

FC-4+ Fader Control Board

Version 2.0

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Description

Whether you build props, design special effects, or work in small-scale lighting control, you have probably had the need to intelligently-control the brightness of one or more 120 VAC lamps. The FC-4+ was created for this purpose, giving the designer the ability to dim up to four, 300W incandescent lamps (per board). A simple serial interface allows the host controller to handle up to four FC-4+ fader boards on a single control channel. And built-in fade and cross-fade functions simplify the commands required by the host controller.



NOTE: The FC-4+ is a replacement for the original FC-4 fader control board. While every attempt was made to maintain backward compatibility with the original product, new or enhanced features in the FC-4+ may require the modification of some prop control programs that were designed for the original FC-4.

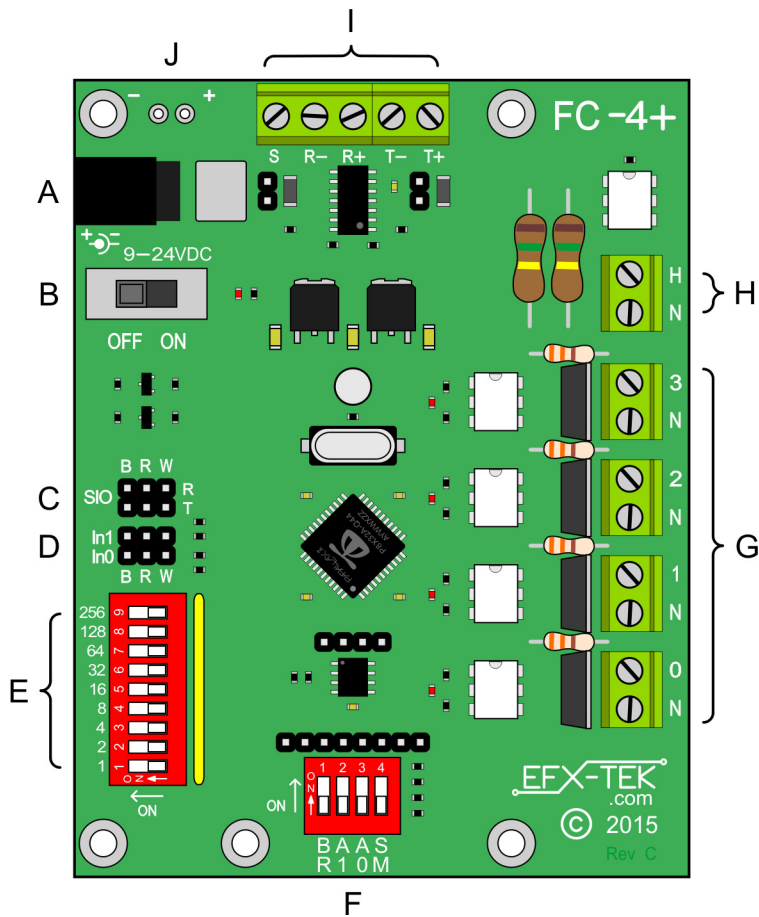
Product Applications

- Props and holiday displays
- Small-scale lighting control
- Special FX

Features & Benefits

- Controls up to four, 300W incandescent lamp channels
- LED on each channel indicates channel level
- Serial control for connection to host microcontroller
- TTL-level serial control
 - 2400 and 38.4k Baud communications (half-duplex, single wire)
 - up to four devices on one half-duplex 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
 - 250k Baud (minimum) communications
- Easily updated
 - programming port available (for Parallax Prop-Plug)
 - enables custom applications development
- Size: 3.20" x 4.15" (81.3mm x 105.4mm)
- Five, 0.14" (3.6mm) mounting holes
- Power input: 9-24VDC

FC-4+ Connections & Controls



- | | |
|---|--|
| A. Power input; 2.1mm barrel jack; 9 to 24 VDC | F. Option select switch and header |
| B. Power switch | G. AC (dimnable) outputs (OUT0..OUT3) |
| C. Bi-directional TTL serial headers (Note 1) | H. AC Power Input |
| D. TTL input headers | I. RS-458 serial connections |
| E. DMX address switch | J. OEM power pads |

Notes:

- Center pins are not powered; connect to 5v using solder-pads on bottom of PCB

Mounting the FC-4+

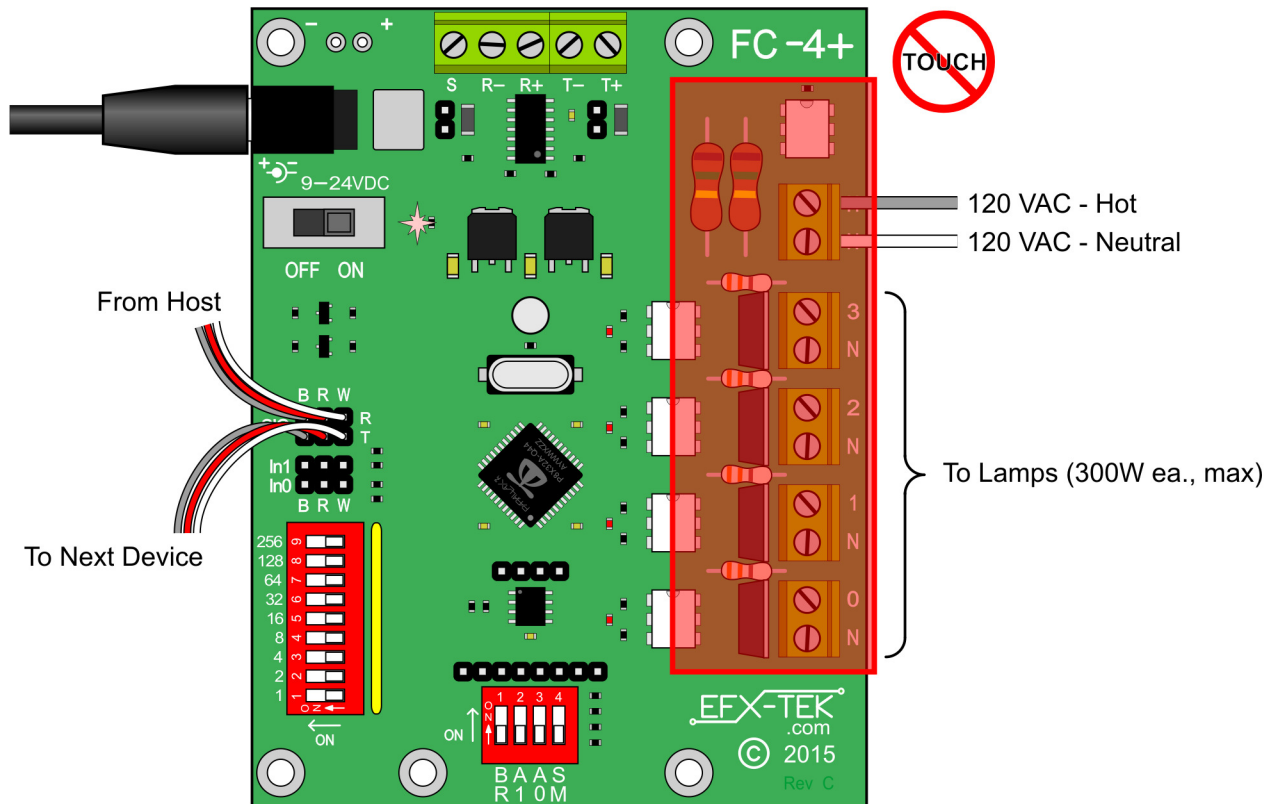


DANGER: The FC-4+ is capable of switching voltages that can be lethal if mishandled. High-voltage AC wiring should be installed by a qualified electrician. Before making any high-voltage connections to the FC-4+, ensure that all power has been removed.

Mount the FC-4+ on a non-conductive surface using ½" (12 mm) stand-offs and appropriate hardware. Mounting the FC-4+ above a conductive (metal) surface could lead to the possibility of a hazardous condition.

Connections – AC Power In and Out

Connect a suitable 120 VAC power cord to the AC IN terminal (G), noting the polarity of the connections (refer to the illustration below). The power cord used must be capable of carrying the expected load of all lamp outputs, not to exceed 1200 watts.



Connect each lamp to the output channel terminals: **OUT0**, **OUT1**, **OUT2**, and **OUT3**. Ensure that the lamp load on each channel is no greater than 300 watts.



WARNING: Do not connect loads in excess of 300 watts to any output channel of the FC-4+. Doing so can damage the FC-4+ switching components.

WARNING: The FC-4+ is designed for dimming 120 VAC incandescent lamps only; do not connect fluorescent lamps or inductive devices like AC motors or solenoids.

Power Input / Power Switch

The FC-4+ is powered from 9 to 24 volts DC. DC power may be connected to the 2.1mm power jack (A), or the OEM power pads (J).



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.

Configuration Switches

The 4-element configuration switch controls many aspects of the FC-4+ 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, HC-8+, etc.).
A1	Controls the upper bit of the FC-4+ address for serial commands (see below).
A0	Controls the lower bit of the FC-4+ address for serial commands (see below).
SM	Sets the operational serial mode. OFF position is used for standard TTL serial command mode, ON position for DMX slave mode.



NOTE: The **BR** and **SM** configuration settings are read on power-up. If changes to configuration are required the FC-4+ must be powered down and then back up to enable the new configuration.

TTL Serial Protocol

The FC-4+ 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 FC-4+ is as follows:

```
"!FC4", address, command { , sub-command } { , data }
```

...where "!FC4" is the preamble that allows the FC-4+ to exist on the same communications line as other devices (e.g., AP-16+, HC-8+, etc.), *address* is the board address set with configuration switches A1 and A0, *command* is a single-character command, and *data* is any value(s) that may be required by command.

Using a serial connection allows the host controller to connect to up to four FC-4+ boards on a single serial connection; to do this, however, each must have a unique address. The FC-4+ 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

"X" Reset

Syntax: `"!FC4", address, "X"`

Reply: None

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

Prop-1 Example

```
SEROUT Sio, OT2400, ("!FC4", %00, "X")
```

"V" Get FC-4+ Version Number

Syntax: `"!FC4", address, "V"`

Reply: 3-byte (ASCII) version string

Prop-1 Example:

```
SEROUT Sio, OT2400, ("!FC4", %00, "V")
SERIN Sio, OT2400, id0, id1, id2
DEBUG "FC-4+ Version ", #@id0, #@id1, #@id2, 13
```

"L" Set Channel Level

Syntax: `"!FC4", address, "L", channel, level`

Reply: None

The "L" command sets the level (0 to 255, 0% to 100%) of a channel (0 to 3, "A" or 255).

Prop-1 Example:

```
SEROUT Sio, OT2400, ("!FC4", %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, ("!FC4", %00, "L", "A", 32)
```

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

"LI" Set Individual Channel Levels

Syntax: `"!FC4", address, "LI", level0 { , level1 ... level3 }`

Reply: None

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

```
SEROUT Sio, OT2400, ("!FC4", %00, "LI", 64, 64)
PAUSE 50
```

...will set outputs OUT0 and OUT1 to 64 (25%) without changing outputs OUT2 or OUT3. Note that the

command is followed by a PAUSE statement to allow the serial processor inside the FC-4+ to timeout and not wait on any additional channel levels.



NOTE: If the "L" command provides less than four levels then a delay must be added before new commands to prevent the new command from being interpreted as channel levels.

"LR" Randomize Individual Channel Levels

Syntax: `"!FC4", address, "LR", mask`
Reply: None

The "LR" command randomizes individual channel levels (0 to 255, 0% to 100%) for up to four 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, ("!FC4", %00, "LR", %1100)
```

...will randomize the levels on OUT3 and OUT2 but will not affect OUT1 or OUT0. Channel position within the mask byte is 3210. As in the example above, using binary notation (%) is recommended for program clarity.

"D" Digital Mode

Syntax: `"!FC4", address, "D", channel, state`
Reply: None

The "D" command allows an 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, ("!FC4", %00, "D", 3, 1)
```

...sets OUT3 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: `"!FC4", 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 %1100 would cause OUT3 and OUT2 to be on, OUT1 and OUT0 to be off.

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

```
SEROUT Sio, OT2400, ("!FC4", %00, "DS", %0100, %0110)
```

...will cause OUT2 to be set to on (100%) and OUT1 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: `"!FC4", 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, ("!FC4", %00, "DR", %0011)
```

...will cause OUT1 and OUT0 to be digitally randomized while OUT3 and OUT2 remain unchanged.

"FL" Fade Channel (Low Resolution Timing)

Syntax: `"!FC4", 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, ("!FC4", %00, "FL", 0, 0, 255, 2)
```

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



NOTE: The FC-4+ allows up to four 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: `"!FC4", 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 timing from 0.1 to 25.5 seconds.

```
SEROUT Sio, OT2400, ("!FC4", %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: `"!FC4", 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:

$$\begin{aligned} \text{msHi} &= \text{milliseconds} / 256 \\ \text{msLo} &= \text{milliseconds} - (\text{msHi} \times 256) \end{aligned}$$

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

$$\begin{aligned} \text{msHi} &= 1250 / 256 = 4 \\ \text{msLo} &= 1250 - (256 \times 4) = 226 \end{aligned}$$

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, ("!FC4", %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: `"!FC4", 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, ("!FC4", %00, "FX", 2, 3, 30)
```

...will create a cross-fade from OUT2 to OUT3 in 3.0 seconds.

"G" Get Channel Level

Syntax: `"!FC4", address, "G", channel`

Reply: Single byte that indicates the FC-4+ level.

Prop-1 Example:

```
SEROUT Sio, OT2400, ("!FC4", %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.

"I" Read TTL Inputs

Syntax: `"!FC4", address, "I"`

Reply: Single byte that indicates the FC-4+ TTL inputs status

Prop-1 Example:

```
SEROUT Sio, OT2400, ("!FC4", %00, "I")
SERIN Sio, OT2400, ttlport
```

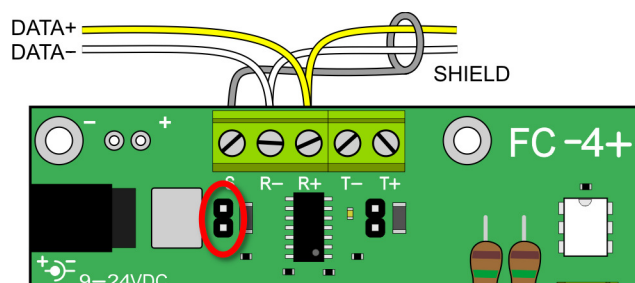
... will request and return the states of TTL inputs IN1 and IN0 as a single byte (%00 to %11).

DMX Mode

When the FC-4+ is powered-up with the 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 three addresses (up to 512). OUT0 through OUT3 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 DMX shield may be connected to the S terminal (this is optional, and should only be connected to the outgoing line). If the FC-4+ is the final device on the DMX line a shunt should be inserted on header just below the shield 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 and the outputs will remain at the last commanded level.

Firmware Updates

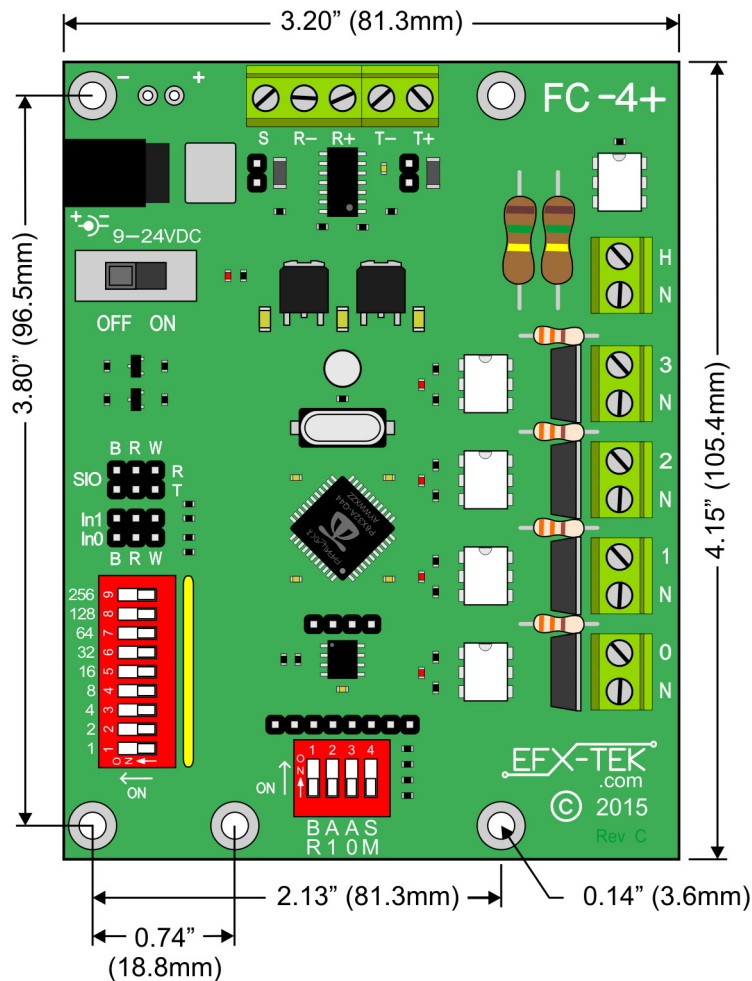
From time-to-time EFX-TEK may release firmware updates to add to or improve the features of the FC-4+. These updates will be provided free of charge. To install the update you will download an update file from EFX-TEK that will have the form:

FC4_vXXX.EEPROM or **FC4_vXXX.BINARY**

...where XXX is the version number. As of this document the latest firmware release is 1.0.

Installation of the new firmware requires a Parallax Propeller-Plug and a Propeller programming IDE (Propeller Tool [Windows only] or PropellerIDE [x-platform]). The Prop-Plug is connected to the FC-4+ 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



Accessories

750-00007	12VDC, 1A power supply; provides ample power for the FC-4+
805-00002	12-inch, 3-pin extension cable; used to connect external devices to the TTL I/O pins
32201	Propeller-Plug programming adapter (for uploading new firmware/custom apps)

Additional Applications

For additional ideas and application notes for the FC-4+, be sure to visit us on the Internet at the following links:

www.efx-tek.com
forums.efx-tek.com