CONFIDENTIAL

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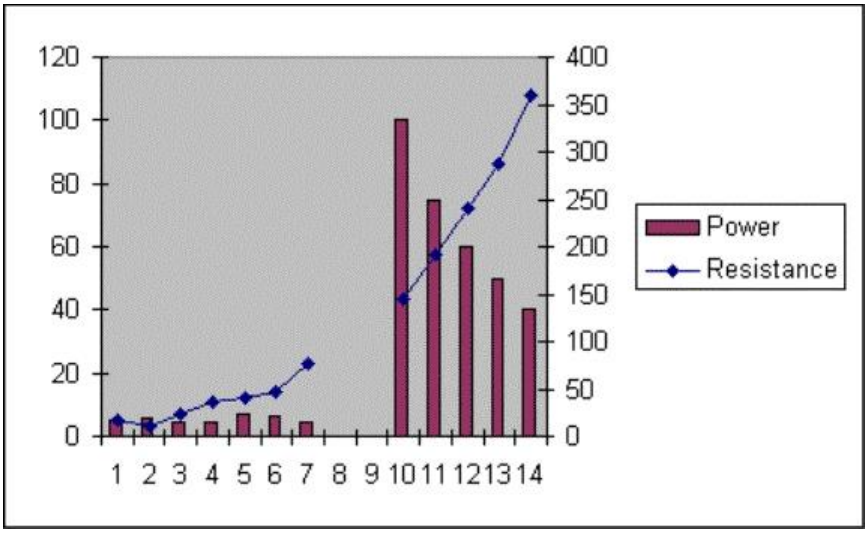
ABSTRACT

This document details many of the steps taken in the development of this technology. Although much of it has been revised over the years as the work progressed and was refined, I believe it may be of interest to those whom wonder what is involved developing a device such as this.

U.S. Patent No. 5,463,307 Issued Oct.31, 1995, protects APS technology. Installation requires a voltage adapter containing a solid-state power processing circuit, and matched lamps. The APS method results in maximum actual efficiency increase up to a 90% rate. Three elements comprise the power system. The aperture is an electronic circuit conducting part of an AC cycle limited to one-quarter cycle, at the end of an AC cycle. The circuit times a conduction delay from zero crossing at the start of a positive AC cycle. When the delay times out the remainder of the cycle is conducted until next zero crossing. As this design is unipolar the negative half of the AC cycle is entirely skipped. The output of the aperture is a Rosenberg wave. The waveform resembles a triangle wave, with a zero voltage gap (3/4 ac cycle gap) between aperture active states.



The wave is also a Direct Current pulse. Power is measured in Average or Mean values. A formula is provided for calculating aperture power into a resistor. The load connected to this aperture is a resistive load. Load Resistance is approximately one tenth that of an AC load used without the aperture. In this document the resistive load is an incandescent lamp. Reduction in resistance in a load means that power is also reduced, in this case as voltage.

Measurement is made through a shunt located in the high voltage power circuit so that Rosenberg wave voltage and current can be acquired by a ground referenced single end differential amplifier and digitized. Neutral side of the power circuit locates a (one-ohm) resistor shunt. Software calculates the MEAN or average power through numeric integration. When a filament resistive load is energized the Rosenberg wave produces a Rosenberg cycle. The Rosenberg wave features a10 amp peak current and a high voltage peak being developed. Rapid heating of the filament creates heat storage in the filament. This heat is slowly dissipated as light after pulse ends. Light output from the lamp is a true triangle wave cycle.

A software/hardware solution has been developed to handle this type of power with a high degree of accuracy. The KWH accumulator can display the sum of Rosenberg cycle power and conventional AC. An analyzer is built into the power meter. This displays voltage and current waveforms, peak voltage and current, aperture conduction delay angle, aperture conduction delay in ms, pulse mean voltage, mean current, mean power and aperture voltage. An improvement in the operation of an incandescent lamp is claimed when compared to a standard lamp. When Average lumens are held constant between two different lamps, a power reduction of a high magnitude can be measured between RMS power and Average power. Mathematic formulas prove the power use is approximately 5 watts. This varies slightly with lamp filament resistance, applied power. Pending further study of this discovery several factors support the efficiency improvement claim.

1. Incandescent lamps are not very efficient.
2. The aperture uses very low power in its operation. Typical power consumption to operate the aperture is a few milliamps.
3. The filament resistance is reduced by a factor of ten from standard lamps that operate on high voltage.
4. There is some evidence to support the theory that the lamps operate at a slightly lower temperature than standard lamps. This may be a result of heat storage and heat dissipation during a Rosenberg cycle.
5. The voltage operating a lamp is reduced. Theory suggests DC power is more efficient at heating than AC power.

6. Cycle skipping during a Rosenberg cycle uses ¾ less cycle than standard AC operated lamps.

Energy conservation specifies the reduction of power used for lighting. One High Efficiency standard is the Compact Fluorescent Light. The High Efficiency, Low Voltage Adapter, Load and Method, theoretically exceeds this standard. APS connects multiple luminaire to one adapter. Light level control is included. Cost projection for replacement of a conventional 100-watt lamp, compared to APS luminaire, over one year of continuous (24 hours a day) service, demonstrates a $100 per lamp cost reduction.

The low voltage load embodied in the Patent is a conventional low voltage lamp designed for commercial service. The absence of hazardous materials in this product qualifies it as a breakthrough in lighting technology. This zero mercury content eliminates disposal cost. A product with lower estimated retail price, light level adjustment, and innovative efficiency might revolutionize the lighting industry**.**

APS method of conservation is an **A**dvance in distribution of electric **P**ower in a demand side **S**ystem. APS improves power efficiency at the site of use. Alternating current practices are set aside from functionality as a transmission medium. Voltage, hence power, can be reduced dramatically. APS low voltage eliminates any concerns of hazardous Electro Magnetic Field radiation, wiring standard conflicts, and shock hazard. With a trade off between cost and performance brings up the proposition that conventional incandescent lamps may become obsolete, and questions the necessity of the health risk associated with Mercury based fluorescent gas.

In electronic terms, the circuit supplies a power pulse, isolated from the AC source high voltage. Power pulse supplied is electronically limited below the maximum rated peak power of a matched low voltage load. Level control is available via resistive elements. This allows photometric brightness of a connected low voltage (less than line voltage) load to be adjusted from high to low lumens.

Refinements eliminate AC source transient voltage interaction triggering and fluctuation of the recurrent conduction angle of an APS pulse above or below the desired conduction angle. True power of the pulse, is 90 percent less than required to drive a conventional lamp.

The technology is patented methodology for conserving electric power. Demand side electronic power source functions by conducting a timed portion of high voltage transmission wave via a patented electronic circuit to matched incandescent lamp(s). Research results indicate this technologically more advanced incandescent light generally consumes five to six watts. This is over ninety percent more efficient than first generation incandescent lamps and thirty eight percent more efficient than CFL, while producing equal level of service.

Economic benefits are on a national scale. 146,942 Million KWH of electricity and twenty four Billion dollars of electrical power can be reduced annually. Environmentally, approximately 180 MMT of carbon emissions can be reduced with new load management technology. Industry sources suggest 1.5 tons of mercury can be prevented from entering ecosystem every year.

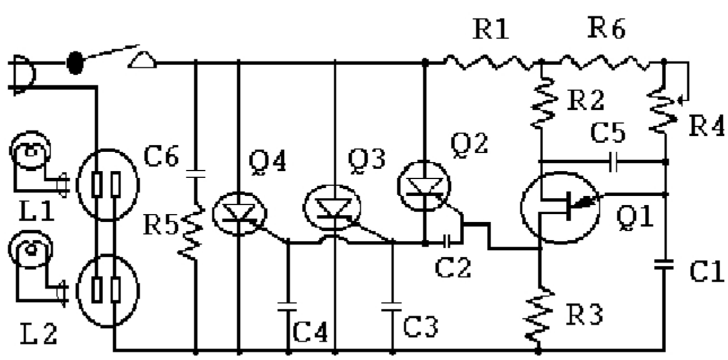
The following material presented is a compilation of research projects and studies the inventor has conducted during the development process of the lighting system.

Theory of Operation

A solid state simulated transformer can transform source voltage to a secondary voltage, completely alleviating the losses associated with inductive transformations. An example is reducing voltage 50% permits the connection of a matched voltage load expecting an output equal to that of a conventional voltage load. The efficiency increase desired is 50%, rather than 50%-15% inductive loss = 35% improvement.

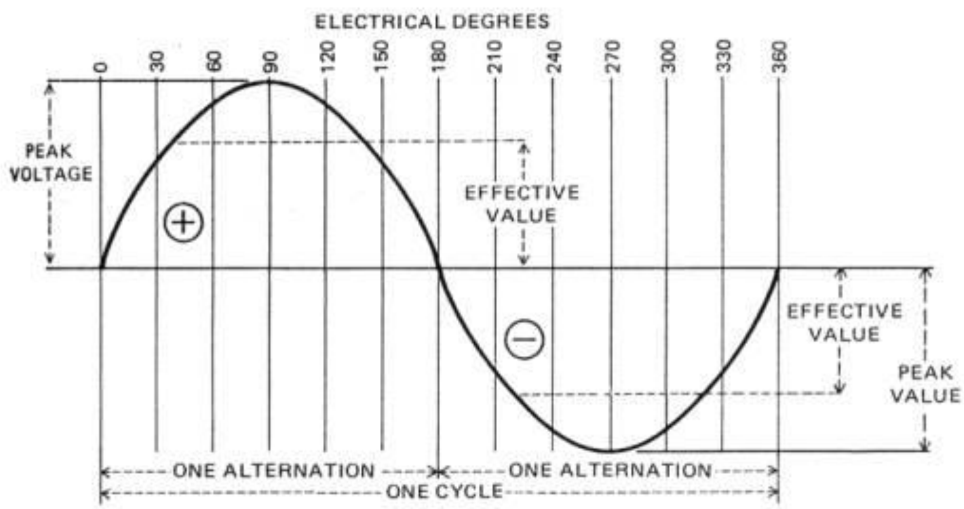
The use of solid state components to simulate transformer action supplies a secondary voltage, with the reliability of a transformer, but transforms line voltage at about 99% efficiency. In one test comparing APS and a transformer lamp, an improvement of 46.84 watts was observed when powering a low voltage lamp from its native power source. A 30 volt 50 watt lamp was supplied 24VAC by a transformer. The 490 foot candle output used 55 watts. APS power resulted with true power wattage of 8.19 watts. This is an 85 percent improvement.

In accordance with the illustrative embodiments demonstrating novel features, method and advantages of the present Invention, there is provided a High Efficiency, Low Voltage Adapter, and Method for a load having a low voltage rating. The circuit has a first terminal adapted to connect said load to a second terminal adapted to connect though a mechanical power switch to an AC high voltage. A switching means comprised of a DC thyristor, supplying low voltage is connected between the first and second terminals. A low voltage lamp is powered through solid state switching means. The High Efficiency, Low Voltage Adapter has a limited timing means coupled to this switching means for operating it so as to isolate a delayed conduction angle, generally within the slope of the latter half transition of the AC source high voltage.



The method also fixes the photometric brightness (all spectrum colors) of a low voltage load, of a matched resistance, to conventional lamp lumens. The photometric brightness of a connected low voltage luminaire load matches that of a conventional incandescent lamp. The method also eliminates probability of interaction faults known to thyristor circuits, relevant to the operation of connected low voltage loads. Other design features eliminate over voltage failure of low voltage loads, caused by switching device tracking of AC source voltage.

Referring to textbook AC theory, a sine wave consists of 360 degrees of phasors, also known as conduction angles. The leading edge of the pulse is formed by delayed conduction. The result is a high intensity instantaneous conduction of electrons. When conduction is held to a precise static angle, conduction delay angle is set somewhere in a range of 150 degrees to 168 degrees, fixing the luminance of a connected low voltage load



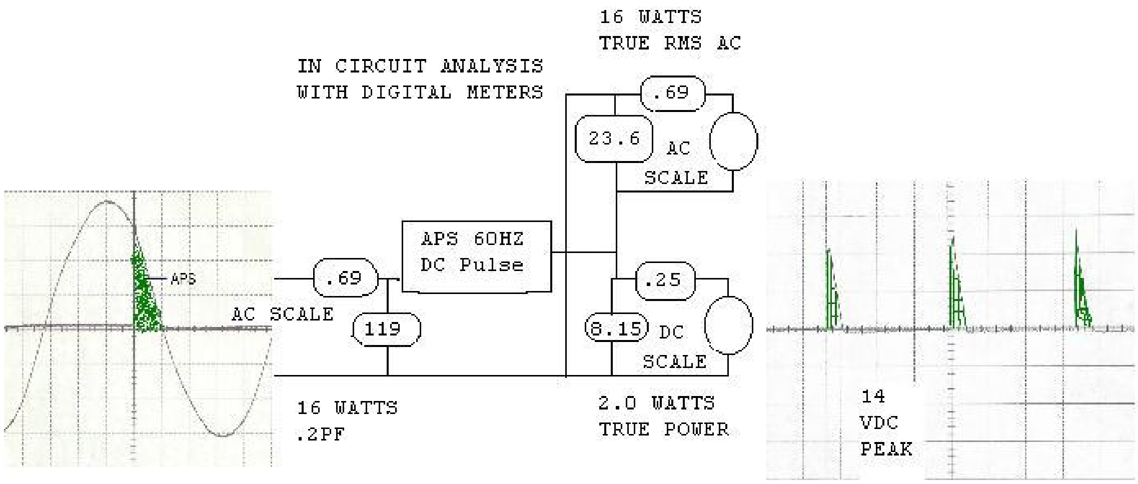
Thyristors are occasionally unstable at high conduction angles. Conduction of half or full cycles can occur. Adhering to one tenth of a degree requires a precision device, as thyristors can be triggered into conduction by line voltage events. The conduction angle of the adapter must be limited below a range of conduction angles. The upper limit of this range cannot be exceeded at any time, as an over voltage may destroy the connected low voltage load. This adapter method permits a low voltage load to be reliable operated as described. A typical CFL has 26 Lumens per watt. APS lumens per watt rating is 150 lumens per watt. This varies as lamp type is changed.

Voltage supplied by phasors as described in this method is more effective than average voltage associated with sine wave. The initial moment the thyristor begins conducting during a cycle; instantaneous voltage conducts the current potential of the line to which it is connected. This raises the molecules in an incandescent lamp to the operating temperature.

Proof of Concept

Instrument Testing

Electric power is measured at the line so as all devices can be measured simultaneously. When



analyzing a single device it is treated as a load and measured at the device input. When measuring or analyzing APS with this method a problem is encountered. Traditionally a voltmeter and amp meter is connected at the load breakout to measure load-input power. Watt-hour meters measure load power at the line. The power measured directly at the load input must match the power measured at the line.

The 60 Hz DC used at this load are unconventional and cannot be exactly measured at the device input as expected. As this power is DC the AC scale is not used for load power. Once the DC measurements are taken at a breakout point the loads' True power can be measured and computed.

The above breakout does not agree with ACRMS measured at the device input. The reason being that the power conducted is DC power. The following will reveal errors using true ACRMS measurement to determine APS load power, or line power.

Metering Scale Factor

All advanced meters use a core processing designed for true RMS. Some claim to have the ability to measure DC. None can measure 60 HZ DC. It has been determined through interviews with meter makers that DC power cannot be measured above 10 HZ. When DC power at 60 HZ is applied, the meters default to AC mode and measure what is obviously DC as AC. This increases I &V to compute watts. The following examples will analyze this problem in depth to find possible solutions to accurate metering of the system.

Using a current transformer to measure power is common. To demonstrate the difference in current used by two efficiency lamps, a 15watt CFL and an APS lamp were studied. The two current spikes are from the CFL. The one spike superimposed over the positive spike is APS. As is apparent, the APS spike shows less current than a CFL. As one CFL spike is 7.5 watts, the APS spike is inferred to be less than 3.75 watts. Aps is developing a meter that will resolve this issue.

Watt-hour Meters

Skepticism regarding the claimed efficiency calculated above is based on the use of conventional instruments to measure this type of energy system. If one is unfamiliar with the nature of this power, then inflated results occur. The publication of this invention in the March 1997 issue of Popular Electronics brought this issue to the surface.

Further tests regarding commercial wattcmeters revealed a systematic discrepancy between APS efficiency claims and measured results. Conventional wattcmeters do not properly measure the sine wave fragment used in the APS system. Generic devices apparently are designed to measure continuous sine wave energy only based upon an analog mechanical device. The power measurements to look at are a 60-Hertz. The following analysis reveals the error margins.

The DC APS operates a 30 volt 50 watt lamp at a phase conduction angle of 151.1 degrees. The lamp values are 12.3 average VDC and .6 average ADC. Wave propagation results in a 1500-foot candle measurement from the luminaries. This is equivalent to a conventional 100-watt lamp' advertised initial lumens. Power used is 7.38 watts.

Fluke 41 B analysis

Data collected with a Fluke 41 B connected before the lamp shows 10 watts lamp input power. At 59 hertz VMAG = 12.16, IMAG = .68 POWER (KWH) =0.01.The average of the calculations above, estimate the load power as 8.49 watts.

Harmonic Information				1 Phase			1 Phase	1 Phase
	Freq.	V Mag	%V RMS	V Ø°	I Mag	%I RMS	I Ø°	Power (KW)
DC	0.00	0.48	0.39	0	0.07	4.19	0	0.00
1	60.04	122.72	99.96	0	0.87	51.88	-46	0.07
2	120.08	0.16	0.13	-13	0.81	48.32	170	0.00

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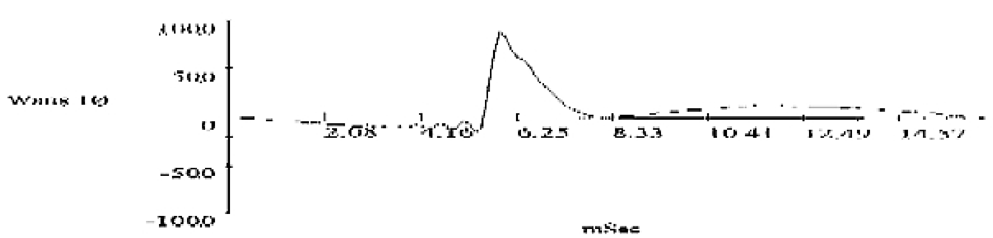
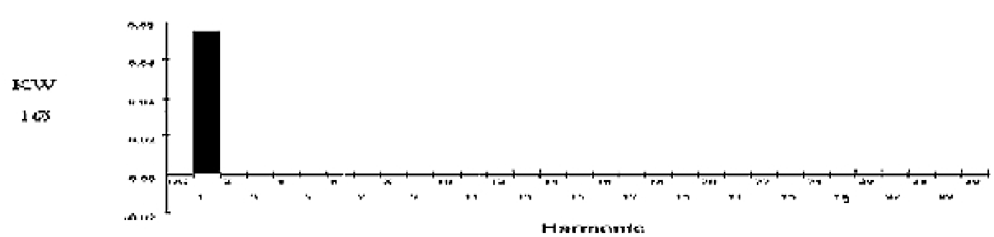
Power



Power



The AC watt-hour meter in commercial use in the US apparently cannot accurately measure the load voltage of the APS system. The integral (load power) produced by watt-hour meters, requires a full cycle of AC voltage. When less than a quarter of a cycle of voltage is conducted, as in the APS system, the meter takes a half cycle measurement. The full cycle line voltage becomes a constant replacing APS low voltage in power calculation.

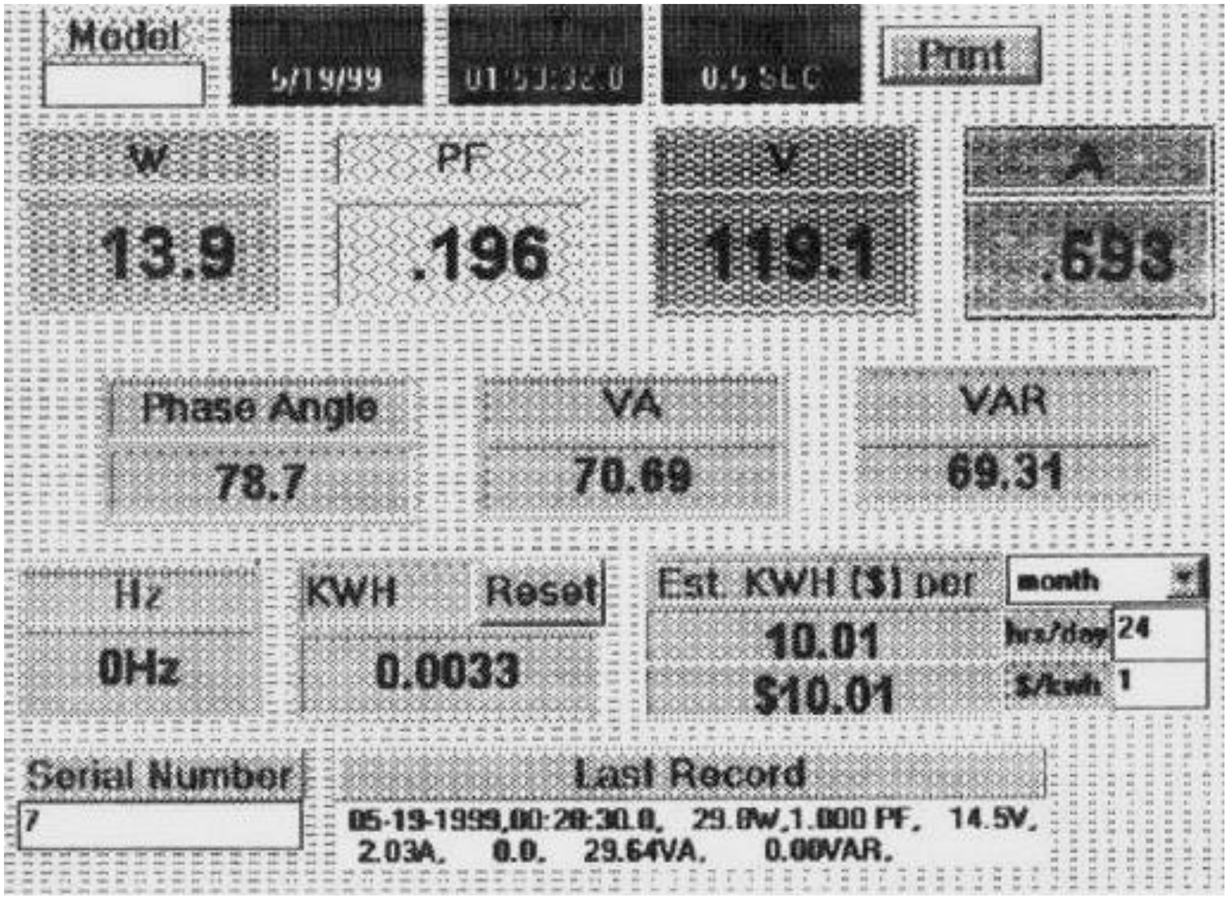
The result is an inflated power measurement of P = I x E in which the current variable or I is actually measured. Instrument error is verified with a Lutron digital wattmeter. Examinations of both printouts show an I MAG of .87 and .84 for the same lamp at 60 hertz. The V MAG is shown at 15.83 and 122.7. The large difference between the voltage measurements results from instrument measurement variations of the same lamp.

When a unipolar pulse is supplied, Lutron wattmeter measures in error 70 watts. This error is analyzed by the following. 115 VAC x .6 AAC = 69 watts. A 61.5 watt error may occur. When bipolar pulses are used to power a 24 volt 50 watt lamp, 8.40 VAC x .9 AAC = 7.56 watts. 8.40 avg. x 1.11 = 9.32 VRMS and current of .9 avg. x 1.11 = .99 ARMS. APS power is 9.32 x .99 = 9.23 watts. This is measured in error as 47 watts on a Lutron meter.

A 37.7 watt error occurs. This error is analyzed as following. Measured current of .9 A RMS must first be converted to average. This is .9 x .9= .81 AAvg. Lutron meter converts peak to peak current (bipolar) to peak current (half cycle), or .81 AAvg x .5 =. 405 AAvg. Lutron wattmeter then calculates 115 VAC x .405AAvg = 46.57 watts.

Extech appliance tester/power analyzer Line Side

The analyzer was connected at the line and load for analysis of power flow. The conduction angle was measured incorrectly at 78.7 deg. apparently a phase reversal occurred here also. The power readings are closer to true power. Watts on the line are 13.9



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Extech appliance tester/power analyzer Load Side

Load: Contrary to expectations the power measurement of 18 watts at the load was higher than at the line. This is a result of no PF operation on AC scale readings.

The correct 60 HZ DC power is 2 watts. When measured on AC scale, 18 watts are computed.

Valhalla 2100 power analyzer

Lamp tested, 25 watt 35 volt lamp 300-Foot Candles. DC Amps .25 DC Volts 8.15 is computed as 2.03 watts.

Line: 117 VAC line x .637 Amps = 74.5 watts x .244 PF = 18 watts.

Load: 16.11 Watts or 17.2 Watts measured (volt or current range) .625 Amps 26.65 Volts 1.0 PF. Same error as above.

Bipolar at line: AC pulse connected at AC line 18.1 Watts Volts 117 x Amps .698 =81.66 watts x .2 PF = 16.8 watts at 23.6 volts (8.02 in circuit) .71 amps (.69 in circuit). 8.02 x .69 = 5.52 watts DC. Current and voltage is apparently measured as ACRMS.

Analog devices AD7755: This highly accurate device made a typical error of AC/DC scale factor. Various lamps were tested and wattage was in between 20 to 25 watts for all lamps tested.

Instrument testing of APS load power conclusion;

This clearly demonstrates the scale of errors encountered with traditional true RMS measuring instruments at 60 HZ DC. To better understand the discrepancies outlined her is to know the difference between this power, also known as non-linear, or pulsed. The unique active power APS embodies is conducted during a portion of the sine wave. Measuring this is not within the scope of any available watt or watt-hour meters. All meters default to AC scale at 60 HZ. The above evidences this analysis device is deficient for accurate measurement of APS power.

Volt-Ampere-Hour meter better known as a Watt-hour meter, measure energy used by an electrical product over time. AC (line voltage) Watts are a product of the integral of RMS current over a period of time *under the assumption that the voltage is constantly conducted* through the cycle. As APS is a DC pulse, APS voltage and current must be measured differently, to accurately determine load power.

The typical revenue wattmeter makes two errors in calculating the true power of an APS DC pulse. The DC pulse voltage does not fit the assumption of constant voltage. This can cause a very large error in the power equation. The magnitude of the error is x10. Example; the RMS line voltage is 117 volts AC. The APS DC load voltage is 17 volts DC. The current is constant. The 117 is substituted for 17 in the P=ExI formula.

This barrier to wide use of APS leads to revenue. Even if the Lamp load is 2 watts rather than 20 watts, if the installed watthour meter cannot measure APS, it can be considered commercially useless. Sampling watthour meters are the means to eliminating the above assumption in the measurement of true power as supplied by APS. The following mathematical analysis reveals the state of the art

Variable R Thermo-luminescence

Standard lamps operated at 115VAC are electrically designed to withstand the high voltage applied. It has become a design doctrine that all appliances shall be this way. It is accepted that some power must be dissipated as heat, when operating at high voltage. The incandescent light bulb is the worst, believed to dissipate approximately 90% of the energy applied as heat. 10% is radiated as light.

AC power is known for its success as a power transmission medium. AC energy can be transmitted over great distances, stepped up, or down, for use. Traditionally, it is applied directly to all loads, lamp, motor or heater. Mr. Rosenberg ventures the theory that there is no longer a valid reason for requiring continuous energy at the point of final use. This is possible regarding Thevins theorem of a power source with no resistance requiring a matched impedance load. AC is transformed to a pulsed low voltage at the demand side. This voltage is applied to an impedance-matched load. These loads use much less power than traditional. The resulting product, light, heat, etc. is the same rate, at a reduced watt level.

If APS actually uses less energy, than the energy must be coming from somewhere. Where does the energy come from? In answer to this, a test was conducted. APS measured the temperature of a standard lamp at 160 degrees with a DMM probe. One type of APS lamp was *over driven,* to the same brightness as a 100-watt lamp. The temperature was measured at 65 degrees. This was demonstrated at the Inventors Exposition in Waterbury Conn. One observer was very surprised when able to touch this lamp without getting burned. The difference in power used by the APS lamp was 90% or about 7 watts vs. 95 watts. The apparent reduction in temperature, and infrared energy emissions, is made obvious by overdriving the APS lamp. Although this demonstration reduces the life of an APS lamp, it answers the above question of, "where is the energy from?" When operated at the proper level, the temperature difference is less noticeable with a temperature probe, as the incandescent filament must operate at 2,000 degrees for full brightness. I will venture a theoretical assumption. The APS method enhances efficiency in incandescent lamps, by reducing the heat liberated.

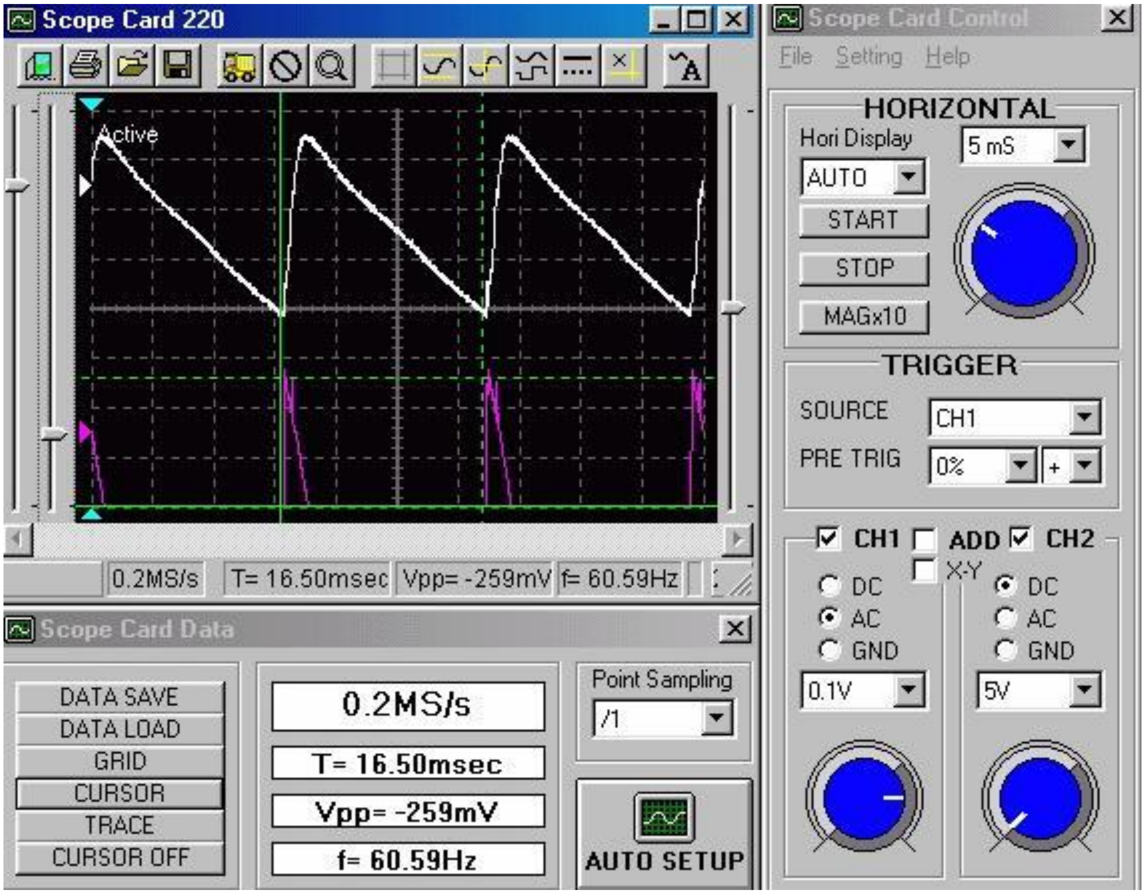
It is known that a heated filament will continue to emit light after power is removed. It is known that a lamp filament resistance varies with temperature. When cool, temperature and resistance is low. When hot, both are at maximum. APS pulse cycles temperature in the filament. As temperature cycles from low to high, resistance varies. The portion of an APS cycle when power is not conducted is timed as a hot filament continues to radiate light.

Applying the pulse to a resistance when at a low (impedance) value, peak voltage of the pulse, increase effective power transfer pertaining to rate of heating. Applied peak voltage rapidly forces resistance, to high (impedance) value. Less energy is wasted to raise a filament to its operating temperature. The pulse continues to heat filament as voltage decreases to zero. The filament continues to emit light, but not heat, until the next pulse is applied.

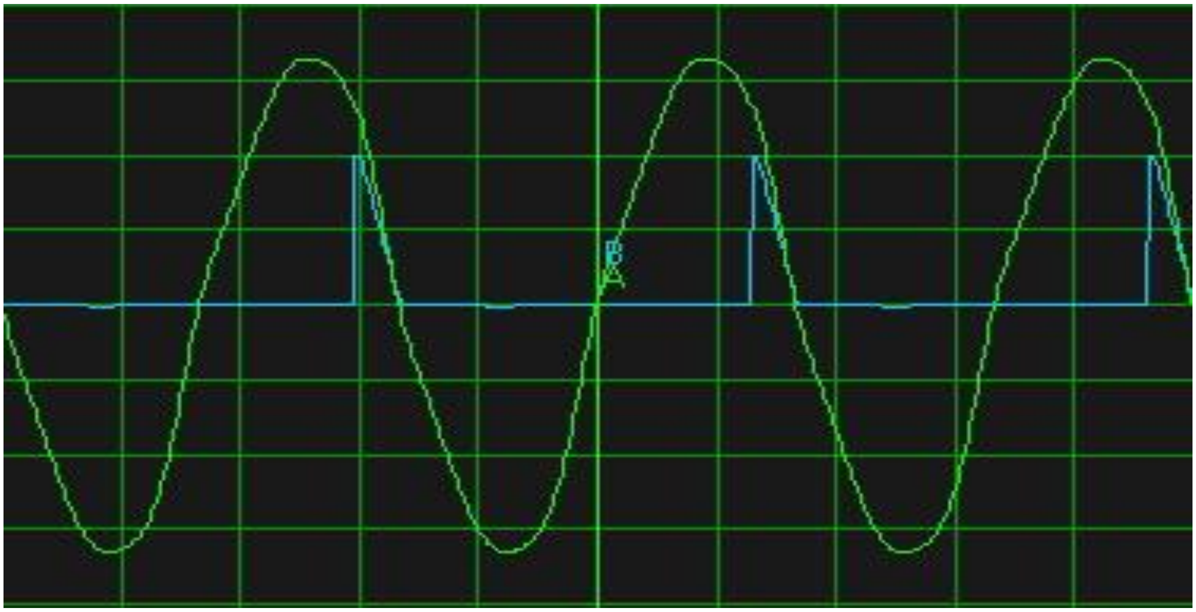
As instruments are not available at this time to obtain exact numbers, I will venture a theory that the pulse (peak) leading edge, forces power transfer in filament at a variable rate. This rapidly heats filament to its operating temperature. Less energy is conducted to bring filament to its operating temperature, as compared to conventional means. In conjunction with the duty cycle, less heat is emitted, indicating higher efficiency than a continuous power method. A faster increase to operating temperature per cycle uses fewer watts. Less heat is liberated over a shorter interval than slow heating of AC. The doctrine that AC power must be applied directly to load is superseded by a means of eliminating waste heat energy. Thermal waste energy from lamps may cost billions of dollars in energy costs. The cost of air-conditioning removing heat from lamps is a hidden additional cost to the above. Incandescent lamps may actually cost 115% more to operate than is necessary.

Power Pulse

High Efficiency, Low Voltage Adapter, and Method for a load having a low voltage rating are described below. A switching means comprised of a DC thyristor, supplying LV is connected between the first and second terminals. A low voltage lamp is powered through said switching means. The High Efficiency, Low Voltage Adapter circuit has a limited timing means coupled to this switching means for isolating a conduction angle, generally within the latter half transition (past peak) of one alternate half cycle of the AC source high voltage.



The timed switching means limits conduction to within the later half transition of alternate DC cycles. The leading edge of the pulse is the phasor discussed above. The trailing edge of the pulse is constituted within the later half transition of the AC source sine wave as it decreases to zero. Since the instantaneous voltage of the leading edge is actually much higher than what is measured, and can over voltage a load even though the average voltage appears below the rated voltage of the load. The voltage decreases to zero after the initial phasor occurs. In the present embodiment of the Invention the DC switching means is timed to conduct, within a range of 150 degrees to 168



Degrees, to fix the luminance of a low voltage lamp to that of an equivalent conventional lamp. At this point, the low voltage adapter isolates a pulse featuring a leading edge rapid rate of rise voltage and current.

The secondary method is based upon the probability of interaction causing variation in recurrent conduction angle that result in a perceptible luminance fluctuation at a logarithmic rate, from an approximate low of 5 to a high of 55 foot candle increase or decrease per tenth of a degree. Therefore, the selected conduction angle must reoccur with a tolerance of .1 degree of conduction. This precision provides a consistent photometric brightness.

L1 is a low voltage incandescent lamp rated at 30 volts. Since AC source power VS is rated 115 VAC, the high voltage cannot be directly applied to T1 or the filament of L1 without the consequence of LV load over voltage failure. According to the secondary method, the conduction angle range is fundamentally limited with a DC thyristor. Further with R6, so the isolation of a conduction angle within the latter half of the DC cycle supplies a power pulse that cannot exceed the connected LV load maximum instantaneous voltage rating.

A pulse is propagated at 60 or 120 pulses per second. The relevant conduction angles regarding the said pulse are toward the extreme limits of those claimed in the patent on page 5 line 64. The patent claims allow conduction from 90 degrees to 180 degrees, where the voltage is always decreasing. Regarding super high efficiency lighting, conduction is from approximately 150 degrees to 168 degrees. This sixteen-degree range of conduction angles drives the specified low voltage lamp. A connected lamp will emit photochromatic brightness equal to generic lamps in the conventional range of 100 watts to 25 watts.

The above are different from the voltages found with APS. In my use, with the given load resistance, the voltage I measure at the load is as shown in the report. The formula provided for sine wave fragment calculates power with the low voltage load resistance.

APS Luminaire

This supplies the LV load from the AC high voltage source, so the connected LV load luminance is equivalent to a range of luminaries from a 100 watt to a 25-watt lamp. At phase conduction angle of 151.1 degrees the values are 12.3 average VDC and .6 average ADC. The power used is 7.38 watts. Conducting this uni-polar power pulse through said load at 60 pulses per second, results in a 1750 foot candle measurement from the luminaire. This is equivalent to conventional 100-watt. A conservative rate is obtained by multiplying the average voltage and average ampere measurement and calculating wattage as V x I = W. The result of the computation is 9.09 watts. A conservative 90% rate of power conservation.

Table of selected lamps, bench test.

Lamp type	Voltage	Current	Foot Candles	V x I=W	Part No. Phillips	R
30V 50W	7.27	0.73	700	5.3	50A30V-ATR	18
24V 50W	7.24	0.75	700	5.43	50A24V-ATR	11.52
34V 25W	14.2	0.47	700	6.67	25A34V-ATR	46.24
24V 25W	9.67	0.46	700	4.44	25A24V-ATR	23.04

Dimming Results, same lamp

152.0^o / 10.81 VDC x .57 ADC = 6.83 Watt, 1750 FC, equivalent to 75 Watt lamp.

158.7^o / 9.28 VDC x .50 ADC = 5.72 Watt, 870 FC, equivalent to 60 Watt lamp.

159.7^o / 8.85 VDC x .48 ADC = 5.23 Watt, 810 FC, equivalent to 50 Watt lamp.

162.5^o / 7.69 VDC x .45 ADC = 4.17 Watt, 505 FC, equivalent to 40 Watt lamp.

167.6^o / 5.42 VDC x .36 ADC = 2.34 Watt, 190 FC, equivalent to 25 Watt lamp

Cost Computation

Standard 100 Watt Lamp at 1750 lumens operating for 8760 Hours (24/7) = 876,000 Watts.

876 Kilowatt-hours x $0.12648 per Kilowatt-hour = costs $110.79 per year.

APS luminaries use 9.09 Watts at 1750 lumens. 9.09% of 876KWH is 79.62 KWH. 79.62 Kilowatt-hours x $0.12648 per Kilowatt-hour = costs $9.97 per year. Based upon the above, the maximum value of one APS lamp over a service life of five years is $500.00, minus initial cost of purchase and lamp replacement.

Lamp Power Testing

Comparison tests are made adhering to IEE standards for measurement of luminaries. A lamp fixture and reflector house lamps in an A B comparison box. A digital light meter (Sperry) is mounted at 90 degrees to the reflector. Testing is calibrated with a standard lamp to produce lumen readout on the meter. The invention replaces a conventional lamp. Adapter voltage is set to display the same lumen readout on the meter. Voltage, current and power are now measured at the lamp and line. The power used in the timing circuit is not measured at the lamp, but is included in line current measurements.

Minute variation in recurrent conduction angle within wave propagation result in a perceptible luminance fluctuation at a logarithmic rate, from an approximate low of five to a high of 55 foot candle increase or decrease per tenth of a degree. Therefore, engineering circuit design and component selection must enhance selected conduction angle must reoccur with a tolerance of .1 degree of conduction.

Electric Power Measurement

This section is intended to provide an electrical engineer the basics required to make an evaluation of Advance Power System technology. Advance Power System supplies an incandescent lamp with innovative true power, contained within a sine wave.

Direct current power, dissipated across a resistor, is true power. This is also known as real power, apparent power, and average power. This applies to incandescent lamps, as the filament is a resistance.

The watt is a unit of true or real power in a circuit containing no reactance. In a typical residential circuit there is usually no reactance.

Load input power is also known as power delivered to a load. Load output power, is the amount of power dissipated in the desired form. In this case is light and heat.

A pulse is a burst of current, voltage or power of a short interval. This interval has meaning if the pulse is recurrent, with a well defined waveshape. This is also known as a cycle. The APS method creates a pulse from a sine wave. Load input power is measured at the lamp, in the form of a pulse.

Average flow of power through a conductor in a cycle is not constant. Most ammeters and voltmeters register average values.

Amplitude is expressed as either maximum instantaneous (peak value) or in terms of average.

DC load input power is measured with a volt and ammeter. The product of the resulting measurements is true power. The formulas for true power are: $P=ExI$ $P=I^2xR$ and $P=E^2/R$. The first equation is used with actual meters connected in a circuit. The others are used when one value can be measured and the R or resistance is known.

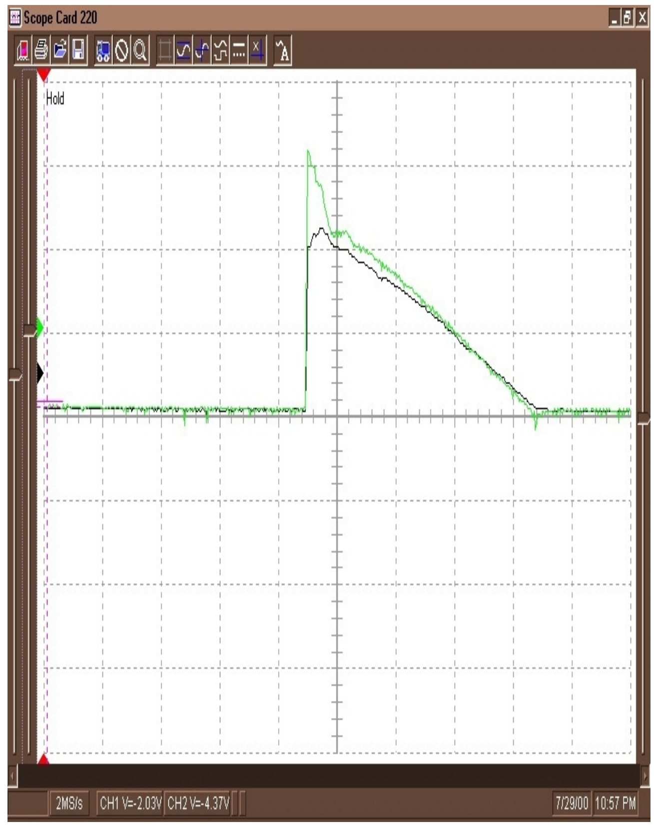
Sampling Measurement

Sampling measurement is when a signal (pulse) is evaluated by a minimum numbers of samples per cycle. The result is an approximation of the waveform. The accuracy depends on the number of samples taken and the complexity of the waveform.

Voltage is measured integrally with current. Wattage is integrated into a value by averaging the voltage and current samples taken. In a simple example (S1)VxI+(S2) VxI+(S3) VxI+(S4) VxI+……/number of samples per cycle. Sampling makes no assumptions.

WAVEFORM DATA ACQUISITION Voltage trace across 2ohm resistor. 20 samples from cursor.

V1	V2
82.8	101.6
84.4	82.8
75	65.6
73.4	64.1
65.6	53.2
59.4	56.3
57.8	48.4
50	43.7
46.9	32.8
39.1	29.7
32.8	25
28.2	17.2
23.4	0.624
17.2	0.314
10	0.779
0.154	10
0.466	20.3
0.939	34.3
1.72	34.3
0	0
779.69 / 20 = 38.98	737.47 / 20 = 36.87



Power through 2Ω between APS and lamp measured with Scope Card 220. V1 and V2 are sampled from waveforms. Sample voltages summed are V1 = 737.47 V2 = 779.69. Dividing by No. of samples (20) is V1 = 38.98 V2 = 36.87.

P = [(V1-V2) / R * V2] * (Pct / Act)

(V1 - V2) / R = 38.98 – 36.87 = 2.11 / 2Ω = 1.055 * 36.87 = 38.89V.

Pulse factor PF = Pulse cycle time in Ms. / AC cycle time in Ms. See conduction delay variables table in Additional Information for pulse cycle time in Ms. by conduction delay angle.

PF = 2.51 Ms. / 16.6 Ms. = .151

P = 38.89 *.151 = 5.88 watts.

ANGLE	Cos.	VOLTS	Ms.	ANGLE	Cos.	VOLTS	Ms.
90	1	26.89	4.158	136	0.28	7.54	2.0328
91	0.98	26.42	4.1118	137	0.26	7.22	1.9866
92	0.96	25.95	4.0656	138	0.25	6.9	1.9404
93	0.94	25.48	4.0194	139	0.24	6.59	1.8942
94	0.93	25.01	3.9732	140	0.23	6.29	1.848
95	0.91	24.54	3.927	141	0.22	5.99	1.8018
96	0.89	24.07	3.8808	142	0.21	5.7	1.7556
97	0.87	23.61	3.8346	143	0.2	5.41	1.7094
98	0.86	23.14	3.7884	144	0.19	5.13	1.6632
99	0.84	22.68	3.7422	145	0.18	4.8	1.617
100	0.82	22.22	3.696	146	0.17	4.59	1.5708
101	0.8	21.75	3.6498	147	0.16	4.33	1.5246
102	0.79	21.29	3.6036	148	0.15	4.08	1.4784
103	0.77	20.84	3.5574	149	0.14	3.84	1.4322
104	0.75	20.38	3.5112	150	0.13	3.6	1.386
105	0.74	19.93	3.465	151	0.12	3.37	1.3398
106	0.72	19.47	3.4188	152	0.11	3.14	1.2936
107	0.7	19.02	3.3726	153	0.1	2.93	1.2474
108	0.69	18.58	3.3264	154	0.1	2.72	1.2012
109	0.67	18.13	3.2802	155	0.09	2.51	1.155
110	0.65	17.69	3.234	156	0.08	2.32	1.1088
111	0.64	17.25	3.1878	157	0.07	2.13	1.0626
112	0.62	16.81	3.1416	158	0.072	1.95	1.0164
113	0.6	16.38	3.0954	159	0.06	1.78	0.9702
114	0.59	15.95	3.0492	160	0.06	1.62	0.924
115	0.57	15.52	3.003	161	0.05	1.46	0.8778
116	0.56	15.1	2.9568	162	0.04	1.31	0.8316
117	0.54	14.68	2.9106	163	0.043	1.17	0.7854
118	0.53	14.26	2.8644	164	0.038	1.04	0.7392
119	0.51	13.85	2.8182	165	0.034	0.91	0.693
120	0.5	13.44	2.772	166	0.029	0.79	0.6468
121	0.48	13.04	2.7258	167	0.025	0.68	0.6006
122	0.47	12.64	2.6796	168	0.021	0.58	0.5544
123	0.45	12.24	2.6334	169	0.018	0.49	0.5082
124	0.44	11.85	2.5872	170	0.015	0.4	0.462
125	0.42	11.29	2.541	171	0.012	0.33	0.4158
126	0.41	11.08	2.4948	172	0.009	0.26	0.3696
127	0.39	10.7	2.4486	173	0.007	0.2	0.3234
128	0.38	10.33	2.4024	174	0.005	0.14	0.2772
129	0.37	9.96	2.3562	175	0.003	0.1	0.231
130	0.35	9.6	2.31	176	0.002	0.06	0.1848
131	0.34	9.24	2.2638	177	0.001	0.03	0.1386
132	0.33	8.89	2.2176	178	0.0006	0.016	0.0924
133	0.31	8.55	2.1714	179	0.0001	0.004	0.0462
134	0.3	8.21	2.1252	180	0	0	0
135	0.29	7.87	2.079	TABLE OF CONDUCTION DELAY ANGLES			

DC Power Measurement

Watts are calculated as Volts x Amps. APS changes traditional expectations of demand side power use by reducing voltage. The question is how can the seller assure the buyer this new technology works? The next generation of digital wattcmeters sample sine wave cycle at 720 samples per second. This allows 2 samples per conduction angle. Transducer measurement systems may also accurately measure lamp power, where permitted by regulations. As APS does not conduct before the last ¼ of a cycle, full line voltage should not be computed with APS load current. The user can achieve a 90% efficiency gain.
Table below gives an accepted method for finding load voltage for a 120 volt line at 60 volts forward (half cycle) voltage. This will match multimeter measurement in a break out test.

$(E/\pi) / 2\pi (1 + \cos \partial)$

This is $30 (1 + \cos \partial)$

Solved for some conduction delay angles ∂

45 deg. 30 (1 + .70) = 51 volts

90 deg. 30 (1 + 0) = 30 volts

135 deg. 30 (1 + .29) = 8.7 volts

This formula integrates the pulse power at 7.5 watts.

$$\frac{(\text{PULSE VOLTAGE})^2 \text{ X } (.0349 \text{ X COND. ANGLE}) - \text{SINE X } (2 \text{ X ANGLE})}{(25.1 \text{ X LAMP RESISTANCE}) \text{ X } (\text{SINE X CON. ANGLE})^2}$$

$$\frac{(12.3)^2 \text{ X } (.0349 \text{ X } 151.1) - \text{SINE } (2 \text{ X } 151.1)}{(25.1 \text{ X } 18) \text{ X } (\text{SINE } 151.1)^2}$$

$$\frac{795.1707941}{105.5232493} = 7.535503307$$ DC Watts at 1750 foot candles.

Theory of thyristor controlled load power in a resistor. The following relationships are between line voltage, conduction delay angle, pulse voltage, resistance and pi in Electronic Power Source operation.

Pulse voltage waveform as above. Average load voltage (pulse DC) in EPS lighting circuit:

$E = E_{RMS} / 2\pi (1 + \text{cosine } \alpha)$

$E_{RMS} = 120 \text{ VAC} * \sqrt{2}$

$E_{RMS} = 1.414 * 120 \text{ VAC} = 169$ peak volts.

Conduction delay $\alpha = 125.5^0$

$E = 169 / 2\pi * (1 + \cos. 125.5^0) = 26.9 * (1 - .5807) = 11.27$ volts DC

Resistance is lamp voltage^2 / lamp watt or $34^2 / 50 = 23\Omega$.
This becomes 18.5Ω from substituting a resistor in circuit replacing EPS lamp. Resistor circuit power estimate is more conservative.

Power of 60 HZ DC pulse into resistance:

$$P = \frac{[ERMS/2\pi * (1+ \cos. \alpha)]^2}{R}$$

$$P = \frac{[169/2\pi * (1+ \cos. 125.5^0)]^2}{18.5\Omega} = \frac{127.01}{18.5\Omega} = 6.86 \text{ watts}$$

23Ω is again substituted for 18.5Ω $P = 127.01/23 = 5.52$ watts.

Average load current $I = Ip / 2\pi * (1+ \text{cosine } \alpha)$

$I = 1.45 * .42 = .61$

$P = E * I = 11.27 * .61 = 6.88$ watts.

$P = E^2 / R$

$P = 11.27^2 / 18.5\Omega = 6.86$ watts.

Instrument Measurement Verification
EPS lamp load average E and average I measured in circuit with Protek 506 multimeter. Results are 11.2 volts DC and .48 amps DC.

$P = E * I = 11.2 * .48 = 5.37$ watts

Bench luminaire wattage comparisons

Lamp	FC	Pw6060	AD7755	Measured	Computed
60w INC.	244fc	57w	56w	Efficiency	Efficiency
15w CFL	237fc	14w	14w	Power	Power
24v25w	240fc	33w	23w	3.42w	3.84w
34v25w	240fc	34w	26w	4.81w	4.55w
34v50w	240fc	48w	26w	5.37w	5.52w
24v50wc	240fc	61w	25w	5.48w	5.27w
32v100w	240fc	51w	25w	4.99w	6.78w
24v100wqh	240fc	76w	26w	5.66w	5.02w

Measured and computed power column contains preliminary product design specifications for frosted "off the self" lamps. A 34v50w lamp is the example lamp. Two typical KW meters tested. AD is Analog Devices 7755EB is a sampling KWH meter. Pw6060 simulates analog wattmeter.

DC Analysis

Variance between computed and measured EPS lamp wattage suggest a need for special purpose instruments to obtain presentation data. EPS example lamp uses approximately 5.4 - 6.8 watts average power. Operating dimming capability of EPS circuit and analysis of other lamps are omitted for brevity.

AC Analysis

Issues regarding AC analysis of EPS power assume full wave conduction 0 – 360 degrees. AC full wave power can be computed as:

$P = E * I = [E_{RMS} / \pi *(1+ \text{cosine } \alpha)] * [E_{RMS} / \pi R * (1+ \text{cosine } \alpha)]$

Variables: $R = 18.5$, $E_{RMS} = 169$, $\alpha = 125.5$, same as DC.

E = 169 / 3.141 = 53.79 * .42 = 22.59 VAC

I = 169 / 58.11 = 2.90 * .42 = 1.21 AAC

P = E * I = 22.59 * 1.21 = 27.33 watts

Average amp (23Ω @ 0^0) $P = I * E = (E_{RMS} / \pi R) * E = 26.25$ watts

As EPS example conducts pulse between 125 and 180 degrees it is not full wave. AC analysis is fundamentally inappropriate. Calculating voltage and current full wave results in power of 27 watts AC. AD meter measures 26 watts AC. Pw6060 measures 48 watts AC. Apparently computational errors result from metering intended to measure full wave AC power only.

With AC electronic metering, users of EPS will pay for an amount of power notwithstanding if it conducts or not. Meter certification research intends to promulgate a standard for general-purpose measurement and metering of 60HZ pulsed DC wattage.

If you use a RMS meter, then you will be working in true RMS. If not, probably average voltage. The difference does not make much of an impact when setting or measuring the voltage at the lamp. When determining the AC power used, it can make a difference when trying to match what a wattmeter and what an ampere and voltmeter connected at the load measure.

Most analog wattcmeters will take a half cycle average of the APS current as a measurement. So if you are trying to compute the line power, strange errors may occur. Current is converted from RMS to average and divided by half when the voltage is past 90 degrees.

Watts are always calculated as volts x amps except in commercial watt-hour meters. APS changes the traditional expectations of power use connected to AC line by reducing the voltage. So the typical 120 V x 1 A = 120 watts is grossly inflated when 12 V are supplied in a nonlinear wave.

Engineering Prototype

Circuit Elements

Timing Concerns

Resistors R1, R6 and R4 referred to as a resistive divider. Together with precision capacitor C1 constitute a resistive capacitive network that operates as a precision timing circuit. Variable resistor R4 can be replaced with a rotary switch SWl. SW1s' wiper connects to the emitter of Q1 and its switched terminals separately connect through precision resistors Ra, Rb, Rc and Rd to junction of resistors R1 and R2 replacing R6 to select one of several conduction angles. This allows multi-level control. The connection of R6 limits the charging voltage on C1, hence the range of conduction angles available through variable resistor R4. In other embodiments variable resistor R4 can be replaced with a low inductance, precision fixed resistor element, selecting the conduction angle of the low voltage adapter at a non-adjustable value. Additional, it may be obvious to one skilled in the art R4 can be replaced with any resistive control element.

The UJT is characterized for SCR trigger circuits to ensure reliable operation. Anticipated transient voltage probable in AC distribution grids may cause undesirable triggering. The UJT triggering device embodies features that eliminate interaction within the timing circuit. One known technique for decoupling against line voltage transients acting on the unijunction transistor use of "bootstrap capacitor" between base 2 and the emitter of the unijunction transistor. The result is positive or negative transients on the unijunction supply voltage will not trigger the UJT. A further step is inclusion of resistor between voltage source and UJT. The resistor is for temperature compensation.

The conduction angle range is wherein voltage applied to lamp starts at zero, and then instantaneously increases to peak voltage and diminishes to zero. Lamp is a low voltage incandescent lamp rated at approximately 30 volts. Since AC source power is rated 115 VAC, the high voltage cannot be directly applied to the filament without the consequence of load over voltage failure. According to the secondary method, the conduction angle range is fundamentally limited to half cycle with a DC thyristor. Further with resistor the isolation of conduction angles within the latter half of the DC cycle supplies a power pulse that cannot exceed the connected load maximum voltage rating.

The UJT is "specifically characterized for SCR trigger circuits...to ensure reliable operation" F.W. Gutzwiller, Silicon Controlled Rectifier Manual p.77. Anticipated transient voltage probable in AC distribution grids may cause undesirable triggering. The UJT triggering device embodies features that eliminate interaction within the timing circuit. One known technique for "decoupling against line voltage transients acting on the unijunction transistor ...use of "bootstrap capacitor" between base 2 and the emitter of the unijunction transistor". The result is "Positive or negative transients on the unijunction supply voltage will not trigger the UJT". A further step is inclusion of resistor between voltage source and UJT. Other secondary method circuit features supply a stable voltage by eliminating source supply, transient induced conduction angle "jitter". A unijunction transistor triggers the SCR. The UJT is itself triggered by a precision capacitor-resistor timing circuit connected to the emitter of the UJT.

Q1 has base 1 connected through resistor R3 to voltage low side and directly to the gate of Q2. The base 2 of Q1 connects through the serial combination of resistors R1 and R2 to the hot side. R1 drops AC source voltage to the supply voltage of the timing circuit. R2 serves to compensate Q1 from thermal variations. Variable resistor R4 connects through the limiting resistor R6, the connection of R6 limits the charging voltage on C1, and hence the range of conduction angles available through variable resistor R4. A precision timing capacitor C1 connects between the emitter of Q1 and the low side.

Decoupling against line voltage transients acting on the unijunction transistor Q1 is achieved with the use of "bootstrap capacitor" C5 between base 2 and the emitter of the unijunction transistor. The result is positive or negative transients on the unijunction supply voltage will not trigger the UJT.

Temperature compensating resistor is connected between supply voltage and UJT base 2. Further, the load is connected to the cathode terminal of the SCR while the anode connects to the hot terminal of AC source voltage supply. This feature removes the load from the power supply of UJT and supplies the load through the SCR.

Known to the art SCR switching circuits deal with cycle skipping, a failure to conduct during a half cycle as intended. This may also cause a perceptible photometric brightness fluctuation. "The ultimate solution to cycle-skipping is to automatically reset the capacitor...through the UJT" F.W. Gutzwiller, Silicon Controlled Rectifier Manual, at 186, 187.

Precision resistors Ra, Rb, Rc, and Rd are chosen to provide a graduated luminance range from L1 equivalent to the luminance of conventional lamp powered by conventional AC source high voltage. The illustrated range is; 100 watt, 75 watt, 60 watt, 50 watt, 40 watt, 25 watt. Further, the graduated luminance provided may be in non-conventional ratings for custom multi level control.

Fuse is connected at the high voltage source to disconnect the low voltage adapter in the event of a component failure that may cause conduction of AC source high voltage. A filter capacitor connected to the gate and cathode of the SCR eliminates false triggering. The connection of a series resistor-capacitor filter across the AC terminals eliminates the probability of AC power switch interaction, (bounce transients) causing SCR tracking of the AC source high voltage.

Thyristor Concerns

To facilitate understanding the illustrative principles associated with the foregoing circuit, its operation method will now be briefly described. For first positive half cycle of Figure 4 (see USS patent in the appendix) voltage rises sinusoidal, past peak value. While voltage rises, precision capacitor C1 is charged through resistors R1, R6 and R4. While capacitor C1 is charging, transients coupled to resistor R1, R6 and R4 will be coupled to both emitter and base 1 of Q1. Undesirable triggering of UJT Q1 is eliminated by capacitor C5. When capacitor C1 is charged to threshold value, increased voltage on gate of thyristor SCRl triggers it into conduction. Consequently, a circuit is formed so that the latter half of a DC cycle of the AC high voltage source VS, can unidirectional conduct through power switch, thyristor SCR1, and lamp. At zero crossing, SCRl is typically reverse biased and stops conducting. The conduction angle applied starts at zero, then instantaneously increases to peak voltage and diminishes to zero.

Circuit features embody a secondary method of eliminating the probability of conduction faults relevant to the life of a matched load and the photometric brightness. The recurrent rating of a single current pulse is advantageous as it provides a maximum cooling period of the switching semiconductor junction, minimizing the probability of undesirable thermal fault conduction. Regarding the duration of an overvoltage fault, a worst-case fault is limited by design to DC cycles available through a SCR, while a full AC cycle is available through a triac. Capacitive filters eliminate spurious fluctuation in recurrent accuracy of an isolated conduction angle. Aversion to inductors and component inductance is based upon anticipated interaction with filter capacitors. The primary and secondary method features are combined so as to supply a stable power pulse voltage at the appropriate DC conduction angle.

A further feature is connection of the load in the return side. This step removes the load from power supply of timing circuit. This feature anticipates the probability of load interaction shifting critical timing requirements thus altering the applied voltage. Fuse is connected to AC line and switch and is rated to open if the current flow through the low voltage adapter rises above the maximum allowable load rating, due to a SCR short or other component failure. Q2 Q3 Q4 has an on-state current of 6-8 amps and a peak reverse voltage of 600 volts maximum. The load is connected to the cathode terminal of Q3 Q4 while the anode connects to the hot terminal of AC source voltage supply.

The high conduction angle of the switching means encourages conduction faults occurring due to over heating of the thyristor junction, “Particularly, if the SCR is switched from a high blocking voltage”. Known control circuits employ thyristors connected in parallel, improving stability. An array arrangement allows a pilot SCR or other control element of minimal power rating and cost to become the timing circuit of an array of SCRs, thereby increasing effective power handling capacity. The pilot SCR and SCR array provide versatility in power handling capability. Increasing array size will match power-handling capability to a heavy demand. Pilot SCRs may require voltage and current adjustment appropriate to the array common gate. A voltage-dropping resistor is connected between AC source voltage and the anode. A current limiting resistor is connected between SCR array common gate and return side. The connection of stages feature an advantageous means with which a increase in power handling capability of the High Efficiency, Low Voltage Adapter is obtained, while maintaining the benefit of the above stated circuit features.

Multiple loads may require advanced protection from circuit component failure overvoltage, as lamp envelope failure may ensue. The circuit has Q3 Q4 SCRs connected in parallel, improving stability in this respect. This allows many lamps to be powered by the circuit. The array design allows preceding SCRs to become the timing circuit of a larger array of SCRs, thereby increasing effective power handling capacity to any level desired. The parallel Q3 Q4 array is shown, and an array of higher power (35-55 amp and above) SCRs is possible.

Filter Concerns

The capacitor filters eliminate spurious fluctuation in the recurrent accuracy of an isolated conduction angle. The filters must function perfectly as a .1 degree recurrent fluctuation in an isolated conduction angle voltage will result in a perceptible fluctuation of photometric brightness of a low voltage luminaire.

A filter capacitor connected to the gate and cathode of the SCR eliminates false triggering. The connection of a series resistor-capacitor filter across the AC terminals eliminates the probability of AC power switch interaction, (bounce transients) causing SCR tracking of the AC source high voltage.

A Capacitive-resistive filter eliminates (dv/dt withstand capability failure) SCR tracking (conduction of line voltage) of AC source voltage induced through "...operation of circuit switching devices. This is relevant to the mortality of the load. Another feature eliminates SCR triggering due to maximum transient voltage interaction between anode and cathode. "If the slope of any pulse applied to the SCR is greater than this (dv/dt) the SCR probably will turn on.

To avoid undesirable triggering from sudden transient voltage, a 0.05 uf capacitor C2 C3 C4 may be connected from the gate to the cathode. A further feature is connection of the load in the return side. This step removes the load from power supply of timing circuit. This feature anticipates the probability of the load interaction shifting critical timing requirements thus altering the conducted voltage.

The filter means shown herein is resistor R5 and capacitor C6, which are serially connected between terminals T1 and T2. The filter eliminates switching (bounce) interaction that in probability causes SCR tracking of AC source voltage. The filter is required, as SW2 is a mechanical power switch. However an inductive filter may replace or augment the above filter. Alternate switch means will avoid the above interaction.

Unit is rated at 8, 25 or 50 Amperes maximum peak RMS voltage. The recommended load is one half the RMS current, in system approved lamps. See lamp chart for various lamp voltages as well as other specifications.

The APS system package is spliced into local BX wiring. HOT side is to connect the (optional for bipolar) diode bridge. This is marked "AC" on the bridge. Quick connect terminals are recommended. Return voltage is routed to lamp(s). This is a pulsing wave as shown. Return or neutral local wire is connected to lamps other side. Lamps are wired in a parallel circuit.

Construction

The project may be constructed into a dimmer case or any small box for use with free standing lamps The hot side should be connected with a red wire to simplify connection to house wiring. Follow the circuit setup procedure and then assemble the circuit onto the case.

The capacitive-resistive filter C6-R5 eliminates SCR tracking of AC source voltage induced through operation of circuit switching devices. Essentially this debounces the power off/on switch.

Another feature eliminates SCR triggering due to maximum transient voltage interaction between anode and cathode. To avoid undesirable triggering from transient voltage, a 0.05 microfarad capacitor C2, C3, and C4 is connected between the gate to the cathode.

Decoupling against line voltage transients acting on the unijunction transistor Q1 is achieved with the use of "bootstrap capacitor" C5 between base 2 and the emitter of the unijunction transistor.

The result is positive or negative transients on the unijunction supply voltage will not trigger the UJT.

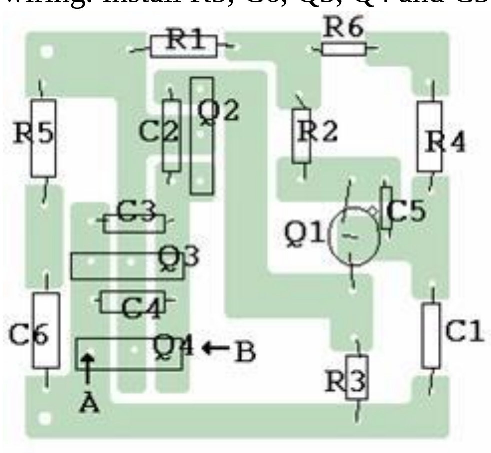
Q1 has base 1 connected through resistor R3 to voltage low side and directly to the gate of Q2. The base 2 of Q1 connects through the serial combination of resistors R1 and R2 to hot side. R1 drops AC source voltage to the supply voltage of the timing circuit. R2 serves to compensate Q1 from thermal variations. Variable resistor R4 connects through the limiting resistor R6. The connection of R6 limits the charging voltage on C1, hence the range of conduction angles available through variable resistor R4. A precision timing capacitor C1 connects between the emitter of Q1 and the low side.

Variable resistor R4 can be replaced with a external potentiometer mounted through the case, a rotary switch selecting resistors, relay contact, timer, occupancy sensor, optoisolator or any resistance element with which to select a static conduction angle.

Q2, Q3, and Q4, have an on-state current of 4-8 amps and a peak reverse voltage of 200-600 volts maximum. The high conduction angle of the switching means compounds conduction faults occurring due to hot spots in the thyristor junction. The highest amperage available and heat sink may also be required.

Load is connected to the cathode terminal of Q3, Q4 while the anode connects to the hot terminal of AC source voltage supply. This feature removes the load from the power supply of UJT and supplies the load through the SCRs.

The circuit can be assembled on the full size PC board shown or on perf board. Assemble the circuit in the following order. First attach the wires to be used to connect the circuit to the line voltage. The hot side at R1 should be connected with a red wire to simplify connection to house wiring. Install R5, C6, Q3, Q4 and C3, C4. Connect this assembly to the AC line and a standard lamp, as shown in the circuit diagram.



If you only intend to use a single lamp, Q2 C2 Q3 C3 may be omitted. Connect a jumper between A and B as shown on the component layout diagram.

Use an alligator clip jumper and standard lamp to briefly connect the gate of the SCRs Q3, Q4 to AC hot side. The lamp should light. If the lamp is on all the time the thyristor is shorted. If it does not light it is open. Correct thyristor problems before proceeding. Next connect Q2 and C2. Test the thyristor circuit as described before. Once the power section is complete, assemble the remaining components to the PC board as shown. Verify that you can vary the conduction angle. The circuit is now ready to be install into a case.

PARTS LIST

SEMICONDUCTORS

Q1-NTE 6401, Motorola 2N2646, GE 2N2647 UJT
Q2-3-4: 200-600V 6-8 AMP SCR

CAPACITORS

Capacitor: C1-0.10 micro farads, 200V 5 %
Capacitors: 2, 3, 4, 5-0.05 micro farads, 200V 10%

RESISTORS

Resistor: R1-33K Ohms, ½ W 10 %
Resistor: R2, 5-100 Ohms, ¼ W 10 %
Resistor: R3-47 Ohms, ¼ W 5 %
Resistor: R4-100K Ohms, potentiometer
Resistor: R6-2K Ohms, ½ W 10 %

These lamps may be obtained from a Phillips of North America® or General Electric® dealer.

0A30V-ATR 30V 100W
50A24V-ATR 24V 50W
25A34V-ATR 34V 25W
25A24V-ATR 24V 25W

CAUTIION, DO NOT INCREASE OR ALLOW THE VOLTAGE TO THE LOW VOLTAGE 30 VOLT LAMP TO INCREASE OVER 12 VDC, AS THE LAMP ENVELOPE INTEGRITY MAY BE COMPROMISED. Please wear safety glasses when testing lamp.

Once the circuit is assembled, connect a standard 100 watt 120VAC lamp. Adjust the variable resistor until the standard lamp is extinguished. Disconnect the 120 VAC lamp and connect the 30 volt lamp. The voltage across the hot side and the lamp should be about 12VDC (unipolar). The current between the lamp and circuit is about .6 ADC (pulsed). The lamp should now emit a level of brightness close to a standard CFL.

The APS system is spliced into local wiring. The hot side is to connect as shown. The return or neutral wire is connected to the lamps. Lamps are wired in a parallel circuit.

The first time applying energy to the circuit and lamps, standard lamps are recommended as a check. The lamps should barely glow. Once the assembled unit is connected as shown in the test diagram, connect a standard 100 watt 120VAC lamp. Adjust the variable resistor until the standard lamp is almost extinguished. If all is as expected, measure voltage across standard lamp and make an adjustment to approximate setting of the lamp selected for installation. Lamp voltage is set as shown in chart. A digital meter set to AC for bipolar or DC for unipolar is connected across the lamp.

If standard lamp is at normal brightness, check the circuitry, and do not go on to installing the system lamps until the condition is corrected. If all is as expected, measure voltage across the lamp and make an adjustment to the approximate setting of the lamp selected.

Disconnect power and change the regular lamps to the low volt lamps used in this installation. Reapply power. The lamp(s) should be brightly lit. If the lamps do not last the 1,000 hours expected, make a slight reduction in the measured voltage across the lamp. At a point, the lamp life will improve. As the lamp manufacturing is beyond APS control, variations in quality between batches can be expected.

If lamp burns out when power is first applied, then the circuit is defective. If low voltage lamps do not last as expected, make a slight reduction in measured voltage across lamp. At a point, lamp life will improve and may extend beyond normal. As lamp manufacturing is beyond APS control, minor variations in quality and price between batches can be expected. Occasional increase or decrease in system brightness is normal, and corresponds to changes in local power company line voltage or local loads on the line.

Voltage Adjustment

Disconnect the 120 VAC lamp and connect the 30 volt lamp. Adjust carefully the variable resistor until, the values are as specified for the specific lamp powered up. Typically this is 9 to 14 volts as measured across the lamp Reducing the voltage via this adjustment will dim the brightness of other lamps, or allow the user to select a custom brightness at will.

APS Micro Grid supplied for installation consists of a circuit board and Lamp. PC board units are rated at 8 to 50 Amperes maximum peak DC current. The recommended Micro Grid voltage is one quarter to half the DC Volts marked on system-approved lamps. System lamps are rated from 24 to 34 volts.

Lamp type	Voltage	Current	V x I	Part no. Phillips	R
30V 50W	7.27	0.73	5.3	50A30V-ATR	18
24V 50W	7.24	0.75	5.43	50A24V-ATR	11.52
32V 25W	14.6	0.47	6.86	25A32V-ATR	40.96
34V 25W	14.2	0.47	6.67	25A34V-ATR	46.24
24V 25W	9.67	0.46	4.44	25A24V-ATR	23.04
30V 25W	12.3	0.38	4.67	25A30V-ATR	36
34V 15W	15.99	0.26	4.15	15A34V-ATR	77.06

The APS Micro Grid PC board is installed by splice into local wiring, usually at the light switch. HOT side of PC board is Red wire. Return voltage is black wire. Black wire is routed to lamp. Return local wire is connected to lamps other side. Multiple lamps are wired in a PARALLEL circuit.

First time applying energy to installed circuit and lamps, a standard 60-watt lamp is used as a check. The lamp filament should glow slightly. If lamp is at normal brightness, check circuitry, and do not go on to installing system lamps until over voltage condition is corrected. Either voltage must be adjusted at the onboard potentiometer or the PC board has a circuit component fault.

If lamp filament glows as expected, disconnect power, install system lamp and reenergize. Measure voltage across APS lamp and make an adjustment to recommended setting of the APS lamp. Lamp voltage may be set as shown in chart. A digital meter set to Direct Voltage, is connected ACROSS lamp to measure. The hot side at the lamp is from the PC board.

If lamp burns out when power is first applied, then the voltage is to high. If APS lamps do not last as expected, make a reduction in measured voltage across lamp. At a point, lamp life will improve and extend beyond normal.

As lamp manufacturing is beyond APS control, minor variations in quality between batches can be expected. Occasional increase or decrease in system brightness when operating is normal, and corresponds to changes in the line voltage delivered by the local power company or loads on the supply line.

TROUBLE SHOOTING

1. Standard lamp will not light.

Check circuit assembly, check that Q1 is of the correct voltage.

Check the SCRs are connected correctly.

Check the circuit components are of the correct voltage rating and the thyristors are not over heating.

2. Can not adjust voltage with standard lamp.

Check the circuit including the UJT polarity.

Check the resistors and capacitors value.

Check the SCR polarity.

3. Low Voltage Lamp L1 illumination varies.

Check that the Hot Side of the circuit is connected to the Hot Side of the house circuit. Measure with a 120 VAC Voltmeter to ground to find hot side.

Check that other appliances on the circuit are in good condition.

Check that all outlets have the proper polarity. House wiring testers are available for this purpose. Appliances with reverse polarity can interact with the circuit.

Appliances that have faulty compressors and ballast may interact with the project.

Off Grid Operations

Generator

Connecting APS to a generator or inverter may deliver the full efficiency possible. This is because there are no wattmeters to make you think it is not working. The amount of horsepower needed to power the lamp or charge batteries is going to be closer to the power used to light the lamp.

Combining fuel motor / generator with a DC APS 50 ampere lighting system creates a demonstration technology showing efficiency gains. The demonstration is based on theory torque load on a generator is reduced Xl0 by APS system. The estimated horsepower load of 20 APS lamps is .25 HP. A motor driving a generator will use approximately xl0 less fuel.

A-B comparison is based upon elapsed time a standard / APS system runs, while comparing quantity of fuel consumed. A precise graduated cylinder holding fuel is attached to motor. Shown next to this is a clock. The systems are proved primarily by fuel held in the cylinder. The generator and clock are started. When the “A” fuel is spent, clock is stopped and run time elapsed recorded. Then the “B” system is run, it should run X10 longer on the same amount of fuel. Fuel quantity can be measured in volume or presented in dollars.

A-B TEST

System ‘1A” will use 20 standard 100w lamps. This is a 2KW load. Standard motor/generator will power the “A” lamps. “A” system base line measurements are taken of; fuel used, for a time period and (optional) Kilowatts, lumens, and emissions. System 1’B” uses a gas motor generator and APS 20 lamp system. The “B” system increase of run time elapsed shows over-all efficiency improvement of the APS system. Monetary gains charted are cost of fuel. If the system is proved at X10, then every dollar of regular fuel spent is really $10. After XlOO run time, the owner of the system earns $1,000.

Inverter

APS photovoltaic lighting concept systematically manages Direct Current power use when applied to PV systems. APS reduces luminaire power load. This is directly applicable to net metering. Systematically manage the residential decision making input as to power ratings in use with PV system. During evening or cloudy situations, battery charge is depleted. Innovative management of battery drain prevents inverter low voltage. APS optimization prevents switching to grid power. Ideal PV system can run off battery in 24-hour cycle.

APS concept manages the decision making process regarding the wattage of luminaries used in residence. Installation of APS modules requires a (unique) low voltage lamp. When lamps are replaced the end user cannot choose a (conventional) higher wattage lamp (60, 75, 100 watt).

Total system KW design specifications can be reduced ten to fifteen percent. This reduction can be applied to initial cost of the system.

While APS technology is in the development stage for this application, a test residence will be evaluated prior to a short run production. The small dimensions of the APS lamp fit in all existing fixtures. This can reduce estimated cost associated with professional efficiency lighting installation.

Advance Power System supplies a low voltage incandescent lamp with innovative 60 HZ DC power. In small power plant operations, this high efficiency lighting can reduce system load. This article explains how solar powered systems can install APS to manage power load.

This new lighting technology is based upon sine wave conduction. Since many inverters are square wave, I have investigated the results one can expect with this power source. Lamps are measured by the lumens produced. As a reference, comparison of APS incandescent lamps and conventional incandescent lamps is used. When a square wave inverter supplies power, some reduction in efficiency occurs.

When hydro or wind is used to generate power APS should deliver the full efficiency possible. Efficiency gains with fuel, wind, or hydro generator are based on torque load. The amount of horsepower needed to power the lamp is going to be close to the actual DC power used to light the lamp. Load reduction is about Xl0. The estimated horsepower load of 20 APS lamps is .25 HP. A motor driving a generator can use approximately xl0 less fuel.

A monetary gain is cost of fuel. If the system actually operates at X10, then every dollar of regular fuel spent is really $10. After XlOO run time, the owner of the system earns $1,000.

Determining inverter power used by this lamp is measured with an amp meter between battery and inverter positive. The DC current flowing between the battery and inverter is load power of inverter plus load(s). Undeviating current power dissipated across a resistor is true power. This applies to incandescent lamps, as the filament is a resistance. Load input power must equal input power for an acceptable power measurement.

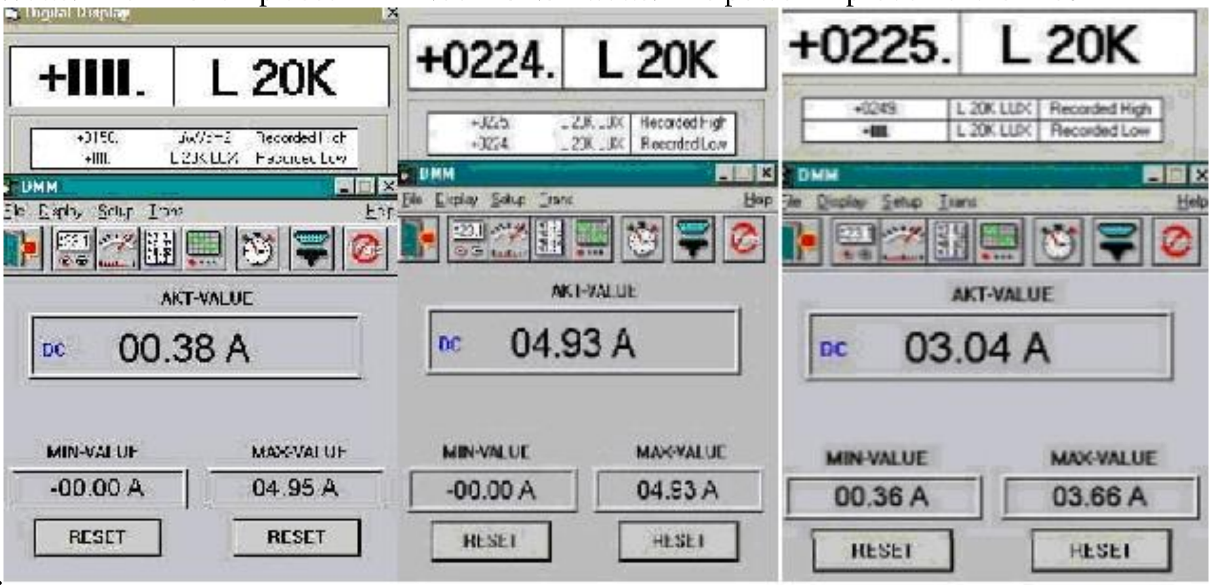
When DC load input power is measured with a volt and ammeter, the product of the measurements is true power. Formulas for true power are P= ExI, P= I2xR and P= E2/R. The first equation is used with actual meters connected in a circuit. The others are used when one value can be measured and the R or resistance is known. This is used to determine load power and is measured directly at the lamp.

Volt-Ampere-Hour meter better known as a watt-hour meter, measure energy used by an electrical product over time. AC (line voltage) watts are a product of the integral of RMS current over a period of time under the assumption that the voltage is constant. As APS is a DC pulse, APS voltage must be measured differently to accurately determine load power.

Wattcmeters make an error in calculating true power of an APS DC pulse. DC pulse voltage does not fit An assumption of constant voltage through the cycle. This can cause a very large error in the power equation. Magnitude of the error is x10. Example, RMS line voltage is 117 volts AC. APS DC load voltage is 17 volts DC. The current is constant. 117 is substituted for 17 in the P=ExI formula. For inverter true power, measure the current flowing between DC positive (battery) and inverter. Load Power = Battery Voltage X (Battery Current - Inverter Idle Current).

Inverter load power measurement of a 40-watt lamp and APS lamp is compared. A Wagen square wave inverter powered this test. At 12VDC and 225 lux, the APS lamp used 3.04 amps while the

40-watt used 4.93 amps. Concluding this comparison, the inverter has an idle current of .38 amps. To find the load power, compute load amps minus idle amps. The 40 watt is 4.93 - .38 = 4.55 amps DC. The APS is 3.04 - .38 = 2.66 amps DC. In watts the 40 watt lamp used 12 x 4.55 = 54.6. Watts. The APS lamp used 12 x 2.66 = 31.92 watts. The power improvement is 42%



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Use of APS substantially improves capacity by reduction of DC ampere flow from battery to inverter. Example; ten 40 watt lamps use 10 x 4.55 = 45.5 amps for one hour operation. Ten APS lamps use 10 x 2.66 = 26.6 amps for the same time. Including optional level control hardware, APS power and lamp output can be reduced to .77 amps. Over 10 hours 10 x .77 = 7.7 amps for low level lighting.

Marketing

Technical Advantages

The notable level of efficiency and cost effectiveness associated with the invention assures the commercial viability of various super high efficiency products. Variability of light level and super high efficiency in one product vs. the cost of compact fluorescent lamps, plus a dimmer, adds further value to the product. The dual lamp adapter powers two lamps. The package cost can be marketed from $8 to $18. Microchip technology places the circuit in the base of an ordinary lamp. Compared to the cost of two compact fluorescent lamps at the same brightness, plus dimmer, the $18 vs. $30 cost gives the traditional consumer a new choice. The lack of mercury removes this product for the future possibility of a total ban on products containing mercury. Various popular and useful features may be added. Infrared sensors touch switches, Power Line Controls (PLC), level control and daylight sensors.

The commercial value is twofold. First the product outperforms and has more features, than compact fluorescent lamps. Secondly the cost per unit is estimated to be less than any lighting product available today. Commercial equipment costs are expected to follow the downward spiral commonly associated with electronic equipment as production volume increases. Surface mount device technology will reduce per unit cost, and decrease the size of the device. The durability of the circuit is estimated to be many years.

Commercial Potential

Manufacture of the invention will place it in competition with all known forms of DSM electric energy conservation applied to existing infrastructure. The zero picocurries of mercury eliminates disposal cost. Lower estimated retail cost, light adjustment feature, and higher efficiency is recognized as an efficiency marketing advantage vs. fluorescent lamps.

Electronic supply of energy for demand side consumption has demonstrated efficiency expectations that exceed all known methods of conservation via an innovative electronic technology. Commercialization of this will provide a new resource applied to demand side energy management. Energy marketers may find this system a valuable tool in swaying customers to sign up. Virtually any appliance or industrial process can be converted to this technology at a low cost, once the capacity to supply ECM equipment exists. Manufacturing is completely conventional, and may begin without capital construction of manufacturing plants, or equipment.

The low voltage minimizes concerns of RF or EMF radiation, wiring standard conflicts, and shock hazard. With a trade off between cost and performance, this method of demand side management suggests direct coupling to carrier wave electrical power is obsolescent. Pulsed power can operate near unity as an efficient, cost-effective method for DSM power distribution. It resolves problems associated with our present demand side system that has existed unchanged for almost a century.

APS plans to license the product in many forms. The product is to be sold worldwide.

Test marketing indicates the southwest area is most open to this technology. Energy load shed from this innovation can be very large. The lack of any toxic chemical eliminates the environmental concerns. Where deregulation allows consumers to choose the type of watt-hour meter for their home, this becomes the most efficient product. Possible the least expensive efficiency device available on the market. New market for homeowners who do not desire to change fixture to accommodate CFLs, and buildings where the cost of wiring excluded the use of any other efficiency lighting system.

This invention may revolutionize the lighting industry. Direct sales to consumers, utilities, conservation programs, and government agencies are expected. Contractors may sell, lease and rent DSM hardware. The target market is to replace incandescent lamps with something much more efficient. The commercial value is twofold. First the product outperforms and has more features and installation flexibility, than compact fluorescent lamps. Secondly the cost per unit is estimated to be less than any lighting product available.

Based upon a unit cost of five to ten dollars, annual cost savings of $95, the simple payback occurs in 50 days or .10 years. Based upon the above, ECM annual energy savings of a single luminare over a service life of five years is $383.00, minus initial cost of purchase and lamp replacement.

Failure of existing KWH metering to accurately measure EPS low voltage load power prevents load management from being placed in general service. Metering industry consensus is there are no meters that will measure pulsed DC at 60 HZ. Therefore as a seller, lighting system cost saving claims cannot be guaranteed. This is the hurdle towards commercialization. Interim marketing solution is to claim lighting system is compatible with installed electronic meters and offer a 55%

efficiency improvement at the meter. Engineering solution is to design a mathematically accurate meter.

Second-generation incandescent lighting can be sold to all consumers. Unique core technology is EPS lighting and metering. Benefits are, actual and potential peak load reduction, lower KWH cost to operate lighting than CFL, dimmable lamp, low temperature operation, miniature lamps, lower initial cost than CFL, and free of waste lamp disposal costs. Competitive CFL lamps may last longer in service, but are less efficient, and becoming restricted as a universal waste hazard.

Estimated Total US Market (Lighting sector estimated at 10-25%)

Residential annual average electrical cost is 12 x $6,892 = $82,704 Million. Commercial annual average electrical cost is 12 x $5,988 = $71,856 Million.

Residential

10% of $82,704 = $8,270.4

25% of $82,704 = $20,676

Average percent = $14,473

Commercial

10% of $71,856 = $7,185.6

25% of $71,856 = $17,964

Average percentage = $12,574.8

Composite annual average US market share is $27,047.8 Million. A 90% reduction creates a new $24,342.3 Million dollar US market.

Utility Generation and Retail Sales–October 1999. U.S. Department of Energy Information Administration.

Commercialization strategy is to license core technology to energy generators and resellers. Pending certification and engineering resolution an interim strategy is to market the lighting system as compatible with installed electronic meters and achieve a 55% efficiency improvement at the meter.

Licensed technology business model offers deregulated energy sellers actual peak load reduction service at customers' premises. Energy marketers sell energy efficient technology combined with retail sale of transmitted power. Hardware reduces total demand up to 16%, 8% to seller and 8% to customer. With typical 15% rate reduction offered by independent resellers, competitive rate becomes 15% + 8% = 23%.

Related electric service plan. Licensed company sells and installs equipment at end users premises. End user either pays for service or is provided with a choice of payment plans. Amortization plan can cover installation cost of electronic KWH meter (about $120) and $10-$5 per lamp. After installation is paid off, customer receives full rate discount of 15% + 16% = 32%.

Government, state and industry programs show demand exists for new load management technology designed for demand side. Corporate interest to date has been in area of initially evaluation of performance levels claimed for system. Total market is $24 Billion, as developed in section 2.3. At this time it is difficult to establish extent of capture of within two years. Pending development of technology, tests, and market exploration a more exact estimate can be presented.

System can be installed in deregulated markets where resellers are allowed to replace customers KWH meter. In New Jersey, as an "electrically related service", a retailer of electricity may be allowed to replace meters as needed to provide efficiency service utility companies cannot. Inventors' limited financial resources will delay release of technology for several years. If utilities' meter cannot be replaced due to indirect cost, regulation, monitoring and evaluation costs, a barrier exists that cannot be overcome.

Invention lamp in test outputs 240 foot-candles at 5.4 watts or 44.44 Fc per watt. In comparison a CFL lamp uses 14 watts to output 237 Fc or 16.92 Fc per watt. A 60-watt incandescent lamp used 56 watts to output 244 Fc or 4.34 Fc per watt. Efficiency improvement is 93% over incandescent and 38% over CFL. A 100 lamp replacement (.05 or .10 cents per KWH) CFL costs $346-$693 more to operate per year and incandescent costs $2,040-$4,080 extra.

Environmental carbon reduction.

Year 2000 estimates 1,552 MMT. 38 percent from electric generation is 589.76 MMT carbon. EIA/AEO 2000 page 37

Estimated carbon reduction, lighting sector.

Residential sector

10% of 589.76 are 58.97 MMT

25% of 589.76 are 147.44 MMT

Average is 103.205 MTT

Commercial sector

10% of 589.76 are 58.97 MMT

25% of 589.76 are 147.44 MMT

Average is 103.205 MMT

Year 2000 combined residential and commercial approximation is 206.4 MMTs'. Reduced by ninety percent is 185.76 MMT.

Projected carbon reduction.

2000-2009 1,67.9 MMT

2010-2019 3,529.4 MMT

2020 3,715.2 MMT carbon reductions.

Demand Side Management

The invention as a demand side energy saving system consists of an electronic adapter connecting line voltage to a matched low voltage lamp. The adapter supplies patented wave propagation, derived from the source AC sine wave. Patented method solves the problem of increasing efficiency of demand side energy consumption. Two innovations regarding the system are; the 99 percent ECM of adapter supplying energy pulse and total ECM is 90 percent.

Phasor voltage is instantaneous, supplied via the leading edge of the pulse. Direct hardwire connection of appliances to 110 or 220-volt AC lines can be eliminated. USS Patent 5,463,307 Description of Related Art section line 16 discusses the inherent waste of energy direct connected appliances exhibit.

Deregulation of present limitations upon digital sampling watthour meters opens the market for APS power controls. The use of nonlinear supply voltage covered by the APS Patent may become the efficiency means of choice. Domestic users whom want more efficiency than conventional incandescent lamps can be marketed. APS lamp has better lamp dimensions, similar light quality, built in dimming, and safe disposability than CFL. Efficiency appears better than compact fluorescent lamps, at a lower initial purchase price, and is free of toxic mercury content. This product that has the best features of both lighting types.

When computerized metering is made available to the consumer, commercial efficiency is expected to be in the 90%range. Energy marketers can pass more savings on to the users, as reduced watthour costs for lighting. Regulatory change promoting installation of 90 percent high efficiency equipment will impact infrastructure regarding generating plants, fuel expended, capital construction costs and maintenance cost. On a national level once this method of Demand Side Management power is in use, domestic and industrial electrical load can be reduced on a scale previously unconsidered. Projected ECM annual energy savings exceeds billions of dollars.

Scope of Energy Impact

The following baseline calculations compare a conventional 100 watt lamp to patented luminare computed over one year of continuous illumination.

Based upon a unit cost of five dollars, the simple payback occurs in 15 days or .0097 years. The annual cost savings is $95. As shown above, this is an unprecedented ECM cost reduction for

ECM equipment. Based upon the above, ECM annual energy/demand savings of a single luminare over a service life of five years is $500.00, minus initial cost of purchase and lamp replacement.

U.S. Electricity Supply: (Billion Kilowatt-hours)

YEAR	1ST	2ND	3RD	4TH	1994	1995
Demand: (Supplied by Electric Utilities)						
Residential	279.4	229.8	272.3	241.5	1023.1	1031.2
Commercial	197.1	196.3	225.5	203.6	822.4	855.1
Industrial	244.1	252.6	263.7	255.3	1015.7	1027.5 [1]

Estimates project retrofitting incandescent lighting with an ECM that operates at 90 percent high efficiency rate. This summarizes the energy impact in kilowatt terms that will result from promulgation of this DSM technology, per se complete replacement of conventional lamps with this ECM.

Residential lighting demand for 1995 is estimated at 10 percent to 25 percent of the total residential electrical demand. At the 10 percent estimate a 103.12 Billion Kilowatt-hour base line is established. A load reduction of ninety percent is 92.8 Billion Kilowatt-hours. At $0.12648 per Kilowatt-hour, 11.737 Billion can be conserved per year.

At the 25 percent demand estimate, a 255.75 Billion Kilowatt-hours load reduction occurs. This is equal to 32.34 Billion per year.

Commercial lighting demand for 1995 is estimated at 20 percent to 30 percent of the total residential electrical demand. One ECM unit can control up to 1,000 amperes. Applied to space lighting, approximately 2,000 lamps may be operated with APS. Installation will result in an annual plant energy/demand reduction of $200,000 per year when operated at full capacity.

Commercialization of this Invention will provide a new resource that may be applied to demand side energy management. Virtually any appliance or industrial process can be converted to this technology at a low cost, once the capacity to supply customer specification ECM equipment is established. Manufacturing is completely conventional, and may begin without cost associated with capital construction of manufacturing plants, or equipment.

Installation of 90 percent high efficiency equipment will impact infrastructure regarding generating plants, fuel expended, capital construction cost and maintenance cost. The product can be distributed through utility companies that must meet federal regulations regarding demand reduction. On a national level domestic and industrial electrical load can be reduced on a macrological scale previously unconsidered. Calculations project ECM annual energy savings exceed 36 billion dollars, should the DSM technology be in use today.

Packaging

Estimated retail price of this equipment in a single lamp disposable form is approximately eight dollars. A conventional dimming lamp product now available contains a similar internal electronic circuit built into to the lamp base. It is obvious that one can replace this circuit with the invention and that filament with a filament of the resistance APS uses. This may reduce cost further. Circuit packaging cases are varied. Dimmer style package, replacing the wall switch allowing variable light level. A unit that plugs in the wall socket connecting two standing lamp plugs. A module is spliced into wiring or concealed within the fixture. A disk is inserted between the lamp and the socket.

Tube fluorescent lamps can be refitted with an incandescent lamp adapter. Multiple luminare can be connected, improving equipment refit cost-effectiveness or offering the commercial consumer an alternative.

A method of preventing the accidental application of AC line voltage to the lamp during installation or maintenance is desirable. A permanently connected chip in the lamp base, or a unique bulb base, so that LV lamp cannot make contact with line voltage. A disk can be made in a range of brightness and reused when the bulb expires.

APS electronic packages are connected to existing fixtures and freestanding lamps. There is no need to change standard medium base fixtures. Hi power adapters may supply over 25 lamps, in large rooms and other interior /exterior spaces. APS technology can be applied to any existing installations and products that use an incandescent lamp and desire an energy efficiency rating.

History of Development

Advance Power System product described here is developed for use in lighting. Present design uses a reliable electronic circuit to supply nonlinear voltage to a design incandescent lamp. Design voltage is less than 1/10 the voltage usually supplied to lamps. This is based on brightness of design lamps compared to conventional vacuum lamps. The original concept occurred while prototyping a Z80 microcomputer for building management project at CUNY. A Triac was considered to control the lighting via computer IO line. When lamp on timing was adjusted slightly the power was also reduced slightly.

Technical problems relating to the innovation are in two categories. The invention originated circa September 1980. A dimmer was modified to work at only one adjustment point. A statistically significant reduction of conduction and a corresponding reduction in power occurred. See Background of the Invention page 3 line 60. It was discovered at the time that the reduction in light output lagged behind the power reduction. Voltage was reduced fifteen percent (a significant amount at the time) with a negligible reduction in light quality. This method is now recommended by well-known consumers reporting publication, and has appeared in dimmer product efficiency claims.

This early discovery is attributed to the instantaneous component introduced into the lamps supply voltage by the method. This has entered the public domain as conventional energy saving devices that preset maximum brightness to include the above stated component. Many conventional energy efficiency devices on the market that use diodes or dimmers to conserve energy by giving the user a choice of brightness levels presently practice the above method, referred to as static conduction. These may be copies of my work released to the public domain. Carried further power could theoretically be reduced to 35-40 percent. Conservation was achieved in an output/energy use trade off.

The concept of supplying power to loads exclusively by this method was advanced. A new circuit was designed and lower voltage lamps were evaluated. The findings predicted a 90% reduction in power use with no reduction in light output. The second pulse available in an AC cycle was not used as it arrives prior to the full release of photon energy. With pure resistive loads such as lamp filaments, the heating of the load continues after the phasor pulse ends, as the molecules have been excited to a high-energy domain by the phasor. Energy released by the second bipolar current pulse overheats the filament, wasting energy. Power decrease below peak extends low voltage lamp filament life to standard expectations or better.

In reference to patent No. 5,463,307 the foundation of this invention can be found in claim No. 3 and 15. Conduction of instantaneous voltage as specified propagates a high efficiency power pulse wave. The pulse is applied to a load device whose characteristics are a low voltage. The leading edge of the pulse formed by the patented conduction is a high intensity instantaneous conduction of current. When conduction is held to a precise static angle, one phasor is propagated as a wave at 60 or 120 pulses per second. Low voltage as a uni-polar power pulse to a matched voltage and resistance load is advantageous over conventional methods and loads. The rapid rate of rise conduction to a matched luminaire load results in instantaneous heating of the resistive element of a LV Load (lamp filament). A further benefit is the trailing edge slope of the uni-polar pulse rapid decrease to zero volts. Power decrease, or heat dissipation in the lamp filament begins immediately after peak power is reached.

The relevant conduction angles regarding the said phasor pulse are toward the extreme limits of those claimed in the patent. The patent claims allow conduction from 90 degrees to 180 degrees, where the voltage is always decreasing. Present high efficiency lighting, conduction is from approximately 150 degrees to 168 degrees. This sixteen-degree range of conduction angle powers all specified low voltage lamps. Connected lamps will emit equal photochromatic brightness of lamps in the conventional range of 100 watts to 25 watts.

Material characteristics of ECM low voltage lamps are low voltage and low resistance. The impedance of selected low voltage lamps yields results in a 90 percent range of high efficiency rating. Lower impedance than standard improves power transfer efficiency. With a source sine wave of 60 hertz at 115 VAC, conduction at 151.1 degrees results in a measured average DC pulsed voltage of 12.3 VDC. This is confirmed by taking the sine at 151.1 degrees of 25.5 volts. Lower peak voltage is due to low impedance of this load. 25.5 volts are the voltage at 90 degrees of one half cycle.

The method of isolating a (static) DC uni-polar pulse via the adapter within the stated conduction angle range exceeds the efficiency of bi-polar pulse(s) conducted through a matched load. A bi-polar pulse consists of two identical current pulses of opposite polarity per cycle. Eliminating one current pulse slightly decreases dissipated power by about 1.5 watts.

Bi-polar pulses can also be used, resulting in a similar measured decrease in power used. The user always gains a substantial improvement in efficiency and cost reduction. RF suppression is needed in some uses.

An innovative ECM voltage supplied by a phasor pulse at the specified conduction angle is more effective than hard-coupled alternating current or direct current. Average current occurring at an instantaneous rate of rise can raise molecules in an incandescent lamp filament to a higher domain of molecular excitation. A specifically engineered luminare that is Xenon gas filled, may improve the light output, lower the wattage, and extend service life.

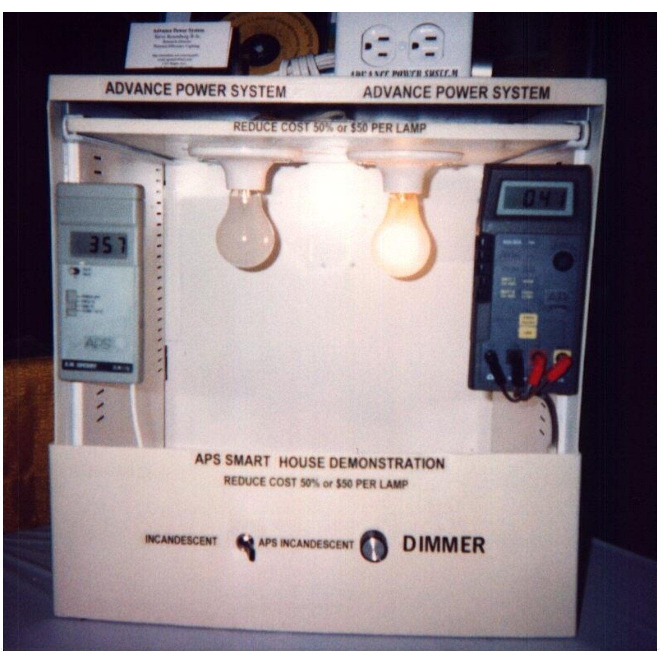
Identifiable features are numerous. Low cost, safe voltage, no toxic chemicals, variable light output, 7.5-2.5 watt power consumption, lamp life as good as standard 1000 hour lamp. Lower installation cost than compact fluorescent lamps when retrofitting older buildings, and 1/3 the cost of CFLs with dimming.

Pulsed current power is long known as efficient power. Any domestic and industrial user of commercial power can permanently connect APS equipment with the services of an electrician. ECM equipment resolves all problems associated with our present demand side system that has existed unchanged for almost a century. APS electronic supply of energy for demand side consumption has demonstrated efficiency expectations that exceed all expectations for this method of conservation.

The Inventor

Mr. Steven Rosenberg graduated from American University of Washington DC in 1974 with a Bachelor of Science degree. Following he enrolled in a PBM program in Computer Science at Kean College of Union N.J. Mr. Rosenberg is presently employed in the engineering department of Rail Operations.

USS Patent No. 5,463,307 titled HIGH EFFICIENCY, LOW VOLTAGE ADAPTER APPARATUS AND METHOD was awarded Oct. 31, 1995. The APS prototype was published in the March 1997 edition of Popular Electronics.



The Invention was demonstrated at the Tesla symposium Colorado Springs Co, 1997.

The Inventors Exposition at Waterbury Conn.

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References

1. Historical data: Energy Information Administration, Monthly Energy Review, and Electric Power Monthly.

2. Encyclopedia of Electronics 2nd Edition. Stan Gibilisco and Neil Sclater Co-Editors-in-Chief. Second Edition, Fourth printing. 1990 by McGraw-Hill Inc.

SCR Manual GE corporation