

<b><i>VJ X-ray Source</i></b> <b><i>A VJ Technologies Company</i></b>	DWG NUMBER: SPC – P032  SHT 1 OF 6	REV: 4
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FILES ASSOCIATED WITH THIS SPECIFICATION

FILENAME	CONTENTS
SPC – P032.doc	This Document

CHANGE HISTORY

ECO#	DATE	DESCRIPTION OF CHANGE
0025	9/18/09	Rev 1
0060	6/15/10	Rev 2: - Clarification: Section 13.7 Command Response Time change from 100ms – sec to <100ms plus output ramp time.
0085	10/01/10	Rev3: -mA Command and Fault Report Command change(Applicable only for Pulsed X-Ray Sources)
0095	1/20/10	Rev4: - Added Watch Dog ON/OFF feature for all systems - MON Command change(Applicable only for Pulsed X-Ray Sources)

TITLE: IXS-FIRMWARE-P032 Specification		Released by: ECO 0095	
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USED ON:	DOC OWNER: X-ray Eng	DATE:	9-18-09

## RS 232 PROTOCOL

### 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 J2 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:

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Command and Report Definitions				
Name	Command	Argument	Response	Comments
Voltage Program	VP	XXXX	<STX>VPXXXX<CR>	XXXX = 000.0 – Max KV
Current Program	CP	XXXX	<STX>CPXXXX<CR>	XXXX = 0000 – Max uA
Current Program(Pulsed Sources only)	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 = 0000 –Max uA TTTT = 000.0 – 070.0 DegC FFFF = 0000 – 4095
Voltage/Current/Temperature/Filament Monitor(Pulsed Sources only)	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<CR>	X X X X X X X X = See Below
Report Fault(Pulsed Sources only)	FLT	N/A	<STX>X<SP>X<SP>X<SP>X<SP>X<SP>X<SP>X<CR>	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>	
Firmware <b>Version</b>	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

### 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 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.

### 13.10 Report Fault Definitions

Fault Bit(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

### Fault For Pulsed Sources Only

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

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X9	X9 = 1 Duty Cycle mode ON X9 = 0 Duty Cycle mode OFF
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#### **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 voltage output.
- b. **Interlock Fault:** When J4-2 does not receive an Interlock input voltage (15VDC or 24VDC as per the model Specification). This will disable the high voltage output.
- c. **Over Cathode Fault:** When Cathode output exceeds the maximum rated output by 2% to 5%. This will disable the high voltage output (Max Duration of over voltage before shutdown is 100ms).
- d. **Over Anode Fault:** When Anode output voltage exceeds the maximum rated output by 2% to 5%. 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 to 65°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 2% to 5%. 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 2% to 5% of the maximum rated power, this will disable the high voltage output.
- i. **Over-current Fault:** When Anode or Cathode Over voltage fault occurred.
- j. **Duty Cycle protection: (This item only apply 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)

$T(\text{on}) = (P_{\text{cont}} \times T_{\text{max}}) / P_{\text{req}}$

$T(\text{off}) = T_{\text{max}} - T(\text{on})$

Example:

Tmax = 30Sec

Pcont = 200W

Ppk-max = 500W

Preq = 400W

Then:

For Preq = 400W ( $400W \leq 500W$ )

$T(\text{on}) = (200W \times 30S) / 400W = 15\text{Sec}$

$T(\text{off}) = 30\text{Sec} - 15\text{Sec} = 15\text{Sec}$

For Preq = 500W

$T(\text{on}) = (200W \times 30S) / 500W = 12\text{Sec}$

$T(\text{off}) = 30\text{Sec} - 12\text{Sec} = 18\text{Sec}$

End of Document.