

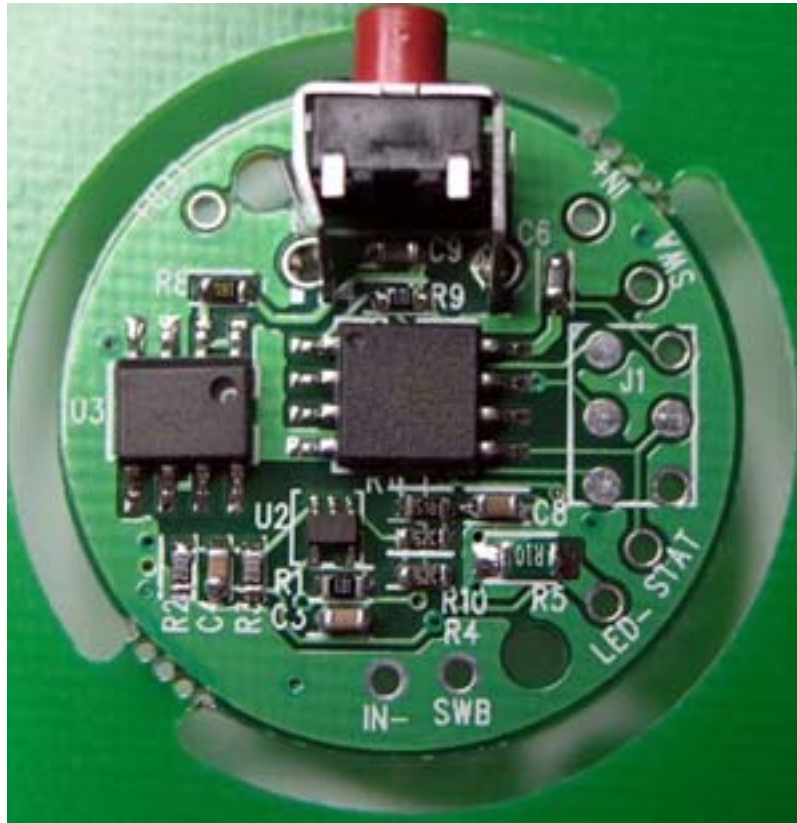
# Operating Manual for bFlex UIF, UIP & UIB (V2.01)

## 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, select the operating modes and set menu options.
- Non-volatile (EEPROM) storage of operating mode, last selected brightness level, and maximum drive level (350mA, 500mA, 750mA or 1000mA).
- Choice of 3 different User Interfaces, UIF fixed lighting optimized, UIP portable lighting optimized and UIB bicycle 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 included (loose) with 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 LED	$V_f+0.7V$	4V	24V
1 to 4 1W LED (in series)	$\Sigma V_{fn}+0.7V$	4V	24V
1 3W LED	$V_f+1.1V$	4V	24V
1 to 4 3W LEDs (in series)	$\Sigma V_{fn}+1.1V$	4V	24V
1 to 2 5W LED	$\Sigma V_{fn}+1.1V$	4V	24V

\* Nominal Minimum input voltage to ensure current regulation is maintained (350mA drive to 1W LEDs, 1000mA drive to 3W or 5W LEDs). 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 LED 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 LED at the driven current.

$\Sigma V_{fn}$  is the sum of the forward voltage of all the series connected LEDs.

\*\* Minimum operating voltage for bFlex.

## 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. Stored data will remain even if battery is disconnected.

## 3 Turning the bFlex ON the first time

**Do not apply power to the bFlex unless an LED is connected. This is to protect the output capacitor (16V rated) and to protect the LED from voltage spikes if it is connected to the bFlex after power has been applied.**

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 safely drive the LED(s) at the nightlight level.

### ***3.1 Initial Power Application***

As shipped, when power is first applied, the bFlex will light the LED(s). If Poweron Mode is active (it is active by default) 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 Overview of the User Interfaces (UIs) and the Control Menu

### 4.1 Fixed (UIF)

Intended for lanterns, household and automotive lighting. Eight brightness levels. Ability to turn on at lowest setting, and quickly change to highest setting without scrolling. Press while on to scroll all levels. Click turns on, and click turns off.

### 4.2 Portable (UIP)

Intended for hand-held torches. Five brightness levels. Ability to turn on at lowest setting. Ability to switch directly to high setting from any other level. Press while off to scroll all levels. Click turns on, and click turns off.

### 4.3 Bicycle (UIB)

Intended for bicycle lighting. Separate modes for constant and strobe. User-configurable quantity and brightness of “constant on” levels. Three scrollable levels for strobe. Emergency low mode accessible from off. Click scrolls chosen levels (constant or strobe). Click turns on and press turns off.

### 4.4 Menu features/choices of all UIs

**Bold** is factory default.

0. Electronic Lockout (enable)
1. Auto Sleep (**disable**, 15min, 30min, 1hr, 2hr, 4hr, 8hr)
2. Force Level (**disable** or choose level for initial on. Not available in UIB)
3. Power On (**enable**/disable “on” function when power is applied)
4. Auto Lock (enable/**disable** automatic electronic lockout after each use)
5. Current Drive level (**350ma**, 500mA 750mA, 1000mA - all intermediate brightness levels scale to this max level)
6. V Warn (protect rechargeable batteries by setting a warning flag at a chosen Voltage level. Enter in form xy.z) [**00.0 - disable**]
7. V Stat (choice of how the light warns that V Warn level has been reached. One flash per 1, 5, 10, 30, 60 seconds, or no flash/stat pin only)
8. UIB Const Level (choose quantity and brightness of levels in UIB constant mode) [**two levels, L3 and L5**]
9. UI selector (**UIF**, UIP, UIB)
10. Reset (menu selections reset to factory defaults for all UIs)

Note: Snip and save the above Menu table for quick reference.

## **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 UIP**

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 UIP**

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

The light will always turn on at Level 1 (dimkest 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 dimkest 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 UIP**

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 UIP**

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 10.4) can automatically lock out the light each time it is turned off.

To manually enter lockout, begin with the light on and ensure light has been 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, go dim for 2.5 seconds, then flash three times and turn off. 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 UIP**

If Autosleep is enabled (see Sec 10.1), 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 at any time during the sequence, click the switch.

## **5.6 Force Mode UIP**

This mode is selected from the menu (see Sec 10.2). 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 UIF**

To turn on the light, click the switch. The light will turn on at the previous level or at 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 UIF**

Pressing the button for longer than  $\frac{1}{2}$  a second but less than 1.5 seconds will select the nightlight illumination level. This level is stored in the EEPROM as the current illumination level.

Pressing the button for longer than 1.5 seconds will select the full brightness illumination level. This level is stored in the EEPROM as the current illumination level.

### **6.3 Adjustment Mode UIF**

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 light is turned on and the light 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 light is turned back on.

### **6.4 Lockout Mode UIF**

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 10.4) can automatically lock out the light each time it is turned off.

To manually enter lockout, begin with the light on and ensure light has been 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, go dim for 2.5 seconds, then flash three times and turn off. 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 UIF**

If Autosleep is enabled (see Sec 10.1), 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 at any time during the sequence, click the switch.

## **6.6 Force Mode UIF**

Force mode (see Sec 10.2) 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, but when Force is enabled, the manually-set level will be overridden the next time the light is turned off and back on.



## **7 UIB (Bicycle Optimized User Interface) two lighting modes - Constant and Strobe.**

There are 6 operating modes for each lighting mode in UIB. They are described below.

### **7.1 On/Off Mode UIB**

To turn on the light, click the switch. The light will turn on in the previous mode (constant or strobe) and at the previously used level. (Force setting has no effect and cannot be set when in UIB).

To turn off the light, press the switch.

### **7.2 Adjustment Mode UIB**

From on (constant or strobe), clicking the button cycles up through all available levels. There are three factory-set strobe levels that scale with the Current Drive menu option (see Sec 10.5). The quantity and brightness of constant levels is chosen in the menu. You may have one two or three brightness levels in constant mode (see Sec 10.9). 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.

### **7.3 Emergency Low Mode UIB**

From off, press the switch to enter Emergency Low Mode. This high-efficiency level is set in the menu (Sec 10.9). Emergency Low Mode can be used when the batteries have discharged to a point where they may be damaged if high-drain levels continue to be used. This mode can be used at any time when low-level lighting is wanted or needed.

To exit Emergency Low Mode, press the switch. A subsequent click will then turn on in the last-used mode (constant or strobe).

### **7.4 Lockout Mode UIB**

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 10.4) can automatically lock out the light each time it is turned off.

To manually enter lockout, begin with the light in Emergency Low Mode (Sec 7.3). Then click the switch rapidly three times, no more than 0.3 seconds apart. The light will blink each time the switch is clicked, flash once, go dim for 2.5 seconds, then flash three times and turn off. 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.

## **7.5 Autosleep Mode UIB**

If Autosleep is enabled (Sec 10.1), the timer will reset and start counting whenever the switch is clicked or pressed. When the selected number of minutes has passed without a switch 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 an additional 10 minutes has elapsed from the start of dimming, the light will turn itself off. Both constant and strobe modes use the 8-level brightness tables of UIF for the dimming sequence.

Strobe mode additionally alerts that the Autosleep sequence has begun by also entering into a harsher strobe that completely shuts the LED off between flashes.

Emergency Low Mode alerts that Autosleep is about to turn off the light by flashing for the last minute before dark. In Emergency Low levels, there are not enough “dimming steps” to use as an alert.

A click during any time after the dimming (or flashing in the case of Emergency Low) has commenced will return the light to its starting brightness level prior to dimming having started.

To turn off the light at any time during the sequence, press the switch.

## **7.6 Constant-Strobe Mode Selection Mode UIB**

To change from Constant Mode to Strobe Mode, begin by turning the light on in either mode. Then press and hold the switch until the light goes off, and then comes on again (about 4.5 seconds of holding the switch down without releasing). The light will now be on, in the alternate mode. The last-used mode is stored in EEPROM and will always be selected when the light is next turned off and back on.

**8 There is no Section 8**

**9 There is no Section 9**

## 10 Menu Selection (Configuring bFlex)

This section describes how to enter the Menu system and how to change operating options. All changes are stored in the EEPROM.

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

To access the Menu in UIB, begin with the light in Emergency Low Mode (Sec 7.3), and click the switch rapidly three times, no more than 0.3 seconds apart. The LED will cycle off/on/off with each click, then flash once, then light up dim. The Menu Mode is now active and you can select the Menu you wish to access.

Click the switch from 0 to 10 times (the LED will flash for each click, do NOT try to beat the flash) to select one of the eleven menu options to change as listed below. If no click occurs within 2.5 seconds lockout is set. If more than 10 clicks (10 clicks performs a configuration reset, see Sec 10.10) 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 0 to 10 times wait for the LED to light up dim (unless you chose zero clicks). Then continue as below.

### **10.0 Zero clicks – Times Out to Lockout**

This option is chosen to manually lock out the light from accidental activation.

Initially the LED will be dim to indicate lockout is chosen. To activate lockout, do nothing, and the LED will flash quickly three times then turn off to indicate that Lockout has been set. To turn the light back on requires following the lockout release sequence of three quick clicks as outlined in Sec 5.4 and Sec 6.4 and Sec 7.4.

### **10.1 One click - Autosleep Enable/Disable**

To preserve battery life, this option allows bFlex to switch the power off after a preset time.

Initially the LED will be dim to indicate Autosleep will activate in 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.

## **10.2 Two clicks - Force Mode Enable/Adjust/Disable**

This mode overrides the last-used level (NOT applicable for UIB).

Initially the LED will be 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 brighter)
- Force Level 3 (LED brighter)
- Force Level 4 (LED brighter)
- 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 6 choices for UIP and all 9 choices for UIF. The LED brightness matches the 5 (or 8) brightness 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.

## **10.3 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 fixture that has an auxiliary power switch in series with the battery and bFlex, the user can choose to have bFlex illuminate 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 disabled (i.e. if you don't click, Poweron Mode will be disabled). A click will brighten the LED to indicate Poweron Mode will be enabled. 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 and turn off to indicate that the selection has saved.

## **10.4 Four clicks – Auto-lockout Enable/Disable**

This option allows for automatic electronic lockout every time the light is turned off.

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.

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.

## **10.5 Five clicks – Current Drive Selection**

bFlex can be set to one of four maximum current drive levels. This selection will be the “high” of every UI. The brightness scales of all other levels are determined by this setting.

Initially the LED will be dim to indicate that 350mA max current 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 brightest)

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

## **10.6 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. The voltage value is entered by setting a number in the format: xy.z (e.g. 06.8V).

Initially the LED will be dim, waiting for entry of the ‘x’ (tens). Click 0 to 2 times (If you don’t click, 0 will be selected for the tens digit). 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 (If you don’t click, 0 will be selected for the units digit). 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 (If you don’t click, 0 will be selected for the tenths digit). After 2.5 seconds the LED will flash once to signify that ‘z’ has been accepted and then BFlex turns off.

If this menu option is selected, and no clicks are entered, 00.0V (the same as disabled) is accepted and stored.

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.

## **10.7 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.

Initially the LED will be Dim to indicate that one flash per second will be chosen. See the table below for all available settings.

- 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

## **10.8 Eight clicks – User Interface Selection**

Initially the LED will be dim to indicate UIF will be active (i.e. if you don't click, UIF will become active). One click will brighten the LED to indicate UIP will be active. A second click will brighten the LED another step to indicate UIB will be active. Another click will cycle back to UIF, etc. When you are happy with the choice, wait 2.5 seconds. The LED will flash once and turn off to indicate the selection has been saved.

- 0 click (dim) → UIF - default
- 1 click (brighter) → UIP
- 2 click (brightest) → UIB

## **10.9 Nine Clicks – UIB Level Selection**

Initially the LED will be dim to indicate that Level One is in setting mode. One click brightens the LED to indicate that Level Two is in setting mode. A second click brightens the LED to indicate that Emergency Low Level is in setting mode. Subsequent clicks cycle through these three level setting choices. Once the level you wish to set is chosen, wait 2.5 seconds. The LED will flash once and come back on dim, indicating that you will now set the brightness associated with the level you have chosen. Click to cycle the brightness levels, or to disable the level. (Emergency Low cannot be disabled). The indications for the brightness levels of Level One and Level Two are shown here.

- 0 click (dim) → L1 (dimmiest)
- 1 click (brighter) → L2
- 2 click (brightest) → L3
- 3 click (brighter) → L4
- 4 click (brighter) → L5 (default for Level Two)
- 5 click (brighter) → L6
- 6 click (brighter) → L7
- 7 click (brighter) → L8
- 8 click (goes off) → Disabled (default for Level One)

Levels One and Two are optional. Level Three is always the Current Drive level set in Sec 10.5.

The indications for the brightness levels of Emergency Low are shown here. Emergency Low level can be set to one of three options:

- 0 click (dim) → LE1 (dimmiest)
- 1 click (brighter) → LE2
- 2 click (brightest) → LE3 (brightest, but still low power)

Note: The strobe levels are factory set and scale with the Current Drive setting (see Sec 10.5).

## **10.10 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 4.4.

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 a number of times to indicate the version number and that the selection has been made. bFlex will then turn off.

## **10.11 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; bFlex turns off after one sequence.