

MULA Serise

High Efficiency Step-UP LED Driver



Features

- RoHS-compliant 2"x1" case Package Power LED Driver
- Constant Current Output (±5% Output Current Accuracy)
- LED Driver Current 150 / 250 / 300 / 350 / 500 / 600 / 700 mA
- Power LED Driver
- Wide Input Voltage Range: 9V to 36V (38V for 0.1sec.)
- Output Power 7.2 / 12 / 14.4 / 16.8 / 24 / 28.8 / 33.6 W
- Driver LED Strings of up to 48V (14V to 48V)
- High Efficiency (up to 95%)
- PWM/Digital Dimming and Analog Voltage Dimming
- Open and Short LED Protection
- Pin or Wire Versions
- -40°C ~ 85°C Operation Temperature Range
- IP67 rated for Wired Version
- With MLCC Capacitors only



Application

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

MULA series is a high efficiency step-up converter optimized to drive high current LEDs. The control algorithm allows highly efficient and accurate LED current regulation. The device operates from an input 9Vdc to 36Vdc and provides an externally adjustable output current of up to 700mA and output power up to 33.6 watts. Compact size of 2"x1" case allows designer to integrate this driver together with LED module. UL94V-0 grade molded case with high grade filling material provide excellent fire proof characteristics.

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

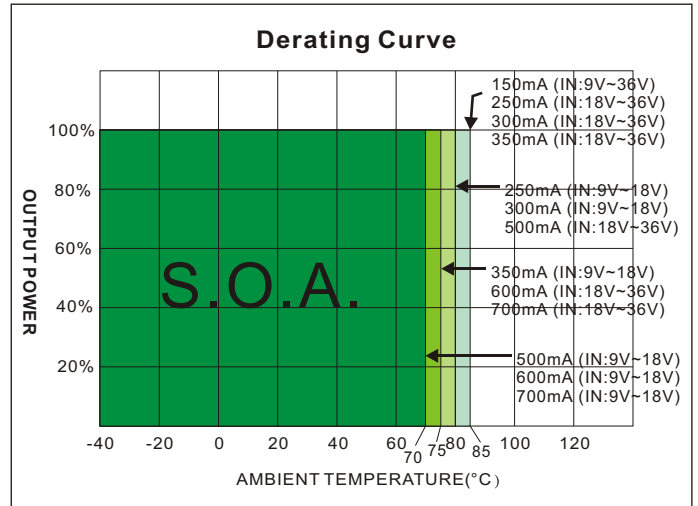
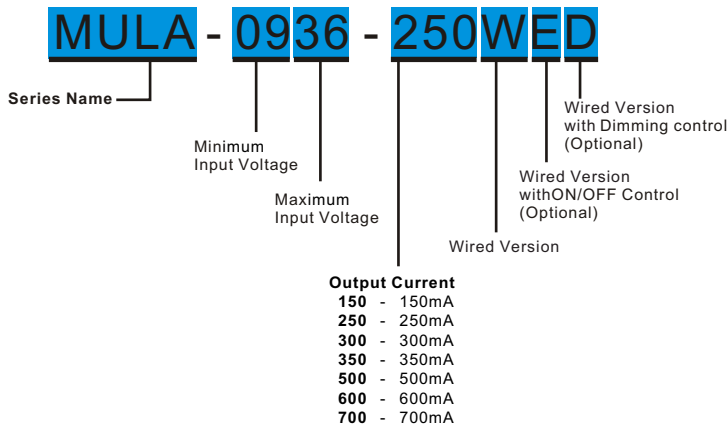
Electrical Specifications		ON/OFF Control (Leave Open if Not Used): (EN)	
Input Voltage (Vdc)	9V ~ 36V, 24V typ.	DC/DC ON	Open
Input Filter	Capacitor	DC/DC OFF (Shutdown)	0V
Output Voltage Range (Vo - Vin ≤ 5V) (1)	14V to 48V	Remote Pin Drive Current (VEN ≤ 3V)	<1.5uA
Output Current Range (Vo - Vin ≤ 5V)	See table	Quiescent Input Current in Shutdown Mode (Vin 9V~32V)	1.3mA Max.
Output Current Accuracy	±5%	(Vin 32V~36V)	8mA Max.
Output Power (2)	See table	Analog and PWM Dimming Control (Leave Open if Not Used): (DIM)	
Ripple and Noise, (20 MHz bandwidth)	See table	Absolute Maximum Ratings	0V to 5V(8V for 0.1sec.)
Efficiency	See table	Analog Dimming Control	
Capacitive Load (3)	See table	DIM Input Voltage Range (See Output Current Vs DIM Graph)	
Operating Frequency	370KHz typ.	ON	0.4V to 1.7V
Over Voltage Protection (OVP)	52.5V Max.	Adjust Output Current (0.4V to 1.7V)	0% to 100%
Short Circuit Protection (4) Automatic Recovery (Cut-off output)		Adjust Output Current (1.7V to 5V)	100%
Under Voltage Protection (Cool Start) (5)	7.6V typ.	OFF	0V to 0.3V
Soft Start Time (Not to increase additional output capacitor)	50mS Max.	DIM Pin Drive Current (0.4V ≤ VDIM ≤ 1.7V)	
Temperature Coefficient (Ta = -40°C to +85°C)	±0.03%/°C Max.	<1.5uA	
Thermal Impedance (Nature Convection)	+17°C/W	PWM Dimming Control (6)	
Safety Standard : (designed to meet)	IEC/EN 60950-1 UL8750 and IEC/EN 61347-2-13	PWM Control Voltage Range Limits (See Output Current Vs DIM Graph)	
Environmental Specifications		ON	0.4V to 5.0V
Operating Temperature Range, Ta	-40°C to +85°C (See Derating Curve)	OFF	0V to 0.3V
Storage Temperature Range	-55°C to +125°C	Recommended Operation Frequency	100Hz~100KHz
Humidity	95% rel H	Adjust Output Current	0% to 100%
Water Resistance (Wired Version only)	IP67	Physical Specifications	
Maximum Case Temperature	+102°C	Case Material	Non-conductive Black Plastic (UL94V-0 rated)
Cooling	Nature Convection	Potting Material	Epoxy (UL94V-0 rated) Silicon (UL94V-0 rated)
Reliability Calculated MTBF (MIL-HDBK-217 F)	>1.29Mhrs	Pin Material	Ø1.0mm Brass Solder-coated
Soldering Temperature (1.5mm from case 10 sec. Max.)	+260°C, Max.	Lead Wires	UL 1015/CSATEM listed/ 18AWG / 600V/ 105°C Rated UL 1015/CSATEM listed/ 22AWG / 600V/ 105°C Rated
EMC Specifications (designed to meet)		Weight (Pinned / Wired)	38g / 44.2g
EMI Radiated & Conducted Emissions	EN 55022 Class B	Dimensions	51.5(L)"x26.1(W)"x15.8(H)"mm

NOTE

1. To prevent the burned out of driver, The output voltage must be 5.0Vdc higher than input voltage.
2. DO NOT operate the driver over output power.
3. The Output ripple has been rather low, it's recommended not to increase the additional output capacitor, otherwise there will be time delay while starting up under cool starting.
4. There is protection while output is shorted, after the short occurs, input current will be cut off and recover while short is removed.
5. The reference value of under voltage protection -- 7.6V means under the condition of cool start and full discharge of output, protection starts when input voltage is lower under 7.6V.
6. Please note, PWM dimming means PWM signals is converted into mimic analog voltage by internal circuits and then do the dimming. The advantage of such approach is to reduce the EMI.

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PART NUMBER STRUCTURE



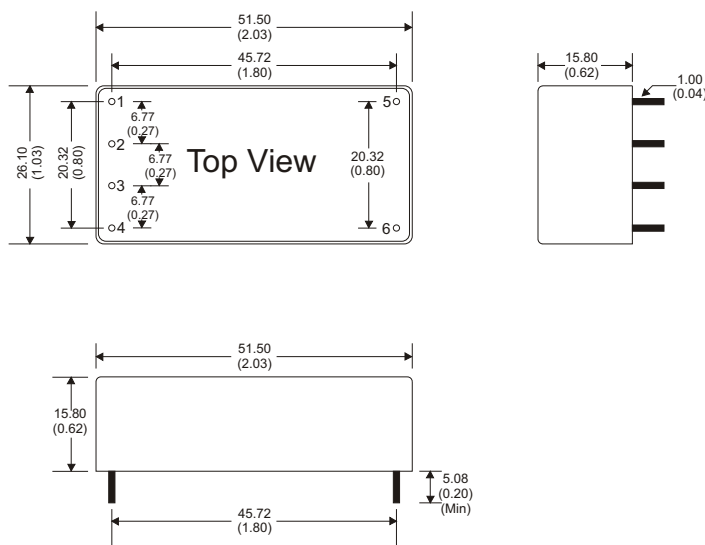
MODEL SELECTION GUIDE

MODEL NUMBER	INPUT	OUTPUT		OUTPUT Current	OUTPUT	EFFICIENCY @FL(%) Max.	Ripple and Noise mVp-p Max.	Capacitor Load(μF)
	Voltage Range (Vdc)	Voltage Range (Vdc)	Current (mA)	Accuracy (%)	Power (W) Max.			
MULA-0936-150	9 - 36	14 - 48	150	±5	7.2	86 - 91	350	100
MULA-0936-250	9 - 36	14 - 48	250	±5	12.0	89 - 93	450	100
MULA-0936-300	9 - 36	14 - 48	300	±5	14.4	89 - 94	450	100
MULA-0936-350	9 - 36	14 - 48	350	±5	16.8	89.5 - 94	600	100
MULA-0936-500	9 - 18	14 - 45	500	±5	24.0	90 - 95	650	47
	18 - 36	23 - 48						
MULA-0936-600	9 - 18	14 - 38	600	±5	28.8	91 - 95	650	47
	18 - 36	23 - 48						
MULA-0936-700	9 - 18	14 - 32	700	±5	33.6	91.5 - 95	700	47
	18 - 36	23 - 48						
MULA-0936-150 WED	9 - 36	14 - 48	150	±5	7.2	86 - 91	350	100
MULA-0936-250 WED	9 - 36	14 - 48	250	±5	12.0	89 - 93	450	100
MULA-0936-300 WED	9 - 36	14 - 48	300	±5	14.4	89 - 94	450	100
MULA-0936-350 WED	9 - 36	14 - 48	350	±5	16.8	89.5 - 94	600	100
MULA-0936-500 WED	9 - 18	14 - 45	500	±5	24.0	90 - 95	650	47
	18 - 36	23 - 48						
MULA-0936-600 WED	9 - 18	14 - 38	600	±5	28.8	91 - 95	650	47
	18 - 36	23 - 48						
MULA-0936-700 WED	9 - 18	14 - 32	700	±5	33.6	91.5 - 95	700	47
	18 - 36	23 - 48						

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MECHANICAL DIMENSION

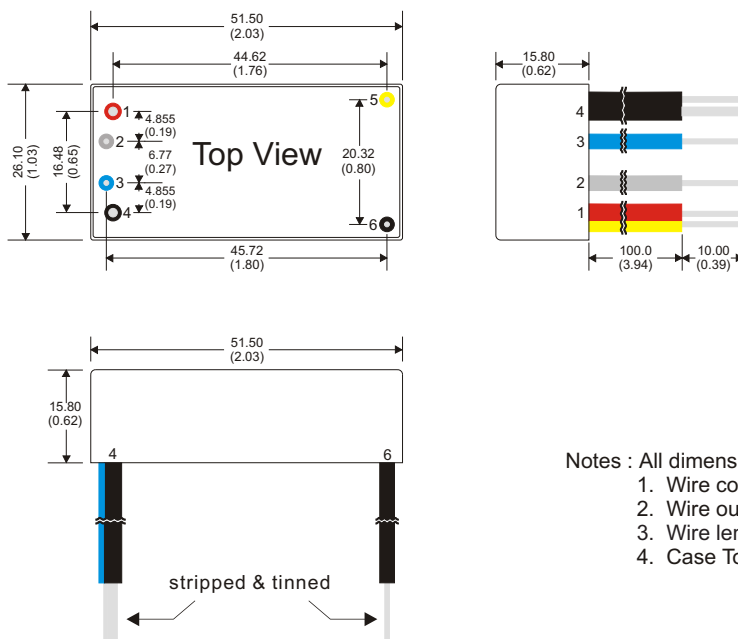
Pinned Version



PIN CONNECTIONS		
PIN #	CONNECTIONS	
1	+Vi	+DC Supply
2	DIM	PWM/ Analog Dimming Control
3	EN	Remote ON/OFF
4	-Vi	-DC Supply (GND)
5	+ LED	LED Anode Connection
6	- LED	LED Cathode Connection

All dimensions are typical in millimeters (inches)
 1. Pin diameter: 1.0 ± 0.05 (0.04 ± 0.002)
 2. Pin pitch tolerance: ± 0.35 (± 0.014)
 3. Case Tolerance: ± 0.5 (± 0.02)

Wired Version

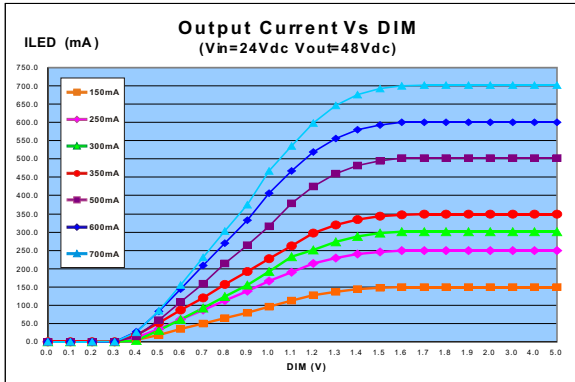


CONNECTIONS		
Wires #	CONNECTIONS	
1 (Red)	+Vi	+DC Supply
2 (White)	DIM	PWM/ Analog Dimming Control
3 (Blue)	EN	Remote ON/OFF
4 (Black)	-Vi	-DC Supply (GND)
5 (Yellow)	+ LED	LED Anode Connection
6 (Black)	- LED	LED Cathode Connection

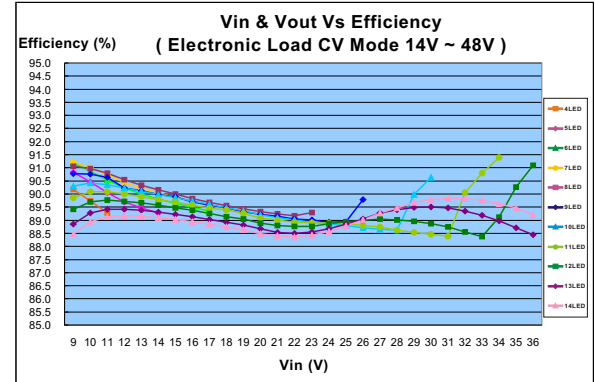
Notes : All dimensions are typical in millimeters (inches).
 1. Wire core diameter: 0.80 ± 0.1 (0.031 ± 0.004) & 1.40 ± 0.1 (0.055 ± 0.004)
 2. Wire outside diameter: 2.4 ± 0.1 (0.094 ± 0.004) & 2.7 ± 0.1 (0.106 ± 0.004)
 3. Wire length = 100 + 10 stripped & tinned = 110 ± 5 (4.33 ± 0.197) total
 4. Case Tolerance: ± 0.50 (± 0.02)

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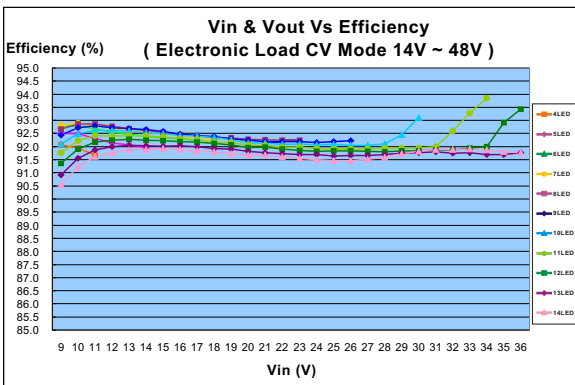
Typical electrical characteristic curves



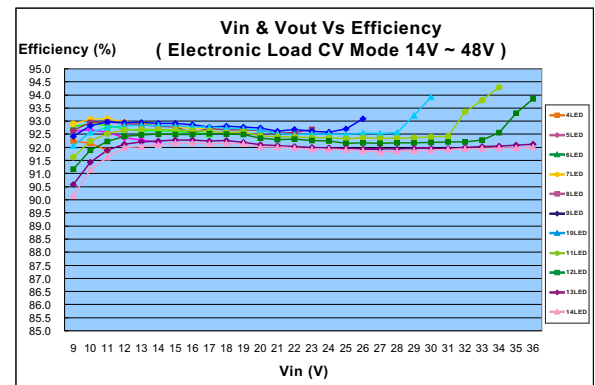
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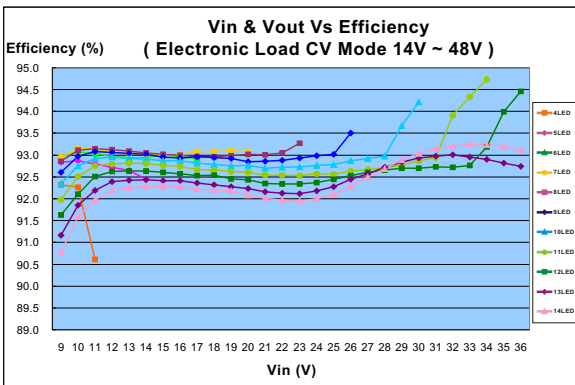
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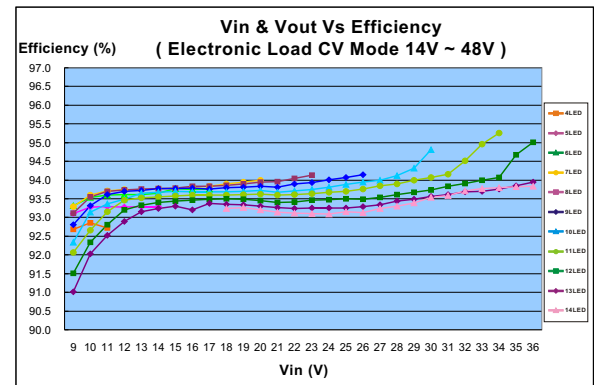
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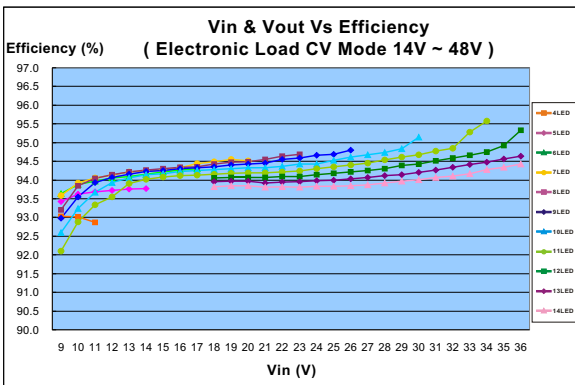
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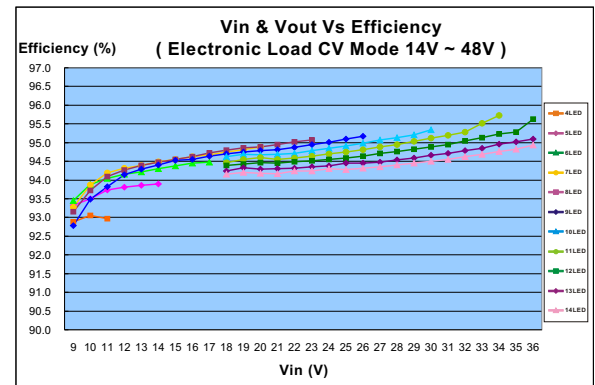
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MULA-0936-350



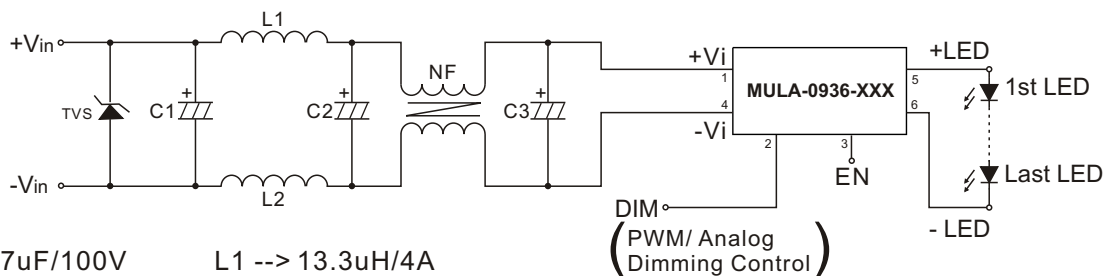
MULA-0936-700



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EMC Characteristics meet EN55022

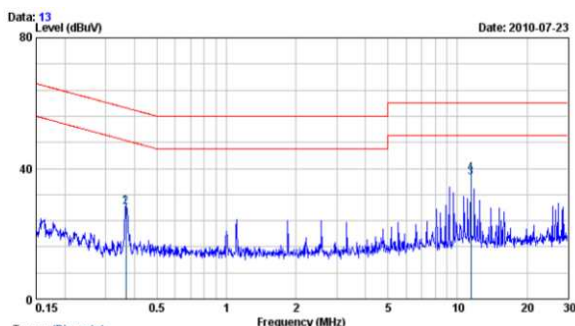
EN55022 Class B Filter Suggestion:



- C1 ----> 47uF/100V
- C2 ----> 330uF/100V
- C3 ----> 330uF/100V
- TVS --> 38V
- L1 --> 13.3uH/4A
- L2 --> 13.3uH/4A
- NF--> 3.0mH/4A(Command choke)

Conducted Emissions Test

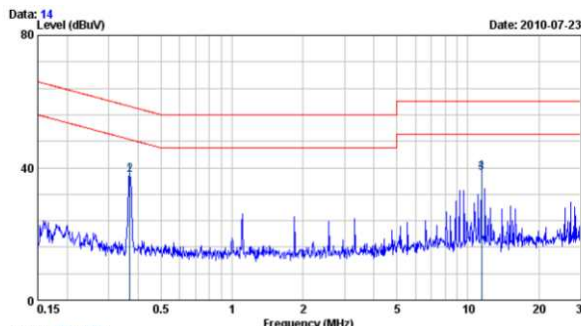
Vin=24V Vout=48V(LED Load Vf=3.5V · 14LED ≐ 48V)
POLARITY:NEUTRAL



Freq. MHz	LISN Factor dB	Cable Loss dB	Meter Reading dBuV	Measured Level dBuV	Limits dBuV	Over Limits dBuV	Detector
0.367	9.81	0.02	18.39	28.22	58.56	1-30.35	QP
0.367	9.81	0.02	18.34	28.17	48.56	1-20.40	AVERAGE
11.405	110.30	0.13	26.73	37.16	50.00	1-12.84	AVERAGE
11.405	110.30	0.13	27.92	38.35	60.00	1-21.65	QP

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

Vin=24V Vout=48V(LED Load Vf=3.5V · 14LED ≐ 48V)
POLARITY:LINE

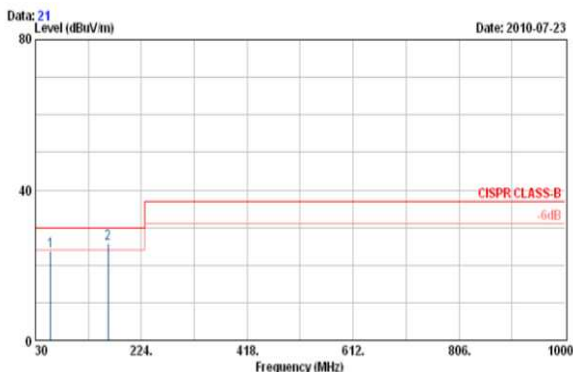


Freq. MHz	LISN Factor dB	Cable Loss dB	Meter Reading dBuV	Measured Level dBuV	Limits dBuV	Over Limits dBuV	Detector
0.369	9.82	0.02	27.72	37.56	58.52	1-20.96	QP
0.369	9.82	0.02	28.11	37.95	48.52	1-10.57	AVERAGE
11.409	110.35	0.13	27.87	38.35	50.00	1-11.65	AVERAGE
11.409	110.35	0.13	28.32	38.80	60.00	1-21.20	QP

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

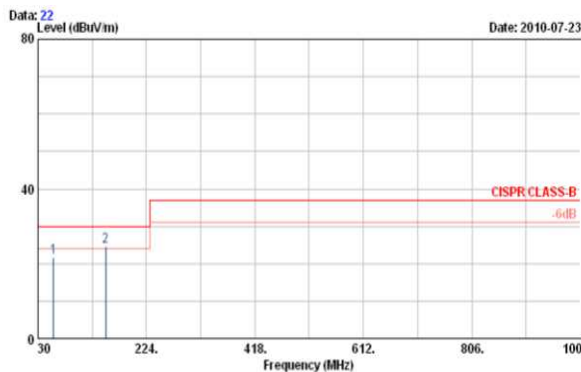
Radiation Emissions Test Result

Vin=12V Vout=32V(LED Load Vf=3.5V · 9LED ≐ 32V)
POLARITY:HORIZONTAL



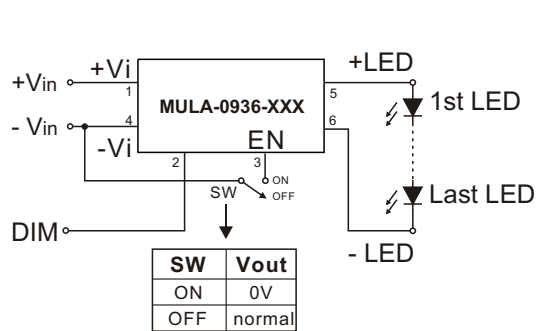
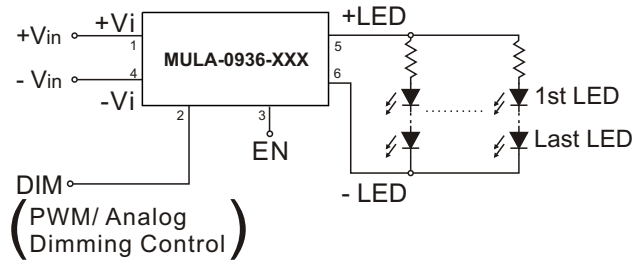
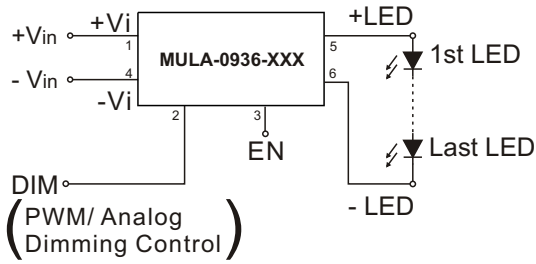
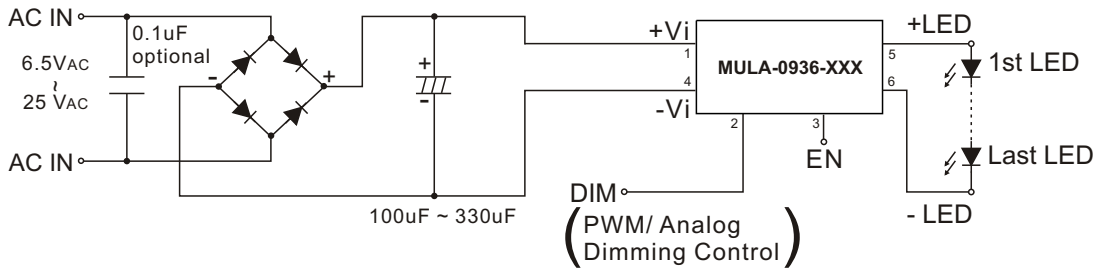
Freq. MHz	Reading Level dBuV	Antenna Factor dB/m	Cable Loss dB	Measure Level dBuV/m	Limit dBuV/m	Over Limit dBuV/m	Detector
57.50	14.48	7.88	1.41	23.77	30.00	-6.23	QP
162.88	10.46	12.21	3.03	25.70	30.00	-4.30	QP

Vin=24V Vout=48V(LED Load Vf=3.5V · 14LED ≐ 48V)
POLARITY:HORIZONTAL

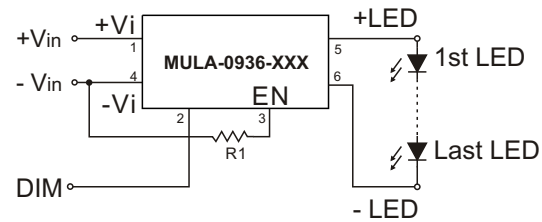


Freq. MHz	Reading Level dBuV	Antenna Factor dB/m	Cable Loss dB	Measure Level dBuV/m	Limit dBuV/m	Over Limit dBuV/m	Detector
57.83	12.47	7.82	1.44	21.73	30.00	-8.27	QP
158.90	9.12	12.74	2.87	24.73	30.00	-5.27	QP

Typical Application



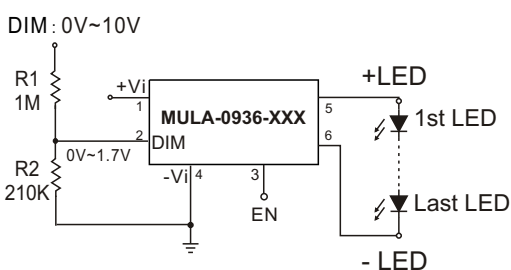
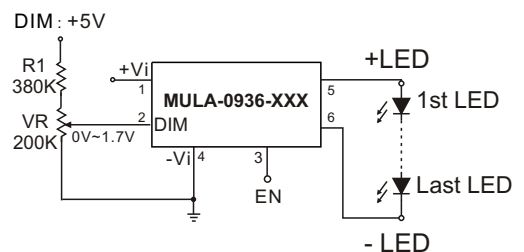
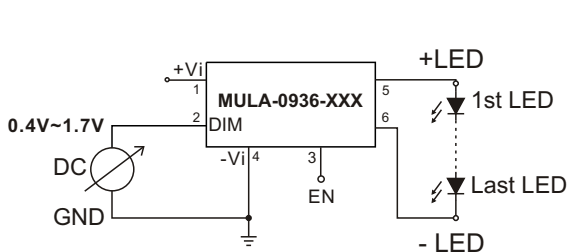
Under Voltage Protection



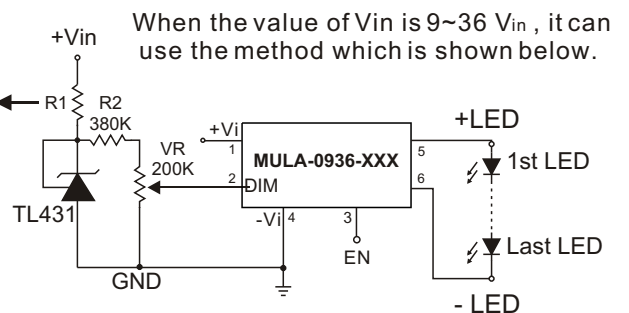
R1	Under Voltage Protection
X	7.6V
12K	10.8V
10K	11.6V
7.5K	13.0V
4.7K	16.5V
3.3K	21.0V
2.7K	24.1V
2.4K	26.2V
2.0K	29.8V
1.8K	32.4V

The R1 Value Only Supplies The Reference

Output Current Adjustment Control By External DC Control Voltage



Vin	R1
5V	4.7K
12V	18K
24V	43K
36V	62K



When the value of Vin is 9~36 Vin, it can use the method which is shown below.

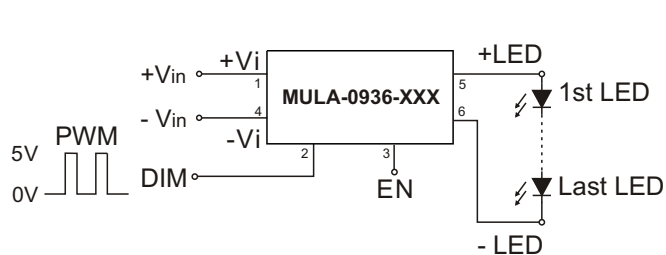
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Typical Application

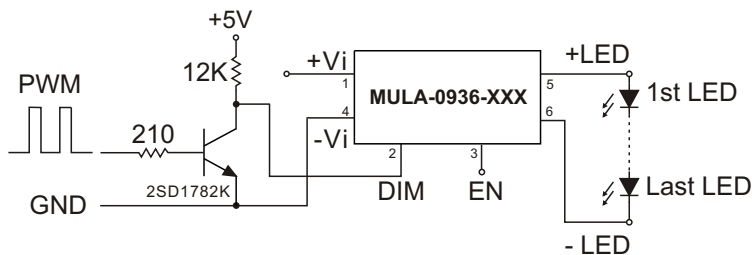
Output Current Adjustment Control By PWM Control

Directly driving DIM input

A Pulse Width Modulated (PWM) signal can be applied to the DIM pin, as shown below

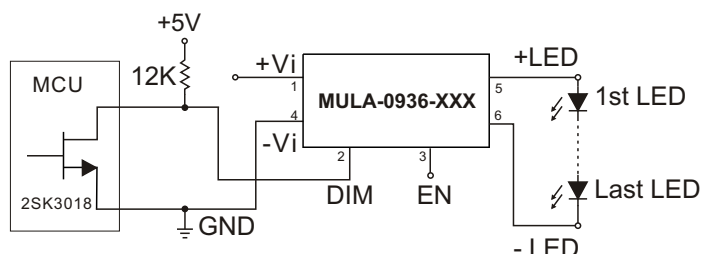


Driving the DIM input via open collector transistor



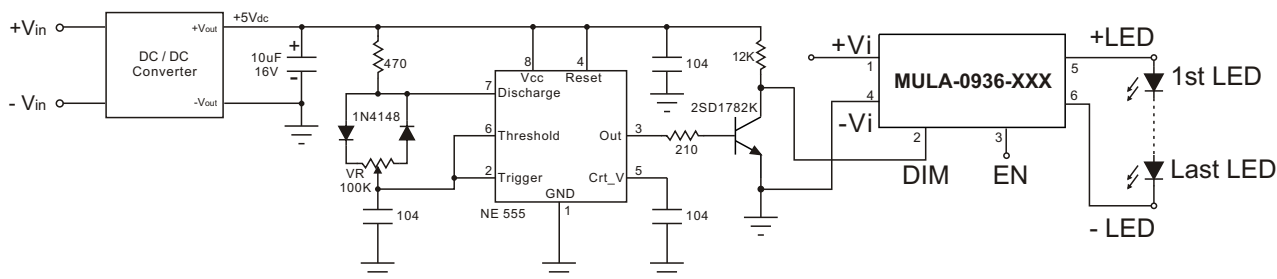
Driving the DIM input from a microcontroller

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

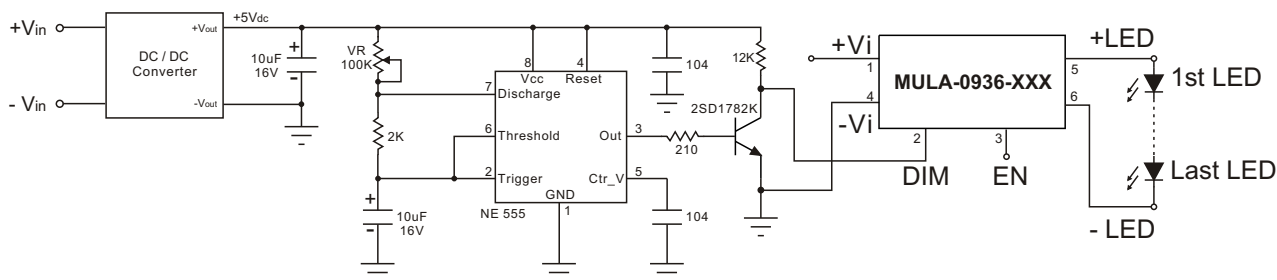


Output Current Adjustment By PWM Control (Dimming)

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



Output Current Adjustment By PWM Control (Flash)



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