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Warranty and Disclaimer

Warranty

Northlight Systems warrants this product against defects in materials and workmanship for a period of 1 year.

If the board is defective, we will, at our option, repair or replace the product. We offer a full refund on the purchase price if returned in original condition in less than 30 days.
Return the product with a description of the problem. We will return your item or its replacement using the same shipping method used to ship the product originally.

Disclaimer of Liability

Northlight Systems is not responsible for any special, incidental, or consequential damages resulting for any breach of warranty, or any legal theory, including lost profits, downtime, goodwill, damage to or replacement of equipment or property, and any costs associated with the use of Northlight Systems products described herein.
Northlight Systems has a policy of continually improving our products as new technology becomes available. Northlight Systems reserves the right to make changes and improvements to the specifications of this equipment at any time without notice.
Northlight Systems has made every attempt to ensure that the information in this document is accurate and complete. Northlight Systems assumes no liability for any damages that result from the use of this manual or the equipment it documents. Northlight Systems reserves the right to make changes to this document at any time without notice.

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4 Channel, Digital Dimmer board

Features

- Accepts DMX512 digital protocol
- Accepts 0-10 VDC control voltage
- Outputs 4 channels, 256 discrete levels
- Mini DIP switch address all 512 channels.

SPECS

Input Signal: Northlight Dim04 board accepts DMX512 - 1990 as specified by USITT. The Dim04 board can receive data at the full rate. The dimmer is responsive to all 512 channels.
The dimmer will also accept 0-10 VDC control voltage simultaneously with the serial input, on a highest takes precedence basis.

Output: Output is 4 channels TRIAC based AC phase control.

Address switch: Mini DIP switches.

Power requirements: 6 to 12 volts AC @ 150 mA. Max. for controller board.

LED Indicators:
Green DMX512 present indicator.
Flashing indicates no DMX. Steady bright indicates good DMX. A steady dim LED indicates bad or backwards DMX connection.

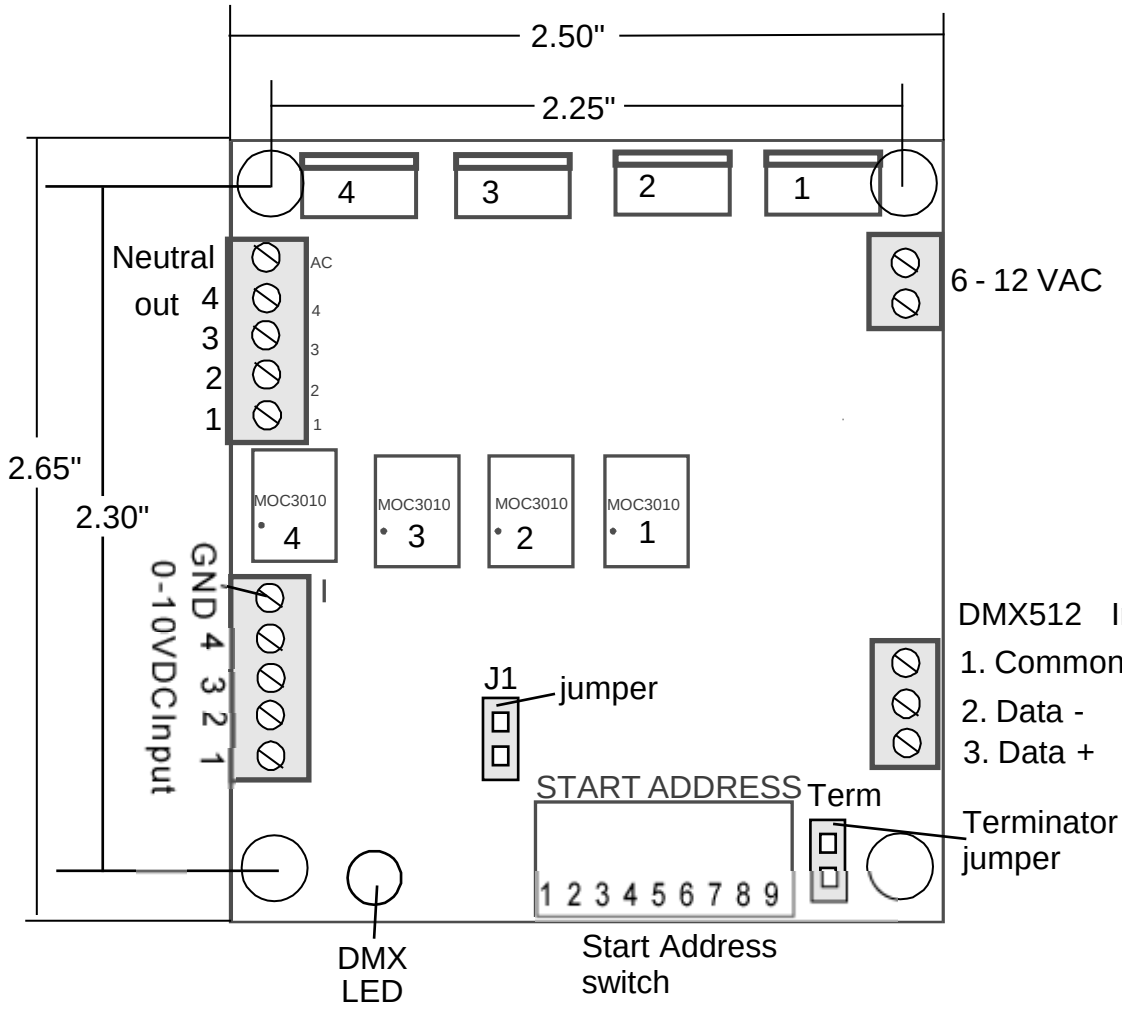
Board connections: All connections are made via screw terminals.

Physical Dimensions

2.65”L X 2.50”W +/- .10”

The **DMX input** pin numbers correspond to the XLR pin numbers.

The **Common** connector is signal ground – not earth ground.



Using the Dimmer

Power Input
6 to 12 volts AC @ 150 mA. MAX current, for the board.
On average the current consumption is around 60 mA.
A 6 volt standard transformer is recommended.
The power transformer and the load must be on the same AC phase.

Ground
The DMX512 signal ground connector is the common signal ground – not earth ground.

DMX512 In
The DMX input pin numbers correspond to the XLR pin numbers.
Pin 1 is signal ground
Pin 2 is DMX512 -
Pin 3 is DMX512 +

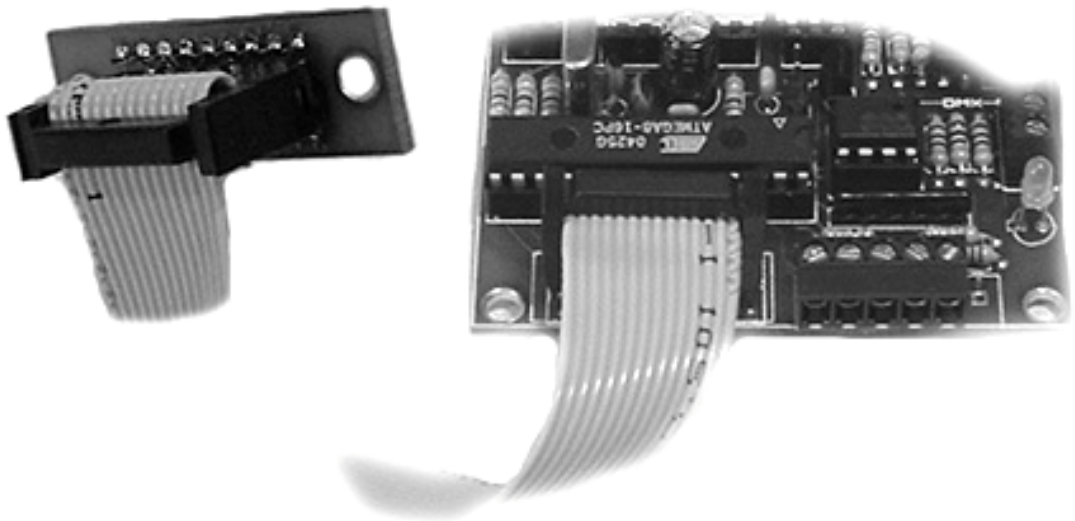
Address Switch
The individual switches are numbered 1 – 10, left to right. On the switches, Up position is on, Down is off.

0-10 VDC input
The 0-10 VDC input should be a clean filtered DC voltage. Any ripple or noise on the signal will be reflected in the output levels, such as flashing or unsteady light levels.
An example circuit is shown at the back of this manual.

Setting the address for DMX512

Set the starting address to the first in a group of 4.
The address is entered on the DIP switches in standard binary code starting with 0.
See the chart of all 512 address switch positions at the back of this manual.
For DMX512 the address can be up 511. On the switch, up is on, down is off.

The mini DIP switch on the ribbon cable is connected as shown below.



Using the configuration jumper

J1 – Determines the output in the event of DMX signal loss.

Open(no jumper) - When the DMX signal is lost, the output will be zero.

Closed(jumper in place) – When the DMX signal is lost the board will hold and continue to output the last valid data.

Setting up the DMX connectors

The current DMX512 standards require one to provide passive loop through connectors.

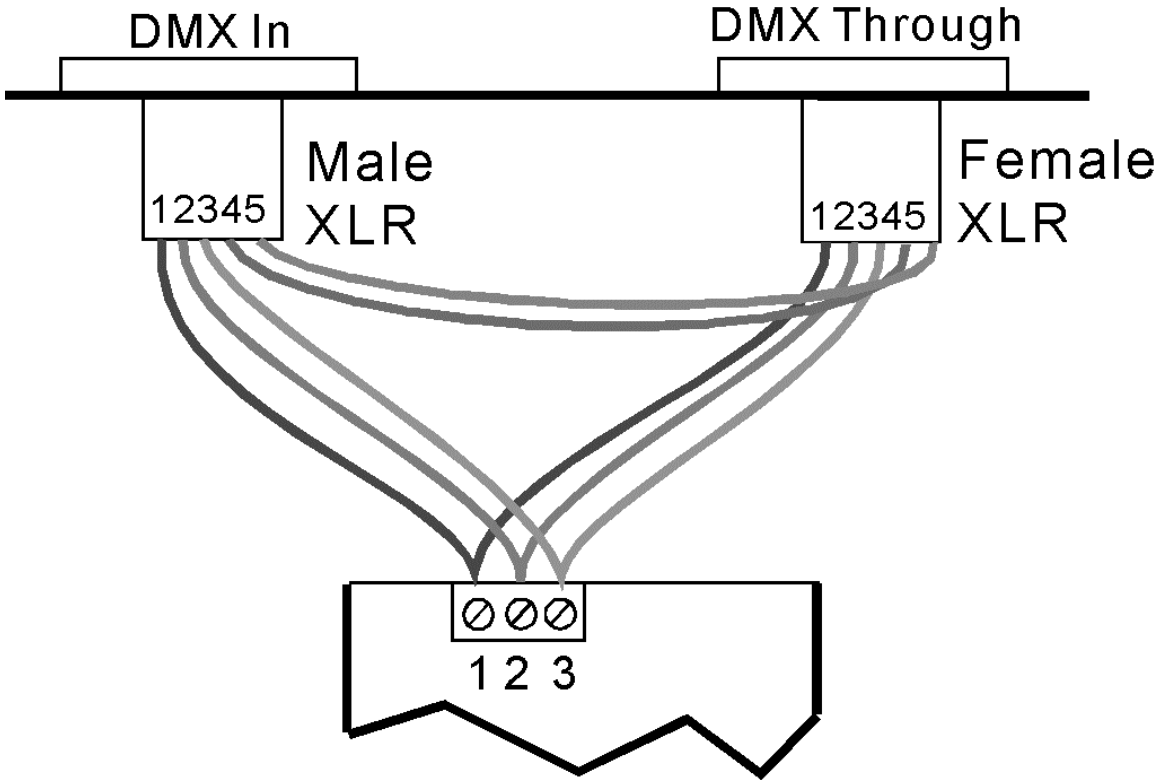
The specific description is below:

Passive loop through ports

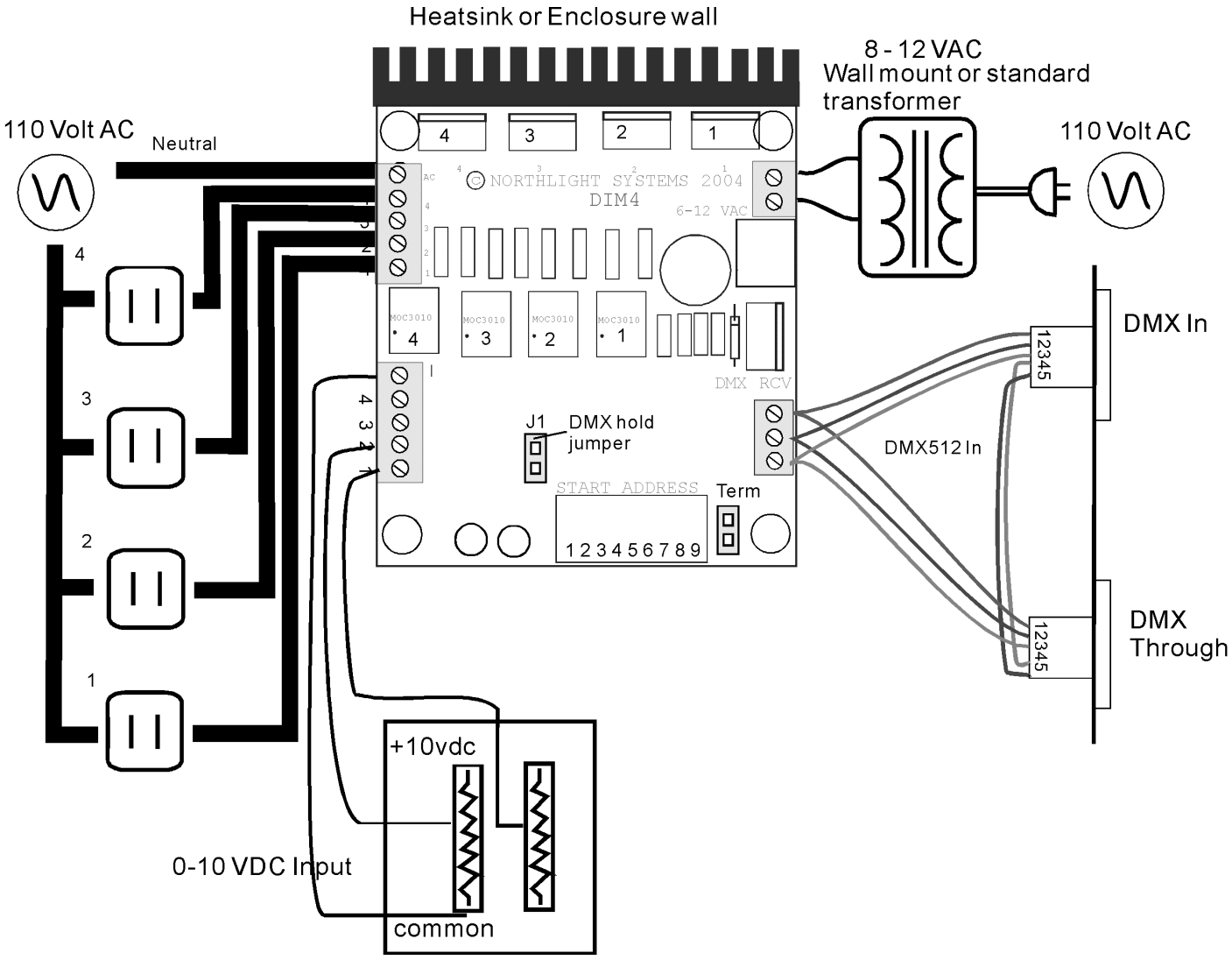
Devices containing two DMX512 ports, one for receive and one for transmit, … , shall provide a direct passive link for all pins between the two ports.

Equipment designers are encouraged to provide passive loop through on Pins 4 and 5 whenever possible, even if not required.

The drawing below shows a typical installation.



Typical hook up



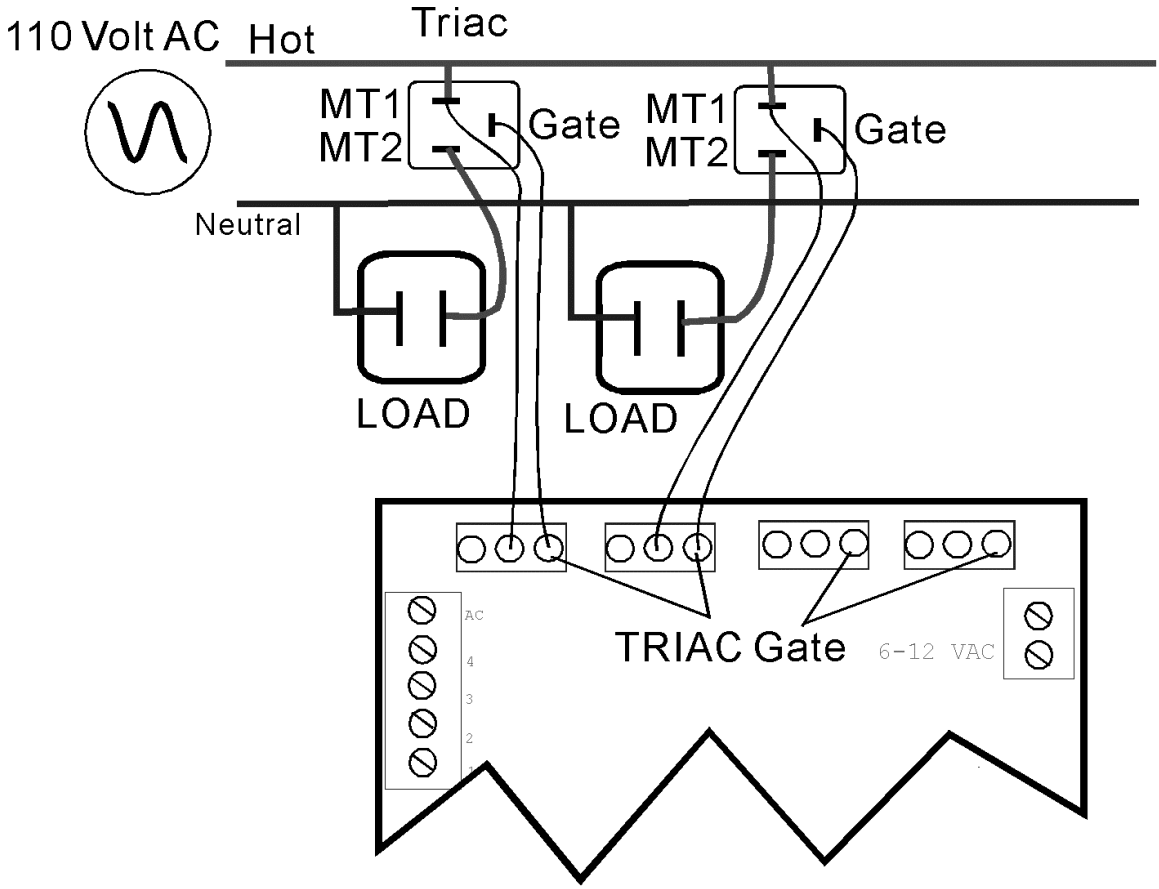
Mounting large TRIACS off the board

The main current limiting factor for board mounted TRIACS is the width of the PCB traces.

Much larger currents can be controlled when the TRIACS are mounted off the PCB and wired with the appropriate size wire.

The drawing below shows a typical wiring layout for using 20 Amp “fastpak” TRIACS mounted on external heatsinks.

The main current limiting factor is the size of the input AC feed, the TRIAC current handling capability and heatsink used. Since the PCB traces only handle a small amount of current the drive the TRIAC gate the load can be any practical size.



Hardware

Transformer

As you can see from the hook up drawing the dimmer board requires an AC transformer input for the board power. The reason for this is that the board uses the transformer power to synch up to the AC line. If DC power is input to the board it will seem to work, the LED's will light up, but it will not dim.

The transformer must be connected to the same hot leg of the AC power line as the TRIAC's.

This dimmer is a single phase dimmer. That is to say that all the TRIAC's must be connected to the same hot leg of the AC power line.

Heatsinks

TRIACS require heatsinks if they are controlling more than a few watts of lighting. The heatsink can be individual or a larger heatsink can be attached to all the TRIAC's . The metal tab on the TRIAC is isolated so it can be attached directly to the heatsink.

In some situations where a metal enclosure is used the enclosure can be used as a heatsink.

Fan cooling is required if the TRIAC is used near its maximum rating. In general any TRIAC that has a load of over 100 watts will require a properly sized heatsink.

For loads up to 200 watts a small aluminum heatsink designed for T0-220 transistors will be fine.

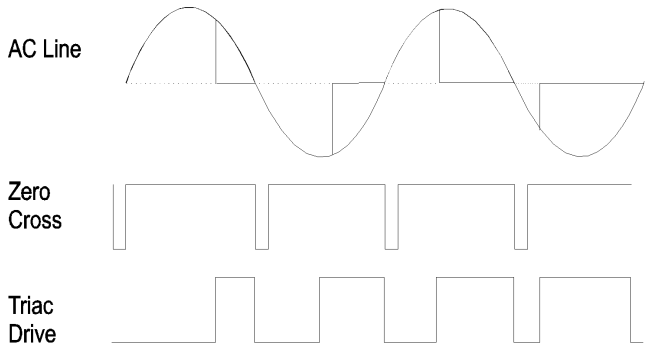
For higher loads a finned cast or machined aluminum heatsink will be needed.

RF noise

Choke coils are sometimes required to minimise RF noise generated by the TRIAC switching of the AC load.

AC phase control

A note about the basic operation TRIAC and SCR based lighting dimmers.



In order to vary the brightness of a lamp the TRIAC is turned on for only a portion of the AC cycle. By controlling when the TRIAC is fired during each AC half cycle the average power to the lamp can be varied, and thus the brightness.

For a microprocessor this is a simple task.

First determine when the AC zero crossing point is reached. This is the beginning of the half cycle. At this point it is a matter of delaying the firing of the TRIAC until the proper time. If the delay time is long the TRIAC will be on for a small portion of the cycle and the lamp will be dim. As the delay becomes shorter, the on time will be longer and lamp will be brighter. This process is repeated every half cycle.

Choke coils

TRIAC's are easy to use but have some disadvantages as well.

One problem is the once the TRIAC is turned on it will stay on until the voltage across the main terminals falls below a certain level called the "hold on" voltage.

On AC the TRIAC will turn off at the end of every half cycle of the AC line. Therefore the TRIAC has to be triggered on every half cycle.

The problem is when the TRIAC need to be on for part of the half cycle. If it could be turned on at the zero crossing point then the voltage would slowly rise and fall with the AC line. However since the TRIAC won't go off until the end of the half cycle, dimming would be impossible. Therefore the TRIAC is turned on after the zero crossing point which cause a large amount of current to suddenly shoot through the TRIAC which causes a momentary spike of high voltage AC noise. This can cause sound systems to "buzz" and cause radio frequency(RF) interference.

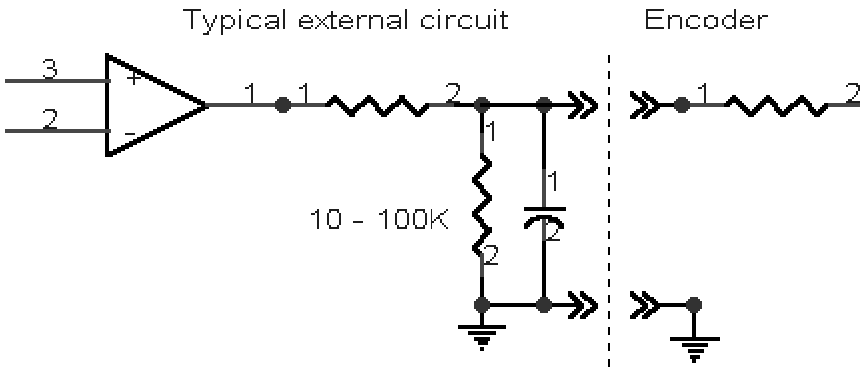
To solve this problem choke coils are commonly used to slow the surge through the TRIAC. This is called slew rate limiting. The slew time or "rise time" of the choke determines how much noise is supressed.

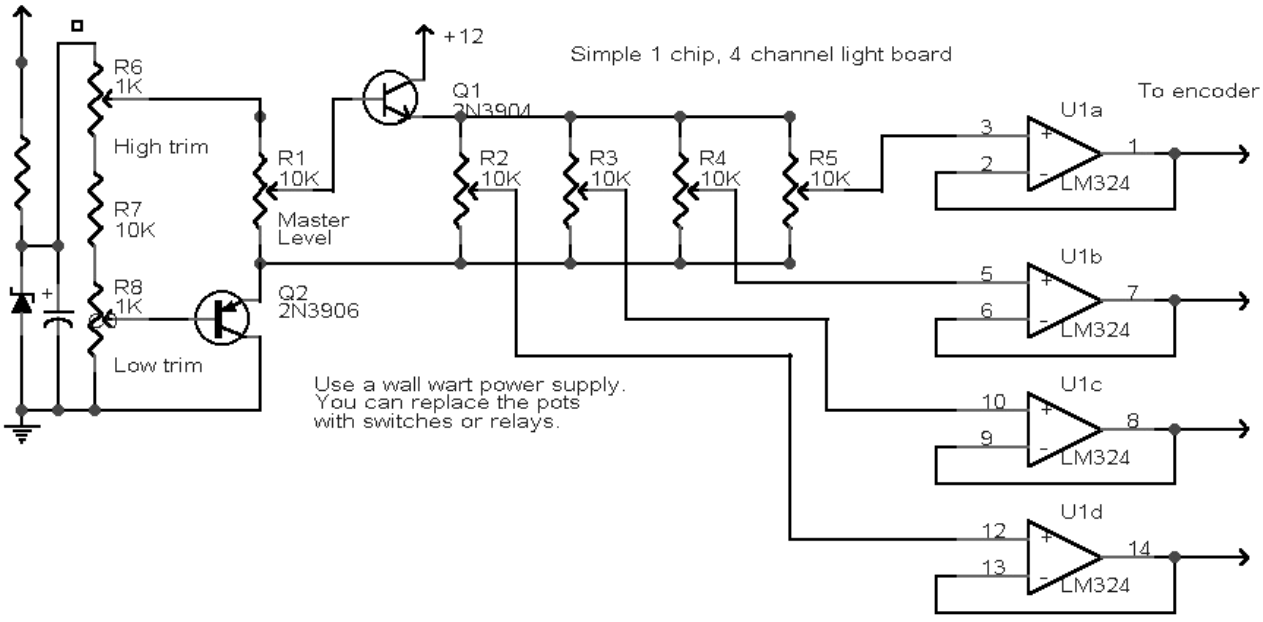
Typical rise times are 100 microseconds for a low cost dimmer. Better "touring" quality dimmers will use chokes with a rise time of 350 – 500 microseconds. The better "Theater or studio quality dimmers will have rise times from 600 - 800 microsenconds. At the highest end are dimmers with 1200 microseconds rise time. These are used in TV studios or areas where noise suppresion is of highest importance.

Analog Inputs

Input is an analog voltage spanning 0 - 10 VDC @5mA. This should be a smooth DC voltage with no noise or ripple. Any imperfections in the input voltage will be reflected in the DMX512 output.

The input impedance should 10K Ohms or less.





Trouble shooting
Basically the board is plug and play. There are no adjustments that have to be made.

Signal Ground/common: On the board, there is NO connection between chassis/earth ground and Signal/common ground. Do not install one.
On the DMX data cable, there is NO connection between the shield/XLR shell earth ground and the signal/common ground. Do not connect these together.

Termination: If the dimmer board is the last one on the DMX link a jumper for the terminating resistor can be installed on the PC board.
It is possible to “over terminate”. In other words make sure there is only 1 terminator on the end of the DMX line. Some devices have internal terminators, double check the settings.

No output:
DMX512 Check the signal wires as noted above.
Be sure the address is set to a valid address. The dimmer start address should not be higher than the highest address received. On the mini DIP switch, up position is on. Down is off.

Power Input: The power must be a standard transformer. DC input will cause the dimmer LED’s to light but it will not dim.

Dimming at unexpected levels: This could be caused by having the input transformer and the TRIAC power connected to different AC phases.
The power transformer and TRIAC power must be on the same AC phase.

Output always on: It is common for a TRIAC’s to fail in as a short circuit, therefor the output is always on.
Optoisolators can fail in the same way.
A quick test is to remove the optoisolator associated with the problem output.
If the output stays on’ the TRIAC is shorted. It it goes off, the optoisolator is shorted.
As always when working with AC voltage, make shure the power is off before removing or replacing any components on the PC board.

Misc: Good solid connections are a must. The mini screw terminals provide good connections. However the screws can be stripped by over tightening.DMX512 signal wires should be twisted together all the way to the connector.
It is recommended that a standard 6 volt transformer be used to power the dimmer.

Using DMX512

DMX 512 is a digital communications protocol that specifies a set of requirements for transmitting and receiving digital signals between lighting controllers and dimmers. There are 2 main components to this spec. The Data Protocol is the meaning of the bits and bytes that are transmitted. Northlight's Decoder is compliant with the full requirements of the Data Protocol. There is a certain amount of flexibility in the signal timing, Northlight's Decoder is capable of receiving data at the full data rate specified.

The other component of DMX512 is the Electrical Specifications. The hardware electrical specs are listed in EIA-485, commonly refereed to as the RS-485 specs. The RS-485 standard, specifies only the electrical characteristics of the driver and the receiver to be used at the line interface. Northlight's Decoder is compliant with RS-485. Each Decoder represents less than 1 node load to the system.

RS485 is a data transmission system using balanced differential signals. That is 2 signal wires and signal ground. 3 wires are required.

Splitters/Repeaters

Isolation between the console and dimmers is sometimes required to prevent signal degradation and protect devices from damaging voltages on the control cable. Optically isolated splitters help avoid these problems.

Each DMX512 output can drive up to 32 devices. If there are more devices on the line, a "repeater" or "booster" is required.

Some cheap devices are not fully compliant and actually represent a load equivalent to 2 or more devices.

Long or improper cables, electrically noisy environment (generators, motors) and improper use of passive "Y" splitters all contribute to DMX signal degradation. A repeater/booster may help to solve these problems.

Why ask WYE?

Wye(Y) splitters are NOT recommended for DMX512 systems. Wye splitters are simply a male inline XLR connector, parallel wired to 2 female inline XLR's. While convenient, Wye splitters cause unwanted signal reflections and possible ground loops, leading to signal degradation.

The best layout for DMX systems is a Daisy chain configuration, where the signal cable jumps from one device to the next, with no branching. Each chain can have up to 32 devices on it. When using an isolated splitter, each outputs can be a separate DMX daisy chain.

Termination

A common problem with DMX systems is improper termination.

A simple terminator consists of a 120 Ohm resistor connected across pins 2-3 of the DMX signal. More complex terminators utilize voltage spike protection and bi-color LEDs to indicate signal integrity.

Terminators are an impedance matching circuit required to damp signals that "reflect " from the end of an improperly terminated cable, causing signal degradation under certain conditions.

On devices the have a DMX thru , a male XLR connector with terminating resistor connected across pins 2-3 and installed on the DMX thru connector will suffice. Some devices with isolated outputs will not use a terminator on the DMX out. These usually have an internal terminator that is selected with a switch.

Wire Type

There is a difference between microphone cable and "Data" cable. Sure you can get away with mic. cable for short runs in many situations. However on longer runs or marginal situations mic. cable will let you down. You may have random errors or the system won't work at all. It comes down to insurance. If you want to insure the most reliable DMX signal distribution you need the most appropriate wire for the job. DMX512 requires wire suitable for RS-485, there is no way to get around that.

Twisted-pair cable is the most common wire type. You can use a range of wire gauges, most frequently use 22 – 24 AWG. The characteristic impedance of the cable should be 100 to 120 Ohms.

Some other requirements are, at least 1 twisted pair plus ground and shield. It should have low capacitance and overall braid and foil shield.

Data Rate VS Cable Length

At 250K bits per second the max cable length is about 1000 ft for DMX512 in good conditions.

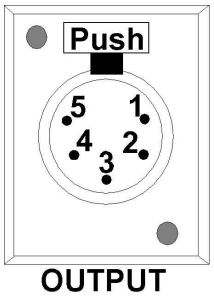
Connectors

DMX512 protocol specifies that 5 pin XLR connectors be used. Female on the transmitter and male on the receiver.

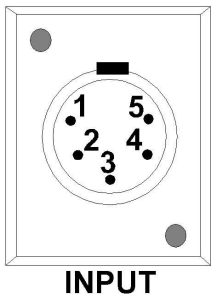
When a 3 pin XLR is used it is wired the same as the first 3 pins on the 5 pin XLR.

PIN	WIRE	SIGNAL
1	shield	ground/return
2	signal	data compliment (-)
3	signal	data true (+)
4	signal	spare data compliment (-)
5	signal conductor	spare data true (+)

Conductors 2/3 and 4/5 should be twisted together.



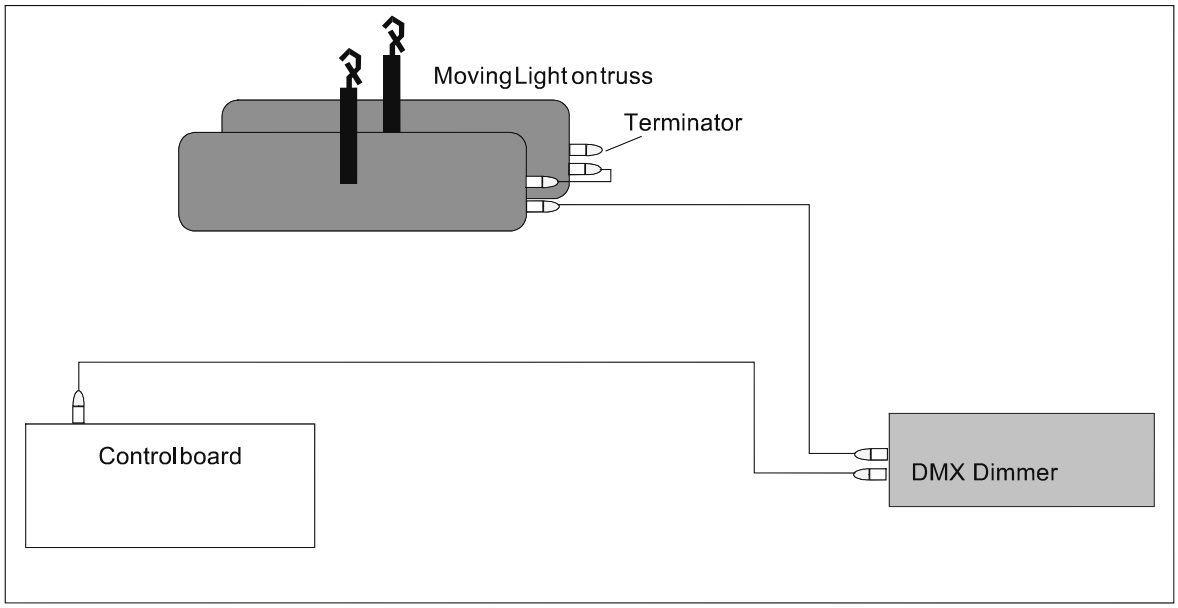
OUTPUT



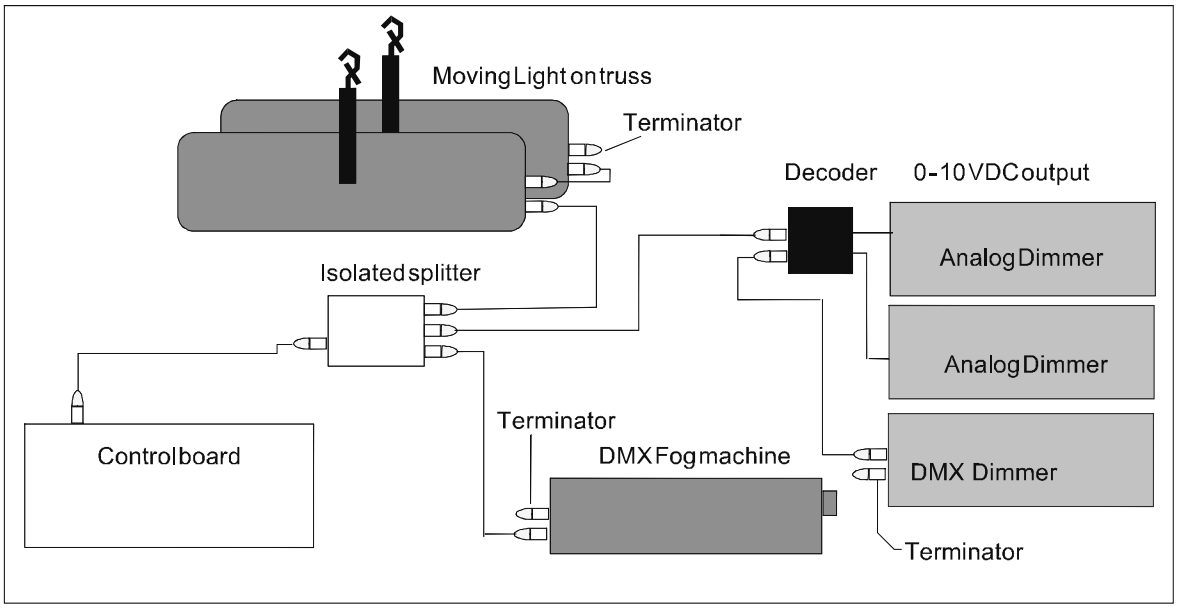
INPUT

Typical DMX signal routing

Simple setup



A more complicated setup. The Isolated splitter greatly simplifies cable routing and keeps individual runs short.



Ch# Dip Switch On	Ch# Dip Switch On	Ch# Dip Switch On	Ch# Dip Switch On
1 = 0	65= 7	129 = 8	193 = 7,8
2 = 1	66= 1,7	130 = 1,8	194 = 1,7,8,
3 = 2	67= 2,7	131 = 2,8	195 = 2,7,8,
4 = 1,2	68= 1,2,7	132 = 1,2,8	196 = 1,2,7,8
5 = 3	69= 3,7	133 = 3,8	197 = 3,7,8
6 = 1,3	70= 1,3,7	134 = 1,3,8	198 = 1,3,7,8
7 = 2,3	71= 2,3,7	135 = 2,3,8	199 = 2,3,7,8
8 = 1,2,3	72= 1,2,3,7	136 = 1,2,3,8	200 = 1,2,3,7,8
9 = 4	73= 4,7	137 = 4,8	201 = 4,7,8,
10 = 1, 4	74= 1,4,7	138 = 1,4,8	202 = 1,4,7,8
11 = 2,4	75= 2,4,7	139 = 2,4,8	203 = 2,4,7,8
12 = 1,2,4	76= 1,2,4,7	140 = 1,2,4,8	204 = 1,2,4,7,S
13 = 3,4	77= 3,4,7	141 = 3,4,8	205 = 3,4,7,8
14 = 1,3,4	78= 1,3,4,7	142 = 1,3,4,8	206 = 1,3,4,7,8
15 = 2,3,4	79= 2,3,4,7	143 = 2,3,4,8	207 = 2,3,4,7,8
16 = 1,2,3,4	80= 1,3,4,7	144 =1,2,3,4,8	208 = 1,2,3,4,7,8
17 = 5	81= 5,7	145 = 5,8	209 = 5,7,8
18 = 1,5	82= 1,5,7	146 = 1,5,8	210 = 1,5,7,8
19 = 2, 5	83= 2,5,7	147 = 2,5,8	211= 2 ,5,7,8
20 = 1,2,5	84= 1,2,5,7	148 = 1,2,5,8	212 = 1,2,5,7,8
21 = 3,5	85= 3,5,7	149 = 3,5,8	213 = 3,5,7,8
22 = 1,3,5	86= 1,3,5,7	150 = 1,3,5,8	214 = 1,3,5,7,8
23 = 2,3,5	87= 2,3,5,7	151 = 2,3,5,8	215 = 2,3,5,7,8
24 = 1,2,3,5	88= 1,2,3,5,7	152 = 1,2,3,5,8	216 = 1,2,3,5,7,8
25 = 4,5	89= 4,5,7	153 = 4,5,8	217 = 4, 5,7, 8
26 = 1,4,5	90= 1,4,5,7	154 = 1,4,5,8	218 = 1,4,5,7,S
27 = 2,4,5	91= 2,4,5,7	155 =2,4,5,8	219 = 2,4,5,7,8
28 = 1,2,4,5	92= 1,2,4,5,7	156 = 1,2,4,5,8	220 = 1,2,4,5,7,8
29 = 3,4,5	93= 3,4,5,7	157 = 3,4,5,8	221 = 3,4,5,7,8
30 = 1,3,4,5	94= 1, 3,4,5,7	158 = 1,3,4,5,8	222 = 1,3,4,5,7,8
31 = 2,3,4,5	95= 2,3,4,5,7	159 = 2,3,4,5,8	223 = 2,3,4,5,7,8
32 = 1,2,3,4,5	96= 1,2,3,4,5,7	160 = 1,2,3,4,5,8	224 = 1,2,3,4,5,7,8
33 = 6	97= 1,6,7	161 = 6,8	225 = 6,7,8
34 = 1,6	98 = 1,6,7	162 = 1,6,8	226 = 1,6,7,8
35 = 2,6	99 = 2,6,7	163 =2,6,8	227 = 2,6,7,8
36 = 1,2,6	100 = 1,2,6,7	164 =1,2,6,8	228 = 1,2,6,7,8
37 = 3,6	101 = 3,6,7	165 =3,6,8	229 = 3,6,7,8
38 = 1,3,6	102 = 1,3,6,7	166 = 1,3,6,8	230 = 1,3,6,7,8
39 = 2,3,6	103 = 2,3,6,7	167 = 2,3,6,8	231 = 2,3,6,7,8
40 = 1,2,3,6	104 = 1,2,3,6,7	168 = 1,2,3,6,8	232 = 1,2,3,6,7,8
41 = 4,6	105 = 4,6,7	169 = 4,6,8	233 = 4,6,7,8
42 = 1,4,6	106 = 1,4,6,7	170 = 1,4,6,8	234 = 1,4,6,7,8
43 = 2,4,6,	107 = 2,4,6,7	171 = 2,4,6,S	235 = 2,4,6,7,S
44 = 1,2,4,6	108 = 1,2,4,6,7	172 = 1,2,4,6,8	236 = 1,2,4,6,7,8
45 = 3,4,6	109 = 3,4,6,7	173 = 3,4,6,8	237 = 3,4,6,7,8
46 = 1,3,4,6	110 = 1,3,4,6,7	174 = 1,3,4,6,8	238 = 1,3,4,6,7,8
47 = 2,3,4,6	111 = 2,3,4,6,7	175 = 2,3,4,6,8	239 = 2,3,4,6,7,8
48 = 1,2,3,4,6	112 = 1,2,3,4,6,7	176 = 1,2,3,4,6,8	240 = 1,2,3,4,6,7,8
49 = 5,6	113 = 5,6,7	177 = 5,6,8	241 = 5,6,7,8
50 = 1,5,6	114 = 1,5,6,7	17S = 1,5,6,8	242 = 1,5,6,7,8
51 = 2,5,6	115 = 2,5,6,7	179 = 2,5,6,8	243 = 2,5,6,7,8
52 = 1,2,5,6	116 = 1,2,5,6,7	180 = 1,2,5,6,8	244 = 1,2,5,6,7,8
53 = 3,5,6	117 = 3,5,6,7	181 = 3,5,6,8	245 = 3,5,6,7,8
54 = 1,3,5,6	118 = 1,3,5,6,7	182 = 1,3,5,6,8	246 = 1,3,5,6,7,8
55 = 2,3,5,6	119 = 2,3,5,6,7	183 = 2,3,5,6,8	247 = 2,3,5,6,7,8
56 = 1,2,3,5,6	120 = 1,2,3,5,6,7	184 = 1,2,3,5,6,8	248 = 1,2,3,5,6,7,8
57 = 4,5,6	121 = 4,5,6,7	185 = 4,5,6,8	249 = 4,5,6,7,8
58 = 1,4,5,6	122 = 1,4,5,6,7	186 = 1,4,5,6,8	250 = 1,4,5,6,7,8
59 = 2,4,5,6	123 = 2,4,5,6,7	187 = 2,4,5,6,8	251 = 2,4,5,6,7,8
60 = 1,2,4,5,6	124 = 1,2,4,5,6,7	188 = 1,2,4,5,6,8	252 = 1,2,4,5,6,7,8
61 = 3,4,5,6	125 = 3,4,5,6,7	189 = 3,4,5,6,8	253 = 3,4,5,6,7,8
62 = 1,3,4,5,6	126 = 1,3,4,5,6,7	190 = 1,3,4,5,6,8	254 = 1,3,4,5,6,7,8
63 = 2,3,4,5,6	127 = 2,3,4,5,6,7	191 = 2,3,4,5,6,8	255 = 2,3,4,5,6,7,8
64 = 1,2,3,4,5,6	128 = 1,2,3,4,5,6,7	192 = 1,2,3,4,5,6,8	256 = 1,2,3,4,5,6,7,8

Ch#	Dip Switch On
257	9
258	1,9
259	2,9
260	1,2,9
261	3,9
262	1,3,9
263	2,3,9
264	1,2,3,9
265	4,9
266	1, 4, 9
267	2,4,9
268	1,2,4,9
269	3,4,9
270	1,3,4,9
271	2,3,4,9
272	1,2,3,4,9
273	5,9
274	1,5,9
275	2, 5, 9
276	1,2,5,9
277	3,5,9
278	1,3,5,9
279	2,3,5,9
280	1,2,3,5,9
281	4,5,9
282	1,4,5,9
283	2,4,5,9
284	1,2,4,5,9
285	3,4,5,9
286	1,3,4,5,9
287	2,3,4,5,9
288	1,2,3,4,5,9
289	6,9
290	1,6,9
291	2,6,9
292	1,2,6,9
293	3,6,9
294	1,3,6,9
295	2,3,6,9
296	1,2,3,6,9
297	4,6,9
298	1,4,6,9
299	2,4,6,9
300	1,2,4,6,9
301	3,4,6,9
302	1,3,4,6,9
303	2,3,4,6,9
304	1,2,3,4,6,9
305	5,6,9
306	1,5,6,9
307	2,5,6,9
308	1,2,5,6,9
309	3,5,6,9
310	1,3,5,6,9
311	2,3,5,6,9
312	1,2,3,5,6,9
313	4,5,6,9
314	1,4,5,6,9
315	2,4,5,6,9
316	1,2,4,5,6,9
317	3,4,5,6,9
318	1,3,4,5,6,9
319	2,3,4,5,6,9
320	1,2,3,4,5,6,9

Ch#	Dip Switch On
321	7,9
322	1,7,9
323	2,7,9
324	1,2,7,9
325	3,7,9
326	1,3,7,9
327	2,3,7,9
328	1,2,3,7,9
329	4,7,9
330	1,4,7,9
331	2,4,7,9
332	1,2,4,7,9
333	3,4,7, 9
334	1,3,4,7,9
335	2,3,4,7,9
336	1,2,3,4,7,9
337	5,7,9
338	1,5,7,9
339	2,5,7,9
340	1,2,5,7,9
341	3,5,7,9
342	1,3,5,7,9
343	2,3,5,7,9
344	1,2,3,5,7,9
345	4,5,7,9
346	1,4,5,7,9
347	2,4,5,7,9
34B	1,2,4,5,7,9
349	3,4,5,7,9
350	1,3,4,5,7,9
351	2,3,4,5,7,9
352	1,2,3,4,5,7,9
353	6,7,9
354	1,6,7,9
355	2,6,7,9
356	1,2,6,7,9
357	3,6,7,9
358	1,3,6,7,9
359	2,3,6,7,9
360	1,2,3,6,7,9
361	4,6,7,9
362	1,4,6,7,9
363	2,4,6,7,9
364	1,2,4,6,7,9
365	3,4,6,7,9
366	1,3,4,6,7,9
367	2,3,4,6,7,9
368	1,2,3,4,6,7,9
369	5,6,7,9
370	1,5,6,7,9
371	2,5,6,7,9
372	1,2,5,6,7,9
373	3,5,6,7,9
374	1,3,5,6,7,9
375	2,3,5,6,7,9
376	1,2,3,5,6,7,9
377	4,5,6,7,9
37S	1,4,5,6,7,9
379	2,4,5,6,7,9
380	1,2,4,5,6,7,9
381	3,4,5,6,7,9
382	1,3,4,5,6,7,9
383	2,3,4,5,6,7,9
384	1,2,3,4,5,6,7,9

Ch#	Dip Switch On
385	8,9
386	1,8,9
387	2,8,9
388	1,2,8,9
389	3,8,9
390	1,3,8,9
391	2,3,8,9
392	1,2,3,8,9
393	4,8,9
394	1,4,8,9
395	2,4,8,9
396	1,2,4,8,9
397	3,4,8,9
398	1,3,4,8,9
399	2,3,4,8,9
400	1,2,3,4,8,9
401	5,8,9
402	1,5,8,9
403	2,5,8,9
404	1,2,5,8,9
405	3,5,8,9
406	1,3,5,S,9
407	2,3,5,8,9
408	1,2,3,5,8,9
409	4,5,8,9
410	1,4,5,8,9
411	2,4,5,8,9
412	1,2,4,5,8,9
413	3,4,5,8,9
414	1,3,4,5,8,9
415	2,3,4,5,8,9
416	1,2,3,4,5,8,9
477	6,8,9
418	1,6,8,9
419	2,6,8,9
420	1,2,6,8,9
421	3,6,8,9
422	1,3,6,8,9
423	2,3,6,S,9
424	1,2,3,6,8,9
425	4,6,8,9
426	1,4,6,8,9
427	2,4,6,8,9
428	1,2,4,6,8,9
429	3,4,6,8,9
430	1,3,4,6,8,9
431	2,3,4,6,8,9
432	1,2,3,4,6,8,9
433	5,6,8,9
434	1,5,6,8,9
435	2, 5, 6, 8, 9
436	1,2,5,6,8,9
437	3,5,6,8,9
438	1,3,5,6,8,9
439	2,3,5,6,8,9
440	1,2,3,5,6,8,9
441	4,5,6,8,9
442	1,4,5,6,8,9
443	2,4,5,6,8,9
444	1,2,4,5,6,8,9
445	3,4,5,6,8,9
446	1,3,4,5,6,8,9
447	2,3,4,5,6,8,9
448	1,2,3,4,5,6,8,9

Ch#	Dip Switch On
449	7,8,9
450	1,7,8,9
451	2,7,8,9
452	1,2,7,8,9
453	3,7,8,9
454	1,3,7,8,9
455	2,3,7,8,9
456	1,2,3,7,8,9
457	4,7,8,9
458	1,4,7,8,9
459	2,4,7,8,9
460	1,2,4,7,8,9
461	3,4,7,8,9
462	1,3,4,7,8,9
463	2,3,4,7,8,9
464	1,2,3,4,7,8,9
465	5,7,8,9
466	1,5,7,8,9
467	2,5,7,8,9
468	1,2,5,7,8,9
469	3,5,7,8,9
470	1,3,5,7,8,9
471	2,3,5,7,8,9
472	1,2,3,5,7,8,9
473	4,5,7,8,9
474	1,4,5,7,8,9
475	2,4,5,7,8,9
476	1,2,4,5,7,8,9
477	3,4,5,7,8,9
478	1,3,4,5,7,8,9
479	2,3,4,5,7,8,9
480	1,2,3,4,5,7,8,9
481	6,7,8,9
482	1,6,7,8,9
483	2,6,7,8,9
484	1,2,6,7,8,9
485	3,6,7,8,9
486	1,3,6,7,8,9
487	2,3,6,7,8,9
488	1,2,3,6,7,8,9
489	4,6,7,8,9
490	1,4,6,7,8,9
491	2,4,6,7,8,9
492	1,2,4,6,7,8,9
493	3,4,6,7,8,9
494	1,3,4,6,7,8,9
495	2,3,4,6,7,8,9
496	1,2,3,4,6,7,8,9
497	5,6,7,8,9
498	1,5,6,7,8,9
499	2,5,6,7,8,9
500	1,2,5,6,7,8,9
501	3,5,6,7,8,9
502	1,3,5,6,7,8,9
503	2,3,5,6,7,8,9
504	1,2,3,5,6,7,8,9
505	4,5,6,7,8,9
506	1,4,5,6,7,8,9
507	2,4,5,6,7,8,9
508	1,2,4,5,6,7,8,9
509	3,4,5,6,7,8,9
510	1,3,4,5,6,7,8,9
511	2,3,4,5,6,7,8,9
512	1,2,3,4,5,6,7,8