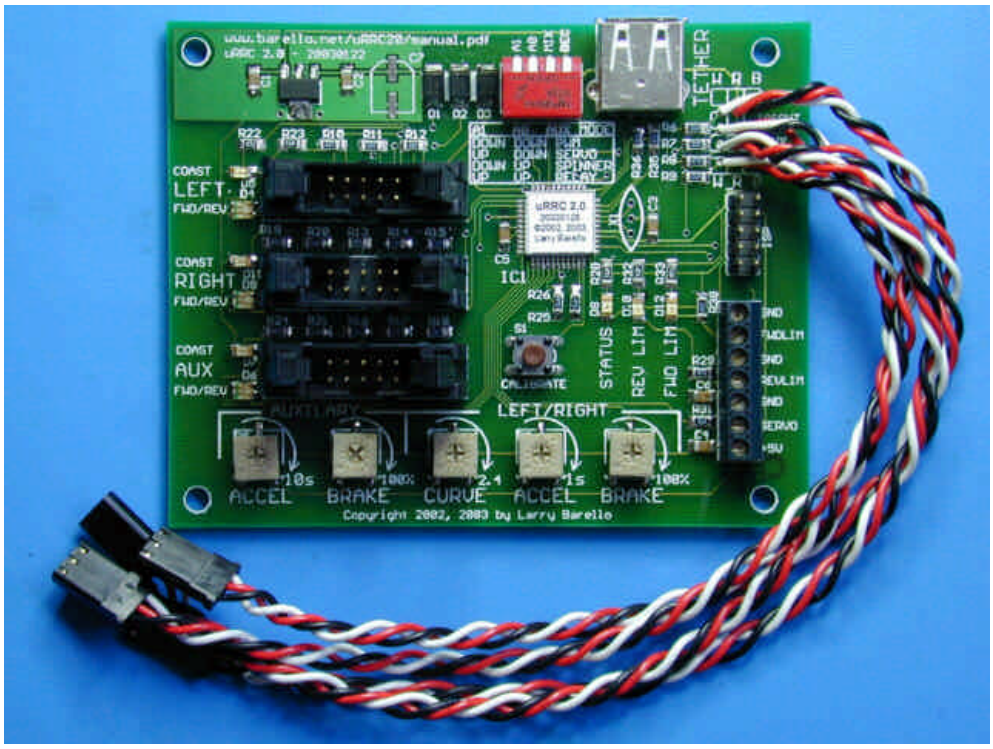
Advance Micro R/C Robot Controller



Specifications

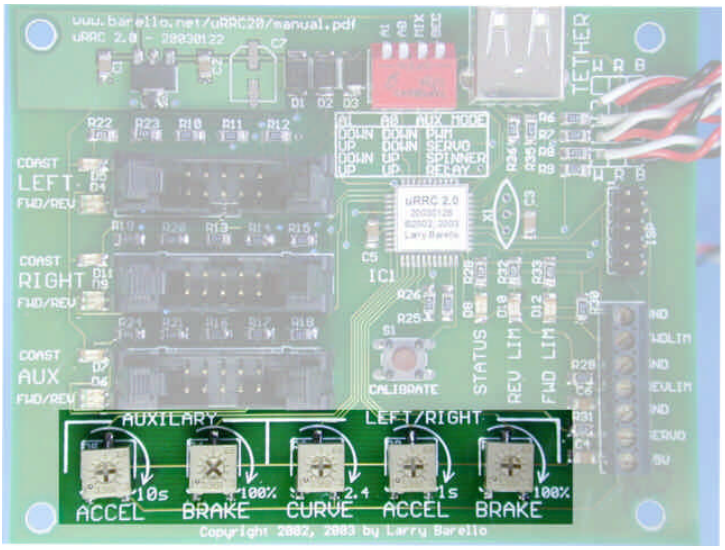
- Four channel R/C style signaling.
- Accepts pulse widths from .85 to 2.15 ms (IFI compatible)
- Two calibrations options
- Multi-mode Auxiliary channel:
    - Normal PWM
    - Servo mode
    - Spin Control mode
    - Fwd-off-Rev relay.
- Limit switch inputs for PWM, Servo and Relay options.
- Interfaces to standard OSMC power drivers
- Robust signal processing for smooth, reliable fail-safe operation.
- Five user programmable inputs via screwdriver adjustments
- Left/Right channel mixing for single stick operation
- Adjustable exponential curve for main drive channels
- Flip input for invertible robots corrects drive while inverted
- Tether port for operation while transmitter is impounded (or the battery is dead)

R/C Inputs

There are four R/C inputs compatible with any modern equipment including Innovation First controllers. They are:

LEFT Controls the LEFT OSMC output, or throttle in single stick (mixed) mode.
RIGHT Controls the RIGHT OSMC output, or steering in single stick (mixed) mode.
AUX Auxiliary input for servo, spin or relay modes
FLIP Used with invertible robots to correct Left/Right inputs while flipped.

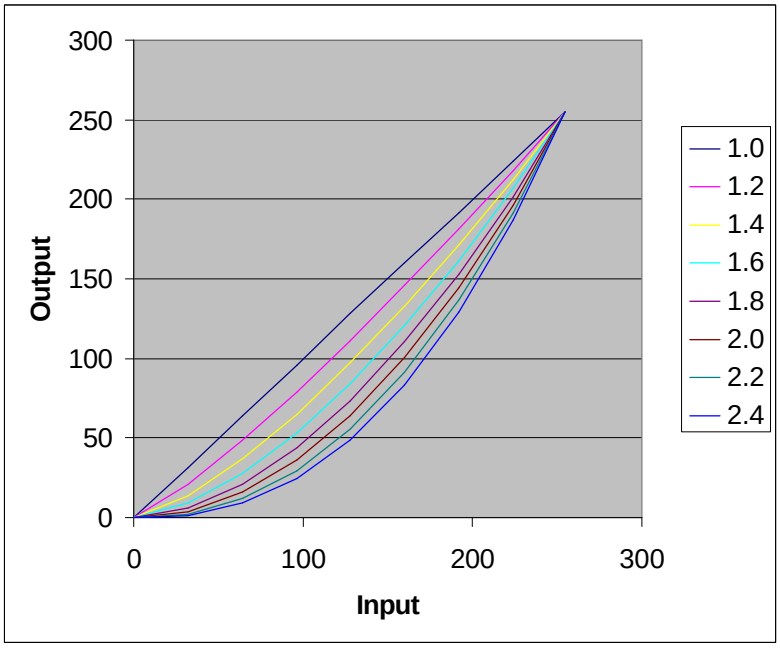
User Adjustable Inputs



There are five user adjustable inputs on the uRRC 2.0 controller. Two apply only to the Auxiliary channel and have alternate functions when the Auxiliary channel is being used as a servo. The other three apply only to the main drive, left and right, channels.

Curve

The CURVE control on the main drive modifies the R/C input signal with an exponential curve. The exponent value can be modified from 1 (no curve) to 2.4, which is a fairly steep curve. Below is a table graphing the various curves available. Note, even a modest curve of 1.4 gives a soft, wide dead band.



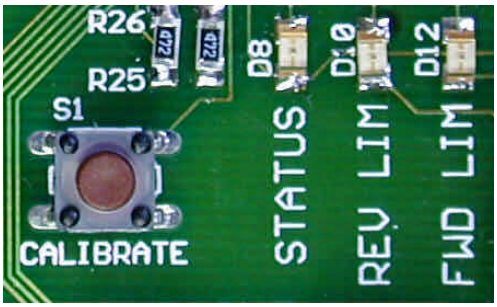
Brake

Sets the amount of braking when the output drive level is zero. Full counter-clockwise sets 0% braking (coasting) and full clockwise sets 100% braking.

ACCEL

Sets the power rate of change value. The maximum is roughly the amount of time, in seconds, it takes to go from –100% to 100% power output. The Auxiliary and Left/Right channels have differing maximum amounts.

Calibration



R/C signal status and Calibration controls are above the LEFT/RIGHT controls as illustrated.

The status light winks once per good R/C signal, per one-second cycle. If one wink, only one good signal has been detected. If two winks, then two good signals have been detected and so forth.

Calibrating to your radio

1. Connect your radio (or computer), disconnect the outputs (if practical) and apply power to the unit.
2. Restore the trim values to their center point and verify the STATUS LED winks once for each channel that has an R/C signal connected
3. Press and hold the CALIBRATE button for one second, until the STATUS LED blinks a steady 2 Hz.
4. Move all controls from one extreme to another. This sets the range of the calibration.
5. Press and hold the CALBRATE button again. The STATUS LED should resume winking, once for each channel of R/C signals.
6. If appropriate, adjust your trim settings to zero each channel and illuminate the COAST LED.
7. If the center setting of the transmitter was off a large amount, it might be necessary to repeat the calibration procedure a second time.

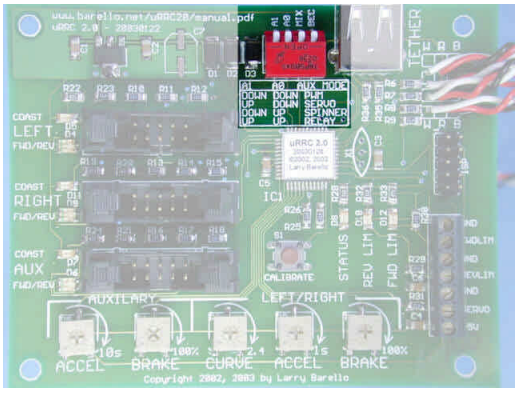
Restoring Factory Settings

The default calibration settings are suitable for most off the shelf R/C gear. The default settings are 1.150 ms to 1.850 ms, with 1.500 ms center. Performing the calibration procedure with no signal attached to the controller, or not varying the stick positions, restores default settings.

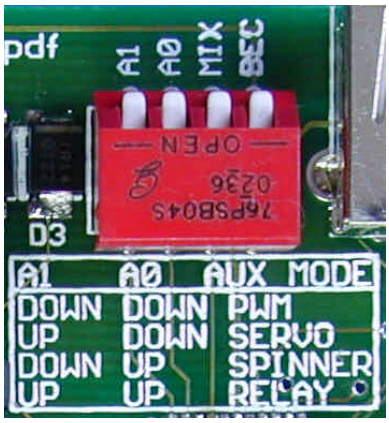
1. Apply power.
2. Press the CALIBRATE button, hold until the STATUS LED flashes steadily, about one to two seconds.
3. Press and hold the CALIBRATE button a second time until the flashing stops. The default values will be restored.

Mode Switch

Various Auxiliary modes and main channel mixing are selected with the MODE switch. Mode switches are active, or '1' when in the open, or up position.



Mode Switch location



Close up view

Mix selects normal (tank style) vs. mixed or single stick control on the Left and Right channels. NOTE: Left becomes "speed" and right becomes "Steering" when in mixed mode.

Mode	Mix
Normal (Tank)	Down
Mixed (Single stick)	Up

Main Drive Mix Table

BEC (Battery Eliminator Circuit) optionally powers the R/C receiver from the board power.

Mode	BEC
On	Down
Off	Up

Mode Switch BEC table

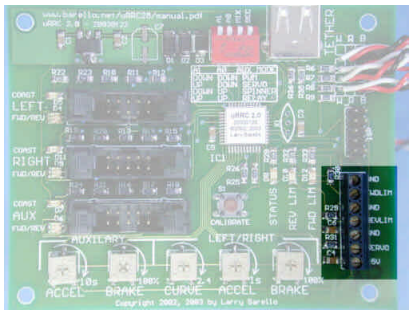
Auxiliary Channel Modes

Mode	A1	A0
Normal PWM	Down	Down
Servo	Up	Down
Spin Control	Down	Up
Relay	Up	Up

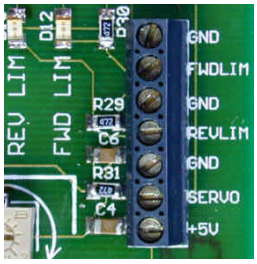
Auxiliary Modes Table

Normal PWM
This mode is straight R/C pulse to PWM with dead-band, variable brake and variable acceleration support. Note: Exponential curve does not apply to the Auxiliary channel.

Servo Controller
The uRRC 2.0 controller supports a position feedback servo mode on the Auxiliary channel. The Servo mode is selected with the mode switch A0 set to OFF (UP) position.



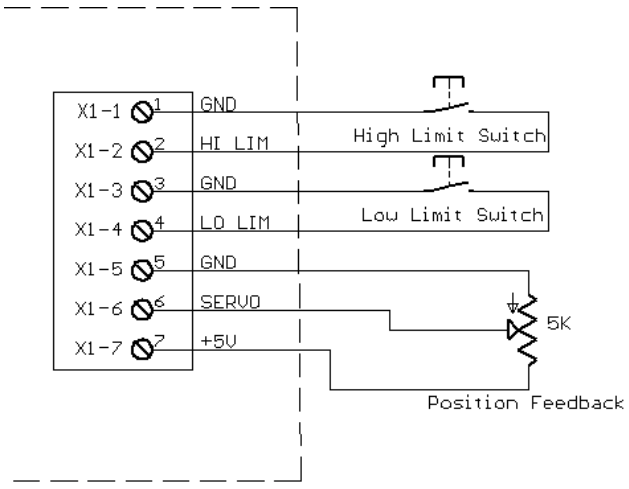
Auxiliary Servo Connection Block



Close up view

The auxiliary servo wiring is illustrated below. The position feedback potentiometer is oriented such that a forward command on the AUX channel will increase the voltage at the connection labeled *SERVO*. Forward motion causes the potentiometers wiper to rotate towards the +5V connection.

The High and Low limit switches are optional and are used to disable forward and reverse commands when their respective limit switches are closed. When disabled, the controller applies maximum brake to the motor to arrest motion.



Tuning the Servo controller
All servomechanisms need to be tuned for the particulars of the hardware involved. With sufficient math and data the parameters can be calculated, but that is way beyond

the scope of this users guide. In practice, by tweaking two parameters *good enough* performance can be achieved.

The two parameters are GAIN and DAMPENING. The former tells the controller how hard to drive the motors when there is an error between the commanded position and the actual position. The latter tells the controller how soon to start cutting the power when approaching the set point so it doesn't overshoot and oscillate.

On the uRRC 2.0 servo controller, the Auxiliary ACCEL and BRAKE controls are used for GAIN and DAMPENING, respectively. Use the following procedure for tuning the controller to a particular hardware configuration.

1. With the power off, turn both the GAIN and DAMPENING controls completely counterclockwise (zero gain and dampening).
2. With the motor mechanically disconnected, apply power to the system. Set the control input some were in the middle of its range.
3. Rotate GAIN clockwise ¼ turn. Move the output forward to the limits and the Yellow LED should be illuminated and the motor should be rotating in the reverse direction. Move the output backwards to the limits and the Green LED should be illuminated and the motor rotating in the forward direction. The crossover point should be somewhere near where the control input is set.
4. With the power off, rotate the GAIN control completely counterclockwise (zero gain) and connect the motor.
5. With the output near the center and the control input near the center, apply power, and then slowly rotate the GAIN control clockwise. At some point the motor should be driven to the control point and stop. It should be mushy at first. Keep increasing the GAIN until the output starts to oscillate a bit. Strong oscillations are BAD as they can destroy your electronics, the motor and the mechanical stuff.
6. With the GAIN set just at the point of oscillations, you can start to increase the DAMPENING to try and get rid of the oscillations. You can then adjust both knobs upward a bit to get crisper more accurate operation. For maximum performance you want the GAIN as high as possible with only one overshoot. Too much gain or too much dampening will cause severe oscillations.

Note: Sometimes reducing the GAIN while keeping the DAMPENING high can improve smoothness of the servo.

Spin Controller

Auxiliary spin control, selected with Mode Switch A1 in the OFF (UP) position, modifies the standard forward/reverse PWM mode for unidirectional operation and variable brake. Forward stick gives 0-100% forward powers while reverse stick gives 0-100% braking. Furthermore, with loss signal (broken cable, dead radio, dead transmitter) full braking is applied at once. Spin control uses the AUX ACCEL control input, but does not use the BRAKE input. ***NOTE****: Read release notes, last page, for changes to this function on boards released after June 2003.*

Relay controller
Auxiliary relay control, selected with Mode Switch A0 and A1 in the OFF (UP) position, drives the AUX controller as a bi-directional relay with Limit switch support. This can be used for non-servo lifter systems. The operations is as follows:

Stick neutral	Coast
Stick ½ forward	100% forward
Stick ½ reverse	100% reverse
Loss of signal	100% brake
High/Low Limit	100% brake

High Limit switch only affects forward operation and Low Limit switch only affects reverse operation.

Indicators and Outputs

Status LED

This LED winks once per valid channel per two-second period. With all four channels connected it appears like four rapid flashes and a long pause. When in calibration mode the LED flashes evenly without pause.

High Limit Switch LED

Illuminated means output disabled in the forward direction: The limit switch is ***active closed*** and needs to be open for the output to be enabled. This switch only affects the PWM, servo and Relay modes.

Low Limit Switch LED

Illuminated means output disabled in the reverse direction: The limit switch is ***active closed*** and needs to be open for the output to be enabled. This switch only affects the servo and relay modes.

COAST LED (Aux, Left & Right)

Illuminated (Amber) indicates the controller has disconnected the power driver from the load. The load is coasting. Dark indicates the power driver connected to the load. This LED varies from fully illuminated to fully dark depending upon the position of the input signal and the BRAKE user adjustment.

FWD/REV LED (Aux, Left, Right)

Green = Forward, Yellow = Reverse. Dark = zero drive. The uRRC modulates the Coast signal to implement variable brake. When the power driver has zero drive and zero COAST (i.e. both LED's are dark) maximum braking is applied to the load.

Tether Interface

The tether interface can be used to display diagnostic information about the signals that the controller sees and the resulting control outputs. In addition, the tether interface may be used to control all aspects of the controller via a serial stream of data.

The tether interface operates at 33.4kbaud 8N1 and supports the following commands:

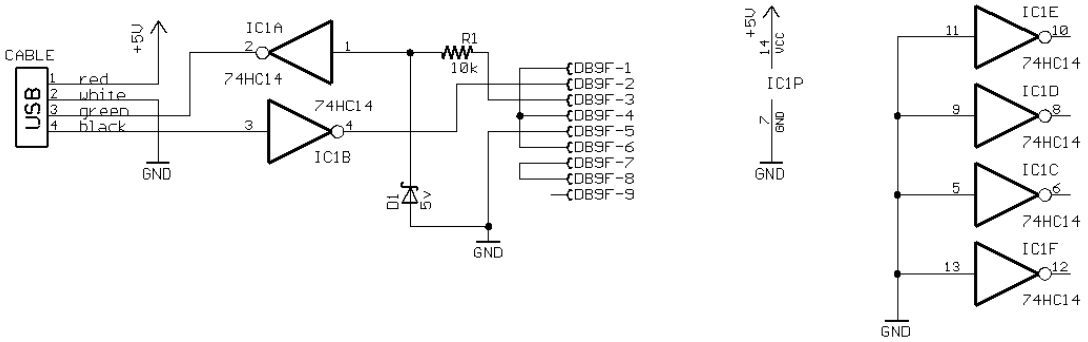
r{c}[1]	Display Left, Right, Aux and Flip R/C input values in microseconds.
d{c}	Displays Left, Right and Aux drive values (-255 to 255)
a{c}	Displays the six analog channels (channel 1 = servo feedback)
c[lra] {c}	Display input value and output drive for Left, Right or Aux channel.
i[lraf] [2]xxxx[3]	Set an R/C pulse width override for the Left Right Aux or Flip channels. Override last ~15 seconds. Input values are in microseconds. Valid range is: 900-2100.
o	Display internal oscillator calibration byte value.
sxxx	Set internal oscillator calibration byte[4].

Notes:

1. {c} = Optional “continuous” output modifier. Leave out braces.
2. [lraf] = select one of left, right or aux + flip on input override.
3. xxx = decimal number
4. Internal oscillator sets all timing including serial interface. If an inappropriate value is entered the communications will fail and further adjustments will not be possible until the calibration is reset.

Connecting the Tether interface

The tether interface is an USB type A connector. However, connecting this port to an USB port on your computer ***WILL NOT WORK AND WILL VOID ANY WARRENTY!*** A special adaptor is needed (not yet available). TTL to RS232 adaptors are available from a variety of sources on the web and would need to be modified for the USB connector. For those technically adept, a simple converter is illustrated below:



Calibrating the internal oscillator

The uRRC 2.0 comes calibrated. However, over time and temperature the accuracy of the oscillator may change and the tether display of received R/C pulse widths will not be accurate. Calibrating the oscillator can restore accuracy. The procedure is as follows:

1. Calibration is against the LEFT channel ONLY. Provide a center stick signal of 1.500 ms on the LEFT channel.
2. Press and hold the CAL button
3. Turn the power on.
4. Wait a second or so and release the CAL button.

The board is now calibrated to read the center stick as a 1500 us pulse width. If the calibration change was large, it might be necessary to re-calibrate the stick travel for your radio.

Restoring the factory calibration

1. Remove all signals sources from the board
2. Press and hold the CAL button
3. Apply power to the board.
4. Release the CAL button. Factory calibration is restored.

Limitations and Warrantees

Larry Barello (barello.net) provides no warrantee of suitability or performance for any purpose for the µRRC 2.0. Use of the µRRC software and or hardware is with the understanding that any outcome whatsoever is at the users own risk. Barello.net sole guarantee is that the software and hardware performs in compliance with this document at the time it was shipped.

Robotics, particularly combat robotics, can be very hazardous. You need to know what you are doing. In the event of defective products, Barello.net will replace or repair products or refund money in exchange for the original product.

Support

On line support, latest software (in files section) and news:

http://www.yahoogroups.com/group/osmc

Or contact Barello.net:

support@barello.net

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Release Notes

The following release notes cover any changes to the operation of the uRRC 2.0 controller with regard to the users guide, above.

20030205 February 5th.

Original uRRC 2.0 release.

20030629 June 9th.

1. Limits maximum forward power to 96% in order to work better with external current limiting devices.
2. Always uses low side FET for braking (used to use low or high depending).
3. Flip input now accepts simple contact closure or R/C signal.

20031111 November 11th.

1. Modified Spin mode. Spin mode no longer has variable brake. Spin mode is bi-directional. When advancing power (increasing forward or reverse stick) the board selected accelerate rate is used (0-10 sec). When reducing power, or, under Loss Of Signal conditions (radio fault), a fixed 10 seconds is used to bring the kinetic weapon to a halt. Center stick is always 100% brake.

   With uni-directional OSMC power units, only forward or reverse stick has any effect. With normal OSMC power units, the kinetic weapon can be driven forward or reverse.
2. Auxiliary normal PWM mode uses the fixed 10 second accelerate function to bring the output to 100% brake under Loss Of Signal conditions (radio failure)