3990 2-in-1 Demo Board | Design Idea

**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\text{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\text{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

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Signal LED driven from 6 to 60 V<sub>DC</sub> 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 on variable DC input voltages (Fig. 1a).

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

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

**Operation:** Vary V<sub>IN</sub> from ~6V to 60V. The LED lights constantly!

The here used CL10MD has a limiting voltage V<sub>L</sub> of 3V and a peak operating voltage V<sub>PK</sub> 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<sub>max</sub> to about 125°C. Though T<sub>max</sub> 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<sub>T</sub> even below 100°C. Fig. 2 and 3 show different operating points.

**Fig. 1a:** Block diagram CLD – LED driver

**Fig. 1b:** Schematic of CLD – LED driver

**Fig. 2a:** I<sub>P</sub> = 28mA at V<sub>IN</sub> = 10V<sub>DC</sub>

**Fig. 2b:** T<sub>C</sub> = 53.4°C at V<sub>IN</sub> = 10V<sub>DC</sub>

**Fig. 3a:** I<sub>P</sub> = 24mA at V<sub>IN</sub> = 60V<sub>DC</sub>

(I<sub>P</sub> decreases due to its negative temperature coefficient)

**Fig. 3b:** T<sub>C</sub> = 126.5°C at V<sub>IN</sub> = 60V<sub>DC</sub>

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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"
Precision Voltage Reference or Low Level Power Supply for µControllers working on 2.7 to 60 V\textsubscript{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 \(^7\). From an unregulated input between 2.7 and 60 V\textsubscript{DC}, the output voltage can be kept stable over a wide temperature to any voltage in the range of V\textsubscript{REF} to V\textsubscript{max} (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\textsubscript{L} = 3V, load currents of up to 20 mA can be supplied.

![Block diagram CLD + Shunt Regulator](image1)

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

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

**Operation:** Vary V\textsubscript{IN} from ~2.7V to 60V. Adjust trim pot to desired V\textsubscript{OUT} at K2.

Measure V\textsubscript{OUT} with digital multi-meter.

![Schematic of CLD + Shunt Regulator Power Supply/Reference](image2)

**Refer to Application Note** "Products for Smart Meter" and **Application Video** "Dedicated Devices for Smart Meter"
Comparison to traditional LDO/Regulator designs

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<th>CL10MD + MMTL431A</th>
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<th>TPS7A4001-EP</th>
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<td>Input Voltage</td>
<td>2.7V ... 60V 1)</td>
<td>1.2V ... 24V</td>
<td>7V ... 100V</td>
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<td>Accuracy of $V_{OUT}$ over full temperature</td>
<td>± 1.4%</td>
<td>± 4%</td>
<td>± 2.7%</td>
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<td>ESD capability</td>
<td>± 4 kV</td>
<td>± 2 kV</td>
<td>± 2.5 kV</td>
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<td>Stable Operation at</td>
<td>$C_{OUT} &lt; 20$ nF</td>
<td>$C_{OUT} &gt; 470$ nF</td>
<td>$C_{IN} &gt; 1$ µF and $C_{OUT} &gt; 4.7$ µF</td>
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<tr>
<td>Cost Comparison</td>
<td>100%</td>
<td>106%</td>
<td>400%</td>
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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. No warranty or guarantee, expressed or implied is made regarding the capacity, performance or suitability of any device, circuit etc.

The demo board itself is for design and test purposes only and must not be used in a commercially sold device.