

**Model 4201-B
DMX512-A Controller
Firmware Revision 2.01
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Instruction Manual

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Intended Use

The Model 4201-B DMX Controller will allow computers and other devices of almost any make and speed to control lighting in situations where a full lighting board is impractical. It also may be used as a stand-alone device (without a host computer or other device). When level changes are being controlled exclusively by the host using RS-232, the number of changes per second is limited by the speed of the RS-232 port and the number of channels in use. For most intended applications this will not be a problem. Using the internal Fade command, you can do smooth fades on all 512 channels no matter how slowly the host sends the command. There are 127 presets; each preset can hold levels for all 512 channels, channel masking values, or a macro. These are non-volatile presets (stored in NV-RAM) and will be held until you change them, even with the power off. Also, a preset of your choice may be automatically selected on power-up. A macro is a list of commands stored in a preset that may be executed by a host command and/or automatically on power up. Macro execution may be modified by host commands (while the macro is executing), by external contact closures, external voltage levels, elapsed time, and even a random number generator. All 512 channels are supported per ANSI DMX512-A (non-isolated, floating or grounded driver, no secondary data channel).

The Demo programs are intended as examples, they are limited and are not optimized. Source code is included for programmers wishing to customize them.

Since the DMX512 protocol itself has no error checking, it should not be used to control anything that might be damaged or cause injury if the wrong data is received.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

The only user serviceable parts inside are the termination and grounding switches. Re-attach the cover securely being careful to not bend the LEDs. Never apply power with the cover removed.

The latest version of this manual, firmware, and examples are available from our support site:

<http://interstellar.com/support.html>

All of our documentation is in Adobe Acrobat format. Download a free reader from:
<http://www.adobe.com>

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Basic Hardware Setup

If you are using lighting control software supplied by a third party, please refer to their manual for setup and use.

Regardless of the final use of the controller, access to a computer with a spare serial or USB port and serial terminal program for initial setup and testing is recommended. An old Windows laptop using HyperTerm (part of Windows) is fine. Mac and Linux systems are also acceptable but a serial terminal program such as Zterm for Mac or GtKTerm for Linux will be needed to use them.

If the RS-232 interface is used a computer, architectural lighting controller, PDA, or PLC that has an available serial port (COM Port) that supports RS-232 at 9600-57600 baud is required along with a cable to connect the computer to the controller (the computer and cable should support RTS/CTS handshaking for reliable operation). If a spare USB port is available, it's recommended to use the USB connection instead.

An external power source is required for RS-232 operation but is optional for USB. The controller will draw power from the USB or external power source, whichever is supplying higher voltage at the moment.

When the USB port is connected to a host, the controller will ignore the RS-232 port (commands can then ONLY come from the USB port). If the host disconnects from the USB port (sleep, hibernate or suspend) it may continue to supply power but allow the RS-232 port to take over again. The USB port will take over as soon as the computer wakes up and reconnects.

Unlike the older version of this controller, there are no special drivers needed to use the USB connection. Most all Windows, Mac, and Linux systems are shipped with the drivers already installed. Windows systems may ask to connect to the Internet to automatically find the latest drivers, this is normal. The latest drivers for all operating systems can be found here:

<http://ftdichip.com>

The controllers are shipped set for 9600 baud, to use a different baud rate, see the B command. USB connections ignore the baud rate, so it can be set to anything on both the host computer and the controller.

Connect the DMX output of the controller (8 pin "RJ-45" jack) to your dimmers (they must support the DMX512/1990 or DMX512-A protocol, see your dimmer instructions for connection and setup information). If possible, set your dimmers to start on the first channel (1 or 0, depending on the dimmer). In any case, note the channel numbers of the dimmers and whether they consider 1 or 0 the first channel.

Attach some lights to the dimmers and disconnect anything that may be damaged or cause injury if the dimmer receives bad control information.

If not already on, turn on the power to the dimmers, the computer, and plug in the external power supply (AC adaptor) if the USB connection is not being used. The POWER light on the controller should come on as well as either the RS-232 light or

the USB light.

If the controller was set to auto-preset mode (factory default), the OUT light will also light (it may appear to be constantly on or blinking) and your lights will be set to whatever levels were stored in the NV-RAM (the levels will probably be 0% on a new controller). If auto-preset was not selected, no DMX data will be sent and the lights attached to the dimmers should remain off. If the auto-execute macro is valid, it will be executed as soon as any auto-preset is loaded.

The factory default for the number of channels is 64 (40 hex) at maximum update frequency, but this may be changed using the “N” command (0-512 channels, programmable update rates). Some dimmers require a slower update rate or they will flicker.

Using the included demo program, a terminal emulator program, or third-party software, communication with the controller should now be possible. If you have difficulties, please call our office for free technical support.

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Windows Serial Demo Software

The DEMO.EXE program was written for our original controller many years ago and only works with Windows. It works fine with the new models using either RS-232 or USB as long as the COM port is 1-4. Our Two Scene Preset demo is recommended, but is currently being updated to work with this version and other operating systems.

Note: This old demo program only controls lights on the first four channels. If no dimmers or lights are on these channels, the demo program cannot be used as supplied. This program is intended to demonstrate one way of using this controller; it is not intended to be used in actual applications.

The controller is shipped with the baud rate set to 9600, if it has been changed and RS-232 is being used, it must be returned to 9600 to use this demo program. If using USB, the baud rate doesn't matter.

If an auto-execute macro is active, the demo program will not be able to control the controller until that macro stops executing.

Run the "demo.exe" program found on the enclosed disk. If the controller is connected to COM:1, the port settings do not need to be changed. If it is connected to another port, click on the ComPort button and select the correct port (see your computer manual if you are unsure of which port you are using). The other settings should always be "9600", "8", "1", "none", and "RTS/CTS". Select OK to return to the main window.

The demo.exe program will work with both RS-232 and USB connections, but ONLY if the USB port number is 1-4 (assigned by Windows when the cable is plugged in the first time).

If the OUT light is on or blinking, click on the button labeled "Playback Mode 0", this will instruct the controller to stop sending data from the active memory (Preset 0). Preset Select was called Playback Mode in earlier models, they both refer to the same command. The RS-232 or USB light should flash momentarily and then the OUT light should stay out. A short time later, your dimmers should turn off any attached lights (and possibly indicate a DMX no-data error, the exact behavior of the dimmers varies with brand). Now, press the button labeled "Slider Data in Loop" and the RS-232 or USB light should be flickering indicating the computer is sending commands to the controller. The OUT light should also be on or flickering indicating that data is being sent to the dimmers.

The 4 sliders are now controlling dimmer channels 1-4 (or 0-3 in some dimmers) and any error indication on your dimmers should now be off. Use your mouse to drag the sliders to new positions and note that you are controlling the lights. If the number of channels in the controller has been increased from the default using the "N" command, there may be a delay between changing a level in the demo program and the lights actually changing. This is a result of the "D" command being sent out without waiting for the prompt. See the "D" command for more information. If "N" is set to a small number, no delay is noticeable (4 channels is all this demo supports).

Select the button labeled "None" to stop sending data to the dimmers. The OUT light

will go out, your dimmers will detect the loss of data and should shut off all attached lights (some brands of dimmers go to full on, a preset level, or hold the last value).

Click on the button labeled “Playback Mode 1”, the RS-232 or USB light will blink once and the OUT light will light. The controller is now constantly sending 64 (or whatever “N” is set to) channels of levels from NV-RAM Preset 1. Your dimmers should clear any error indication and set all attached lights to whatever levels were stored in the NV-RAM.

Set the sliders to four different positions and then click the button labeled “Slider Data To Memory”. The RS-232 or USB LED will blink once and the level of the sliders will be stored in the first four channels of the active memory (channels 5-512 will not be changed by this demo program). The new levels will be sent out to the dimmers immediately (no delay as there was with the loop mode, this mode is using the “W” command). Try setting the sliders to various positions and clicking the “Slider Data To Memory” button to see how you can change levels in the active memory. These levels will be maintained until changed, but will be lost when the power is turned off. The demo program does not write to the NV-RAM presets.

Click on “Playback Mode 1” again and the levels from NV-RAM Preset 1 will be copied back to the active memory, overwriting any changes that you made.

Press the “Exit” button to leave the program.

Two Scene Preset Demo Software

Our Two Scene Preset demo is being modified to work with this controller and will be available soon. It will also support operating systems other than windows and will continue to be open source. Please check our support page for updates:

<http://interstellar.com/support.html>

Mac & Linux Systems

Most Mac and Linux computers should automatically see the controller as a serial port using the USB cable. You can then communicate with it using any program that connects to normal serial ports. The latest drivers can be found here:

<http://ftdichip.com/>

For computers without a spare USB port, architectural lighting systems, home built controllers, etc. you can use the RS-232 port to connect.

We do not have any demo software that runs on Mac or Linux at this time but our Two Scene Preset software is being modified for other operating systems and should be available soon.

Advanced Hardware

The RJ-45 pinout follows the ANSI standard, but not all devices do. An adaptor cable may be needed. The following table is from the ANSI "E1.11-2004 DMX512-A" specification:

Pin	Wire Color	DMX512-A Function
1	white/orange	data 1+
2	orange	data 1-
3	white/green	data 2+
4	blue	not assigned
5	white/blue	not assigned
6	green	data 2-
7	white/brown	data link common (power supply ground)
8	brown	data link common (power supply ground)
-	shield	chassis ground (see grounding switch)

The controller only uses pins 1, 2, 7, 8, and shield.

The DMX data pins are protected from shorts and reasonable over-voltage but are not isolated. Plugging into telephone or Ethernet cables may damage the DMX driver chip, the controller will have to be returned for repair.

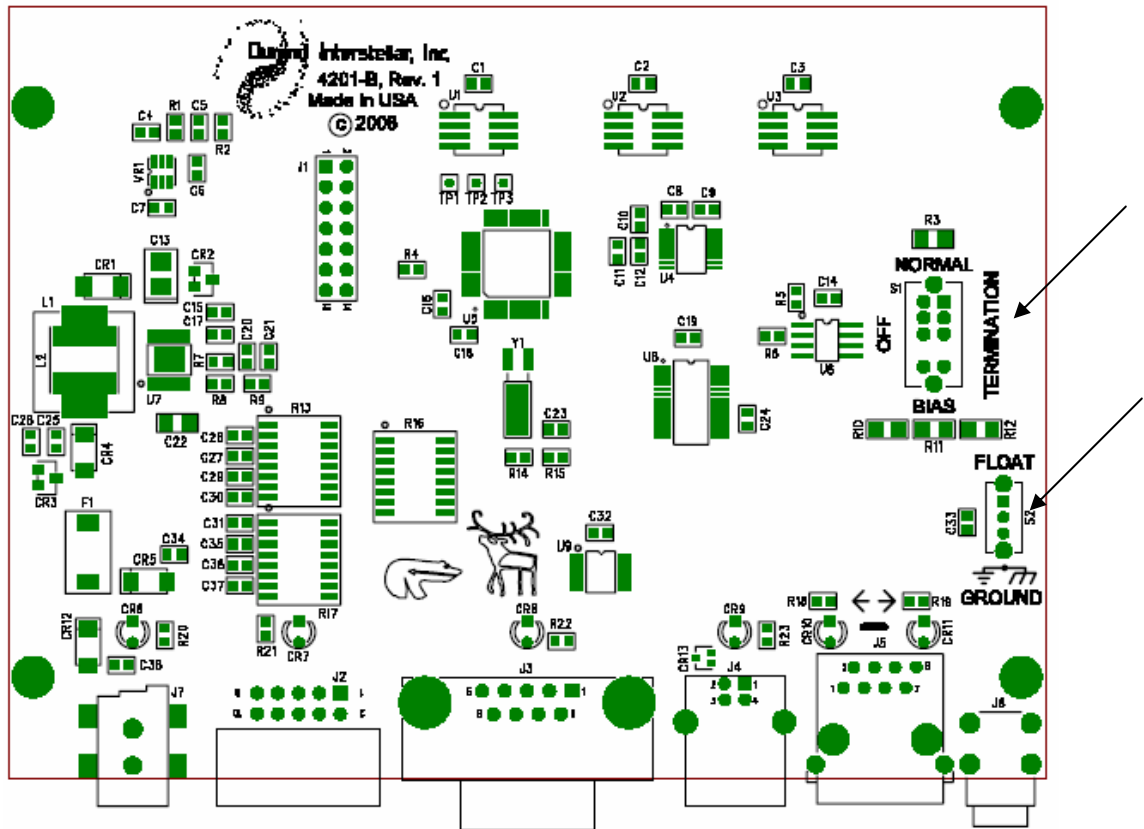
According to the DMX specification, CAT-5 wire and RJ-45 (8P8C) connectors are allowed for use if the cable and connections are protected from damage and flexing. For long runs the cable should be either shielded or run in grounded metallic conduit. The specification also strongly suggests that only authorized personnel have access to the cable and connectors. However, many people ignore the above and just run normal CAT-5 wire as if they were running network cable and never have a problem. You must evaluate your installation and determine your needs. If you need to connect to dimmers using XLR connectors, CAT-5 to XLR (3 and 5 pin) adaptors are starting to show up on the market. A preferred one is the "CPOINT XLRJ45", these may be added to our Order page when they become more available.

Most users will never need to remove the cover of the box. Unlike our older models, there are no jumpers inside, but there are two switches. Baud rate is now selected by the B command and stored in the start-up settings with the Z command. If you are using the USB connection, the baud rate is ignored on both the host computer and in the controller. Handshaking however, does work with both RS-232 and USB connections (see the H command).

The switches change the termination style and grounding for the DMX connection. If you're not sure what these are, it's probably best to leave the switches set to NORMAL and FLOAT.

In the drawing below (your board may differ slightly from the drawing) these two switches are on the right hand side of the board. The TERMINATION switch has three positions. The NORMAL position is simply a 121 ohm, 1% resistor across D+ and D-. The OFF position removes all termination. The BIAS position applies both termination as well as pull up and down resistors. This is a newer termination that is required for RDM and other bidirectional systems.

There can be a maximum of two terminations in a system, one at each physical end of the wire. One of these may be a BIAS type termination, the other may not be BIAS. If using RDM or other bidirectional system, you must have a termination on each end of the cable, one NORMAL and one BIAS. It doesn't matter which end is BIAS.



The grounding switch selects between floating and grounded shield. The shield of the RS-232, USB, and DMX cables are all tied together ("chassis ground") and connected to the GND screw on the lower right. If the grounding switch is set to FLOAT, then there is a small capacitor between chassis ground and the power supply ground. If the switch is in the other position, then chassis ground is connected directly to the power supply ground.

Chassis ground should only be connected to power supply ground and earth ground at one point in the system. If a computer is connected to either the RS-232 port or the USB port, the chances are that the shield is tied to power supply ground and also earth ground inside the computer. If the controller is being used in stand-alone mode, then you may want to change the switch to tie chassis ground to power supply ground. If the power supply does not have an earth ground connection, then you can use the GND screw to provide this.

Anyone working with DMX512 systems should refer to the booklet "Recommended Practice for DMX512" available from PLASA Ltd. in the UK and USITT.org in the USA.

More about how the DMX512 signal is actually sent to dimmers, is contained in "ANSI Standard E1.11-2004, DMX512-A" available from ESTA.org, USITT.org, and

LEDs

There are six LED indicator lights that shine through the label on top of the converter. In the descriptions below ON means steadily lit, OFF means dark, SLOW means mostly lit with a short off cycle about every second, FAST means blinking on and off rapidly, and FLICKER means random blinking. From the left the LEDs are:

- POWER: ON when power is supplied and the converter is ready to receive a command. SLOW when a macro or fade is executing. FAST if there was an error (cleared when the next command is received). OFF during a firmware update or power failure.
- USER: Controlled by the ^U command (ON/OFF/SLOW/FAST). Also FAST during a firmware update.
- RS-232: ON when the RS-232 port is selected but idle. FLICKER when data is sent or received.
- USB: ON when the USB port is selected but idle. FLICKER when data is sent or received.
- DMX-IN: Always OFF. Not used in this firmware version, reserved for RDM.
- DMX-OUT: OFF if no DMX data being sent. ON or FLICKER if DMX data is being sent.

RDM

This version of the firmware was designed to have the fewest changes possible from our old models so current users would have no problems using the new hardware. RDM and other features will appear in the version 3.x firmware but this will not be backward compatible in all cases.

Analog/Switch Inputs

Our previous model had five digital inputs, four on screw terminals and one that was a jumper. This controller has eight 0-5V analog inputs accessed with a standard 10-pin ribbon cable. Pins 1-8 are the inputs, pin 9 is +5V supplied by the controller (do NOT force power into this pin!), and pin 10 is ground. Inputs 2 and 4-7 are dual purpose and can be read as digital inputs and/or analog inputs.

To use the digital inputs, simply read the Event register ("ER") as normal. Any pin currently over 2.5V will show up as a one in the flags. **Note: This is the reverse of the 4201a units!**

Each pin has a light pull down to ground (200K ohm), this should present no problem for most analog voltage sources and also allows the direct connection of a potentiometer (slider). To use as a digital input, you may either drive this with standard digital logic (5V or 3V) or simply connect a mechanical switch between pin 9 and the input. For long runs of wire you may need to use either a DPST switch to switch the line between power and ground or add a pull up or down resistor. If you need any assistance connecting your switches, please contact us.

Analog inputs are read with the ^A command which returns a value from 0-255 representing 0-5V. If you have 0-10V inputs, you can use a simple resistor divider

to reduce the voltage.

You may use a potentiometer or slider by connecting one end to pin 9 (power), the other end to pin 10 (ground) and the wiper to any of the 8 inputs. The potentiometer should have a resistance between 1K and 10K ohms.

If desired, a macro could read all 8 inputs and feed them directly to 8 channels in Active Memory. Instant 8 channel slider control! The macro for this would be (this should be all one line):

```
:0; ^A0; MW0; ^A1; MW1; ^A2; MW2; ^A3; MW3; ^A4; MW4;  
^A5; MW5; ^A6; MW6; ^A7; MW7; J 0
```

The above reads analog input 0 and then stores it in channel 0. This is repeated for channels 1-7 and then the macro starts over at the beginning.

Advanced Software

If the demo programs and macros don't do everything you need, you will need to purchase a third party program, have us write a custom program, or write your own control software. For just setting static lighting levels, you may use any terminal emulator program or the demo programs. You may also enter macros using a terminal emulator and then set the unit to run them automatically on power up. This would be good for trade shows, museums, store windows, art exhibits, fixed TV sets, etc. An external device like a PLC can also send Events and external switches/potentiometers can be used to control branching in macros.

If using a serial port on the host computer, it MUST be set up as:

- baud rate (must match the speed selected by the B command)
- 8 data bits
- 1 stop bit
- no parity
- RTS/CTS handshaking (optional but highly recommended)

If the USB connection is being used, the controller will show up as another serial port. Your software should be set up as if it were talking to the controller over a "real" serial port, only the baud rate setting is ignored (the controller will always transfer data at the maximum USB rate). When the controller detects a USB connection, the RS-232 port is disabled so you may not use both at once. The RS-232 port is re-enabled any time the host computer is turned off or tells us to disconnect. The lights over the RS-232 and USB connectors show which is currently selected.

Hardware handshaking is where the host computer and the controller tell each other to pause sending data when they are busy using the RTS and CTS signals. If handshaking is turned off in the controller and the host is busy, then the controller will try to send anyway and will discard any data that would overflow its buffer. If handshaking is turned on, then the controller will hold whatever it has to send until the host says it's ready (possibly forever).

HyperTerm (a standard Windows program) seems to have problems at times remembering to tell the controller it's OK to reply (the handshaking gets stuck). If you press ENTER in HyperTerm and the RS-232 or USB light on the controller blinks but nothing prints on the screen, type:

H0

(the letter 'H' and the number zero) followed by a ENTER. This tells the controller to ignore the handshaking and the reply should now be received. It is normally safe to leave handshaking turned off in the controller if commands are being sent slowly (human typing as opposed to a program rapidly sending them). The H0 state can be saved in the startup settings with the Z command.

If you are writing your own software, it is highly recommended that you use RTS/CTS handshaking and remember to receive data from the controller, even if you do nothing more than discard it. Otherwise buffers on both the host computer and the controller will eventually fill up.

If you aren't comfortable with hexadecimal numbers any introductory computer programming text. All numbers sent to and returned from the DMX controller are in hex. There are also hexadecimal conversion application notes on our web page under Support and on the CD.

Leading zeros are not required, but for the number zero you must send at least one "0" unless otherwise noted in the command. Numbers returned from the controller may or may not have leading zeros. If a number is received by the controller with more digits than it is looking for, only the last digits are kept ("12345678" is read as "5678" or "78" depending on the command). Do NOT send the "0x" prefix in front of any number.

All commands and hex numbers are not case sensitive. White space is defined as Horizontal Tab (09 hex), Line Feed (0A hex), Vertical Tab (0B hex), Form Feed (0C hex), and Space (20 hex). Any amount/combination of white space may precede a command or number. White space may also follow the last data on a line and precede the carriage return.

All commands execute as they are received but they MUST be terminated with a carriage return (0D hex). C programmers need to use '\r', NOT '\n'. If you want to send "\r\n" or "\n\r", that's OK. The controller always sends the sequence "\r\n" when a return is called for except when output from a macro, then you have total control of what's sent.

Any of these commands (except the D command) may be typed in from a terminal emulator program (such as Hyper Terminal in Windows). There are no timeouts on commands (except D), you could start a command today and finish it tomorrow and the controller wouldn't care (unless there was a power failure). Aside from debugging, the main use of manual command entry would be for setting up a macro for applications where you set the levels and time or event-based changes once, enable auto-preset and possibly the auto-exec macro, unplug the computer, and go home.

If your computer allows you to copy text files to the serial port, you could make up a text file containing anything from a single cue to a long series. Using the time and delay commands, you could create fairly complicated lighting effects with nothing more than a text editor (like Notepad in Windows or Text Edit in OS X). You could even insert timer commands to lock the effects to the internal clock with 1/10 second resolution. If using the RS-232 connection, handshaking MUST be enabled on the host computer end to keep the commands in sync.

Text files can also be used to load macros and presets into memory, that way you could edit the copy on your computer and re-load it whenever you needed to change something. This would also allow you to load the same Macros and Presets into a number of controllers. You can also cut and paste from many programs directly to your terminal emulator (HyperTerm on a PC, ZTerm on a Mac, GtkTerm in Linux).

When you power up the controller, you will receive a message that it is starting the Auto-Exec Macro (if using USB you may have to press RETURN once to establish the connection). The factory default is for this macro to be empty, so you will then receive a message to that effect and the normal prompt will appear. If the macro wasn't empty, it will continue executing until aborted or it terminates itself. While a

macro is executing, the POWER light will blink slowly.

See below for more information on Macros.

When using a terminal emulator, do NOT use the backspace or delete key. The controller executes commands as they are entered and can not backspace. If you make a mistake while typing, press ENTER and reenter the entire command again.

Presets

A preset in the controller refers to a block of memory used to hold one set of static levels for a number of channels. Presets are also used to store macros and masking data (see below for more information on masking).

There are three different types of presets, it's important to understand the differences between these.

Presets stored in RAM allow very fast access and may be changed as often as needed with no wear or damage. Anything stored in a RAM preset will be lost when the power is turned off.

Presets 01-7D (1-125 decimal) are always stored in NV-RAM. There is nothing special about any of these other than by default Preset #1 is copied to Active Memory on power up (you can change this with).

Presets stored in NV-RAM are not lost even with the power off. Accessing this data is considerably slower than RAM, but still quite fast. Changing (writing) this data is very slow in computer terms, 200 channels takes about a second. As this data shouldn't change often, this shouldn't be a problem. Also, NV-RAM memory wears out after about 1 million changes (per location). Burning out one location does not affect the others and the memory chips can be replaced but the controller has to be returned to us for repair. See the NV-RAM notes for more information.

There are two special Presets (126-127 decimal) called Shadow Memory Presets. The "^S" command lets you specify whether these are currently stored in RAM or NV-RAM. If you have a need to constantly change the data in presets, or just want better performance, then you would select RAM. If you don't wish the data to be lost, then you would select NV-RAM. Switching back and forth between modes does NOT change any data stored in the other mode.

Example:

(channel numbers refer to the channel in the preset, not the actual address you'd write to)

- Start with Shadow turned off and write the level "12" to channel 0;
- Turn Shadow on and write the level "55" to channel 0;
- Read channel 0 and you'll get the number "55";
- Turn Shadow off and read channel 0, you'll get the number "12"
- Turn Shadow back on and read channel 0, "55" again;
- And so on.

On power-up, the Shadow presets will be set to whatever data is in the NV-RAM presets 126-127. NV-RAM does not lose data on power cycles. Factory default is for the Shadow RAM to be disabled in order to be compatible with older models. Most people who use Shadow RAM will probably want to turn it on and leave it on.

The first preset (#0, also called the "Active Memory") is stored in RAM. Any data stored in this preset is sent out through the DMX port to control your dimmers/other devices. Changes to this data take effect immediately. The "N" command sets the number of channels sent out (up to 512) as well as the speed the channel data is

sent out. Any data stored in channels beyond the number set with “N” will not be sent out or changed with the “P” or “F” commands. Often, these spare locations (channel numbers higher than “N”) are used to store data used in macros. Preset #0 can be used in most commands, but can not be used as a mask. Storing a macro in location zero actually stores it in a separate, special location in NV-RAM (the “Auto-Exec Macro”) and has no effect on Active Memory.

Masking

Often there is a requirement to change the levels on certain channels while leaving the others untouched. One example would be to fade channels 1, 23, and 257 to new levels while leaving the others unchanged. The way this is accomplished is by using a mask ("mask" is a programming term for only selecting certain items). To use masking, one preset is used in a special way to determine which channels are changed and which are not. Any channel in the mask preset that is not set to zero will allow that same channel to be changed in the command.

Here's an example using the fade mentioned above:

- N is set to 257 (decimal) or greater;

- Preset 0 is the active memory and has the current light levels;

- We wish to fade only channels 1, 23, and 257 to preset 5 over 8 seconds;

- Preset 3 will be used for masking; it has channels 1, 23, and 257 set to some number other than zero (one is fine);

- Here's the command: **F 5 50 3**

Ok, what happened?

- "F" is the fade command;

- "5" is the preset we are fading to;

- "50" is hex for 80 decimal (80 times 0.1 seconds = 8 seconds);

- "3" is the preset used for masking.

Preset 3 will be inspected and only channels that are non-zero will be allowed to fade. All other channels will be untouched.

All commands that support masking work the same way. You may use any preset other than zero for the mask. Leaving off the mask number or setting it to zero means "do not use masking" and all channels will be updated.

Using Commands

There aren't that many commands to master and you really only need a couple in most applications. To make sure you have the correct version manual for the firmware in your controller use the I command and check that the version number matches the cover of this manual. Firmware updates may be downloaded from our web page under Support.

To get started, look at the "W" command below, depending on your application, it may be the only command you need.

Don't forget the carriage return (0D hex) after every line!

If an error is detected while processing a command, a '!' character is sent to the host and the POWER light will flash rapidly. When the controller is ready for a command, it will send a prompt to the host. The prompt consists of a return (0D) and linefeed/newline (0A) followed by the character '>'. In most applications you can safely ignore error checking (you shouldn't ever get any errors), however you **MUST** set up your software to deal with incoming characters or set handshaking to OFF.

The demo.exe program discards all replies, if you turn off that section of code everything will be fine for about 10 seconds and then the receive buffer will fill up. When this happens Windows sets RTS to FALSE (the host saying "Stop sending characters"). If handshaking is ON, the controller will then wait for RTS to go back to TRUE before it sends out the next character. Since the controller can't execute the next command, its receive buffer will fill up and it will set CTS to FALSE telling the host to stop sending characters. Both computers will now wait a very long time for something to happen. Setting handshaking to OFF tells the controller to ignore any errors while sending data to the host. This **MAY** cause lost characters on long replies such as the I and ? commands. As long as the host doesn't mind lost characters, this will not affect the operation of the controller.

If you don't care about receiving responses from the controller, you can use the "H0" command to turn off the checks for RTS, then save the settings with the Z command. The controller will still send the responses, but will ignore RTS and always send the data. If the host doesn't accept data fast enough, the controller will simply discard characters until the host catches up. The controller will always use the CTS line to tell the host to stop, when using RS-232 connections the host should always be set to obey this. USB connections have additional handshaking so the host can never send data to the controller if it isn't ready.

There is no harm in issuing the next command before the current one has completed. The new command(s) will be buffered and executed as soon as the previous one has completed unless you issue an abort. This buffer can hold over 200 characters and the host computer will be signaled to pause if the buffer fills up. As soon as the converter catches up the host will be given the OK to send more data.

Command Descriptions

Some commands have changed from previous versions.
Shadow Presets can be used anywhere a normal preset can be used.

B BAUD RATE SETTING

This changes the RS-232 baud rate. Baud rate is ignored with USB connections but can be set from USB (handy if you need to change it before your RS-232 device can talk to the converter).

To set the default baud rate of 9600, you would enter:

B 0

The possible baud rates are:

0 = 9600, n, 8, 1

1 = 19200, n, 8, 1

2 = 38400, n, 8, 1

3 = 57600, n, 8, 1

You can check the current setting with the I command.

The baud rate is saved in the startup settings with the Z command.

C COPY PRESET WITH MASKING

This will copy any preset to any other. This command always processes all 512 channels no matter what "N" is set to. Simply enter the source preset number, the destination preset number, and an optional mask preset. If the destination is in NV-RAM, this command will be somewhat slow as writing to this memory is not fast.

The active memory is Preset 0. If the current preset (set with the P command) is not 0 and you copy from to Preset 0, the new levels will be sent out as they are copied (possibly over several DMX packets). This could be a problem if you are controlling moving lights or other specialty items. It is recommended to use the Preset Select to copy to active memory as it is optimized for speed, is synchronized with the outgoing DMX packets, and does not overwrite spare channels. Making a copy from preset 0 to another preset does not interfere with the DMX output.

To copy from active memory to NV-RAM Preset 16 (10 hex), enter:

C 0 10

To copy from Preset 1 to Preset 63 using Preset 5 as a mask, enter:

C 1 3F 5

D DIRECT TO DMX

This command not recommended for new applications, it is

only here to maintain compatibility with older versions. Use the W command instead.

This is the only command that you shouldn't type in at a terminal emulator. The DMX specification has a 1-second timeout for loss of data detection, so unless you type VERY fast, your dimmers will time out and shut down.

The simple version of this command is just a D followed by a string of hex numbers separated by white space. The first number is channel 0, the next is 1, and so on. The controller will hold the data as it's received until you send a return, then it will all be sent out as one packet. If you send more than the number of channels set with "N", the extra channels will be ignored.

Sample:

```
D 1 2 3 4 5 6 7 8 9 a b c d e f 10 11 12 13
```

Since the DMX format doesn't let you skip channels before you get to the one you're interested in, this can get tedious (and slow) if you have a device on channel 500. To use the simple format you'd have to insert 499 zeros plus white space. Enter the Skip subcommand (a form of RLL coding). DMX data is only 8 bits, so each value on the line must be between 00 and FF. If a number is between F00 and FFF it is interpreted as a skip command and will insert a number of zeros in the DMX data stream at high speed relieving both the host computer and the programmer of the task. The number of channels "skipped" is determined by the lower 8 bits (the right two digits) of the 3-digit number. F01 means "insert one channel of 0", F02 means insert 2 zeros, etc. with F00 a special case that inserts 256 zeros. So to send the data 55 to channel 500, you could enter:

```
D F00 FF3 55
```

Note that we had to use two skip commands in a row, as long as they're separated by white space, this works fine. Simply repeat the skip command as many times as you need.

You can also intersperse skip commands with data as in:

```
D F12 55 F22 AA
```

Please note that skipped channels are set to a level of 0. If you have any lights on those channels, they'll be dark. If you have 500 channels of lights and want to change any one of them, you **MUST** send out all 500 channels of data every time. If this is too much trouble for you, then see the W command.

With the above commands the host has to send a minimum of 2 characters and normally 3 characters per channel (white space + one or two digits). This isn't slow but it isn't fast, either. For those of you who want the fastest updates possible, there's the binary subcommand. It works something like the skip command, only the first digit is 'B' and the lower 8 bits are the number of binary channels to

follow (“B12 ” means the next 12 hex bytes that come from the host are 8-bit binary levels). Since binary data doesn’t print well, we’ll use ‘x’ in the example to represent the 8-bit binary data.

D B04 xxxx F05 AA 55

In the above example the “B04 ” means that the next 4 characters, whatever they are, are treated as a level with no checks performed. Note there **MUST** be a single space (or other white space) after the “B04” or the command won’t work. The rest of the command string just shows that you can mix these subcommands with normal simple data. BE CAREFUL, if one of the ‘x’s was missing, the white space in front of the “F05” would be sent as a level and then the “F05” would generate an error. So, if you had 8 channels in binary mode starting at channel 1, the command would look like:

D B08 xxxxxxxx

A note on the “D” command: As soon as the “D” is received, the Preset Select is switched to 0. As each channel is received it is stored in active memory. When the Carriage Return at the end of the line is received, one (and only one) DMX packet is sent out and then the DMX output is halted again. The last data sent out will remain in active memory until changed by the D or some other command (including a P command). You can use the Copy command to place this data in some other Preset, if you wish.

Also, due to buffering delays in the host computer and the controller, if you are sending out D commands rapidly and N is set to a large number, you will notice a delay between issuing a D command with new levels and the lights actually changing. There are several ways around this, send the D commands slower than the packet rate (depends on the setting of N), wait for the prompt before sending the next D command, use a smaller value of N, or use the W command (preferred).

When the D command completes, the DMX output is turned OFF (the same as entering the command “P 0”). If you’re going to issue another D command within one second, there’s no problem. If you’re not, use the command “P FF” to turn the output back on so your dimmers don’t time out.

ER READ EVENT

This command returns the current value of the Event data as well as the Flags byte. See the Macros section for more on Event data and Flags. An example of the data returned may be:

1435

The first digit is the status of the digital inputs. The “1” indicates that digital input #4 is high (switch closed) and the other 3 are low (switches open).

The next digit is the rest of the flag bits. The 4 indicates that Zero, Carry, and Sign are zero and digital input #2 is high. If only Zero was

set, this would read “1”. If only Carry were set it would read “2”. Sign would read “8”. Any combination of flag bits may be on at one time.

EW EVENT & FLAGS WRITE

This allows a way for the host to update the Event data. EW only works when a macro is not running and works with normal hex numbers. EW 156 will load the number 0x56 into the Event memory while setting the Zero flag to 1 and the Carry and Sign flags to zero. No other flag bits are changed. EW 56 would still load 0x56 into the Event memory and also clear the flags Zero, Carry, and Sign. You might want to use the “~” command; it always works, uses binary data, and does not update the flags. The flags and Event are cleared to zero on power up.

F FADE WITH MASKING

This command will execute a cross fade from whatever levels are currently being output (from Active Memory) to any preset (1-127). Masking allows you to only fade selected channels while leaving the others untouched. Fading to preset #0 is a special case for “fade to black”.

The command format is an ‘F’ followed by the preset number to fade to, the time that the fade should take, and optionally the preset to use for a mask (see below). The fade time is given in 0.1 second steps, so 12.3 seconds would be 123 (7B hex). The valid range of time is 0-FFFF (instant to a little over 109 minutes). If you issue the abort command ‘*’, the fade will be terminated and the levels will jump to the final value.

If you wanted to fade from the current levels to preset #4 over 12.3 seconds, you would issue the command:

F 4 7B

If you only want to fade certain channels, you need to set up a preset as a mask (any preset other than zero will do). In this special preset, any channel that is set to zero will NOT be updated during the fade. For example, if you only want to fade channels 2 and 5 you could setup a mask preset like this:

F0 0

W2 1 0 0 1

C 0 10

In this example the Fade to 0 sets all channels in active memory to zero, then we write a one (could be any non-zero number) into channels 2 and 5. After that we copy preset #0 (Active Memory) to preset #10 (hex). This example assumes you are doing this with your lights turned off as part of your setup. If you need to do this while your lights are on, you could write directly to the EEPROM using:

W 2000 0 0 1 0 0 1 0 0 0 0 0

Here 2000 is the starting address of preset #10 in the NV-RAM (200 hex times the preset number). Note that in this case you will have to write a zero to every channel that you don’t want changed during the

fade, there's no quick way to clear an entire preset in NV-RAM. At least you should only have to do this once and you only have to clear the channels in use (if you only have 12 dimmers, there's no need to worry about the rest of the channels). If you have a few different channels you wish to mask at different times, simply set up a different mask preset for each case.

Now, let's fade to preset #4 over 12.3 seconds again, only using masking so that only channels 2 & 5 actually change:

F 4 7B 10

The smoothness of the fade is dependent on the number of channels and the update rate set with the N command. With all 512 channels enabled and the update rate set to zero (fastest), the lights are only updated about 40 times a second. With 19 or fewer channels the fastest update rate is over 800 times per second!

Note: Many low cost dimmers can not handle fast update rates, you can use the N command to set both the number of channels and the update rate.

When the command is finished the Active Memory will contain the final levels and the DMX output will be on, regardless of what the Preset Select was originally set to.

H HANDSHAKING

In order to control the flow of information over a serial connection, handshaking is used. The controller uses Hardware Handshaking, meaning that it will not send any data to the host computer when the RTS line is false and it will signal the host to stop sending by setting the CTS line false. If your software does not keep the RTS line true (for example, you don't even care about the responses), responses to commands will back up in the controller until it runs out of memory, and then it will not execute any more commands. To prevent this from happening, send the command "H 0". This will prevent the controller from locking up; it will now attempt to send the data regardless of the state of the RTS pin and will discard data if the buffer fills. This is recommended if you are executing Macros with no host attached. Sending "H 1" turns handshaking back on.

The controller will ALWAYS generate CTS signals, no matter what H is set to. The host computer should obey this line or commands may be lost.

The "Z" command will save the current setting of "H" and other options and restore them at the next power cycle.

Setting handshaking off MAY cause loss of characters on long replies (such as from the I and ? commands). This does not affect the DMX output in any way and if software on the host doesn't care about the lost characters, then no harm is done.

I INFORMATION

When the controller receives this command it will respond with several lines of text describing the software and what the initial conditions are. Here's an example of what the controller will send:

```
RS-232/USB to DMX Controller
Copyright 1999-2008, Durand Interstellar, Inc.
Version: 4201B 2.01 20080621
Serial Number: 12345678
Preset Select: 01
Start Code: 00
Channels: 040
Frame Rate: 00
Serial Handshaking: ON
RS-232 Baud Rate: 9600, n, 8, 1
USB Connection: ON
Shadow Presets: OFF
Temperature: 25C, 77F
```

You may wish to set up your software to check that you're talking to the right device. The first number after "Version:" is the model number ("4201B"), the next number is the firmware version ("2.00") and the last number is the firmware date ("21June 2008"). The Preset Select reflects the current setting (00 = off, 01-7F = which preset was last copied to active memory). Frame Rate is the current maximum DMX update rate (0 = fastest possible). Serial Handshaking indicates whether the controller pays attention to the RTS signal from the host. Baud Rate shows the current RS-232 baud rate. USB Connection indicates if a USB connection is currently active. Shadow Presets tells if presets 126-127 are RAM ("ON") or NV-RAM ("OFF"). Temperature is the temperature of the processor in the converter (given in decimal degrees C and F). Other versions of this product may have different information.

N NUMBER OF CHANNELS AND FRAME RATE

This command lets you set the number of channels sent out to the DMX cable as well as the speed they are sent out. If you use a small number of channels, this GREATLY increases the number of packets sent out per second. Note that the P and F commands will only copy/change the number of channels set by the N command. The higher channel numbers in active memory will not be changed (and may be used for data storage by macros).

If you set N to 0, DMX packets of zero length will be sent. Be careful, as this may confuse some devices. If your device doesn't mind this, you could use this as a way to pause the DMX transmission while you update active memory with the W command. A better way would be to issue the "P 0" command to turn off the output entirely, make your changes, then issue the "P FF" command to turn it back on without changing presets. You could also write the updates to Shadow Memory and then use the appropriate command ("P 7E" or "P 7F") to

copy this to Active Memory.

The maximum number of channels is 512 (200 hex), the factory default is 64 (40 hex) at the fastest update rate.

Some dimmers and other devices malfunction when DMX data is sent at the maximum speed allowed. In order to work with these products, you may need to adjust the maximum speed that DMX frames (updates) are sent out. In order to do this, include a number after the number of channels, as in:

N 10 20

The above command tells the controller to send out 16 channels (10 hex) at no more than 32 (20 hex) updates per second. Any number from 01 to FF is valid here. Leaving the number off or setting it to zero tells the controller to run at the maximum speed possible. You may have to try several speeds to find what your dimmers are happy with.

These settings are saved with the Z command.

P PRESET SELECT

Valid numbers are 00 for off and 01-7F. When this command is entered, the current DMX packet is completed then the DMX output is stopped. If the new selection is not equal to zero, the first N channels of the selected preset is copied to the active memory (Preset 0) and the DMX output is re-started. This all happens VERY quickly (slow frame rates might slow this down).

This value will be saved to NV-RAM by the Z command as the auto-preset. On power up, the auto-preset is loaded before the auto-execute macro (if any) starts.

There's a special case when the command is "P FF". This does NOT change the preset or modify Active Memory, it only turns the DMX output back on if it was off. Whatever data is in Active Memory will now be sent out.

Samples:

P0

P4

PFF

R READ MEMORY

This command will cause 16 bytes to be read back to the host from memory. The memory is accessed as a single 64K block, so the starting address is a 16 bit hex number calculated by multiplying the preset number by 512 and adding the channel number. Addresses 0000-01FF are channels 1-512 in the active memory (these are what are sent out the DMX port), 0200-03FF are preset 1, etc. The memory from 0200-FBFF (presets 1-125) is always NV-RAM. Memory from FC00-FFFF is either NV-RAM or RAM, depending on the Shadow setting.

This command always sets the lower 4 bits of the address low before starting the read so the last digit of the address you send doesn't matter (but is required). If you send 123, the first byte returned will be from Preset 0, channel 120 (hex). The first line below shows a read command for channels 120 through 12F, the second line shows a typical response:

R123

11 22 33 44 55 66 77 88 99 00 AA BB CC DD EE FF

Each channel is returned as a 2-digit hex number with a space between channels.

To read the first 16 channels of NV-RAM Preset 1, you would send "R200" (200 hex times the preset number). To read NV-RAM Preset 2 you would send "R400". The very last channel in the last preset is at address "FFFF".

S START CODE

This command lets you change the DMX Start Code. The only valid number defined by the DMX Standard for dimmers is 0, but other devices may require a different start code. There's no reason you can't change the start code between commands. This way you could have some non-standard item on the same DMX cable as well as normal lighting dimmers. Your computer would have to keep track of what it was sending to which device.

Example:

S0	(control regular lighting channels)
P 2	(send lighting data from preset #2)
P 0	(stop DMX output after current frame)
S55	(special start code for non-standard item)
W0 AA 55 42	(send commands to non-standard item)
P FF	(restart DMX output to send the data)
P 0	(stop DMX output after current frame)
S0	(back to beginning of loop)

TD TIME DELAY

This command will allow you to pause processing of any further commands until the delay has passed. The format is TD followed by the delay in hours, minutes, seconds, and tenths of seconds. It may be aborted with the * command. To delay for 1 hour, 2 minutes, and 3.4 seconds, send:

TD 1 2 3 4

You may truncate the line, the missing numbers will be assumed to be zero. To delay for 2 minutes exactly, you would send:

TD 0 2

See note below on Timer Range

TR TIMER READ

This command will give you the current timer value in hours, minutes,

seconds, and tenths of seconds. The hours are returned as a 4-digit hex number, all other numbers are 2-digit hex.

See note below on Timer Range

TS TIMER SET

This command will set the timer to whatever value you wish. It is useful for setting a known time at the start of a show (often 0h, 0m, 0.0s). To set the timer to all zeros, simply enter:

TS

To set it to 1 hour, 2 minutes, 3.4 seconds enter:

TS 1 2 3 4

The timer will start counting immediately after setting the new values.

See note below on Timer Range

TW TIMER WAIT

This command will wait until the given timer value (like an alarm clock). It may be aborted with the * command. If the time requested has already passed, you will receive an error. To wait until the time is 1 hour, 2 minutes, enter:

TD 1 2

See note below on Timer Range

UPDATE! UPDATE FIRMWARE

This command is only to be used when there is a firmware update available for your model number (firmware updates will NOT work on different models) and you wish to install it. If you are not having any problems with your current firmware, then there's probably no need to update it.

If you have custom firmware, then the update may only work for one specific serial number. Use the I command to check your model and serial numbers (these should also be on the label of the controller).

Assuming we sent you a new update or you downloaded one from our web site, then the first thing you should do is open the firmware file with a text editor and verify that the only thing it contains is 1000 or more lines that look like:

```
ED ED DC ED E0 E7 BE 99 8C 9F 99 84 83 8A CD AC 98 99 82 C0 A8 95 88 8E
CD BE 8E 9F 84 9D 99 CD C5 9D 9F 88 9E 9E CD C7 CD 99 82 CD 8C 8F 82 9F
99 C4 C3 C3 C3 ED B5 A8 DD E0 ED 12 85 D9 F7 FC DC FC FC 8C E0 E7 B8 9D
89 8C 99 88 CD 8C 8F 82 9F 99 88 89 C1 CD 9F 88 9E 99 8C 9F 99 84 83 8A
```

If there is any other text in the file, then there is something wrong with it.

Exit the file without saving it.

To install the update it's best to use the USB interface, but the RS-232 interface will work fine as long as your computer is using handshaking.

Installing an update will clear ALL presets, settings, macros, etc. The reason for this is new versions of firmware may store things differently

so nothing is saved.

To start the update process, enter:

UPDATE!

You must enter it exactly as it is above, all upper case and with the exclamation point at the end. Press return and you should be asked to send the file.

If you are using HyperTerm in Windows, select Edit and then "Paste from file". Select "Paste to remote computer" and then browse to where you've saved the update file and select it. Click OK and you should see lots of hexadecimal data flowing to the controller. If you are using some other terminal program, refer to its documentation as to how to send a text file.

After a while if there were no errors you should see a line that asks you to type a letter. The letter is chosen randomly to make SURE you want to do this. Type the letter shown (it will be a capital A-Z) and nothing else. Once you do that you are committed to the update. The POWER light will go out and the USER light (next to the POWER light) will start blinking. Do NOT turn off the power or interrupt this process or you may corrupt the update. If this happens the controller may have to be returned to us to have the firmware reinstalled.

After a couple of minutes the POWER light will come back on. At this point the RS-232 baud rate has been reset to 9600 and the handshaking to ON. Press your RETURN key once or twice and you should see the normal prompt.

Now use the I command to verify the firmware version is what you expected.

W WRITE TO MEMORY

This command allows you to update locations in the memory (Active or NV-RAM). You supply a 16 bit starting address followed by 1 or more bytes of data to be written. To write the data (1, 2, 3, 4) to channels 5-8 of Active Memory, you would use this command:

W 4 1 2 3 4

Note that the memory address is always 1 less than the channel number (assuming channel numbers for your dimmer start at 1). If you are writing to addresses in the Active Memory and the DMX output is on (green light lit), every change you make will be sent out to the DMX port immediately. This is the preferred way to dynamically control lights from your software; you only need to send the changes and they take effect immediately. If you are writing to presets 1-127 (addresses 0200-FFFF), each channel is stored as you enter it but it does not affect the current DMX output. Presets start every 200 hex addresses (512 bytes), so preset #3 would start at 600 hex and run through 7FF.

This command will allow you to write past the end of one preset and into the next. This could be handy for writing several presets all at once, but be careful that you don't erase the beginning of the next preset by accident.

XE EXECUTE MACRO

This command will start execution of a macro. You enter the command as:

`XE 0 1`

Where 0 is the macro number (0 = Auto-Exec Macro) and the 1 is the Label you wish to jump to. If the label is left off, execution will start at label 0.

If you specify a preset that isn't a valid macro or the label is not found, you will receive an error message. Also, if during execution an error occurs, a message will be sent to the host. All errors result in the macro aborting.

While a macro is executing, the POWER light will blink slowly.

XR READ MACRO

This command will copy a macro from memory to the host. You enter the command as:

`XR 0`

Where 0 is the macro number (0 = Auto-Exec Macro).

XW WRITE MACRO

This command will copy a macro from the host to memory. You enter the command as:

`XW 0 :0; TS; F1 100; TW 0 1; F0 200; J 0`

Where the first 0 is the macro number (0 = Auto-Exec Macro) followed by white space character(s). The rest of the line will be written to the preset as the macro (exactly as entered).

The example macro will clear the timer, fade to preset 1, wait until the timer gets to 1 minute, fade to black, then jump to label 0 (loop forever).

The Auto-Exec Macro can hold just under 400 characters (INCLUDING white space and comments), while the others can hold up to 511 characters (an entire preset terminated with '\0').

To erase a macro, enter the XW command followed by the macro number, then press ENTER.

X? MACRO HELP

This will print out a list of the currently available Macro Commands. The letters in parenthesis to the right of a command are the Flag Bits that are updated by this command.

Z WRITE STARTUP DATA

This command will copy the Preset Select, Start Code, Number of Channels, Frame Rate, Handshaking, baud rate, Shadow Preset mode, and Temperature Set to NV-RAM. These settings will be recalled the next time power is cycled. If you don't want anything to transmit on power up, clear the Auto-Exec Macro, set Preset Select to 0 and then issue the Z command. Note that you only have to set this up once and it will work every time power is cycled.

*** ABORT**

This will abort any current fade, timer or macro-based command (in case you told it to wait 20 hours instead of 20 seconds). The commands affected are TD, TW, F, and all the Macro commands. Everything that may have been sent between the current fade/timer/macro command and the * will be discarded. If the USB interface is being used and the host computer sends a RESET, or SETUP command, that will also cause an abort.

~ EXTERNAL EVENT

This is a special command for controlling the execution of Macros. The controller keeps an 8-bit Event variable in memory. This is set to 0 upon power up and is updated with this command as well as through macros. The format of this command varies slightly depending on if a Macro is running or not. Also see the "ER" and "EW" commands.

If a Macro is not running and you want to send the event 0x55, you would send the command as:

~U

followed by a carriage return. The U is the ASCII character 0x55, which is the number stored in Event. You may send any 8-bit value, but it MUST be the very next character after the '~'. Also be careful with sending '*' as it will be interpreted as an abort (abort has a higher priority when macros are not running). The last event sent will be held and will be immediately available to any Macros running. Also, see the EW command.

If a Macro IS running, you may send the "~U" at any time, even in the middle of entering another command (do not send carriage returns or extra characters, it could fill up the buffer and then the controller would ignore you). Note that EVERY character sent to the controller while a macro is running is checked to see if it's a '~' BEFORE any other checks are performed. The character following the '~' will ALWAYS be interpreted as an event and both characters will be removed from any further processing (they will not fill up the buffer). The controller will not give any response to receiving an event other than anything you may have programmed your Macro to output or do.

+ INCREMENT CHANNEL

This command allows you to increment one or more channels by set amounts. It is intended for applications where a simple controller like a

PLC or architectural lighting control needs to fade one or more channels up but doesn't have the processing power to calculate the values itself.

Enter the command by typing a '+', followed by the starting channel number, followed by white space and a list of amounts to add to the existing channel values. For example, the following command:

+ 5 1 2 0 3

Will start with channel 5 and add 1 to whatever value was stored there. It will then add 2 to channel 6, 0 to channel 7, and 3 to channel 8. All channel data is clamped meaning that if the channel was set to the value 0xFE and you increment it by 1 or more, the resulting value will not exceed 0xFF. The amount you increment by can be any value from 0 (do nothing to this channel) to 0xFF (go to full on).

If your list of values causes the channel number to go past the last channel (0x1FF), it will wrap back to channel zero. This could be handy, or dangerous, depending on your view.

- **DECREMENT CHANNEL**

This command is identical to the INCREMENT CHANNEL command, only the values you supply are subtracted from the channel data. The channel data will clamp at zero, so you don't need to worry about decrementing too much.

^A ANALOG INPUT

This command reads the input lines as analog data. You can read any of the 8 inputs with this command. The data returned will be a number from 0-255 decimal which represents 0-5V on the input. The inputs are numbered 0-7.

To read input number 3 you would enter:

^A 3

and the response would be a two digit hex number.

^S SHADOW PRESET ENABLE

This command will enable the Shadow Presets. When turned on, preset numbers 126-127 will be read/written from RAM instead of NV-RAM. This makes access much faster and removes any possibility of burning out NV-RAM presets. Upon power-up, whatever data is in NV-RAM presets 126-127 will be copied into the Shadow Presets. Once enabled, you may treat these two presets like any other preset (reading, writing, use for macros or mask data, etc.). The format of the command is:

^S 1

A zero will turn off Shadow Presets, any other number will turn them on. This setting is saved with the "Z" command.

^TC READ TEMPERATURE IN C

This command will reply with the current temperature of the processor inside the controller. This could be used to generate an

alert for a controller in a remote location. The temperature is given in degrees C as a two digit hex number. Any temperature below zero is reported as zero.

^TF READ TEMPERATURE IN F

This command will reply with the current temperature of the processor inside the controller. This could be used to generate an alert for a controller in a remote location. The temperature is given in degrees F as a two digit hex number. Any temperature below zero is reported as zero.

^TS SET TEMPERATURE

This command allows you to calibrate the temperature setting. To make the calibration as accurate as possible, allow the controller to sit at a constant temperature for an hour or more with the power off. Measure the temperature of the controller's surroundings then turn on the power and issue the command. For example, if the controller is currently in a room that's 80.6F (27C) you would issue the command:

^TS 1B

Where 1B is 27 in hex. You must use degrees C to set the calibration.

Save the calibration with the Z command.

^U USER LIGHT

This command lets you control the User light. The light is to the right of the POWER light. It allows you to do four things with the light:

- 0 = turn off
- 1 = slow blink
- 2 = fast blink
- 3 = solid on

So, to make the light blink rapidly you'd enter:

^U 2

? HELP

This will print a list of the currently available commands.

Macros

This controller has a powerful macro language built in. More commands may be added in the future, but the current commands allow a lot of options. Using the Macro feature requires a little care, as is the case whenever you are programming a computer or PLC.

A little explanation about how macros are stored. The Auto-Execute Macro (#0) is stored in a reserved part of NV-RAM but Macros 1-127 use the SAME NV-RAM locations as Presets 1-127. If you have Shadow Presets enabled, then Macros 126-127 will be stored in RAM. This means you can read/write Macros 1-127 with the R and W commands and also read/write/execute Presets 1-127 with the X commands (this is perfectly OK as long as you keep track of what is where). The Macros are stored in straight ASCII Text with a NULL ('\0') to terminate the string. The difference between the XW command and the W command is that XW accepts a text string and adds the NULL at the end for you. Feel free to use either method of editing Macros, just be careful. You MUST use the XW and XR commands to write/read the Auto-Exec Macro (Macro 0).

Since Macros and Presets use the same memory, this means you can confuse things. If you write a Macro into location 0x10 and then issue the "P 10" command, you will send the Macro out as lighting levels. This is probably not what you had in mind. We suggest either sticking with only Macro 0 which is in a reserved place in NV-RAM or placing all the macros at the end of NV-RAM while placing all your Presets at the beginning of NV-RAM. Something like 1-100 = Presets, 101-127 = Macros. In almost all cases, Macro 0 should be enough.

There is one other thing about Macro 0, it can only hold just under 400 characters while the rest of the Macros can use the entire Preset they are in (511 characters plus one NULL).

When a Macro is started, it is copied to RAM and scanned to find all labels. A macro must have at least one label before the first executable command. After all the labels have been located, the Macro is executed from whatever label was specified when it was called (if no label was specified, 0 is assumed).

You may have any amount of white space and/or comments in the Macro that you want, but excess space uses up memory and also slightly slows down execution of the Macro.

Every command inside a Macro must be terminated with the ';' character, except for the last command in the Macro. If execution reaches the end of the Macro, execution is aborted without an error.

The math instructions treat the Event data as an register in a microprocessor. All math operations are done through the register (Event) and the results may effect the Flags and/or one of the lighting channels (0-0x1FF). If the host sends new Event data with the ~ command while a macro is executing, the new data will overwrite whatever a math instruction may have written to Event. It's probably best to not use math instructions that change Event when the host is also changing it.

Flags

Math instructions often update flags to indicate the result of the operation. Flags are also used to read the contact closure (digital) inputs.

The Flags are stored in a single byte and are defined as follows:

bit 0	Zero	The last instruction caused Event to be zero
bit 1	Carry	The last instruction caused an over or underflow
bit 2	Digital 2	Status of digital input 2, high == 1
bit 3	Sign	The last instruction caused bit 7 of Event to be high
bit 4	Digital 4	Status of a digital input, high == 1
bit 5	Digital 5	Status of a digital input, high == 1
bit 6	Digital 6	Status of a digital input, high == 1
bit 7	Digital 7	Status of a digital input, high == 1

The Carry bit is also set/cleared by the TT command.

The Zero, Carry, and Sign flags may also be set using the MF command and “EW” from the host.

Flag bits can be tested with the J (jump) instruction.

Macro Commands

The following commands are available for use INSIDE a Macro:

F, P, S, TD, TS, TW, TR, +, -, ^U, ^A, ^TC, ^TF

All operate the same as the regular versions. The “TR” command sends the time back to the host, this could be handy for debug and triggering of other devices. The “TW” command does NOT generate an error if the time has already passed, it just continues execution of the macro.

^A Same as the “^A” command, except the analog value is placed into Event. Sign and Zero are updated.

^TC Same as the “^TC” command, except the temperature in degrees C is placed into Event. Carry set if temperature is below zero. Zero flag also set.

^TF Same as the “^TF” command, except the temperature in degrees F is placed into Event. Carry set if temperature is below zero. Zero flag also set.

TT Same as the “TW” command, except instead of waiting for the time to pass, the time is only tested and the Carry bit is set if the current time is greater or equal to the specified time, otherwise Carry is cleared. Execution does not pause.

Q Quit Macro, return control to host.

- : Set a label. Example “:0;” is label 0. Valid range of labels is 0-0xFF. Labels do not have to be in order (you may skip around);
- ‘ Comment. Anything following the apostrophe until the next ‘;’ will be ignored. Reserved characters like ‘~’ are not allowed in comments. Comments slow down execution slightly. Comments must start where a valid command would start (not before the ‘;’ of the previous command).
- L Link to another Macro (“long jump”). “L 10 5;” would start Macro 0x10 at Label 0x05, the same as sending “XE 10 5” from the host. “L 10” would start Macro 0x10 at label 0.

J Test Event and/or Flag Bits and jump to label. The format is:
 J 1 2155 0150;
 Where the 1 is the label to jump to, the 0x2155 will be ANDed with the most recent Flags and Event data, and the 0x0150 is what must be matched to perform the jump. In the case of the example,
 “if(((Flags & 0x21) == 0x01)) && ((Event & 0x55) == 0x50)))
 Jump to Label_1”.

If you aren’t interested in the Flags, you can just look at the event as in:

J1 55 50;

If you leave the last number off (the 0x50), the result must equal zero. If you leave off both numbers, then this will be an unconditional jump.

J1;

Will jump to label one in all cases. If the label is not found, an error is generated.

Execution speed is not affected by the length or direction of the jump.

- O Output string to host. The string format is similar to a “C” string. Example: O “String to host. \r\n”;
 Restricted characters are ‘*’, ‘,’ , ‘:’, ‘”’, ‘~’, ‘\’ and NULL. Do NOT use these characters directly in a string. If you wish to use any of these, use the escape commands below. Note that to send the ‘\’ from “C” you need two of them “\\”.

\\a = bell

\\b = backspace

\\f = formfeed

\\n = newline

\\r = return

\\t = horizontal tab

\\v = vertical tab

\\ = ~ (tilde)

\\8 = * (asterisk)

\\. = : (colon)

\\, = ; (semi-colon)

\\# = Event data as a two digit hex number

\\ = backslash (from “C” this would look like “\\”))

Math Commands

All the following commands work with the Event data as if it were an accumulator and the Active Memory (Preset 0) as if it were 512 registers. Note that any channels above the number set by the N command will NOT be changed with the Fade or Preset commands and so may be used for general storage (data in these locations will be random when the macro starts unless a Copy command was issued before the macro started). In most applications, this will give you several hundred bytes of storage. Any changes to a channel that’s currently being sent out will take effect on the next update (essentially instantly).

Some commands set/clear flag bits depending on the results of the operation. The host can force-load the Event data at any time with the “~” command, so use this carefully.

The first two commands (+ & -) do NOT start with ‘M’ to differentiate them from the “M+” and “M-” commands.

+ INCREMENT CHANNEL[Event]

This command allows you to increment a channel by a set amount. Note that this differs from the normal ‘+’ command in that the channel number is taken from the Event register and you supply a fixed increment amount. Also, you can only increment one channel at a time from inside the macro, but you could easily write a loop to increment the channel number and then the channel.

The format is a ‘+’, followed by white space and the amount to add to the existing channel value (pointed to by the Event register). For example, the following command:

+ 1

Will add 1 to whatever value was stored in the channel pointed to by the Event register. Zero, Sign, and Carry are updated.

All channel data is clamped, meaning that if the channel was set to the value 0xFE and you increment it by 1 or more, the resulting value will be 0xFF. The increment value can be any value from 0 (do nothing to this channel) to 0xFF (go to full on).

Note that since the Event register is only 8 bits, this command can only be used on the first 256 channels (00-FF).

- DECREMENT CHANNEL[Event]

This command is identical to the “INCREMENT CHANNEL[Event]” command, only the value you supply is subtracted from the channel

data. The channel data will clamp at zero, so you don't need to worry decrementing too much.

- MA Bitwise AND channel into Event. "MA 105" will read the data from channel number 0x105 and AND it into the Event data, with the result left in Event. The Zero and Sign flags will be updated.
- MD Divide Event by a channel. "MD 1" will divide the Event by the data in channel 1 and leave the results in Event. Zero and Sign are updated. Divide by zero results in 0xFF in Event.
- MF Set the flag bits (z, c, s only). "MF 0" will clear all three bits.
- MIL Load Event indirectly. Assume channel 0x103 has the data 0x12 in it. "MIL 103" will copy the data from channel 0x12 into Event, using channel 0x103 as a pointer. In order to indirectly access channels 0x100-0x1FF, set the high bit of the pointer channel number to one. "MIL 8103" will copy the data from channel 0x112 into Event. No flags are changed.
- MIW Write Event indirectly. The same as "MIL", except Event is copied TO the channel pointed to. If channel 0x103 has 0x12 in it, "MIW 103" will copy Event to channel 0x12.
- ML Loads Event with the data from the channel. "ML 5" copies the data in channel number 5 into Event. No flags are changed.
- MM Multiply Event by channel. "MM 4" will multiply the Event by the data in channel 4, leaving the results in Event. Zero, Sign, and Carry are updated. Carry set on overflow.
- MN Bitwise compliment of the data in Event. If Event is 0xAA and you issue the "MN" command, Event will become 0x55. Zero and Sign are updated.
- MO Bitwise OR channel data into Event. Zero and Sign are updated.
- MR Load Event with a random number. The normal "C" rand() function is used. The seed is set from an interrupt counter the first time "MR" is called, so there will be a variation in the sequence of numbers every time you power up the unit. The numbers returned will fall between 0 and 0xFF with any number as likely as any other. Zero and Sign are updated.
- MS Swap the data in Event with a channel. Assume Event has 0x12 in it and channel 3 has 0x34 in it. When you execute the "MS 3" command, Event will now have 0x34 in it and channel 3 will have 0x12. No flags are updated.
- MW Write Event to a channel. "MW 6" will copy the contents of Event to channel #6.

- MX Bitwise XOR Event by a channel with the results left in Event. Zero and Sign are updated.
- M# Load Event with a constant. “M# 6” will place the number 0x06 in Event. No flags are updated.
- M+ Increment Event. Zero, Sign, and Carry are updated. Carry will be 1 if Event rolled over to zero.
- M- Decrement Event. Zero, Sign, and Carry are updated. Carry will be 1 if Event rolled over to 0xFF.
- M> Roll Event Right through Carry. Assume Carry is 1 and Event is 0x10. After the “M>” command, Event will contain 0x88 and Carry will be zero. Zero, Sign, and Carry are updated.
- M< Roll Event LEFT through Carry. Assume Carry is 1 and Event is 0x10. After the “M<” command, Event will contain 0x21 and Carry will be zero. Zero, Sign, and Carry are updated.

Macro Examples

Let's walk through an example.

First, write the macro to the Auto-Exec location

```
XW0 :0; P 1; TD 0 1; F 2 100; J 10 FF 1; F 1 200; J 0; :10; F 3 100; TD 0 1; J 0
```

We wrote this to the Auto-Exec position, so you can either manually start it with "XE0" or just cycle the power and it will start executing.

:0;	Label 0
P 1;	Copy Preset 1 to Active Memory
TD 0 1;	Delay for 1 minute
F 2 100;	Fade to preset 2 over 25. 5 seconds
J 10 FF 1;	Conditional jump. AND Event with 0xFF and compare to 0x01
F 1 200;	Fade to preset 1 over 51. 2 seconds
J 0;	Unconditional jump to Label 0
:10;	Label 10
F 3 100;	Fade to preset 3 over 25. 5 seconds
TD 0 1;	Delay for 1 minute
J 0	Unconditional jump to Label 0
	(semi-colon not needed since it's the last command)

This will loop forever unless an Abort (**) is received.

It's OK to add comments after the last command, assuming the last command is either an Unconditional Jump or Quit. Be sure there's a semi-colon ';' between the last command and the comments. You may also put comments BEFORE the first label, if you wish. Anything before the first label will not be executed (do NOT put colons in the comments!).

The label that starts the Macro does NOT have to be the first label. The Auto-Exec Macro always starts at Label 0, but the label may appear anywhere in the macro.

Here are some macros that show a few more possibilities:

Use a 2 pole rotary switch to select one of four presets:

```
:0; J1 3000 0; J2 3000 1000; J3 3000 2000; J4 3000 3000; :1; 'Fade to Black; F0 0 0 5; J0; :2; 'Light Door; F1 0 0 10; J0; :3; 'Light Window; F 2 0 0 20; J0; :4; 'Flash; TS; :5; P3; TD 2; P4; TD 2; TT 0 0 2; J5 200 0; J0
```

The above would all be one macro without the line breaks. Here's what's going on:

:0; Label 0 is the default starting label for a macro

J1 3000 0; J2 3000 1000; J3 3000 2000; J4 3000 3000; This is a "jump table", it tests the digital inputs 4 & 5 (which are connected to external switches, or other device) and then depending on their levels, decides where to jump next. Note, the first test "J1 3000 0;" could be left out since the other tests would fail, letting the

execution continue with label 1 anyway.

:1; 'Fade to Black; F0 0 0 5; J0; This label is jumped to if both switches are open (high). The comment will be ignored and the lights will fade to black in 0.5 second, then execution will jump back to testing the switches. Note that if the switches haven't changed, this will be executed over and over again. In this case nothing is hurt by this since fading from black to black doesn't change anything. A better version of this might be:

:1; 'better Fade to Black; F0 0 0 5; :11; J11 3000 0; J0

This will fade to black once, and then loop just testing the switches until they change to some other value. This same sort of thing can also be done for sections 2 & 3 below.

:2; 'Light Door; F1 0 0 10; J0; This will fade the lights to preset #1 over 5 seconds. Note the comment above about a better jump condition (otherwise the switches will only be tested every 5 seconds at the end of each fade).

:3; 'Light Window; F 2 0 0 20; J0; See "Light Door" above.

:4; 'Flash; TS; :5; P3; TD 2; P4; TD 2; TT 0 0 2; J5 200 0; J0 This one's a bit more interesting. It starts out by resetting the clock to all zero. Then it sets the lights to Preset #3 with no delay (let's say this is all lights on). It then delays 0.2 second and sets the lights to Preset #4 (lets say this is all lights off). It waits 0.2 second more, then it tests to see if 2 seconds have gone by since the TS command. If not (carry = 0), then we jump to label 5 and do one more blink cycle (without resetting the clock). Once 2 seconds have gone by, the TT command will set the carry high, causing the J5 test to fail. We then jump back to Label 0 to start all over again.

Use two switches to raise/lower a set of lights:

:0; TD 0 0 0 1; J1 3000 1000; J2 3000 2000; J0; :1; 'raise lights; M# 0; + 2; M+; + 3; J0; :2; 'dim lights; M# 0; - 2; M+; - FF; J0

Here's what's going on:

:0; TD 0 0 0 1; The macro starts at label 0, then delays for 1/10th second.

J1 3000 1000; J2 3000 2000; J0; This is a jump table. If one switch is pressed, it jumps to label 1 (fade up). If the other switch is pressed it jumps to label 2 (fade down). If both or neither switch is pressed, it jumps back to label 0 to start over (does nothing).

:1; 'raise lights; M# 0; + 2; M+; + 3; J0; Here we have a label, a comment, and then we load the value 0 into the Event register. We then increment channel zero (based on Event being zero) by 2. Then we increment Event and increment channel 1 by 3. Now we jump back to label 0 to start over.

:2; 'dim lights; M# 0; - 2; M+; - FF; J0 This is similar to the above, only we're decrementing. Note also that channel 1 will go full off at the first press of the switch and stay there.

NV-RAM Notes

The original version of this controller made in 1999 used FRAM for all the memory. This had good and bad points. FRAM is non-volatile (maintains the contents with the power off) and is fast enough to keep up with the DMX output speed, but until recently would burn out too soon. This forced us to set the DMX frame rate (number of times per second that one set of N channels is sent out) very low. This made it hard to control certain devices or get smooth fades without sending constant data using the D command.

The processors used in our newer versions have lots of static RAM (SRAM) and several other nice features. This is something you just couldn't find when we built our first controllers in 1999. The DMX data is now sent from this RAM (Preset "0"), so the number of reads/writes does not matter (RAM does not wear out from use). This allows a control program to use the W command to just send changes to the Active Memory. Presets 01-127 are now stored in EEPROM (126-127 may optionally be also stored in RAM). EEPROM isn't all that fast, but is only accessed when you change presets or edit it (neither of which should mind a few milliseconds delay). Now here's the warning: an EEPROM allows unlimited reads but is limited to about 1 million writes before it is burned out. This limit is per memory location, so if you constantly wrote to Preset 1 it would eventually burn out (return invalid data) but the rest of the memory would still work fine. So, if you have a need to change presets a lot, change which one you use from time to time.

If you were to change Preset 1 every hour non-stop, it would burn out in 114 years. If you changed it every minute, it would burn out in just under 2 years. Still not bad.

If you DO burn out the memory, it can only be replaced by returning the controller to us for repair. It's not expensive but you will be without a controller during shipping/handling time.

If you need to change macros or presets often, you should use the Shadow Presets. Being in RAM, these will not burn out and are very fast.

Timer Notes

In order to keep track of real-time events, this controller maintains a real-time clock. Most commands don't care what the absolute value of the clock is, only how much time has passed since the command was issued. If you never use the "TW" or "TT" commands (which use an absolute time), then you will probably never need to set the clock with the "TS" command or read it with the "TR" command.

If you DO wish to use absolute time, there are a couple of things to keep in mind. First, the clock can count up to about 6 months before rolling back over to all zeros, but the timer commands will only accept times up to about 10 days. If you have a need to time longer than that or you want the clock synchronized to your watch, you're going to have to set it at least every 10 days with the "TS" command. This shouldn't be a problem as long as a host computer is connected (just issue a "TS" command at the beginning of each show).

Next is accuracy. This clock isn't intended to be super accurate and may be off by as much as a minute a day. Again, if you need more accuracy, your host computer can reset the clock as often as you wish. Most shows that use absolute time will want to start at zero for every show anyway.

When you are issuing any command that requires you to supply a time value (such as "TS"), the format is:

TS hh mm ss tt

hh = hours, range is 00-FF (0-255 hours)

mm = minutes, range is 00-FF (0-255 minutes)

ss = seconds, range is 00-FF (0-255 seconds)

tt = tenths of seconds, range is 00-FF (0-25.5 seconds)

You may leave off tt, if you wish.

You may leave off ss if you also leave off tt.

You may leave off mm if you also leave off ss and tt.

You may leave off hh if you leave off mm, ss, and tt.

Any values you leave off will be set to zero. The command "TS" with no numbers following it will set the clock to all zeros.

You'll notice that other than hours, you are allowed to enter values larger than what's normal in that place. This allows you to enter 78 (hex) in the seconds position and get the same result as if you entered 2 minutes. All of the following will get you a 2 minute delay:

TD 0 2

TD 0 0 78

TD 0 1 3A 14

When reading back the time, you will see FOUR digits for the hour, and 2 for the rest of the numbers. This allows about six months before the clock rolls over back to zero, if you care.

Power Notes

This controller runs on 5V and 3.3V internally and has a switching voltage regulator that is specified to work from about 4.5V to 50V. To allow a little margin, we have specified the voltage requirements as 5-48VDC at about 150mA (a DMX short will draw more current but will not hurt the controller). If you are drawing any power from the INPUT ribbon connector, then the current draw will also increase. The lower the voltage you run the controller at, the more current the board will draw. If you are using the USB, your computer will normally supply all the power needed. If you need external power, you may use your own AC adapter (we recommend between 5 and 24VDC) or you may order an AC adapter and/or DC power cord (with or without a cigarette lighter plug on it) from us. Here are the specifications for the power plug:

Co-axial Power Plug
2.5mm internal diameter
5.5mm external diameter
Center Positive

There are blocking diodes in line with the AC adapter and USB power so there is no interaction between the two (the adapter won't try to power the host computer). If the AC adapter is supplying a higher voltage than the USB connection, then the controller will use that power and not the host computer's (saving a laptop's batteries). If the host is turned off or the USB cable is unplugged, the controller will continue to operate. If AC power is lost or the adapter unplugged, the controller will switch to using power from the USB host, if one is connected. It's perfectly OK to plug and unplug the AC adaptor while the USB cable is plugged in.

There is a 0.5 Amp circuit breaker on the power input, it will automatically reset after an overload is removed.

If you need to power external devices, you may draw 5V power from the ribbon cable connector. The amount available ranges from 50mA to 200mA, depending on the voltage of the power source. If you need more than 50mA, you should use a higher voltage external power source (such as 12V or 24V). Shorting the ribbon cable power pin to ground will reset the controller but should do no other harm. Do not feed power into this pin.

USB Notes

USB = Universal Serial Bus. See <http://www.usb.org> for more information.

There are several types of USB devices that all host computers are supposed to know how to talk to without any additional drivers. Unfortunately, serial ports aren't one of them. Our previous controller used a USB interface chip that required a driver or extra work by programmers writing software for it. That chip is now obsolete and we are using an FTDI chip. The serial port driver for this chip is probably already installed on your computer (Windows, Mac, Linux). If it isn't and you're using Windows, then it will be automatically downloaded from the Internet the first time you plug in the controller. If your computer doesn't already have the driver, then you can find the latest for many different systems here:

<http://ftdichip.com/Drivers/VCP.htm>

If they've moved the page, go to

<http://ftdichip.com>

click on their DRIVERS link and look for the VCP driver for your system.

Some things to be aware of with USB devices

- This controller is a "Full Speed" USB 2.0 device and may be plugged into either a "Full Speed" or "High-Speed" port (USB versions 1.0, or higher)
- The USB is a shared resource. If you have a lot of devices (or a few data intensive ones like cameras or disk drives) on the bus, the amount of data you can send to the controller per second will go down.
- With USB devices, if you plug and unplug them rapidly or several times in a row, some host computers may get confused and crash. Whenever attaching a USB device, plug the cable in quickly and don't unplug it again for several seconds. Also wait before plugging it back in.
- If the host computer or USB hub thinks a device is drawing too much power, that particular device will be turned off. There is no harm done (other than the DMX Controller shutting down), but this often means rebooting your computer to get the power back on. Some older hubs are much more sensitive than newer ones. If you have any trouble with this, use an AC adapter to supply power to the controller (this will also keep the DMX signal alive, even if the host or hub is turned off and will save a laptop's batteries).
- Computers will try to place USB devices into SUSPEND (power down) mode when the computer isn't used for a while. If a SUSPEND command is received, the controller will switch back to the RS-232 connection but will continue to draw power from the USB host as long as it's available.
- Some old Windows machines don't like to boot with the controller plugged in.

California Proposition 65 Warning

The following information is required by the State of California's Safe Drinking Water and Toxic Enforcement Act of 1986, or Proposition 65. This California regulation does not address safe levels, anything detectable at any level counts; therefore, even trace amounts of the chemicals included on Proposition 65's list of chemicals known to the State of California to cause cancer or reproductive toxicity must be noted with the "Safe Harbor" wording. A "lead free" and/or RoHS device will probably still have detectable quantities of some chemical on this list.

WARNING: This product contains lead and other chemicals known to the State of California to cause cancer and/or birth defects and/or other reproductive harm.

Warranty

Durand Interstellar, Inc. warrants this product to be free from manufacturing defects in original material, including original parts, and workmanship under normal use and conditions ("manufacturing defect") for a period of one (1) year from date of original purchase. A charge will be made for repairs not covered by the warranty.

Should service become necessary, contact Durand Interstellar, Inc. for return authorization and then:

- Pack the unit in a well-padded corrugated box
- Enclose a copy of your proof of purchase, if you are not the original purchaser
- Ship the unit prepaid via an insured carrier

NOTE: This warranty is void if the product is:

- Damaged through negligence, misuse, abuse, or accident
- Modified or repaired by anyone other than Durand Interstellar, Inc.
- Damaged because it is improperly connected to equipment of other manufacturers or through the failure of other equipment

NOTE: This warranty does not cover:

- Damage to equipment connected to the product
- Cost incurred in the shipping of the product to Durand Interstellar, Inc.
- Damage or improper operation caused by customer abuse, misuse, negligence, or failure to follow operating instructions
- Ordinary adjustments to the product which can be performed by the customer as outlined in the instruction manual
- EEPROM burnout after the first 60 days
- Improper operation caused by software written by any third party

ANY APPLICABLE IMPLIED WARRANTIES, INCLUDING THE WARRANTY OF MERCHANTABILITY, ARE LIMITED IN DURATION TO THE PERIOD OF THE EXPRESSED WARRANTY AS PROVIDED HEREIN BEGINNING WITH THE DATE OF ORIGINAL PURCHASE AT RETAIL, AND NO WARRANTIES, WHETHER EXPRESS OR IMPLIED, SHALL APPLY TO THE PRODUCT THEREAFTER. DURAND INTERSTELLAR, INC. MAKES NO WARRANTY AS TO THE FITNESS OF THE PRODUCT FOR ANY PARTICULAR PURPOSE OR USE.

UNDER NO CIRCUMSTANCES SHALL DURAND INTERSTELLAR, INC. BE LIABLE FOR ANY LOSS, DIRECT, INDIRECT, INCIDENTAL, SPECIAL, CONSEQUENTIAL DAMAGE, OR PATENT ISSUES ARISING OUT OF OR IN CONNECTION WITH THE USE OF THIS PRODUCT.

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