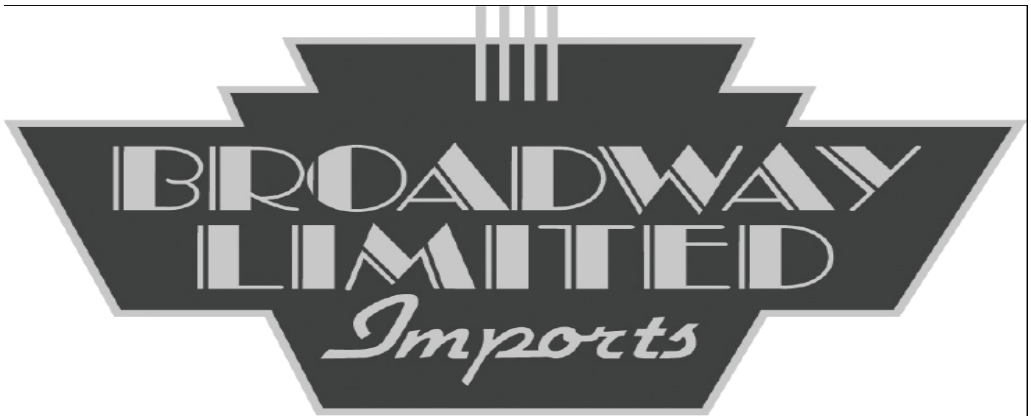

Release 0.8

Multi-Purpose Light Unit Technical Reference Manual

INTRODUCTION

Introduction

The Multi-Purpose Light unit is a multi-function DCC decoder that supports the following:

DCC Characteristics

- 14 bit addressing
- 7 bit addressing (1-127)
- Enhanced Lighting Control
- Consist Support
- Support for F0—F15 including remapping
- Operations mode support for all CV settings
- Configuration Variable Access Acknowledgement in Service mode
- Direct, Address Only, Physical Addressing and Paged CV Addressing Modes support in Service Mode including Write and Verify

DC characteristics

- DCMaster™ uses Direct Mode for CV Programming
- All Defined CV's Programmable and Readable
- Enhanced Lighting Control
- Consist Support
- Selectable DCMaster™ AUX Control

System CVs Table

CV	Description	Initial	Yours
1	Primary Address	3	
7	Manufacturer Version	?	
8	Manufacturer ID	38	
17	Extended Address MSB	192	
18	Extended Address LSB	128	
19	Consist Address	0	
21	Consist Functions Type 0	255	
22	Consist Functions Type1	255	
29	Configuration Bits	4	
33	L1 Control	Varies	
34	L2 Control	Varies	
35	L3 Control	Varies	
36	L4 Control	Varies	
37	L5 Control	Varies	
63	Lights Power-Up Control	Varies	
64	AUX Control	Varies	

Decimal to Binary Primer

Setting CV's

Setting the CV's requires knowledge of conversion between binary and decimal. The following examples demonstrates the conversion process from binary to decimal after determining which bits in a CV need to be "1" and which needs to be "0". The tables are also useful for converting binary to decimal.

Reading CV's

The tables are also useful for converting decimal to binary when reading the CV's in service mode. After reading the CV, use the tables to determine which bits are "1" and which bits are "0". Once the bit patterns are identified, find the CV in this manual to determine what functions are controlled by the bits.

Bit 7							**Bit 0**
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
128	64	32	16	8	4	2	1

Consider a binary number 10001011

128+0+0+0+8+0+2+1=139

Consider a binary number 00011101

0+0+0+16+8+4+0+1=29

CVxx read is 39. Table lookup is: 00100111

Decimal to Hexadecimal Conversion

Dec	Hex	Oct	Bin
0	0	000	00000000
1	1	001	00000001
2	2	002	00000010
3	3	003	00000011
4	4	004	00000100
5	5	005	00000101
6	6	006	00000110
7	7	007	00000111
8	8	010	00001000
9	9	011	00001001
10	A	012	00001010
11	B	013	00001011
12	C	014	00001100
13	D	015	00001101
14	E	016	00001110
15	F	017	00001111

Dec	Hex	Oct	Bin
16	10	020	00010000
17	11	021	00010001
18	12	022	00010010
19	13	023	00010011
20	14	024	00010100
21	15	025	00010101
22	16	026	00010110
23	17	027	00010111
24	18	030	00011000
25	19	031	00011001
26	1A	032	00011010
27	1B	033	00011011
28	1C	034	00011100
29	1D	035	00011101
30	1E	036	00011110
31	1F	037	00011111

Dec	Hex	Oct	Bin
32	20	040	00100000
33	21	041	00100001
34	22	042	00100010
35	23	043	00100011
36	24	044	00100100
37	25	045	00100101
38	26	046	00100110
39	27	047	00100111
40	28	050	00101000
41	29	051	00101001
42	2A	052	00101010
43	2B	053	00101011
44	2C	054	00101100
45	2D	055	00101101
46	2E	056	00101110
47	2F	057	00101111

Dec	Hex	Oct	Bin
48	30	060	00110000
49	31	061	00110001
50	32	062	00110010
51	33	063	00110011
52	34	064	00110100
53	35	065	00110101
54	36	066	00110110
55	37	067	00110111
56	38	070	00111000
57	39	071	00111001
58	3A	072	00111010
59	3B	073	00111011
60	3C	074	00111100
61	3D	075	00111101
62	3E	076	00111110
63	3F	077	00111111

Dec	Hex	Oct	Bin
64	40	100	01000000
65	41	101	01000001
66	42	102	01000010
67	43	103	01000011
68	44	104	01000100
69	45	105	01000101
70	46	106	01000110
71	47	107	01000111
72	48	110	01001000
73	49	111	01001001
74	4A	112	01001010
75	4B	113	01001011
76	4C	114	01001100
77	4D	115	01001101
78	4E	116	01001110
79	4F	117	01001111

Dec	Hex	Oct	Bin
80	50	120	01010000
81	51	121	01010001
82	52	122	01010010
83	53	123	01010011
84	54	124	01010100
85	55	125	01010101
86	56	126	01010110
87	57	127	01010111
88	58	130	01011000
89	59	131	01011001
90	5A	132	01011010
91	5B	133	01011011
92	5C	134	01011100
93	5D	135	01011101
94	5E	136	01011110
95	5F	137	01011111

Decimal to Hexadecimal Conversion

Dec	Hex	Oct	Bin
96	60	140	01100000
97	61	141	01100001
98	62	142	01100010
99	63	143	01100011
100	64	144	01100100
101	65	145	01100101
102	66	146	01100110
103	67	147	01100111
104	68	150	01101000
105	69	151	01101001
106	6A	152	01101010
107	6B	153	01101011
108	6C	154	01101100
109	6D	155	01101101
110	6E	156	01101110
111	6F	157	01101111

Dec	Hex	Oct	Bin
112	70	160	01110000
113	71	161	01110001
114	72	162	01110010
115	73	163	01110011
116	74	164	01110100
117	75	165	01110101
118	76	166	01110110
119	77	167	01110111
120	78	170	01111000
121	79	171	01111001
122	7A	172	01111010
123	7B	173	01111011
124	7C	174	01111100
125	7D	175	01111101
126	7E	176	01111110
127	7F	177	01111111

Dec	Hex	Oct	Bin
128	80	200	10000000
129	81	201	10000001
130	82	202	10000010
131	83	203	10000011
132	84	204	10000100
133	85	205	10000101
134	86	206	10000110
135	87	207	10000111
136	88	210	10001000
137	89	211	10001001
138	8A	212	10001010
139	8B	213	10001011
140	8C	214	10001100
141	8D	215	10001101
142	8E	216	10001110
143	8F	217	10001111

Dec	Hex	Oct	Bin
144	90	220	10010000
145	91	221	10010001
146	92	222	10010010
147	93	223	10010011
148	94	224	10010100
149	95	225	10010101
150	96	226	10010110
151	97	227	10010111
152	98	230	10011000
153	99	231	10011001
154	9A	232	10011010
155	9B	233	10011011
156	9C	234	10011100
157	9D	235	10011101
158	9E	236	10011110
159	9F	237	10011111

Dec	Hex	Oct	Bin
160	A0	240	10100000
161	A1	241	10100001
162	A2	242	10100010
163	A3	243	10100011
164	A4	244	10100100
165	A5	245	10100101
166	A6	246	10100110
167	A7	247	10100111
168	A8	250	10101000
169	A9	251	10101001
170	AA	252	10101010
171	AB	253	10101011
172	AC	254	10101100
173	AD	255	10101101
174	AE	256	10101110
175	AF	257	10101111

Dec	Hex	Oct	Bin
176	B0	260	10110000
177	B1	261	10110001
178	B2	262	10110010
179	B3	263	10110011
180	B4	264	10110100
181	B5	265	10110101
182	B6	266	10110110
183	B7	267	10110111
184	B8	270	10111000
185	B9	271	10111001
186	BA	272	10111010
187	BB	273	10111011
188	BC	274	10111100
189	BD	275	10111101
190	BE	276	10111110
191	BF	277	10111111

SYSTEM CVs

CV1
Primary Address

Description
The Decoders Primary Address is Stored Here
Values
Bits 0-6 contain an address with a value between 1 and 127
Initial Value
3 (Engine 3)
Related CVs
CV29 Bit 5
CV17, CV18, CV19

Bit 7 **Bit 0**

0	A6	A5	A4	A3	A2	A1	A0

The decoder responds to all valid commands if the address matches the value in CV1 and CV29 Bit 5 is set to 0.

Programming CV1 will program CV19 (Consists Address) to zero and programs CV29 Bit 5 to 0 (Extended Addressing Off).

SYSTEM CVs

CV7
Manufacturer Version Number

Description
The Decoders Read Only Type/Revision is Stored Here
Values

Initial Value

Related CVs
None

Bit 7							Bit 0
D7	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**

This value cannot be modified.

SYSTEM CVs

CV8
Manufacturer ID

Description
The Decoders NMRA Assigned Number is Stored Here. Broadway Limited is assigned ID 38.
Values

Initial Value
38
Related CVs

Bit 7							Bit 0
0	0	1	0	0	1	1	0

Writing "***value***" to CV8 causes the following:

VALUE	
8	Resets all CVs back to their original manufactured values .

SYSTEM CVs

CV17 and CV18
Extended Address

Description
This Value Contains the Decoders Extended Address and is Valid Only if CV29 Bit 5 is 1
Values
Values From 0 to 10239 are Valid
Initial Value
1100 0000 1000 0000 (Engine 128)
Related CVs
CV29 Bit 5

Bit 15							Bit 8
1	1	A13	A12	A11	A10	A9	A8

CV17 Extended Address MSB

Bit 7							Bit 0
A7	A6	A5	A4	A3	A2	A1	A0

CV18 Extended Address LSB

CV17 Valid Values are 1100 0000 thru 1110 0111
CV18 Valid Values are 0000 0000 thru 0000 0000

SYSTEM CVs

CV19
Consist Address

Description
The Decoders Consist Address is Stored Here
Values
0-255
Initial Value
0
Related CVs
CV21, CV22

Bit 7 **Bit 0**

Dir	A6	A5	A4	A3	A2	A1	A0

Consist valid address are 1-127 or A6-A0 where a value of 0 breaks the consist and all received consist commands are ignored. The Dir bit selects normal or reverse directional lighting. If Dir=0 than normal directional lighting is selected. If Dir=1 than reverse directional lighting is selected. Reverse directional lighting is useful when the engine is oriented backwards in the consist.

SYSTEM CVs

CV21
Consist Functions Type 0

Description
Determines Which Functions (F1-F8) are Allowed in the Consist
Values
0-255
Initial Value
255
Related CVs
CV19, CV22

Bit 7							Bit 0
F8	F7	F6	F5	F4	F3	F2	F1

The decoder responds to all functions that have a "1" set in this CV once a consist is configured. A consist is configured by CV19 programmed to a value from 1-127. A value of 0 breaks the consist. See CV19.

SYSTEM CVs

CV22
Consist Functions Type 1

Description
Determines Which Functions (F0; F9-F12) are Allowed in the Consist
Values
0-255
Initial Value
255
Related CVs
CV19, CV21

Bit 7							Bit 0
nu	**nu**	**F12**	**F11**	**F10**	**F9**	**nu**	**F0**

The decoder responds to all functions that have a "1" set in this CV once a consist is configured. A consist is configured by CV19 programmed to a value from 1-127. A value of 0 breaks the consist. See CV19.

SYSTEM CVs

CV29
Configuration Bits

Description
Decoder Configuration Feature Bits
Values

Initial Value
4 (Primary Address)
Related CVs
CV1, CV17, CV18

Bit 7							Bit 0
0	**0**	**EA**	**0**	**0**	**1**	**0**	**0**

Bit 5: EA (Extended Address Mode Enable)
0 = Decoder Responds to Primary Address CV1
1 = Decoder Responds to Extended Address CV17, CV18
Bit 4: ignored
Bit 2: ignored
Bit 1: ignored
Bit 0: 0 = normal lighting for front and rear lights
1 = reverse lighting for front and rear lights

FUNCTION CVs

CV33-CV64
F0 – F15 Function Definitions

The function keys may be programmed to contol any of the lights by setting the corresponding Function Key Number into the Light CV.

Assigned CV Number	Function Controlled
CV33	L1 Light
CV34	L2 Light
CV35	L3 Light
CV36	L4 Light
CV37	L5 Light
CV63	Power-On State
CV64	AUX (DC Master)

CV33 through CV37 may contain 0 through 15, representing function key F0 through F15 for control of the lights L1 through L5. DC mode as well as DCC mode uses these values. DCC modes uses all the bits while DC mode uses bits “d” and “m”

FUNCTION CVs

CV33
L1 Output Function Control

Description
Selects Which Function Activates L1
Values
0 to 15 plus d and m
Initial Value
Varies
Related CVs
CV33—CV63; CV29; CV63; CV64

Bit 7							Bit 0
d	**m**	**0**	**0**	**a**	**a**	**a**	**a**

Function Key F1 toggles L1 on and off.

aaaa	Function Key F0 Thru F15
d = 0	Non Directional Light
d = 1	Directional Light
m = 0	Active in Forward
m = 1	Active in Reverse

Bits “a” and “m” are used in DCC and DC Modes, while Bits “aaaa” are used in DCC mode only

FUNCTION CVs

CV34
L2 Output Function Control

Description
Selects Which Function Activates L2
Values
0 to 15 plus d and m
Initial Value
Varies
Related CVs
CV33—CV63; CV29; CV63; CV64

Bit 7							Bit 0
d	**m**	**0**	**0**	**a**	**a**	**a**	**a**

Function Key F1 toggles L2 on and off.

aaaa	Function Key F0 Thru F15
d = 0	Non Directional Light
d = 1	Directional Light
m = 0	Active in Forward
m = 1	Active in Reverse

Bits “a” and “m” are used in DCC and DC Modes, while Bits “aaaa” are used in DCC mode only

FUNCTION CVs

CV35
L3 Output Function Control

Description
Selects Which Function Activates L3
Values
0 to 15 plus d and m
Initial Value
Varies
Related CVs
CV33—CV63; CV29; CV63; CV64

Bit 7							Bit 0
d	**m**	**0**	**0**	**a**	**a**	**a**	**a**

Function Key F1 toggles L3 on and off.

aaaa	Function Key F0 Thru F15
d = 0	Non Directional Light
d = 1	Directional Light
m = 0	Active in Forward
m = 1	Active in Reverse

Bits “a” and “m” are used in DCC and DC Modes, while Bits “aaaa” are used in DCC mode only

FUNCTION CVs

CV36
L4 Output Function Control

Description
Selects Which Function Activates L4
Values
0 to 15 plus d and m
Initial Value
Varies
Related CVs
CV33—CV63; CV29; CV63; CV64

Bit 7							Bit 0
d	**m**	**0**	**0**	**a**	**a**	**a**	**a**

Function Key F1 toggles L4 on and off.

aaaa	Function Key F0 Thru F15
d = 0	Non Directional Light
d = 1	Directional Light
m = 0	Active in Forward
m = 1	Active in Reverse

Bits “a” and “m” are used in DCC and DC Modes, while Bits “aaaa” are used in DCC mode only

FUNCTION CVs

CV37

L5 Output Function Definition

Description
Selects Which Function Activates L5
Values
0 to 15 plus d and m
Initial Value
Varies
Related CVs
CV33—CV63; CV29; CV63; CV64

Bit 7							Bit 0
0	0	0	0	a	a	a	a

Function Key F1 toggles L5 on and off.

aaaa	Function Key F0 Thru F15
d = 0	Non Directional Light
d = 1	Directional Light
m = 0	Active in Forward
m = 1	Active in Reverse

Bits “a” and “m” are used in DCC and DC Modes, while Bits “aaaa” are used in DCC mode only

FUNCTION CVs

CV63
Lights Power-Up Definition

Description
Selects the Power-Up Condition of L1 Through L5
Values
0 to 31
Initial Value
Varies
Related CVs
CV33—CV37

Bit 7							Bit 0
0	**0**	**0**	**L5**	**L4**	**L3**	**L2**	**L1**

Bit 4: 0 = L5 Powers Up Off
1 = L5 Powers Up On
Bit 3: 0 = L4 Powers Up Off
1 = L4 Powers Up On
Bit 2: 0 = L3 Powers Up Off
1 = L3 Powers Up On
Bit 1: 0 = L2 Powers Up Off
1 = L2 Powers Up On
Bit 0: 0 = L1 Powers Up Off
1 = L1 Powers Up On

FUNCTION CVs

CV64
AUX Output Function Definition

Description
Selects Which Lights AUX (DCMaster) Toggles
Values
0 to 31
Initial Value
Varies
Related CVs

Bit 7							**Bit 0**
0	**0**	**0**	**L5**	**L4**	**L3**	**L2**	**L1**

Bit 4: 0 = L5 Off
1 = L5 Toggles
Bit 3: 0 = L4 Off
1 = L4 Toggles
Bit 2: 0 = L3 Off
1 = L3 Toggles
Bit 1: 0 = L2 Off
1 = L2 Toggles
Bit 0: 0 = L1 Off
1 = L1 Toggles

DCC Function Keys

Function Key	Description
CV33	L1 Control
CV34	L2 Control
CV35	L3 Control
CV36	L4 Control
CV37	L5 Control

DCMaster™ Control

Key	Description	
Aux **(CV64)**	**AUX Function Select:**	
	Nothing	0
	L1 Toggle	1
	L2 Toggle	2
	L3 Toggle	4
	L4 Toggle	8
	L5 Toggle	16

Product Configurations

Product Description	CV33	CV34	CV35	CV36	CV37	CV63	CV64
Observation Car	128	192	0	0	7	31	16