Avnet Memec-Silica, The Netherlands

Paul Botermans, LED event December 3, 2015

Accelerating Your Success™

LED EVENT 2015 DEN BOSCH 3 december 2015

Acrich-3, The next generation smart lighting LED technology

Agenda:

- Transforming AC line voltage to drive LED's
- History of SSC direct AC technology
- Basic working principles of AC direct driven technology
- Improvements made over the the years
- Smart lighting possibilities going forward
- Some examples of AC direct LED technology

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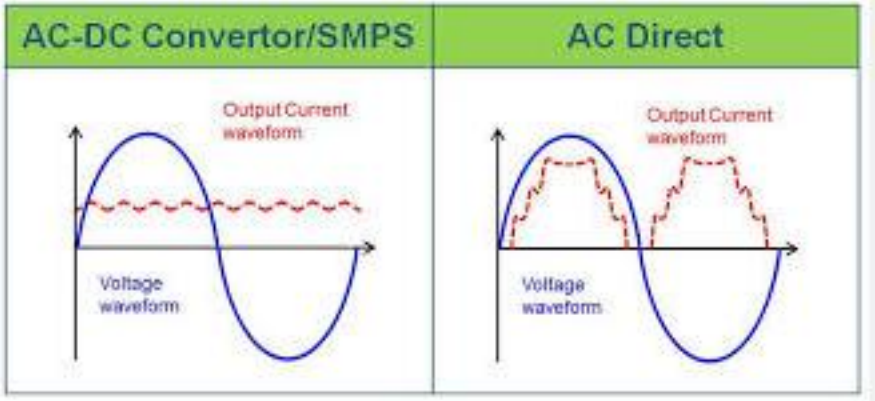
Transforming AC line voltage to drive LEDs

- Basic idea of SSC is to **change the way we drive LEDs** and get rid of using typical SMPS (switch mode power supplies)

- SSC proposal is to use a system that is based in a **sequential mode driver for LEDs** following the mains voltage sinusoidal wave

Basic working principle



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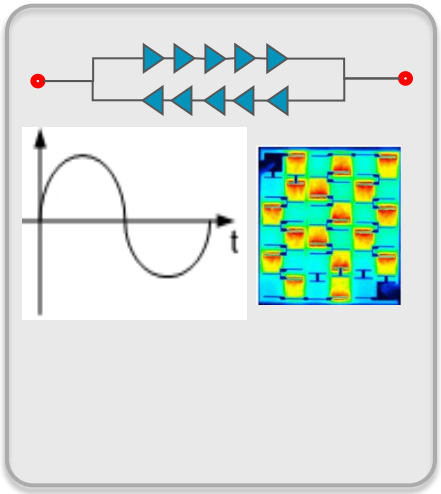
History of Seoul Semiconductor Acrich Technology

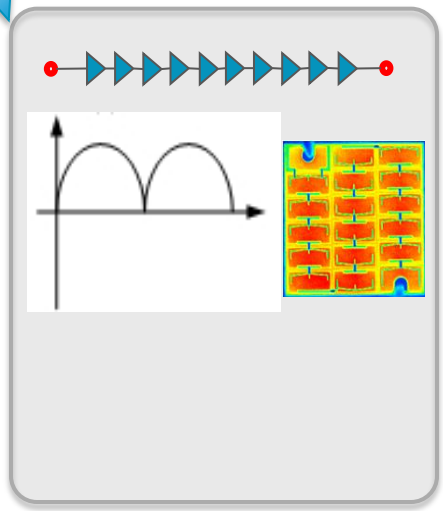
Opto-electrical Efficiency: 50%



Anti Parallel

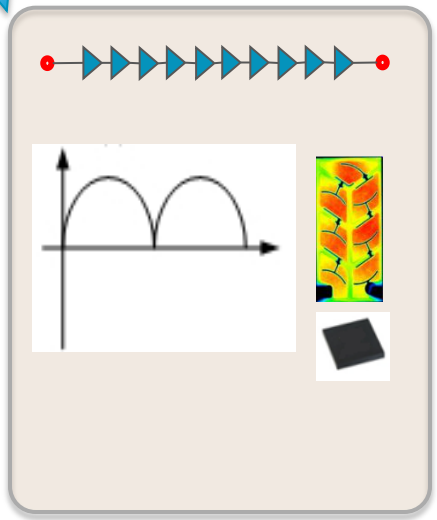
Acriche LEDs 220Vf

Opto-electrical Efficiency: 65%



One direction LEDs + Bridge Diode

Opto-electrical Efficiency: 75%

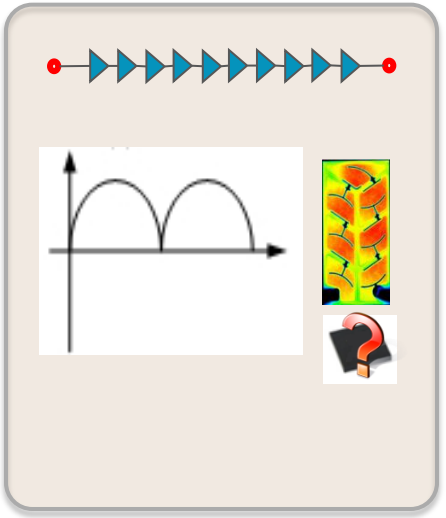


IC Based LED System

Acrich

Acrich 2

Opto-electrical Efficiency: 85%



IC Advanced LED System

Acrich 2.5

Acrich 3.0

Acrich 4.0 ??

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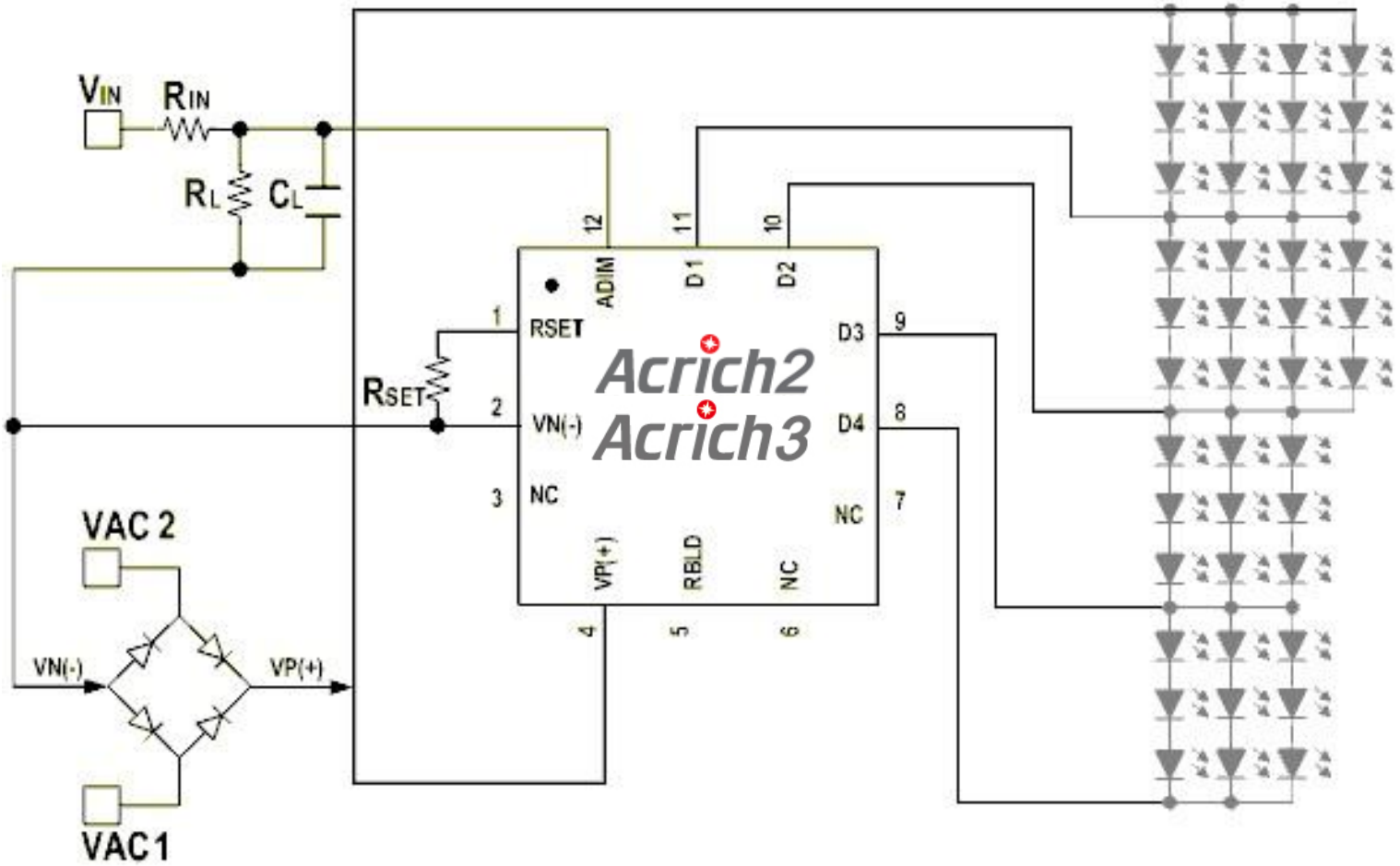
Basic Acrich working system



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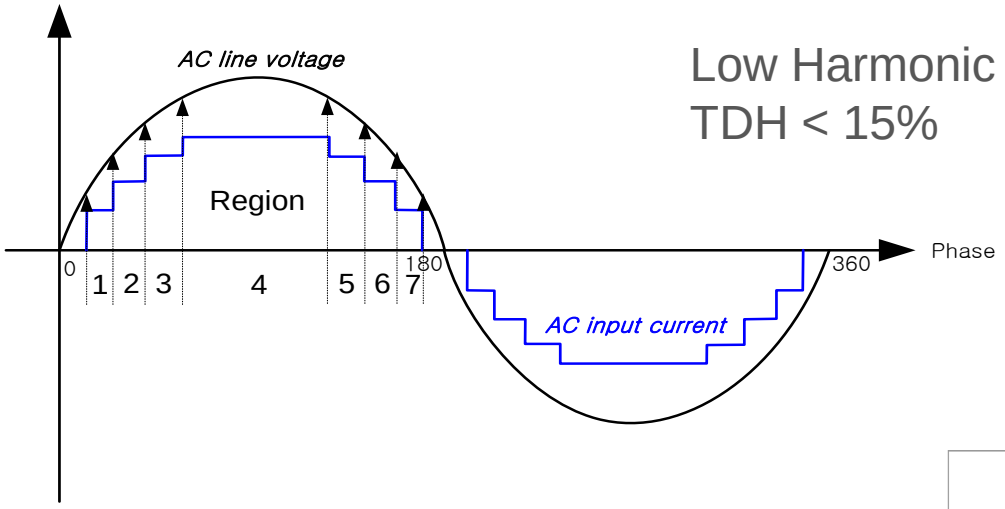
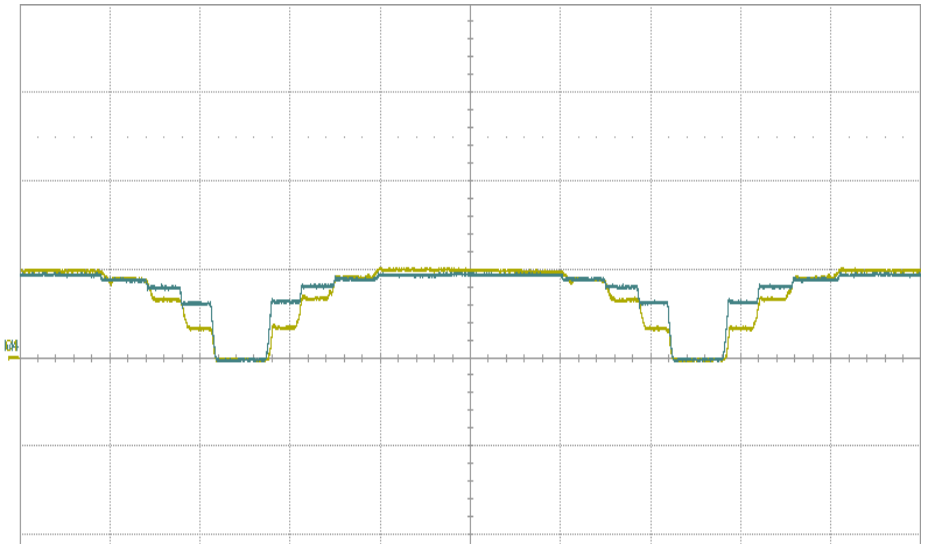
Basic Acrich working system

High Power Factor: PF > 0,97

Low Harmonic Distortion:
TDH < 15%



Voltage and current to the Acrich system



Light output and current in the LEDs of a basic Acrich system

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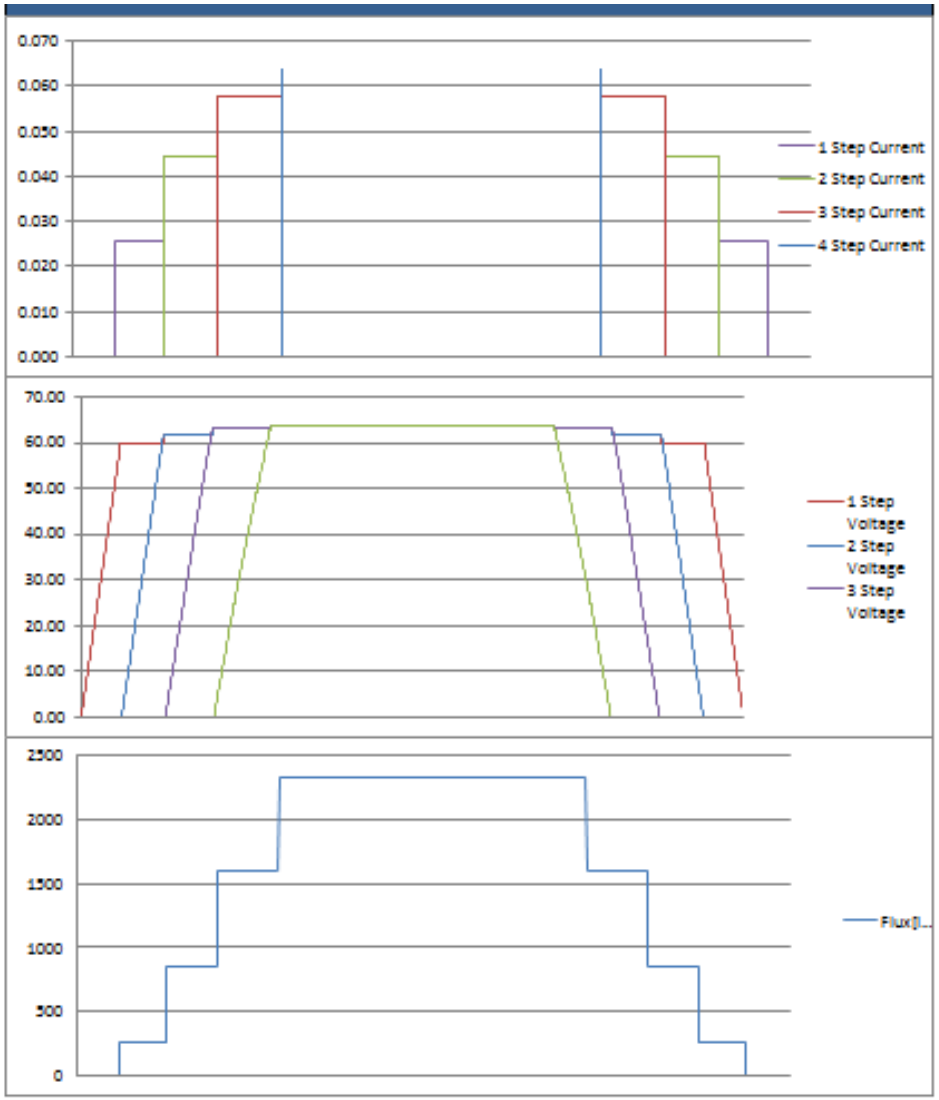
Basic Acrich working system



High Power Factor:
PF > 0,97

Low Harmonic Distortion:
TDH < 15%

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Basic Acrich working system

Acrich 3.0 Module Simulator

1) Design — Product Name

No	Item	Unit	Value				PKG current
1	Input Voltage	V	230				
2	Input Freq.	Hz	50				
3	1 Step LED array's	ea	series	3	parallel	3	17.08
	2 Step LED array's	ea	series	3	parallel	3	16.80
	3 Step LED array's	ea	series	3	parallel	3	15.82
	4 Step LED array's	ea	series	3	parallel	3	13.71
4	R-set	Ω	5000				LED TOTAL 36 EA
5	IC type	B type					
6	PKG type	P/N SAW8KG0B[5630 7Ce			Iv rank	J0 [60.95]	Vf rank A [21.1]

2) Module Specification

No	Item	Unit	Typ	Target
1	Power Consumption	W	12.011	
2	Luminous Flux	lm	1386.22	
3	Acrich Module Efficacy	lm/W	115.41	
4	Power Factor	PF	0.989	
5	Circuit Efficacy	%	84.72%	

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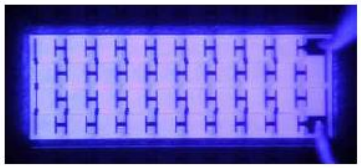
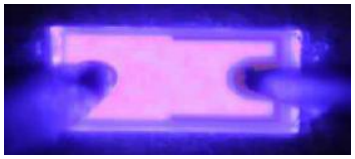
Basic Acrich working system

Development of the **M**ulti **J**unction **T**echnology LEDs Patented by SSC in 2007



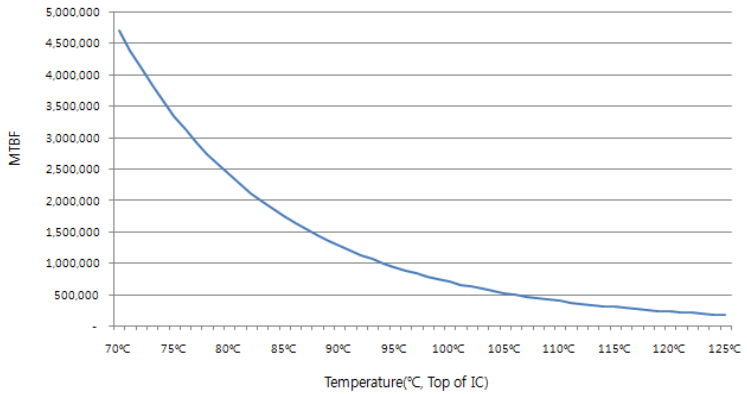
MJT LED

Example with
21 cells x 3Vf = 63Vf



Typical DC LED
1 cell x 3Vf = 3Vf

Longer lifetime of Acrich system compared with a SMPS driver



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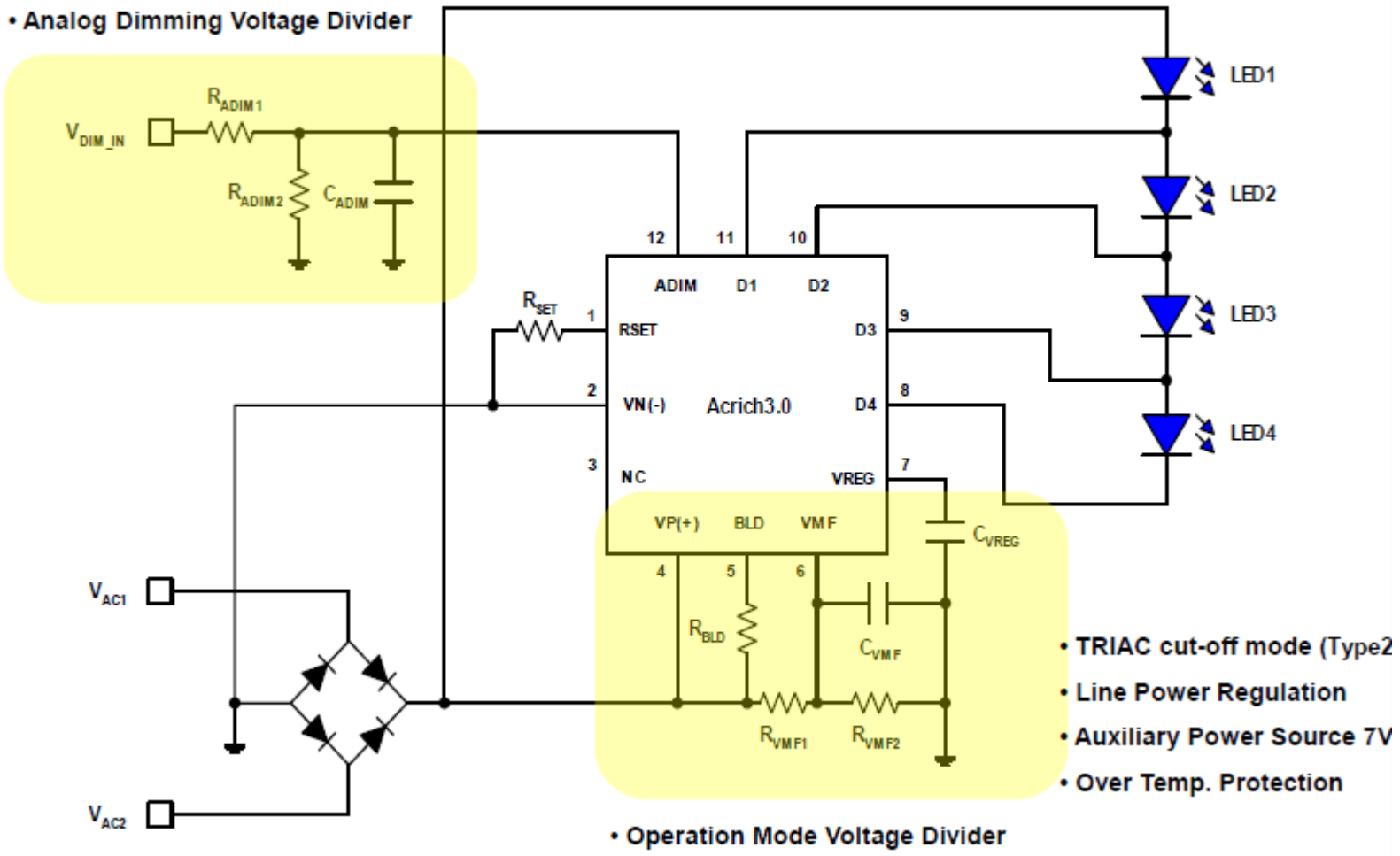
Improvements made



Improvements made, Analog

Analog dimming 0-10V / PWM

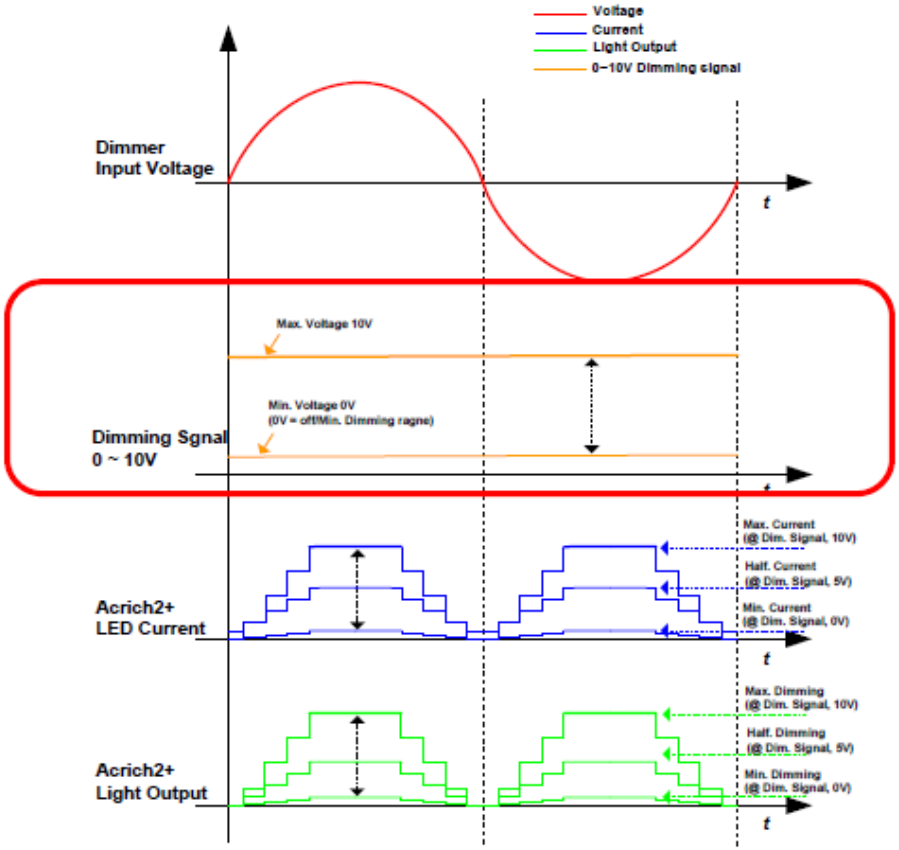


Figure 1. Analog Dimming Timing chart

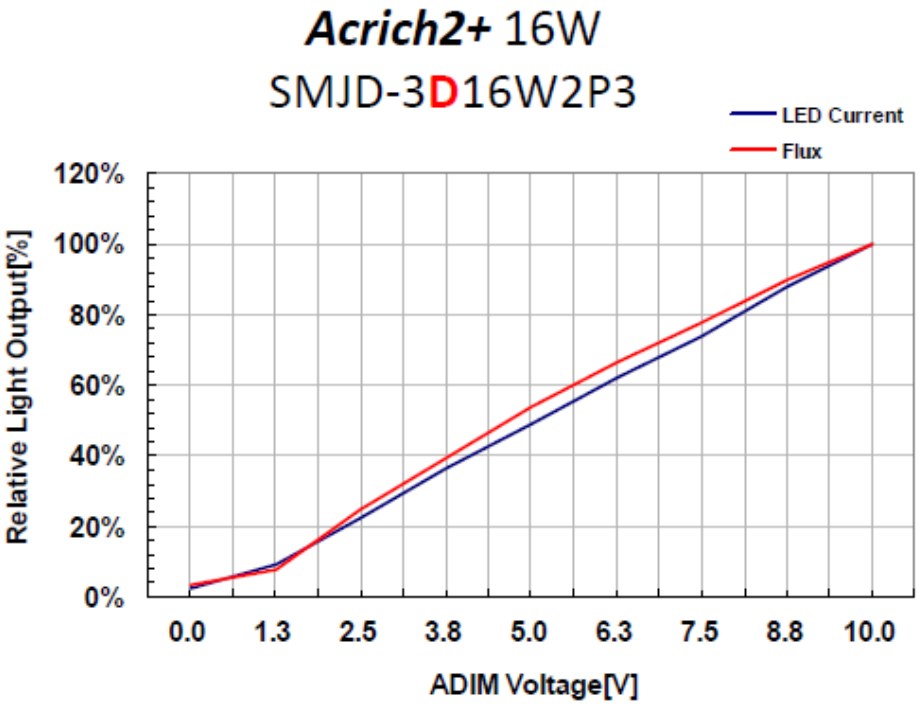


Figure 2. Analog Dimming Curve
(Measurements performed at *Acrich2+* 16W Module)

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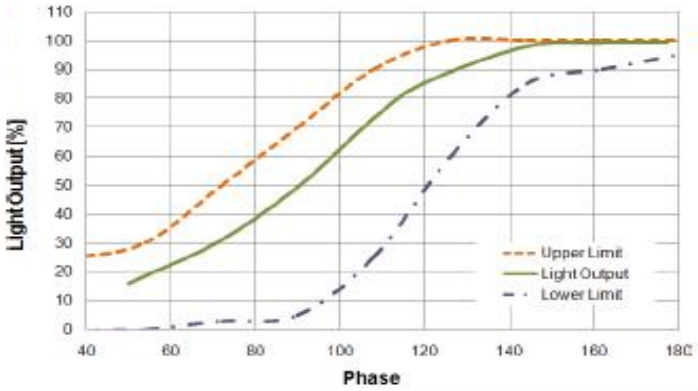
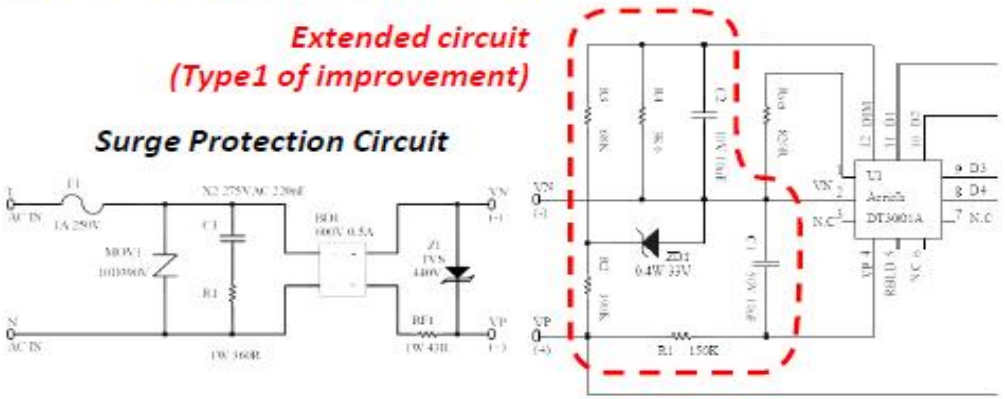
Improvements made, TRIAC

Improved solution on module level is compatible with *NEMA SSL-6*

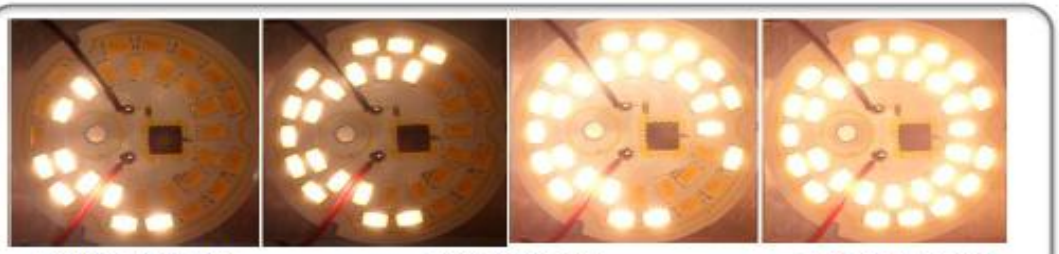


Extended circuit
(Type1 of improvement)

Surge Protection Circuit

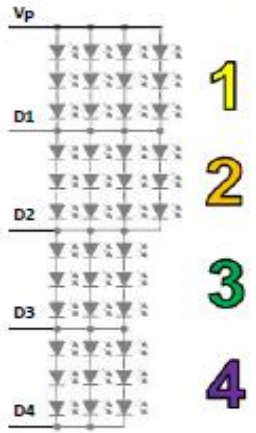


Regular



Improved

Example LED Array:



(4 groups of LEDs)

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Improvements made, Flickering

- Percent Flicker = 100*(A-B) / (A+B)
  - ✓Described in early versions of the IESNA Handbook
  - ✓Percent modulation of the intensity waveform
  - ✓Range is from 0% to 100%
  - ✓0% is a pure DC waveform
  - ✓100% would occur when the range extends to 0 light output at any time during the waveform
  - ✓Does not include information about the duty cycle

- Flicker Index = Area 1 (Area 1 + Area 2)
  - ✓Relates the area under the curve above the average light intensity to
  - ✓the area under the curve below the average light intensity.
  - ✓Range is from 0 to 1.0
  - ✓0 is a pure DC waveform
  - ✓1.0 can only occur with the most dramatic changes in light output Includes the effects of duty cycle

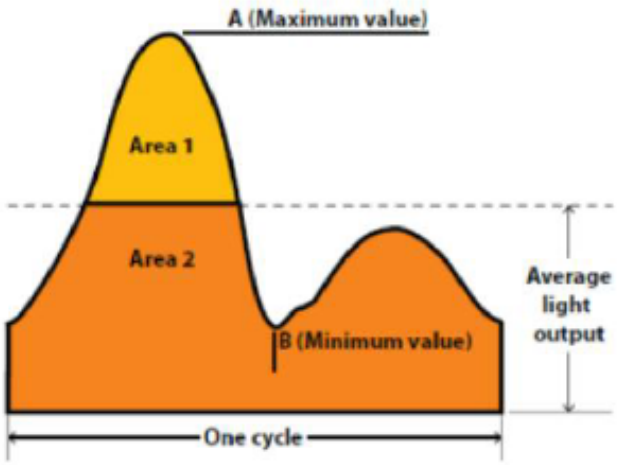

Figure 1. Defining Flicker Index and Percent Flicker (IES Lighting Handbook, Kaufman, 1984)

$$Percent\ Flicker = \frac{(Max - Min)}{(Max + Min)} \times 100$$

$$Flicker\ Index = \frac{(Area\ 1)}{(Area\ 1 + Area\ 2)}$$

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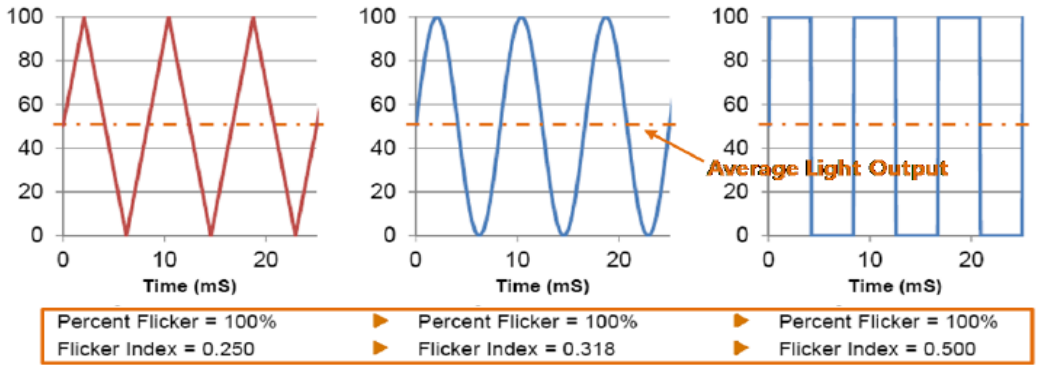
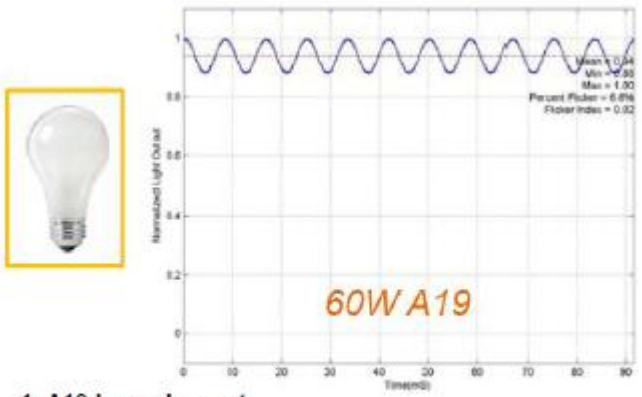
Improvements made, Flickering

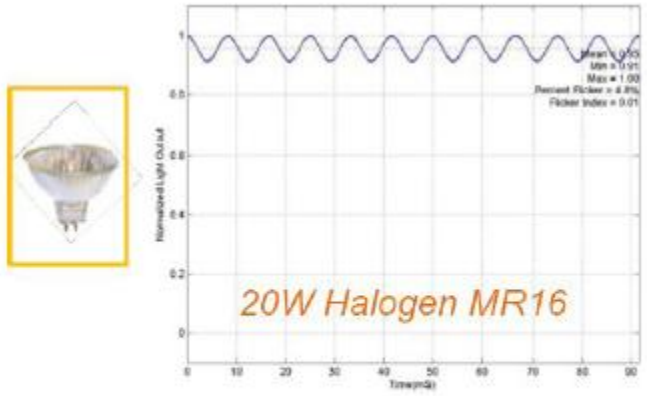




1. A19 Incandescent

Flicker Index: 0.02

Percent Flicker: 6.6%



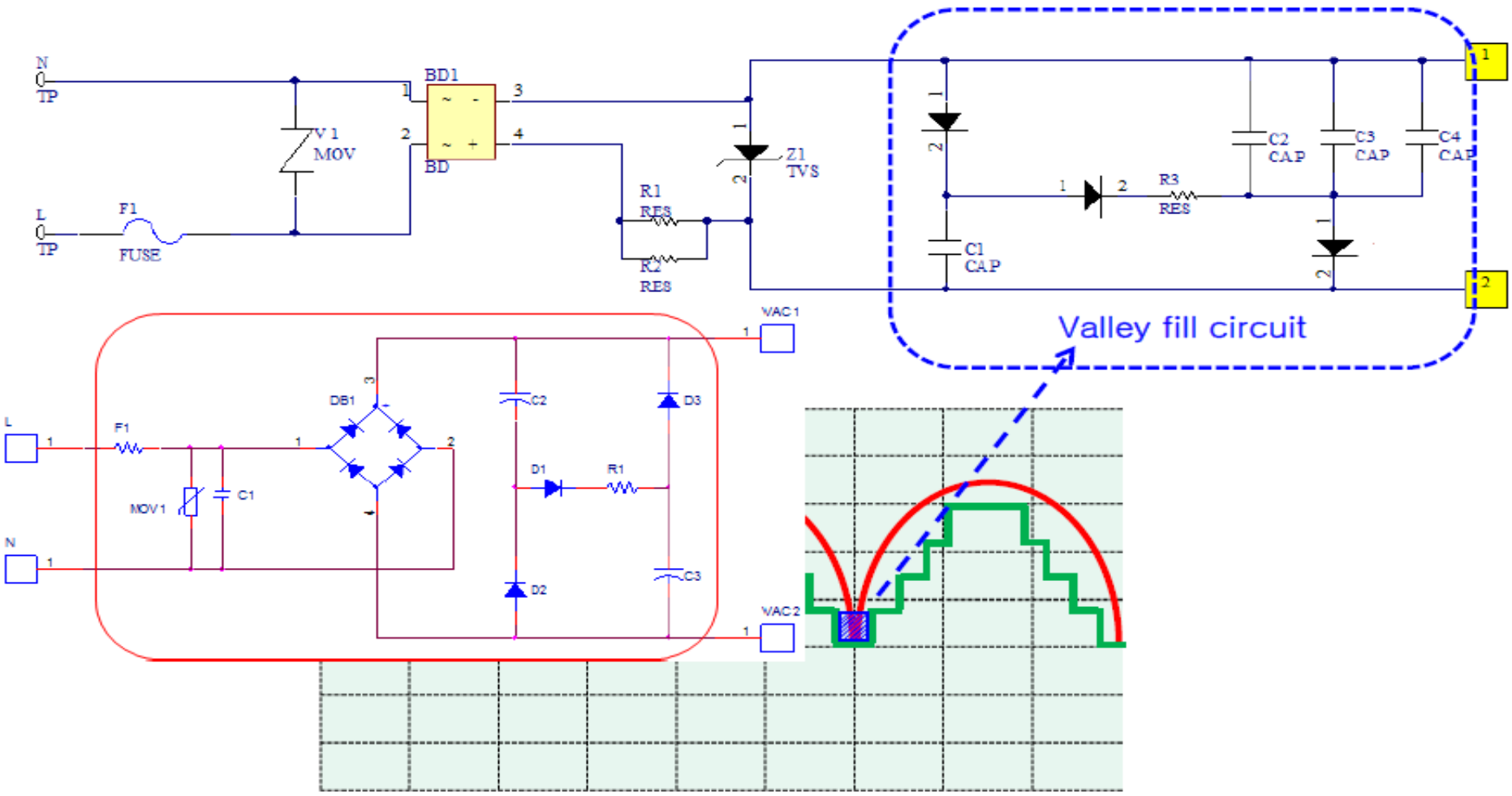
4. R20 Halogen

Flicker Index: 0.04

Percent Flicker: 13.4%

Improvements made, Flickering

Valley fill circuit to meet PSE regulation



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Smart Lighting Solutions

Controllers

Bluetooth® SMART

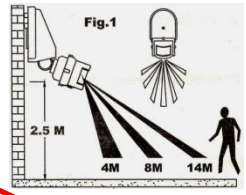
DALI

KNX

0-10V

TRIAC

Autonomous systems - Sensors



Movement sensor

Lighting sensor

Noise sensor

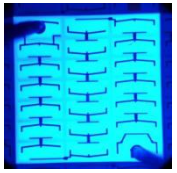
Magnetic sensor

...

Acrich3

Semiconductor EcoLight

LED



MJT LEDs for best compact solutions

Design freedom

Reduced mechanic parts

Low cost than DC solution

Electrical solutions

PF>0.95

AC/DC Output 7V 5mA

FLICKER FREE

Power Compensation

Thermal security

Low THD

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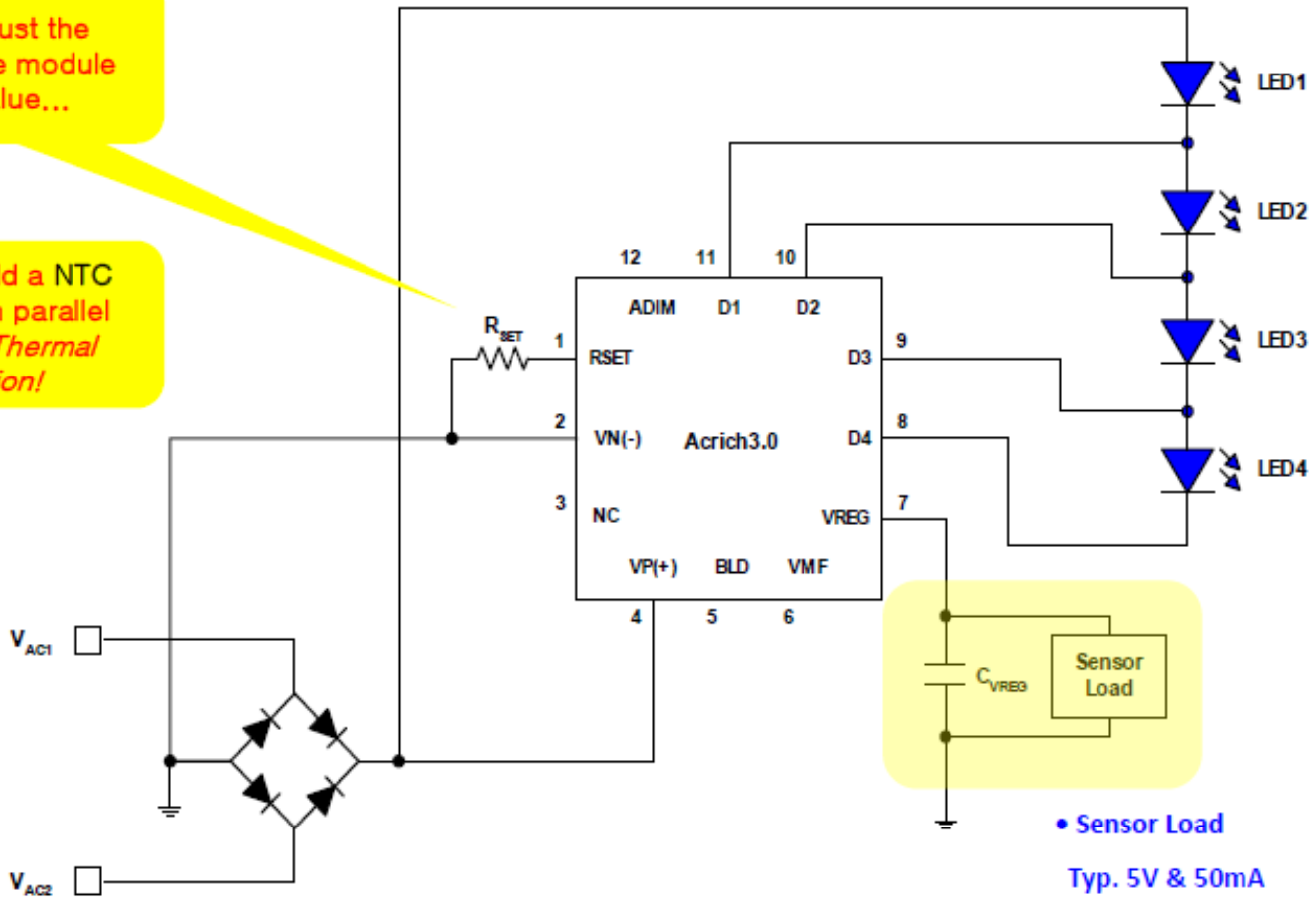
Smart Lighting Solutions

You can adjust the power of the module with Rset value…

…so and add a NTC thermistor in parallel to Rset for *Thermal Compensation!*



- Sensor Load

Typ. 5V & 50mA

Movement sensors, Light sensors etc.

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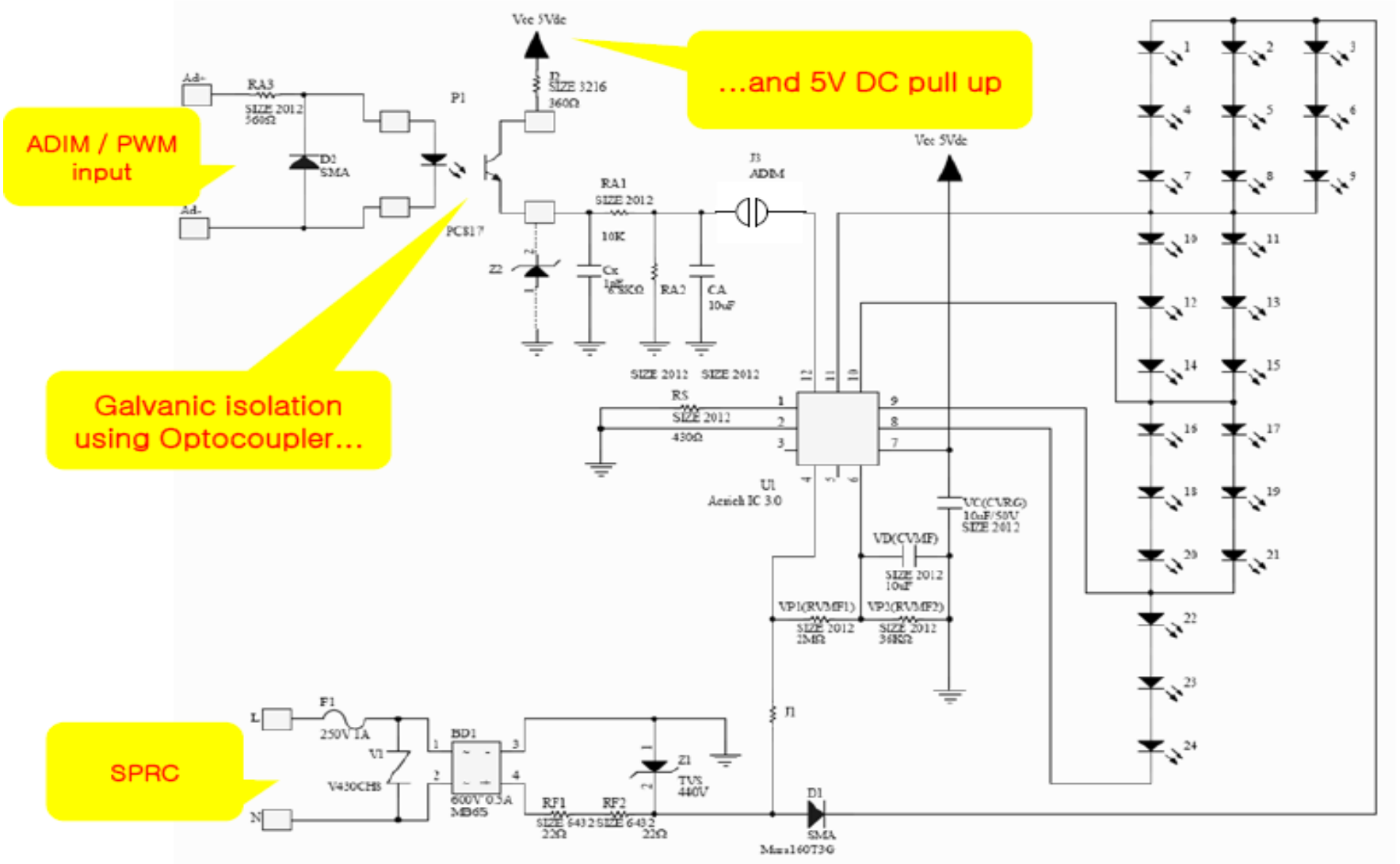
Smart Lighting Solutions



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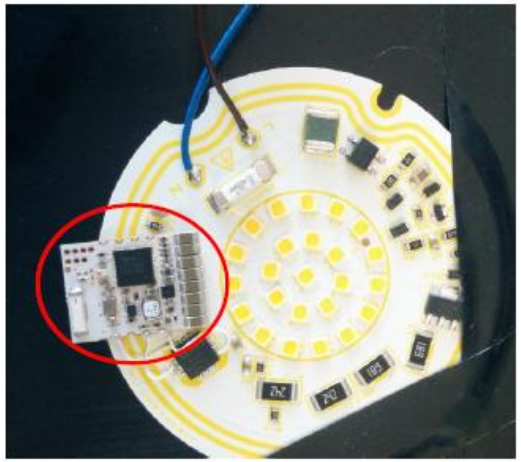
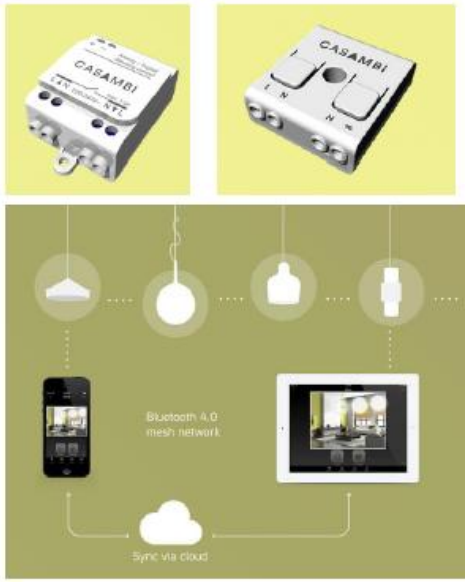
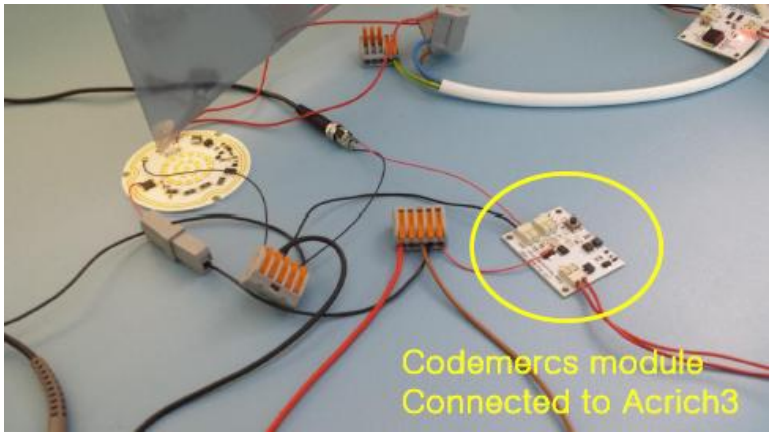
Smart Lighting Solutions, examples

Smart solutions with Acrich 3.0 system (BLE, DALI, 0-10V, PWM, sensors…)



Casambi module
Connected to Acrich3





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Why AC direct technology?

1. Small form factor compared with a SMPS for the same power
2. All on board system → LED + Driver + Controller → all in one PCB
3. Lifetime of the system is based on LED lifetime, the driver is no more the weakest part
4. Fast time to market
5. Reduced system cost
    - Less mechanical parts
    - Easy and fastest assembly
    - Cheaper driving technology
6. Compliant with international regulations
7. Less components compared with a SMPS driver
8. Compatible with an external world of controllers and smart systems

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