highly_liquid

MD24

Firmware Version 1.0, 1.1

User Manual

Updated 2009-08-26

Additional documentation available at:

http://highlyliquid.com/support/

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1.0 Overview

The MD24 has 24 outputs, each of which can change state in response to a wide range of incoming MIDI events including note, controller ("CC"), program change, and start/stop/continue messages.

Each MD24 output is independently configured via MIDI System Exclusive (SysEx) message.

Instructions for using a PC to create and send SysEx messages can be found at:

http://highlyliquid.com/support/library/midi-sysex.html

The ***MIDI Configuration SysEx Message*** specifies the output mode for one or more MD24 outputs. There are several possible output modes, each of which is categorized as either a *logic mode* or a *servo mode*.

A logic mode output can change between one of two logic states: "on" (5V) or "off" (0V). The mapping of MIDI event to logic state depends on the specific output mode and other settings in the *MIDI Configuration SysEx Message*.

A servo mode output generates a servo control signal. The arm of a servo connected to an MD24 servo mode output will change position in response to MIDI events. The MD24 divides the range of servo arm travel into 128 equally-spaced positions corresponding to the 128 possible values of a MIDI control parameter, as shown in Figure 3-4. The output's mode and other settings in the *MIDI Configuration SysEx Message* determine which MIDI parameter controls the output.

The characteristics of the signal generated by a servo mode output can be adjusted via the ***PWM Configuration SysEx Message*. The message can be used to alter the range of motion of a connected servo. It also allows the MD24 to control servos of differing control signal specifications. Logic mode outputs are unaffected by settings in the *PWM Configuration SysEx Message*.

Some MD24 output modes are MIDI channel-specific. Each MD24 output uses either an independent channel setting or the "global" channel setting specified by DIP switch SW1. The contents of the *MIDI Configuration SysEx Message* determine which type of channel setting is used.

The MD24 ships preloaded with a default configuration. The default configuration can be restored at any time via the Initialization Jumper.

2.0 MIDI Configuration

2.1 Overview

The MD24 ships with a preloaded default MIDI configuration. The *MIDI Configuration SysEx Message* is used to alter the behavior of one or more MD24 outputs.

2.2 MIDI Configuration SysEx Message

Figure 2-1 shows the format of the MIDI Configuration SysEx Message. The message consists of a fixed header, a variable length body, and a fixed footer.

The body of the message consists of one or more 4 byte blocks, each specifying the configuration of a single MD24 output. The configuration of outputs not specified in the message will remain unchanged.

The Activity LED blinks three times upon receipt of a properly formatted SysEx configuration message. If no indication is given, the MD24 configuration has not been changed.

Configuration is retained when the MD24 is disconnected from a power supply.

2.2.1 Output Number (*nn*)

Parameter *nn* specifies which MD24 output is configured by the three bytes that follow it. The valid range is 00 to 17 hex, corresponding to MD24 outputs 0 to 23.

2.2.2 Output Mode (*mm*)

Parameter *mm* specifies the output mode for the output specified by *nn*. Valid range is 00 to 2E hex. The meanings of *ch* and *ss* depend on the value of *mm*. Table 2-2 lists each output mode and the associated meanings of *ch* and *ss.*

Each output mode is categorized as a *logic mode* or *servo mode*. The characteristics of servo mode outputs can be adjusted via the PWM Configuration SysEx Message.

Servo modes are available in both “Forward” and “Reverse”. The direction refers to the travel (clockwise / counter-clockwise) of the servo arm in response to a change in the MIDI control parameter. Arm travel for some servo models is the opposite of travel for other models. Use trial-and-error to determine whether “forward” or “reverse” is the correct choice for your application.

2.2.3 MIDI Channel (*ch*)

Some output modes respond to channel-specific MIDI messages (see Table 2-2). Outputs thus configured can respond to the channel specified by DIP switch SW1, a specific channel independent of other outputs, or to all channels (“Omni”). See Table 2-3.

2.2.4 Selector (*ss*)

The meaning of *ss* depends on the value of the corresponding *mm*. See Table 2-2.

2.3 DIP Switch Channel Selection

Each MD24 output can use either an independent MIDI channel setting or the “global” channel setting specified by DIP switch SW1. The contents of the MIDI Configuration SysEx Message determine which outputs, if any, use the DIP switch channel setting.

Note: Changes to the DIP switch setting take effect only at power-up.

Table 2-1 shows the SW1 settings for each channel.

Table 2-1: MIDI Channel Selection

MIDI Channel	**SW1 Setting**			
	1	**2**	**3**	**4**
1	off	off	off	off
2	off	off	off	**on**
3	off	off	**on**	off
4	off	off	**on**	**on**
5	off	**on**	off	off
6	off	**on**	off	**on**
7	off	**on**	**on**	off
8	off	**on**	**on**	**on**
9	**on**	off	off	off
10	**on**	off	off	**on**
11	**on**	off	**on**	off
12	**on**	off	**on**	**on**
13	**on**	**on**	off	off
14	**on**	**on**	off	**on**
15	**on**	**on**	**on**	off
16	**on**	**on**	**on**	**on**

2.4 Default Configuration

The MD24 ships with a preloaded default MIDI configuration which can be expressed as an equivalent SysEx configuration message. See Figure 2-2. In the default configuration, MD24 outputs use “note trigger” mode for a block of MIDI notes beginning with Middle C. Each output uses the MIDI channel specified by the DIP switch SW1.

2.5 Examples

Figure 2-3 shows a configuration which uses MIDI CC messages to control each MD24 output in servo mode. MIDI controllers 0 to 23 are used.

Figure 2-4 uses 14 bits from the bank number (CC #0 and #32) and 7 bits from the program number to control the state of 21 logic outputs. Each bank/program combination will cause a unique combination of on/off output states.

Figure 2-5 assigns a pair of outputs to each of 12 notes. The first output in each pair is a note trigger. The second output in each pair is a servo mode output which sets the servo arm position in response to the velocity of the corresponding note.

Figure 2-1: MIDI Configuration SysEx Message Format (Hex)

Header (6 bytes)	**MIDI Configuration (repeat as desired)**				**Footer (1 byte)**
F0 00 01 5D 03 01	*nn*	*mm*	*ch*	*ss*	F7

Table 2-2: Output Modes

***mm* (Hex)**	**Type**	**Mode Description**	***ch***	***ss***
00	N/A	**Disabled** Output is "off".	Ignored	Ignored
01	Logic	**Note Trigger** Output is "on" for the duration of a corresponding MIDI note, and "off" otherwise.	MIDI channel	Note number (hex)
02	Logic	**Inverted Note Trigger** Output is "off" for the duration of a corresponding MIDI note, and "on" otherwise.	MIDI channel	Note number (hex)
03	Logic	**Note Toggle** Output state is toggled & latched upon receipt of a matching Note On message. Initial output state is “off”.	MIDI channel	Note number (hex)
04	Logic	**Note Number – Bit 0** Output state corresponds to bit 0 of the note number of the most recent Note On message. Bit 0 is the least significant bit.	MIDI channel	Ignored
05	Logic	**Note Number – Bit 1** Output state corresponds to bit 1 of the note number of the most recent Note On message.	MIDI channel	Ignored
06	Logic	**Note Number – Bit 2** Output state corresponds to bit 2 of the note number of the most recent Note On message.	MIDI channel	Ignored
07	Logic	**Note Number – Bit 3** Output state corresponds to bit 3 of the note number of the most recent Note On message.	MIDI channel	Ignored
08	Logic	**Note Number – Bit 4** Output state corresponds to bit 4 of the note number of the most recent Note On message.	MIDI channel	Ignored
09	Logic	**Note Number – Bit 5** Output state corresponds to bit 5 of the note number of the most recent Note On message.	MIDI channel	Ignored
0A	Logic	**Note Number – Bit 6** Output state corresponds to bit 6 of the note number of the most recent Note On message. Bit 6 is the most significant bit.	MIDI channel	Ignored
0B	Logic	**Note Velocity – Bit 0** Output state corresponds to bit 0 of the note velocity of the most recent Note On message. Bit 0 is the least significant bit.	MIDI channel	Ignored
0C	Logic	**Note Velocity – Bit 1** Output state corresponds to bit 1 of the note velocity of the most recent Note On message.	MIDI channel	Ignored

Table 2-2: Output Modes (Continued)

***mm* (Hex)**	**Mode Type**	**Mode Description**	***ch***	***ss***
0D	Logic	**Note Velocity – Bit 2** Output state corresponds to bit 2 of the note velocity of the most recent Note On message.	MIDI channel	Ignored
0E	Logic	**Note Velocity – Bit 3** Output state corresponds to bit 3 of the note velocity of the most recent Note On message.	MIDI channel	Ignored
0F	Logic	**Note Velocity – Bit 4** Output state corresponds to bit 4 of the note velocity of the most recent Note On message.	MIDI channel	Ignored
10	Logic	**Note Velocity – Bit 5** Output state corresponds to bit 5 of the note velocity of the most recent Note On message.	MIDI channel	Ignored
11	Logic	**Note Velocity – Bit 6** Output state corresponds to bit 6 of the note velocity of the most recent Note On message. Bit 6 is the most significant bit.	MIDI channel	Ignored
12	Logic	**Controller – Bit 0** Output state corresponds to bit 0 of the controller (CC) position. Bit 0 is the least significant bit.	MIDI channel	Controller number (hex)
13	Logic	**Controller – Bit 1** Output state corresponds to bit 1 of the controller (CC) position.	MIDI channel	Controller number (hex)
14	Logic	**Controller – Bit 2** Output state corresponds to bit 2 of the controller (CC) position.	MIDI channel	Controller number (hex)
15	Logic	**Controller – Bit 3** Output state corresponds to bit 3 of the controller (CC) position.	MIDI channel	Controller number (hex)
16	Logic	**Controller – Bit 4** Output state corresponds to bit 4 of the controller (CC) position.	MIDI channel	Controller number (hex)
17	Logic	**Controller – Bit 5** Output state corresponds to bit 5 of the controller (CC) position.	MIDI channel	Controller number (hex)
18	Logic	**Controller – Bit 6** Output state corresponds to bit 6 of the controller (CC) position. Bit 6 is the most significant bit.	MIDI channel	Controller number (hex)
19	Logic	**Program Change – Bit 0** Output state corresponds to bit 0 of the current program number. Bit 0 is the least significant bit.	MIDI channel	Ignored
1A	Logic	**Program Change – Bit 1** Output state corresponds to bit 1 of the current program number.	MIDI channel	Ignored
1B	Logic	**Program Change – Bit 2** Output state corresponds to bit 2 of the current program number.	MIDI channel	Ignored
1C	Logic	**Program Change – Bit 3** Output state corresponds to bit 3 of the current program number.	MIDI channel	Ignored

Table 2-2: Output Modes (Continued)

***mm* (Hex)**	**Mode Type**	**Mode Description**	***ch***	***ss***
1D	Logic	**Program Change – Bit 4** Output state corresponds to bit 4 of the current program number.	MIDI channel	Ignored
1E	Logic	**Program Change – Bit 5** Output state corresponds to bit 5 of the current program number.	MIDI channel	Ignored
1F	Logic	**Program Change – Bit 6** Output state corresponds to bit 6 of the current program number. Bit 6 is the most significant bit.	MIDI channel	Ignored
20	Logic	**Sync: Run** MIDI Start and Continue messages latch output “on.” MIDI Stop message latches output "off.”	Ignored	Ignored
21	Servo	**Note Number - Forward** Servo position corresponds to the note number from the most recent Note On message.	MIDI channel	Ignored
22	Servo	**Note Number - Reverse** Servo position corresponds to the note number from the most recent Note On message.	MIDI channel	Ignored
23	Servo	**Note Velocity - Forward** Servo position corresponds to the note velocity from the most recent Note On message.	MIDI channel	Note number
24	Servo	**Note Velocity - Reverse** Servo position corresponds to the note velocity from the most recent Note On message.	MIDI channel	Note number
25	Servo	**Aftertouch - Forward** Servo position corresponds to aftertouch value.	MIDI channel	Note number
26	Servo	**Aftertouch - Reverse** Servo position corresponds to aftertouch value.	MIDI channel	Note number
27	Servo	**Controller - Forward** Servo position corresponds to controller position.	MIDI channel	Controller number
28	Servo	**Controller - Reverse** Servo position corresponds to controller position.	MIDI channel	Controller number
29	Servo	**Program Change - Forward** Servo position corresponds to the current program number.	MIDI channel	Ignored
2A	Servo	**Program Change - Reverse** Servo position corresponds to the current program number.	MIDI channel	Ignored
2B	Servo	**Channel Pressure - Forward** Servo position corresponds to channel pressure value.	MIDI channel	Ignored
2C	Servo	**Channel Pressure - Reverse** Servo position corresponds to channel pressure value.	MIDI channel	Ignored
2D	Servo	**Pitch Wheel - Forward** Servo position corresponds to pitch wheel position.	MIDI channel	Ignored
2E	Servo	**Pitch Wheel - Reverse** Servo position corresponds to pitch wheel position.	MIDI channel	Ignored

Table 2-3: MIDI Channel

***ch* (Hex)**	**Channel Setting**
00	Channel as specified by DIP switch SW1.
01	Channel 1
02	Channel 2
03	Channel 3
04	Channel 4
05	Channel 5
06	Channel 6
07	Channel 7
08	Channel 8
09	Channel 9
0A	Channel 10
0B	Channel 11
0C	Channel 12
0D	Channel 13
0E	Channel 14
0F	Channel 15
10	Channel 16
11	Omni: events on all channels are used to update output state.

Figure 2-2: Default Equivalent MIDI Configuration SysEx Message

Section	**Bytes (Hex)**	**Meaning**
Header	F0 00 01 5D 03 01	Fixed Data
Output 0 Configuration	00 01 00 3C	Note Trigger: Note #60 (Middle C)
Output 1 Configuration	01 01 00 3D	Note Trigger: Note #61
Output 2 Configuration	02 01 00 3E	Note Trigger: Note #62
Output 3 Configuration	03 01 00 3F	Note Trigger: Note #63
Output 4 Configuration	04 01 00 40	Note Trigger: Note #64
Output 5 Configuration	05 01 00 41	Note Trigger: Note #65
Output 6 Configuration	06 01 00 42	Note Trigger: Note #66
Output 7 Configuration	07 01 00 43	Note Trigger: Note #67
Output 8 Configuration	08 01 00 44	Note Trigger: Note #68
Output 9 Configuration	09 01 00 45	Note Trigger: Note #69
Output 10 Configuration	0A 01 00 46	Note Trigger: Note #70
Output 11 Configuration	0B 01 00 47	Note Trigger: Note #71
Output 12 Configuration	0C 01 00 48	Note Trigger: Note #72
Output 13 Configuration	0D 01 00 49	Note Trigger: Note #73
Output 14 Configuration	0E 01 00 4A	Note Trigger: Note #74
Output 15 Configuration	0F 01 00 4B	Note Trigger: Note #75
Output 16 Configuration	10 01 00 4C	Note Trigger: Note #76
Output 17 Configuration	11 01 00 4D	Note Trigger: Note #77
Output 18 Configuration	12 01 00 4E	Note Trigger: Note #78
Output 19 Configuration	13 01 00 4F	Note Trigger: Note #79
Output 20 Configuration	14 01 00 50	Note Trigger: Note #80
Output 21 Configuration	15 01 00 51	Note Trigger: Note #81
Output 22 Configuration	16 01 00 52	Note Trigger: Note #82
Output 23 Configuration	17 01 00 53	Note Trigger: Note #83
Footer	F7	Fixed Data

Figure 2-3: Servo Control via MIDI CC Message

Section	**Bytes (Hex)**	**Meaning**
Header	F0 00 01 5D 03 01	Fixed Data
Output 0 Configuration	00 27 00 00	Servo Control: CC #0
Output 1 Configuration	01 27 00 01	Servo Control: CC #1
Output 2 Configuration	02 27 00 02	Servo Control: CC #2
Output 3 Configuration	03 27 00 03	Servo Control: CC #3
Output 4 Configuration	04 27 00 04	Servo Control: CC #4
Output 5 Configuration	05 27 00 05	Servo Control: CC #5
Output 6 Configuration	06 27 00 06	Servo Control: CC #6
Output 7 Configuration	07 27 00 07	Servo Control: CC #7
Output 8 Configuration	08 27 00 08	Servo Control: CC #8
Output 9 Configuration	09 27 00 09	Servo Control: CC #9
Output 10 Configuration	0A 27 00 0A	Servo Control: CC #10
Output 11 Configuration	0B 27 00 0B	Servo Control: CC #11
Output 12 Configuration	0C 27 00 0C	Servo Control: CC #12
Output 13 Configuration	0D 27 00 0D	Servo Control: CC #13
Output 14 Configuration	0E 27 00 0E	Servo Control: CC #14
Output 15 Configuration	0F 27 00 0F	Servo Control: CC #15
Output 16 Configuration	10 27 00 10	Servo Control: CC #16
Output 17 Configuration	11 27 00 11	Servo Control: CC #17
Output 18 Configuration	12 27 00 12	Servo Control: CC #18
Output 19 Configuration	13 27 00 13	Servo Control: CC #19
Output 20 Configuration	14 01 00 14	Servo Control: CC #20
Output 21 Configuration	15 01 00 15	Servo Control: CC #21
Output 22 Configuration	16 01 00 16	Servo Control: CC #22
Output 23 Configuration	17 01 00 17	Servo Control: CC #23
Footer	F7	Fixed Data

Figure 2-4: On/Off by Bank Select & Program Change

Section	**Bytes (Hex)**	**Meaning**
Header	F0 00 01 5D 03 01	Fixed Data
Output 0 Configuration	00 19 00 00	Program Change: Bit 0
Output 1 Configuration	01 1A 00 00	Program Change: Bit 1
Output 2 Configuration	02 1B 00 00	Program Change: Bit 2
Output 3 Configuration	03 1C 00 00	Program Change: Bit 3
Output 4 Configuration	04 1D 00 00	Program Change: Bit 4
Output 5 Configuration	05 1E 00 00	Program Change: Bit 5
Output 6 Configuration	06 1F 00 00	Program Change: Bit 6
Output 7 Configuration	07 12 00 20	Controller #32 (Bank Select L): Bit 0
Output 8 Configuration	08 13 00 20	Controller #32 (Bank Select L): Bit 1
Output 9 Configuration	09 14 00 20	Controller #32 (Bank Select L): Bit 2
Output 10 Configuration	0A 15 00 20	Controller #32 (Bank Select L): Bit 3
Output 11 Configuration	0B 16 00 20	Controller #32 (Bank Select L): Bit 4
Output 12 Configuration	0C 17 00 20	Controller #32 (Bank Select L): Bit 5
Output 13 Configuration	0D 18 00 20	Controller #32 (Bank Select L): Bit 6
Output 14 Configuration	0E 12 00 00	Controller #0 (Bank Select H): Bit 0
Output 15 Configuration	0F 13 00 00	Controller #0 (Bank Select H): Bit 1
Output 16 Configuration	10 14 00 00	Controller #0 (Bank Select H): Bit 2
Output 17 Configuration	11 15 00 00	Controller #0 (Bank Select H): Bit 3
Output 18 Configuration	12 16 00 00	Controller #0 (Bank Select H): Bit 4
Output 19 Configuration	13 17 00 00	Controller #0 (Bank Select H): Bit 5
Output 20 Configuration	14 18 00 00	Controller #0 (Bank Select H): Bit 6
Output 21 Configuration	15 00 00 00	Disabled
Output 22 Configuration	16 00 00 00	Disabled
Output 23 Configuration	17 00 00 00	Disabled
Footer	F7	Fixed Data

Figure 2-5: Note Trigger Logic & Note Velocity Servo

Section	**Bytes (Hex)**	**Meaning**
Header	F0 00 01 5D 03 01	Fixed Data
Output 0 Configuration	00 01 00 3C	Note Trigger: Note #60 (Middle C)
Output 1 Configuration	01 23 00 3C	Servo: Note Velocity: Note #60
Output 2 Configuration	02 01 00 3D	Note Trigger: Note #61
Output 3 Configuration	03 23 00 3D	Servo: Note Velocity: Note #61
Output 4 Configuration	04 01 00 3E	Note Trigger: Note #62
Output 5 Configuration	05 23 00 3E	Servo: Note Velocity: Note #62
Output 6 Configuration	06 01 00 3F	Note Trigger: Note #63
Output 7 Configuration	07 23 00 3F	Servo: Note Velocity: Note #63
Output 8 Configuration	08 01 00 40	Note Trigger: Note #64
Output 9 Configuration	09 23 00 40	Servo: Note Velocity: Note #64
Output 10 Configuration	0A 01 00 41	Note Trigger: Note #65
Output 11 Configuration	0B 23 00 41	Servo: Note Velocity: Note #65
Output 12 Configuration	0C 01 00 42	Note Trigger: Note #66
Output 13 Configuration	0D 23 00 42	Servo: Note Velocity: Note #66
Output 14 Configuration	0E 01 00 43	Note Trigger: Note #67
Output 15 Configuration	0F 23 00 43	Servo: Note Velocity: Note #67
Output 16 Configuration	10 01 00 44	Note Trigger: Note #68
Output 17 Configuration	11 23 00 44	Servo: Note Velocity: Note #68
Output 18 Configuration	12 01 00 45	Note Trigger: Note #69
Output 19 Configuration	13 23 00 45	Servo: Note Velocity: Note #69
Output 20 Configuration	14 01 00 46	Note Trigger: Note #70
Output 21 Configuration	15 23 00 46	Servo: Note Velocity: Note #70
Output 22 Configuration	16 01 00 47	Note Trigger: Note #71
Output 23 Configuration	17 23 00 47	Servo: Note Velocity: Note #71
Footer	F7	Fixed Data

3.0 PWM Configuration

3.1 Overview

A servo is controlled by a pulse width modulation (PWM) signal—a continuously repeating 5V pulse. The frequency of pulses is called the "refresh rate". At any point in time, servo arm position is set by the width of the most recent pulse—changes to pulse width cause motion of the servo arm.

Different servo models require different ranges of pulse width. Consult your servo documentation for the characteristics of the required control signal.

Typical radio control ("RC") servos accept pulse widths between 1ms and 2ms for approximately 90º of arm travel (Figure 3-1). MD24 servo mode outputs using the default PWM configuration will generate pulses in this range.

The PWM signal generated by an MD24 servo mode output can be adjusted via the *PWM Configuration SysEx Message*. Each output can be adjusted independently to alter the range of arm travel for a connected servo or to accommodate servos with differing PWM control requirements.

3.2 PWM Configuration SysEx Message

Figure 3-2 shows the format of the PWM Configuration SysEx Message. The message consists of a fixed header, a variable length body, and a fixed footer.

The body of the message consists of one or more 4 byte blocks, each specifying the PWM configuration of a specific MD24 output. The configuration of outputs not specified in the message will remain unchanged.

Outputs which are configured in logic modes are unaffected by the settings from the *PWM Configuration SysEx Message*.

The Activity LED blinks three times upon receipt of a properly formatted SysEx configuration message. If no indication is given, the MD24 configuration has not been changed.

Configuration is retained when the MD24 is disconnected from a power supply.

The direction (clockwise / counter-clockwise) of servo arm travel in response to a given change in control parameter value is determined by the output mode as specified in the MIDI Configuration SysEx Message.

3.2.1 Output Number (*nn*)

Parameter *nn* specifies which MD24 output is configured by the three bytes that follow it. The valid range is 00 to 17 hex, corresponding to MD24 outputs 0 to 23.

3.2.2 Minimum Pulse Width (*ww*)

Parameter *ww* specifies the minimum pulse width of the PWM servo control signal, based on the following formula:

$$\text{minimum pulse width} = (ww + 1) \times 64\mu\text{s}$$

The valid range for *ww* is 00 to 3F hex.

3.2.3 Pulse Width Step (*ss*)

Parameter *ss* specifies the change in pulse width for each increment or decrement in the associated MIDI control value, based on the following formula:

$$\text{pulse width step} = (ss + 1) \times 0.25\mu\text{s}$$

The valid range for *ss* is 00 to 7F hex.

3.2.4 Initial Position (*pp*)

Parameter *pp* specifies the initial position of the servo upon MD24 power-up. Valid range is 00 to 7F hex.

3.2.5 Maximum Pulse Width

The maximum pulse width can be calculated using the values *ww* and *ss* as follows:

maximum pulse width =

$$[(ww + 1) \times 64\mu s] + [(ss + 1) \times 32\mu s]$$

3.3 Refresh Rate

The MD24 refreshes each servo mode output in series. By default, the MD24 will initiate refresh cycles at 20 ms intervals, for a refresh rate of 50 Hz.

The quantity and configuration of servo mode outputs may affect the servo refresh rate. At any time, the actual refresh period will be the greater of 20 ms or the sum of all servo mode output pulse lengths.

3.4 Default Configuration

The MD24 ships with a preloaded PWM configuration which can be expressed as an equivalent SysEx configuration message. See Figure 3-3.

The default PWM configuration is intended to accommodate typical "radio control"-type servos. Under default settings, a servo mode output will generate a signal with a pulse width varying between approximately 1ms and 2ms. This will cause a 90º range of motion of the servo arm. Some servo models may require adjustment of the PWM configuration.

Note that the default PWM settings are unused unless an output is configured in servo mode by a MIDI Configuration SysEx Message.

3.5 Examples

Figure 3-4 shows servo arm position as a function of MIDI control parameter value, assuming that the servo is a typical RC servo, and that the MD24 output uses the default PWM configuration.

Figure 3-5 shows the altered range of servo arm travel, given that the step width is reduced by half. Note that the range of arm travel has also been reduced by half (from 90º to 45º). The servo responds to the full range (0-127) of the MIDI control parameter, but each increment in the value causes a smaller movement.

Figure 3-6 shows the effect of changes to *ww*. Because the value for *ss* is the same as that in figure Figure 3-5, the servo arm covers a range of 45º. But because the minimum pulse width has been increased by approximately 0.5ms, the range of travel is shifted by 45º.

Choice of values for *ww* and *ss* will depend both on the characteristics of the connected servo and on the desired range of servo arm travel.

Most servos are mechanically limited to a 180º range of arm travel. If the control signal specifies a position outside the mechanical range of the servo arm, the servo may "strain" against its mechanical stop. If maximum arm travel is desired, use trial-and-error to find the appropriate PWM configuration.

Figure 3-1: RC Servo Arm Travel & PWM Signal

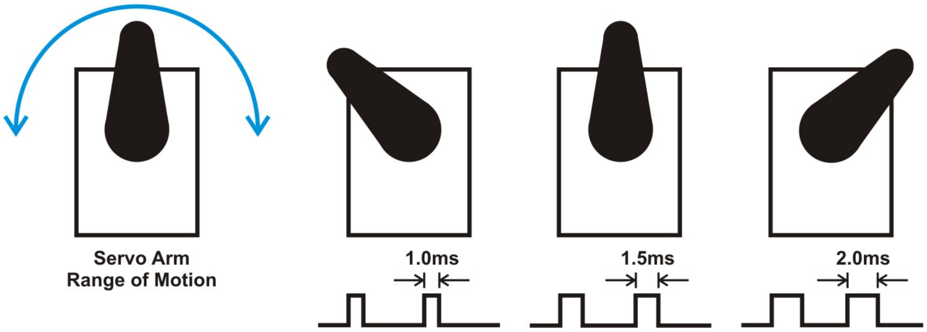


Figure 3-2: PWM Configuration SysEx Message Format (Hex)

Header (6 bytes)	**PWM Configuration (repeat as desired)**				**Footer (1 byte)**
F0 00 01 5D 03 02	*nn*	*ww*	*ss*	*pp*	F7

Figure 3-3: Default Equivalent PWM Configuration SysEx Message

Section	**Bytes (Hex)**	**Meaning**
Header	F0 00 01 5D 03 02	Fixed Data

Output *nn* Configuration for *nn* = [00..17] hex	*nn* 0F 1D 3F	Minimum Pulse Width = 1.02ms;
		Pulse Width Step = 7.5µs;
		Maximum Pulse Width = 1.98ms;
		Initial Position = 63

Footer	F7	Fixed Data

Figure 3-4: Servo Arm Travel (RC Servo; *ww* = 0Fh; *ss* = 1Dh)

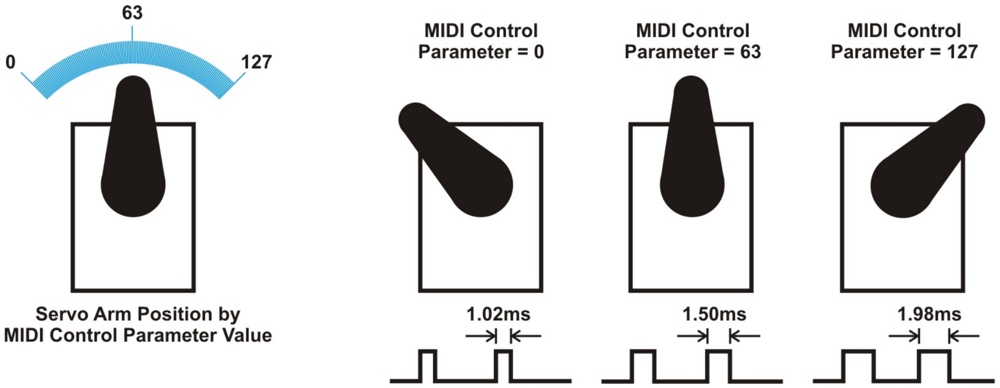


Figure 3-5: Servo Arm Travel (RC Servo; *ww* = 0Fh; *ss* = 0Eh)

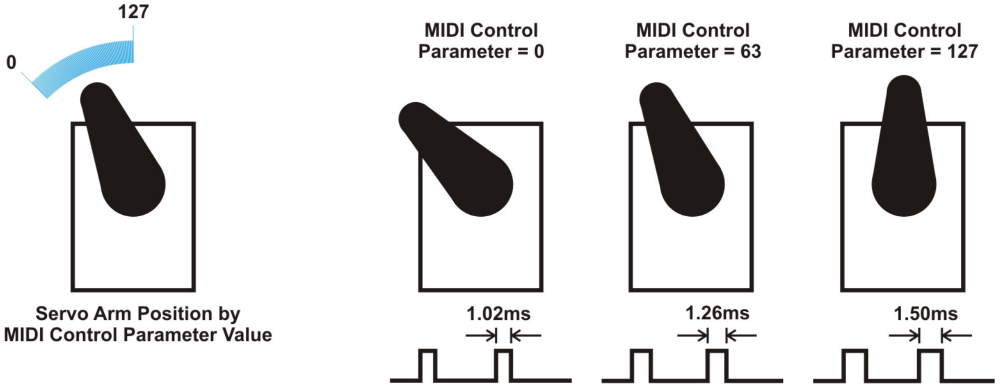
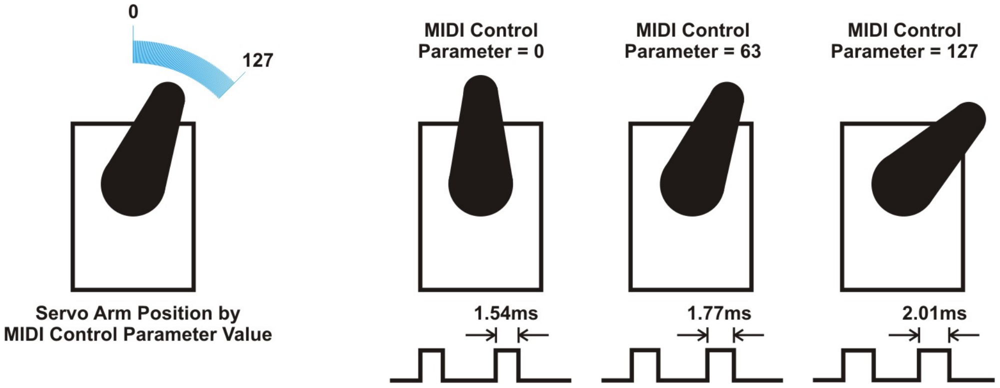


Figure 3-6: Servo Arm Travel (RC Servo; *ww* = 17h; *ss* = 0Eh)



4.0 Initialization Jumper

At any time, the default MIDI configuration and default PWM configuration can be simultaneously restored by connecting the two terminals of the “INIT” jumper JP1 and simultaneously powering up the MD24. Upon use of the INIT Jumper, the Activity LED will blink 6 times, and any user-specified configuration will be lost.

5.0 Indicator LEDs

The MD24 has two indicator LEDs: PWR (Power) and ACT (Activity).

The Power LED indicates the presence of a connected power supply. If the Power LED switches off or “dims” during operation, an inadequate power supply or overloading of MD24 outputs is indicated.

The Activity LED blinks briefly when the MD24 processes any MIDI event that affects the state of any output. MIDI events which do not match the configured output modes will not cause an activity indication.

When any properly formatted SysEx configuration message is received, the Activity LED will blink three times. Use of the INIT Jumper will cause the Activity LED to blink six times.

The Activity LED performs a brief self-test upon power-up.