

Chip-EC Howto

Rev 12

< The information here is current as of Chip-EC software revision 7, 8-2005. >

The "Chip-EC" acts much as any other type of EC when connected to the Control Computer ("CC"). Overdrive software settings pertaining to an "EC" affect the Chip-EC and "Stack-EC" alike.

The current revision of the Chip-EC ("CEC") has 12 PWM outputs for RC Servos, supports 12 digital PID servo controllers, has a serial port for connection with the Control Computer, an Inter-EC bus, which can connect up to 6 Chip-ECs together for 64 channels of output, 8 digital inputs and 8 digital outputs. RC Servo power pads allows a separate power source to be connected.

RC servos are controlled at 60Hz, over a 4096 position range of 1520usec +/- 620 usec. This yields about 120 degrees of movement on most devices. The center position is 1520 microseconds, the same as that of a Futaba radio-receiver set (per Futaba servo spec). Servos from Futaba, HiTEC, MAXX, JR, and Airtronics have been tested to comply with this range.

The Chip-EC is a combination of products. The base microcontroller board is a New Micros "Isopod V2-SR", which is a Motorola 56F805 motor controller DSP board. An Overdrive mezzanine circuit board adds servo logic-level conversion, crosstalk reduction, short-circuit protection and RCservo connectors. There is no "Isopod" software present, the unit has been flashed entirely with software written by Concept Overdrive Inc.

The Chip-EC is static sensitive and may be damaged if its pins are touched without taking static dissipation safety precautions.

Chip-EC's also support Custom PID Servos, (DC motor with gearhead, and analog or encoder feedback). Third party motor controllers are interfaced via the Inter-EC bus. See the PID-servo Howto.

Logic Power

Tests show the Chip-EC logic drawing a maximum of :
93 mA at 12Volts power, dissipating 1.12 W
125mA at 7.2V power, dissipating .90 W

This is the power into the Chip-EC's on board DC-DC converter. It appears that the converter becomes less efficient (wastes Watts) as the input voltage gets higher. These numbers may go down as software revisions change, but assume the worst case.

Nominally, at least 6V is needed into the DC-DC converter, so higher voltage batteries are less likely to cause a Chip-EC to turn off as they discharge. Yet, tests that show that the Chip-EC runs and boots OK with as low as 5.5V. So there is plenty of

headroom for a 7.2V battery to discharge.

It is best to have separate power (or at least separate regulators) for the Chip-EC logic versus RCservos. This prevents current surges caused by motors from interfering with the Chip-EC logic.

Servo Power

The Servo Power "+V" is isolated from any other circuit, this power goes directly into the 12 servo connectors. The 12x3 Servo Connector can be mounted two different ways: "inline" with the board, or perpendicular to the board.

Inline : The bottom pin (closest to board) of the 3-pin connector is GND, the middle pin is +V, the top pin (highest off of board) is signal.

Perpendicular: The right pin (closest to edge of board) of the 3-pin connector is GND, the middle pin is +V, the left pin (furthest from edge of board) is signal.

Further, you can see, where the power traces connect from the servo power pads to the Servo Connector.

You can also apply power directly to the servo connector pins, as is frequently done with RC radio receivers. Power may also be provided to the solder pads next to the PWM bus.

Don't connect RCServo GND to the Chip-EC GND externally. The two are made common on the circuit board when GND is applied to the servo connector. It should not be done elsewhere.

Each Chip-EC supports 12 RC servo channels. Pairs of channels can draw current simultaneously, namely, these channel pairs: 1+7 2+8 3+9 4+10 5+11 6+12. This may make the supply voltage droop momentarily. So the instantaneous current required of any single Supply or Battery can be higher than on a standard hobby receiver (which support fewer servos and may not implement simultaneous current draw, depending on manufacturer and refresh rate).

Its best to allocate channels such that two high-current functions are not in one of the channel-pairs listed above. Power consumption is, of course, relative to the load on the mechanism which the servo drives.

When power to RC servos comes on and there is no signal (Ramped down), servos move momentarily, then relax. This is the servo circuitry itself, initializing. To avoid this, Ramp up RC servos at power on, then ramp down.

"Inter EC" Bus

This "IEC" bus is the wiring on which CEC's talk to each other, and talk to other devices like PID motor controllers.

Wiring and connectors should be daisy-chained in a linear fashion, like Christmas-tree lights, not in a star topology. Each connector contacts the same signals in parallel.

Termination is recommended on both physical ends of the Inter-EC bus. Use 220 ohm resistors across the two wires. If small gage wire is used, the resistors can be crimped into the connector with the wire (insulate the protruding resistor leads). All Chip-ECs must have a common power GND in order to communicate on the IEC bus.

For the technologically curious: communications on this bus is 1Mbit and is signalled in accordance with the CAN (Controller Area Network) spec. Devices, such as PID servo controllers, which use CAN can be interfaced with on this bus.

Wiring

The Chip-EC logic wiring uses Molex contacts and crimps. Part numbers are on the Chip-EC pin out sheet.

The "pig-tailed" signal pin wiring is hot-glued for added strain-relief. The glue can be removed with alcohol or acetone.

Both 18 AWG Belden and Alpha wire fit the Servo Power pads next to the servo connector, the positive voltage pad is marked with a "+". There is a lot of inherent heat-sinking in the wire and servo connector, so a large soldering iron tip must be used, not a small "pencil tip". Solder the wires quickly, with significant heat; the iron should be at least 700 degrees.

Channel Allocation

There are 12 Output Devices per Chip-EC. These are allocated sequentially as may be seen on an freshly created, non-reordered, Outchan list. If all OutDevs are of type RCServo, the first OutDev on the list is the first RCservo on the first Chip-EC, The second OutDev on the list is the second RCservo on the first Chip-EC. The thirteenth OutDev on the list is the first RCservo on the second Chip-EC, and so forth. Be sure to assign the proper device type ("Rcservo"/Hydraulic/PIDservo, etc) to each OutDev.

At present the maximum number of PID Servos supported on the Inter-EC bus is 12. At present the maximum number of RC servos supported on the Inter-EC bus is 48. These numbers can easily be increased.

Each Output Channel ("OC") in the system is mapped 1:1 with an Output Device ("OD") of the same number. OD's represent the real world actuators which reside out at the ECs. Each OD has a type, like "RCServo" "Hydraulic" or "PID-Servo", which you can set on the OD tab of the OC page.

A Chip-EC can control up to 12 actuators, either of type RCservo or of type PID-Servo. You must choose which type of OD to use, as the CEC will not support more than a total of 12 actuators. If say, OD1 of a CEC is of type PID-Servo, no signal will be output on the CEC's RCServo pin 1.

Example with two CEC's :

The OC list on the OC page is configured this way :

OC1 -> OD1 (RCServo)

OC2 -> OD2 (PID-Servo)
OC3 -> OD3 (RCServo)
OC4 -> OD4 (PID-Servo)
OC5 -> OD5 (RCServo)
OC6 -> OD6 (RCServo)
OC7 -> OD7 (RCServo)
OC8 -> OD8 (RCServo)
OC9 -> OD9 (RCServo)
OC10 -> OD10 (RCServo)
OC11 -> OD11 (RCServo)
OC12 -> OD12 (RCServo)
OC13 -> OD13 (PID-Servo)
OC14 -> OD14 (RCServo)

On the Inter-EC bus, you have three PID-Servo controller units with dip switches set to id2, id4 and id13.

OC1 will drive RCServo 1 on the first CEC.

OC2 will drive PIDServo id2, and RCservo signal 2 on the first CEC will be unavailable (since OD2 is of type PIDServo).

...

OC13 will drive PIDServo id13, and the first RCservo signal of the second CEC will be unavailable.

OC14 will drive RCServo 14, the second Rcservo signal of the second CEC.

Note that although you can graphically re-sort the OC list on the OC page, this does not change any mapping, it is merely visual. OC1 is still mapped to OD1, and OD1 is still mapped to the same real-world actuator as it originally was.

ID and Flashing

One Chip-EC is the master, it has an ID of 1. This is usually the only unit which communicates with the Control Computer. It is also possible for CECs to connect in "Broadcast Mode", where multiple CECs connect to one CC via a 'fiber broadcast stack'.

Unique, sequential Chip-EC IDs (1-6) must be set for Chip-ECs to talk amongst themselves on the inter-EC bus. It's best to shut down all other Chip-ECs and connect just one at a time to the CC serial port for flashing an ID.

Plug the Chip-EC into the CC serial port and turn it on. Once a connection is established, click the "Assign EC ID" button on the EC page. Depending on how long it takes for the Chip-EC to flash itself, it may generate communications warnings, or it may lose connection with the CC altogether. This is harmless.

To confirm that the ID assignment succeeded, turn the Chip-EC off, turn it back on, the red LED will indicate what the ID is every 2 seconds. If you don't have access and can't see the CEC LEDs, let it connect to the CC again, click the "Assign EC ID" button to see what the new ID is, then Cancel. Note that Chip-EC's with an ID other than 1

will stop attempting to contact the CC after they have been contacted by a Master on the Inter-EC bus.

Chip-EC's with IDs greater than 1 will take longer to connect to the CC when first turned on; they also attempt to connect less frequently (this may be seen by looking at the fiber). This staggered connect timing helps multiple ECs to connect to a single CC when in Broadcast mode.

A boot delay can be flashed from the EC page, the EC will delay up to 25 seconds before contacting any device on any of its communications buses. This can be done for CEC 1 only.

LEDs

The Green LED flashes at $\frac{1}{2}$ the communications frequency. It signifies that the CEC is communicating with something on either the serial or the Inter-EC bus.

The Red LED blinks to indicate the CEC ID. It blinks like a grandfather clock: one blink means an ID of one, two blinks means an ID of two, etc. A pause of 2 seconds takes place after the unit blinks its ID. This is the ID that was flashed into the Chip-EC.

Note: The number on the label on the bottom of the board is a manufacturing serial number, not the ID of the Chip-EC.

Ramps

Overdrive "Gain Ramps" tell a Chip-EC to make servos power down their motor driver stage, though the servo logic stays on. This causes most types of servo to "relax" so the servo motor no longer holds position. This is valuable for power savings and servo longevity. Note that a ramp causes a Chip-EC to turn on/off RC servo signals when the ramp input is within 5% of the end of its range, which is different from the gradual gain effect a ramp has on analog actuators, like Hydraulic or PID Servos. PID servos implemented through a driver card, like the AMC series, will be gradually gained to/from zero-gain by a ramp. All servos on a common Chip-EC do not necessarily ramp up together. An individual servo will ramp up independently of its neighbors if it is in a different OutChan group with a different ramp.

Certain RC servos* do not power down their driver stage when signal is removed. Thus, one cannot ramp down these servos like others. Each Chip-EC drives its last digital output bit "DIGOUT-8" along with the first servo's Ramp. So this bit will be high (3.3V) when the first servo's ramp goes high, and low (0V) when the first servo's ramp goes low. Driven by this output, the "Chip-EC Servo Power Switch" circuit can be used to turn servo power on and off. See the schematic "Servo-power-switch-CEC.png" in this documentation. The circuit has a safety turn-on delay of about 400 milliseconds, to insure that the Chip-EC has fully booted and initialized servo positions before they get turned on.

* RC Servos which do not Ramp down: HiTEC HS5735MG, HiTec HSR5995TG

If you use the Servo Power Switch circuit for RC servo power, there is no need for manual or “channel 9” power switches. When the Chip-EC Ramp or logic power goes down, all RC servo power is **completely** cut off by a Servo Power Switch.

Note that RC Servos which are ramped down when servo power is switched on will “hunt” once as they power up, causing them to move slightly, then relax. This is caused by the design of the servo electronics itself, it is not caused by the Chip-EC. If this is undesirable, ramp-up before switching on servo power so servos go to known positions, then ramp down once it is on.

Digital In/Out

The Chip-EC has eight Digital Input pads “DIN1-DIN8”, which are 3.3V CMOS logic. Wiring can be soldered to these pads directly. It is best to strain relief such wiring so it does not tear pads off accidentally. Hot glue can be used to strain relief and insulate such a connection, the glue can later be removed with alcohol or acetone.

Digital Inputs are located on the underside of the CEC board directly below the digital outputs (the underside of the CEC is the side not shown in the photo at the end of this document). DIN1 is directly below DO1, and closest to the power leads. DIN2 is directly below DO2, etc. Digital inputs are pulled high by internal pull-up resistors, so there is no need to supply positive voltage to them for a logical “1”. Connecting a DIN to PWR-COMMON asserts a logical “0”. When the state of a digital input changes, the value of all eight are sent to the CC, where they appear as Telemetry Channels 1-8. Note that the initial state of all digital inputs is also sent to the CC when a connection is first established.

The Chip-EC has eight digital output pads, which are 3.3V CMOS logic. Only “DigOut 8” is implemented at this time, as described in the “Ramps” section above.

PID Servos

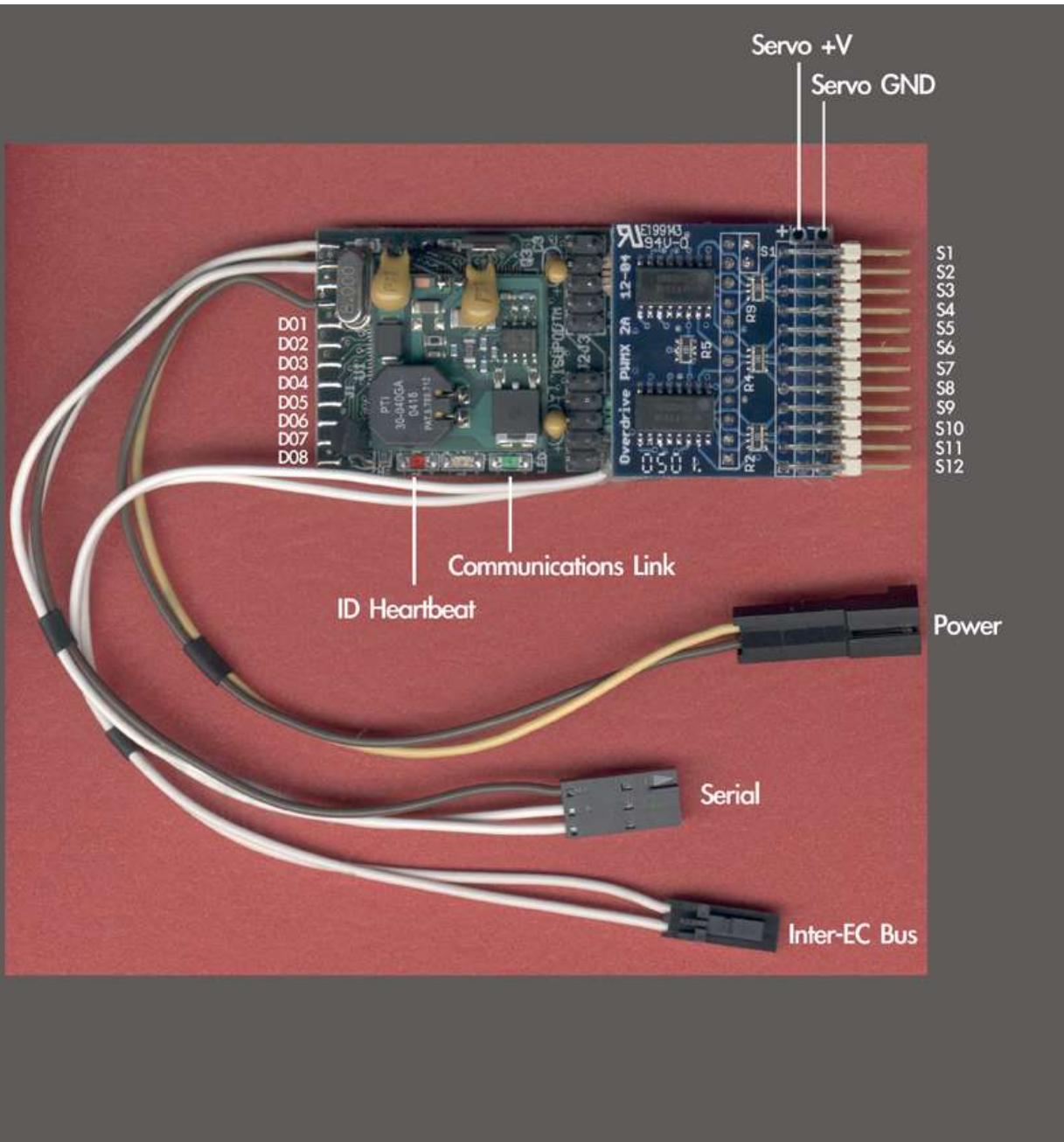
When CEC 1 boots, it scans the IEC bus for PID servo controllers. See the PID-Servo Howto in this documentation for details.

Since digital motor controllers, like the AMC series, take a few seconds to boot, the CEC can be programmed to wait for a delay, up to 25 seconds, before scanning the IEC bus and subsequently connecting to the CC. Use “Set EC Delay” on the EC page for this.

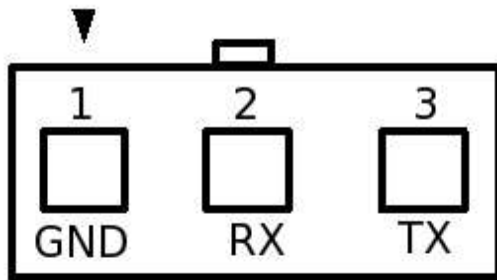
Currently a maximum of 12 PID motor controllers per Chip-EC are supported.

Analog Outputs

The Chip-EC can output an analog voltage in the range +/-10V to operate an analog output device. The addition of a small output board ("DAC") is required. This feature is "Beta". Currently two analog outputs per Chip EC are supported. Higher numbers may be supported in the future, contact tech support for details.



Chip-EC Pinout - rev 3 8/2005



Color Code

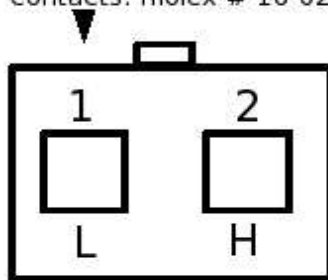
Gnd	Black
+7 to 12V	Yellow
Signal	White

Serial

Female - Front View

Female molex connector #50-57-9403
(mates with male molex #70-107-0002)
contacts: molex # 16-02-1125

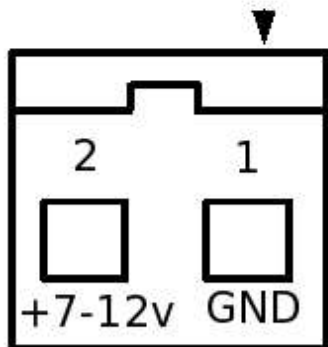
Note: Pin one indicated by arrow on top of connector



Inter-EC Bus

Female - Front View

Female molex connector #50-57-9402
(mates with male molex #70-107-0001)
contacts: molex # 16-02-1125



PWR

Male pins - Front View

Male molex connector #70-107-0001
(mates with female molex #50-57-9402)
contacts: molex 16-02-0115