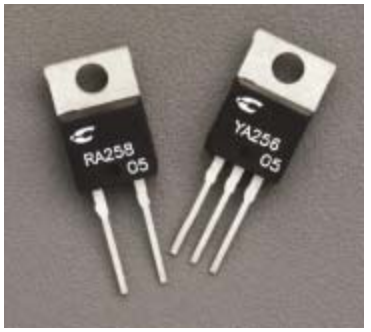
PHILIPS

Strand Lighting
Dimming Technologies

Forward Phase
Reverse Phase
Sinewave

Good - SCR & TRIAC Power Devices

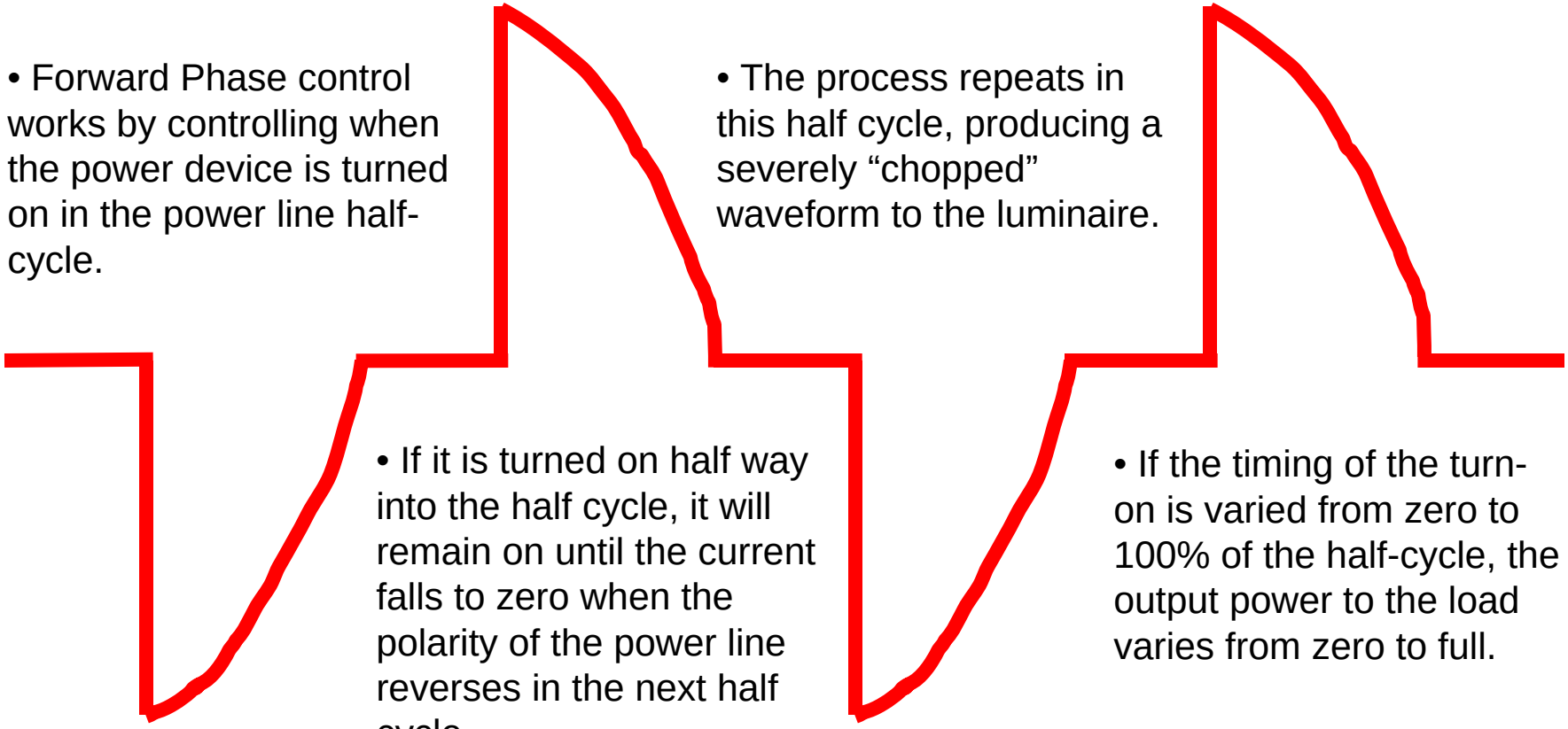


- Since the 1950's, lighting manufactures have built FPC (forward phase control) dimmers based on Silicon-controlled rectifier (SCR) and TRIAC power technology.

- These technology has dominated dimming technology, and Strand Lighting has shipped in excess of over 2 million FPC dimmer channels.

Good - Forward Phase Control Waveform

• Forward Phase control works by controlling when the power device is turned on in the power line half-cycle.



• If it is turned on half way into the half cycle, it will remain on until the current falls to zero when the polarity of the power line reverses in the next half cycle.

• The process repeats in this half cycle, producing a severely “chopped” waveform to the luminaire.

• If the timing of the turn-on is varied from zero to 100% of the half-cycle, the output power to the load varies from zero to full.

For “Leading Edge” Transformer Applications

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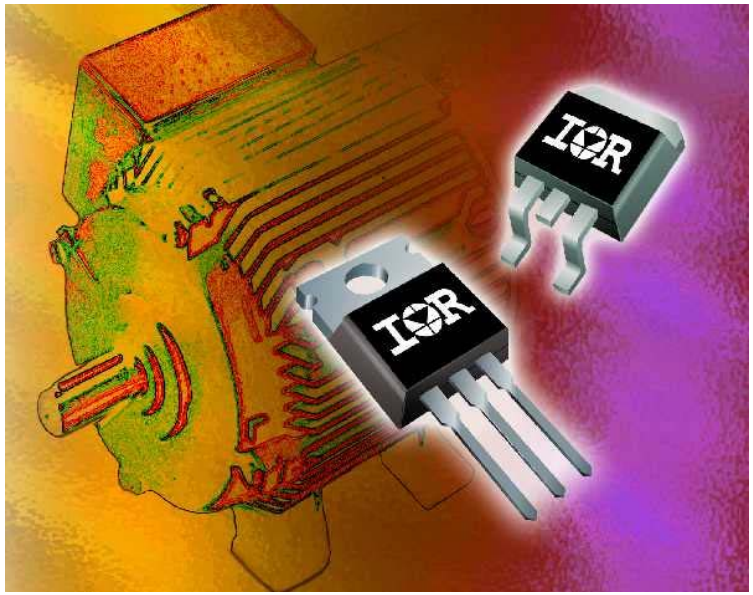
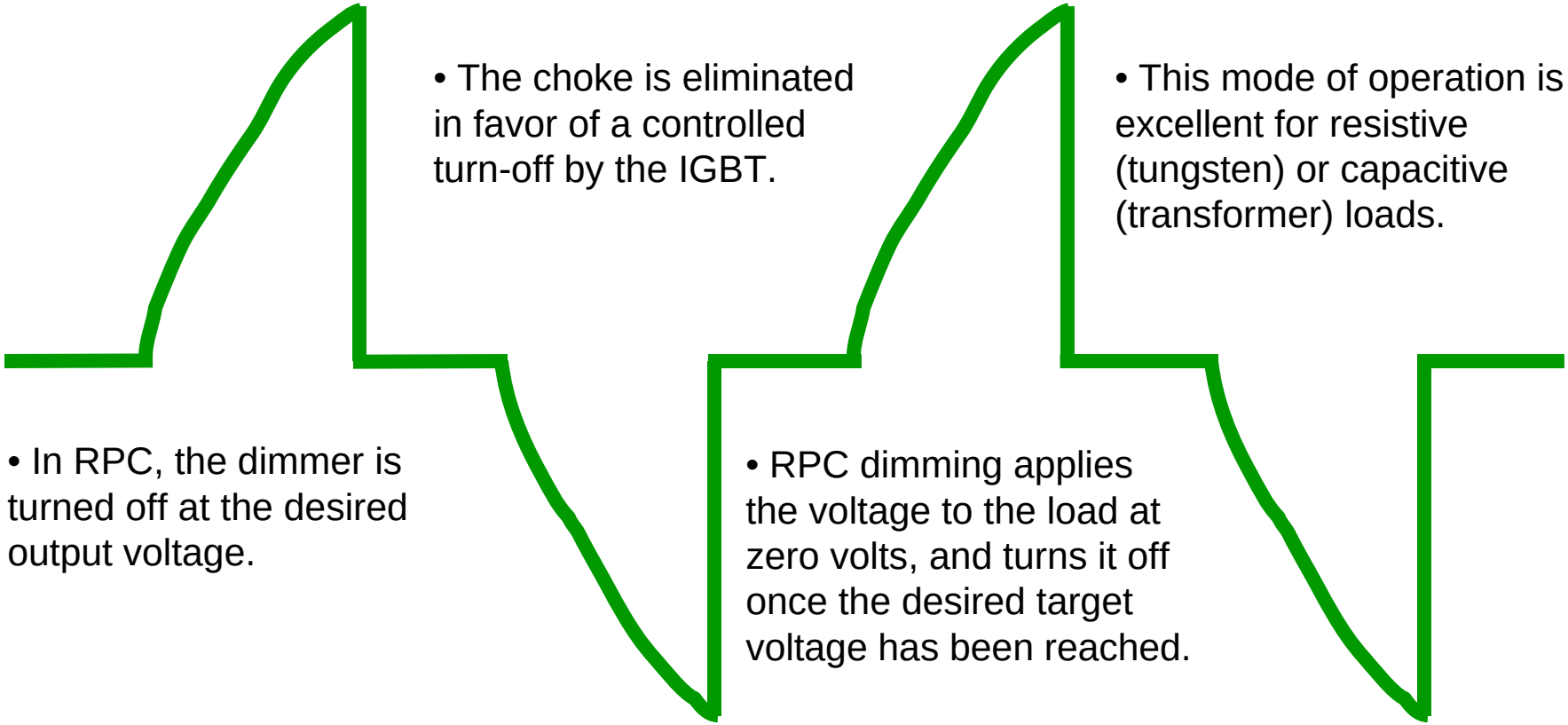
Better - IGBT's Forward & Reverse Phase Control

- Insulated Gate Bipolar Transistor (IGBT) have been a well proven power device technology used primarily for motor control since the 1980's.
- Toyota's second generation hybrid Prius has a 50 kW IGBT inverter controlling it's AC motors.
- IGBT's are also widely used in switch-mode power supplies, UPS systems, and inverters.



Better - Reverse Phase Control Waveform



• The choke is eliminated in favor of a controlled turn-off by the IGBT.

• This mode of operation is excellent for resistive (tungsten) or capacitive (transformer) loads.

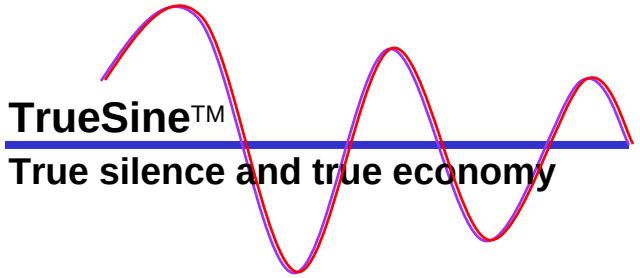
• In RPC, the dimmer is turned off at the desired output voltage.

• RPC dimming applies the voltage to the load at zero volts, and turns it off once the desired target voltage has been reached.

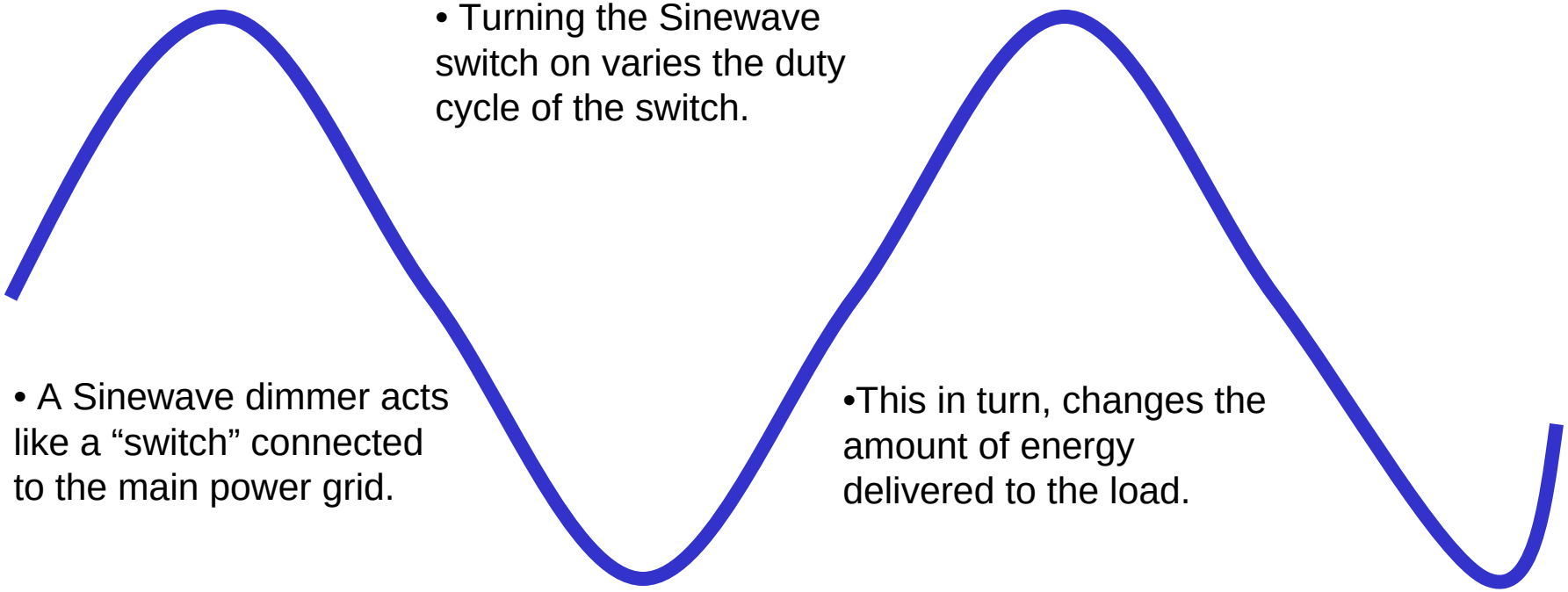
For “Trailing Edge” Transformer Applications

Best - IGBT's Used In Sinewave

- TrueSine™ is an IGBT based Sinewave dimmer that uses 4 IGBT's to deliver voltage and current to the load in the same way as a direct connection to the power line.
- No phase control dimmer can do this!
- Many loads that were not controllable by phase-controlled dimmers may now be used.



Best - Sinewave Waveform



• Turning the Sinewave switch on varies the duty cycle of the switch.

• A Sinewave dimmer acts like a “switch” connected to the main power grid.

•This in turn, changes the amount of energy delivered to the load.

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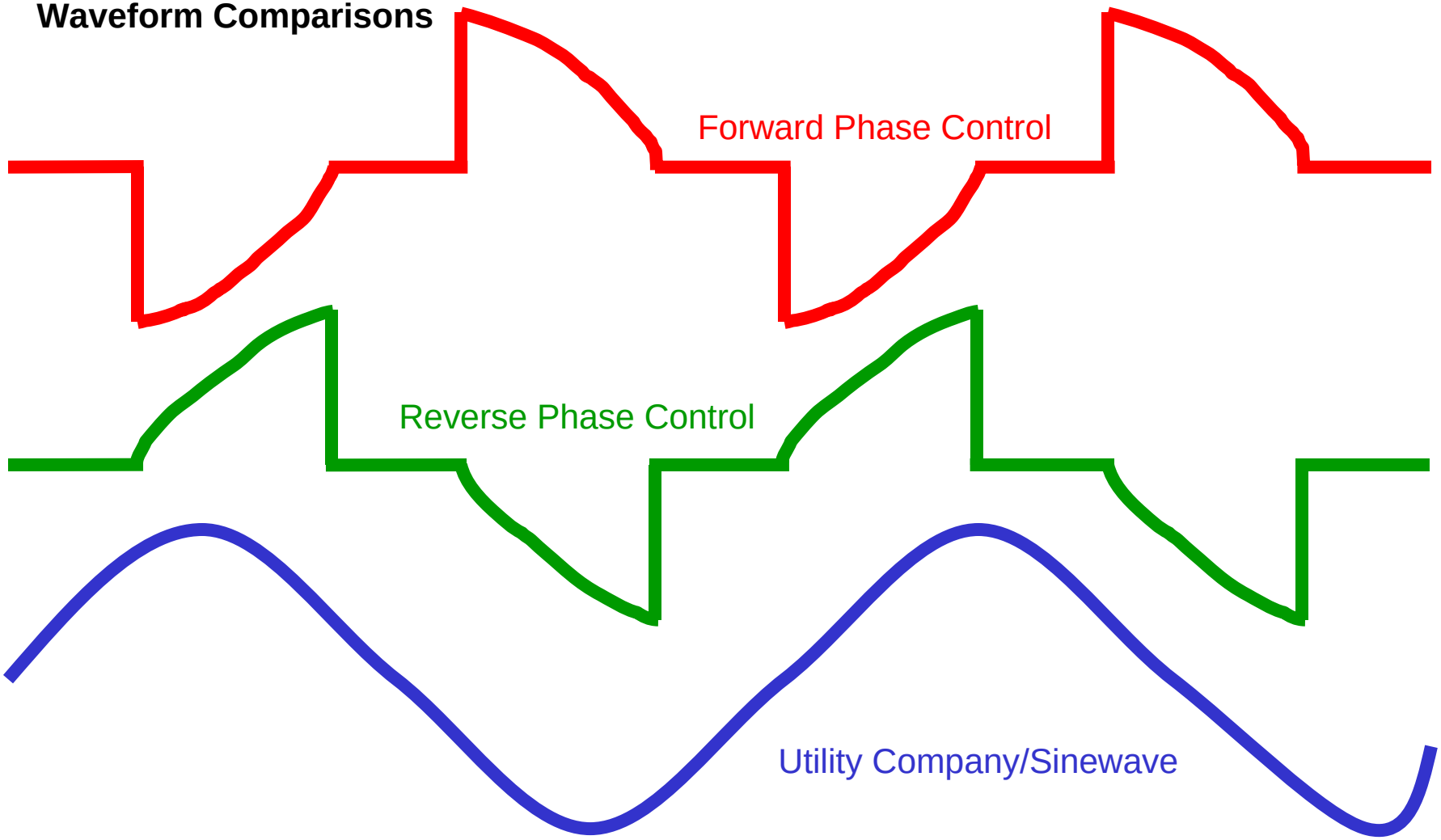
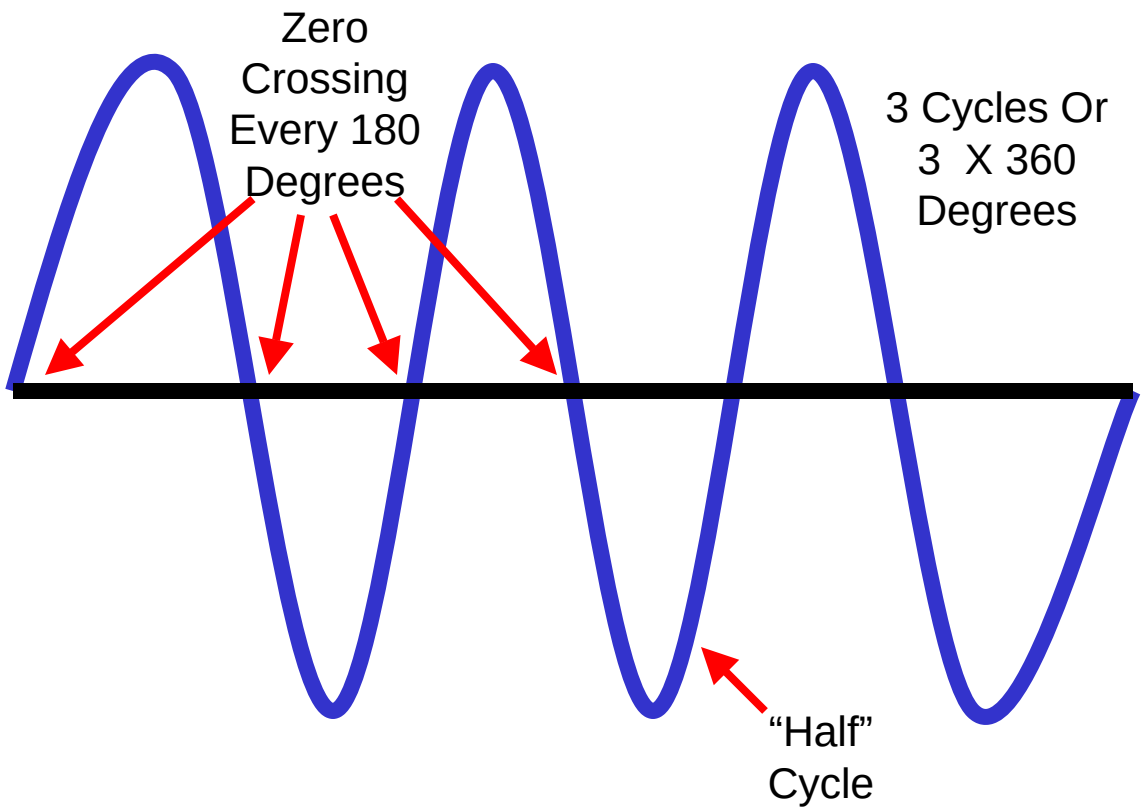
Waveform Comparisons



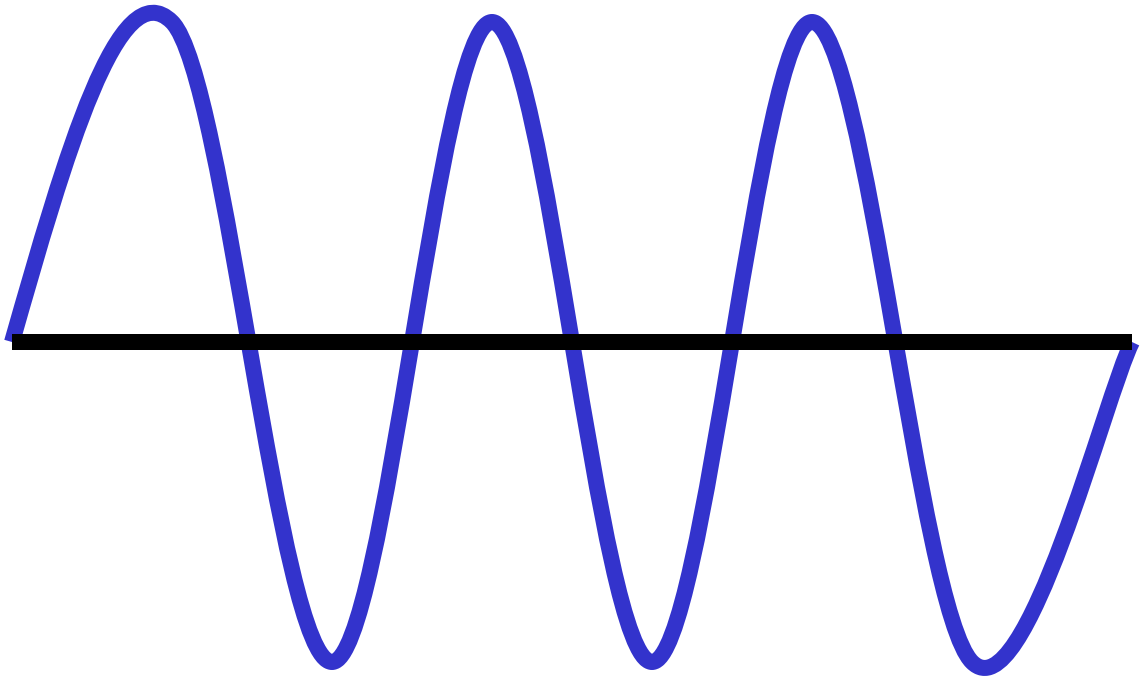
AC Cycles

- There are three AC cycles in this Sinewave.
- Every time the AC line equals neutral (or ground) we say that the AC has “Zero Crossed”.
- The peak-to-peak value of an AC voltage is defined as the difference between its positive peak and its negative peak.

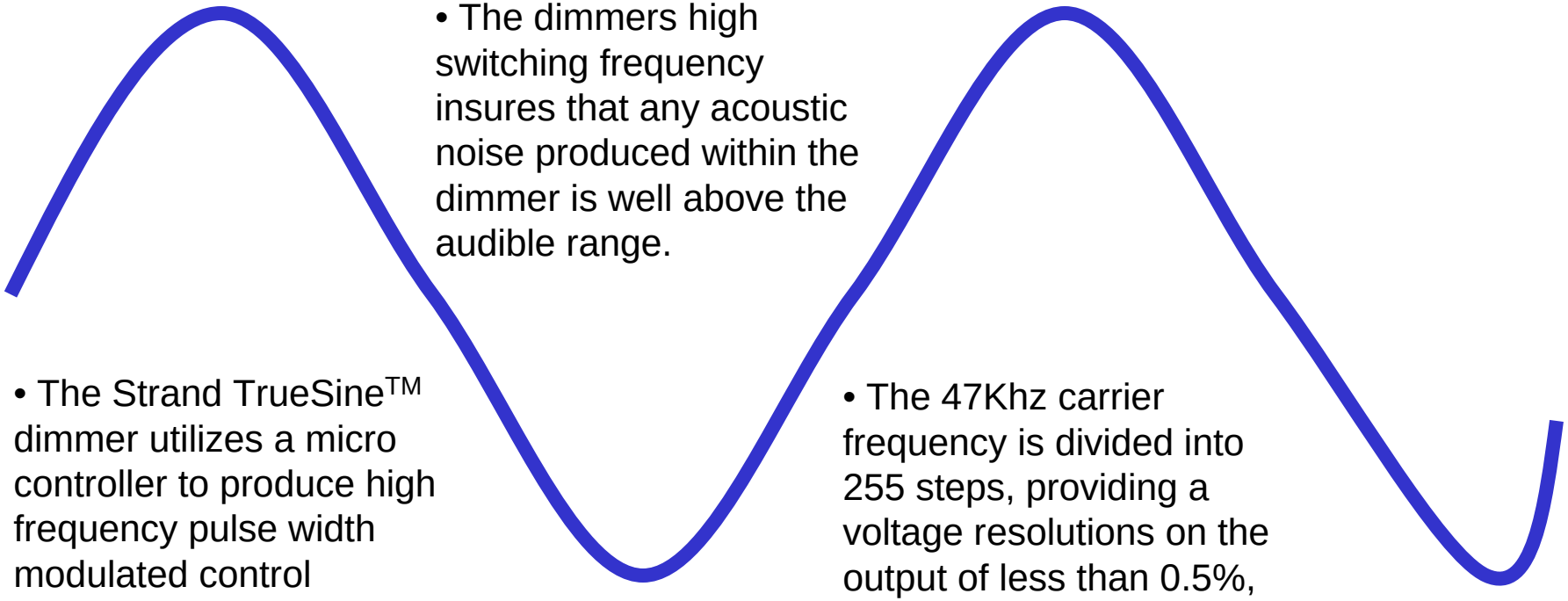


Utility Power

- Your local power utility provides power as AC current in a Sinewave.
- This allows the utility to raise and lower the voltage of the power throughout the grid.



How TrueSine™ Sinewave Works



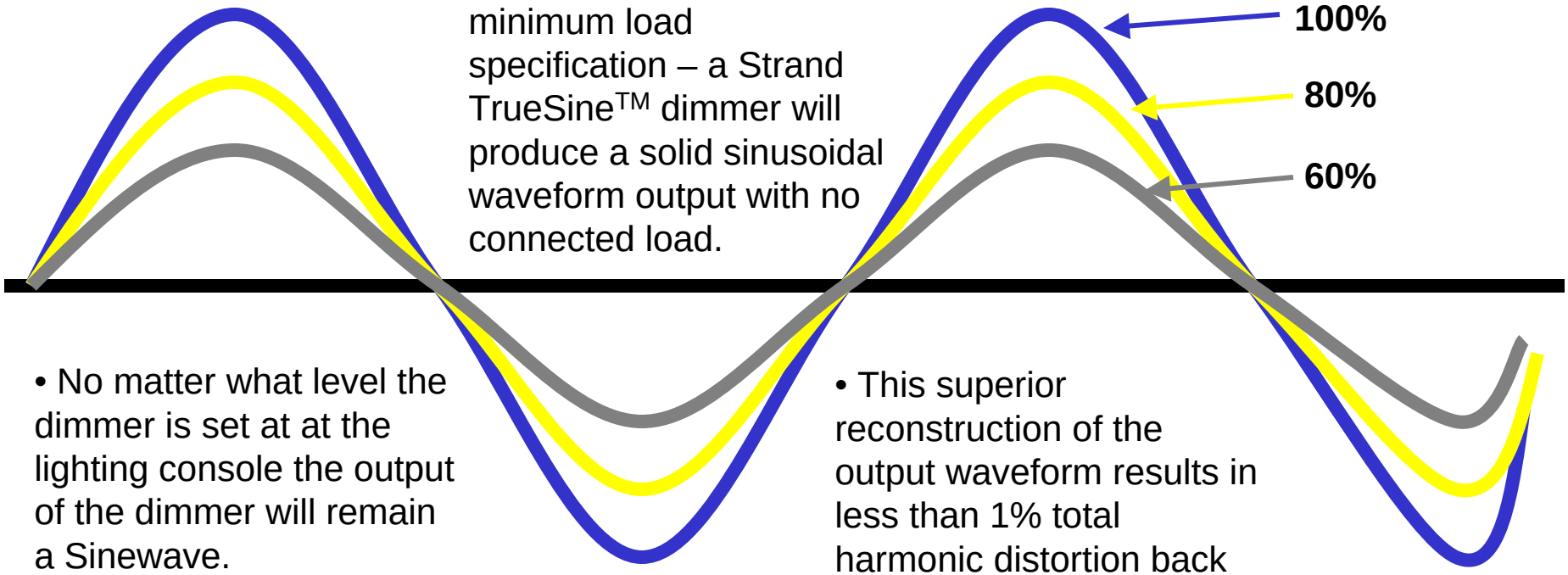
• The dimmers high switching frequency insures that any acoustic noise produced within the dimmer is well above the audible range.

• The Strand TrueSine™ dimmer utilizes a micro controller to produce high frequency pulse width modulated control waveforms to the dimmers IGBT's.

• The 47Khz carrier frequency is divided into 255 steps, providing a voltage resolutions on the output of less than 0.5%, resulting in a flawless Sinewave output!

Sinewave Levels

• In fact, there is no minimum load specification – a Strand TrueSine™ dimmer will produce a solid sinusoidal waveform output with no connected load.



• No matter what level the dimmer is set at at the lighting console the output of the dimmer will remain a Sinewave.

• This superior reconstruction of the output waveform results in less than 1% total harmonic distortion back to the power grid.

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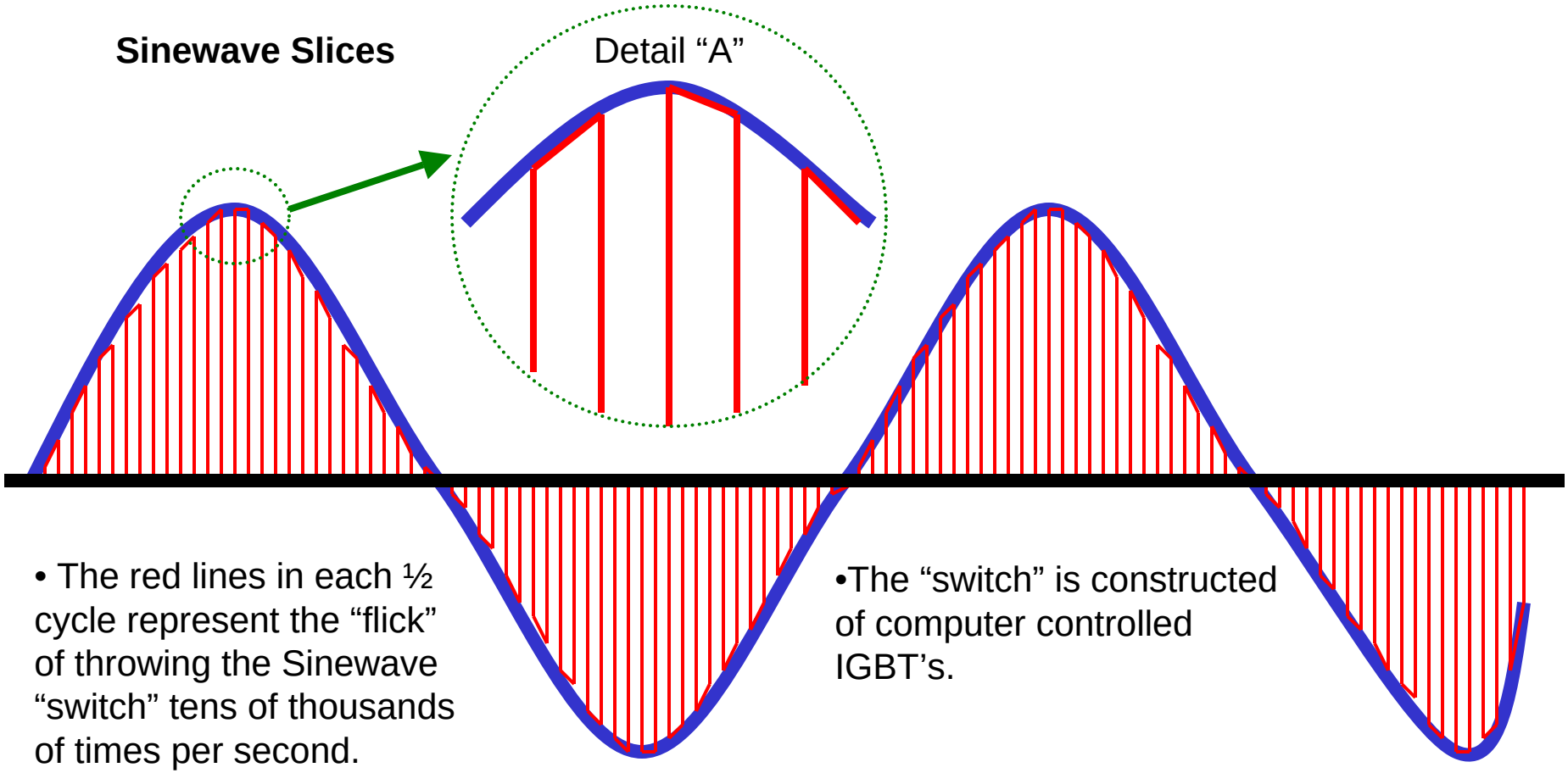
Sinewave Slices



• The red lines in each ½ cycle represent the “flick” of throwing the Sinewave “switch” tens of thousands of times per second.

•The “switch” is constructed of computer controlled IGBT’s.

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Comparing SCR, IGBT and Sinewave Technology

Item	SCR	IGBT	Sinewave
Produces triplen harmonics & neutral over currents.	✓	✓	
Produces a chopped waveform.	✓	✓	
Large choke that adds weight and heat output.	✓		
Required K13 (or better) rated transformers.	✓	✓	
Extends lamp life (no cold in-rush, less lamp “sing”)		✓	✓
Minimum load requirement.	✓		

Good – SCR Dimming – Economically priced, but has heat loss and voltage drop.

Better – IGBT Dimming - Forward or reverse phase control, quiet, minimal voltage drop.

Best – Sinewave Dimming - No harmonics, silent dimming.

Philips Entertainment

Philips Entertainment offers the world's most comprehensive and competitive range of theatrical and display luminaires, dimming equipment, control systems and software to answer the creative needs of lighting designers working in theatre, television, film, themed environments and sophisticated architectural applications.

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