

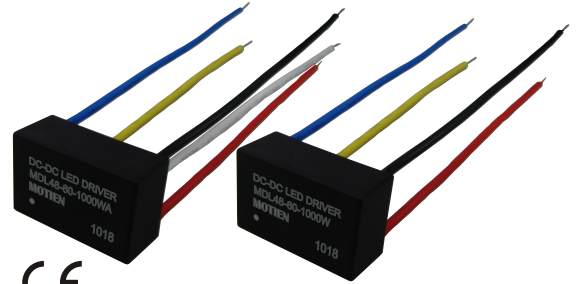
# MDL48W(A) Series

## High Efficiency Step Down LED Driver



### Features

- RoHS-compliant 24 Pin DIL Package wired version Constant
- Current Output ( ±7% Output Current Accuracy )
- LED Driver Current 150 / 250 / 300 / 350 / 500 / 600 / 700 / 1000 mA
- Power LED Driver
- Wide Input Voltage Range: 7V to 60V ( 65V for 0.5sec )
- Output Power 9 / 14 / 17 / 20 / 29 / 34 / 40 / 48W
- Driver LED Strings of up to 57V ( 2V to 57V )
- High Efficiency ( up to 97% )
- PWM/Digital Dimming and Analog Voltage Dimming
- Open and Short LED Protection
- -40°C ~ 85°C Operation Temperature Range
- With MLCC Capacitors only
- IP67 rated



### Application

- 12V,24V,36V and 48V Lighting Systems
- Household/Commercial lighting
- Suitable for high illumination LED
- Power limited ( battery ) lighting system

**M**DL48W(A) Series is a high efficiency step-down converter optimized to drive high current LEDs. The control algorithm allows highly efficient and accurate LED current regulation. The device operates from an input 7Vdc to 60Vdc and provides an externally adjustable output current up to 1000mA and output power up to 48 watts. Compact size of DIL24 allows designer to integrate this driver together with LED module. UL 94V-0 grade molded case with high grade filling material provide excellent fire proof characters.

Typical at Ta = +25°C, nominal input voltage, rated output current unless otherwise specified.

Electrical Specifications:	
Input Voltage (Vdc)	7V ~ 60V, 48Vdc Nominal
Input Filter	Capacitor
Output Voltage Range (Vin = 60V)	2V to 57V
Output Current Range (Vin - Vout > 3V)	See table
Output Current Accuracy	See table, max.
Output Power	See table, max.
Ripple and Noise (20 MHz bandwidth)	See table, max.
Efficiency	97%, max.
Capacitive Load	470µF, max.
Operating Frequency	20 kHz ~ 500 kHz
Short Circuit Protection	Regulated at Rated Output Current
Temperature Coefficient	±0.03%/°C, max.
Thermal Impedance (Nature Convection)	+30°C/W
Safety Standard (designed to meet)	IEC / EN 60950-1

Environmental Specifications	
Operating Temperature Range	-40°C to +85°C(See Derating Curve)
Storage Temperature Range	-40°C to +125°C
Environmental	IP67
Maximum Case Temperature	+110°C
Cooling	Nature Convection
Reliability Calculated MTBF(MIL-HDBK-217 F)	>950 Khrs
Soldering Temperature (1.5mm from case 10sec max.)	+260°C, max.

Physical Specifications	
Case Material	Non-Conductive Black Plastic(UL94V-0 rated)
Potting Material	Epoxy (UL94V-0 rated)
Lead wires	UL 1015/CSATEM listed / 22AWG / 600V / 105°C Rated
Weight	22.1g/23.1g
Dimensions	1.25"x0.80"x0.49"

Dimming Control and ON/OFF Control (Leave Open if Not Used): For WA	
V <sub>ADJ</sub> Pin Input Voltage Range	0V to 1.25V
V <sub>ADJ</sub> Pin Drive Current (V <sub>ADJ</sub> = 1.25V)	<1mA
Analog Dimming	
Adjust Output Current (Vin - Vout < 30V)	25% to 100%
Control Voltage Range Limits	
On	0.3V < V <sub>ADJ</sub> < 1.25V
Off	V <sub>ADJ</sub> < 0.15V
PWM Dimming	
Recommended Maximum Operation Frequency	1KHz
Adjust Output Current	0% to 100%
Remote ON/OFF	
DC/DC ON	0.3V < V <sub>ADJ</sub> < 1.25V or open circuit
DC/DC OFF (Shutdown)	V <sub>ADJ</sub> < 0.15V or Short circuit wire 1 and wire 2
Quiescent Input Current in Shutdown Mode (Vin = 60V)	100µA, max.

EMC SPECIFICATIONS	
EMI Radiated & Conducted Emissions	EN 55015 (CISPR22)
EMS Immunity EN 61547	
IEC 61000-4-2	Perf. Criteria A
IEC 61000-4-3	Perf. Criteria A
IEC 61000-4-4	Perf. Criteria A
IEC 61000-4-5	Perf. Criteria A
IEC 61000-4-6	Perf. Criteria A
IEC 61000-4-8	Perf. Criteria A

### NOTE

1. Reversed power source damages the circuit, No connection is allowed between input ground and output .
2. DO NOT operate the driver over output power.
3. Leave pin V<sub>ADJ</sub> open if not in use, ground pin to shut down the converter. Connecting V<sub>ADJ</sub> to Vin damages the circuit.
4. Maximum output open voltage is equal to input voltage .
5. Input filter components (C1, C2, L, C3) are used to help meet conducted emissions requirement for the module.
6. The test Conditions of IEC 61000-4-5 is ±0.5kV input DC power ports.

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**PART NUMBER STRUCTURE**

**MDL48 - 60 - 1000 W A**

Series Name

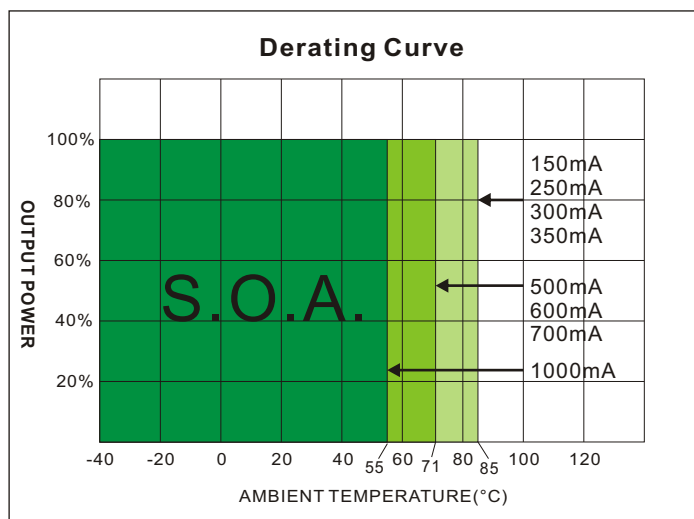
Input Max. Voltage

Wired Version

**Output Current**

- 150 - 150mA
- 250 - 250mA
- 300 - 300mA
- 350 - 350mA
- 500 - 500mA
- 600 - 600mA
- 700 - 700mA
- 1000 - 1000mA

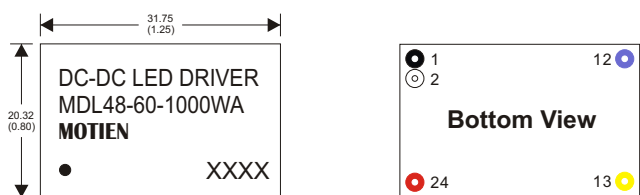
Dimming Control Wire (Optional)



**MODEL SELECTION GUIDE**

MODEL NUMBER	INPUT	OUTPUT		OUTPUT Current Accuracy (% , max.)	OUTPUT Power (W, max.)	EFFICIENCY @FL (% , max )	Capacitor Load @FL (µF, max.)
	Voltage Range (Vdc)	Voltage Range (Vdc)	Current (mA)				
MDL48-60-150W(A)	7 - 60	2 ~ 57	150	±8	9	60 - 97	470
MDL48-60-250W(A)	7 - 60	2 ~ 57	250	±7	14	65 - 97	470
MDL48-60-300W(A)	7 - 60	2 ~ 57	300	±6	17	67 - 97	470
MDL48-60-350W(A)	7 - 60	2 ~ 57	350	±5	20	66 - 97	470
MDL48-60-500W(A)	7 - 60	2 ~ 57	500	±5	29	69 - 97	470
MDL48-60-600W(A)	7 - 60	2 ~ 57	600	±5	34	69 - 97	470
MDL48-60-700W(A)	7 - 60	2 ~ 57	700	±5	40	69 - 97	470
MDL48-60-1000W(A)	7 - 60	2 ~ 48	1000	±5	48	64 - 97	470

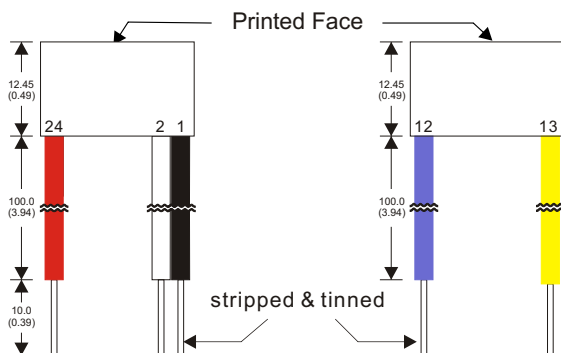
**MECHANICAL DIMENSION**



**24 Pin DIL Package wired version**

- Notes : All dimensions are typical in millimeters ( inches ).
1. Wire core diameter: 0.80±0.1 ( 0.31±0.004 )
  2. Wire outside diameter: 2.4±0.1 ( 0.094±0.004 )
  3. Wire length = 100 + 10 stripped & tinned = 110±5 total
  4. Case Tolerance: ±0.5 ( ±0.02 )

Lead wires are under the specification of general lamps :  
Wire is UL1015/CSA TEM listed #22AWG / 600V / 105°C



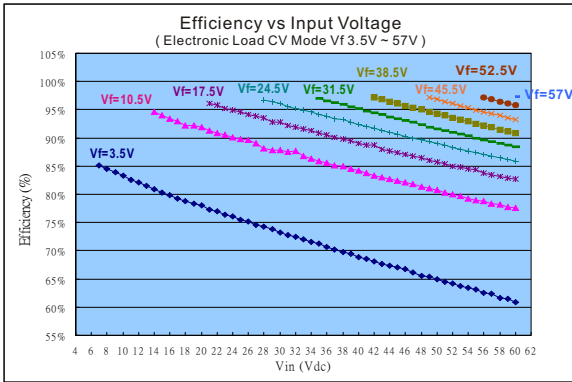
Wire #	CONNECTIONS		
		MDL48-60-XXXWA	MDL48-60-XXXW
1 (Black)	- V Input	- DC Supply	- DC Supply
2 (White)	V <sub>ADJ</sub>	PWM/ON/OFF or not used	No wires
12 (Blue)	- V Output	LED Cathode Connection	LED Cathode Connection
13 (Yellow)	+V Output	LED Anode Connection	LED Anode Connection
24 (Red)	+V Input	+DC Supply	+DC Supply

No connection is allowed between input and output

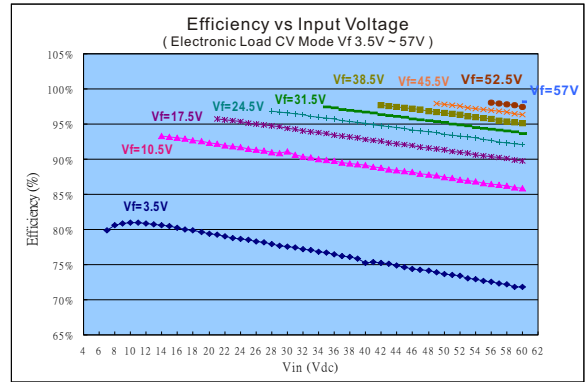
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Typical Operating Conditions

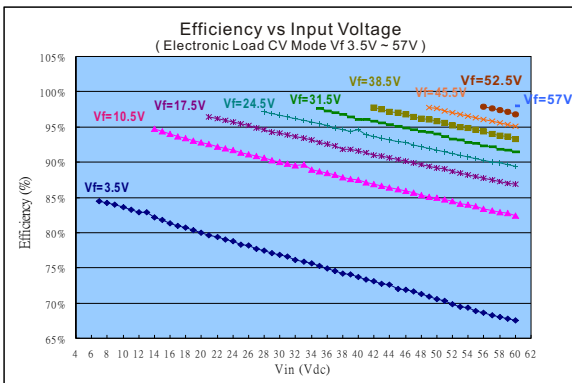
MDL48-60-150WA



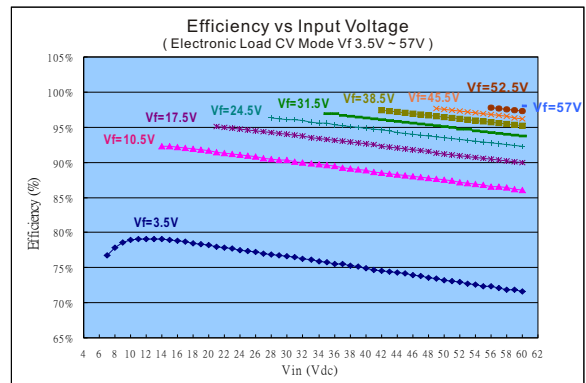
MDL48-60-500WA



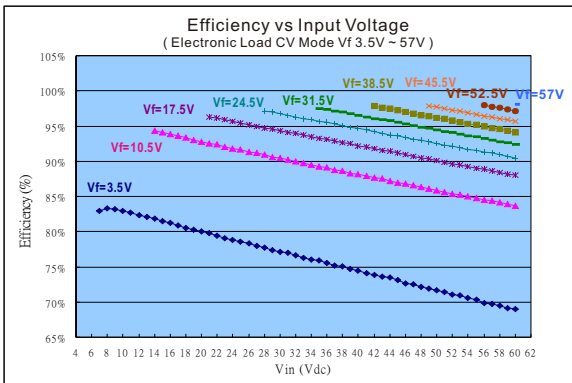
MDL48-60-250WA



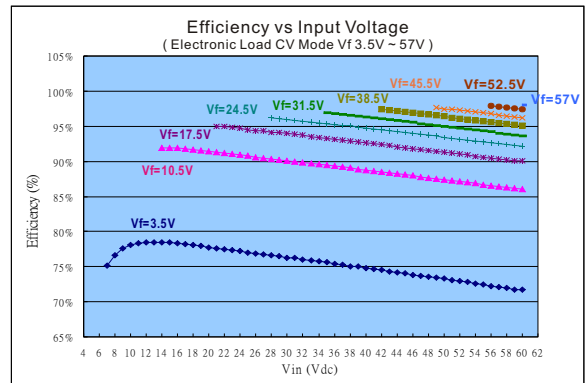
MDL48-60-600WA



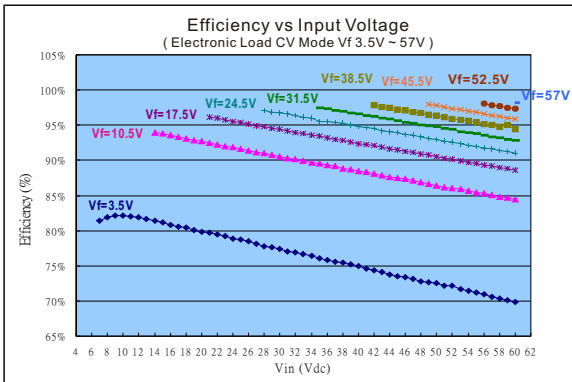
MDL48-60-300WA



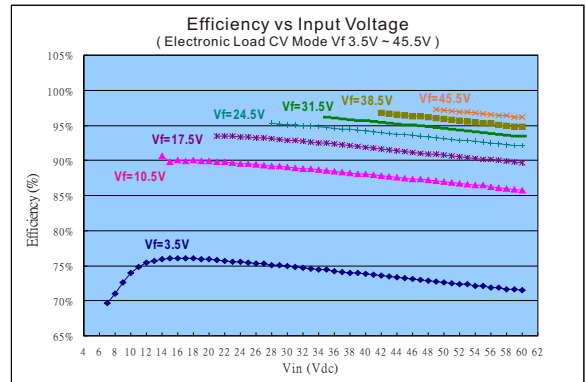
MDL48-60-700WA



MDL48-60-350WA



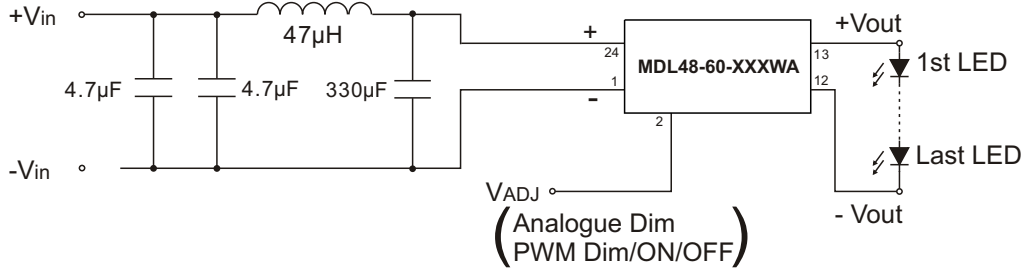
MDL48-60-1000WA



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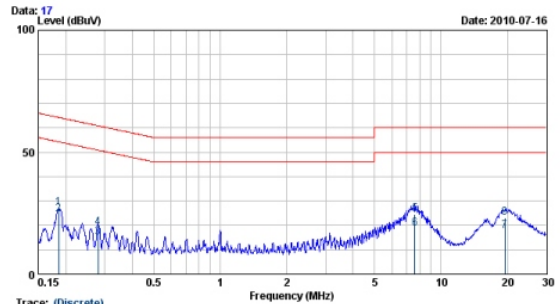
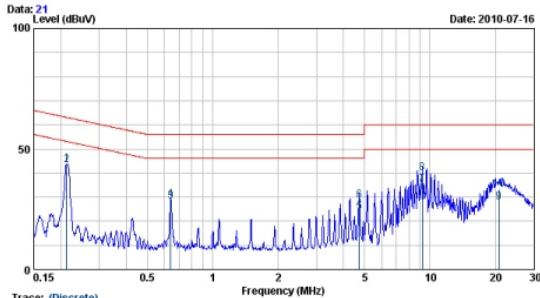
EMC Characteristics meet EN55022

EN55015 Conduction Class B Filter Suggestion



Vin=60V Vout=30V (LED Load Vf=3.3V , 9LED=30V)

Vin=12V Vout=3.3V (LED Load Vf=3.3V , 1LED=30V)



Freq. MHz	LISN Factor dB	Cable Loss dB	Meter Reading dBuV	Measured Level dBuV	Limits dBuV	Over Limits dBuV	Detector
0.213	9.93	0.03	33.77	43.73	63.10	-19.36	QP
0.213	9.93	0.03	33.37	43.33	53.10	-9.76	AVERAGE
0.641	9.95	0.06	18.14	28.15	46.00	-17.85	AVERAGE
0.641	9.95	0.06	18.84	28.85	56.00	-27.15	QP
4.721	9.96	0.06	13.66	23.68	46.00	-22.32	AVERAGE
4.721	9.96	0.06	18.66	28.68	56.00	-27.32	QP
9.212	110.01	0.07	24.91	34.99	50.00	-15.01	AVERAGE
9.212	110.01	0.07	29.72	39.80	60.00	-20.20	QP
20.814	110.04	0.12	17.76	27.91	50.00	-22.09	AVERAGE
20.814	110.04	0.12	23.23	33.38	60.00	-26.62	QP

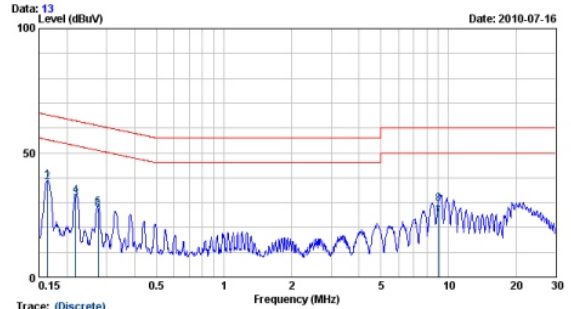
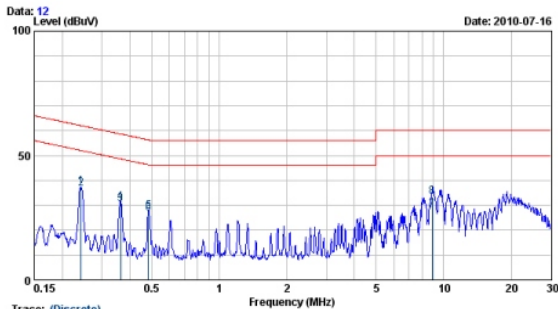
Freq. MHz	LISN Factor dB	Cable Loss dB	Meter Reading dBuV	Measured Level dBuV	Limits dBuV	Over Limits dBuV	Detector
0.185	9.92	0.04	16.97	26.92	64.24	-37.32	QP
0.185	9.92	0.04	14.56	24.51	54.24	-29.73	AVERAGE
0.280	9.95	0.04	5.10	15.10	50.81	-35.71	AVERAGE
0.280	9.95	0.04	9.09	19.09	60.81	-41.72	QP
7.606	9.99	0.08	14.56	24.63	60.00	-35.37	QP
7.606	9.99	0.08	8.70	18.77	50.00	-31.23	AVERAGE
19.428	110.03	0.10	7.33	17.46	50.00	-32.54	AVERAGE
19.428	110.03	0.10	12.82	22.95	60.00	-37.05	QP

REMARKS: 1.Level(dBuV/m)=Read Level(dBuV)+Antenna Factor(dB/m)+Cable loss(dB)  
2.Over Limit value(dB)=Level(dBuV/m)-Limit Line(dBuV/m)

REMARKS: 1.Level(dBuV/m)=Read Level(dBuV)+Antenna Factor(dB/m)+Cable loss(dB)  
2.Over Limit value(dB)=Level(dBuV/m)-Limit Line(dBuV/m)

Vin=60V Vout=48V (LED Load Vf=3.3V , 14LED=15V)

Vin=7V Vout=3.3V (LED Load Vf=3.3V , 1LED=30V)



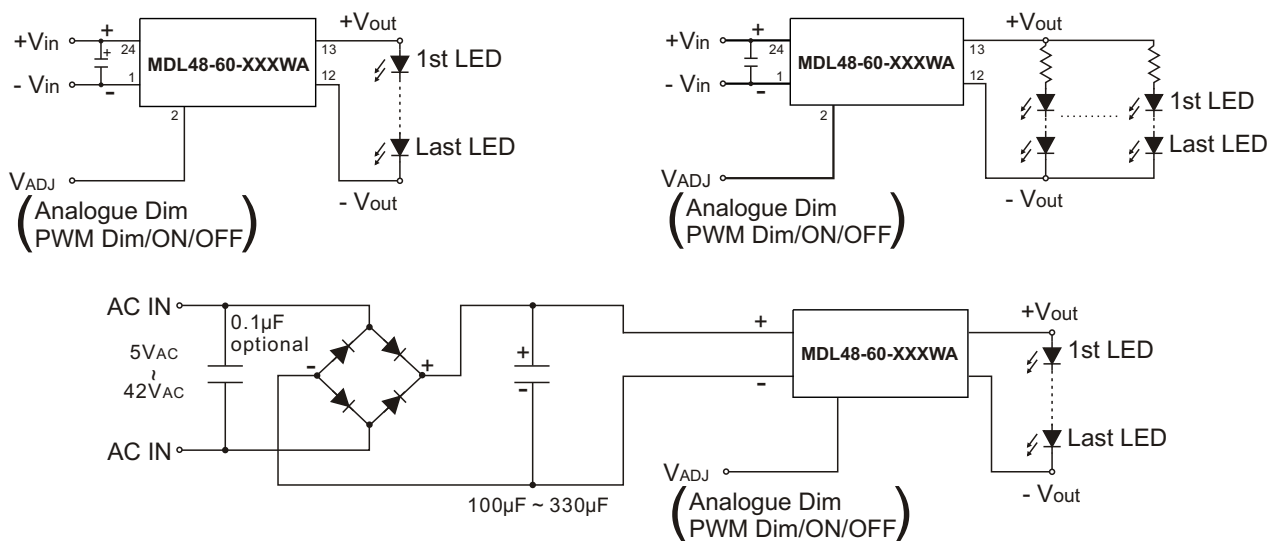
Freq. MHz	LISN Factor dB	Cable Loss dB	Meter Reading dBuV	Measured Level dBuV	Limits dBuV	Over Limits dBuV	Detector
0.242	9.94	0.04	27.29	37.27	62.04	-24.77	QP
0.242	9.94	0.04	26.56	36.54	52.04	-15.50	AVERAGE
0.363	9.95	0.05	20.52	30.52	48.65	-18.13	AVERAGE
0.363	9.95	0.05	21.22	31.22	58.65	-27.43	QP
0.484	9.94	0.06	17.42	27.42	56.27	-28.85	QP
0.484	9.94	0.06	16.58	26.58	46.27	-19.69	AVERAGE
8.869	110.00	0.07	17.71	27.79	50.00	-22.21	AVERAGE
8.869	110.00	0.07	23.20	33.28	60.00	-26.72	QP

Freq. MHz	LISN Factor dB	Cable Loss dB	Meter Reading dBuV	Measured Level dBuV	Limits dBuV	Over Limits dBuV	Detector
0.163	9.91	0.04	28.96	38.91	65.30	-26.38	QP
0.163	9.91	0.04	28.15	38.10	55.30	-17.19	AVERAGE
0.219	9.93	0.03	21.65	31.62	52.88	-21.26	AVERAGE
0.219	9.93	0.03	22.81	32.78	62.88	-30.10	QP
0.274	9.95	0.04	17.94	27.93	60.98	-33.05	QP
0.274	9.95	0.04	17.26	27.25	50.98	-23.73	AVERAGE
9.059	110.00	0.07	14.24	24.32	50.00	-25.68	AVERAGE
9.059	110.00	0.07	19.41	29.49	60.00	-30.51	QP

REMARKS: 1.Level(dBuV/m)=Read Level(dBuV)+Antenna Factor(dB/m)+Cable loss(dB)  
2.Over Limit value(dB)=Level(dBuV/m)-Limit Line(dBuV/m)

REMARKS: 1.Level(dBuV/m)=Read Level(dBuV)+Antenna Factor(dB/m)+Cable loss(dB)  
2.Over Limit value(dB)=Level(dBuV/m)-Limit Line(dBuV/m)

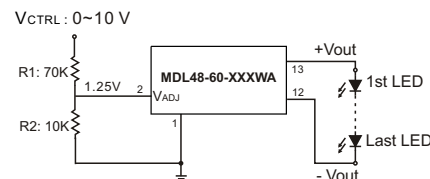
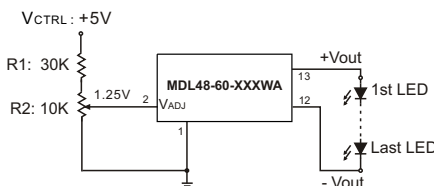
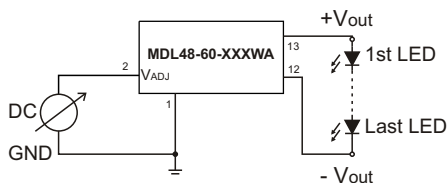
Typical Application



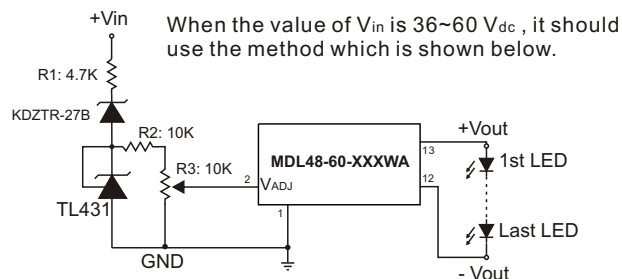
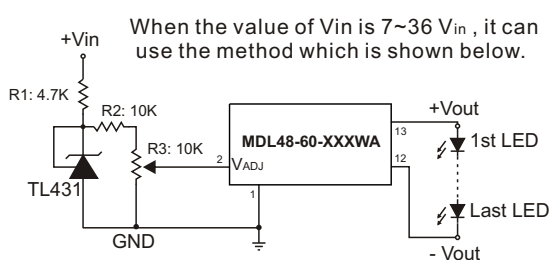
Output Current Adjustment By External DC Control Voltage ( $V_{CTRL}$ )

$V_{ADJ} = V_{CTRL}$  [If  $V_{CTRL} = 0 \sim 1.25V_{dc}$ ]

$V_{ADJ} = \frac{R2}{R1 + R2} \times V_{CTRL}$  [If  $V_{CTRL} > 1.25V_{dc}$ ]



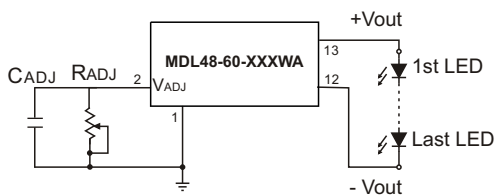
$V_{ADJ} = \frac{R3}{R2 + R3} \times 2.5$  [If  $V_{CTRL} = V_{in}$ ]



The nominal output current ( $I_{outnom}$ ) is given by:  $I_{outnom} \approx I_{out} \times \frac{V_{ADJ}}{1.25}$

Resistor dimming

By connecting a variable resistor between ADJ and GND, simple dimming can be achieved. Capacitor  $C_{ADJ}$  is optional for better AC mains interference and HF noise rejection. Recommend value of  $C_{ADJ}$  is 0.22µF.



The current output  $I_{outnom}$  can be determined using the equation:

$I_{outnom} = \frac{I_{out} \times R_{ADJ}}{(R_{ADJ} + 50K)}$

If the value of  $R_{ADJ}$  is 0 to 2M ohm, the maximum adjust range of output current is 25% to 90%. (For  $V_{in} - V_{out} < 30V$ )

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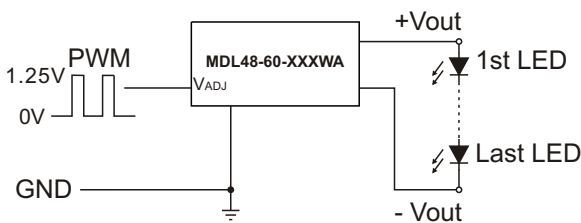
Typical Application

## Output Current Adjustment By PWM Control

### Directly driving ADJ input

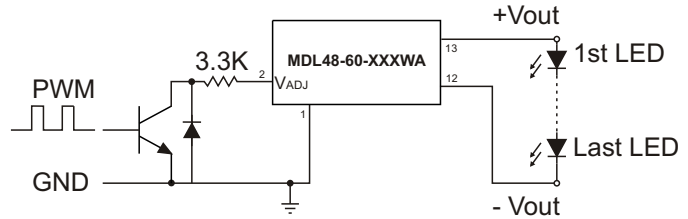
A Pulse Width Modulated (PWM) signal with duty cycle DPWM can be applied to the ADJ pin, as shown below

$$I_{outnom} \approx I_{out} \times DPWM \quad [\text{If PWM frequency} < 200\text{Hz, for } 0.1 < DPWM < 1]$$



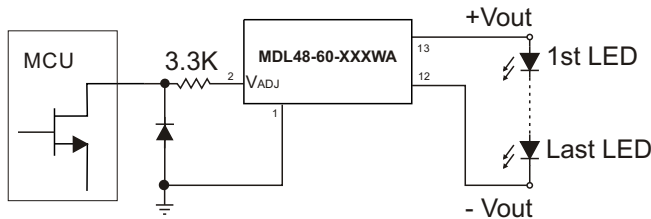
### Driving the ADJ input via open collector transistor

The diode and resistor suppress possible high amplitude negative spikes on the ADJ input resulting from the drain-source capacitance of the transistor. Negative spikes at the input to the device should be avoided as they may cause errors in output current, or erratic device operation.



### Driving the ADJ input from a microcontroller

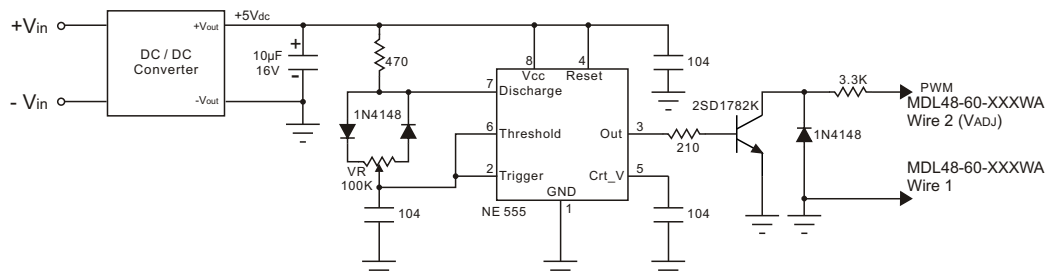
Another possibility is to drive the device from the open drain output of a microcontroller. The diagram below shows one method of doing this:



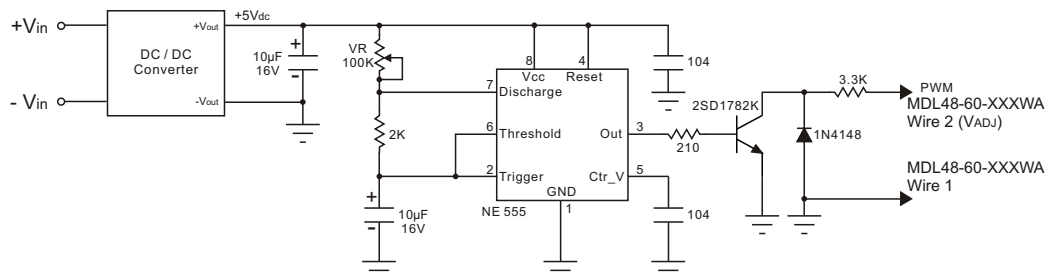
The diode and resistor suppress possible high amplitude negative spikes on the ADJ input resulting from the drain-source capacitance of the FET. Negative spikes at the input to the device should be avoided as they may cause errors in output current, or erratic device operation.

## Output Current Adjustment By PWM Control (Dimming)

To avoid visible flicker the PWM signal must be greater than 100Hz.



## Output Current Adjustment By PWM Control (Flash)



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