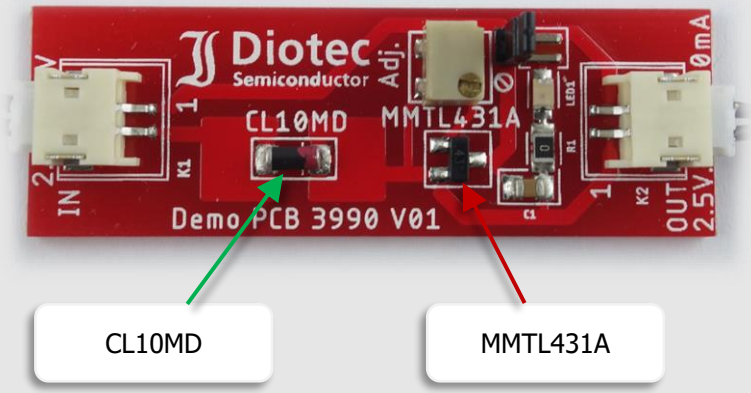
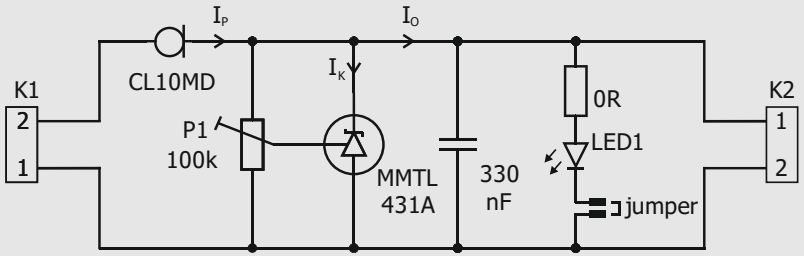
CLD + Shunt Regulator





SPICE model available
At diotec.com – search for part number 3990

Target Applications

Battery Powered Tools | Smart Home Devices | Industrial Controls
Electric Mobility | Offline Charger | Home Appliances | Smart Meter

Demo 1

Signal LED driven from
6 to 60 V_{DC}
with just one CLD

Optical Indicators | Display Backlights | Marking Lights | LED Arrays

Demo 2

Precision Voltage Reference
or Low Level Power Supply
working on **2.7 to 60 V_{DC}**
using CLD and Shunt Regulator

Control Circuits | Power Supply for µController | LDO Replacement

Benefits

Low Device Count | Board Space Savings | Wide Input Range
Robust | Reliable | Temperature Stability | Low Costs

Demo 1

Signal LED driven from **6 to 60 V_{DC}**
with just one single CLD
(Wide Input Range / Low Power LED Driver)

CLD stands for Current Limiting Diode, also called Constant Current Regulator. It can be used to drive standard LEDs with typically about 10 to 30 mA of driving current [1]) on variable DC input voltages (Fig. 1a).

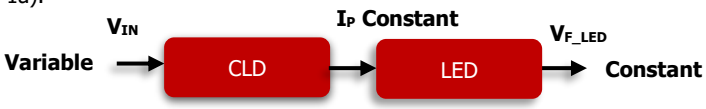


Fig. 1a: Block diagram CLD – LED driver

Preparation: Insert jumper. Connect an adjustable DC voltage supply to K1

Attention: Connect positive input to connector 2, negative to 1

Operation: Vary V_{IN} from ~6V to 60V. The LED lights constantly!

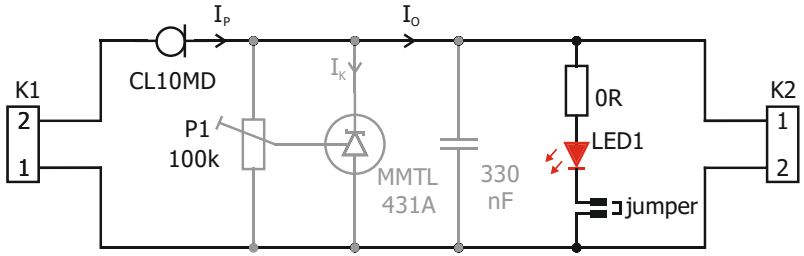


Fig. 1b: Schematic of CLD – LED driver

The here used CL10MD has a limiting voltage V_L of 3V and a peak operating voltage V_{AK} of 90V. Assuming a forward voltage of around 3V of the LED, the input voltage applied can vary from about 6V up to 60V, while the LED lights constantly. There is no need for the usual series resistor, the 0 Ω on the board proves it! The limitation to 60V is simply done to keep the junction temperature T_{jmax} to about 125°C. Though T_{jmax} is specified to 150°C for the CL10MD, it is recommended to keep this parameter as low as possible, in order to keep lifetime high. It is a good practice to keep T_j even below 100°C. Fig. 2 and 3 show different operating points.

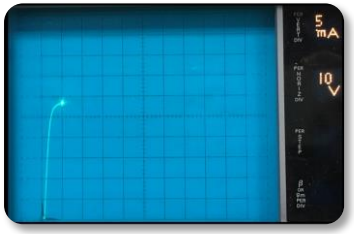


Fig. 2a: I_P= 28mA at V_{IN} = 10V_{DC}

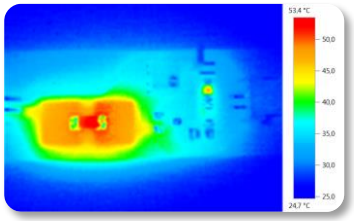


Fig. 2b: T_C = 53.4°C at V_{IN} = 10V_{DC}

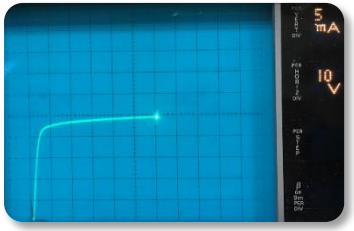


Fig. 3a: I_P = 24mA at V_{IN} = 60V_{DC}
(I_P decreases due to its negative temperature coefficient)

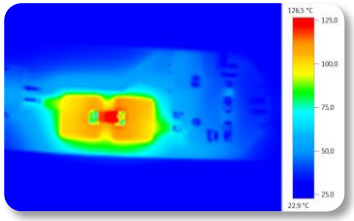


Fig. 3b: T_C = 126.5°C at V_{IN} = 60V_{DC}

[1] Refer to **Application Note** "Cost Effective Driving of Standard LEDs from 10VDC up to 110/230VAC with Current Limiting Diodes - and no flicker!" and **Application Video** "Diotec Products for LED Driver"

Demo 2

Precision Voltage Reference ***or***
Low Level Power Supply for µControllers
working on **2.7 to 60 V_{DC}**
using CLD and Shunt Regulator

The combination of CLD and Shunt Regulator allows to build a wide range input/low device count solution for providing either a precise, temperature stable voltage reference or even supplying a low power load such as a µController [2]). From an unregulated input between 2.7 and 60 V_{DC}, the output voltage can be kept stable over a wide temperature to any voltage in the range of V_{REF} to V_{KAmax} (2.5V to 36V for the MMTL431A/AR), by means of a voltage divider (here trim potentiometer). The CLD provides at 200mV voltage drop already enough current to drive a 1mA load. Above a drop of V_L = 3V, load currents of up to 20 mA can be supplied.

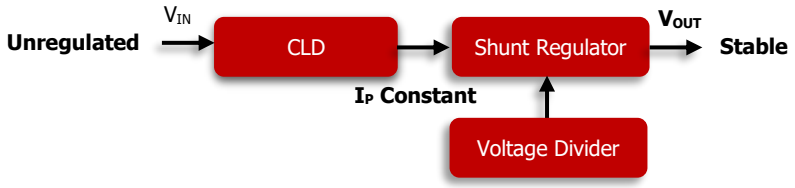


Fig. 4a: Block diagram CLD + Shunt Regulator

Preparation: Remove jumper. Connect an adjustable DC voltage supply to K1

Attention: Connect positive input to connector 2, negative to 1

Operation: Vary V_{IN} from ~2.7V to 60V. Adjust trim-pot to desired V_{OUT} at K2. Measure V_{OUT} with digital multi-meter.

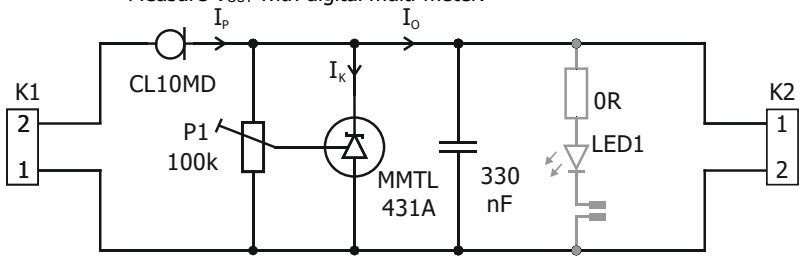


Figure 4b: Schematic of CLD + Shunt Regulator Power Supply/Reference

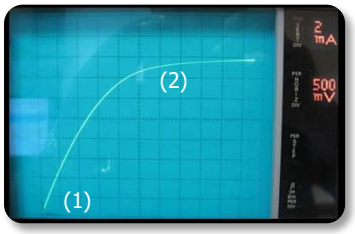


Fig. 5a: CLD. At I_P= 1mA (start-up), the voltage drop at the CLD is only about 200 mV (1). At 3V drop, already 16 mA are possible (2)

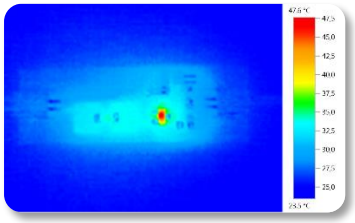


Fig. 5b: Shunt Regulator T_C = 47.6°C at V_{IN} = 6V_{DC} Above: V_{OUT} set to 3.3V

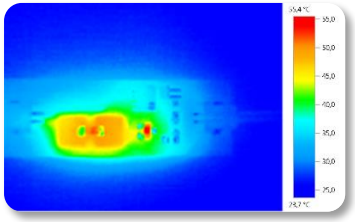


Fig. 5c: Shunt Regulator T_C = 55.4°C at V_{IN} = 10V_{DC} Above: V_{OUT} stable at 3.3V

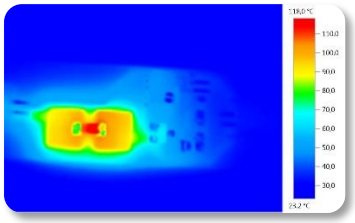


Fig. 5d: Shunt Regulator T_C = 65.2°C at V_{IN} = 60V_{DC} Above: V_{OUT} still stable at 3.3V

[2] Refer to **Application Note** "Products for Smart Meter" and **Application Video** "Dedicated Devices for Smart Meter"

Demo 2

Comparison to traditional LDO/Regulator designs

	CL10MD + MMTL431A Design Idea by ***Diotec***	**TPS715** Adjustable LDO	**TPS7A4001-EP** High Voltage Linear Regulator
Input Voltage	**2.7V ... 60V** [1])	1.2V ... 24V	7V ... 100V
Accuracy of V_{OUT} *over full temperature*	**± 1.4%**	± 4%	± 2.7%
ESD capability	**± 4 kV**	± 2 kV	± 2.5 kV
Stable Operation at	**C_{OUT} < 20 nF**	C_{OUT} > 470 nF	C_{IN} > 1 µF and C_{OUT} > 4.7 µF
Cost Comparison	**100%**	106%	400%

[1]) *Input voltage limited by thermal considerations as described in Demo 1*

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Note

a) The demo board 3990 Version 01 is marked with CL10MD but equipped with a CL15MD
b) At very low output voltages, there might occur a small oscillation. In that case, the output capacitance must be reduced to < 20nF.
This does not affect the function to be demonstrated with the board, but must be considered in real designs.

Disclaimer

This board must be used exclusively by persons which are familiar with the design and test of electronic circuits.

The maximum admissible input voltage is 60 V_{DC}. Input of alternating voltage or wrong polarity leads to immediate board damage.

This demo board contains **design ideas** and shall not be considered as assured and proven solution for any circuit.
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