm	—
24680	6068	A	HVPS Module 1: IPS 10.5-2 (GPS) failed	—	Power module detected alarm	—
24681	6069	A	HVPS Module 1: IPS 10.5-3 (GPS) failed	—	Power module detected alarm	—
24682	606A	A	HVPS Module 1: IPS 10.5-4 (GPS) failed	—	Power module detected alarm	—
24683	606B	A	HVPS Module 1: Umains 50% sag detected	—	Power module detected alarm	—
24684	606C	A	HVPS Module 1: Umains 70% sag detected	—	Power module detected alarm	—
24685	606D	A	HVPS Module 1: Umains 80% sag detected	—	Power module detected alarm	—
24686	606E	A	HVPS Module 1: Umains 85% sag detected	—	Power module detected alarm	—
24687	606F	A	HVPS Module 2: EEPROM Check-sum does not match	—	Power module detected alarm	—
24688	6070	A	HVPS Module 2: EEPROM access denied	—	Power module detected alarm	—

32 Message type: A = Alarm, W = Warning, I = Information.

Dec. no.	Hex. no.	Type [32]	Message texts	Effect	Cause	Measure
24689	6071	A	HVPS Module 2: AC line voltage too low	—	Power module detected alarm	—
24690	6072	A	HVPS Module 2: AC line voltage too high	—	Power module detected alarm	—
24691	6073	A	HVPS Module 2: U800 voltage too low	—	Power module detected alarm	—
24692	6074	A	HVPS Module 2: U800 voltage too high	—	Power module detected alarm	—
24693	6075	A	HVPS Module 2: U800_init voltage too high	—	Power module detected alarm	—
24694	6076	A	HVPS Module 2: Communication between master and slave got lost	—	Power module detected alarm	—
24695	6077	A	HVPS Module 2: Communication lost with host	—	Power module detected alarm	—
24696	6078	A	HVPS Module 2: Ambient tempera-ture above the alarm limit	—	Power module detected alarm	—
24697	6079	A	HVPS Module 2: Cooling plate 1 temperature above the alarm limit	—	Power module detected alarm	—
24698	607A	A	HVPS Module 2: Cooling plate 2 temperature above the alarm limit	—	Power module detected alarm	—
24699	607B	A	HVPS Module 2: DC module 1 temperature above the alarm limit	—	Power module detected alarm	—
24700	607C	A	HVPS Module 2: DC module 2 temperature above the alarm limit	—	Power module detected alarm	—
24701	607D	A	HVPS Module 2: DC module 3 temperature above the alarm limit	—	Power module detected alarm	—

32 Message type: A = Alarm, W = Warning, I = Information.

Dec. no.	Hex. no.	Type [32]	Message texts	Effect	Cause	Measure
24702	607E	A	HVPS Module 2: IPS 6V PREDRV failed	—	Power module detected alarm	—
24703	607F	A	HVPS Module 2: IPS +6V MEAS failed	—	Power module detected alarm	—
24704	6080	A	HVPS Module 2: IPS -6V MEAS failed	—	Power module detected alarm	—
24705	6081	A	HVPS Module 2: IPS 24V W failed	—	Power module detected alarm	—
24706	6082	A	HVPS Module 2: IPS 24V CI failed	—	Power module detected alarm	—
24707	6083	A	HVPS Module 2: IPS 15V Heat failed	—	Power module detected alarm	—
24708	6084	A	HVPS Module 2: IPS 9V INT failed	—	Power module detected alarm	—
24709	6085	A	HVPS Module 2: IPS 4V UC failed	—	Power module detected alarm	—
24710	6086	A	HVPS Module 2: IPS 10.5-1 (GPS) failed	—	Power module detected alarm	—
24711	6087	A	HVPS Module 2: IPS 10.5-2 (GPS) failed	—	Power module detected alarm	—
24712	6088	A	HVPS Module 2: IPS 10.5-3 (GPS) failed	—	Power module detected alarm	—
24713	6089	A	HVPS Module 2: IPS 10.5-4 (GPS) failed	—	Power module detected alarm	—
24714	608A	A	HVPS Module 2: Umains 50% sag detected	—	Power module detected alarm	—
24715	608B	A	HVPS Module 2: Umains 70% sag detected	—	Power module detected alarm	—
24716	608C	A	HVPS Module 2: Umains 80% sag detected	—	Power module detected alarm	—
24717	608D	A	HVPS Module 2: Umains 85% sag detected	—	Power module detected alarm	—
24718	608E	A	Current imbalance 1	—	Power module detected alarm	—
24719	608F	A	Current imbalance 2	—	Power module detected alarm	—
24720	6090	A	Internal Communication to DC-Supply is faulty	—	Power module detected alarm	—

32 Message type: A = Alarm, W = Warning, I = Information.

Dec. no.	Hex. no.	Type 32	Message texts	Effect	Cause	Measure
24721	6091	A	Regulation fault	—	Power module detected alarm	—
24722	6092	A	Critical impe-dance	—	Power module detected alarm	—
24750	60AE	A	SystemPORT matchbox alarm.	—	Check SystemPORT matchbox state.	—
24751	60AF	A	Invalid System-PORT matchbox selected.	—	Check SystemPORT matchbox selection.	—
24752	60B0	A	Communication error on SysPORT.	—	Check SystemPORT connection to match-box.	—
24968	6188	A	Fatal internal error occured.	MPC has opened the interlock.	In case of customer safety the RF is switched off and the generator must have a mains cycle.	—
24969	6189	A	CANopen Bus sense error - severe system error.	—	In case of customer safety the RF is switched off and the generator must have a mains cycle.	—
24970	618A	A	CANopen Bus off event - severe system error.	—	In case of customer safety the RF is switched off and the generator must have a mains cycle.	—
24971	618B	A	CANopen Bus error status - severe system error.	—	In case of customer safety the RF is switched off and the generator must have a mains cycle.	—
24972	618C	A	CANopen guard fail slave - severe system error.	—	In case of customer safety the the RF is switched off and generator must have a mains cycle.	—
24973	618D	A	CANopen guard fail master - severe system error.	—	In case of customer safety the RF is switched off and the generator must have a mains cycle.	—
24974	618E	A	Configuration fail-ure - severe sys-tem error.	—	The XML configura-tion file is corrupted or not suitable for the generator.	—
24975	618F	A	DeviceNet critical fault - severe system error.	—	DeviceNet interface has detected an unrecoverable fault.	—
24976	6190	A	Configuration changed - severe system error.	Pending changes inhibit RF power on.	New configuration was uploaded.	—
24992	61A0	A	Fatal error.	—	Error code not used.	—

32 Message type: A = Alarm, W = Warning, I = Information.

Dec. no.	Hex. no.	Type [32]	Message texts	Effect	Cause	Measure
24993	61A1	A	Temperature sensor of cooling plate 1 fault.	—	Value not feasible. Sensor T1 is defective.	—
24994	61A2	A	Temperature sensor of cooling plate 2 fault.	—	Value not feasible. Sensor T2 is defective.	—
24995	61A3	A	Temperature sensor of ambient air fault.	—	Value not feasible. Sensor T3 is defective.	—
24996	61A4	A	Temperature sensor of temperature control fault.	—	Value not feasible. Sensor T4 is defective.	—
24997	61A5	A	Temperature sensor of RF-Detector fault.	—	Value not feasible. Sensor T5 is defective.	—
24998	61A6	A	EtherCAT module alarm: Reboot failed.	—	EtherCAT module is defective or missing.	—
24999	61A7	A	EtherCAT module alarm: invalid configuration.	—	EtherCAT module can not be initialized (internal error).	—
25000	61A8	A	EtherCAT module alarm: profile doesn't match.	EtherCAT can't be initialized and it stopped working.	Control unit and regulation unit have different versions of ethercat profile. No profile can be loaded (internal error).	—
25001	61A9	A	HVPS Module 1: Input circuit overload.	—	Power module detected temperature alarm.	—
25002	61AA	A	HVPS Module 2: Input circuit overload.	—	Power module detected temperature alarm.	—
26001	6591	W	Warning in power module detected.	—	The control unit reports a general warning.	—
26002	6592	W	EEPROM DeviceNet store cancelled.	—	DeviceNet could not store parameters (i.e. storing is blocked).	—
26003	6593	W	EEPROM restore factory settings is running, the current request is cancelled.	—	The EEPROM is busy and does not accept any other task.	—
26004	6594	W	Invalid interface.	—	Wrong interface tries to control the generator.	—
26005	6595	W	Customer interface timeout.	—	No valid command frame while customer interface has control.	—

32 Message type: A = Alarm, W = Warning, I = Information.

Dec. no.	Hex. no.	Type [32]	Message texts	Effect	Cause	Measure
26006	6596	W	Customer interface checksum error.	—	Wrong checksum when receiving a message through customer interface.	—
26007	6597	W	Address error customer interface.	—	Cusomter uses wrong address to control the generator.	—
26008	6598	W	RF off timer expired.	—	There was no RFoff command in time.	—
26009	6599	W	Interface settings have been changed.	—	Changes of address/ baudrate not takes place until a reset occurs.	—
26110	65FE	W	SPI channel 0 timeout reading.	—	Data stream over SPI not feasible.	—
26111	65FF	W	SPI channel 1 timeout reading.	—	Data stream over SPI not feasible.	—
26112	6600	W	SPI channel 2 timeout reading.	—	Data stream over SPI not feasible.	—
26113	6601	W	SPI channel 3 timeout reading.	—	Data stream over SPI not feasible.	—
26114	6602	W	SPI channel 4 timeout reading.	—	Data stream over SPI not feasible.	—
26115	6603	W	SPI channel 5 timeout reading.	—	Data stream over SPI not feasible.	—
26116	6604	W	SPI channel 6 timeout reading.	—	Data stream over SPI not feasible.	—
26117	6605	W	SPI channel 7 timeout reading.	—	Data stream over SPI not feasible.	—
26120	6608	W	SPI channel 0 timeout writing.	—	Data could not be written over SPI.	—
26121	6609	W	SPI channel 1 timeout writing.	—	Data could not be written over SPI.	—
26122	660A	W	SPI channel 2 timeout writing.	—	Data could not be written over SPI.	—
26123	660B	W	SPI channel 3 timeout writing.	—	Data could not be written over SPI.	—
26124	660C	W	SPI channel 4 timeout writing.	—	Data could not be written over SPI.	—
26125	660D	W	SPI channel 5 timeout writing.	—	Data could not be written over SPI.	—
26126	660E	W	SPI channel 6 timeout writing.	—	Data could not be written over SPI.	—
26127	660F	W	SPI channel 7 timeout writing.	—	Data could not be written over SPI.	—
26128	6610	W	Wrong checksum of DPRAM value.	Read value from DPRAM may not work.	Hardware is defect or regulation unit does not work properly.	—

32 Message type: A = Alarm, W = Warning, I = Information.

Dec. no.	Hex. no.	Type [32]	Message texts	Effect	Cause	Measure
26130	6612	W	Reading from customer serial interface RS232 is time out.	Can't read customer interface.	Hardware is defect or connection to interface got lost.	—
26131	6613	W	Writing to customer serial interface RS232 is time out.	Can't write to customer interface.	Hardware is defect or connection to interface got lost.	—
26132	6614	W	Reading from service serial interface RS232 is time out.	Can't read service interface.	Hardware is defect or connection to interface got lost.	—
26133	6615	W	Writing to service serial interface RS232 is time out.	Can't write to service interface.	Hardware is defect or connection to interface got lost.	—
26296	66B8	W	DeviceNet supervisor state machine transition from execute to idle.	—	—	—
26297	66B9	W	DeviceNet explicit receive error.	—	—	—
26298	66BA	W	DeviceNet IO receive error.	—	—	—
26299	66BB	W	DeviceNet explicit connection deleted.			
26300	66BC	W	DeviceNet explicit connection timeout.	—	—	—
26301	66BD	W	DeviceNet IO connection timeout.	—	—	—
26302	66BE	W	DeviceNet IO connection deleted.	—	—	—
26303	66BF	W	DeviceNet slave reset.	—	—	—
26304	66C0	W	DeviceNet bus sense error.	—	—	—
26306	66C2	W	DeviceNet duplicate MAC-ID error.	—	—	—
26307	66C3	W	DeviceNet Rx queue overrun.	—	The interface unit did not empty the receive queue in time.	—
26308	66C4	W	DeviceNet Tx queue overrun.	—	The can controller did not send the data in time.	—

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Dec. no.	Hex. no.	Type 32	Message texts	Effect	Cause	Measure
26309	66C5	W	DeviceNet I/O send error.	—	I/O message could not be sent.	—
26310	66C6	W	DeviceNet CAN bus off event.	—	There were to many transmission errors on the bus.	—
26311	66C7	W	DeviceNet CAN bus overrun.	—	The can register was written twice before it was cleared.	—
26312	66C8	W	EEPROM busy.	—	Because EEPROM is busy writing is blocked.	—
26313	66C9	W	EEPROM store fault.	—	Writing EEPROM was faulty. Please retry.	—
26314	66CA	W	Time inconsis-tency.	—	Real time clock stops during power down.	—
26315	66CB	W	DeviceNet send-ing a message fails.	—	Handler could not send a message.	—
26316	66CC	W	DeviceNet releas-ing semaphore failed.	—	Handler could not release a locked semaphore.	—
26317	66CD	W	DeviceNet pro-duced path has been changed. Reset required.	Reset on Device-Net required before the change of the path takes place.	The produced path has been changed.	—
26318	66CE	W	DeviceNet con-sumed path has been changed. Reset required.	Reset on Device-Net required before the change of the path takes place.	The consumed path has been changed.	—
26319	66CF	W	DeviceNet regula-tion mode has been changed. Reset required.	Reset on Device-Net required before the change of the regulation mode takes place.	The regulation mode has been changed.	—
27000	6978	W	Value exceeded upper limit.	—	Value acceded the upper warning limit.	—
27001	6979	W	Value underran lower limit.	—	Value underan the lower warning limit.	—
28000	6D60	W	Value exceeded lower limit.	—	Value exceeded the lower warning limit.	—
29000	7148	W	Command not available.	—	In the generator state the intended command is not allowed.	—

32 Message type: A = Alarm, W = Warning, I = Information.

Dec. no.	Hex. no.	Type 32	Message texts	Effect	Cause	Measure
29001	7149	W	Old EtherCAT Module Firmware is detected.	—	Current Software is expecting a higher EtherCAT Module Firmware Version.	—
29002	714A	W	Total number of operation hours has been reset to 0.	—	—	—
29003	714B	W	Total number of power on hours has been reset to 0.	—	—	—
29004	714C	W	Arc Management is not available.	—	Arc Management is not supported by current device	—
29005	714D	W	Temperature of control may be faulty.	—	Control Module: plausibility check of temperature failed	—
29006	714E	W	Temperature of RF Detector may be faulty.	—	Control Module: plausibility check of temperature failed	—
29007	714F	W	Temperature of ambient air may be faulty.	—	Control Module: plausibility check of temperature failed	—
29008	7150	W	Temperature of cooling plate 1 may be faulty.	—	Control Module: plausibility check of temperature failed	—
29009	7151	W	Temperature of cooling plate 2 may be faulty.	—	Control Module: plausibility check of temperature failed	—
29010	7152	W	HVPS 1: Temperature of ambient air may be faulty.	—	Control Module: plausibility check of temperature failed	—
29011	7153	W	HVPS 1: Temperature of cooling plate 1 may be faulty.	—	Control Module: plausibility check of temperature failed	—
29012	7154	W	HVPS 1: Temperature of cooling plate 2 may be faulty.	—	Control Module: plausibility check of temperature failed	—
29013	7155	W	HVPS 1: Temperature of DC Module 1 may be faulty.	—	Control Module: plausibility check of temperature failed	—
29014	7156	W	HVPS 1: Temperature of DC Module 2 may be faulty.	—	Control Module: plausibility check of temperature failed	—
29015	7157	W	HVPS 1: Temperature of DC Module 3 may be faulty.	—	Control Module: plausibility check of temperature failed	—

32 Message type: A = Alarm, W = Warning, I = Information.

Dec. no.	Hex. no.	Type [32]	Message texts	Effect	Cause	Measure
29016	7158	W	HVPS 2: Temperature of ambient air may be faulty.	—	Control Module: plausibility check of temperature failed	—
29017	7159	W	HVPS 2: Temperature of cooling plate 1 may be faulty.	—	Control Module: plausibility check of temperature failed	—
29018	715A	W	HVPS 2: Temperature of cooling plate 2 may be faulty.	—	Control Module: plausibility check of temperature failed	—
29019	715B	W	HVPS 2: Temperature of DC Module 1 may be faulty.	—	Control Module: plausibility check of temperature failed	—
29020	715C	W	HVPS 2: Temperature of DC Module 2 may be faulty.	—	Control Module: plausibility check of temperature failed	—
29021	715D	W	HVPS 2: Temperature of DC Module 3 may be faulty.	—	Control Module: plausibility check of temperature failed	—
29022	715E	W	DC Module is not ready.	—	DC Module is not ready, please try later	—
29023	715F	W	Factory restore in progress.	—	Current operation is not allowed during factory restore	—
29024	7160	W	Power output is active	—	Current operation is not allowed when RF is on	—
29025	7161	W	DSP is busy.	—	Current operation is not allowed when DSP is busy	—
29026	7162	W	Change factory mode failed.	—	Current operation is not allowed during RF on or selected mode is invalid	—
29027	7163	W	Change User Role failed.	—	Current operation is not allowed during RF on or in Factory Mode	—
29028	7164	W	Change clock source failed.	—	Current operation is not allowed during RF on or DSP is busy	—
29029	7165	W	Change Pulse source failed.	—	Current operation is not allowed during RF on	—

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Dec. no.	Hex. no.	Type [32]	Message texts	Effect	Cause	Measure
29030	7166	W	CANopen heart beat was missing (Debug mode).	CANopen does not work properly.	Regulation unit software stopped working or CANopen was not initialized properly.	—
29031	7167	W	Arc rate exceeds limit	Plasma not stable	Process dependant	Check process paramters or increase warning limit
29032	7168	W	Setpoint is reduced to max. software setpoint limit	Setpoint was larger than max. software setpoint limit	Setpoint and max. software setpoint limit mismatch	Check current setpoint or its max. software limit
29033	7169	W	RF is swiched off because Joule limit has been reached.	RF is switched off by regulation unit.	Joule limit has been reached.	—
29034	716A	W	Mixed Mode settings are conflicting with user inputs.	User inputs are discarded.	User operating error.	—
29035	716B	W	Action not possible, mixed mode is still active.	—	User operating error.	—
29036	716C	W	Regulation unit reports a temperature warning.	—	A certain temperature may be faulty.	—
29037	716D	W	Device is booted via NFS file system. Modify ethernet configuration failed.	Modify ethernet configuration failed.	Device is booted via NFS file system.	—
29038	716E	W	Ethernet is not activated as service interface. Modify ethernet configuration failed.	Modify ethernet configuration failed.	Ethernet is not activated as service interface.	—
29039	716F	W	Modify ethernet configuratoin failed.	Modify ethernet configuration failed.	It could be caused by internal error.	—
29040	7170	W	Reboot generator to validate pending changes.	Pending changes are not synchronized until power cycle.	Configuration changed.	—
29041	7171	W	There are unsaved parameter changes.	Unsaved parameter changes will get lost after power cycle and they are not active yet.	Parameter changes are not confirmed yet.	—
29042	7172	W	Temperature too low.	Dewing may cause damage.	Cooling water temperature is too low.	—

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Dec. no.	Hex. no.	Type [32]	Message texts	Effect	Cause	Measure
29050	717A	W	SystemPORT matchbox warning.	—	Check SystemPORT matchbox state.	—
29051	717B	W	SystemPORT matchbox interlock is open.	—	Check SystemPORT matchbox state.	—
32765	7FFD	W	Unknown error message.	—	—	—

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