The THE WHITE BOX (TWB) is the next generation power quality and power management solution. THE WHITE BOX decreases total electrical energy consumption by decreasing electrical losses in the system. As a consequence of decreased total electrical consumption, electrical efficiency increases to almost 100%. TWB is automatic, self-programming, self-learning and performs with the same high efficiency for highly unbalanced and balanced electrical load conditions.

Contents

US ENERGY
CONCEPTS, INC

Introduction

The patented technology and UL listed products are the next generation products in power quality and power management solutions that decrease the total electrical energy consumption, electrical energy generation and the carbon foot print for our country without having to replace inefficient or old electrical and mechanical equipment in buildings.

The science behind the technology is the Maximum Power Transfer Theorem (Jacobi's Law-1840) that focuses on increasing total electrical efficiency in electrical systems by decreasing losses using impedance matching.

The technology used in our TWB - THE WHITE BOX device is based on principles of dynamic impedance matching, synchronous processing, advanced power switching, and real time, accurate and precise correction using multi-tasking algorithm control to optimize each phase to attain maximum efficiency.

When connected to electrical alternating current (AC) inductive and other balanced or unbalanced phase loads, our solution dynamically matches the source and load impedances resulting in reduced total electrical power consumption and significant electrical efficiency improvement.

THE WHITE BOX solution is a solid state electronic solution that consumes very little energy and is not a parasitical load on the network - consumes less than 40 watts per 100 Amperes, 3 phase, 480 volts application.

The unique feature of engineering design of this solution is that it is “fail safe”- it does not interrupt the power supply to the load whether it is “on” or “off”, active or passive!

THE WHITE BOX solution when installed in front of a electrical panel, or a individual piece of equipment or a combination of different mechanical equipment will decrease the required current in the electrical network.

Science and Technology

The science behind the technology is the Maximum Power Transfer Theorem (Jacobi's Law-1840) that focuses on increasing total electrical efficiency in electrical systems by decreasing losses using impedance matching.

Moritz Hermann von Jacobi

Moritz Hermann von Jacobi

Born: September 9th, 1801, Potsdam, Kingdom of Prussia

Died: March 10th , 1874, Saint Petersburg, Russia

Residence: Prussia, Russian Empire

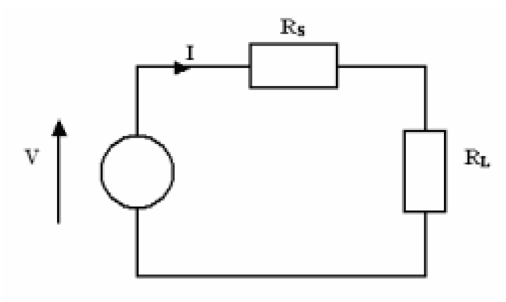
Nationality: German

Fields: Physics and Engineering

Institutions: Russian Academy of Sciences

Known for: Maximum Power Transfer

Jacobi's Law – known for Maximum Power Transfer Theorem



Circuit Diagram

Power is being transferred from the source,
with voltage *V* and resistance R_S,
to a load with resistance R_L,
resulting in a current *I*. *I* is simply
the source voltage divided by the total
circuit resistance

The law known as the Maximum Power Theorem states:

> **"Maximum power is transferred when the internal resistance of the source equals the resistance of the load, when the external resistance can be varied, and the internal resistance is constant."**

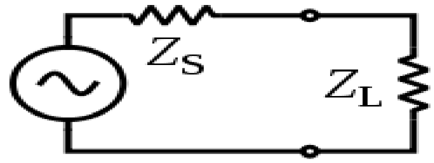
The transfer of maximum power from a source with a fixed internal resistance to a load, the resistance of the load must be the same as that of the source. This law is of use when driving a load such as an electric motor from a battery

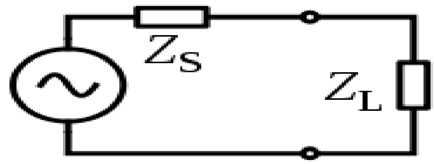
Maximum power transfer theorem

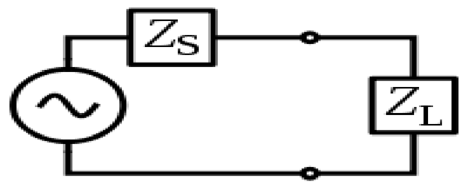
In Electrical Engineering, **maximum power transfer theorem** states that, to obtain *maximum* external power from a source with a finite internal resistance, the resistance of the load must equal the resistance of the source as viewed from its output terminals. Moritz Hermann Von Jacobi published the maximum power (transfer) theorem around 1840; it is also referred to as "Jacobi's law"

The theorem can be extended to Alternating Current (AC) circuits that include reactance, and states that maximum power transfer occurs when the load impedance is equal to the Complex conjugate of the source impedance.

All electrical networks consist of Resistive, Inductive and Capacitive components. There is no electrical source or load that is totally resistive





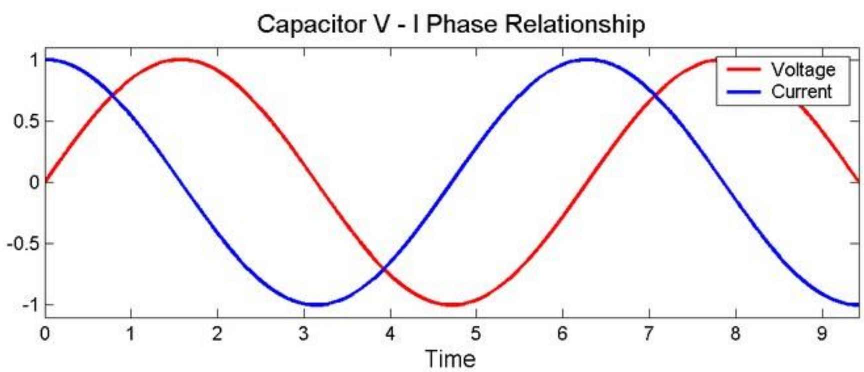


Source Impedance is denoted as:

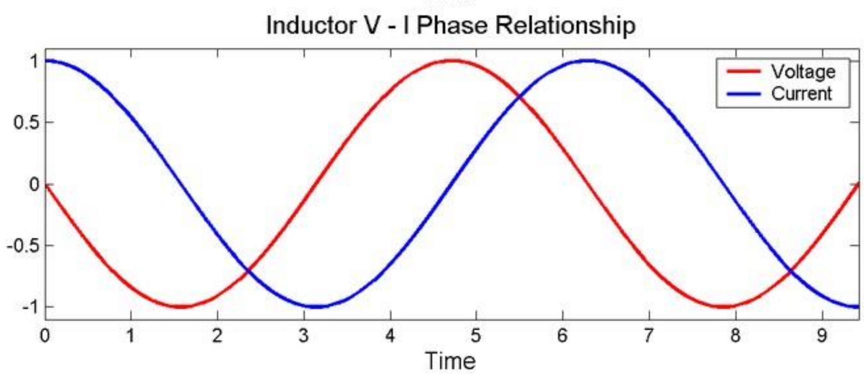
Z_S

Load Impedance is denoted as:

Z_L



Voltage leads current

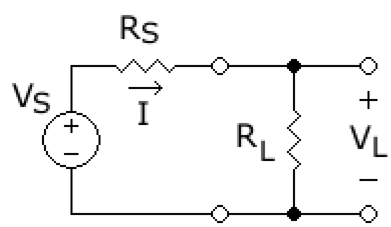


Voltage lags current

The phase angles in the equations for the impedance of inductors and capacitors indicate that the voltage across a capacitor *lags* the current through it by a phase of $\pi/2$, while the voltage across an inductor *leads* the current through it by $\pi/2$. The identical voltage and current amplitudes indicate that the magnitude of the impedance is equal to one.

Maximizing power transfer

To achieve maximum efficiency, the resistance of the source (whether a battery or a dynamo or generator or electrical source) could be made close to zero.



If we define the efficiency η as the ratio of power dissipated by the load to power developed by the source, then it is straightforward to calculate from the above circuit diagram that

$$\eta = \frac{R_{\mathrm{load}}}{R_{\mathrm{load}} + R_{\mathrm{source}}} = \frac{1}{1 + \frac{R_{\mathrm{source}}}{R_{\mathrm{load}}}}.$$

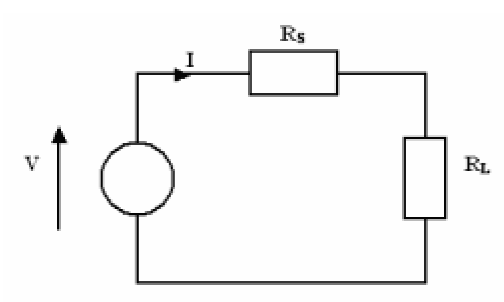
- If $R_{\mathrm{load}} = \infty$ or $R_{\mathrm{source}} = 0$, then $\eta = 1$,

The efficiency is 100% as the load resistance approaches infinity. Efficiency also approaches 100% if the source resistance can be made close to zero.

Impedance matching

Calculus-based proof for purely resistive circuits

(See Cartwright[2] for a non-calculus-based proof)



In the diagram, power is being transferred from the source, with voltage V and fixed source resistance R_{S}, to a load with resistance R_{L}, resulting in a current I. By Ohm's Law, I is simply the source voltage divided by the total circuit resistance:

$$I = \frac{V}{R_\mathrm{S} + R_\mathrm{L}}.$$

The power P_L dissipated in the load is the square of the current multiplied by the resistance:

$$P_\mathrm{L} = I^2 R_\mathrm{L} = \left(\frac{V}{R_\mathrm{S} + R_\mathrm{L}}\right)^2 R_\mathrm{L} = \frac{V^2}{R_\mathrm{S}^2/R_\mathrm{L} + 2R_\mathrm{S} + R_\mathrm{L}}.$$

The value of R_L for which this expression is a maximum could be calculated by differentiating it, but it is easier to calculate the value of R_L for which the denominator

$$R_\mathrm{S}^2/R_\mathrm{L} + 2R_\mathrm{S} + R_\mathrm{L}$$

is a minimum. The result will be the same in either case. Differentiating the denominator with respect to R_L:

$$\frac{d}{dR_\mathrm{L}}\left(R_\mathrm{S}^2/R_\mathrm{L} + 2R_\mathrm{S} + R_\mathrm{L}\right) = -R_\mathrm{S}^2/R_\mathrm{L}^2 + 1.$$

For a maximum or minimum, the first derivative is zero, so

$$R_\mathrm{S}^2/R_\mathrm{L}^2 = 1$$

or

$$R_\mathrm{L} = \pm R_\mathrm{S}.$$

In practical resistive circuits, R_S and R_L are both positive, so the positive sign in the above is the correct solution. To find out whether this solution is a minimum or a maximum, the denominator expression is differentiated again:

$$\frac{d^2}{dR_\mathrm{L}^2}\left(R_\mathrm{S}^2/R_\mathrm{L} + 2R_\mathrm{S} + R_\mathrm{L}\right) = 2R_\mathrm{S}^2/R_\mathrm{L}^3.$$

This is always positive for positive values of R_S and R_L, showing that the denominator is a minimum, and the power is therefore a maximum, when

$$R_\mathrm{S} = R_\mathrm{L}.$$

For any given load resistance a source resistance of zero is the way to transfer maximum power to the load.

In reactive circuits

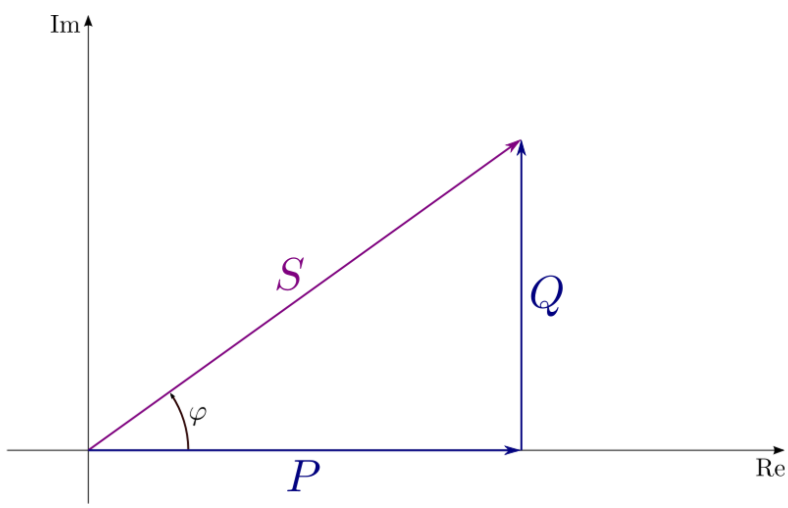
The theorem also applies where the source and/or load are not totally resistive. This invokes a refinement of the maximum power theorem, which says that any reactive components of source and load should be of equal magnitude but opposite phase. (*See below for a derivation.*)

This means that the source and load impedances should be complex Conjugate of each other. In the case of purely resistive circuits, the two concepts are identical. However, physically realizable sources and loads are not usually totally resistive, having some inductive or capacitive components, and so practical applications of this theorem, under the name of complex conjugate impedance matching, do, in fact, exist.

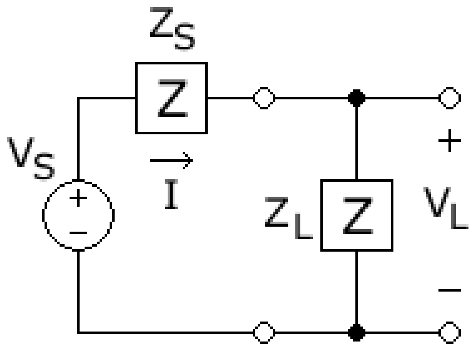
For a fixed reactive *source*, the maximum power theorem maximizes the real power (P) delivered to the load by complex conjugate matching the load to the source.

For a fixed reactive *load*, power factor correction minimizes the apparent power (S) (and unnecessary current) conducted by the transmission lines, while maintaining the same amount of real power transfer.

Unlike power factor correction that minimizes the phase angle, a complex conjugate impedance matching decreases current by decreasing losses in the electrical circuit.



Proof



In this diagram, AC Power is being transferred from the source, with phasor magnitude voltage $|V_\mathrm{S}|$ (peak voltage) and fixed source impedance Z_S , to a load with impedance Z_L resulting in a phasor magnitude current $|I|$.

$|I|$ is simply the source voltage divided by the total circuit impedance:

$$|I| = \frac{|V_\mathrm{S}|}{|Z_\mathrm{S} + Z_\mathrm{L}|}.$$

The average power P_L dissipated in the load is the square of the current multiplied by the resistive portion (the real part) R_L of the load impedance:

$$P_\mathrm{L} = I_\mathrm{rms}^2 R_\mathrm{L} = \frac{1}{2}|I|^2 R_\mathrm{L} = \frac{1}{2}\left(\frac{|V_\mathrm{S}|}{|Z_\mathrm{S} + Z_\mathrm{L}|}\right)^2 R_\mathrm{L}$$
$$= \frac{1}{2}\frac{|V_\mathrm{S}|^2 R_\mathrm{L}}{(R_\mathrm{S} + R_\mathrm{L})^2 + (X_\mathrm{S} + X_\mathrm{L})^2},$$

where the resistance R_S and reactance X_S are the real and imaginary parts of Z_S, and X_L is the imaginary part of Z_L.

To determine the values of R_L and X_L (since V_S, R_S, and X_S are fixed) for which this expression is a maximum, we first find, for each fixed positive value of R_L, the value of the reactive term X_L for which the denominator

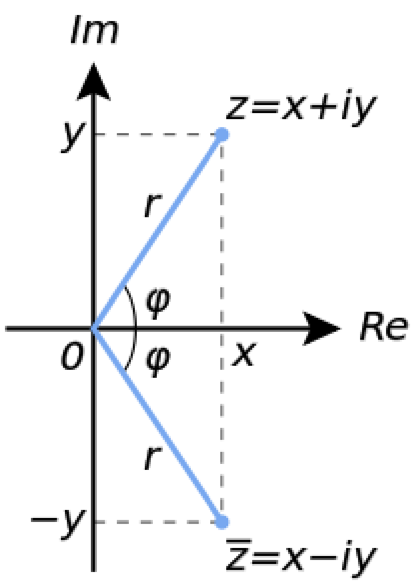
$(R_\mathrm{S} + R_\mathrm{L})^2 + (X_\mathrm{S} + X_\mathrm{L})^2$ is a minimum. Since reactances can be negative, this denominator is easily minimized by making $X_\mathrm{L} = -X_\mathrm{S}$.

The power equation is now reduced to:

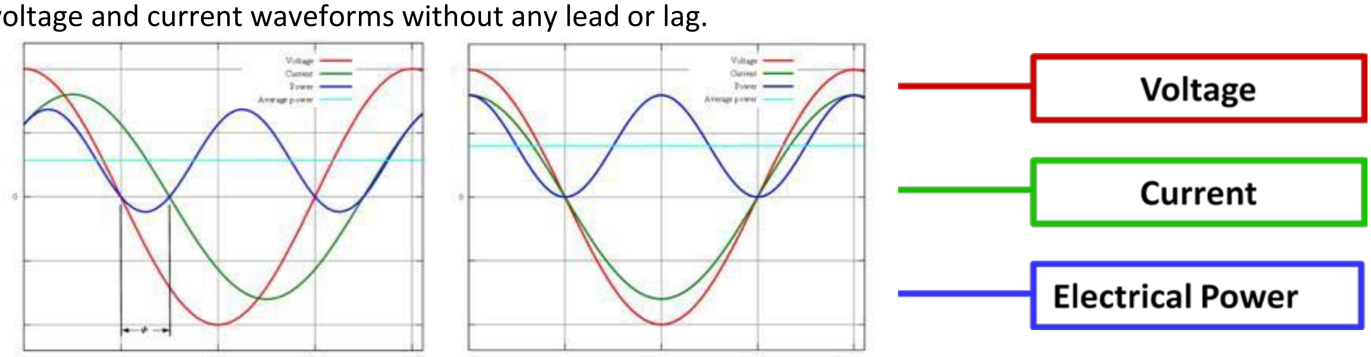
$$P_\mathrm{L} = \frac{1}{2}\frac{|V_\mathrm{S}|^2 R_\mathrm{L}}{(R_\mathrm{S}+R_\mathrm{L})^2}$$

and it remains to find the value of R_L which maximizes this expression. However, this maximization problem has exactly the same form as in the purely resistive case, and the maximizing condition $R_\mathrm{L} = R_\mathrm{S}$ can be found in the same way.

The combination of conditions $R_\mathrm{L} = R_\mathrm{S}, \quad X_\mathrm{L} = -X_\mathrm{S}$ can be concisely written with a complex conjugate as:



Geometric representation of z and its conjugate z̄ in the complex plane
When losses decrease, the current in the electrical required also decrease, resulting in clean voltage and current waveforms without any lead or lag.



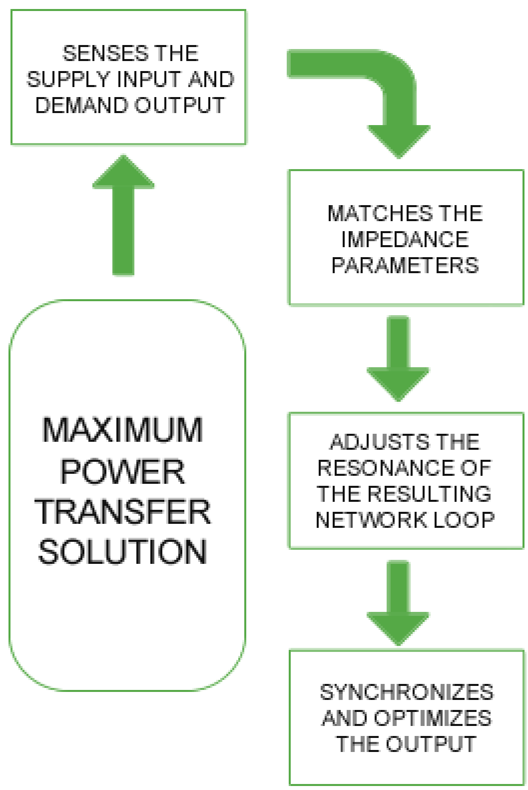
Technology and Design

The technology used in THE WHITE BOX - THE WHITE BOX device is based on principles of dynamic impedance matching, synchronous processing, advanced power switching, and real time, accurate and precise correction using multi-tasking algorithm control to optimize each phase to attain maximum efficiency.

TWB is an electronic system that works in real-time. TWB advanced algorithms live in an Application Specific Integrated Chip (ASIC) which performs 4 million calculations per second, instantaneously and dynamically matching the electrical wave forms. The ASIC Chip and the motherboard communicate in real time to interface with the electrical network to match impedance that results in decreased losses, clean waveforms, reduction in current requirement and improved electrical network efficiency.

TWB is a next generation power quality improvement solution. It is an electronic solution consists of a motherboard controlled by algorithms that reside inside a application specific IC Chip.

Inside THE WHITE BOX you will see an electronic RLC* network. The RLC are part of the electronic network.

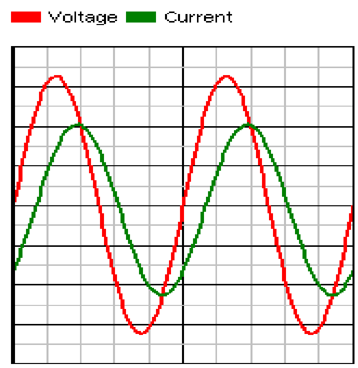


TWB and waveforms

The amplitude of the current waveform will drop as a result of impedance matching.

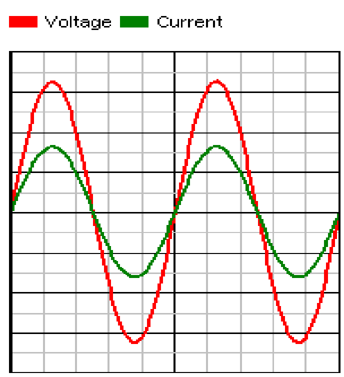
When TWB is OFF

$I1 = Im1 \sin \omega t$



When TWB is ON

$I2 = Im2 \sin \omega t$, Where $I2 < I1$



TWB and Harmonics

TWB is not a source of harmonics. TWB will prevent harmonics on the line side of TWB from affecting or damaging the connected equipment. The harmonics are discharged to the ground as they reach THE WHITE BOX.

Any measuring instrument will display an increase of Harmonics at the input of TWB as though TWB is generating them when it is ON. The characteristics of Harmonics is such that they flow from a high harmonics point to a low harmonics point. Harmonics become more visible at the input of THE WHITE BOX. The decrease in current value at the input also makes the percentage of harmonics look exaggerated/increased.

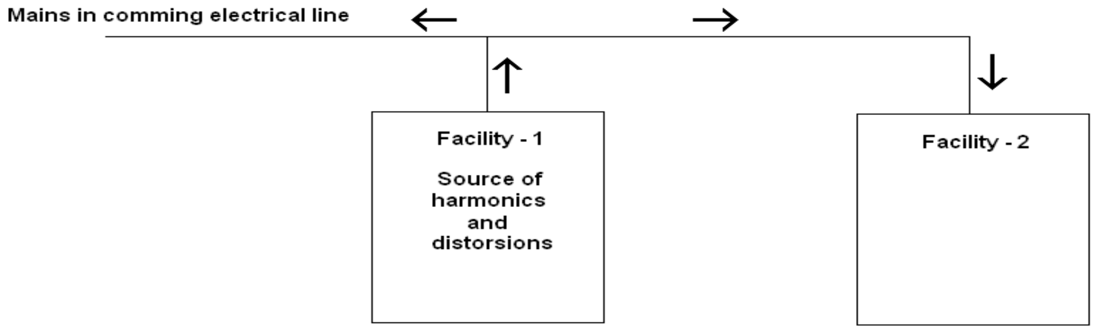


Fig-1

Consider a case in which a facility -1 (figure 1) generates harmonics because of the presence of number of non linear loads like Computers, VFD's, Office equipment, HVAC, pumps ..etc.
These harmonics and electrical distortions generated from this facility will be injected on to the mains incoming electrical line and will go to other facilities like facility-2 and will affect the equipments in facility -2.

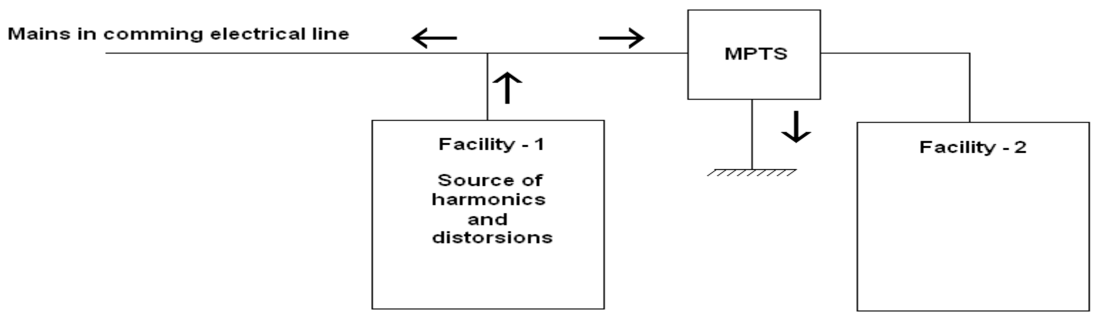


Fig-2

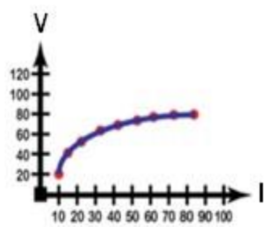
When TWB is connected and ON as shown in **Fig-2** it acts like an electrical buffer blocking the harmonics coming to the facility-2 from the electrical incoming line and will discharge it to the ground. The measuring instruments will display or record all harmonics coming in on the input side of THE WHITE BOX unit. The combined effect of all harmonics flowing into the line side and the reduction of the current makes it appear that the harmonics is actually being reduced.

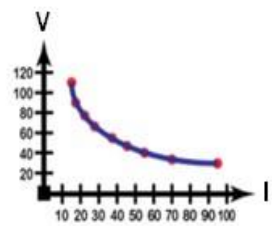
For Example:
When THD is 20 percent on a 100 Amp line current. The same 20 percent THD on 60 Amps line current will be 33.3 percent.
With THE WHITE BOX in ON position the THD will drop. Let us assume that THE WHITE BOX is discharging 8 percent of the original THD. Then the new THD value will be still be 20 percent = 12/60 * 100
If the THD drops by 5 percent then the new THD will be 25 percent = 15/60 * 100 which is more than the initial value of the THD.

Equipment life will increase when TWB unit is ON.

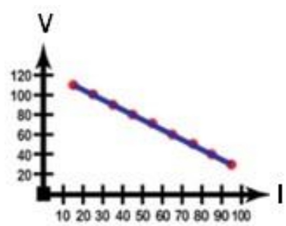
Most of the alternating current (AC) based electrical load such as motors, industrial machines, lighting loads, heaters, air conditioners,… etc, are designed for 60Hz line frequency with line rated standard voltage of 277 Volts or 120 Volts, these equipments consume current based on their own load line graphs and when different loads are combined the load line graph is the resultant of the combined load line graphs as shown below

Load line graphs for different type of loads





Combined load -line graph



Under such conditions, the current required by the combined loads has an effect on the source Voltage and Current values based on source impedance. When the loads are connected to TWB, THE WHITE BOX acts as the immediate source for the connected loads. With TWB as the power source, the Voltage and Current values of source impedance will continuously match the load impedance to deliver almost the precise value of Voltage and Current required by the load maintaining an electrical equilibrium. This factor contributes to the increased life of the load or combination of loads.

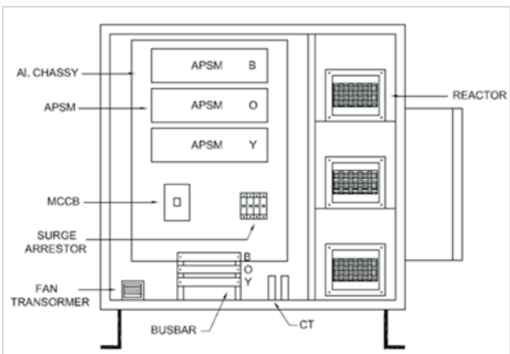
In addition to the above, the electrical line noise and high line voltage surges from the line side of THE WHITE BOX will not pass through THE WHITE BOX network thus safeguarding the connected equipments. When the load or the combination of loads is not subjected to the varying line voltage conditions then the equipment is not subjected same level of electrical variation and this has an impact on the longevity of the life of the connected equipment.

THE WHITE BOX is equipped with easily replaceable, modular type over current/surge protective devices and protection fuses for enhanced equipment safety and to minimize downtime.

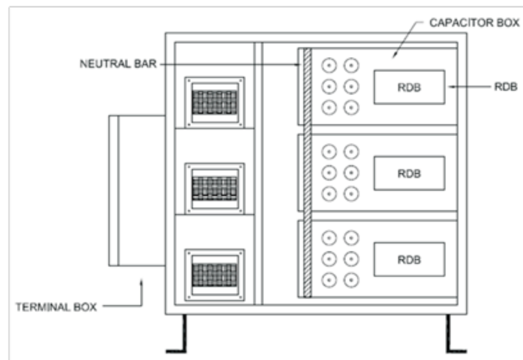
High fault protection MCCB with 65 kA rating used for enhanced safety. Operation security and safety with key switch enables maintenance department to ensure uninterrupted safe operation in select mode.

Current transformers, potential transformers, and all similar critical devices internally used are powered by energy limiting transformers. Easily traceable, labeled wires for simple troubleshooting and easy replacements

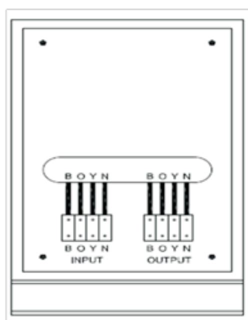
RIGHT-SIDE OPEN VIEW



LEFT-SIDE OPEN VIEW



BACK OPEN VIEW



480V/3Ph/100 Amp Module

Multiples of the same for
Scaled up versions
example: 225, 450

A/B/C- Incoming lines / phases
N - Neutral
G- Grounding

Automatic and self-regulating operation with an informative Energy meter to displays all important parameters. Conservatively designed high quality UL approved components used in all key areas provide enhanced performance and reliability. THE WHITE BOX is equipped with easily replaceable, modular type over current/surge protective devices and protection fuses for enhanced equipment safety to minimize downtime. The unit has a strong long lasting heavy duty enclosure with internally optimized architecture for optimal ventilation, inspection and quick maintenance. Forced air ventilation optimizes equipment longevity through regulated heat dissipation.

Thermal switches installed at strategic locations for enhanced thermal protection to ensure safe shutdown of operation in case of accidental blocked/obstructed ventilation. Lead wires, Lugs and terminations used are UL certified rated for 125 deg C for additional safety.

Durable heavy duty steel enclosure with quality powder coating to withstand harsh industrial environment. The hinged enclosure panels enable easy inspection and maintenance.

RC network Caps are internal fault protected with dry metalized film for enhanced performance, longevity and safety. Current transformers, potential transformers and all similar critical devices internally used are powered by energy limiting transformers. Operation security and safety with key switch enables maintenance department to ensure uninterrupted safe operation in selected mode.

Enclosure designed with bottom frame lifting base for easy lifting/positioning during installation and provided with anchor bolt slots to allow securing to foundation for permanent installation.

Applications

When connected to electrical alternating current (AC) inductive and other balanced or unbalanced phase loads, our solution dynamically matches the source and load impedances resulting in reduced total electrical power consumption and significant electrical efficiency improvement.

The applications for TWB are all high energy consuming electrical and mechanical equipment such as alternating current (AC) complex loads such as motor driven equipment, inductive lighting, induction heating etc.

Examples of typical applications are;

- ✓ 24 hour electrical energy environments
- ✓ Refrigeration and Chillers
- ✓ Conveyor belt systems
- ✓ High electrical energy consumption environments
- ✓ Capacity constrained electrical environments
- ✓ Closed systems – Solar, Wind & Co-Generation
- ✓ Data Centers
- ✓ Parallel refrigeration racks
- ✓ HVAC – RTU's, AHU's
- ✓ Water filtration plants, pumps and motors
- ✓ Parking lot, warehouse, metal halide or office lighting (LED conversions not recommended initially due to efficiencies already being captured by the technology
- ✓ Parking lot exhaust fans
- ✓ Manufacturing equipment
- ✓ Vending machines
- ✓ Compressors
- ✓ Elevators and escalators

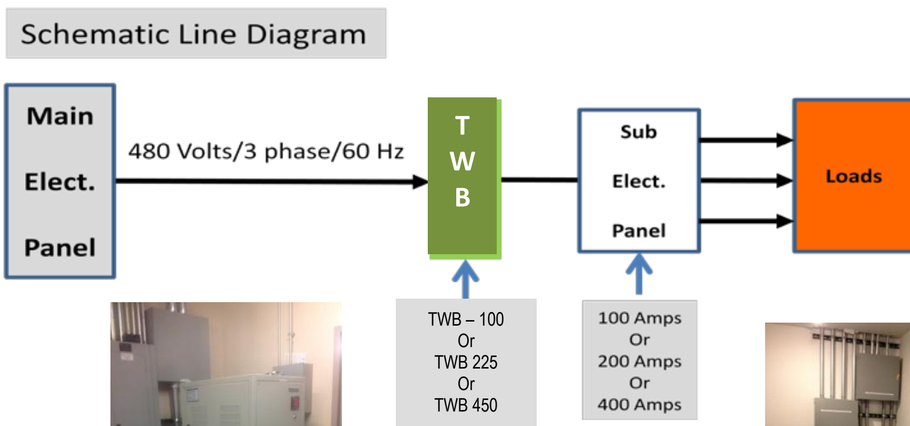
The type of facilities where the device or technology can be implemented are widespread

Virtually anywhere alternating current (AC) current and non linear loads are being used is a good location for THE WHITE BOX solution

- Manufacturing

- Commercial office buildings
- Warehouses
- Distribution centers
- Retail stores
- Data centers
- Industrial plants
- Education
- Medical
- Water Filtration Plants
- Pumping Stations

THE WHITE BOX can be installed very quickly either on a electrical panel or individual loads or a combination of loads. TWB automatically adjusts to varying load conditions.



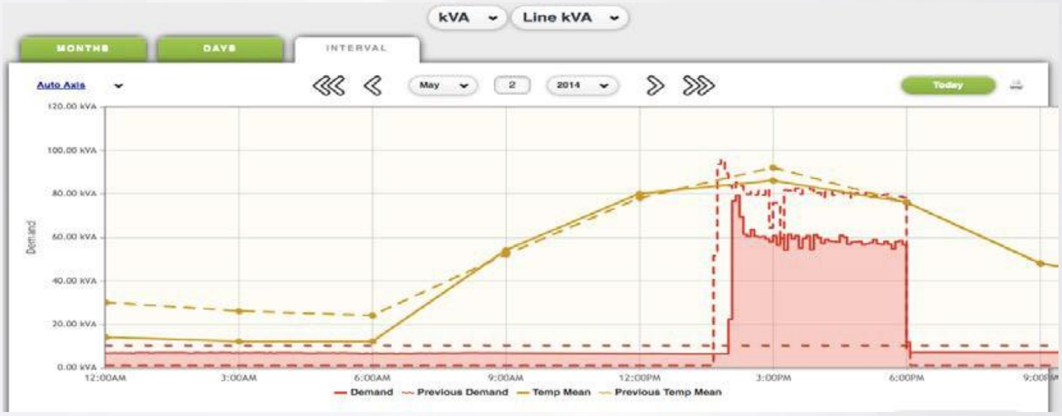
TWB is installed on the main electrical supply panel or a sub-panel on supply side of the selected load.

THE WHITE BOX is non-intrusive and does not modify the existing system; it reduces the inefficient part of Total Power Consumption (KVA) and increases efficiency of the electrical system supplying the load. THE WHITE BOX releases Amp capacity from installed switchgear. It also reduces heat losses due to over-current draw in local area network, switchgear and transformers.

TWB operates seamlessly with minimal preventive maintenance and monitoring

Here is an example of performance seen from the installation of THE WHITE BOX units: see next page:

TECHNOLOGYPERFORMANCE

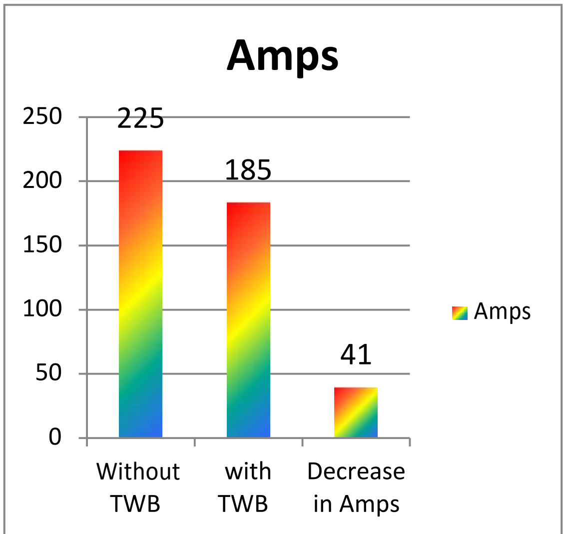


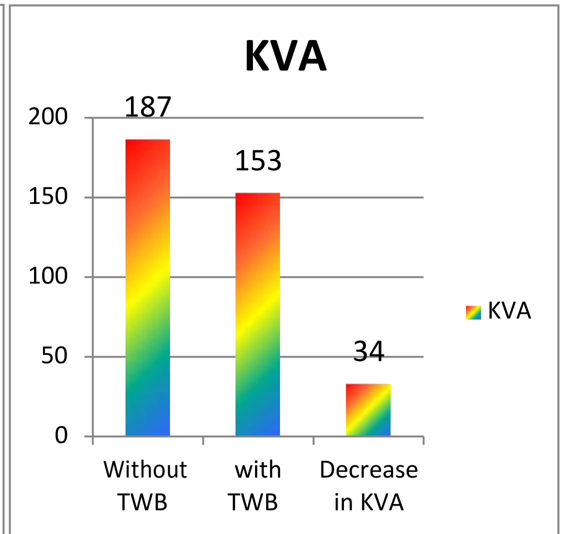
THE WHITE BOX 450 Amp 480 Volt Comparison Before (April 11th, 2014 – THE WHITE BOX with Testing) and after (May 2nd, 2014) THE WHITE BOX Installed Kaiser Permanente

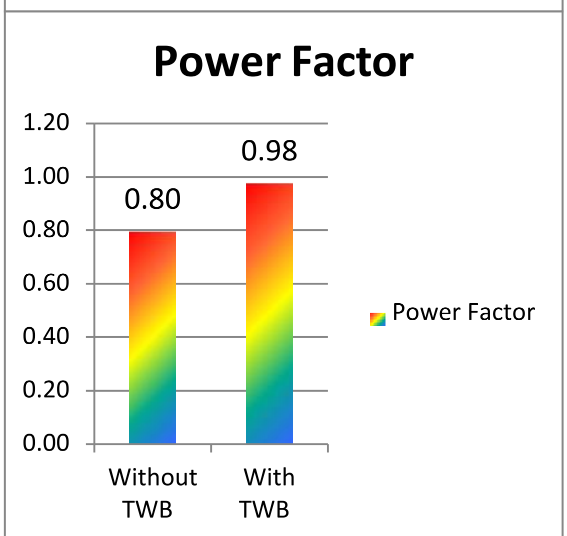
Improvement in power quality - metrics

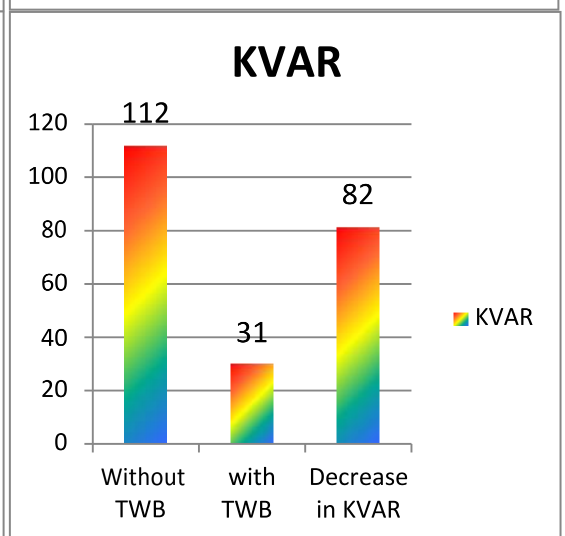
Item	Existing values without TWB		Values with TWB	Changes in Values with TWB	
Volts	480		480	-	-
Load Amps	102		77	Decrease in Line Amps	25
Load PF	0.69		0.93	PF improvement on load side	0.24
Load KVA	85		64	Decrease in Line KVA	20
Load KVAr	61		24	Decrease in KVAr	38
CO2 before TWB	713,441		541,930	Decrease in CO2	171,511

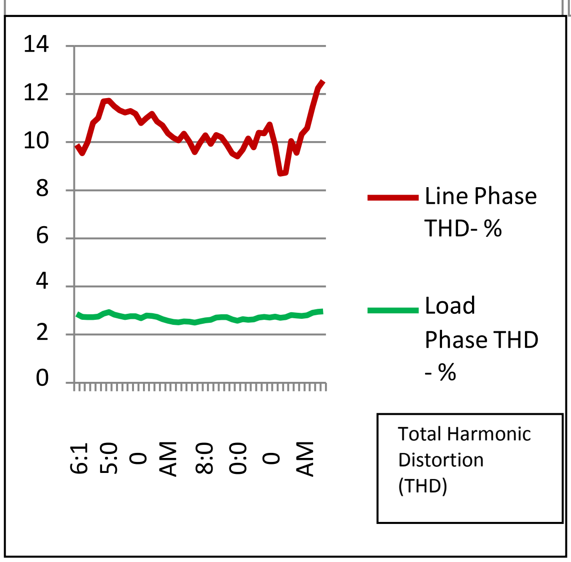
Another Example:











Continued…

Improvement In Power Quality - Metrics

Item	Existing values without TWB	Values with TWB	Changes in Values with TWB	
Volts	480	480	-	-
Load Amps	225	185	Decrease in Line Amps	41
Load PF	0.80	0.98	PF improvement on load side	0.18
Load KVA	187	153	Decrease in Line KVA	34
Load KVAr	112	31	Decrease in KVAr	82
CO2 before TWB in Lbs	1,574,076	1,290,743	Decrease in CO2	283,334

Item	Existing values without TWB	Values with TWB	Changes in Values with TWB	
KVA supplied by the Utility	187	153	Reduction in KVA supplied by the Utility	34
KVAH supplied by the Utility	841,752	690,237	Reduction in KVAH supplied by the Utility	151,515
KVAR	112	31	Reduction in KVAR	82
KVARH	505,051	137,355	Reduction in KVARH	367,696

<u>These are the unique features of THE WHITE BOX:</u>

• Reduces wasted energy, decreasing amps required to operate equipment
• Reduces current, harmonics, thermal and eddy current losses
• Reduces KVA and KVAR
• Does not increase harmonics in electrical systems
• THE WHITE BOX is a fail-safe technology and does not interrupt power to facilities equipment when it is either on or off
• TWB does not add a parasitical load on the network
• TWB is an electronic solution and consumes less than 1 ampere of current for every 100 Amps/3phase installed
• THE WHITE BOX system does not add capacitance to the electrical network
• TWB releases electrical systems capacity - expansion cost avoidance
• TWB does not require programming, as it is self-programming upon commissioning
• As a consequence of the above attributes, THE WHITE BOX improves and maintains power factor to greater than 95%
• TWB is a standard solution for any type of inductive load
• TWB is a solution for balanced or unbalanced 3 phased system
• TWB performs with the same efficiency and effectiveness from 20% to 100% utilization of its rated capacity
• Except for ventilation fans there are no moving parts in THE WHITE BOX

The above features result in reduction of total electrical consumption by significant levels and enhances electrical efficiency of the network by minimizing wasted electrical energy.

Financial Benefits of using TWB technology and products.

TWB has several financial benefits to the end-user. Some may be dependent on the specific applicable utility tariffs. The typical benefits are as follows:

• Reduced total electrical power cost
TWB can save money on the utility bill where there is KVA and/or kVAh billing, or kVAr or Power Factor Fees or Penalties.

• Reduced maintenance, repairs, replacements and down time
TWB can reduce maintenance, repairs, replacement and down-time costs related to electrical power inefficiencies and problems. This comes through attributes that include: reducing Amps, reducing heat, stabilizing voltage, surge protection, and reducing harmonics. The percentage of reduction in Amps will increase the life of the equipment by at least the same percentage.

• Capacity Release
Equipment inefficiency causes higher KVA consumption that decreases the ability to utilize the installed switchgear, transformers and local network to their full potential. The cost avoidance and downtime elimination benefit due to Capacity release is substantial and can be worked out on specific cases.

• Environmental Sustainability
Improved efficiency is directly proportional to lowering the impact of greenhouse gasses and carbon footprint. A typical greenhouse gas computation will provide the economic benefit realized.

What does TWB do for you?

TWB complements and/or replaces Capacitors, Automatic Power Factor Correction systems (APFCs), Harmonics Filters, Power Conditioners, Voltage Stabilizers and Surge Protectors, **while also reducing Amps.**

TWB units have a c(UL)usa Mark and have gone through following testing and approval:

UL – Underwriter's Laboratory testing – UL Whitefield lab, New Zealand.
CPRI - Central Power Research Institute
UL - Underwriter's Laboratory - Bangalore and Chicago, USA

Benefits to the Customer – End User

- ✓ Improves electrical efficiency to almost 100% through impedance matching
- ✓ Releases system capacity immediately- additional cost avoidance.
- ✓ Reduction in overloading of switchgear, transformers, cables etc.
- ✓ Maintains stability of voltage for connected equipment.
- ✓ Protects expensive investment in electrical and mechanical equipment
- ✓ Reduced operating, and maintenance costs

TWB, THE WHITE BOXs, are next generation power quality products for demand side management that **decrease the Electrical Demand, Total Electrical Power requirement or Generation, and the Carbon foot print without** replacing/retrofitting inefficient electrical and mechanical equipment

Benefits to the Utility

- ✓ Decrease in total energy demand by users
- ✓ Reduction in total electrical energy supplied
- ✓ Reduces line current & power transmission losses (I^2R losses)
- ✓ Improves utility of installed equipment / switchgear/ cable to maximum capacity.
- ✓ Decreases eddy current heat generation/loss in Transformers
- ✓ Reduces distribution, transmission, Operations & Maintenance costs
- ✓ Assists in relieving peak demand power outages

The **Useful (Real) Power** and the **Reactive power** together determine the **Total Power** drawn from the network, (also known as apparent power), measured in **KVA**. The benefit to the Utility is that the total electrical demand by end users is decreased

Benefits to Power Generation

- ✓ Reduces voltage surges & helps to maintain stable voltages
- ✓ Decreases peak load current demand (Matches production to consumption KVA=KW)
- ✓ Improves generator efficiency and performance
- ✓ Cuts carbon emissions
- ✓ Reduces capital requirements for new expansions

TWB will decrease the wasted electrical power through decrease in losses in electrical system. This has direct impact on the amount of coal burned in thermal power plants.

Benefits to the Environment

- ✓ Decreases the carbon footprint and improves energy availability.
- ✓ Helps in the green movement.

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Impact to the Utility Grid

Due to the complexity and variation of end user electrical load (particularly in industrial and commercial sectors), inefficiency at end user increases **Total Power Consumption.**

The **Useful Power** and the **Reactive power** together determine the **Total Power** drawn from the network, (also known as apparent power), measured in **KVA**.

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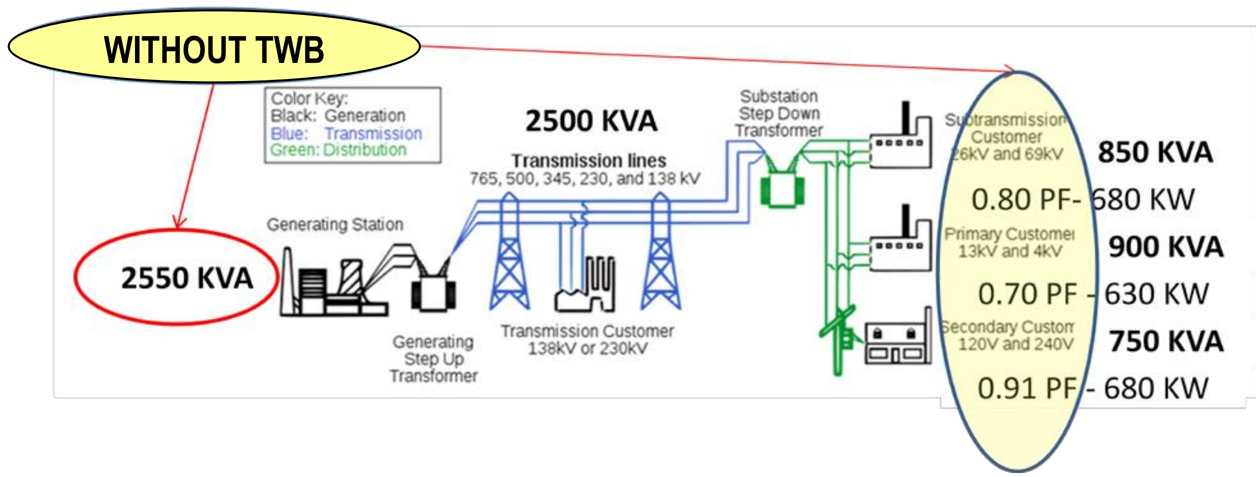

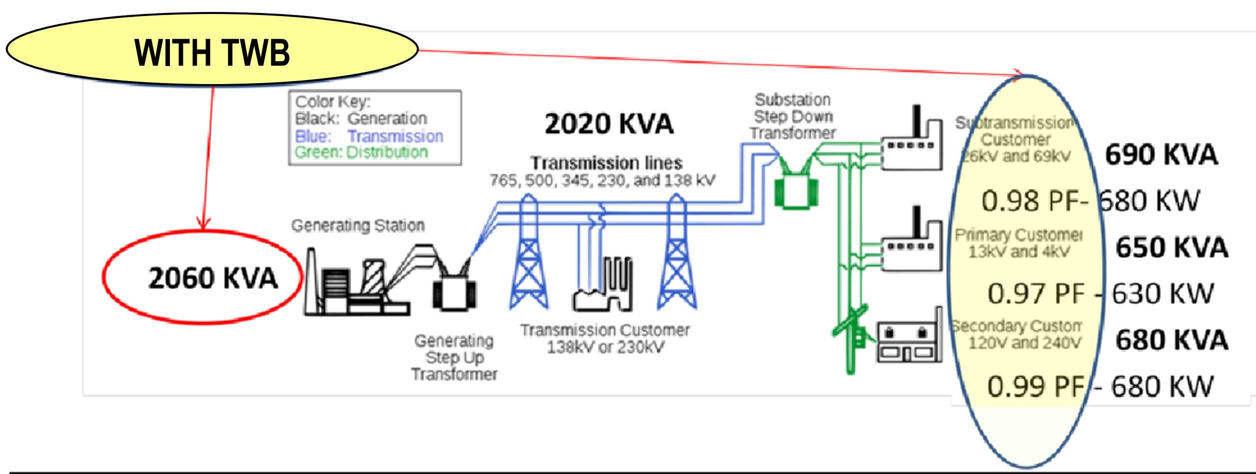

Benefits to Power Generation

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- ✓ Decreases peak load current demand (Matches production to consumption KVA=KW)
- ✓ Improves generator efficiency and performance
- ✓ Cuts carbon emissions
- ✓ Reduces capital requirements for new expansions

TWB deployment helps release KVA capacity.
When TWB is in any network it takes the power factor close to unity.

KVA = √ 3 X (KV) x (A)

WITH TWB

Less Total Plant KVA for the Same KW Working Power

POWER FACTOR	60%	70%	80%	90%	100%
ACTIVE POWER	600 KW	600 KW	600 KW	600 KW	600 KW
REACTIVE POWER	800 KVAR	612 KVAR	450 KVAR	291 KVAR	0 KVAR
Total Electrical Power Generated and Supplied by the Utility	1000 KVA	857 KVA	750 KVA	667 KVA	600KVA

This allows for more efficient operation of plant transformers and "frees up" KVA for additional load. Cost avoidance can be significant.

Another way to look at the above is:
When TWB is deployed, it helps support more KW loads for the same KVA generation KVA = KW when TWB is in the network.

KVA = √ 3 x (KV) x (A)

KW = √ 3 x (KV) x (A) x (Power Factor)

Less (KVA) "total electrical power plant" capacity for the same connected load(KW)

Power Plant Capacity	1000 KVA	857 KVA	750 KVA	667 KVA	600 KVA
Active or Real Power	600 KW	600 KW	600 KW	600 KW	600 KW
Wasted Electrical Power	400 KW	257 KW	150 KW	67 KW	0 KW
Power Factor	60%	70%	80%	90%	100%

Released capacity with TWB

Allows for more efficient operation of the generation plant, transformers and frees up KVA for additional loads. Cost avoidance of building new electrical plants is significant

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Benefits to the Environment

- ✓ Decreases the carbon footprint and improves energy availability.
- ✓ Helps in the green movement.

Minimum amounts of Power Generation and Carbon Emission Reduction in thermal power plants when TWB is deployed.

TWB 100/480V/3P - 10 KVA - 39,106 Pounds

TWB 225/480V/3P - 20 KVA – 78,213 Pounds

TWB 450/480V/3P - 40 KVA - 156,426 Pounds

TWB 600/480V/3P - 60 KVA - 234,639 Pounds

Please contact US ENERGY CONCEPTS, INC representative if you are interested in learning more about TWB technology and products www.usenergyconcepts.com.