RESISTORS FOR LIGHTING APPLICATIONS - Application Note

Increasing safety standards and the growing trend towards more efficient lighting methods have greatly increased the complexity of lighting circuits and placed new stresses upon components.

In a market where customers demand low prices, small physical size, plus the latest safety standards, designers are faced with a difficult task. TT electronics has worked closely with lighting designers and manufacturers to make this task easier.

TT electronics can provide not only standard Metal Film/Oxide and Wirewound resistors, for general non-critical circuitry, but also fusible resistors for circuit protection and pulse withstand resistors capable of withstanding the high surges present during tube start up or strike. TT electronics can also design and manufacture custom resistors to meet specific circuit requirements.

Applications are not limited to fluorescent light ballast circuits, TT electronics can provide resistors for use in any lighting application. Some of the more common applications are detailed below.

- High Intensity Discharge
- Mercury Vapour
- Metal Halide
- High Pressure Sodium
- LED
- UL1412 Recognised

Resistor selected and designed to customer specifications

Available features include:

- **Metal Film**
- **Metal Oxide**
- **Wirewound**
- **Surface Mount**
- **Custom Leadforming**

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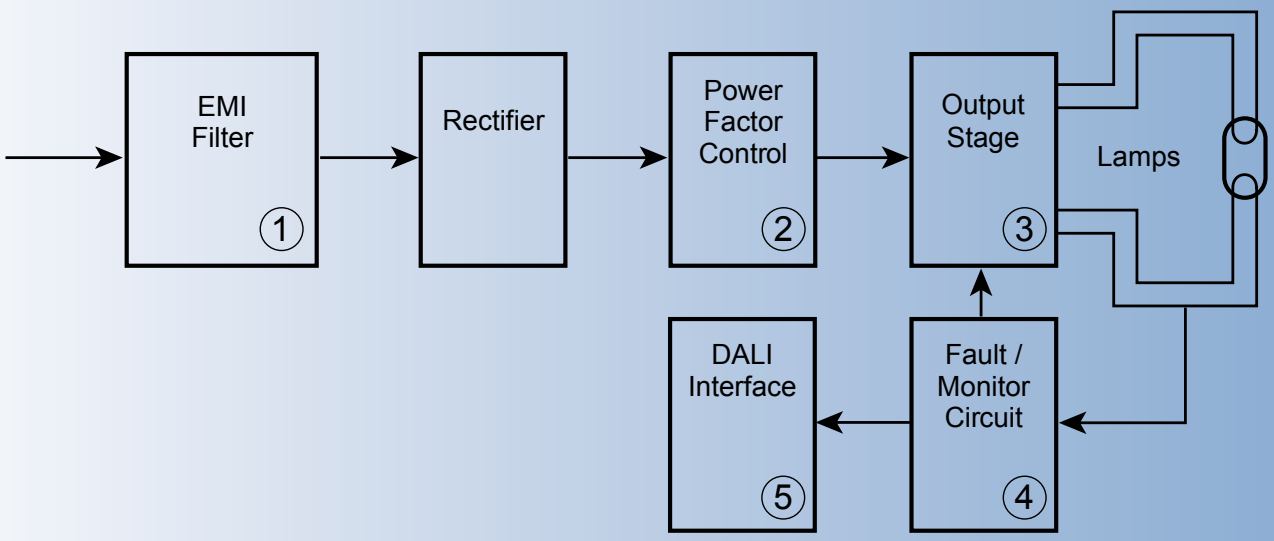
Typical Electronic Ballast Circuit

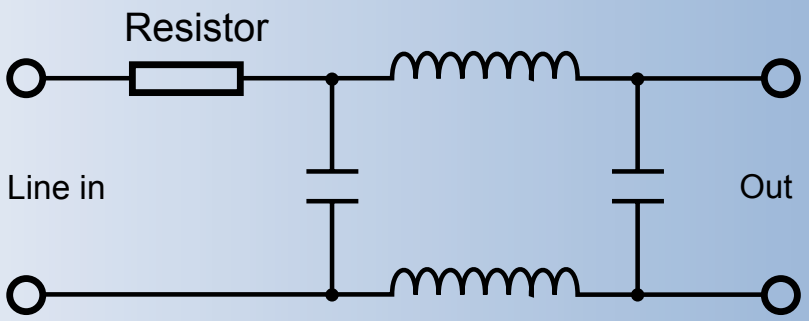


Block Diagram of a Typical Electronic Ballast Circuit

1. EMI Filter

Ballasts have an inrush current during the initial start-up several times greater than their normal operating current and in general electronic ballasts have a higher inrush current than electromagnetic or hybrid ballasts.

Inrush current limiting resistors are designed to withstand these surges but to fuse safely should a fault occur, for example if a capacitor were to go short resulting in a mains short circuit. Typical parts are WP-S, ULW and EMC Series.



EMI filter (example)

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POWER WIREWOUND RESISTORS

WP-S Series

- **Flameproof protection**

Electrical Data

		WP1S	WP2S	WP25S	WP3S	WP4S	WP5S
Power rating at 25ºC	watts	1	2	2.5	3	4	5
Overload Rating (5s)	watts	5	10	12.5	15	20	25
Short pulse performance		Available on request					
Resistance range	ohms	R068 to 430R	R05 to 900R	R05 to 900R	R01 to 2K2	R01 to 10K	R015 to 6K8
Limiting element voltage	volts	50	50	75	100	100	150
TCR	ppm/°C	<1R:350 =1R: 200					
Isolation voltage	volts	250			350	500	
Resistance tolerence	%	<20R: 5 ≥20R: 1, 2, 5				<R10:5 ≥1r10: 1,2, 5	<20R: 5 ≥20R: 1, 2, 5
Standard values		E24 preferred					
Thermal Impedance	°C/watt	140	110	90	82	62	54
Ambient temp range	°C	-55 to +155					

Electrical Data

ULW Series

- **UL1412 recognised fusible resistor**
- **Failsafe mains fusing at 120 / 240Vrms**
- **Inrush and surge withstanding**

		ULW2	ULW3	ULW4	ULW5
Power rating at 25°C	watts	2	3	4	5
5 second overload rating at 25ºC	watts	10	15	20	25
Inrush / surge performance		See Pulse Performance graphs			
Resistance range	ohms	22 to 100	10 to 100	10	4R7-100
TCR	ppm/°C	±200			
Isolation voltage	volts	250	350	500	
Resistance tolerance	%	5			
UL recognised standard values	ohms	22, 33, 47, 68, 100	10, 22, 27, 33, 47, 68, 100	10	4R7, 10, 22, 27, 33, 47, 68, 100
Thermal impedance	°C/watt	110	82	62	54
Ambient temperature range	°C	-55 to +155			

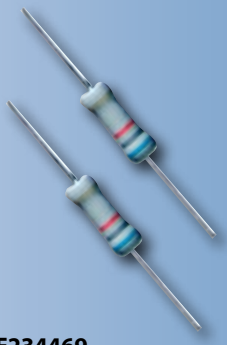
Electrical Data

PULSE WITHSTANDING FUSIBLE FLAMEPROOF METAL FILM RESISTORS

EMC Series

- **UL1412 recognised***
- **Failsafe 240V mains fusing**
- **Good Pulse handling capability**
- **Small size for power rating**
- **UL94-V0 flameproof protection**

*** Values 22R and above. UL file number E234469**



		EMC2
Power rating at 70ºC	watts	2
Resistance range	ohms	4R7-68R
TCR (25 to 75ºC)	ppm/ºC	100
Isolation voltage	volts	500
Resistance tolerance	%	10, 20
Standard values		E12
Thermal impedance	ºC/watt	82
Ambient temperature range	ºC	-55 to +155

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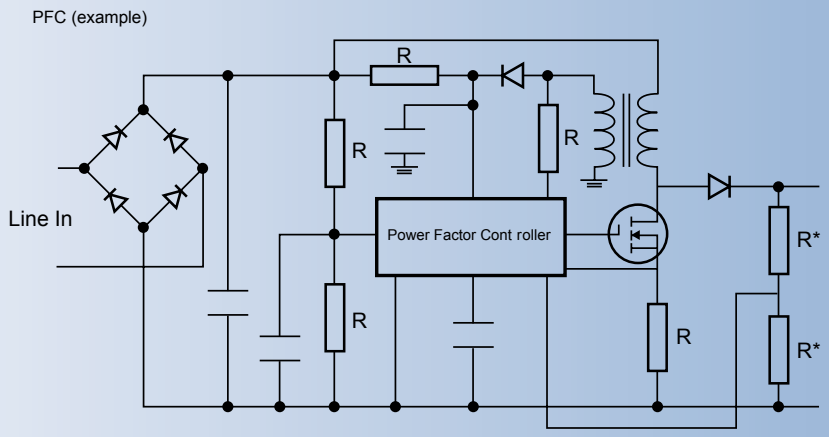
2. Power Factor Control

As a general rule, electronic ballasts use a large reservoir capacitor associated with the bridge rectifier; this results in a low power factor, poor waveshape and harmonic distortion. In order to meet the EN61000 family of standards, designers usually incorporate active or passive circuits to improve the power factor. These circuits contain general purpose parts such as the axial MFP series and surface mount types such as the WCR and PCF series.

The MOSFET source resistor (current sense) would be from the LR family, which has enhanced pulse performance.

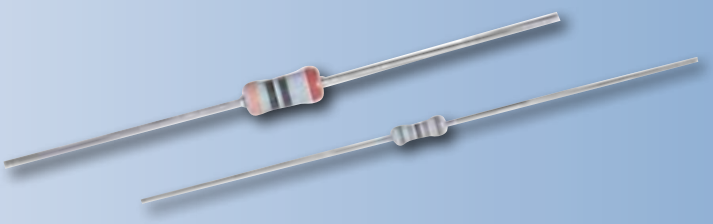


R = Standard Resistors
R* = Possible high Voltage (depending on circuit) resistors

FLAMEPROOF POWER METAL FILM RESISTORS

MFP Series

- **Smallest size for power rating**
- **Resistance range 0.1 ohms to 1M ohms**
- **Flameproof protection**



Electrical Data

		MFP1	MFP2
Power rating at 70ºC	watts	<1 Ω: 0.7 >= W:1.0	2
Resistance range	ohms	0R1 – 1M	1R0 – 1M 1R0 – 1M
Limiting element voltage	ohms	350	
TCR	ppm/ºC	<1 Ω:300 1 Ω – 9.1 Ω: 200 =10 Ω:50	100
Resistance tolerance	%	1, 2, 5	
Standard values		Standard values	
Thermal impedance	ºC/watt	120	82
Ambient temperature range ºC	%	-55 to 155	

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3 & 4. Output/Fault Monitoring

The output and fault/monitoring stages of the ballast can subject components to high electrical stresses; for example a typical fluorescent tube has a strike voltage of 1KV or more, depending on size and operating frequency.

In these conditions a standard resistor is unlikely to be suitable. TT electronics can offer high duty / high voltage types (VRW series), cement coated wirewound resistors with excellent pulse handling properties (SQP series), as well as specially designed pulse withstanding resistors suitable for these applications.

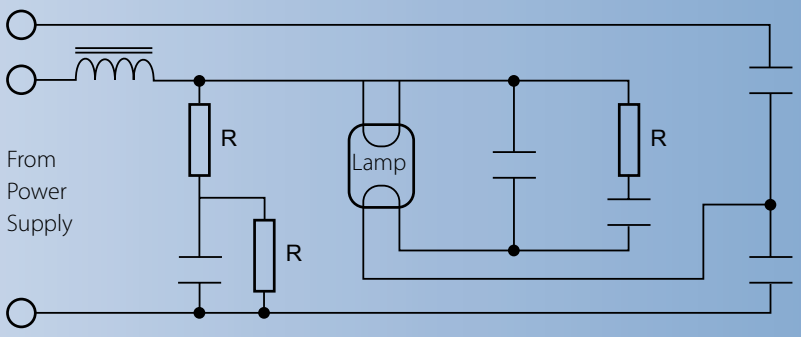
We can also supply surface mount parts with these high performance properties; High Voltage Chip (HVC series), Pulse Withstanding Chip (PWC series).

HIGH VOLTAGE THICK FILM RESISTORS

VRW Series

- **VRW37 is approved to BS/EN/IEC 60065**
- **High working voltage to 3.5kV in compact size**
- **High ohmic range to 30M**
- **High pulse load capacity**
- **Robust flameproof coating material**
- **RoHS compliant**

Possible Output Circuit



R = Possible High Voltage Resistors

Electrical Data

		VRW25	VRW37
Power rating at 70ºC	watts	0.25	0.5
Resistance range	ohms	100K to 30M	100K to 10M
Limiting element voltage	ohms	1600	3500
Isolation voltage	volts	700	
TCR	ppm/ºC	200	
Resistance tolerance	%	1, 2, 5	
Standard values		E24 and E96 preferred	
Thermal impedance	ºC/watt	140	112
Ambient temperature range	ºC	-55 to +155	

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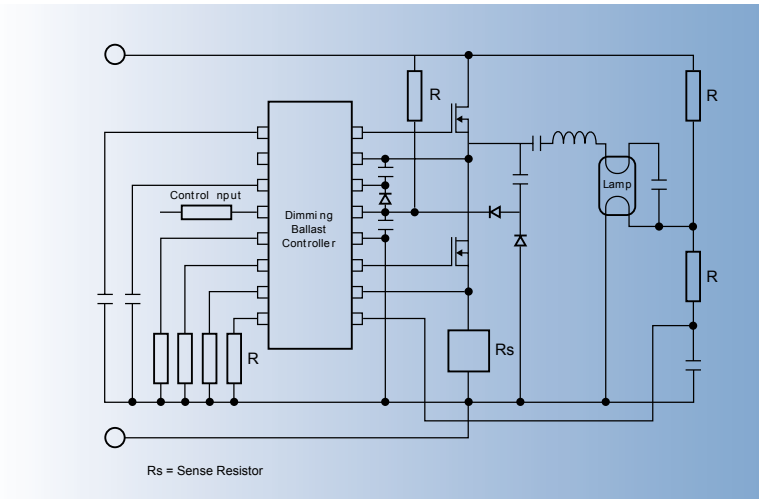
GENERAL PURPOSE CERAMIC CASE RESISTORS – WIREWOUND / METAL OXIDE

SQP Series

- **2 watts to 20 watts**
- **Resistance 0R1 to 100K**
- **High overload capability**
- **Flameproof case**
- **RoHS compliant**

		SQP2	SQP3	SQP5	SQP7/7S	SQP10	SQP15	SQP20
Power rating at 70ºC	watts	2	3	5	7	10	15	20
Resistance range	Wirewound	0.1R-50R	0.1R-100R	0.1R-100R	0.1R-100R	0.1R-200R	0.1R-200R	0.1R-500R
	Metal Oxide (ohms)	51R-47K	110R-47K	110R-47K	110R-47K	220R-68K	220R-68K	510R-100K
Limiting element voltage	Volts dc or ac peak	150	300	350	500 (7S-350)	750	1000	1000
Thermal impedance	ºC/watt	50	45	30	28	23	16	13
Isolation voltage	volts	1000						
TCR	ppm/ºC	WW types, <0R68, 1700ppm; =0R68, 200ppm: MO types all values 350ppm						
Resistance tolerance	%	5 (J)						
Standard values		E24 preferred						
Ambient temperature range	ºC	-55 to +155ºC						



5. Other Applications

TT electronics can also provide resistors for specialised lighting applications, such as the increasingly popular energy saving lamps, high intensity discharge (HID) lamps for automotive use, emergency lighting packs and dimmable fluorescent lighting, an example of the latter is shown here. Dimming ballasts use not only general purpose axial and surface mount resistors as seen in other forms of ballast, but require low value current sense resistors to provide feedback signals for pre-heat, ignition, dimming and fault currents.

TT electronics can offer low value current sense resistors with enhanced pulse performance for surface mount applications (LR series). For lower current, surface mount pulse applications (such as gate drives), the DSC (double sided chip) should be selected.

TT electronics: leading in fixed resistor technology.

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