Description

Whether you build props or design small-scale industrial controls, there will come a time when the control high-current DC devices like relays, solenoids, or high-current LED modules is required. The HC-8+ is designed just for this purpose, giving the engineer the ability to control up to eight high-current DC loads (per board). Each of the outputs may be set to on or off, or to a variable PWM output with 256 (DMX-compatible) levels.

The HC-8+ supports two built-in command modes: 1) TTL serial mode for bi-directional communications with a microcontroller which allows setting outputs and reading inputs and, 2) DMX mode in which the HC-8+ serves as a DMX slave (output only) for DC lighting and device control.

Advanced users may wish to re-purpose ("hack") the HC-8+ hardware with their own firmware; the board is designed for this and EFX-TEK is available to assist in the development of custom applications.

Product Applications

- Museum exhibits, educational and holiday displays, film and theatrical props.
- Small-scale industrial control
- Direct or DMX-enabled DC lighting control

Features & Benefits

- Controls up to eight 9- to 24-volt, high-current outputs (*improved on Rev F PCB*)
  – output status indicated with LED on each
- TTL output header to provide digital control signals to other circuits (*improved on Rev F PCB*)
- Eight dedicated TTL-level digital inputs
- Four non-committed 3.3v IO pins (*new on Rev F PCB*)
- TTL-level I2C expansion header (*new on Rev F PCB*)
- TTL-level serial control
  – 2400 or 38.4k Baud communications (half-duplex, single wire) in standard mode
  – up to four devices on one serial line
- DMX slave option
  – built in 9-position DIP switch for DMX addressing
  – up to 32 devices on buss
- RS-485 serial port
  – half (e.g., DMX) and full-duplex communications supported
- Option header for devices like microSD adapter, etc.
- Easily updated
  – programming port available (for Parallax Prop-Plug)
  – enables custom applications development
- Size: 3.20" x 4.15" (81.3mm x 105.4mm) with four 0.15" (3.6mm) mounting holes
- Power input: 9-24VDC
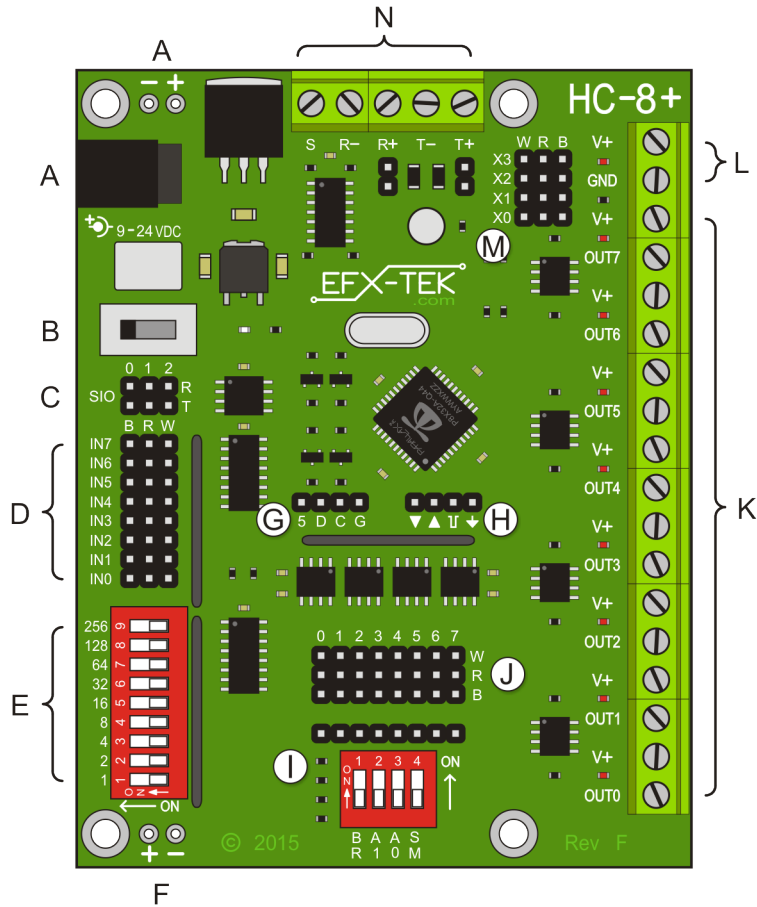
A. Power input; 2.1mm barrel jack; OEM pads

B. Power switch

C. Bi-directional TTL serial headers (Note 1)

D. TTL input headers

E. DMX address switch

F. Optional TTL header power input (Note 2)

G. I2C Expansion Header

H. Programming header

I. Options switches and header (Note 3)

J. TTL output headers

K. High-current outputs (low-side drive)

L. External power

M. XPort IO header

N. RS-485/DMX port

Notes:
1. Center pins are not powered; connect to 5v using solder-pads on bottom of PCB
2. Before use, internal 5v supply to TTL header must be severed (see bottom of PCB for cut point)
3. Open Options switches before attaching device to header.

Power Input / Power Switch

The HC-8+ is powered from 9 to 24 volts DC. DC power may be connected to the 2.1mm power jack (A), the OEM power pads (A, top of board), or the V+/GND terminals (M).

☞ **CAUTION**: Do not apply more than 24 volts DC to the power input; this is the maximum voltage allowed by the internal power supply used for logic control.

A three-position switch controls power on the HC-8+. In position 0 all power is off; in position 1 power is supplied to the regulator, the on-board command processor, and to the TTL-level IO headers (center pin of each). In position 2 the incoming power is also routed to the V+ terminal and high-current outputs.

> **NOTE**: If power is provided via the V+/GND terminals then the power switch must be placed in position 2 for the HC-8+ to operate. In this mode do not connect power to the 2.1mm barrel jack (A) or OEM power pads.

Configuration Switches

The 4-element configuration switch controls many aspects of the HC-8+ behavior; the table below describes the function of each switch.

BR	Sets the baud rate for TTL serial control (see below). When OFF, the baud rate is 2400 (Prop-1); when ON the baud rate is 38400 (Prop-2).
A1	Controls the upper bit of the HC-8+ address for serial commands (see below).
A0	Controls the lower bit of the HC-8+ address for serial commands (see below).
SM	Sets the operational serial mode. OFF position is used for standard TTL serial command mode; ON position is for DMX slave mode.

> **NOTE**: The **SM** configuration switch is read at power up. If a changes to **SM** configuration is required the HC-8+ must be powered down and then back up to enable the new configuration.
>
> As of firmware version 1.1, the **BR** switch is read during program operation (SM mode 0) and may be changed without power-cycling the HC-8+.

TTL Serial Protocol

The HC-8+ serial connection conforms to the Parallax AppMod bi-directional communications protocol, which operates at TTL (0 to 5 VDC) using "open-true" baud mode to enable daisy-chaining devices. All exchanges are initiated by the host controller. The format of host communications to the HC-8+ is as follows:

```
"!HC8", address, command { , sub-command } { , data }
```

…where "!HC8" is the preamble that allows the HC-8+ to exist on the same communications line as other devices (e.g., AP-16+, FC-4+, etc.), *address* is the board address set with configuration switches A1 and A0, *command* is a single-character command designator, and *data* is any value(s) that may be required by command.

Using TTL serial mode allows the host controller to connect to up to four HC-8+ boards on one serial connection; to do this, however, each must have a unique address. The HC-8+ board address is set with the **A1** and **A0** configuration switches.

	OPTION A1	OPTION A0
Address = %00 (0)	OFF	OFF
Address = %01 (1)	OFF	ON
Address = %10 (2)	ON	OFF
Address = %11 (3)	ON	ON

☞ | **NOTE**: Valid addresses are in the range of %00 (0) to %11 (3). Commands that do not generate a response to the host will also work with the global address, $FF (255).

The baud rate for TTL serial communications is set with the **BR** option switch.

BR	Baud Rate
OFF	2400 (Prop-1)
ON	38.4k (Other controllers)

TTL Serial Commands (Version 1.10 firmware)

"X"   Reset

Syntax: "!HC8", *address*, "X"
Reply: None

The "X" (reset) command resets all outputs to off (0%).

Prop-1 Example:

```
SEROUT Sio, OT2400, ("!HC8", %00, "X")
```

"V"   Get HC-8+ Version Number

Syntax: "!HC8", *address*, "V"
Reply: 3-byte (ASCII) version string

Prop-1 Example:

```
SEROUT Sio, OT2400, ("!HC8", %00, "V")
SERIN  Sio, OT2400, id0, id1, id2
DEBUG "HC-8+ Version ", #@id0, ".", #@id1, #@id2, CR
```

"L"   Set Channel Level

Syntax: "!HC8", *address*, "L", *channel, level*
Reply: None

The "L" command sets the level (0 to 255, 0% to 100%) of a channel (0 to 7, "A" or 255).

Prop-1 Example:

```
SEROUT Sio, OT2400, ("!HC8", %00, "L", 3, 128)
```

...will set OUT3 to level 128 (50%). All channels can be set to the same level by using "A" or 255 (global value) for the channel number, for example:

```
SEROUT Sio, OT2400, ("!HC8", %00, "L", "A", 32)
```

...will set all channels to 32 (13%).

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"LI"   Set Individual Channel Levels

Syntax: "!HC8", *address*, "LI", *level0 { , level1 ... level7 }*
Reply: None

The "LI" command sets individual channel levels (0 to 255, 0% to 100%) for up to eight channels. Less than eight channel levels may be specified; for example:

```
SEROUT Sio, OT2400, ("!HC8", %00, "LI", 16, 32, 64, 96)
PAUSE 25
```

...will set outputs OUT0 through OUT3 without changing outputs OUT4 through OUT7. Note that the command is followed by a PAUSE statement to allow the serial processor inside the HC-8+ to timeout and not wait on any additional channel levels.

☞   **NOTE**: If the "LI" command provides less than eight levels a 25ms delay must be added before new commands to prevent the new command from being interpreted as channel levels.

"LM"   Set Multiple Channels with Mask (New in V1.10)

Syntax: "!HC8", *address*, "LM", level, mask
Reply: None

The "LM" command causes selected channels to be set to the same level. Channel selection is via mask; a "1" bit in the mask will set the channel to the new level; a "0" bit in the mask will leave that channel at its current level.

Only pins having a "1" in the mask byte will be affected by the command.

```
SEROUT Sio, OT2400, ("!HC8", %00, "LM", $80, %11000011)
```

...will cause channels 7, 6, 1, and 0 to be set to 50% ($80), while channels 5, 4, 3, and 2 will remain unchanged. Channel position within the mask byte is 76543210. As in the example above, using binary notation (%) is recommended for program clarity.

"LR"   Randomize Individual Channel Levels

Syntax: "!HC8", *address*, "LR", *mask*
Reply: None

The "LR" command randomizes individual channel levels (0 to 255, 0% to 100%) for up to eight channels. The channels affected by the command are specified in the mask byte; a "1" bit in the mask will randomize that channel; a "0" bit in the mask will leave that channel at its current level.

Only pins having a "1" in the mask byte will be affected by the command.

```
SEROUT Sio, OT2400, ("!HC8", %00, "LR", %11110000)
```

...will randomize the levels on OUT7 to OUT4 but will not affect OUT3 through OUT0.

"D"   Digital Mode

Syntax: "!HC8", *address*, "D", *channel, state*
Reply: None

The "D" command allows a channel to be treated as a simple digital output: either off (0%) or on (100%). A state value of zero will set the channel off; if the low bit of state is "1" (i.e., the value of state is odd) the channel will be turned on.

Prop-1 example:

```
  SEROUT Sio, OT2400, ("!HC8", %00, "D", 7, 1)
```

...sets OUT7 to on (100%). As with the "L" command, all channels may be set to the state value by specifying the channel as "A" or 255.

"DS"   Digital Select Mode

Syntax: "!HC8", *address*, "DS", *states, mask*
Reply: None

The "DS" command allows advanced digital control of select outputs. The desired state (off or on) for each output is specified using the states value; a "0" bit in the channel position will cause the output to be off, a "1" bit in the channel position will cause the channel to be on. For example, a states value of %11110000 would cause OUT7 to OUT4 to be on, OUT3 to OUT0 to be off.

The mask byte controls which outputs are affected by the states byte, for example:

```
  SEROUT Sio, OT2400, ("!HC8", %00, "DS", %11110000, %00111000)
```

...will cause OUT5 and OUT4 to be set to on (100%) and OUT3 to be set to off (0%). The following table describes the interaction of the states and mask bytes.

State	Mask	Channel
0	0	No change
1	0	No change
0	1	OFF (0%)
1	1	ON (100%)

"DR"   Digital Randomize Mode

Syntax: "!HC8", *address*, "DR", *mask*
Reply: None

The "DR" command allows the outputs controlled by the mask byte to be randomized in digital mode (either off or on); for example:

```
  SEROUT Sio, OT2400, ("!HC8", %00, "DR", %00001111)
```

...will cause OUT3 to OUT0 to be digitally randomized while OUT7 to OUT4 remain unchanged.

"FL"   Fade Channel (Low Resolution Timing)

Syntax: "!HC8", *address*, "FL", *channel*, *start*, *stop*, *seconds*
Reply: None

The "FL" command allows the a single output to be faded (change in variable output level) from the start point (0 to 255, 0% to 100%) to the stop point (0 to 255, 0% to 100%) in a specified number of seconds (1 to 255).

```
SEROUT Sio, OT2400, ("!HC8", %00, "FL", 0, 0, 255, 2)
```

...will cause OUT0 to fade from off (0%) to on (100%) in two seconds.

☞   **NOTE**: The HC-8+ allows up to eight simultaneous channel fades with individual levels and timing controls. A cross-fade (see below) is two channels operating in tandem.

"FM"   Fade Channel (Medium Resolution Timing)

Syntax: "!HC8", *address*, "FM", *channel*, *start*, *stop*, *tenths*
Reply: None

The "FM" command allows the a single output to be faded from the start point to the stop point in 0.1-second units. This command provides finer timing control than "FL" with fade durations from 0.1 to 25.5 seconds.

```
SEROUT Sio, OT2400, ("!HC8", %00, "FM", 1, 128, 0, 35)
```

...will cause OUT1 to fade from 128 (50%) to full off (0%) in 3.5 seconds.

"FH"   Fade Channel (High Resolution Timing)

Syntax: "!HC8", *address*, "FH", *channel*, *start*, *stop*, *msLo*, *msHi*
Reply: None

The "FH" command allows the a single output to be faded from the start point to the stop point in one millisecond units. In order to accommodate reasonable time ranges, the milliseconds value must be specified as two bytes in the command string. To determine the values for the msLo and msHi bytes:

```
msHi = timing / 256
msLo = timing - (msHi x 256)
```

For example, a fade of 1.25 seconds (1250 milliseconds) is desired.

```
msHi = 1250 / 256 = 4
msLo = 1250 - (256 x 4) = 226
```

Note that all values are rounded down to the next whole value. In the example above, 1250 divided by 256 is 4.88; this is rounded down to 4.

Prop-1 Example:

```
SEROUT Sio, OT2400, ("!HC8", %00, "FH", 2, 0, 255, 226, 4)
```

...will cause OUT2 to fade from 0 (0%) to 255 (100%) in 1250 milliseconds.

"FX"   Cross-fade Two Channels (Medium Resolution Timing)

Syntax: "!HC8", *address*, "FX", *channelA*, *channelB*, *tenths*
Reply: None

The "FX" command causes a full cross-fade between two channels in 0.1-second units. The first channel (A) will be set to 100% and will fade to 0%; the second channel (B) will set to 0% and will fade to 100%. Using medium resolution timing a cross fade can last from 0.1 to 25.5 seconds.

Prop-1 Example:

```
  SEROUT Sio, OT2400, ("!HC8", %00, "FX", 6, 7, 30)
```

...will create a cross-fade from OUT6 to OUT7 in 3.0 seconds.

"G"   Get Channel Level

Syntax: "!HC8", *address*, "G", *channel*
Reply: Single byte that indicates the HC-8+ level.

Prop-1 Example:

```
  SEROUT Sio, OT2400, ("!HC8", %00, "G", 0)
  SERIN  Sio, OT2400, level
```

... will request and return the level on OUT0. This command is useful for checking the completion of a fade or cross-fade process.

"IT"   Read TTL Inputs (Updated in V1.10)

Syntax: "!HC8", *address*, "IT"
Reply: Single byte that indicates the HC-8+ TTL inputs status

Prop-1 Example:

```
  SEROUT Sio, OT2400, ("!HC8", %00, "IT")
  SERIN  Sio, OT2400, ttlport
```

... will request and return the states of TTL inputs IN0 to IN7 as a single byte.

"ID"   Read DMX Switch (New in V1.10)

Syntax: "!HC8", *address*, "ID"
Reply: Two bytes that hold the HC-8+ DMX switch positions

Prop-1 Example:

```
  SEROUT Sio, OT2400, ("!HC8", %00, "ID")
  SERIN  Sio, OT2400, dmxlo, dmxhi
```

... will request and return the DMX switch positions. In this example, *dmxlo* and *dmxhi* are the low and high bytes of a word variable.

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"IX" Read XPort Inputs (New in V1.10; Rev F PCB only)

Syntax: "!HC8", *address*, "IX"
Reply: Single byte that indicates the HC-8+ XPort inputs status

Prop-1 Example:

```
SEROUT Sio, OT2400, ("!HC8", %00, "IX")
SERIN  Sio, OT2400, xport
```

... will request and return the states of XPort inputs X0 to X3 as a single byte.

DMX Mode

When the HC-8+ is powered-up with the Option **SM** (serial mode) switch in the ON position it will act as a standard DMX slave controller that responds to the address set with the DMX switch (E) plus the next seven addresses (up to 512). OUT0 through OUT7 will correspond to the channel values transmitted by a DMX master.

Connections
The DMX Data+ and Data- signals are connected to the R+ and R- terminals at the top of the board. The outgoing DMX shield may be connected to the S terminal (this is optional). If the HC-8+ is the final device on the DMX line a shunt should be inserted on header just below the R+ terminal.
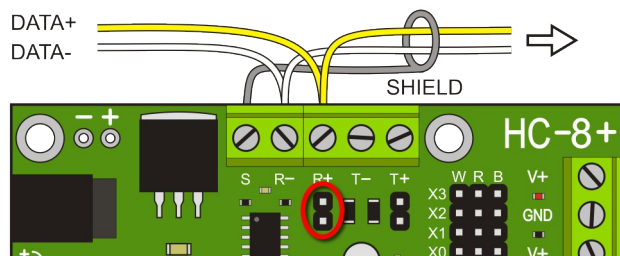
Operation
When a DMX signal is present the status LED at the top of the board will light green and the outputs will track with selected channels from the DMX stream. If the DMX signal is lost for more than one second this LED will extinguish. If the Option **A1** switch is set to OFF, the outputs will stay at the last level; if this switch is set to ON the outputs will be extinguished when DMX signal loss is detected.

Brightness Control of LEDs

When controlling LEDs it may be desirable to modify the PWM output from a linear to pseudo-logarithmic curve. In TTL serial mode the DMX #9 (256) switch is used, in DMX mode the Option **A0** switch is used.

TTL (DMX #9)	DMX (Option A0)	Output
OFF	OFF	Linear (unmodified)
ON	ON	Pseudo-Logarithmic

In either mode the LED curve input is constantly scanned so the HC-8+ does not need to have power cycled for a a change of output curve.

Firmware Updates

From time-to-time EFX-TEK may release firmware updates to add to or improve the features of the HC-8+. These updates will be provided free-of-charge. To install the update you will download an update file from EFX-TEK that will have the form:

`hc-8+_production_VxVV__YYYY-MM-DD.binary`

...where `VxVV` is the version number, and `YYYY-MM-DD` is the date of program compilation. As of this document the latest firmware release is 1.10.

Installation of the new firmware requires a Parallax Propeller-Plug and a Propeller programming IDE. Parallax's Propeller Tool is the original IDE for Windows. There is a new cross-platform tool called PropellerIDE which supports Windows, Mac, and Linux operating systems. Either of these tools can be downloaded at no charge from **www.parallax.com**.

The Prop-Plug is connected to the HC-8+ programming header (H) with the Prop-Plug label facing the P8X32A chip in the center of the board. Open the file with the IDE and select Download to EEPROM (F11 key) to install the new firmware.

Mechanical Specifications

Electrical Specifications

Parameter	Symbol	Specification			Unit
		Min.	Typical	Max.	
Supply Voltage	V_{IN}	9		24	VDC
Supply Current (no loads @ 12VDC)	I_{IN}		~125		mA
TTL (5v) Output Current – per pin	I_{TTL1}			125	mA
TTL (5v) Output Current – all pins	I_{TTL8}			1000	mA
HC Output Current – per output	I_{HCO1}			500	mA
HC Output Current – all outputs (Note 1)	I_{HCO8}			4	A

Notes:
1. When using more than 1A (total) for outputs power must be connected to V+/GND terminal block (L).