4. Special Capacitor

› Application

Harmonic is commonly generated in electricity system due to devices using Thyristor.
It can causes electricity accidents and interference in the system
Therefore, the application of filter facilities is essential to prevent the effect
of Harmonic in the system and use electricity more efficiently.

› What is harmonic

Cyclic distortion wave is expressed as the sum of sine wave [50Hz], the integral number frequency and major sine wave, integral number [50Hz] frequency.
This integral number frequency is called harmonic wave and according to the change of amplitude and phase, wave form is changed resulting in synthetic distortion.
Combined distortion wave is manifested in distorted sine wave form. This form can be analyzed into one fundamental wave [50Hz] which has random cycle and major sine wave which has integral number frequency or subharmonic frequency.
If the frequency of it is higher than the fundamental frequency, it is called harmonics and if the frequency of it is lower, it is called fractional harmonic wave or subharmonic.
For example, an distorted wave form comprising sine wave type [50Hz] and 5th [250Hz] and 7th [350Hz] wave form is analyzed as following :

| ex) Harmonic | = | Fundamental Wave | + | 5th Harmonic Part | + | 7th Harmonic Part |
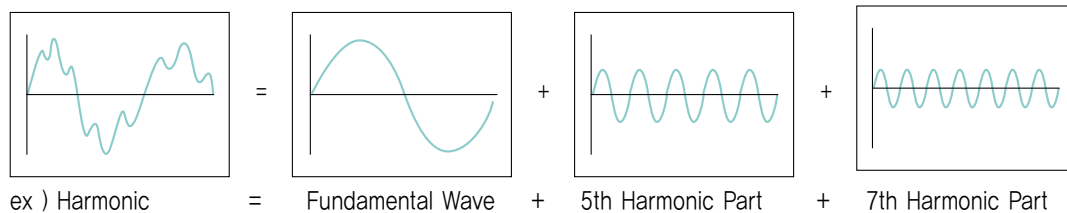
› Harmonic Generator

• Thyristior controller
• Speed controller
• Low speed starter
• Power factor compensator
• Rectifier
• Arc furnace
• Transformer, Reactor
• Transformer, Reactor
• Non-linear loads such as rotating devices changing the wave form of the current which generates harmonics.

› Process of Harmonic Filter Engineering

• Collecting data[system condition, harmonics spectrum, THD limit]
• Drawing system impedance map
• Calculating harmonics impedance and determining filtering order
• Harmonic flow calculation
• Simulation
• Checking abnormal resonance in the system and the possibility of harmonics extension
• Designing Switcher PNL, Structure
• Testing the operation after installation
• Test report

4-1 A.C. Harmonic Filter

› Disturbance by Harmonics

Once Harmonic is generated in system, it moves around and affects on the connected other electricity facilities.
- Overheating and loss of transformer
- Influx of over current of capacitor and noise
- Instability of control system
- Voltage change
- Overload of rotator
- Errors on the movement of circuit breaker
- Impediment in communication and interfering OA functions
- Heavy current in neutral and low voltage between phase and earthing

› What is Harmonic Filter?

Harmonic filter is a device which represses and absorbs the outflow of harmonics generated in the electricity system. It consists of resistor, reactor and capacitor.
Basic harmonic filter consists of lower order [5–13th order] single shunt filter which is synchronized with the harmonics current generated.
For other higher order frequency, higher order filter shall be installed, if necessary.

› Effects of Harmonic Filter

- Improvement of power factor [invalid power in the electricity system is removed, resulting in the improvement of economics]
- Absorption and removal of harmonics
- Resolving the problem of resonance between inductive and capacitive in the system.
- Keeping the performance and lifetime of the facility high by keeping normal voltage

The effects of contained harmonic current by filter can be expressed as following :
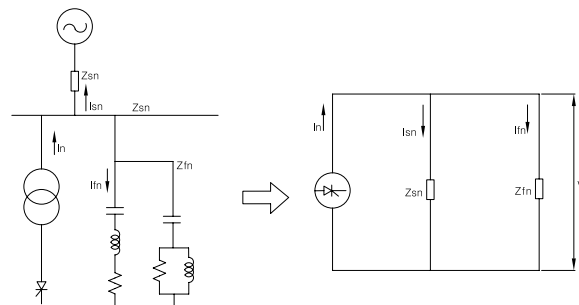
$$Vn = \frac{Zfn \cdot Zsn}{Zfn + Zsn} \cdot In = \frac{In}{Yfn + Ysn}$$

$$Vn = \frac{Zfn}{Zfn + Zsn} \cdot In = \frac{Ysn}{Yfn + Ysn} \cdot In \ , \quad Ifn = \frac{Zsn}{Zfn + Zsn} \cdot In = \frac{Ysn}{Yfn + Ysn} \cdot In$$

4. Special Capacitor

4-1 A.C. Harmonic Filter

› Current Distortion Limits for General Distribution Systems [IEEE Std 519-199]

Maximum Harmonic Current Distortion in Percent of I_L
Individual Harmonic Order [Odd Harmonics]

I_{SC} / I_L	‹11	11≤h‹17	17≤h‹23	23≤h‹35	35≤h	TDD
‹20	4	2	1.5	0.6	0.3	5
20‹50	7	3.5	2.5	1	0.5	8
50‹100	10	4.5	4	1.5	0.7	12
100‹1000	12	5.5	5	2	1	15
›1000	15	7	6	2.5	1.4	20

Even harmonics are limited to 25% of the odd harmonic limits above
Current distortions that result in a dc offset, e.g., half wave converters are not allowed.
* All power generation equipment is limited to these values of current distortion regardless of actual
   lsc / I_L where
lsc = maximum short circuit current at PCC
I_L = maximum demand load current [fundamental frequency component] at PCC

› Voltage Distortion Limits [IEEE Std 519-1992]

Bus Voltage at PCC	Individual Voltage Distortion [%]	Total Voltage Distortion THD [%]
69kV and below	3.0	5.0
69.001kV through and 161kV	1.5	2.5
161.001kV and above	1.0	1.5

4. Special Capacitor

4-2. Zero Sequence Filter(ZSF)

› General

1. General

Increasing use of computer and electric home appliance, the neutral current zero sequence
harmonic in line make variety types of disturbances in system.
ZSF(Zero Sequence Filter) is easy to install with electric accessories and
it can reduce this large neutral current up to 90% depending on the installed position.

2. The problems of Zero Sequence harmonics

• Trip the circuit breaker due to overcurrent
• Malfuction of electric protector
• Communication disturbance

• Heat deterionration on transformer
• Overheat / Fire on the neutral line

3. Application

• Applicable load : Computer, OA appliance, Electronic fluorescent lamp, Single Phase SCR heater and UPS etc
• Applicable system : Single phase nonlinear loads on Three phase four wire systerm
• Applicable place : Office/Commercial Building, School, Apartment, Department, Factory, Medical center etc.

› Features

• Neutral impedence adjuster upon request
• Easy to Install
• Increasing power quality

• Ammeter displaying the neutral current in option
• Easy to select

› Effects

• Protect heating and loss of line and neutral cable that is effected by zero sequence harmonic current
• Reduce unbalance of line current
• Protect overinvestment by increasing capacity
• Reduce K–factor rating of load current at main transformer.

• Reduce system loss

› Standard specification

(Rated Voltage : 220V)

Type	Currents in Neutral [A]	Dimensions [mm]		
		W	D	H
ZSF22030	30	350	500	500
ZSF22060	60	350	500	500
ZSF22100	100	600	400	850
ZSF22150	150	650	450	900
ZSF22300	300	800	450	1000
ZSF22450	450	800	500	1200
ZSF22600	600	800	1500	2350
ZSF221000	1000	1100	1500	2350
ZSF223000	3000	1100	1500	2350

* Approximate dimensions and weights are given above.
  Please contact to factory for exact dimensions.

› External Shape
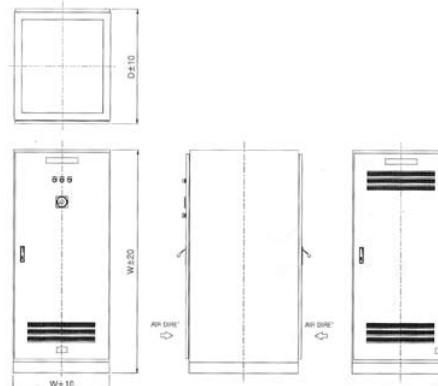
4-3. Hybrid Harmonic Filter(HHF)

> General

1. General

The Hybrid Harmonic Filter(HHF) enable most three phase non-linear load to comply with both the voltage and current distortion limits of IEEE Std.519-1992 and other international limits such as AS-2279, EN61000-3-4, and BS G5/4.
Comparing with the classical broad band harmonic filter, the HHF have only 30% of capacitance with better filtering. Less capacitance can minimize leading current at light loading condition.

2.Problems of Harmonic

• Resonance at Power
• Trip the Relay or cut fuse
• Over voltage trip and malfuction of Drive

3. Application

• Applicable loads : Inverter, UPS, Elevator, AC/DC motor drive, Diode/SCR Rectifier, Induction heater, DC power supply, HVAC system, Fan and Pumps etc.
• Applicable place : Office/Commercial building, School, Shopping Mall, Department store, Apartment, Hospital, Factory etc
• Applicable system : Low Voltage 3P nonlinear loads

> Features

• Patent No.0383791 as Hybrid Harmonic Filter
• Qualified as Excellent Product by the ministray of commerce, industry and energy
• Compact and easy-to-install.
• Standardized up to 1000HP (based on load capacity)
• Quite operation and proper ventilation.
• Special voltage available upon request.

> Effects

• Protect loss and reduce capacity effected by harmonic current at transformer.
• Protect heating and loss of line cable that is effected by harmonic current.
• Protect burning of reactor and capacitor by harmonic current injection.
• Improve power factor and reduce system loss.
• Minimize interference with other equipment.
• Improve system voltage/current waveform.
• Prevent nuisance tripping of fuse and circuit breakers which can result from the presence of harmonics.

> Standard specification

> External Shape

(Rated Voltage : 380V)

Type	Currents in Neutral [A]	Dimensions [mm]		
		W	D	H
HHF38005	5	350	500	500
HHF38010	10	500	800	1000
HHF38020	20	600	1000	1200
HHF38040	40	600	1200	1600
HHF38060	60	800	1400	1600
HHF38100	100	800	1500	1600
HHF38200	200	900	1500	2350
HHF38300	300	1100	1500	2350
HHF38400	400	1100	1500	2350

* Rated Voltage 220V or 440V is also available
* Approximate dimensions and weights are given above. Please contact to factory for exact dimensions.

4. Special Capacitor
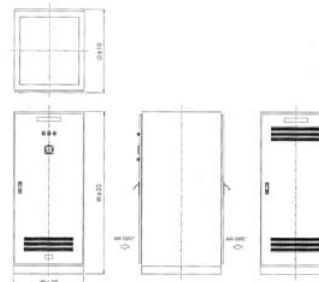
4-4. L-C Complex Harmonic Filter(LCF)

> General

1. General

The motor using inverter is causing riffle wave form on voltage, and it causes many problems on the system like breaking down dielectric.
LCF can convert PWM wave form to sine wave form making more safe operation in the system.

2. Problems of Harmonic

- Destroying dielectric in Motor by spike
- Damage on Voltage raising transformer
- Malfuction and reduced life spam of Inverter by inversed voltage.
- Instantaneous Over voltage phenomenon by distorted voltage wave form
- Malfuntion of precision apparatus
- Damage on Cable
- Decreasing productivity
- Over heat on distribution line

3. Application

- Applicable load : Motor and machines using inverter(Between inverter and motor)
- Applicable system: 220V, 380V, 440V, 1000HP
- Applicable place : Plants, Steel Mills, power plant, sewage disposal plants, Garbage dumps etc

> Features

- Make smooth voltage and current wave form
- Reduce voltage reflection and surge impedance
- Reduce peak voltage of motor

> Effects

- Prevent dielectric destruction
- Increase productivity and quality
- Increase system communication quality and life span

> Wave form with LCF

PWM wave form

Voltage

Currint

〈Before installing LCF〉   〈After installing LCF〉

> Standard specification

(Rated Voltage : 380V)

| Type	Currents in Neutral [A]	Dimensions [mm]		
		W	D	H
LCF38005	3.7	350	500	500
LCF38008	5.6	350	500	500
LCF38010	7.5	420	730	1000
LCF38015	11	420	730	1000
LCF38020	15	420	730	1000
LCF38025	19	600	900	1200
LCF38030	22	600	900	1200
LCF38040	30	600	900	1200
LCF38050	37	600	900	1200
LCF38060	45	600	900	1200
LCF38100	75	600	900	1200
LCF38150	112	900	900	2150
LCF38200	149	900	900	2150
LCF38400	298	900	900	2150

* Rated Voltage 220V or 440V is also available
* Approximate dimensions and weights are given above. Please contact to factory for exact dimensions.
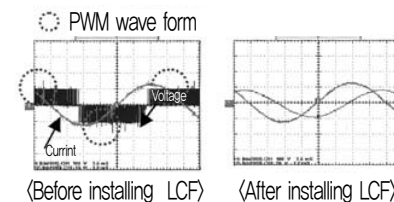
> External Shape
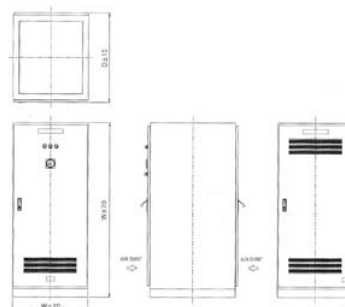
4-5. Active Power Harmonic Filter(APF)

> General

1. General

The proliferation of nonlinear loads such as static power converters and arc furnaces results in variety of undesirable phenomena in the operation of power systems.

The most important among these are harmonic contamination, increased reactive power demand and power system voltage fluctuations.

Harmonic currents increase power systems losses, excessive heating in rotating machinery, can create significant interference with the power line communication.

The harmonic is a growing problem for both electricity suppliers and consumers.

2. Problems of Harmonic

- Malfunction of precision control
- High current in neutral conductors
- Damage to sensitive equipment
- Frequent tripping of circuit breakers
- Capacitor overloading and failures
- Excitation of network resonance
- Overheating of transformer, motor and cables

3. Application

- Applicable load : Welding Machine, Electrolyzer in Chemical Factory, Electrolytic machine of ceramic plasitc, Arc furnace, Crain etc
- Applicable system : 380V, 440V, 50-300A
- Applicable place : Steel Mills, Chemical Plants, Metal mills, Harbors etc

> Features

- Patent No.0459000 as Three Phase fourwire active power filter control device
- Meet IEEE standard 519-1992
- Parallel connection allows easy retrofit for large system
- Solve Power Quality Problems
- Curtailment of maintenance fee

> Installation Effect

〈Before installing APF〉　　〈After installing APF〉　　〈Before installing APF〉　　〈After installing APF〉
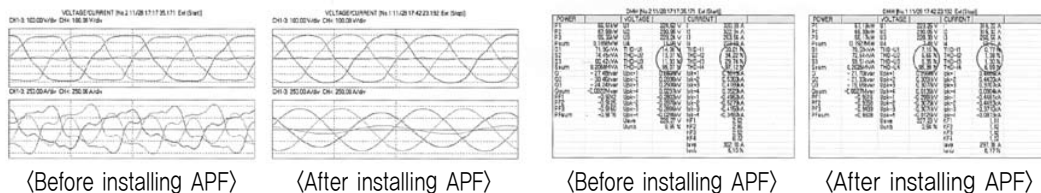
> Standard specification

(Rated Voltage : 380V)

Type	Rating Current [A]	Dimensions [mm]		
		W	D	H
APF38050	50A	600	600	1670
APF38100	100A	750	600	2000
APF38200	200A	900	600	2000
APF38300	300A	1200	6850	2000

* Approximate dimension is given above.
  Please contact to factory for exact dimension and application.

> External Shape
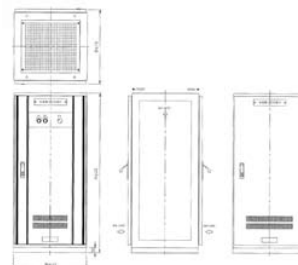
4-6. Intelligent Var Compensator(IVC)

› General

1. General

Intelligent Var Compensator(IVC) is the product designed to improve power quality
in the systems with welding, crane and many unspecified loads which is generating reactive power.

2. Application

• Applicable loads : Welding machines, Arc furnace, unspecified loads generating reactive power,
• Applicable system: 380V, 440V, 30~1800kvar
• Applicable place : Steel mills, Chemical plants, Metal mills, Harbors etc.

› Features

• Patent No.0459000
• 3Phase 4Wire reactive power compensation system with linear response characteristics.
• Prevent the voltage drop and flicker with 5-20ms response speed.
• Control the reactive power using power switching sockets without transient
• Protect senstive electric machines and save energy
• Exact and fast power factor improvement   • Long life span of swiching sockets and capacitors

› Effects

• Power factor on the secondary side of transformer is improved at 98%
• Average current is decreased to 30%   • Allowance capacity of transformer is increased.
• Prevent voltage flicker phenomenon through resolving reactive power in real-time
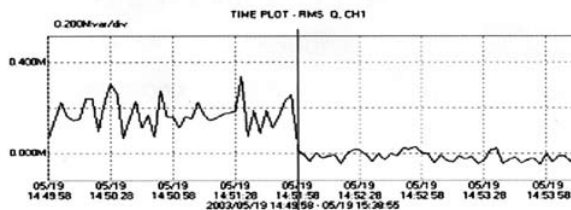

〈Before installing IVC〉   〈After installing IVC〉

› Standard specification

(Rated Voltage : 380V)

Type	Capacity [kvar]	Step [kvar]	Ratio	Dimension [mm]		
				W	D	H
IVC38100	100	20	1:2:2	800	800	2000
IVC38120	120	40	1:1:1	800	800	2000
IVC38140	140	20	1:2:4	800	800	2000
IVC38200	200	40	1:2:2	800	800	2000
IVC38240	240	80	1:1:1	800	800	2000
IVC38280	280	40	1:2:4	800	800	2000
IVC38400	400	80	1:1:1	1000	800	2000
IVC38480	480	160	1:1:1	1000	800	2000
IVC38560	560	80	1:2:4	1600	800	2000
IVC38800	800	160	1:2:2	2400	800	2000
IVC381120	1120	160	1:2:4	3200	800	2000
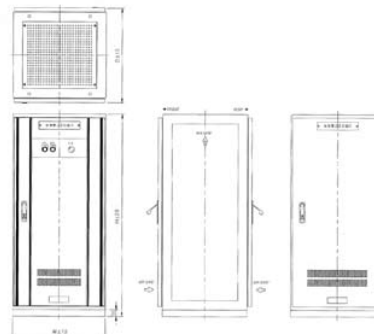
* Rated Voltage 220V or 440V is also available
* Approximate dimensions and weights are given above. Please contact to factory for exact dimensions.

› External Shape

4. Special Capacitor

4-7 Low Frequnecy Induction Furnace Capacitor

› Application

This product was developed in 1977 with the purpose of rationalizing power supply by improving heat efficiency and power factor of Low Frequency Induction Furnace. This product consists of polypropylene film, aluminum thin film or metalized film which has excellent voltage resistance.
It contains specially produced composite oil, resulting in high reliability.

› Product Scope

- Installation Place : Indoor
- Ambient Temperature for use : −20℃ ~ +40℃ [below 35℃ average for 24 hours]

› Technical Data

Tolerance	−5 ~ +15% [at 20℃]
Withstand Voltage	10 seconds of 2.0 times of rated voltage between mutual terminals
Insulation Level	$2U_N$ + 2kV or 3kV, whichever is the higher, for 10s
Max Overvoltage	Less than 105% of rated voltage : within 12hours per day
Max overcurrent	120% of rated capacity [less than 60Hz], 115% of rated capacity [more than 60Hz] or less
Capacitor Loss [Under stabilized condition]	0.35% [rated voltage, 20℃] or less

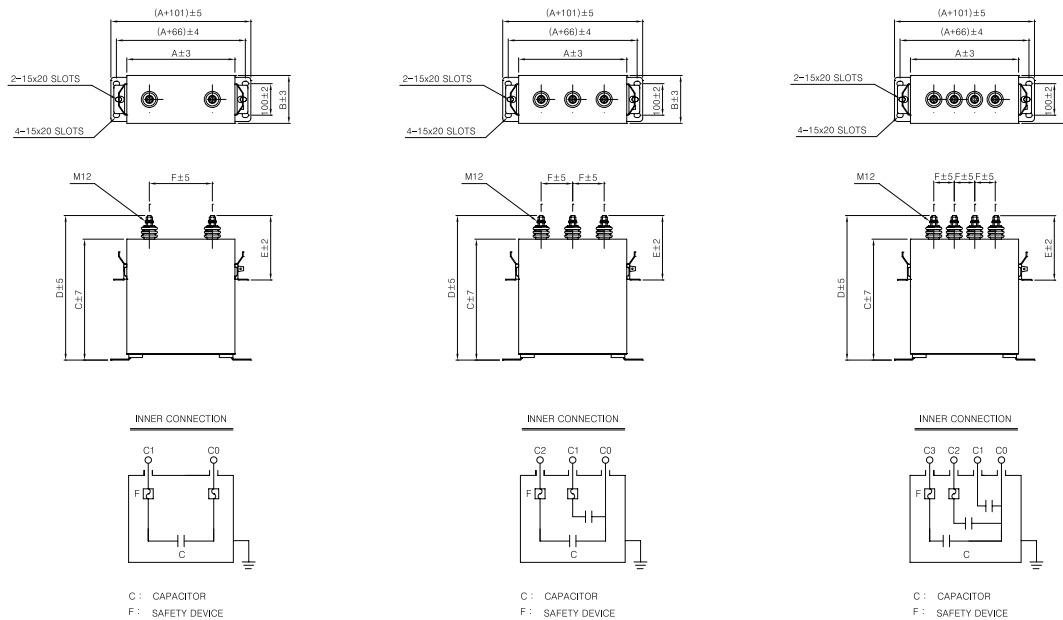## › Diagram

Figure 1

Figure 2

Figure 3

4-7 Low Frequnecy Induction Furnace Capacitor

❯ Ratings and Dimensions

Capacity	Votage [V]	Phase	Frequency [Hz]	Rated Capacity [kvar]	Type	Dimension [mm]						Figure
						A	B	C	D	E	F	
50	630	1	60	50	SMFL−66050KS	343	153	280	355	205	200	1
100	440	1	60	11.1+22.2+66.7	SMFL−46100KS	343	153	390	465	205	65	3
	600	1	60	50+50	SMFL−66100KS	630	135	380	455	205	100	2
	630	1	60	100	SMFL−66100KS	343	153	380	455	205	200	1
	800	1	60	100	SMFL−86100KS	343	153	470	545	205	200	1
150	600	1	60	50+100	SMFL−66150KS	630	135	500	575	205	100	2
	800	1	60	150	SMFL−86150KS	343	153	640	715	295	200	1
200	600	1	60	200	SMFL−66200KS	343	153	660	735	255	200	1
	750	1	60	25+40+135	SMFL−76200KS	343	153	580	655	255	65	3
	1000	1	60	30+60+110	TAFL−106200KS	343	153	840	915	295	65	3
	1000	1	60	100+100	TAFL−106200KS	530	135	610	685	295	100	2
	1200	1	60	25+25+150	TAFL−126200KS	530	170	480	555	205	65	3
	1200	1	60	50+50+100	TAFL−126200KS	530	170	480	555	205	65	3

* Approximate Dimensions and ratings are given above. Please contact factory to check it before order.

4-8 Water Cooling Capacitor

> Application

This product is specially designed to accommodate high capacity to be easily used for matching circuit of high frequency induction furnace device.

For dielectric, polypropylene film and capacitor paper was used together and aluminium foil electrode of non induction method was used. For insulating oil,
non PCB dielectric was impregnation resulting in stable and excellent feature.

For cooling method, it was designed that cooling water can absorb the heat generated from the inner dielectric loss.

To make matching circuit easily when inductive load is changed, capacity was divided into proper capacity and lead bushing was treated.

The material of case is non magnetic aluminum to minimize induction loss due to high frequency electric filed. The loss of capacitor itself is about 0.1%.

Maximum Water temperature rise should not exceed 4deg[5l/min], on the standard of maxim capacitance.

Permissible load power is 1.05 times of rated voltage [within1 hour per day] and maximum permissible current is 1.35 times of rated current.

High frequency water cooling capacitor does not contain discharging resistor since it is connected to high capacity coil circuit in paralleled.

When capacitor is input into circuit again, the permissible limit of residual voltage should be within 10% of rated voltage and nuts with DC voltage.

Tightening strength on nuts at terminal is   200kg·㎝ or less.

> Technical data

Installation place	Only for Indoor
Temperature of Cooling Water	Cooling water exit temperature less than 45℃
Ambient Temperature	More than 0℃
Tolerance	Within ± 10% of rated capacity
Withstand Voltage	2.15 times of rated voltage, 10 seconds
Flux of Cooling Water	More than 5ℓ per minute
Pressure of Cooling Water	Less than 10kg/㎠
Safety Device	Thermostat contact capacity [250VAC, 7.5A]
Case	Aluminium non painted product

⟨Head Loss and Cooling Water Quanfity Curve⟩
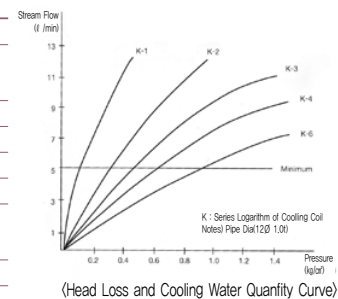
> Caution

Since the outer case of capacitor is unilateral electrode, please be sure to use the insulated rack in installation.

When more than 2 capacitors are connected in paralleled, there should be space at least 35mm.

The flow quantity of cooling water shall be more than 5ℓ /min.

In case when capacitor is kept at subzero temperature, remove the water entirely from copper pipe
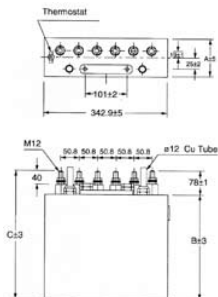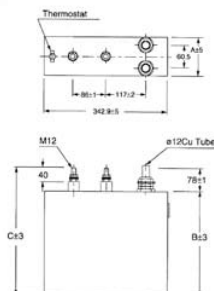
4-8 Water Cooling Capacitor
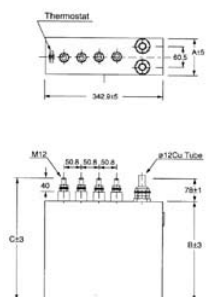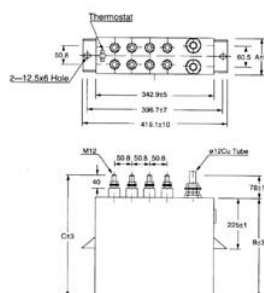
> Diagram

Figure 1

Figure 2

Figure 3

Figure 4

> Ratings and Dimensions

Frequency [Hz]	Rated Votage [VAC]	Rated Capacity [kvar]	Total [μF]	μF Per Section								Dimension [mm]			Figure
				1	2	3	4	5	6	7	8	A	B	C	
960	800	450	117	5	8	16	44	44	–	–	–	136.7	330.2	398.2	1
960	1000	480	80	13	13	27	27	–	–	–	–	104.6	330.2	398.2	3
1000	1250	750	76	3	3	3	3	13	13	19	19	104.6	360.2	428.0	4
1200	1250	1200	102	–	–	17	17	17	17	17	17	104.6	330.2	398.2	
2000	1250	300	15	7.6	7.6	–	–	–	–	–	–	136.7	200.0	368.0	2
3000	400	300	100	7	13	27	53	–	–	–	–	104.6	200.0	268.0	3
3000	800	1000	84	21	21	21	21	–	–	–	–	104.6	330.2	398.2	
3000	1250	1200	40	3	3	3	3	7	7	7	7	104.6	330.2	398.2	4
3000	1250	1200	40	2	2	2	2	6	10	10	10	104.6	330.2	398.2	

* Approximate Dimensions and ratings are given above. Please contact factory to check it before order.

4. Special Capacitor

| 39   Samwha

4-9 Surge Absorbing Capacitor

> Application

This product was developed by our company in 1976 to absorb and reduce surge
which may be generated when the breaker is open or closed and lighting surge
by connecting transmission line and, closed and lightning surge which may be delivered by connecting transmission line and ground.
Its dielectric is polypropylene film which has excellent withstand voltage and good quality capacitor paper and it also contains specially produced composite oil.
The Capacitor with series resistance was developed to improve electric feature.

> Product Scope

- Installation Place : Indoor / Outdoor
- Ambient Temperature : −20℃ ~ +40℃ [below average 35℃ per day, below 25℃ average per year]

> Technical Data

Tolerance	−5% ~ +15% [at 20℃], less than 108% of unbalanced ratio between phases
Max overvoltage	Below 110% of rated voltage : within 8 hours per day
	Below 115% of rated voltage : within 30 minutes per day
	Below 120% of rated voltage [less than 2 times of 5 min. per month]
	Below 130% of rated voltage [less than 2 times of 1 min. per month]
Max overcurrent	Transient current 130% of rated current allowed
Withstand Voltage	Between case and all of terminals

Line voltage	Test voltage	
3300V	16kVAC [1 min.]	45kVDC [10 sec.]
6600V	22kVAC [1 min.]	60kVDC [10 sec.]
11000V	28kVAC [1 min.]	90kVDC [10 sec.]
22000V	50kVAC [1 min.]	150kVDC [10 sec.]

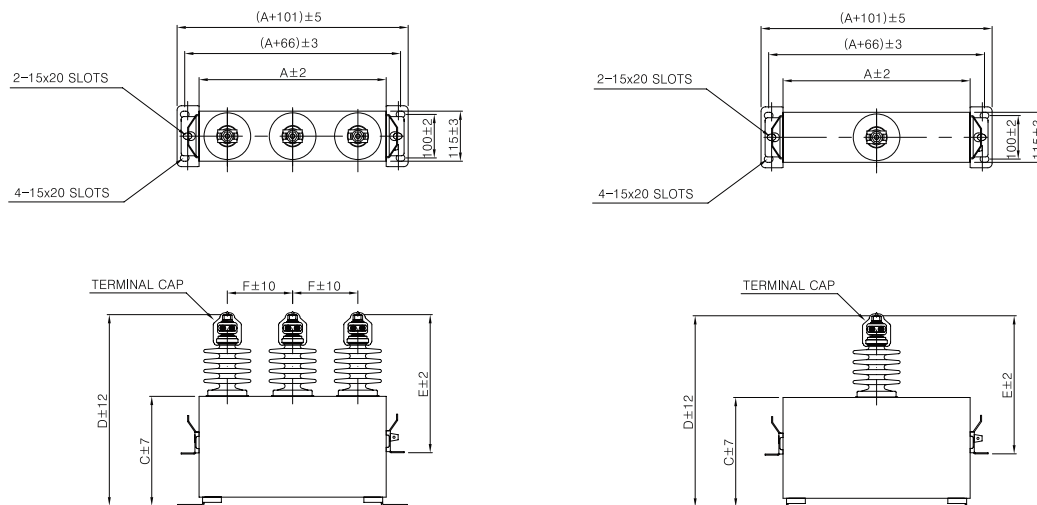|	
Capacitor Loss [Under stabilized condition]	Less than 0.5% [at rated voltage, 20℃], in case C−R type less than 0.6%
Reference Standard	JEM1362 [1999]

> Diagram
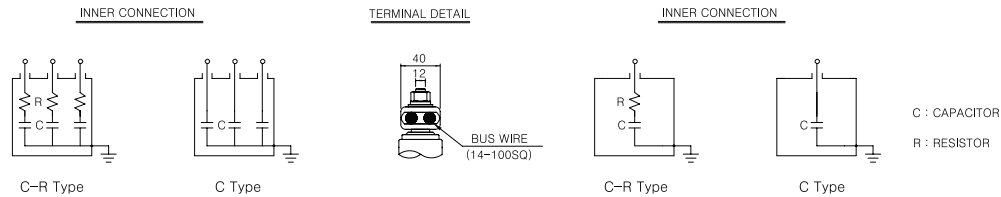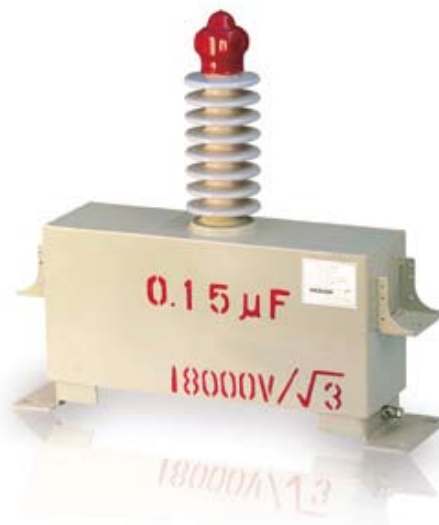

Figure 1

Figure 2

4-9 Surge Absorbing Capacitor

INNER CONNECTION   TERMINAL DETAIL   INNER CONNECTION

C-R Type   C Type   C-R Type   C Type

C : CAPACITOR
R : RESISTOR

BUS WIRE
(14-100SQ)

Figure 1   Figure 2

› Ratings and Dimensions

Rated Voltage [VAC]	Rated Capacity	Type	Dimension [mm]						Figure
			A	B	C	D	E	F	
3300/√3	0.05 μF x 3	THF-T30015T [CR]	430	115	250	435	315	150	1
3300/√3	0.1 μF x 3	THF-T3003T [CR]	430	115	220	435	315	150	
3300/√3	0.5 μF x 3	THF-T305T	430	115	270	455	315	150	
3300/√3	0.8 μF x 3	THF-T3024T	430	115	270	455	315	150	
6600/√3	0.05 μF x 3	THF-T60015T [CR]	430	115	250	435	315	150	
6600/√3	0.1 μF x 3	THF-T6003T [CR]	430	115	250	435	315	150	
22900/√3	0.1 μF	THF-T23001S	430	145	250	520	400	-	2
13800/√3	0.3 μF	THF-T13003S	430	145	280	510	360	-	
24000/√3	0.2 μF	THF-T24002S	430	145	350	620	400	-	
24000/√3	0.4 μF	THF-T24004S	530	135	450	720	400	-	

* Approximate Ratings and Dimensions are given above. Please contact factory before order.

4-9 Surge Absorbing Capacitor

› Operation principle

To explain the effect of surge absorbing capacitor, the rotator is expressed as intensive equivalent resistance R as in the figure A.
In parallel with this, on the circuit to which the protecting Capcitor is connected,
VO = EOH[t] travelling wave invaded from line of surge impedance Z.
Then, when terminal voltage of R and C is Vc, the current Ip at P point is

$$Ip = C\frac{dVc}{dt} + \frac{1}{R}Vc = \frac{1}{Z}[2Vo - Vo]$$

To rearrange the expression $\frac{d}{dt} = P$, $Vo = EoH[t]$

$$PVc = \left(\frac{R+Z}{CRZ}\right)Vc = \frac{2Eo}{CZ}H[t]$$

$$\left(\frac{R+Z}{CRZ}\right) = \alpha$$

$$Vc = \frac{2Eo}{CZ} \times \frac{1}{P+\alpha}H[t] = \frac{2Eo}{\alpha CZ}[1-e^{-\alpha t}]H[t]$$

When Z and R is constant and C is changed, the terminal voltage of the rotator Vc is as in the figure B.
From this, it can be seen that the wave height value is reduced
according to the value of C or R. When R = ∞ and C = 0.3μF, the terminal voltage of the rotator is reduced to 1/2 of invasion wave, which shows the effects of surge absorbing capcitor.

Figure A

Figure B
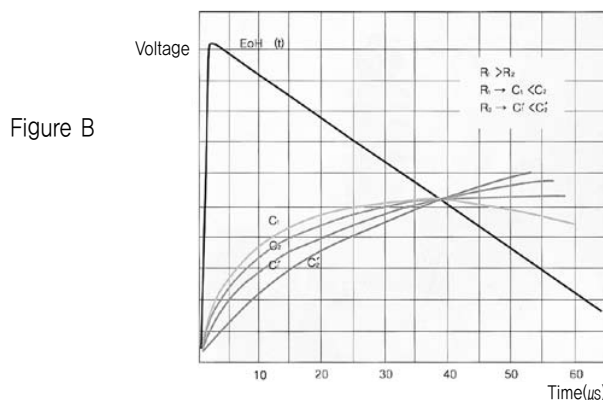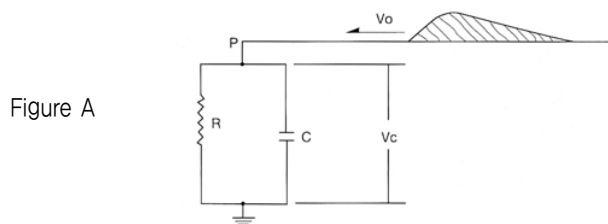
4-10 Grounding Capacitor

> Application

This porduct was developed by our company in 1975 to improve capacity between distribution line and earth by connecting the 2nd winding distribution line of insulation transformer and earth.
It uses polypropylene film which has excellent insulation ability and good quality capacitor paper as dielectric and contains specially produced composite oil to improve electric feature.

> Product Scope

- Installation Place : Indoor / Outdoor
- Ambient Temperature : −20℃ ~ +40℃[below 35℃ average per day, below 25℃ average per year]

> Technical Data

Tolerance	−5% ~ +15% [at 20℃], less than 108% of unbalanced ratio between phases		
Max overvoltage	Below 110% of rated voltage : within 12 hours per day		
	Below 115% of rated voltage : within 30 minutes per day		
	Below 120% of rated voltage : within 5 minutes		
	Below 130% of rated voltage : within 1 minute		
	Below 182% of rated voltage : within 2 seconds		
Max overcurrent	Transient current 130% of rated current allowed		
Withstand Voltage	Between case and all of terminals		
	Line voltage	Test voltage	
	3300V	10kVAC [1 min.]	30kVDC [10 sec.]
	6600V	16kVAC [1 min.]	45kVDC [10 sec.]
Capacitor Loss	Less than 0.35% [at rated voltage, 20℃]		
Painting Color	Munsell no. 5Y 7/1		
Reference Standard	JEM1362 [1999]		

> Diagram
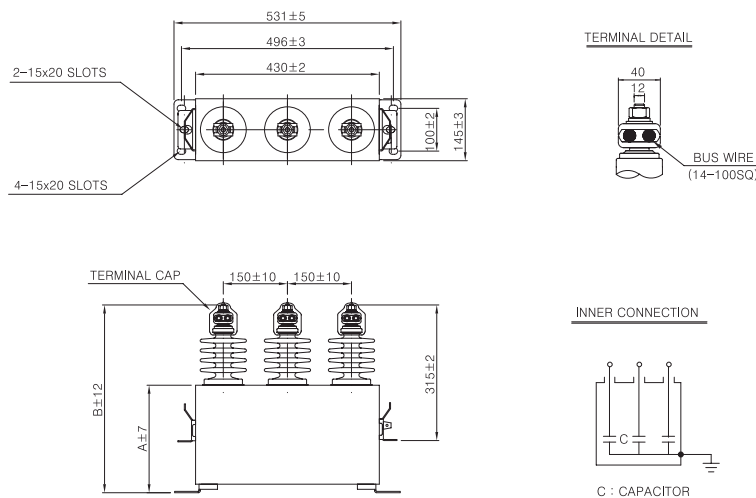
4-10 Grounding Capacitor

› Ratings and Dimensions

Line Voltage [V]	Rated Capacity [kvar]	Type	Dimension [mm]	
			A	B
3300	10	TBF−T36010Y	490	675
6600	10	TBF−T66010Y	290	475

* Approximate Dimensions are give above. Please contact factory for exact deimensions of a particular capacitor

› Operation Principle

In 3 phase circuit, for 1 line grounding current is calculated from the following formula.

$$Ig = 3j\omega CEa = j\sqrt{3}E \times 2\pi fC$$

Ig : Grounding Current [A]   E : Line Voltage [V]

Ea : Phase Voltage [V]   C : Equivalent Ground Capacitance [$C = C_1 + C_2$]

I_{c1} [Ground fault current Ig in figure A − charged current after zero phase current transformer [ZCT]] passes the zero phase current transformer. Therefore, ground fault current Ig_1 passing ZCT can be calculated from the following formula.

$$Ig_1 = \sqrt{3}E \times 2\pi \times f \times C_1$$

When the distance between transformer and ZCT is small, ground capacity in line is small and penetration ground fault current I_{g1} is not enough to move circuit breaker. Therefore, use capacitor for earthing to improve ground capacity in line.

For example, when E = 3300V, $C_1 = 0.5\mu F$, and f = 50Hz in figure B, ZCT penetration ground fault current is as following :

$$Ig_1 = \sqrt{3} \times 3300 \times 2\pi \times 60 \times 0.5 \times 10^{-6} = 1.08A$$

Since detecting current of grounding breaker is selected to be 0.1 ~ 0.8A, it is good to select the value of C_1 to be more than this value

[C_1 is equivalent to 1 phase and in case of $C_1 = 0.5\mu F$, capacitor for grounding of $0.5\mu F \times 3$ is to be selected]
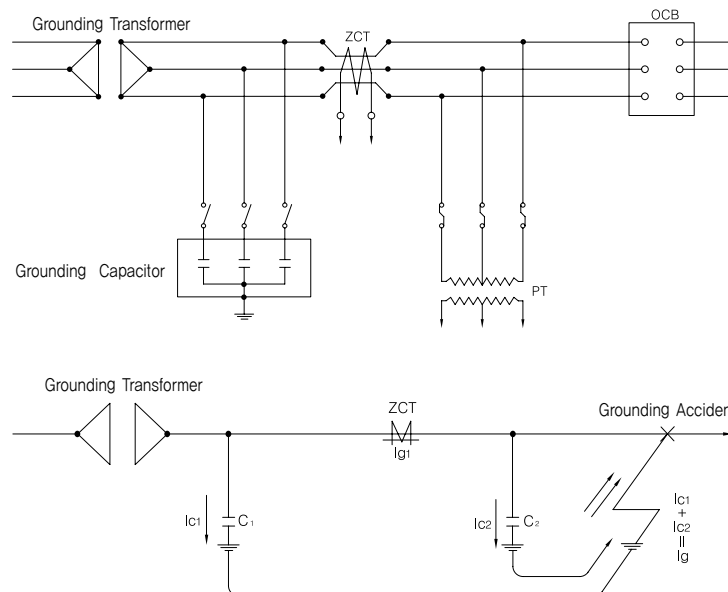
4-11 Pulse Power Capacitor

> Application

It is normally used in the area of power supply device for tests,for example IVG, ICG, Mark Generator, Power Supply for L−C resonance circuit and small scale power supply for fusion study and Power supply pulse power[state of art medical instruments, rock destruction and pulse laser] and recently, households which use this capacitor have been rapidly increased.

Since high energy density capacitor for pulse power is the key part of aircrafts [fighter, artificial satellite and passenger airplane], electronic / electric heat chemical gun, high efficiency laser and high efficiency munitions such as radar, the supply of this product was difficult since the industrialized countries regulated the outflow of technology. But, recently our company mass porduced the capacitor resulting in smooth supply of the product. In 1997, 11kVDC 150μF 9kJ rated capacitor for energy storage was developed with our own technology and delivered them for power supply of simple composite test facility and its performance has been recognized.

Several capacitors were also installed at heavy electro mechanics manufacturers in Korea and are used for test facilities.
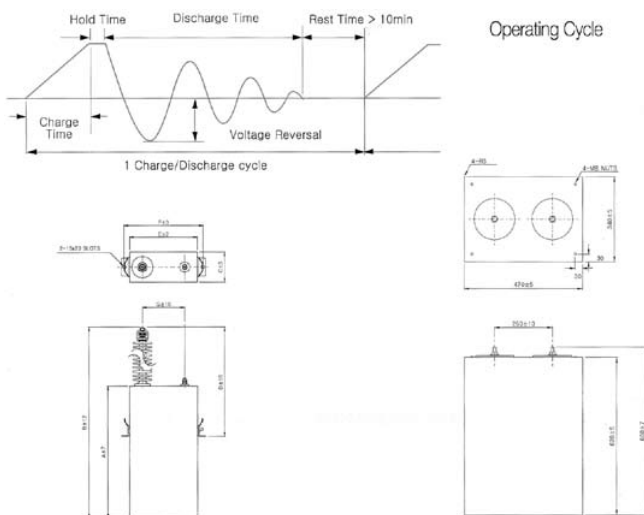

Figure 1   Figure 2

> PulsePower Low Capacitor

This product uses polypropylene film which has excellent withstand voltage and good quality capacitor paper as dielectric and contains refined impregnation oil, resulting in high reliability. To minimize inner inductance, it employs non inductive solder for reducing self inductance.

• Installation Place : Indoor
• Ambient Temperature : −10℃ ~ +40℃ [Average 35℃ or less per day]
• Technical Data

Tolerance	−10% ~ +10% [at 20℃]
Insulation Resistance	More than 1000MΩ between batch terminal and case [below20℃]
Withstand Voltage	Rated voltage×1.2times, for 60 seconds between terminal and case
Painting Color	Munsell no. 5Y 7/1
Self Inductance	Max. 150nH
Duty Cycle	Pause for more than 10 min. per charging / discharging
Voltage Reversal	20% ~ 90%

4-11 Pulse Power Capacitor

› Ratings and Dimensions

Rated Volage [kVDC]	Capacity [μF]	Joule [kJ]	Type	Dimension [mm]							Weight [kg]	Figure	Remarks
				A	B	C	D	E	F	F			
11	150	9.08	TFT-T11150S	810	995	160	315	370	424	228	70.7	1	Steel Case
40	0.01	0.01	TFT-T40001S	190	375	115	315	430	496	300	20.8		
	11	8.80	TFT-T40011S	560	745	170	530	530	583	300	71.8		
100	0.5	2.50	TFT-T100001S	390	660	135	530	530	583	380	42.6		
	1.0	5.00	TFT-T100001S	690	690	135	530	530	583	380	73.4		
25	0.3	0.09	TAE-25001S	–	–	–	–	–	–	–	6.7	2	Plastic Case
100	0.1	0.50	THE-100001S	–	–	–	–	–	–	–	7.5		

* Approximate Ratings and Dimensions are given above. Please contact factory before order.

› High Energy Density Pulse Power Capacitor

With metalized polypropylene film made through metalized technology and good quality capacitor paper as dielectric, this product realized high energy density, high reliability and long life span.
• Installation Place : Indoor
• Ambient Temperature for Use : −10℃ ~ +40℃ [below 35℃ average per day]
• Techinical Data

Tolerance	−10% ~ +10% [at 20℃]
Insulation Resistance	More than 1000MΩ between batch terminal and case [below 20℃]
Withstand Voltage	Rated voltage×1.2 times, for 60 seconds between terminal and case
Painting Color	Munsell no. 5Y 7/1
Self Inductance	Max. 150nH
Duty Cycle	Pause for more than 10 min. per charging / discharging
Voltage Reversal	20% ~ 90%

› Ratings and Dimension

Rated Volage [kVDC]	Capacity [μF]	Energy Density [kJ/kg]	Type	Dimension [mm]			Weight [kg]	Figure
				A	B	C		
20	200	0.33	SDF-T20200S	620	660	340	120	2

› Basic Information for Order

• Capacity and tolerance on capacitance
• Rated voltage and voltage reversal [%]
• Required life span and 1 time charging / discharging cycle
• Charging time and hold time
• Maximum current [kA] in discharging and discharge time