PHIL fibre optic interface

Optical link between real time simulator and power hardware in the loop

The relating applications:
Mains supply simulation
$115V_{AC}/230V_{AC}$ (50/60Hz)

Avionic systems onboard supply simulation
$115V_{AC}/230V_{AC}$ (50/60Hz)
$115V_{AC}/230V_{AC}$ (400/800Hz)
$28V_{DC}/270V_{DC}$

Automotive systems onboard supply simulation
$12V_{DC}$ / $24V_{DC}$ / $48V_{DC}$

Fig. 1: PHIL power source: 4-quadrant amplifier APS 1000

The optical link option of the APS amplifier is an additional fibre optic interface connector with a specific communication protocol for easy and high speed communication between the real time simulator and the power hardware in the loop.

Optical link specifications:

Protocol type: Aurora 8B/10B, framing, no flow control
Baud rate: 2 Gbit/s
Connector: LC-Duplex

With the optical link option it is possible to control the APS amplifier via its fibre optic interface. This real-time data link provides low latency control of the amplifier output voltage and current as well as measurement of output voltage and current.
Data packets can be sent to the APS amplifier at any time. After each received packet the amplifier sends back a data packet with the latest measurement values as response. The communication is based on 32bit values. Each data packet has a CRC32 checksum at the end.

The minimal packet size sent to the amplifier looks like the following:

setpoint	CRC32

Once the amplifier's output is switched to ON and communication has started (first packet received by the amplifier) the amplifier expects new data continuously. If there is no data packet received for more than 1ms a timeout error occurs and the amplifier's output is automatically switched to OFF.

The interpretation of the data sent to the amplifier depends on the selected operating mode of the amplifier. The mode of operation can either be **controlled voltage** (CV) or **controlled current** (CC). The amplifier's operating mode can be selected either by using the touch panel menu or by remote commands through the ethernet interface.

The scaling of current and internal resistance of the amplifier depends on the maximum current capability of the amplifier. (see table 1)

Optional data which can be sent to the amplifier using the full packet structure is:

setpoint	max limit	min limit	internal resistance	command value	echo request	CRC32

CV Mode:

<setpoint>:	Setpoint for **output voltage** (signed 32bit integer): $value = voltage[V] \cdot \frac{2147483648}{921.6}$
<max limit>:	**Maximum** value for **current** limit (signed 32bit integer): $value = current[A] \cdot \frac{2147483648}{1.024 \cdot peakCurrent}$
<min limit>:	**Minimum** value for **current** limit (signed 32bit integer): $value = current[A] \cdot \frac{2147483648}{1.024 \cdot peakCurrent}$
<internal resistance>:	**Internal resistance** setting (unsigned 32bit integer): $value = resistance[Ohm] \cdot \frac{4294967296}{921.6} \cdot 1.024 \cdot peakCurrent$

CC Mode:

<setpoint>:	Setpoint for **output current** (signed 32bit integer): $value = current[A] \cdot \frac{2147483648}{1.024 \cdot peakCurrent}$
<max limit>:	**Maximum** value for **voltage** limit (signed 32bit integer): $value = voltage[V] \cdot \frac{2147483648}{921.6}$
<min limit>:	**Minimum** value for **voltage** limit (signed 32bit integer): $value = voltage[V] \cdot \frac{2147483648}{921.6}$
<internal resistance>:	not used

<command value>:	The command value is split into two 16bit fields: control command | control data
<control command>:	0x0000: Request echo. In the response frame of the amplifier the status value will be set to the control data 0x0001: Switch amplifier output on (<control data> unequal 0) or off (<control data> equal 0)
<echo request>:	When this value is transmitted the amplifier will add an additional echo response in the response packet
<CRC32>:	CRC32 checksum

In response to a received packet, the amplifier sends a packet with following structure:

voltage measurement	current measurement	status value	echo response	CRC32

<voltage measurement>:	measured output voltage (signed 32bit integer): $voltage[V] = value \cdot \frac{921.6}{2147483648}$
<current measurement>:	measured output current (signed 32bit integer): $current[A] = value \cdot \frac{1.024 \cdot peakCurrent}{2147483648}$
<status value>:	The status value is split into two 16bit fields: status ID | status data <status ID>: 0x0000: Response to echo request 0x0001: Amplifier status, data in <status data>: Bit15:10 reserved | Bit9 CC/CV | Bit8 output | Bit7 error | Bit6 overload | Bit5 max limit | Bit4 min limit | Bit3:0 range <CC/CV>: amplifier mode: controlled current (1) or controlled voltage (0) <output>: output: on (1) or off (0) <error>: set when amplifier has an error <overload>: set while overload condition <max limit>: set while limiting (maximum limit) <min limit>: set while limiting (minimum limit) <range>: currently selected voltage range
<echo response>:	When an echo request value has been received this value will be transmitted
<CRC32>:	CRC32 checksum

Table 1: peak current of the different amplifiers

Amplifier	Peak current
APS 1000	26.4 A
APS 1250	44 A
APS 2500	88 A
APS 5000	176 A
APS 7500	264 A
APS 10000	440 A
APS 15000	616 A
APS 20000	880 A
APS 25000	1056 A
APS 30000	1232 A
APS 40000	1760 A
APS 50000	2112 A
APS 60000	2464 A