

# Instruction Manual

## DXM SERIES

### High Voltage Power Supply

MODEL : DXM  
SERIAL# :  
DATE :

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## IMPORTANT SAFETY PRECAUTIONS

### SAFETY

THIS POWER SUPPLY GENERATES VOLTAGES THAT ARE DANGEROUS AND MAY BE FATAL.  
OBSERVE EXTREME CAUTION WHEN WORKING WITH THIS EQUIPMENT.

High voltage power supplies must always be grounded.

Do not touch connections unless the equipment is off and the  
Capacitance of both the load and power supply is discharged.

Allow five minutes for discharge of internal capacitance of the power supply.

Do not ground yourself or work under wet or damp conditions.

### SERVICING SAFETY

Maintenance may require removing the instrument cover with the power on.

Servicing should be done by qualified personnel aware of the electrical hazards.

**WARNING** note in the text call attention to hazards in operation of these units  
that could lead to possible injury or death.

**CAUTION** notes in the text indicate procedures to be followed to avoid possible  
damage to equipment.

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model described herein, and publication of this information does not convey any right to reproduce it or to use it for  
any purpose other than in connection with installation, operation, and maintenance of the equipment described.

# Table of Contents

## PAGE

### 1. INTRODUCTION

1.1	Description of the DXM Series.....	1
1.2	DXM Specifications.....	1
1.3	Standard Features .....	2
1.4	System Status and Fault Diagnostic Display .....	2
1.5	Interpreting the Model Number .....	3
1.6	High Voltage Connector Pin out Diagrams .....	3

### 2. INSPECTION & INSTALLATION

2.1	Initial Inspection .....	6
2.2	Mechanical Installation .....	6

### 3. OPERATING INSTRUCTIONS

3.1	Operation.....	8
3.2	Standard Control Features.....	8

### 4. PRINCIPLES OF OPERATION

4.1	AC to DC Rectifier and Associated Circuits .....	21
4.2	High Frequency Inverter .....	21
4.3	High Voltage Circuits .....	21
4.4	Control Circuits.....	22
4.5	Options .....	22

### 5. OPTIONS

5.7	Custom Designed Models .....	23
5.8	Filament .....	23

### 6. MAINTENANCE

6.1	Periodic Servicing .....	24
6.2	Performance Test .....	24
6.3	High Voltage Dividers .....	24

### 7. FACTORY SERVICE

7.1	Warranty Repairs .....	25
7.2	Factory Service Procedures .....	25
7.3	Ordering Options and Modifications .....	25
7.4	Shipping Instructions .....	25

## APPENDIX

### A. Specification Controls (Custom Models Only)

# Chapter 1

## INTRODUCTION

### 1.1 Description of the DXM Series

The DXM Series of X-ray generator modules are designed for OEM applications up to 70kV and up to 1200 watts. Its universal input, small package size and choice of three standard digital interfaces simplifies integrating the DXM into your X-ray analysis system. Models are available to operate either floating filament (negative HV polarity) or ground referenced filament (positive HV polarity) based X-ray tube designs. DSP based emission control circuitry provides excellent regulation of emission current, along with outstanding stability performance.

The dramatically reduced size of the DXM Module, compared to traditional high voltage modules, is obtained by a state of the art off-line resonant converter. The resonant converter utilizes a unique control scheme, which allows constant frequency operation while maintaining high efficiency. The high efficiency is obtained by zero current switching (ZCS) resonant control. High operating frequency, typically 50kHz, allows for low ripple and excellent dynamic response capabilities.

The DC output voltage and current are controllable over the full range of operation. Monitoring and control signals are provided for simple, yet flexible control of the power supply. The DXM series operates from 90 - 265VAC, at 50/60 Hz single phase for the 300Watt Models and 180 - 264vac, at 50/60 Hz single phase for the 600Watt and 1200 watt Models. The input is power factor corrected. The DXM series operates at full power continuous. The ambient temperature must be kept below the maximum rating as specified in 1.2. The standard warranty applies to the modules. Consult factory about the warranty for custom DXM modules.

### 1.2 DXM Specifications

- **Input Voltage:**

90-264VAC 47-63Hz, for 300watt models

180-264VAC 47-63Hz, for 600watt models

180-264VAC 47-63Hz, for 1200watt models

- **Power Factor:**

FL: 0.99, NL: 0.98

- **Output voltage Regulation:**

**Load Regulation:** 0.01% of full voltage for a no load to full load change.

**Line Regulation:**  $\pm 0.01\%$  of full voltage over the specified input voltage range.

- **Current Regulation:**

**Load Regulation:** 0.01% from 30% voltage to full voltage.

**Line Regulation:**  $\pm 0.01\%$  of full current over the specified input voltage range.

- **Ripple:**  $\leq 1\%$  rms at  $> 20$  kHz,  $0.1\%$  rms below 20 kHz.

- **Polarity:** Positive or Negative polarity with respect to ground. (Specify at time of ordering).

- **Stability:**  $\leq 25$  ppm/hr after a 2 hour warm up

- **Temperature Coefficient:**  $\leq 50$  ppm /  $^{\circ}\text{C}$ .

- **Temperature:**

Operating:  $0^{\circ}\text{C}$  to  $40^{\circ}\text{C}$

Storage:  $-40^{\circ}\text{C}$  to  $+85^{\circ}$

- **Monitoring:**

0-10 VDC corresponding to 0-100% of output voltage

0-10VDC corresponding to 0-100% of output current.

0-5VDC corresponding to 0-5arms of filament current.

## LOCAL Operating Features

- (1) **Output Control:** Voltage, current filament limit and preheat level are externally programmable over the entire range from zero to maximum rating via 0-10VDC input.
- (2) **+10VDC Reference:** A +10VDC reference is provided for local programming via two potentiometers to be used to adjust filament limit and preheat level.
- (3) **High Voltage Enable:** A hardware based, dry contact closure will enable the power supply into the high voltage on mode.

## 1.3 Standard Features

The DXM series incorporates several standard features designed to optimize user operation.

**Controlled Ramping:** Controlled Ramping is a user-controlled feature that allows the customer to program kV, filament and mA ramps to meet the application use and X-ray tube requirements. Standard DXM units are shipped with this ramping feature disabled. The standard DXM ramping is a 5 second (to full scale) kV ramp and a 2.5 second filament ramp which starts when the kV output exceeds 30% of full-scale output.

The Controlled Ramping feature can be accessed via any of the DXM digital interfaces with the DXM GUI version SWD0159-007. See section 3.1.1 X-ray Tube Operation and the DXM Digital Manual for more information.

**Arc Fault Control:** Arc Fault Control features allow the user to custom select the type of arc intervention that is required. This feature is disabled as a default, which means the unit will shut down with one arc fault. When Arc Control is enabled, the user can set the arc detection parameters to custom fit their requirements.

The Arc Fault Control feature can be accessed via any of the DXM digital interfaces with the DXM GUI version SWD0159-007. See section 3.2 and the DXM Digital Manual for more information.

### Default Remote Program:

The DXM unit can be controlled by analog signals in Local mode or Digital interfaces in Remote mode. The standard unit powers up in Local mode and can be switched to Remote via a command on the digital interface.

The Default Remote program feature will default the unit to only power up in Remote mode and not allow the analog control signals local enable to be active at power up. It can be enabled and stored in non-volatile memory. The Default Remote program feature can be accessed via any of the DXM digital interfaces with the DXM GUI version SWD0159-007. See the DXM Digital Manual for more information.

**Power Factor and Universal Input:** The input voltage of the DXM can operate within the range from 90VAC to 265VAC for the 300Watt Model and at 180 –264vac, for the 600Watt Model. The power factor is actively corrected across this entire range and is better than 0.99 at full load.

**Internal EMI Filter and Fuse Protection:** An internal EMI filter and fuse provide protection against line voltage surges and power supply faults.

## Remote Operating Features

**Remote Control:** USB, Ethernet and RS232 are standard. A provided G.U.I allow user to control the unit via RS232 and USB interfaces. An imbedded Applet web Brower allow user to control the unit via Ethernet. Refer to DXM Digital Protocol spec for Details.

**Remote Monitor:** Allows remote monitoring of the Output voltage, current, filament limit, preheat level and total HV On clock counter via the USB, Ethernet or RS232.

**Remote Programming:** Allows remote programming of the Output voltage, current, filament limit and preheat level via the USB, Ethernet or RS232.

**X-ray Enable/Interlock:** In local mode, allows remote ON/OFF control of the high voltage. In remote mode, the hardware based dry contact closure must be closed in order to enable the high voltage via the USB, Ethernet or RS232.

## IMPORTANT

**This control signal is not a safety interlock and should not be used for protection from high voltage generation for safety purposes.**

## 1.4 System Status and Fault Diagnostic Display

If a fault occurs, the power supply will revert to the Shutdown mode indicated by extinguishing of X-ray ON led and via RS-232 as HV OFF. To reset a fault in local mode the enable must be reset. To reset a fault in remote mode a HV ON command must be sent via the RS-232, USB or Ethernet.

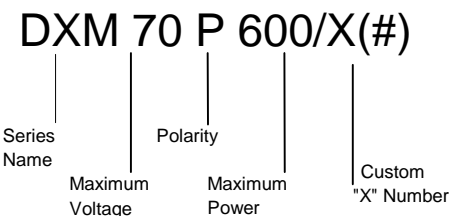
- **OVER CURRENT FAULT:** Indicates the over current protection circuitry has caused the high voltage to turn off. This fault will occur if the output current exceeds 110% of full scale or 110% of current program value. This fault is indicated by illumination of over current led status on the front cover and via RS-232, USB or Ethernet as Over Current.
- **OVERVOLTAGE:** Indicates the over voltage protection circuitry has caused the high voltage to turn off. This fault will occur if the output voltage exceeds 110% of full scale or 110% of program value. This fault is indicated by over voltage led status on the front cover and via the RS-232, USB or Ethernet as Over voltage.
- **ARC FAULT:** Indicates that an arc has occurred. This fault is indicated by illumination of Arc Fault led status on front cover and via RS-232, USB or Ethernet as arc fault. See Arc Fault Control in section 3.2.
- **UNDER VOLTAGE:** Indicates a failure in the voltage regulation circuitry. This fault occurs when there is a lack of output power to maintain regulation and will result in shutdown of the HV. This fault will occur if the output voltage less than 10% below the program value. This fault is indicated by illumination of under voltage led status on the front cover and via RS-232, USB or Ethernet as under voltage.
- **UNDER CURENT:** Indicates failure in the current regulation circuitry. This fault occurs when the allowable percentage of error between actual and programmed emission current is exceeded. This fault will not cause a shutdown of the HV. This fault will occur if the output current less than 10% below the program value. This fault is indicated by illumination of under current led status on front cover and via RS-232, USB or Ethernet as under current.
- **OVER TEMPERATURE:** Indicates either a failure in the cooling system that would cause the internal heat sink temperature to exceed it's operating range or the ambient temperature to exceed 40degC, resulting in shutdown of HV. This fault is indicated by over temperature led status on the front cover and via RS-232, USB or Ethernet as over temperature.

- **Filament Protection:** If the output voltage goes below 30% of full rating the filament power will be disable to protect the filament in the users X-ray tube, but the filament preheat will still be active. This will cause an undercurrent fault.
- **PS Fault Indication:** PS Faults an open collector output with a 1k ohm series impedance on J2-1, indicates that a fault has occurred. High = no faults
- **X-ray On Indication:** X-ray On Signal is an open collector output a 1k ohm series impedance on J2-14, indicates X-ray status. High = X-ray Off, Low =X-ray On
- **X-ray On LED:** when the high voltage status is "On" state it is indicated by X-RAY ON led status on the front cover
- **Power On LED:** when the input power is applied to the unit it is indicated by PWR ON led status on the front cover

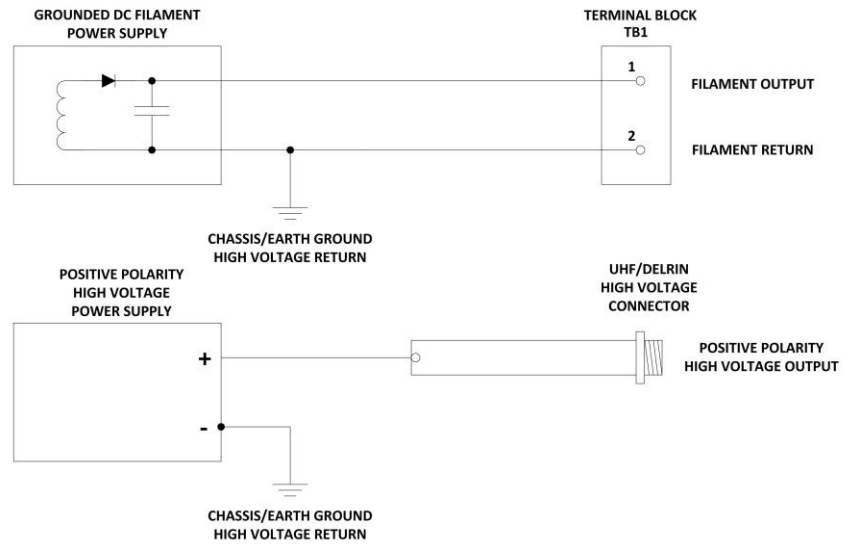
## 1.5 Interpreting the Model Number:

The model number of the power supply describes its capabilities. After the series name is:

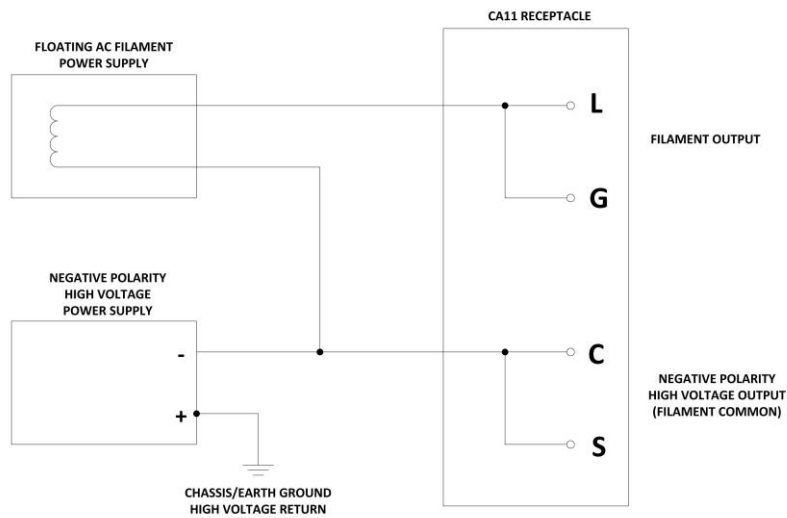
- (1) The maximum voltage in kilovolts.
- (2) The polarity of the output – positive (P), or negative (N).
- (3) The maximum output in watts.
- (4) Custom "X" number representing details listed in a separate specification control drawing.



## 1.6 High Voltage Connector Pin out Diagrams

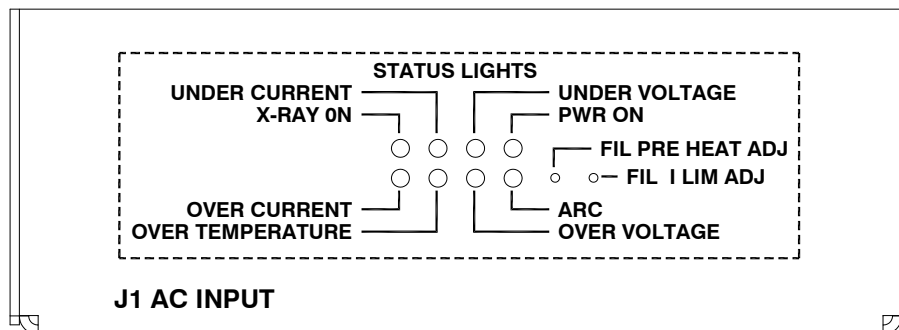


### DXM – POSITIVE POLARITY



### DXM – NEGATIVE POLARITY

TOP COVER



FRONT PANEL

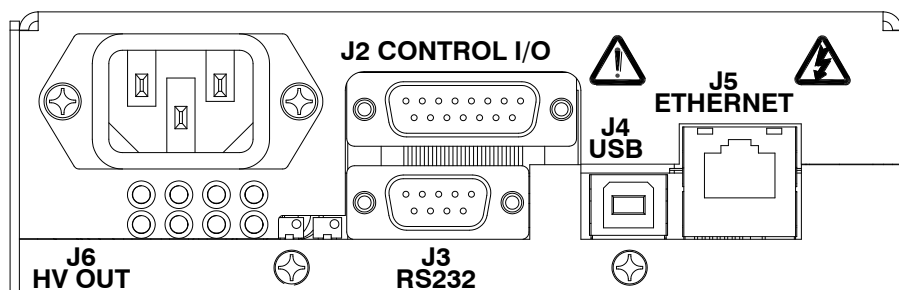


Figure 1.1 LED Legend (300W and 600W unit)



# Chapter 2

Initial inspection and preliminary checkout procedures are recommended. For safe operation, please follow the step-by-step procedures described in Chapter 3, Operating Instructions.

## 2.1 Initial Inspection

Inspect the package exterior for evidence of damage due to handling in transit. Notify the carrier and Spellman immediately if damage is evident. Do not destroy or remove any of the packing material used in a damaged shipment. After unpacking, inspect the panel and chassis for visible damage.

Standard DXM high voltage power supplies and components are covered by warranty. Custom and special order models (with an X suffix in the model number) are also covered by warranty.

# INSPECTION AND INSTALLATION

## 2.2 Mechanical Installation

The DXM series module power supplies are designed for installation into existing or newly developed OEM equipment. The power supply can also easily fit into bench top applications or test set requirements. Standard unit dimensions are shown in Figure 2.1

For custom mounting requirements or specific package size requirements consult Spellman's Sales Department. Spellman has many package designs available, or can design a specific enclosure for your requirements.

The DXM series utilizes solid encapsulations for corona free operation. No periodic maintenance is required.

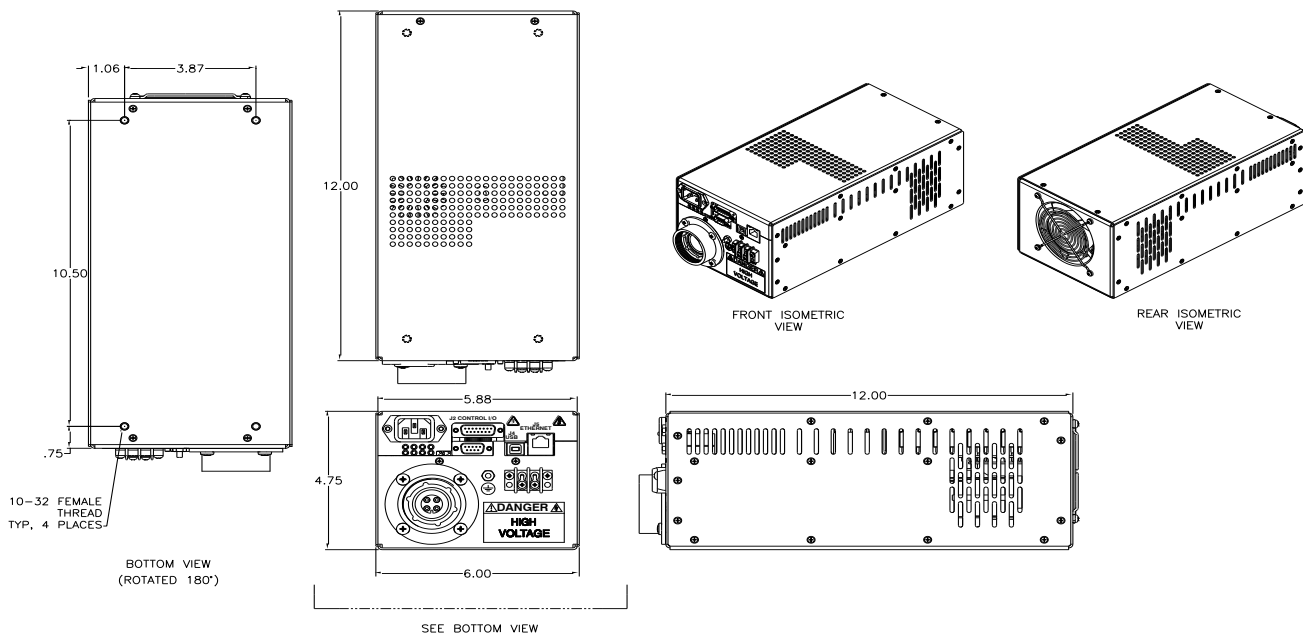
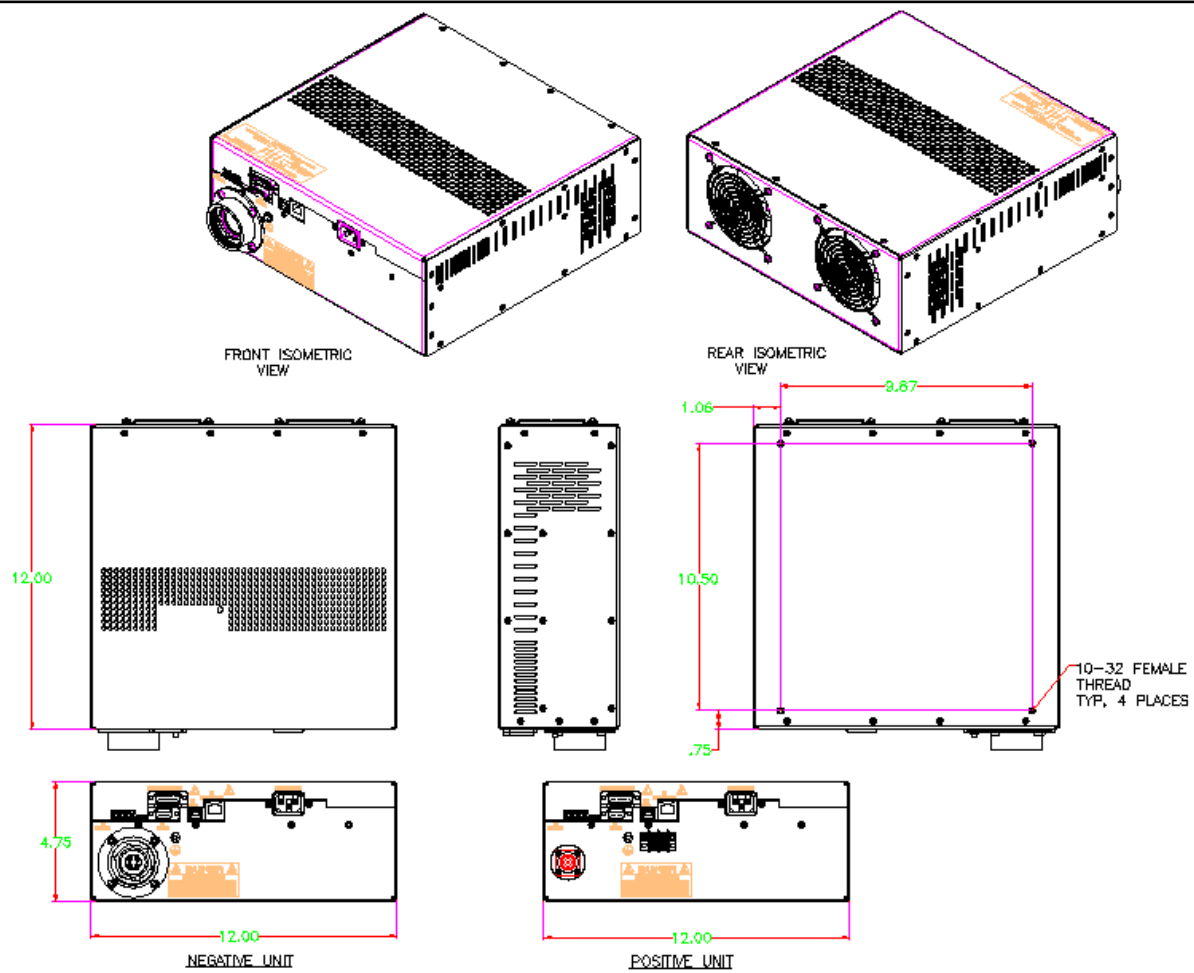


Figure 2.1 Unit Dimensions (300W and 600W unit)



**Figure 2.2 Unit Dimensions (1200W unit)**

# Chapter 3

## OPERATING INSTRUCTIONS

### 3.1 Operation

#### WARNING

**THIS EQUIPMENT GENERATES DANGEROUS VOLTAGES THAT MAY BE FATAL. PROPER GROUNDING OF ALL HIGH VOLTAGE EQUIPMENT IS ESSENTIAL.**

#### IMPORTANT:

**Before connecting the power supply to the AC line, follow this step-by-step procedure.**

**Do not connect the power supply to the AC line until Step F is reached.**

**Failure to follow these procedures may void the warranty.**

A) Insure that the high voltage cable is properly installed and terminated to the load. Insure that all circuits connected to the high voltage output are safely interlocked against accidental contact. Insure external load is discharged.

B) Check the input voltage rating on the serial nameplate of the supply and make certain that this is the rating of the available power source

C) **PROPER GROUNDING TECHNIQUE:** The chassis of high voltage power supplies must be grounded, preferably to a water system ground using copper pipe or other earth ground. A ground stud is provided on the front panel. See Figure 3.1 for a typical operating setup. The return line from the load should be connected to the power supply chassis. Using a separate external ground at the load is not recommended. An IEC 320 connector is provided for connection to the line voltage source. A standard line cord is also provided.

D) **Hook-up:** Connect control and monitoring connections as described in this manual.

E) For initial turn-on, program the voltage and current for zero output. Connect the enable/disable signal to disable.

F) The input power cable may now be connected to the AC power line.

G) Enable the power supply via the enable/disable hardware based, dry contact closure.

H) Slowly program the output voltage and current to desired level. Monitor the output voltage and current via the monitoring test points. Note equipment operation is normal, i.e. Load is behaving as predicted.

I) To turn high voltage off, use the enable/disable signal. If equipment is to be kept off for extended periods, disconnect power supply from line voltage source.

#### WARNING

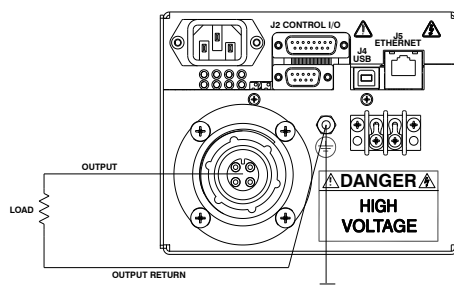
**AFTER TURNOFF, DO NOT HANDLE THE LOAD UNTIL THE CAPACITANCE HAS BEEN DISCHARGED!  
LOAD CAPACITANCE MAY BE DISCHARGED BY SHORTING TO GROUND.**

#### WARNING

**THE VOLTAGE MONITOR ON THE POWER SUPPLY FRONT PANEL DOES NOT READ THE OUTPUT VOLTAGE WHEN THE POWER IS TURNED OFF, EVEN IF A CHARGE STILL EXISTS ON THE LOAD.**

#### CAUTION

**ALWAYS OPERATE THE UNIT WITH THE COVER ON. DO NOT ATTEMPT TO ACCESS OR REPAIR ANY INTERNAL CIRCUITS. DANGEROUS AND LETHAL VOLTAGES ARE GENERATED INSIDE THE MODULE.**



**Figure 3.1 Proper Grounding Technique**

### 3.1.1 X-ray Tube Operation

The X-ray tube should be operated according to the X-ray manufacturers specifications. Filament Limit program and Filament Preheat program shall be set so not to exceed maximum filament current as per the X-ray tube manufacturers specifications. X-ray tube seasoning schedules and kV ramp profiles should also be per the X-ray tube manufacturer's specification.

**Set Filament Limit:** One of the most critical settings is the Filament Limit adjustment. The Filament Limit set point limits that maximum output current of the filament power supply to protect the filament of the X-Ray tube. This setting will make it impossible for the X-Ray generator to exceed this value under any circumstance. It should be set at or below the X-Ray tube manufacturer's specification.

Filament Limit program scaling is 0 to 10Vdc = 0 to 5 amps.

When setting the Filament Limit below the maximum X-Ray tube specification, the Filament Limit should be 10-15% higher than the filament current required to achieve the maximum programmed emission current (mA) at the lowest kV setting to be used. Remember, filament maximum values are different than the REQUIRED values for emission. Setting 10-15% over the needed emission current values provides headroom as well as better trainset response characteristics.

***Always keep the Filament Limit level at or below the manufacturers recommended maximum filament current specification.***

Some common X-Ray tubes used with the DXM: See table below

X-Ray Tube	Data Sheet	Maximum Filament Current
Comet CXR105	<a href="http://www.comet-xray.com/Resources/Products/X-Ray-Tubes/Documents/cxr_105_en.pdf">http://www.comet-xray.com/Resources/Products/X-Ray-Tubes/Documents/cxr_105_en.pdf</a>	3.2 amps
Comet MXR-160-HP/20	<a href="http://www.comet-xray.com/Resources/Products/X-Ray-Tubes/Documents/mxr_160hp_20_en.pdf">http://www.comet-xray.com/Resources/Products/X-Ray-Tubes/Documents/mxr_160hp_20_en.pdf</a>	4.1 amps
Comet MXR-75-HP/20	<a href="http://www.comet-xray.com/Resources/Products/X-Ray-Tubes/Documents/mxr_75hp_20_en.pdf">http://www.comet-xray.com/Resources/Products/X-Ray-Tubes/Documents/mxr_75hp_20_en.pdf</a>	3.4 amps
Comet MXR101	<a href="http://www.comet-xray.com/Resources/Products/X-Ray-Tubes/Documents/mxr_101_en.pdf">http://www.comet-xray.com/Resources/Products/X-Ray-Tubes/Documents/mxr_101_en.pdf</a>	4.2 amps
Lohmann 160/3EPN	<a href="http://www.lohmannx-ray.com/products.htm#xl_stanmen">http://www.lohmannx-ray.com/products.htm#xl_stanmen</a>	3.7 amps
Rontgen-Technik MCBM 65B-50	<a href="http://www.rtwxray.de/tubes/pdf/mcbm65b50x.pdf">http://www.rtwxray.de/tubes/pdf/mcbm65b50x.pdf</a>	3.2 amps
RTW MCD100H-3	<a href="http://www.rtwxray.de/tubes/pdf/mcd100h3x.pdf">http://www.rtwxray.de/tubes/pdf/mcd100h3x.pdf</a>	4.4 amps
RTW MCT100F panoramic	<a href="http://www.rtwxray.de/tubes/pdf/mct100f05x15.pdf">http://www.rtwxray.de/tubes/pdf/mct100f05x15.pdf</a>	4.5 amps

Disclaimer: The most recent X-ray tube data sheet should always be consulted regarding accurate specifications.

**Set Filament Standby (Preheat):** The Filament Standby current (referred to as Filament Preheat on some product lines) is the idle current supplied to the X-Ray tube filament during X-Ray Standby (HV OFF/X-Ray disabled) conditions.

Filament Standby programming scaling is 0 to 10Vdc = 0 to 2.5 amps.

The Filament Preheat set point is typically around 1 amp to 2 amps, but the X-Ray tube manufacturer should be consulted. A good guideline to consider is the maximum Filament Preheat level should be limited to 50% of the Filament Limit specification. It is perfectly fine to set standby current to zero if fast emission current ramping is not required.

For additional information please visit this [link](#).

## DXM Controlled Ramping:

Controlled Ramping is a user-controlled feature that allows the customer to program kV, filament and mA ramps to meet the application use and X-ray tube requirements. Standard DXM units are shipped with this user-controlled ramping feature disabled. The standard DXM ramping is defaulted to 5 second (to full scale) kV ramp and a 2.5 second filament ramp which starts when the kV output exceeds 30% of full-scale output.

The following parameters are programmable in the firmware and are stored in non-volatile memory.

**KV Ramp Time:** This setting controls the ramp time of the kV output to full-scale value upon X-ray enable and during programming changes when the Set Point Ramping feature has been enabled. It is programmable from 1-20 seconds and is Factory defaulted to 5 seconds. All value changes are stored in non-volatile memory once the Save settings button is clicked.

**Filament Ramp Time:** This setting controls the ramp time of the Filament output to full-scale value (0- 5A) upon X-ray enable. Filament ramping starts at the completion of the kV ramp. It is programmable from 0.5-30 seconds and is defaulted to 30 seconds. All value changes are stored in non-volatile memory once the Save settings button is clicked.

**mA Ramp Time:** This setting control the ramp time of the mA to full-scale value upon X-ray enable and during programming changes when the Set Point Ramping feature has been enabled. mA ramping starts at the completion of the KV ramp and steps to 5% of the mA program value set point. It is held at this value for a

period of time (which is set by the mA Ramp Hold), prior to ramping to its mA programmed value. It is programmable from 0.5- 5 seconds and is Factory defaulted to 5 seconds. All value changes are stored in non-volatile memory once the Save settings button is clicked.

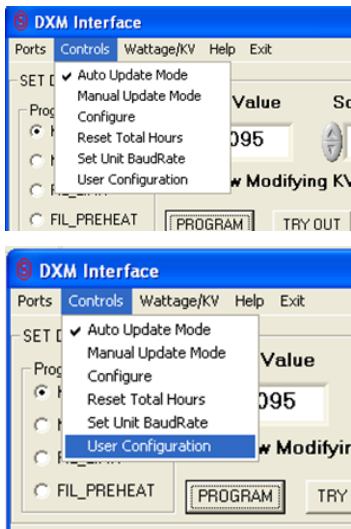
**mA Ramp Hold:** This setting controls the length of time the mA program is held at 5% of the mA program value during the ramping sequence. This feature is used to hold the mA programming at a low level during filament ramping to allow the mA regulation control circuitry to take control prior to the mA ramping to the programmed mA value. It is programmable from 1- 30 seconds and is Factory defaulted to 30 seconds. Typically this mA Ramp hold period should be equal or great than the filament ramp time. All value changes are stored in non-volatile memory once the Save settings button is clicked.

**Set Point Ramp:** This setting, when enabled, will ramp both the kV and mA during programming setting changes during operations of the X-ray tube. The rate of the ramping will be the same as the settings selected for KV Ramp Time and mA Ramp Time. This is Factory defaulted to disabled. The Enable status is stored in non-volatile memory once the Save settings button is clicked.

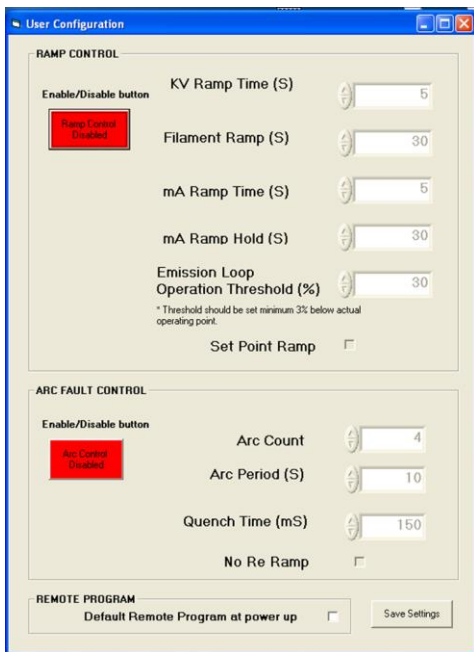
**Emission Loop Operation Threshold:** This setting controls the kV output threshold for when the emission loop is active. It is programmable from 5% to 50% of full-scale kV output and determines at what kV output the Filament loop is disabled. This protects the X-ray tube from operating mA output at low kV outputs that are not recommended by the X-ray tube manufacturer. The threshold should be set 3% below the minimum required kV operation point. For an example, setting to 37% on a 75kV output unit will allow for a minimum of 30kV operation (and not allow operation at approximately 27.8kV or below). Consult your X-ray tube manufacturer for minimum operating specifications.

To setup the DXM Controlled Ramping feature, the unit must be connected to a Host PC using either RS-232, USB, or Ethernet using The DXM GUI (SWD0159-007). Refer to DXM Digital Manual to setup communications.

Once communications have been established between the DXM and the GUI (also see Digital manual for command list for these features), proceed through the following screens as follows: Click on the Control Tab.

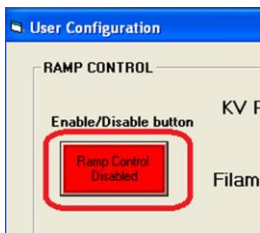


The below User Configuration screen will open:



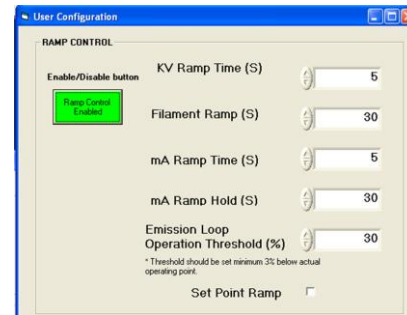
Standard units are shipped with the Controlled Ramp disabled.

To enable, Click the “Ramp Control Disabled” button circled below

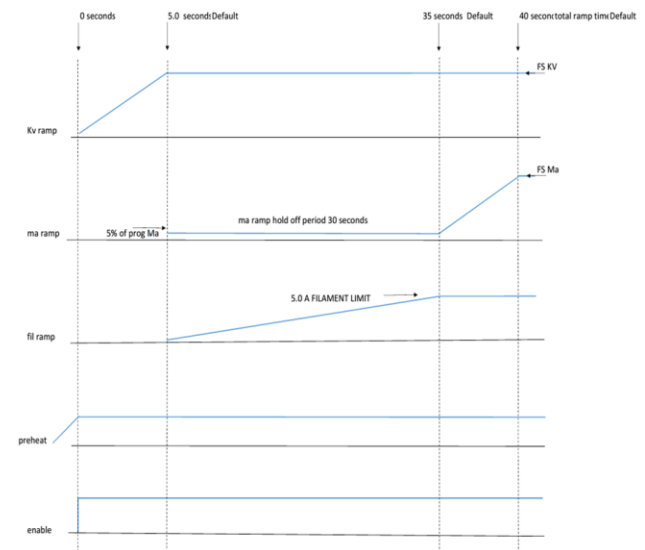


The button will then turn green per below, indicating the Control Ramp feature has been enabled. Click “Save Settings” button at the bottom of the window to save parameters.

The unit now has default control Ramp settings as shown below:



The below defines the ramp sequence with the above default values



EXAMPLE #1 – Default settings



Programmed set points:

Preheat set point = 1.0A (1V/A)

Filament limit set point = 3.6A (1V/A)

kV set point = full scale 10V

kV set point = full scale 10V

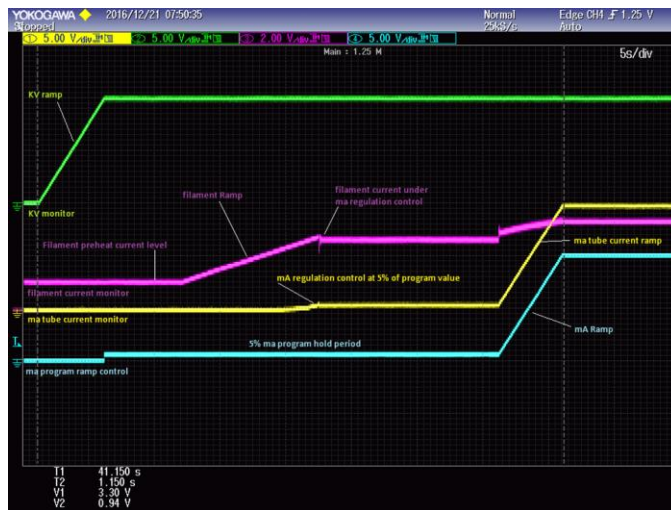
Scope waveforms:

CH1 (YELLOW) mA tube current monitor

CH2 (GREEN) high voltage monitor (kV Ramp Time 5 seconds)

CH3 (PURPLE) Filament current monitor (Filament ramp 30 seconds)

CH4 (BLUE) mA program ramp (mA Ramp Time 5 second, after mA Hold of 30 seconds)



At the completion of the kV ramp, the mA program steps to 5% of the programmed mA value. At the same time, the filament slowly ramps up allowing mA regulation to take control. After mA regulation is in control and stabilizes, the mA ramps to the final program value with no overshoot. The Filament current never reaches the maximum filament limit set point of 3.6A. The total enable ramps sequence to full-scale is 40 seconds.

By adjusting the set point values in the User Configuration screen users can customize ramp length to meet applications requirement and X-ray tube requirements.

Example #2 - Faster ramp setting result:

**RAMP CONTROL**

Enable/Disable button: ☒ Ramp Control Enabled

KV Ramp Time (S): 1

Filament Ramp (S): 0.75

mA Ramp Time (S): 1

mA Ramp Hold (S): 1

Emission Loop Operation Threshold (%): 30

\* Threshold should be set minimum 3% below actual operating point.

Set Point Ramp: ☐

Programmed set points:

Preheat set point = 0.0A (1V/A)

Filament limit set point = 3.6A (1V/A)

kV set point = full scale 10V

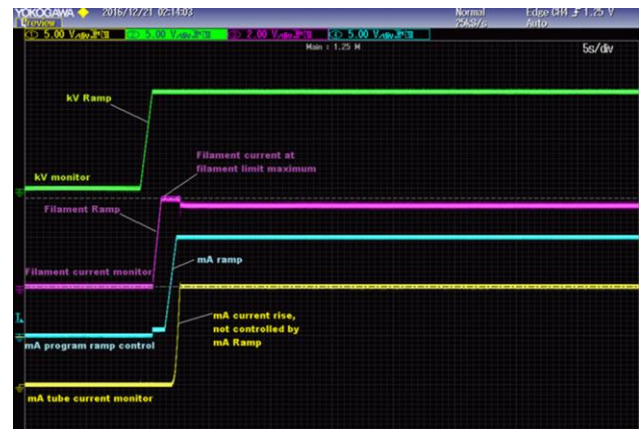
kV set point = full scale 10V

CH1 (YELLOW) mA tube current monitor

CH2 (GREEN) high voltage monitor

CH3 (PURPLE) Filament current monitor

CH4 (BLUE) mA program ramp



The faster ramp sequence does not allow enough time for the tube filament to achieve the required temperature for emissions current before the mA ramp starts. This causes the filament current to ramp to the maximum filament limit and stay at that level for several seconds while the filament reaches required temperature for emission. The mA current rise is not controlled by the mA ramp and may have slight overshoot due to this.

Example #3 – increased times compared to Example#2 (14 sec)



**RAMP CONTROL**

Enable/Disable button Ramp Control Enabled

KV Ramp Time (S)

Filament Ramp (S)

mA Ramp Time (S)

mA Ramp Hold (S)

Emission Loop Operation Threshold (%)

\* Threshold should be set minimum 3% below actual operating point.

Set Point Ramp ☐

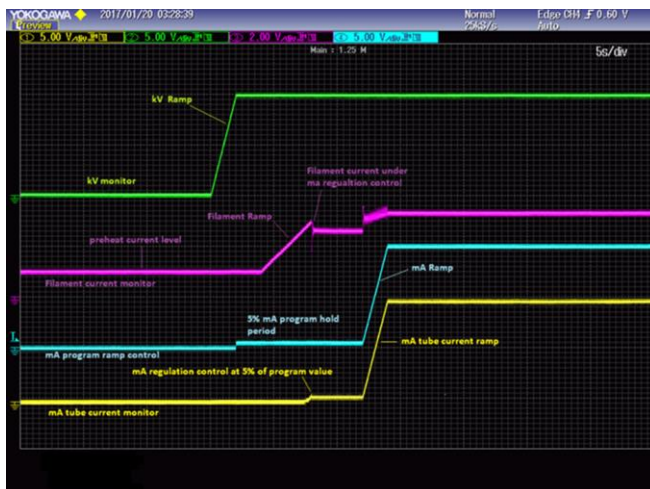
Programmed set points:

Preheat set point = 1.0A (1V/A)

Filament limit set point = 3.6A (1V/A)

kV set point = full scale 10V

kV set point = full scale 10V



The total enable ramps sequence to full-scale is 14 seconds.

EXAMPLE #4 – 10sec sequence

**RAMP CONTROL**

Enable/Disable button Ramp Control Enabled

KV Ramp Time (S)

Filament Ramp (S)

mA Ramp Time (S)

mA Ramp Hold (S)

Emission Loop Operation Threshold (%)

\* Threshold should be set minimum 3% below actual operating point.

Set Point Ramp ☐

Same Programmed set points as Example #3



The total enable ramps sequence to full-scale is 10 seconds.

EXAMPLE#5 – 5 sec sequence

**RAMP CONTROL**

Enable/Disable button Ramp Control Enabled

KV Ramp Time (S)

Filament Ramp (S)

mA Ramp Time (S)

mA Ramp Hold (S)

Emission Loop Operation Threshold (%)

\* Threshold should be set minimum 3% below actual operating point.

Set Point Ramp ☐

Preheat set point =1.5A (1V/A)

Filament limit set point =3.6A (1V/A)

KV set point =full scale 10V

KV set point =full scale 10V





The total enable ramps sequence to full-scale is 5 seconds.

It is recommended to set the ramp times as long as your application can tolerate. As the results may vary depending on the X-ray tube characteristics, user testing of ramp times is required to ensure requirements of X-ray tube Manufacturer and applications are met (See DXM/DXB data sheet for monitor pin outs). Consult with the X-ray tube manufacturer about required ramp speed and Filament limit set points for the X-ray tube.

### Set Point Ramp:

**Set Point Ramp:** This setting, when enabled, will ramp both the kV and mA during programming setting changes during operation of the X-ray tube. The rate of the ramping will be the same as the settings selected for **kV Ramp Time** and **mA Ramp Time**. Standard units are shipped from the factory with this feature disabled. Enable status is stored in non-volatile memory once the Save settings button is clicked.

To enable set point ramping, click the box shown below and the Click the “Save Settings” button.

**RAMP CONTROL**

Enable/Disable button: ☐ Ramp Control Enabled

kV Ramp Time (S): 5

Filament Ramp (S): 30

mA Ramp Time (S): 5

mA Ramp Hold (S): 30

Emission Loop Operation Threshold (%): 30

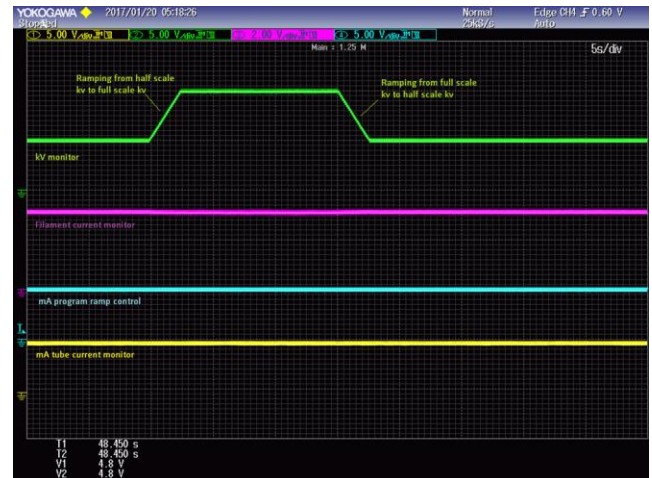
\* Threshold should be set minimum 3% below actual operating point.

Set Point Ramp: ☒

Example of set point ramping with the above Ramping parameters:

CH1 (YELLOW) mA tube current monitor  
CH2 (GREEN) high voltage monitor  
CH3 (PURPLE) Filament current monitor  
CH4 (BLUE) mA program ramp

Below plot shows, kV programming that was changed from half-scale value to full-scale value. Then changed back to half-scale value. Ramping is 2.5 second for half scale change because the total ramp time is set for 5 seconds.



Below plot shows mA programming that was changed from half-scale value to full-scale value. Then changed back to half-scale value. Ramping is 2.5 second for half-scale change because the total ramp time is set for 5 seconds.



## 3.2 Standard Control Features

A note on remote interface circuitry and remote signal grounding: whenever possible, electrical isolation should be provided when interfacing with any high voltage power supply. For enable/disable signal connections, an isolated relay or optocoupler should be used. For PS Fault indication an optocoupler should be used. If possible, analog programming and monitoring signals should be isolated via analog isolation amplifiers. Spellman application engineers are available to assist in interface circuitry design. All interface cables should be properly shielded. All power supply signals should be referenced to the power supplies signal ground or power supply chassis ground

**Local Programming potentiometers:** The filament limit and preheat level controls on the front panel can be used as follows: For local filament limit control, jump J2-4 to J2-5. For local preheat control, jump J2-6 to J2-7. See Figure 3.2.

**LOCAL PROGRAMMING:** Allows local adjustment of the output voltage, current filament limit and preheat level via an external voltage source. 0-10VDC signal is supplied to pin 3 of the J2 for voltage programming and 0-10 VDC signal is supplied to Pin 2 J2 for current programming. 0-10VDC signal is supplied to pin 4 of the J2 for filament limit programming. 0-10VDC signal is supplied to pin 6 of the J2 for filament preheat programming (2.5a max). Programming signals should be referenced to Pin 9 of J2, signal ground. By adjusting the voltage source from 0 volts (zero output) to 10 volts (full rated output) the desired output can be selected. See Figure 3.3 for wiring diagram and specifications.

**Local Monitoring:** Monitor outputs are made available for monitoring the voltage, current output and filament

preheat level. The Monitor outputs are always positive regardless of the output polarity, where zero (0) to 10 (10) volts equals 0-100% of output. See Figure 3.4 for monitoring wiring and see data sheet for pin outs.

**X-RAY Enable/Interlock:** In Local Mode allows ON/OFF control of the high voltage. The hardware based dry contact closure must be closed in to enable the high voltage. **In Remote Mode** this I/O acts as an Interlock. The hardware based dry contact closure must be closed in order to enable the high voltage via the USB, Ethernet or RS232. This can be done by connecting pins 11 and 12 on J2. See Figure 3.5.

### REMOTE PROGRAMMING:

**After establishing communication with the DXM as per the DXM Digital Protocol spec.** Switch the DXM to Remote Mode by sending a Program Local/Remote Mode command. If the unit is in Local Mode and enabled prior to switching it to Remote Mode, the DXM will shutdown and a P.S Fault indicator will occur when it is switch to Remote Mode. A clear command can be sent to clear this fault.

**Remote Control:** USB, Ethernet and RS232 are standard Refer to DXM Digital Protocol spec for Details.

**Remote Monitor:** Allows remote monitoring of the Output voltage, current, filament limit and preheat level via the USB, Ethernet or RS232.

**Remote Programming:** Allows remote programming of the Output voltage, current, filament limit and preheat level via the USB, Ethernet or RS232.

### ARC FAULT CONTROL:

Arc Fault Control features allow the user to custom select the type of arc intervention that is required. This feature is disabled as a default, which means the unit will shut down with one arc fault.

When Arc Control is enabled, the user can set the arc detection parameters to custom fit their requirements. The following parameters are programmable in the firmware and are stored in non-volatile memory once the Save settings button is clicked.

#### Arc Count:

This sets how many arcs are required within the selected time period to cause an arc shutdown. It is programmable from 2 arc to 10 arcs. The factory default setting is 4 arcs when Arc Control is enabled.

#### Arc Period:

This sets the time period that the selected arc count must occur within to cause an arc shutdown .It is programmable

from 10 to 20 seconds. The default setting is 10 seconds when Arc Control is enabled.

#### Quench Time:

This sets the length of time that the high voltage is shutdown to quench the arc after an arc occurs. It is programmable from 50ms to 300ms. The factory default setting is 150ms when Arc Control is enabled.

#### No Re-Ramp:

After an arc occurs, the kV output will re-ramp to the programmed value as per the ramp time settings. If the Ramp control in Section 1.0 is enable the programmed ramps will be used. If the Ramp control is disable, the Standard DXM ramps will be used.

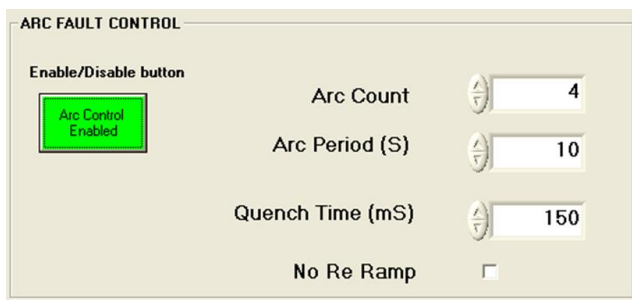
If No Re-ramp is enabled (by clicking the box next to “No Re Ramp”) and clicking “Save Settings”) then there will be no ramping after an arc.

The standard units are shipped with the Arc Control disabled.

To enable Click the Arc Control button circled below.



The button will turn green, indicating the Control Ramp feature has been enabled . Click “Save Settings” button at the bottom of the window to save parameters.



### 3.0 Default Remote Program

The DXM unit can be controlled by analog signals in Local mode or Digital interfaces in Remote mode. The standard unit powers up in Local mode and can be switched to Remote via a command on the digital interface.

The Remote program feature will default the unit to only power up in Remote mode and not allow the analog control signals local enable to be active at power up. It can be enabled by clicking the box shown below and clicking “Save Settings”.



## WARNING

It is extremely dangerous to use this circuit to inhibit high voltage generation for the purpose of servicing or approaching any area of load considered unsafe during normal use.

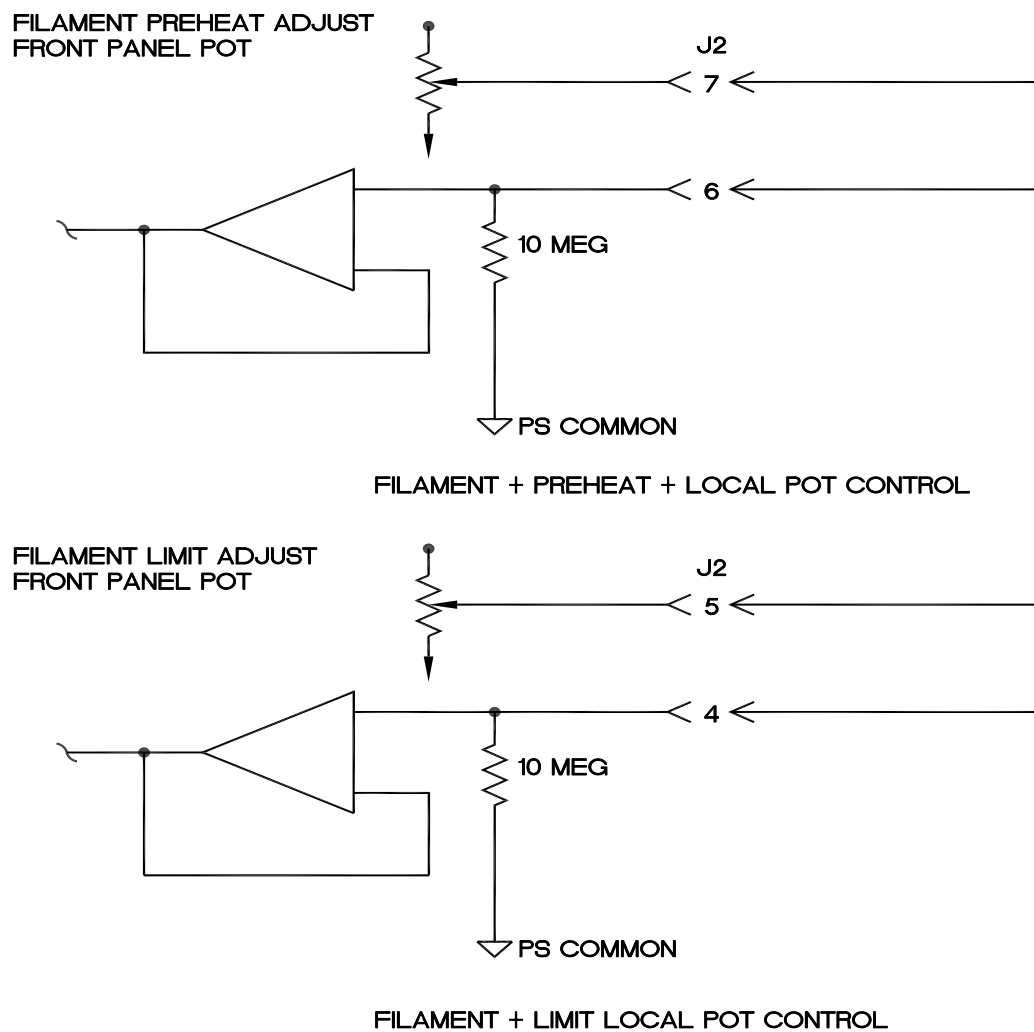
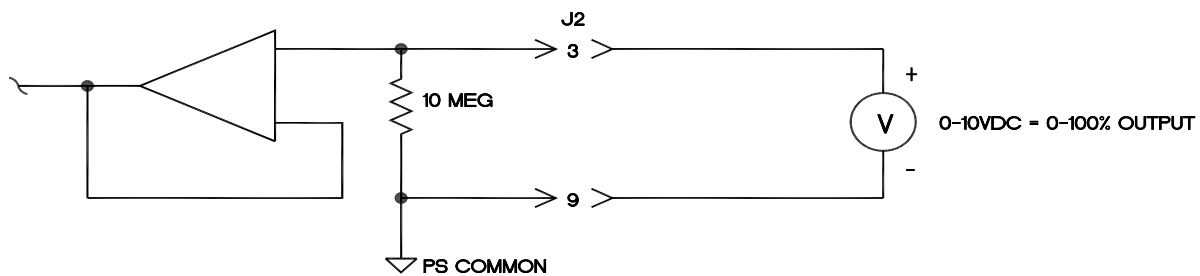
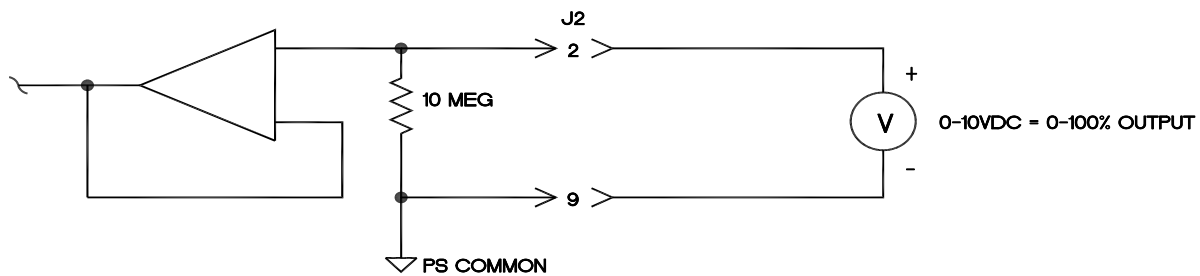


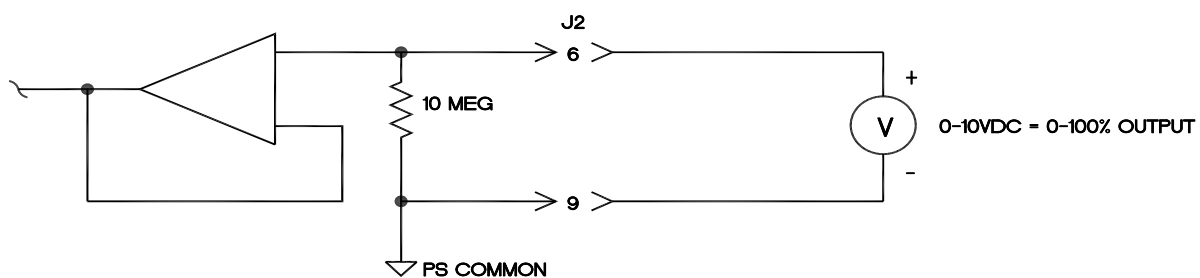
Figure 3.2 Local Programming Via Internal Front Panel Pot Voltage Source.



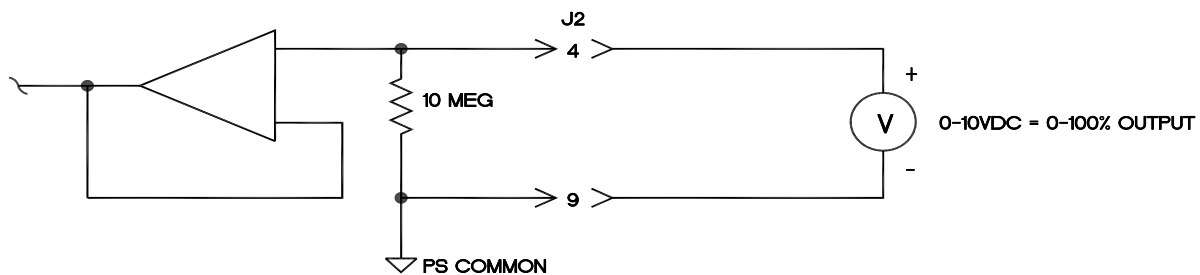
VOLTAGE CONTROL



CURRENT CONTROL

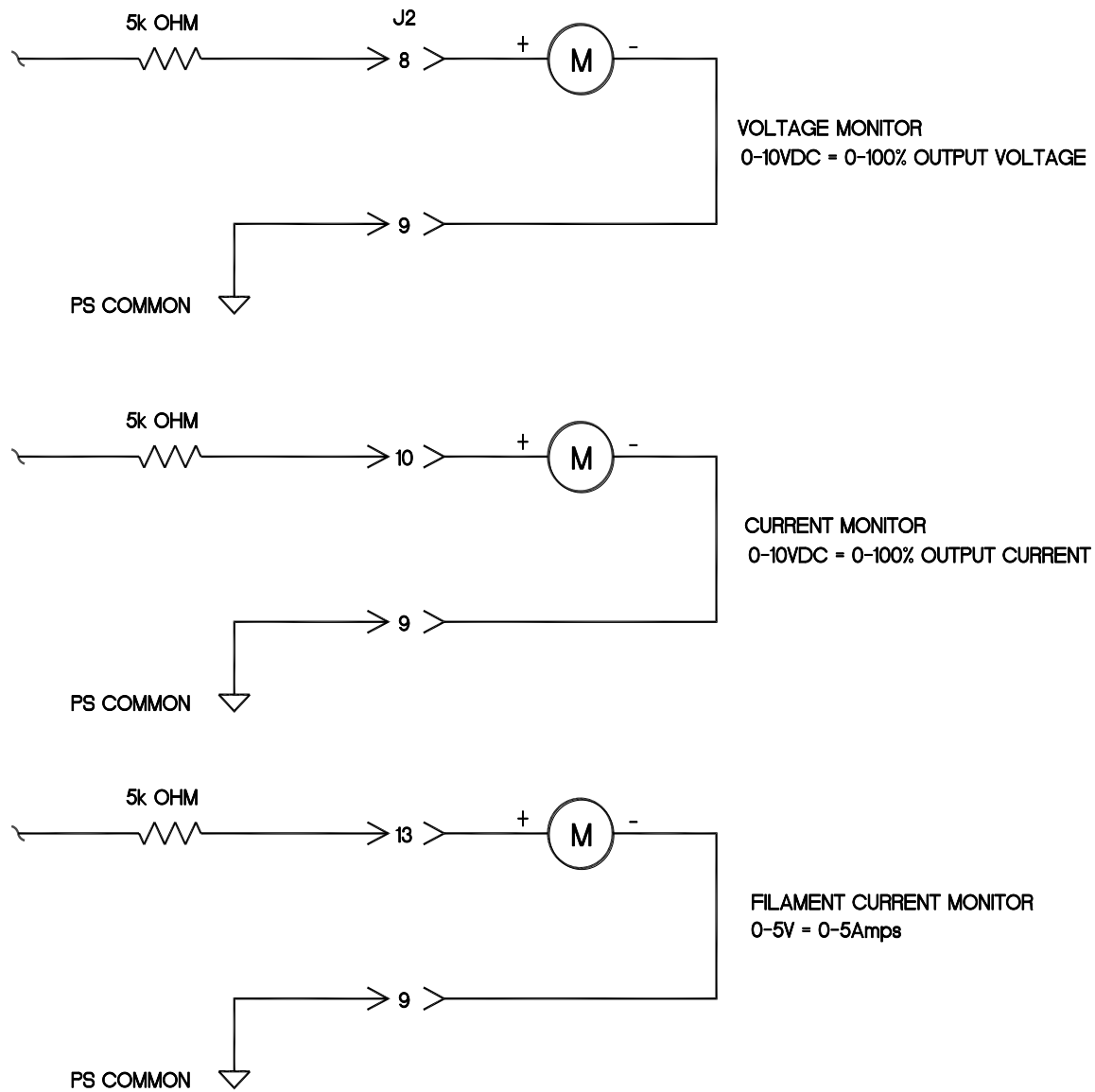


FILAMENT PREHEAT CONTROL

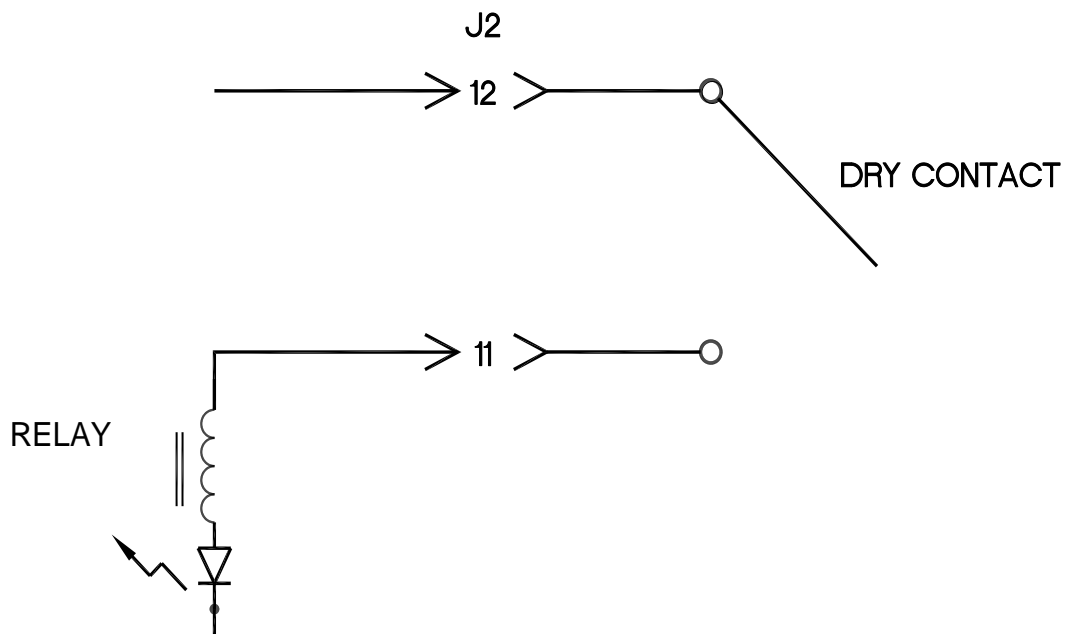


FILAMENT LIMIT CONTROL

**Figure 3.3 Local Programming Via External Voltage Source**



**Figure 3.4 Remote Monitoring**



**Figure 3.5 Enable/Interlock Logic Control**

# Chapter 4

## PRINCIPLES OF OPERATION

The DXM Series of high voltage power supplies utilizes sophisticated power conversion technology.

Advanced analog and power conversion techniques are used in the DXM series. The intention of the Principles of Operation is to introduce the basic function blocks that comprise the DXM power supply. For details on a specific circuit, consult Spellman's Engineering Department.

The DXM power supply is basically an AC to DC power converter. Within the power supply, conversions of AC to DC then to high frequency AC, then to high voltage DC take place.

Typical DXM power supplies comprise a few basic building blocks. These are: 1) AC to DC rectifier, 2) Power Factor correction boost circuitry 3) High frequency quasi-resonant inverter, 4) High voltage transformer and rectifier circuits, and 5) Control and monitoring circuits. The following is a brief description of each building block.

### 4.1 Power Factor and Associated Circuits

The DXM series can operate from 90 - 265VAC, for the 300Watt Model and 180 - 264VAC for the 600 and 1200 Watt Models. The input voltage is connected via a typical IEC 320 type input connector. An internal EMI filter and fuse housing is an integral part of the DXM module. The input circuits actively correct the power factor.

The input line voltage is applied to a current limit device to reduce the initial inrush current. The input line voltage is converted to a 400VDC voltage via an active PFC Converter.

#### WARNING

**The energy levels used and generated by the power supply can be lethal! Do not attempt to operate the power supply unless the user has a sufficient knowledge of the dangers and hazards of working with high voltage. Do not attempt to approach or touch any internal or external circuits or components that are connected or have been connected to the power supply. Be certain to discharge any stored energy that may**

**be present before and after the power supply is used. Consult IEEE recommended practices for safety in high voltage testing #510-1983.**

### 4.2 High Frequency Inverter

The DXM is a resonant converter operating in a zero current switching, series resonant, parallel loaded topology. MOSFET transistors switch the 400 VDC voltage to the resonant tank circuit. Typical operating frequency is in the range of 35-65kHz depending on model. Control of the resonant circuit output is done by the low voltage control circuits, and are isolated by an isolated pulse transformer. The output of the resonant circuit is applied to the primary of the high voltage transformer.

### 4.3 High Voltage Circuits

The high voltage transformer is a step-up type. The secondary of the high voltage transformer is connected to the high voltage rectifier circuit. The rectifier circuit will vary depending upon the rated output voltage. For lower power a half wave Cockroft-Walton multiplier is used, for higher power a full wave Cockroft-Walton multiplier is used. A feedback signal is generated by the high voltage resistor divider. This feedback signal is sent to control circuits to provide voltage regulation and monitoring. A current sense resistor is connected at the low voltage end of the rectifier circuit. The circuit sense signal is sent to the control circuits to provide current regulation and monitoring.

The high voltage rectifier output is connected to the output limiting resistors. These resistors limit the peak surge current in the event an arc or discharge occurs. The limiting resistor output is connected to the output connector provided.



## 4.4 Control Circuits

Control circuits are used for regulation, monitoring, pulse-width, control, slow-start and inhibit control. Feedback signals are calibrated and buffered via general purpose OP-AMPS. Pulse width control is accomplished by a typical PWM type control I.C. Logic enable/disable is provided by a logic gate I.C. Regulators generate +/- 15V and 10VDC. DSP based control circuitry provides excellent regulation, along with outstanding stability performance

### **WARNING**

**LINE VOLTAGE IS PRESENT  
WHENEVER THE POWER SUPPLY IS  
CONNECTED TO EXTERNAL LINE  
VOLTAGES. BE SURE TO DISCONNECT  
THE LINE CORD BEFORE OPENING THE  
UNIT. ALLOW 5 MINUTES FOR  
INTERNAL CAPACITANCE TO  
DISCHARGE BEFORE REMOVING ANY  
COVER.**

## 4.5 Options

Due to the variations of models and options provided in the DXM series, details of actual circuits used may differ slightly from above descriptions. Consult Spellman's Engineering Department for questions regarding the principles of operations for the DXM series.

# Chapter 5

## OPTIONS

The options available for this power supply are described in this section. Interface diagrams are shown where required. Options are specified by including the option code in the model number as described in Section 1.4.

### 5.1 Custom Designed Models X (#)

Units built to customer specifications are assigned an X number by the factory. If this unit is an X model, specification control sheet is added at the end of this instruction manual.

### 5.2 Filament

Filament outputs with an emission control loop are available for use with X-ray tubes. Generally, filament outputs are in the range of 3V – 10V, at currents up to 5A. Both floating AC and grounded DC filaments are available. The filament on a standard DXM Module is calibrated to 5A@10V using either a 10ft High Voltage cable for floating filament or 10ft of 18awg wire for grounded filament

Spellman welcomes the opportunity to tailor units to fit your requirements or to develop new products for your applications. Contact Spellman Sales Department.

Note: Before operating this system, refer to operating instructions in Chapter 3.

# Chapter 6

## MAINTENANCE

This section describes periodic servicing and performance testing procedures.

### WARNING

**THIS POWER SUPPLY GENERATES VOLTAGES THAT ARE DANGEROUS AND MAY BE FATAL.**

**OBSERVE EXTREME CAUTION WHEN WORKING WITH HIGH VOLTAGE.**

### 6.1 Periodic Servicing

Approximately once a year (more often in high dust environments), disconnect the power to the unit. Use compressed air to blow dust out of the inside of the unit. Avoid touching or handling the high voltage assembly.

### 6.2 Performance Test

### WARNING

**HIGH VOLTAGE IS DANGEROUS.  
ONLY QUALIFIED PERSONNEL SHOULD  
PERFORM THESE TESTS.**

High voltage test procedures are described in Bulletin STP-783, Standard Test Procedures for High Voltage Power Supplies. Copies can be obtained from the Spellman Customer Service Department. Test equipment, including an oscilloscope, a high impedance voltmeter, and a high voltage divider such as the Spellman HVD-100 or HVD-200, is needed for performance tests. All test components must be rated for operating voltage.

### 6.3 High Voltage Dividers

High voltage dividers for precise measurements of output voltage with an accuracy up to 0.1% are available from Spellman. The HVD-100 is used for voltages up to 100KV. The HVD-200 measures up to 200KV. The Spellman divider is designed for use with differential voltmeters or high impedance digital voltmeters. The high input impedance is ideal for measuring high voltage low current sources, which would be overloaded by traditional lower impedance dividers.

# Chapter 7

## FACTORY SERVICE

### 7.1 Warranty Repairs

During the Warranty period, Spellman will repair all units free of charge. The Warranty is void if the unit is worked on by other than Spellman personnel. See the Warranty in the rear of this manual for more information. Follow the return procedures described in Section 7.2. The customer shall pay for shipping to and from Spellman.

### 7.2 Factory Service Procedures

Spellman has a well-equipped factory repair department. If a unit is returned to the factory for calibration or repair, a detailed description of the specific problem should be attached.

For all units returned for repair, please obtain an authorization to ship from the Customer Service Department, either by phone or mail prior to shipping. When you call, please state the model and serial numbers, which are on the plate on the rear of the power supply, and the purchase order number for the repair. A Return Material Authorization Code Number (RMA Number) is needed for all returns. This RMA Number should be marked clearly on the outside of the shipping container. Packages received without an RMA Number will be returned to the customer. The Customer shall pay for shipping to and from Spellman.

A preliminary estimate for repairs will be given by phone by Customer Service. A purchase order for this amount is requested upon issuance of the RMA Number. A more detailed estimate will be made when the power supply is received at the Spellman Repair Center. In the event that repair work is extensive, Spellman will call to seek additional authorization from your company before completing the repairs.

### 7.3 Ordering Options and Modifications

Many of the options listed in Chapter 5 can be retrofitted into Spellman power supplies by our factory. For prices and arrangements, contact our Sales Department.

### 7.4 Shipping Instructions

All power supplies returned to Spellman must be sent shipping prepaid. Pack the units carefully and securely in a suitable container, preferably in the original container, if available. The power supply should be surrounded by at least four inches of shock absorbing material. Please return all associated materials, i.e. high voltage output cables, interconnection cables, etc., so that we can examine and test the entire system.

All correspondence and phone calls should be directed to:

**Spellman High Voltage Electronics Corp.**  
475 Wireless Boulevard  
Hauppauge, New York 11788  
TEL: (631) 630-3000 FAX: (631) 435-1620  
E-Mail: [sales@Spellmanhv.com](mailto:sales@Spellmanhv.com)  
<http://www.spellmanhv.com>

# WICHTIGE SICHERHEITSHINWEISE

## SICHERHEIT

DIESES HOCHSPANNUNGSNETZTEIL ERZEUGT LEBENSGEFÄHRLICHE HOCHSPANNUNG.  
SEIN SIE SEHR VORSICHTIG BEI DER ARBEIT MIT DIESEM GERÄT.

Das Hochspannungsnetzteil muß immer geerdet sein.

Berühren Sie die Stecker des Netzteiles nur, wenn das Gerät ausgeschaltet ist und die elektrischen Kapazitäten des Netzteiles und der angeschlossenen Last entladen sind.

Die internen Kapazitäten des Hochspannungsnetzteiles benötigen ca. 5 Minuten, um sich zu entladen.

Erden Sie sich nicht, und arbeiten Sie nicht in feuchter oder nasser Umgebung.

## SERVICESICHERHEIT

Notwendige Reparaturen können es erforderlich machen, den Gehäusedeckel während des Betriebes zu entfernen.

Reparaturen dürfen nur von qualifiziertem, eingewiesenem Personal ausgeführt werden.

“WARNING” im folgenden Text weist auf gefährliche Operationen hin, die zu Verletzungen oder zum Tod führen können.

“CAUTION” im folgenden Text weist auf Prozeduren hin, die genauestens befolgt werden müssen, um eventuelle Beschädigungen des Gerätes zu vermeiden.

# PRECAUTIONS IMPORTANTES POUR VOTRE SECURITE

## CONSIGNES DE SÉCURITÉ

CETTE ALIMENTATION GÉNÈRE DES TENSIONS QUI SONT DANGEUREUSES ET PEUVENT ÊTRE FATALES.  
SOYEZ EXTRÊMEMENT VIGILANTS LORSQUE VOUS UTILISEZ CET ÉQUIPEMENT.

Les alimentations haute tension doivent toujours être mises à la masse.

Ne touchez pas les connectiques sans que l'équipement soit éteint et que la capacité à la fois de la charge et de l'alimentation soient déchargées.

Prévoyez 5 minutes pour la décharge de la capacité interne de l'alimentation.

Ne vous mettez pas à la masse, ou ne travaillez pas sous conditions mouillées ou humides.

## CONSIGNES DE SÉCURITÉ EN CAS DE REPARATION

La maintenance peut nécessiter l'enlèvement du couvercle lorsque l'alimentation est encore allumée.

Les réparations doivent être effectuées par une personne qualifiée et connaissant les risques électriques.

Dans le manuel, les notes marquées « **WARNING** » attire l'attention sur les risques lors de la manipulation de ces équipements, qui peuvent entrainer de possibles blessures voire la mort.

Dans le manuel, les notes marquées « **CAUTION** » indiquent les procédures qui doivent être suivies afin d'éviter d'éventuels dommages sur l'équipement.

## IMPORTANTI PRECAUZIONI DI SICUREZZA

### SICUREZZA

QUESTO ALIMENTATORE GENERA TENSIONI CHE SONO PERICOLOSE E POTREBBERO ESSERE MORTALI.  
PONI ESTREMA CAUTELA QUANDO OPERI CON QUESTO APPARECCHIO.

Gli alimentatori ad alta tensione devono sempre essere collegati ad un impianto di terra.

Non toccare le connessioni a meno che l'apparecchio sia stato spento e la capacità interna del carico e dell'alimentatore stesso siano scariche.

Attendere cinque minuti per permettere la scarica della capacità interna dell'alimentatore ad alta tensione.

Non mettere a terra il proprio corpo oppure operare in ambienti bagnati o saturi d'umidità.

### SICUREZZA NELLA MANUTENZIONE.

Manutenzione potrebbe essere richiesta, rimuovendo la copertura con apparecchio acceso.

La manutenzione deve essere svolta da personale qualificato, coscio dei rischi elettrici.

Attenzione alle **AVVERTENZE** contenute nel manuale, che richiamano all'attenzione ai rischi quando si opera con tali unità e che potrebbero causare possibili ferite o morte.

Le note di **CAUTELA** contenute nel manuale, indicano le procedure da seguire per evitare possibili danni all'apparecchio.

To obtain information on Spellman's product warranty please visit our website at:

<http://www.spellmanhv.com/en/About/Warranty.aspx>







# **DXM Digital Interface Manual Ethernet Serial – RS-232 Universal Serial Bus - USB**



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118079-001 Rev G

**USA      CHINA      EUROPE      JAPAN      MEXICO**

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## Table Of Contents

<b>1.0 Scope</b>	3
<b>2.0 Functional Description</b>	3
<b>3.0 Getting Started - Interface Wiring and Pin-outs</b>	3
3.1 RS232 Interface	3
3.2 Ethernet Interface	5
3.3 Universal Serial Bus Interface	6
3.4 RS-232 Cabling	6
3.5 Ethernet Cabling	6
3.6 USB Cabling	8
<b>4.0 Getting Started - Software</b>	10
4.1 RS-232	10
4.2 Ethernet	12
4.3 USB	26
<b>5.0 Ethernet Commands</b>	34
5.1 TCP/IP Format	34
5.2 Command Arguments	35
5.3 Command Overview	35
5.4 Response Overview	37
5.5 Command Structure	38
<b>6.0 Serial Commands – RS-232 / USB</b>	67
6.1 Serial Interface Protocol	67
6.2 Command Arguments	67
6.3 Checksums	67
6.4 Command Overview	69
6.5 Response Overview	70
6.6 Command Structure	72
6.7 Spellman Test Commands	100
6.8 Serial Command Handling	100

## WARNING

**THIS EQUIPMENT GENERATES DANGEROUS VOLTAGES THAT MAY BE FATAL. PROPER GROUNDING OF ALL HIGH VOLTAGE EQUIPMENT IS ESSENTIAL. SEE DXM OWNERS MANUAL FOR PROPER GROUNDING TECHNIQUE AND SAFETY PRECAUTIONS BEFORE APPLYING AC INPUT POWER TO THE DXM UNIT.**

**TO PREVENT DAMAGE TO THE HOST COMPUTER THE COMPUTER SHOULD BE GROUNDED TO THE SAME GROUND AS THE UUT.**

### 1.0 SCOPE

This document applies to the communications interfaces on the DXM , assembly 460067.

### 2.0 FUNCTIONAL DESCRIPTION

The DXM provides 3 different types of digital communications interfaces:

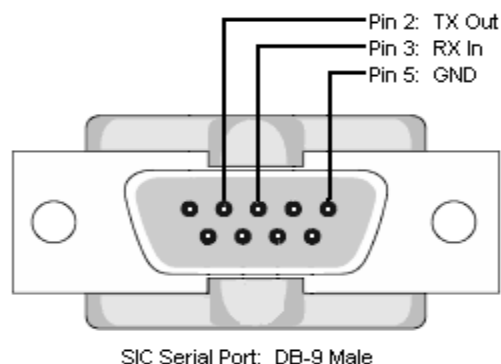
- RS-232 on J3
- Ethernet (10/100-Base-T) on J5
- Universal Serial Bus on J4.

### 3.0 GETTING STARTED - INTERFACE WIRING AND PIN-OUTS

#### 3.1 RS232 INTERFACE

The RS232C interface has the following attributes:

- 115K bits per second
- No Parity
- 8 Data Bits
- 1 Stop Bit
- No handshaking
- DB-9 connector as shown



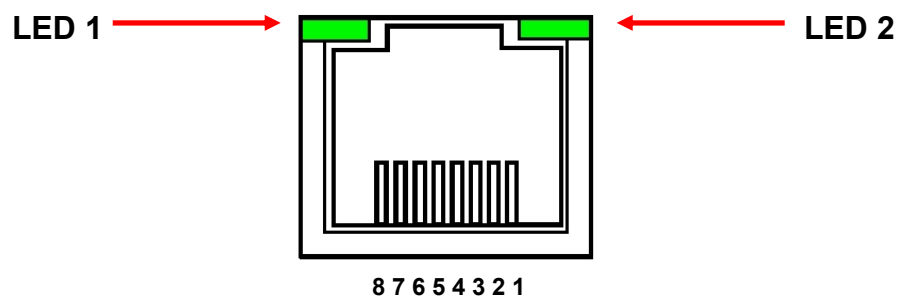
**Figure 1 – J3, RS-232 DB-9M pinout (front view)**

PIN	DESCRIPTION
1	-
2	Tx Out
3	Rx In
4	-
5	Ground
6	-
7	-
8	-
9	-

### 3.2 ETHERNET INTERFACE

The Ethernet interface has the following attributes:

- 10/100-Base-T
- IP address can be set by the system integrator
- Network Mask can be set by the system integrator
- TCP Port Number can be set by the system integrator
- RJ-45 connector
- Network attachment via Crossover and Standard Ethernet cables.
- Supported Operating Systems: Windows 98 2ED, Windows 2000 (SP2), Windows NT (SP6), Windows XP Professional



**Figure 2 – J5, Ethernet RJ45 Jack (front view)**

PIN	DESCRIPTION
1	TX+
2	TX-
3	RX+
4	-
5	-
6	RX-
7	-
8	-

The Ethernet RJ-45 has two LED indicators, as shown in Figure 2. The left LED, LED1 indicates that the network processor has a valid network link. The right LED, LED2 indicates network activity.

### 3.3 USB – UNIVERSAL SERIAL BUS INTERFACE

The USB interface has the following attributes:

- Compliant with USB 1.1 and USB 2.0 specifications
- Type B male connector
- Included driver can be communicated with via standard Windows serial communications methods



**Figure 3 – J4, USB Type B (front view)**

PIN	DESCRIPTION
1	Vbus +5V
2	D-
3	D+
4	Ground

### 3.4 RS-232 CABLING

A standard shielded RS-232 cable is used to connect the DXM serial port to the serial port on a standard personal computer. Please refer to the following chart.

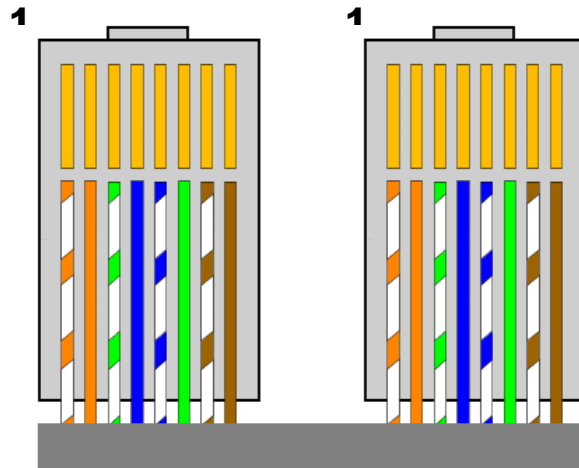
PC to DXM Board Cable Details	
PC Connector (DB-9 Female)	DXM Connector (DB-9 Male)
Pin 2: RX In	Pin 2: TX Out
Pin 3: TX Out	Pin 3: RX In
Pin 5: Ground	Pin 5: Ground

### 3.5 ETHERNET CABLING

Unshielded Category 5e (CAT5e) Ethernet patch cables are used to connect the DXM to the host computer. Although it is not recommended to use shielded cables, if a shielded Ethernet cable is used, it is advised to only connect the shield to Earth ground at one end of the Ethernet cable. This will prevent ground loops and other issues from occurring that can cause data corruption. Please note the DXM's Ethernet connector's (J5) shell is connected Earth ground. The end user should conduct tests to

determine the best method of grounding the cable shield for their application.

A standard connection through a hub, switch, or network uses a standard CAT5 patch cable. Please refer to the two cable ends shown below in figure 4.



**Figure 4 – Standard Straight Through Cable – Standard CAT5 Patch**

### 3.6 USB CABLING

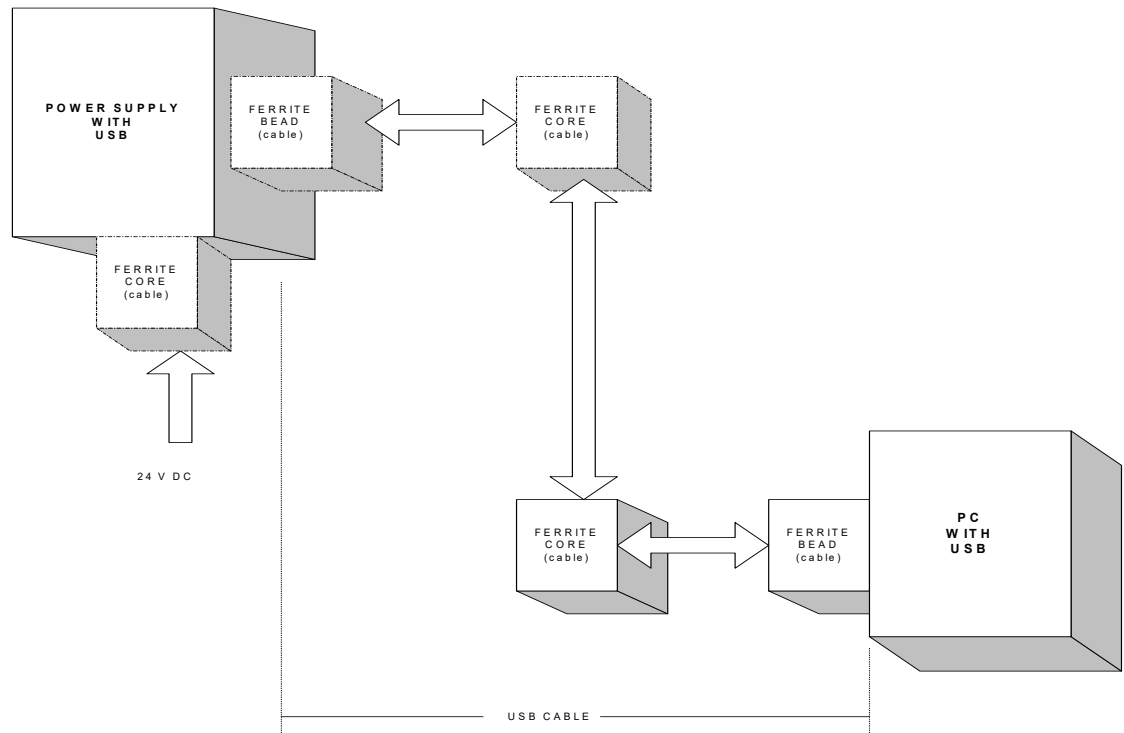
A high-quality double shielded USB 2.0 Type A to B (host to slave) cable should be used in all applications. This type of cable is a standard PC to peripheral cable that utilizes full-size connectors.



Figure 5 – USB A-to-B cable

#### 3.6.1 HIGH EMI ENVIRONMENTS

If the DXM USB interface is being used in a high-EMI environment, ferrites should be added to the USB cable. Figure 7 illustrates the possible combinations of ferrites that can be used to achieve acceptable operation under these conditions.





### **Figure 6 – Block Diagram of USB Cable Utilizing Ferrites**

Ferrite beads should be attached to the USB cable next to the connectors – both sides should be installed. In extreme cases ferrite cores may be added where the cable is looped 3 or 4 times around the core as shown in figure 8. Cores of 1.5 to 2 inches should be used at both ends of the cable.



**Figure 7 - Example of a USB Cable Using Ferrites**

Please refer to the USB Interface Setup section, for an explanation of how USB works and why EMI may present a problem for this communications interface.

## 4.0 GETTING STARTED – SOFTWARE

The following sections detail how to create software to interface to the DXM communications interfaces.

### 4.1 RS-232

The RS-232 interface makes use of a standard 'command/response' communications protocol. See section 6.0 for the syntax of the serial interface protocol. The programmer should also review section 4.3 for programming considerations for the USB interface as the code is nearly identical for the RS-232 interface.

All software that addresses the RS-232 interface must adhere to the following parameters:

- A default Baud rate of 115.2K bps
- No Parity
- 8 Data Bits
- 1 Stop Bit
- No handshaking

The Baud rate can be changed to 115.2K ,57.6k,38.4k,19.2k or 9600 bps and stored in the unit.

#### 4.1.1 Enabling Communications Objects in Visual Basic for RS-232

Communications in Microsoft Visual Basic 6.0 are directed to a control that abstracts the port. In the case of serial and USB we need Microsoft Comm Control 6.0. To enable this in your VB 6 project, go to:

##### **Project -> Components**

Then in the list make sure that Microsoft Comm Control 6.0 has a check next to it. The Comm Control Object should then appear in your toolbox. It will have an icon of a telephone and will be named: MSComm. This can be dragged and dropped into your application. You will then need to set the object's properties.

#### 4.1.2 Configuring Communications in Visual Basic for RS-232

In order to configure the MSComm Object, first you must initialize it in the Object properties:

Settings	115200,n,8,1
Handshaking	0 – comNone

The application can be set to either default to a specific COM Port or the End User can be allowed to choose one for the particular PC.

For the “Default” scenario, include the following commands in the Form\_Load() routine:

```
MSComm1.CommPort = portNumber  
MSComm1.PortOpen = True
```

For the “Choice” scenario, place the above two commands in a selectable menu item.

## 4.2 ETHERNET

The DXM contains an embedded diagnostic web server that can be accessed through any standard web browser by browsing to the DXM's IP address. For example:

`http://192.168.1.4`

The following are the default username and password to access webserver:

Username: root  
Password: shv

The Ethernet interface communicates using the following protocols:

- TCP/IP
- HTTP
- TFTP
- FTP

## 4.2.1 Web Server

DXM contains an embedded webserver which allows the user change network settings and do firmware updates.

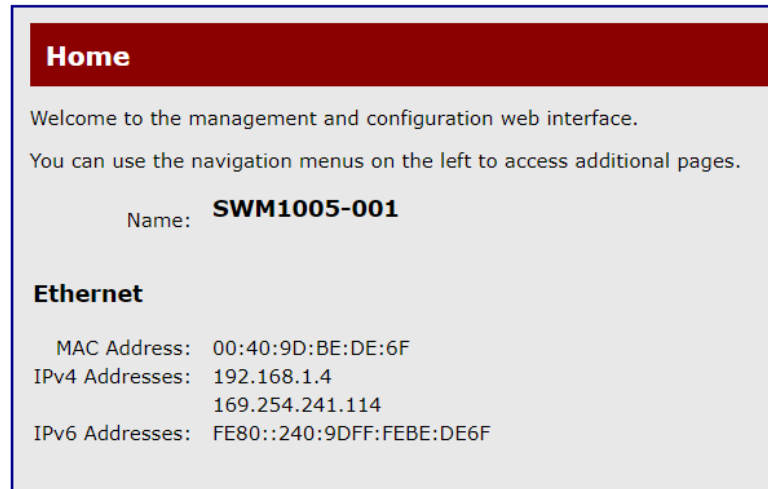
### 4.2.1.1 Web Pages

#### 4.2.1.1.1 Home Page

Here is the Home page.



[Home](#)  
[Network](#)  
[Upload Firmware](#)  
[Reboot](#)

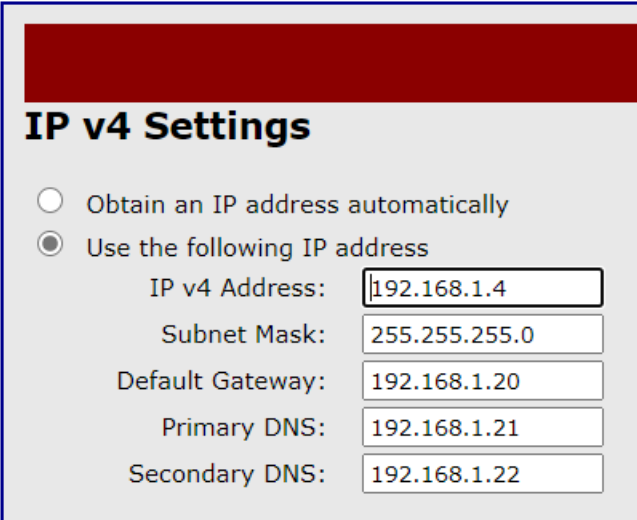


**Figure 8: Web Server – Home Page**

#### 4.2.1.1.2 Network Settings

Click Network on left column of Home page to access Network settings window. You can change any parameter and save them by clicking Save button.

[Home](#)  
[Network](#)  
[Upload Firmware](#)  
[Reboot](#)



The screenshot shows a web interface for 'IP v4 Settings'. It has a red header bar. Below the header, there are two radio buttons: 'Obtain an IP address automatically' (unselected) and 'Use the following IP address' (selected). Below the selected option, there are five input fields: 'IP v4 Address' (192.168.1.4), 'Subnet Mask' (255.255.255.0), 'Default Gateway' (192.168.1.20), 'Primary DNS' (192.168.1.21), and 'Secondary DNS' (192.168.1.22).

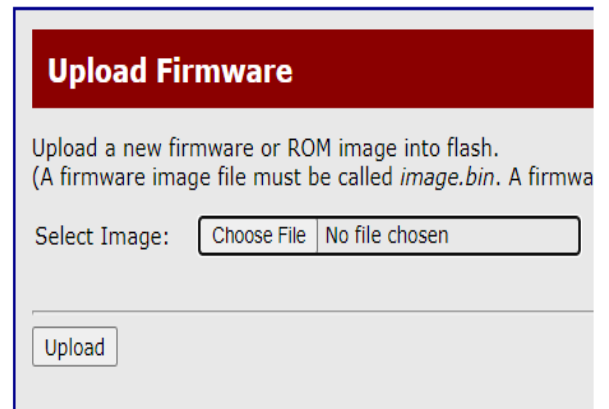
IP v4 Settings	
<input type="radio"/>	Obtain an IP address automatically
<input checked="" type="radio"/>	Use the following IP address
IP v4 Address:	192.168.1.4
Subnet Mask:	255.255.255.0
Default Gateway:	192.168.1.20
Primary DNS:	192.168.1.21
Secondary DNS:	192.168.1.22

**Figure 9 – Network Settings**

#### 4.2.1.1.3 Firmware Update

Click Upload Firmware on left column of Home page to access Upload Firmware window. Click Choose File will open a browser window where you can select the file to download. The file needs to be named *image.bin* for the Upload to work.

[Home](#)  
[Network](#)  
[Upload Firmware](#)  
[Reboot](#)



The screenshot shows a web interface titled "Upload Firmware" in a red header. Below the header, there is instructional text: "Upload a new firmware or ROM image into flash. (A firmware image file must be called *image.bin*. A firmwa". Below this text, there is a "Select Image:" label followed by a button labeled "Choose File" and a text field displaying "No file chosen". At the bottom of the form, there is an "Upload" button.

**Figure 10 – Firmware Update**

After image.bin file is selected, click upload to start uploading the file. Image upload complete message is displayed after uploading successfully finished. A message will propmp user to reboot. You can do this by clicking Reboot on left of screen. Sometimes yo may be asked to re-login before re-boot. If ths is the case, enter username and padsword again.

[Home](#)  
[Network](#)  
[Upload Firmware](#)  
[Reboot](#)



The screenshot shows a web interface titled "Upload Firmware" in a red header. Below the header, there is a text instruction: "Upload a new firmware or ROM image into flash. (A firmware image file must be called *image.bin*.)". Underneath this, there is a label "Select Image:" followed by a "Choose File" button and the text "image.bin". At the bottom of the form, there is an "Upload" button.

**Figure 11: Firmware Update - File**



## 4.2.2 Reset Network Settings

Ethernet device inside DXM can be reset to factory configuration values. This becomes useful when network settings were accidentally changed or became unknown.

To reset network settings you need to have access to DXM control board. Turn power off and remove top cover. Locate Ethernet module and find JP5 pin header. JP5 is located nearby Ethernet module. Install jumper on JP5. Replace top cover and turn power on for about one minute and then turn back off. At this point firmware has already retored newtowk seting to factory values. You can remove jumper now, close the unit and turn power back on.

## 4.2.3 Connection between the DXM and a Computer

A direct Ethernet connection between the DXM and the computer requires a standard Ethernet cable.

When direct connecting the DXM to a computer using an Ethernet cable, they are essentially participating in a private network. As such you need to pick two valid IP addresses, one for each device.

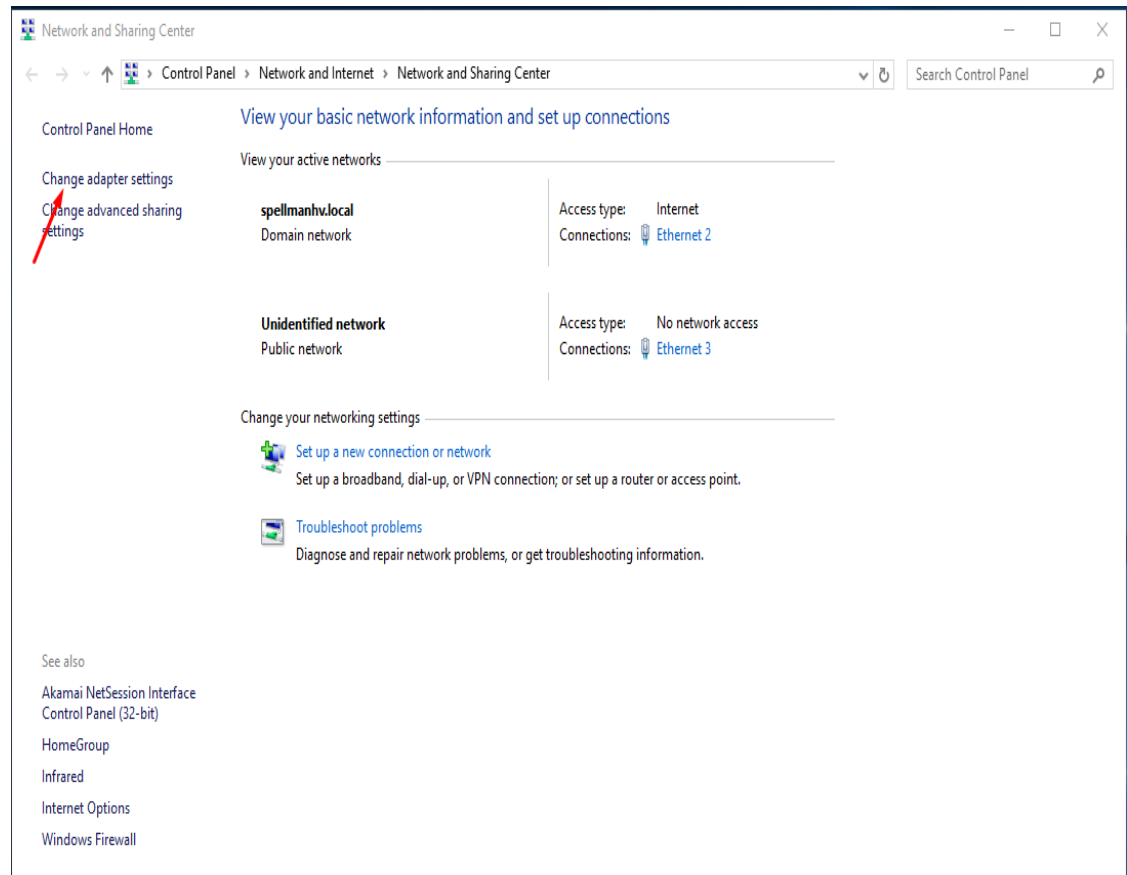
The table below illustrates that not all IP addresses are actually valid IP addresses. For example, IP addresses beginning with 127 are not valid.

Class	Address Range
A	1.0.0.0-126.255.255.255
B	128.0.0.0-191.255.255.255
C	192.0.0.0-223.255.255.255

### 4.2.3.1 Configuring the Computer for Direct Ethernet Connection

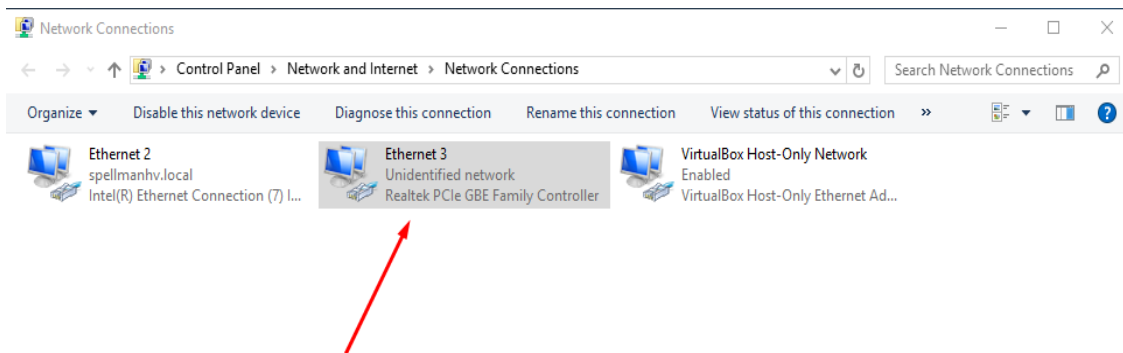
As mentioned above both the IP Address and Subnet Mask need to be configured. In our environment computers normally are assigned IP addresses dynamically, using DHCP. We need to change this and assign the IP Address statically to the one we have selected.

Here are the steps to follow when using Windows 10. Go to Control Panel, Network and Internet, Network Sharing. Click on Change Adapter Settings on left column.



**Figure 12: Change Adapter Settings**

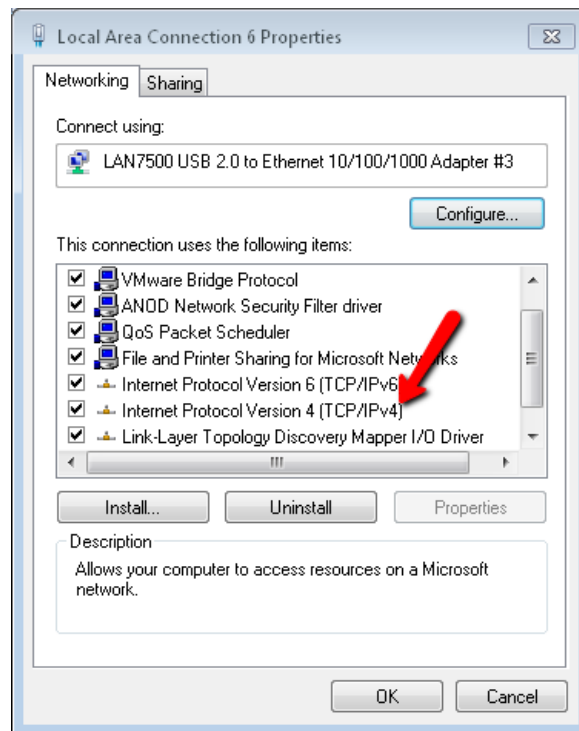
Right click on Ethernet Controller connected to DXM unit and select Properties.



**Figure 13: Ethernet Controller**

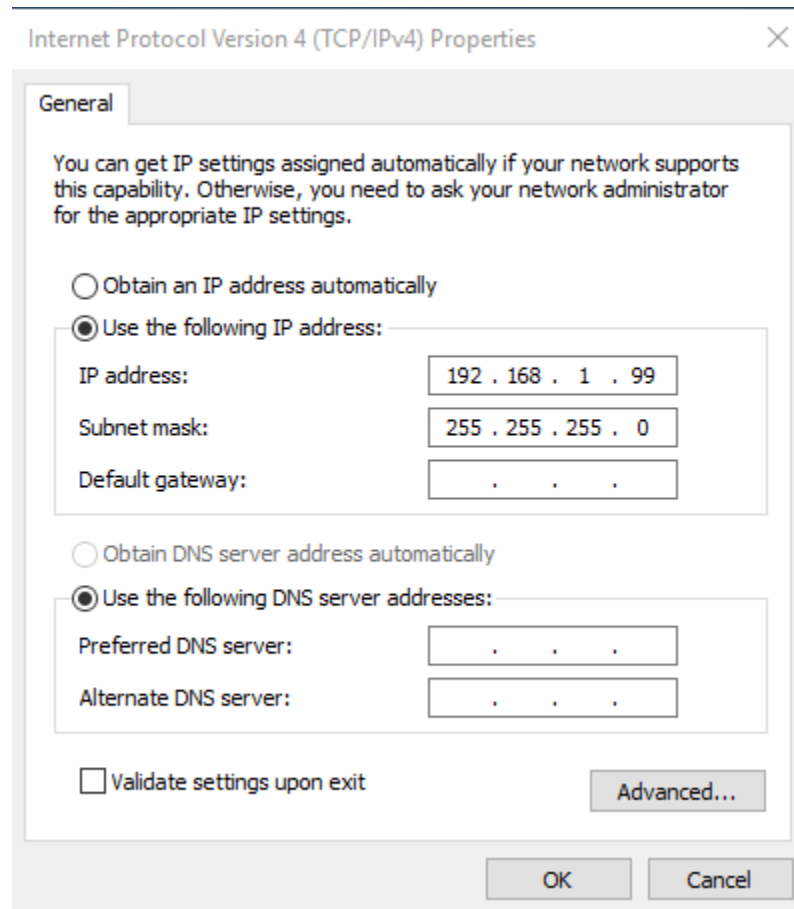
After selecting properties you are brought up to the screen below . You must RIGHT CLICK and select Properties on Local Area Connection.

Now you must select “Internet Protocol (TCP/IP)” and click on the Properties button to be brought to figure 20.



**Figure 14 – Local Area Connection Properties**

Here you need to change the IP address to the one that is programmed in the DXM.



**Figure 15 – TCP/IP Properties**

Lastly you must disable any firewall software you have running. If you are running a proxy server for Internet access, you must also disable the proxy client. Disabling this also requires a reboot.

#### 4.2.3.2 Testing a Direct Connection

You can use the program “Ping” to test a network connection between the computer and the DXM. “Ping” is a command line tool so we will need to bring up a command prompt.

To do this, on Windows search bar at bottom of screen, type ‘command’ and hit Enter

Then on the command line type

Ping <IP Address>

For example

Ping 192.168.1.4

If the DXM is found at the specified IP address, the Ping command will respond with a report that is similar to:

Pinging 192.168.1.4 with 32 bytes of data:

Reply from 192.168.1.4: bytes=32 time<1ms TTL=64

Reply from 192.168.1.4: bytes=32 time<1ms TTL=64

Reply from 192.168.1.4: bytes=32 time<1ms TTL=64

Reply from 192.168.1.4: bytes=32 time<1ms TTL=64

Ping statistics for 192.168.1.4:

Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

Approximate round trip times in milli-seconds:

Minimum = 0ms, Maximum = 0ms, Average = 0ms

#### 4.2.4 Configuring the DXM For a Local Area Network (LAN)

If you have chosen to place the DXM onto your local area network you will need:

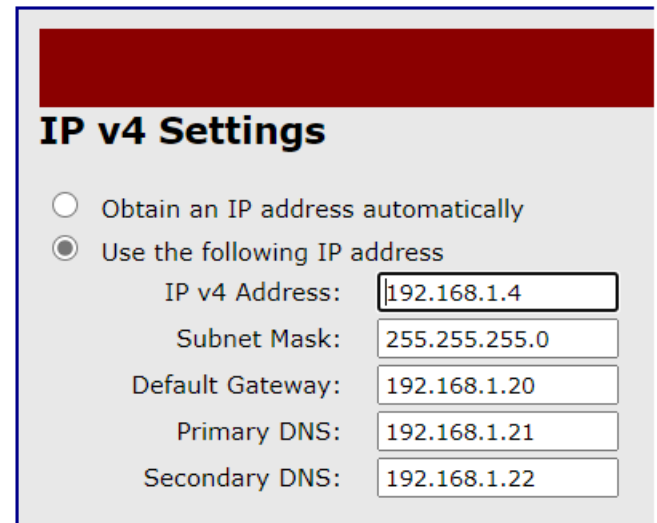
- A CAT5 network patch cable to physically connect the DXM to the LAN
- A static IP address to assign to the DXM.

Remember that even if the IP address you have selected is in general a valid IP address it needs to be valid for your LAN (local area network). Otherwise the device will not be accessible from an Internet browser or Ping.

#### 4.2.4.1 Configuring the Network Settings from the Web Server

Click [Network](#) on left column of Home page to access Network settings window. You can change any parameter and save them by clicking Save button.

[Home](#)  
[Network](#)  
[Upload Firmware](#)  
[Reboot](#)



**IP v4 Settings**

☐ Obtain an IP address automatically

☒ Use the following IP address

IP v4 Address:

Subnet Mask:

Default Gateway:

Primary DNS:

Secondary DNS:

**Figure 16: Configure Network Settings**

The network settings are configurable from the Settings->Network Settings screen, refer to figure 24.

The settings that can be changed are the:

- IP Address
- Subnet Mask
- Default Gateway
- Primary DNS
- Secondary DNS

Once the network settings of the SIC are configured, the SIC is rebooted, and the Web server is disconnected from the SIC. You must type the NEW IP address into a web browser to bring up a new instance of the Web Server. This may also require reconfiguring the host computer with the correct host IP address, subnet mask, and TCP port.

Depending on the type of network you are attaching the SIC to, you may need to configure the host PC's IP address and subnet mask as shown in section 4.2.2.1. You can also test a network connection to the SIC by following the instructions listed in section.

#### **4.2.5 Enabling Communications Objects in Visual Basic for Ethernet Communications**

For Ethernet communications, we need Microsoft Winsock Control 6.0 and SP5. To enable this in your VB 6 project, go to:

##### **Project -> Components**

Once selected in your toolbox you will have an icon of two computers linked together and it will be named: Winsock. This can be dragged and dropped into your application. Then set the object's properties.

#### **4.2.6 Configuring Communications in Visual Basic for Ethernet**

In order to configure the Winsock Object, you must make the following initialization in the object's properties:

Protocol	0 – sckTCPProtocol
----------	--------------------

Then, in the application code, include the following commands:

```
tcpClient.RemoteHost = host  
tcpClient.RemotePort = portNumber  
tcpClient.Connect
```

For further information regarding the use of the above commands, please refer to your Visual Studio Help File.

#### 4.2.6.1 Data Output Example

MSComm1 is both the serial and USB port. TcpClient is the Ethernet port.

```
If (portType = "ethernet") Then
    tcpClient.SendData (str)
Else
    MSComm1.InBufferCount = 0
    On Error GoTo done
    MSComm1.Output = str
done:
    tmrOpenClose.Enabled = True
End If
```



#### 4.2.6.2 Data Input Example

```
If (portType = "ethernet") Then
    Do
        DoEvents
        tcpClient.GetData temp$
        str = str + temp$
        Loop Until InStr(str, Chr(3)) Or Timer - t1 > 1
        On Error Resume Next
    Else
        Do
            DoEvents
            If MSComm1.InBufferCount > 0 Then
                str = str & MSComm1.Input
            End If
            Loop Until InStr(str, Chr(3)) Or Timer - t1 > 1
            If InStr(str, Chr(3)) > 0 Then
                tmrOpenClose.Enabled = False
            End If
        End If
    End If
```

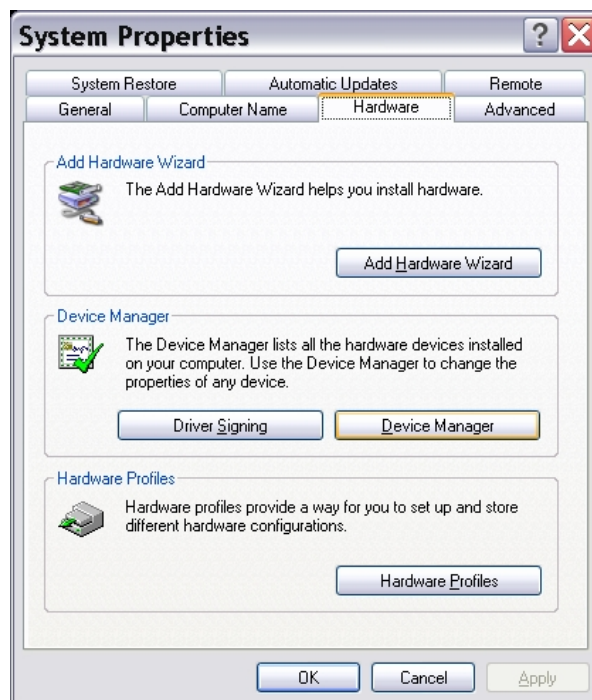
## 4.3 USB

The USB interface makes use of a standard 'command/response' communications protocol. See section 6.0 for the syntax of the serial interface protocol.

The USB interface is accessed through a Windows USB Human Interface driver (HID).

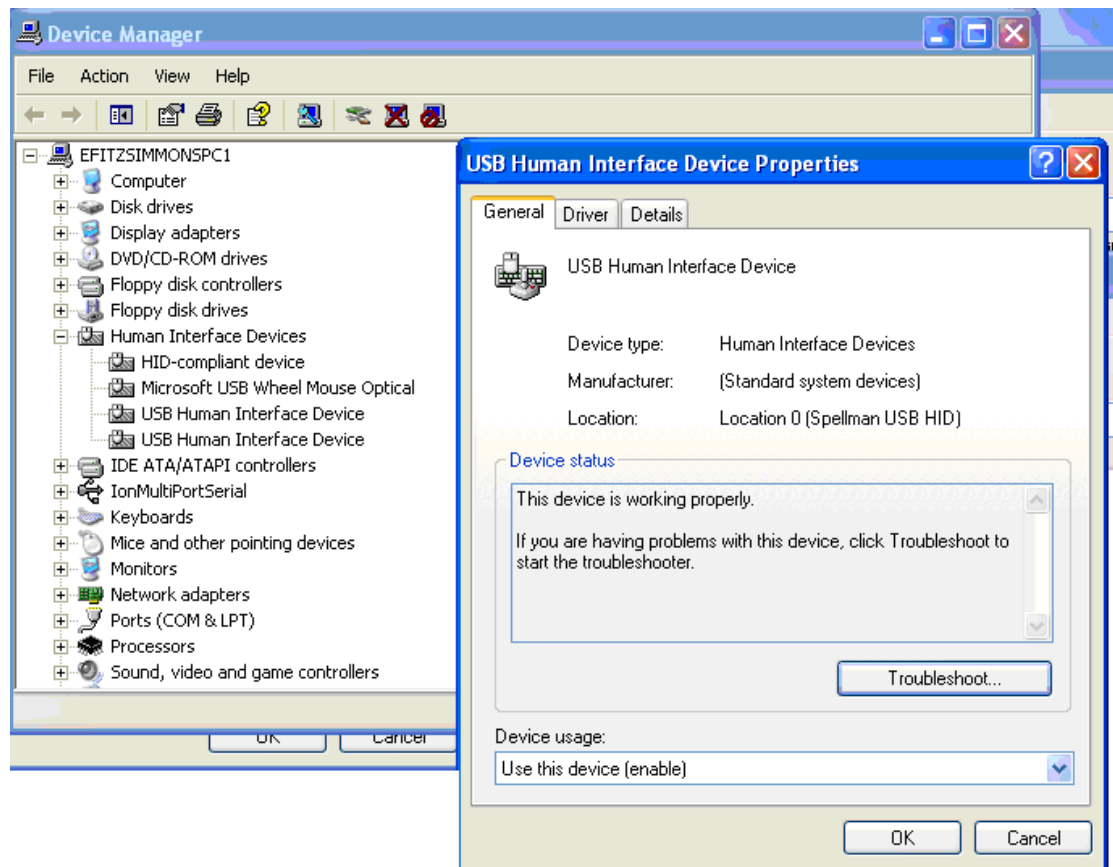
### 4.3.1 USB Driver Installation

The HID driver is a Windows driver installed with the operating system. To determine if the driver had been acquired open the System properties window selecting the Control Panel System Properties.



**Figure 16 – System Properties**

Then select Device Manager and expand the Human Interface Devices. View the properties of the USB Human Interface Device icon and verify that Spellman USB HID appears in the Location section.



**Figure 17 – Device Manager showing USB HID**

#### **4.3.2 USB and EMI**

The USB protocol utilizes a heartbeat signal from each client device back to the host (PC). If the heartbeat is interrupted due to radiated or conducted transient noise, it is possible that the host may lose connection with the client. This can cause problems with data transfers over the USB cable.

The DXM when used in combination with the HID Windows driver makes it possible for the host to renumerate the client connection and reestablish communications. This is provided the control application implements a method of timeout and retry.

**NOTE:** If an EMI disruption occurs the DXM will continue to renumerate until a connection with the GUI is re-established.

### 4.3.3 Enabling Communications Objects in Visual Basic for USB

The dynamic link library USB\_dll.dll will be provided which needs to be added to the project. The library has three functions that can be called from the VB code.

The three functions are:

- FindTheHid – finds the connection with the correct VID, PID and Serial Number
- WriteReport(str) – Writes a string to the connected HID interface
- ReadReport() – Returns a string from the connected HID interface

### 4.3.4 Configuring Communications in Visual Basic for USB

To use the USB\_dll.dll in VB the following statements are needed.

```
Dim usb As usbDll
Dim MyDeviceDetected As Boolean
```

```
Set usb = New usbDll
```

Using this statement determines whether a connection is present.

```
MyDeviceDetected = usb.FindTheHid
```

If MyDeviceDetected is true then the connection is present.

### 4.3.5 Software Considerations for USB Reconnection

The following Visual Basic code snippets are presented as a guideline for implementation with revision C and higher assemblies.

#### 4.3.5.1 Recognize partial, corrupt, or absent data

```
1: temp2$ = inputInputString
2: If temp2$ <> "" Then
3:     btn_UPDATEDATA.Value = False
4:     CommStatusFlag = True
5:     CommaPos = InStr(Start, temp2$, Comma, vbTextCompare)
6:     ' Channel 0
7:     On Error GoTo endhere
8:     AmbTemp = Mid(temp2$, Start, (CommaPos - Start))
```

Please note that even though we have guarded against no data, in line 2, we still need to guard against bad data, in this case no comma, on line 8. If there is no comma, we wind up passing a negative value to Mid, which is an error, that we should trap for.

#### **4.3.5.2 Retrieve data only if it exists**

```
1: Do
2:   DoEvents
3:   If MSComm1.InBufferCount > 0 Then
4:     str = str & MSComm1.Input
5:   End If
6:   Loop Until InStr(str, Chr(3)) Or Timer - t1 > 1
7:   'str = str & MSComm1.Input
8:   If InStr(str, Chr(3)) > 0 Then
9:     tmrOpenClose.Enabled = False
10:  End If
```

Notice that in line 3 we check for the existence of data before we extract data from the USB port. Normally, if there is no data, line 4 would append an empty string. However, during a noise event, retrieving data without first checking the existence of data could hang.

#### **4.3.5.3 Example Output Routine**

Notice that on line 13 we register an error handler in case the port is invalid because we have closed it in another routine. Notice that on line 16 we start a timer. When we output data on the port we start a timer to keep track of incoming data. If we get no incoming data it means that communications have been interrupted.

```
1: Private Sub outputOutputString(outputString As String)
2:   Dim str As String
3:   str = ProcessOutputString(outputString)
4:   StatusBar1.Panels(4).Text = "TX: " & str
5:   'StatusBar1.Panels(3).Text = "RX: Waiting"
6:   If (portType = "ethernet") Then
7:     tcpClient.SendData (str)
8:   ElseIf (portType = "USB") Then
9:     usb.WriteReport (str)
10:  Else
11:    MSComm1.InBufferCount = 0
12:
13:  On Error GoTo done
14:    MSComm1.Output = str
15: done:
16:    tmrOpenClose.Enabled = True
17:  End If
18: End Sub
```

#### 4.3.5.4 Example Input Routine

Notice on line 26 we check for data first before extracting data from the input. Then if we have actual data we turn off the timer. Otherwise the timer routine toggles the port open/close.

```
1: Private Function inputInputString() As String
2:   Dim str As String
3:   Dim t1 As Single
4:   Dim temp$

5:   Dim stra As String
6:   Dim stri(300) As String

7:   t1 = Timer
8:
9:   If (portType = "ethernet") Then
10:    Do
11:      DoEvents
12:      tcpClient.GetData temp$
13:      str = str + temp$
14:      Loop Until InStr(str, Chr(3)) Or Timer - t1 > 1
15:      On Error Resume Next

16:   ElseIf (portType = "USB") Then
17:    Do
18:      DoEvents
19:      stra = usb.ReadReport
20:      str = str & stra
21:      'str = str & ReadReport
22:      Loop Until InStr(str, Asc(3)) Or Timer - t1 > 0.09

23:   Else
24:    Do
25:      DoEvents
26:      If MSComm1.InBufferCount > 0 Then
27:        str = str & MSComm1.Input
28:      End If
29:      Loop Until InStr(str, Chr(3)) Or Timer - t1 > 1
30:
31:      If InStr(str, Chr(3)) > 0 Then
32:        tmrOpenClose.Enabled = False
33:      End If
34:
35:      frm_EXTRAS.txt_MSCOMMBUFF.Text = str
36:      tmr_COMMWDT.Enabled = True
37:      On Error Resume Next
```

```

38: End If
39: StatusBar1.Panels(3).Text = "RX: " & str
40: inputInputString = str
41: tmr_RCVTIMER.Enabled = True
42: End Function

```

#### **4.3.5.5 Example Timer Routine: Toggle Port State**

This is the timer routine in which the open/closed state of the port is toggled. If communications are interrupted, the USB device will re-register itself with the OS (vendor term: reenumeration). Once this happens, re-opening the port will enable communications. Until the re-registration happens, open operations will fail. Notice line 5 where we register an error handler.

```

1: Private Sub tmrOpenClose_Timer()
2: If MSComm1.PortOpen = True Then
3:
4:     MSComm1.PortOpen = False
5:     On Error GoTo done
6:     MSComm1.PortOpen = True
7: done:
8:     tmrOpenClose.Enabled = False
9: End If
10:
11: End Sub

```

#### **4.3.5.6 Example Timer Routine: Port Reconnection**

This is another timer routine whose purpose is to turn the port on if it is off. Notice that in line 8 an error handler is called because if the device has not re-registered itself with the OS, an error will be raised.

```

1: Private Sub tmr_COMMWDT_Timer()
2:
3: tmr_COMMWDT.Enabled = False
4:
5: If CommStatusFlag = True Then
6:
7:     If MSComm1.PortOpen = False Then
8:         On Error GoTo done
9:         MSComm1.PortOpen = True
10: done:
11: End If
12:
13: Elseif CommStatusFlag = False Then
14:

```

```

15: If MSComm1.PortOpen = False Then
16:
17:     MSComm1.PortOpen = True
18: Else
19:     MSComm1.PortOpen = False
20: End If
21:
22: End If

```

#### 4.3.5.7 Data Parsing Example

Here we have an example of a code that parses incoming data. Notice that it makes use of our generic input and output routines. The important consideration is to gracefully handle corrupted input data after a noise event. In this case we may get data, so a test against empty string returns false, but we may not get commas in the correct place. Notice that we register an error handler on line 26 so that the mid function, which would raise an error when given a negative number, is handled.

```

1: Private Sub btn_EMI_Click()
2:   Dim temp2$
3:   Dim Response1$
4:   Dim Response2$
5:   Dim number$
6:   Dim Comma
7:   Dim CommaPos
8:   Dim Start
9:   Dim ODATA$
10:
11:   Comma = ","
12:   Start = 5
13:
14:   If tmr_RCVTIMER.Enabled = True Then
15:     tmr_RCVTIMER.Enabled = False
16:   If tmr_NETRCVTMR.Enabled = True Then
17:     tmr_NETRCVTMR.Enabled = False
18:
19:   If AutoUpdate = True Then
20:     tmr_UPDATE.Enabled = False
21:   End If
22:
23:   number$ = "15,"
24:   outputOutputString (number$)
25:
26:   temp2$ = inputInputString
27:   CommaPos = InStr(Start, temp2$, Comma, vbTextCompare)

```



```
26: On Error GoTo endhere
27: Response1$ = Mid(temp2$, Start, (CommaPos - Start))
28:
29: 'With a 5v reference:
30: ODATA$ = Format(str(Response1$ * 0.0004884), "0.##0")
31:
32: txt_DACB.Text = ODATA$ + " mA"
33: frm_RAWDATA.txt_RAWDACB.Text = str(Response1$)
34: txt_DACB.BackColor = vbWhite
35: CommStatusFlag = True
36: endhere:
37:
38: If portType = "ethernet" Then
39:   tmr_NETRCVTMR.Enabled = True
40: Else
41:   tmr_RCVTIMER.Enabled = True
42: End If
43:
44: If AutoUpdate = True Then tmr_UPDATE.Enabled = True
46: End Sub
```

## 5.0 ETHERNET COMMANDS

## 5.1 TCP/IP FORMAT

Each Ethernet command will consist of a TCP/IP header followed by the required data bytes. Figure 18 summarizes the TCP/IP header configuration. Please note that this functionality is provided by the software implementation of the Open Systems Interconnection (OSI) TCP/IP protocol stack, specifically the upper 4 layers.

[illegible]

### Figure 18: Network TCP/IP datagram header

The format of Data Bytes 1 through N are as follows:

<STX><CMD><,>ARG><,><ETX>

Where:

<STX> = 1 ASCII 0x02 Start of Text character  
 <CMD> = 2 ASCII characters representing the command ID  
 <,> = 1 ASCII 0x2C character  
 <ARG> = Command Argument  
 <,> = 1 ASCII 0x2C character  
 <ETX> = 1 ASCII 0x03 End of Text character

## 5.2 COMMAND ARGUMENTS

The format of the numbers is a variable length string. To represent the number 42, the string '42', '042', or '0042' can be used. This being the case, commands and responses that carry data are variable in length.

## 5.3 COMMAND OVERVIEW

Data Byte section of the TCP/IP Datagram			
Command Name	<CMD>	<ARG>	RANGE
Program RS-232 unit baud rate	07	1 ASCII	1 - 5
PROGRAM USER CONFIGURATION	09	16 ASCII	
Program kV	10	1-4 ASCII	0-4095
Program mA	11	1-4 ASCII	0-4095
Program Filament Limit	12	1-4 ASCII	0-4095
Program Filament Pre-Heat	13	1-4 ASCII	0-4095
Request kV Setpoint	14	None	-
Request mA Setpoint	15	None	-
Request Filament Limit Setpoint	16	None	-
Request Filament Pre-Heat Setpoint	17	None	-
Request Analog Monitor Readbacks	19	None	-
			-
Request HV On Hours Counter	21	None	-

Request Status	22	None	-
Request Software Version	23	None	-
Request Hardware Version	24	None	-
Request User Configuration	27	None	
Reset HV On Hours Counter	30	None	-
Reset Faults	31	None	-
Request kV monitor	60	None	-
Request mA monitor	61	None	-
Request Filament Feedback	62	None	-
Request Filament Limit	63	None	-
Request Filament Pre-Heat	64	None	-
Request -15V LVPS	65	None	-
			-
Program Local/Remote Mode	99	1 ASCII	0 or 1

## 5.4 RESPONSE OVERVIEW

The command responses will follow the same network TCP/IP header format as outlined above in section 5.1. This list is comprised of Commands with complex responses only. Commands using a simple response will use the <\$> character (ASCII 0x24) as a “Success” response or a single character error code. These will be seven ASCII characters in length.

Response Name	<CMD>	Response
Request kV Setpoint	14	10 ASCII
Request mA Setpoint	15	10 ASCII
Request Filament Limit Setpoint	16	10 ASCII
Request Filament Pre-Heat Setpoint	17	10 ASCII
Request Analog Monitor Readbacks	19	23-50 ASCII
Request Total Hours High Voltage On	21	13 ASCII
Request Status	22	11 ASCII
Request DSP Software Version	23	17 ASCII
Request Hardware Version	24	9 ASCII
Request User Configuration	27	16 ASCII
Read Interlock Status	55	11 ASCII
Request kV monitor	60	7-10 ASCII
Request mA monitor	61	7-10 ASCII
Request Filament Feedback	62	7-10 ASCII
Request -15V LVPS	65	7-10 ASCII
Request Faults	68	6 ASCII

## 5.5 COMMAND STRUCTURE

### 5.5.1 Program kV

Description:

The host requests that the firmware change the setpoint of kV.

Direction:

Host to supply

Syntax:

<STX><10><,><ARG><,><ETX>

Where:

<ARG> = 0 - 4095 in ASCII format

Example:

<STX>10,4095,<ETX>

Response:

<STX><10><,><\$><,><ETX>

<STX><10><,><ARG><,><ETX>

where <ARG> = error code

Error Codes TBD, 1 = out of range

### 5.5.2 Program mA

Description:

The host requests that the firmware change the setpoint of mA.

Direction:

Host to supply

Syntax:

<STX><11><,><ARG><,><ETX>

Where:

<ARG> = 0 - 4095 in ASCII format

Example:

<STX>11,4095,<ETX>

Response:

<STX><11><,><\$><,><ETX>

<STX><11><,><ARG><,><ETX>

where <ARG> = error code

Error Codes TBD, 1 = out of range

### 5.5.3 Program Filament Limit

Description:

The host requests that the firmware change the setpoint of Filament Limit.

Direction:

Host to supply

Syntax:

<STX><12><,><ARG><,><ETX>

Where:

<ARG> = 0 - 4095 in ASCII format

Example:

<STX>12,4095,<ETX>

Response:

<STX><12><,><\$><,><ETX>

<STX><12><,><ARG><,><ETX>

where <ARG> = error code

Error Codes TBD, 1 = out of range

Standard Scaling(0 – 4095 = 0 – 5 amps)



#### 5.5.4 Program Filament Pre-Heat

Description:

The host requests that the firmware change the setpoint of Filament Pre-Heat.

Direction:

Host to supply

Syntax:

<STX><13><,><ARG><,><ETX>

Where:

<ARG> = 0 - 4095 in ASCII format

Example:

<STX>13,4095,<ETX>

Response:

<STX><13><,><\$><,><ETX>

<STX><13><,><ARG><,><ETX>

where <ARG> = error code

Error Codes TBD, 1 = out of range

Standard Scaling(0 – 4095 = 0 – 2.5 amps)

### 5.5.5 Request kV Setpoint

Description:

The host requests that the firmware report the kV setpoint.

Direction:

Host to supply

Syntax:

<STX><14><,><ETX>

Response:

<STX><14><,><ARG><,><ETX>

Where:

<ARG> = 0 - 4095 in ASCII format

Example:

<STX>14,4095,<ETX>

### 5.5.6 Request mA Setpoint

Description:

The host requests that the firmware report the current mA setpoint.

Direction:

Host to supply

Syntax:

<STX><15><,><ETX>

Response:

<STX><15><,><ARG><,><ETX>

Where:

<ARG> = 0 - 4095 in ASCII format

Example:

<STX>15,4095,<ETX>

### 5.5.7 Request Filament Limit Setpoint

Description:

The host requests that the firmware report the current Filament Limit setpoint.

Direction:

Host to supply

Syntax:

<STX><16><,><ETX>

Response:

<STX><16><,><ARG><,><ETX>

Where:

<ARG> = 0 - 4095 in ASCII format

Example:

<STX>16,4095,<ETX>

### 5.5.8 Request Filament Pre-Heat Setpoint

Description:

The host requests that the firmware report the current Filament Pre-Heat setpoint.

Direction:

Host to supply

Syntax:

<STX><17><,><ETX>

Response:

<STX><17><,><ARG><,><ETX>

Where:

<ARG> = 0 - 4095 in ASCII format

Example:

<STX>17,4095,<ETX>

### 5.5.9 Request Analog Monitor Readbacks

Description:

The host requests that the firmware transmit the present values of Analog Monitor Readbacks.

Direction:

Host to supply

Syntax:

<STX><19><,><ETX>

Example:

<STX><19>,<ETX>

Response:

<STX><19><,><ARG1><,><ARG2><,><ARG3><,><ETX>

Where:

ARG1 = kV monitor = 0 – 4095

ARG2 = mA monitor = 0 – 4095

ARG3 = Filament monitor = 0– 4095

Example:

<STX><19>,4095,4095,4095,<ETX>

### 5.5.10 Request Total Hours High Voltage On

Description:

The host requests that the firmware sends the present value of the Total Hours High Voltage On.

Direction:

Host to supply

Syntax:

<STX><21><,><ETX>

Example:

<STX>21,<ETX>

Response:

<STX><21><,><ARG1>< ARG2>< ARG3><ARG4><ARG5>  
<.><ARG6><,><ETX>

Where:

<.> = ASCII 0x2E

ARGx =0-9 in ASCII format

Example:

<STX>21,99999.9,<ETX>

### 5.5.11 Request Status

Description:

The host requests that the firmware sends the power supply status.

Direction:

Host to supply

Syntax:

<STX><22><,><ETX>

Example:

<STX>22,<ETX>

Response:

<STX><22><,><ARG1><,><ARG2><,><ARG3><,><ARG4><,><,><ETX>

Where:

<ARG1> 1 = HvOn, 0 = HvOff

<ARG2> 1 = Interlock 1 Open, 0 = Interlock 1 Closed

<ARG3> 1 = Fault Condition, 0 = No Fault

<ARG4> 1 = Remote Mode, 0 = Local Mode

Example:

<STX>22,1,1,0,0,<ETX>

NOTE: This response will also be sent in an unsolicited manner when a change of state is detected on the HvOn and Interlock 1 bits. This is providing that a valid handle has already been established with a host.



### 5.5.12 Request DSP Software Part Number/Version

Description:

The host requests that the firmware sends the DSP firmware version.

Direction:

Host to supply

Syntax:

<STX><23><,><ETX>

Example:

<STX>23,<STX>

Response:

<STX><23><,>< ARG><,><ETX>

Where:

<ARG> consists of eleven ASCII characters representing the current firmware part number/version. The format is SWM9999-999

Example:

<STX>23,SWM9999-999,<ETX>

### 5.5.13 Request Hardware Version

Description:

The host requests that the firmware sends the hardware version.

Direction:

Host to supply

Syntax:

<STX><24><,><ETX>

Example:

<STX>24,<ETX>

Response:

<STX><24><,>< ARG><,><ETX>

Where:

<ARG> consists of 3 ASCII characters representing the hardware version.  
The format is ANN, where A is an alpha character and N is a numeric character

Example:

<STX>24,A01,<ETX>

#### **5.5.14 Reset Run Hours**

Description:

The host requests that the firmware resets the run hour counter.

Direction:

Host to supply

Syntax:

<STX><30><,><ETX>

Example:

<STX>30,<ETX>

Response:

<STX><30><,><\$><,><ETX>

### 5.5.15 Reset Faults

Description:

The host requests that the firmware resets all Fault messages and indicators.

Direction:

Host to supply

Syntax:

<STX><31><,><ETX>

Example:

<STX>31,<ETX>

Response:

<STX><31><,><\$><,><ETX>

### 5.5.16 Read Interlock Status

Description:

The host requests that the firmware read the status of the interlock channel.

Direction:

Host to supply

Syntax:

<STX><55><,><ETX>

Response:

<STX><55><,><ARG1><,><ETX>

Where ARG1 is Interlocks 1. A 1 indicates that the Interlock is energized

Example:

<STX>55,1,<ETX>

### 5.5.17 Request kV Monitor

Description:

The host requests that the firmware report kV monitor.

Direction:

Host to supply

Syntax:

<STX><60><,><ETX>

Response:

<STX><60><,><ARG><,><ETX>

Where:

<ARG>=0-4095 in ASCII format representing unscaled value.

Example:

<STX>60,4095,<ETX>

### 5.5.18 Request mA Monitor

Description:

The host requests that the firmware report mA monitor.

Direction:

Host to supply

Syntax:

<STX><61><,><ETX>

Response:

<STX><61><,><ARG><,><ETX>

Where:

<ARG>=0-4095 in ASCII format representing unscaled value.

Example:

<STX>61,4095,<ETX>

### 5.5.19 Request Filament Feedback

Description:

The host requests that the firmware report Filament Feedback.

Direction:

Host to supply

Syntax:

<STX><62><,><ETX>

Response:

<STX><62><,><ARG><,><ETX>

Where:

<ARG>=0-4095 in ASCII format representing unscaled value.

Example:

<STX>62,4095,<ETX>



### 5.5.20 Request –15V LVPS

Description:

The host requests that the firmware report –15V LVPS.

Direction:

Host to supply

Syntax:

<STX><65><,><ETX>

Response:

<STX><65><,><ARG><,><ETX>

Where:

<ARG>=0-4095 in ASCII format representing unscaled value.

Example:

<STX>65,4095,<ETX>

## 5.5. 21 Request Faults

### Description:

The host requests that the firmware report Faults.

### Direction:

Host to supply

### Syntax:

<STX><68><,><ETX>

### Response:

<STX><68><,><ARG1><,><ARG2><,><ARG3><,><ARG4><,><ARG5><,><ARG6><,><ETX>

### Where:

<ARGx> 1 = Fault, 0 = No Fault in ASCII format

ARG1 = ARC

ARG2 = Over Temperature

ARG3 = Over Voltage

ARG4 = Under Voltage

ARG5 = Over Current

ARG6 = Under Current

### Example:

<STX>67,0,0,0,0,1,0,<ETX>

### 5.5.22 Turn HV on/off

Description:

The host requests that the firmware turn high voltage on or high voltage off.

Direction:

Host to supply

Syntax:

<STX><98><,><ARG><,><ETX>

Where:

<ARG> 1 = HV on, 0 = HV off in ASCII format

Example:

<STX>98,1,<ETX>

Response:

<STX><98><,><\$><,><ETX>

<STX><98><,><ARG><,><ETX>

where <ARG> = error code

Error Codes TBD,

1 = out of range

### 5.5.23 Program Local/Remote Mode

Description:

The host requests that the firmware to switch between Local and Remote Mode.

Direction:

Host to supply

Syntax:

<STX><99><,><ARG><,><ETX>

Where:

<ARG> 1 = Remote, 0 = Local in ASCII format

Example:

<STX>99,1,<ETX>

Response:

<STX><99><,><\$><,><ETX>

<STX><99><,><ARG><,><ETX>

where <ARG> = error code

Error Codes TBD,

1 = out of range

### 5.5.24 Program RS-232 Baud rate

Description:

The host requests that the firmware change the Baud rate for RS-232.

Direction:

Host to supply

Syntax:

<STX><07><,><ARG><,><ETX>

Where:

<ARG> 1 = 9.6k in ASCII format  
<ARG> 2 = 19.2k in ASCII format  
<ARG> 3 = 38.4k in ASCII format  
<ARG> 4 = 57.6k in ASCII format  
<ARG> 5 = 115.2k in ASCII format

Example:

<STX>07,1,><ETX>

Response:

<STX><07><,><\$><,><CSUM><ETX>  
<STX><07><,><ARG><,><CSUM><ETX>

where <ARG> = error code

Error Codes TBD,

1 = out of range

### 5.5.25 Program User Configuration( Controlled Ramping and Arc Fault Control)

Description:

The User Configuration command is used to update the user configurable items of the DXM.

Direction:

Host to supply

Syntax:

`<STX><0><9><,><ARG1><,><ARG2><,><ARG3><,><ARG4><,>  
<ARG5><,><ARG6><,><ARG7><,><ARG8><,><ARG9><,><ARG10><,>  
<ARG11><,><ARG12><,><ARG13><,><ARG14><,><ARG15><,><ARG1  
6><,><ETX>`

Where:

Argument Number	Description
ARG1	kV Ramp Time. Adjustable between 1 to 20 seconds. Units are tenths of second.
ARG2	Filament Ramp time (MSB). Adjustable from 0.5 to 30 seconds. Units are tenths of second. Most significant byte
ARG3	Filament ramp time (LSB). Least significant byte
ARG4	mA Ramp Time. Adjustable from 0.5 to 5 seconds. Units are tenths of seconds.
ARG5	Minimum filament emission. Adjustable from 5% to 50% of full scale kV output
ARG6	Arc count. Number of arcs allowed before shutting down supply. Adjustable from 2 to 10 arcs.
ARG7	Arc period. If the number of arcs programmed (ARG6) is found during this period of time, supply will shut down. Adjustable from 10 to 20 seconds
ARG8	Arc Quench time (MSB). Adjustable from 50 to 300 milliseconds. Units are milliseconds. Most significant byte
ARG9	Arc Quench time (LSB). Least significant byte
ARG10	Arc re-ramp. After the quench period is completed, kV and mA will re-ramp to programmed values in 100 milliseconds. 1: Disable 0: Enable
ARG11	Enable ramp control. 1: Enable 0: Disable
ARG12	Enable arc control 1: Enable 0: Disable
ARG13	Enable set point ramp. After ramp is complete, kV and mA will ramp up or down during any set point change. 1: Enable

	0: Disable
ARG14	mA Ramp hold time (MSB). Time delay, after kV ramp is completed, before mA ramp starts. Adjustable from 1 to 30 seconds. Units are tenths of seconds. Most significant byte
ARG15	mA Ramp hold time (LSB). Least significant byte
ARG16	Remote programming enable. If enabled, the unit will default to Remote programming mode upon power up. 1: Remote mode enable 0: Remote mode disable

Example:

Sending this command will set the user configurable items as follows:

<STX>09,50,1,44,50,30,4,10,0,150,0,1,1,0,0,50,1, ><ETX>

<ARG 1> kV Ramp time = 5 seconds.  
 <ARG 2> Filament Ramp time MSB = 1  
 <ARG 3> Filament Ramp time LSB = 44  
            $1 \times 256 + 44 = 300$ , equivalent to 30 seconds  
 <ARG 4> mA Ramp Rate = 5 seconds.  
 <ARG 5> Minimum filament emission = 30%  
 <ARG 6> Arc count = 4  
 <ARG 7> Arc time period = 10 seconds  
 <ARG 8> Arc Quench time MSB = 0  
 <ARG 9> Arc Quench time LSB = 150  
            $0 \times 256 + 150 = 150$  milliseconds  
 <ARG 10> Arc re-ramp = 0, Enable  
 <ARG 11> Ramp control = 1, Enabled  
 <ARG 12> Arc Control = 1, Enabled  
 <ARG 13> Set point ramp = 1, Enabled  
 <ARG14> mA ramp hold off time MSB = 0  
 <ARG15> mA ramp hold off time LSB = 50  
            $0 \times 256 + 50 = 50$  equivalent to 5 seconds  
 <ARG16> Remote programming enable = 1, Enabled

Response:

<STX><0><9><,><\$><,><ETX>



## 5.5.26 Request User Configuration( Controlled Ramping and Arc Fault Control)

### Description:

This command returns the current user configuration parameters.

### syntax

<STX><2><7><,><\$><,><ETX>

### Response:

<STX><2><7><,><ARG1><,><ARG2><,><ARG3><,><ARG4><,>  
<ARG5><,><ARG6><,><ARG7><,><ARG8><,><ARG9><,><ARG10><,>  
<ARG11><,><ARG12><,><ARG13><,><ARG14><,><ARG15><,><ARG1  
6><,><ETX>

Where:

Argument Number	Description
ARG1	kV Ramp Time. Units are tenths of second.
ARG2	Filament Ramp time (MSB). Units are tenths of second. Most significant byte
ARG3	Filament ramp time (LSB). Least significant byte
ARG4	mA Ramp Time. Units are tenths of seconds.
ARG5	Minimum filament emission. Adjustable from 5% to 50% of full scale kV output
ARG6	Arc count.
ARG7	Arc period in seconds
ARG8	Arc Quench time (MSB). Units are milliseconds. Most significant byte
ARG9	Arc Quench time (LSB). Least significant byte
ARG10	Arc re-ramp in 100 milliseconds. 1: Disabled 0: Enabled
ARG11	Enable ramp control. 1: Enabled 0: Disabled
ARG12	Enable arc control 1: Enabled 0: Disabled
ARG13	Enable set point ramp.

	1: Enabled 0: Disabled
ARG14	mA Ramp hold time (MSB). Units are tenths of seconds. Most significant byte
ARG15	mA Ramp hold time (LSB). Least significant byte
ARG16	Remote programming enable. 1: Remote mode enable 0: Remote mode disable

## **6.0 SERIAL COMMANDS – RS-232 / USB**

### **6.1 SERIAL INTERFACE PROTOCOL**

Serial communications will use the following protocol:

`<STX><CMD><,>ARG><,><CSUM><ETX>`

Where:

<code>&lt;STX&gt;</code>	= 1 ASCII 0x02 Start of Text character
<code>&lt;CMD&gt;</code>	= 2 ASCII characters representing the command ID
<code>&lt;,&gt;</code>	= 1 ASCII 0x2C character
<code>&lt;ARG&gt;</code>	= Command Argument
<code>&lt;,&gt;</code>	= 1 ASCII 0x2C character
<code>&lt;CSUM&gt;</code>	= Checksum (see section 6.3 for details)
<code>&lt;ETX&gt;</code>	= 1 ASCII 0x03 End of Text character

### **6.2 COMMAND ARGUMENTS**

The format of the numbers is a variable length string. To represent the number 42, the string '42', '042', or '0042' can be used. This being the case, commands and responses that carry data are variable in length.

### **6.3 CHECKSUMS**

The checksum is computed as follows:

- Add the `<CMD>`, `<,>`, and `<ARG>` bytes into a 16 bit (or larger) word. The bytes are added as unsigned integers.
- Take the 2's compliment (negate it).
- Truncate the result down to the eight least significant bits.
- Clear the most significant bit (bit 7) of the resultant byte, (bitwise AND with 0x7F).
- Set the next most significant bit (bit 6) of the resultant byte (bitwise OR with 0x40).

Using this method, the checksum is always a number between 0x40 and 0x7F. The checksum can never be confused with the `<STX>` or `<ETX>` control characters, since these have non-overlapping ASCII values.

If the DSP detects a checksum error, the received message is ignored – no acknowledge or data is sent back to the host. A timeout will act as an implied NACK.

The following is sample code, written in Visual Basic, for the generation of checksums:

```
Public Function ProcessOutputString(outputString As String) As String
```

```
Dim i As Integer
```

```
Dim CSb1 As Integer
```

```
Dim CSb2 As Integer
```

```
Dim CSb3 As Integer
```

```
Dim CSb$
```

```
Dim X
```

```
X = 0
```

```
For i = 1 To (Len(outputString))      'Starting with the CMD character
```

```
X = X + Asc(Mid(outputString, i, 1))  'adds ascii values together
```

```
Next i
```

```
CSb1 = 256 - X
```

```
CSb2 = 127 And (CSb1)      'Twos Complement
```

```
CSb3 = 64 Or (CSb2)        'OR 0x40
```

```
CSb$ = Chr(Val("&H" & (Hex(CSb3))))
```

```
ProcessOutputString = Chr(2) & outputString & CSb$ & Chr(3)
```

```
End Function
```

## 6.4 COMMAND OVERVIEW

Data Byte section of the TCP/IP Datagram			
Command Name	<CMD>	<ARG>	RANGE
Program RS-232 unit baud rate	07	1 ASCII	1 - 5
PROGRAM USER CONFIGURATION	09	16 ASCII	
Program mA	11	1-4 ASCII	0-4095
Program Filament Limit	12	1-4 ASCII	0-4095
Program Filament Pre-Heat	13	1-4 ASCII	0-4095
Request kV Setpoint	14	None	-
Request mA Setpoint	15	None	-
Request Filament Limit Setpoint	16	None	-
Request Filament Pre-Heat Setpoint	17	None	-
Request Analog Monitor Readbacks	19	None	-
			-
Request HV On Hours Counter	21	None	-
Request Status	22	None	-
Request Software Version	23	None	-
Request Hardware Version	24	None	-
Request Model Number	26	None	-
Request User Configuration	27	None	
Reset HV On Hours Counter	30	None	-
Reset Faults	31	None	-
Read Interlock Status	55	None	-
Request kV monitor	60	None	-
Request mA monitor	61	None	-

Request Filament Feedback	62	None	-
Request Filament Limit	63	None	-
Request Filament Pre-Heat	64	None	-
Request -15V LVPS	65	None	-
Turn HV on/off	98	1 ASCII	0 or 1
Program Local/Remote Mode	99	1 ASCII	0 or 1

## 6.5 RESPONSE OVERVIEW

The command responses will follow the same format as outlined above in section 6.1. This list is comprised of Commands with complex responses only. Commands using a simple response will use the <\$> character (ASCII 0x24) as a "Success" response or a single character error code. These responses will be eight ASCII characters in length.

Response Name	<CMD>	Response
Request kV Setpoint	14	10 ASCII
Request mA Setpoint	15	10 ASCII
Request Filament Limit Setpoint	16	10 ASCII
Request Filament Pre-Heat Setpoint	17	10 ASCII
Request Analog Monitor Readbacks	19	23-50 ASCII
Request Total Hours High Voltage On	21	13 ASCII
Request Status	22	11 ASCII
Request DSP Software Version	23	17 ASCII
Request Hardware Version	24	9 ASCII

Request Model number	26	11 ASCII
Request User Configuration	27	16 ASCII
Read Interlock Status	55	11 ASCII
Request kV monitor	60	7-10 ASCII
Request mA monitor	61	7-10 ASCII
Request Filament Feedback	62	7-10 ASCII
Request -15V LVPS	65	7-10 ASCII
Request Faults	68	6 ASCII

## 6.6 COMMAND STRUCTURE

### 6.6.1 Program kV

Description:

The host requests that the firmware change the setpoint of kV.

Direction:

Host to supply

Syntax:

<STX><10><,><ARG><,><CSUM><ETX>

Where:

<ARG> = 0 - 4095 in ASCII format

Example:

<STX>10,4095,<CSUM><ETX>

Response:

<STX><10><,><\$><,><CSUM><ETX>

<STX><10><,><ARG><,><CSUM><ETX>

where <ARG> = error code

Error Codes TBD, 1=out of range



## 6.6.2 Program mA

### Description:

The host requests that the firmware change the setpoint of mA.

### Direction:

Host to supply

### Syntax:

<STX><11><,><ARG><,><CSUM><ETX>

### Where:

<ARG> = 0 - 4095 in ASCII format

### Example:

<STX>11,4095,<CSUM><ETX>

### Response:

<STX><11><,><\$><,><CSUM><ETX>

<STX><11><,><ARG><,><CSUM><ETX>

where <ARG> = error code

Error Codes TBD, 1=out of range

### 6.6.3 Program Filament Limit

Description:

The host requests that the firmware change the setpoint of Filament Limit.

Direction:

Host to supply

Syntax:

<STX><12><,><ARG><,><CSUM><ETX>

Where:

<ARG> = 0 - 4095 in ASCII format

Example:

<STX>12,4095,<CSUM><ETX>

Response:

<STX><12><,><\$><,><CSUM><ETX>

<STX><12><,><ARG><,><CSUM><ETX>

where <ARG> = error code

Error Codes TBD, 1 = out of range

#### 6.6.4 Program Filament Pre-Heat

Description:

The host requests that the firmware change the setpoint of Filament Pre-Heat.

Direction:

Host to supply

Syntax:

<STX><13><,><ARG><,><CSUM><ETX>

Where:

<ARG> = 0 - 4095 in ASCII format

Example:

<STX>13,4095,<CSUM><ETX>

Response:

<STX><13><,><\$><,><CSUM><ETX>

<STX><13><,><ARG><,><CSUM><ETX>

where <ARG> = error code

Error Codes TBD, 1 = out of range

### **6.6.5 Request kV Setpoint**

Description:

The host requests that the firmware report the kV setpoint.

Direction:

Host to supply

Syntax:

<STX><14><,><CSUM><ETX>

Response:

<STX><14><,><ARG><,><CSUM><ETX>

Where:

<ARG> = 0 - 4095 in ASCII format

Example:

<STX>14,4095,<CSUM><ETX>

### 6.6.6 Request mA Setpoint

Description:

The host requests that the firmware report the current mA setpoint.

Direction:

Host to supply

Syntax:

<STX><15><,><CSUM><ETX>

Response:

<STX><15><,><ARG><,><CSUM><ETX>

Where:

<ARG> = 0 - 4095 in ASCII format

Example:

<STX>15,4095,<CSUM><ETX>

### 6.6.7 Request Filament Limit Setpoint

Description:

The host requests that the firmware report the current Filament Limit setpoint.

Direction:

Host to supply

Syntax:

<STX><16><,><CSUM><ETX>

Response:

<STX><16><,><ARG><,><CSUM><ETX>

Where:

<ARG> = 0 - 4095 in ASCII format

Example:

<STX>16,4095,<CSUM><ETX>

### 6.6.8 Request Filament Pre-Heat Setpoint

Description:

The host requests that the firmware report the current Filament Pre-Heat setpoint.

Direction:

Host to supply

Syntax:

<STX><17><,><CSUM><ETX>

Response:

<STX><17><,><ARG><,><CSUM><ETX>

Where:

<ARG> = 0 - 4095 in ASCII format

Example:

<STX>17,4095,<CSUM><ETX>

### 6.6.9 Request Total Hours High Voltage On

Description:

The host requests that the firmware sends the present value of the Total Hours High Voltage On.

Direction:

Host to supply

Syntax:

<STX><21><,><CSUM><ETX>

Example:

<STX>21,<CSUM><ETX>

Response:

<STX><21><,><ARG1>< ARG2>< ARG3><ARG4><ARG5>  
<.><ARG6><,><CSUM><ETX>

Where:

<.> = ASCII 0x2E

ARGx = 0 - 9 in ASCII format

Example:

<STX>21,99999.9,<CSUM><ETX>



### 6.6.10 Request Status

Description:

The host requests that the firmware sends the power supply status.

Direction:

Host to supply

Syntax:

<STX><22><,><CSUM><ETX>

Example:

<STX>22,<CSUM><ETX>

Response:

<STX><22><,><ARG1><,><ARG2><,><ARG3><,><ARG4><,><CSUM><ETX>

Where:

<ARG1> 1 = HvOn, 0 = HvOff

<ARG2> 1 = Interlock 1 Open, 0 = Interlock 1 Closed

<ARG3> 1 = Fault Condition, 0 = No Fault

<ARG4> 1 = Remote Mode, 0 = Local Mode

Example:

<STX>22,1,1,0,0,<CSUM><ETX>

NOTE: This response will also be sent in an unsolicited manner when a change of state is detected on the HvOn and Interlock 1 bits.

### 6.6.11 Request DSP Software Part Number/Version

Description:

The host requests that the firmware sends the DSP firmware version.

Direction:

Host to supply

Syntax:

<STX><23><,><CSUM><ETX>

Example:

<STX>23,<CSUM><STX>

Response:

<STX><23><,>< ARG><,><CSUM><ETX>

Where:

<ARG> consists of eleven ASCII characters representing the current firmware part number/version. The format is SWM9999-999

Example:

<STX>23,SWM9999-999,<CSUM><ETX>

### 6.6.12 Request Hardware Version

Description:

The host requests that the firmware sends the hardware version.

Direction:

Host to supply

Syntax:

<STX><24><,><CSUM><ETX>

Example:

<STX>24,<CSUM><ETX>

Response:

<STX><24><,>< ARG><,><CSUM><ETX>

Where:

<ARG> consists of 3 ASCII characters representing the hardware version.  
The format is ANN, where A is an alpha character and N is a numeric character

Example:

<STX>24,A01,<CSUM><ETX>

### 6.6.13 Request Model Number

Description:

The host requests that the firmware sends the unit model number

Direction:

Host to supply

Syntax:

<STX><26><,><CSUM><ETX>

Example:

<STX>26,<CSUM><ETX>

Response:

<STX><26><,><ARG><,><CSUM><ETX>

Where:

<ARG> consists of five ASCII characters representing the model number. The format is XNNNN or DXMNN, where N is a numeric character. See section 7.0 for model number codes.

Example:

<STX>25,X9999,<CSUM><ETX>

#### **6.6.14 Reset Run Hours**

Description:

The host requests that the firmware resets the run hour counter.

Direction:

Host to supply

Syntax:

<STX><30><,><CSUM><ETX>

Example:

<STX>30,<CSUM><ETX>

Response:

<STX><30><,><\$><,><CSUM><ETX>

### **6.6.15 Reset Faults**

Description:

The host requests that the firmware resets all Fault messages and indicators.

Direction:

Host to supply

Syntax:

<STX><31><,><CSUM><ETX>

Example:

<STX>31,<CSUM><ETX>

Response:

<STX><31><,><\$><,><CSUM><ETX>

### **6.6.16 Read Interlock Status**

Description:

The host requests that the firmware read the status of the interlock channel.

Direction:

Host to supply

Syntax:

<STX><55><,><CSUM><ETX>

Response:

<STX><55><,><ARG1><,><CSUM><ETX>

Where ARG1 is Interlocks 1. A 1 indicates that the Interlock is energized

Example:

<STX>55,1,<CSUM><ETX>

### 6.6.17 Request kV Monitor

Description:

The host requests that the firmware report kV monitor.

Direction:

Host to supply

Syntax:

<STX><60><,><CSUM><ETX>

Response:

<STX><60><,><ARG><,><CSUM><ETX>

Where:

<ARG>=0-4095 in ASCII format representing unscaled value.

Example:

<STX>60,4095,<CSUM><ETX>



### 6.6.18 Request mA Monitor

Description:

The host requests that the firmware report mA monitor.

Direction:

Host to supply

Syntax:

<STX><61><,><CSUM><ETX>

Response:

<STX><61><,><ARG><,><CSUM><ETX>

Where:

<ARG>=0-4095 in ASCII format representing unscaled value.

Example:

<STX>61,4095,<CSUM><ETX>

### 6.6.19 Request Filament Feedback

Description:

The host requests that the firmware report Filament Feedback.

Direction:

Host to supply

Syntax:

<STX><62><,><CSUM><ETX>

Response:

<STX><62><,><ARG><,><CSUM><ETX>

Where:

<ARG>=0-4095 in ASCII format representing unscaled value.

Example:

<STX>62,4095, <CSUM><ETX>

### 6.6.20 Request –15V LVPS

Description:

The host requests that the firmware report –15V LVPS.

Direction:

Host to supply

Syntax:

<STX><65><,><CSUM><ETX>

Response:

<STX><65><,><ARG><,><CSUM><ETX>

Where:

<ARG>=0-4095 in ASCII format representing unscaled value.

Example:

<STX>65,4095,<CSUM><ETX>

### 6.6.21 Request Faults

Description:

The host requests that the firmware report Faults.

Direction:

Host to supply

Syntax:

<STX><68><,><CSUM><ETX>

Response:

<STX><68><,><ARG1><,><ARG2><,><ARG3><,><ARG4><,><ARG5><,><ARG6><,><CSUM><ETX>

Where:

<ARGx> 1 = Fault, 0 = No Fault in ASCII format

ARG1 = ARC

ARG2 = Over Temperature

ARG3 = Over Voltage

ARG4 = Under Voltage

ARG5 = Over Current

ARG6 = Under Current

Example:

<STX>67,0,0,0,0,1,0,<CSUM><ETX>

### 6.6.22 Program Local/Remote Mode

Description:

The host requests that the firmware to switch between Local and Remote Mode.

Direction:

Host to supply

Syntax:

<STX><99><,><ARG><,><CSUM><ETX>

Where:

<ARG> 1 = Remote, 0 = Local in ASCII format

Example:

<STX>99,1,<CSUM><ETX>

Response:

<STX><99><,><\$><,><CSUM><ETX>

<STX><99><,><ARG><,><CSUM><ETX>

where <ARG> = error code

Error Codes TBD,

1 = out of range

### 6.6.23 Program RS-232 Baud rate

Description:

The host requests that the firmware change the Baud rate for RS-232.

Direction:

Host to supply

Syntax:

<STX><07><,><ARG><,><CSUM><ETX>

Where:

<ARG> 1 = 9.6k in ASCII format  
<ARG> 2 = 19.2k in ASCII format  
<ARG> 3 = 38.4k in ASCII format  
<ARG> 4 = 57.6k in ASCII format  
<ARG> 5 = 115.2k in ASCII format

Example:

<STX>07,1,<CSUM><ETX>

Response:

<STX><07><,><\$><,><CSUM><ETX>  
<STX><07><,><ARG><,><CSUM><ETX>

where <ARG> = error code

Error Codes TBD,

1 = out of range

## 6.6.24 Program User Configuration( Controlled Ramping and Arc Fault Control)

### Description:

The User Configuration command is used to update the user configurable items of the DXM.

### Direction:

Host to supply

### Syntax:

```
<STX><0><9><,><ARG1><,><ARG2><,><ARG3><,><ARG4><,>  
<ARG5><,><ARG6><,><ARG7><,><ARG8><,><ARG9><,><ARG10><,>  
<ARG11><,><ARG12><,><ARG13><,><ARG14><,><ARG15><,><ARG1  
6><,><CSUM><ETX>
```

### Where:

Argument Number	Description
ARG1	kV Ramp Time. Adjustable between 1 to 20 seconds. Units are tenths of second.
ARG2	Filament Ramp time (MSB). Adjustable from 0.5 to 30 seconds. Units are tenths of second. Most significant byte
ARG3	Filament ramp time (LSB). Least significant byte
ARG4	mA Ramp Time. Adjustable from 0.5 to 5 seconds. Units are tenths of seconds.
ARG5	Minimum filament emission. Adjustable from 5% to 50% of full scale kV output
ARG6	Arc count. Number of arcs allowed before shutting down supply. Adjustable from 2 to 10 arcs.
ARG7	Arc period. If the number of arcs programmed (ARG6) is found during this period of time, supply will shut down. Adjustable from 10 to 20 seconds
ARG8	Arc Quench time (MSB). Adjustable from 50 to 300 milliseconds. Units are milliseconds. Most significant byte
ARG9	Arc Quench time (LSB). Least significant byte
ARG10	Arc re-ramp. After the quench period is completed, kV and mA will re-ramp to

	programmed values in 100 milliseconds. 1: Disable 0: Enable
ARG11	Enable ramp control. 1: Enable 0: Disable
ARG12	Enable arc control 1: Enable 0: Disable
ARG13	Enable set point ramp. After ramp is complete, kV and mA will ramp up or down during any set point change. 1: Enable 0: Disable
ARG14	mA Ramp hold time (MSB). Time delay, after kV ramp is completed, before mA ramp starts. Adjustable from 1 to 30 seconds. Units are tenths of seconds. Most significant byte
ARG15	mA Ramp hold time (LSB). Least significant byte
ARG16	Remote programming enable. If enabled, the unit will default to Remote programming mode upon power up. 1: Remote mode enable 0: Remote mode disable

Example:

Sending this command will set the user configurable items as follows:

<STX>09,50,1,44,50,30,4,10,0,150,0,1,1,0,0,50,1,<CSUM><ETX>

- <ARG 1> kV Ramp time = 5 seconds.
- <ARG 2> Filament Ramp time MSB = 1
- <ARG 3> Filament Ramp time LSB = 44  
 $1 \times 256 + 44 = 300$ , equivalent to 30 seconds
- <ARG 4> mA Ramp Rate = 5 seconds.
- <ARG 5> Minimum filament emission = 30%
- <ARG 6> Arc count = 4
- <ARG 7> Arc time period = 10 seconds
- <ARG 8> Arc Quench time MSB = 0
- <ARG 9> Arc Quench time LSB = 150



0x256 + 150 = 150 milliseconds  
<ARG 10> Arc re-ramp = 0, Enable  
<ARG 11> Ramp control = 1, Enabled  
<ARG 12> Arc Control = 1, Enabled  
<ARG 13> Set point ramp = 1, Enabled  
<ARG14> mA ramp hold off time MSB = 0  
<ARG15> mA ramp hold off time LSB = 50  
0x256 + 50 = 50 equivalent to 5 seconds  
<ARG16> Remote programming enable = 1, Enabled

Response:

<STX><0><9><,><\$><,><CSUM><ETX>

## 6.6.25 Request User Configuration( Controlled Ramping and Arc Fault Control)

### Description:

This command returns the current user configuration parameters.

### syntax

<STX><2><7><,><\$><,><CSUM><ETX>

### Response:

<STX><2><7><,><ARG1><,><ARG2><,><ARG3><,><ARG4><,>  
<ARG5><,><ARG6><,><ARG7><,><ARG8><,><ARG9><,><ARG10><,>  
<ARG11><,><ARG12><,><ARG13><,><ARG14><,><ARG15><,><ARG1  
6><,><CSUM><ETX>

Where:

Argument Number	Description
ARG1	kV Ramp Time. Units are tenths of second.
ARG2	Filament Ramp time (MSB). Units are tenths of second. Most significant byte
ARG3	Filament ramp time (LSB). Least significant byte
ARG4	mA Ramp Time. Units are tenths of seconds.
ARG5	Minimum filament emission. Adjustable from 5% to 50% of full scale kV output
ARG6	Arc count.
ARG7	Arc period in seconds
ARG8	Arc Quench time (MSB). Units are milliseconds. Most significant byte
ARG9	Arc Quench time (LSB). Least significant byte
ARG10	Arc re-ramp in 100 milliseconds. 1: Disabled 0: Enabled
ARG11	Enable ramp control. 1: Enabled 0: Disabled
ARG12	Enable arc control 1: Enabled 0: Disabled
ARG13	Enable set point ramp.

	1: Enabled 0: Disabled
ARG14	mA Ramp hold time (MSB). Units are tenths of seconds. Most significant byte
ARG15	mA Ramp hold time (LSB). Least significant byte
ARG16	Remote programming enable. 1: Remote mode enable 0: Remote mode disable

## 6.7 SPELLMAN TEST COMMANDS

- Program Hardware Version (Hardware setup)
- Program Model number(Hardware setup)
- Set USB Mode (Program USB)
- Set USB Page Address (Program USB)
- Send USB Page Data (Program USB)
- Toggle Passthrough Mode (Diagnostics)
- Store A/D Calibration Value (Hardware setup)
- Request Miscellaneous Analog Readbacks

Contact Spellman High Voltage for details and the syntax of these commands.

## 6.8 SERIAL COMMAND HANDLING

**6.8.1 Command Time Out** The host computer should set a serial time out at approximately 100mS. This allows the DSP to process the incoming message, and transmit a response. The DSP will initiate a reply to incoming messages in approximately 1-2mS, with a worst case of 5mS.

### 6.8.2 Buffer Flushing

The DSP will flush the incoming serial data buffer every time an STX is received. This provides a mechanism to clear the receive buffer of partial or corrupt messages.

### 6.8.3 Handshaking

The only handshaking implemented on the host interface, is built in to the implementation of this protocol. That is, the host must initiate all communications. If the supply receives a program command, an acknowledge message is sent back to the host via the "\$" message. If the host does not receive an acknowledge within the time out window, the host should consider the message lost or the device off-line.

Similarly, if the supply receives a request command, the requested data is sent back to the host. If the host does not receive the requested data within the time out window, the host should consider the message lost or the device off-line.

This essentially uses the full-duplex channel in a half-duplex communication mode.

## 7.0 Dxm Standard Firmware Model # Codes

<u>Standard</u> Model no	<u>Firmware</u> Model Code	<u>Standard</u> Model no	<u>Firmware</u> Model Code
<b><u>300W</u> Negative</b>		<b><u>600W</u> Positive</b>	
DXM20N300	DXM01	DXM20P600	DXM13
DXM30N300	DXM02	DXM30P600	DXM14
DXM40N300	DXM03	DXM40P600	DXM15
DXM50N300	DXM04	DXM50P600	DXM16
DXM60N300	DXM05	DXM60P600	DXM17
DXM70N300	DXM06	DXM70P600	DXM18
DXM75N300	DXM37	DXM75P600	DXM40
<b><u>300W</u> Positive</b>		<b><u>600W</u> Negative</b>	
DXM20P300	DXMO7	DXM20N600	DXM19
DXM30P300	DXMO8	DXM30N600	DXM20
DXM40P300	DXMO9	DXM40N600	DXM21
DXM50P300	DXMO10	DXM50N600	DXM22
DXM60P300	DXMO11	DXM60N600	DXM23
DXM70P300	DXMO12	DXM70N600	DXM24
DXM75P300	DXM38	DXM75N600	DXM39
<b><u>1200W</u> Positive</b>		<b><u>1200W</u> Negative</b>	
DXM20P1200	DXM25	DXM20N1200	DXM31
DXM30P1200	DXM26	DXM30N1200	DXM32
DXM40P1200	DXM27	DXM40N1200	DXM33
DXM50P1200	DXM28	DXM50N1200	DXM34
DXM60P1200	DXM29	DXM60N1200	DXM35
DXM70P1200	DXM30	DXM70P1200	DXM36
DXM75P1200	DXM42	DXM75P1200	DXM41