Interface and command description
for the Control and Supply Unit 2 (CSU2)
of IFG Institute for Scientific Instruments GmbH
(as of 2016-03-21, translated July 2016)

General remarks regarding the network interface

Communication with the CSU2 works over a TCP/IP network connection. The CSU2 acts as TCP server using a fixed IP address and port (standard is 192.168.1.3 port 23, i.e. telnet port). In case a different IP address is needed, preferably inform IFG before delivery of the hardware.

Overview of command syntax

Commands start with a dollar sign '**$**', immediately followed by a command mnemonic (two upper case letters, digits, or special (printable) characters). One ore more parameters may follow. Each command ends with a carriage return character (in the following represented as <CR>). All characters between two commands ('<CR>…$') are ignored, i.e. commands can also be completed with <CR><LF> (carriage return, line feed).

Parameter can be whole numbers (no float values), switches (boolean values) or other characters. Switches can be 'ON' and 'NO' or alternatively '+' and '-'. Both forms are equivalent. The first parameter may act as a subcommand, for example see the HV group of commands.

A parameter may be preceded with blanks. Two parameters must be seperated with at least on blank. The last parameter is directly followed by <CR>.

Every '**$**' character starts a new command, i.e. previously read characters get discarded silently. A command must not contain more than 89 characters.

There is a **response** to each command. The reponse might be an error message or a command confirmation. A response starts with an exclamation mark '**!**' instead of a '**$**' sign.

A list of commands follows. Parameters are represented as lower case strings. Optional parameter are bracketed in ' […]'.

The query command **$OK** returns the time since power-on (in ms). The value returned is a double word (4 bytes) with a maximum of 4 294 967 295. After that it starts again from zero. Its primarily purpose it to check synchronicity of computer and CSU2.

For **remote control** using the interface described here the CSU2 has to be in "PC" mode: The LED next to the green button "PC" should be illuminated. The actual mode can be queried using the command **$RM?**. *All modifying commands lead to a positive response in local mode „LOC" – yet they are not executed!* Read only commands function in local mode just as in remote mode.

To ensure an adequate **warm-up** of the tube and operation in line with its **prefomance limits** the type of tube (see TT-group of commands), and system time ($RKOK, $RKTP) have to be set correctly.

Command syntax

1	OK	14	FH	27	RK TP		
2	HV	15	FU	28	RK OK		
3	HV W-	16	XR	29	RK R?		
4	HV WP	17	XR ?	30	RK T?		
5	HV W?	18	RM ?	31	RK L?		
6	HV UP	19	TT I?	32	RK S?		
7	HV IP	20	TT IP	33	RK RX		
8	HV HP	21	TT #?	34	RK RN		
9	HV U?	22	TT LP	35	RK CX		
10	HV I?	23	RK PP	36	RK CN		
11	HV H?	24	RK LP	37	RK ID		
12	HV ??	25	RK PB	38	XV		
13	HV ?1	26	RK LB	39	<<		

```
 1  Command OK: Query system time since power-on
--------------------------------------------------------------------------
    Query:   $OK<CR>
    Response: !OK system time in ms<CR>

 2  Command HV: Power high voltage generator on/off
--------------------------------------------------------------------------
    Query:   $HV cmd<CR>                    cmd = ON bzw. '+': on
    Response: !HV<CR>                             NO bzw. '-': off

 3  Command HVW-: Skip warm-up of tube (immediately "warmed-up")
--------------------------------------------------------------------------
    Query:   $HVW-<CR>
    Response: !HVW-<CR>

 4  Command HVWP: Manually set last time the tube was used
--------------------------------------------------------------------------
    Query:   $HVWP cmd<CR>       cmd = Time in format YYYY-MM-DD-hh:mm:ss
    Response: !HVWP<CR>
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 5   Command HVW?: Query last time the tube was warmed-up
-------------------------------------------------------------------------------
     Query:    $HVW?<CR>
     Response: !HVW? YYYY-MM-DD-hh:mm:ss <CR>

 6   Command HVUP: Set high voltage of HV generator
-------------------------------------------------------------------------------
     Query:    $HVUP par<CR>                par = Voltage in Volt V
     Response: !HVUP par<CR>

 7   Command HVIP: Set anode current of HV generator
-------------------------------------------------------------------------------
     Query:    $HVIP par<CR>                par = Current in Microampere µA
     Response: !HVIP par<CR>

 8   Command HVHP: Set filament current limit (maximum) of HV generator
     (Controlled automatically after $HV+ and until first use of this command)
-------------------------------------------------------------------------------
     Query:    $HVHP par<CR>                par = Current in Milliampere mA
     Response: !HVHP par<CR>

 9   Command HVU?: Query actual voltage of HV generator
-------------------------------------------------------------------------------
     Query:    $HVU?<CR>
     Response: !HVU? mwert<CR>              mwert = Voltage in Volt V

10   Command HVI?: Query actual anode current of HV generator
-------------------------------------------------------------------------------
     Query:    $HVI?<CR>
     Response: !HVI? mwert<CR>              mwert = Current in Microampere µA

11   Command HVH?: Query actual filament current of HV generator
-------------------------------------------------------------------------------
     Query:    $HVH?<CR>
     Response: !HVH? mwert<CR>              mwert = Current in Milliampere mA

12   Command HV??: Query actual state of HV generator
-------------------------------------------------------------------------------
     Query:    $HV??<CR>                    on, warmed = '+' oder '-'
     Response: !HV?? on warmed time <CR>    time = JJJJ-MM-TT-hh:mm:ss
                                            (remaining time for warm-up)

13   Command HV?1: Query error code
-------------------------------------------------------------------------------
     Query:    $HV?1<CR>                    errorcode = 4 digit error id
     Response: !HV?1 errorcode<CR>              (0 if no error)

14   Command FH: Query maximum measured current of HV generator
-------------------------------------------------------------------------------
     Aufruf :  $FH<CR>
     Response: !FH uA<CR>                   uA: max. anode current in uA

15   Command FU: Query maximum measured voltage of HV generator
-------------------------------------------------------------------------------
     Query:    $FU<CR>
     Response: !FU volt<CR>                 volt: max. Voltage in V

16   Command XR: Open/Close the shutter
-------------------------------------------------------------------------------
     Query:    $XR cmd<CR>                  cmd = ON bzw. '+': open shutter
     Response: !XR<CR>                            NO bzw. '-': close shutter
```

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17  Command XR?: Query shutter state
    ----------------------------------------------------------------------------
    Query:   $XR<CR>                     status = ON bzw. '+': shutter is open
    Response: !XR status<CR>                      NO bzw. '-': shutter is closed

18  Command RM?: Query remote mode
    ----------------------------------------------------------------------------
    Query:   $RM?<CR>                    status = ON bzw. '+': remote control on
    Response: !RM  status<CR>                     NO bzw. '-': local mode


19  Command TTI?: Query index of selected tube type
    ----------------------------------------------------------------------------
    Query:   $TTI?<CR>                   ix = Index 0..(ixcnt-1)
    Response: !TTI? ix<CR>

20  Command TTIP: Set tube type by index
    ----------------------------------------------------------------------------
    Query:   $TTIP ix<CR>                ix = Index 0..(ixcnt-1)
    Response: !TTIP<CR>

21  Command TT#?: Query number of known tube types
    ----------------------------------------------------------------------------
    Query:   $TT#?<CR>                   ixcnt = biggest index + 1
    Response: !TT#? ixcnt<CR>

22  Command TTLP: Query caption of tube type at index ix
    ----------------------------------------------------------------------------
    Query:   $TTLP ix<CR>                ix = index 0..(ixcnt-1)
    Response: !TTLP cap<CR>              cap = caption/description

23  Command RKPP: Program a string
    ----------------------------------------------------------------------------
    Query:   $RKPP position string<CR>   position = 0..99 (101)
    Response: !RKPP<CR>                   String length of max. 32 Byte

24  Command RKLP: Read string from position
    ----------------------------------------------------------------------------
    Query:   $RKLP position <CR>          position = 0..101
    Response: !RKLP position String<CR>   string length of max. 32 Byte

25  Command RKPB: Program pair of words
    ----------------------------------------------------------------------------
    Query:   $RKPB position value1 value2<CR>   position = 0..99
    Response: !RKPB<CR>                          value = 0..65535

26  Command RKLB: Read pair of words from position
    ----------------------------------------------------------------------------
    Query:   $RKLB position<CR>                  position = 0..99
    Response: !RKLB position value1 value2<CR>   value = word (2 bytes)

27  Command RKTP: Set realtime clock
    ----------------------------------------------------------------------------
    Query:   $RKTP cmd<CR>               cmd = time as YYYY-MM-DD-hh:mm:ss
    Response: !RKTP<CR>

28  Command RKOK: Query realtime clock
    ----------------------------------------------------------------------------
    Query:   $RKOK<CR>
    Response: !RKOK cmd <CR>             cmd = time as YYYY-MM-DD-hh:mm:ss
```

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29  Command RKR?: Query tube temperature
    ----------------------------------------------------------------------------
    Query:   $RKR?<CR>
    Response: !RKR? temp<CR>                        temp = temperature in m°C

30  Command RKT?: Query temperature of HV generator (SIC)
    ----------------------------------------------------------------------------
    Query:   $RKT?<CR>
    Response: !RKT? temp<CR>                        temp = temperature in m°C

31  Command RKL?: Query temperature of LED board (PT100)
    ----------------------------------------------------------------------------
    Query:   $RKL?<CR>
    Response: !RKL? temp<CR>                        temp = temperature in m°C

32  Command RKS?: Query temperature of shutter board (PT100)
    ----------------------------------------------------------------------------
    Query:   $RKS?<CR>
    Response: !RKS? temp<CR>                        temp = temperature in m°C

33  Command RKRX: Query maximum tube temperature
    ----------------------------------------------------------------------------
    Query:   $RKRX<CR>
    Response: !RKRX temp<CR>                        temp = temperature in m°C

34  Command RKRN: Query minimum tube temperature
    ----------------------------------------------------------------------------
    Query:   $RKRN<CR>
    Response: !RKRN temp<CR>                        temp = temperature in m°C

35  Command RKCX: Query maximum temperature of HV generator
    ----------------------------------------------------------------------------
    Query:   $RKCX<CR>
    Response: !RKCX temp<CR>                        temp = temperature in m°C

36  Command RKCN: Query minimum temperature of HV generator
    ----------------------------------------------------------------------------
    Query:   $RKCN<CR>
    Response: !RKCN temp<CR>                        temp = temperature in m°C

37  Command RKID: Query serial numbers / seconds of operation
    ----------------------------------------------------------------------------
    Query:   $RKID<CR>
    Response: !RKID HVSerNo HVSeconds TubeSerNo TubeSeconds<CR>
                                       SerNo:   serial number (string[32])
                                       Seconds: seconds of operation

38  Command XV: query fimware version
    ----------------------------------------------------------------------------
    Aufruf : $XV <CR>                              sig : signature (string[16])
    Response: !XVsig<CR>

39  Command <<: reset programmed parameters
    ----------------------------------------------------------------------------
    Query:   $<<<CR>
    Response: !<<

40  Command R#0: Query parameter version (number and type)
    ----------------------------------------------------------------------------
    Query:   $R#0<CR>
    Response: !R#9999
```

Error messages

```
!ERROR: 00  General error or buffer overflow
!ERROR: 01  Unknown command
!ERROR: 02  Numeric parameter expected
!ERROR: 04  Boolean parameter expected
!ERROR: 05  Additional parameter expected
!ERROR: 06  Unexpected parameter or character
!ERROR: 07  Illegal numeric value
!ERROR: 08  Unknown subcommand
!ERROR: 09  Function not implemented or no hardware support
!ERROR: 10  Flash-EPROM programming fault
!ERROR: 11  Error clearing Flash-EPROM
!ERROR: 12  Flash-EPROM read error
!ERROR: 13  Hardware error
```

Error codes (see command No. 13 $HV?1)

Error codes are shown on the display "µA". LEDs of "PC" and "LOC" buttons are constantly flashing.

Warnings:

1111 : Safety line at housing not connected (RJ45 connector)
1112 : External interlock (RJ45 connector at tube)
1113 : Interlock of HV-Generator
2111 : Real time clock broken or battery empty
2112 : Temperature of LED-board critical

Errors with self inhibition. These require power cycling the device:

3111 : Temperature sensor at LED-board broken / not connected
3112 : Temperature sensor at shutter-board broken / not connected
3121 : Temperature of LED-board above limit
3122 : Temperature of shutter-board above limit

3211 : HV LED at tube housing broken
3221 : Shutter hangs or shutter light bulb broken
3222 : Shutter hangs or shutter-LEDs at tube housing broken

3321 : Vacuum switch 1 broken
3322 : Vacuum switch 2 broken
3331 : HV powered on, and filament cable not (properly) connected
3332 : "PC"-mode active and HV on / shutter opened, but communication with PC timed out
3333 : No connection to HV generator. Power failure? Safety relais?