



For Nuclear power plant

Susol
Super Solution

For Nuclear power plant
Vacuum Circuit Breakers

LSI

Susol

Super Solution

Vacuum Circuit Breaker **Nuclear Power Plants**

It was developed for KEPCO nuclear power stations. This breaker satisfies quality, safety measures (secure from earthquake and other environments), and surge protection class complies with “1E-CLASS” provisions. It is featured with high breaking technologies, safety, and reliability by applying our own vacuum interrupters (50KA) approved by ANSI standard tests.

VCB Full Option

To prevent fatal error, property and life loss caused from operator during operation, it is equipped with safety mechanisms such as shutter padlock.

Bushing applied for Window CT adaptation

The bushing provides sufficient strength to collaborate with the internal insulation and is adaptable with CT offering safety mechanically and electrically when applying large current.

Satisfies earthquake and other internal environment specifications

During the lifespan of power stations (40yrs), it is designed to operate its fundamental breaking functions even under the most severe conditions like earthquake, which is critical from safety perspectives. These technologies proven through tests that comply with KEPIC standard and relevant specifications are to guarantee nuclear reactor safety.



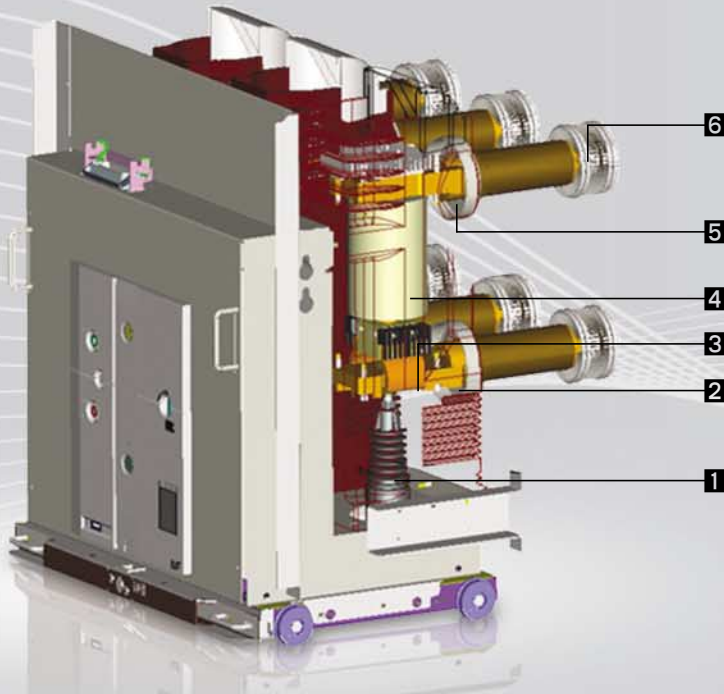
Contents

• External structure	8
• Basic functions and interrupting operation	9
• Types and ordering information	12
• Ratings	14
• Accessories	15
• Control circuit diagrams	22
• Dimensions	23
• Technical data	28



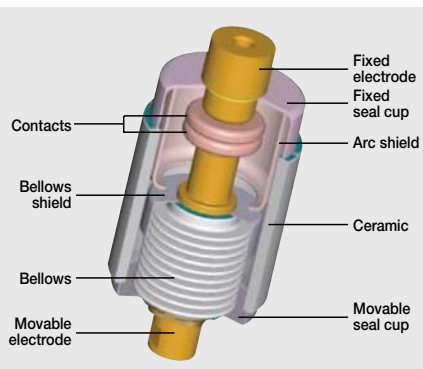
Main circuit structure with high reliability

Susol VCB



Breaker

- 1** Insulation rod
- 2** Lower terminal
- 3** Shunt
- 4** Vacuum interrupter
- 5** Upper terminal
- 6** Tulip contactor



Vacuum Interrupter, VI

The vacuum rate within the VI is very high (approximately 5×10^{-5} Torr) and the spacing between fixed contact and movable contact is about 6~20mm, depending on the voltage.

The contacts are in a structure that arc can easily be extinguished and the surfaces of

the contacts are made of special alloy (copper-chromium) and the interior is completely sealed to prevent loss of vacuum.

Therefore the wearing of the contacts can be minimized in the event of short-circuit and the arc energy by overvoltage or switching can be reduced effectively.

Convenience and Variety

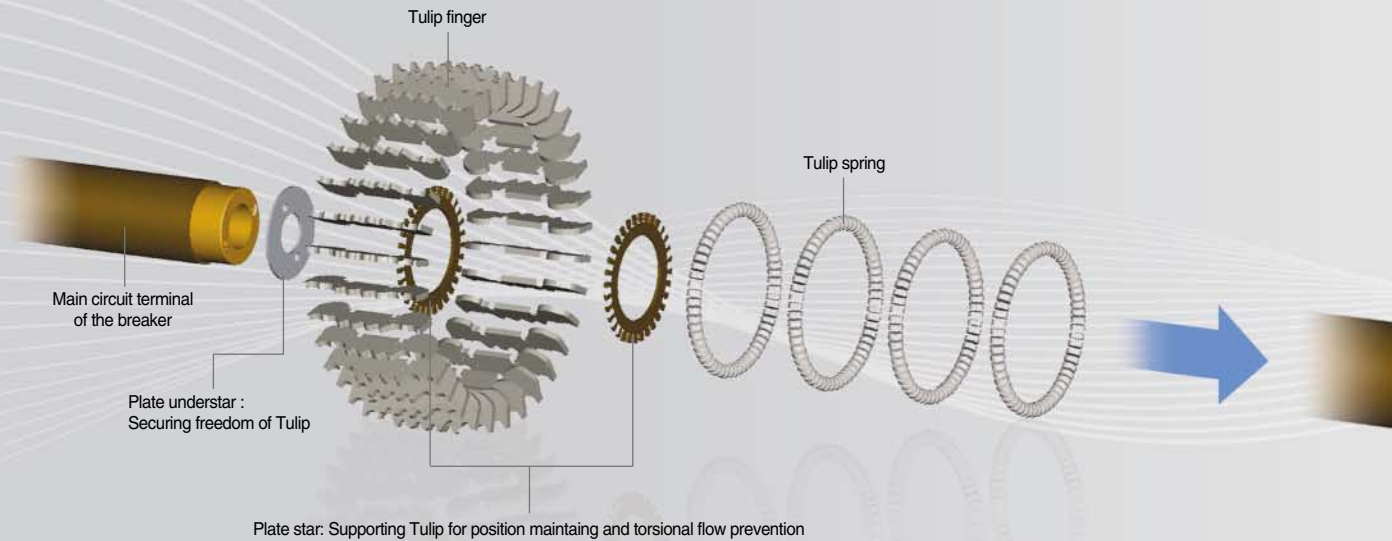
- Maximizing the durability and reliability of the main circuit contactors (Stego Tulip contactor)
- Strong structure for the temperature rise (Natural cooling system)



Stego Tulip

Main circuit structure with high reliability

- Maximizing the durability and reliability of the main circuit contactors (Stego Tulip contactor)
- Strong structure for the temperature rise (Natural cooling system)



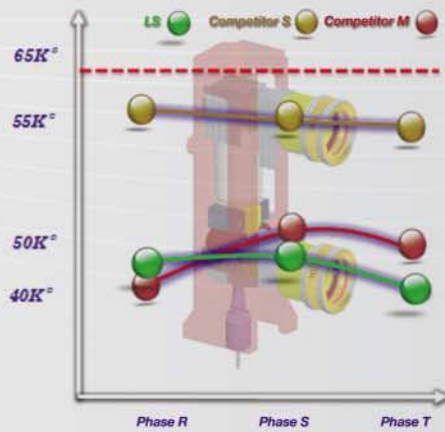
Structure of Stego Tulip Terminal

- Maintaining the connection between breaker and cradle for the optimum current path through securing freedom of Tulip.
- Increasing the heat dissipation area of the contactors and minimizing aging.



4.76/15kV

- Drawout / natural cooling system
- Improved temperature characteristics and ensured high reliability



4.76/15kV 50kA 1200/2000A
Tulip contactor



4.76/15kV 50kA 3000A
Tulip contactor

Susol

Breaker ... VH type



Name of each part

- ① Push ON Button
- ② Push OFF Button
- ③ Charge/Discharge Indicator
- ④ ON/OFF Indicator
- ⑤ Manual Charging Handle
- ⑥ Operation Counter
- ⑦ DISCONNECTED/TEST/
CONNECTED Position Indicator

Back side



Basic functions

Manual operation

① Manual Charge

- a) VL type: operate the charge handle 7-8 times as a fully stroke.
- b) VH type: Insert the charge handle into the handle slot first. Rotate the handle clockwise 40 times more and then charge will be complete with a click sound.
- When the closing spring is charged fully "CHARGED" is displayed at the charge indicator.

② Manual closing

- a) Pressing the ON button the breaker is closed.
- b) With the closing of the breaker "ON" is displayed at Close/Trip indicator and "DISCHARGED" at the charge indicator.

③ Manual trip

- a) Pressing the OFF button the breaker is opened.
- b) "OFF" is displayed at Close/Trip indicator.

Electric operation

① Electric charge

The breaker is remotely closing with charging of closing spring.
If the breaker trips the closing spring is automatically charged by gear motors.

② Electric closing

Remote closing is operated by the closing coil.

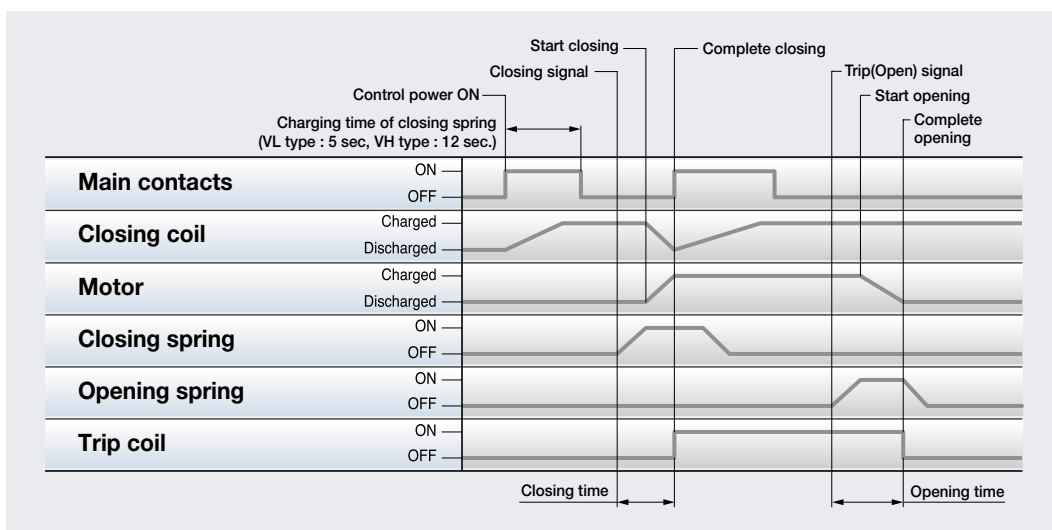
③ Electric trip

Remote trip can be operated by the trip coil.

Main contacts are operated by the energy of the spring mechanism and closing spring is charged by the motor in the mechanism.

Breaker is closed by closing coil and tripped by trip coil.

These operations are repeated in VCB as shown in the below sequence chart.



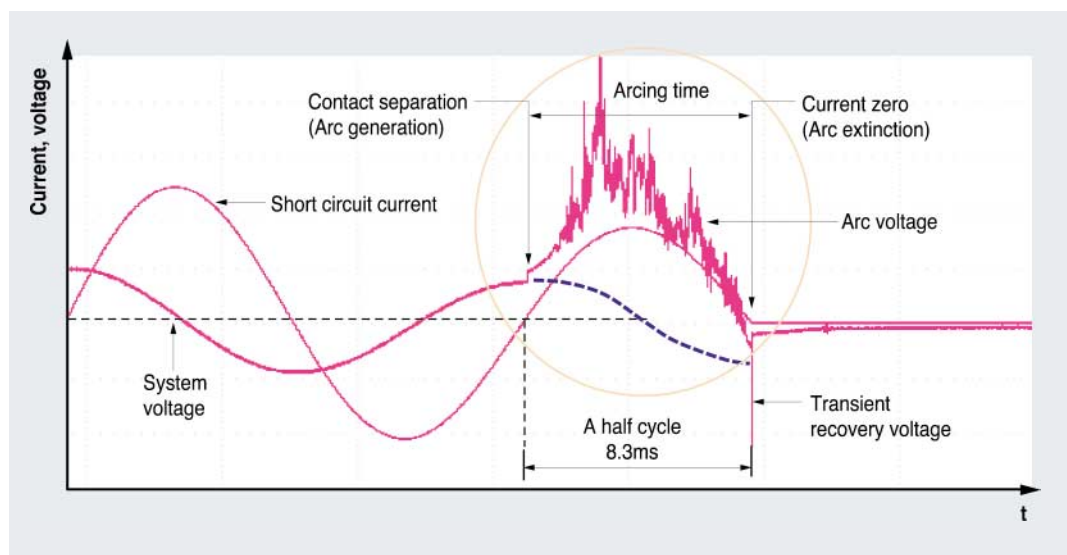
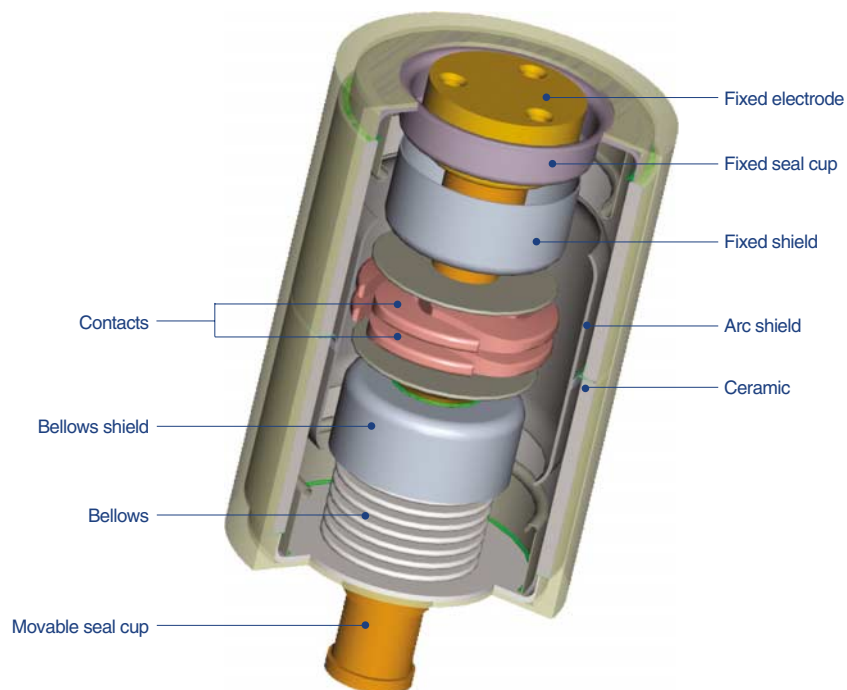
Sequence of the switching mechanism

The interruption of vacuum interrupters

The interruption of VCB is carried out by the vacuum interrupters.

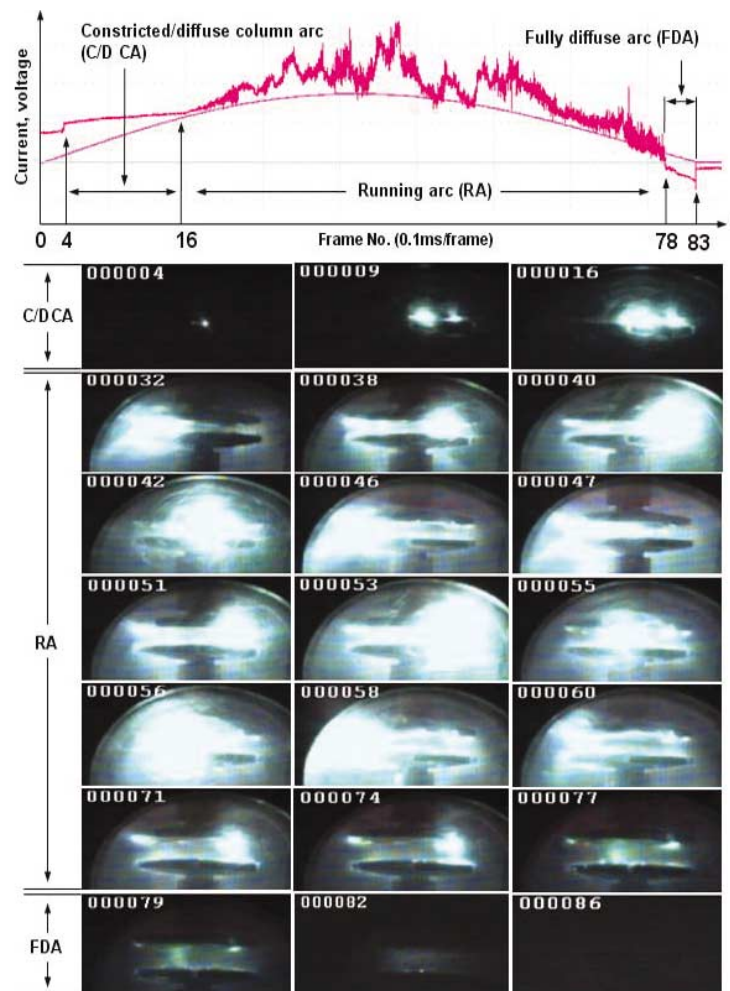
Interrupter contacts as a key part made of copper - chromium (CuCr) material with spiral shape have low contact wear characteristics and withstand voltage is excellent.

Spiral contacts make the arc generated between the surfaces of contacts rotated around the surface of contact by the induced magnetic field generated due to the spiral contact structure, which results in preventing local heating, thereby corrosion and interrupting instantaneously.



An example of oscillogram obtained through the interrupting test using LC resonant circuit

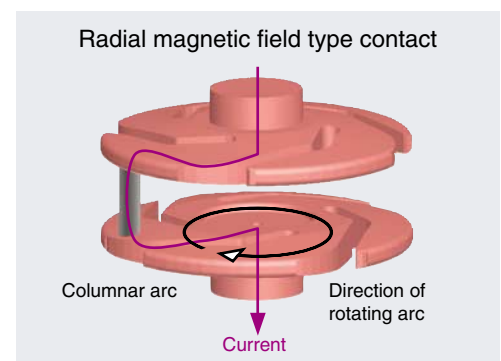
The interruption of vacuum interrupters



Arc voltage waveforms and arc image captured during arcing time

In case of using the flat contact any of the designs do not reflect on when contacts are opening the arc with high temperature is contracted and fixed in the center of the contacts, Which is called pinch effect. To prevent the effect two kinds of contact shapes are designed. One is Axial magnetic field which spreads the arc before its contraction, and the other is Radial magnetic field which permits the contraction of the arc but makes it rotated to disperse the energy. Because contracted arc is shaped like a cylinder it is called Contracted arc or columnar arc.

Spiral contact structure (Radial magnetic field), using the force ($F = j \times B$) generated by the interaction of the radial magnetic field caused by the current flowing through the arc between two contacts, disperse the arc energy evenly on the surface of contact by rotating the arc that is contracted by the pinch effect so as to minimize contact damage. The images show arc behavior during the arcing time of about 8ms by shooting with high-speed camera capable of shooting 10,000 frames per sec. (0.1ms/frame) by focusing on parts of the arcing time on the above graph and simultaneously measured arc voltage also represented to show arc state by section.



Arc driving principle in the contacts of Radial magnetic field

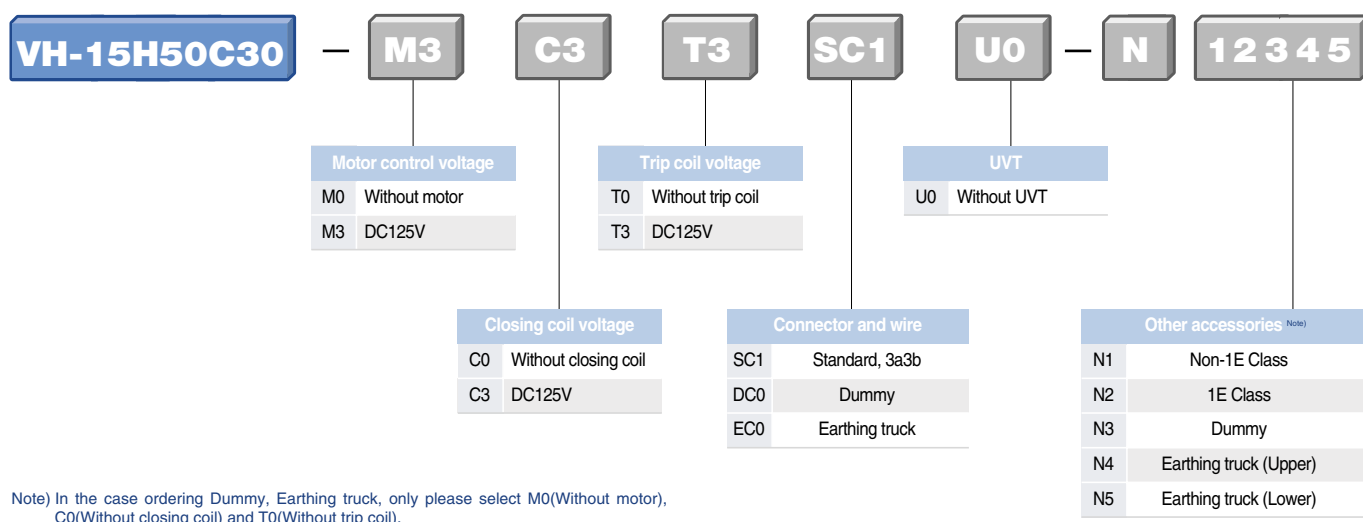
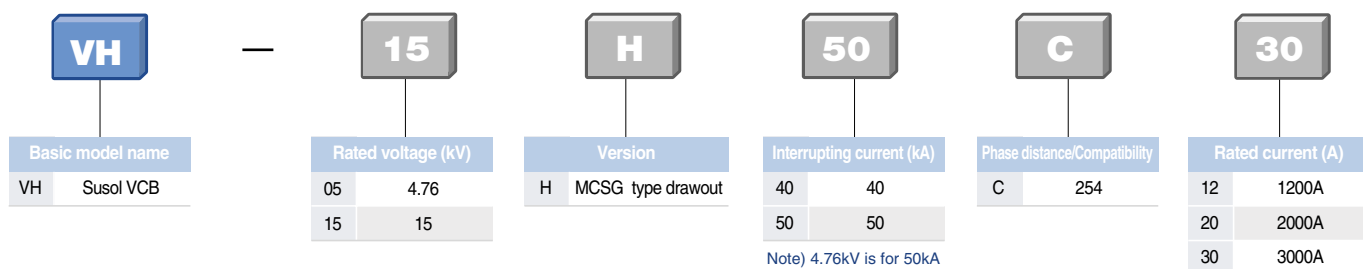
Types and ordering information

For Nuclear power plant

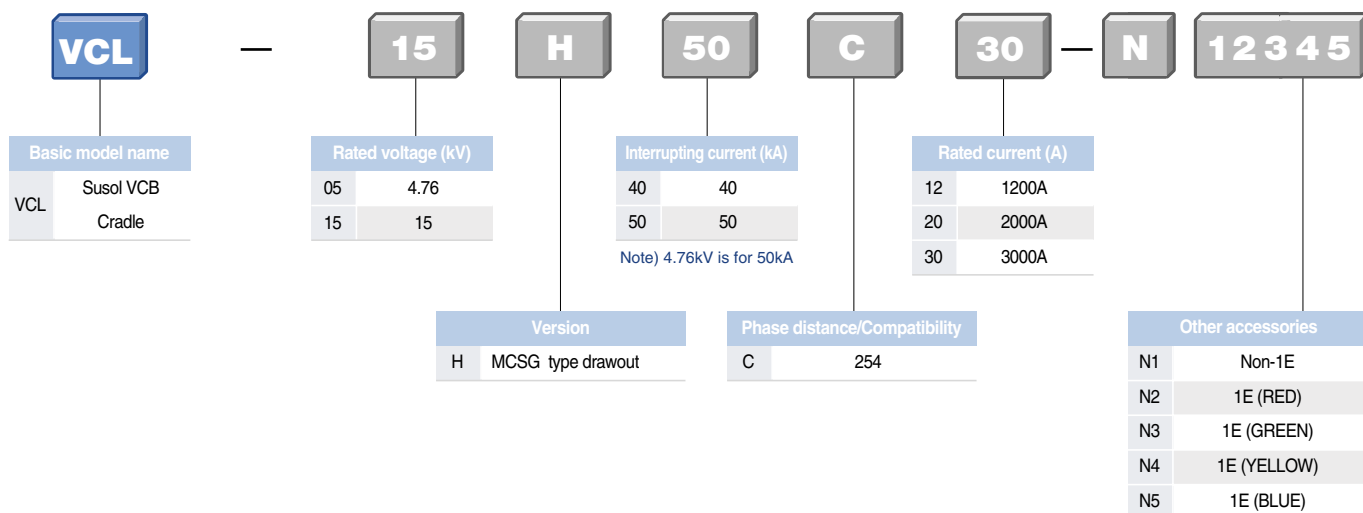
Susol

VH-05/15

Breaker



Cradle



Susol

VH-05/15

Maximum Voltage [V]	Short-circuit current [kA]	Continuous current p=254	VCB		CRADLE		Connector type
			Type	Version	Type	Version	
4.76	50	1200	VH-05H50C12	H	VCL-05H50C12	H	Auto connection
		2000	VH-05H50C20	H	VCL-05H50C20	H	Auto connection
		3000	VH-05H50C30	H	VCL-05H50C30	H	Auto connection
15	40	1200	VH-15H40C12	H	VCL-15H40C12	H	Auto connection
		2000	VH-15H40C20	H	VCL-15H40C20	H	Auto connection
		3000	VH-15H40C30	H	VCL-15H40C30	H	Auto connection
	50	1200	VH-15H50C12	H	VCL-15H50C12	H	Auto connection
		2000	VH-15H50C20	H	VCL-15H50C20	H	Auto connection
		3000	VH-15H50C30	H	VCL-15H50C30	H	Auto connection

Note) 1. P=Phase distance

Ratings

- 4.76/15kV 40/50kA 1250/2000/3150A

For Nuclear power plant

Susol

VH-05/15



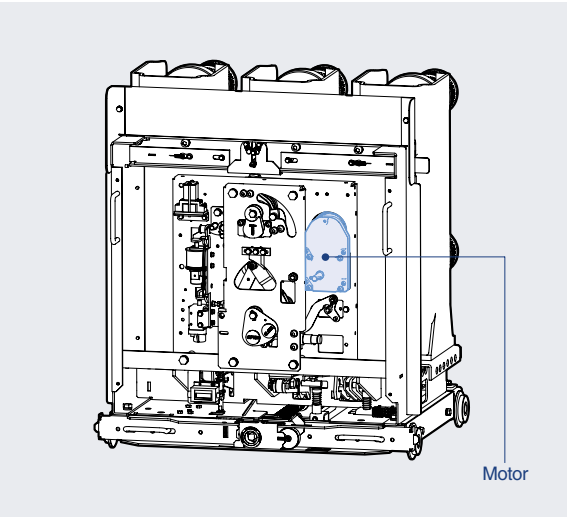
Item			VH-05H50C12/20/30			VH-15H40,50C12/20/30		
Rated voltage		Ur (kV)	4.76			15		
Rated normal current		Ir (A)	1250	2000	3150	1250	2000	3150
Rated frequency		fr (Hz)	50/60					
Rated short-circuit current		Isc (kA)	50			40, 50		
Rated short-time withstand current		Ik/tk (kA/s)	50/2			40/2, 50/2		
Rated short-circuit breaking capacity		(MVA)	412			1039, 1299		
Rated short-circuit making current		Ip (kA)	2.5 * Isc (50Hz)/2.6 * Isc (60Hz)					
Rated breaking time		(Cycle)	3					
Rated withstand voltage	Power frequency (1 min)	Ud (kV)	19			36		
	Impulse (1.2×50μs)	Up (kV)	60			95		
Rated operating sequence			O-0.3s-CO-3min-CO					
Control voltage	Closing coil	(V)	DC 125V					
	Trip coil	(V)	DC 125V					
Auxiliary contacts *			3a3b					
Rated opening time		(sec)	≤ 0.04					
No-load closing time		(sec)	≤ 0.06					
Lifetime	Mechanical		10,000					
	Electrical		See graph, Page 27					
Installation version	Drawout		H type (for MESG)					
Phase distance		(mm)	254					
Weight	Breaker (MESG, MCSG)	(kg)	230	230	265	230	230	265
	Cradle (MESG, MCSG)	(kg)	248	248	286	248	248	286
Dimensions	Breaker (MESG, MCSG)		Page 22					
	Cradle (MESG, MCSG)		Page 23					
Standards			ANSI/IEEE Std. C37.09, , KEPIC EED 1100					

* Two(2) "Early b" auxiliary contact is provided.

Motor: M

Installed inside of a breaker as standard

VH type



- Charge the closing spring of a circuit breaker by the external power source. When the charging is complete, control power of the motor will be "OFF" by the built-in Limit S/W. Without the external power source, charge manually.

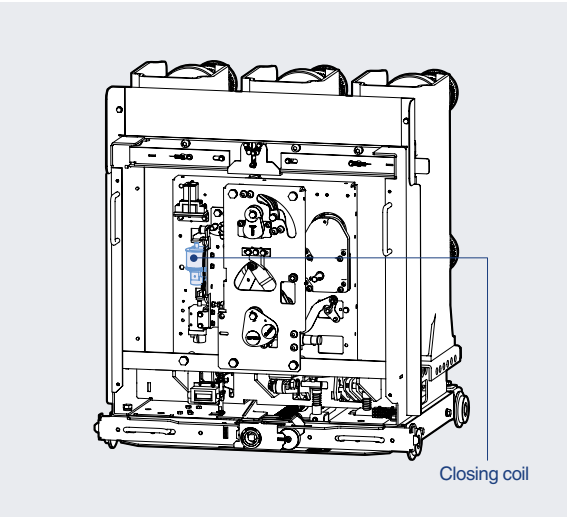
Input voltage(Vn)	DC 125V
Load current(A)	3
Starting current(A)	20
Charge time	Less than 12sec

Note) Rated operation and control voltage range, see page 15.

Closing Coil: C

Installed inside of a breaker as standard

VH type



- It is a control device which closes a circuit breaker, when applying voltage continuously about 45ms to the coil control terminals. Electrical pumping preventing circuit is built in.

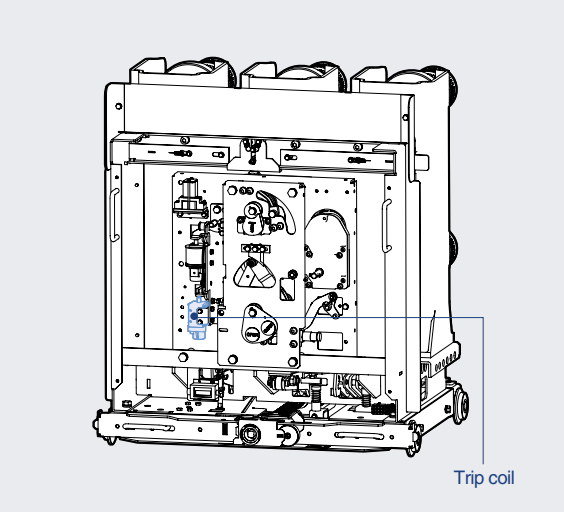
Input voltage(Vn)	DC 125V
Rated current(A)	3

Note) Rated operation and control voltage range, see page 15.

Trip Coil: T

Installed inside of a breaker as standard

VH type



- It is a control device which trips a circuit breaker, when applying voltage continuously or instantaneously over 35ms to the coil control terminals.

Input voltage(Vn)	DC 125V
Rated current(A)	3

Note) Rated operation and control voltage range, see page 15.

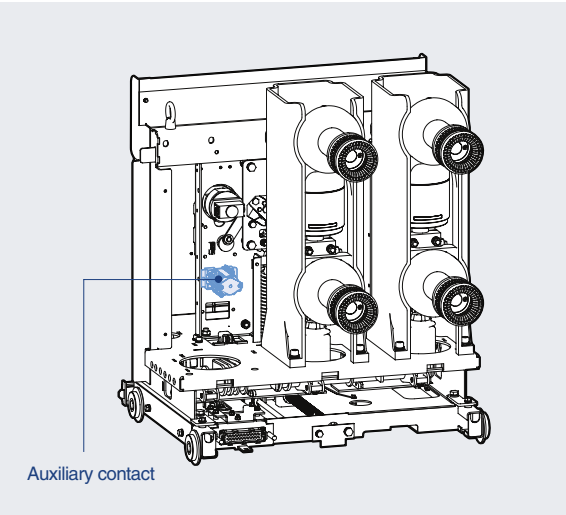
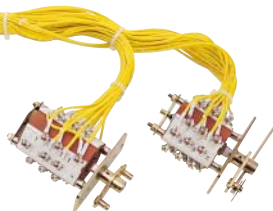
Rated operation and control voltage range

Item		Voltage range	Remarks
Motor	DC 125V	100~140V	90~140V (KEPCO technical specification)
Closing		100~140V	
Trip		70~140V	
Applied standards		ANSI/IEEE Std. C37.09 KEPIC EED 1100	

Auxiliary Contact: SC1

Installed inside of a breaker as an option

VH type



- It is a contact used to monitor ON/OFF status of a breaker from remote place.
- The auxiliary contacts supplied as standard configuration is 3a3b.
- Two(2) “Early b” auxiliary contact is provided.(Terminal No. 56-57, 58-59)

Item		Resistive load(A)	Inductive load(A)
Contact configuration	DC 125V	10	5

Counter

Installed inside of a breaker as standard

VH type

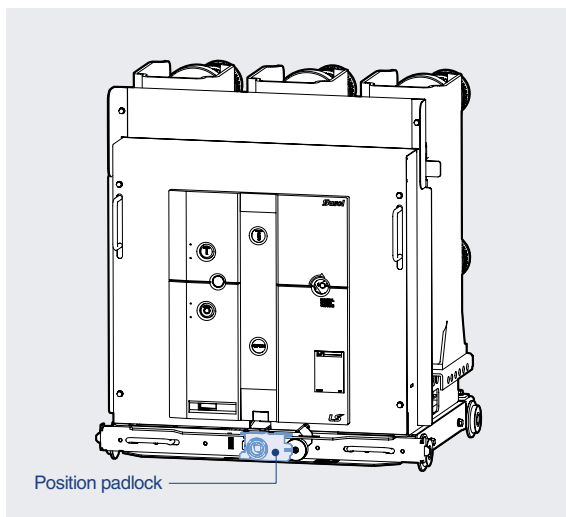


- It displays the total number of ON/OFF operations of a breaker.

Position padlock

Installed inside of a breaker as an option

VH type

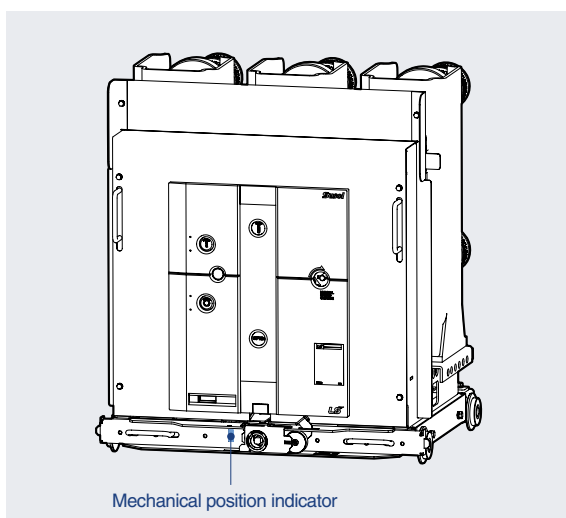
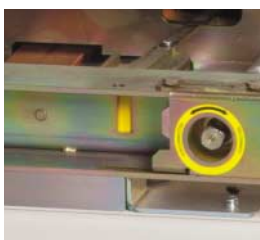


- It is located at the screw hole to prevent the draw-in and out of a breaker from the present position(Disconnected, Test or Connected)

Mechanical position indicator

Installed inside of a breaker as an option

VH type

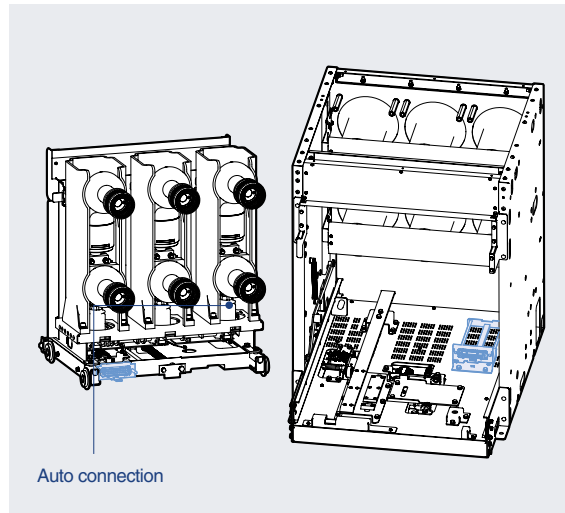


- It is located in the lower part of a breaker to check the present position - Disconnected, Test or Connected- easily.

Auto connection

Installed inside of a breaker as an option

VH type

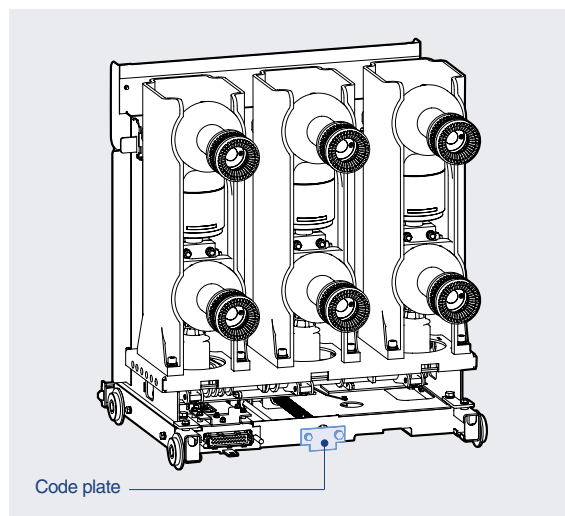


- When the breaker is moved to 'Test' position from 'Disconnected' position the connector for control powers is automatically connected. In case of reverse moving of the breaker the connector is automatically disconnected.

Code plate

Installed inside of a breaker as an option

VH type

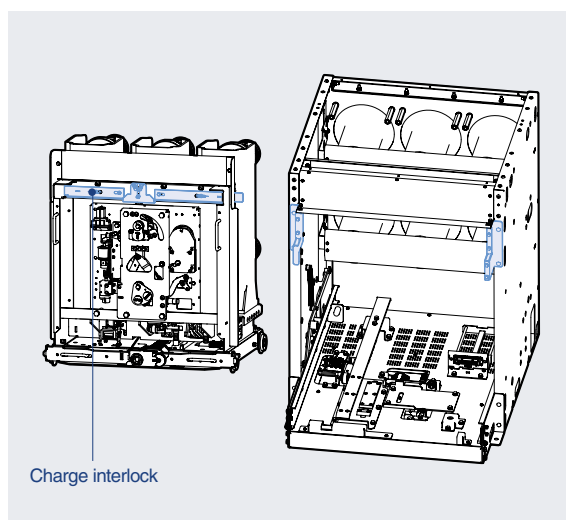


- When the breaker is inserted to the cradle, if the ratings does not match with the cradle, it mechanically prevents the breaker from being inserted into the cradle.

Charge interlock

Installed inside of a breaker as an option

VH type

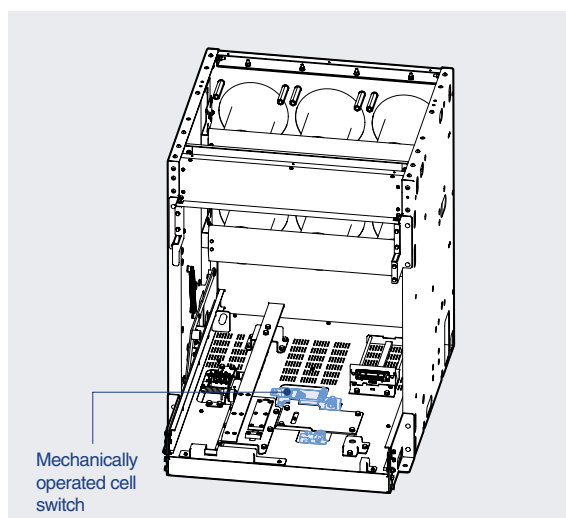


- In case the breaker is drawn-out when the closing spring is charged in the 'Disconnected' position, it prevents the complete withdrawal of the circuit breaker from the housing.

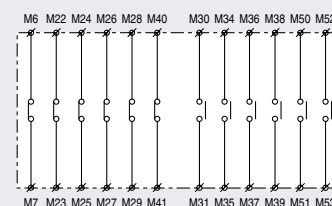
Mechanically operated cell switch (MOC)

Installed inside of a breaker as an option

VH type



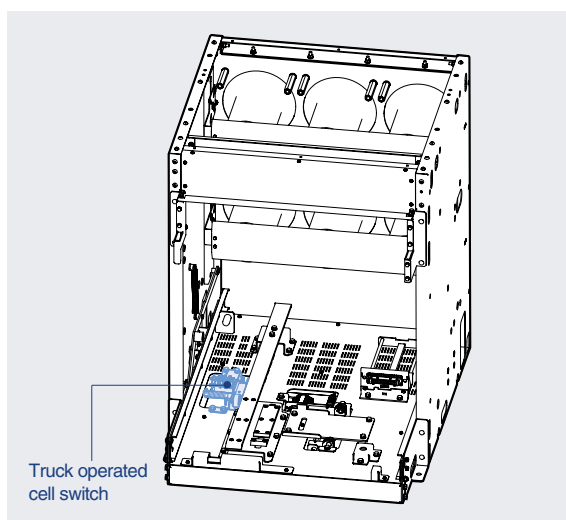
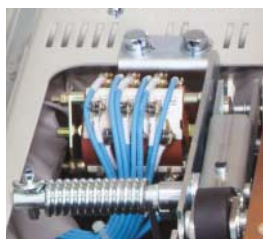
- This 6a6b switch indicates the 'ON' or 'OFF' condition of a VCB and is operated in the positions of 'Connected' and 'Test'. Below circuit diagram is based on 'OFF' status of VCB.



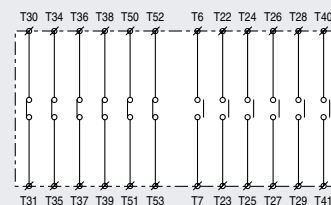
Truck operated cell switch (TOC)

Installed inside of a breaker as an option

VH type



- This 6a6b switch indicates the 'Connected' state of a VCB and is operated by the movement of a VCB frame.
Below circuit diagram is based on 'Test' status of VCB.

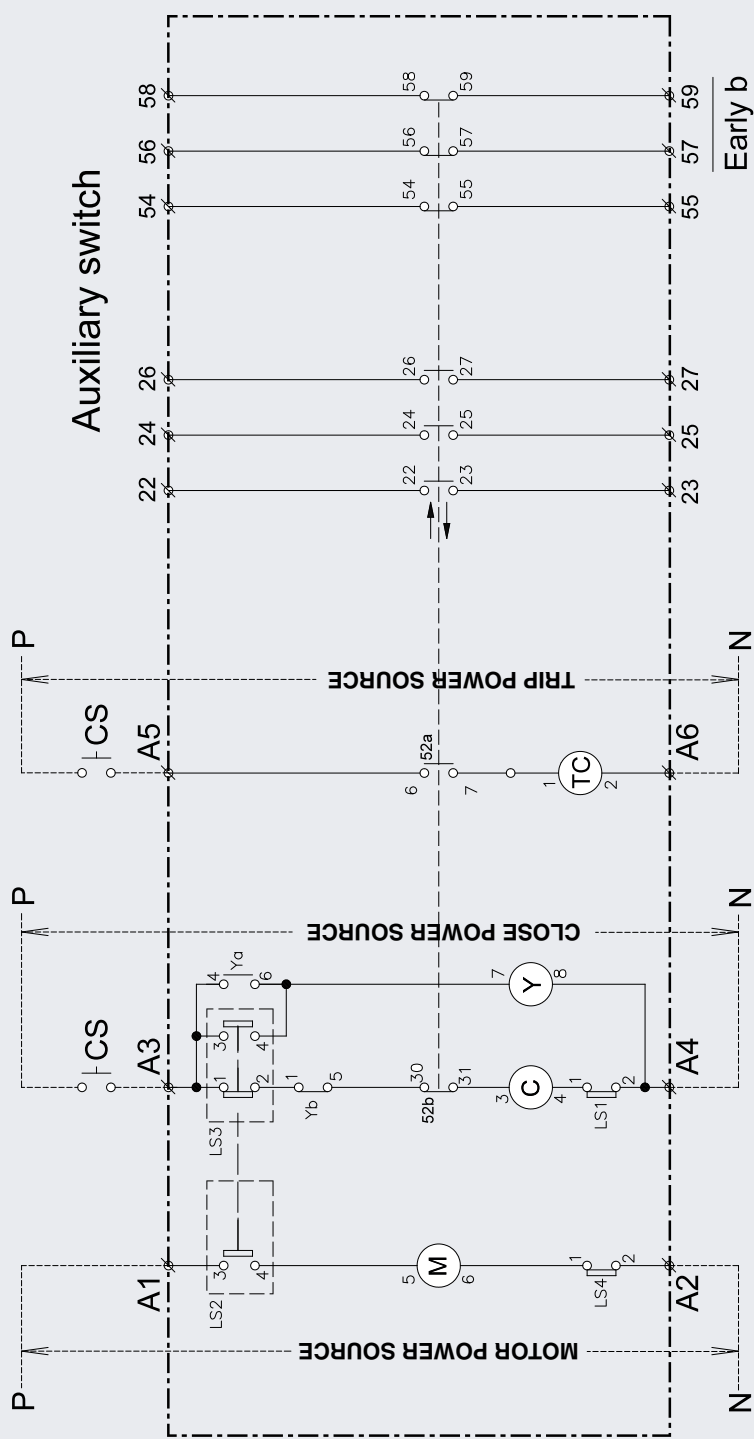


Control circuit diagram

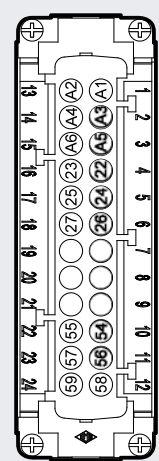
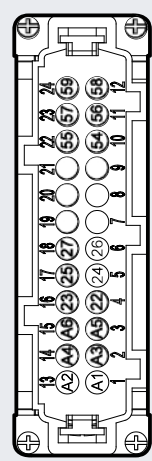
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VH-05/15



Early b



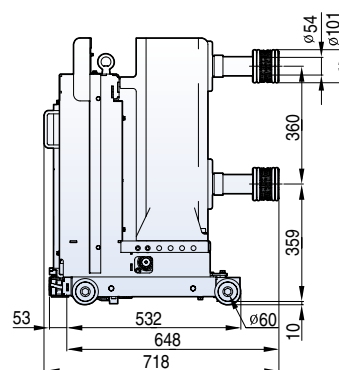
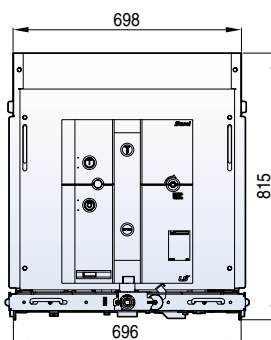
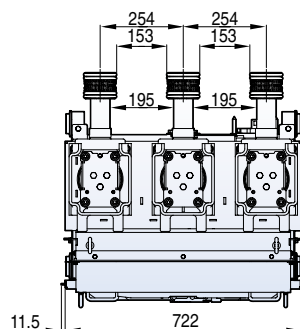
- 02: External terminal of VCB
- 52: Vacuum circuit breaker
- M: Spring charging motor
- TC: Trip coil
- C: Closing coil
- Y: Anti-pump relay
- 52a: Auxiliary switch (NO)
- 52b: Auxiliary switch (NC)
- LS1: Close interlock limit switch
- LS2: Motor stopping limit switch
- LS3: Anti-closing, Anti-pumping limit switch
- LS4: Motor charging interlock limit switch

Note) 1. Above circuit diagram is based on "OFF" state of VCB and closing spring is charged.
2. Please follow direction of P, N marked in the above circuit diagram.
3. Two(2) "Early b" auxiliary contact is provided.(Terminal No. 56-57, 58-59)

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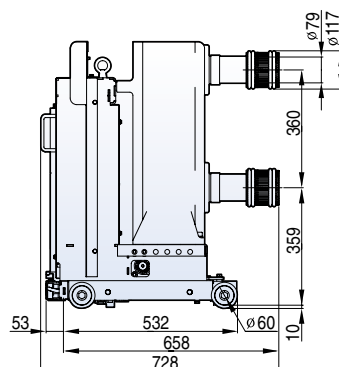
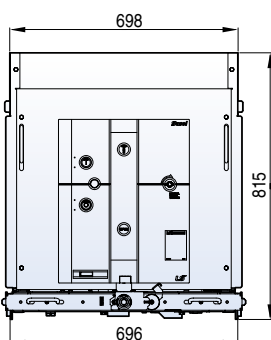
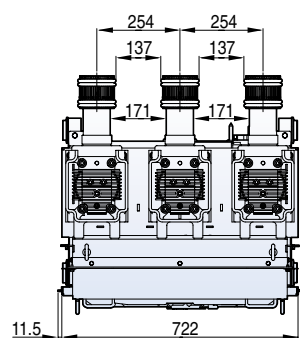
**4.76kV, 50kA, 1200/2000A
15kV, 40/50kA, 1200/2000A**

Withdrawable (H type unit)



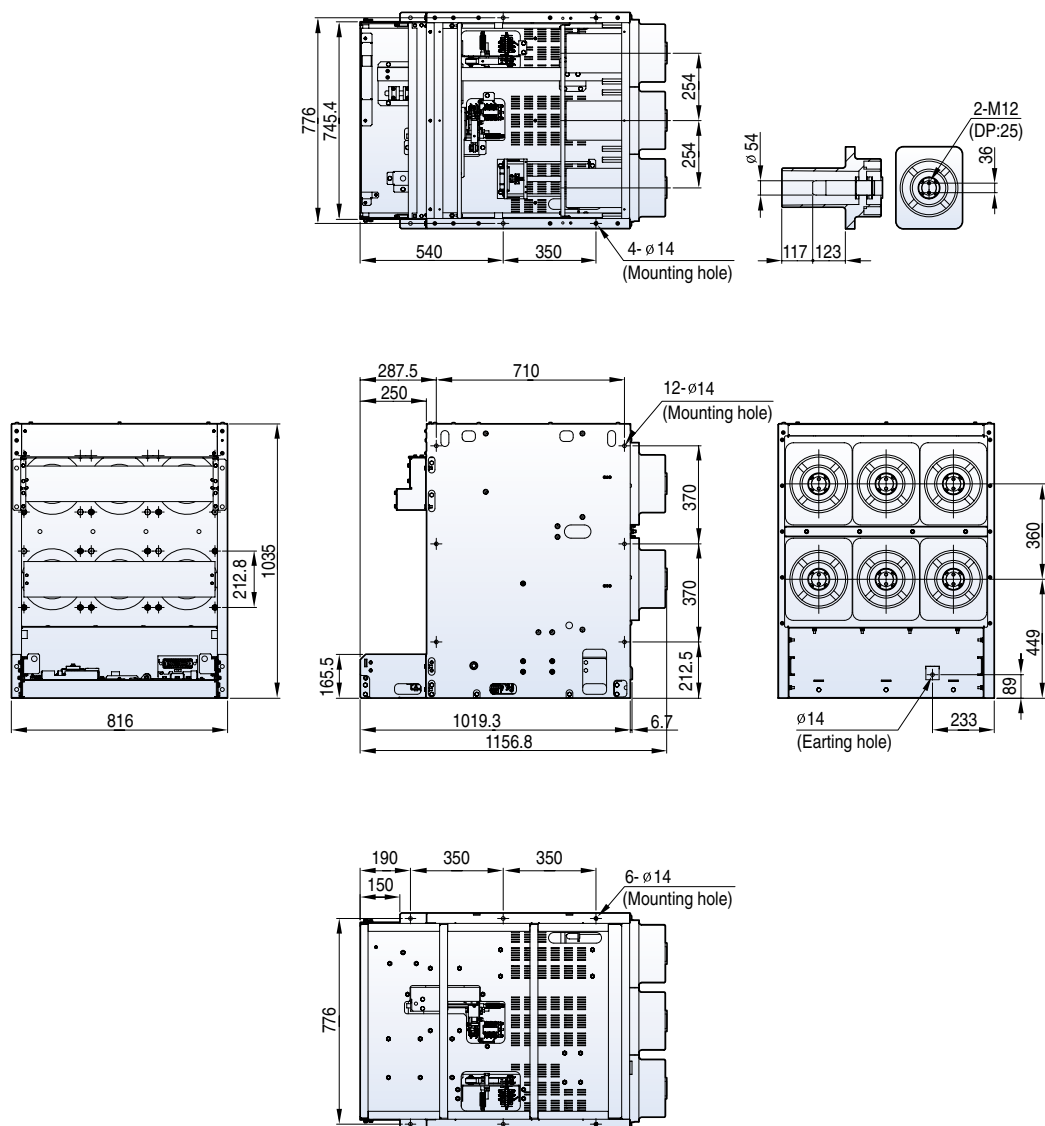
**4.76kV, 50kA, 3000A
15kV, 40/50kA, 3000A**

Withdrawable (H type unit)

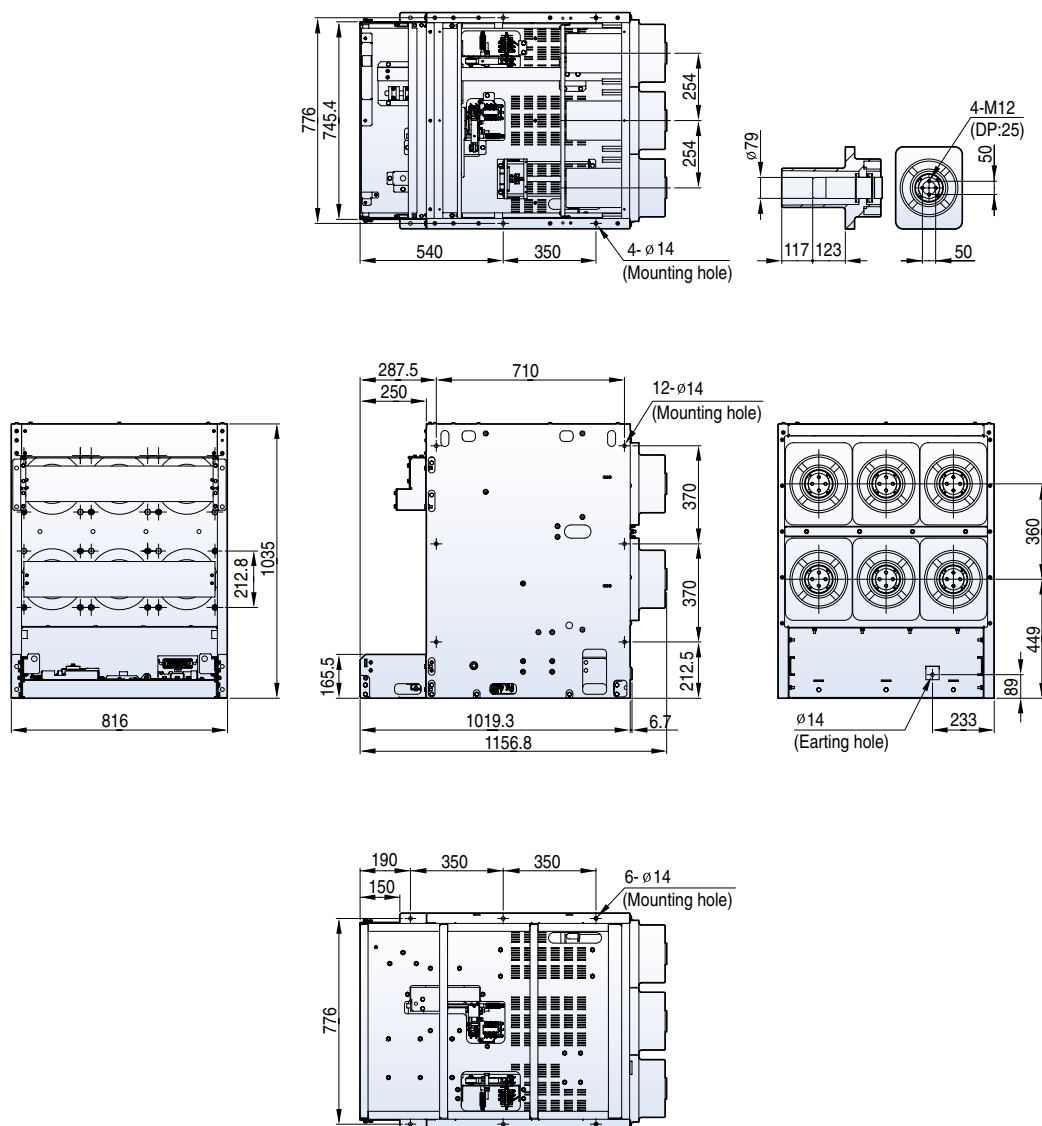


4.76kV, 50kA, 1200/2000A
15kV, 40/50kA, 1200/2000A

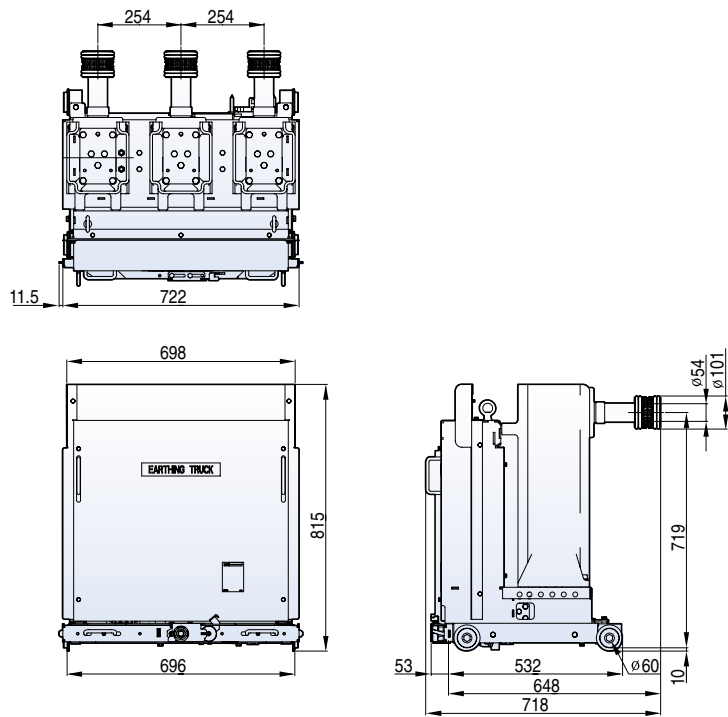
Withdrawable (H type cradle)



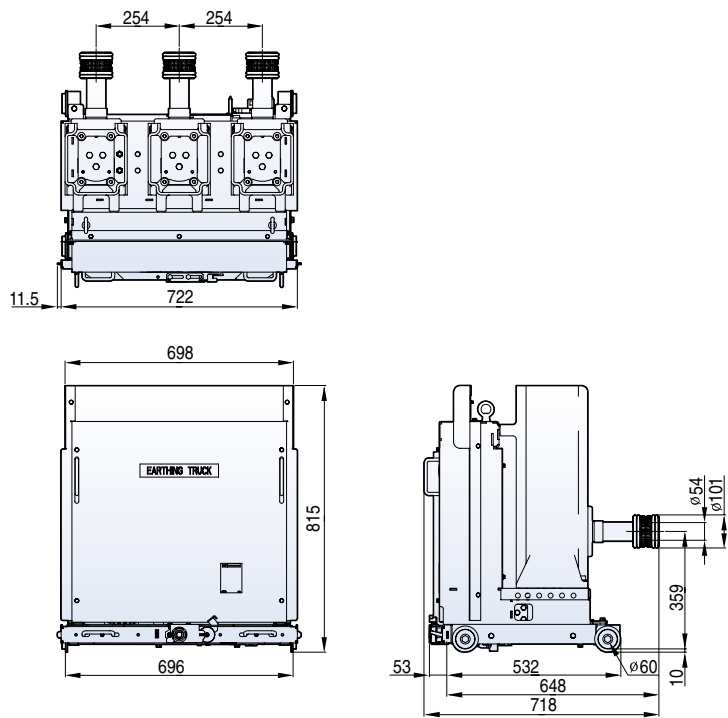
4.76kV, 50kA, 3000A
15kV, 40/50kA, 3000A
Withdrawable (H type cradle)



4.76kV, 50kA, 1200/2000A
15kV, 40/50kA, 1200/2000A
Earthing truck(Upper)

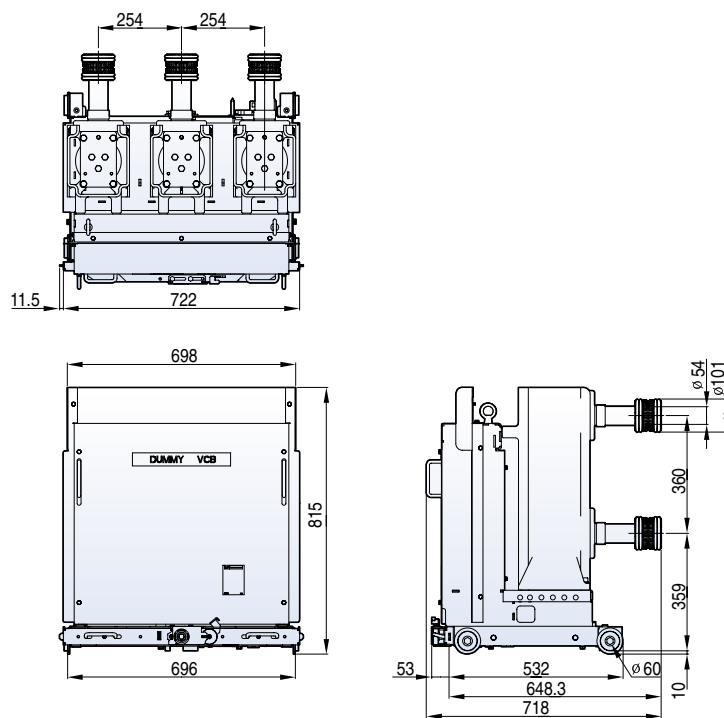


Earthing truck(Lower)

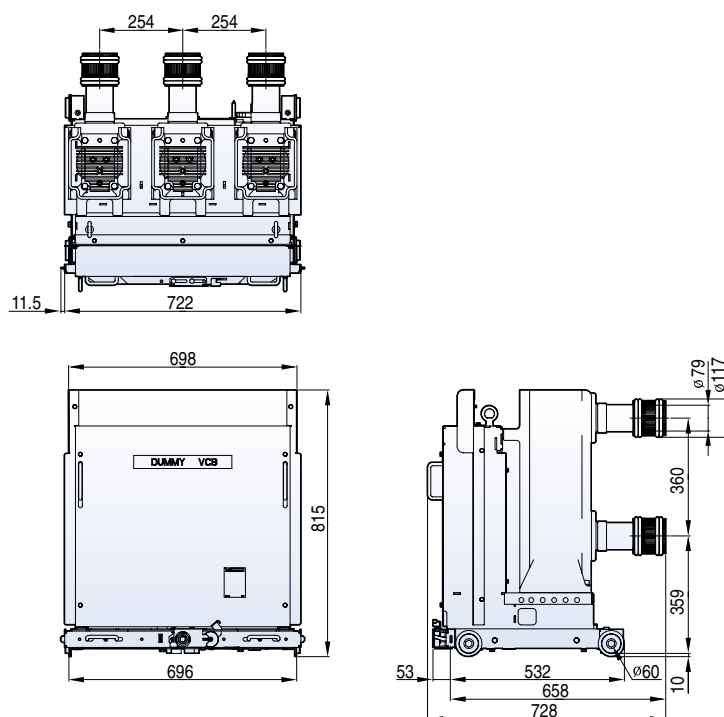


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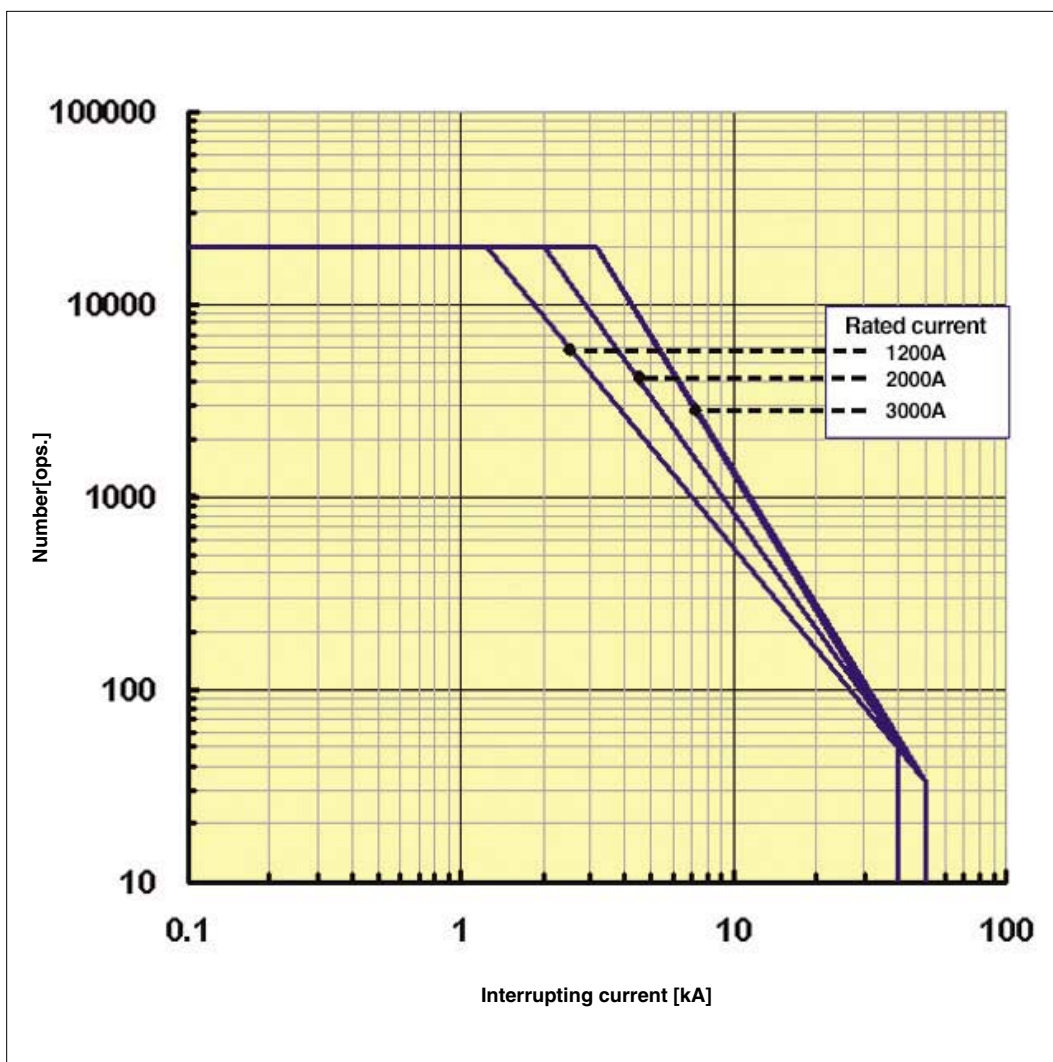
4.76kV, 50kA, 1200/2000A
15kV, 40/50kA, 1200/2000A
 Dummy



4.76kV, 50kA, 3000A
15kV, 40/50kA, 3000A
 Dummy



Electrical endurance by interrupting current



VI model LV8 at 4.76/15kV, 1200/2000/3000A, 40/50kA

- N : Operation numbers
- I : Interrupting current

Green Innovators of Innovation



Safety Instructions

- For your safety, please read user's manual thoroughly before operating.
- Contact the nearest authorized service facility for examination, repair, or adjustment.
- Please contact qualified service technician when you need maintenance.
Do not disassemble or repair by yourself!
- Any maintenance and inspection shall be performed by the personnel having expertise concerned.

LSIS Co., Ltd.

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■ HEAD OFFICE

LS-ro 127 (Hogye-dong) dongan-gu Anyang-si
Gyeonggi-do Korea
Tel. (82-2)2034-4887, 4873, 4918, 4148
Fax. (82-2)2034-4648

■ CHEONG-JU PLANT

Cheong-Ju Plant #1, 95, Baebong-ro, Heungdeok-gu,
Cheongju-si, Chungcheongbuk-do, 361-720, Korea

■ Global Network

- **LSIS (Middle East) FZE >> Dubai, U.A.E.**
Address: LOB 19 JAFZA VIEW TOWER Room 205, Jebel Ali Freezone P.O. Box 114216, Dubai, United Arab Emirates
Tel: 971-4-886 5360 Fax: 971-4-886-5361 e-mail: dhleef@lsis.biz
- **Dalian LSIS Co., Ltd. >> Dalian, China**
Address: No.15, Liaohezi 3-Road, Economic and Technical Development zone, Dalian 116600, China
Tel: 86-411-8273-7777 Fax: 86-411-8730-7560 e-mail: tangyh@lsis.com.cn
- **LSIS (Wuxi) Co., Ltd. >> Wuxi, China**
Address: 102-A, National High & New Tech Industrial Development Area, Wuxi, Jiangsu, 214028, P.R.China
Tel: 86-510-8534-6666 Fax: 86-510-522-4078 e-mail: luw@lsis.com.cn
- **LSIS-VINA Co., Ltd. >> Hanoi, Vietnam**
Address: Nguyen Khe - Dong Anh - Ha Noi - Viet Nam
Tel: 84-4-882-0222 Fax: 84-4-882-0220 e-mail: sjbaik@lsis.biz
- **LSIS-VINA Co., Ltd. >> Hochiminh, Vietnam**
Address: 41 Nguyen Thi Minh Khai Str. Yoco Bldg 4th Floor, Hochiminh City, Vietnam
Tel: 84-8-3822-7941 Fax: 84-8-3822-7942 e-mail: hjchold@lsis.biz
- **LSIS Shanghai Office >> Shanghai, China**
Address: Room 32 floors of the Great Wall Building, No. 3000 North Zhongshan Road, Putuo District, Shanghai, China
Tel: 86-21-5237-9977 Fax: 89-21-5237-7189 e-mail: baijh@lsis.com.cn
- **LSIS Beijing Office >> Beijing, China**
Address: B-Tower 17FL Beijing Global Trade Center B/D. No.36, BeiSanHuanDong-Lu, DongCheng-District, Beijing 100013, P.R. China
Tel: 86-10-5825-6025,7 Fax: 86-10-5825-6026 e-mail: sunmj@lsis.com.cn
- **LSIS Guangzhou Office >> Guangzhou, China**
Address: Room 1403, 14/F, New Poly Tower, No.2 Zhongshan Liu Road, Guangzhou 510180, P.R. China
Tel: 020-8326-6754 Fax: 020-8326-6287 e-mail: chenxs@lsis.com.cn
- **LSIS Chengdu Office >> Chengdu, China**
Address: Room 1701 17Floor, huamin hanjun international Building, No1 Fuxing Road Chengdu, 610016, P.R. China
Tel: 86-28-8670-3201 Fax: 86-28-8670-3203 e-mail: yangcf@lsis.com.cn
- **LSIS Qingdao Office >> Qingdao, China**
Address: Room 2001,20/F,7B40, Galaxy Building, No.29 Shandong Road, Shinan District, Qingdao 266071, P.R. China
Tel: 86-532-8501-6058 Fax: 86-532-8501-6057 e-mail: wangzy@lsis.com.cn
- **LSIS NETHERLANDS Co.Ltd >> Schiphol-Rijk, Netherlands**
Address: 1st. Floor, Tupolevlaan 48, 1119NZ, Schiphol-Rijk, The Netherlands
Tel: 31-20-654-1420 Fax: 31-20-654-1429 e-mail: junshickp@lsis.biz
- **LSIS Gurgaon Office >> Gurgaon, India**
Address: 109 First Floor, Park Central, Sector-30, Gurgaon- 122 002, Haryana, India e-mail: hwyim@lsis.biz

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