

Introduction



Fulham's programmable LED drivers are the WorkHorse of LED drivers. These innovative drivers can be programmed with a large number of outputs, allowing the user to stock fewer SKUs. The functionality of one programmable driver can replace over 3500 standard drivers.

The following pages contain information to not only operate, but also customize Fulham's programmable LED drivers for use with in a vast array of luminaires. Fulham's programmable LED drivers are available in various configurations with wattages ranging from 40W to 200W and an impressive HotSpot Plus Emergency driver that acts as both an LED driver and Emergency driver in one compact unit. These drivers feature either 0-10V Dimming, Pulse Dimming, DALI Dimming or a Wireless Protocol.

Further information on all Fulham products can be found at www.fulham.com.



Currently available programmable LED drivers:

Programmable – 0-10V Dimming

T1M1UNV105P-40E
T1M1UNV150P-40L
T1M1UNV105P-60E
T1M1UNV105P-60F
T1M1UNV105P-60G
T1M1UNV160P-60L
T1M1UNV210P-60L
T1M1UNV240P-96L
T1M1UNV150P-100C
T1M1UNV150P-150L
T1M1UNV500P-185L
T1M1UNV140P-200L

Programmable – DALI Dimming

T1A1UNV105P-40E
T1A1UNV150P-40L
T1A1UNV105P-60E
T1A1UNV105P-60F
T1A1UNV210P-60L
T1A1UNV105P-60G
T1A1UNV150P-100C
T1A1UNV150P-150L
T1A1UNV140P-200L

Programmable - HotSpot Constant Power/Constant Current

FHSCP-UNV-10P-L-SD
FHS2-UNV-36L
FHS2-UNV-56S

Programmable – Twilight (Wireless)

T1R1UNV150P-40C
T1R1UNV150P-40CE
T1R1UNV160P-60C
T1R1UNV210P-60C
T1R1UNV210P-60CE
T1R1UNV150P-100C
T1R1UNV150P-150L
T1R1UNV140P-200L

Programmable - HotSpot Plus

FHSAC1-UNV-40C
FHSAC1-UNV-40BLS
FHSAC1-UNV-40L
FHSAC1-230-45CE

Be sure to check www.fulham.com for the latest list of programmable drivers available

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Safety



Safety Warnings and Instructions during design:

- Avoid touching any live parts and do not use damaged products such as products with damaged wiring.
- Disconnect mains voltage when servicing driver and before connecting or disconnecting the LED load.
- Cap off all unused wires to prevent any damage.
- The luminaire manufacturer is responsible for its own luminaire design as well as having to comply with all relevant safety standards.
- For further design support contact Fulham directly.
- Care must be taken so that NTC / Programming / R-set leads never touch LED output.

Features



Programmable Output Current:

All drivers are initially set to the minimum output current of the driver. The driver current can be set in several ways, all of which are accessed by using the input connections labeled **PRG + -** on the driver. As LED's become more efficient and require less drive current to achieve similar outputs as earlier versions, this allows for flexibility of design with newer technology.

There are three methods for programming output current. The TPSB-100/E setting controller allows users to program the desired voltage for a constant voltage driver or desired current for a constant current driver. Advanced programming can also be done through a PC using the Setting Tool software available at www.fulham.com. In addition, on supporting drivers the current can be set by using the appropriate resistor value on the RSET input in accordance with the output current needed (note that supporting drivers are in RSET mode by default, with no additional programming needed, but if the output is subsequently changed the driver must be reprogrammed to "0"mA in order to return to RSET mode).

Adjusting Output Current (3 Methods):

1. RSET Mode
 - Placing an external resistor across the RSET (+) and RSET (-) input on supporting drivers. The driver will check the value of RSET and output the current corresponding to the resistor value. Please note that the driver is in RSET mode by default, with no additional programming needed, but if the output is subsequently changed the driver must be reprogrammed to "0" mA with the TPSB-100/E setting Controller or the Setting Tool software to return to RSET mode.
2. Setting Tool Software
 - Please refer to the TPSB-100/E User Manual or the "Programming" section of this document for further instructions.
3. Setting Controller
 - Please refer to the TPSB-100/E User Manual or the "Programming" section of this document for further instructions.

**** As of September 2017, only Constant Current programmable drivers are available/compatible.***

Features



Benefits of Adjustable Output:

One common issue luminaire manufacturers face is the continuous improvement of lumen output in LEDs. As the LEDs' efficacy increases, the lumen output of the fixtures also increases. Although the same fixture is being sold, the overall lumen output of the fixture increases once a new version of an LED is used. This leaves a mismatch with previous product of lower lumen output and newer product with increased lumen output.

With Fulham's programmable output drivers, the driver can be set to a lower current to offset the difference in light output. With this ability, the manufacturer can offer a product rated for a certain lumen output without any engineering changes even when using the latest LEDs with higher lumens per watt. This helps prevent the common problem of mismatched fixtures in the field when higher lumen fixtures have been installed alongside existing lower output fixtures.

One example of this scenario is when the LED module manufacturer changes their LEDs to a newer, more efficient version. Although no physical change to the LED module has occurred, it becomes noticeably brighter. With the ability to program down the current we can ensure the system keeps the same lumen output.

The table below shows an example of how to calculate new current settings based on the improvements of the LEDs, i.e. the lumens per watt of the LED.

Luminaire System Rating (lm)	Existing LED Module Current (mA)	Existing LED Specifications (lm/w)	New LED Specifications (lm/w)	Existing LED Power	New LED Power	New LED Module Current (mA)
1500lm	350mA	130 lm/w	150 lm/w	11.5W	10.0W	304mA

**** To maintain the same lumen output of the luminaire by reducing output current when higher efficacy LED's are used; the first calculation is to divide the output lumen rating of the luminaire (1500lm) by the new lm/w rating (150lm/w) of the new LED's (1500lm / 150lm/w = 10W). This will give you the new LED power (10W). To determine the new LED current, you will then divide the new LED power (10W) by the product of original LED power (11.5W) divided by the original module current (350mA). This product (10W / 11.5W/350mA = 304mA) will be the new LED module current (304mA).***

Log File Recording:

This feature allows for easy maintainability and tracking of product setting during luminaire assembly. Specifically, at which point the unit was programmed and to what specification, allowing for future replacements to be easily managed. This lets an OEM know what a specific driver was programmed to in case a field replacement is needed.

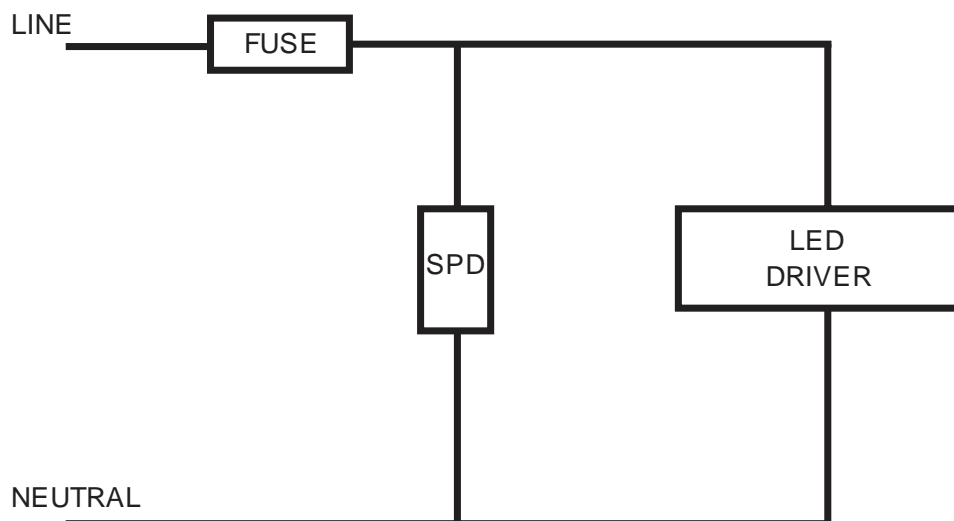
Features



Surge Protection:

The drivers have a level of surge protection built in to them, for actual surge ratings please refer to each driver's specification sheet. A driver specification of kV means that the driver has been tested to withstand this voltage of line transient. The drivers themselves are tested for all line coupling modes (Line (L) to Neutral (N), Line (L) to Protection Line (PE), Neutral (N) to Protection Line (PE) and Line (L)/Neutral (N) to Protection Line (PE)) ensuring their rating of line voltage transient.

It is recommended to wire a series connected Surge Protection Device (SPD) in high risk applications or when higher surge ratings are required/needed. The Luminaire manufacturer should design into their fixtures sufficient surge protection to meet the specific category of Energy Star/ANSI requirement as needed.



Above shows a series wired Surge Protection Device (SPD).

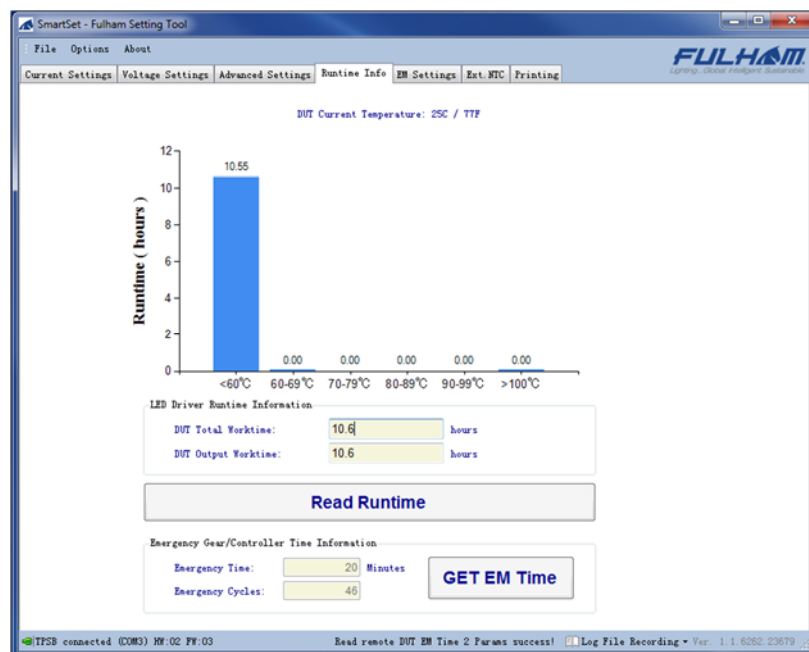
Features



Read Runtime/GET EM Time:

This feature allows reading of the operating hours as well as their corresponding temperatures during times of use. Through the software interface under the “Runtime Info” tab this information can be generated by directly reading the runtime information from the driver. Please note that this feature is enabled only on applicable drivers.

With the GET EM Time feature found under the “Runtime Info” tab you can read the emergency runtimes and cycles for Emergency drivers with this feature.



Pictured above is an example of the Read Runtime and GET EM time information read from the driver.

Features



Programmable Emergency Output (Constant Power / Constant Current):

All drivers come programmed to a setting of "0" or RSET. Under this default the Constant Power emergency driver will output the maximum power rating of the battery and achieve the minimum 90 minutes of operation. By default, the Constant Current emergency driver will output the rated current of the output harness used. They will also never exceed the max power rating of the battery used, this is done to ensure they achieve the minimum 90 minutes of operation.

The output power/current can be set in several ways, all of which are accessed by using the input connections labeled **PRG + -** on the emergency driver.

There are three methods for programming/setting the output power/current. The TPSB-100/E setting controller allows users to program the desired output power/current of the EM driver. Advanced programming can also be done through a PC using the Setting Tool software available at www.fulham.com.

Adjusting EM Output Power (3 Methods):

1. RSET/Default Mode
 - Plugging in an appropriate battery which will yield the max output of the battery. The driver will check which battery is plugged in and output its max power rating. Please note that the EM driver is in RSET mode by default, with no additional programming needed, if the output is subsequently changed the driver must be reprogrammed to "0" W with the TPSB-100/E setting Controller or the Setting Tool software to return to RSET/Default mode.
2. Setting Tool Software
 - Please refer to the "Programming" section of this document for further instructions.
3. Setting Controller
 - Please refer to the "Programming" section of this document for further instructions.

Adjusting EM Output Current (3 Methods):

1. RSET/Default Mode
 - Plugging in an appropriate output harness on supporting drivers. The driver will check the value of RSET and output the current corresponding to the resistor value. Please note that the driver is in RSET mode by default, with no additional programming needed, if the output is subsequently changed the driver must be reprogrammed to "0" mA with the TPSB-100/E setting Controller or the Setting Tool software to return to RSET mode. The harness value will only be relevant if in RSET.
2. Setting Tool Software
 - Please refer to the "Programming" section of this document for further instructions.
3. Setting Controller
 - Please refer to the TPSB-100/E User Manual or the "Programming" section of this document for further instructions.

**** Only the latest CEC versions of the FHS2 products will have the capability of programmable Emergency Output.***

Programming



TPSB-100/E:

The handheld Setting Controller is designed for configuring the parameters of the Fulham LED drivers either as a standalone option or when paired with the Setting Tool Software. For further details please refer to the User Manual or the TPSB-100/E section of this document.

TPSB-100/E – Contents:



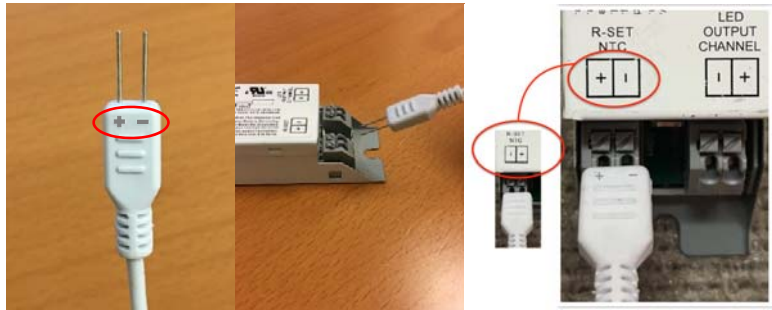
The above pictured are the contents of what comes inside the box along with the TPSB-100/E handheld Setting Controller.

*** The TPSB-100E power supply is not shown.**

Programming

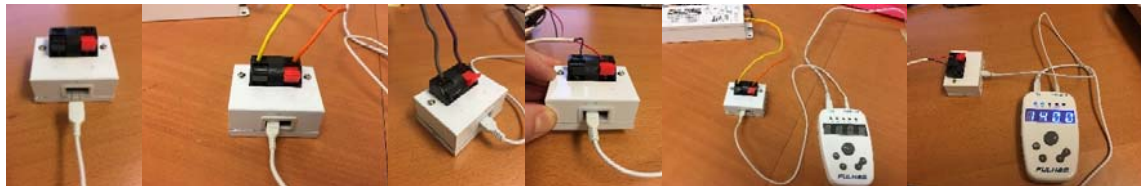


TPSB-100/E – Making the Connection:



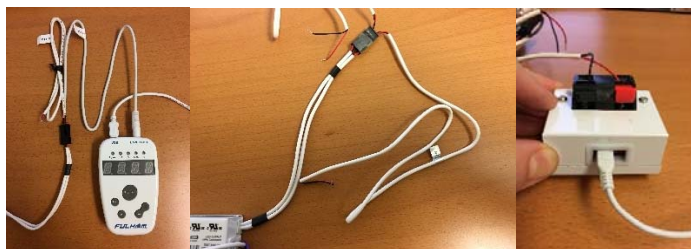
Programmable drivers with push in connectors can be programmed using either the larger or smaller pitch fork cables. Simply insert the forks directly into the connectors labeled **R-SET/PRG/NTC**, ensure that proper polarity is established otherwise an error code will be displayed.

** Refer to the TPSB-100/E User Manual for further details on error codes.*



Programmable drivers with wires can be programmed using the wire block adapter. Insert either the larger or smaller pitched fork cable into the back of the adapter. Ensure that proper polarity is established. Next insert the wires labeled **R-SET/PRG/NTC** into the Red (+) and Black (-) quick release connectors located on the top of the adapter. The polarity of the programming wires are as follows; Orange Wire (+), Yellow wire (-), Purple Wire (+), Grey Wire (-), Red Wire (+), Black Wire (-).

**Applicable drivers will use the 0-10V dimming wires as the programming wires. If programmed while powered, a power cycle is required for the programmed current to take effect.*



Programmable drivers with connectors on their output can be programmed using the mating connector cable. If the drivers mating output harness is plugged in, then they can be programmed using the wires labeled **R-SET/PRG/NTC** by plugging them into the Red (+) and Black (-) quick release connectors located on the top of the wire block adapter. The polarity of the program wires are as follows; Orange Wire (+), Yellow wire (-), Purple Wire (+), Grey Wire (-), Red Wire (+), Black Wire (-).

Programming



TPSB-100/E – Simple Mode:



When first powered up the Setting Controller defaults to Simple Mode and will toggle a display of “SIMP” / “MODE”. While in simple mode the parameters you can program are limited to either “ISET” (Current) or “VSET” (Voltage). Pressing the “M” button will allow you to cycle through the programming options of either voltage or current.

** As of September 2017, only Constant Current programmable drivers are available/compatible.*

TPSB-100/E – Simple Mode – Reading:



Pressing the “READ” button will allow reading of the programmed parameters for either “ISET” (Current) or “VSET” (Voltage). After pressing the read button, the screen will display the value that is currently programmed to the driver followed by “R – I” (Current Read) displayed on the screen.

TPSB-100/E – Simple Mode – Programming:



To program a Current or Voltage (“ISET” or “VSET” must be selected), use the “+”/“-” buttons to dial in the appropriate value, then press the “PROGRAM” button. If successful, the display will flash “OK” followed by the programmed current. If needed you can verify that the current has been set by re-reading the value, which can be done by again pressing the “READ” button (Refer to “TPSB-100/E - Simple Mode - Reading”).

Programming



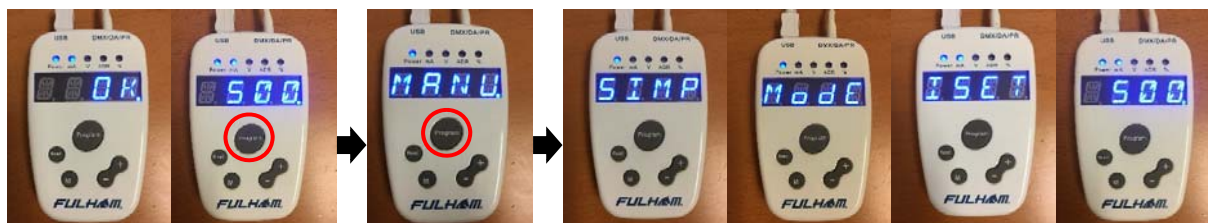
TPSB-100/E – Simple Mode – Auto Programming:



When programming multiple units of the same value under Simple Mode, the Auto Program feature simplifies the programming process. To start using this feature first dial in the appropriate value using the “+”/“-” buttons, then press and hold the **“PROGRAM”** button. When you see **“AUTO”** displayed on the screen, immediately press the **“PROGRAM”** button three times. If successful, **“CHECK.”** will flash followed by **“OK.”** and the programmed current being display on the screen. From this point forward you will not need to press the program button. Simply plug in the next unit and it will automatically program. While in Auto Program all other buttons will be disabled.

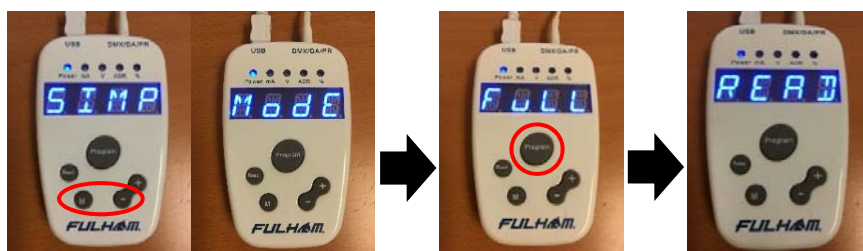
** The Auto Program feature can also be accessed while under Advance/Full mode. There, more programming options are available and can all be programmed at once.*

TPSB-100/E – Simple Mode – Exit Auto Programming:



To exit the auto program feature press and hold the **“PROGRAM”** button. When you see **“MANU.”** displayed on the screen, immediately press the **“PROGRAM”** button three times. **“SIMP”/“MODE”** will quickly flash on the screen followed by either **“ISET”** or **“VSET”** and its value being displayed on the screen.

TPSB-100/E – Advance/Full Mode:



Under **“FULL MODE”** you will be able access advance features. To enter full mode press and hold the **“M”** and **“-”** buttons simultaneously until the screen flashes **“FULL”/ “MODE”**, immediately press the **“PROGRAM”** button three times. The screen will display **“READ”** indicating that it’s reading the advance parameters of the driver.

Programming



TPSB-100/E – Advance/Full Mode – Emergency Power:



While in **"FULL MODE"** applicable drivers will have the ability to program emergency power. Use the **"M"** button to cycle through the various programming options. Once **"EPOW"** is displayed use the **"+"**/**"-"** buttons to dial in the appropriate value, then press the **"PROGRAM"** button. The screen will flash **"OK"** indicating the desired power has been programmed.

TPSB-100/E – Advance/Full Mode – Self-Diagnostics:



While in **"FULL MODE"** applicable drivers will have the ability to enable or disable the Self-Diagnostic feature. Use the **"M"** button to cycle through the various programming options. Once **"SELD"** is displayed use the **"+"**/**"-"** buttons to dial in either **"EN"** (Enable Self-Diagnostics) or **"DIS"** (Disable Self-Diagnostics), then press the **"PROGRAM"** button. The screen will flash **"OK"** indicating the desired option has been programmed.

TPSB-100/E – Advance/Full Mode - Setting Dim Profile:

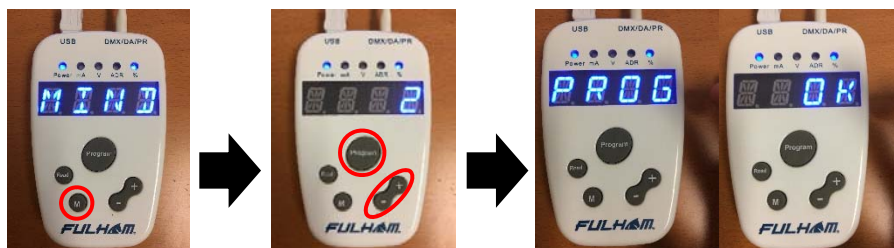


While in **"FULL MODE"** applicable drivers will have the ability to change the dimming profile to either Linear **"LINR"**, Logarithmic **"LOG"**, Custom **"CUST"** or Pulse **"PULS"**. Use the **"M"** button to cycle through the various programming options. Once **"CURV"** is displayed use the **"+"**/**"-"** buttons to dial in the appropriate dim profile, then press the **"PROGRAM"** button. The screen will flash **"PROG"**/**"OK"** indicating the desired profile has been programmed.

Programming



TPSB-100/E – Advance/Full Mode – Minimum Dim Level:



While in “**FULL MODE**” applicable drivers will have the ability to change the minimum dim level percentage. Use the “**M**” button to cycle through the various programming options. Once “**MIND**” is displayed use the “**+**”/”**-**” buttons to dial in the appropriate percentage, then press the “**PROGRAM**” button. The screen will flash “**PROG**”/”**OK**” indicating the desired profile has been programmed.

** Currently the only way to disable dim-to-off on applicable drivers is through the PC Software.*

TPSB-100/E – Advance/Full Mode – Enable Pulse Dimming:

Currently the only programmable model with the Pulse Dim option is the FHSAC1-UNV-45CE. This driver has the 0-10V dimming protocol set by default.

To enable the Pulse Dim option the driver must be programmed using the TPSB-100/E setting controller.



First the setting controller must be in “**FULL MODE**” to access the advance features. To enter full mode press and hold the “**M**” and “**-**” buttons simultaneously until the screen flashes “**FULL MODE**”, immediately after press the “**Program**” button three times. The screen will display “**READ**” indicating that it’s reading the advance parameters of the driver.

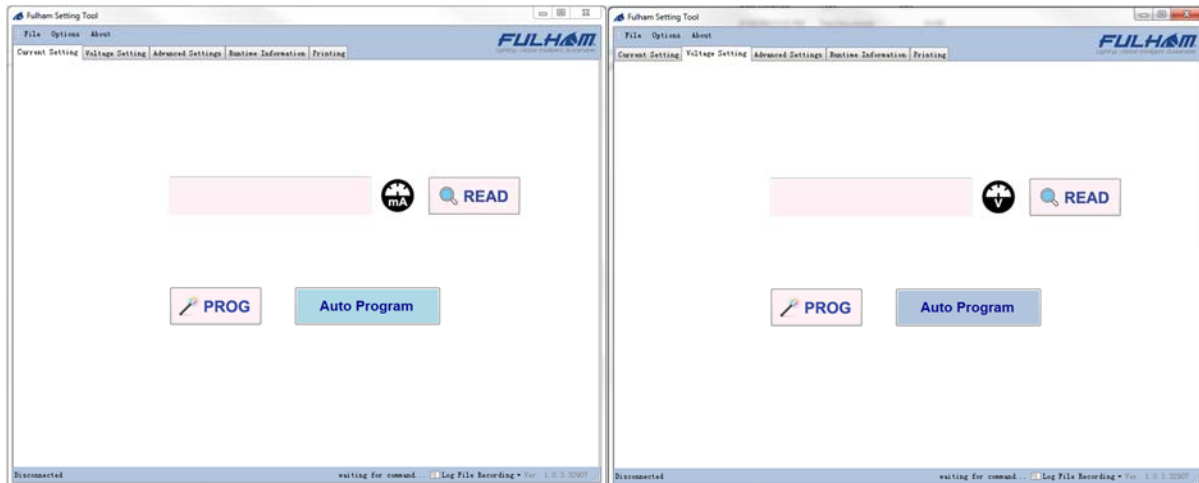


While in full mode, use the “**M**” button to cycle through the menu options until the “**CURV**” option is displayed. Next use the “**+**”/”**-**” buttons to select the “**PULS**” option then press the “**PROGRAM**” button, “**OK**” will flash on the screen indicating the Pulse Dim protocol has now been set on the driver.

Programming



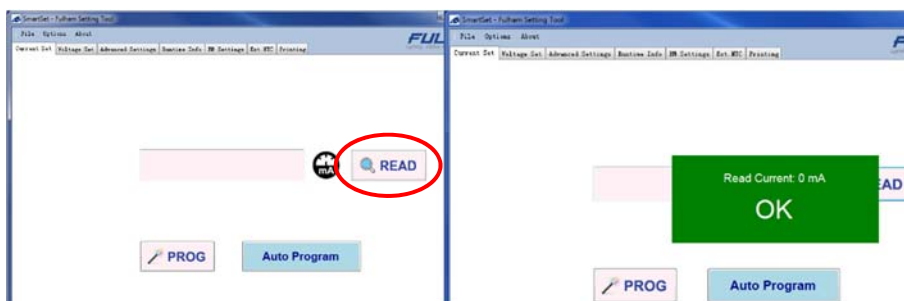
Setting Tool Software - Current and Voltage:



Using either the Voltage or Current tab in the Setting Tool interface the user can easily input the desired values. Depending on the driver, for a constant current application the user can program the desired output current dependent on the minimum and maximum current settings of the driver (refer to the specification sheet of driver for further information).

The same will apply to a constant voltage application in which a user can set a static output voltage depending on the limitations of the driver. With constant voltage, the current will be determined by the maximum allowable output current of the driver (for example a driver set to a 24V output would have its maximum current set to the maximum allowable current of the driver not to exceed its total maximum power).

Setting Tool Software – Reading Current or Voltage:



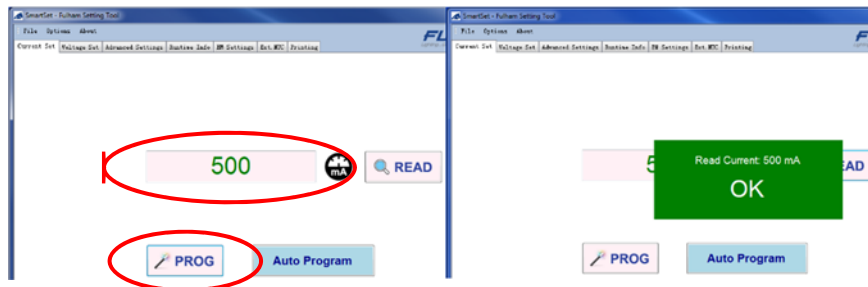
The above shows the “READ” function in the software which is used to determine what current the driver is programmed to.

*** As of September 2017, only Constant Current programmable drivers are available/compatible.**

Programming



Setting Tool Software – Programming Current or Voltage:



The above shows the “PROGRAM” function in the software which is used to set an appropriate output current on the driver. This can be used for single or small batch programming. After typing in the appropriate current select the “PROG” button to program/set the drivers output current.

Setting Tool Software - Auto Programming:

This feature will automatically program current or voltage to multiple units while leaving all other settings unchanged once the programming port / leads are connected to the TPSB-100/E. The software keeps a count of the number of drivers programmed.



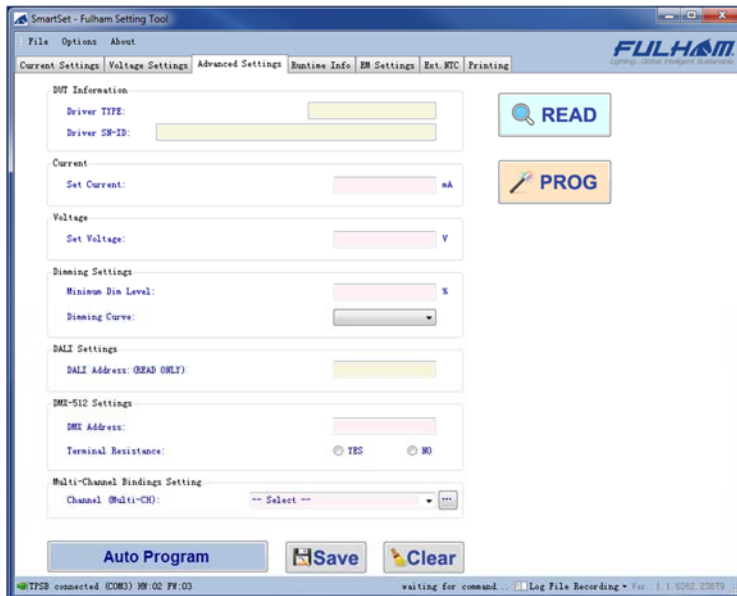
The above shows the “Auto Program” function in the software. This can be used for large batch programming of drivers that will have the same programmed current. After each program, all that is needed is to insert / connect to the port / leads of the TPSB-100/E. The software will keep a count of the number of drivers programmed. To stop the auto programming simply press the “Stop Auto” button.

Programming



Setting Tool Software - Advance Settings:

The Advanced Settings tab of the programming software includes additional options and settings. Information that is currently saved to the driver such as; General Product Information, Current/Voltage settings, Dim settings, DALI Settings, DMX-512 Settings, and Multi-Channel Binding settings when applicable are displayed here. Custom profiles can also be saved, for use when programming different configurations in high volumes.

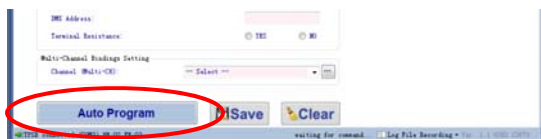


The Advanced Setting tab also gives the user the ability to set different parameters, such as dim levels, dimming curves (linear, logarithmic or custom), and DMX settings, and even to group multiple channels on supporting drivers.

The minimum Dim level is important for applications in which the 0-10V dimming leads are connected to a normally closed contact of an occupancy sensor. For applications that require 24/7 illumination, such as stairwells, the user could set a dim level of 50% when no occupancy is detected and up to 100% when occupancy is detected.

**** As of September 2017, no programmable DMX drivers are available and certain DALI features may be unavailable.***

Setting Tool Software - Advanced Settings - Auto Programming:

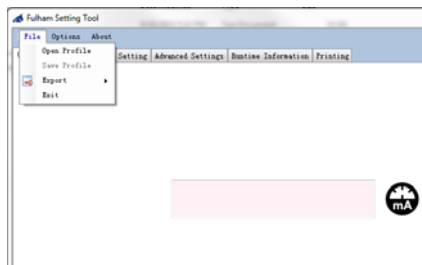


With this feature, auto programming of the advanced settings is done once the programming port / leads are connected to the TPSB-100/E. All the units are set to the appropriate current, and all settings from the Advanced Settings tab are transmitted to every unit. A count of the number of drivers that have been programmed is kept.

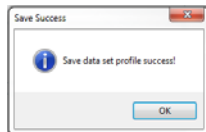
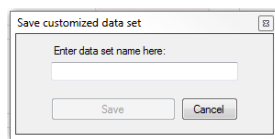
Programming



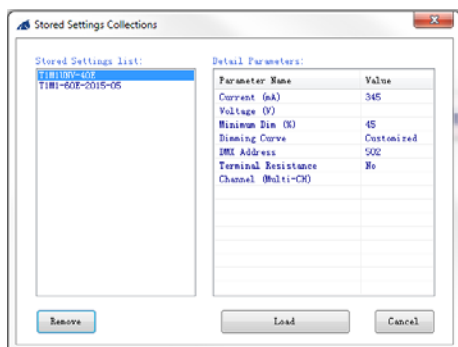
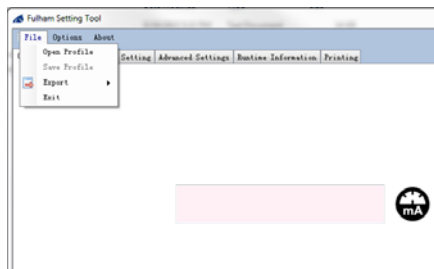
Setting Tool Software - Advanced Settings - Loading Profiles:



Under the File pulldown menu, the user can access the “Open Profile” or “Save Profile” options. Once a driver has been programmed to the setting needed, the profile can be saved for later access to program more drivers to these specific settings.



The above windows will pop up. One will prompt the user to assign a name to the profile and another will confirm the file has been saved.

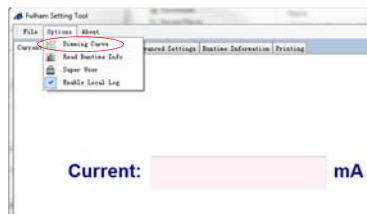


When opening a profile, the user navigates to the File pulldown menu and selects Open Profile. Next, a window will pop up showing all saved profiles. From this list, one can select a profile and it will load the previously saved settings.

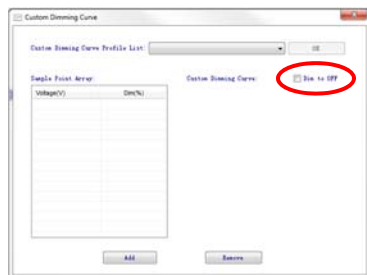
Programming



Setting Tool Software - Custom Dimming Curve:

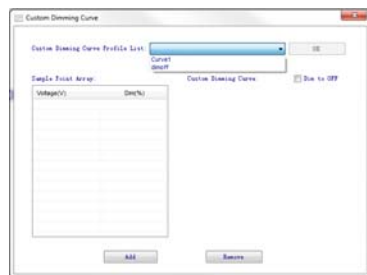


Under the Options setting the user can select the Dimming Curve option in the dropdown menu. This option allows the creation of a custom dimming curve. The user can then select certain minimum and maximum levels to dim to, as well as enable/disable dim to off.

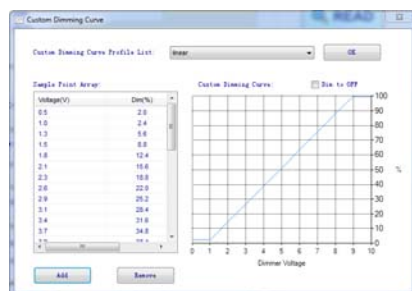


The dim to off feature allows you to dim down below a certain point where the driver turns off and then turns back on once you've got back up past that point.

****To disable the dim-to-off feature a custom dim curve must be loaded with the "Dim to OFF" box un-checked.***



The software will generate a dimming curve based on the input set by either selecting one of the custom dimming curve profiles in the pulldown menu or entering the voltage with dimming percentage on the table to the left. A minimum of 2 points are required to generate a custom dimming curve. This allows Fulham's programmable driver to match the dimming curve of other driver suppliers.



The image above shows a plot of what the dimming curve looks like and the breakdown of the voltage assigned to the percentage of dimming.

Programming



Setting Tool Software - NTC:

With this thermal feedback feature the driver can regulate power to the LED module or modules during times of excess temperatures. This helps protect the LED's themselves by ensuring that temperatures do not exceed those of what is deemed appropriate by the manufacturer. The NTC (Negative Thermal Coefficient resistor) is usually placed on the LED module itself and is connected to either the yellow and orange wires or connections labeled "NTC" on the drivers.

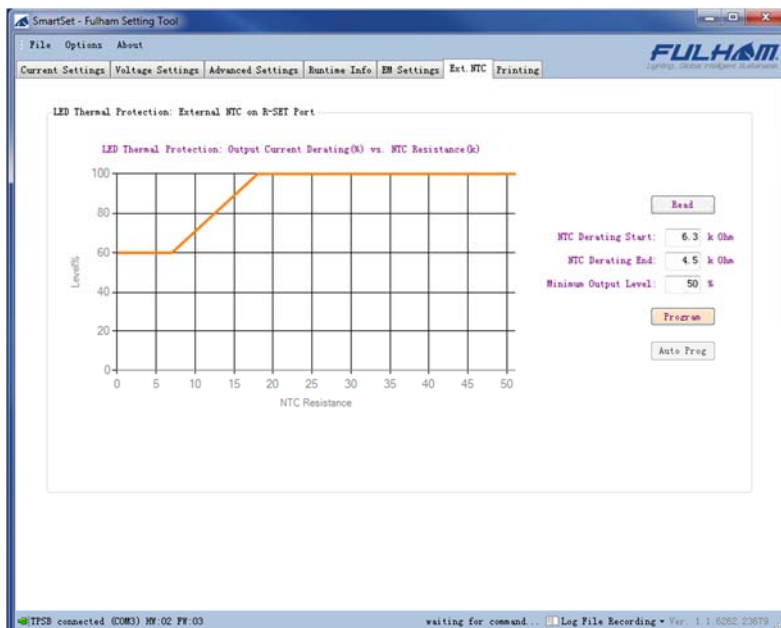
Using the recommended NTC the derating profile is available on the drivers corresponding specification sheet.

Recommended NTC: Thinking Electronic – TSM2A204 – SMD0805

Thinking Electronic – TSM2A204											
Temperature	0°C	25°C	50°C	60°C	70°C	80°C	90°C	100°C	110°C	120°C	130°C
Resistance	650.0kΩ	200.0kΩ	70.0kΩ	47.0kΩ	33.0kΩ	25.0kΩ	10.8kΩ	10.2kΩ	9.5kΩ	7.0kΩ	5.3kΩ

When another NTC is used one can simply program a custom derating curve by entering the start and end of the curve as well as the minimum output power level. This can all be achieved by using the Fulham SmartSet software interface. Please note that the programmable derating resistance for the LED driver is from 1k to 51k ohms.

Please note that when the RSET feature is used the drivers NTC feature is disabled. This means RSET and NTC cannot be used at the same time. If the RSET/NTC wires are not used, then you can simply can cut off each wire individually.

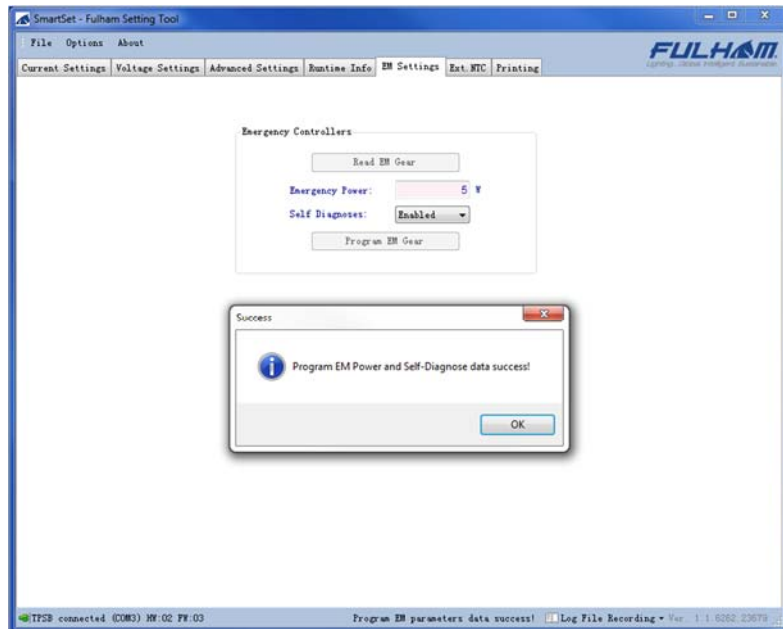


The image above shows what the NTC derating curve will look like once it has been programmed/calibrated.

Programming



Setting Tool Software - EM Settings:



Under the EM Settings tab for applicable products you will be able to read existing emergency characteristics as well as program additional emergency features. Such features as setting/programming the emergency power, as well as the ability to Enable/Disable Self-Diagnostics.



DALI Dimming:

DALI dimming drivers comply with IEC #62386.

0-10V Dimming:

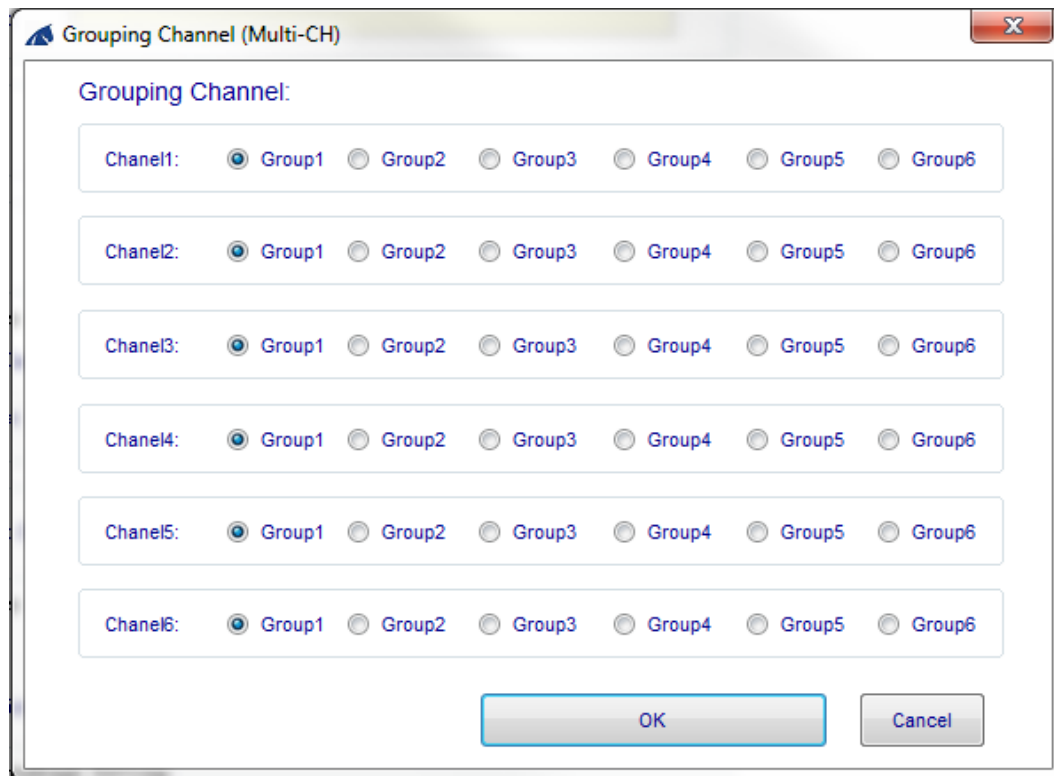
Can work with sink type dimmers and control systems that can do both sink and source.

Pulse Dimming:

Momentary push button switch, when pushed and held can dim up/down. Quick push to turn on/off. Option available on select models and must be enabled using TPSB-100/E or through Setting Tool software.

DMX Dimming:

DMX dimming drivers comply with DMX512 standard.



With DMX drivers, users will have the ability to group different output channels together.

HotSpot Plus



LED Driver and Emergency:

Fulham's new HotSpot Plus driver gives the flexibility of having both a stand-alone driver and emergency backup system in one. While in normal operating mode the driver is fully programmable, dependent to the minimum and maximum current/power constraints.

The FHSAC1-UNV-40BLS/C/L is a programmable 40W normal driver that has two mode options for emergency operation: 5W for 180 minutes or 10W for 90 minutes. It also has a self-diagnostics feature built in which can be enabled or disabled via dip-switch.

The FHSAC1-230-45CE is a programmable 45W normal driver that has a programmable emergency output of 1W - 6W pf either 180 minutes when set for 1W to 3w or 90 minutes when set.

This allows for fixture manufactures to provide one unit to do both run-times while still meeting minimum emergency light output requirements. It also comes equipped with self-diagnostic as a standard option.

By incorporating both the normal LED driver and Emergency LED driver into a single unit, Fulham can provide a driver with the smallest package possible. This enables a new era of luminaire designs with emergency capabilities.