Power Factor Correction

Presented by Voon YS

MUN HEAN

ESTA Roederstein

↓

Vishay Intertechnology

VISHAY


ESTAmat PFC12
Blindleistungsregler
Power Factor Controller
Current
Target - cos φ
Switching Delay Time
Harmonic Current (%)
Roederstein
IN
OUT

Capacitor

Type

Dry Type → **PhMKPg / AcMKP**

Oil-filled → **PhMKP**

External

Connection Terminal

Discharge Resistor

Aluminium Casing

VISHAY

ESTA Spring

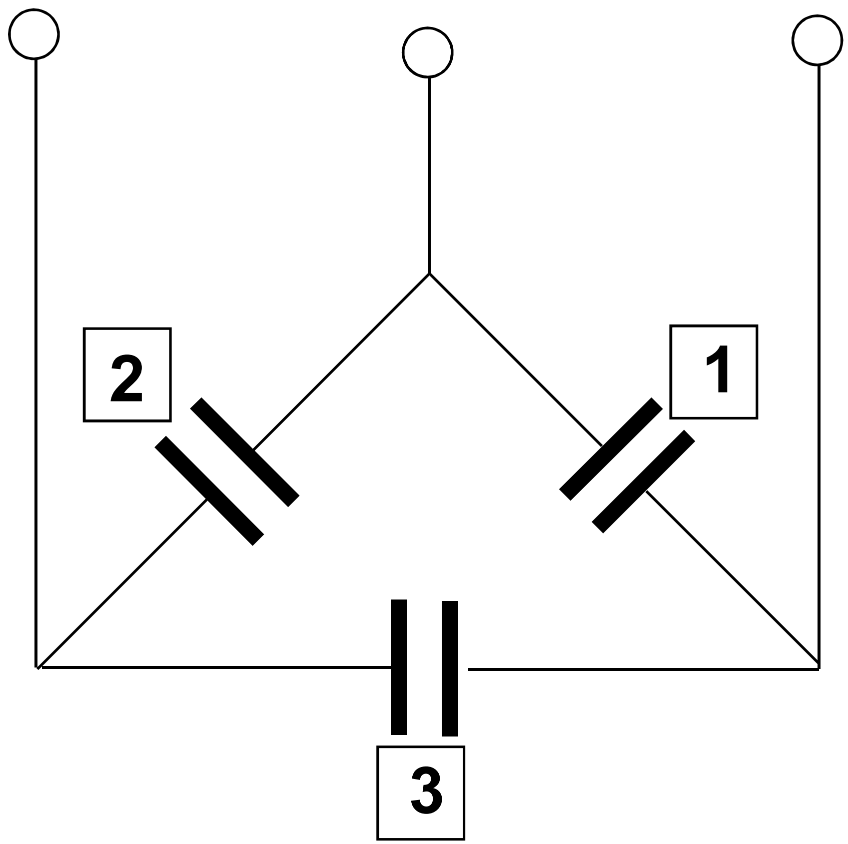
MUN HEAN

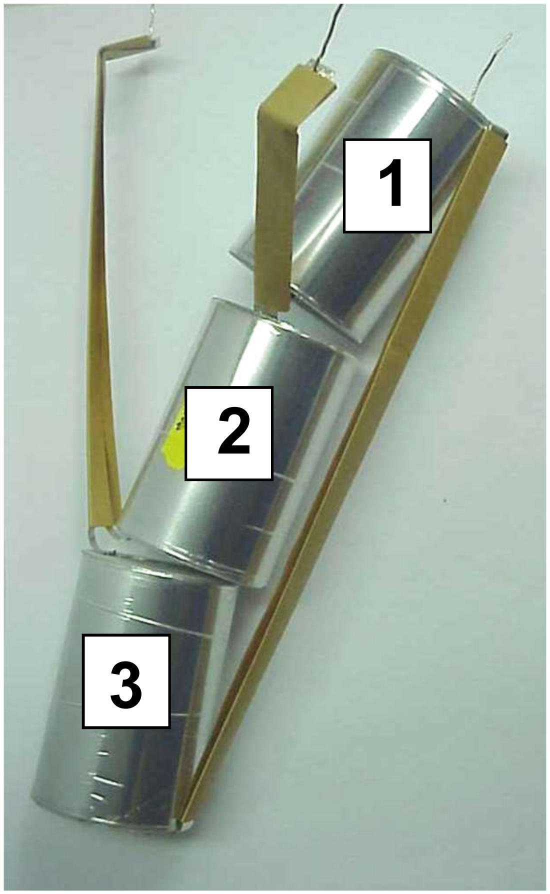
Spring Type Terminal

Additional Test on ESTA Spring

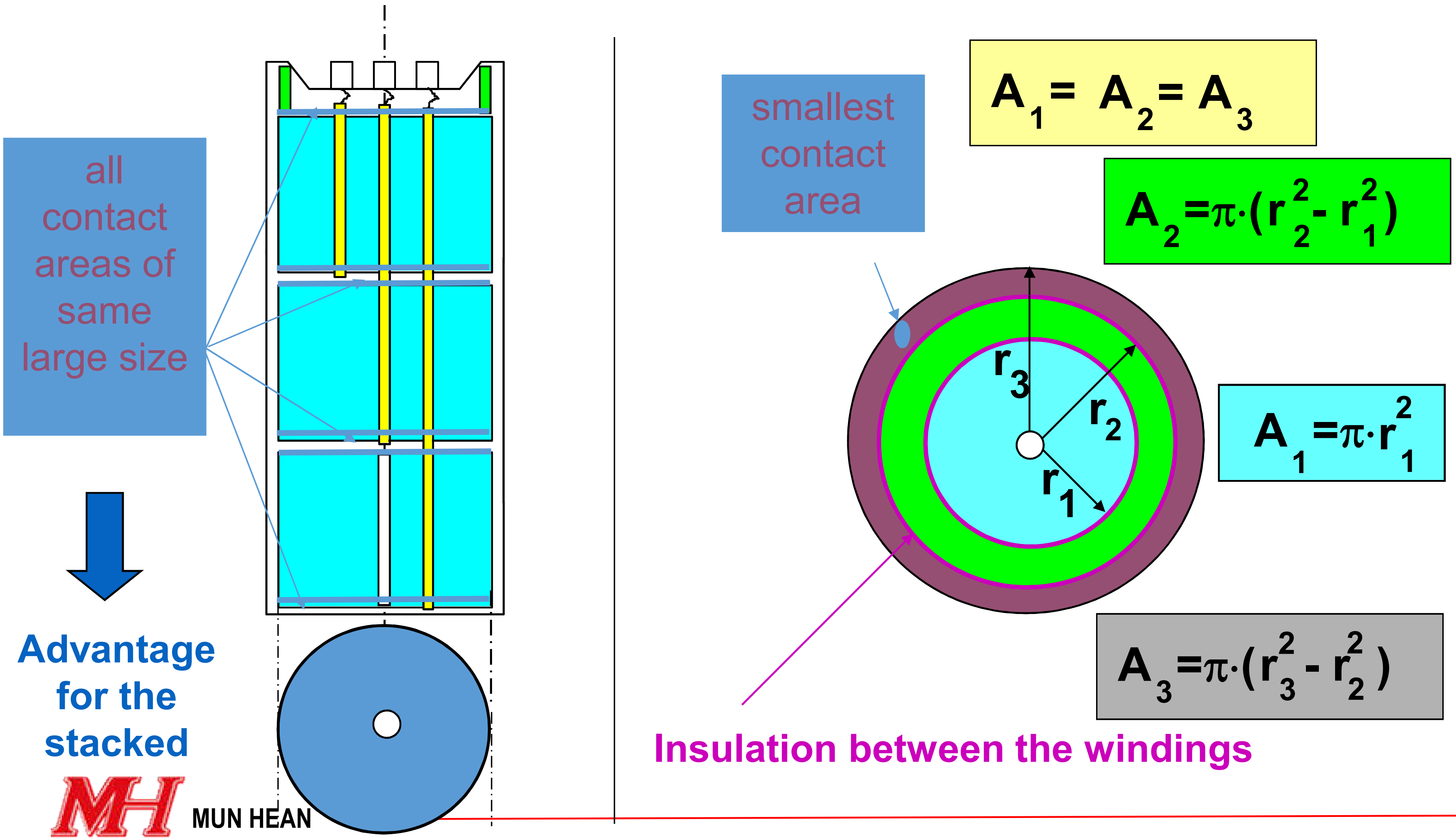
- Conductor pull-out test according to IEC 60998-2-1
- Current carrying capacity up to 90 A / phase according to IEC 60512-5-2
- Vibration test according to IEC 60068-2-6

Internal





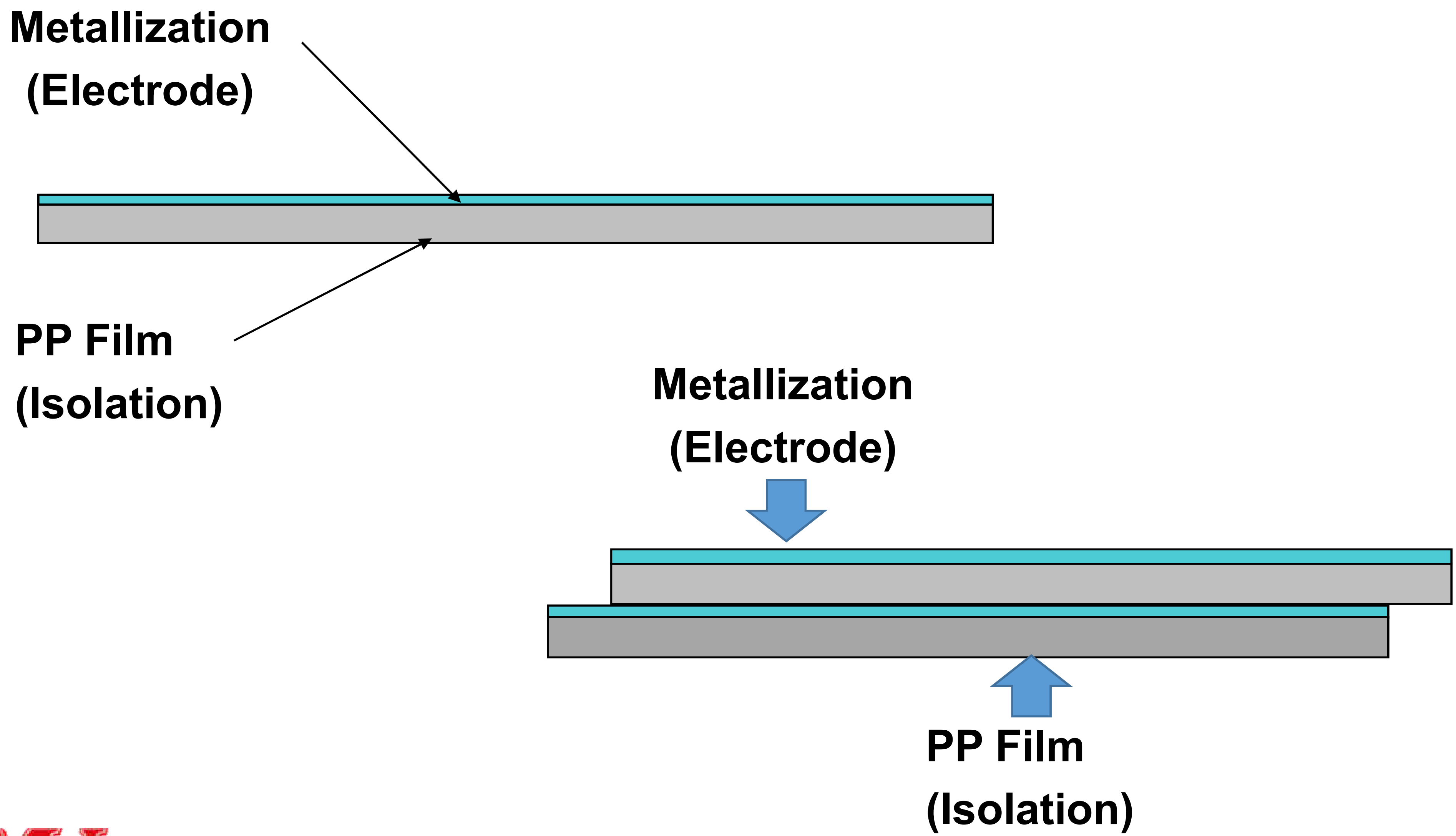
Comparison between the ESTA stacked assembly and “concentric” competitor design



MH VIHSYA ESTA
LV Tubular Can Type Capacitors

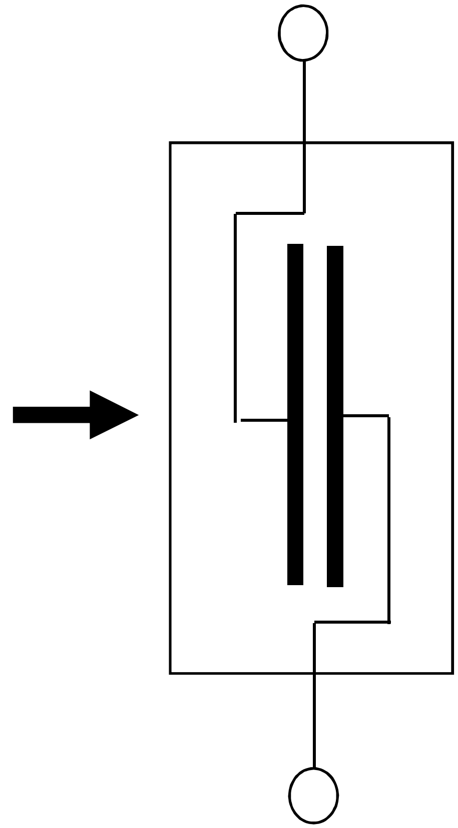
MKP-Technology

MKP: " Metallized Polypropylene Film "



Top View

Side View

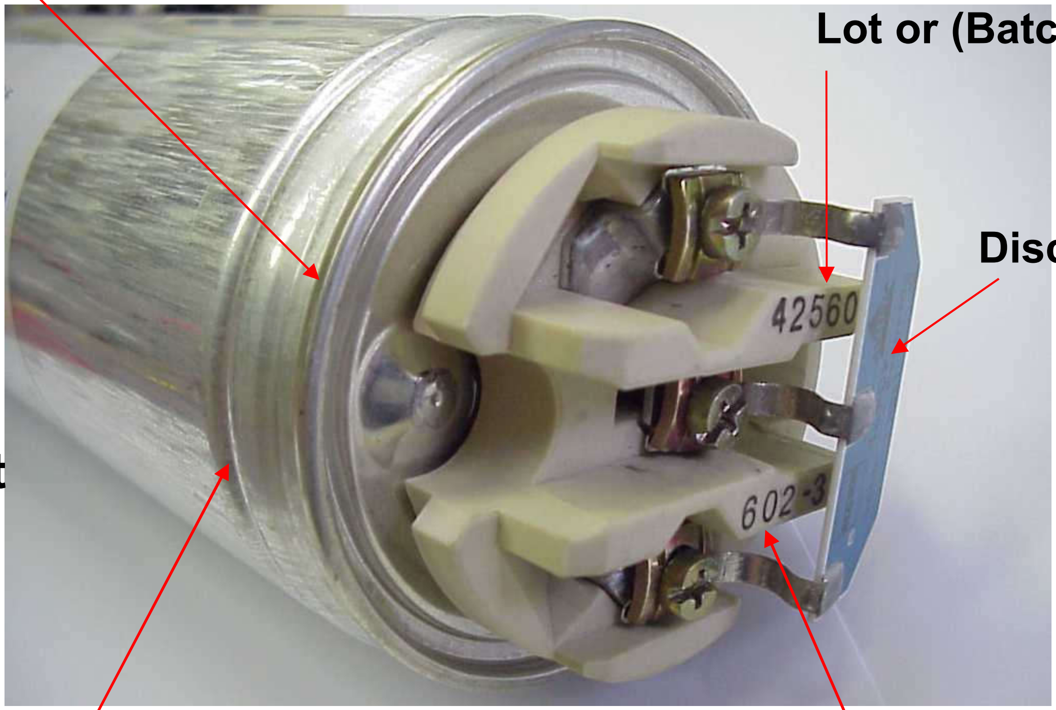


Jointed Flange Connection

ESTA's L.V. tubular can type capacitors are

burstproof,

as confirmed by independent international inspection centres such as UL and UL_c



Lot or (Batch) No.

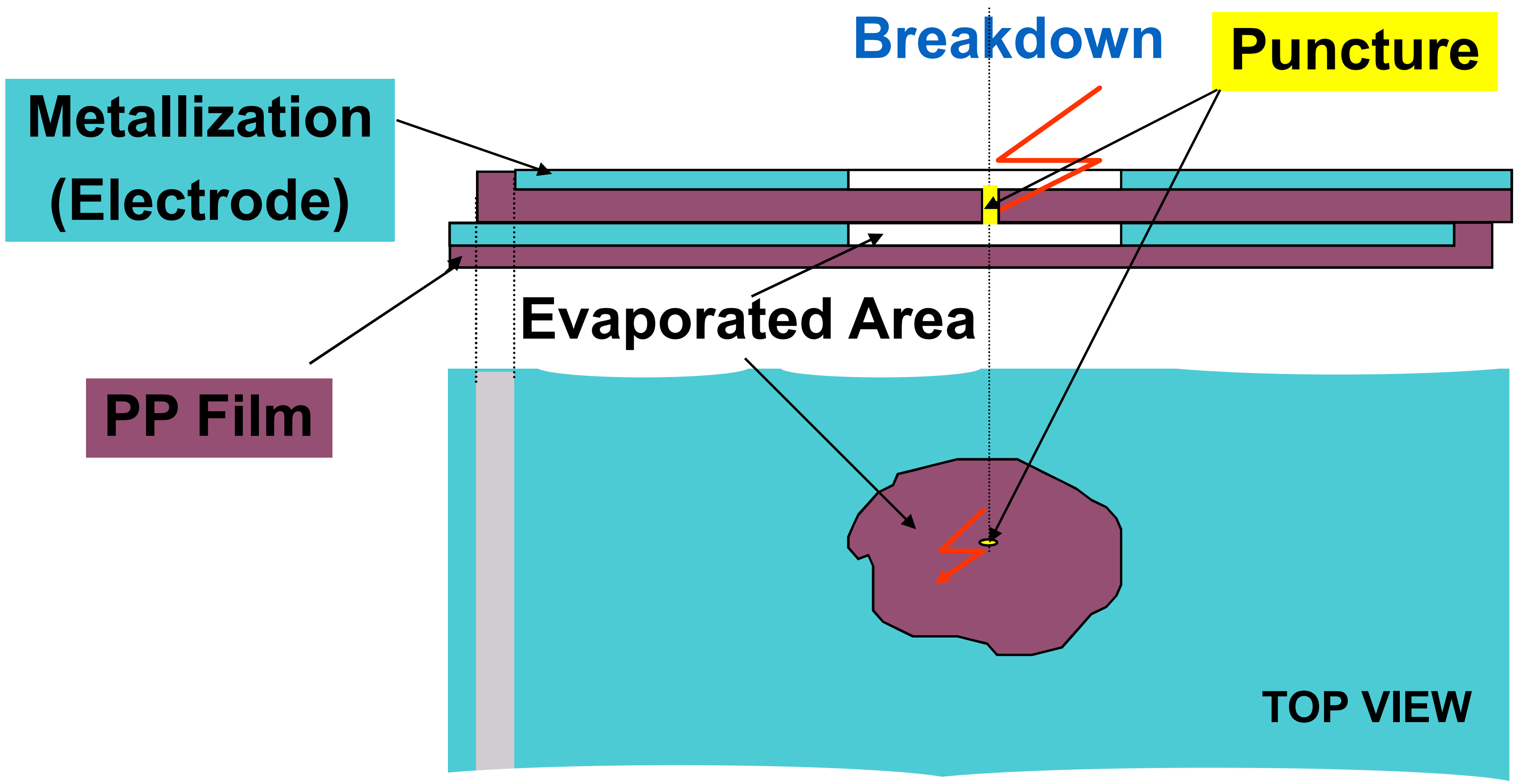
Discharge Resistor

Crimping or Expansion Gap

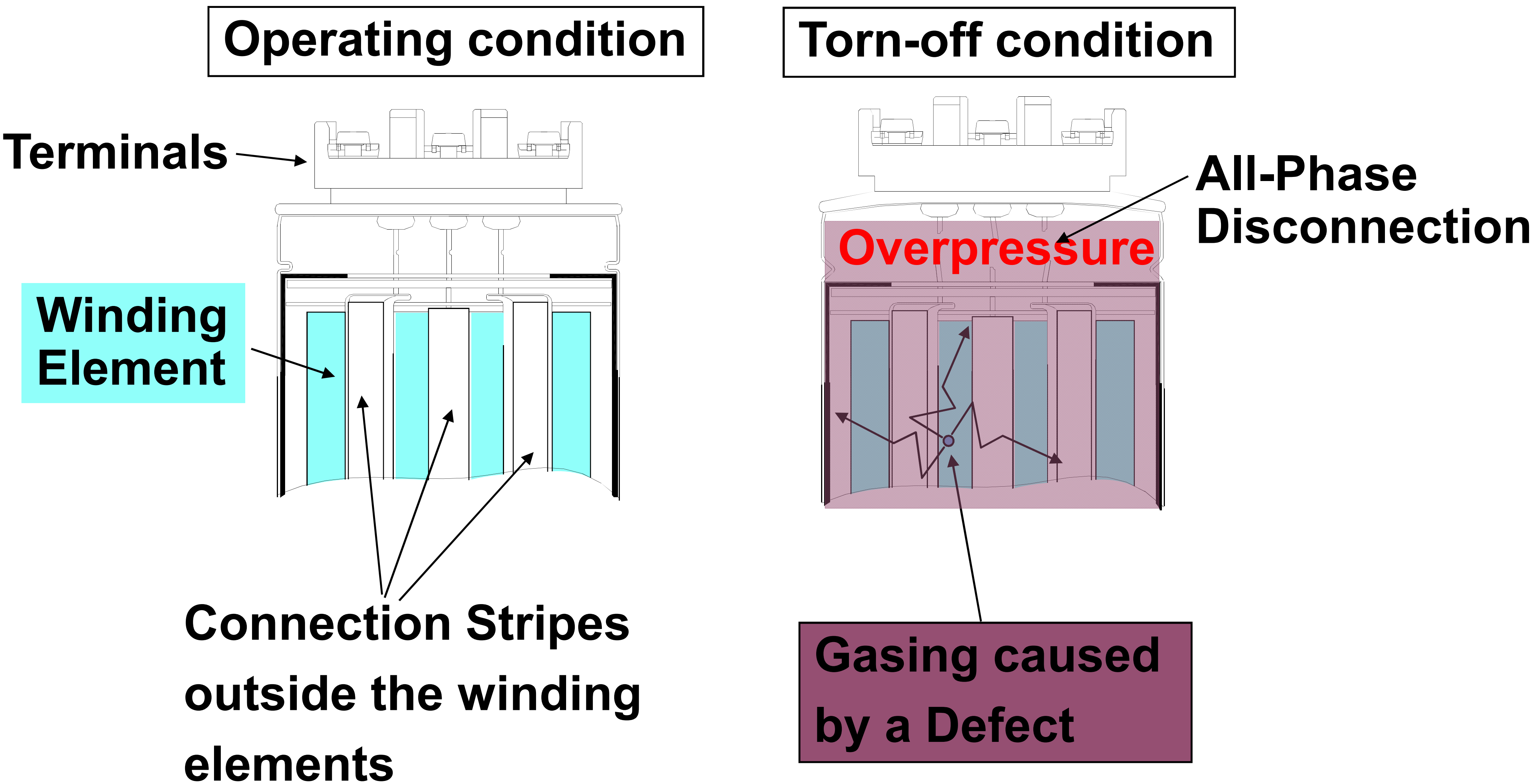
Type No., corresponding to the article No.

Features of MH VISHAY ESTA

Self Healing



Overpressure Tear-off Fuse System

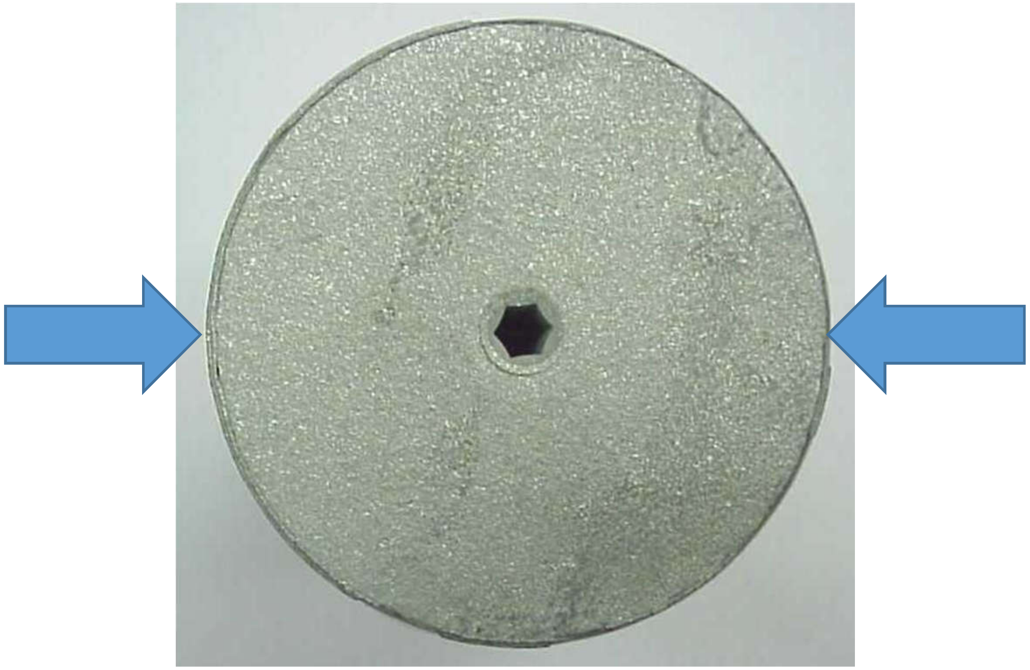


VISHAY

One piece burstproof turbular can design

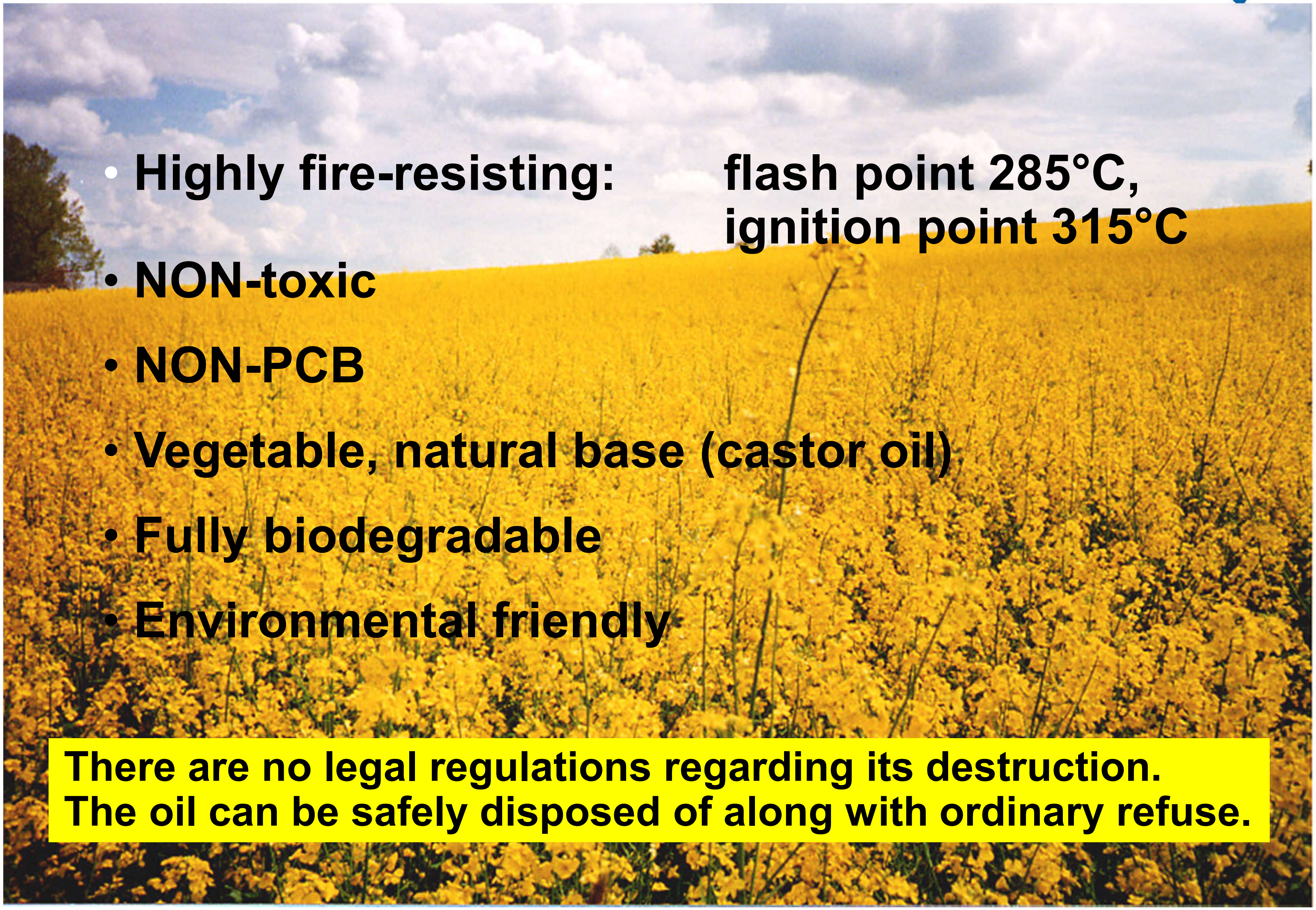
VISHAY

Highest temperature class D (max. value of ambient temperature = 55°C)



Small diameters
Excellent heat transfer

ESTAprop (oil type)

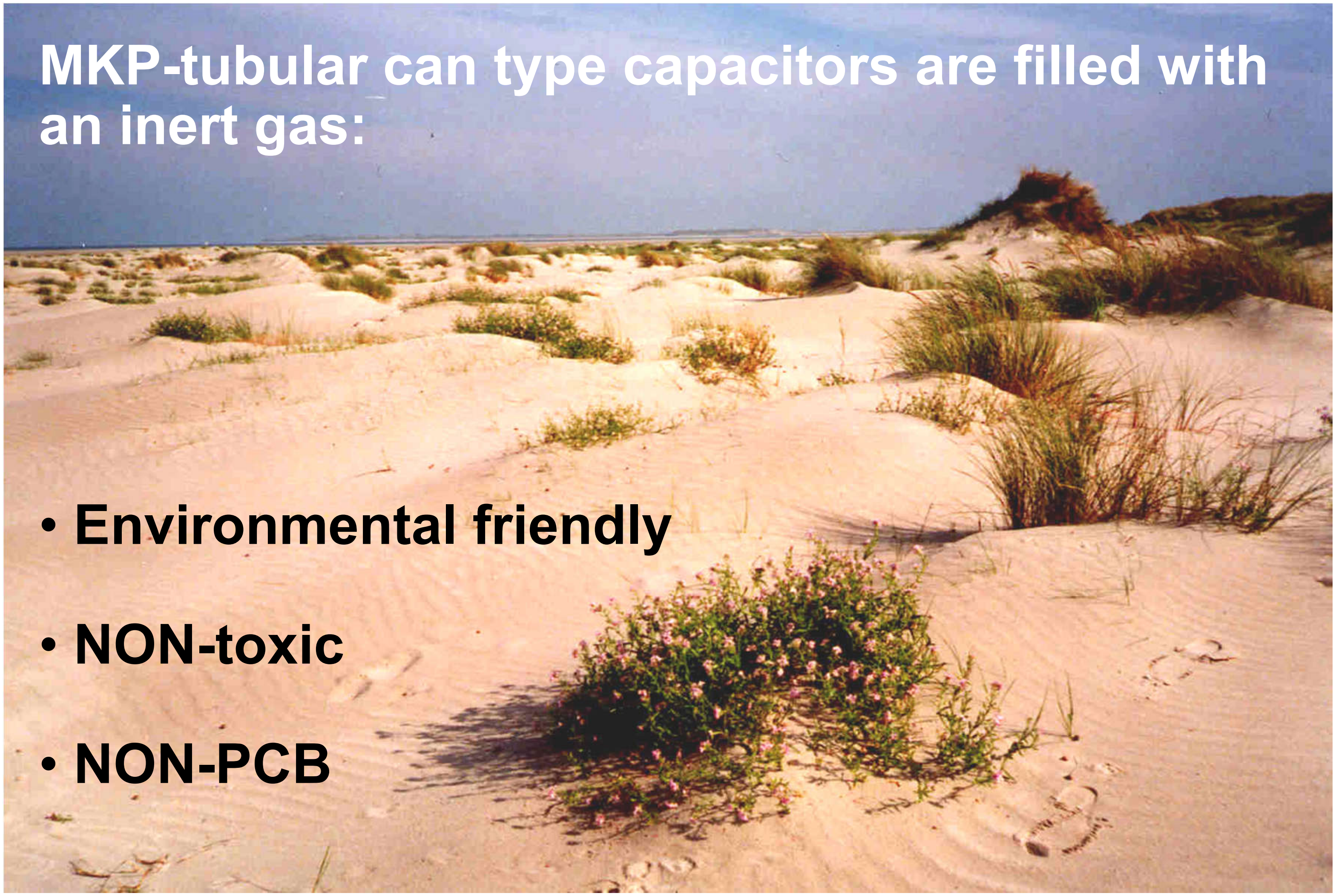


- Highly fire-resisting: flash point 285°C, ignition point 315°C
- NON-toxic
- NON-PCB
- Vegetable, natural base (castor oil)
- Fully biodegradable
- Environmental friendly

There are no legal regulations regarding its destruction. The oil can be safely disposed of along with ordinary refuse.

VISHAY

ESTAdry



Electronicon
EPCOS
FRACO
Shizuki
ELCO

……

Reactor

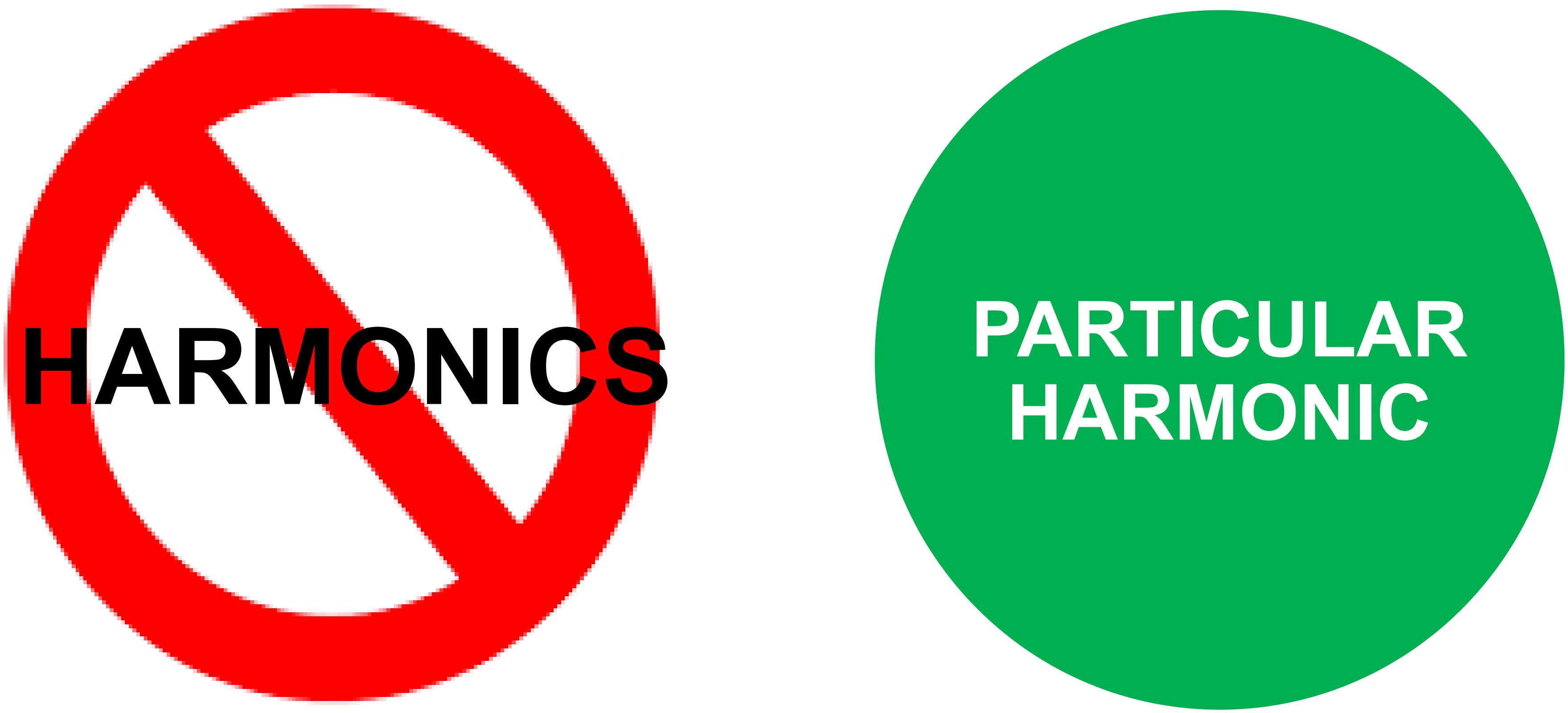
Type of Reactor

Tuned

Detuned

Tuned Reactor

VISHAY



Application: Passive Harmonic Filter

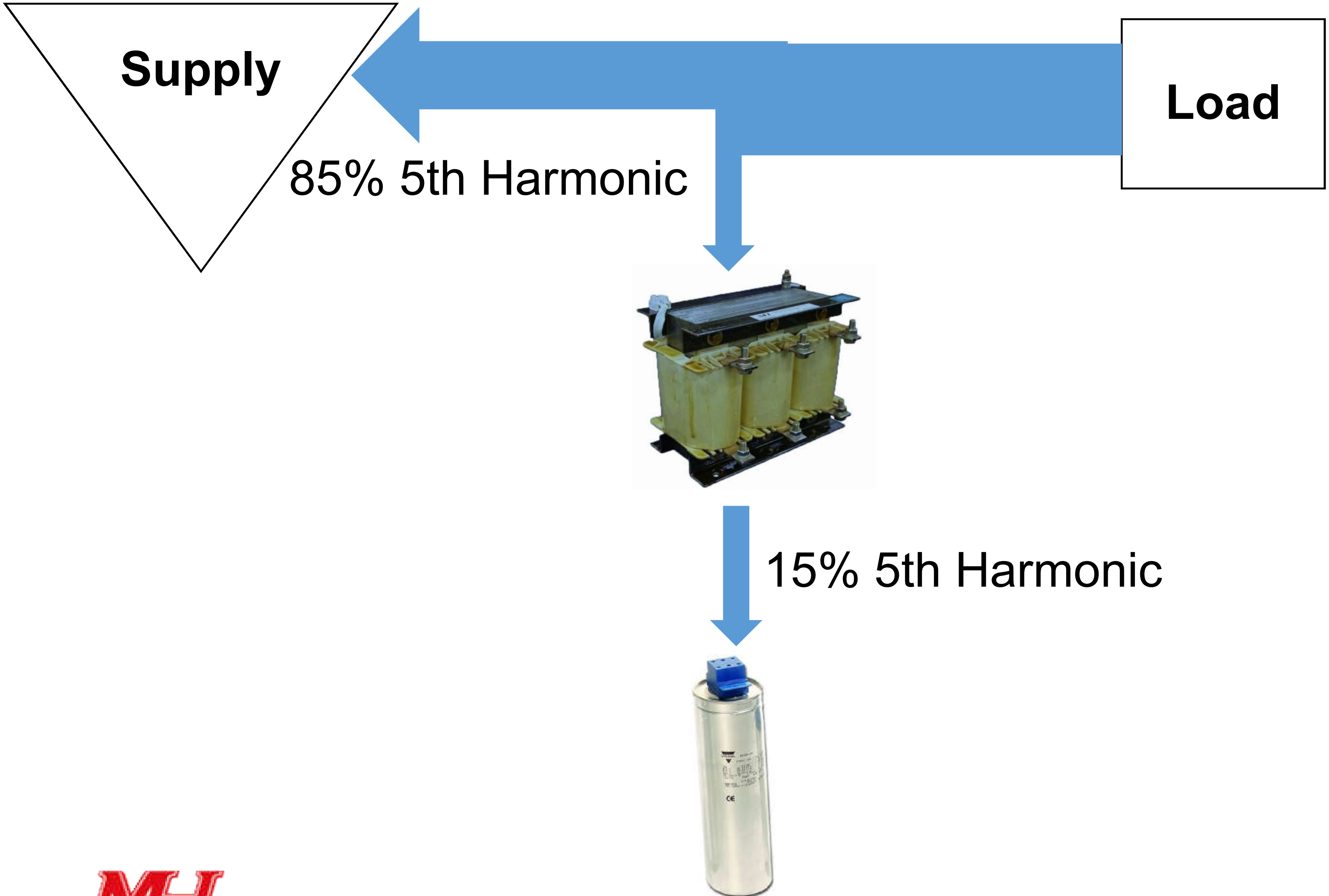
Detuned Reactor

HARMONICS

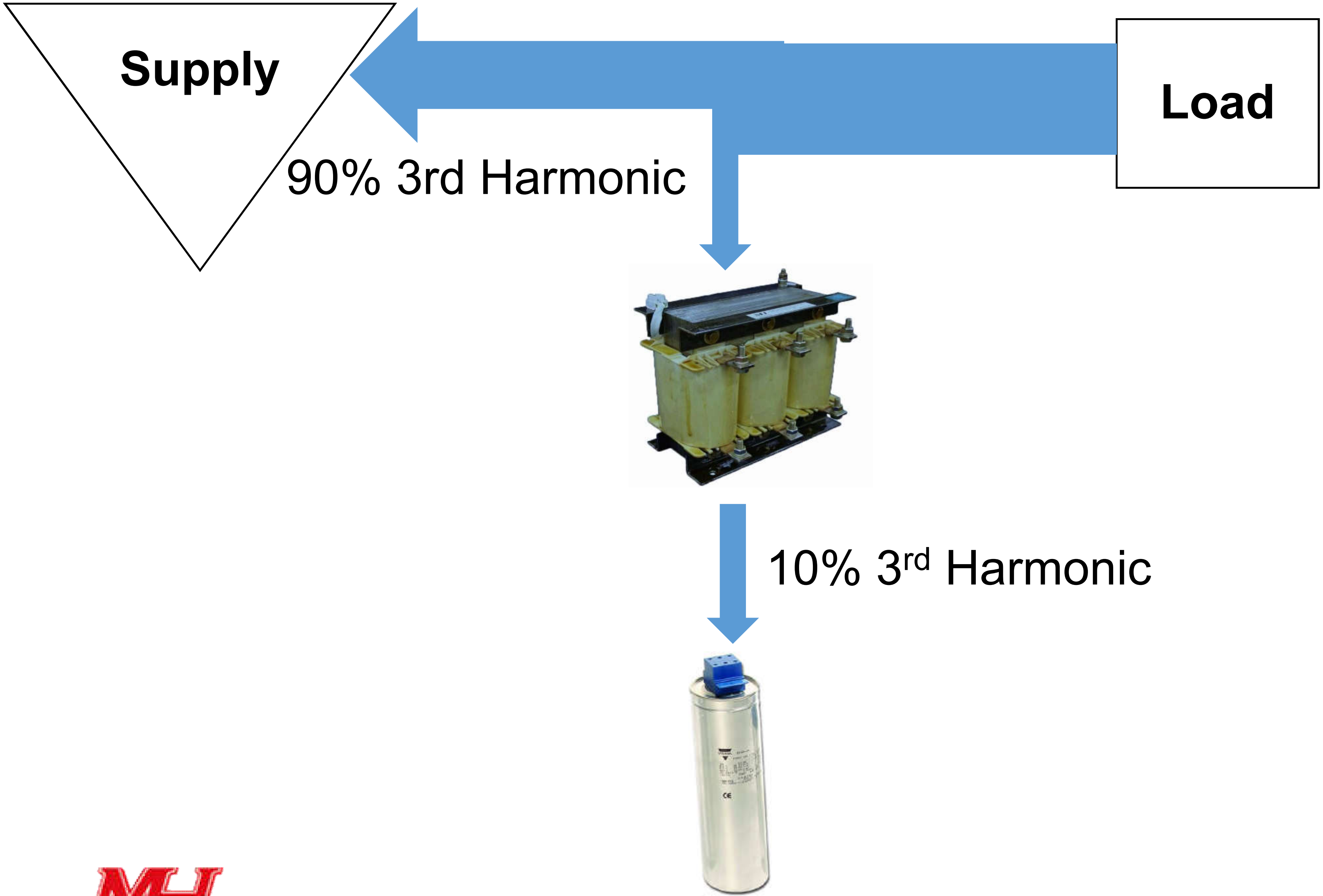
SOME OF
CERTAIN
HARMONIC

Application: Capacitor Bank

7% Detuned Reactor



14% Detuned Reactor



Detuned Reactor

$$f_{tuned} = \frac{50}{\sqrt{\%}}$$

3 phase load:
6% - 204Hz
7% - 189Hz

Single phase load:
13% - 139Hz
14% - 134Hz

Tuned Reactor

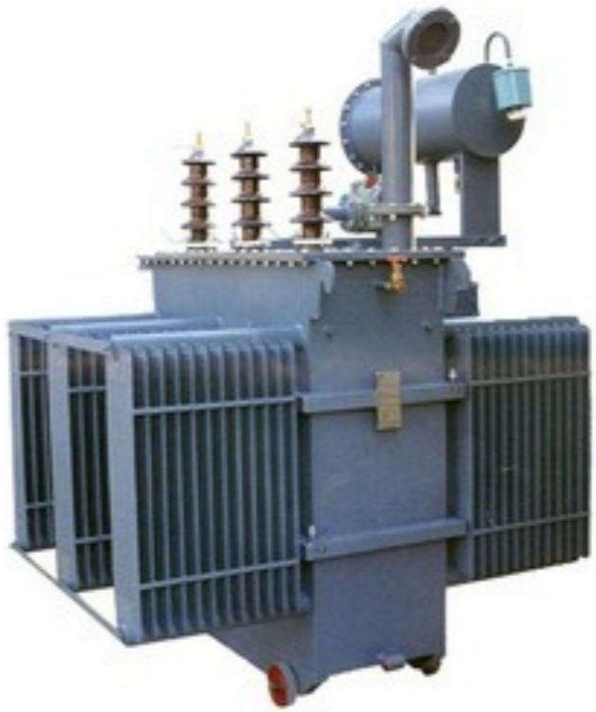
$$f_{tuned} = \frac{50}{\sqrt{\%}}$$

3rd Harmonic, 150Hz

5th Harmonic, 250Hz

7th Harmonic, 350Hz

Cap Bank Sizing



Or

Maximum Demand, MD

20% to 30% of TX size or MD

VISHAY

	TARGET POWER FACTOR									
	0.70	0.75	0.80	0.85	0.90	0.92	0.94	0.96	0.98	1.00
ACTUAL POWER FACTOR										
0.40	1.27	1.41	1.54	1.67	1.81	1.87	1.93	2.00	2.09	2.29
0.45	0.96	1.10	1.23	1.36	1.50	1.56	1.62	1.69	1.78	1.98
0.50	0.71	0.85	0.98	1.11	1.25	1.31	1.37	1.44	1.53	1.73
0.55	0.50	0.64	0.77	0.90	1.03	1.09	1.16	1.23	1.32	1.52
0.60	0.31	0.45	0.58	0.71	0.85	0.91	0.97	1.04	1.13	1.33
0.65	0.15	0.29	0.42	0.55	0.68	0.74	0.81	0.88	0.97	1.17
0.70	0.00	0.14	0.27	0.40	0.54	0.59	0.66	0.73	0.82	1.02
0.75		0.00	0.13	0.26	0.40	0.46	0.52	0.59	0.68	0.88
0.80			0.00	0.13	0.27	0.32	0.39	0.46	0.55	0.75
0.85				0.00	0.14	0.19	0.26	0.33	0.42	0.62
0.90					0.00	0.06	0.12	0.19	0.28	0.48

Example

1,000kVA

Diversity Factor,
DF = 0.8

Existing PF = 0.7

Target PF = 0.9

Q_C = 1,000 x 0.8 x 0.7 x 0.54 = 300kVar

Capacitor Selection

Without Reactor

440V

With Reactor

525V

Capacitor Selection

415V

ΔV

$$V_C = \Delta V + 415V$$

Detuned Reactor Selection

Majority
Single Phase
Load

13 or 14%

Majority
Three Phase
Load

6 or 7%

Cap Bank Sizing

Q_{Net} = Net Reactive Power

V_N = Nominal Voltage

% = % of Detuned Reactor

Capacitor Voltage, $V_C = \frac{V_N}{1-\%}$

Reactive Power at V_C, $Q_{V_C} = \frac{Q_{Net}}{1-\%}$

Rated Reactive Power, $Q_{Rated} = \left(\frac{V_{Rated}}{V_C}\right)^2 \times Q_{V_C}$

Current, $I_C = \frac{Q_{VC}}{\sqrt{3} \times V_C}$

Example

Q_{Net} = 50kVar V_N = 415V % = 7%

Capacitor Voltage, $V_C = \frac{415}{1-0.07} = 446V$

Reactive Power at V_C, $Q_{V_C} = \frac{50k}{1-0.07} = 53.76kVar\ @\ 446V$

Rated Reactive Power, $Q_{Rated} = \left(\frac{525}{446}\right)^2 \times 53.76k = 75kVar\ @\ 525V$

Current, $I_C = \frac{53.76k}{\sqrt{3}\times 446} = 70A$

Switching Sequence

1:1:1 – 50kVar, 50kVar, 50kVar, …, 50kVar

1:2:2 – 50kVar, 100kVar, 100kVar, … , 100kVar

1:2:4 – 25kVar, 50kVar, 100kVar, … , 100kVar

1:4:8 – 25kVar, 50kVar, 100kVar, 200kVar, … , 200kVar

1:1:2:2 – 50kVar, 50kVar, 100kVar, 100kVar … , 100kVar

1:1:2:4 – 50kVar, 50kVar, 100kVar, 200kVar … , 200kVar

1:1:4:8 – 25Var, 25kVar, 50kVar, 100kVar, 200kVar … , 200kVar

1:1:2.:4 – 25Var, 25kVar, 50kVar, 50kVar, 100kVar … , 100kVar

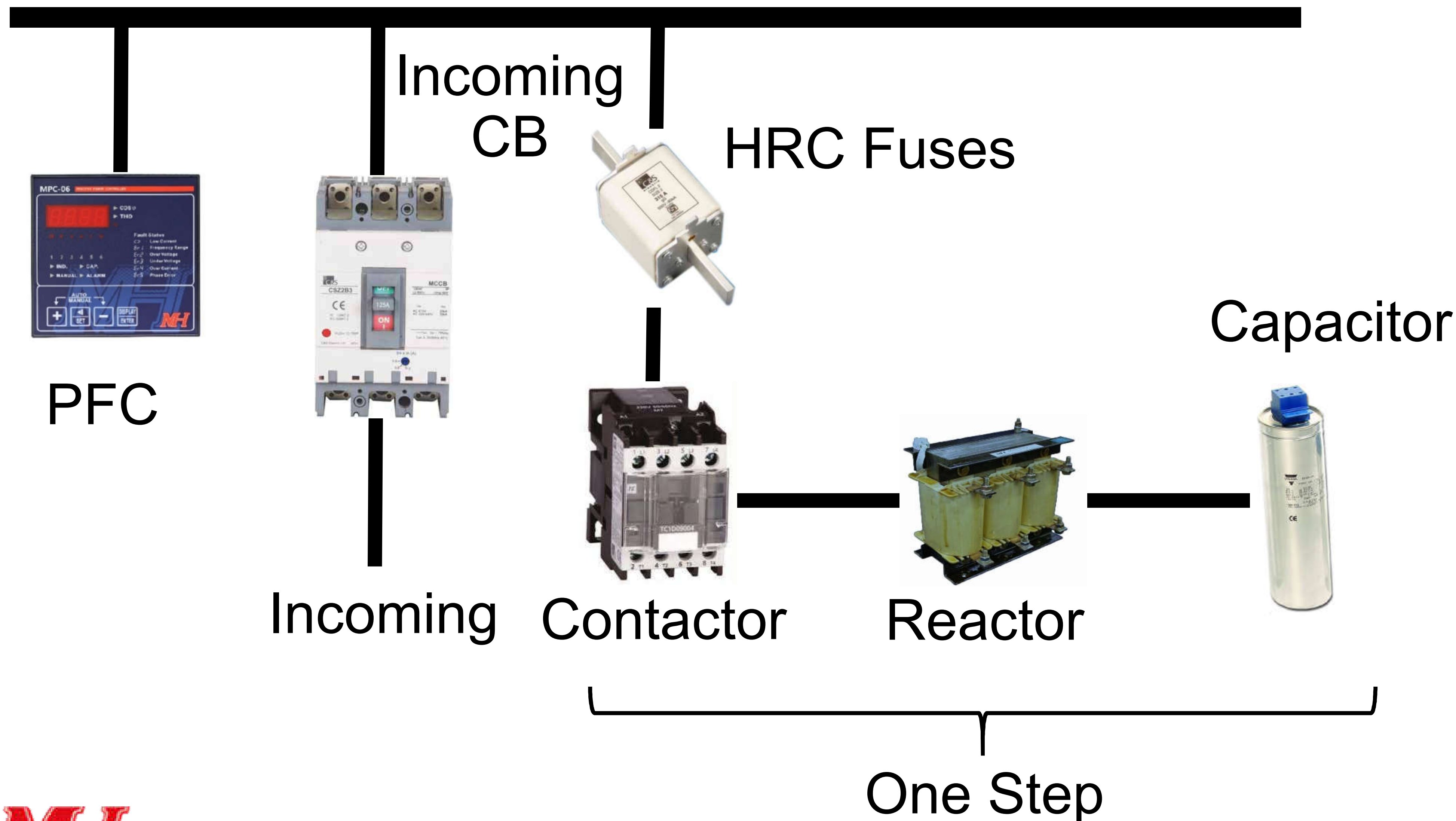
Fuses, Contactors, & Cable Selection

Fuse ≥ 1.5 x I_C

Contactor ≥ 1.3~1.35 x I_C

Cable ≥ 1.35 x I_C

Typical Cap Bank SLD



MUN HEAN

Power Factor Correction

Presented by Voon YS

MUN HEAN