Light-O-Rama

CMB24D DMX

24 Channel DC Controller

User Manual
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Introduction

The CMB24D is a member of the Component line of Light-O-Rama (LOR) products. It was designed to control DC lighting or any DC device that will tolerate a PWM modulated voltage. It is a microprocessor based, intelligent controller that can perform a number of lighting effects including dimming, fading, shimmering and twinkling. It can be daisy-chained with any mix of LOR controllers up to the maximum of 240 controllers.

The CMB24D automatically detects and obeys either LOR protocol or DMX protocol. It can be used with the LOR Windows Showtime Software Suite. This software allows you to design your sequences (*sequences* are lighting control command sets), arrange your sequences into shows and to schedule and play your shows.

To allow your PC to communicate with this controller, you will need one of Light O Rama's RS485 adapters. When you purchase the Generic Starter Package, you get the LOR Showtime Software, a 10' Cat5 network cable and a choice of RS485 adapters. Choose the adapter appropriate for your PC/laptop. The RS485 adapter will allow you to connect your PC/laptop via the Cat5 cable to your DC controller.

As with all LOR controllers, this controller is field firmware upgradeable so you are guaranteed compatibility with future LOR products.

This controller has Common Anode (common positive) outputs. This means that the positive voltage is applied to all outputs continuously and the negative is switched.

Caution: Although most applications for this product use low voltages, this product may be used with dangerous DC voltages. It is important that you have an understanding of electrical wiring.

What's in the Box

The CMB24D comes with a user manual. The latest version of this manual is also available at www.lightorama.com ► Support ► User Manuals ► CMB24D User Manual.

Applications

The CMB24D can be controlled by another LOR controller or, if you would like audio coordinated with the controller, one of the LOR Show Directors or a Windows PC. The CMB24D can also run a standalone sequence. This means a set of lighting (or other device) commands created using the Windows Showtime Software can be downloaded into the CMB24D. The CMB24D can use these internally stored commands to direct itself and additional controllers. See the *Standalone Operation* section for more information.

The low voltage (safety) and standalone capabilities allow the CMB24D to be deployed in a myriad of remote applications with no additional hardware being required. For example:

- General LED lighting (spot lights, etc.)
- Vehicle lighting (Bike, Car, Boat, etc.)
- Landscaping, pool and pond lighting
- DC Motors, solenoids, valves, relays

Metal Tab Transistor Consideration

CMB24D boards have transistors with metal tabs. Heat sinks are not required if the current draw per channel is 4 amps or less. **The metal tab of the transistor is electrically hot and a TO-220 insulating kit (mica wafer and screw grommet) is required when mounting the transistors to metal heat sinks.** Also, keep this fact in mind when using the board since it is possible to short out the metal tab transistors.

Installing Heat Sinks

The CMB24D is not designed to easily attach external heat sinks. The transistors are mounted inside the edges of the board to make attachment of controlled devices easier since the screw terminals are on the outside edge of the board.

A small amount of thermal compound is needed to facilitate the transfer of heat from the transistors to the heat sink. **Remember to use a TO-220 insulating kit.** Put a 1/8" x 1/4" dab of heat sink compound on the back surface of the transistor just below the screw hole.

The mica wafer goes between the transistor and the heat sink. There must be heat sink compound on both sides of the wafer. Use a screw grommet to prevent the screw from connecting the transistor's metal tab with the metal heat sink or use nylon screws.

Put screws from the outside of the board through the end two transistors and then align the heat sink with these two screws and press it against the transistors.

Put a lock washer on each screw and a bolt, don't tighten the bolts yet. Do the same for the other ten screws. Now tighten but don't over-tighten the bolts. Repeat the process for the other channel bank.

Quick Start Guide

This section assumes you have previous Light O Rama hardware experience. It provides the minimum needed to get the controller up and running.

The assumptions here are 12 volt DC power (or greater) and loads not requiring heat sinks. Read the *Hardware Fundamentals* section for more detail. See Figure 1 in the Hardware Fundamentals section for circuit board locations.

All DIP switches should be OFF except for switch 9. This will set the Unit ID to 01.

Connect DC power to at least the Channels 1-12 Power Inputs. The Status LED should be blinking about twice/second. Connect a DC load to +v and the channel 1 power outputs.

Connect the CMB24D to your network and fire up the Hardware Utility. The Status LED should go to steady on. Refresh the controllers, select this controller and use the *Test Unit's Operation* section to exercise the lights.

Hardware Fundamentals
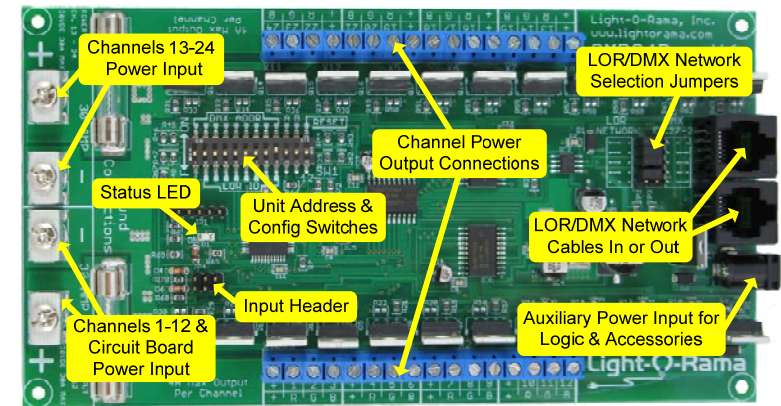
Figure 1

LOR/DMX Network Selection Jumpers
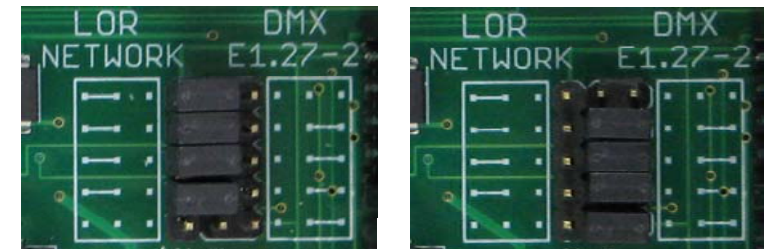
LOR Network Jumpers   DMX Universe Jumpers

This header allows the RJ45 network jacks to be wired for LOR or DMX (E1.27-2) networks. The previous image shows how the jumpers should be positioned. All four jumper blocks are required in either case. The jumpers are on the upper right of Figure 1.

Setting the Unit ID (and DMX address)

Use the Unit Address Switches to set the controller's LOR/DMX network address. DIP switch positions 1-9

set the address. Refer to the *DIP Switch Address Settings* section for the mapping of your desired LOR/DMX address to DIP switch settings.

Legal LOR Network unit IDs are '01' to 'F0' hexadecimal, in decimal that would be 1 to 240.

Legal DMX Network start addresses are 1 to 511 decimal.

Reset the CMB24D

To set all device parameters back to factory defaults and erase any stand-alone program, power the controller down, set DIP switch 12 to ON and power it up. The Status LED will flash quickly. Power the controller down and turn DIP switch 12 off.

Data Cable Connections

The two LOR/DMX network jacks are RJ45s.

Connecting to PC

To use Cat5 LAN cable to connect your controller to the PC RS485 adapter, plug one end of the data cable into the adapter and the other end into either of the network jacks.

Connecting to Other Controllers

To use Cat5 LAN cable to connect your controller to another controller, go from either network jack on one controller to either RJ45 network jack on the other controller.

Status LED

LED blinking approximately twice/second: The controller has booted correctly and is waiting for

commands. The controller is not connected to an active Light O Rama network or DMX universe.

LED is on solid: The controller is connected to an active network (is receiving the heartbeat and commands from a PC, a Show Director, another controller or DMX source.)

LED blinks quickly: The controller is resetting because DIP switch 12 is on.

LED blinks on for a long pulse and off for a short pulse: The controller firmware needs to be downloaded. See the *Updating Controller Firmware* section.

Auxiliary Power Input Barrel

Use a 12 to 24 volt DC, 300 milliamp external power supply here if the power input to channels 1-12 is less than 12 volts DC.

If the main power input to channels 1-12 is 12 volts DC or greater, the microprocessor and accessory power supplies will be derived from it.

The center pin of the power barrel is positive.

Channel Power Inputs

Bank power input connections are made with lugs.

Figure 1 shows the two channel bank power inputs on the left. The bottom power input is for channels 1 to 12. If this input is at 12 volts DC or higher, it will automatically be used to power the circuit board logic and accessories (like wireless.) If the DC power to channels' 1-12 input is less than 12 volts DC, see the *Auxiliary Power Input Barrel* section.

You may use different voltages on channel banks 1-12 and 13-24. The ground between the two channel banks is common, but you must use both grounds when using the board to switch more than 30 amps.

Channel Power Outputs
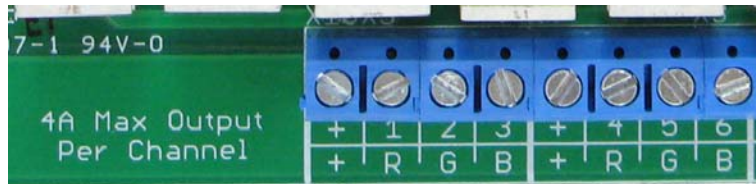
Figure 2

All output connections are made with screw terminals.

Figure 2 shows the power output connections for channels 1 through 6. The silk-screening on the board labels each channel (negative connection) and their shared positive connections.

Remember that DC loads can be polarity sensitive. If you find that LEDs connected to the outputs do not light, try swapping the positive and negative connections.

Input Header (JP4)

The next figure shows how to connect a push button switch to the controller's input header to start a standalone sequence.

Currently, only 'Input 1' is supported for stand-alone sequence starting. (All inputs can be used for interactive shows.) The standalone sequence in the CMB24D will start when the push button is pressed.

If you use a toggle switch, the sequence will run until the switch it turned off.

The sequence always runs to completion, even if the toggle switch is turned off in the middle.

Hold the board with the "JP4" label as shown in the following figure for correct pin assignments.

JP4 Input Header
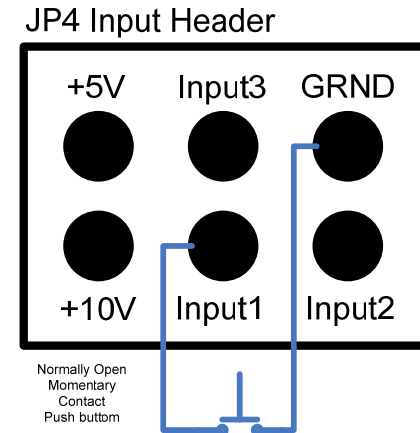
Current Handling Considerations

This board has metal tab transistors that will easily handle 4 amps each without a heat sink. For this reason LOR does not include heat sinks with the board. 4 amps times 24 channels is 96 amps which exceeds the total current carrying capacity of the board. The board is rated at 30 amps maximum per 12 channel bank.

Trial and error is a reasonable way to determine if your loads are within acceptable limits. Connect up your load and use the Hardware Utility to slowly increase the intensity. If your voltage is 12v or less, see how warm the transistors get, if you can't touch

it, it needs a heat sink. If your voltage is higher where it might be dangerous to touch the metal tab of the transistor, use a thermometer.

Nitty-Gritty

This section is for technical types who are not sure whether their application would be a good match for the CMB24D.

There are two banks of MOSFETs, bank 1 for output channels 1 to 12, and bank 2 for output channels 13 to 24. The positive outputs of a bank are all tied together (common anode) and connected through their fuse to the positive power input. A MOSFET is used to ground the load connected to its channel, so positive power is always present at the load.

The MOSFETs are Pulse Width Modulated at 400 Hz. $1/400^{th}$ second = 2.5 milliseconds. There are 240 possible intensities. This means that in each 400th of a second, the grounding pulse is somewhere between 0/240*2.5 ms (off) and 240/240*2.5ms (full on.)

Connecting Controller-to-PC Data Cable

If you have not installed your RS485 adapter, do it now. If you have an SC485 (PC serial port adapter, shown on the left below), you need only plug it into an available PC 9-pin serial port. The cable from an SC485 serial adapter to the first controller is limited to 100' or less. Cable length to the first controller is not so limited for USB adapters.

If you have one of the USB adapters (shown center and right above), follow the installation instructions that came with the adapter.

Testing the CMB24D

To perform this test, the CMB24D must have a unit address between '01' and 'F0,' and it must be powered up and connected to the PC. The LED on the CMB24D should be blinking twice/second before the CMB24D is connected to a PC running the Hardware Utility.

In the *Max Units* section of the Hardware Utility window, click the *Change* button. Move the slider in the *Change Maximum Units* box so that the Max Units is set to 10. (Unless you are using unit addresses above 10 hexadecimal) This will limit the search for controllers to the first 16 unit IDs, otherwise 240 controllers will be searched for – taking a long time. Click the *Save* button.

In the *Select Unit to Configure..Download..Test* section of the Hardware Utility screen, click the *Refresh* button to locate the attached CMB24D controller. Select the controller from the drop down menu to the right of the *Refresh* Button.

The *Test Unit's Operation* section of the screen should be active. Attach some lights into your

controller and use the sliders and buttons in this section to test your controller.

Designing and Playing a Sequence

Lighting commands for your shows are called *Sequences* and are designed and implemented using the Sequence Editor Windows software.

Stop the Hardware Utility. You will not be able to command your controller from the Sequence Editor if the Hardware Utility is running. Only one program may use the RS485 adapter at a time to talk to Light O Rama controllers.

There are Quick Start Guides for creating animation (non-musical) and musical sequences, Flash Tutorials and much more at:

www.lightorama.com ► *Support* ► *User Manuals*

The following Wiki is also an excellent source of information on all things Light-O-Rama:

www.lorwiki.com

There is also a very active and helpful Light-O-Rama user community:

www.lightorama.com ► *Forums*

Stand Alone Operation

An animation sequence (sequence with no accompanying audio) can be downloaded in the CMB24D. This sequence can contain approximately 10,000 commands. These commands can also be for controllers other than this CMB24D, so this controller can direct a network of controllers. There is

no restriction on the types of controllers in this network.

The sequence is designed and tested using the Showtime Software Sequence Editor. When you are happy with the sequence, save it and stop the Sequence Editor.

Start the Hardware Utility and click the *Refresh* button to find the CMB24D. Use the drop down menu next to the *Refresh* button to select the CMB24D.

Click the *Standalone* button at the bottom of the window. Select one of "Run when power is on," "Input (norm open switch)" or "Input (norm closed switch.)" Click the *Send Trigger info to Unit* button.

Finally, Use the *Open* button to browse to your sequence and click the *Download* button.

Troubleshooting

Erratic Behavior When Lights Turned On

The most likely cause is insufficient power. If the CMB24D is being powered by the same power supply as the lights/loads, turning them on may cause a voltage drop and crash the microcomputer. If you suspect that your power supply may not be up to the task, see the *Auxiliary Power Input Barrel* section. This section will explain how to power the card logic independently of the loads.

Refresh in the HWU fails to find the controller

Make sure the LOR/DMX Network Selection Jumpers are in the LOR position. See the *LOR/DMX Network Selection Jumpers* section.

Make sure the Unit ID switches are set to a legal LOR unit ID. See the *Setting the Unit ID (and DMX address)* section.

Make sure the Status LED is on steady when the controller is connected to the PC running the Hardware Utility, otherwise you may have selected the wrong communications port or there is a problem with your RS485 adapter or cabling.

AutoConfigure fails to find COM port

Make sure the LOR/DMX Network Selection Jumpers are in the LOR position. Make sure the Unit ID switches are set to a legal LOR unit ID. See previous section.

If the COM port is not detected, you can manually select it from the drop down list.

If you are not sure which COM port is the RS485 adapter and you have a USB adapter, stop the Hardware Utility, disconnect the USB adapter from the PC and start the Hardware Utility. Use the Manual Select drop-down on the upper left to see which comm ports you have. Then stop the Hardware Utility, plug in the USB adapter, wait for it to install and start the Hardware Utility. The drop-down should show a new comm port, select it.

If you are not sure which COM port is the RS485 adapter and you have a serial port RS485 adapter, you will have to consult your PC's documentation; it is normally COM1, COM2 or COM3.

Updating Controller Firmware

Periodically, Light-O-Rama will distribute new firmware for the CMB24D. If you believe you need updated firmware, use the Hardware Utility to determine your current firmware version. Use the *Refresh* button to find your controller and check its firmware version. The drop-down menu to the right of the *Refresh* button will be filled in with the attached controllers. The right part of the controller name in this drop-down is the current firmware version.

If the controller type or firmware version is not present, get the latest software that your license permits from www.lightorama.com ► *Software*. Run the program downloaded to install the software and devices text file. Retry the *Refresh* operation.

The latest firmware can be found by going to www.lightorama.com ► *Support* ► *Firmware*. Find your controller type and roll the mouse over the *Firmware* button – look at the bar in the lower left of the browser window. It will show the name of the firmware file. The file name contains the version at the end. If the version number is greater than what you saw in the Hardware Utility, new firmware is available. Click the *Firmware* button to download the firmware installer to your PC – remember where you put it.

To load new firmware, use a data cable (not wireless) to connect the controller(s) to the PC. Start

the Hardware Utility and click the *Refresh* button to find your controller(s). Select the one you want to update from the drop-down menu to the right of the *Refresh* button. Click the *Firmware* button at the bottom of the window.

In the **Firmware** section of the window, under **Step 1 – Select Unit,** select the *unit* listed above. Under **Step 2 – Select Firmware File,** use the *Open* button to browse to the firmware file you downloaded. Under **Step 3 – Press Download Button** click the *Download* button. Do not interrupt this process. Your controller will reboot after the download completes.

You can click the *Refresh* button to see that the new firmware was loaded into your controller. Repeat this process for additional controllers.

DIP Switch Address Settings

'1' means On and '0' means Off.

DMX Start	LOR ID	Switch 1-9	DMX Start	Switch 1-9
1	01	0 0000 0001	257	1 0000 0001
2	02	0 0000 0010	258	1 0000 0010
3	03	0 0000 0011	259	1 0000 0011
4	04	0 0000 0100	260	1 0000 0100
5	05	0 0000 0101	261	1 0000 0101
6	06	0 0000 0110	262	1 0000 0110
7	07	0 0000 0111	263	1 0000 0111
8	08	0 0000 1000	264	1 0000 1000
9	09	0 0000 1001	265	1 0000 1001
10	0A	0 0000 1010	266	1 0000 1010
11	0B	0 0000 1011	267	1 0000 1011
12	0C	0 0000 1100	268	1 0000 1100
13	0D	0 0000 1101	269	1 0000 1101
14	0E	0 0000 1110	270	1 0000 1110
15	0F	0 0000 1111	271	1 0000 1111
16	10	0 0001 0000	272	1 0001 0000
17	11	0 0001 0001	273	1 0001 0001
18	12	0 0001 0010	274	1 0001 0010
19	13	0 0001 0011	275	1 0001 0011
20	14	0 0001 0100	276	1 0001 0100
21	15	0 0001 0101	277	1 0001 0101
22	16	0 0001 0110	278	1 0001 0110
23	17	0 0001 0111	279	1 0001 0111
24	18	0 0001 1000	280	1 0001 1000
25	19	0 0001 1001	281	1 0001 1001
26	1A	0 0001 1010	282	1 0001 1010
27	1B	0 0001 1011	283	1 0001 1011
28	1C	0 0001 1100	284	1 0001 1100
29	1D	0 0001 1101	285	1 0001 1101
30	1E	0 0001 1110	286	1 0001 1110
31	1F	0 0001 1111	287	1 0001 1111
32	20	0 0010 0000	288	1 0010 0000
33	21	0 0010 0001	289	1 0010 0001
34	22	0 0010 0010	290	1 0010 0010
35	23	0 0010 0011	291	1 0010 0011
36	24	0 0010 0100	292	1 0010 0100
37	25	0 0010 0101	293	1 0010 0101
38	26	0 0010 0110	294	1 0010 0110

39	27	0 0010 0111	295	1 0010 0111
40	28	0 0010 1000	296	1 0010 1000
41	29	0 0010 1001	297	1 0010 1001
42	2A	0 0010 1010	298	1 0010 1010
43	2B	0 0010 1011	299	1 0010 1011
44	2C	0 0010 1100	300	1 0010 1100
45	2D	0 0010 1101	301	1 0010 1101
46	2E	0 0010 1110	302	1 0010 1110
47	2F	0 0010 1111	303	1 0010 1111
48	30	0 0011 0000	304	1 0011 0000
49	31	0 0011 0001	305	1 0011 0001
50	32	0 0011 0010	306	1 0011 0010
51	33	0 0011 0011	307	1 0011 0011
52	34	0 0011 0100	308	1 0011 0100
53	35	0 0011 0101	309	1 0011 0101
54	36	0 0011 0110	310	1 0011 0110
55	37	0 0011 0111	311	1 0011 0111
56	38	0 0011 1000	312	1 0011 1000
57	39	0 0011 1001	313	1 0011 1001
58	3A	0 0011 1010	314	1 0011 1010
59	3B	0 0011 1011	315	1 0011 1011
60	3C	0 0011 1100	316	1 0011 1100
61	3D	0 0011 1101	317	1 0011 1101
62	3E	0 0011 1110	318	1 0011 1110
63	3F	0 0011 1111	319	1 0011 1111
64	40	0 0100 0000	320	1 0100 0000
65	41	0 0100 0001	321	1 0100 0001
66	42	0 0100 0010	322	1 0100 0010
67	43	0 0100 0011	323	1 0100 0011
68	44	0 0100 0100	324	1 0100 0100
69	45	0 0100 0101	325	1 0100 0101
70	46	0 0100 0110	326	1 0100 0110
71	47	0 0100 0111	327	1 0100 0111
72	48	0 0100 1000	328	1 0100 1000
73	49	0 0100 1001	329	1 0100 1001
74	4A	0 0100 1010	330	1 0100 1010
75	4B	0 0100 1011	331	1 0100 1011
76	4C	0 0100 1100	332	1 0100 1100
77	4D	0 0100 1101	333	1 0100 1101
78	4E	0 0100 1110	334	1 0100 1110
79	4F	0 0100 1111	335	1 0100 1111
80	50	0 0101 0000	336	1 0101 0000
81	51	0 0101 0001	337	1 0101 0001
82	52	0 0101 0010	338	1 0101 0010

83	53	0 0101 0011	339	1 0101 0011
84	54	0 0101 0100	340	1 0101 0100
85	55	0 0101 0101	341	1 0101 0101
86	56	0 0101 0110	342	1 0101 0110
87	57	0 0101 0111	343	1 0101 0111
88	58	0 0101 1000	344	1 0101 1000
89	59	0 0101 1001	345	1 0101 1001
90	5A	0 0101 1010	346	1 0101 1010
91	5B	0 0101 1011	347	1 0101 1011
92	5C	0 0101 1100	348	1 0101 1100
93	5D	0 0101 1101	349	1 0101 1101
94	5E	0 0101 1110	350	1 0101 1110
95	5F	0 0101 1111	351	1 0101 1111
96	60	0 0110 0000	352	1 0110 0000
97	61	0 0110 0001	353	1 0110 0001
98	62	0 0110 0010	354	1 0110 0010
99	63	0 0110 0011	355	1 0110 0011
100	64	0 0110 0100	356	1 0110 0100
101	65	0 0110 0101	357	1 0110 0101
102	66	0 0110 0110	358	1 0110 0110
103	67	0 0110 0111	359	1 0110 0111
104	68	0 0110 1000	360	1 0110 1000
105	69	0 0110 1001	361	1 0110 1001
106	6A	0 0110 1010	362	1 0110 1010
107	6B	0 0110 1011	363	1 0110 1011
108	6C	0 0110 1100	364	1 0110 1100
109	6D	0 0110 1101	365	1 0110 1101
110	6E	0 0110 1110	366	1 0110 1110
111	6F	0 0110 1111	367	1 0110 1111
112	70	0 0111 0000	368	1 0111 0000
113	71	0 0111 0001	369	1 0111 0001
114	72	0 0111 0010	370	1 0111 0010
115	73	0 0111 0011	371	1 0111 0011
116	74	0 0111 0100	372	1 0111 0100
117	75	0 0111 0101	373	1 0111 0101
118	76	0 0111 0110	374	1 0111 0110
119	77	0 0111 0111	375	1 0111 0111
120	78	0 0111 1000	376	1 0111 1000
121	79	0 0111 1001	377	1 0111 1001
122	7A	0 0111 1010	378	1 0111 1010
123	7B	0 0111 1011	379	1 0111 1011
124	7C	0 0111 1100	380	1 0111 1100
125	7D	0 0111 1101	381	1 0111 1101
126	7E	0 0111 1110	382	1 0111 1110

127	7F	0 0111 1111	383	1 0111 1111
128	80	0 1000 0000	384	1 1000 0000
129	81	0 1000 0001	385	1 1000 0001
130	82	0 1000 0010	386	1 1000 0010
131	83	0 1000 0011	387	1 1000 0011
132	84	0 1000 0100	388	1 1000 0100
133	85	0 1000 0101	389	1 1000 0101
134	86	0 1000 0110	390	1 1000 0110
135	87	0 1000 0111	391	1 1000 0111
136	88	0 1000 1000	392	1 1000 1000
137	89	0 1000 1001	393	1 1000 1001
138	8A	0 1000 1010	394	1 1000 1010
139	8B	0 1000 1011	395	1 1000 1011
140	8C	0 1000 1100	396	1 1000 1100
141	8D	0 1000 1101	397	1 1000 1101
142	8E	0 1000 1110	398	1 1000 1110
143	8F	0 1000 1111	399	1 1000 1111
144	90	0 1001 0000	400	1 1001 0000
145	91	0 1001 0001	401	1 1001 0001
146	92	0 1001 0010	402	1 1001 0010
147	93	0 1001 0011	403	1 1001 0011
148	94	0 1001 0100	404	1 1001 0100
149	95	0 1001 0101	405	1 1001 0101
150	96	0 1001 0110	406	1 1001 0110
151	97	0 1001 0111	407	1 1001 0111
152	98	0 1001 1000	408	1 1001 1000
153	99	0 1001 1001	409	1 1001 1001
154	9A	0 1001 1010	410	1 1001 1010
155	9B	0 1001 1011	411	1 1001 1011
156	9C	0 1001 1100	412	1 1001 1100
157	9D	0 1001 1101	413	1 1001 1101
158	9E	0 1001 1110	414	1 1001 1110
159	9F	0 1001 1111	415	1 1001 1111
160	A0	0 1010 0000	416	1 1010 0000
161	A1	0 1010 0001	417	1 1010 0001
162	A2	0 1010 0010	418	1 1010 0010
163	A3	0 1010 0011	419	1 1010 0011
164	A4	0 1010 0100	420	1 1010 0100
165	A5	0 1010 0101	421	1 1010 0101
166	A6	0 1010 0110	422	1 1010 0110
167	A7	0 1010 0111	423	1 1010 0111
168	A8	0 1010 1000	424	1 1010 1000
169	A9	0 1010 1001	425	1 1010 1001
170	AA	0 1010 1010	426	1 1010 1010

171	AB	0 1010 1011	427	1 1010 1011
172	AC	0 1010 1100	428	1 1010 1100
173	AD	0 1010 1101	429	1 1010 1101
174	AE	0 1010 1110	430	1 1010 1110
175	AF	0 1010 1111	431	1 1010 1111
176	B0	0 1011 0000	432	1 1011 0000
177	B1	0 1011 0001	433	1 1011 0001
178	B2	0 1011 0010	434	1 1011 0010
179	B3	0 1011 0011	435	1 1011 0011
180	B4	0 1011 0100	436	1 1011 0100
181	B5	0 1011 0101	437	1 1011 0101
182	B6	0 1011 0110	438	1 1011 0110
183	B7	0 1011 0111	439	1 1011 0111
184	B8	0 1011 1000	440	1 1011 1000
185	B9	0 1011 1001	441	1 1011 1001
186	BA	0 1011 1010	442	1 1011 1010
187	BB	0 1011 1011	443	1 1011 1011
188	BC	0 1011 1100	444	1 1011 1100
189	BD	0 1011 1101	445	1 1011 1101
190	BE	0 1011 1110	446	1 1011 1110
191	BF	0 1011 1111	447	1 1011 1111
192	C0	0 1100 0000	448	1 1100 0000
193	C1	0 1100 0001	449	1 1100 0001
194	C2	0 1100 0010	450	1 1100 0010
195	C3	0 1100 0011	451	1 1100 0011
196	C4	0 1100 0100	452	1 1100 0100
197	C5	0 1100 0101	453	1 1100 0101
198	C6	0 1100 0110	454	1 1100 0110
199	C7	0 1100 0111	455	1 1100 0111
200	C8	0 1100 1000	456	1 1100 1000
201	C9	0 1100 1001	457	1 1100 1001
202	CA	0 1100 1010	458	1 1100 1010
203	CB	0 1100 1011	459	1 1100 1011
204	CC	0 1100 1100	460	1 1100 1100
205	CD	0 1100 1101	461	1 1100 1101
206	CE	0 1100 1110	462	1 1100 1110
207	CF	0 1100 1111	463	1 1100 1111
208	D0	0 1101 0000	464	1 1101 0000
209	D1	0 1101 0001	465	1 1101 0001
210	D2	0 1101 0010	466	1 1101 0010
211	D3	0 1101 0011	467	1 1101 0011
212	D4	0 1101 0100	468	1 1101 0100
213	D5	0 1101 0101	469	1 1101 0101
214	D6	0 1101 0110	470	1 1101 0110

215	D7	0 1101 0111	471	1 1101 0111
216	D8	0 1101 1000	472	1 1101 1000
217	D9	0 1101 1001	473	1 1101 1001
218	DA	0 1101 1010	474	1 1101 1010
219	DB	0 1101 1011	475	1 1101 1011
220	DC	0 1101 1100	476	1 1101 1100
221	DD	0 1101 1101	477	1 1101 1101
222	DE	0 1101 1110	478	1 1101 1110
223	DF	0 1101 1111	479	1 1101 1111
224	E0	0 1110 0000	480	1 1110 0000
225	E1	0 1110 0001	481	1 1110 0001
226	E2	0 1110 0010	482	1 1110 0010
227	E3	0 1110 0011	483	1 1110 0011
228	E4	0 1110 0100	484	1 1110 0100
229	E5	0 1110 0101	485	1 1110 0101
230	E6	0 1110 0110	486	1 1110 0110
231	E7	0 1110 0111	487	1 1110 0111
232	E8	0 1110 1000	488	1 1110 1000
233	E9	0 1110 1001	489	1 1110 1001
234	EA	0 1110 1010	490	1 1110 1010
235	EB	0 1110 1011	491	1 1110 1011
236	EC	0 1110 1100	492	1 1110 1100
237	ED	0 1110 1101	493	1 1110 1101
238	EE	0 1110 1110	494	1 1110 1110
239	EF	0 1110 1111	495	1 1110 1111
240	F0	0 1111 0000	496	1 1111 0000
241		0 1111 0001	497	1 1111 0001
242		0 1111 0010	498	1 1111 0010
243		0 1111 0011	499	1 1111 0011
244		0 1111 0100	500	1 1111 0100
245		0 1111 0101	501	1 1111 0101
246		0 1111 0110	502	1 1111 0110
247		0 1111 0111	503	1 1111 0111
248		0 1111 1000	504	1 1111 1000
249		0 1111 1001	505	1 1111 1001
250		0 1111 1010	506	1 1111 1010
251		0 1111 1011	507	1 1111 1011
252		0 1111 1100	508	1 1111 1100
253		0 1111 1101	509	1 1111 1101
254		0 1111 1110	510	1 1111 1110
255		0 1111 1111	511	1 1111 1111
256		1 0000 0000	512	n/a

Specifications

Configuration	Two banks of 12 channels
Individual Channel Capacity	4 amps – No Heat Sinks 8 amps – Regular Heat Sinks
Individual Bank Capacity	30 amps
Board Capacity	60 amps
Channel Supply Voltage	5 to 30 volts DC (Bank voltages may be different)
Auxiliary Power Barrel Voltage	12 volts DC (center pin of barrel is positive)
Fuses	30 amp fast acting
Power Connections	Screw terminals
Logic Power Consumption	450 mW
Stand alone memory capacity	Approximately 10,000 commands
LOR Network Speeds supported (kilobits/sec)	19.2, 57.6, 115.2 & 500
Dimensions	7¼"w x 4"h x 1 ½"d