Ultravar™

AUTOMATIC POWER FACTOR CORRECTION SYSTEM

Ultravar is a trademark of GE.

IDL Extra Capacitor Catalog

TRANSIENT-FREE REACTIVE POWER COMPENSATION SYSTEMS

VAR PLUS:
A real-time, transient-free system used to compensate extremely rapid loads within one cycle (typically 5-16 mSec).

VAR:
A fast, transient-free system, used to compensate any load within 3-4 seconds.

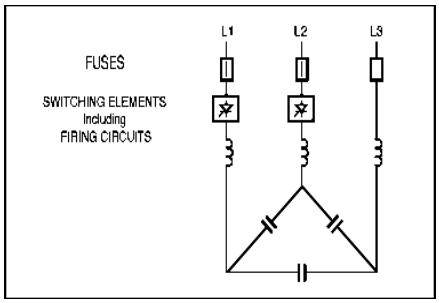
TYPES AVAILABLE:
- **Basic Systems:** Include iron core reactors to limit the inrush current
- **Detuned Systems:** Include Iron core reactors that detune the network to prevent resonance and absorb up to 50% of the 5th harmonic
- **Tuned Systems:** Individually designed to absorb the 5th and 7th harmonics.

ADVANTAGES:

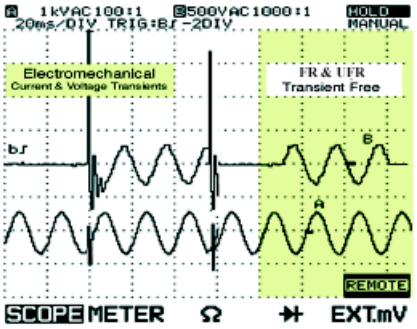
VAR PLUS & VAR:
- Transient-free capacitor group switching, using electronic switching elements
- Prevents damage to sensitive electronic equipment
- Saves energy
- Harmonic filtration
- Accurate power factor control, even in the presence of harmonics
- Dramatically increases the life expectancy of switching elements and capacitors
- Considerably lower temperature rise of capacitors and inductors due to unique scan feature
- Built-in three phase network analyzer, measuring all network parameters including harmonics
- Unique self-testing and comprehensive reporting feature.

VAR PLUS (in addition to the above):
- Cycle by cycle reactive power compensation (total acquisition time of 5-16 mSec)
- Prevents voltage drop and flickering
- Used for Real Time applications, such as spot welding and motor start-up
- Enhances capacity of local generator systems, such as diesel and windmill generators.

The VAR is a state of the art, electronic switching device designed to replace electromechanically switched equipment in power factor correction (PFC) systems.



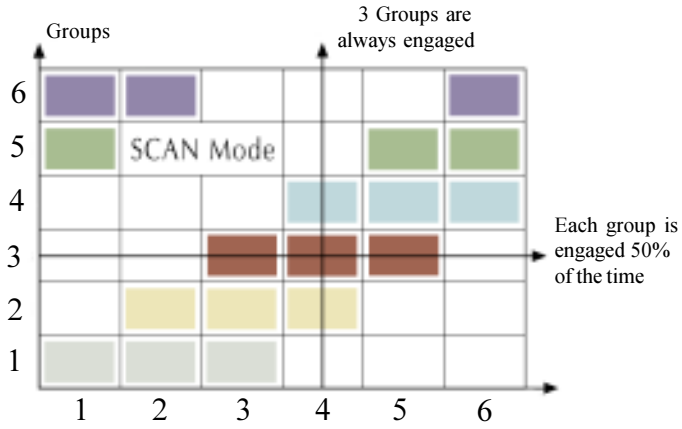
Connection and disconnection of the capacitors to and from the network occurs at zero current crossing. This smooth connection avoids the transient effects typically created by electromechanically switched PFC systems. The total acquisition time (full compensation of reactive current) is only 3 to 4 seconds which is much faster than electromechanically switched PFC systems.



The electronic switches do not wear out or deteriorate during the switching process and the capacitors are not adversely affected by transients. These advantages contribute to a much longer life expectancy compared with electromechanically switched PFC systems.

The power factor is controlled very accurately by means of an advanced closed loop control & measuring unit, that takes into consideration all three phases and the effect of harmonics (1 through 63).

The VAR system is equipped with a unique scan feature that protects capacitors from “exploding” and contributes to longer life expectancy. This is achieved by reducing overcurrent and overheating in the capacitors which may result from harmonics on the mains. The switching element can perform an unlimited number of switching operations. The connection of one group of capacitors occurs simultaneously with the disconnection of another group. This operation is performed every few seconds and engages all capacitor groups in turn, resulting in a reduction of mean current due to the lower ratio of engagement time to cycle time (duty cycle).

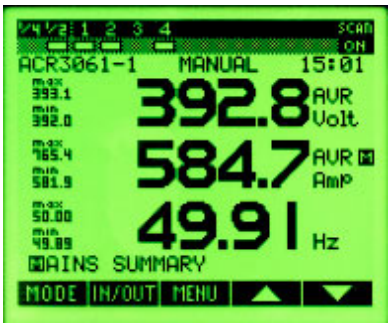


The scan feature, together with the unique reactor design, substantially reduces the temperature rise of the reactors and protects the cabinet from overheating.

There is an ongoing cumulative reduction of capacity in electromechanically switched PFC systems due to theeffect of transients during connection and disconnection.

This can be detrimental to detuned electromechanically switched systems where the changes in ratio between the capacitors/reactors shift the resonance frequency, which may result in resonance. The VAR prevents these conditions.

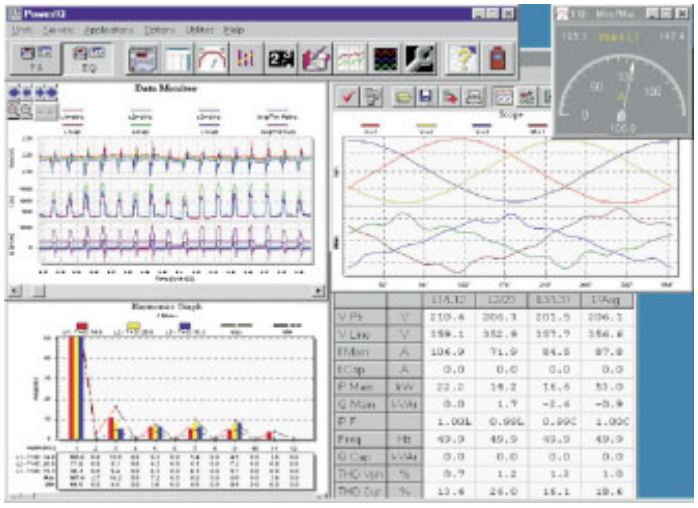
The controller is a full measuring device that includes an LCD display. It measures, cycle by cycle, all network and internal parameters.

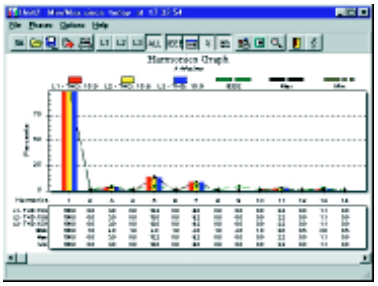


POWER IQ Measurement & Analysis Software (optional)

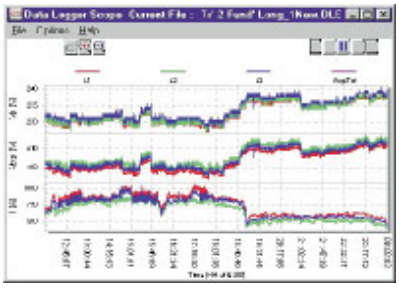
This software displays the system's status as well as the measurement results on numerous screens running under Windows.

All network parameters, including harmonics up to the 63rd can be recorded at preselected intervals. The duration of the recording is only limited to the size of the computer's hard disk. The software can be set to record data based on selected triggers of various network parameters, such as voltage sags and/or current spikes. The system records before and after the trigger event. The software has intranet and internet support.



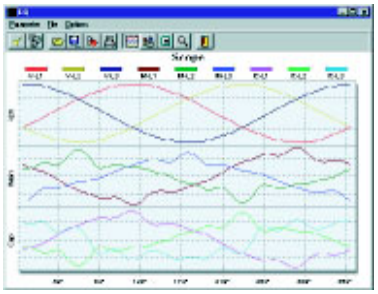


Harmonics

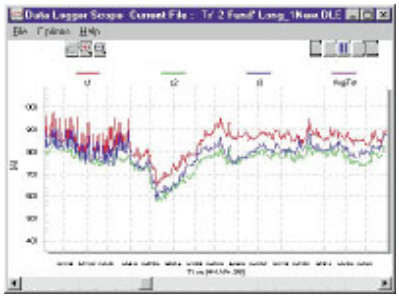


Data Logger

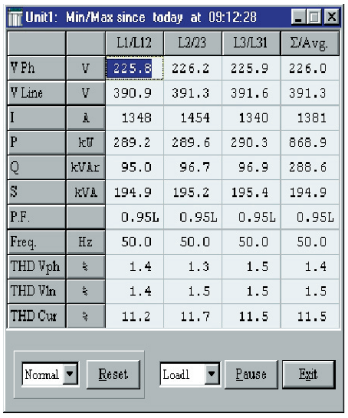
Consumption



Waveforms

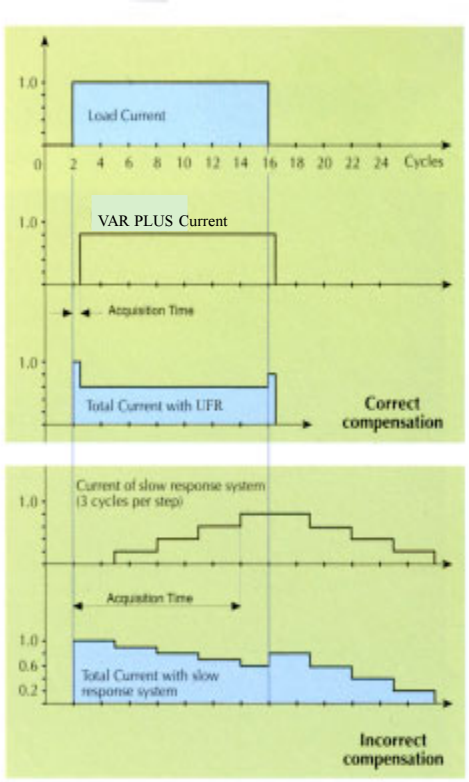


Zoom in



Real time measurement including min & max values

The **VAR PLUS** is a fast response system that is used to compensate any variation in reactive power within one cycle of the network.



Correct compensation using the VAR PLUS:

The top graph demonstrates how the VAR PLUS compensates the reactive current of fast loads with a duration of 14 cycles.Typical acquisition time (full compensation of reactive current) is less than one cycle and the total current is substantially reduced.

Adverse effects of slower response systems

The bottom graph demonstrates incorrect compensation where the response time is 3 cycles for the connection of a single group and the acquisition time required to connect a total of 4 groups is 12 cycles.

Due to the delay in compensation the current is partially reduced and due to the corresponding delay in disconnection of the capacitor groups there is residual current.

The total effect of the compensation system on the current is negative since the average current of the load is increased instead of being reduced. This increases voltage flickering due to overcompensation.

Applications

Large and rapid variations in reactive power normally occur during spot welding operations and motor start-up. The VAR PLUS minimizes the negative effects of these loads, resulting in improved power quality and system capacity.

Spot Welding

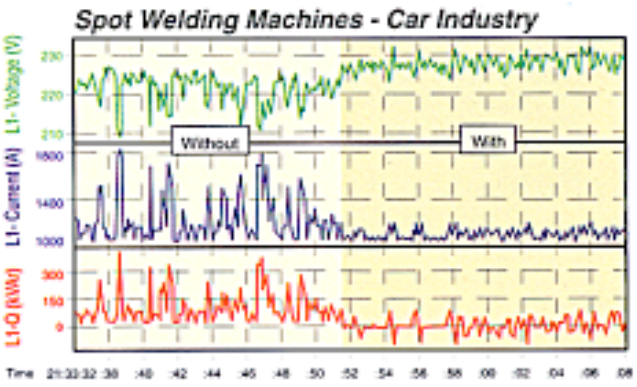
Spot Welding loads fluctuate extremely rapidly and consume large amounts of reactive power. Resultant voltage sags tend to reduce welding quality and can impact welding productivity. In addition, these loads often create a high level of voltage flickering, which frequently exceed the recommended IEEE limits.

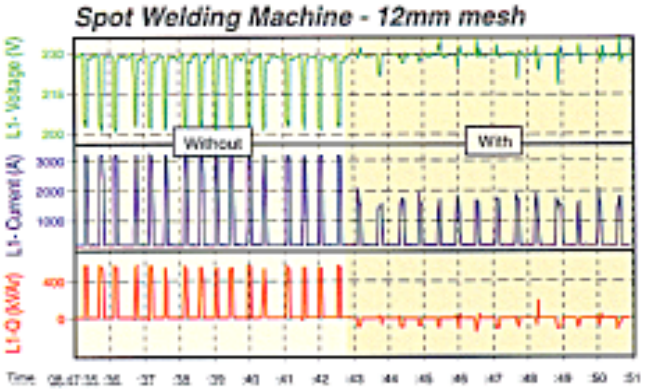
High-speed reactive compensation systems clearly offer the following benefits:

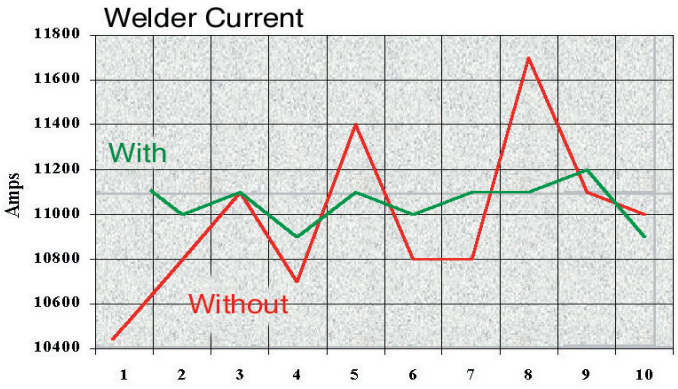
Improved welding quality, increased process output and elimination of flickering. Significant capital investment is reduced by better utilization of the existing infrastructure.

The top and middle graphs on the next page demonstrate that the VAR PLUS prevents voltage drop and flickering, substantially reduces the current and compensates reactive energy.

The bottom graphs demonstrate welder output current (car industry).The optimal condition is a stable current within a range of 11,000 amp. With the VAR PLUS, the current variations are +/-200 Amp and without the VAR PLUS the current variations are +/-800 Amp. A stable current significantly improves welding quality. Over-current can cause damage to the electrodes as well as to the material being welded.Undercurrent during welding operations deteriorates welding quality.





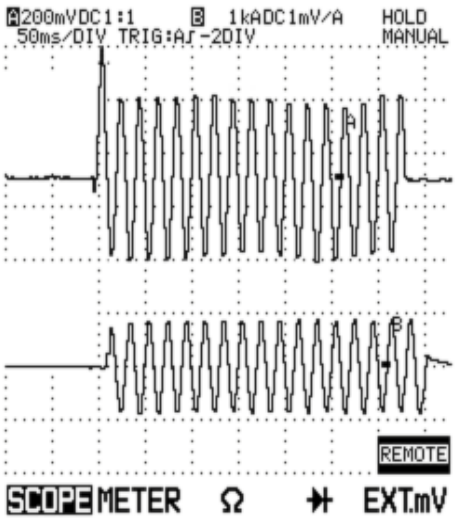


Central Compensation of Start-Up Current of Large Motors

Large squirrel case inductive motors, when connected directly on-line, consume high current during the start-up period (six times higher than steady state operation). However, if the network is weak, the high current leads to substantial voltage drops which interfere with other loads, reducing the initial torque and increasing start-up time.

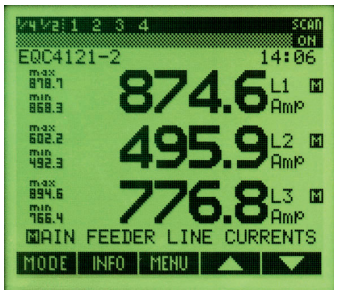
The VAR PLUS tracks the reactive current, compensates it within one cycle, and provides the following features:

- Protects mains against voltage drops caused by high momentary consumption of reactive current.
- Central starting of all loads, thus avoiding the use of individual starters required to protect the mains against voltage drop.
- Direct connection of motor to mains, to obtain maximum torque during connection. This feature is unique to the VAR PLUS system, since starters of all types reduce the current going through the motor, thereby reducing the starting torque.



CONTROLLER

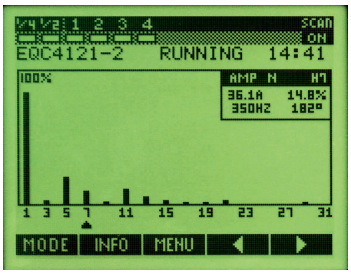
The Controller is based on a Digital Signal Processor (DSP) and a VLSI component. It includes an LCD display, analog and digital circuitry, firing and optional communication cards.

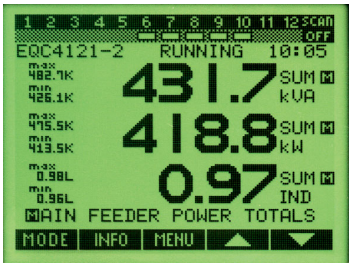


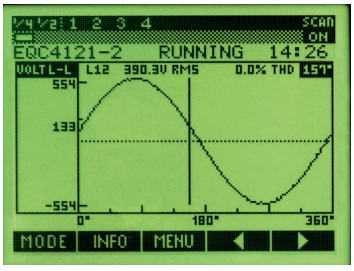
SPECIFICATIONS

POWER SUPPLY:	115/230V, 50/60 Hz
LCD Display Size:	94x76 mm
LCD Display Resolution:	Graphic 160x128 pixels
LCD Display Type:	FSTN, LED backligh
FREQUENCY:	45 to 65 Hz
POWER CONSUMPTION:	10 VA
OPERATING TEMPERATURE:	-20 to +55°C
9 ANALOG CHANNELS:	3 current channels for mains load 2 current channels for Equalizer cabine 4 voltage channels
COMMUNICATIONS:	RS485/422 communications por
PROTOCOL:	ELCOM, Modbus / RTU
ALARM:	Voltage free N.O. / N.C. relay, max 2A@250VAC
PROTECTION CLASS:	IP 40
DIMENSIONS:	144 x 144 x 138 mm
WEIGHT:	1.4kg
STORAGE TEMPERATURE:	-25 to +70°C
ELECTROMAGNETIC COMPATIBILITY:	EN50081-2, EN50082-2, EN55011, EN61000-4-2/3/4/5, ENV50204, ENV50141
SAFETY STANDARDS:	EN61010-1, EN50439-1, UL508

Parameter	Phases	Loads	Measurement Level 1	2	3	4
Frequency	Common	Mains	x	x	x	x
Phase Current	L1, L2, L3	Mains, Load, Cap.	x	X	x	x
Neutral Current	Neutral	Mains	x	X	x	x
Phase to Phase Current	L1-2, L2-3, L3-1	Mains , Load	x	x	x	x
Phase Voltage	L1, L2, L3	Mains	x	X	x	x
Neutral Voltage	Neutral	Mains	x	x	x	x
Phase to Phase Voltage	L1-2, L2-3, L3-1	Mains	x	x	x	x
Active Power (kW)	L1, L2, L3, Total	Mains	x	x	x	x
Reactive Power (kVAr)	L1, L2, L3, Total	Mains, Load, Cap.	x	x	x	x
Apparent Power (kVA)	L1, L2, L3, Total	Mains, Load, Cap.	x	X	x	x
Power Factor	L1, L2, L3, Total	Mains, Load, Cap.	x	x	x	x
Time of use (TOU) – in, out, net, total:						
Active Energy (kWh)	Total	Mains		x	x	x
Reactive Energy (kVARh)	Total	Mains		x	x	x
THD at Phase Current	L1, L2, L3	Mains, Load, Cap.		x	X	x
THD at Neutral Current	Neutral	Mains		x	X	x
THD at Phase ti Phase Current	L1-2, L2-9, L3-1	Mains , Load		x	X	x
THD at Phase Voltage	L1, L2, L3	Mains		x	X	x
THD at Neutral Vintage	Neutral	Mains		x	X	x
THD at Phase to Phase Voltage	L1-2, L2-3, L3-1	Mains		x	x	x
Harmonics of Phase Current	L1, L2, L3	Mains, Load, Cap.			x	x
Harmonics of Neutral Current	Neutral	Mains			x	x
Harmonics of Phase to Phase Current	L1-2, L2-3, L3-1	Mains , Load			x	x
Harmonics of Phase Voltage	L1, L2, L 3	Mains			x	x
Harmonics of Neutral Voltage	Neutral	Mains			x	x
Harmonics of Phase to Phase Voltage	LI-2, L2-9, L9-1	Mains			x	x
Waveforms of Phase Current	L1, L2, L3	Mains, Load, Cap.			x	x
Waveforms of Neutral Current	Neutral	Mains			x	x
Waveforms of Phase to Phase Current	L1-2, L2-3, L3-1	Mains			x	x
Waveforms of Phase Voltage	L1, L2, L3	Mains			x	x
Waveforms of Neutral Voltage	Neutral	Mains			x	x
Waveforms of Phase to Phase Voltage	L1-2, L2-3, L3-1	Mains			x	x
System Log			x	x	x	X
Event Log						X
Data log (future)						x







Typical Screens

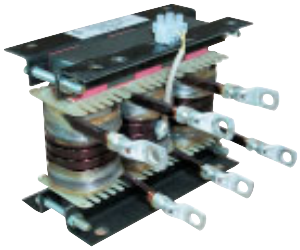
The VAR PLUS Capacitor/Reactor Model includes custom designed, iron core reactors in series with the capacitors.

Capacitor/Reactor Module

Iron Core Reactors

The iron core reactors are manufactured under tight tolerances. The reactors are constructed with a laminated low hysteresis losses iron core, precision controlled air gaps and copper windings, and have class H insulation (180°C).

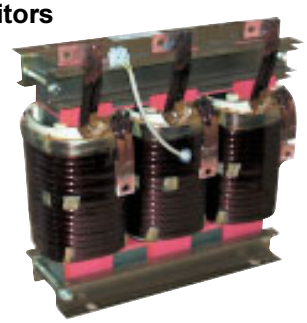
Systems without tuned or detuned reactors are equipped with limiting reactors designed to limit the inrush current which may develop in the capacitors during power up. This avoids damage to the switching elements, fuses and capacitors.



Iron Core Limiting Capacitors

The detuned reactors prevent resonance by shifting the capacitor/network resonance frequency below the first dominant harmonic (usually the 5th).

A tuned reactor design is available upon request (to absorb most of the 5th and 7th harmonics).



Iron Core Tuned or Detuned Reactor

Capacitors

The capacitors are low loss (0.25W/kVAr) MKP type in cylindrical aluminium casing. The MKP capacitor is a metallized polypropylene film capacitor with self healing properties and an overpressure tearoff fuse. Capacitor elements for 480V networks are rated 525V +10% to cope with harmonics and over-voltage. The capacitors are connected during current zero crossing, and operated in time sharing (SCAN mode), in order to reduce the effects of electrical or thermal overload and ensure an extended period of operating time (statistical life expectancy: twenty years).

Capacitors

SWITCHING MODULE

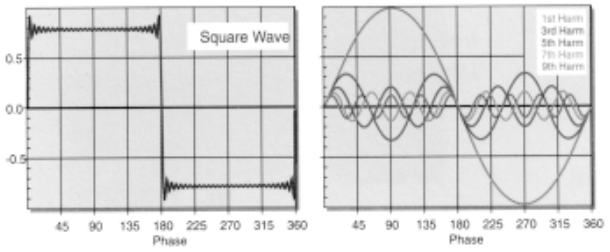
The switching module is comprised of solid state switching elements, which provide reliable, high speed, transient free operation. Each switching module switches up to three capacitor groups, using double phase electronic switches for each three phase capacitor group.

Switching Module

HARMONICS THEORY

Introduction

Utilities generate an almost perfect sinusoidal voltage. Harmonics are created by nonlinear loads such as variable speed drives, power rectifiers, inverters etc. which cause nonlinear voltage drop and change the sinusoidal nature of the voltage. The term “harmonic” refers to sinusoidal components at a frequency which is a multiple (2,3,4,5 ....) of the fundamental.

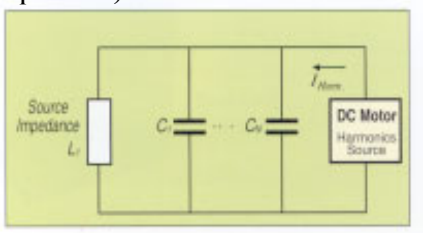


Harmonic source frequencies (fn) can be expressed as: fn=fo(PXN ±1) Where: fo=Fundamental frequency P=Number of rectifier/switching elements N=Integer number 1, 2, 3, ...
Example: Six pulse rectifier (P=6),

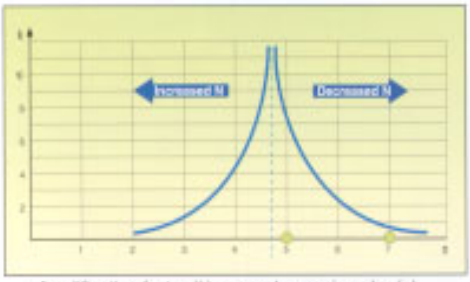
fn=5,7,11,13,17,19...

The Problem

When the reactive energy is compensated using capacitors, there is a frequency at which the capacitors are in parallel resonance with the mains (high impedance).



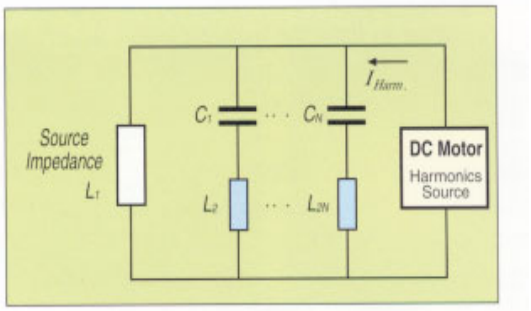
If the resonance frequency of the capacitors-mains occurs close to one of the harmonic sources, the current can circulate between the supply and the capacitors. This results in high voltage on the line and the capacitor current may exceed the rated current by more than double or triple its value.

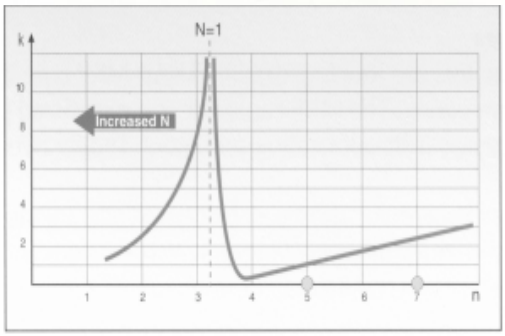


Amplification factor (k) versus harmonic order (n)

The Solution

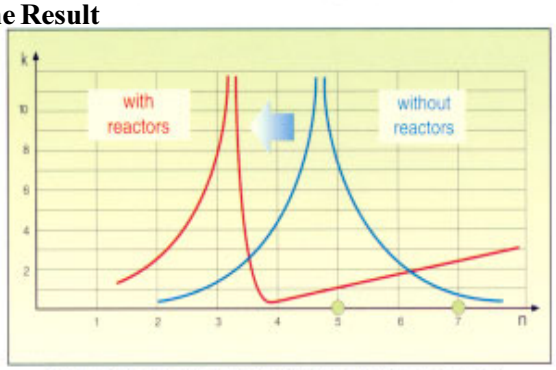
Resonance can occur on any frequency, however in most cases the current harmonic sources exist at the 5th, 7th, 11th and 13th harmonic. The VAR PLUS’ custom designed reactors, in series with the capacitors, prevent resonance by shifting the capacitor/network resonance frequency below the first dominant harmonic (usually the 5



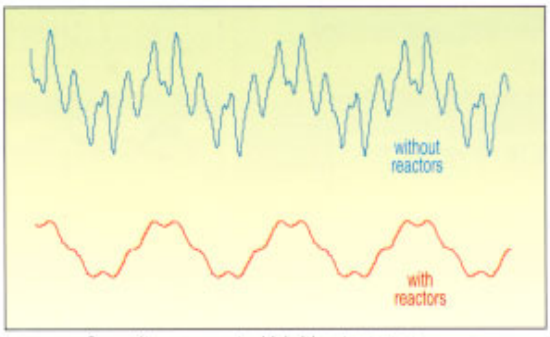


Amplification factor (k) versus harmonic order (n)

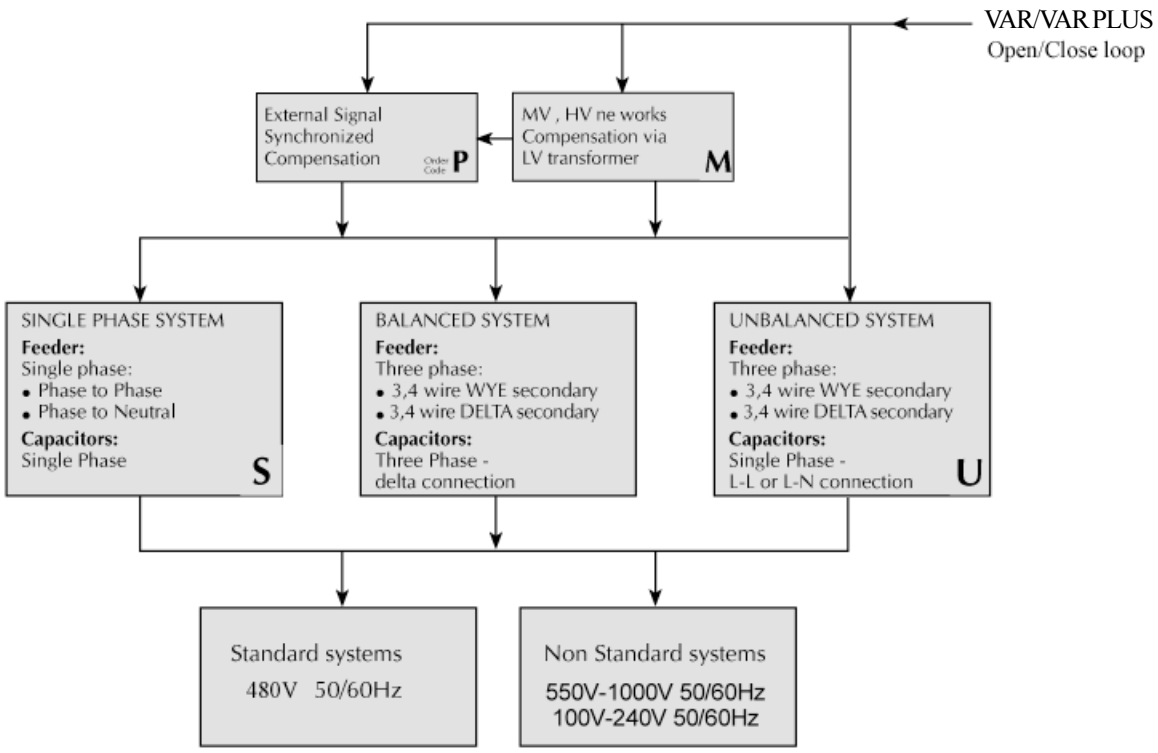
The Result



Shifting resonance frequency below the 5th harmonic



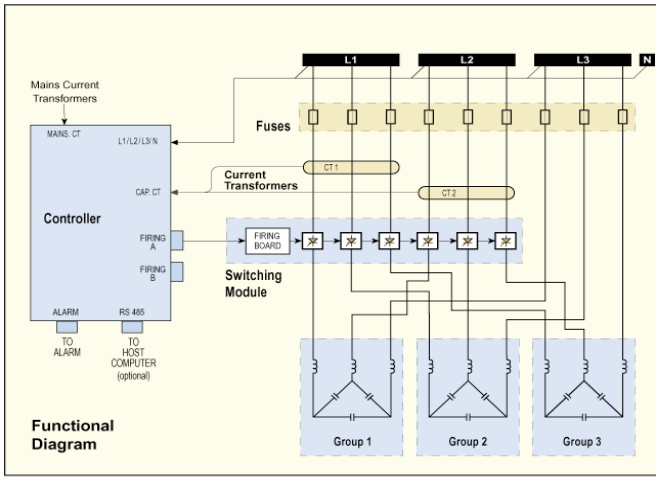
Capacitors current with/without reactors



Standard balanced systems for 480V/60Hz networks for:
Systems with inrush limiting reactors
Detuned systems with tuning frequency of 245 Hz (4.08th Harmonic at 480VAC, 60Hz)
up to 100 kVAr per group at 400V/50Hz
Tuned systems with tuning frequency of 282 Hz (4.7th Harmonic at 480VAC, 60Hz)

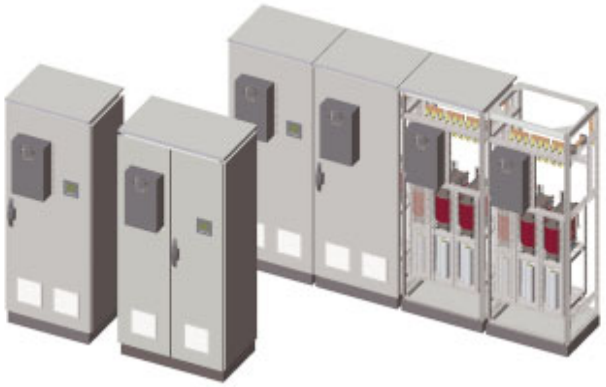
Output (kVAR)	Output per step (kVAR)	Ratio	Cabinet Dimensions W x D x H	
480V/60Hz	480V/60Hz		(mm)	(in.)
156	31	1:2:2	1400 x 600 x 2100	55 x 24 x 83
187	37.5	1:2:2	1400 x 600 x 2100	55 x 24 x 83
219	31	1:2:4	1400 x 600 x 2100	55 x 24 x 83
250	50	1:2:2	1400 x 600 x 2100	55 x 24 x 83
262	37.5	1:2:4	1400 x 600 x 2100	55 x 24 x 83
312	62.5	1:2:2	1400 x 600 x 2100	55 x 24 x 83
375	75	1:2:2	1400 x 600 x 2100	55 x 24 x 83
437	62.5	1:2:4	1600 x 600 x 2100	63 x 24 x 83
450	150	1:1:1	1600 x 600 x 2100	63 x 24 x 83
525	75	1:2:2	2200 x 600 x 2100	87 x 24 x 83
600	150	1:1:1	2200 x 600 x 2100	87 x 24 x 83
600	100	1:1:1	2200 x 600 x 2100	87 x 24 x 83
687	62.5	1:2:2	2200 x 600 x 2100	87 x 24 x 83
750	125	1:1:1	2200 x 600 x 2100	87 x 24 x 83
825	75	1:2:2	2200 x 600 x 2100	87 x 24 x 83
900	150	1:1:1	2200 x 600 x 2100	87 x 24 x 83
1125	125	1:1:1	3000 x 600 x 2100	118 x 24 x 83
1350	150	1:1:1	3000 x 600 x 2100	118 x 24 x 83
1500	125	1:1:1	3000 x 600 x 2100	150 x 24 x 83
1800	150	1:1:1	3000 x 600 x 2100	150 x 24 x 83

- ***Design:***
  Steel sheet cabinet
- ***Enclosure Finish:***
  Epoxy powder coated, in grey (RAL 7032),
  Internal parts: rust proof aluzinc
- ***Rated Voltage:***
  400V/50Hz and 480V/60Hz
  Other voltage values are available upon request
- ***Output Rating:***
  Refer to the table
  Other output ratings are available upon request
- ***Capacitors:***
  Low loss, self healing, IEC 831-1/2 .
- ***Ambient Temperature:***
  +40°C max short time
  +35°C average in 24 hours
  +20°C annual average
  -10°C low limit
- ***Protection class: IP 20 . Standards:***

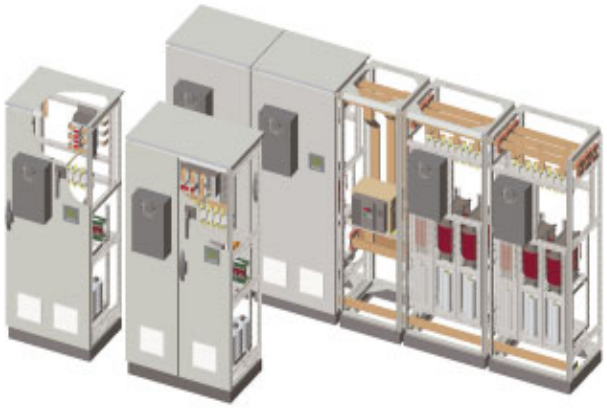


Electromagnetic Compatibility: EN50081-2, EN50082-2, EN55011, EN61000-4-2/3/4/5, ENV50204, ENV501 41

Safety Standards: EN61010-1, EN50439-1, UL508



Standard systems
Without Circuit Breaker
Single cabinet: 80x60x210 cm. (32x24x83 in.)
(W x D x H), 3 groups
Dual door single cabinet: 100x60x210 cm.
(40x24x83 in.), 4 groups
Two cabinets: 160x60x210 cm. (63x24x83 in.),
6 groups
Three cabinets: 240x60x210 cm. (95x24x83 in.), 9 groups
Four cabinets: 320x60x210 cm. (126x24x83 in.) 12 groups



Non-Standard Systems
With Circuit Breaker or Load Breaker
With or without Busbar Connection
Single cabinet
Dual door single cabinet
Mechanical structure and dimensions of larger systems are available *upon request.*

Ultravar™ offers other power quality products. For additional information on TVSS, line & load reactors, high voltage capacitor equipment and harmonic solutions, contact your Sales Representative or the address below.

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