

INTRODUCTION

Meso 50W LED Driver is an intelligent and flexible device, designed for fast and easy configuration. This Application Note provides technical information on how to realize an efficient and cost effective Over Temperature Protection of the LEDs driven by Meso50, and shows also how to dim linearly the output current with a 0-10 V or 1-10 V external dimming signal, or with a push/step dimmer device.

LED OVER TEMPERATURE PROTECTION OPERATION PRINCIPLES

Meso50 includes a dedicated input (NTC) to realize LEDs Over Temperature protection. If is not necessary to adopt this protection, please notice that the Meso50 Thermal sense input pin (NTC) can be left unconnected and this function will be not used. Basically the thermal protection uses a Negative Temperature Coefficient thermistor (NTC) mounted on the LED PCB assembly, or in thermal contact with the LED module, to monitor the LED temperature. While operating, the LED temperature will increase up to the nominal operating temperature. The Meso50 driver will monitor continuously the resistance of the NTC thermistor, that is correlated to the LED temperature, thus verifying the correct operation of the LED assembly. If the LED temperature increases, the resistor of the NTC thermistor will decrease: MESO50 can start to reduce the output current to keep the temperature on the LED assembly nearly constant to the maximum operating temperature chosen for that specific LED assembly. Selecting the right NTC thermistor value, will set the maximum operating temperature for the LED assembly.

SMD E NON-SMD NTC THERMISTORS

There are many NTC thermistors with various technologies/case size available in the market and produced by several manufacturers (Epcos, Vishay, Murata, AVX and others).

The most common NTCs used in LED Lighting are SMD devices (see Figure 1). This kind of NTC can be quickly mounted during the SMD assembling phase and it is available with different sizes (0805, 1206, 0603 and others).

Of course if LEDs are placed into the LED Board through the SMD process (e.g. LEDs produced by Lumileds, CREE, Osram, Seoul, Nichia etc.), then the right choice for the NTC is a SMD Thermal Sensor.



Figure 1: SMD NTC thermistor



Figure 2: Ring lug NTC thermistor

Nevertheless, some LEDs (e.g. Multichip LEDs) produced by Manufactures like Bridgelux, Citizen, Xicato etc., are designed to be mounted directly on the heatsink fixing them by the use of screws. In this case the SMD assembling phase is not present in the LED Board production process and a LUG NTC (see Figure 2) can be easily adopted because it is assembled as a probe, in order to be assembled on the LED's heatsink by using a screw.

For best performance, the NTC sensing thermistor should be located close to LEDs or in the hot spot of the LED Board, if any.

CURRENT REDUCTION VERSUS THE RESISTANCE VALUE

When the temperature increases over a certain limit, the NTC thermistor mounted on the LED Board measures the Temperature of the mounting surface (PCB or heatsink) and the Temperature Sense feature allows to reduce the output current of the Driver. The following graph shows the relationship between the resistance connected to the Temperature Sense input and the corresponding output current reduction, respect to the set-point.

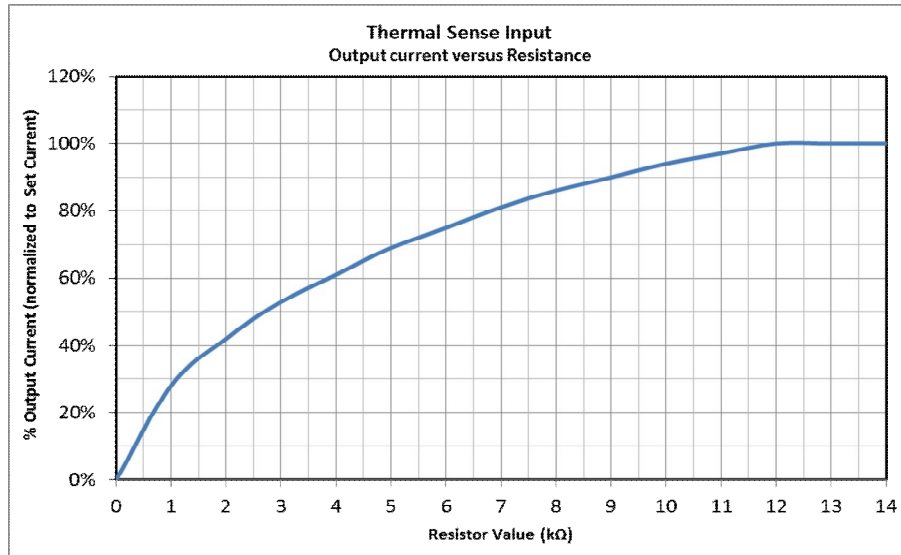


Figure 3: Output Current (%) along Thermistor (NTC) Resistance Value

At normal operating condition (where NTC's resistor is more than about 12 kΩ), the temperature sense input has no effect on the driver output current. This means that the Output Current is equal to the Current Set ($I_{OUT} = 100\% I_{SET}$). As the temperature rises determining a NTC resistor value below 10kΩ-10.5kΩ, the output current of the driver begins to drop resulting in a reduction in the temperature at the LEDs.

In this graphic the current reduction is exclusively due to the Over Temperature Condition and the effect of the Dimming is NOT considered (Dimming = 100%), to avoid to mix the two different current reduction causes.

When the current is reduced due to LED Board Over Temperature condition, many factors, predominately the thermal impedance of the LED heatsink, play a role in determining the ultimate thermal equalization.

According to Figure 3, when the Over Temperature Condition is removed, the Output current comes back gradually to its original Value ($I_{OUT} = 100\% I_{SET}$).

NTC SELECTION

Figure 3 shows that the Output Current reduction starts when the NTC resistance measured by Meso50 is around 10kΩ. This is the key parameter to take in consideration to choose the more appropriate NTC to realize the required Current Reduction behavior.

For example, if the Current Reduction has to start from around 75-80°C, a NTC with 10kΩ-12kΩ @ 80°C has to be chosen. Here below you can find some examples that use SMD NTC devices produced by Epcos; of course, Epcos Codes mentioned are only for a design reference. In fact, different Epcos codes or NTC produced by other manufacturers can be used and the diagram of the Current Reduction Vs NTC Temperature (see Figures 4 and 5) is always obtained starting from Figure 3 and considering the R (T) characteristic of the chosen thermistor.

Meso50 design produces a knee in the output current regulation at approximately 75°C when it operates with the Epcos Code B57471V2104J062 (100kΩ @ 25°C) as shown in Figure 5.

At temperatures less than 75°C, the temperature sense input has no effect on the driver output current ($I_{OUT} = 100\%I_{SET}$); as the NTC temperature rises above 75°C, the output current of the driver begins to drop resulting in LED temperature reduction.

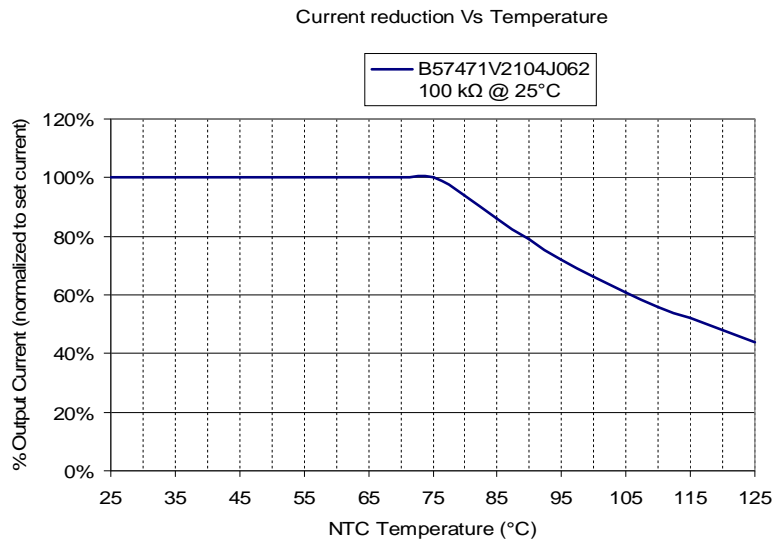


Figure 4: Output Current (%) along NTC Temperature

The graphic represented in Figure 4 refers to the current reduction caused only by the LED Over Temperature protection. The effect of the current reduction due to dimming is excluded (Dimming = 100%).

Of course, the changing of the nominal value of the NTC @25°C (typically this parameter is indicated as R_{25} in the NTC datasheets) generates a different current reduction behavior in particular with a different derating starting point (knee). The following section clears up how to do it.

CHANGING THE CURRENT REDUCTION BEHAVIOUR BY USING A DIFFERENT NTC

If a current reduction with a different knee is required, it can be easily obtained by choosing an NTC with a different nominal resistance value @ 25° C (R_{25}).

The graph depicted in Figure 3 can be used to determine the required resistance characteristics of alternate NTC resistors; the general rule that comes from it is that if a knee at lower temperature is required, then the resistance value @25°C has to be reduced, whereas if a knee with a higher temperature is admitted then the R_{25} value has to be increased.

For example, the Figure 5 shows the different curves depending on different NTC used.

Starting from the NTC used in the Figure 4 (B57471V2104J062 (100k Ω @ 25°C), if a lower maximum PCB temperature is required, an NTC with lower R_{25} has to be used.

For example, the Epcos NTC code B57471V2473J062 (47k Ω @25°C) produces a curve with a knee at around 55°C; the device code B57471V2333J062 (33k Ω @25°C) produces a curve with a knee at around 45°C and so on, as shown in the Figure 5 below.

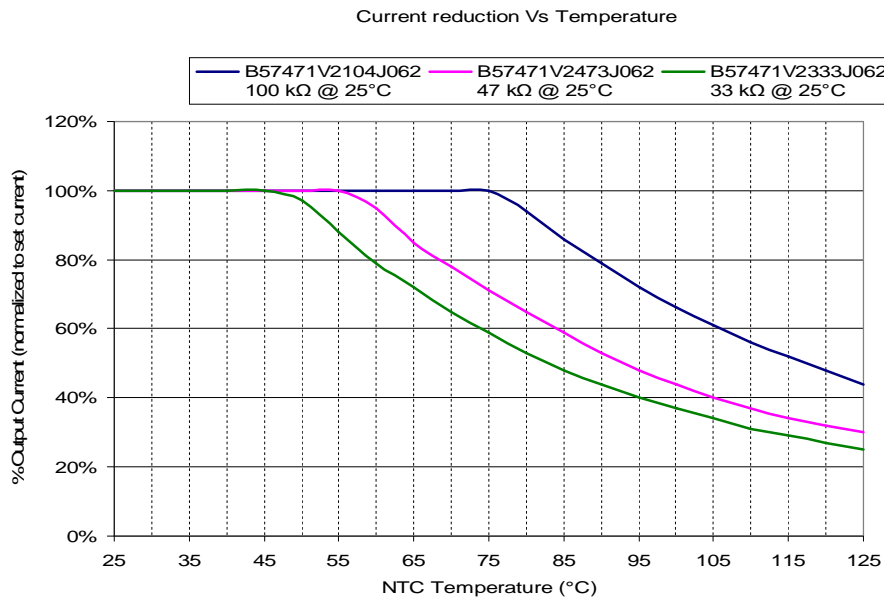


Figure 5: Output Current (%) along Temperature, by using different NTC Thermistors (Epcos)

Generally moving from one code to another to change the R_{25} value, the size case of the NTC can remain the same (in this case a 0805 size has been selected), so that the LED Board layout is not required to be modified.

The graphics showed in the Figure 5 refer to the current reduction caused only by the LED Over Temperature protection. The effect of the current reduction due to dimming is excluded (Dimming = 100%).

All the examples mentioned above use Surface-mount NTC thermistors (Epcos, **Series B574**V2**).

Alternatively, Epcos offers a similar thermistor (**Series B57703M**), specifically designed for Surface temperature measurement, e.g. on housings and heat sinks, with a probe assembly (see Figure 2), useful to measure the temperature close to LEDs in non-SMD applications.

The method explained above that allows to obtain the Current Reduction Vs NTC Temperature diagram (see Figures 4 and 5) is valid regardless of the NTC used.

In the non-SMD applications also the NTCs Series **NTCALUG**, produced by Vishay are designed to be fixed directly to the LED Board heatsink.

0-10V OR 1-10V DIMMING

By controlling the voltage at the dimming input between 1V and 10V the output current of the driver will change linearly from 3% to 100% of the maximum settable current. When the dimmer voltage is set below 1V the driver can have two different, and programmable, behaviours:

- If the 1-10V dimming is selected, the driver will maintain the 3% of the current set even if the dimmer voltage is lower than 1V (down to 0V).
- If the 0-10V dimming is selected, the driver will turn-off the LED, reducing the current to zero, when the dimmer voltage is lower than 1V (down to 0V).

In order to program the desired option, please refer to “AN3_Meso50 Setting” document.

The Dim inputs can be connected in parallel with other Meso50 drivers to enable control of multiple fixtures from a single control point.

The driver includes an internal pull-up; therefore, if no connection is made to the dimming input, the driver will operate at the nominal set point ($I_{OUT} = 100\%I_{SET}$). The external dimming control is not required to inject current into the driver but must be capable of sinking current (about 600uA) provided by the driver at the dimming input connection. If the external dimming control does provide a 0-10V source, it must also be capable of sinking the current from the dimming input.

Figure 6 and 7 will show the output current versus the Voltage at the dimming input when the 1-10V and 0-10V option is programmed. The output current is normalized to 100% of the maximum current (100% means $I_{OUT} = 100\% I_{MAX}$).

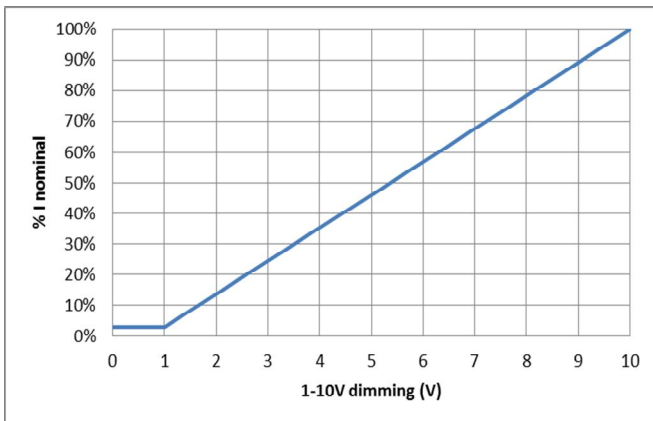


Figure 6: Output Current (%) along dimming input voltage for 1-10V option

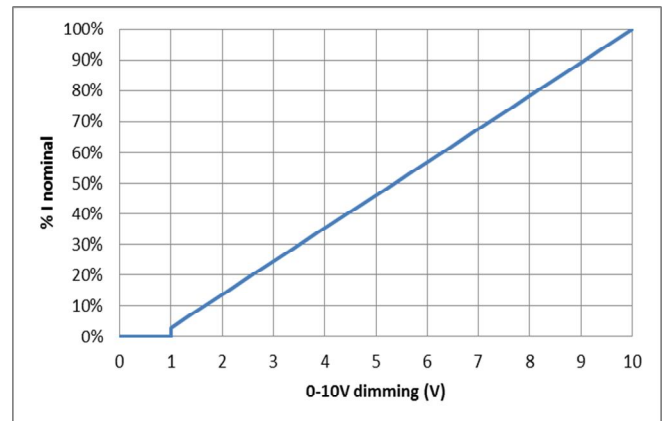


Figure 7: Output Current (%) along dimming input voltage for 0-10V option

PUSH/STEP DIMMING

The Meso50 LED driver can dim the output current of the driver also by using the Push/Step dimmer connector. In order to program the desired option (Push or Step dimming), please refer to "AN3_Meso50 Setting" document.

1. Push dimming

With the term "push dimmer" we are referring to a push button connected between AC Line and Push/Step connector (P.B.) (see "AN1_Meso 50 Wiring Diagram" for details).

This feature allows the user to turn-off/on the unit by using the PUSH dimming button. This button can also be used to change the intensity of the output light (dimming between 3% and 100% of the maximum current).

Here described the actions taken by the PUSH feature when the button is pressed as single shot (short press) or long hold pressure (long press):

Key press	Unit switched OFF (stand-by)	Unit switched ON
Short press (<1s)	Switches the device ON. The device switch On at light level set at switch-OFF.	Switches the device OFF.
Long press (>1s)	-	The devices are dimmed until the button is released. A second long press will dim in the opposite direction.

There is an optional setting for Push Dimming Recovery Status which is only programmable with the Ozone Toolset Software (for details refer to the "UM1_Ozone Toolset Software Manual. This refers the way the driver responds when the AC input is turned on. The factory default setting is "Memory" which will recover to the last setpoint. The alternate setting is "Safe" which recovers with the output off. In this case, a short press of the Push Dimming input is required to turn on the output to the last setpoint.

If more than one device is operated with a single key during PUSH operation, asynchronous behavior can occur, which will require manual resynchronization using the method described (i.e. some lamps will be on, others off or the dimming direction will differ from lamp to lamp).

Method of resynchronization: when the drivers are switched on, press the PUSH key for more than 10 seconds followed with a short press (<1s). Now the devices are switched off, do a long press (>1s), the system will now be synchronized.

It is recommended not to control more than four devices using a single key.

2. Step dimming

With the term "step dimming" we are referring to a switch (ON/OFF) connected between AC Line and Push/Step connector (P.B.) (see "AN1_Meso50 Wiring Diagram" for details).

This feature allows the user to change the output light (set a different current value) by using the STEP dimming button.

When the STEP button is open (OFF) the output of the driver shall be at the set-point. If the STEP button is closed (ON) the output of the drive is reduced to 50% of the set-point.

The step dim level can be programmable from 10% to 90% by using the "Ozone toolset software" (for details refer to the "UM1_Ozone Toolset Software Manual").

CONNECTING OPTIONS

Meso50 LED driver accepts various control options to dim the output current. The recommended connections are shown in the figures below.

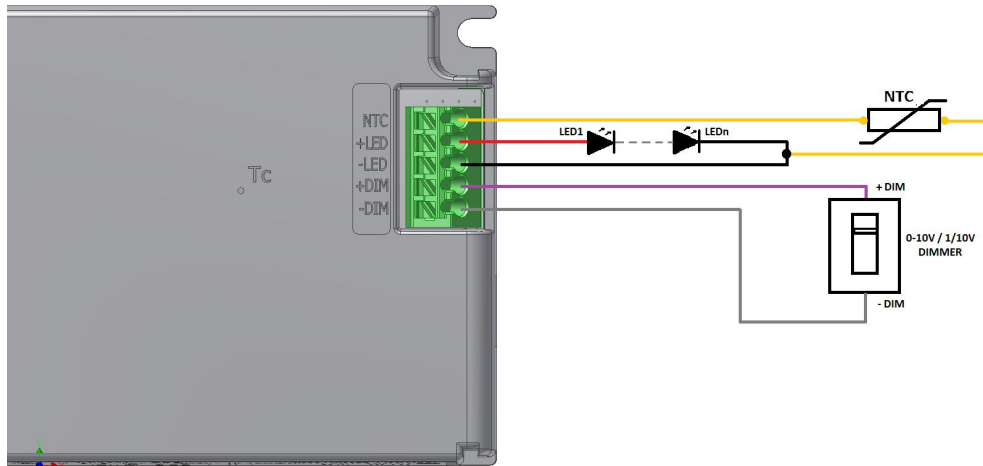


Figure 8: Connection of a 0-10V/1-10V dimmer and NTC

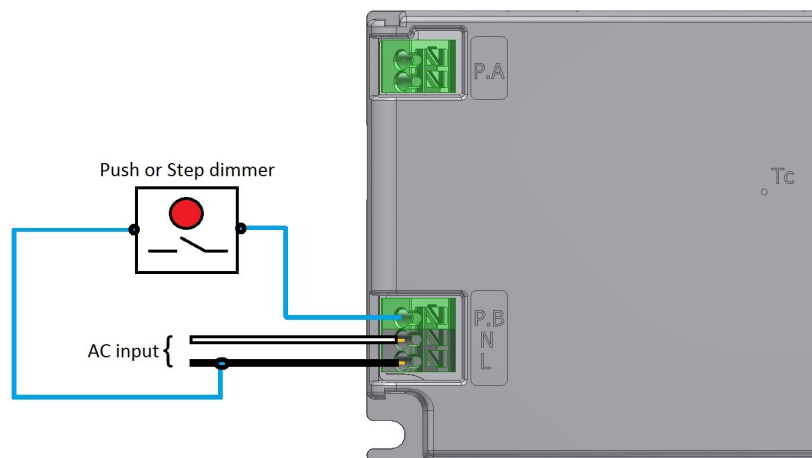


Figure 9: Connection of a Push or Step dimmer

Recommended wires configuration is below:

Cross section	0.2-1.31 mm ²	(24-16 AWG)
Strip length	8.5-9.5 mm	(0.32-0.36 in)

When using a power supply, control equipment/circuitry or similar device, care must be taken to ensure the equipment is isolated from the AC power source. If the dimming connections are to be wired as a Class 2 circuit, all connected equipment must have the appropriate safety approvals for Class 2 circuits.

When connecting multiple drivers to a single control device, it must be appropriately rated and capable of sinking 600uA of current from each connected driver. As the number of drivers increase, the dimming performance characteristics may change due to the increased current into the dimming control circuitry (depending on the characteristics of the external circuit).

The length of the dimming circuit wiring, wire size and the number of drivers connected to the dimming control must be designed so that the total voltage drop is less than 0.2-0.3V between the drivers and the dimming control.

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