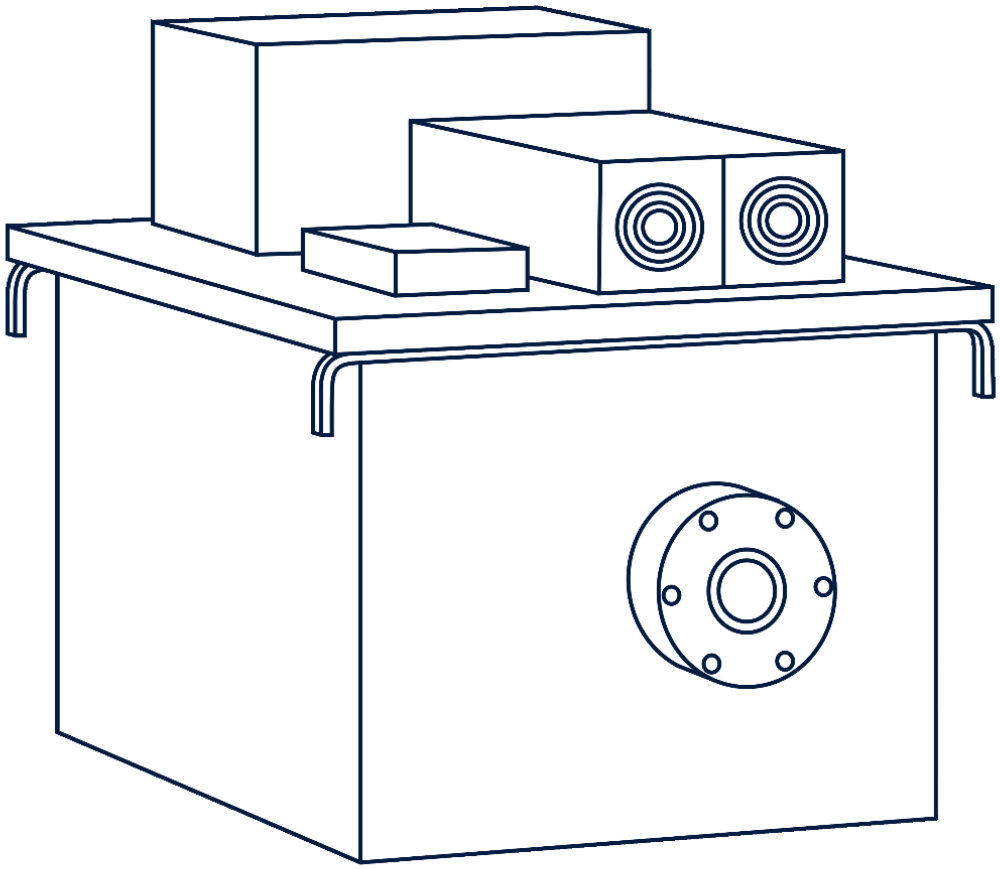
Integrator manual

Communication Protocol

T3 Protocol for iVario - SW V.4.0.0



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Content

1 Introduction

1.1 Purpose

This document describes the iVario high voltage generator communication protocol (T3) and its architecture. All the implemented commands (key's) for the latest iVario software version are specified and their corresponding generator functionality documented.

1.2 Scope

This document is intended for users who work with the T3 protocol. It presumes basic knowledge in TCP/IP and serial communication as well as a deep understanding of the operation of the iVario Generator.

1.3 iVario Generator Family

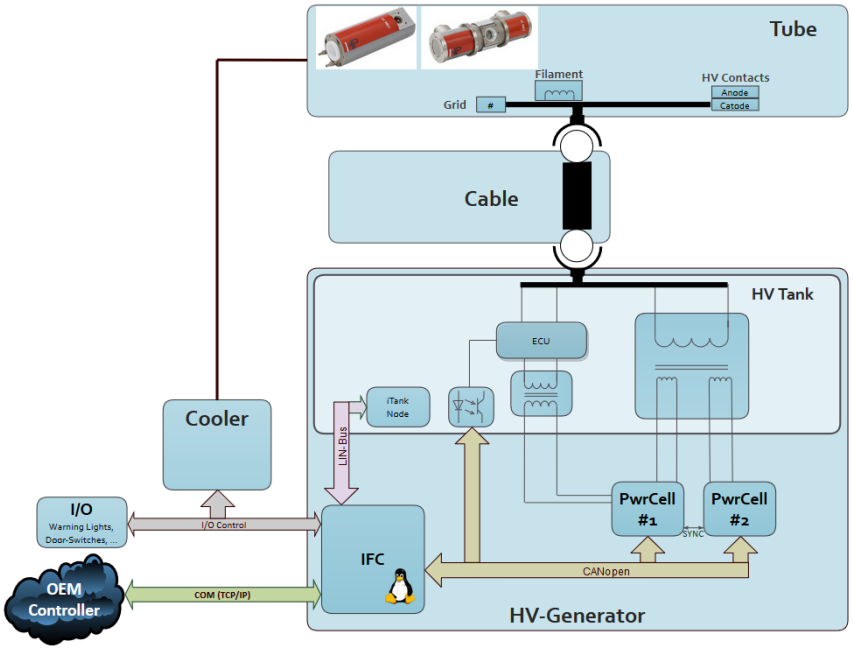


Fig. 1: iVario Generator Overview

Fig. 1: presents a module overview showing interrelations between different elements of the module. Mentioned communication interfaces are part of the connection to OEM Controller or any other system which controls or monitors the generator (IFC ← COM → OEM Controller). The interface for new development is always TCP/IP (see also chapter 2.1 TCP/IP).

2 General Description

2.1 TCP/IP

The iVario generator provides a standard Ethernet interface (RJ45 connector X4) and a TCP server for the T3-Communication. The necessary server and client-side communication stack is shown in Fig. 2: (SSH and SFTP are IFC server side only and not related to iVario communication). From the T3-protocol stack only the message and key-value-pair layers (marked in blue) are used (since the transport layer is provided by TCP/IP).

For detailed information about the T3 protocol frames and payload structure see Chapter 3. The client and server applications handle the key-value pairs which are further described in the Appendix.

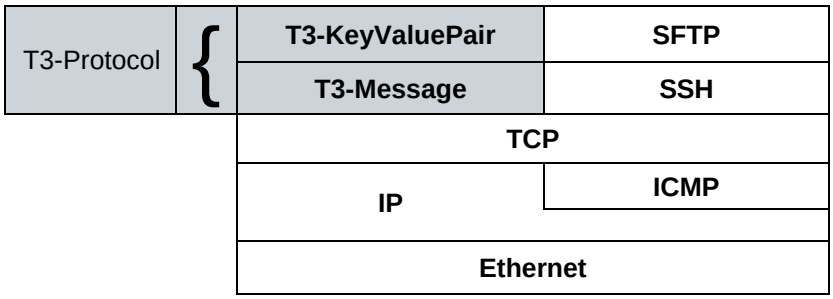


Fig. 2: TCP/IP T3 ASCII Stack

The iVario generator TCP-server opens per default 2 ports and accepts one client per port. A second client who connects on an already used port will force a disconnection of the other client on the same port and then connect. The standard ports are defined as follow:

- Port 50505
- Port 50506

The clients don't need to open and close the connection on every read/write access. This will only be necessary if multiple client's needs to be supported on a single port. In normal operation scenarios, the connection shall stay open for the whole communication sessions. If closing / reopening is needed, be aware that this leads to significantly higher response times.

Typical response times for single key read/write commands on opened connections are less than 20ms.

NOTE: TCP/IP is fast but not a real time communication protocol (no guaranteed response time or jitter). Depending on operation conditions and load, the typical response time can vary. The minimum polling period is 50ms. We strongly recommend to limit the polling period to 200ms to avoid overloading the communication. However, best practice is to use the auto-message subscription "on change" instead of polling.

2.2 Protocols

The communication protocol on the ethernet based interfaces is T3 ASCII. For legacy reasons and on serial interface only, the MG protocol is also supported. If MG protocol is configured for serial communication T3 ASCII will be still available on TCP/IP interfaces.

Note: Please use MG only for replacement projects since this protocol will no longer be maintained nor enhanced.

2.3 T3 ASCII / T3-Protocol

T3 ASCII was designed to realize a human readable layered protocol to handle key-value pairs. The term T3 ASCII is related to the protocol id ‘TA’ (PID) in the T3-Message header data. However, the other layers of the T3-protocol are also ASCII encoded and human readable and therefore the whole T3-protocol-stack is called T3-ASCII (synonym). The complete T3-protocol stack consists of 2 layers and is structurally oriented to ISO/OSI model.

3 T3 ASCII Protocol Specification

3.1 Protocol Layers Overview

The following image shows the T3-Protocol stack used on the ethernet interface and some “real-world” examples for the iVario generator.

T3-Ethernet, ASCII

T3-Layer																				ISO/OSI Layer	
T3-KeyValuePair							KEY		KEY	VSEP	VAL		KEY	VSEP	VAL1	VLSEP	VAL2	VLSEP	VALn	7	Application
							KEY_VALUE_PAIR1	KSEP	KEY_VALUE_PAIR2		KSEP	KEY_VALUE_PAIRn						KSEP		6	Presentation
T3-Message	PID	PORT	MTYPE	DLEN	RES	SEP	Payload -> Trintiy ASCII protocol (key value pair)													5	Session
TCP/IP	Payload (SDU)																			4	Transport
																				3	Network
Ethernet																				2	Data Link
																				1	Physical

Size [Bytes]:	2	2	1	4	2	1	
	Header length 12						Max payload length for T3-Serial 243
	T3-Message total: max 255						

Examples

set request	TA	10	S	0019	--	|	HIVO=200E3;TUCU=123.4E-5;	=>	TA10S0019--|HIVO=200E3;TUCU=123.4E-5;
response	TA	10	R	0010	--	|	HIVO=#0;TUCU=#0;	=>	TA10R0010--|HIVO=#0;TUCU=#0;
command	TA	10	S	0007	--	|	HVEN=1;	=>	TA10S0007--|HVEN=1;
response ok	TA	10	R	0008	--	|	HVEN=#0;	=>	TA10R0008-|HVEN=#0;
response error	TA	10	R	000A	--	|	HVEN=#111;	=>	TA10R000A--|HVEN=#111;
read request	TA	60	S	0005	--	|	HIVO;	=>	TA60S0005--|HIVO;
response	TA	60	R	000C	--	|	HIVO=200000;	=>	TA60R000C--|HIVO=200000;
read request	TA	60	S	0006	--	|	HIVOM;	=>	TA60S0006--|HIVOM;
response	TA	60	R	000D	--	|	HIVOM=199937;	=>	TA60R000D--|HIVOM=199937;

Fig. 3: General information

3.2 Message Layer

The T3-Message frame consists of header (12 Byte) and payload (containing the T3-KeyValuePair frame).

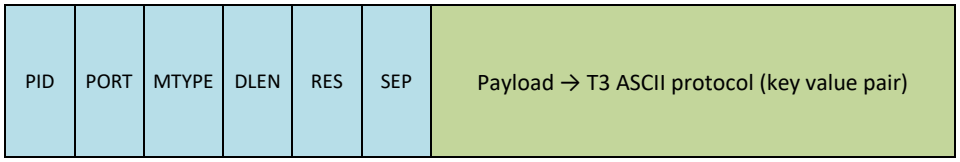


Fig. 4: T3-Message Frame

The following table describes the header fields:

Field	Char	ASCII	Size	Description
PID	CC	-	2	Protocol id (encoding ASCII 2 characters): Defines the protocol of the payload data (e.g. TA for T3 ASCII). Actually, the following protocols are defined: • TA = T3 ASCII • MG = Legacy MG protocol (internal use only)
PORT	HH	-	2	Port (encoding ASCII hex, 2 digits): Used for routing the data to the correct application / device in the system. The port allows a point-to-point communication between a client application and the T3 system or a sub device (e.g. a power cell). For the iVario generator, 0x10 is the System write port and 0x60 the system read port (Chapter 3.2.1)
MTYPE	C	-	1	Message Type (encoding ASCII 1 character): • 'S' = Request (read/write) • 'R' = Response (MTYPE for a response to a 'S') • 'A' = Asynchronous (auto messages from T3)
DLEN	HHHH	-	4	Data length (encoding ASCII hex, 4 digits): Length of data field (payload). For T3 ASCII this means the number of bytes used for the (not '\0'-terminated) key-value-pair string. The length field is 2 Byte; hence the maximal data length would be 65536 Byte. However, the data length for T3-Messages is limited to 1Kb (1024 Byte).
RES	--	-	2	Reserved (for future use) unused, ignored, set to "–"
SEP	|	0x7C	1	Field separator

3.2.1 Read and Write Ports

The read and write ports of the T3 message layer are used for routing the data and commands to the correct application / device in the system. The idea is to be able to use the same keys for all the devices in the system if these keys address the same information / command. For example, the key TUCUM (tube current measured) key shall be available from the system (total tube current) or from the powercells in the iVario generator directly (e.g., in bipolar mode).

The write ports are used to send set points, commands, and other write requests to the corresponding device. The following write ports are defined:

Port	Description
0x10	System Port (generator)
0x11	POC1 (powercell 1)
0x12	POC2 (powercell 2)
0x19	IFC
0x20	ECU
0x30	iTank Cathode
0x33	iTube
0x40	iTank Anode

The read ports are used to access any kind of information on the corresponding device with so called read requests. This also allows reading back e.g., set points with the same keys as writing them to the device (e.g., HIVO – High Voltage). The following read Ports are defined:

Port	Description
0x60	System Port (generator)
0x61	POC1 (powercell 1)
0x62	POC2 (powercell 2)
0x69	IFC
0x6A	POC1 Safety
0x6B	POC2 Safety
0x70	ECU
0x80	iTank Cathode
0x83	iTube
0x90	iTank Anode

3.2.2 Request / Response (MTYPE)

The message type for both, read and write requests is always ‘S’ (= request, formally known as synchronous). All requests will be answered with a message type ‘R’ (= response). This allows synchronous communication and timeout handling on clients and servers. Furthermore, with MTYPE it is possible to create asynchronous messages from the server (Chapter 3.2.3) without corrupting the synchronous communication (although interpreting MTYPE is mandatory for clients in such case).

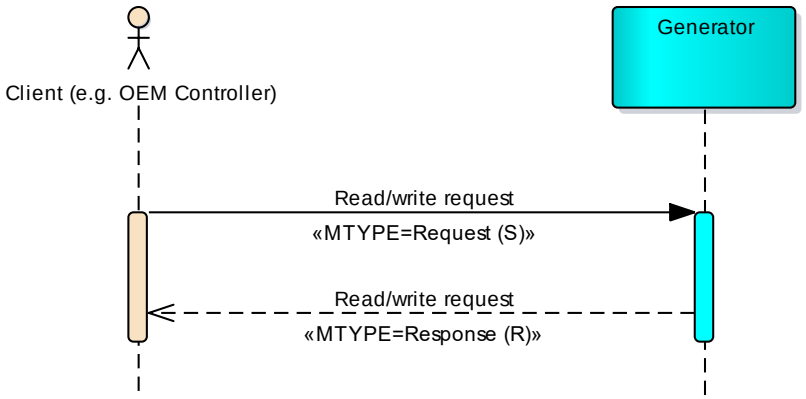


Fig. 5: Request / Response MTYPE

It is best practice to always check the system state (SYSSTAT) before issuing a follow-up command to make sure the generator is in the desired state. E.g., before issuing a HVEN command the system state shall be ‘ready’. Refer also to the tutorial examples in chapter 4.2.

3.2.3 Asynchronous / Auto Messages (MTYPE)

Auto message is a feature to allow event driven clients (like monitoring systems and displays) to get automatically generated (asynchronous) messages from the iVario generator. The auto messages are configurable (which keys, time triggered or on event, period if time triggered …). An auto message can contain one or more keys with one or more values according to the corresponding key definition. Fig. 6: shows an example communication sequence with configured auto messages.

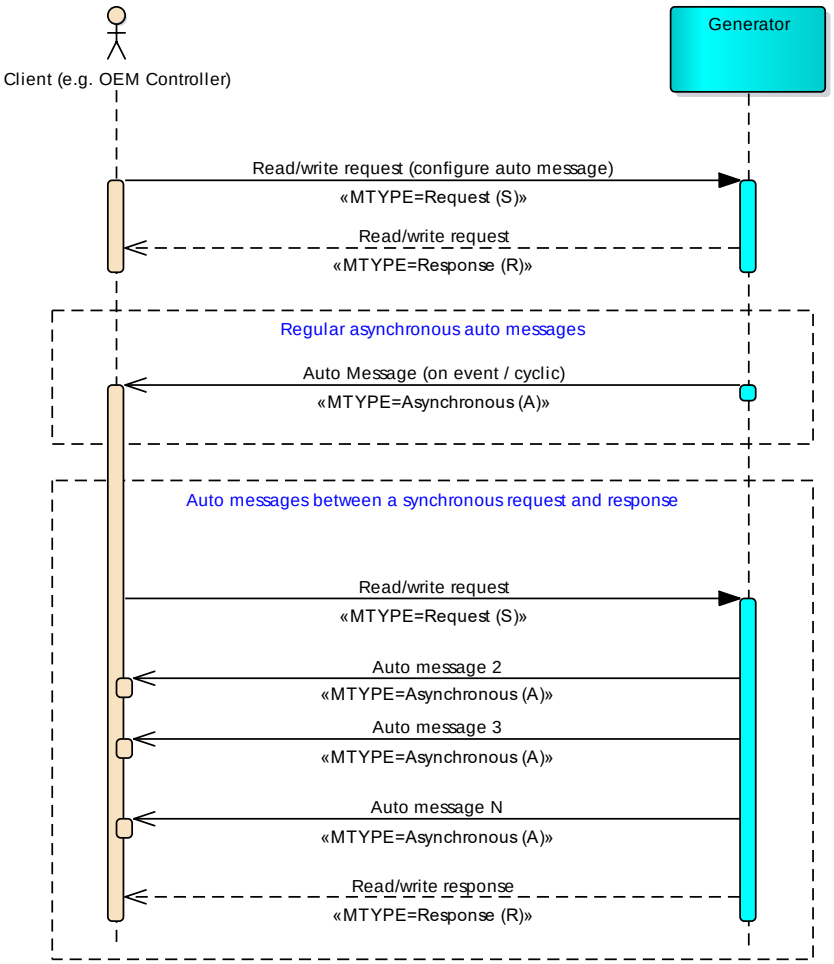


Fig. 6: Auto Messages

3.3 KeyValuePair (Presentation / Application Layer)

The T3-KeyValuePair layer is a protocol that defines the encoding for keys with no values (commands like RESET), one value (e.g., set-point or index) or a list of values (e.g., more complex data like emission curve). One T3-Message frame can contain one or more keys or key-value pairs separated by the KSEP. Fig. 7: shows an example with a single key, a key with a single value and a key with a value list.

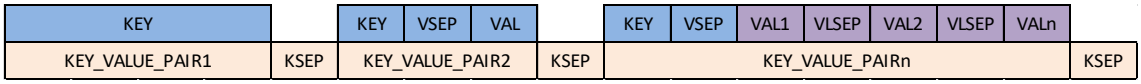


Fig. 7: T3-KeyValuePair

The following table describes the protocol fields:

Field	Char	ASCII	Size	Description
KSEP	;	0x3B	1	Key value pair separator / end of key value pair marker. This character is also needed if only one key or key-value-pair is used. **! Do not send further final character such as 0x00 at the end of key value pair**
KEY	C*		1..16	Key The key / command used to access the required data in the iVario generator. For description of all available keys see the appendix.
VSEP	=	0x3D	0/1	Key/value separator if value not empty
VAL	C*		0..240	Value if required
VLSEP	,	0x2C	0/1	Value separator in a value list (multiple values for a single key)
RETC	#	0x23	1	Return Code prefix used within a value to determine return / error codes.

NOTE: the key value pair protocol is ASCII and the special characters KSEP and VLSEP are not allowed in string values at all. The special characters VSEP and RETC are not allowed at the first position in string values (there are no escape characters yet → if needed solve this on application layer).

There are basically two types of keys (read and write keys) which show a slightly different behavior.

3.3.1 Write Keys

Within the write key group, there are different use cases which can be achieved:

- Commands: keys without values used to trigger an event or a specific behavior on the iVario generator (like REBOOT, …)
- Complex commands: keys used for triggering an event or a specific behavior on the iVario generator according to their values (e.g., HVEN=1 → HV operation enable)
- Set keys: keys which are used to set a control set point, change configuration values, system settings and other persisted data

Since all those key types use the same protocol, we will only use the term write keys for further examinations.

Write keys are always acknowledged with a return code.

3.3.2 Read Keys

Within the read key group there are only two different kinds of keys:

- Simple read access: keys without value to access any kind of readable information on the iVario generator such as measurement values, set points, status information, not ready codes, etc.
- Specified read access: some information needs an index or other information to access a specific content. For example, the not ready codes of the components can be addressed with an index in the NRDY key which will return only the requested not ready code.

Read keys will either respond with the same key and the requested values or a return code in case of errors.

3.3.3 Request / Response Return codes (ACK)

Read request can be and write requests are always acknowledged with one or more return code(s). A return code is defined like a regular integer value but is prefixed with the '#' character (ASCII 0x23).

The following table shows the possible return codes for the iVario generator.

Return Code	Value	Description
T3_RETCODE_NOK	-1	General not ok code (unknown issue).
T3_RETCODE_OK	0	OK code (write acknowledge).
T3_RETCODE_NACK	1	Write failed (not acknowledged).
T3_RETCODE_ERR_TIMEOUT	102	Read/write timeout.
T3_RETCODE_ERR_BUFFER_FULL	103	Buffer overflow (e.g., RX/TX buffer on communication interface).
T3_RETCODE_ERR_TOO_MANY_PARAMETERS	104	The given key takes less than the received values.
T3_RETCODE_ERR_TOO_FEW_PARAMETERS	105	The given key requires more than the received values.
T3_RETCODE_ERR_INVALID_PARAMETER	106	Parameter value is not known or invalid (Not parseable)
T3_RETCODE_ERR_INVALID_NUMBER	107	Value has invalid number encoding (e.g., hex and float mixture).
T3_RETCODE_ERR_FRAMING_ERROR	108	Data frame parsing error.
T3_RETCODE_ERR_UNKNOWN_COMMAND	109	The received key is not supported.

T3_RETCODE_ERR_INTERNAL_ERROR	110	Unexpected internal software error (e.g., data cannot be accessed, ...)
T3_RETCODE_ERR_NOT_ALLOWED	111	The key, action or command is in the actual operating mode not allowed.
T3_RETCODE_ERR_ACCESS_DENIED	112	You don’t have permission to send the key or command.
T3_RETCODE_ERR_BUSY	113	The requested operation cannot be performed because needed resources are busy
T3_RETCODE_ERR_NO_DEVICE	114	The key, action or command couldn’t be done because device at the addressed port doesn’t exist.
T3_RETCODE_ERR_PARAMETER_OUT_OF_RANGE	115	The received value is lower or higher than the specified / accepted range
T3_RETCODE_ERR_NOT_AVAILABLE_ DUE_TO_BOOT_ISSUE	116	ERR: The data or functionality requested is not available due to an existing boot issue (boot error != 0x0)

3.3.4 Value formatting

The key values are ASCII encoded numbers or strings where the following basic data types (and lists/arrays of them) are supported:

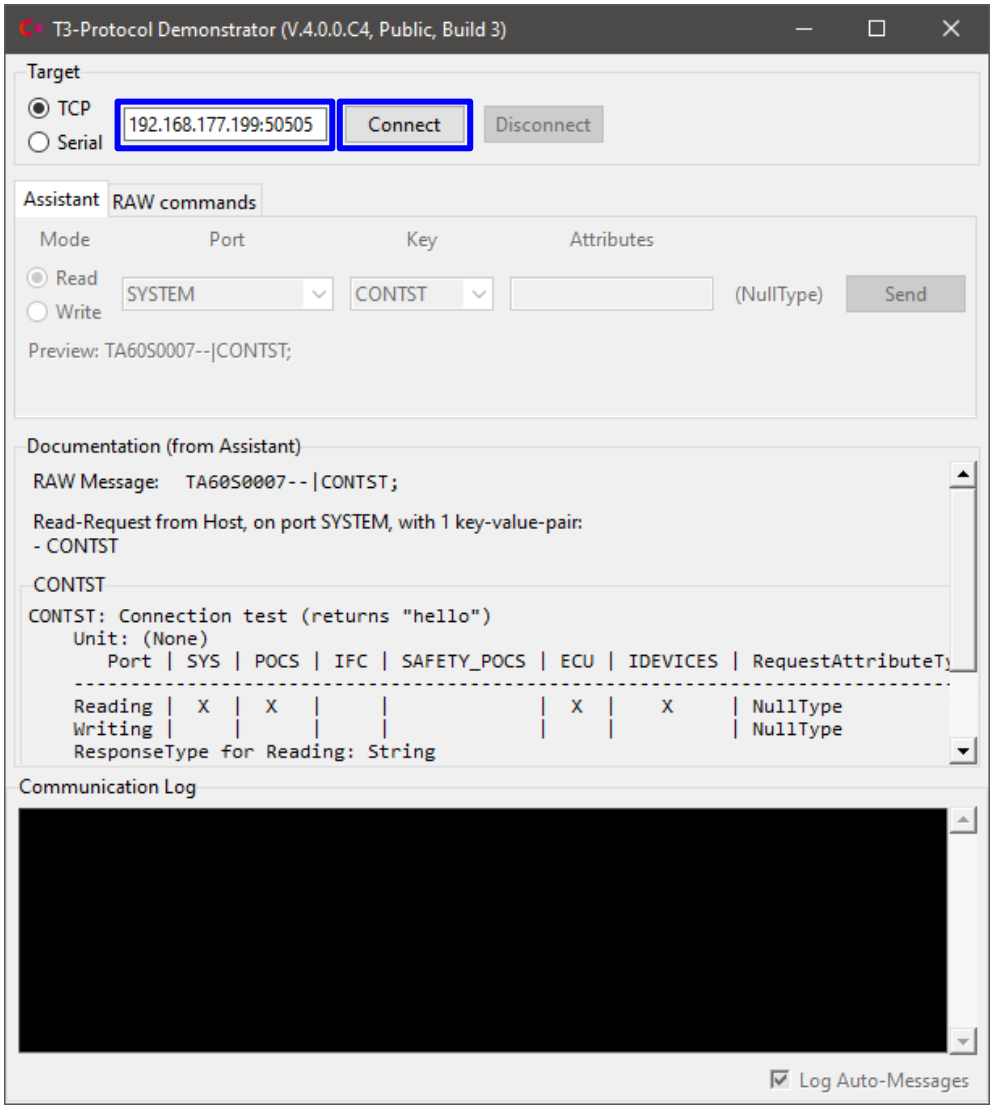
Type	Request Format (interpreted by iVario)	Response Format
Uint32	**32 Bit unsigned integer**	
	• Decimal number from 0 … (2^{32}-1) (0 ... 4'294'967'295) • Scientific notation (e.g. 100e3) • Hexadecimal notation (with '0x' prefix) and upper- or lower-case letters ('a' … 'f', 'A' … 'F')	• Decimal number from 0 ... (2^{32}-1) (0 ... 4'294'967'295) • Hexadecimal notation (with '0x' prefix) and upper- or lower-case letters.
Int32	**32 Bit signed integer**	
	• Decimal number from -(2^{31}) … (2^{31}-1) (-2,147,483,648 ... 2,147,483,647) • Scientific notation (e.g. -10e3)	• Decimal number from -(2^{31}) … (2^{31}-1) (-2,147,483,648 ... 2,147,483,647)
Boolean	**Boolean value**	
	• Decimal numbers 1 or 0 • "true" or "false" *Note: everything which is not 0 or "false" will be interpreted as true.*	• Decimal numbers 1 or 0
Float64	**Double precision floating point number (64 Bit)**	
	• Real number from ±5.0*10^{-324} … ±1.8*10^{308} with max 15 significant decimal digits precision (e.g. -0.000123456789012345 or 123456789012345000) • Scientific notation (e.g. 1.23e-5) Implementation on iVario generator allows max. 15 significant decimal digits precision. Some values will be internally used with single precision (32Bit) and will be rounded to 7 significant decimal digit precision.	• Real number from ±5.0*10^{-324} … ±1.8*10^{308} with max 15 significant decimal digits precision (e.g. -0.000123456789012345 or 123456789012345000) • Scientific notation (e.g. 1.23e-5) • 'inf' or '-inf' for infinity
String	**Character sequence**	
	• Any printable ASCII character with limitations for the special characters (KSEP, VSEP, VLSEP, RETC) used in the T3-KeyValuePair layer • Max length = 240 characters • No 0-termination! The special characters KSEP and VLSEP described in Table 6 are not allowed in string values at all. The special characters VSEP and RETC are not allowed @ the first position in string values. There are no escape characters yet → if needed solve this on application layer.	• Any printable ASCII character with limitations for the special characters (KSEP, VSEP, VLSEP, RETC) used in the T3-KeyValuePair layer • Max length = 240 characters • No 0-termination!

4 Tutorial examples

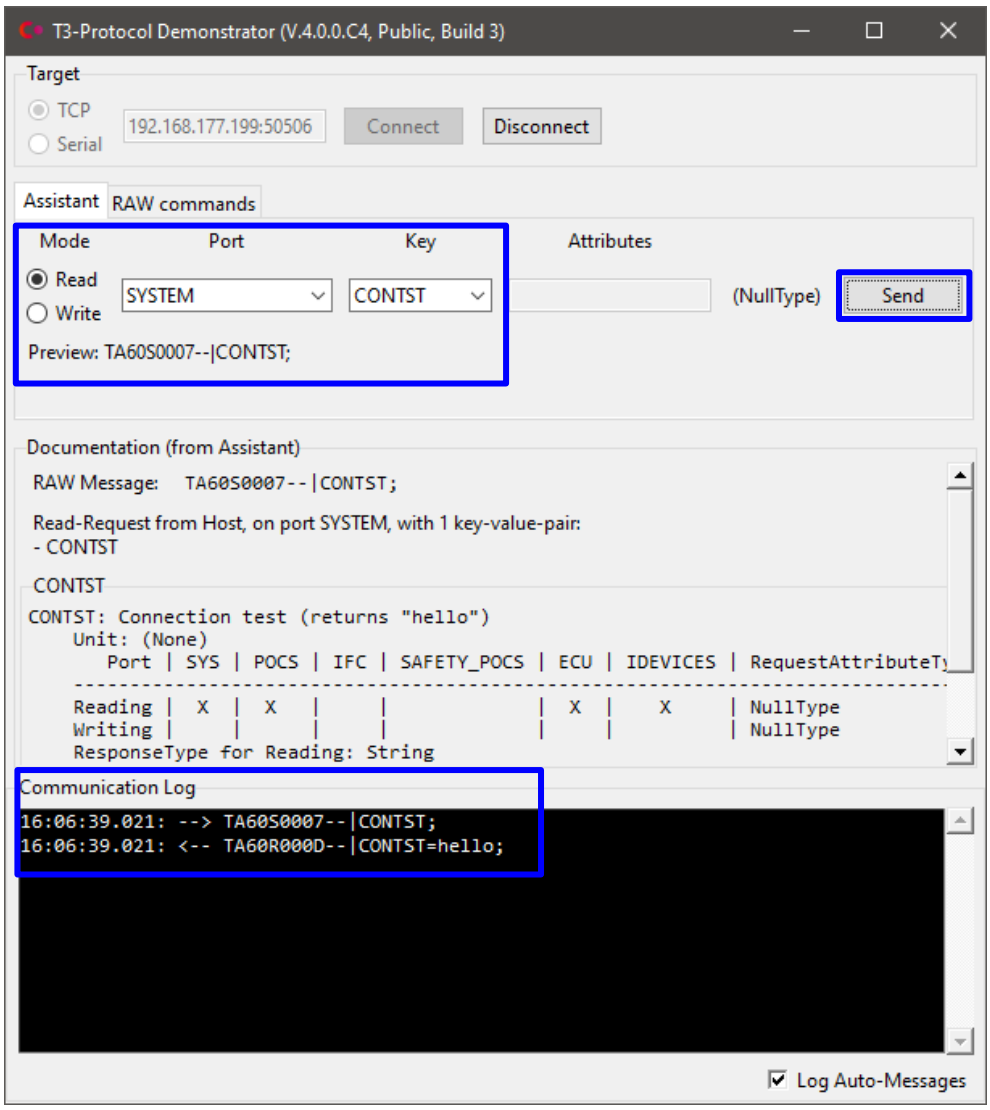
4.1 Use the T3 Demonstrator software as an implementation guide

4.1.1 How to set up and use the T3 Demonstrator tool

- Unzip the “t3demonstrator_Public_V.4.0.0.xxx.zip”
- run the “t3demonstrator.bat” file
- Set the correct IP address and port and press “Connect” to establish the communication with the generator

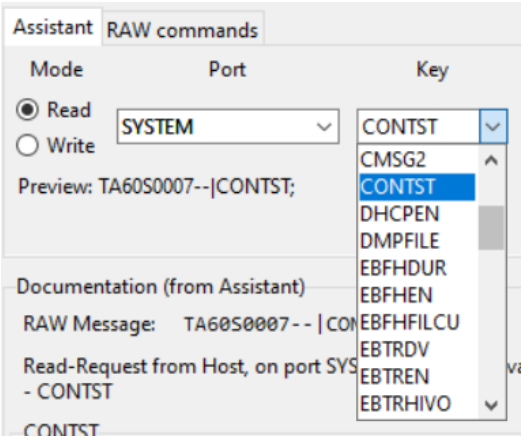


To test if the communication is established, we can simply send a pre-defined telegram from the “Assistant” tab. The response should be visible in the “Communication Log”. The used key in the example is “Connection Test”.



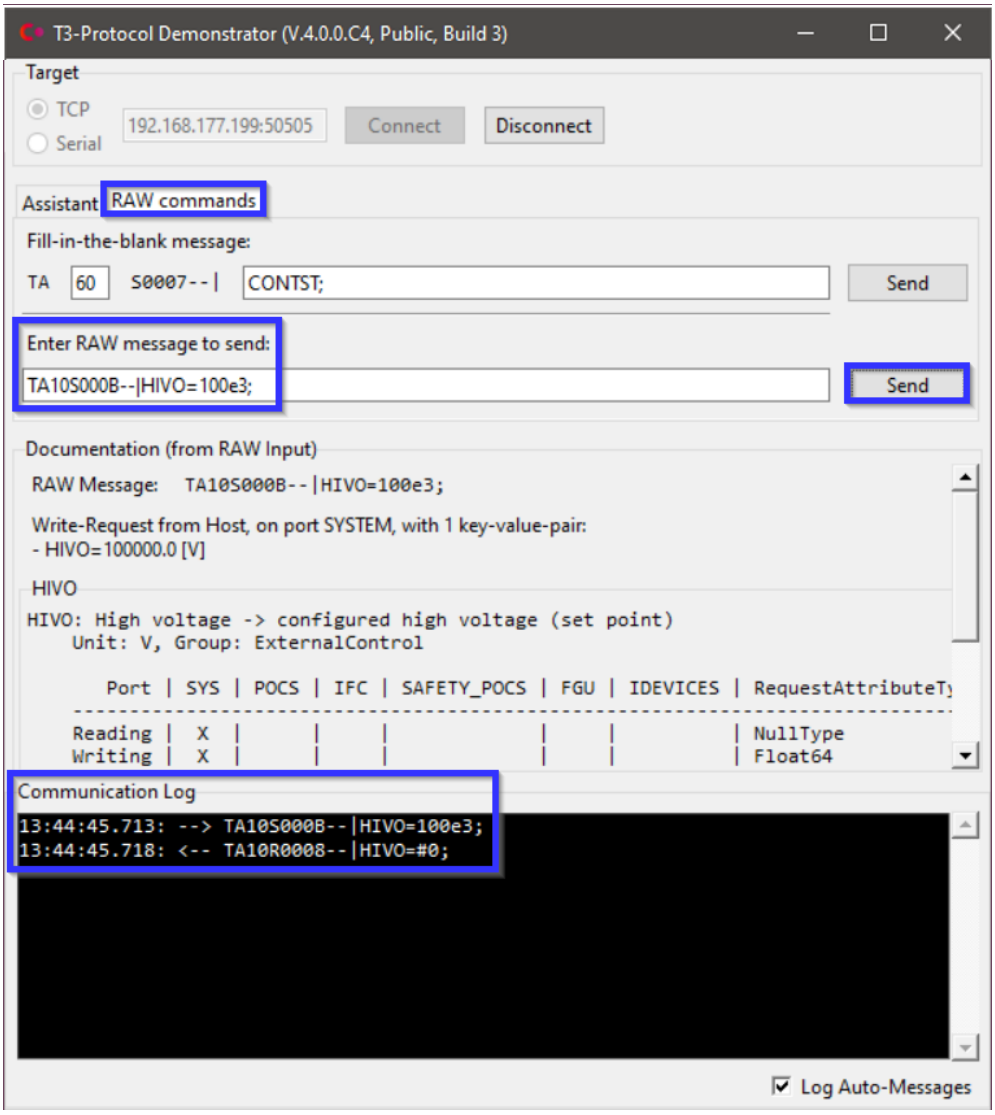
4.1.2 Use keys from within the “Assistant tab”

There are plenty of predefined keys to use from within the “Assistant” tab.



4.1.3 Work with “RAW commands”

You can also switch into the tab “RAW commands” and send any T3 command from the “Enter RAW message to send:” field.



Below is now listed a meaningful sequence of telegrams as an implementation start. In the annex of this document, you'll find all the available T3 keys with explanation and example.

4.2 Example sequence start high voltage on

- Firstly, we define a useful high voltage and tube current setpoint.
- Then we'll check if the generator is in ready state
- If yes, we can switch high voltage on

4.2.1 HIVO – High Voltage Set

Set the high voltage to 100kV and read it back:

```
[TX] - TA10S000B--|HIVO=100e3;
[RX] - TA10R0008--|HIVO=#0;
[TX] - TA60S0005--|HIVO;
[RX] - TA60R000C--|HIVO=100000;
```

4.2.2 TUCU – Tube Current Set

For the MF systems, setting the tube current is not required. The tube current is calculated automatically depending on the power curve of the selected focal spot.

Set tube current to 3mA and read it back:

```
[TX] - TA10S000A--|TUCU=3e-3;
[RX] - TA10R0008--|TUCU=#0;
[TX] - TA60S0005--|TUCU;
[RX] - TA60R000B--|TUCU=0.003;
```

4.2.3 Check if generator is in ready state

Refer to the iVario Status manual for the signification of the system status code.
Before switching high voltage on, the status "normal operation – ready: 2,5,0,0,0" shall be reached. Send SYSTAT key to check it.

```
[TX] - TA60S0008--|SYSSTAT;
[RX] - TA60R0012--|SYSSTAT=2,5,0,0,0;
```

4.2.4 HVEN – High Voltage Enable/Disable

Set HVEN to ON (1) and read it back:

```
[TX] - TA10S0007--|HVEN=1;
[RX] - TA10R0008--|HVEN=#0;
[TX] - TA60S0005--|HVEN;
[RX] - TA60R0007--|HVEN=1;
```

4.2.5 Check if generator is in status “setpoint reached”

Before starting the image acquisition, check that the required setpoints HIVO and TUCU are reached. To do so, read the system status: SYSSTAT key shall return 2,7,100,0,0

Refer to the iVario Status manual for the signification of the system status code.

```
[TX] - TA60S0008--|SYSSTAT;
[RX] - TA60R0014--|SYSSTAT=2,7,100,0,0;
```

4.3 Getting measured values and system status in polling mode

4.3.1 Polling HIVOM

Read the actual measured high voltage of 83.54kV (system / total)

```
[TX] - TA60S0006--|HIVOM;
[RX] - TA60R000C--|HIVOM=83540;
```

4.3.2 Polling TUCUM

Read the actual measured tube current (3.04 mA)

```
[TX] - TA60S0006--|TUCUM;
[RX] - TA60R000E--|TUCUM=0.00304;
```

4.3.3 Check if generator stays in “setpoint reached” during exposure

If an arc in the tube occurs or if the generator cannot maintain the required setpoint, the system status will change to ramping: 2,7,80,0,0. In this case, the image quality is affected; the acquisition could be stopped and resumed when setpoint is reached again.
An arc handling and recovery may take several seconds; more than 15s for a MF tube. We suggest as well to check the warning bit “arc active” with the key WARN.

```
[TX] - TA60S0008--|SYSSTAT;
[RX] - TA60R0014--|SYSSTAT=2,7,100,0,0;
```

If the generator leaves the status setpoint reached:

```
[TX] - TA60S0008--|SYSSTAT;
[RX] - TA60R0013--|SYSSTAT=2,7,80,0,0;
```

If an arc occurs during the exposure, the warning bit “arc active” stays set until the recovery is completed:

```
[TX] - TA60S0005--|WARN;
[RX] - TA60R0009--|WARN=0x1;
```

4.4 Getting measured values and status via auto-message subscription

All the T3 Keys marked with “AMSG allowed” are qualified for auto-messaging subscription.

In this example we consider the keys “HIVOM”, “TUCUM”, “SYSSTAT” and “WARN”.

4.42 HIVOM – High Voltage Measured

Key	HIVOM	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Read the measured high voltage total in [V]: • For bipolar operation this is the sum of POC1 and POC2 high voltage • For unipolar operation this is POC1 (master) high voltage Note: the high voltage can also be read from POC1 and POC2 directly (ports 0x61 and 0x62)	
Ports	**Read**	**Write**
	0x60, 0x61, 0x62	-
Request Value	-	-
Response Value	Float64 [V]	-

4.107 TUCUM – Tube Current Measured

Key	TUCUM	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Read the actually measured tube current in [A] for the generator.	
Ports	**Read**	**Write**
	0x60, 0x61, 0x70	-
Request Value	-	-
Response Value	Float64 [A]	-

5.98 SYSSTAT – System Status

Key	SYSSTAT	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Read the system status of the iVario generator. For the definition of the system status, refer to the T3 Status Manual The response value is a system status object [object_sysstat] and is defined as follows:	
Ports	**Read**	**Write**
	0x60	
Request Value	-	-
Response Value	[object_sysstat]	-

Index	Value-Description	Type
0	System Status	Uint32
1	Operation Status	Uint32
2	Operation Sub-Status	Uint32
3	reserved	Uint32
4	reserved	Uint32

5.107 WARN – Warning Register

Key	WARN	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Read the 32bit system warning register (warning flags) in hex. Warning register is described in the T3 status manual.	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-
Response Value	Uint32hex	-
Examples TCP	Read actual warning register (there is no warning active) [TX] - TA60S0005--|WARN; [RX] - TA60R0009--|WARN=0x0;	

All these keys are qualified for auto-messaging.

To setup the auto message key, we use the T3 Key “AMSGS”. The set up for auto-messaging must be done for each key individually. We’ll have to set it up for “HIVOM” and “TUCUM” separately.

There are three modes available for the subscription:

- Off
- On event
- Periodical

4.12 AMSGS – Setup Auto Message Key

<table>
<tr><th>Key</th><td>AMSGS</td></tr>
<tr><th>AMSG allowed</th><td>On change: No, Periodical: No</td></tr>
<tr><th>Description</th><td>Setup the auto message configuration for one T3 key or read it back. The auto message setup object is defined as follows:
<table>
<tr><th>Index</th><th>Value-Description</th><th>Type</th><th>Description</th></tr>
<tr><td>0</td><td>Auto Message Key Name</td><td>String</td><td>The name of the T3 key to configure for auto message</td></tr>
<tr><td>1</td><td>Auto Message Mode</td><td>[Index_amsgm]</td><td>The mode for this key (off / on change / periodical)</td></tr>
<tr><td>2</td><td>Interval in [s]</td><td>Float64</td><td>The interval time in [s] (min = 0.01s, max = 86400s =1day, default=1s):
• for on change this is the max interval
• for periodical this is the period</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table>
For each key the mode defines whether and under what conditions auto messages are generated. The mode is defined by the index [index_amsgm]:
<table>
<tr><th>Name</th><th>Value</th><th>Note</th></tr>
<tr><td>OFF</td><td>0</td><td>The specific key doesn’t generate any auto messages (deactivated)</td></tr>
<tr><td>ON_EVENT</td><td>1</td><td>The specific key generates auto messages if the contained data has changed.
For this mode the interval (see [object_amsgs]) limits how often change events are signaled. If multiple changes arise within the given interval, only the first and under certain circumstances the last will generate an auto message.</td></tr>
<tr><td>PERIODICAL</td><td>2</td><td>The specific key generates auto message periodically with a period defined by the interval (see [object_amsgs]).</td></tr>
</table>
Note: auto messages will not be generated if the auto message handler is not enabled which can be done by sending the AMSGE key.

The generated auto messages will have the T3 message type asynchronous to differ between auto messages and responses.</td></tr>
</table>

In the example we will use a periodical subscription with an interval of 1 second.

4.4.1 Set up auto message for HIVOM

```
[TX] – TA10S0010--|AMSGS=HIVOM,2,1;
[RX] – TA10R0009--|AMSGS=#0;
```

4.4.2 Set up auto message for TUCUM

```
[TX] – TA10S0010--|AMSGS=TUCUM,2,1;
[RX] – TA10R0009--|AMSGS=#0;
```

4.4.3 Set up auto message for SYSSTAT

```
[TX] – TA10S0014--|AMSGS=SYSSTAT,1,0.1;
[RX] – TA10R0009--|AMSGS=#0;
```

4.4.4 Set up auto message for WARN

```
[TX] – TA10S0011--|AMSGS=WARN,1,0.1;
[RX] – TA10R0009--|AMSGS=#0;
```

4.4.5 Enable the auto message feature

In this very next step, the auto message can be enabled.
First, we read the status of the auto message handler:

```
[TX] – TA60S0006--|AMSGE;
[RX] – TA60R0008--|AMSGE=0; → auto message is disabled
```

If we enable the auto message handler, all previously configured auto message keys will be processed / sent over the T3 protocol.

```
[TX] – TA10S0008--|AMSGE=1;
[RX] – TA10R0009--|AMSGE=#0; → positive acknowledge
```

Verify and read the status of the auto message handler (enabled)

```
[TX] – TA60S0006--|AMSGE;
[RX] – TA60R0008--|AMSGE=1; → auto message is enabled
```

If we would like to stop the auto messaging feature, we can disable the auto message handler:

```
[TX] – TA10S0008--|AMSGE=0;
[RX] – TA10R0009--|AMSGE=#0; → positive acknowledge
```

4.5 Check in the diagnostic report if communication errors are happening

The diagnostic report indicates if syntax errors are happening in the communication on the T3 protocol. Check the files syslog.txt in the log-history of the diagnostic report to ensure that the implementation of the T3 protocol is correct. To download and open the diagnostic report, refer to the service manual.

Example of communication errors reported into the diagnostic report:

2023-… local0.warning IFC: [WARNING] com-svclibt3com: T3ComSocketAdapter: failed to process rx data -> exception 33 - invalid ASCII hex number encoding

2023…local0.warning IFC: [WARNING] com-svc system:Unknown Tube key received (len=7): NLHIVO

5 Appendix – Public Keys

5.1 ACIEXPTM – Application Initial Operation Exposure Time

Key	ACIEXPTM	
AMSG allowed	On change: No, Periodical: No	
Description	Set the application initial operation exposure time. The key works similar to the EXPTM key as time can be set with an object_time or just as [s]. For more details check the EXPTM key. The application initial operation values are used after a power cycle if the mode (see ACIM key) is set to CONFIGURED_PARAMS.	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	[object_time] with varying elements [h,min,s], [min,s] or [s].
Response Value	[object_time]	ACK ReturnCode #0
Examples TCP	Read application initial op exposure time set to 0: [TX] - TA60S0009--|ACIEXPTM; [RX] - TA60R000F--|ACIEXPTM=0,0,0; Write and read back application initial op exposure time (2h,45min,30s): [TX] - TA10S0011--|ACIEXPTM=2,45,30; [RX] - TA10R000C--|ACIEXPTM=#0; [TX] - TA60S0009--|ACIEXPTM; [RX] - TA60R0011--|ACIEXPTM=2,45,30; Write and read back application initial op exposure time (300min,99s → 5h,1min,39s): [TX] - TA10S0010--|ACIEXPTM=300,99; [RX] - TA10R000C--|ACIEXPTM=#0; [TX] - TA60S0009--|ACIEXPTM; [RX] - TA60R0010--|ACIEXPTM=5,1,39; Write and read back application initial op exposure time (3855s → 1h,4min,15s): [TX] - TA10S000E--|ACIEXPTM=3855; [RX] - TA10R000C--|ACIEXPTM=#0; [TX] - TA60S0009--|ACIEXPTM; [RX] - TA60R0010--|ACIEXPTM=1,4,15;	

5.2 ACIFOCSL – Application Initial Operation Focal Spot

Key	ACIFOCSL	
AMSG allowed	On change: No, Periodical: No	
Description	Select a focal spot or read back the actually selected one for the application initial operation parameter. The application initial operation values are used after a power cycle if the mode (see ACIM key) is set to CONFIGURED_PARAMS.	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Uint32 - [index_foc]
Response Value	Uint32 - [index_foc]	ACK ReturnCode #0
Examples TCP	Read the application initial op focal spot: [TX] - TA60S0009--|ACIFOCSL; [RX] - TA60R000B--|ACIFOCSL=0; Set the application initial op focal spot (to 1): [TX] - TA10S000B--|ACIFOCSL=1; [RX] - TA10R000C--|ACIFOCSL=#0; Read the application initial op focal spot: [TX] - TA60S0009--|ACIFOCSL;	

	[RX] - TA60R000B--|ACIFOCSL=1;

5.3 ACIHIVO – Application Initial Operation High Voltage

Key	ACIHIVO	
AMSG allowed	On change: No, Periodical: No	
Description	Set the application initial operation high voltage in [V] or read it back in [V]. The application initial operation values are used after a power cycle if the mode (see ACIM key) is set to CONFIGURED_PARAMS.	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Float64 [V]
Response Value	Float64 [V]	ACK ReturnCode #0
Examples TCP	Read application initial op high voltage [TX] - TA60S0008--|ACIHIVO; [RX] - TA60R000A--|ACIHIVO=0; Set applicaton initial op hivo to 100kV and read it back [TX] - TA10S000E--|ACIHIVO=100e3; [RX] - TA10R000B--|ACIHIVO=#0; [TX] - TA60S0008--|ACIHIVO; [RX] - TA60R000F--|ACIHIVO=100000;	

5.4 ACIM – Application Initial Operation Mode

Key	ACIM		
AMSG allowed	On change: No, Periodical: No		
Description	Sets or reads the application initial operation mode. After a power cycle the operation parameters shall be initialized depending of the selected mode. If NONE is selected the operation parameters are set to minimum (high voltage, tube/emission current, exposure time, focal spot). If CONFIGURED_PARAMS is selected, then the application initial parameter is loaded. The autosave function saves the last used parameters if FSM state changes to HV Off (Leaving HV operation state). If AUTOSAVE is selected, then these saved parameters are loaded.		
	Name	**Value**	**Note**
	NONE	0	use hivo.min, is default
	CONFIGURED_PARAMS	1	use application initial operation parameters
	AUTOSAVE	*2*	*use autosaved parameters*
Ports	**Read**		**Write**
	0x60		0x10
Request Value	-		[index_acim]
Response Value	[index_acim]		ACK ReturnCode #0
Examples TCP	Read application initial mode [TX] - TA60S0005--|ACIM; [RX] - TA60R0007--|ACIM=0; Set application initial op mode to autosave and read it back [TX] - TA10S0007--|ACIM=2; [RX] - TA10R0008--|ACIM=#0; [TX] - TA60S0005--|ACIM; [RX] - TA60R0007--|ACIM=2;		

5.5 ACITUCU – Application Initial Operation Tube Current

Key	ACITUCU
AMSG allowed	On change: No, Periodical: No
Description	Read or write the application initial operation tube/emission current in [A].

	The application initial operation values are used after a power cycle if the mode (see ACIM key) is set to CONFIGURED_PARAMS.	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Float64 [A]
Response Value	Float64 [A]	ACK ReturnCode #0
Examples TCP	Set application initial op tube current to 3mA and read it back [TX] - TA10S000D--|ACITUCU=3e-3; [RX] - TA10R000B--|ACITUCU=#0; [TX] - TA60S0008--|ACITUCU; [RX] - TA60R000E--|ACITUCU=0.003	

5.6 ALARCWIN – Application Limit Max Allowed Arcs in Window

Key	ALARCWIN	
AMSG allowed	On change: No, Periodical: No	
Description	Sets or reads the application limits for maximal allowed Arcs in the specified Arc window. Default value is 4. If 0 is set, after an arc the generator will immediately stop with an arc shut down code.	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Int32
Response Value	Int32	ACK ReturnCode #0
Examples TCP	Read the application limit for ALARCWIN [TX] - TA60S0009--|ALARCWIN; [RX] - TA60R000B--|ALARCWIN=4; Sets the application limits max arcs in windows to 0 [TX] - TA10S000B--|ALARCWIN=0; [RX] - TA10R000C--|ALARCWIN=#0;	

5.7 ALFILCU– Application Limit Filament Current

Key	ALFILCU			
AMSG allowed	On change: No, Periodical: No			
Description	Sets or reads the application limits for filament current. Application limits are focal spot independent. Application limits are stored persistently. Unit of min/max filament current is [A].			
	Index	**Value-Description**	**Type**	**Description**
	0	min	Float64	Min Limit [SI-Unit]
	1	max	Float64	Max Limit [SI-Unit]
	2	focalspot	[Index_foc]	Optional Parameter used if limits are focalspot dependent. If no focalspot is set the current focalspot is taken.
Ports	**Read**		**Write**	
	0x60		0x10	
Request Value	-		[object_limrng] (min/max in [A])	
Response Value	[object_limrng] (min/max in [A])		ACK ReturnCode #0	
Examples TCP	Read the application limits filament current [TX] - TA60S0008--|ALFILCU; [RX] - TA60R000D--|ALFILCU=0,10; Sets the application limits filcu (min = 0.2A, max = 5.6A) [TX] - TA10S0010--|ALFILCU=0.2,5.6; [RX] - TA10R000B--|ALFILCU=#0;			

5.8 ALHIVO– Application Limit High Voltage

Key	ALHIVO	
AMSG allowed	On change: No, Periodical: No	
Description	Sets or reads the application limits for high voltage. Application limits are focal spot independent. Application limits are stored persistently. The unit for application limits min/max high voltage is [V].	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	[object_limrng] (min/max in [V])
Response Value	[object_limrng] (min/max in [V])	ACK ReturnCode #0
Examples TCP	Read the application limits high voltage [TX] - TA60S0007--|ALHIVO; [RX] - TA60R0011--|ALHIVO=0,1000000; Sets the application limits hivo (min = 7kV, max = 110kV) [TX] - TA10S0013--|ALHIVO=7000,110000; [RX] - TA10R000A--|ALHIVO=#0;	

5.9 ALPWR– Application Limits Power

Key	ALPWR	
AMSG allowed	On change: No, Periodical: No	
Description	Sets or reads the application limits for power. Application limits are focal spot independent. Application limits are stored persistently. The unit for application limits min/max power is [W].	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	[object_limrng] (min/max in [W])
Response Value	[object_limrng] (min/max in [W])	ACK ReturnCode #0
Examples TCP	Read the application limits power [TX] - TA60S0006--|ALPWR; [RX] - TA60R0010--|ALPWR=10,7653.5; Sets the application limits power(min = 10W, max = 7653.5W) [TX] - TA10S0010--|ALPWR=10,7653.5; [RX] - TA10R0009--|ALPWR=#0;	

5.10 ALTUCU– Application Limit Tube Current

Key	ALTUCU	
AMSG allowed	On change: No, Periodical: No	
Description	Sets or reads the application limits for tube current. Application limits are focalspot independent. Application limits are stored persistently. The unit for application limits tube current is [A].	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	[object_limrng] (min/max in [A])
Response Value	[object_limrng] (min/max in [A])	ACK ReturnCode #0
Examples TCP	Read the application limits tube current [TX] - TA60S0007--|ALTUCU; [RX] - TA60R000E--|ALTUCU=0,0.05; Sets the application limits tucu (min = 3mA, max = 35mA) [TX] - TA10S0013--|ALTUCU=0.003,0.035; [RX] - TA10R000A--|ALTUCU=#0;	

5.11 AMSGE – Auto Message Enable/Disable

Key	AMSGE
AMSG allowed	On change: No, Periodical: No

Description	Enables or disables the auto message generation for all configured auto message keys.	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Boolean: 0 = disable 1 = enable
Response Value	Boolean: 0 = disabled 1 = enabled	ACK ReturnCode #0
Examples TCP	Read the status of the auto message handler (disabled) [TX] – TA60S0006--|AMSGE; [RX] – TA60R0008--|AMSGE=0; Enable the auto message handler (configured auto message keys will be processed / sent after this) [TX] – TA10S0008--|AMSGE=1; [RX] – TA10R0009--|AMSGE=#0; Read the status of the auto message handler (enabled) [TX] – TA60S0006--|AMSGE; [RX] – TA60R0008--|AMSGE=1;	

5.12 AMSGS – Setup Auto Message Key

Key	AMSGS
AMSG allowed	On change: No, Periodical: No
Description	Setup the auto message configuration for one T3 key or read it back. The auto message setup object is defined as follows:

Index	Value-Description	Type	Description
0	Auto Message Key Name	String	The name of the T3 key to configure for auto message
1	Auto Message Mode	[Index_amsgm]	The mode for this key (off / on change / periodical)
2	Interval in [s]	Float64	The interval time in [s] (min = 0.01s, max = 86400s =1day, default=1s): • for on change this is the max interval • for periodical this is the period

For each key the mode defines whether and under what conditions auto messages are generated. The mode is defined by the index [index_amsgm]:

Name	Value	Note
OFF	0	The specific key doesn't generate any auto messages (deactivated)
ON_EVENT	1	The specific key generates auto messages if the contained data has changed. For this mode the interval (see [object_amsgs]) limits how often change events are signaled. If multiple changes arise within the given interval, only the first and under certain circumstances the last will generate an auto message.
PERIODICAL	2	The specific key generates auto message periodically with a period defined by the interval (see [object_amsgs]).

Note: auto messages will not be generated if the auto message handler is not enabled which can be done by sending the AMSGE key.

<table>
<tr><td></td><td colspan="2">The generated auto messages will have the T3 message type asynchronous to differ between auto messages and responses.</td></tr>
<tr><td rowspan="2">Ports</td><td>Read</td><td>Write</td></tr>
<tr><td>0x60</td><td>0x10</td></tr>
<tr><td>Request Value</td><td>String
(the t3 key to read the configuration)</td><td>[object_amsgs]</td></tr>
<tr><td>Response Value</td><td>[object_amsgs]</td><td>ACK ReturnCode #0</td></tr>
<tr><td>Examples TCP</td><td colspan="2">Setup&read auto msg. config for HIVOM (off/int. defaults to 1s)
[TX] – TA10S0010--|AMSGS=HIVOM,0,0;
[RX] – TA10R0009--|AMSGS=#0;
[TX] – TA60S000C--|AMSGS=HIVOM;
[RX] – TA60R0010--|AMSGS=HIVOM,0,1;
Setup&read auto msg. config for HIVOM (on event/10ms)
[TX] – TA10S0013--|AMSGS=HIVOM,1,0.01;
[RX] – TA10R0009--|AMSGS=#0;
[TX] – TA60S000C--|AMSGS=HIVOM;
[RX] – TA60R0013--|AMSGS=HIVOM,1,0.01;
Setup&read auto msg. config for HIVOM (peridocal/1.5s)
[TX] – TA10S0012--|AMSGS=HIVOM,2,1.5;
[RX] – TA10R0009--|AMSGS=#0;
[TX] – TA60S000C--|AMSGS=HIVOM;
[RX] – TA60R0012--|AMSGS=HIVOM,2,1.5;
Setup&read auto msg. config for TUCUM (off/int. defaults to 1s)
[TX] – TA10S0010--|AMSGS=TUCUM,0,0;
[RX] – TA10R0009--|AMSGS=#0;
[TX] – TA60S000C--|AMSGS=TUCUM;
[RX] – TA60R0010--|AMSGS=TUCUM,0,1;
Setup&read auto msg. config for TUCUM (on event/10ms)
[TX] – TA10S0012--|AMSGS=TUCUM,1,1.0;
[RX] – TA10R0009--|AMSGS=#0;
[TX] – TA60S000C--|AMSGS=TUCUM;
[RX] – TA60R0010--|AMSGS=TUCUM,1,1;
Setup&read auto msg. config for TUCUM (peridocal/1.0s)
[TX] – TA10S0012--|AMSGS=TUCUM,2,1.0;
[RX] – TA10R0009--|AMSGS=#0;
[TX] – TA60S000C--|AMSGS=TUCUM;
[RX] – TA60R0010--|AMSGS=TUCUM,2,1;
Setup CONTEST periodical/1s, activate auto message handler,
after 5s → deactivate auto message handler:
16:26:47.960 [TX] – TA10S0013--|AMSGS=CONTST,2,1.0;
16:26:47.970 [RX] – TA10R0009--|AMSGS=#0;
16:26:49.630 [TX] – TA10S0008--|AMSGE=1;
16:26:49.636 [RX] – TA10R0009--|AMSGE=#0;
16:26:49.648 [RX] – TA60A000D--|CONTST=hello;
16:26:50.644 [RX] – TA60A000D--|CONTST=hello;
16:26:51.645 [RX] – TA60A000D--|CONTST=hello;
16:26:52.647 [RX] – TA60A000D--|CONTST=hello;
16:26:53.650 [RX] – TA60A000D--|CONTST=hello;
16:26:54.127 [TX] – TA10S0008--|AMSGE=0;
16:26:54.136 [RX] – TA10R0009--|AMSGE=#0;
Setup HIVO, TUCU & NRDY periodical/1s, activate auto message
handler, after 5s stop NRDY, after 10s stop HIVO, after 15s
stop TUCU (auto message handler still active)
Configuration and activation sequence:
16:31:53.300 [TX] – TA10S0013--|AMSGS=HIVOM,2,1.00;
16:31:53.309 [RX] – TA10R0009--|AMSGS=#0;
16:31:56.300 [TX] – TA10S0012--|AMSGS=TUCUM,2,1.0;
16:31:56.305 [RX] – TA10R0009--|AMSGS=#0;
16:32:05.125 [TX] – TA10S0011--|AMSGS=NRDY,2,1.0;
16:32:05.132 [RX] – TA10R0009--|AMSGS=#0;
16:32:18.028 [TX] – TA10S0008--|AMSGE=1;
16:32:18.038 [RX] – TA10R0009--|AMSGE=#0;</td></tr>
</table>

```
Auto message sequence:
16:32:18.252 [RX] - TA60A003B--
|HIVOM=0;TUCUM=0;NRDY=0x11004,0x0,0x0,0x5E,0x0,0x0,0x10,0x0;
16:32:19.047 [RX] - TA60A003B--
|HIVOM=0;TUCUM=0;NRDY=0x11004,0x0,0x0,0x5E,0x0,0x0,0x10,0x0;
16:32:20.049 [RX] - TA60A003B--
|HIVOM=0;TUCUM=0;NRDY=0x11004,0x0,0x0,0x5E,0x0,0x0,0x10,0x0;
16:32:21.049 [RX] - TA60A003B--
|HIVOM=0;TUCUM=0;NRDY=0x11004,0x0,0x0,0x5E,0x0,0x0,0x10,0x0;
16:32:22.049 [RX] - TA60A003B--
|HIVOM=0;TUCUM=0;NRDY=0x11004,0x0,0x0,0x5E,0x0,0x0,0x10,0x0;
Stop NRDY by setting it's mode to OFF
16:32:22.406 [TX] - TA10S000F--|AMSGS=NRDY,0,0;
16:32:22.419 [RX] - TA10R0009--|AMSGS=#0;
Auto message sequence:
16:32:23.049 [RX] - TA60A0010--|HIVOM=0;TUCUM=0;
16:32:24.050 [RX] - TA60A0010--|HIVOM=0;TUCUM=0;
16:32:25.051 [RX] - TA60A0010--|HIVOM=0;TUCUM=0;
16:32:26.050 [RX] - TA60A0010--|HIVOM=0;TUCUM=0;
16:32:27.050 [RX] - TA60A0010--|HIVOM=0;TUCUM=0;
Stop HIVOM by setting it's mode to OFF
16:32:27.446 [TX] - TA10S0010--|AMSGS=HIVOM,0,0;
16:32:27.453 [RX] - TA10R0009--|AMSGS=#0;
Auto message sequence:
16:32:28.050 [RX] - TA60A0008--|TUCUM=0;
16:32:29.052 [RX] - TA60A0008--|TUCUM=0;
16:32:30.052 [RX] - TA60A0008--|TUCUM=0;
16:32:31.053 [RX] - TA60A0008--|TUCUM=0;
16:32:32.052 [RX] - TA60A0008--|TUCUM=0;
Stop TUCUM by setting it's mode to OFF
16:32:32.258 [TX] - TA10S0010--|AMSGS=TUCUM,0,0;
16:32:32.270 [RX] - TA10R0009--|AMSGS=#0;
Since no more auto messages are active, no more will be
generated, even if the auto message handler is still enabled.
Reactivating a key will immediately restart the auto message
generation.
```

Fig. 8: shows the timing for an auto message key with on change or periodical mode. The monitored value is a T3 key with underlining value (e.g. HIVOM). The interval time is for both auto message modes the same. The values sent for the on change and periodical modes are marked in the corresponding timelines (send state in “on change” and “periodical”).

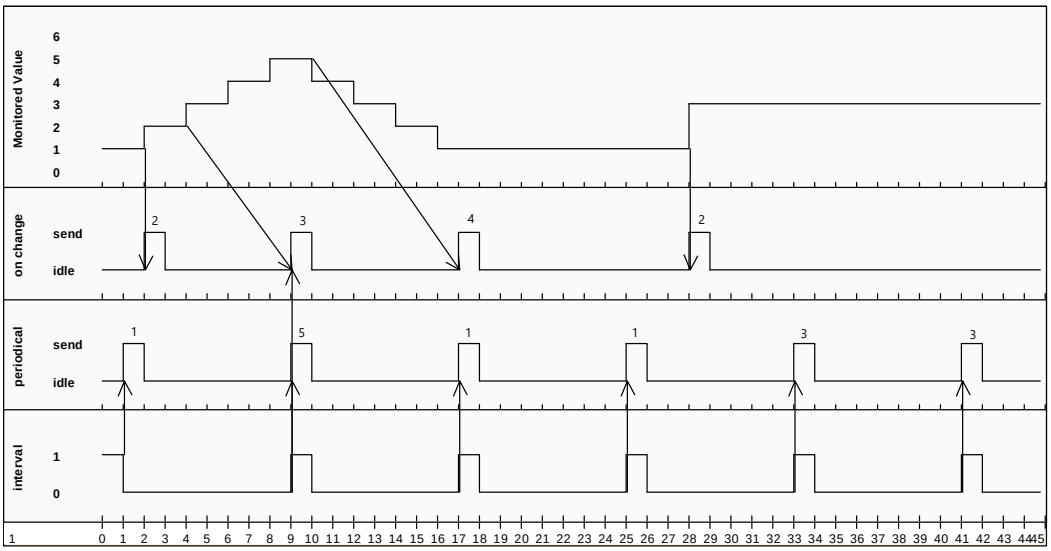


Fig. 8: Auto message timing for on change and periodical configuration

The on-change mode will immediately send the new value after the first change. If consecutive value changes are following within the given time interval, the value after the second change will be sent after the interval time is elapsed. All other changes within the interval time will be ignored, therefore set the interval as low as necessary to capture all changes required (although the minimal interval time is defined as 50ms to avoid heavy communication interface load).

The periodical mode works as the name says periodically and simply sends the current value every so often (defined by the interval time, minimal interval time is 50ms to avoid heavy communication interface load)

5.13 ARCCNT – Arc Count

Key	ARCCNT	
AMSG allowed	On change: No, Periodical: No	
Description	The systems Arc counter is output	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-
Response Value	Uint32	-
Examples TCP	Read the arc count [TX] - TA60S0007--|ARCCNT; [RX] - TA60R0009--|ARCCNT=3;	

5.14 ARCINT– Arc Intensity

Key	ARCINT	
AMSG allowed	On change: No, Periodical: No	
Description	Arc Intensity isn't measured on generators. For compatibility reasons to MG this key is added. Key returns value 4.	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-
Response Value	Uint32	-
Examples TCP	Read the arc intensity [TX] - TA60S0007--|ARCINT; [RX] - TA60R0009--|ARCINT=4;	

5.15 APHEN – Auto Preheat Enable/Disable

Key	APHEN	
AMSG allowed	On change: No, Periodical: No	
Description	Enable or disable filament Auto preheat mode. If enabled, the generator supplies the tube filament with the tubes auto preheat current value as soon as mains power is present and for the maximum duration configured with the APHTO key	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Boolean 0: Disable 1: Enable
Response Value	Boolean	ACK ReturnCode #0
Examples TCP	Enable the Filament Heating Mode [TX] - TA10S0008--|APHEN=1; [RX] - TA10R0009--|APHEN=#0;	

5.16 APHTO – Auto Preheat Timeout

Key	APHTO	
AMSG allowed	On change: No, Periodical: No	
Description	Read or write the configured auto preheat timeout value (Maximum idle time for which the auto preheat filament current is maintained. Has no effect if the auto preheat mode is disabled. Only values from 300 to 1800 seconds are allowed. Default value is 1800 (30 minutes). Change is applied after a reboot of the IFC.	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Int32 [s]
Response Value	Uint32 [s]	ACK ReturnCode #0
Examples TCP	Read the configured cooler flow timeout [TX] - TA60S0006--|APHTO; [RX] - TA60R000B--|APHTO=1800; Set the cooler flow timeout to 3s [TX] - TA10S000A--|APHTO=300; [RX] - TA10R0009--|APHTO=#0; [TX] - TA60S0006--|APHTO; [RX] - TA60R000A--|APHTO=300;	

5.17 BSPVERS – IFC BSP version

Key	BSPVERS	
AMSG allowed	On change: No, Periodical: No	
Description	Returns the software version of the BSP (board support package) used on the IFC device. The BSP version can differ from the IFC software version.	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-
Response Value	String	-
Examples TCP	Read request [TX] - TA60S0008--|BSPVERS; [RX] - TA60R0016--|BSPVERS=V.0.4.0.16177;	

5.18 CLEN – Cable Length

Key	CLEN	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Configure the HV-cable length. The maximum configurable cable length can be found with key CLENMAX. Cable length is stored persistently. For a bipolar generator anode- and cathode-cable length must have the same length. Configure cable length of one cable. Change affects after a reboot of the IFC.	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Float64 [m]
Response Value	Float64 [m]	-
Examples TCP	Read cable length [TX] - TA60S0005--|CLEN; [RX] - TA60R0009--|CLEN=7.5; Set cable length [TX] - TA10S0009--|CLEN=7.5; [RX] - TA10R0008--|CLEN=#0;	

5.19 CLENMAX – Cable Length Max

Key	CLENMAX
AMSG allowed	On change: No, Periodical: No
Description	Gets the maximal configurable cable length.

Ports	Read	Write
	0x60	-
Request Value	-	-
Response Value	Float64 [m]	-
Examples TCP	Read cable length max [TX] - TA60S0008--|CLENMAX; [RX] - TA60R000B--|CLENMAX=35;	

5.20 CMSGx – Custom Message 1 and 2

Key	CMSG1 CMSG2	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Check the custom message digital input of the IFC.	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-
Response Value	Boolean	-
Examples TCP Read	Read Custom Message Input 1 [TX] - TA60S0006--|CMSG1; [RX] - TA60R0008--|CMSG1=0; Read Custom Message Input 2 [TX] - TA60S0006--|CMSG2; [RX] - TA60R0008--|CMSG2=1;	

5.21 CONTST – Connection Test

Key	CONTST	
AMSG allowed	On change: No, Periodical: Yes	
Description	This command is used to check the connection (on read port only) and response with a friendly “hello” string. Further the command can be used to check the existence of POCs, tanks, and ECU. If a device doesn’t exist, then a read on the specific port gets the return code #114.	
Ports	**Read**	**Write**
	0x60, 0x61, 0x62, 0x70, 0x80, 0x90	-
Request Value	-	-
Response Value	String: “hello”	-
Examples TCP Read	[TX] - TA60S0007--|CONTST; [RX] - TA60R000D--|CONTST=hello; Check for POC2 [TX] - TA62S0007--|CONTST; [RX] - TA62R000D--|CONTST=hello; No Anode Tank [TX] - TA90S0007--|CONTST; [RX] - TA90R000C--|CONTST=#114;	
Examples SCI Read	To device @ address 0x01 (iVario generator default address) [TX] - [AA0113--|TA60S0007--|CONTST;|A8B0] [RX] - [01AA19--|TA60R000D--|CONTST=hello;|D1B1] To Broadcast address: [TX] - [AAFF13--|TA60S0007--|CONTST;|A8B0] [RX] - [01AA19--|TA60R000D--|CONTST=hello;|D1B1]	

5.22 DHCPEN – DHCP client enable / disable

Key	DHCPEN
AMSG allowed	On change: Yes, Periodical: Yes
Description	Activate or deactivate dynamic network configuration (dhcp client). If dhcp is disabled, the network configuration needs to be configured with the key IFCNET. Change affects after a reboot of the IFC.

Ports	Read	Write
	0x60	0x10
Request Value	-	Boolean 0 = static ip config (dhcp off) 1 = dynamic ip config (dhcp on)
Response Value	Boolean 0 = static ip config (dhcp off) 1 = dynamic ip config (dhcp on)	-
Examples TCP	Read request [TX] - TA60S0007--|DHCPEN; [RX] - TA60R0009--|DHCPEN=0; Enable DHCP [TX] - TA10S0009--|DHCPEN=1; [RX] - TA10R000A--|DHCPEN=#0;	

5.23 DMPFILE – Trigger a log file dump

Key	DMPFILE	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Triggers a log file dump to the USB stick. It's like the action on a short S1 button press (copy logs to USB stick). **Name** / **Value** / **Note** DMPFILE_USB / 0 / Dump to USB **Index** / **Value-Description** / **Type** 0 / Destination to dump / Index_dmpfile 1 / Path / String All parameters are optional. If no parameter is set, dump is done to USB and path is the root directory. Therefore, if no path is set log is dumped to the root directory. The log is copied to a folder with the name "t3-dump". If the path is given it will be in the root folder with mnt/usbdrive/<YOUR PATH>.	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	object_dmpfile
Response Value	Boolean 0 = dumpfile process is idle 1 = dumpfile process is busy	• ACK ReturnCode #0 • Busy ReturnCode #113
Examples TCP	Trigger a log file dump to USB (path is optional) [TX] - TA10S0013--|DMPFILE=0,logs/lab; [RX] - TA10R000B--|DMPFILE=#0; Trigger a log file dump to USB and root directory [TX] - TA10S0008--|DMPFILE; [RX] - TA10R000B--|DMPFILE=#0; Read the dumpfile status, is busy [TX] - TA60S0008--|DMPFILE; [RX] - TA60R000A--|DMPFILE=1;	

5.24 EMCURV – Emission curve

Key	EMCURV	
AMSG allowed	On change: No, Periodical: No	
Description	Read the emission curve for the actual selected focal spot or a specific focal spot (value = [index_foc])	
Ports	**Read**	**Write**
	0x60	-
Request Value	One of the following: • none (for the actual selected FOC)	-

	• Uint32 - [index_foc]	
Response Value	Float64 list with 5 points on emission curve, each with [V, A]	-
Examples TCP	Read emission curve @ focal spot 0 [TX] - TA60S0009--|EMCURV=0; [RX] - TA60R0048--|EMCURV=10000,0.015,20000,0.03675,25000,0.04325,40000,0.054,70000,0.0642; Read emission curve @ focal spot 1 [TX] - TA60S0009--|EMCURV=1; [RX] - TA60R0046--|EMCURV=10000,0.003,25000,0.00575,34000,0.007,40000,0.00775,60000,0.01 Read emission curve @ actual selected focal spot (0) [TX] - TA60S0007--|EMCURV; [RX] - TA60R0048--|EMCURV=10000,0.015,20000,0.03675,25000,0.04325,40000,0.054,70000,0.0642;	

5.25 EXPTM – Exposure Time Set

Key	EXPTM	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Set the exposure time or read back the set value. The exposure time can be set using a list of [h,min,s], [min,s] or just [s]. Each value can exceed the "real world" time range (like 24h, 59min and 59s). The total time will be converted to seconds internally. **Value-Index** / **Value-Description** / **Type** 0 / hours / Uint32 1 / minutes / Uint32 2 / seconds / Uint32 Read back of the exposure time will always be in the format [h,min,s] and only the h-value can possibly exceed the "real world" time range. Therefore, a value which was set to 300s will result on a read back with "0,5,0" (5 minutes). Note: The exposure time maximum is limited to (2^{16}-1) seconds which will lead to 18h12m15s.	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	object_time with varying elements [h,min,s], [min,s] or [s].
Response Value	[object_time]	ACK ReturnCode #0
Examples TCP	Write & read back exposure time (2h,45min,30s): [TX] - TA10S000E--|EXPTM=2,45,30; [RX] - TA10R0009--|EXPTM=#0; [TX] - TA60S0006--|EXPTM; [RX] - TA60R000E--|EXPTM=2,45,30; Write & read back exposure time (300min,99s → 5h,1min,39s): [TX] - TA10S000D--|EXPTM=300,99; [RX] - TA10R0009--|EXPTM=#0; [TX] - TA60S0006--|EXPTM; [RX] - TA60R000D--|EXPTM=5,1,39; Write & read back exposure time (3855s → 1h,4min,15s): [TX] - TA10S000B--|EXPTM=3855; [RX] - TA10R0009--|EXPTM=#0; [TX] - TA60S0006--|EXPTM; [RX] - TA60R000D--|EXPTM=1,4,15;	

5.26 EXPTMM – Exposure Time Actual

Key	EXPTMM

AMSG allowed	On change: Yes, Periodical: Yes	
Description	Read the remaining exposure time until stop HV as object_time	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-
Response Value	[object_time]	-
Examples TCP	Read actual exposure time 0 (HV stopped or EXPTM never set): [TX] - TA60S0007--|EXPTMM; [RX] - TA60R000D--|EXPTMM=0,0,0; Read actual exposure time 1h, 15min, 30s: [TX] - TA60S0007--|EXPTMM; [RX] - TA60R000F--|EXPTMM=1,15,30;	

5.27 FILCUM – Filament Current Actual

Key	FILCUM	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Read the measured filament current (control reference value) in [A]. Reference value for filament current is in function to tube current and tube high voltage and cannot be directly controlled.	
Ports	**Read**	**Write**
	0x60, 0x70	-
Request Value	-	-
Response Value	Float64 [A]	-
Examples TCP	Read actual filament current (0) [TX] - TA60S0007--|FILCUM; [RX] - TA60R0009--|FILCUM=0; Read actual filament current (1.56A) [TX] - TA60S0007--|FILCUM; [RX] - TA60R000C--|FILCUM=1.56; Read actual filament current from ECU (1.936 A) [TX] - TA70S0007--|FILCUM; [RX] - TA70R000D--|FILCUM=1.936;	

5.28 FILVOM – Filament Voltage Actual

Key	FILVOM	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Read the measured filament voltage.	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-
Response Value	Float64 [V]	-
Examples TCP	Read actual filament voltage [TX] - TA60S0007--|FILVOM; [RX] - TA60R000C--|FILVOM=2.56;	

5.29 FOCCNT – Focal Spot Count

Key	FOCCNT	
AMSG allowed	On change: No, Periodical: No	
Description	Returns the number of available focal spots of the selected tube (see also SELTUB). The number of focal spots is depending on the tube installed, can vary between 1 to 2 for the mini focus tubes and up to 5 for the MF tubes.	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-

Response Value	Uint32	-
Examples TCP	Read focal spot count: [TX] - TA60S0007--|FOCCNT; [RX] - TA60R0009--|FOCCNT=2; Read focal spot count on a MXR-225MF tube: [TX] - TA60S0007--|FOCCNT; [RX] - TA60R0009--|FOCCNT=3;	

5.30 FOCSL – Selected Focal Spot

Key	FOCSL	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Select a focal spot or read back the selected one. This key takes (write) or returns (read) the focal spot index. **Changing focal spot requires 1-2s.** During the change, the system status changes to NRDY until requested focal spot is selected. Check SYSSTAT to check completion before continuing the sequence with the next keys. The number of focal spots is depending on the tube installed (see tube data sheet), can vary between 1 to 2 for the mini focus tubes and up to 5 for the MF tubes. FOCCNT returns the number of focal spots for the installed tube (SELTUB).	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Uint32 - [index_foc]
Response Value	Uint32 - [index_foc]	ACK ReturnCode #0
Examples TCP	Read actual focal spot: [TX] - TA60S0006--|FOCSL; [RX] - TA60R0008--|FOCSL=0; Set new focal spot (to 1): [TX] - TA10S0008--|FOCSL=1; [RX] - TA10R0009--|FOCSL=#0; Read actual focal spot: [TX] - TA60S0006--|FOCSL; [RX] - TA60R0008--|FOCSL=1; Read focal spot on a MF tube: [TX] - TA60S0006--|FOCSL; [RX] - TA60R0008--|FOCSL=3;	

Name	**Value**	**Note**
FOCALSPOT_1	0	In iVario-Control, for mini focus tube = Large
FOCALSPOT_2	1	In iVario-Control, for mini focus tube = Small
FOCALSPOT_3	*2*	Available on some MF tubes type
FOCALSPOT_4	*3*	Available on some MF tubes type
FOCALSPOT_5	*4*	Available on some MF tubes type

5.31 FOCSZ – Size of Selected Focal Spot

Key	FOCSZ	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Read the configured size of the actual focal spot (read with no value) or the focal spot @ the given index.	
Ports	**Read**	**Write**
	0x60	-
Request Value	One of the following: • none	-

	• Uint32 - [index_foc]	
Response Value	Float64 [m]	-
Examples TCP	Set new focal spot (to 0): [TX] - TA10S0008--|FOCSL=0; [RX] - TA10R0009--|FOCSL=#0; Read actual selected focal spot size in [m] [TX] - TA60S0006--|FOCSZ; [RX] - TA60R000D--|FOCSZ=0.0055; Read focal spot size of FOC0 in [m] [TX] - TA60S0008--|FOCSZ=0; [RX] - TA60R000D--|FOCSZ=0.0055; Read focal spot size of FOC1 in [m] [TX] - TA60S0008--|FOCSZ=1; [RX] - TA60R000D--|FOCSZ=0.0012; Read focal spot size of FOC4 on a MF tube in [m] [TX] - TA60S0008--|FOCSZ=4; [RX] - TA60R000D--|FOCSZ=6.3e-05;	

5.32 GENCTM – Generator clock time and date

Key	GENCTM	
AMSG allowed	On change: No, Periodical: No	
Description	Sets or reads the clock time and date of the generator. The value is a ISO8601 formatted time/date string including UTC offset / time zone YYYYMMDDThhmmss±hhmm. Here an example: 20240316T050719+0000. Writing the UTC offset time different to 0000 will correct the time accordingly and returns the corrected time as UTC with +0000 as offset	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	String
Response Value	String	-
Examples TCP	Set clock / time of the generator [TX] - TA10S001C--|GENCTM=20240316T060719+0100; [RX] - TA10R000A--|GENCTM=#0; Read clock / time of the generator [TX] - TA60S0007--|GENCTM; [RX] - TA60R001C--|GENCTM=20240316T050719+0000;	

5.33 GENTYP – Generator Type

Key	GENTYP	
AMSG allowed	On change: No, Periodical: No	
Description	Reads type of the generator **Name** / **Value** / **Note** **GENTYPE_COMET_iVario** / 0 / COMET iVario **GENTYPE_COMET_MF** / 2 / COMET MF	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-
Response Value	[index_gentype]	-
Examples TCP	Read generator type COMET [TX] - TA60S0007--|GENTYP; [RX] - TA60R0009--|GENTYP=0;	

5.34 GENTZN – Generator time zone (DEPRECATED)

Key	GENTZN
AMSG allowed	On change: No, Periodical: No

Description	From V.4.0, time zone is fixed to UTC. The key is still usable for compatibility but has no effect. Setting a time zone is accepted but has no effect, will remain at UTC. Reading the time zone of the generator returns always “UTC”.	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	String
Response Value	String	-
Examples TCP	Set timezone of the generator [TX] – TA10S0015--|GENTZN= Europe/Zurich; [RX] – TA10R000A--|GENTZN=#0; Read timezone of the generator [TX] – TA60S0007--|GENTZN; [RX] – TA60R0015--|GENTZN=UTC;	

5.35 GRDEN – Communication Guard Enable

Key	GRDEN	
AMSG allowed	On change: No, Periodical: No	
Description	Enables or disables guarded communication on all interfaces. Has no effect on interfaces where the guard mode is set to “disabled” **Warning:** This setting persists. Do not forget to reenable it if you disable it for debugging a system.	

Name	**Value**	**Note**
OFF	0	Disable all com-guards
ON	1	Enable all com-guards

Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Uint32
Response Value	Uint32	ACK ReturnCode #0
Examples TCP	Read communication guard enable: [TX] – TA60S0006--|GRDEN; [RX] – TA60R0008--|GRDEN=1; Disable guarded communication: [TX] – TA10S0008--|GRDEN=0; [RX] – TA10R0009--|GRDEN=#0; Enable guarded communication: [TX] – TA10S0008--|GRDEN=1; [RX] – TA10R0009--|GRDEN=#0;	

5.36 GRDKA – Communication Guard Keep-Alive

Key	GRDKA	
AMSG allowed	On change: No, Periodical: No	
Description	Resets the Interfaces Guard timeout. If guarded communication is enabled on this interface, this key must be written by the client periodically. The send interval must be faster than the guard timeout set for this interface. This is for detection of client connection loss. If the client fails to write this key in the needed time, the generator will react according to the guard mode set for this interface, resulting in a shutdown and/or a not ready condition set.	
Ports	**Read**	**Write**
		0x10
Request Value	-	-
Response Value	[index_gentype]	-
Examples TCP	Reset the interface Guard timeout [TX] – TA10S0006--|GRDKA; [RX] – TA10R0009--|GRDKA=#0;	

5.37 GRDM – Communication Guard Mode

<table>
<tr><th>Key</th><td colspan="3">GRDM</td></tr>
<tr><th>AMSG allowed</th><td colspan="3">On change: No, Periodical: No</td></tr>
<tr><th>Description</th><td colspan="3">The “GRDM” key gets or sets the guard-mode for the given interface. When read without attribute, it returns the guard mode of the interface it is read from. If read with the interface index [index_extitf] as attribute, it returns the guard mode of the interface specified. On write it takes the object_grdmode, which contains the interface index [index_extitf] and the guard-mode. On guarded interfaces, the client has to send the keep-alive key (GRDKA) on regular basis and within the timeout set by the GRDTO key, or action is taken depending on the mode set. There are three modes:
• DISABLED: the feature is disabled for this interface.
• RESTRICTIVE: when this mode is configured on an interface, the connected client has to send the keep-alive keys (GRDKA) periodically, otherwise the generator will set a not-ready code and will therefore not be able to start generating high-voltage. If the generator is already generating high-voltage, it will switch off and then set the not-ready code. The system gets ready again, as soon as all needed clients are back online. This should be the default mode if the guard is enabled.
• TOLERANT: in this mode, as soon as a client sends the keep-alive key (GRDKA) periodically, it will be guarded. So if the generator is generating high voltage, it switches off when the client stops sending the keep-alive. But the generator will not require the client to send the keep-alive key again, to switch on the next time.

Note: When using the guarded communication on the serial interface, make sure the serial protocol is set to T3. If the MG protocol is set, the guarded communication setting for the serial port is ignored.
<table>
<tr><th>Index</th><th>Value-Description</th><th>Type</th><th>Description</th></tr>
<tr><td>0</td><td>interface index</td><td>index_extitf</td><td>index of the interface</td></tr>
<tr><td>1</td><td>guard mode</td><td>index_grdmode</td><td>guard mode of the interface</td></tr>
</table>
<table>
<tr><th>Name</th><th>Value</th><th>Note</th></tr>
<tr><td>TCP_50506</td><td>0</td><td>TCP interface port 50506</td></tr>
<tr><td>TCP_50505</td><td>1</td><td>TCP interface port 50505</td></tr>
<tr><td>SERIAL</td><td>3</td><td>Serial Interface</td></tr>
</table>
<table>
<tr><th>Name</th><th>Value</th><th>Note</th></tr>
<tr><td>DISABLED</td><td>0</td><td>Comm. guard disabled</td></tr>
<tr><td>RESTRICTIVE</td><td>1</td><td>restrictive mode</td></tr>
<tr><td>TOLERANT</td><td>2</td><td>tolerant mode</td></tr>
</table></td></tr>
<tr><th>Ports</th><th>Read</th><th>Write</th></tr>
<tr><td></td><td>0x60</td><td>0x10</td></tr>
<tr><th>Request Value</th><td>[index_extitf]</td><td>[object_grdmode]</td></tr>
<tr><th>Response Value</th><td>[index_grdmode]</td><td>ACK ReturnCode #0</td></tr>
<tr><th>Examples TCP</th><td colspan="2">Read Mode of current Interface
[TX] - TA60S0005--|GRDM;
[RX] - TA60R0007--|GRDM=0;
Read Mode for tcp port 50506:
[TX] - TA60S0007--|GRDM=0;
[RX] - TA60R0007--|GRDM=1;
Set Mode for tcp port 50505 to tolerant:
[TX] - TA10S0009--|GRDM=1,2;
[RX] - TA10R0008--|GRDM=#0;</td></tr>
</table>

5.38 GRDTO – Communication Guard Timeout

<table>
<tr><th>Key</th><td colspan="2">GRDTO</td></tr>
<tr><td>AMSG allowed</td><td colspan="2">On change: No, Periodical: No</td></tr>
<tr><td>Description</td><td colspan="2">The “GRDTO” gets or sets the timeout for guarded communication on a specific interface. When read without attribute, it returns the guard timeout of the current interface. If read with the interface index [index_extitf] as attribute, it returns the guard timeout of the interface specified.
When written, it takes the interface index [index_extitf] as the first argument and a value of 1 to 4294967 (UINT32 maximum / 1000) as the second. The value set is in seconds.
<table>
<tr><th>Index</th><th>Value-Description</th><th>Type</th><th>Description</th></tr>
<tr><td>0</td><td>interface index</td><td>index_extitf</td><td>index of the interface</td></tr>
<tr><td>1</td><td>timeout</td><td>Uint32</td><td>timeout of communication guard in [s] (min=1, max=10)</td></tr>
</table>
<table>
<tr><th>Name</th><th>Value</th><th>Note</th></tr>
<tr><td>TCP_50506</td><td>0</td><td>TCP interface port 50506</td></tr>
<tr><td>TCP_50505</td><td>1</td><td>TCP interface port 50505</td></tr>
<tr><td>SERIAL</td><td>3</td><td>Serial Interface</td></tr>
</table></td></tr>
<tr><td rowspan="2">Ports</td><td>Read</td><td>Write</td></tr>
<tr><td>0x60</td><td>0x10</td></tr>
<tr><td>Request Value</td><td>[index_extitf]</td><td>[object_grdtimeout]</td></tr>
<tr><td>Response Value</td><td>Uint32</td><td>ACK ReturnCode #0</td></tr>
<tr><td>Examples TCP</td><td colspan="2">Read actual timeout of this interface:
[TX] - TA60S0005--|GRDTO;
[RX] - TA60R0008--|GRDTO=3;
Read actual Read Mode for tcp port 50506:
[TX] - TA60S0007--|GRDTO=0;
[RX] - TA60R0008--|GRDTO=1;
Set guard timeout Read Mode for tcp port 50505 to 5 seconds
[TX] - TA10S000A--|GRDTO=1,5;
[RX] - TA10R0009--|GRDTO=#0;</td></tr>
</table>

5.39 HIVO – High Voltage Set

<table>
<tr><th>Key</th><td colspan="2">HIVO</td></tr>
<tr><td>AMSG allowed</td><td colspan="2">On change: Yes, Periodical: Yes</td></tr>
<tr><td>Description</td><td colspan="2">Set the desired high voltage (set point) in [V] or read it back in [V].</td></tr>
<tr><td rowspan="2">Ports</td><td>Read</td><td>Write</td></tr>
<tr><td>0x60</td><td>0x10</td></tr>
<tr><td>Request Value</td><td>-</td><td>Float64 [V]</td></tr>
<tr><td>Response Value</td><td>Float64 [V]</td><td>ACK ReturnCode #0</td></tr>
<tr><td>Examples TCP</td><td colspan="2">Read actual high voltage before first set (min = 7.5kV)
[TX] - TA60S0005--|HIVO;
[RX] - TA60R000A--|HIVO=7500;
Set high voltage to 100kV and read it back
[TX] - TA10S000B--|HIVO=100e3;
[RX] - TA10R0008--|HIVO=#0;
[TX] - TA60S0005--|HIVO;
[RX] - TA60R000C--|HIVO=100000;
Set high voltage to 83.5kV and read it back
[TX] - TA10S000E--|HIVO=83.50e+3;
[RX] - TA10R0008--|HIVO=#0;
[TX] - TA60S0005--|HIVO;
[RX] - TA60R000B--|HIVO=83500;</td></tr>
</table>

5.40 HIVOM – High Voltage Measured

Key	HIVOM	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Read the measured high voltage total in [V]: • For bipolar operation this is the sum of POC1 and POC2 high voltage • For unipolar operation this is POC1 (master) high voltage Note: the high voltage can also be read from POC1 and POC2 directly (ports 0x61 and 0x62)	
Ports	**Read**	**Write**
	0x60, 0x61, 0x62	-
Request Value	-	-
Response Value	Float64 [V]	-
Examples TCP	Read actual measured high voltage of 0 (system / total) [TX] - TA60S0006--|HIVOM; [RX] - TA60R0008--|HIVOM=0; Read actual measured high voltage of 83.54kV (system / total) [TX] - TA60S0006--|HIVOM; [RX] - TA60R000C--|HIVOM=83540; Read actual measured high voltage from POC1 [TX] - TA61S0006--|HIVOM; [RX] - TA61R000C--|HIVOM=83540; Read actual measured high voltage from POC2 [TX] - TA62S0006--|HIVOM; [RX] - TA62R0008--|HIVOM=0;	

5.41 HIVOU – High Voltage Set Used

Key	HIVOU	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Read the used high voltage set point in [V]. The value is related to the high voltage set point (see HIVO) but respects internal limitations.	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-
Response Value	Float64 [V]	-
Examples TCP	Read high voltage used set point [TX] - TA60S0006--|HIVOU; [RX] - TA60R000B--|HIVOU=7500;	

5.42 HVEN – High Voltage Enable/Disable

Key	HVEN	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Start or stop HV-operation (HV enable / disable). This key takes (write) or returns (read) the HVEN index:	

Name	Value	Note
OFF	0	Stop HV generation
ON	1	Start HV generation

Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Uint32 - [index_hven]
Response Value	Uint32 - [index_hven]	ACK ReturnCode #0
Examples TCP	Read actual HVEN index (hv-operation = OFF) 03.11.2015 10:14:35.828 [TX] - TA60S0005--|HVEN; 03.11.2015 10:14:35.841 [RX] - TA60R0007--|HVEN=0; Set HVEN to ON (1) and read it back 03.11.2015 10:13:31.102 [TX] - TA10S0007--|HVEN=1;	

	03.11.2015 10:13:31.109 [RX] - TA10R0008--|HVEN=#0; 03.11.2015 10:13:37.886 [TX] - TA60S0005--|HVEN; 03.11.2015 10:13:37.896 [RX] - TA60R0007--|HVEN=1;

5.43 HVSTAT – HV Status (DEPRECATED)

Key	HVSTAT DEPRECATED since V.1.1.0 (do not use for new designs). Use key SYSSTAT as a replacement.	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Read the actual high voltage status of the system (port 0x60). The HV status is one of the following status codes ([index_hvstat]): **Name** / **Value** / **HV** / **Note** **HVST_OFF** 0 OFF High voltage off and powercell ready **HVST_FOC_CHANGING** 5 OFF Focal spot changing **HVST_FILAMENT_TEST** 10 OFF Testing filament **HVST_PREWARN** 30 OFF Prewarning **HVST_PREPARED** 50 ON Prepared **HVST_HV_ON** 100 ON High voltage ON/available **HVST_POSTHEAT** 120 ON Postheating **HVST_SHUTDOWN** 200 OFF Error / Shut down **HVST_OFF_NOTREADY** 210 OFF High voltage off and powercell not ready Use only port (0x60). Other ports are only for development department.	
Ports	**Read**	**Write**
	0x60, (0x61, 0x62)	-
Request Value	-	-
Response Value	Uint32 [index_hvstat]	-
Examples TCP	Read actual hv status for the system [TX] - TA60S0007--|HVSTAT; [RX] - TA60R000B--|HVSTAT=210; Read actual hv status for POC1 [TX] - TA61S0007--|HVSTAT; [RX] - TA61R000C--|HVSTAT=#110; Read actual hv status for POC2 [TX] - TA62S0007--|HVSTAT; [RX] - TA62R000C--|HVSTAT=#110;	

5.44 HWVERS – Hardware Version

Key	HWVERS	
AMSG allowed	On change: No, Periodical: No	
Description	Read the hardware version string from a specific device. Devices are selected by port. HVWERS is stored as an UINT16.	
Ports	**Read**	**Write**
	0x60, 0x61, 0x62, 0x69, 0x70, 0x80, 0x90	
Request Value	-	
Response Value	String	
Examples TCP	Read the hw version of the IFC device [TX] - TA69S0007--|HWVERS; [RX] - TA69R000A--|HWVERS=12;	

5.45 IFCNET – IFC Network Configuration

Key	IFCNET
AMSG allowed	On change: No, Periodical: No
Description	Read or write the static network configuration (ip, netmask, gateway and dns server list) of the system. The network config object is defined as follows: **Index** / **Value-Description** / **Type** 0 IP address String

	1	Netmask	String
	2	Gateway	String
	3	DNS-Nameserver(s)	String[List]

The ip address, netmask and gateway are defined as a regular IP-String (dot separated decimal values).
The DNS-Nameserver value is a space separated IP-String list.
ATTENTION: the IP address notation including the netmask (like ip/24) is not supported!
Change affects after a reboot of the IFC.

Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	[object_net]
Response Value	[object_net]	ACK ReturnCodes #0
Examples TCP	Read the static network configuration of the IFC [TX] - TA60S0007--|IFCNET; [RX] - TA60R0041--|IFCNET=192.168.177.150,255.255.255.0, 192.168.177.1,192.168.177.1; Set and read the static network configuration of the IFC (set the ip address 192.168.100.10/24 with gateway 192.168.100.1 and 2 google dns-servers (8.8.8.8 and 8.8.4.4) [TX] - TA10S0042--|IFCNET=192.168.100.10,255.255.255.0, 192.168.100.1,8.8.8.8 8.8.4.4; [RX] - TA10R000A--|IFCNET=#0; [TX] - TA60S0007--|IFCNET; [RX] - TA60R0042--|IFCNET=192.168.100.10,255.255.255.0, 192.168.100.1,8.8.8.8 8.8.4.4;	

5.46 IO_ASC – Auto Start Cycle Enable/Disable

Key	IO_ASC	
AMSG allowed	On change: No, Periodical: No	
Description	Enable / Disable the automatic start cycle. If enabled, the start button cycle is no longer required. The auto start cycle is disabled per default (start button cycle is required).	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Boolean 0 = disable (default) 1 = enable
Response Value	Boolean 0 = disabled (default) 1 = enabled	ACK ReturnCode #0
Examples TCP	Read the auto start cycle [TX] - TA60S0007--|IO_ASC; [RX] - TA60R0009--|IO_ASC=0; Enable the auto start cycle and read it back [TX] - TA10S0009--|IO_ASC=1; [RX] - TA10R000A--|IO_ASC=#0; [TX] - TA60S0007--|IO_ASC; [RX] - TA60R0009--|IO_ASC=1;	

5.47 IO_BLINKT – Warning Light Blink Configuration

Key	IO_BLINKT
AMSG allowed	On change: No, Periodical: No
Description	Read or write the overall blink time configuration for all warning lights and digital outputs which have a blink operation defined (see IO_WL and IO_OUT keys for more details).

<table>
<tr><td></td><td colspan="2">The blink time configuration object is defined as follows:
<table><tr><th>Index</th><th>Value-Description</th><th>Type</th></tr><tr><td>0</td><td>Blink on time [s]</td><td>Float64</td></tr><tr><td>1</td><td>Blink off time [s]</td><td>Float64</td></tr></table>The configurable range for the blink time is defined as min=0.4s and max=1s.</td></tr>
<tr><td>Ports</td><td>Read</td><td>Write</td></tr>
<tr><td></td><td>0x60</td><td>0x10</td></tr>
<tr><td>Request Value</td><td>-</td><td>[object_blinkt]</td></tr>
<tr><td>Response Value</td><td>[object_blinkt]</td><td>ACK ReturnCodes #0</td></tr>
<tr><td>Examples TCP</td><td colspan="2">Read the blink time configuration for the warning lights
[TX] - TA60S000A--|IO_BLINKT;
[RX] - TA60R0012--|IO_BLINKT=0.5,0.5;
Set the new blink time configuration to 400ms ON / 750ms OFF
[TX] - TA10S0013--|IO_BLINKT=0.4,0.75;
[RX] - TA10R0010--|IO_BLINKT=#0,#0;
[TX] - TA60S000A--|IO_BLINKT;
[RX] - TA60R0013--|IO_BLINKT=0.4,0.75;</td></tr>
</table>

5.48 IO_CFG – I/O Configuration

<table>
<tr><td>Key</td><td>IO_CFG</td></tr>
<tr><td>AMSG allowed</td><td>On change: No, Periodical: No</td></tr>
<tr><td>Description</td><td>Read or write the Input/output configuration.
This key was introduced to configure the I/O handling feature introduced with V.2.2.0. This feature makes the keys IO_WL and IO_OUT obsolete.
The I/O configuration object is defined as follow:
<table><tr><th>Index</th><th>Value-Description</th><th>Type</th></tr><tr><td>0</td><td>Index I/O config</td><td>index_io_cfg</td></tr><tr><td>1</td><td>Index I/O config register</td><td>index_io_cfg_reg</td></tr><tr><td>2</td><td>Configuration Register</td><td>Uint32 hex</td></tr></table>
For a read request the I/O configuration request object is used, which is:
<table><tr><th>Index</th><th>Value-Description</th><th>Type</th></tr><tr><td>0</td><td>Index I/O config</td><td>index_io_cfg</td></tr><tr><td>1</td><td>Index I/O config register state</td><td>index_io_cfg_reg</td></tr></table>
The available I/Os are defined as [index_io_cfg]:
<table><tr><th>Name</th><th>Value</th><th>Note</th></tr><tr><td>IO_CFG_WARNING_LIGHT_1</td><td>0</td><td>Warning light 1</td></tr><tr><td>IO_CFG_WARNING_LIGHT_2</td><td>1</td><td>Warning light 2</td></tr><tr><td>IO_CFG_WARNING_LIGHT_3</td><td>2</td><td>Warning light 3</td></tr><tr><td>IO_CFG_WARNING_LIGHT_4</td><td>3</td><td>Warning light 4</td></tr><tr><td>IO_CFG_OUTPUT_1</td><td>4</td><td>Output 1</td></tr><tr><td>IO_CFG_OUTPUT_2</td><td>5</td><td>Output 2</td></tr><tr><td>IO_CFG_OUTPUT_3</td><td>6</td><td>Output 3</td></tr><tr><td>IO_CFG_OUTPUT_4</td><td>7</td><td>Output 4</td></tr><tr><td>IO_CFG_OUTPUT_5</td><td>8</td><td>Output 5</td></tr><tr><td>IO_CFG_OUTPUT_6</td><td>9</td><td>Output 6</td></tr><tr><td>IO_CFG_LAMP_FAILURE_CONTACT</td><td>10</td><td>Lamp Failure Contact</td></tr></table>
For every I/O the following registers are available:
<table><tr><th>Name</th><th>Value</th><th>Note</th></tr><tr><td>TOP_STEADY</td><td>0x02</td><td>Top states steady</td></tr><tr><td>TOP_BLINK</td><td>0x03</td><td>Top states blink</td></tr><tr><td>SYSTEMINFO_STEADY</td><td>0x04</td><td>System info steady</td></tr><tr><td>SYSTEMINFO_BLINK</td><td>0x05</td><td>System info blink</td></tr><tr><td>NORMAL_OP_STEADY</td><td>0x06</td><td>Normal OP steady</td></tr></table></td></tr>
</table>

		NORMAL_OP_BLINK	0x07	Normal OP blink
		NORMAL_HV_OP_STEADY	0x08	Normal HV OP steady
		NORMAL_HV_OP_BLINK	0x09	Normal HV OP blink
		WARMUP_OP_STEADY	0x0A	Warmup OP steady
		WARMUP_OP_BLINK	0x0B	Warmup OP blink
		WARMUP_RDY_OP_STEADY	0x0C	Warmup Ready OP steady
		WARMUP_RDY_OP_BLINK	0x0D	Warmup Ready OP blink
		WARMUP_HV_OP_STEADY	0x0E	Warmup HV OP steady
		WARMUP_HV_OP_BLINK	0x0F	Warmup HV OP blink
Ports	**Read**		**Write**	
	0x60		0x10	
Request Value	[object_io_cfg_req]		[object_io_cfg]	
Response Value	[object_io_cfg]		ACK ReturnCode #0	
Examples TCP	Read IO config register 'system info blink' of output 4 [TX] - TA60S000E--|IO_CFG=7,0x05; [RX] - TA60R0011--|IO_CFG=7,0x5,0x0; Write 'imminent' flag in 'system info blink' config register of output 4 [TX] - TA10S0015--|IO_CFG=7,0x05,0x0001; [RX] - TA10R000A--|IO_CFG=#0; Read back IO config register 'system info blink' of output 4 [TX] - TA60S000E--|IO_CFG=7,0x05; [RX] - TA60R0011--|IO_CFG=7,0x5,0x1;			

All states of the state machine can be used for an input or output. Outputs can be set to blink or steady ON in certain states. Inputs are used to monitor that lamps blinks or are steady ON.

Additional to the state registers a system info register is available. Some events of the generator can so also be mapped to the I/Os, see reg_io_cfg_systeminfo. The system info register and the state registers are exclusive or. Means if flags in system info are set no flags in state registers can be set or vice versa.

It is possible to set the flags in the register so that in a specific state an I/O could have blink and steady ON flag set. The rule is that blink comes before steady ON.

Example 1:

Configuration:
Register 'Normal OP Blink': flag 'High Voltage Operation' is set
Register 'Normal HV OP Steady ON': flag 'Set Point Reached' is set
Behavior:
As blink comes before steady ON the 'Set Point Reached' flag has no effect. As long the generator is in HV Operation (SYSSTAT=2,7,x,x,x) the I/O is blinking.

Example 2:

Configuration:
Register 'Normal OP Steady ON': flag 'High Voltage Operation' is set
Register 'Normal HV OP Steady BLINK': flag 'Set Point Reached' is set
Behavior:
As long the generator is in HV Operation (SYSSTAT=2,7,x,x,x) the I/O is steady ON except the 'Set Point Reached' state (SYSTAT=2,7,100,x,x) where the I/O is blinking.

The registers are containing 32bit. A register consists out of an 8 bit header and 24 bit configuration flags.

bit 31-24	**bit 23-0**

Header	Configuration Flags

The header has 7bits reserved for the register ID and 1 bit to define the mode if it is blink or steady on. The indexes defined in index_io_cfg_reg consist already out of the full header.

bit 7-1	**bit 0**
Register ID	Mode (Blink or Steady ON)

In the following all I/O configuration registers are described. For all state dependent registers, the corresponding SYSSTAT value is added to the description.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Header = TOP_STEADY or TOP_BLINK								-	-	-	-	-	-	-	-

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
-	-	-	-	-	-	-	-	-	-	-	-	**WU**	**NO**	**SE**	**BO**

Bits	**Name**	**SYSSTAT (equal)**
31:24	Header = TOP_STEADY or TOP_BLINK	
23:4	Not used	-
3	**WU: Warm-up**	3,x,x,x,x
2	**NO: Normal Operation**	2,x,x,x,x
1	**SE: Severe Error**	0xFFFFFFFF,x,x,x,x
0	**BO: Booting**	1,x,x,x,x

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Header = NORMAL_OP_STEADY or NORMAL_OP_BLINK								-	-	-	-	-	-	-	-

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
-	-	-	-	-	-	-	-	**IS**	**HV**	**PW**	**RY**	**MC**	**SR**	**CC**	**NR**

Bits	**Name**	**SYSSTAT (equal)**
31:24	Header = NORMAL_OP_STEADY or NORMAL_OP_BLINK	
23:8	Not used	-
7	**IS: Illegal Shutdown**	2,8,x,x,x
6	**HV: High Voltage Operation**	2,7,x,x,x
5	**PW: Prewarn**	2,6,x,x,x
4	**RY: Ready**	2,5,x,x,x
3	**MC: Mains Check**	2,4,x,x,x
2	**SR: Safety Ready**	2,3,x,x,x
1	**CC: Cooler Check**	2,2,x,x,x
0	**NR: Not Ready**	2,1,x,x,x

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Header = NORMAL_HV_OP_STEADY or NORMAL_HV_OP_BLINK								-	-	-	-	-	-	-	-

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
-	-	-	-	-	-	-	-	-	-	**HE**	**PH**	**HS**	**SP**	**RP**	**PR**

Bits	**Name**	**SYSSTAT (equal)**
31:24	Header = NORMAL_HV_OP_STEADY or NORMAL_HV_OP_BLINK	
23:6	Not used	-
5	**HE: HV extant**	2,7,130,x,x

4	**PH: Postheat**	2,7,120,x,x
2	**SP: Setpoint Reached**	2,7,100,x,x
1	**RP: Ramping**	2,7,80,x,x
0	**PR: Preparing**	2,7,50,x,x

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Header = WARMUP_OP_STEADY or WARMUP_OP_BLINK								-	-	-	-	-	-	-	-

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
-	-	-	-	-	-	-	**ER**	**HV**	**PW**	**RY**	**MC**	**SR**	**CC**	**NR**	**IN**

Bits	**Name**	**SYSSTAT (equal)**
31:24	Header = WARMUP_OP_STEADY or WARMUP_OP_BLINK	
23:7	Not used	-
6	**HV: High Voltage Operation**	3,7,x,x,x
5	**PW: Prewarn**	3,6,x,x,x
4	**RY: Ready**	3,5,x,x,x
3	**MC: Mains Check**	3,4,x,x,x
2	**SR: Safety Ready**	3,3,x,x,x
1	**CC: Cooler Check**	3,2,x,x,x
0	**NR: Not Ready**	3,1,x,x,x

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Header = WARMUP_RDY_OP_STEADY or WARMUP_RDY_OP_BLINK								-	-	-	-	-	-	-	-

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
-	-	-	-	-	-	-	-	-	-	-	-	-	-	**IR**	**PS**

Bits	**Name**	**SYSSTAT (equal)**
31:24	reserved for register header	
23:3	Not used	-
1	**IR: Interrupted**	3,5,20,x,x
0	**PS: Paused**	3,5,10,x,x

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Header = WARMUP_HV_OP_STEADY or WARMUP_HV_OP_BLINK								-	-	-	-	-	-	-	-

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
-	-	-	-	-	-	-	-	-	**ST**	**CR**	**HS**	**HR**	**PF**	**FH**	**SU**

Bits	**Name**	**SYSSTAT (equal)**
31:24	reserved for register header	
23:7	Not used	-
6	**ST: Stabilization**	3,7,7,x,x
5	**CR: Current Ramping**	3,7,6,x,x
4	**HS: HV Stabilization**	3,7,5,x,x
3	**HR: HV Ramping**	3,7,4,x,x
2	**PF: Post Filament Heating**	3,7,3,x,x
1	**FH: Filament Heating**	3,7,2,x,x
0	**SU: Starting Up**	3,7,1,x,x

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16

Header = SYSTEMINFO_STEADY or SYSTEMINFO_BLINK	-	-	-	-	-	-	-	-

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
-	-	-	-	-	-	-	-	-	-	-	-	-	**SU**	**AA**	**IM**

Bits	**Name**
31:24	reserved for register header
23:21	Not used
2	**SU: System Unstable**
1	**AA: Arc Active**
0	**IM: Imminent**

5.49 IO_CFG_CNT– I/O Configuration Count

Key	IO_CFG_CNT	
AMSG allowed	On change: No, Periodical: No	
Description	Get numbers of configurations that have flags set for an I/O.	

Index	**Value-Description**	**Type**
0	Index I/O configuration	index_io_cfg
1	Number of configuration entries	Uint32

Ports	**Read**	**Write**
	0x60	-
Request Value	[index_io_cfg]	-
Response Value	Uint32	-

Examples TCP

```
Read the number of I/O configuration for Warning Light 1
[TX] - TA60S000D--|IO_CFG_CNT=0;
[RX] - TA60R000F--|IO_CFG_CNT=0,2;
No configuration set for Lamp Failure Contact (all 'OFF')
[TX] - TA60S000E--|IO_CFG_CNT=10;
[RX] - TA60R0010--|IO_CFG_CNT=10,0;
```

5.50 IO_CFG_EN – I/O Configuration Enable

Key	IO_CFG_EN	
AMSG allowed	On change: No, Periodical: No	
Description	Read or write the enable for the I/O.	

Index	**Value-Description**	**Type**
0	Index I/O configuration	[index_io_cfg]
1	Enable I/O	Boolean

Ports	**Read**	**Write**
	-	0x10
Request Value	Uint32- [index_io_cfg]	[object_io_cfg_en]
Response Value	[object_io_cfg_en]	ACK ReturnCode #0

Examples TCP

```
Write the enable for Warning Light 1
[TX] - TA10S000E--|IO_CFG_EN=0,1;
[RX] - TA10R000D--|IO_CFG_EN=#0;
Read the enable of Warning Light 1
[TX] - TA60S000C--|IO_CFG_EN=0;
[RX] - TA60R000E--|IO_CFG_EN=0,1;
```

5.51 IO_CFG_FM – I/O Configuration Lamp Failure Contact Mode

Key	IO_CFG_FM
AMSG allowed	On change: No, Periodical: No
Description	Read or write the I/O Configuration Lamp Failure Contact Mode (former dynamic monitoring logic).

	• True = Normally open (multiple failure mode contacts may be connected in parallel) • False = Normally closed (multiple failure mode contacts may be connected in series)	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Boolean
Response Value	Boolean	ACK ReturnCode #0
Examples TCP	Write the Lamp Failure Contact Mode (Normally open) [TX] - TA10S000C--|IO_CFG_FM=1; [RX] - TA10R000D--|IO_CFG_FM=#0; Read the Lamp Failure Contact Mode [TX] - TA60S000A--|IO_CFG_FM; [RX] - TA60R000C--|IO_CFG_FM=0;	

5.52 IO_CFG_REG – I/O Configuration Register

Key	IO_CFG_REG	
AMSG allowed	On change: No, Periodical: No	
Description	Get I/O configuration registers that have flags set. The range for index of I/O configuration entries is a Uint32 number from 0 up to the number of available configurations for this I/O minus 1. The number of available configurations can be read with IO_CFG_CNT.	

Index	**Value-Description**	**Type**
0	Index I/O configuration	index_io_cfg
1	Index of I/O configuration entries	Uint32

Index	**Value-Description**	**Type**
0	Index I/O configuration	index_io_cfg
1	Index of I/O configuration entries	Uint32
2	Index I/O configuration register	index_io_cfg_reg

Ports	**Read**	**Write**
	0x60	-
Request Value	[object_io_cfg_reg_req]	-
Response Value	[object_io_cfg_reg]	-
Examples TCP	Read index 0 of I/O configuration Warning Light 1 [TX] - TA60S000F--|IO_CFG_REG=0,0; [RX] - TA60R0013--|IO_CFG_REG=0,0,0x8; Read index 1 of I/O configuration Warning Light 1 [TX] - TA60S000F--|IO_CFG_REG=0,1; [RX] - TA60R0013--|IO_CFG_REG=0,1,0x9; Read an empty I/O configuration register of WL1 [TX] - TA60S000F--|IO_CFG_REG=0,0; [RX] - TA60R0013--|IO_CFG_REG=0,0,0x0;	

5.53 IO_CFG_RST – I/O Configuration Reset

Key	IO_CFG_RST	
AMSG allowed	On change: No, Periodical: No	
Description	Reset the I/O configuration of the specified I/O. Set all register and flags to 'OFF'.	
Ports	**Read**	**Write**
	-	0x10
Request Value	-	Uint32- [index_io_cfg]
Response Value	-	ACK ReturnCode #0
Examples TCP	Reset the I/O Configurations of Warning Light 3 [TX] - TA10S000D--|IO_CFG_RST=2; [RX] - TA10R000E--|IO_CFG_RST=#0;	

5.54 IO_CFG_TH – I/O Configuration Threshold

<table>
<tr><th>Key</th><td colspan="2">IO_CFG_TH</td></tr>
<tr><th>AMSG allowed</th><td colspan="2">On change: No, Periodical: No</td></tr>
<tr><th>Description</th><td colspan="2">Read or write the thresholds for current monitoring of the warning lights.
<table>
<tr><th>Index</th><th>Value-Description</th><th>Type</th></tr>
<tr><td>0</td><td>Index I/O configuration</td><td>[index_io_cfg],
only Warning Lights 1-3 are allowed</td></tr>
<tr><td>1</td><td>Current monitoring threshold min (off) in [A]</td><td>Float64</td></tr>
<tr><td>2</td><td>Current monitoring threshold max (on) in [A]</td><td>Float64</td></tr>
<tr><td>3</td><td>Current monitoring short circuit threshold [A]</td><td>Float64</td></tr>
</table></td></tr>
<tr><th rowspan="2">Ports</th><th>Read</th><th>Write</th></tr>
<tr><td>-</td><td>0x10</td></tr>
<tr><th>Request Value</th><td>Uint32- [index_io_cfg]
only Warning lights are allowed</td><td>[object_io_cfg_th]</td></tr>
<tr><th>Response Value</th><td>[object_io_cfg_th]</td><td>ACK ReturnCode #0</td></tr>
<tr><th>Examples TCP</th><td colspan="2">Write the thresholds for WL 1
[TX] - TA10S001A--|IO_CFG_TH=2,0.01,0.02,0.2;
[RX] - TA10R000D--|IO_CFG_TH=#0;
Read the thresholds for WL 1
[TX] - TA60S000B--|IO_CFG_TH=2;
[RX] - TA60R001A--|IO_CFG_TH=2,0.01,0.02,0.2;
Read not allowed index Output1 -> Error #106
[TX] - TA60S000B--|IO_CFG_TH=4;
[RX] - TA60R000F--|IO_CFG_TH=#106;</td></tr>
</table>

5.55 IO_DYNMO – Dynamic Monitoring Configuration (DEPRECATED)

<table>
<tr><th>Key</th><td colspan="2">IO_DYNMO DEPRECATED since V.2.2.0 (do not use for new designs)</td></tr>
<tr><th>AMSG allowed</th><td colspan="2">On change: No, Periodical: No</td></tr>
<tr><th>Description</th><td colspan="2">Read or write the dynamic monitoring configuration (logic, phase and blink). Dynamic monitoring is used to monitor the run state and handle failure modes of warning lights etc. with a dedicated monitoring I/O pair. The dynamic monitoring configuration object is defined as follows:
<table>
<tr><th>Index</th><th>Value-Description</th><th>Type</th></tr>
<tr><td>0</td><td>Logic (active on high/low)</td><td>Boolean</td></tr>
<tr><td>1</td><td>Phase (see 5.42.1)</td><td>Uint32 hex</td></tr>
<tr><td>2</td><td>Blink (see 5.42.2</td><td>Uint32 hex</td></tr>
</table></td></tr>
<tr><th rowspan="2">Ports</th><th>Read</th><th>Write</th></tr>
<tr><td>0x60</td><td>0x10</td></tr>
<tr><th>Request Value</th><td>-</td><td>[object_dynmo]</td></tr>
<tr><th>Response Value</th><td>[object_dynmo]</td><td>ACK ReturnCodes #0</td></tr>
<tr><th>Examples TCP</th><td colspan="2">Read the dynamic monitoring configuration
[TX] - TA60S0009--|IO_DYNMO;
[RX] - TA60R0016--|IO_DYNMO=0x1,0x10,0x0;
Set the dynamic monitoring on for HV phases ‘prewarn’ and ‘HV ON’ with positive logic (1)
[TX] - TA10S0016--|IO_DYNMO=1,0x18,0x0;
[RX] - TA10R0012--|IO_DYNMO=#0,#0,#0;
[TX] - TA60S0009--|IO_DYNMO;
[RX] - TA60R0016--|IO_DYNMO=0x1,0x18,0x0;
Set the dynamic monitoring to blink for HV phases ‘prewarn’ and ‘HV with positive logic (1)
[TX] - TA10S0016--|IO_DYNMO=1,0x0,0x18;
[RX] - TA10R0012--|IO_DYNMO=#0,#0,#0;
[TX] - TA60S0009--|IO_DYNMO;
[RX] - TA60R0016--|IO_DYNMO=0x1,0x0,0x18;</td></tr>
</table>

5.56 IO_OUT – Digital Output Configuration (DEPRECATED)

<table>
<tr><th>Key</th><td colspan="3">IO_OUT DEPRECATED since V.2.2.0 (do not use for new designs)</td></tr>
<tr><th>AMSG allowed</th><td colspan="3">On change: No, Periodical: No</td></tr>
<tr><th>Description</th><td colspan="3">Read or write the digital output configuration (blink and phase). The digital output configuration object is defined as follows:
<table>
<tr><th>Index</th><th>Value-Description</th><th>Type</th></tr>
<tr><td>0</td><td>Index (output 1-4)</td><td>index_ioout</td></tr>
<tr><td>1</td><td>Blink (see 5.42.2)</td><td>Uint32 hex</td></tr>
<tr><td>2</td><td>Signaling Phase (see 5.42.1)</td><td>Uint32 hex</td></tr>
</table>
Where index_ioout is defined as follows:
<table>
<tr><th>Name</th><th>Value</th><th>Note</th></tr>
<tr><td>OUTPUT_1</td><td>1</td><td>Digital Output 1</td></tr>
<tr><td>OUTPUT_2</td><td>2</td><td>Digital Output 2</td></tr>
<tr><td>OUTPUT_3</td><td>3</td><td>Digital Output 3</td></tr>
<tr><td>OUTPUT_4</td><td>4</td><td>Digital Output 4</td></tr>
</table></td></tr>
<tr><th rowspan="2">Ports</th><th>Read</th><th>Write</th></tr>
<tr><td>0x60</td><td>0x10</td></tr>
<tr><th>Request Value</th><td>[index_ioout]</td><td>[object_ioout]</td></tr>
<tr><th>Response Value</th><td>[object_ioout]</td><td>ACK ReturnCodes #0</td></tr>
<tr><th>Examples TCP</th><td colspan="2">Read the configuration for output 2:
[TX] - TA60S0009--|IO_OUT=2;
[RX] - TA60R0011--|IO_OUT=2,0x0,0x8;
Read the configuration for all 4 digital outputs:
[TX] - TA60S0024--|IO_OUT=1;IO_OUT=2;IO_OUT=3;IO_OUT=4;
[RX] - TA60R0047--|IO_OUT=1,0x0,0x4;IO_OUT=2,0x38,0x6;
IO_OUT=3,0x0,0x10;IO_OUT=4,0x0,0x10;
Set the digital output 2:
• blinking in phases ‘prewarn’, ‘hvon’ and ‘postheat’ (0x08 | 0x10 | 0x20 = 0x38)
• active in phases ‘safetycircuit’ and ‘ready’ (0x02 | 0x04 = 0x06)
[TX] - TA10S0013--|IO_OUT=2,0x38,0x06;
[RX] - TA10R000D--|IO_OUT=#0,#0;
[TX] - TA60S0009--|IO_OUT=2;
[RX] - TA60R0012--|IO_OUT=2,0x38,0x6;</td></tr>
</table>

5.57 IO_PEN – Optional Panel Enable / Disable

<table>
<tr><th>Key</th><td colspan="2">IO_PEN</td></tr>
<tr><th>AMSG allowed</th><td colspan="2">On change: No, Periodical: No</td></tr>
<tr><th>Description</th><td colspan="2">Enable / disable the iVario Control panel. If set to 1 (enabled), the control elements of the external control panel (like HV ON button) are activated otherwise the iVario Control panel can only be used for monitoring.</td></tr>
<tr><th rowspan="2">Ports</th><th>Read</th><th>Write</th></tr>
<tr><td>0x60</td><td>0x10</td></tr>
<tr><th>Request Value</th><td>-</td><td>Boolean:
0 = optional panel disabled
1 = optional panel enabled</td></tr>
<tr><th>Response Value</th><td>Boolean:
0 = optional panel disabled
1 = optional panel enabled</td><td>ACK ReturnCode #0</td></tr>
<tr><th>Examples TCP</th><td colspan="2">Read the optional panel enable/disable flag:
[TX] - TA60S0007--|IO_PEN;
[RX] - TA60R0009--|IO_PEN=0;
Enable/activate the optional panel
[TX] - TA10S0009--|IO_PEN=1;
[RX] - TA10R000A--|IO_PEN=#0;
[TX] - TA60S0007--|IO_PEN;</td></tr>
</table>

	[RX] - TA60R0009--|IO_PEN=1;

5.58 IO_WL – Warning Light Configuration (DEPRECATED)

Key	IO_WL DEPRECATED since V.2.2.0 (do not use for new designs)	
AMSG allowed	On change: No, Periodical: No	
Description	Read or write the warning light configuration (enable, blink, phase and current monitoring threshold). The warning light configuration object is defined as follows: **Index** / **Value-Description** / **Type** 0 / Index (warning light 1-4) / index_wl 1 / Enable/Disable warning light / Boolean 2 / Blink / Uint32 hex 3 / Phase / Uint32 hex 4 / Current monitoring threshold min (off) in [A] / Float64 5 / Current monitoring threshold max (on) in [A] / Float64 Where index_wl is defined as follows: **Name** / **Value** / **Note** WARNING_LIGHT_1 / 1 / Warning light 1 WARNING_LIGHT_2 / 2 / Warning light 2 WARNING_LIGHT_3 / 3 / Warning light 3 OTP_WARNING_LIGHT_4 / 4 / Optional warning light 4 (no current monitoring)	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	[index_wl]	[object_wl]
Response Value	[object_wl]	ACK ReturnCodes #0
Examples TCP	Read the configuration for warning light #2 [TX] - TA60S0008--|IO_WL=2; [RX] - TA60R001E--|IO_WL=2,1,0x10,0x10,0.04,0.05; Read the configuration for all 4 warning lights (including optional warning light (output 4): [TX] - TA60S0020--|IO_WL=1;IO_WL=2;IO_WL=3;IO_WL=4; [RX] - TA60R006E--|IO_WL=1,1,0x10,0x10,0.04,0.05;IO_WL=2,1,0x10,0x10,0.04,0.05;IO_WL=3,1,0x10,0x10,0.04,0.05;IO_WL=4,1,0x10,0x10; Set the warning light #2: • Enabled • blinking in phases 'prewarn' and 'hvon' (0x08 | 0x10 = 0x18) • active in phase 'ready' (0x04) • current threshold = 55mA [TX] - TA10S0020--|IO_WL=2,1,0x18,0x04,0.055,0.065; [RX] - TA10R0015--|IO_WL=#0,#0,#0,#0,#0; [TX] - TA60S0008--|IO_WL=2; [RX] - TA60R001F--|IO_WL=2,1,0x18,0x4,0.055,0.065;	

5.59 MATNBR – Material Number

Key	MATNBR	
AMSG allowed	On change: no, Periodical: no	
Description	Read the material number of a specific device. Devices are selected by port. MATNBR is stored as an UINT64.	
Ports	**Read**	**Write**
	0x60, 0x61, 0x62, 0x69, 0x70, 0x80, 0x83, 0x90	
Request Value	-	

Response Value	String	
Examples TCP	Read the material number of the IFC device [TX] - TA69S0007--|MATNBR; [RX] - TA69R0010--|MATNBR=20071441;	

5.60 MGCE – MG Protocol Enable/Disable

Key	MGCE	
AMSG allowed	On change: No, Periodical: No	
Description	Enable/Disable the MG protocol for the serial interface (if disabled, the serial interface will provide T3 ASCII protocol). Change affects after a reboot of the IFC.	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Boolean: 1 = Serial interface MG 0 = Serial interface TA
Response Value	Boolean: 1 = Serial interface MG 0 = Serial interface TA	ACK ReturnCode #0
Examples TCP	Read the serial protocol flag (result = T3 ASCII) [TX] - TA60S0005--|MGCE; [RX] - TA60R0007--|MGCE=0; Set the serial protocol to MG and read it back [TX] - TA10S0007--|MGCE=1; [RX] - TA10R0008--|MGCE=#0; [TX] - TA60S0005--|MGCE; [RX] - TA60R0007--|MGCE=1;	

5.61 MGP99 – MG UU/UD Voltage

Key	MGP99	
AMSG allowed	On change: No, Periodical: No	
Description	Set and read the persisted voltage for UU/UD fast voltage steps on MG (the ominous “Programmplatz 99”).	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Float64 [V]
Response Value	Float64 [V]	ACK ReturnCode #0
Examples TCP	Read the P99 initial/default value (MG configuration) [TX] - TA60S0006--|MGP99; [RX] - TA60R0008--|MGP99=0; Set the MG P99 value to 50kV and read it back [TX] - TA10S000B--|MGP99=50e3; [RX] - TA10R0009--|MGP99=#0; [TX] - TA60S0006--|MGP99; [RX] - TA60R000C--|MGP99=50000;	

5.62 MNHIVO – Minimal Permissible High Voltage

Key	MNHIVO	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Read the minimal permissible high voltage in [V] for the actual configuration (iVario generator).	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-
Response Value	Float64 [V]	-
Examples TCP	Read the minimal permissive high voltage (result 5kV)	

	[TX] - TA60S0007--|MNHIVO; [RX] - TA60R000C--|MNHIVO=5000;

5.63 MPHIVO – Maximal Permissible High Voltage

Key	MPHIVO	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Read the maximal permissible high voltage in [V] for the actual configuration.	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-
Response Value	Float64 [V]	-
Examples TCP	Read the maximal permissive high voltage (result 160kV) [TX] - TA60S0007--|MPHIVO; [RX] - TA60R000E--|MPHIVO=160000;	

5.64 MPPWR – Maximal Permissible Power

Key	MPPWR	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Read the maximal permissible power in [W] for the actual selected focal spot (read with no value) or for the focal spot @ the given index (value = [index_foc]	
Ports	**Read**	**Write**
	0x60	-
Request Value	One of the following: • none (for the actual selected FOC) • Uint32 - [index_foc]	-
Response Value	Float64 [W]	-
Examples TCP	Read the maximal permissive power @ actual selected focal spot [TX] - TA60S0006--|MPPWR; [RX] - TA60R000B--|MPPWR=2250; Read the maximal permissive power @ focal spot 0 (large) [TX] - TA60S0008--|MPPWR=0; [RX] - TA60R000B--|MPPWR=2250; Read the maximal permissive power @ focal spot 1 (small) [TX] - TA60S0008--|MPPWR=1; [RX] - TA60R000A--|MPPWR=600;	

5.65 MPTUCU – Maximal Permissible Tube Current

Key	MPTUCU	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Read the maximal permissible tube current in [A] for the actual selected focal spot (read with no value) or for the focal spot @ the given index (value = [index_foc]	
Ports	**Read**	**Write**
	0x60	-
Request Value	One of the following: • none (for the actual selected FOC) • Uint32 - [index_foc]	-
Response Value	Float64 [A]	-
Examples TCP	Read the maximal permissive tube current @ actual focal spot [TX] - TA60S0007--|MPTUCU; [RX] - TA60R000F--|MPTUCU=0.06429; Read the maximal permissive tube current @ focal spot 0 (large) [TX] - TA60S0009--|MPTUCU=0; [RX] - TA60R000F--|MPTUCU=0.06429; Read the maximal permissive tube current @ focal spot 1 (small) [TX] - TA60S0009--|MPTUCU=1;	

	[RX] - TA60R000C--|MPTUCU=0.01;

5.66 NBRPOC – Number of Power cells

Key	NBRPOC	
AMSG allowed	On change: No, Periodical: No	
Description	Read the number of power cells connected to the generator.	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-
Response Value	Uint32	-
Examples TCP	Read the number of POCs [TX] - TA60S0007--|NBRPOC; [RX] - TA60R0009--|NBRPOC=1;	

5.67 NBRTANK – Number of Tanks

Key	NBRTANK	
AMSG allowed	On change: No, Periodical: No	
Description	Read the number of tanks connected to the generator.	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-
Response Value	Uint32	-
Examples TCP	Read the number of tanks [TX] - TA60S0008--|NBRTANK; [RX] - TA60R000A--|NBRTANK=1;	

5.68 NLFILCU– Nominal Limit Filament Current

Key	NLFILCU	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Reads the nominal limits for filament current. Nominal limits are focal spot dependent. The unit is [A].	
Ports	**Read**	**Write**
	0x60	-
Request Value	[Index_foc]	-
Response Value	[object_limrng] (min/max in [A])	-
Examples TCP	Read the filament current nominal limits @ actual focal spot [TX] - TA60S0008--|NLFILCU; [RX] - TA60R0010--|NLFILCU=0,4.2,0; Read the filament current nominal limits @ focal spot 0 [TX] - TA60S000A--|NLFILCU=0; [RX] - TA60R0010--|NLFILCU=0,4.2,0; Read the filament current nominal limits @ unknown focal spot [TX] - TA60S000A--|NLFILCU=1; [RX] - TA60R000D--|NLFILCU=#110;	

5.69 NLHIVO– Nominal Limit High Voltage

Key	NLHIVO	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Reads the nominal limits for high voltage. Nominal limits are focal spot dependent. The unit is [V].	
Ports	**Read**	**Write**
	0x60	-
Request Value	[Index_foc]	-
Response Value	[object_limrng] (min/max in [V])	-

Examples TCP	Read the high voltage nominal limits @ actual focal spot [TX] - TA60S0007--|NLHIVO; [RX] - TA60R0012--|NLHIVO=0,160000,0; Read the high voltage nominal limits @ focal spot 0 [TX] - TA60S0009--|NLHIVO=0; [RX] - TA60R0012--|NLHIVO=0,160000,0; Read the high voltage nominal limits @ unknown focal spot [TX] - TA60S0009--|NLHIVO=1; [RX] - TA60R000C--|NLHIVO=#110;

5.70 NLPWR– Nominal Limit Power

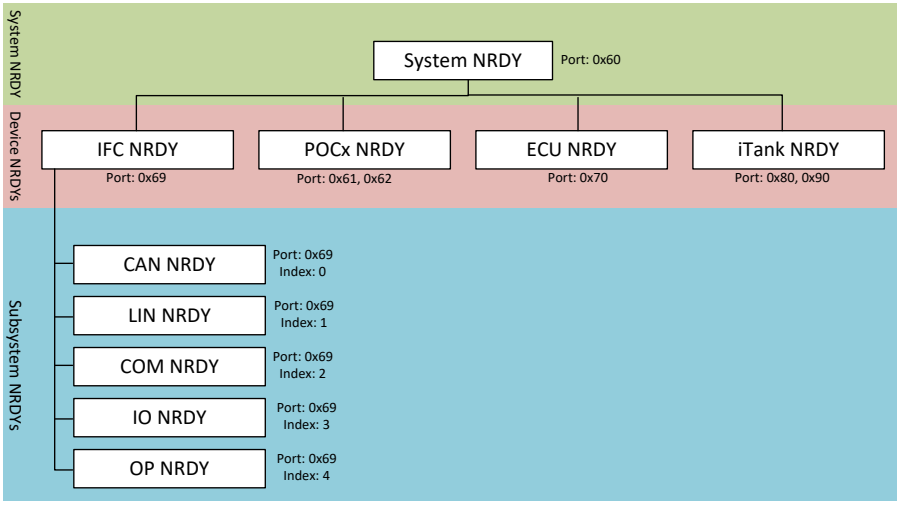
Key	NLPWR	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Reads the nominal limits for power. Nominal limits are focal spot dependent. The unit is [W].	
Ports	**Read**	**Write**
	0x60	-
Request Value	[Index_foc]	-
Response Value	[object_limrng] (min/max in [W])	-
Examples TCP	Read the power nominal limits @ actual focal spot [TX] - TA60S0006--|NLPWR; [RX] - TA60R000F--|NLPWR=0,2250,0; Read the power nominal limits @ focal spot 0 [TX] - TA60S0008--|NLPWR=0; [RX] - TA60R000F--|NLPWR=0,2250,0; Read the power nominal limits @ unknown focal spot [TX] - TA60S0008--|NLPWR=1; [RX] - TA60R000B--|NLPWR=#110;	

5.71 NLTUCU– Nominal Limit Tube Current

Key	NLTUCU	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Reads the nominal limits for tube current. Nominal limits are focal spot dependent. The unit is [A].	
Ports	**Read**	**Write**
	0x60	-
Request Value	[Index_foc]	-
Response Value	[object_limrng] (min/max in [A])	-
Examples TCP	Read the tube current nominal limits @ actual focal spot [TX] - TA60S0007--|NLTUCU; [RX] - TA60R0011--|NLTUCU=0,0.045,0; Read the tube current nominal limits @ focalspot 0 [TX] - TA60S0009--|NLTUCU=0; [RX] - TA60R0011--|NLTUCU=0,0.045,0; Read the tube current nominal limits @ unknown focalspot [TX] - TA60S0009--|NLTUCU=1; [RX] - TA60R000C--|NLTUCU=#110;	

5.72 NRDY – Not Ready Code

Key	NRDY
AMSG allowed	On change: Yes, Periodical: Yes
Description	The NRDY code is hierarchically organized. The highest NRDY code is the system NRDY. After that a device NRDY layer gives more detail. For modules with different subsystems a subsystem NRDY layer exists.



System NRDY code on port 0x60.

Bit	Name	Description
0	IFC	IFC NRDY flag
1	POC1	POC1 NRDY flag
2	POC2	POC2 NRDY flag
3	Reserved	Reserved
4	ECU	ECU NRDY flag
5	Cathode Tank	Cathode Tank NRDY flag
6	Anode Tank	Anode Tank NRDY flag
7 - 30	reserved	*reserved for future use*
31	general	General NRDY flag

To request the Subcomponent NRDY codes, an index is used. Subcomponent NRDY codes are available for the IFC subcomponent on port 0x69.

Name	Value	Note
NRDY_SUAMB_SYS_IFC_CAN	0	Index for CAN sub-sys
NRDY_SUB_SYS_IFC_LIN	1	Index for LIN sub-sys
NRDY_SUB_SYS_IFC_COM	2	Index for COM sub-sys
NRDY_SUB_SYS_IFC_IO	3	Index for IO sub-sys
NRDY_SUB_SYS_IFC_OP	4	Index for OP sub-sys

Ports	**Read**	**Write**
	0x60, 0x61, 0x62,0x69, 0x70, 0x80, 0x90	-
Request Value	Uint32- [index_ifcservice]	-
Response Value	Uint32 hex	**-**
Examples TCP	Read the system not ready code [TX] - TA60S0005--|NRDY; [RX] - TA60R000D--|NRDY=0x11004; Read the device IFC not ready code [TX] - TA69S0005--|NRDY; [RX] - TA60R0037--|NRDY=0x3; Read the subsystem IFC COM not ready codes [TX] - TA69S0007--|NRDY=2; [RX] - TA60R0037--|NRDY=0x3;	

5.73 NRDYALL – All Not Ready Codes (DEPRECATED)

Key	NRDYALL DEPRECATED since V.1.0.0 (do not use for new designs)
AMSG allowed	On change: Yes, Periodical: Yes
Description	Read a list with all not ready codes for all subsystems.

Ports	Read	Write
	0x60	-
Request Value	-	-
Response Value	Uint32List in hex with following order: • POC1, POC2, reserved, io, op, can, lin, com, ECU, CTank, ATank	-
Examples TCP	Read the all subsystem not ready codes [TX] - TA60S0008--|NRDYALL; [RX] - TA60R003F--|NRDYALL=0x11004,0x0,0x0,0x40000000,0x0,0x0,0x0,0x0,0x0,0x0,0x0;	

5.74 PWRM – Power Measured

Key	PWRM	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Read the measured power in [W] (the calculated total power of all power cells = HIVOM * TUCUM)	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-
Response Value	Float64 [W]	-
Examples TCP	Read actual measured power in [W] [TX] - TA60S0005--|PWRM; [RX] - TA60R000C--|PWRM=1820.5;	

5.75 PWTL – Pre Warn Time Long

Key	PWTL	
AMSG allowed	On change: No, Periodical: No	
Description	Read or write the pre warn time long in [s]. The condition for using the long pre warn time instead of the regular one is defined by the pre warn time long mode configuration.	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Uint32 [s]
Response Value	Uint32 [s]	ACK ReturnCode #0
Examples TCP	Read the configured pre warn time long in [s] [TX] - TA60S0005--|PWTL; [RX] - TA60R0008--|PWTL=10; Set the pre warn time long to 15s and read it back [TX] - TA10S0008--|PWTL=15; [RX] - TA10R0008--|PWTL=#0; [TX] - TA60S0005--|PWTL; [RX] - TA60R0008--|PWTL=15;	

5.76 PWTLM – Pre Warn Time Long Mode

Key	PWTLM
AMSG allowed	On change: No, Periodical: No
Description	Read or write the pre warn time long mode configuration. The mode defines in which situation, the pre warn time long (and not regular) shall be used. The index_pwtlm is defined as follows:

Name	Value	Note
DISABLED	0	Pre warn time regular is always used.
CUSTOMER_INTERLOCK_1	1	Pre warn time long is used for next HVEN when customer interlock 1 is set.

	CUSTOMER_INTERLOCK_2	2	Pre warn time long is used for next HVEN when customer interlock 2 is set.
	CUSTOMER_INTERLOCK_ALL	3	Pre warn time long is used for next HVEN when one or both of the customer interlocks are set.

Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	[index_pwtlm]
Response Value	[index_pwtlm]	ACK ReturnCode #0
Examples TCP	Read the configured pre warn time long mode [TX] - TA60S0006--|PWTLM; [RX] - TA60R0008--|PWTLM=0; Set the pre warn time long mode to customer interlock 2 [TX] - TA60S0006--|PWTLM; [RX] - TA60R0008--|PWTLM=2; [TX] - TA10S0007--|PWTR=2; [RX] - TA10R0008--|PWTR=#0;	

5.77 PWTR – Pre Warn Time Regular

Key	PWTR	
AMSG allowed	On change: No, Periodical: No	
Description	Read or write the regular pre warn time in [s]. *Note: this will be the pre warn time for all situations where the conditions for a long pre warn time are not met.*	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Uint32 [s]
Response Value	Uint32 [s]	ACK ReturnCode #0
Examples TCP	Read the configured pre warn time regular in [s] [TX] - TA60S0005--|PWTR; [RX] - TA60R0007--|PWTR=1; Set the pre warn time regular to 2s and read it back [TX] - TA10S0007--|PWTR=2; [RX] - TA10R0008--|PWTR=#0; [TX] - TA60S0005--|PWTR; [RX] - TA60R0007--|PWTR=2;	

5.78 QLFLDEN – Cooler Flow Detection Enable

Key	QLFLDEN	
AMSG allowed	On change: No, Periodical: No	
Description	Enables/disables the cooler flow detection transition. If true then cooler flow input signal must show a transition from open to closed when the cooler ON output signal is switched on. If false the cooler flow input signal must be closed when the cooler ON output signal is on (but no transition needed).	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Boolean
Response Value	Boolean	ACK ReturnCode #0
Examples TCP	Enable check cooler flow transition [TX] - TA10S000A--|QLFLDEN=1; [RX] - TA10R000B--|QLFLDEN=#0; Read the check cooler flow detection enable [TX] - TA60S0008--|QLFLDEN; [RX] - TA60R000A--|QLFLDEN=0;	

5.79 QLFLTO – Cooler Flow Timeout

Key	QLFLTO	
AMSG allowed	On change: No, Periodical: No	
Description	Read or write the configured cooler flow timeout in [s].	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Uint32 [s]
Response Value	Uint32 [s]	ACK ReturnCode #0
Examples TCP	Read the configured cooler flow timeout [TX] - TA60S0007--|QLFLTO; [RX] - TA60R0009--|QLFLTO=1; Set the cooler flow timeout to 3s [TX] - TA10S0009--|QLFLTO=3; [RX] - TA10R000A--|QLFLTO=#0; [TX] - TA60S0007--|QLFLTO; [RX] - TA60R0009--|QLFLTO=3;	

5.80 QLPCT – Cooler Post Cooling Time

Key	QLPCT	
AMSG allowed	On change: No, Periodical: No	
Description	Read or write the configured post cooling time in [s].	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Uint32 [s]
Response Value	Uint32 [s]	ACK ReturnCode #0
Examples TCP	Read the configured post cooling time in [s] [TX] - TA60S0006--|QLPCT; [RX] - TA60R0009--|QLPCT=60; Set the post cooling time to 75s and read it back [TX] - TA10S0009--|QLPCT=75; [RX] - TA10R0009--|QLPCT=#0; [TX] - TA60S0006--|QLPCT; [RX] - TA60R0009--|QLPCT=75;	

5.81 QLPCTE – Cooler Post Cooling Time Emergency

Key	QLPCTE	
AMSG allowed	On change: No, Periodical: No	
Description	Read or write the configured emergency post cooling time in [s].	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Uint32 [s]
Response Value	Uint32 [s]	ACK ReturnCode #0
Examples TCP	Read the configured emergency post cooling time in [s] [TX] - TA60S0007--|QLPCTE; [RX] - TA60R0009--|QLPCTE=5; Set the emergency post cooling time to 6s and read it back [TX] - TA10S0009--|QLPCTE=6; [RX] - TA10R000A--|QLPCTE=#0; [TX] - TA60S0007--|QLPCTE; [RX] - TA60R0009--|QLPCTE=6;	

5.82 RC_DFLT – Remote Control Default

Key	RC_DFLT
AMSG allowed	On change: Yes, Periodical: Yes

Description	Set the default remote control for controlling the generator. The default remote control is stored persistently on the IFC. Default remote control has effect if generator is set into single-master-remote-control with key RC_MODE.

Name	Value	Note
TCP_50506	0	TCP interface port 50506
TCP_50505	1	TCP interface port 50505
SERIAL	3	Serial Interface

Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	[index_extitf]
Response Value	[index_extitf]	ACK ReturnCode #0
Examples TCP	Set default master control to TCP port 50506 [TX] - TA10S000A--|RC_DFLT=0; [RX] - TA10R000B--|RC_DFLT=#0; Set default master control to Serial Communication Interface [TX] - TA10S000A--|RC_DFLT=3; [RX] - TA10R000B--|RC_DFLT=#0; Get default master [TX] - TA60S0008--|RC_DFLT; [RX] - TA60R000A--|RC_DFLT=3;	

5.83 RC_HANDL – Remote Control Handle

Key	RC_HANDL	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Release or requests the handle for remote control. To have only one application which control the generator. The generator is set into the single-master-mode with key RC_MODE. By sending key RC_HANDL the handle for control can be requested. If the handle is released the default master is set. Default master can be set with RC_DFLT key.	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Boolean: 0: Release master handle 1: Request master handle
Response Value	Boolean: 0: hasn't master handle 1: has master handle	ACK ReturnCode #0
Examples TCP	Read the remote control handle (hasn't master handle) [TX] - TA60S0009--|RC_HANDL; [RX] - TA60R000B--|RC_HANDL=0; Read the master control (is master) [TX] - TA60S0009--|RC_HANDL; [RX] - TA60R000B--|RC_HANDL=1; Request master control [TX] - TA10S000B--|RC_HANDL=1; [RX] - TA10R000C--|RC_HANDL=#0; Release master control [TX] - TA10S000B--|RC_HANDL=0; [RX] - TA10R000C--|RC_HANDL=#0;	

5.84 RC_MODE – Remote Control Mode

Key	RC_MODE
AMSG allowed	On change: Yes, Periodical: Yes
Description	Activate single-master remote control for the generator. Then only one application can control the generator. The master mode is stored persistently on the IFC.

	If single master remote control is activated. Then only the default master (key RC_DFLT) can control the generator. Or another application can get control by requesting the master (key RC_HANDL).	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Boolean: 0: multi-master-control 1: single-master-control
Response Value	Boolean: 0: multi-master-control 1: single-master-control	ACK ReturnCode #0
Examples TCP	Read the master mode [TX] - TA60S0008--|RC_MODE; [RX] - TA60R000A--|RC_MODE=0; Disable single-master-mode control [TX] - TA10S000A--|RC_MODE=0; [RX] - TA10R000B--|RC_MODE=#0; Enable single-master-mode-control [TX] - TA10S000A--|RC_MODE=1; [RX] - TA10R000B--|RC_MODE=#0;	

5.85 REBOOT – Reboot the System

Key	REBOOT	
AMSG allowed	On change: No, Periodical: No	
Description	Reboots the IFC and therefore also resets the devices (on IFC bootup). *Note: since this will also shut down the com-svc, it is possible, that the return code cannot be processed properly before the connection gets closed.*	
Ports	**Read**	**Write**
	-	0x10
Request Value	-	-
Response Value	-	ACK ReturnCode #0
Examples TCP	Reboot the system (this will also close the connection you are communicating on!) [TX] - TA10S0007--|REBOOT; [RX] - TA10R000A--|REBOOT=#0;	

5.86 SELTBFLT – Select Tube Filter

Key	SELTBFLT	
AMSG allowed	On change: No, Periodical: No	
Description	Select a tube filter. Or read the currently selected tube filter. To get the possible tube filters use key TUBFLT. Use key TUBFLTCT to get number of available tube filters.	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	String
Response Value	String	ACK ReturnCode #0
Examples TCP	Read the actual selected tub filter [TX] - TA60S0009--|SELTBFLT; [RX] - TA60R000F--|SELTBFLT=COMET; Select a tube filter (filter=comet) [TX] - TA10S000F--|SELTBFLT=comet; [RX] - TA10R000C--|SELTBFLT=#0; Select an invalid tube filter [TX] - TA10S000F--|SELTBFLT=blabla; [RX] - TA10R000E--|SELTBFLT=#106;	

5.87 SELTUB – Select Tube

Key	SELTUB	
AMSG allowed	On change: No, Periodical: No	
Description	Select a tube or read the type of the actually selected / configured tube. To get the possible tube types use key TUBE. Key TUBE allows reading of information for all available tubes by index and TUBCNT to get number of available tubes for this generator. Change affects after a reboot of the IFC.	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	String
Response Value	String	ACK ReturnCode #0
Examples TCP	Read the actual selected tube (type=MXR-225/22) [TX] - TA60S0007--|SELTUB; [RX] - TA60R0012--|SELTUB=MXR-225/22; Select a tube (type=MXR-225/26) [TX] - TA10S0014--|SELTUB=MXR-225/26; [RX] - TA10R000A--|SELTUB=#0; Select an invalid tube [TX] - TA10S0011--|SELTUB=blabla; [RX] - TA10R000C--|SELTUB=#106;	

5.88 SERNBR – Serial Number

Key	SERNBR	
AMSG allowed	On change: no, Periodical: no	
Description	Read the serial number of a specific component. Components are selected by port. Serial number is stored as an UINT64.	
Ports	**Read**	**Write**
	0x60, 0x61, 0x62, 0x69, 0x80, 0x83, 0x90	
Request Value	-	
Response Value	String	
Examples TCP	Read the serial number of the IFC device [TX] - TA69S0007--|SERNBR; [RX] - TA69R000A--|SERNBR=12;	

5.89 SEVOPER – Severe Operating Error Register

Key	SEVOPER	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Read the 32 bit severe operating error register in hex.	
Ports	**Read**	**Write**
	0x60	
Request Value	-	-
Response Value	Uint32hex	-
Examples TCP	Read the severe operating error register [TX] - TA60S0008--|SEVOPER; [RX] - TA60R000C--|SEVOPER=0x0;	

5.90 SHTDN – Shutdown Reason

Key	SHTDN
AMSG allowed	On change: Yes, Periodical: Yes
Description	Read the last shutdown reason of the iVario generator. The response value is a shutdown reason object [object_shtdn] and is defined as follows:

Value-Index	Value-Description	Type
0	Source	Uint32
1	Code	Uint32

		2	Detail	Uint32
Ports	**Read**		**Write**	
	0x60		-	
Request Value	-		-	
Response Value	[object_shtdn]		-	
Examples TCP	Read the actual shutdown reason (no shutdown occurred) [TX] - TA60S0006--|SHTDN; [RX] - TA60R000C--|SHTDN=0,0,0; Read the actual shutdown reason (power cell 1, kV value out of tolerance during emission, value to small) [TX] - TA60S0006--|SHTDN; [RX] - TA60R000D--|SHTDN=1,10,2;			

5.91 SOPMOD – Special Operating Mode

Key	SOPMOD	
AMSG allowed	On change: No, Periodical: No	
Description	For MF, set the “normal operating mode” or the ”Unfocused mode”. Unfocused mode allows setting the high voltage and the emission current while being in unfocused focal spot. This mode is used for instance for detector calibration.	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	[index_sopmode]
Response Value	[index_sopmode]	ACK ReturnCode #0
Examples TCP	Read special operating mode [TX] - TA60S0007--|SOPMOD; [RX] - TA60R0009--|SOPMOD=0; Set special operating mode UNFOCUSED MODE [TX] - TA10S0009--|SOPMOD=4; [RX] - TA10R000A--|SOPMOD=#0;	

Name	**Value**	**Note**
NONE	0	Normal operating mode active. This operating mode is persisted and remains after reboot.
UNFOCUSED MODE	4	Special operating mode for MesoFocus. This special operating mode is volatile, is set back to normal operating mode after a reboot.

5.92 STACT – Statistic Arc Counter Total

Key	STACT	
AMSG allowed	On change: No, Periodical: No	
Description	Read the statistic arc counter total value.	
Ports	**Read**	**Write**
	0x60	
Request Value	-	-
Response Value	Uint32	-
Examples TCP	Read the statistic arc counter [TX] - TA60S0006--|STACT; [RX] - TA60R0009--|STACT=10;	

5.93 STARTER – Boot / Start-Error Register

Key	STARTER
AMSG allowed	On change: Yes, Periodical: Yes

Description	Read the boot- / start error register. Read the 32-bit boot- / start error register in hex.	
Ports	**Read**	**Write**
	0x60	
Request Value	-	-
Response Value	Uint32hex	-
Examples TCP	Read the boot-/start-error register [TX] - TA60S0008--|STARTER; [RX] - TA60R000C--|STARTER=0x0;	

5.94 STITMT – Statistic Idle Time Total (HV off)

Key	STITMT	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Returns the statistic idle time total value. Value is the cumulated time where HV was off.	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-
Response Value	object_time	-
Examples TCP	Read statistic idle time total e.g. 1h 32min 20s [TX] - TA60S0007--|STITMT; [RX] - TA60R000F--|STITMT=1,32,20;	

5.95 STOTMT – Statistic Operating Time Total (HV on)

Key	STOTMT	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Returns the total operating hours where HV was on. Unit is [s].	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-
Response Value	Uint32 [s]	-
Examples TCP	Read total operating hours in [s] [TX] - TA60S0007--|STOTMT; [RX] - TA60R0009--|STOTMT=8;	

5.96 SWUPDATE– Software Update

Key	SWUPDATE
AMSG allowed	On change: No, Periodical: No
Description	Starts a SW-update on system or component level. The Software update command contains various modes; each could have a path.

Index	Value-Description	Type	Description
0	Update mode	Index_swupdate	
1	URL / Path	String	If mode = Net then URL If mode = USB or mode = Direct then Path

Name	Value	Note
USB	0	Update from USB-Stick If the path parameter is left empty the default path "/mnt/usbdrive/t3-release.fw" is taken.
NET	1	Update from Net needs the URL to the update package as parameter. If no URL parameter is set then key returns #105.
COMPONENTS	2	If a new component (POC, ECU, iDevice) should be integrated to the generator. The IFC can be pushed to check all SW version of the component. If the

			versions mismatch the component will be programmed with the actual version from IFC. URL/path parameter is ignored.
	DIRECT	3	A direct update from the IFC. As an optional parameter path can be set. If no path parameter is set, default path is taken.
	~~**FACTORY_RST**~~	~~4~~	Not supported since V.4.0
	ROLLBACK	5	After an update a rollback to the latest version can be done. URL/path parameter is ignored.

Ports	**Read**	**Write**
	-	0x10
Request Value	-	[object_swupdate]
Response Value	-	ACK ReturnCode #0 Not Allowed ReturnCode #111 Too few parameters #105
Examples TCP	Update from USB stick [TX] – TA10S0020--|SWUPDATE=0,blabla/t3-release.fw; [RX] – TA10R000C--|SWUPDATE=#0; Update from net [TX] – TA10S0038--|SWUPDATE=1,https://blabla.com/sw/V.0.4.0/t3-release.fw; [RX] – TA10R000C--|SWUPDATE=#0; Update components with actual SW version [TX] – TA10S000B--|SWUPDATE=2; [RX] – TA10R000C--|SWUPDATE=#0; Update direct from System [TX] – TA10S0023--|SWUPDATE=3,/home/gui/t3-release.fw; [RX] – TA10R000C--|SWUPDATE=#0; Rollback to latest version [TX] – TA10S000B--|SWUPDATE=5; [RX] – TA10R000C--|SWUPDATE=#0;	

5.97 SWVERS – Software Version

Key	SWVERS	
AMSG allowed	On change: No, Periodical: No	
Description	Read the current software versions in the system.	
Ports	**Read**	**Write**
	0x60, 0x61, 0x62, 0x6A, 0x6B, 0x70, 0x80, 0x83, 0x90	-
Request Value	-	-
Response Value	String	-
Examples TCP	Read the overall (generators) software version string [TX] – TA60S0007--|SWVERS; [RX] – TA60R0018--|SWVERS=V.0.2.2.T9.14764; Read the power cell software version strings [TX] – TA61S0007--|SWVERS; [RX] – TA61R0018--|SWVERS=V.0.2.2.T9.14764; [TX] – TA62S0007--|SWVERS; [RX] – TA62R0018--|SWVERS=V.0.2.2.T9.14764;	

5.98 SYSSTAT – System Status

Key	SYSSTAT
AMSG allowed	On change: Yes, Periodical: Yes
Description	Read the system status of the iVario generator. For the definition of the system status, refer to the T3 Status Manual The response value is a system status object [object_sysstat] and is defined as follows:

		Index	**Value-Description**	**Type**
		0	System Status	Uint32
		1	Operation Status	Uint32
		2	Operation Sub-Status	Uint32
		3	reserved	Uint32
		4	reserved	Uint32
Ports	**Read**		**Write**	
	0x60			
Request Value	-		-	
Response Value	[object_sysstat]		-	
Examples TCP	Read the system status object [TX] - TA60S0008--|SYSSTAT; [RX] - TA60R0014--|SYSSTAT=1,7,100,0,0;			

5.99 TPMATNBR – Tube Package Material Number

Key	TPMATNBR	
AMSG allowed	On change: No, Periodical: No	
Description	Get the tube package material number.	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-
Response Value	String	-
Examples TCP	Get last installed package mat-nr from the HVPS (port 0x60) [TX] - TA60S0009--|TPMATNBR; [RX] - TA60R0011--|TPMATNBR=4654654;	

5.100 TUBCNT – Tube Count

Key	TUBCNT	
AMSG allowed	On change: No, Periodical: No	
Description	Get number of available tubes for this generator.	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-
Response Value	Uint32 – [index_tube]	-
Examples TCP	Get number of tubes [TX] - TA60S0007--|TUBCNT; [RX] - TA60R000A--|TUBCNT=31;	

5.101 TUBE – Tube

Key	TUBE	
AMSG allowed	On change: No, Periodical: No	
Description	Read tube type of a tube at a given index. Use TUBCNT to get number of available tubes for this generator. The tube index ([index_tube]) is a Uint32 number from 0 (tube 1) up to the number of available tubes in the generator (see TUBCNT) – 1.	
Ports	**Read**	**Write**
	0x60	-
Request Value	Uint32 – [index_tube]	-
Response Value	String	-
Examples TCP	Read the tube type (tube at index 0) [TX] - TA60S0007--|TUBE=0; [RX] - TA60R0017--|TUBE=DummyPlug-Bipolar;	

	Read the tube type (tube at index 30) [TX] - TA60S0008--|TUBE=30; [RX] - TA60R0011--|TUBE=Y.TU600-D02; Error read tube with a too high index [TX] - TA60S0008--|TUBE=31; [RX] - TA60R000A--|TUBE=#106;

5.102 TUBFLT – Tube Filter

Key	TUBFLT	
AMSG allowed	On change: No, Periodical: No	
Description	Read tube filter at a given index. Use TUBFLTCT to get number of available tube filters. The parameter is a index from 0 up to the number of available filters (see TUBFLTCT) – 1.	
Ports	**Read**	**Write**
	0x60	-
Request Value	Uint32	-
Response Value	String	-
Examples TCP	Read the tube type (tube at index 0) [TX] - TA60S0009--|TUBFLT=0; [RX] - TA60R000D--|TUBFLT=YXLON; Read the tube type (tube at index 30) [TX] - TA60S0009--|TUBFLT=2; [RX] - TA60R000D--|TUBFLT=COMET; Error read tube with a too high index [TX] - TA60S0009--|TUBFLT=4; [RX] - TA60R000C--|TUBFLT=#106;	

5.103 TUBFLTCT – Tube Filter Count

Key	TUBFLTCT	
AMSG allowed	On change: No, Periodical: No	
Description	Get number of available tubes filters.	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-
Response Value	Uint32	-
Examples TCP	Get number of tube filters [TX] - TA60S0009--|TUBFLTCT; [RX] - TA60R000B--|TUBFLTCT=4;	

5.104 TUCU – Tube Current Set

Key	TUCU	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Read or write the tube/emission current set point in [A]	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Float64 [A]
Response Value	Float64 [A]	ACK ReturnCode #0
Examples TCP	Read actual tube current before first set (min = 0A) [TX] - TA60S0005--|TUCU; [RX] - TA60R0007--|TUCU=0; Set tube current to 3mA and read it back [TX] - TA10S000A--|TUCU=3e-3; [RX] - TA10R0008--|TUCU=#0; [TX] - TA60S0005--|TUCU; [RX] - TA60R000B--|TUCU=0.003;	

5.105 TUCUM – Tube Current Measured

Key	TUCUM	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Read the actually measured tube current in [A] for the generator.	
Ports	**Read**	**Write**
	0x60, 0x61, 0x70	-
Request Value	-	-
Response Value	Float64 [A]	-
Examples TCP	Read actual measured tube current (3.04 mA) [TX] - TA60S0006--|TUCUM; [RX] - TA60R000E--|TUCUM=0.00304; Read actual measured tube current on ECU (0.83 mA) [TX] - TA70S0006--|TUCUM; [RX] - TA70R000E--|TUCUM=0.00083;	

5.106 TUCUU – Tube Current Set Used

Key	TUCUU	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Read the used tube current set point in [A]. The value is related to the tube current set point (see TUCU) but respects internal limitations.	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-
Response Value	Float64 [A]	-
Examples TCP	Read tube current set used [TX] - TA60S0006--|TUCUU; [RX] - TA60R0008--|TUCUU=0;	

5.107 WARN – Warning Register

Key	WARN	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Read the 32 bit system warning register (warning flags) in hex. Warning register is described in the T3 status manual.	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-
Response Value	Uint32hex	-
Examples TCP	Read actual warning register (there is no warning active) [TX] - TA60S0005--|WARN; [RX] - TA60R0009--|WARN=0x0;	

5.108 WUP – Warm-up @ Index

Key	WUP
AMSG allowed	On change: Yes, Periodical: Yes
Description	Set actual warm-up mode or read it back. The mode is defined by the [index_warmup]:

Name	Value	Note
DISABLED	0	No warm-up active / stop active warm-up
SHORT	1	Short warm-up
MEDIUM	2	Medium warm-up
LONG	3	Long warm-up

Note:

- This key cannot be set when driving High voltage.

	• A warm-up can be interrupted (HVEN=0;) and then disabled with WUP=0; In this case, the warm-up end voltage (WUPHIVO) is set to the last HV value reached during the canceled warm-up. Then the max HV value cannot be higher than the warm-up end voltage (WUPHIVO). This is to save the lifetime of the x-ray tube. To reset the max HV value to nominal, write WUPHIVO with nominal HV value.	
Ports	**Read**	**Write**
	0x60	0x10
Request Value	-	Uint32 – [index_warmup]
Response Value	Uint32 – [index_warmup]	ACK ReturnCode #0
Examples TCP	Read actual warm-up mode (not active) [TX] - TA60S0004--|WUP; [RX] - TA60R0006--|WUP=0; Set short warm-up, read it back then disable warm-up [TX] - TA10S0006--|WUP=1; [RX] - TA10R0007--|WUP=#0; [TX] - TA60S0004--|WUP; [RX] - TA60R0006--|WUP=1; [TX] - TA10S0006--|WUP=0; [RX] - TA10R0007--|WUP=#0;	

5.109 WUPCD – Warm-up Countdown Time

Key	WUPCD	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Returns the countdown time of the warm-up.	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-
Response Value	[object_time]	-
Examples TCP	Read warm-up countdown time e.g 0h, 32min, 10s [TX] - TA60S0006--|WUPCD; [RX] - TA60R000E--|WUPCD=0,32,10;	

5.110 WUPD – Warm-up Duration

Key	WUPD		
AMSG allowed	On change: No, Periodical: No		
Description	Returns the warm-up duration at [index_warmup].		
	Value-Index	**Value-Description**	**Type**
	0	Warm-up	[index_warmup]
	1	hours	Uint32
	2	minutes	Uint32
	3	seconds	Uint32
Ports	**Read**		**Write**
	0x60		-
Request Value	[index_warmup]		-
Response Value	[object_wuptime]		-
Examples TCP	Read the warm-up duration at short warm-up, duration 45min [TX] - TA60S0007--|WUPD=1; [RX] - TA60R000E--|WUPD=1,0,45,0;		

5.111 WUPHIVO – Warm-up High Voltage End

Key	WUPHIVO
AMSG allowed	On change: Yes, Periodical: Yes

Description	Set the warm-up high voltage end. The warm-up high voltage end value is the maximum high voltage that the warm-up is going to. After a warm-up has finished the warm-up high voltage end is set to nominal again. Setting a custom warm-up end voltage **will limit the generator maximum drivable voltage to the set voltage**. Interrupting a warm-up with WUP=0; will set the warm-up end voltage at the last HV value reached during the warm-up. **This will limit the generator maximum drivable voltage to the warm-up end voltage**. If the warm-up end voltage is increased from a previous set value to a higher value or to the nominal HV value using the WUPHIVO key, the maximum drivable voltage is immediately set to this value, without requiring a warm-up. Be aware that the x-ray tube may still require a warm-up to be stable. The warm-up high voltage must be in a range defined from the generator and the selected tube. In case value is out of range error code #106 is returned. In case warm-up is running / paused no value can be set (error code #111).	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	Float64 [V]
Response Value	Float64 [V]	ACK ReturnCode #0
Examples TCP	Set the warm-up high voltage end [TX] - TA10S000F--|WUPHIVO=100000; [RX] - TA10R000B--|WUPHIVO=#0; Set warm-up high voltage end bigger than default of XRS [TX] - TA10S000F--|WUPHIVO=200000; [RX] - TA10R000D--|WUPHIVO=#106; Read the warm-up high voltage end [TX] - TA60S0008--|WUPHIVO; [RX] - TA60R000F--|WUPHIVO=160000;	

5.112 WUPIT – Warm-up Idle Time

Key	WUPIT	
AMSG allowed	On change: No, Periodical: No	
Description	Returns the warm-up idle time at [index_warmup].	
Ports	**Read**	**Write**
	0x60	-
Request Value	[index_warmup]	-
Response Value	[object_wuptime]	-
Examples TCP	Read the warm-up idle time for long warm-up, duration 336h [TX] - TA60S0007--|WUPIT=3; [RX] - TA60R0010--|WUPIT=3,336,0,0;	

5.113 WUPMHIVO – Warm-up Maximum High Voltage

Key	WUPMHIVO	
AMSG allowed	On change: Yes, Periodical: Yes	
Description	Read the Warm-up induced maximum high voltage in [V]	
Ports	**Read**	**Write**
	0x60	-
Request Value	-	-
Response Value	Float64 [V]	-
Examples TCP	Read the Warm-up induced maximum high voltage [TX] - TA60S0009--|WUPMHIVO; [RX] - TA60R0010--|WUPMHIVO=160000;	

5.114 WUPRIT – Warm-up Remaining Idle Time

Key	WUPRIT
AMSG allowed	On change: No, Periodical: No

Description	Returns the warm-up remaining idle time at [index_warmup].	
Ports	**Read**	**Write**
	0x60	-
Request Value	[index_warmup]	-
Response Value	[object_wuptime]	-
Examples TCP	Read the warm-up remaining idle time for medium warm-up, remaining 149h, 39min, 21s [TX] - TA60S0009--|WUPRIT=2; [RX] - TA60R0011--|WUPRIT=2,149,39,21;	

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