Fast Amplifiers communication protocol

Specifications:

1. The fast amplifiers communication protocol (FACP) uses two separate bytes to receive and transmit information.
2. Each byte has 8 bits plus one odd parity bit.
3. Each byte has a single start bit and a double stop bit.
4. The communication baud rate is set to 921600 Baud.
5. The first byte is identified with a “0” on the 8^{th} bit and the second byte is identified with a “1” in the 8^{th} bit.
6. There are special commands for “charge”, “start operation”, “stop operation” and “shutdown”.
7. After the “charge” command the Fast Amplifiers reply with the status of the initiative.
8. After the “shutdown” command the Fast Amplifiers also reply with the status of that initiative.
9. After the “start operation” command the Fast amplifiers reply with “started ok” or with the specific impediment. If a start operation is sent during operation the reply will be a “started ok”
10. After the stop operation the Fast amplifiers should reply with “stopped” message. If a repeated “stop operation” command is sent when the Fast amplifiers are already on idle mode (stopped or shutdown) the answer will be also “stopped”.
11. If there is a problem during the operation the Fast amplifiers will send twice the error found and will enter in the auto shutdown mode.
12. A shutdown command during operation will trigger the stop operation and shutdown modes but the fast amplifiers will only reply on the stop operation.
13. A start operation without the fast amplifiers charge status achieved will result in a specific error code.
14. Normally the communication is started by the plasma shape control unit with the exception of an error report as seen in the point 11 of this specification.
15. If the fast amplifiers don’t receive a valid instruction they will reply with a “command error” instruction.
16. During operation mode the Fast amplifiers receive the desired current set-point in a 10-bit linear format (-6000A -> 0 value, 0A -> 511 value, 6000A -> 1022 value). 1023 value from FireSignal interface is used to represent feedback control.
17. If the power supplies don’t have a capacitor bank the charge and shutdown instructions are not available and the power supplies status is similar to always charged. (the charge and shutdown commands are not available and will be considered as communication error)

Instructions for the fast amplifiers:

Start operation instruction:

8^{th} bit	7^{th} bit	6^{th} bit	5^{th} bit	4^{th} bit	3^{rd} bit	2^{nd} bit	1^{st} bit	HEX
1	1	1	1	1	1	1	0	FE
1	1	1	1	1	1	1	1	FF

Comments: enters operation mode

Stop operation instruction:

8^{th} bit	7^{th} bit	6^{th} bit	5^{th} bit	4^{th} bit	3^{rd} bit	2^{nd} bit	1^{st} bit	HEX
0	0	0	0	0	0	0	0	00
0	0	0	0	0	0	0	1	01

Comments: exits operation mode.

During operation instructions:

8^{th} bit	7^{th} bit	6^{th} bit	5^{th} bit	4^{th} bit	3^{rd} bit	2^{nd} bit	1^{st} bit	HEX
a_2	a_1	a_0	$-a_9$	$-a_8$	$-a_7$	$-a_6$	0	-----
a_9	a_8	a_7	a_6	a_5	a_4	a_3	1	-----

Comments:

- The "-"signal denotes the complementary bit. Example a_9= 1 then "$-a_9$" is equal to "0"
- The ADC value has 10-bit (from 0 to 1022). 1023 is reserved
- 0 value corresponds to a set-point of -6000 Ampere.
- 511 value corresponds to a set-point of 0 A.
- 1023 value corresponds to a set-point of 6000 A.

Replies from the fast amplifiers:

During operation instructions:

8^{th} bit	7^{th} bit	6^{th} bit	5^{th} bit	4^{th} bit	3^{rd} bit	2^{nd} bit	1^{st} bit	HEX
a_2	a_1	a_0	$-a_9$	$-a_8$	$-a_7$	$-a_6$	0	-----
a_9	a_8	a_7	a_6	a_5	a_4	a_3	1	-----

Comments:

- outputs the value read on the ADC of the fast amplifiers
- The ADC value has 10-bit (from 0 to 1022). 1023 is reserved
- 0 value corresponds to a set-point of -6000 Ampere.
- 511 value corresponds to a set-point of 0 A.
- 1022 value corresponds to a set-point of 6000 A.

Temperature fault instruction:

8^{th} bit	7^{th} bit	6^{th} bit	5^{th} bit	4^{th} bit	3^{rd} bit	2^{nd} bit	1^{st} bit	HEX
1	0	1	1	0	1	1	0	B6
1	0	1	1	0	1	1	1	B7

Comments: overheat of the H-bridge

24V failure (future implementation) instruction:

8^{th} bit	7^{th} bit	6^{th} bit	5^{th} bit	4^{th} bit	3^{rd} bit	2^{nd} bit	1^{st} bit	HEX
0	1	0	0	1	0	0	0	48
0	1	0	0	1	0	0	1	49

Comments: 24V SMPS are not active, not possible to start a shot.

Start ok instruction:

8^{th} bit	7^{th} bit	6^{th} bit	5^{th} bit	4^{th} bit	3^{rd} bit	2^{nd} bit	1^{st} bit	HEX
1	1	1	1	1	1	1	0	FE
1	1	1	1	1	1	1	1	FF

Comments: the fast amplifier is ready to receive set-point commands

Stopped instruction:

8^{th} bit	7^{th} bit	6^{th} bit	5^{th} bit	4^{th} bit	3^{rd} bit	2^{nd} bit	1^{st} bit	HEX
0	0	0	0	0	0	0	0	00
0	0	0	0	0	0	0	1	01

Comments: fast amplifier is on idle mode.

Stop error (not frequent and possibly not implemented) instruction:

8th bit	7th bit	6th bit	5th bit	4th bit	3rd bit	2nd bit	1st bit	HEX
0	0	1	0	0	1	0	0	24
0	0	1	0	0	1	0	1	25

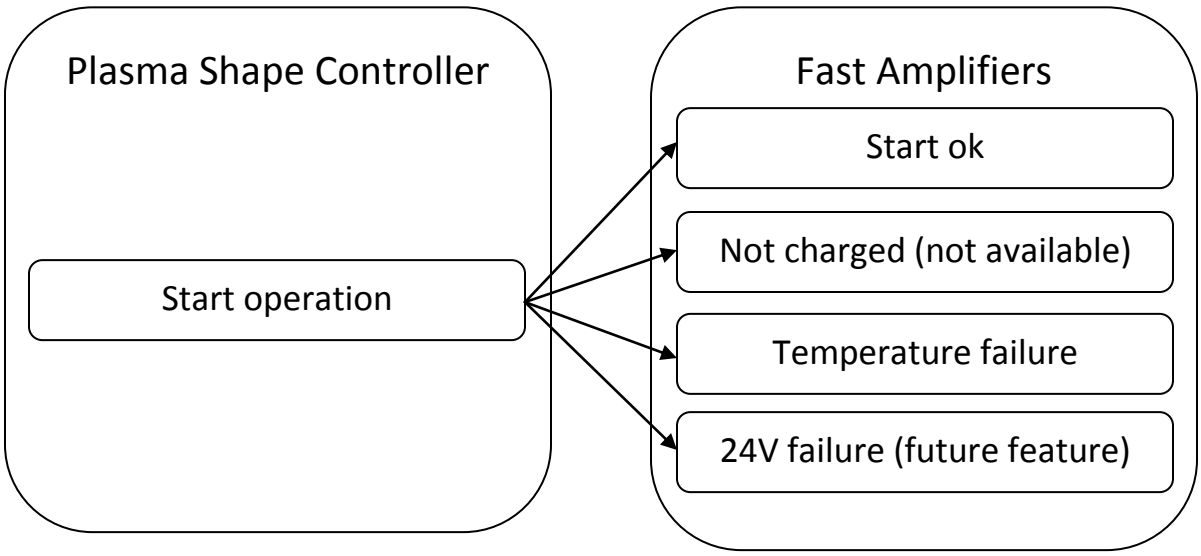
Comments: some error occurred during stop (not a problem the watch dog timer will reset the operation).

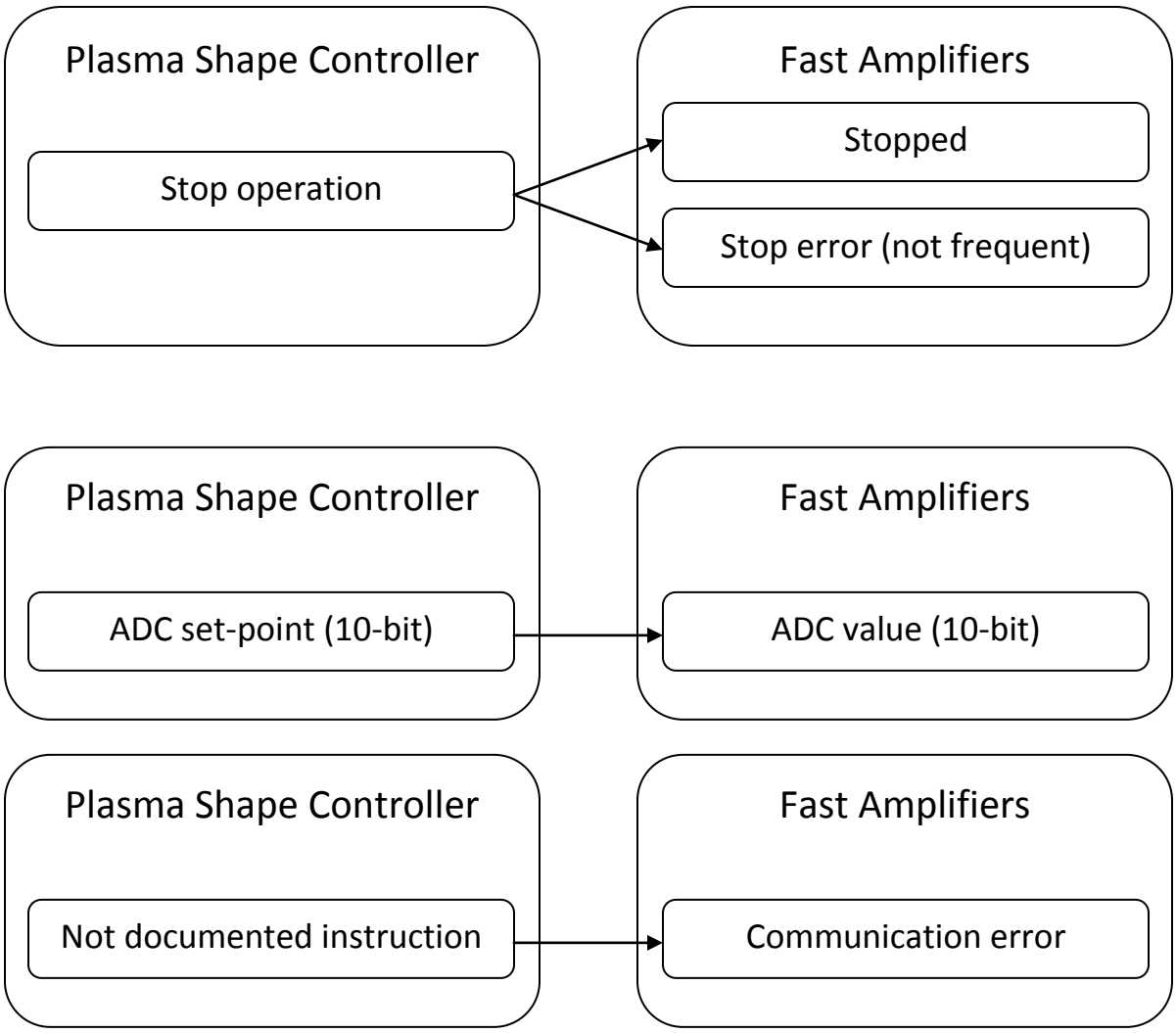
Communications error instruction:

8th bit	7th bit	6th bit	5th bit	4th bit	3rd bit	2nd bit	1st bit	HEX
1	1	0	1	1	0	1	0	DA
1	1	0	1	1	0	1	1	DB

Comments: instruction was not recognized by the fast amplifier.

Normal communication from Plasma position controller to fast amplifiers:





Exceptional communications from the fast amplifiers: