

# ADL x.547 RS-232/RS-485-Slave-Interface

### **User Manual**

Revision 2.0

Hardware-Revision 2.547

Firmware-Revision 2.0

Master-Software-Revision 1.0



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All rights reserved. Printed in Germany. This user manual is published in German and English to enable the reader to safely install and operate the RS-232/RS-485-Slave-Interface described herein.

# **A** NOTICE

 This manual must carefully be read before using the RS-232/RS-485-Slave-Interface. It should be kept for later look-up.

ADL products are constantly improved. ADL Analoge & Digitale Leistungselektronik GmbH therefore reserves the right to make technical changes without prior notice or obligation. To the best of our knowledge, the information contained in this user manual is the most accurate available as the date of the current edition. The information is not binding.

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### **Naming Conventions**

The following pictograms are used in this manual:

# **A** DANGER



- Type of risk
- This symbol warns about hazards, which are dangerous to life of the operator, and / or the risk of complete destruction of the device in case of disregarding of warnings.

## **A** WARNING



- Type pf risk
- This symbol warns about likely hazards, which could be dangerous to life of the user, and which could risk the complete destruction of the device in case of disregarding of warnings.

# **A** CAUTION



- Type of risk
- Dieses symbol warns about possible medium heavy or minor health hazards risks of the user, and / or possible malfunctions of the device in case of disregarding of warnings.

# **A** NOTICE

 Notes with this symbol give further information how the described functions and steps can be used most efficiently.



### 1 Function of the Interface

The PCB x.547 is equipped with a RS-232 and with a RS-485 Slave-Interface. With this interface, every ADL-power supply can be operated. The Slave is controlled and configured via ADL-Master-Software. The interface represents an ADL RS-232, RS-485 and Profibus-Master.

The Master-Software and the user manual in German and English on CD belong to the delivery package. For operation with a standard system control, the protocol and the commands of the Slave have to be integrated into the customer system software, which has the function of the Master.



### 2 Revisions

### 2.1 Firmware

The firmware revision number (section 4.3) can be reviewed via the configuration.

| FW-Rev. | Date    | Changes  |  |
|---------|---------|--|--|
| 1.0     | 04-2016 | <ul> <li>Compatible with HW-Revision 2.547 only</li> <li>Only RS-232/RS-485 support, no Profibus</li> </ul>  |  |
| 2.0     | 05-2016 | <ul> <li>Firmware for Profibus and RS-232/RS-485</li> <li>New commands (Protocol-Revision 2)</li> <li>Ramp-Mode and Joule-Mode modified</li> </ul> |  |

### 2.2 Software

Revision of Master-Software is shown in headline of main window and in "Info" window as well, which can be selected via menu bar "? / Info".

| SW-<br>Rev. | Date    | Changes |
|-------------|---------|---------|
| 1.0.        | 05-2017 | -       |

### 2.3 Hardware

Number of Hardware-Revision is found on the PCB, bottom right, see Figure 2.

| HW-Rev. | Date    | Changes   |
|---------|---------|---|
| 1.547   | 01-2015 | <ul> <li>Prototype PCBs</li> <li>No local operation possible</li> <li>RS-232/RS-485-assembly only</li> </ul>                                  |
| 2.547   | 05-2016 | <ul> <li>Layout- and component changes</li> <li>Toggle between Local / Remote control</li> <li>Profibus- or RS-232/RS-485-assembly</li> </ul> |



## 3 PCB, Connectors and Control Elements

The following is found on the front cover of the Slave:

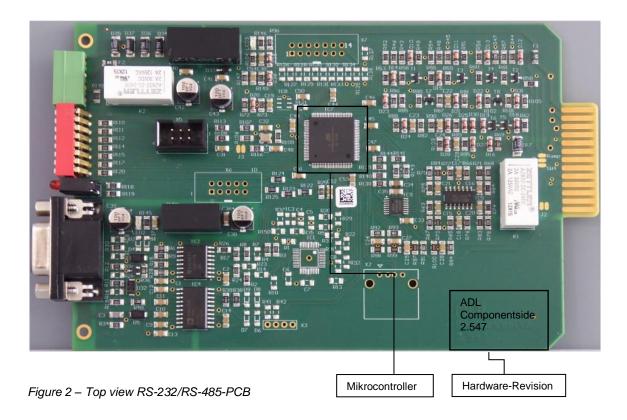
- Sub.-D-connector, 9-pole for connection to RS-232 or RS-485.
- LEDs to show operational status
- Eightfold DIP-switch for address, local / remote switch
- Terminal block for Interlock and external supply voltage



Figure 1 - Front cover of RS-232/RS-485-PCB

For disassembling the PCB the two hexagon socket screws on the cover plate have to be removed. Then the PCB can be pulled out.





### 3.1 RS-232/RS-485-Connection

The connector is a 9-pin Sub.-D-type:

| Pin     | Signal    | Description   |
|---------|-----------|---|
| 1       | RxD/TxD-P | RS-485 Receive-/Transmit Data-Plus (A)                                      |
| 2       | TxD       | RS-232 Transmit data Slave  |
| 3       | RxD       | RS-232 Receive data Slave   |
| 4       | -         |   |
| 5       | DGND      | Data reference potential (Ground) for RS-232 and RS-485                     |
| 6       | RxD/TxD-N | RS-485 Receive-/Transmit Data-Minus (B)                                     |
| 7       | -         | -   |
| 8       |           | -   |
| 9       | -         | -   |
| Housing | Shielding | SubD-housing is connected via front cover with shield (PE) of power supply. |



# **A** NOTICE

- For a maximum shielding, shield the data line at the Master and the Slave.
- The data line should be as short as possible and never be guided in parallel to the power cable.





- Destruction of theRS-232/RS-485-Interface.
- To pin 1, or pin 6, no voltages under -9 V, or over 14 V (related to pin 5), must be applied. The RS-485-Transceiver could be destroyed.

### **3.1.1 Activating RS-232**

To activate the RS-232, the address "Zero" has to be set at the DIP-switch before switching on the Slave. The RS-232 interface is not bus compatible. For the connection between Master and Slave a 9-pole serial cable can be used. The following pin-assignment is applied for the Master (9-pole, Sub.-D plug, EIA/TIA-232):

| Pin     | Function            | Description   |
|---------|---------------------|---|
| 1       | Input               | Data Carrier Detect (DCD)   |
| 2       | Input               | Receive Data (RXD)  |
| 3       | Output              | Transmit Data (TXD)   |
| 4       | Output              | Data Terminal Ready (DTR)   |
| 5       | Reference potential | Ground (GND)  |
| 6       | Input               | Data Set Ready (DSR)  |
| 7       | Output              | Request To Send (RTS)   |
| 8       | Input               | Clear To Send (CTS)   |
| 9       | Input               | Ring Indicator (RI)   |
| Housing | Shielding           | SubD-housing should be connected with the protective earth of the master. |



For the RS-232-communication between Master and Slave only the pins 2, 3 and 5 are used. Pins 1 and 6 of the RS-485 have a resting level of 2.5 V. The RS-232-inputs need a level of -15 V to -3 V or +3 V to +15 V. Therefore, they are in the undefined range of the RS-232 and can be switched onto the Master-inputs without hesitation.

### **3.1.2 Activating RS-485**

To activate the RS-485, the address has to be set between 1 and 31 at the DIP-switch before switching on the Slave. Therefore, a Master can control up to 31 slaves via buscable. The RS-485 is designed half-duplex, which means, that input and output data use the same data cable. The positive data cable of the Master has to be connected with pin 1, the negative data cable with pin 6 of the slave. The symmetrical transmission enlarges the resistivity against electro-magnetic disturbances.

For the connection from Master to the slaves, a twisted data cable with a surge impedance of  $120~\Omega$  has to be used. At the end of the cable, the data connection pair has to be closed with  $120~\Omega$ , in order to avoid reflections. The reference potential at pin 5 can be connected with an additional cable with the one of the Master and of the other slaves. Ground loops cannot appear, as the RS-232/RS-485-interfaces are set-up galvanically isolated.

### 3.2 LEDs

Two LEDs on the PCB indicate the following operating status:

| Color | Function         | Description  |
|-------|------------------|--|
| green | Supply voltage   | Blinks with a frequency of 2 Hz, when the Slave is supplied. |
| red   | Data<br>transfer | Lights up, when the Slaves receives data.                    |



### 3.3 Remote / Local Switch

The switch SW1 of the 8-fold DIP switch array is used to switch between RS-232/RS-485 remote control and local control (via front panel of the power supply). The address of the device is set via switch SW2 to SW8.

| Position  | Mode                              | Description  |
|-----------|-----------------------------------|--|
| SW1 = Off | RS-232/RS-485<br>(remote control) | All functions are controlled via the Master.  If the power supply is equipped with an active front panel and toggle switch, the switch must be in the position "DC On".  |
| SW1 = On  | Front panel (local control)       | Operating the power supply via front panel.  Via RS-232/RS-485 no commands can be activated. Nevertheless, the remote indications of the actual values are still active. |

# **A** NOTICE

Before switching the power supply to local or remote control, the power supply has to be switched off ("DCoff"). In case that the Remote/Local-switch is switched during running operation ("DC-On"), the power supply automatically turns off.

### 3.4 Baud Rate

The Baud rate is set via 8-fold DIP switch SW3 (B0) und SW2 (B1). The settings are activated with switching on the Slave. A change after switching on will only be accepted by switching on and off again the Slave. The higher the transmission frequency of the RS-232/RS-485 connection, the shorter the data cable has to be.



| Position |     | RS-232    |                      | RS-485    |                      |
|----------|-----|-----------|----------------------|-----------|----------------------|
| SW2      | SW3 | Baudrate  | Maximum cable length | Baudrate  | Maximum cable length |
| OFF      | OFF | 9600 Bd   | 150 m                | 19200 Bd  | 5200 m               |
| OFF      | ON  | 19200 Bd  | 15 m                 | 57600 Bd  | 1700 m               |
| ON       | OFF | 57600 Bd  | 5 m                  | 115200 Bd | 850 m                |
| ON       | ON  | 115200 Bd | 2 m                  | 921600 Bd | 100 m                |

### 3.5 Address

The address is set via DIP switch SW8 (A0) to SW4 (A4). When switching on the Slave, address Zero activates the RS-232. Address 1 to 31 activates the RS-485 interface. Example: A1 and A4 are activated, this corresponds to the address 18 (2+16).

| Position        | Mode    | Description   |
|-----------------|---------|---|
| SW4 8<br>(A4A0) | Address | Configuration of the 5-Bit address of the RS-232/RS-485 interface via DIP switch. Address 1 to 31 are accepted by the DIP switch.  Address 0 activates RS-232 (not bus compatible) Address 131 activates RS-485 |

### 3.6 Interlock Connection and external 24 V-Supply

The 4-pin terminal block (see Figure 1) can be used, together with the connector (included in delivery), as interlock loop and for external supply of the Slave (see Figure 3). In case the interlock contact is open, the power output remains switched off. The interlock connection has to be a floating contact and serves for example as a process alarm loop or in a personal protection system for door contacts etc.



For wiring of the Interlock connector four configurations are possible:

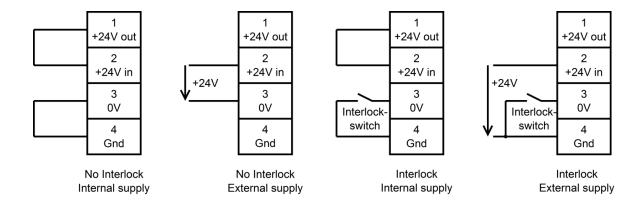


Figure 3 - Schematic wiring diagram interlock connector

| Wiring                     | Description  |
|----------------------------|--|
| No Interlock 24 V internal | Pin 1 and pin 2, pin 3 and pin 4, respectively, have to be bridged. In this case the interlock function should be fulfilled on the mains side (e.g. via mains contactor). For communication between Slave and the PLC, mains voltage of the ADL power supply has to be switched on.                  |
| No Interlock 24 V external | The external 24 V supply must be connected between pin 2 and 3. It is not necessary to galvanically isolate the 24 V supply, because this is done on the interface side. In this case the Interlock function should be fulfilled on the mains side of the power supply (e.g. contactor).             |
| Interlock<br>24 V internal | The safety switch has to be connected between Pin 3 and Pin 4. Pin 1 and Pin 2 have to be bridged. For communication between Slave and the PLC, mains voltage of the ADL power supply has to be switched on.   |
| Interlock<br>24 V external | The external 24 V supply must be connected between pin 2 and 4. In order to avoid disturbing voltage (hum pickup), the 24 V supply <b>must be</b> galvanically isolated, because in this case it is connected to the internal ground. The safety switch has to be connected between Pin 3 and Pin 4. |



# **A** NOTICE

The external voltage supply allows a bus communication between the Slave and the PLC, even when the power supply has been switched off. In addition, the Slave is supplied internally, when the power supply is switched on. The supply from an internal and external source at the same time is intended and inherits, when correctly connected, no danger.

# **A** CAUTION



- Destruction of the RS-232/RS-485 interface.
- The external voltage supply must not exceed 30 V<sub>DC</sub>.
- An external AC voltage is not allowed.
- The interlock connection of the PCB is protected against false polarity. Nevertheless, only the correct polarity guarantees correct functioning.



# 4 Operation and Configuration via ADL-Master Software

The ADL-Master Software is composed of the two data files ADL\_Master.exe and crc.dll. For program execution both data files have to be in the same file folder. The software on the CD works under Windows 2000, XP, 7, 8 and 10.

For a RS-232/RS-485 connection the PC needs a RS-232 or RS-485 interface, executed as COM-Port, on the hardware side. The customer can check its own PC-status in Windows via device manager. Possibly it could be necessary to install a COM-Port.

The configuration of the Slaves is customized. In case a new configuration is desired, see section 4.3.

| Connection | Master/COM-Port | Slave          |
|------------|-----------------|----------------|
| RS-232     | TxD             | Pin 3 RxD      |
|            | RxD             | Pin 2 TxD      |
|            | Ground          | Pin 5 Gnd      |
| RS-485     | RS-485+         | Pin 1 RxD/TxD+ |
|            | RS-485-         | Pin 6 RxD/TxD- |



### 4.1 Control Elements and Status Information

After execution of the ADL\_Master.exe the following dialogue window opens:

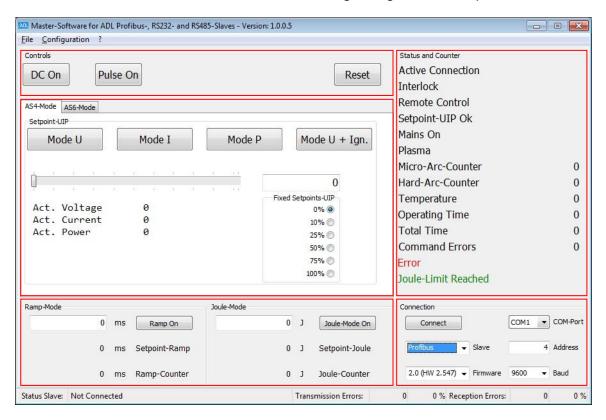


Figure 4 - Master-Software - Start window

As long as there is no connection to the Slave, the control elements remain deactivated and the status information remain frozen.

The software elements "Navigation bar", "Controls", "AS4-/AS6-Mode", "Ramp-/Joule-Mode", "Status and Counter", "Connection" and "Status line" are specified below:

### **Navigation bar**

| File - Close                            | Closes program                            |
|---|---|
| Configuration                           |   |
| -Configure Slave                        | Starts configuration menu                 |
| -Software-Limits-UIP                    | Manual Software-limits for Profibus x.408 |
| -Calibrate-Slave-<br>Temperature-Sensor | Calibration of the temperature sensors    |
| ? -Info                                 | Shows the information window              |



### **Controls**

| DC On    | Caution! Output voltage of the power supply is switched on! Next to the button a green bar appears as feedback. Press again for switching off, the bar disappears, status "DC Off". A yellow bar indicates, that the switch is in the position "On", whereas the power supply still remains in the status "DC Off". |
|----------|---|
| Pulse On | Activates a connected pulse generator. A yellow bar appears next to the button, as soon as the command was accepted by the Slave. The bar turns green, as soon as the connected generator starts pulse operation. Press again for deactivating.   |
| Reset    | The power supply will be switched off and the setpoints will be reset to zero.  |

The Slave is configured either in AS4- or in AS6-mode. Accordingly, only one of the two menu tabs is open. The AS6-mode will be described in-depth in subsection 4.2.2.

### AS4-mode (see Figure 5)

| Mode U                            | Voltage control  |
|-----------------------------------|--|
| Mode I                            | Current control  |
| Mode P                            | Power control  |
| Mode U + Ign.                     | Type GX, HX: Voltage control with ignition help (for reactive processes).  Type GS, GSW, Ion sources: fade out and not supported.  |
| Setpoint-UIP                      | There are three possibilities, to set the setpoint:  1. via scroll bar  2. via input in a text box  3. via fixed values  In case of a mode change the setpoint is automatically reset to zero and the maximum value is limited to the configured coefficients-UIP. |
| Actual Voltage,<br>Current, Power | The actual values are given out.   |



### AS6-Mode (see Figure 6)

| Limit-UIP                         | There are two possibilities to preset the limit value:  1. via scroll bar  2. via input in a text box |
|-----------------------------------|---|
| Actual Voltage,<br>Current, Power | The actual values are shown in a line below the limit values.   |

### Ramp- and Joule-Mode

| Ramp-Mode<br>-Text box        | Fill in the ramp time in ms.  Maximum value is 2 <sup>16</sup> -1 = 65535 ms.   |
|-------------------------------|---|
| -Setpoint-Ramp                | Feedback of ramp time.  |
| -Ramp-Counter                 | The time, which has passed since the start of the ramp, will be reported in milliseconds during active ramp function.   |
| -Ramp On                      | During the status "DC Off", the ramp can be activated via button "Ramp On". Deactivation of the ramp function is possible under every condition. As soon as the Slave accepted the command "Ramp On", a green bar appears next to the button.                     |
| Joule-Mode (option) -Text box | Here Joule-Limit can be entered.  Maximum value is 2 <sup>24</sup> -1 = 16777215 Joule.   |
| -Setpoint-Joule               | Feedback of the actual Joule-Limits   |
| -Joule-Counter                | If switched on, energy supply will be counted.  |
| -Joule-Mode On                | During the status "DC Off", Joule-Mode can be activated via button Joule-Mode "On". Deactivation of the Joule-Mode function is possible under every condition. As soon as the Slave accepted the command "Joule-Mode On", a green bar appears next to the button. |

# **A** NOTICE

■ The commands "Pulse On", "Mode-Change", "Ramp On" and "Joule-Mode On" are only accepted by the Slave in the status "DC off" (no output power). Otherwise the Slave does not accept the commands and the status remains unchanged.



### **Status and Counter**

| Active Connection                 | Blinking                          | An active connection exists   |
|-----------------------------------|-----------------------------------|---|
| Interlock                         | Green<br>Red                      | Interlock enabled Interlock locked, (no output voltage available)   |
| Remote Control /<br>Local Control | Green<br>Blue                     | Remote control Local control  |
| Setpoint ok                       | Green<br>Red                      | Setpoint within allowed range Setpoint outside allowed range  |
| Mains On                          | Green<br>Black                    | Mains contactor has been activated / mains voltage applied Mains contactor has not been activated   |
| Plasma                            | Green<br>Black                    | Plasma has ignited<br>No plasma   |
| Micro-Arc-Counter                 |                                   | Micro-Arcs counter  |
| Hard-Arc-Counter                  |                                   | Hard-Arcs counter   |
| Temperature                       |                                   | Temperature of the microcontrollers   |
| Operating Time                    |                                   | Time that has passed since Slave has been switched on   |
| Total Time                        |                                   | Total operation hours of the Slave  |
| Command Errors                    | Red                               | Number of commands, which have not been accepted by the Slave, Error code of the last command, which has not been accepted. The command errors can be reset via clicking on the message |
| Error                             | -<br>Red                          | Not indicated: No error<br>Error, (see Subsection 5.3.3)  |
| Joule-Limit<br>Reached            | Green<br>otherwise<br>not visible | Joule-Counter has reached the Setpoint-Joule (Joule-Mode: optional hardware)  |

### Connection

| Slave    | Selection of the Slave-Interface   |
|----------|------------------------------------|
| Firmware | Selection of the Profibus-Firmware |
| Com-Port | Selection of the COM-Port          |
| Address  | Address of the Slave               |
| Baud     | Baud rate of the connection        |



#### Status bar

| Status Slave           | Connection status of the Slave.   |
|------------------------|---|
| Transmission<br>Errors | Transmission errors: Total numbers and percentage If the Slave does not answer a command, this counts as a <a href="mailto:transmission">transmission</a> error                   |
| Reception<br>Errors    | Reception error: Total numbers and percentage If a master receives a data package with an inaccurate checking sum or with a parity mistake, it counts as a <u>reception</u> error |

### 4.2 Connection Set-up and Control

The first step to set-up a connection to the Slave is the selection of the Slave-interface in the connection-panel, see Figure 4.

Select RS-232 or RS-485.

In the next step select the COM-Port as well as the address and the baud rate of the Slave.

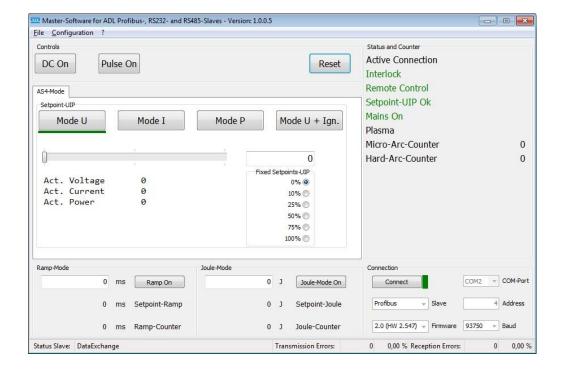


Figure 5 - active connection, AS4-Mode



In Figure 5 "RS-232" is selected as interface-Slave. The COM-Port has to be selected in accordance to the PC. All switches of the DIP-switch of the Slave are in position "Off" (see section 3.4 and 3.5), therefore the Slave has the address "0" and the baud rate "9600" (default configuration).

As soon as all parameters are properly set, press "Connect": Then a green bar appears next to the "Connect"-button. The green bar now indicates an active connection from the Master to the Slave.

A yellow bar next to the "Connect"-button indicates, that the Master attempts to build up a connection, but without feedback. The "Transmission Errors" in the status line count every failed connection try. Very likely one of the parameters in the Connection-Panel is wrong or the Slave has not been switched on.

### 4.2.1 Switching-on the Power Supply in AS4-Mode

In order to switch on the power supply, the following procedure is necessary:

- 1. Select Control-Mode
- 2. Enter setpoint
- 3. Press button "DC-On" (Switch on)

Pressing "DC-on" again to switch off, the green bar next to the button "DC-On" disappears.

# **A** NOTICE

- A connected pulse generator has to be activated <u>before</u> switching-on!
- For the operation in Ramp-Mode/Joule-Mode the ramptime and the joule-limit as well as Ramp on/Joule-Mode also have to be activated <u>before</u> switching on.

After switching on, in Ramp-Mode the setpoint-UIP linearly boots-up within the ramp-time from zero to final value. Ramping up can be deactivated during booting, in this case the setpoint directly jumps to the final value.



After switching on, in Joule-Mode (hardware option) the device counts the transferred amount of energy. As soon as the limit has been reached, the device switches off and the status message "Joule-Limit Reached" is shown.

### 4.2.2 Switching on the Power Supply in AS6-Mode

A selection of the control mode is not possible, if Slave and power supply are configured in AS6-Mode. In this case, the limit values for each controller are set individually via three slide bars instead. This allows a continuous change between the three control modes. The respective actual value for voltage, current and power is in position bottom down to the value, see Figure 6.

Switching on power supply:

- 1. Set limit values for the controller U, I and P
- 2. Press "DC-On"

The functions "Pulse On", "Ramp"- and "Joule-Mode" have to be activated before switching on, like in AS4-Mode (Subsection 4.2.1).

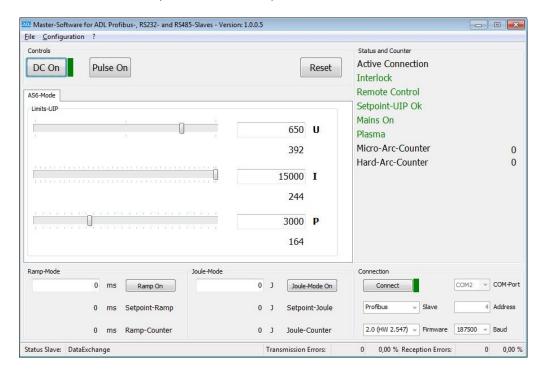


Figure 6 - active connection in AS6-Mode



# **A** NOTICE

While using the ramp function, only limit value P ramps up linearly.

### 4.3 Configuration

Factory side the Slave is customized configured. Nevertheless, changes are possible later on.



# **A WARNING**

- Changing the configuration can cause malfunctions!
- The power supply cannot be damaged, but possibly the connected load.

To make changes to the Slave, a connection via RS-232 or RS-485 has to established, see section 4.2.

- 1. Establish a connection with the Slave.
- 2. Select "Configuration Configure Slave" via the menu bar of the main window.



### The following window is displayed:

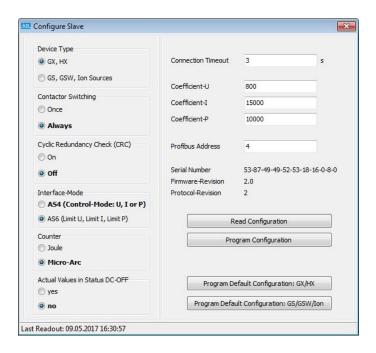


Figure 7 - configuration window of the Master-Software

### Device type:

| GX, HX                  | These power supplies have no main contactor. As soon as the power supplies are connected to mains voltage, "Mains On" is automatically logged on.  |  |  |  |  |  |
|-------------------------|--|--|--|--|--|--|
| GS, GSW,<br>Ion Sources | These power supplies are equipped with a main contactor. After switching on via "DC-On", the power supply gives out the message "Mains On". GS, GSW and Ion Sources have no pulse generator interface. The commands "Pulse On/Off" and control mode "Mode U + Ign." are not supported. |  |  |  |  |  |

### **Contactor Switching:**

| Once   | Main contactor is switched on, as soon as the command "DC On" is set for the first time.  The command "DC Off" only causes an electronic switching off, whereas the main contactor remains activated. This makes an immediate switching-on possible. The option should be chosen in case output voltage is switched on and off repeatedly during the process. |
|--------|---|
| Always | The main contactor of the power supply is generally switched on with the command "DC On" and switched off with the command "DC Off". (Default configuration)  |



### CRC (Cyclic Redundancy Check):

| On | 1 | The Slave checks the commands of the masters via check sum.  If an error occurs, the command will be ignored. |
|----|---|---|
| Of | f | The Slave ignores the values of the checking sum. (Default configuration).                                    |

#### Interface-Mode:

| AS4 | The control is done by selecting the control mode (U, I, P or U-Ign.) and the corresponding setpoint. (Default configuration) |  |  |  |
|-----|---|--|--|--|
| AS6 | Instead of the control modes, there are setpoints for voltage, current and power.   |  |  |  |

# **A WARNING**



- Changing the configuration can cause malfunctions!
- ADL-power supplies are delivered in AS4-Mode or AS6-mode. Accordingly, the Slave-interface is configured. A power supply delivered in AS4-mode cannot be operated with a slave configured in AS6-mode and vice versa. The unit and slave cannot be damaged, but possibly the connected load.

# **A** NOTICE

A new configuration of the power supply from operation in AS4- to AS6-mode (or vice versa) can exclusively be done directly from ADL Darmstadt or an authorized ADL service partner.

#### Counter

| Joule         | The Joule-Counter (option) counts the energy released in [Ws]. The Master-Software fades-in the Joule-Mode-Functions.   |
|---------------|---|
| Micro-<br>Arc | Micro-Arcs are counted, if this function is supported by the hardware (not possible with Ion Sources). The Master-Software fades-in the Micro-Arc-Counter. (Default configuration). |



#### **Actual Values in Status DC Off**

| Yes | The latest actual values are always reported back.   |  |  |  |  |  |
|-----|--|--|--|--|--|--|
| No  | If the output voltage is switched off, all actual values are zeroed. (Default configuration) |  |  |  |  |  |

#### **Connection Timeout:**

If the Slave does not receive any commands (e.g. the connection cable has been disconnected), the Slave must switch off the output power after a certain time, defined in the "Connection Timeout". (Default value: 3s).

#### Coefficient-U, I, P

This value is the coefficient for 10 V (internal processing of the setpoints/limit values). Example: If 0-10 represent 0-30 kW in power control, enter 30.000 to receive the actual values as decimal value in watt. The entered number must be within the value range of an unsigned 16-Bit-integer number (0-65535). As the internal converter modules have a 12-Bit resolution, the highest accuracy can be achieved with a value of 4095 (Default value: 4095).

### **Profibus-Address**

The address is only relevant for Profibus-Slaves. It has no influence on the RS-232/RS-485-Slave described here. (Default value: 4).

#### Slave-Information

Output of the serial number of the microcontroller, the Firmware- and protocol revisions.

#### **Read Configuration**

The actual configuration of the slave is read out, by pressing the button "Read Configuration".

#### **Program Configuration**

The actual configuration of the serial interface is entered, by pressing the button "Program Configuration".

### **Program Default Configuration GX/HX**

The default values for GX, HX are entered into the slave, by pressing the button "Program Default Configuration: GX/HX".



### **Program Default Configuration GS/GSW/Ion**

The default values for GS, GSW and Ion Sources are entered into the slave, by pressing the button "Program Default Configuration: GS/GSW/Ion".

### X

Closes the configuration menu.



### 5 Commands and Responses of RS-232 / RS485

Every command of the master and response of the slave uses the following UART settings:

| Baud rate | 9600, 19200, 57600, 115200 or 921600 (according to section 3.4) |
|-----------|---|
| Data Bits | 8   |
| Stop Bits | 1   |
| Parity    | Even  |

The communication of the master and the slave follows the guidelines of the Modbus protocol (See: <a href="http://www.modbus.org/">http://www.modbus.org/</a>) but isn't Modbus compliant. Generally, the Master sends commands to the slave. If the command is invalid, it is discarded. The Slave only answers, it doesn't start to communicate.

### 5.1 Master Command protocol

Every Master command is constructed identically. It begins with a Slave address. The function code follows (see section 5.2), 8 Bytes "Master-to-Slave", 2 Bytes CRC and the final character. The Master command is always 13 Bytes long, even when the CRC-control of the Slave is deactivated (see section 4.3). In this case the Slave ignores the content of both Bytes.

| Byte | Description                        | R/W |
|------|------------------------------------|-----|
| 1    | Slave Address                      | W   |
| 2    | Function Code                      | W   |
| 3    | Master-an-Slave-Byte 1             | W   |
| 4    | Master-an-Slave-Byte 2             | W   |
| 5    | Master-an-Slave-Byte 3             | W   |
| 6    | Master-an-Slave-Byte 4             | W   |
| 7    | Master-an-Slave-Byte 5             | W   |
| 8    | Master-an-Slave-Byte 6             | W   |
| 9    | Master-an-Slave-Byte 7             | W   |
| 10   | Master-an-Slave-Byte 8             | W   |
| 11   | CRC Low Byte                       | W   |
| 12   | CRC High Byte                      | W   |
| 13   | Final Character: 59 <sub>dec</sub> | W   |



### 5.2 Master Command List

The following table gives an overview of the Master commands. Included in every command is the content of the "Master-to-Slave" Bytes. For example, command 1 "DC-On" doesn't need "Master-to-Slave"-data. In this case the content of the data is ignored. For simplification every unused data Byte should be set to " $0_{dec}$ ".

For the command 9 "Mode U" (voltage control) the Slave expects inside of the "Master-to-Slave" Bytes 1 and 2 the Setpoint-U (0 to coefficient U). The highest Byte is always the mentioned first, here Byte 1.

The Slave responds to commands according to the answer protocol. The "Slave-to-Master" Bytes can also be obtained from there. The annotations are explained in another table. They describe in which operation state each command is allowed. For example: command 1 is not allowed if the power supply is in local operation-mode. If the command is sent nevertheless, then the "Command Error-Bit" is set in the response. The error description can be obtained from the "Command Error Code"-Bits.

The protocol number can be read from the configuration. The supported commands can be described from it.

| Func. Description Code |                                  |     | Master-to-Slave-<br>Bytes |     | Slave-to-Master-<br>Bytes |   | Protocol<br>Nr. |
|------------------------|----------------------------------|-----|---------------------------|-----|---------------------------|---|-----------------|
| 1 <sub>dec</sub>       | Switch on power supply (DC On)   | 1-8 | O <sub>dec</sub>          | 1-8 | O <sub>dec</sub>          | 5 | 1               |
| 2 <sub>dec</sub>       | Switch off power supply (DC Off) | 1-8 | Odec                      | 1-8 | Odec                      | 5 | 1               |
| 3 <sub>dec</sub>       | Read out actual                  | 1-8 | O <sub>dec</sub>          | 1-2 | AV-U                      | - | 1               |
|                        | values (U, I, P),                |     |                           | 3-4 | AV-I                      |   |                 |
|                        | (AV = Actual                     |     |                           | 5-6 | AV-P                      |   |                 |
|                        | Value)                           |     |                           | 7-8 | O <sub>dec</sub>          |   |                 |
| 4 <sub>dec</sub>       | Read out                         | 1-8 | O <sub>dec</sub>          | 1-2 | Setpoint-UIP              | 1 | 1               |
|                        | Setpoint-UIP                     |     |                           | 3-8 | O <sub>dec</sub>          |   |                 |
| 5 <sub>dec</sub>       | Read out actual                  | 1-8 | Odec                      | 1-2 | AV-U                      | - | 2               |
|                        | values (U, I, P,                 |     |                           | 3-4 | AV-I                      |   |                 |
|                        | $U_{Bias}$ ), (AV =              |     |                           | 5-6 | AV-P                      |   |                 |
|                        | Actual Value)                    |     |                           | 7-8 | AV-U-Bias                 | 1 |                 |
| 6 <sub>dec</sub>       | Read our Hard-                   | 1-8 | O <sub>dec</sub>          | 1-2 | O <sub>dec</sub>          | - | 1               |
|                        | Arc counter                      |     |                           | 3-4 | Hard-Arcs                 |   |                 |
|                        |                                  |     |                           | 5-8 | O <sub>dec</sub>          |   |                 |



| Func.<br>Code     | Description                                   | Master-to-Slave-<br>Bytes |                    | Slave-to-Master-<br>Bytes |                    | Anno-<br>tation | Protocol<br>Nr. |
|-------------------|---|---------------------------|--------------------|---------------------------|--------------------|-----------------|-----------------|
| Func.<br>Code     | Description                                   | Master-to-Slave-<br>Bytes |                    | Slave-to-Master-<br>Bytes |                    | Anno-<br>tation | Protocol<br>Nr. |
| 9 <sub>dec</sub>  | Activate voltage                              | 1-2                       | Setpoint-U         | 1-2                       | Setpoint-U         | 1, 4, 5         | 1               |
|                   | control<br>(Mode U)                           | 3-8                       | Odec               | 3-8                       | O <sub>dec</sub>   |                 |                 |
| 10 <sub>dec</sub> | Activate current                              | 1-2                       | Setpoint-I         | 1-2                       | Setpoint-I         | 1, 4, 5         | 1               |
|                   | control<br>(Mode I)                           | 3-8                       | O <sub>dec</sub>   | 3-8                       | O <sub>dec</sub>   |                 |                 |
| 11 <sub>dec</sub> | Activate power                                | 1-2                       | Setpoint-P         | 1-2                       | Setpoint-P         | 1, 4, 5         | 1               |
|                   | control<br>(Mode P)                           | 3-8                       | O <sub>dec</sub>   | 3-8                       | O <sub>dec</sub>   |                 |                 |
| 12 <sub>dec</sub> | Activate voltage                              | 1-2                       | Setpoint-          | 1-2                       | Setpoint-          | 1, 3, 4,        | 1               |
|                   | + ignition control                            |                           | U+lgn.             |                           | U+lgn.             | 5               |                 |
|                   | (Mode U + Ign.)                               | 3-8                       | Odec               | 3-8                       | O <sub>dec</sub>   |                 |                 |
| 13 <sub>dec</sub> | Read out status                               | 1-8                       | O <sub>dec</sub>   | 1-8                       | O <sub>dec</sub>   | -               | 1               |
| 20 <sub>dec</sub> | Activate                                      | 1-2                       | Setpoint-U         | 1-2                       | Setpoint-U         | 2, 5            | 1               |
|                   | setpoints for                                 | 3-4                       | Setpoint-I         | 3-4                       | Setpoint-I         |                 |                 |
|                   | voltage, current                              | 5-6                       | Setpoint-P         | 5-6                       | Setpoint-P         |                 |                 |
|                   | and power                                     | 7-8                       | Odec               | 7-8                       | Odec               |                 |                 |
| 21 <sub>dec</sub> | Read out<br>setpoints for<br>voltage, current | 1-8                       | O <sub>dec</sub>   | 1-2                       | Setpoint-U         | 2               | 1               |
|                   |   |                           |                    | 3-4                       | Setpoint-I         |                 |                 |
|                   |   |                           |                    | 5-6                       | Setpoint-P         |                 |                 |
|                   | and power                                     |                           |                    | 7-8                       | O <sub>dec</sub>   |                 |                 |
| 30 <sub>dec</sub> | Activate Setpoint-                            | 1-2                       | O <sub>dec</sub>   | 1-2                       | O <sub>dec</sub>   | 4, 5            | 1               |
|                   | Ramp  | 3-4                       | Setpoint-          | 3-4                       | Setpoint-          |                 |                 |
|                   |   |                           | Ramp               |                           | Ramp               |                 |                 |
|                   |   | 5-8                       | Odec               | 5-8                       | Odec               |                 |                 |
| 31 <sub>dec</sub> | Ramp On                                       | 1-8                       | O <sub>dec</sub>   | 1-8                       | Odec               | 4, 5            | 1               |
| 32 <sub>dec</sub> | Ramp Off                                      | 1-8                       | O <sub>dec</sub>   | 1-8                       | O <sub>dec</sub>   | 5               | 1               |
| $33_{\rm dec}$    | Read out                                      | 1-8                       | Odec               | 1-2                       | O <sub>dec</sub>   |                 | 1               |
|                   | Setpoint-Ramp                                 |                           |                    | 3-4                       | Setpoint-<br>Ramp  |                 |                 |
|                   |   |                           |                    | 5-8                       | O <sub>dec</sub>   |                 |                 |
| 34 <sub>dec</sub> | Read out Ramp-                                | 1-8                       | O <sub>dec</sub>   | 1-2                       | Odec               | -               | 1               |
|                   | Counter                                       |                           |                    | 3-4                       | Ramp-<br>Counter   |                 |                 |
|                   |   |                           |                    | 5-8                       | O <sub>dec</sub>   |                 |                 |
| 40 <sub>dec</sub> | Activate Setpoint-Joule                       | 1                         | O <sub>dec</sub>   | 1                         | O <sub>dec</sub>   | 4, 5            | 1               |
|                   | ·   | 2-4                       | Setpoint-<br>Joule | 2-4                       | Setpoint-<br>Joule |                 |                 |
|                   |   | 5-8                       | O <sub>dec</sub>   | 5-8                       | O <sub>dec</sub>   |                 |                 |
| 41 <sub>dec</sub> | Joule-Mode On                                 | 1-8                       | Odec               | 1-8                       | O <sub>dec</sub>   | 4, 5            | 1               |
| 42 <sub>dec</sub> | Joule-Mode Off                                | 1-8                       | O <sub>dec</sub>   | 1-8                       | O <sub>dec</sub>   | 5               | 1               |



| Func. Description Code |  | Master-to-Slave-<br>Bytes |                    |     | Slave-to-Master-<br>Bytes                      |         | Protocol<br>Nr. |
|------------------------|--|---------------------------|--------------------|-----|--|---------|-----------------|
| 43 <sub>dec</sub>      | Read out Micro-                              | 1-8                       | O <sub>dec</sub>   | 1   | O <sub>dec</sub>                               | 6       | 1               |
|                        | Arc-/Joule-<br>Counter<br>(Depending on      |                           |                    | 2-4 | Micro-Arc-<br>/Joule-<br>Counter               |         |                 |
|                        | the hardware)                                |                           |                    | 5-8 | O <sub>dec</sub>                               |         |                 |
| 44 <sub>dec</sub>      | Read out                                     | 1-8                       | O <sub>dec</sub>   | 1   | O <sub>dec</sub>                               | -       | 1               |
|                        | Setpoint-Joule                               |                           |                    | 2-4 | Setpoint-<br>Joule                             |         |                 |
|                        |  |                           |                    | 5-8 | O <sub>dec</sub>                               |         |                 |
| 50 <sub>dec</sub>      | Pulse On                                     | 1-8                       | O <sub>dec</sub>   | 1-8 | O <sub>dec</sub>                               | 3, 4, 5 | 1               |
| 51 <sub>dec</sub>      | Pulse Off                                    | 1-8                       | Odec               | 1-8 | O <sub>dec</sub>                               | 3, 4, 5 | 1               |
| 100 <sub>dec</sub>     | Read out (total)                             | 1-8                       | O <sub>dec</sub>   | 1-4 | Total Time                                     | -       | 2               |
|                        | operation hours                              |                           |                    | 5-8 | Operating<br>Time                              |         |                 |
| 101 <sub>dec</sub>     | Microcontroller temperature                  | 1-8                       | O <sub>dec</sub>   | 1-2 | Temperature /°C                                | -       | 1               |
|                        | ·  |                           |                    | 3   | = 0 <sub>dec</sub><br>Sensor not<br>calibrated |         |                 |
|                        |  |                           |                    |     | = 1 <sub>dec</sub><br>Sensor<br>calibrated     |         |                 |
|                        |  |                           |                    | 4-8 | O <sub>dec</sub>                               |         |                 |
| 112 <sub>dec</sub>     | Read out Coefficients-UIP                    |                           | B O <sub>dec</sub> | 1-2 | Coefficient-<br>U                              | -       | 1               |
|                        |  |                           |                    | 3-4 | Coefficient -I                                 |         |                 |
|                        |  |                           |                    | 5-6 | Coefficient -                                  |         |                 |
|                        |  |                           |                    | 7-8 | Odec   |         |                 |
| 131 <sub>dec</sub>     | Reset  | 1-8                       | O <sub>dec</sub>   | 1-8 | Odec   | 5       | 1               |
| 180 <sub>dec</sub>     | Activate                                     | 1-2                       | Setpoint-U         | 1-2 | AV-U   | 2, 5    | 1               |
|                        | setpoints for                                | 3-4                       | Setpoint-I         | 3-4 | AV-I   |         |                 |
|                        | voltage, current                             | 5-6                       | Setpoint-P         | 5-6 | AV-P   |         |                 |
|                        | and power, Slave responds with actual values | 7-8                       | Odec               | 7-8 | Odec   |         |                 |
| 183                    | Activate Setpoint-DAC4                       | 1-2                       | Setpoint-<br>DAC4  | 1-2 | Setpoint-<br>DAC4                              | 5       | 2               |
|                        | (For future applications)                    | 3-8                       | O <sub>dec</sub>   | 3-8 | O <sub>dec</sub>                               |         |                 |
| 184                    | Read out<br>Setpoint-DAC4                    | 1-8                       | Odec               | 1-2 | Setpoint-<br>DAC4                              | -       | 2               |
|                        |  |                           |                    | 3-8 | O <sub>dec</sub>                               | ]       |                 |



# **A** NOTICE

- If no command occurs during "Connection Time Out", an already switched-on power supply is switched off. For continuous operation the Slave has to receive constantly commands.
- The command table doesn't contain any configuration commands. The configuration is only possible with the Master-Software.

| Annotation | Description  |
|------------|--|
| 1          | The command is only allowed in AS4-Mode.   |
| 2          | The command is only allowed in AS6-Mode.   |
| 3          | The command is only allowed for the configuration type GX/HX.  |
| 4          | The command is only allowed for status "DC Off".   |
| 5          | The command is only allowed for status "Remote Control".   |
| 6          | The hardware of the power supplies of type GX, HX, GS and GSW standardly have a micro-arc-counter. A Joule-counter is optional. Without the appropriate Hardware the counter responds with zero. |

### 5.3 Slave Response protocol

The Slave response is always 16 Bytes long and similarly constructed to the master command. It always begins with the Slave address, followed by the function code (see section 5.2), 3 status Bytes, 8 Bytes "Slave-to-Master", 2 Bytes CRC and the final character. The slave always calculates a CRC value, the master can either check or ignore it.



| Byte | Description                        | R/W |
|------|------------------------------------|-----|
| 1    | Slave Address                      | R   |
| 2    | Function Code                      | R   |
| 3    | Status Byte 1                      | R   |
| 4    | Status Byte 2                      | R   |
| 5    | Status Byte 3                      | R   |
| 6    | Slave-to-Master-Byte 1             | R   |
| 7    | Slave-to-Master-Byte 2             | R   |
| 8    | Slave-to-Master-Byte 3             | R   |
| 9    | Slave-to-Master-Byte 4             | R   |
| 10   | Slave-to-Master-Byte 5             | R   |
| 11   | Slave-to-Master-Byte 6             | R   |
| 12   | Slave-to-Master-Byte 7             | R   |
| 13   | Slave-to-Master-Byte 8             | R   |
| 14   | CRC Low Byte                       | R   |
| 15   | CRC High Byte                      | R   |
| 16   | Final Character: 13 <sub>dec</sub> | R   |

### 5.3.1 Status Byte 1

| Bit | Description     | Definition            |           |                          |                  |  |  |
|-----|-----------------|-----------------------|-----------|--------------------------|------------------|--|--|
| 0   | Active toggle   | This Bit toggles with | h 2 Hz.   |                          |                  |  |  |
| 1   | Interlock       | =1 Interlock-blocke   | d         | =0 Interlo               | ock-released     |  |  |
| 2   | Remote Control  | =1 Remote control     |           | =0 Manual control        |                  |  |  |
| 3   | Setpoint-UIP Ok | =1 Setpoint-UIP all   | owed      | =0 Setpoint-UIP exceeded |                  |  |  |
| 4   | Mains On        | =1 mains voltage o    | n         | =0 mains voltage off     |                  |  |  |
| 5   | Output-Status   | =1 Output voltage of  | on        | =0 Outpu                 | it voltage off   |  |  |
| 6   | Pulse Generator | DC                    | = 0 DC-o  | peration                 |                  |  |  |
|     | Status          | Unipolar              | = 1 Unipo |                          | = 0 DC-Betrieb   |  |  |
|     |                 | Bipolar               | = 1 powe  |                          | = 0 time control |  |  |
|     |                 | Dipolai               | control a |                          | active           |  |  |
| 7   | Plasma          | =1 Plasma ignited     |           | =0 no Pla                | asma             |  |  |

### Bit 1 Interlock

The interlock prevents the output voltage from switching on and turns it off automatically if the lock is tripped during operation.



#### Bit 2 Remote Control

Manual control is active during two operating conditions:

- 1. The Slave is supplied with voltage externally only.
- 2. The power supply is operated manually via front panel.

During manual operation only, the actual values are transmitted through Profibus but no commands are accepted.

### Bit 3 Setpoint-UIP Ok





- Undesired operation status.
- In case the "Setpoint-UIP" exceeds the allowed value range (0 max. X), an error message is given out in Status Byte 1, bit 3, "Setpoint-UIP Ok". The power supply remains switched off until the "Setpoint-UIP" has reached the allowed value range again.

#### Bit 4 Mains On

The mains contactor is closed.

#### Bit 5 Output-Status

This Bit signals that the output voltage is switched on.

**Exception:** The pulse generator is signaling a fault, see Error-Bit description.

#### Bit 6 Pulse Generator Status

If the DC-power supply is connected with a pulse generator of the series SD or SB, this bit reflects the status of the pulse generator.

#### Bit 7 Plasma

The power supply has recognized a plasma.



# **A** NOTICE

■ The power supplies GDI09, GG03, GG03.1, GIP10, GIP10.1, GG08 do not support this function.

### 5.3.2 Status Byte 2

| Bit | Description             | Definition                           |                                |
|-----|-------------------------|--------------------------------------|--------------------------------|
| 0   | Mode P                  | =1 Power control                     | =0 other control               |
| 1   | Mode U                  | =1 Voltage control                   | =0 other control               |
| 2   | Mode I                  | =1 Current control                   | =0 other control               |
| 3   | Mode U + Ign.           | =1 Voltage control + plasma ignition | =0 other control               |
| 4   | Ramp Enabled            | =1 Ramp activated                    | =0 Ramp de-activated           |
| 5   | Joule-Mode<br>Enabled   | =1 Joule-Mode activated              | =0 Joule-Mode<br>de-activated  |
| 6   | Joules-Limit<br>Reached | =1 Joule-threshold reached           | =0 Joule-threshold not reached |
| 7   | Pulse On<br>Enabled     | =1 Pulse unit activated              | =0 Pulse unit de-activated     |

### Bit 0-3 Mode

The corresponding control mode is shown through a set bit.

If the Slave is configured in AS6-Mode, then all four mode-Bits are set to 1.

# **A** NOTICE

- The voltage control with and without plasma ignition use the U-coefficient. The plasma ignition increases the U-setpoint automatically until the plasma has ignited and then adjusts to the pre-defined Mode U + Ign-setpoint.
- The voltage control with plasma ignition is recommended for bipolar operated reactive processes. This control mode must be supported from the hardware of the DC-power supply (Only type GX and HX).



### Bit 4 Ramp Enabled

This bit indicates that when the power is turned on (command  $1_{dec}$ ), the ramp function is started.

#### Bit 5 Joule-Mode Enabled

This bit signalizes that the Joule-mode is active. It turns on as a reaction to the input bit "Joule-Mode On" (command 41<sub>dec</sub>).

#### Bit 6 Joule-Limit Reached

This Bit indicates that the requested amount of energy in Joule-Mode is reached and the output is turned off.

#### Bit 7 Pulse On Enabled

This bit is the feedback of the DC power supply to the command Pulse On (command  $50_{\rm dec}$ ).

### 5.3.3 Status Byte 3

| Bit | Description        | Definition                 |             |  |  |  |  |
|-----|--------------------|----------------------------|-------------|--|--|--|--|
| 0   | Error              | =1 Error                   | =0 No error |  |  |  |  |
| 1   | Command Error      | =1 Command error           | =0 No error |  |  |  |  |
| 2   | Watchdog           | =1 Watchdog-error          | =0 No error |  |  |  |  |
| 3-7 | Command Error Code | See table on the next page |             |  |  |  |  |

#### Bit 0 Error

The device has been operated too long in the overload range and has turned off. Depending on the device configuration this fault can have multiple causes.

- Short-circuit at the DC output
- The setpoint cannot be reached and also none of the thresholds (e.g. idle running during power supply undervoltage)
- Overheating

For further information see manual of the power supply.



# **A** NOTICE

- If the condition "Error" = 1 and "Output-Status" = 0 is met, the error message originates from the power supply. In this case the device is turned off. After removal of the error the device can be reset through "Power On".
- If the condition "Error" = 1 and "Output-Status" = 1 is met, the error message originates from the pulse generator. The power supply stays off until the error is removed (overvoltage, overtemperature, strong arcing). Afterwards the device resets automatically.

#### Bit 1 Command Error

If the Slave doesn't accept a command, it sets Bit 1 "Command Error" and the "Command Error Code"-Bits (See Bit 3...7) in the response. The not accepted command has no effect on the state of the Slave.

#### Bit 2 Watchdog

The Bit is set, when the Watchdog of the Microcontroller is triggered. The state can only be reset through a "Power on reset".

#### Bit 3...7 Command Error Codes

In case of "Command Errors" the following Bits give information of the error type.

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Error type                                      |
|-------|-------|-------|-------|-------|---|
| 0     | 0     | 0     | 0     | 0     | No error  |
| 0     | 0     | 0     | 0     | 1     | Function code wrong                             |
| 0     | 0     | 0     | 1     | 0     | Function only available in AS6-Mode             |
| 0     | 0     | 0     | 1     | 1     | Function only available in AS4-Mode             |
| 0     | 0     | 1     | 0     | 0     | Function only available in DC Off state         |
| 0     | 0     | 1     | 0     | 1     | Function only available in remote control state |
| 0     | 0     | 1     | 1     | 0     | Undefined error                                 |
| 0     | 0     | 1     | 1     | 1     | Parameter out of allowed range                  |
| 0     | 1     | 0     | 0     | 0     | Function only possible for device type HX/GX    |



### 5.4 Cyclic Redundancy Check (CRC)

The Cyclic Redundancy Check is a process to define a test value for the data to check for transmission errors. The CRC can be used for Master commands and Slave responses. For the calculation of the checksum the Bytes 1 to 10 of the command and Bytes 1 to 13 of the response protocol are used. The final value is not taken into account. The checksum is included in the sent message. The receiver can calculate the checksum out of the sent message and compare it with the delivered checksum. If both checksums are identical, the transmission was successful. Otherwise the message is discarded.

The default setting for the Slave is that it doesn't check the CRC checksum of the master commands. The Slave always calculates a checksum. The master can assess or ignore it. Further information of the CRC calculation (C-Code, Pascal-Version, DLL) are found on the supplied CD.

### 5.5 Exemplary Control

For the following examples a power supply for sputtering HX 300/800 is used. The power supply has a maximum output power of 30 kW. The internal memory of the slave shall have a coefficient-P = 30000 saved. The maximum output voltage is 1000 V (coefficient-U = 1000), though these are only reached during idle load. After the plasma ignition, the power supply limits the voltage to 800 V. The maximum output current is 60 A (coefficient-I = 60000). The coefficients correspond to physical parameters. These are chosen to have the highest possible resolution in the rage of 1 - 65535. Generally, it is recommended that all coefficients are set to 4095. This corresponds to the internal resolution of the AD- and DA-converter.



### 5.5.1 DC-Operation

The power supply shall be operated via RS-232 with half of the power.

Two operations must be performed:

- 1. Switch power supply to power control and use (15000<sub>dec</sub>) as setpoint
- 2. Turn on the power supply.

The Slave response depends on the status of the Toggle-Bit. The specified answers applies to Toggle-Bit=1.

### Master command 11 "Power control":

| Addr.            | Func.             | MtS               | MtS                | MtS              | MtS              | MtS              | MtS              | MtS              | MtS              | CRC                | CRC                | Final             |
|------------------|-------------------|-------------------|--------------------|------------------|------------------|------------------|------------------|------------------|------------------|--------------------|--------------------|-------------------|
|                  | Code              | B1                | B2                 | B3               | B4               | B5               | B6               | B7               | B8               | LB                 | HB                 | Ch.               |
| O <sub>dec</sub> | 11 <sub>dec</sub> | 58 <sub>dec</sub> | 152 <sub>dec</sub> | O <sub>dec</sub> | 0 <sub>dec</sub> | 153 <sub>dec</sub> | 149 <sub>dec</sub> | 59 <sub>dec</sub> |

### Slave response:

| Addr. | Func.<br>Code     | St.<br>B1         | St.<br>B2        | St.<br>B3        | StM<br>B1         | StM<br>B2          | StM<br>B3        |                  | StM<br>B5        |                  | StM<br>B7        | StM<br>B8        | CRC<br>LB         | CRC<br>HB         | Final<br>Ch.      |
|-------|-------------------|-------------------|------------------|------------------|-------------------|--------------------|------------------|------------------|------------------|------------------|------------------|------------------|-------------------|-------------------|-------------------|
| Odec  | 11 <sub>dec</sub> | 29 <sub>dec</sub> | 1 <sub>dec</sub> | O <sub>dec</sub> | 58 <sub>dec</sub> | 152 <sub>dec</sub> | 0 <sub>dec</sub> | O <sub>dec</sub> | 66 <sub>dec</sub> | 59 <sub>dec</sub> | 13 <sub>dec</sub> |

### Master command 1 "Switch on power supply":

| Addr.            | Func.<br>Code    | MtS<br>B1        | MtS<br>B2        | MtS<br>B3        | MtS<br>B4        | MtS<br>B5        | MtS<br>B6        | MtS<br>B7        | MtS<br>B8        | CRC<br>LB          |                    | Final<br>Ch.      |
|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|--------------------|--------------------|-------------------|
| O <sub>dec</sub> | 1 <sub>dec</sub> | O <sub>dec</sub> | 0 <sub>dec</sub> | 125 <sub>dec</sub> | 151 <sub>dec</sub> | 59 <sub>dec</sub> |

### Slave response:

| Addr.            | Func.<br>Code    | St.<br>B1         | St.<br>B2        | St.<br>B3        |                  |                  |                  |                  |                  |                  |                  |                  | CRC<br>LB          | CRC<br>HB          | Final<br>Ch.      |
|------------------|------------------|-------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|--------------------|--------------------|-------------------|
| O <sub>dec</sub> | 1 <sub>dec</sub> | 29 <sub>dec</sub> | 1 <sub>dec</sub> | 0 <sub>dec</sub> | 192 <sub>dec</sub> | 129 <sub>dec</sub> | 13 <sub>dec</sub> |

### 5.5.2 Pulse Operation

The HX power supply, with a bipolar pulse generator connected, shall be operated via RS-485 (address 1) at 600 V output voltage. To ensure that the plasma safely ignites, the voltage control with plasma ignition (Mode U + Ign.) is recommended.



### Three commands have to be performed:

- 1. Set the power supply to voltage control with plasma ignition and use 600 V (600<sub>dec</sub>) as setpoint.
- 2. Turn on pulse generator.
- 3. Turn on power supply.

### Master command 12 "Voltage control with plasma ignition":

|                  | Func.<br>Code     | MtS<br>B1        | MtS<br>B2         | MtS<br>B3 |      | MtS<br>B5 | MtS<br>B6 | MtS<br>B7 | MtS<br>B8 | CRC<br>LB         | CRC<br>HB          | Final<br>Ch.      |
|------------------|-------------------|------------------|-------------------|-----------|------|-----------|-----------|-----------|-----------|-------------------|--------------------|-------------------|
| 1 <sub>dec</sub> | 12 <sub>dec</sub> | 2 <sub>dec</sub> | 88 <sub>dec</sub> | Odec      | Odec | Odec      | Odec      | Odec      | Odec      | 44 <sub>dec</sub> | 222 <sub>dec</sub> | 59 <sub>dec</sub> |

### Slave response:

|                  | Func.<br>Code     | St.<br>B1         |                  |                  |                  | _                 |                  |                  | _                |                  |                  | l_               |                    | CRC<br>HB          | Final<br>Ch.      |
|------------------|-------------------|-------------------|------------------|------------------|------------------|-------------------|------------------|------------------|------------------|------------------|------------------|------------------|--------------------|--------------------|-------------------|
| 1 <sub>dec</sub> | 12 <sub>dec</sub> | 29 <sub>dec</sub> | 8 <sub>dec</sub> | 0 <sub>dec</sub> | 2 <sub>dec</sub> | 88 <sub>dec</sub> | 0 <sub>dec</sub> | 167 <sub>dec</sub> | 224 <sub>dec</sub> | 13 <sub>dec</sub> |

### Master command 50 "Activate pulse generator":

| Addr.            | Func.<br>Code     | MtS<br>B1        | MtS<br>B2        | MtS<br>B3        | MtS<br>B4        | MtS<br>B5        | MtS<br>B6        | MtS<br>B7        | MtS<br>B8        | CRC<br>LB          | CRC<br>HB          | Final<br>Ch.      |
|------------------|-------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|--------------------|--------------------|-------------------|
| 1 <sub>dec</sub> | 50 <sub>dec</sub> | O <sub>dec</sub> | 0 <sub>dec</sub> | O <sub>dec</sub> | 0 <sub>dec</sub> | 108 <sub>dec</sub> | 163 <sub>dec</sub> | 59 <sub>dec</sub> |

### Slave response:

| Addr.            | Func.<br>Code     | St.<br>B1         | St.<br>B2          |                  | _                |                  |                  | StM<br>B4        |                  |                  |                  | StM<br>B8        | CRC<br>LB         | CRC<br>HB          | Final<br>Ch.      |
|------------------|-------------------|-------------------|--------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|-------------------|--------------------|-------------------|
| 1 <sub>dec</sub> | 50 <sub>dec</sub> | 29 <sub>dec</sub> | 136 <sub>dec</sub> | 0 <sub>dec</sub> | 0 <sub>dec</sub> | O <sub>dec</sub> | 0 <sub>dec</sub> | 0 <sub>dec</sub> | 0 <sub>dec</sub> | 0 <sub>dec</sub> | O <sub>dec</sub> | 0 <sub>dec</sub> | 81 <sub>dec</sub> | 131 <sub>dec</sub> | 13 <sub>dec</sub> |

### Master command 1 "Turn on power supply":

| Addr.            | Func<br>Code     | MtS<br>B1        | MtS<br>B2        | MtS<br>B3        | MtS<br>B4        | MtS<br>B5        | MtS<br>B6        | MtS<br>B7        | MtS<br>B8        | CRC<br>LB         | CRC<br>HB         | Final<br>Ch.      |
|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|-------------------|-------------------|-------------------|
| 1 <sub>dec</sub> | 1 <sub>dec</sub> | 0 <sub>dec</sub> | 44 <sub>dec</sub> | 82 <sub>dec</sub> | 59 <sub>dec</sub> |

### Slave response:

| А | ddr. | Func.<br>Code    | St.<br>B1         | St.<br>B2          |                  |                  |                  |                  |                  |                  |                  | StM<br>B7        |                  | CRC<br>LB         | CRC<br>HB          | Final<br>Ch.      |
|---|------|------------------|-------------------|--------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|-------------------|--------------------|-------------------|
| 1 | dec  | 1 <sub>dec</sub> | 29 <sub>dec</sub> | 136 <sub>dec</sub> | 0 <sub>dec</sub> | 21 <sub>dec</sub> | 199 <sub>dec</sub> | 13 <sub>dec</sub> |



### 5.5.3 Ramp Mode

The HX shall, in a time frame of 1000ms, increase the current setpoint linearly from 0 A to 15 A.

Four commands have to be performed:

- 1. Set power supply to current control and use 15A (15000<sub>dec</sub>) as setpoint.
- 2. Set Ramp time.
- 3. Activate Ramp-On.
- 4. Turn on power supply.

### Master command 10 "Current control":

| Addr.            | Func.<br>Code     | MtS<br>B1         | MtS<br>B2          | MtS<br>B3        | MtS<br>B4        | MtS<br>B5        | MtS<br>B6        | MtS<br>B7        | MtS<br>B8        | CRC<br>LB          | CRC<br>HB          | Final<br>Ch.      |
|------------------|-------------------|-------------------|--------------------|------------------|------------------|------------------|------------------|------------------|------------------|--------------------|--------------------|-------------------|
| 1 <sub>dec</sub> | 10 <sub>dec</sub> | 58 <sub>dec</sub> | 152 <sub>dec</sub> | O <sub>dec</sub> | 0 <sub>dec</sub> | O <sub>dec</sub> | O <sub>dec</sub> | O <sub>dec</sub> | O <sub>dec</sub> | 197 <sub>dec</sub> | 192 <sub>dec</sub> | 59 <sub>dec</sub> |

### Slave response:

|                  | Func.<br>Code     |                   |                  | St.<br>B3        | StM<br>B1         | StM<br>B2          | StM<br>B3        | l_               |                  |      | _                | _                | CRC<br>LB          | CRC<br>HB          | Final<br>Ch.      |
|------------------|-------------------|-------------------|------------------|------------------|-------------------|--------------------|------------------|------------------|------------------|------|------------------|------------------|--------------------|--------------------|-------------------|
| 1 <sub>dec</sub> | 10 <sub>dec</sub> | 29 <sub>dec</sub> | 8 <sub>dec</sub> | O <sub>dec</sub> | 58 <sub>dec</sub> | 152 <sub>dec</sub> | 0 <sub>dec</sub> | 0 <sub>dec</sub> | 0 <sub>dec</sub> | Odec | 0 <sub>dec</sub> | 0 <sub>dec</sub> | 173 <sub>dec</sub> | 105 <sub>dec</sub> | 13 <sub>dec</sub> |

### Master command 30 "Set Ramp time":

| Addr.            | Func.<br>Code     | MtS<br>B1 | MtS B2 | MtS<br>B3        | MtS<br>B4          | MtS<br>B5 | MtS<br>B6 | MtS<br>B7 | MtS<br>B8 | CRC<br>LB          | CRC<br>HB         | Final<br>Ch.      |
|------------------|-------------------|-----------|--------|------------------|--------------------|-----------|-----------|-----------|-----------|--------------------|-------------------|-------------------|
| 1 <sub>dec</sub> | 30 <sub>dec</sub> | Odec      | Odec   | 3 <sub>dec</sub> | 232 <sub>dec</sub> | Odec      | Odec      | Odec      | Odec      | 192 <sub>dec</sub> | 70 <sub>dec</sub> | 59 <sub>dec</sub> |

### Slave response:

| Addr.            | Func.<br>Code     | St.<br>B1         | St.<br>B2        |                  | StM<br>B1        |                  |                  | StM<br>B4          | StM<br>B5        |                  | StM<br>B7        |                  | CRC<br>LB          | CRC<br>HB          | Final<br>Ch.      |
|------------------|-------------------|-------------------|------------------|------------------|------------------|------------------|------------------|--------------------|------------------|------------------|------------------|------------------|--------------------|--------------------|-------------------|
| 1 <sub>dec</sub> | 30 <sub>dec</sub> | 29 <sub>dec</sub> | 4 <sub>dec</sub> | 0 <sub>dec</sub> | 0 <sub>dec</sub> | 0 <sub>dec</sub> | 3 <sub>dec</sub> | 232 <sub>dec</sub> | 0 <sub>dec</sub> | 0 <sub>dec</sub> | 0 <sub>dec</sub> | 0 <sub>dec</sub> | 103 <sub>dec</sub> | 223 <sub>dec</sub> | 13 <sub>dec</sub> |

### Master command 31 "Activate Ramp-On":

| Addr.            | Func.<br>Code     | MtS<br>B1        | MtS<br>B2        | MtS<br>B3        | MtS<br>B4        | MtS<br>B5        | MtS<br>B6        | MtS<br>B7        |                  | CRC<br>LB          | CRC<br>HB          | Final<br>Ch.      |
|------------------|-------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|--------------------|--------------------|-------------------|
| 1 <sub>dec</sub> | 31 <sub>dec</sub> | O <sub>dec</sub> | 173 <sub>dec</sub> | 242 <sub>dec</sub> | 59 <sub>dec</sub> |



### Slave response:

|                  | Func.<br>Code     |                   | St.<br>B2         | St.<br>B3        | StM<br>B1        | l_               |                  |                  |                  |                  |                  | StM<br>B8        | CRC<br>LB          | CRC<br>HB          | Final<br>Ch.      |
|------------------|-------------------|-------------------|-------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|--------------------|--------------------|-------------------|
| 1 <sub>dec</sub> | 31 <sub>dec</sub> | 29 <sub>dec</sub> | 20 <sub>dec</sub> | O <sub>dec</sub> | O <sub>dec</sub> | 0 <sub>dec</sub> | 251 <sub>dec</sub> | 173 <sub>dec</sub> | 13 <sub>dec</sub> |

# Master command 1 "Turn on power supply":

| Addr.            | Func<br>Code     | MtS<br>B1        | MtS<br>B2 | MtS<br>B3 | MtS<br>B4 | MtS<br>B5        | MtS<br>B6        | MtS<br>B7        | MtS<br>B8        | CRC<br>LB         | CRC<br>HB         | Final<br>Ch.      |
|------------------|------------------|------------------|-----------|-----------|-----------|------------------|------------------|------------------|------------------|-------------------|-------------------|-------------------|
| 1 <sub>dec</sub> | 1 <sub>dec</sub> | 0 <sub>dec</sub> | Odec      | Odec      | Odec      | 0 <sub>dec</sub> | 0 <sub>dec</sub> | 0 <sub>dec</sub> | 0 <sub>dec</sub> | 44 <sub>dec</sub> | 82 <sub>dec</sub> | 59 <sub>dec</sub> |

### Slave response:

| , | Addr.            | Func.<br>Code    | St.<br>B1         | St.<br>B2         | St.<br>B3        | StM<br>B1        | _                | StM<br>B3        | StM<br>B4        |                  | StM<br>B6        | _                | StM<br>B8        | CRC<br>LB          | CRC<br>HB          | Final<br>Ch.      |
|---|------------------|------------------|-------------------|-------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|--------------------|--------------------|-------------------|
| - | 1 <sub>dec</sub> | 1 <sub>dec</sub> | 29 <sub>dec</sub> | 20 <sub>dec</sub> | O <sub>dec</sub> | O <sub>dec</sub> | 0 <sub>dec</sub> | O <sub>dec</sub> | O <sub>dec</sub> | 0 <sub>dec</sub> | 0 <sub>dec</sub> | 0 <sub>dec</sub> | 0 <sub>dec</sub> | 211 <sub>dec</sub> | 133 <sub>dec</sub> | 13 <sub>dec</sub> |



### 6 Warranty

Pre-tested material was used for the production and final inspection of the unit. However, should there still be reason for complaint, our warranty for the material and production-related technical defects applies for a period of:

#### 24 months

starting from the date of purchase. Damages caused by foreign material brought into the interface, or by liquids, especially through the formation of condensate, are excluded from the warranty. Furthermore, damages caused by improper use or unauthorized work carried out on the unit are not covered by this warranty. The manufacturer shall be liable for replacements and repair work to the same extent as for the original delivery item. Even if replacement or repair work is carried out, the original warranty shall not be extended. However, a prerequisite for any defect liability is that the customer must have fulfilled his contractual obligations, namely the payment agreements.

### 6.1 Manufacturer and Service Address

# ADL Analoge & Digitale Leistungselektronik GmbH

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In case of any trouble, or if you just have a question, please feel free to contact us. We shall be glad to help you.