INTRODUCTION

Meso LED Driver is a digital and intelligent Single Channel LED Driver.

This Application Note provides technical information on how to realize an efficient and cost effective Over Temperature Protection of the LEDs driven by Meso, and shows also how to dim linearly the output current with a 0-10V or 1-10V external dimming signal. The inputs may also be used to trim the output set current to a lower value than the rated current.

LED OVER TEMPERATURE PROTECTION OPERATION PRINCIPLES

Meso includes a dedicated input (Ts) to realize LEDs Over Temperature protection.

If is not necessary to adopt this protection, please notice that the Meso Thermal sense input pin (Ts) can be leaved 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 Meso 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 resistance of the NTC thermistor will decrease: MESO 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 & 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.

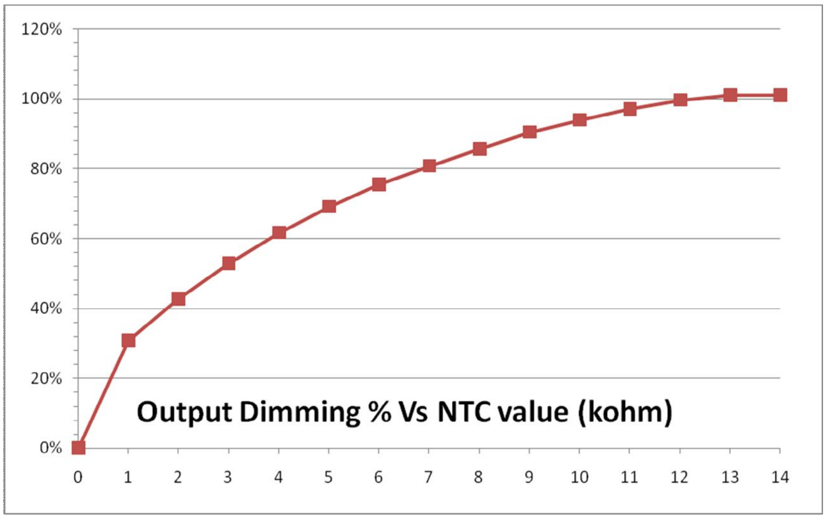


Figure 3: Output Current (%) along Thermistor (NTC) Resistance Value

At normal operating condition (where NTC's resistance is above 12kΩ), the temperature sense input has no effect on the driver output current. This means that the Output Current is equal to the Current Set (Iout=100% Iset). As the temperature rises determining a NTC resistance 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 (Iout=100% Iset).

Figure 3 shows that the Output Current reduction starts when the NTC resistance measured by Meso is around 10kΩ. This is the key parameter to take in consideration to choose the more appropriate NTC to realize the required Current Reduction behaviour.
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 form Figure 3 and considering the R(T) characteristic of the chosen thermistor.
Meso 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 (Iout=100%Iset); as the NTC temperature rises above 75°C, the output current of the driver begins to drop resulting in LED temperature reduction.

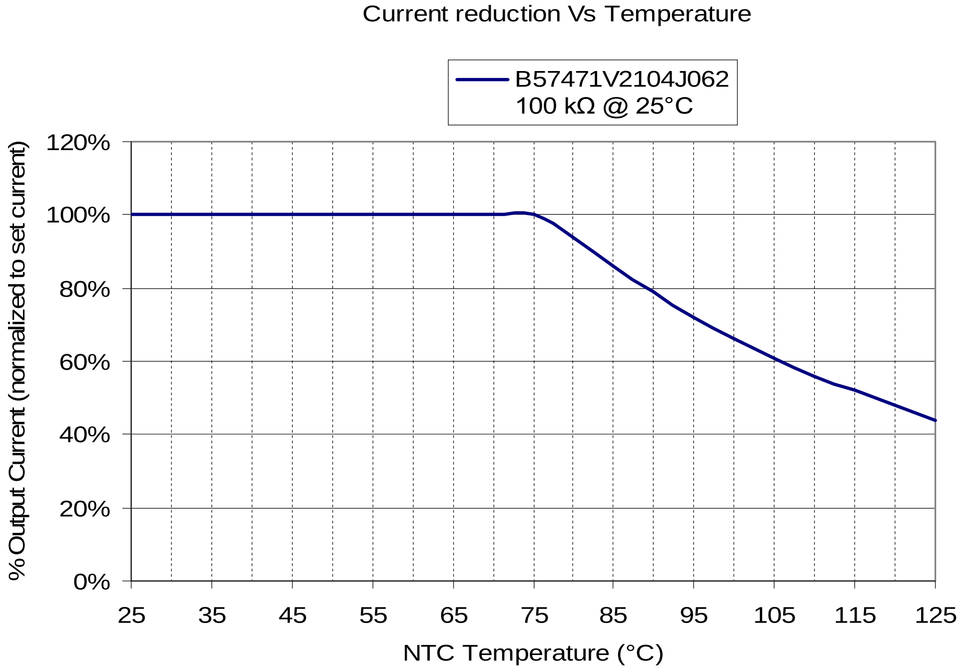


Figure 4: Output Current (%) along NTC Temperature

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 behaviour 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 a 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 (100kΩ @ 25°C), if a lower maximum PCB temperature is required, a NTC with lower R_{25} has to be used.

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

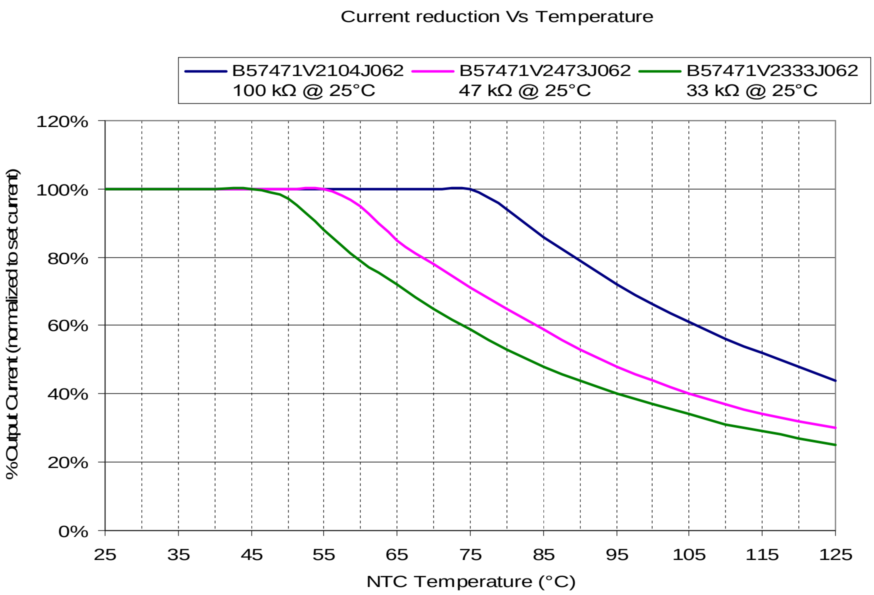


Figure 5: Output Current (%) along Temperature, by using different NTC Thermistors (Epcos)

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 6 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 10% to 100% of the current set (Iset). When the dimmer voltage is set below 1V the driver can have two different, and programmable, behaviors:

- If the 1-10V dimming is selected, the driver will maintain the 10% 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_Meso Setting” document.
The Dim inputs can be connected in parallel with other Meso 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 (Iout=100%Iset). 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 is a graph showing the output current versus the Voltage at the dimming input when the 1-10V option is programmed. The output current is normalized to 100% of the current set (100% means Iout=100% Iset).

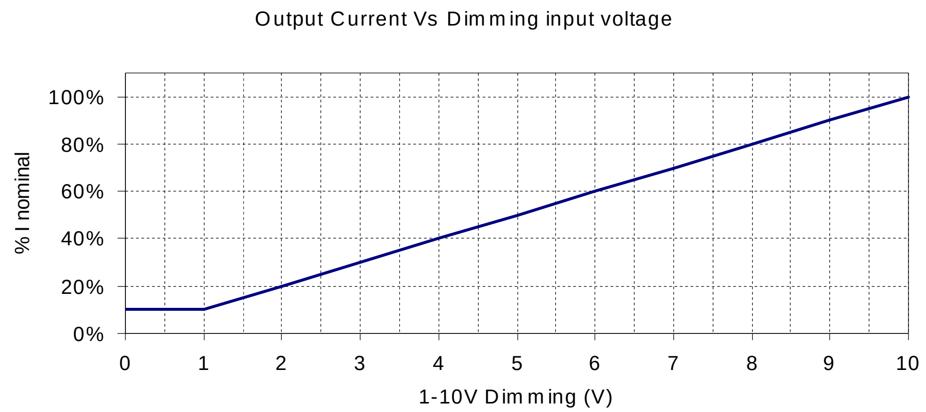


Figure 6: Output Current (%) along dimming input voltage

Figure 7 is a graph showing the output current versus the Voltage at the dimming input when the 0-10V option is programmed. The output current is normalized to 100% of the current set (100% means Iout=100% Iset).

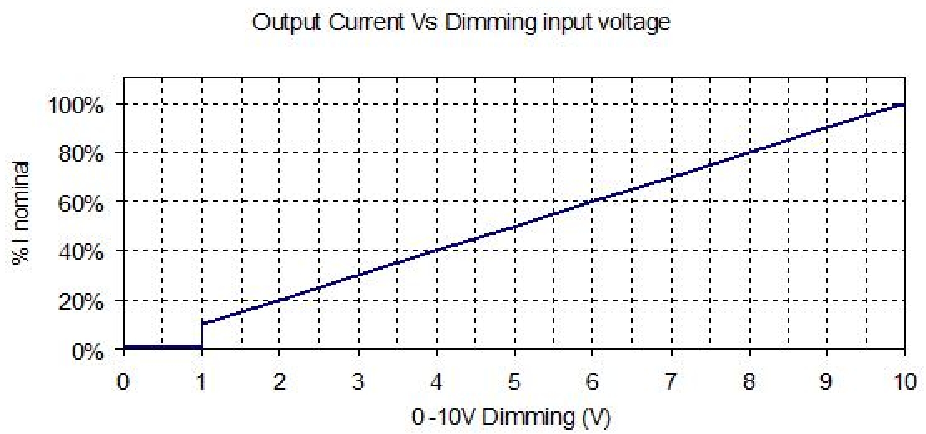


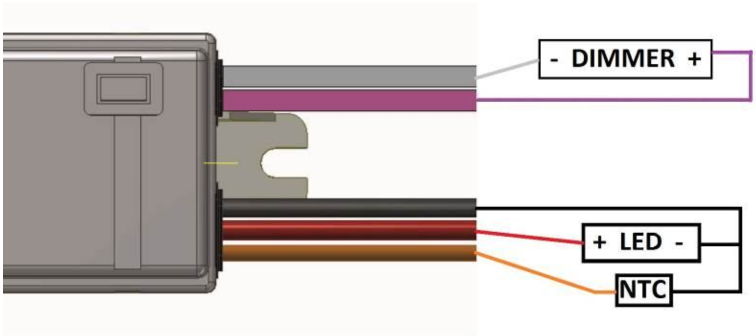
Figure 7: Output Current (%) along dimming input voltage

CONNECTING OPTIONS

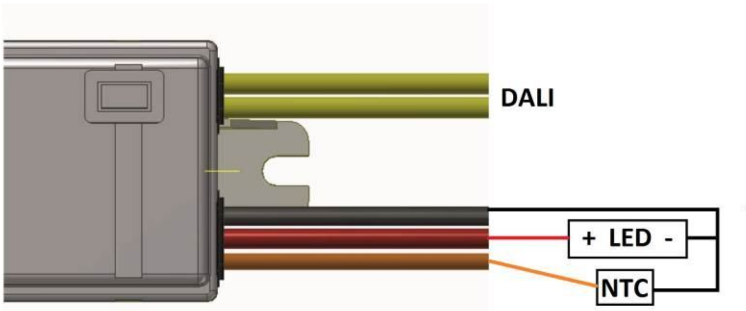
Meso LED driver accepts various control options to dim the output current. The recommended connections are shown in the figures below.

For the plastic drivers, the AC input wires are 18AWG, 152mm long, 105°C rated and double insulated, stranded and stripped by approximately 9,5mm and tinned.

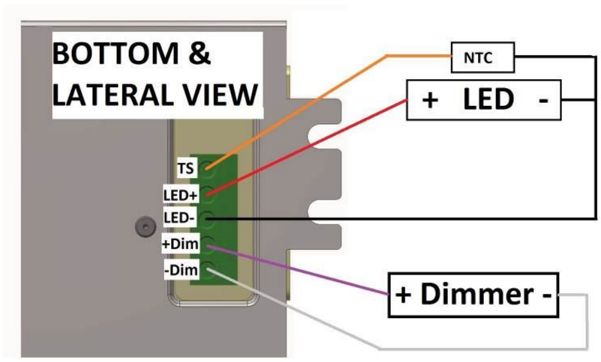
The LED output wires are 18AWG, while all the other signals (NTC, DALI and DIMMER) are AWG22. The DALI wires are double insulated. All the output wires are 152mm long, 105°C rated, stranded and stripped by approximately 9.5mm and tinned.



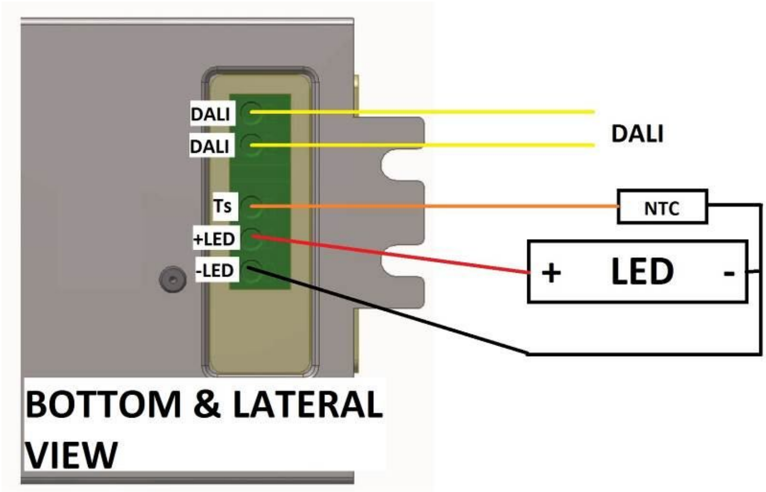
Recommended connection of the NTC thermistor (if present) and 0-10V or 1-10V dimmer (if present) for Analog Plastic versions



Recommended connection of the NTC thermistor (if present) for Dali Plastic versions



Recommended connection of the NTC thermistor (if present) and 0-10V or 1-10V dimmer (if present) for Analog Metal versions.



Recommended connection of the NTC thermistor (if present) for Dali Metal versions.

Recommended wires configuration for Metal drivers is below:

Cross section [mm²]	0.5 - 1.5 mm²
Cross section [AWG]	20 - 16 AWG
Strip length from	8.5 mm
Strip length to	9.5 mm
Strip length from [inch]	0.32 in
Strip length up to [inch]	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 II circuit, all connected equipment must have the appropriate safety approvals for Class II 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.