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| <i>VJ X-ray Inc.</i> <i>A VJ Technologies Company</i> | DWG NUMBER: SPC – P198 SHT 1 OF 6 | REV: 2 |
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FILES ASSOCIATED WITH THIS SPECIFICATION

| FILENAME | CONTENTS |
|----------------|---------------|
| SPC – P198.doc | This Document |
| | |
| | |
| | |

CHANGE HISTORY

| ECO# | DATE | DESCRIPTION OF CHANGE |
|------|----------|---|
| 0288 | 11/15/13 | Rev 1 release. Modify from P032 Rev4 For Class B Control Box. |
| | 11/30/13 | Text correction: RS232 is J3; Interlock is J2. |
| 0450 | 8/17/15 | Rev2 Release <ul style="list-style-type: none"> - Add Serial Number info - Add Model Number info - Add Pre-warn Status (selected models only) - Pre-warn Time Set (selected models only) - Pre-warn Time Selected Status (selected models) |
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| TITLE: IXS-FIRMWARE-P198 Specification | Released by: ECO 0450 |
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RS 232 PROTOCOL for “Class B” X-Ray Controllers

1. DIGITAL INTERFACE

Overview

RS232 based Digital Interface between user and the X-Ray Controller. It provided the ability to program the output voltage and current, monitor the output voltage and current, and monitor the fault conditions.

13.1 RS232 Communication Parameters

The RS232 interface has the following attributes:

9600 baud

No Parity

8 Data Bits

1 Stop Bit

XON / XOFF handshaking (also called software handshaking) is not supported. Hardware handshaking is not supported. None of the RS232C signals DTR, DSR, CTS, RTS, RI, or DCD is supported.

(Connect an RS232 (9 pin) M/F straight cable between Computer RS232 port to J3 on the X-Ray control.)

13.2 Command Structure

There are two categories of commands from the host computer to the tank.

1) Commands that have an argument.

2) Commands that do not have an argument.

The syntax of commands that have an argument is:

<STX>CMDARG<CR>

The syntax of commands that do not have an argument is:

<STX>CMD<CR>

The specification of the above symbols is as follows:

<STX> Start of message. The hex value 0x02 is used.

CMD One of the commands defined below.

ARG An argument string that is defined below for each command.

<CR> The carriage return character 0x0D.

13.3 Report Structure

Reports sent from the power supply to the host computer shall be structured as an ASCII string as shown below:

<STX>RPT<CR>

<STX> Start of message. The Hex value 0x02 used to indicate the start of a message.

RPT Report. The reports are defined below.

<CR> The carriage return character 0x0D.

<SP> The Space Character 0x20.

13.4 Command Arguments

Command arguments (when used) are always 1 to 8 characters representing a number.

13.5 Command and Report Definitions:

| | | |
|--|--------------------------------------|--------|
| VJ X-ray Inc. A VJ Technologies Company | DWG NUMBER: SPC – P198 SHT 3 OF 6 | REV: 2 |
|--|--------------------------------------|--------|

| Command and Report Definitions | | | | |
|--|---------|----------|---|---|
| Name | Command | Argument | Response | Comments |
| Voltage Program | VP | XXXX | <STX>VPXXXX<CR> | XXXX = 000.0 – Max KV |
| Current Program | CP | XXXXX | <STX>CPXXXXX<CR> | XXXXX = 00000 – Max uA |
| Voltage/Current/Temperature/ Filament Monitor | MON | N/A | <STX>VVVV<SP>CCCC <SP>TTTT<SP>FFFF<CR> | VVVV = 000.0–Max KV CCCC = 00000 – Max uA TTTT = 000.0 – 070.0 DegC FFFF = 0000 – 4095 |
| Fault Clear | CLR | N/A | <STX>CLR<CR> | |
| Report Fault | FLT | N/A | <STX>X<SP>X<SP>X<SP> X<SP>X<SP>X<SP>X<SP> X<SP>X<SP>X<CR> | X X X X X X X X X = See Below |
| HV Status | STAT | N/A | <STX>X<CR> | X = 1 is X-Ray On X = 0 is X-Ray Off |
| X-Ray Enable | ENBL | X | <STX>ENBLX<CR> | X = 1 Enable X-Ray X = 0 Disable X-Ray |
| Watch Dog Timer | WDTE | N/A | <STX>OK<CR> | |
| Comm Port Echo | FREV | N/A | <STX>XNNN<CR> | XNNN = 2000 |
| Watch Dog Enable/Disable | WDOG | X | <STX>WDOGX<CR> | X = 1 Enable Watch Dog X = 0 Disable Watch Dog |
| Watch Dog Status | WSTAT | N/A | <STX>X<CR> | X = 1 Watch Dog On X = 0 Watch Dog Off |
| Serial Number Info | SNUM | N/A | <STX>XXXXXXXXXXXXX<CR> | XXXXXXXXXXXXX = Serial Number |
| Model Number Info | MNUM | N/A | <STX>MMMMMMMMMMMM MMMM<CR> | MMMMMMMMMMMM MMM = Model Number |
| Pre-warn Status | PSTAT | N/A | <STX>X<CR> | X = 1 Pre-warn Stat On X = 0 Pre-warn Stat Off |
| Pre-warn Time Set | PTM | XX | <STX>PTMXX<CR> | XX = 0-60 Seconds |
| Pre-warn Time Selected Status | PTST | N/A | <STX>XX<CR> | XX = 0-60 Seconds |

13.6 WDOG Command

This command enables/disables the Watch Dog feature. Upon Power up X-Ray Generator has Watch Dog feature Enabled. Once WDOG Disable command is sent to X-Ray Controller then it turns off Watch Dog feature until next Power Cycle.

13.7 WDTE Command

Once Micro Controller doesn't receive any command within 750ms after it sends response to previous command then it turns off X-Ray Enable and turns off KV program and mA Program. So WDTE command should be sent once at least 750ms if no command is sent to Micro controller.

NOTE: If Watch Dog feature is disabled then this command has no effect on X-Ray Enable Status.

13.8 Serial Command Handling

Command Response Time:

All commands from the host will be processed and replied anywhere from less than 100ms plus output ramp time.

13.9 Comm Port Echo:

This command is used to automatically configure Communication Port by user GUI. GUI can send this command to each available Comm Port in computer and when GUI receives response from X-Ray Controller, GUI can establish a link with Comm Port.

13.10 Command Buffering:

The X-Ray tank does not buffer commands. The tank can process only one command at a time. Before sending another command, wait for the response of the previous command.

13.11 Report Fault Definitions

| Fault Bit(X9 X8 X7 X6 X5 X4 X3 X2 X1 X0) | Description |
|--|---|
| X0 | X0 = 1 Regulation X0 = 0 No Regulation Fault |
| X1 | X1 = 1 Interlock Open X1 = 0 No Interlock Open |
| X2 | X2 = 1 Cathode Over KV Fault X2 = 0 No Fault |
| X3 | X3 = 1 Anode Over KV Fault X3 = 0 No Fault |
| X4 | X4 = 1 Over Temperature Fault X4 = 0 No Fault |
| X5 | X5 = 1 Arc Fault X5 = 0 No Fault |
| X6 | X6 = 1 Over Current Fault X6 = 0 No Fault |
| X7 | X7 = 1 Power Limit Fault X7 = 0 No Fault |
| X8 | X8 = 1 Over Voltage Fault X8 = 0 No Fault |
| X9 | X9 = 1 Duty Cycle mode ON X9 = 0 Duty Cycle mode OFF |

Fault Cause and Effect:

If a shutdown occurred from a fault, the fault must be cleared before X-Ray On can be enabled.

When a fault occurs, RS232 command “CLR” must be used to clear the fault. Once cleared, a ‘High’ on the enable signal to the micro controller will turn X-Rays On.

Fault conditions will not cause the tank to forget any stored information, such as the tank voltage and current. For example, if the voltage is set to 150 kV and a fault then occurs, the voltage will still be set to 150 kV after the fault is cleared.

Fault Definition:

a. Regulation Fault: When kV or mA is no longer in regulation. This will disable the high

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|--|--------------------------------------|--------|
| VJ X-ray Inc. A VJ Technologies Company | DWG NUMBER: SPC – P198 SHT 5 OF 6 | REV: 2 |
|--|--------------------------------------|--------|

voltage output.

- b. Interlock Fault:** When J2-2 does not receive an Interlock input voltage (15VDC or 24VDC as per the model Specification). This will disable the high voltage output.
- c. Cathode Over KV Fault:** When Cathode output voltage exceeds the maximum rated output by 5% to 10%. This will disable the high voltage output (Max Duration of over voltage before shutdown is 100ms).
- d. Anode Over KV Fault:** When Anode output voltage exceeds the maximum rated output by 5% to 10%. This will disable the high voltage output (Max Duration of over voltage before shutdown is 100ms)
- e. Over temperature Fault:** when Oil temperature reaches 60°C±3°C. This will disable the high voltage output.
- f. Arc Fault:** When four (4) Arcs occurred within 10Sec. This will disable the high voltage output.
- g. Over-current Fault:** When output current exceeds the maximum rated output by 5% to 10%. This will disable the high voltage output (Max Duration of over current before shutdown is 100ms).
- h. Power Limit Fault:** When the kV/mA feedback values exceed 5% to 10% of the maximum rated power, this will disable the high voltage output.
- i. Duty Cycle protection: (This item only applies to units that operate under pulse mode)**
 - The unit does not accept kV and mA program values above the maximum peak kV, mA and power ratings.
 - The unit does not turn On before completing the required Off time as per below Duty cycle definitions.
 - When the “Duty cycle mode” indicator is On, the unit does not accept new command.
 - The unit does not accept new KV and mA program values during On time.
 - Duty cycle is defined such:
 Max duration = Max On time + Min Off time = Tmax (Tmax is defined as a fix value)
 Max continuous power = Pcont. (Pcont is defined as a fix value)
 Max peak power = Ppk-max. (Ppk-max is defined as a fix value)

 Max requested peak power (Preq) = kV x mA (kV/mA are the program values)
 $T(on) = (Pcont \times Tmax) / Preq$
 $T(off) = Tmax - T(on)$

Example:

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| Tmax = 30Sec | Pcont = 200W |
| Ppk-max = 500W | Preq = 400W |

Then:

For Preq = 400W ($400W \leq 500W$)
 $T(on) = (200W \times 30S) / 400W = 15Sec$
 $T(off) = 30Sec - 15Sec = 15Sec$

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|--|--------------------------------------|-------|
| <i>VJ X-ray Inc.</i> <i>A VJ Technologies Company</i> | DWG NUMBER: SPC – P198 SHT 6 OF 6 | REV:2 |
|--|--------------------------------------|-------|

For Preq = 500W
 $T(\text{on}) = (200\text{W} \times 30\text{S}) / 500\text{W} = 12\text{Sec}$
 $T(\text{off}) = 30\text{Sec} - 12\text{Sec} = 18\text{Sec}$

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