Wireless Dimming | Wireless DMX | Wireless Motion

RC4 Wireless Since 1991

RC6

Safe Wireless Motion

User Manual

RC6 User Manual

Revision 1.1, April 2013

Contents

Disclaimers

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Product Safety

Motor drivers, power drivers, and dimmers should not be allowed to operate at dangerous temperatures. Appropriately sized wire, connectors, and fuses/circuit breakers, as determined by local and national electrical codes and industry best practices, must be used. Suitable ventilation is required.

Additional information is provided in this manual, but this manual is not intended to be a comprehensive electrical safety guide.

Statements of RF Conformity

Operation of the RC6 Wireless Motion System is subject to the following two conditions: (a) this device may not cause harmful interference and (b) this device must accept any interference received, including interference that may cause undesired operation.

United States (FCC)

The RC6 system contains devices identified as FCC ID: MCQ-XBEE09P.
The RC6 complies with Part 15 of the FCC Rules.

Canada (IC)

The RC6 system contains RF Module XBEE09P, IC: 1846A-XBEE09P.
The RC6 system complies with IC ICES-003 Rules.

RC6 System Overview

The RC6 Safe Wireless Motion System provides a safe and reliable means for controlling motorized, battery-powered, untethered theatrical set pieces. Two transmitter types are available: the RC6-HH handheld model, and the RC6-RU rack-mount model.

RC6 Data Security and RF Range

Every RC6 transmitter is configured with a private, unique, and unalterable digital ID. Each RC6-RX remote data receiver is capable of decoding data only from the transmitter it is paired with.

It is not possible for multiple RC6 systems to cross-talk. Only devices from the same specific system, programmed with the correct transmitter digital ID, can intercommunicate.

The RC6 system operates in the 902-928Mhz Industrial / Scientific / Medical (ISM) RF band, using Frequency Hopping Spread Spectrum (FHSS) digital encoding. FHSS systems are resistant to interference, and multiple FHSS systems can effectively coexist and operate in the same RF band.

The reliable operating range typically exceeds 400 feet. (Useable range will vary with site conditions and must be determined through testing.)

RC6 Transmitters

The RC6-RU transmitter is a 3U rack-mount device intended for connection to a theatrical automation system. Eight slots are provided for installation of axis cards, which interface with a range of automation controllers via control voltage inputs. A global E-Stop input, separate from the axis cards, affects all axes in the system.

The RC6-HH handheld transmitter is small and lightweight, with an array of controls for manually driving a set piece and monitoring the status of remote RC6 components. A large deadman pushbutton must be held by the operator during all movements; release of the deadman button will quickly stop the system.

Receivers

The RC6-RX receives digital radio signals from the transmitter, and delivers control data to RC6 motor drivers over short data cables within the mobile set piece.

This device is actually a transceiver, and also returns status information back to the transmitter from connected motor drivers.

Motor Drivers

The RC6-1MOT motor driver is a sophisticated bidirectional motor controller. It is capable of delivering up to 25A at up to 30V (typically 24V), with built-in current limiting. A quadrature encoder input allows position tracking with 32-bit resolution. Four limit-switch inputs can be configured to stop the motor when closed or opened, or to reset the rotary encoder position to a preset value.

Up to eight axes are supported with one RC6 system. In the HH transmitter, axis assignments are determined by the firmware modules installed. A simple 2-motor tank drive uses two axes. A more sophisticated mecanum drive uses four axes.

In the RU transmitter, an axis input card is required for each axis used. On remote set pieces, one (and only one) 1MOT motor driver is required for each axis used.

RC4 MSS Motion Safety System

The RC4 MSS Motion Safety System is a heartbeat system that ensures reliable E-Stop functionality. A continuously changing control signal (the heartbeat) is generated at the transmitter. A heartbeat detector circuit in the RC6-1MOT driver, independent of other systems and not software-based, disconnects power to safety-critical devices if the heartbeat is too slow, too fast, or absent. In order to continue operating, the heartbeat must be continually changing state. If it stops while high, low, or anywhere in between, the heartbeat detector will shut things down.

Physical disconnection of power to critical devices is done with an external Main Contactor (MC) relay supplied by the user. The MC must be carefully selected to match the task at hand: it must operate at the voltage being used, and it must be able to reliably open connected circuits without contact welding.

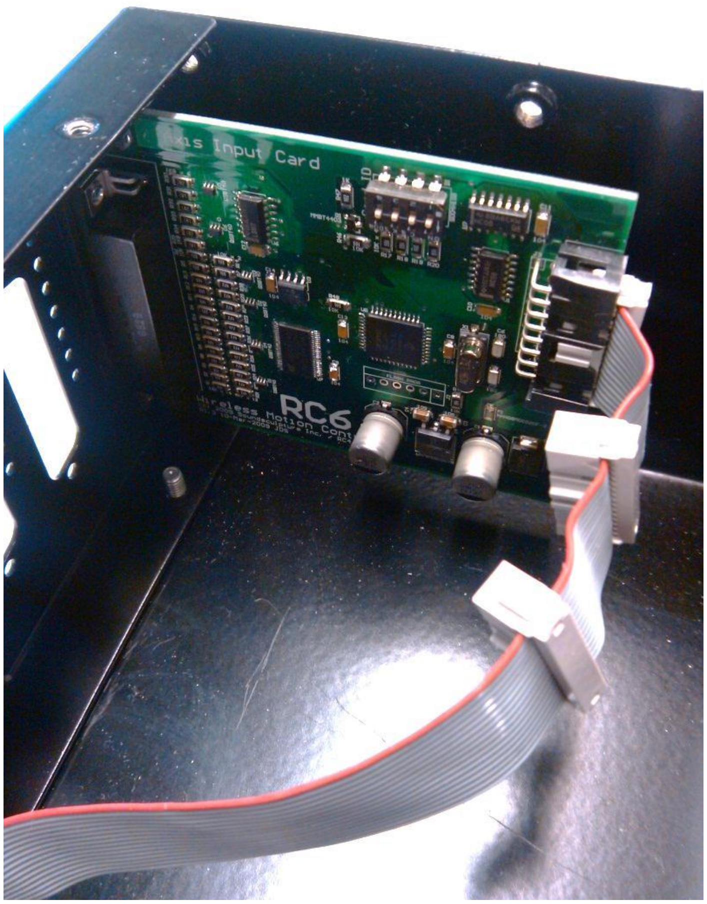
When everything is operating normally, system software monitors the heartbeat and anticipates actions taken by the independent MC relay driver. Electronic power drivers are disabled before the MC contacts open, and are not enabled until after the MC contacts have closed. This ensures that little or no arcing occurs and MC contacts are maintained in optimal condition for as long as possible.

In the rare and unlikely case where something goes severely wrong, the Main Contactor relay may open when maximum power and current is flowing. It is the responsibility of the installer and user to be certain the MC contactor is correctly connected and capable of interrupting the highest possible loads.

RC6-RU Rack Mount Transmitter

The RC6-RU transmitter is a 3U rack-mount device intended for connection to a theatrical automation system. Eight slots are provided for installation of axis cards, which interface with a range of automation controllers via control voltage inputs. A global E-Stop input, separate from the axis cards, affects all axes in the system.

Axis cards can be added, removed, or replaced at any time, up to the maximum of eight cards.



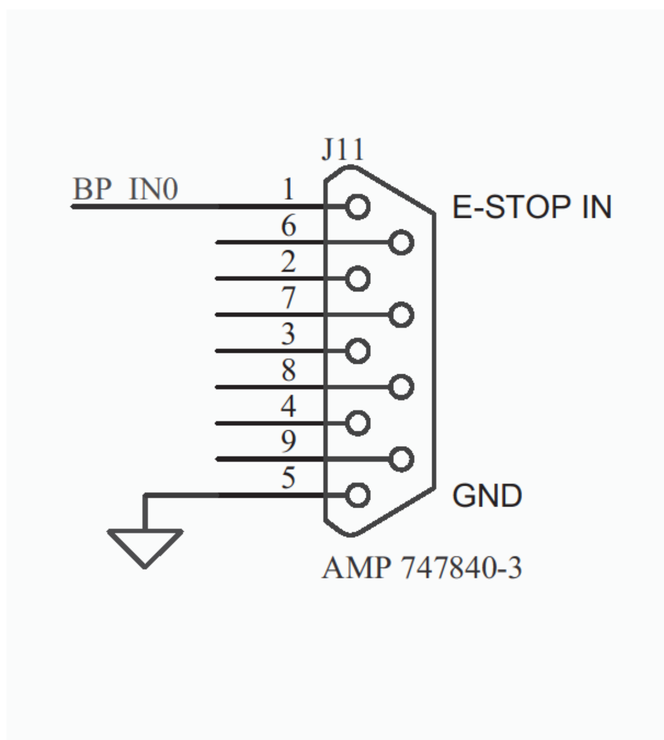
Global Connections

Power

The AC adaptor provided with your RC6-RU will work with most AC power supplies worldwide, from 100 – 240VAC. It outputs 9VDC and should be connected to the **9-12VDC In** connector on the rear of the transmitter.

E-Stop

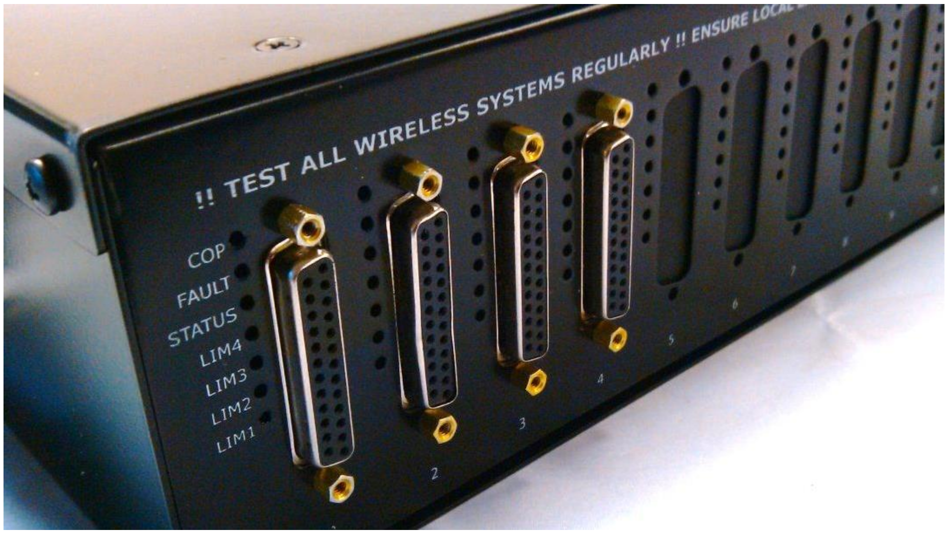
A male 9-pin connector on the rear of the RC6-RU is marked **E-Stop/Global Inputs**. On this connector, Pin 1 is the E-Stop input. Pin 5 is GND/Common. A control-voltage in the range of +7V to +24VDC should be applied to pin 1 relative to Pin 5.



The active state of the E-Stop input is a global parameter, editable from the front panel user interface.

The E-Stop input is pulled low in the RC6-RU and will be low when left open (no connection). The recommended active state is "high=run" so that a control voltage must be present to allow remote motion to occur. In this case, E-Stop engages if the external automation controller takes the E-Stop line low, or if the connection between the automation controller and the RC6 transmitter opens for any reason.

Axis Card Connections and IDs



Up to eight axis cards can be installed in the RC6-RU. Each card provides a separate 25-pin connector on the rear of the unit.

Each card is fastened into place with the mounting hardware for the 25-pin connector.

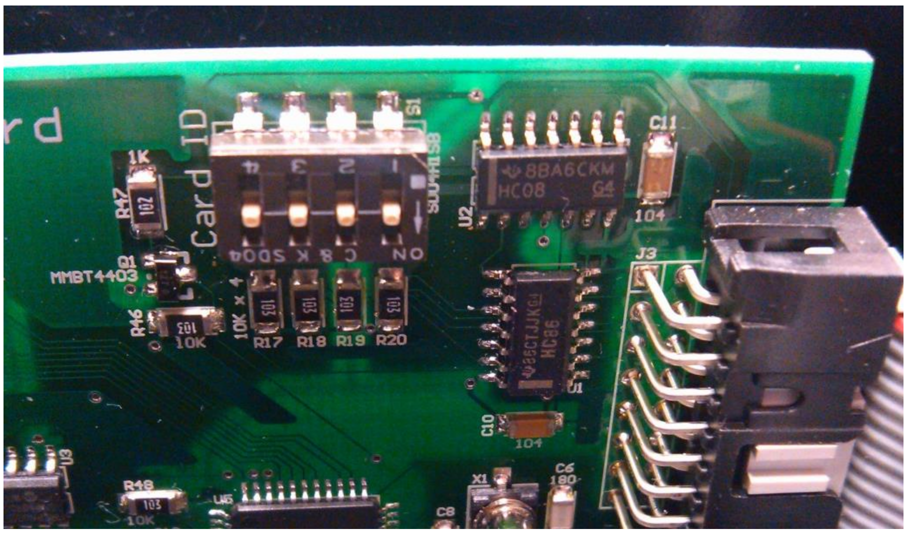
A ribbon cable inside the rack unit connects all the axis cards to the main processor card at the front.

Setting the Axis Card ID

Each card must be set to a unique Axis ID from 0 – 7, corresponding to axes 1 – 8. This is done with a 4-position bank of dipswitches at the top of the axis card, marked with the label *Card ID*.

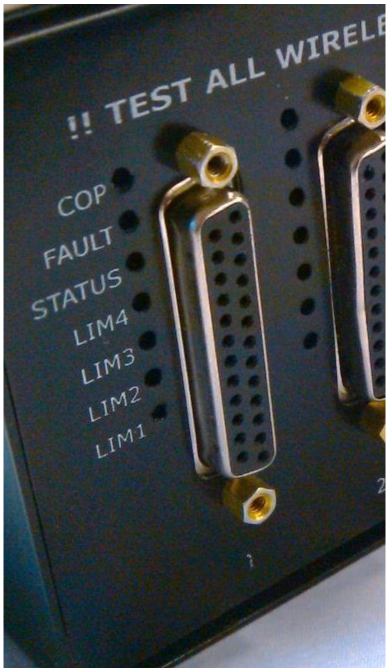
Switch 1 is binary bit 0, value = 1 when UP, value = 0 when DOWN.
Switch 2 is binary bit 1, value = 2 when UP.
Switch 3 is binary bit 2, value = 4 when UP.
Switch 4 should always be DOWN.
The Card ID is the sum of the values of switches that are UP.
The Axis Number is the Card ID plus 1.

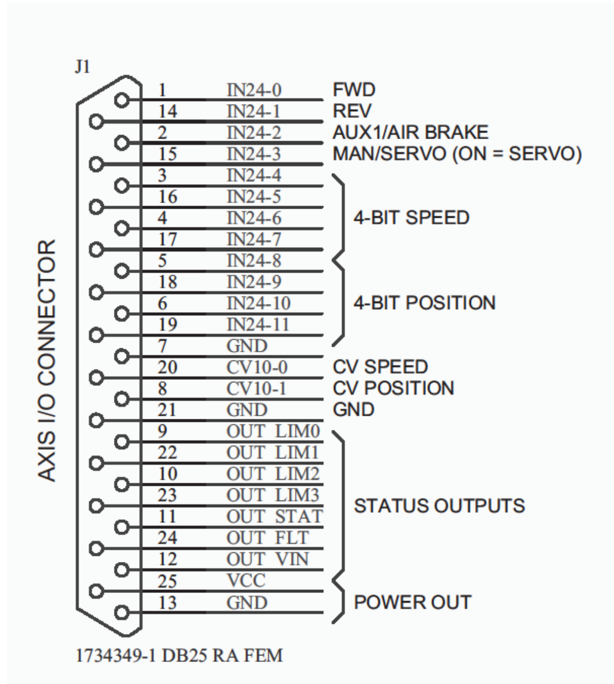
Card / Axis	**Sw 4**	**Sw 3**	**Sw 2**	**Sw 1**
0 (Axis 1)	off	off	off	off
1	off	off	off	**ON**
2	off	off	**ON**	off
3	off	off	**ON**	**ON**
4	off	**ON**	off	off
5	off	**ON**	off	**ON**
6	off	**ON**	**ON**	off
7 (Axis 8)	off	**ON**	**ON**	**ON**



In this image, all 4 switches are DOWN, which is Card 0 / Axis 1.

Control Voltage (CV) Inputs





All control inputs on the RC6-RU, either global or on an axis card, are internally pulled low. They will be inactive (low) if left disconnected. A control voltage from +7V to +24VDC is required to make the input active.

For axis inputs, the GND/common line is Pin 13 on the 25-pin connector. All input voltages are relative to this pin.

To invoke a motion in a remote RC6-1MOT motor driver, either FWD Pin 1 or REV Pin 14 must be active. If both are high, FWD takes precedence.

Each 1MOT driver has an auxiliary power output for lamps, air brakes, etc. This output is non-dim, and is controlled by AUX1 Pin 2 on the RC6-RU. When the input is active, the 1MOT output delivers power to the load on the Aux output.

The 1MOT motor driver has two modes: Direct Drive and Servo Mode (detailed later in this manual). The mode is selected with MAN/SERVO Pin 15. The inactive (low) mode is Direct Drive; active (high) selects Servo Mode.

Parameters for manual control, and up to 16 preset motions, are stored in the RC6-RU in three data tables. These tables are Drive Mode Speeds, Servo Preset Speeds, and Servo Preset Positions.

The values in the tables are selected with two sets of 4 inputs. Use 4-BIT SPEED Pins 3/16/4/17 (relative to Pin 13 GND) to select motor speed. Use 4-BIT POSITION Pins 5/18/6/19 to select positions. (Position of the set piece is tracked by the 1MOT driver using a quadrature encoder, detailed later in this manual.)

When Drive Mode is selected, the values in the Drive Mode Speeds table are used. In Servo Mode, the Servo Preset Speeds and Servo Preset Positions are used. Thus, different speeds are available for each mode. (The actual speeds and modes are set using the RC6-RU Front Panel User Interface detailed later in this manual.)

Analog Control Inputs (Not Used)

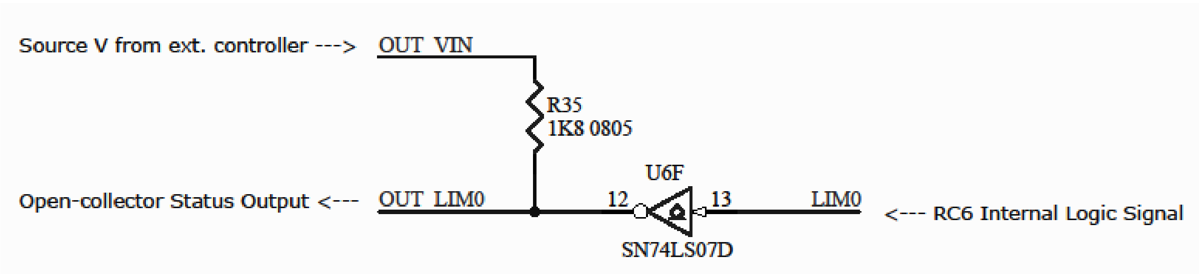
Each axis card also has two 12-bit 0V to +10V analog control voltage inputs: CV SPEED Pin 20, and CV POSITION Pin 8. To minimize electrical noise, a separate GND/common reference pin is provided at Pin 21.

These analog inputs are not supported at this time.

To avoid damage to the axis card do NOT connect a 24V input to these pins. Damage caused by over-voltage on the analog inputs is NOT covered under warranty.

Status Outputs

Each axis card provides six control-voltage status outputs. These outputs are open-collector and require a voltage input from the connected automation controller.



The controller voltage must be in the range of 5V – 24V, typically the same voltage as other lines connected to the 25-pin connector.

Status outputs are provided for each limit switch on the associated RC6-1MOT motor driver (pins 9/22/10/23).

Pin 11 indicates the presence of a functioning RC6-1MOT motor driver. This line is pulled low when the card is present and operating as expected. If this line is high, the motor driver is not communicating with the transmitter.

RC6-RU Front Panel User Interface

The RC6-RU User Interface is an 8-line LCD display with 3 pushbuttons above, 3 pushbuttons below, and 1 pushbutton to the right. The function of these buttons depends on the mode currently displayed.

In general, the buttons to the left navigate between axes, pages, and tables. The middle buttons select parameters or table elements within the currently displayed page. The right buttons increment and decrement the value or setting for the currently selected parameter.

The Enter/Confirm button to the far right is used to switch from Main Screen running mode to table and parameter editing mode. Once in an editing mode, the Enter/Confirm button is used to save changes to non-volatile eeprom memory and proceed to the next mode.

When editing, nothing is saved until the Enter/Confirm button is pressed.

UI Main Screen

The main screen is the most cryptic, in order to present as much useful information as possible for all 8 available axes at once. There are 8 lines displayed, one for each axis, from top to bottom. A typical screen might appear like this:

```
1> FSA 0 2 25.6V  1.5A  82.5F
2.     0 e 25.5V  0.0A  81.5F
3.     b 0 25.3V  0.0A  77.2F
4.     0 1 25.7V  0.0A  72.5F
5.     1 f 25.2V  0.0A  71.5F
6.     2 f 25.2V  0.0A  72.5F
7.     c 2 25.1V  0.0A  71.5F
8.     c 2 25.6V  0.0A  71.5F
```

From left to right, the top line indicates:
This is the status of Axis 1, which is selected for editing (indicated by >).
The F WD line is high.
The MAN/SERVO line is high for S ervo Mode.
The A UX line is high.
Speed 0 is selected.
Position 2 is selected.
The battery voltage for the remote RC6-1MOT on axis 1 is 25. 6V.
The remote RC6-1MOT is supplying 1. 5A to its outputs.
The temperature inside the 1MOT is 82. 5 degrees F ahrenheit.

Only one axis can be selected for editing at a time. If an axis is not selected for editing, it will appear with a . , rather than >, as in the 3rd line:

```
3.        b 0 25. 3V    0. 0A    77. 2F
```

There are 16 speeds and 16 positions. These are indicated with a single hexadecimal character: the values 10 – 15 are represented with letters a – f. In this example, speed b is speed 11.

The left-most buttons above and below the display choose which axis is selected for editing. Press the upper button to move the arrow up a line, press the lower button to move the arrow down a line. The selection rolls over at the bottom and top.

For the currently selected axis, indicated by the >, the middle upper button selects the normal Volts/Amps/Temperature status display. The middle lower button selects the alternate Servo Status display. It might appear like this:

```
2.  FSA 0 e t024000   p-11662
```

This tells us that the t arget position being sent to the remote 1MOT motor driver is 24000 encoder counts, and the current p osition of the remote driver is -11662 (a negative value in this example). The target is determined by the transmitter, from the selected Servo Position Table element. The current position is reported back from the remote RC6-1MOT motor driver.

The current display type can be toggled at any time for any axis. All data for all axes is continuously updated and displayed in real time.

If no RC6-1MOT is detected, and no status information is being returned, the transmitter displays an x in that line, and the status output on the axis card is pulled low.

Main Screen Live Function Buttons

To assist in system setup, two live button functions are available from the main screen. These buttons send control messages to the RC6-1MOT motor driver that is assigned to the currently selected edit axis. The arrowhead appears to the right of the edit axis number. In the example above, it is axis 1, indicated by 1>.

Be sure the intended axis is selected and indicated by the arrowhead before using a live function button.

Release Remote Brake

The bottom right button tells the selected 1MOT to release the motor brake. This function is always available and should be used with caution: releasing the brake could cause a set piece to roll unexpectedly. This feature makes it easier to reposition a set piece manually. Used in combination with the encoder clear function above, it is easy to release the brakes (bottom right button held down), roll the piece to the start or other reference mark, lock the brakes (let go of the bottom right button), and clear the encoder to zero (tap the top right button).

Clear Remote Encoder Position

The top right button tells the selected RC6-1MOT to clear its encoder position to zero. Because this can be dangerous, this command will not work unless Enc Remote Clear is Enabled on the RC6-1MOT itself. By default, this features is Disabled in the RC6-1MOT and the encoder will not be cleared.

Table Editing

To set the values in the 3 data tables, enter Table Edit Mode by pressing the button to the far right labeled Enter/Confirm.

If you are entering the table editing mode for the first time since powering up the RC6-RU, it will display Drive Preset Speeds for Axis 1 with the arrowhead indicating that preset 0 is selected for editing. If you change which axis and table are displayed, then exit and later return, you will return to the same axis and table you last selected.

```
Ax: 1 Drive Preset Speeds

0>  19    6:  0     c:  0
1:  39    7:  0     d:  0
2:  -19   8:  0     e:  0
3:  -39   9:  0     f:  0
4:  0     a:  0     Accl:  40
5:  0     b:  0     Scal: 255
```

To increment the selected axis, press the top left button. There is no decrement key. To select a lower axis, cycle up past 8 and the count will wrap back around to 1. In the example above, Ax: 1 (axis 1) is selected.

To select a different table, press the bottom left button. Each press of the button will select the next table, wrapping back to the first table at the end.

The sixteen values if the table are displayed in 3 columns. The left column shows presets 0 – 5, the middle column shows presets 6 – 11 (where a = 10, and b = 11), and the right column shows presets 12 – 15 (c – f).

At the bottom of the right column are one or two additional parameters, if applicable for the selected table.

The top and bottom middle buttons select a table element for editing. Press the top middle button to move up to the previous element; press the bottom middle button to move down to the next element. The currently selected element is indicated by the arrowhead >. The selection wraps around at the ends of the table.

The top and bottom right buttons change the value of the selected element. The top right button increments, the bottom right button decrements the value.

Edited values are not saved until you exit table edit mode by pressing Enter/Confirm at the far right. The display will briefly indicate ...saved and proceed to the Global Parameter Editing mode.

When editing, nothing is saved until the Enter/Confirm button is pressed.

Direct Drive – Preset Speed Table

Direct drive mode (selected when the MAN/SERVO Pin 15 line is low) provides direct control of axis motor speed and direction. Quadrature encoder position is not used in this mode, but actual position in encoder counts is always tracked and will remain correct as the encoder moves forward and backward for any reason (including movement caused by external forces, like manually pushing the piece with the brake released).

Direct drive speeds are in the range of -128 to +127. Zero (0) is stopped. When motion is invoked with the FWD Pin 1 line, negative values are reverse speeds and positive values are forward speeds. The direction is reversed if motion is invoked with the REV Pin 14 line.

Thus, an installation that makes full use of all available axis inputs can select from 16 speeds both forward and backward (a total of 32 choices). An installation that needs to conserve input lines can ignore the REV line and use negative speed settings to run in reverse.

The Direct Drive Speeds display also provides access to direct drive Accel and Scale values. Accel (Accl) affects both increases and decreases in speed. A lower value results in a slower acceleration that takes more time. A higher value delivers faster acceleration that is more immediate and abrupt.

To conserve battery power and ensure safety, use the lowest acceptable Accel setting.

Scale (Scal)is used to reduce the maximum power that will be delivered to the motor, and scales all Direct Drive Speeds to the reduced range. Thus, the presets can simply be a range of speeds from lowest to highest, and the Scale setting will determine the real upper limit of the range.

Direct Drive mode simple delivers power to the motors. Because of this, settings are not really “speeds”, they are “power levels.” In most cases, half power results in approximately half speed. No regulation of speed is provided by the 1MOT driver in this mode. (Trajectory tracking in Servo Mode does provide regulated speed for actual cues within a show.)

Servo Mode – Preset Speed Table

Preset speeds for Servo Mode are independent of Direct Drive Mode speeds. Servo speeds do not work the same way. The range of values is different and there is no correlation between values in each mode.

Servo Mode speeds are in the range of 0-255. There are no negative values. Zero is not a stop, it is the slowest available speed. Direction of movement is determined by the RC6-1MOT servo controller, based on the relationship between target and real position at the time the motion is invoked.

There is no Scale parameter for servo speeds.

The Accel parameter is independent of the Direct Drive parameter of the same name, and works differently. Actual rate of velocity change relative to the Accel value in the table is determined by how the remote 1MOT motor driver is configured (detailed later in this manual).

Servo Mode – Preset Position Table

Preset positions are absolute encoder values, represented internally by 32-bit signed integers. This provides a range greater than +/- 2 billion counts. (If 1 encoder count is 0.001 inches, total available travel distance exceeds 300,000 feet. If 1 count is 1/8th of an inch, available travel distance exceeds 41 million feet!)

In addition to the editing buttons for incrementing and decrementing values in the position table, you can copy the current remote encoder position into the table. This is the recommended method for setting table values:

Move the set piece to a position you wish to save as a preset. You can do this using Direct Drive mode, or release the brakes and manually push the piece. The 1MOT must be powered on and actively communicating with the RC6-RU transmitter while doing this.

When the piece is in the desired position, and the correct element of the table is selected with the arrowhead, press both the top right and bottom right buttons together. The position of the remote RC6-1MOT encoder will be copied to the table.

If you press and hold the top and bottom right buttons while rolling the piece, you will see the encoder value change in real time. Using this method, simple let go of the buttons when the piece reaches the position you wish to save. The position at the time of button release will be stored.

Remember to exit Table Edit mode with the Enter/Confirm button to save new values in all tables. No new table data is saved until you exit, and ...saved **is briefly displayed on the screen.**

Global Parameter Editing

After exiting Table Editing, Global Parameter Editing is invoked. For each of a series of editable parameters, the parameter name appears on one line and the setting or value for that parameter appears below.

In this mode, the left buttons are not used.

The top and bottom middle buttons step backward and forward through the list of available parameters.

The top and bottom right buttons increment and decrement the value or setting for the currently displayed parameter.

After making any needed changes, new settings are saved by pressing the Enter/Confirm button. The message ...saved will briefly be displayed, and the user interface will return to the main screen.

No changes are saved until the Enter/Confirm button is pressed.

E-Stop Input Polarity

This parameter has two possible settings:
high=run / low=stop is the default and recommended setting. In this state, all motion commands are inhibited and no axes are allowed to move unless an E-Stop control voltage in the range of +7V to +24VDC is present at the 9-pin connector on the rear of the RC6-RU. (Connection details are provided earlier in this manual.)

low=run / high=stop can be used to disable the E-Stop input. In this case, the RC6 system allows all motions to occur, even when nothing is connected to the 9-pin connector on the rear of the RC6-RU. If a voltage in the range of +7V to +24VDC is applied, all motion commands are inhibited.

When motion is inhibited, the RC6-RU tells all remote 1MOT controllers to stop moving, and stops transmitting the safety heartbeat. This ensures that everything stops both by command, and by activating the RC4 MSS Motion Safety System shutdown.

An MSS shutdown turns off the RC6-1MOT Main Contactor (MC) power output. It is important that all safety-critical systems be wired through a contactor that is operated from this output. This ensures that any fault that opens that contactor will stop those critical systems.

LCD Backlight

If the LCD backlight is casting unwanted visible light, it can be turned off. Note that it is difficult to read the display when the backlight is off.

LCD Contrast

LCD Contrast can be optimized for the viewing angle of the RC6-RU operator. In most cases, looking straight at the display, a value in the range of 41 – 47 is optimal. If the value is higher or lower than this, streaks and lines will make the display difficult to read at some angles.

RC6-HH Handheld Transmitter

The RC6-HH handheld transmitter is small and lightweight, with an array of controls for manually driving a set piece and monitoring the status of remote RC6 components. A large deadman pushbutton must be held by the operator during all movements; release of the deadman button will quickly stop the system.

Additional information about the handheld transmitter will be provided in a future revision of this document.

RC6-RX Remote Data Receiver

The RC6-RX receiver is actually a transceiver, capable of both receiving and sending information by radio. It is factory programmed and coded to communicate with only one transmitter. The user cannot change this.

Components from different RC6 systems cannot be shared or interchanged.

The five-pin XLR data ports use all 5 pins:

1: GND/common
2: data pair A-
3: data pair A+
4: data pair B-
5: data pair B+

Data pair A carries data arriving from the transmitter and being delivered to 1MOT motor drivers. All data for all axes are present at all receivers, allowing multiple 1MOT drivers assigned to different axes to be daisy-chained together with data cables from a single RX receiver unit.

Data pair B carries status information from 1MOT drivers back to the transmitter. This includes battery voltage, current draw, driver temperature, encoder position, state of the limit switches, and more.

DMX lighting cables will fit in RC6 data connectors but may not have conductors attached to pins 4 and 5. All 5 conductors must be present for proper RC6 operation.

Five-conductor DMX cables are ideal for RC6 data connections. When making cables, follow the same guidelines and recommendations that apply to making DMX cables, using a separate twisted-pair for pins 1/2 and pins 4/5. The shield must be connected to pin 1.

To minimize the possibility of noise and interference, follow these recommendations:

- Use the shortest possible cable lengths. Avoid coils of unneeded cable.

- Do not run data cables in parallel with power cables. When they do travel nearby, never tie or bundle data and power cables tightly together.

- Follow the same daisy-chain topology recommended for DMX wiring. Avoid a star topology.
- Terminators are generally not required. However, if total data cable length exceeds 50 feet in a daisy-chain circuit, and/or data errors arise, a 100-ohm resistor can be used to terminate each data pair (a 100-ohm resistor between pins 1 & 2, and another resistor between pins 4 & 5). A terminator connector can be made for this purpose. A commercial DMX terminator can also be used. Place the terminator at the last 1MOT motor driver, so that the RC6-RX is at one end of the cable, and the terminator is at the other end, with one or more RC6-1MOT motor drivers along the way.

Most RC6 installations do not require terminators. If you are experiencing difficulties, contact RC4 Wireless technical support for help and assistance. Contact information is provided at the end of this manual.

RC6-1MOT DC Motor Driver

The RC6-1MOT motor driver does all the real work of wireless motion control. This is the device that delivers current to motors and other loads, counts quadrature encoder pulses, and manages set piece positioning.

Functional Blocks

The 1MOT is a complex device that is best thought of as a stack of functional layers. At the bottom are direct interfaces to the physical world: drivers for the motor and other loads, and inputs for a quadrature encoder and limit switches. Next is the PID servo control layer. Above that is a trajectory or path manager. And finally, at the top of the stack, are the data input/output manager and the user interface:

<table>
<tr><td>Control Data Input/Output Manager</td><td>User Interface Display and Buttons</td></tr>
<tr><td colspan="2">Trajectory Manager</td></tr>
<tr><td colspan="2">PID Loop</td></tr>
<tr><td>Encoder and Limit Switch Inputs</td><td>H-Bridge and Other Power Drivers</td></tr>
</table>

The Physical Interface Layer

H-Bridge Driver

A high-power bidirectional H-bridge driver consisting of 4 discrete mosfet power transistors delivers power to the external motor. Pulse-width-modulation (PWM) is used to modulate power at 17kHz, high enough to be silent to human ears.

For the highest possible safety, the RC6-1MOT H-bridge is designed so that any single mosfet that fails short (conducting power continuously) will cause failure of at least 1 other mosfet (and sometimes all 4), rendering the driver unable to deliver power to the motor. This design differs from other motor driver designs, where a single mosfet failure can cause full power, uncontrolled, to be delivered to the load. Regardless of whether a mosfet fails open (off) or short (delivering power), it is nearly impossible for unexpected motion to result.

In the world of motor drivers, most mosfet failures result from overloading and overheating. To minimize the probability of this happening, the RC6-1MOT driver constantly measures current draw and limits output to 25 amps. In addition, a cooling fan operates whenever current or temperature rises above a threshold.

It is not possible to design a power driver that is 100% fool proof and fault proof. RC6 systems should never be operated unattended.

Quadrature Encoder Input

A quadrature encoder input allows the motor driver to track position. This is most commonly done with an idler wheel connected to a rotary encoder. As the set piece moves, the idler wheel runs along the floor. Alternatively, an encoder is sometimes connected to the motor shaft or drive wheel shaft. Linear quadrature encoders can also be used, some as simple as optical sensors detecting a series of reflective marks along the path of movement.

The 1MOT counts encoder increments, both forward and backward, maintaining a 32-bit signed integer for current position. This provides a range greater than +/- 2 billion counts. If 1 encoder count is 0.001 inches, total available travel distance exceeds 300,000 feet. If 1 count is 1/8th of an inch, available travel distance exceeds 41 million feet!

To ensure no counts are missed by the controller, the maximum input rate is 2375 encoder pulses per second.

When the encoder speed approaches this upper limit, the red indicator LED on the side of the RC6-1MOT begins to flash. If the LED is lighting dimly, precision is still maintained but higher speeds should be avoided. When the LED is solidly lit and bright, it is likely that pulses are being missed and positional accuracy is compromised.

When using a 1024ppr (pulse per rotation) encoder, the maximum input speed is 2.32 rotations per second. If faster encoder rotation is required, use a lower ppr. The maximum speed for a 256ppr encoder is 9.3 rotations per second. A 128ppr encoder can rotate up to 18.5 times per second.

Limit Switch Inputs

Four limit switch inputs provide additional feedback to the RC6-1MOT and the controlling transmitter. Each switch can be configured to invoke a user-selectable action: either to stop the 1MOT, or to reset the current encoder position to a predetermined value. Thus, a switch could be used as an emergency stop, perhaps in the event of collision with another object, or overrunning a physical position. Or it could be used to realign the encoder position at one or more fixed locations along the travel path.

The PID Loop Layer

The functional layer above the physical interface is the PID (Proportional – Integral – Derivative) servo processor.

An in-depth discussion of PID loops is beyond the scope of this manual. A good introduction to PID control is available at:
http://en.wikipedia.org/wiki/PID_controller

A PID loop is a continuously repeating algorithm that compares a desired target position with the current quadrature encoder position. It controls the motor driver, varying direction and power level, to smoothly reduce the difference between the target and current position. When the difference is zero, the job is done.

In servo-speak, the difference between target and current position is referred to as positional *error*. The objective of the process is to reduce the error to zero.

P

Proportion (*P*) is the easiest part of PID to understand: the greater the error, the more power is applied to the motor. If the target is above the current position, the motor is driven positively, or forward. If the target is below, the motor is driven negatively, or backward. In simple math:

P = Target - Position

P is the error right *now*, at the current instant in time.

The relationship between positional error and motor power (the slope if shown on a graph) is controlled by *P gain*, or the *P term*, which is simply a multiplier. If the multiplier is high, then motor power will drop rapidly as the target is approached. With a lower multiplier, the motor will slow more gradually.

I

Integral (*I*) error is accumulated P error over time. It is used to counteract or counterbalance against influences like gravity. For example, when a servo system is lifting a vertical load, it will have a harder time lifting than lowering. This will cause *I* errors to generally be more negative in the up direction (the system lags behind), and more positive in the down direction (the system races ahead). In the PID loop, *I gain* can be tuned so that more power is applied when lifting, and less power is applied when lowering.

In the case of a balanced load, I error tends to cancel itself out. In simple math:

$$I = I + P$$

I is the total of all P errors, both positive and negative, that have ever occurred.

Because *I* error accumulates, it can quickly become a huge and overly influential value. This is referred to as "*I* wind-up". To avoid wind-up, the RC6-1MOT PID servo loop manages *I* with two parameters: the multiplier *I gain*, and a numeric ceiling, *I limit*.

In many cases, *I* is not needed. When tuning a PID system, start with *I gain* at zero.

D

Derivative (*D*) error relates to velocity, and – more importantly – changes in velocity. Velocity is determined not just by the motor driver, but also by external influences. For example, a large mass resists changes in speed, due to its inertia. Bumps and obstructions along the travel path can introduce unexpected drops in velocity.

D is the difference between the previous V and the present one:

$$D = V_{\text{previous}} - V_{now}$$

The effect that *D* has on the servo loop is controlled with multiplier *D gain*.

PID Math

Remember that all these values – for target position, current position, velocity, *P*, *I*, and *D* – are all signed numbers – they can be positive or negative. In the case of *I*, adding a string of positive and negative errors of approximately equal size results in something close to zero. For *D*, a positive number indicates speed increasing, while a negative value indicates speed decreasing. And, as already mentioned, the sign of *P* tells us if we need to be moving forward or backward. Finally, down at the physical interface layer, positive power to the motor moves it forward; negative power moves it backward. In the end, the result of PID math is a signed number, and that number is sent to the motor driver.

A well-tuned PID loop will quickly reduce positional error to zero, with little or no overshoot or undershoot. Overshoot is when the motor runs past the target then backs up to the mark. Undershoot is when the motor slows down before reaching the target and stops before getting there. If the PID loop is tuned to be too aggressive, it will overshoot on approach, then overshoot again when backing up, reverse and overshoot again, oscillating. If the loop is entirely unstable, this oscillation will continue indefinitely. More commonly, the overshoot distance will decrease on each reversal until movement finally stops. This is "damped oscillation," sometimes called "hunting."

The ideal configuration is powerful but stable, fast but not susceptible to oscillation. All the parameters for PID tuning are:

- Proportional (*P*) Gain
- Max *P* Error
- Derivative (*D*) Gain
- Integral (*I*) Gain
- Integral (*I*) Limit

Additional help with PID tuning and setup are provided later in this manual.

Trajectory Manager

A positional PID loop does not regulate travel speed and does not inherently provide smooth acceleration and deceleration. This is handled by the next functional layer: the Trajectory Manager.

When the RC6-1MOT receives a command to move to a particular servo position, it does not send that position value directly to the PID loop as the target. Instead, it plots a series of incremental points to create a trapezoidal path, accelerating to a target speed, holding that regulated speed, and decelerating smoothly to stop at the destination. The PID loop tracks these trajectory points, so the PID target is continually changing.

In this way, the Trajectory manager has complete control over speed of travel, acceleration, and deceleration. The PID servo loop, one layer below, dynamically responds to changes in load caused by inertia, bumps on the deck, people stepping on and off, slope of the stage, gravity, and anything else affecting position and velocity.

Trajectory form is determined in setup with 5 parameters:

- Minimum speed
- Maximum speed
- Minimum acceleration rate
- Maximum acceleration rate
- Stop window size

The RC6-1MOT internal servo clock runs 38 *tics* per second. A new trajectory point is calculated, and PID values are recalculated, on every tic. The trajectory values for minimum and maximum speed are expressed as encoder counts per tic.

The maximum rate at which encoder counts can be accurately measured is 250 counts per tic, or 9500 counts per second. Do not attempt to run trajectories with a maximum speed that is higher than 250. For faster physical speeds, use a quadrature encoder with fewer counts per revolution, a larger idler wheel, or find some other way to reduce the number of counts per inch of actual movement.

Data Input/Output Manager

The top functional layer of the RC6-1MOT is the data processor. This layer receives, interprets, and processes incoming commands, and returns status information when requested.

All data for all axes are available to all devices in the RC6 system. Each 1MOT is assigned to a specific axis number from 1 – 8.

Only one RC6-1MOT should be assigned to each axis. If multiple axes are to be operated together, they still must be assigned unique axis numbers.

RC6-1MOT Connections

All power connections on the RC6-1MOT are Anderson Powerpole PP15/45. Additional information about these connectors is available at: http://www.andersonpower.com/products/standard-powerpole.html.

PP30 (30A) or PP45 (45A) should be used for the DC IN and Motor Drive connections. PP15 can be used for Main Contactor, Brake, and Aux connections.

Use a power supply voltage that is suitable for the loads being controlled. Most commonly this will be 12V or 24V batteries for use with 12V or 24V motors. The serviceable input voltage range is 8V to 30V.

Power Input

Use red and black PP30 or PP45 connector pins for DC IN. A current limiting fuse or circuit-breaker should be installed at the power source, and an appropriate wire gauge for that fuse or breaker size must be used.

Power Outputs

MSS Output

The MSS Motion Safety System output can deliver up to 5A to an external Main Contact (MC) relay. This power output is protected against overload and overheating. In the event of either, the output will turn off and the MC will open.

In some cases, only motor power needs to be wired through a Main Contactor. In other cases, brake power, and other devices as well, should be part of the Main Contactor system. When multiple circuits must be interrupted, multiple sets of independent MC contacts are required.

An external Main Contactor (MC) relay must be used with any part of the RC6 system that is safety-critical. This relay must be wired so that it disconnects power and stops motion if power to the MC relay is off.

Maximum MC drive current is 5A.

Motor Drive

The RC6-1MOT uses a solid-state H-bridge motor driver. This is a configuration of power mosfets that can deliver power in either polarity to run a DC motor clockwise or counter-clockwise. Pulse-width-modulation (PWM) provides more than 300 linear power level steps in each direction. Motor direction is determined by motor power polarity.

To swap the directions that the motor runs, swap the motor connections.

Maximum continuous motor output current is 25A.

Brake

The Brake driver delivers current whenever the motor drive is spinning the motor. It is intended for use with an electrically operated brake that is normally engaged (locked) and powered to release (free). When no power is present, the motor will be locked by the brake.

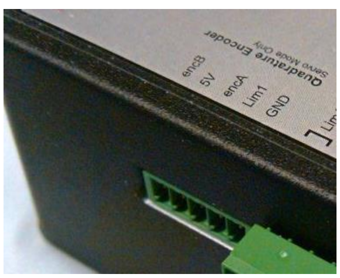
Maximum brake output current is 5A.

Aux.

The auxiliary power driver is controlled by the auxiliary (A) control line for the selected axis. It is a switching output only, no variable dimming or speed control is provided.

Maximum aux output current is 5A.

Quadrature Encoder



The RC6-1MOT requires an incremental quadrature encoder for positional feedback. An introduction to this type of encoder is available at:
http://en.wikipedia.org/wiki/Rotary_encoder#Incremental_rotary_encoder

The quadrature encoder input connection is a 5-pin Eurostyle interchangeable terminal block:

Make: **TE Connectivity**, Part Number: **284506-5**

Pin-out:
Pin 1: GND/common (0V)
Pin 2: Limit Switch 1 (alternate connection, usually left disconnected)
Pin 3: quadrature signal A
Pin 4: 5V
Pin 5: quadrature signal B

If your encoder provides an index output on pin 2, it should NOT be connected to the pin 2 input.

Encoder direction is determined by the phase relationship between signal A and signal B. The decoded direction can be reversed by swapping the A and B lines. There is also a setup parameter to change the counting direction.

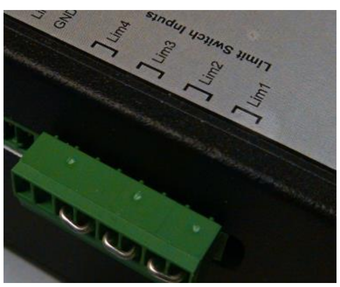
To ensure high-speed responsiveness, encoder input lines are only minimally filtered. To avoid glitches and positional errors, encoder data lines should be shielded and kept as short as possible. If long lines are required, additional signal conditioning may be required. A balanced line encoder/decoder works well for running encoder signals over long distances.

The RC6-1MOT uses the highest possible resolution of quadrature decoding, which is 4x (four times) the number of quadrature cycles per rotation. Thus, a 1024ppr (pulse per rotation) encoder produces 4096 counts per rotation.

The maximum encoder input rate for the RC6-1MOT is 9500 counts per second, which is 2375 pulses per second. For a 1024ppr encoder, the maximum rotational speed is 2.32 rotations per second. Exceeding this speed will result in lost counts,positional inaccuracies, and potential system instability.

The red error indicator LED on the side of the RC6-1MOT will light brightly and continuously when encoder speed is too high.

Limit Switches



The limit switch input connection is an 8-pin Eurostyle interchangeable screw terminal block:

Make: **TE Connectivity**, Part Number: **284506-8**

Pin-out:
Limit Switch 1: Pins 1, 2
Limit Switch 2: Pins 3, 4
Limit Switch 3: Pins 5, 6
Limit Switch 4: pins 7, 8

Internally, each limit switch input is a logic line pulled to 5V by a 10K-ohm pull-up resistor. An external switch (or open-collector transistor) must pull this line to ground. Odd numbered connector pins (1, 3, 5, 7) are ground; even numbered pins are logic inputs.

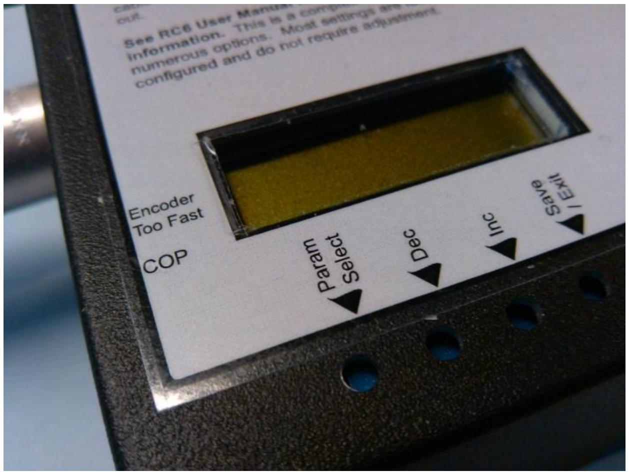
If a normally closed switch is used, the normal state of the logic line will be LOW because the input will be pulled to ground by the switch. When the switch is activated it will open the circuit and the logic line will go HIGH.

If a normally open switch is used, the normal state of the logic line will be HIGH because the input is held high by the 10K pull-up resistor. When the switch is activated it will pull the logic line LOW.

To avoid sensitivity to noise, interference, glitches, and contact bounce, limit switch inputs are filtered in both hardware and firmware. Nonetheless, limit switch wiring should be shielded and kept as short as possible.

Normally closed limit switches are recommended. A setup parameter allows either normally open or normally closed switches to be used.

RC6-1MOT User Interface



The user interface on the RC6-1MOT consists of a 2-line LCD display and four recessed push-buttons. The buttons are recessed to ensure they cannot be accidentally bumped while the unit is installed.
On power-up, the LCD display shows status information for the currently active mode, either Drive Mode, or Servo Mode.

Pushing any of the 4 buttons will enter the parameter editing mode. Each button is a different *entrypoint* for parameter editing:

The leftmost button, labeled **Param Sel**, is the *All Parameter* entrypoint. This provides access to all parameters available in the RC6-1MOT, across all categories.

The next button, labeled **Dec**, is the *Limits and Encoder* entrypoint. This provides access only to parameters related to limit switch and encoder setup parameters, a subset of All Parameters.

The button labeled **Inc** is the *PID Tune* entrypoint. It provides access only to parameters related to PID setup and tuning.

Finally, the **Save/Exit** button is the *Trajectory Setup* entrypoint, providing access to parameters that control trajectory form.

When any of the buttons are pressed, the name of the entrypoint is displayed for 1 second, then remains displayed until all buttons are released. On release of the button, the UI is now in *parameter edit mode*.

To step up and down through available parameters, press and hold the **Param Sel** button while tapping the **Dec** and **Inc** buttons. The range of parameters offered depends on the entrypoint you used to enter edit mode. For full access to all parameters, enter edit mode with the **Param Sel** button.

Remember: To enter edit mode, press and release (tap) an entrypoint button.

In edit mode, the currently selected parameter is displayed by name on the top line of the LCD. The current setting or value for the parameter is displayed on the bottom line.

To change the value of the currently displayed parameter, release the **Param Sel** button (so it is not pressed), then use the **Dec** and **Inc** buttons to find the desired setting.

In all modes, holding buttons down will invoke auto-repeat, which starts slowly and increases in speed over time.

If no buttons are pressed for 4 seconds, the UI automatically exits edit mode and returns to displaying status information. In this case, any edits or changes that were made are discarded.

Parameters

All parameter values are stored in non-volatile eeprom memory. No backup battery is required for eeprom. Life expectancy exceeds 100 years, and values can be changed more than 100,000 times.

Global Parameters

Axis Assignment

The RC6 transmitter sends data for 8 different axes, numbered 1 – 8. The axis assignment determines which data this RC6-1MOT motor driver will respond to. Only one RC6-1MOT should be assigned to each axis number.

Max Power

This parameter affects the H-bridge motor driver, at the lowest functional layer. It is the maximum pwm power level that is allowed while in Direct Drive mode.

This setting is overridden by Servo mode to ensure the PID process always has maximum power available to it.

Max Accel

This parameter affects the H-bridge motor driver, at the lowest functional layer. It determines the maximum rate of change for pwm power levels. Lower accel values result in slow changes; higher values result in rapid and abrupt changes.

This setting is overridden by Servo mode to ensure the PID process can respond as quickly as possible.

Limit Switch Configuration

Limit Switch n Polarity (n = 1 to 4)

The RC6-1MOT has 4 limit switch inputs labeled 1 – 4. For each switch, the active polarity can be selected. Select *Normally Closed* or *Normally Open*. A normally closed switch invokes a function when it opens. A normally open switch invoked a function when it closes.

Limit Switch n Function (n = 1 to 4)

Each of the 4 limit switches can either cause the motor driver to stop, or it can write a preset numeric value to the current encoder position. Select *Stop Drive* or *Update Position*.

Limit Switch n Preset Encoder Position (n = 1 to 4)

This parameter is always available for editing but has no effect unless the associated limit switch function is set to *Update Position*. In that case, the value of this parameter is written to the current encoder position when the limit switch invokes its function.

For example, if Limit Switch 2 is configured as a *Normally Closed* switch that will *Update Position*, then: when switch 2 opens, the current encoder position will be changed to the value of Lim Sw 2 Preset Encoder Position.

Note that current position will be continually overwritten until the switch returns to its normal state. Until then, encoder counts have no effect on current position.

Quadrature Encoder Configuration

Encoder Setup

This parameter selects whether the current position counts *Up* or counts *Down* when the connected quadrature encoder rotates clockwise. The RC6-1MOT always uses the highest resolution method of quadrature decoding, resulting in 4 numeric increments for each pulse cycle of the encoder.

A 1024ppr (pulse per rotation) encoder produces 4096 position counts per rotation in the RC6-1MOT.

Velocity Setup

This parameter is currently not implemented and has no effect.

Remote Clear Enable

If this option is enabled, then the transmitter is capable of clearing the current encoder position value to zero. By default this feature is disabled.

Inadvertent changing of the position value can result in unwanted and dangerous movement.

Servo (PID) Tuning

Target Scale

This multiplier scales the axis target position received from the transmitter. The default value of 1.000 is ideal in most cases.

Target Range

This parameter limits the maximum allowable value for target position. For safest operation, set this value to the same or slightly more than the largest position target used in your show.

A Target Range of zero (0) disables this feature. Zero (0) is the default setting.

Proportional (P) Gain

This is one of the three "classic" PID tuning parameters. *P* is the difference between the target and current encoder position. Thus, it represents real positional error *now*.

P gain determines how much influence the value of *P* has on actual motor power, via the equation *P* x *P gain*. A higher gain results in faster power rise as the servo error widens. Low values of *P gain* will result in slower and softer approaches and stops. If *P gain* is too low, the system may not reach the target and may lag too far behind trajectory points.

Max P Error

Max P Error is a safety feature that ensures the servo cannot run out of control in the event of a failure in the sensor/motor feedback loop. If the motor or encoder spins in the wrong position (most likely due to a wiring error or parameter change), the PID servo error will increase rather than decrease. Without a limit on this behavior, the motor will spin at maximum speed and power for an indefinite period, leading to potentially catastrophic results.

For most effective protection, *Max P Error* should be set for a value that is a bit larger than the maximum distance between two points in a trajectory path. The default setting is 3500.

Derivative (D) Gain

This is one of the three "classic" PID tuning parameters. *D* represents the rate at which system velocity is changing. In a way, *D* predicts what is going to happen *next*.

If *V* (velocity) is changing very little as time passes, regardless of whether travel is fast or slow, *D* will be low. Values of *D* rise and are most significant in the vicinity of the target (slowing down), or when the system encounters an obstruction that causes an unexpected jolt.

D gain determines how much influence the value of *D* has on motor power, via the equation *D* x *D gain*. In general, *D* slows the transient response of the servo system, reducing over-shoot, and improves end-of-travel servo performance. It can also amplify system noise and lead to instability if *D gain* is too high or is the wrong polarity.

Integral (I) Gain

This is one of the three “classic” PID tuning parameters. *I* is the sum of all previous values of *P*. It represents what has happened *before*, sometimes called residual error.

I gain determines how much influence *I* has on actual motor power, via the equation *I* x *I gain*. Since the *P* term results in declining motor power as the target is approached, the servo may stall before reaching the mark. This results in a series of errors which accumulate as the value of *I*. Eventually, *I* grows large enough to push the motor up to the target. Ideally, *Igain* is adjusted to be a transparent contributor to a smooth servo transit that ends precisely on the target mark.

The influence of *I* is affected by both *I gain* and the next parameter, *I limit. T*he maximum possible value is *I limit* x *I gain*, where *I limit* can be either positive or negative.

Integral Maximum Error Limit – I limit

A common problem with most PID implementations is integral wind-up: the cumulative error, *I*, builds on itself endlessly, resulting in a larger and larger value.

The RC6-1MOT avoids *I* wind-up by preventing *I* from becoming larger than a maximum value, *I limit*. The default setting, suitable for many applications, is 10,000. Remember that this value is scaled by *I gain* before influencing actual motor power.

I limit in the UI is expressed as a positive number. In actual implementation, this is both a positive and negative limit. If, for example, the limit is set to 5800, then *I* will be prevented from getting higher than 5800 or getting lower then -5800.

Trajectory Tracking

Unlike PID values, which are somewhat abstract in their relationship to encoder counts and motor performance, trajectory setup values are directly related to encoder counts and encoder velocity.

As already noted, the fastest encoder speed that can be accurately counted by the RC6-1MOT is 9500 counts per second, which is 2375 encoder pulses per second.

The RC6-1MOT calculates and manages the PID servo loop and recalculates the trajectory every tic. There are 38 tics per second. Thus, the maximum number of encoder counts per tic is 250, which is 62.5 encoder pulses per tic.

Minimum Speed

This value must be between 1 and the value of the next parameter, *Maximum Speed*. It is important that *Minimum Speed* is not set too low, or the system will fail to move (stall).

The default and recommended value for *Minimum Speed* is 25.

Maximum Speed

This value must be between *Minimum Speed* and 250, the maximum allowed.

The maximum allowable value for maximum trajectory speed is 250.

Minimum Acceleration

Acceleration and deceleration rates are calculated using floating point math. The value is expressed as a small fractional value that is a multiplier in a proprietary mathematical algorithm.

The default and recommended value for *Minimum Acceleration* is 0.04. Lower values will produce slower ramps up and down.

Maximum Acceleration

The default and recommended value for maximum acceleration is 0.3. Higher values will produce faster ramps up and down.

At the RC6 transmitter, Servo Accel rates are set with a range from 0 – 255. This is mapped in the RC6-1MOT from the slowest accel, determined by the value of the *Min Accel* parameter, up to the fastest accel, determined by the value of *Max Accel*.

Stop Window Size

To avoid oscillating and hunting, and ensure that the motor brake is reliably engaged at the end of transit, the RC6-1MOT stops correcting position and applies the physical brake when the encoder is within a specified number of counts, which is plus or minus *Stop Window Size*.

The ideal *Stop Window Size* depends on the resolution of the overall system. If a small physical distance is represented by many encoder counts, *Stop Window Size* can be fairly large to ensure stable stops.

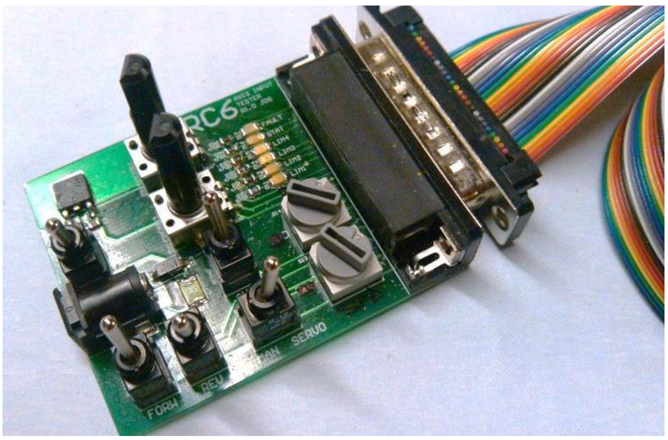
Hysteresis is used to avoid hunting near the edge of the stop window. The system will not stop until it is inside half of the window size. It will not begin to move again until it is outside the full window size.

The default stop window size is 40.

Initial RC6 System Setup

RC6-RU Transmitter Setup

If you have an **RC6 Axis Input Tester**, use it to confirm proper operation of your RC6-RU transmitter. You may also use it to confirm initial setup of your RC6-1MOT motor drivers. Once everything is performing as expected using the Axis Tester, proceed to wiring your automation system to the transmitter.



RC6-1MOT Motor Driver Setup

Install the RC6-1MOT so that the screen and buttons can be accessed easily during both initial setup and troubleshooting later if required. Do not bury it in a hard-to-reach location that is inaccessible while the piece is being operated.

It is recommended that your first tests be done with drive wheels off the floor to confirm proper motor operation.

Confirm Correct Motor Direction

Use Direct Drive mode to run the motor forward and backward. Confirm that the piece actually moves in the correct direction. If directions are reversed, swap the motor wires.

Confirm Correct Encoder Count Direction

Set the transmitter to display Servo Status for the axis you are testing. This shows the encoder position. Confirm that the position value increases when moving forward, and decreases when moving backward. If counting direction is backwards, either swap the signal A and signal B wires from the encoder, OR change the Encoder Setup parameter in the RC6-1MOT.

Test Servo/Trajectory Motion

While testing, determine how many counts is just a few feet forward from zero. In the transmitter, set one of the Servo Position table values to be that position. Set one of the Servo Speed table values to a slow speed. Set the Servo Accel rate to 20 (moderately slow).

Be sure the current encoder position is zero. Enable servo mode, then enable Forward movement. The set piece should advance a few feet to the programmed position.

Repeat all of these steps for each set piece and axis.

PID Tuning

For best results, the PID loop must be tuned for quick and strong movements with minimal overshoot. Optimizing the PID settings can be done by setting up servo commands that move the set piece a few feet at a fairly high speed and the fastest acceleration rate. While sending the piece back and forth, adjust PID parameters to minimize overshoot and oscillation.

Caution: fast abrupt movements will heavily stress mechanical components, particularly shaft keys, gear teeth, and chains. Do not force the machine to do things it may not be able to withstand safely.

You may not be able to achieve optimal performance for these fast movements. Simply adjust them for the best possible results.

Now try slower speeds and accel rates. Find the rates that are most suitable for your show.

If necessary, go back and tweak the PID settings further.

Repeat these steps until you are satisfied with the quality of motion and system responsiveness.

Troubleshooting

Please contact RC4 Wireless for assistance.

Additional information will be added to this section in a future revision of this document.

Contact RC4 Wireless

Physical Address

RC4 Wireless is a registered trade-name of
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