

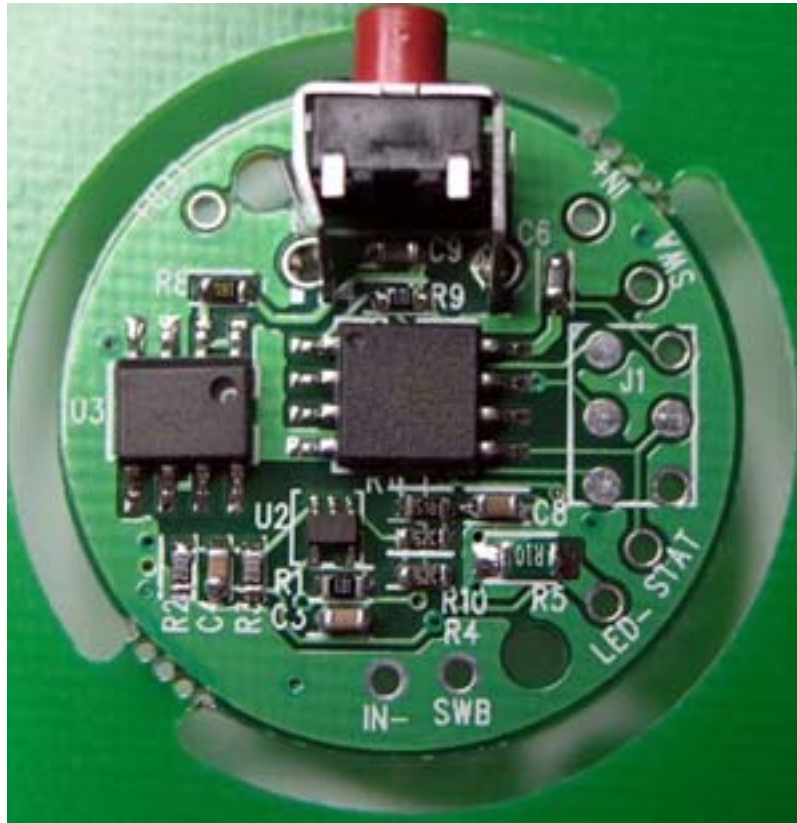
Operating Manual for bFlex (V1.00)

1 Description

The heart of the bFlex board is a Microcontroller (uC) that contains the firmware to implement the following features:

- High efficiency Buck mode (step down) switching regulator (maximum drive current set in firmware).
- Single switch to select from various brightness levels, turn the unit on/off and to select the operating mode.
- Non-volatile (EEPROM) storage of operating mode, last selected brightness level and maximum drive level (350mA, 500mA, 750mA or 1000mA).
- Choice of 2 different User Interfaces, UIF fixed lighting optimized, UIP portable lighting optimized.

1.1 Wiring the bFlex



The picture shows the connections to the bFlex. The user needs to provide DC power to the bFlex (e.g. battery, DC wallwart, vehicle/boat/RV 12V).

The bFlex is reverse polarity protected by a schottky diode in series with the +IN (D1 on the PCB).

The bFlex has a switch soldered on the board; an additional switch may be connected via leads soldered to the holes SWA and SWB. The switch needs to be of a momentary action push to close type, i.e. normally open contacts.

Input power is connect via IN+ (positive input voltage) and IN- (negative input voltage).

The LED load is connected to LED+ (positive LED) and LED- (negative LED). NOTE: LED- is NOT the same as IN-. Below is the view of the other side of the bFlex board.



As shipped, the bFlex is configured for nominal 350mA drive. The user may reconfigure the bFlex drive level as described later in this document.

The following table shows the supported configurations of the bFlex.

Driver Configuration	Input voltage for regulation (min)*	Input voltage Operating (min)**	Input voltage (max)
1 1W Luxeon	$V_f+0.7V$	4V	24V
1 to 4 1W Luxeons (in series)	$\Sigma V_{fn}+0.7V$	4V	24V
1 Luxeon III	$V_f+1.1V$	4V	24V
1 to 4 Luxeon III (in series)	$\Sigma V_{fn}+1.1V$	4V	24V
1 to 2 5W Luxeon	$\Sigma V_{fn}+1.1V$	4V	24V

* Nominal Minimum input voltage to ensure current regulation is maintained (350mA drive to 1W Luxeons, 1000mA drive to 3W or 5W Luxeons). Below this voltage the bFlex will enter direct drive and the brightness will drop. If lower light levels are selected, bFlex may be able to keep the Luxeon in current regulation due to lower V_f requirements at lower current. These dropout voltages assume that the input protection diode is shorted out.

V_f is the forward voltage of the Luxeon at the driven current.

ΣV_{fn} is the sum of the forward voltage of all the series connected Luxeons.

** Minimum operating voltage for bFlex.

1.2 Turning the bFlex ON the first time

Do not apply power to the bFlex unless the Luxeon(s) is/are connected. This is to protect the output capacitor and to protect the Luxeon from voltage spikes if it is then connected to the bFlex.

The bFlex is shipped with the lowest drive level (350mA) as the default, with auto-sleep mode turned off and Poweron mode turned on. When power is first applied, the bFlex will drive the Luxeon(s) at the nightlight level.

2 Definitions

- Click – a short, less than 0.3 seconds press and release.
- Press – a longer, greater than 0.3 seconds press and hold.
- Force – an option to always have the light turn on at a specific user-selected level.
- UI – User Interface.
- EEPROM – non-volatile memory. Data stored here will remain even if the battery is disconnected.

3 Initial Power Application

As shipped, when power is first applied, the bFlex will light the LED(s). If Poweron Mode is active (it ships by default with it enabled) bFlex will power up and light the LED at the lowest level. If the switch is pressed when the electrical circuit is first made, bFlex will light up in the same way as if the switch had been pressed from off.

4 Initial Shipped Configuration

bFlex is shipped preconfigured as follows:

- Autosleep OFF
- Force OFF
- Poweron Mode ON
- Autolockout OFF
- 350mA maximum drive
- Voltage Warning (0V → OFF)
- Voltage Warning Status (flash interval = 1 second)
- UIF selected

5 UIP (Portable lighting optimized User Interface), 5 Discrete Levels

There are 6 operating modes for UIP. They are described below.

5.1 On/Off Mode

To turn on the light, click the switch. The light will turn on at the previous level or the Force level if Force is enabled.

To turn off the light, click the switch.

5.2 Adjustment Mode

To adjust the brightness of the light start with the light off, then press the switch.

The light will always turn on at Level 1 (dimmiest level) and in the brightening direction.

Release the switch at the desired level, and that new level will be stored in the EEPROM. Pressing the switch again (within 1.5 seconds) will start the light adjustment in the opposite direction (the direction toggles each time).

When the light reaches the dimmiest or brightest level it will stay there until the switch is released.

Once the switch is released for longer than 1.5 seconds no more brightness adjustment is possible without turning off the light and starting the sequence again.

5.3 Latched Full Brightness Mode

With the light turned on, a press will latch to Level 5 (brightest). A second press will unlatch and return the light to the original brightness level.

To turn off the light, click the switch.

5.4 Lockout Mode

To prevent accidental turn on or unintended use the light can be electronically locked out. Lockout can be manually selected each time prior to turning off the light or a menu option (see Sec 7.4) can auto-lockout every time the light is turned off.

To manually enter lockout, begin with the light on and ensure light is on for at least 1 second. Then click the switch rapidly three times, no more than 0.3 seconds apart. The light will cycle off/on/off and then flash once and then go dim for 2.5 seconds then flash three times. The light is now in lockout mode and can only be turned on again by three clicks spaced no more than 0.3 seconds apart.

5.5 Autosleep Mode

If Autosleep is enabled (see Sec 7.0), the timer will reset and start counting whenever a switch click or press occurs. When the selected number of minutes goes by without a click or press, the Autosleep function will commence dimming the light. The brightness level will visibly drop after each subsequent minute until the lowest light level is reached. After a further 10 minutes elapses from the start of dimming the light will turn itself off.

A press during any time after the dimming has commenced will return the light to its starting brightness level prior to dimming having started.

To turn off the light, click the switch.

5.6 Force Mode

This mode is selected from the power-on menu (see Sec 7). Force mode overrides the initial turn on brightness level that was set via the Adjustment Mode on the previous turn off. The user can always set a new temporary light level by using the Adjustment mode during turn on, but it will be overridden the next time the light is turned off and back on.

6 UIF (Fixed lighting optimized User Interface), 8 Discrete Levels

There are 6 operating modes for UIF. They are described below.

6.1 On/Off Mode

To turn on the light, click the switch. The light will turn on at the previous level or the Force level if Force is enabled.

To turn off the light, click the switch.

6.2 Turning the bFlex ON to an alternate brightness level

Pressing the button for longer than $\frac{1}{2}$ a second but less than $1\frac{1}{2}$ seconds will select the nightlight illumination level. To aid the user in knowing this level is being selected, the Luxeon will illuminate at the nightlight level after $\frac{1}{2}$ a second. This level is stored in the EEPROM as the current illumination level.

Pressing the button for longer than $1\frac{1}{2}$ seconds will select the full brightness illumination level. To aid the user in knowing this level is being selected, the Luxeon will switch to full brightness level after $1\frac{1}{2}$ seconds. This level is stored in the EEPROM as the current illumination level.

6.3 Adjustment Mode

There are 7 equally spaced brightness levels (human eye model) in addition to the nightlight level. With the bFlex already switched on, the user can scroll through the brightness levels by pressing the button for longer than $\frac{1}{2}$ a second. The brightness will either increase or decrease one level every $\frac{1}{3}$ of a second. bFlex will toggle from the bright or dim direction each time the button is released.

If the unit is turned on and the unit starts in nightlight mode, then the direction is initially set to increasing. If the unit is turned on and the unit starts in full bright mode, then the direction is initially set to decreasing. If the unit is turned on at any in between level then the direction is initially set to decreasing.

Each time the brightness level is changed the new level is stored in EEPROM ready to be retrieved next time the unit is turned back on.

6.4 Lockout Mode

To prevent accidental turn on or unintended use the light can be electronically locked out. Lockout can be manually selected each time prior to turning off the light or a menu option (see Sec 7.4) can auto-lockout every time the light is turned off.

To manually enter lockout, begin with the light on and ensure light is on for at least 1 second. Then click the switch rapidly three times, no more than 0.3 seconds apart. The light will cycle off/on/off and then flash once and then go dim for 2.5 seconds then flash three times. The light is now in lockout mode and can only be turned on again by three clicks spaced no more than 0.3 seconds apart.

6.5 Autosleep Mode

If Autosleep is enabled (see Sec 7.0), the timer will reset and start counting whenever a switch click or press occurs. When the selected number of minutes goes by without a click or press, the Autosleep function will commence dimming the light. The brightness level will visibly drop after each subsequent minute until the lowest light level is reached. After a further 10 minutes elapses from the start of dimming the light will turn itself off.

A press during any time after the dimming has commenced will return the light to its starting brightness level prior to dimming having started.

To turn off the light, click the switch.

6.6 Force Mode

This mode is selected from the power-on menu (see Sec 7). Force mode overrides the initial turn on brightness level that was set via the Adjustment Mode on the previous turn off. The user can always set a new temporary light level by using the Adjustment mode during turn on, but it will be overridden the next time the light is turned off and back on.

7 Menu Selection (Configuring bFlex)

This section describes how to enter the Menu system and how to change operating options. The changes will be stored in the EEPROM.

To access the Menu, begin with the light on and ensure light is on for at least 1 second. Then click the switch rapidly three times, no more than 0.3 seconds apart. The light will cycle off/on/off and then flash once and then light up dim. The Menu Mode is now active and you can select the Menu you wish to access.

Click the switch from 1 to 8 times (the LED will flash for each click) to select one of the five menu options to change as listed below. If no click occurs within 2.5 seconds lockout is set. If more than 7 clicks (10 clicks performs a configuration reset, refer Sec 7.8) are entered, the menu mode is exited, the LED flashes quickly 5 times to indicate a selection error and the light turns off.

After clicking from 1 to 7 times wait for the LED to light up dim (unless your choice is zero clicks). Then continue as below.

7.0 Zero clicks – Times Out to Lockout

If no menu is selected (zero clicks), after 2.5 seconds the LED flashes quickly 3 times to indicate Lockout has been set. The LED then turns off and the unit is locked out. To turn it back on requires following the lockout release sequence of three quick clicks as outlined in Sec 5.4 and Sec 6.4.

7.1 One click - Autosleep Enable/Disable

Initially the LED will be dim to indicate Autosleep will be active with 15 minutes. Each click will cycle through the next time value. The sequence is:

- 15 minutes, initial value (LED dim)
- 30 minutes (LED brighter)
- 1 hour (LED brighter)
- 2 hour (LED brighter)
- 4 hour (LED brighter)
- 8 hour (LED brighter)
- Autosleep disabled (LED off)

When you are happy with the choice, wait 2.5 seconds and the LED will flash once to indicate the selection has been made and bFlex will then turn off.
has been made and the light will then turn off.

7.2 Two clicks - Force Mode Enable/Adjust/Disable

Initially the LED will dim to indicate Force Level 1 (dimkest) will be active (i.e. if you don't click, Force will become active and set to Level 1). Each click will cycle to the next Force setting. The sequence is:

- Force Level 1 (LED dim)
- Force Level 2 (LED med/low)
- Force Level 3 (LED medium)
- Force Level 4 (LED med/high)
- Force Level 5 (LED brighter)
- Force Level 6 (LED brighter – ONLY AVAILABLE IN UIF)
- Force Level 7 (LED brighter – ONLY AVAILABLE IN UIF)
- Force Level 8 (LED brighter – ONLY AVAILABLE IN UIF)
- Force Disabled (LED is off)

The sequence will cycle through all 6 choices for UIP and all 8 choices for UIF. The LED brightness matches the 5 (or 8) operating levels of the UI. When you are happy with the choice, wait 2.5 seconds. The LED will flash once to indicate the selection has been made and the light will then turn off.

7.3 Three clicks – Poweron Mode Enable/Disable

bFlex can be configured to either power-up with the LED lit or unlit when power is first applied. E.g. In a light that has a power switch in series with bFlex and the battery the user may want bFlex to light up the LED as soon as the power switch is turned on. In this case the user would Enable Poweron Mode.

Initially the LED will be dim to indicate Poweron Mode will be enabled (i.e. if you don't click, Poweron Mode will be enabled). A click will brighten the LED to indicate Poweron Mode will be disabled. Each click will cycle from enabled to disabled. When you are happy with the choice, wait 2.5 seconds and the LED will flash once to indicate the selection has been made and the light will then turn off.

7.4 Four clicks – Auto-lockout Enable/Disable

To prevent accidental turn on or unintended use, the light can be electronically locked out. Auto-lockout can be enabled so that each time the light is turned off it enters Lockout and requires 3 quick clicks or 2 quick clicks and a press to turn the light back on.

Initially the LED will be dim to indicate Auto-lockout will be active (i.e. if you don't click, Auto-lockout will become active). A click will brighten the LED to indicate Auto-lockout will be inactive. Each click will cycle from active to inactive. When you are happy with the choice, wait 2.5 seconds and the LED will flash once to indicate the selection has been made and the light will then turn off.

7.5 Five clicks – Current Drive Selection

Initially the LED will light up dim to indicate the 350mA current drive will be active. Each click will cycle to the next current drive level. The sequence is:

- 350mA (LED dim)
- 500mA (LED brighter)
- 750mA (LED brighter)
- 1000mA (LED brighter)

The sequence will cycle through all 4 choices. The LED brightness increases at each click. When you are happy with the choice, wait 2.5 seconds. The LED will flash once to indicate the selection

7.6 Six Clicks – Voltage Warning Setting

bFlex can be configured to warn the user when low input voltage occurs. The user can set the voltage warning to any value between 0V – 20V.

Entering the voltage is performed by setting a number in the format: xy.z (e.g. 06.8V).

Once 6 clicks are entered, the LED will dim and wait for entry of the 'x' (tens). Click 0 to 2 times. Wait and after 2.5 seconds the LED will flash once to signify that 'x' has been accepted.

The LED will dim again and wait for entry of the 'y' (units). Click 0 to 9 times. Wait and after 2.5 seconds the LED will flash once to signify that 'y' has been accepted.

The LED will dim again and wait for entry of the 'z' (tenths). Click 0 to 9 times. Wait and after 2.5 seconds the LED will flash once to signify that 'z' has been accepted and then BFlex turns off.

The xy.z value is stored in the EEPROM and can be changed by following the above procedure as often as necessary.

Note: bFlex senses the input voltage across IN+ and IN-. This means that measured voltage for the Voltage Warning circuitry is quite accurate.

7.7 Seven Clicks – Voltage Warning Status

How bFlex reports the low voltage condition is configured using this menu option.

bFlex reports the low voltage condition via the STAT pin on the PCB. STAT will drive high (~2.5V) when the low voltage condition is detected. It will drive back to 0V when the low voltage condition is no longer detected. The STAT pin can drive a single 3mm or 5mm (at approximately 20mA). If this feature is used, wire the 3mm or 5mm LED between STAT and GND.

If the user does not want to wire a status LED to the STAT pin but still wants an indication of low voltage occurring, then the main LED(s) can be set to flash at a specific interval to give a visual warning. The main LED(s) will flash off for 0.1seconds, long enough to warn the user, but short enough that the user can ignore the warning (in an emergency) and continue to use the light.

- 0 click (dim) → Main LED(s) flash once per 1 sec (undervoltage) - default
- 1 click (brighter) → Main LED(s) flash once per 5 sec (undervoltage)
- 2 click (brighter) → Main LED(s) flash once per 10 sec (undervoltage)
- 3 click (brighter) → Main LED(s) flash once per 30 sec (undervoltage)
- 4 click (brighter) → Main LED(s) flash once per 60 sec (undervoltage)
- 5 click (goes off) → No Main LED(s) flash for undervoltage

7.8 Eight clicks – User Interface Selection

Initially the LED will light up dim to indicate UIF will be active (i.e. if you don't click, UIF will become active). A click will light the LED up bright to indicate UIP will be active. Each click will cycle between UIF and UIP. When you are happy with the choice wait and after 2.5 seconds the LED will flash once to indicate the selection has been made and the light will then turn off.

7.9 Nine Clicks – Illegal entry

The LED flashes quickly 5 times to indicate a selection error and the light will then turn off.

7.10 Ten Clicks – Configuration Reset (to Initial shipping defaults)

If the user wants to reset bFlex menu options to their initial shipping defaults, this menu option will perform that function. All configuration options will return to their defaults, refer to Sec 4.

Initially the LED will be dim to indicate a Configuration Reset will not occur (i.e. if you don't click to toggle this option). A click will brighten the LED to indicate a Configuration Reset will occur. Each click will toggle from active to inactive. When you are happy with the choice, wait 2.5 seconds and the LED will flash once to indicate the selection has been made and bFlex will then turn off.

7.11 Menu Selection Complete

Once the above menu procedure is complete and the light turns off the new menu selection is immediately active. bFlex is ready to be used.

Only one menu item can be changed per Menu Selection sequence, i.e. bFlex turns off after one sequence.