



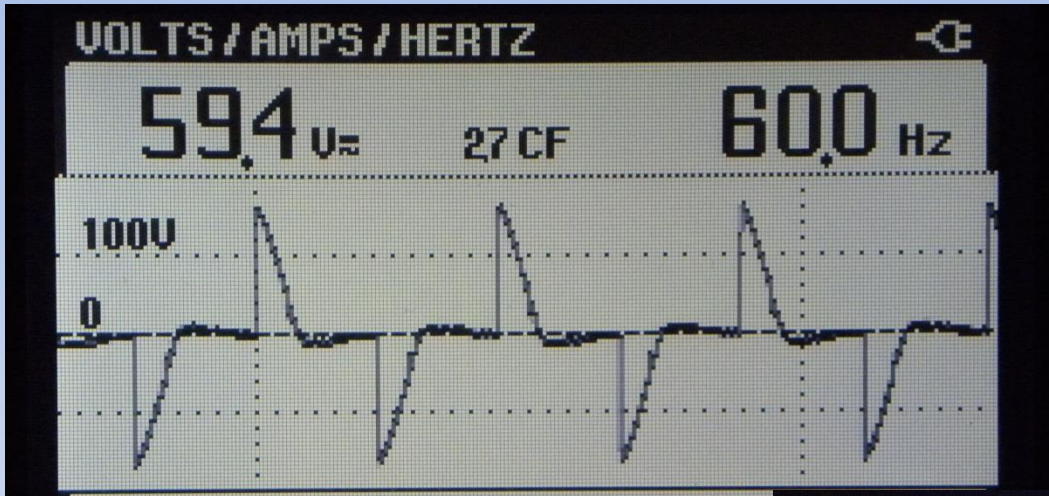
# LEDs and Dimming, etc.

And you thought they were just  
another light bulb.....

# Existing Types of Dimming Systems

- Wall Box Dimmers – various ages and performance levels
- Smart Wall Box Dimmers – Lightolier Multi-Set (Original Tuscan Farmhouse and some Red Lobsters)
- Marlin
  - Analog (the original Marlin – 4 white knobs) (SCR)
  - Digital – same dimming technology – only smarter. (SCR)
  - SMP (Small panel, little used) (TRIAC)
  - Stellar – same cabinet as analog and digital, easy retrofit. Can select either MOSFET or TRIAC module based on load type and need for Forward or Reverse Phase dimming.
- Lutron
  - Typically embedded in CPI cabinets
  - Either a 2D or 4A module
    - 2D capable of 2 outputs each at 16 amps, aggregate of both 16 amps. Forward Phase AND switching. (TRIAC)
    - 4A capable of 4 outputs each at 10 amps, aggregate of all 4 16 amps. Reverse Phase and Forward Phase dimming – no switching (MOSFET)

# Two Primary Dimming Signals

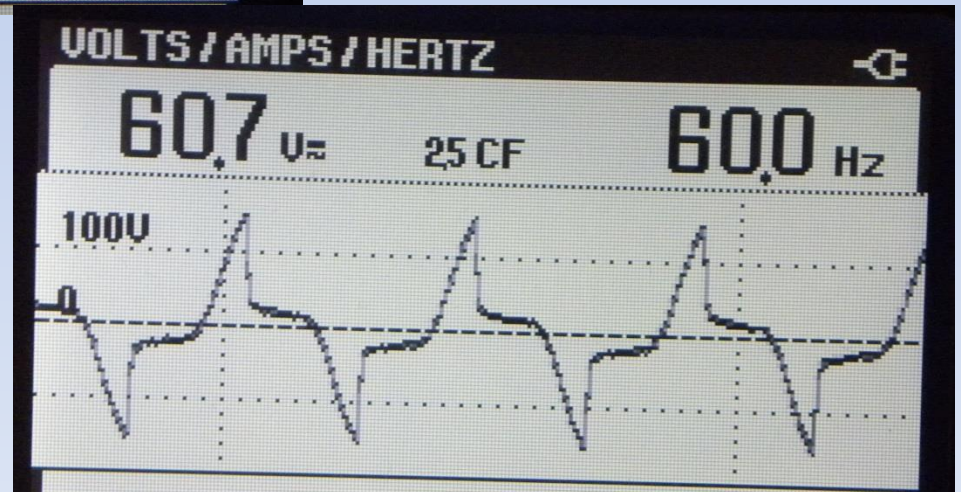


## Forward Phase

TRIACs	Incandescent
SCRs	And
MOSFETs	Magnetic Loads

## Reverse Phase

MOSFETs  
Incandescent  
And  
Electronic Loads



# Dimming LEDs

- Challenges
  - ‘Dimmable’ printed on the side of a box – don’t make it so.
  - LED lamp manufacturers appear to have little or no understanding as to how dimming works
  - When dimming LEDs – even the ones that work well:
    - Stepping
    - Limited dimming range
    - Equivalent Incandescent Rating – for dimming calculation.

# Lutron Report Cards

## Manufacturer's Description

Type of Fixture: Recessed Downlight  
 Operating Voltage: 120 Vac  
 Input Power: 12 W  
 Current: Not Specified  
 Frequency: 60 Hz  
 Control Types: Standard Incandescent Dimming  
 Dimming Range: 25% - 100% (one fixture)  
 Output Power: N/A  
 Lumens: 650 lumens

## Lutron Test Results

Date Tested: Feb 25, 2009  
 Model Number Tested: LR6C  
 Smooth and Continuous: Yes  
 Test Notes:

## Lutron Recommended Compatible Products

Product	Part Number	Fixtures per Dimmer	Measured Light Output Range <sup>(1)</sup>	Comments
Nova	NLV-600	1 – 8	22% - 90%	Low-end trim available
Nova T*	NTLV-400VA-CPN0199	1 – 8	22% - 90%	Low-end trim available
Skylark	SF-10	1 – 12	22% - 90%	Low-end trim available
RadioRA2	RRD-10ND	1 – 12	21% - 90%	Low-end trim available
RadioRA2	RRD-10D	3 – 12	21% - 90%	Low-end trim available
RadioRA2	RRD-6D	3 – 8	21% - 90%	Low-end trim available
RadioRA2	RRD-8ANS	1 – 12	100%	
<b>Homeworks</b>	HRD-6ND	1 – 8	21% - 84%	Low-end trim available
	HWD-6ND	1 – 8	21% - 84%	Low-end trim available
	HW-RPM-4A-120	1 – 16 per output	23% - 100%	Max. 25 per module Low-end trim available
<b>Commercial Systems</b>	LP-RPM-4A-120	1 – 16 per output	23% - 100%	Max. 25 fixtures per module Low-end trim available
<b>Interfaces</b>	FDI-FTU <sup>(2)</sup>	1 – 16	23% - 96%	Low-end trim available

<sup>(1)</sup> Values are based on light output using the specified dimming control, and may not be an indication of the fixture's full capability

<sup>(2)</sup> Controlled with Ariadni, Diva, Lyneo Lx, Nova, Nova T\*, Skylark, Vareo, or Verti Fluorescent dimmers.

**Comments:** Due to a high Repetitive Peak Current spike, each fixture should be perceived as 75 W for dimmer loading purposes.

The high current spike of a single fixture may create acoustic noise in the dimmer, which will increase as fixtures are added to the systems. A single fixture can be dimmed to 20%. However, the low end would need to be raised to provide consistent operation of multiple fixtures, as well as, help maintain the fixtures' operation in applications where line noise is a problem. This higher low-end value would set the low-end output nearer to 25%.

The ability to set the low-end trim is available on select 3-Wire Fluorescent dimmers, Homeworks, and Commercial Systems products. Refer to product documentation or [www.lutron.com](http://www.lutron.com) for details.

# Nomad Group Testing



Same Lamp – Forward and then Reverse Phase Dimming

# Nomad Group Testing

## Sample PAR 20 Lamps

	SAMPLE A		SAMPLE B		SAMPLE C	
	Reverse Phase	Forward Phase	Reverse Phase	Forward Phase	Reverse Phase	Forward Phase
Min Stable Light output Vrms	37.7	39.1	28.5	21.7	23.7	27
Min Stable Light output %	1%	10%	1%	1%	1%	5%
Maximum Light output Vrms	116	118	117	118.9	114.5	114.5
Foot candles @ minimum @ 76"	<1	<1	<1	<1	3	11
Foot candles @ maximum @ 76"	55	57	29	24	76	76
EQ Inc Load (watts)	6	60	15	15	15	60
Repetive peak current	0.2	2	0.5	0.5	0.5	2
Stepping begins at Vrms	90		60		60	



# MR16 LED – Lutron Dimmers

## Same Lamp – Different Transformers

	Lutron 2D Lightolier MLV					Lutron 2D Contech MLV				
	% Out	FC	Amps	VRMS	Notes	% Out	FC	Amps	VRMS	Notes
Strike	10%	2.9	0.2	24		8%	1	0.2	22	Pulsing
No Flicker LL	10%	2.9	0.2	24		14%	10	0.2	29	
Maximum LL	70%	138	0.4	99		70%	115	0.4	100	
Full Output	100%	137	0.7	119		100%	115	0.4	118	
Useable Dimming Range	10-70%		24-99Vrms		2.9-138fc	14-70%		29-100Vrms		10-115fc

	Lutron 4A Lightolier MLV					Lutron 4A Contech MLV				
	% Out	FC	Amps	VRMS	Notes	% Out	FC	Amps	VRMS	Notes
Strike	1%	1	0.2	22	Pulsing	1%	<1	0.2	22	Pulsing
No Flicker LL	16%	32	0.3	42		18%	32	0.3	45	
Maximum LL	64%	134	0.4	99		70%	115	0.4	102	
Full Output	100%	134	0.7	121		100%	115	0.4	117	
Useable Dimming Range	16-64%		42-99Vrms		32-134fc	18-70%		45-102Vrms		32-115fc

	Lutron 4A Lightolier ELV TRACK				
	% Out	FC	Amps	VRMS	Notes
Strike	11%	<1	0.1	33	Strobe
No Flicker LL	32%	53	0.2	60	
Maximum LL	85%	165	0.3	108	
Full Output	100%	165	0.3	113	
Useable Dimming Range	32-85%		60-108Vrms		53-165fc



# MR16 LED – Wall Box Dimmers

## Same Lamp – Different Transformers

	Lyneo LXLV-10PL-AL - Lightolier MLV				Lyneo LXLV-10PL-AL - Contech MLV			
	FC	Amps	VRMS	Notes	FC	Amps	VRMS	Notes
Strike	17	0.2	32		11	0.2	32	
No Flicker LL	49	0.3	48		45	0.3	58	
Maximum LL	167	0.5	113		100	0.4	115	
Useable Dimming Range	49-167fc		48-113Vrms		45-100fc		58-115Vrms	

	Skylark SLV-600P-WH - Lightolier MLV				Skylark SLV-600P-WH - Contech MLV			
	FC	Amps	VRMS	Notes	FC	Amps	VRMS	Notes
Strike	9	0.3	28		7	0.3	29	
NoFlicker	34	0.3	41		27	0.3	45	
Maximum	169	0.5	114		101	0.4	115	
Useable Dimming Range	34-169fc		41-114Vrms		27-101fc		45-115Vrms	

	Lyneo LXELV-600PL-AL - ELVTrack				Skylark SELV-300P-WH - ELVTrack			
	FC	Amps	VRMS	Notes	FC	Amps	VRMS	Notes
Strike	4	0.1	38		3	0.1	37	
NoFlicker	55	0.2	61		65	0.2	68	
Maximum	174	0.3	117		170	0.3	114	
Useable Dimming Range	55-174fc		61-117Vrms		65-170fc		68-114Vrms	

# LEDs in the Future

- The future looks bright – even brighter, and flicker free!
- Remember the ‘Brick Phone?’
- The LED is NOT a light bulb – it is Technology.

# Plan 'Review'

When we look at plans related to lighting we are trying to make sure they reflect the intent of the owner AND that they are – to the best of our ability – not boxing themselves in to future options.

- Type of fixture – electrical characteristics
- Function of fixture – table, wall, walkway, etc.
- Room/other consideration
- Loading of dimming module

# Control Relay Outputs

RELAY	Longhorn			Olive Garden			Red Lobster		
	Control	Time On	Time Off	Control	Time On	Time Off	Control	Time On	Time Off
1	All Signs LED Band	11:00 AM	Sunrise	Signs	PHC 5 or less	Alarm Armed +15 Min	Signs	PHC 5 or less	Alarm Armed +15 Min
2	Exterior Building Lights	Sunset	Alarm + 15 min	Building Lights/ Parking	PHC 6 or less	Alarm Armed +15 Min	Building Lights	Sunset	Alarm Armed +15 Min
3	Exterior Sconces at Front Door	11:00 AM	Alarm + 15 min	Security	PHC 5 or less	PHC 5 or more	Parking	Sunset	Alarm Armed +15 Min
4	Parking Lights	Sunset	Alarm + 15 min	Hot Water Recirculating Pump	Alarm Disarmed	Alarm Armed +15 Min	Flag Pole/Security	Sunset	Sunrise
5	<u>Security Lighting</u> a. Service Yard Lighting b. Front Canopy Down Lights c.	Sunset	Sunrise				Hot Water Recirculating Pump Restroom Exhaust Fans	Alarm Disarmed	Alarm Armed
6	Interior - non-Guest Occupied a. Restroom Fans b. Hot Water Circulating Pump c.	Alarm Off	Alarm + 15 min						
7	Interior - Guest Occupied a. Bar Lights b. Restroom 'H' Fixtures	10:45 AM	Alarm + 15 min						

# Interior Lighting Control

	Longhorn	Olive Garden	Red Lobster
Panel Size and Type	Lutron 7x4A	Lutron 8x4A	Lutron 6x4A
SCENES			
On (All lights 90%)	Manual	Manual	Manual
Lunch/Day	10:45 AM	10:45 AM	10:45 AM
Dusk	PHC 6 or less	PHC 6 or less	Sunset - 1 hour
Dinner	PHC 5 or less	PHC 5 or less	Sunset
Prep/Clean (no décor lts)	ADT Disarmed	ADT Disarmed (Individual occupancy sensors control lights until 10:45AM)	ADT Disarmed
Over Night/GO Home	ADT Armed + 15 Min If alarm activates all lights on	ADT Armed + 15 Min If alarm activates all lights on	ADT Armed + 15 Min If alarm activates all lights on
OFF (All lights 0%)	Manual	Manual	Manual
RESTROOM LIGHTING			
Occupied (no guests)	No lights on Down lights come on with motion	25% Minimum 70% upon motion	Single fixture inside door wired to hallway lighting, on during all occupied times. All other lights come on to programmed dim level via switching through relay upon motion
Occupied (w/guests)	H fixtures over mirror on during this period. Downlights come on with motion	On per programmed light level (typically 70%)	Same as above

# Typical HVAC Controls

	Longhorn	Olive Garden	Red Lobster
Back of House	<u>1 RRU</u> Supply Duct Sensor Space Temperture Sensor Trane Combination Temp/Hum Sensor direct to RRU	<u>2 RTU</u> Supply Duct Sensor Space Temperature Sensor	<u>1 RTU</u> Supply Duct Sensor Space Temperature Sensor <u>1 RRU</u> Supply Duct Sensor Trane Combination Temp/Hum Sensor
Front of House	<u>3 RTU</u> Supply Duct Sensor Space Combination Temp/Hum Sensor <u>1 RRU</u> Supply Duct Sensor Trane Combination Temp/Hum Sensor	<u>4 RTU</u> Supply Duct Sensor Space Combination Temp/Hum Sensor	<u>2 RTU</u> Supply Duct Sensor Space Combination Temp/Hum Sensor <u>1 RRU</u> Supply Duct Sensor Trane Combination Temp/Hum Sensor