

Single-phase pad-mounted step voltage regulator



General

Eaton's Cooper Power™ series single-phase pad-mounted voltage regulators add a dimension to underground system planning. They provide system planners freedom to improve the safety, reliability, and power quality in existing and new underground distribution systems. The pad-mounted voltage regulator provides all the functionality of traditional round-tank pole-mounted and substation voltage regulators, with the convenience of pad-mounting.

The pad-mounted voltage regulator provides step-type voltage regulation in 32 steps of approximately 5/8% each for a maximum of $\pm 10\%$ regulation when used singly or in wye-connected banks. Voltage ratings are available from 2500 V (60 kV BIL) to 34,500 V (150 kV BIL) for 60 Hz and 50 Hz systems.

Control of the voltage regulator is microprocessor-based, with a digital metering package of Class 1 accuracy. Instantaneous metering, time/date-stamped demand metering, and profile recording are provided. Features include voltage limiting capability, voltage reduction capability, reverse power flow operation, and tap position tracking.

The pad-mounted voltage regulator provides state-of-the-art voltage regulation while reducing installation costs and preserving site aesthetics.

Pad-mounted voltage regulators, in conjunction with pad-mounted transformers and switchgear, can be used to create a modular pad-mounted substation. This substation can be placed in areas that require a low-profile installation. It can exist inconspicuously and quite possibly utilize shared rights-of-way.

EATON

Powering Business Worldwide

Catalog number information

Use **Table 1** as a guide when ordering voltage regulators or to interpret a voltage regulator catalog number.

Table 1. Voltage regulator catalog number system

Description	Catalog number
Base letters for a voltage regulator	VR
Physical configuration	
W = Pad—1PH—ONAN rated with IDPT	VRX
J = Pad—1PH—Delta connected with IDPT	
Nominal voltage rating	
1 = 2500	VRXX
3 = 7620	
5 = 14400	
6 = 19920	
8 = 34500	
9 = Special 60 Hz	
D = 11000	
N = 22000	
R = 33000	
X = Special 50 Hz	
kVA rating	
07 = 76.2	VRXXX
10 = 100	
11 = 110, 114.3	
14 = 144	
15 = 152	
16 = 167	
20 = 200	
21 = 219	
22 = 220	
25 = 250	
28 = 288	
33 = 333	
40 = 400	
41 = 416.3	
43 = 432	
44 = 440	
50 = 500	
57 = 576	
66 = 660, 667	
69 = 690	
83 = 833	
SP = Special	

Description	Catalog number
Losses	
J = Standard (2018)	VRXXXXX
K = Low (2018)	
Control identifier	
000 = None	VRXXXXXXXX
CL7 = CL-7	
System usage	
1 = Single-phase regulator	VRXXXXXXXXX
2 = Multi-phase—2	
3 = Multi-phase—3	
Random alphanumeric character	VRXXXXXXXXXXXXXXX
Tap changer revision	
A = QD3 (T350)	VRXXXXXXXXXXXXXXX
G = QD5 (T556)	
N = QD8 (T875)	

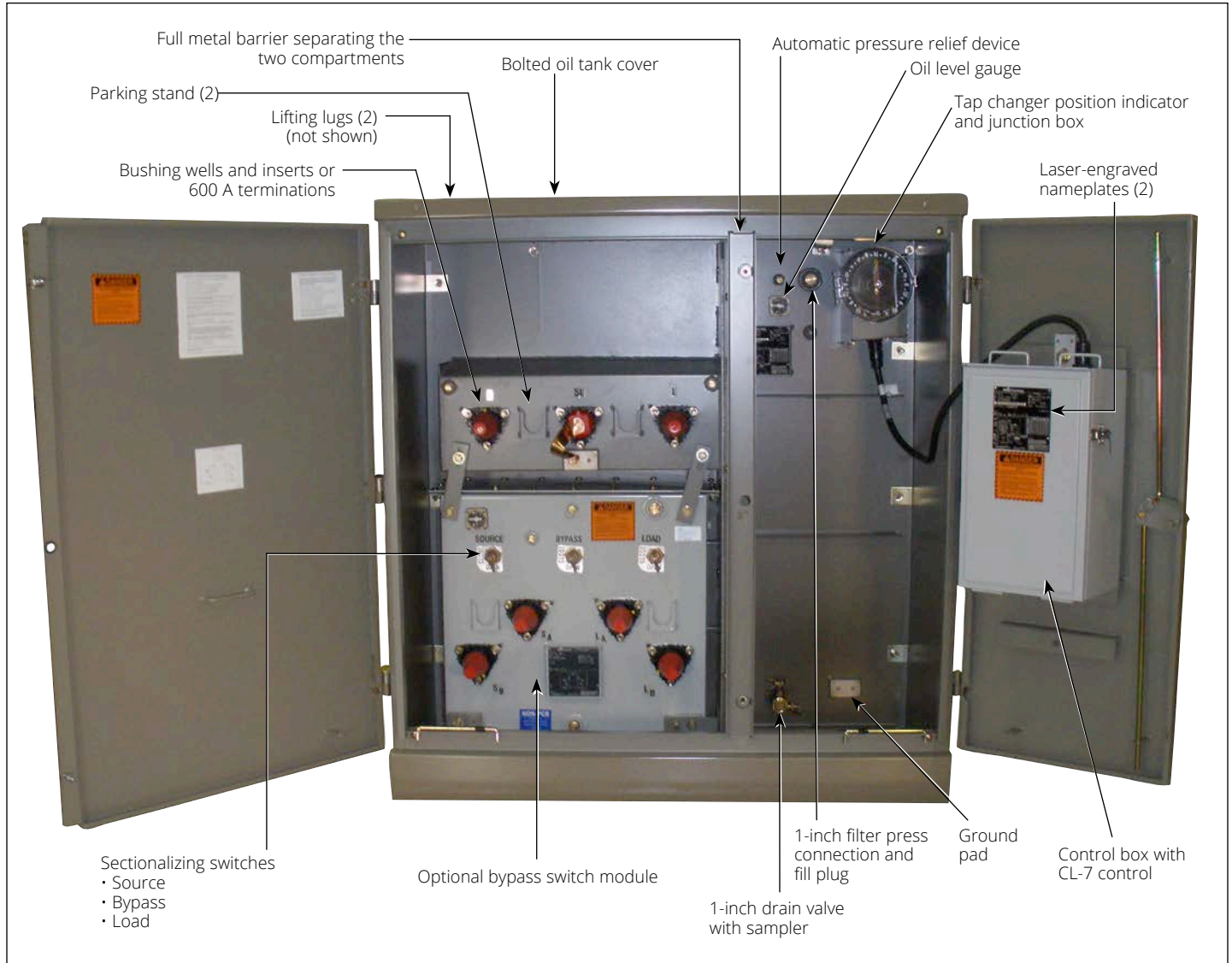


Figure 1. The pad-mounted voltage regulator is delivered fully equipped, ready for your application

Standard features

A sealed tank construction combined with a 65 °C average winding rise insulation system provides a proven design for long life installations. Additional capacity is available through the ADD-AMP™ feature.

Internal construction allows easy removal of the interior assembly. A bolted cover also provides a large area to perform maintenance with the assembly in the tank.

- Full metal barrier separating the two compartments
- Two parking stands
- Three bushing wells and inserts, 600 A or 900 A terminations
- Standard “pad-mounted green” paint (Munsell 7GY3.29/1.5)
- Ground pads
- Bolted oil tank cover
- Nameplates (2)
- Internal differential PT
- Deep removable cabinet
- Automatic pressure relief device
- Lifting lugs
- Under-oil series arrester (3 kV or 6 kV)
- Provisions for pressure/vacuum gauge and thermometer
- 1-inch filter press connection and fill plug
- Control box with CL-7 control
- Oil level gauge
- Junction box and position indicator
- 1-inch drain valve with sampler
- Control cable disconnect at junction box and control box
- Line-side lift-off door secured with two captivated bolts
- Pad-lockable lift-off control-side door with three-point latching
- Door position-retention rods
- Faceplate-mounted tap changer for PT taps

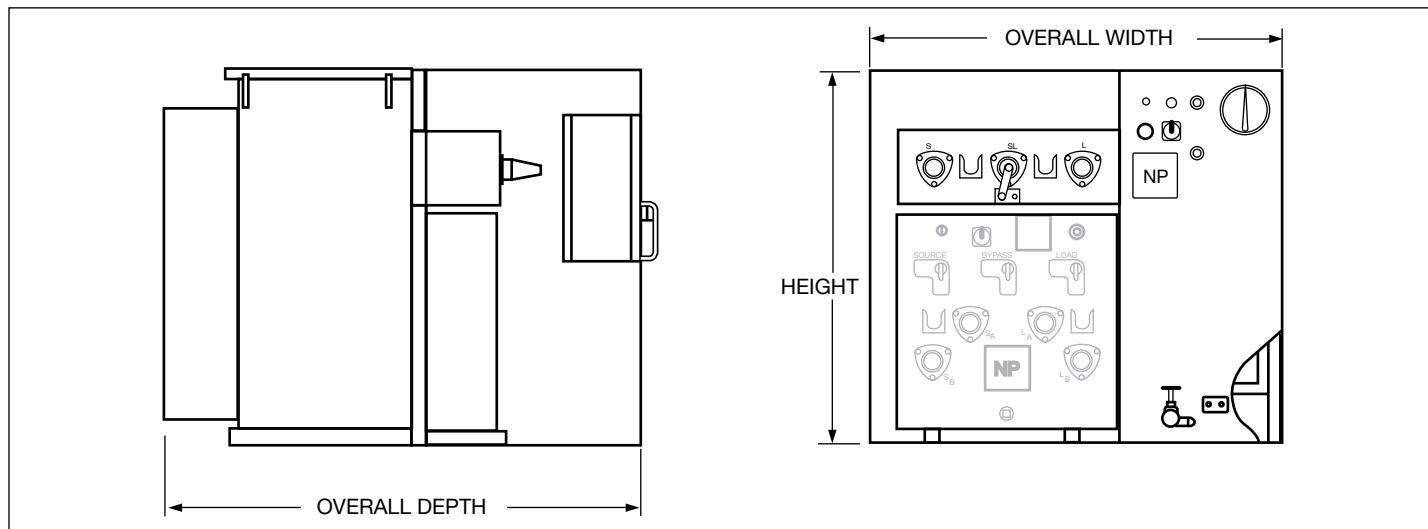


Figure 2. Single-phase pad-mounted voltage regulator and optional bypass switch module

Table 2. Pad-mounted voltage regulator weights and dimensions 60 Hz

Voltage rating	Height (in)	Overall width (in)	Overall depth (in)	Total weight (lb)
2500	50-65	55-65	50-65	3000-6000
7620	50-65	55-65	50-85	3000-7000
14,400	50-70	55-65	50-75	3000-7000
19,920	50-70	55-75	50-85	3500-8500
34,500	50-70	55-75	50-90	8000-10,000

Note: Some ratings include corrugate cooling. Weights and dimensions are for reference only and are not for construction. Please contact Eaton for exact dimensions.

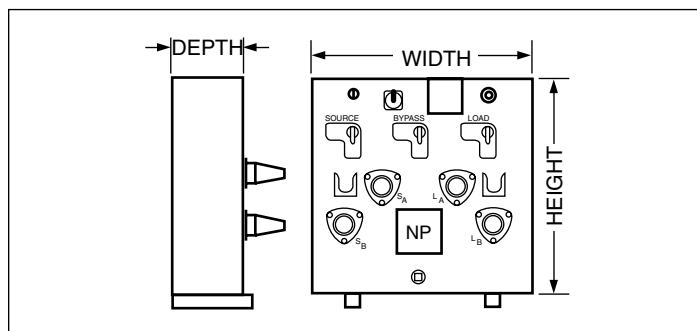


Figure 3. Bypass switch module (optional)

Table 3. Pad-mounted voltage regulator weights and dimensions 50 Hz

Voltage rating	Height (mm)	Overall width (mm)	Overall depth (mm)	Total weight (kg)
11,000	1250-1650	1400-1650	1250-1900	1300-3175
22,000	1250-1800	1400-1900	1250-2200	1300-3900
33,000	1250-1800	1400-1900	1250-2300	3100-4500

Note: Some ratings include corrugate cooling. Weights and dimensions are for reference only and are not for construction. Please contact Eaton for exact dimensions.

Table 4. Bypass switch module weights and dimensions

Voltage rating	Current (amperes)	Height (in)	Width (in)	Overall depth (in)	Weight (lb)
All	200	30	30	12	400
	400	36	36	12	525
	550	36	36	12	550

Note: Weights and dimensions are for reference only and are not for construction. Please contact Eaton for exact dimensions.

Optional accessories

- Bypass switch module (550 A ratings and below, grounded-wye systems only)
- FR3™ dielectric fluid
- 40-inch deep cabinet
- Alternate top coat color
- No barrier
- Pressure/vacuum gauge (with or without alarm contacts)
- Dial-type thermometer (with or without alarm contacts)
- Alarm contacts for oil level gauge
- Under-oil shunt arresters
- Nameplates in alternate languages and/or metric units
- Elbow shunt arresters
- Position indicator (PI) viewing window
- Infrared (IR) window
- External 2X control box

Ease of operation

The control box is mounted on the door of the operational side of the cabinet for easy access. As the operator uses the control, the position indicator is in clear view.

The junction box has a removable side door that permits access to the terminal block for the connections from the tank to the control cable. The control is connected from the control box to the junction box with a quick-disconnect control cable, which enables easy removal. The current transformer is automatically shorted when the cable is removed.

Table 5. Regulator voltage ratings and corresponding terminations

Voltage rating	Current (amperes)	kVA	Bushing	BIL
60 Hz				
2500	400	100	600 A integral bushing	60
2500	668, 875	167, 219	900 A integral bushing	60
7620	100, 150, 200	76, 114, 152	200 A well and 15 kV class insert	95
7620	328, 438, 548	250, 333, 416	600 A integral bushing	95
7620	656, 875	500, 667	900 A integral bushing	95
14,400	100, 200	144, 288	200 A well and 25 kV class insert	125 (see note below)
14,400	300, 400, 463, 578	432, 576, 667, 833	600 A integral bushing	125 (see note below)
19,920	100, 200	200, 400	600 A integral bushing	150
19,920	335	667	600 A integral bushing	150
34,500	200	690	600 A integral bushing	150
50 Hz				
11,000	100, 200	110, 220	200 A well and 15 kV class insert	95
22,000	100, 200	220, 440	200 A well and 25 kV class insert	125 (see note below)
	300	660	600 A integral bushing	150
33,000	200	660	600 A integral bushing	150

Note: The 7620 V units rated 200 A or less are available with optional 25 kV class inserts. The 125 kV BIL rating is only limited by the bushing; all internal connections are designed and constructed to 150 kV BIL. A 600 A, 150 kV BIL integral bushing is available as an option. 600 A or 900 A bushing upgrades are available as well for each voltage rating.

Position indicator and ADD-AMP feature

Exclusive to Eaton, the uniquely designed position indicator offers corrosion-resistant materials, an oversized viewing area and a reset solenoid that is replaceable using a single thumbscrew. It is mounted on a junction box on the frontplate of the regulator and is directly connected to the tap changer by a flexible drive shaft passing through the junction box and terminal board via a sealing gland.

The indicator face is graduated in steps, numbered 1 through 16 on each side of neutral. Drag hands indicate the maximum and minimum positions attained during raise and lower operations. The drag hands are reset around the position indicator hand by operating the drag hand reset switch on the voltage regulator control.

The ADD-AMP feature of the pad-mounted voltage regulator allows increased current capacity by reducing the regulation range. The CL-7 control also allows for an Adaptive ADD-AMP feature that will automatically change the Soft ADD-AMP setting based upon the current readings of the control.

This is accomplished by either setting limit switches in the position indicator (HARD-ADD-AMP feature) or enabling the SOFT-ADD-AMP feature to prevent the tap changer from traveling beyond a set position in either raise or lower directions. The limit switches have scales graduated in percent regulation, and are adjustable to specific values of 5, 6-1/4, 7-1/2, 8-3/4, and 10%.

The five possible load current ratings associated with the reduced regulation ranges are summarized in **Table 6** and **Table 7**. At each setting, a detent stop provides positive adjustment. Settings other than those with stops are not recommended. The raise and lower limits need not be the same value, except for locations where reverse power flow is possible.



Figure 4. Position indicator

Table 6. Regulator voltage ratings

Voltage rating	Standard internal tap settings							
60 Hz								
2500	2500	2400						
7620 ①	8000	7970	7620	7200	6930	4800	4160	2400
14,400	14,400	13,800	13,200	12,000	7970	7620	7200	6930
19,920	19,920	17,200	16,000	15,242	14,400	7970	7620	7200
34,500	34,500	19,920						
50 Hz								
11,000	11,600	11,000	10,000	6930	6600	6350	6000	5500
22,000	23,000	22,000	20,000	19,100	15,000	12,700	11,000	10,000
33,000	33,000	30,000	22,000	20,000	11,600	11,000	10,000	

① Regulators are capable of carrying current corresponding to rated KVA when operated at 7200 V.

Note: Other ratings may be available upon request. Contact your Eaton representative for more information.

Table 7. ADD-AMP capabilities of 60 Hz ratings

Voltage rating	Rated kVA	Load current rating (amperes)				
		Regulation range				
		±10%	±8.75%	±7.50%	±6.25%	±5%
2500	100	400	440	480	540	640 ②
	167	668	668	668	668	668
	219	875	—	—	—	—
7620 ③	76	100	110	120	135	160
	114	150	165	180	203 ①	240 ①
	152	200	220 ①	240 ①	270 ①	320 ①
	250	328	361	394	443	525
	333	438	482	526	591	668 ②
	416	548	603 ②	658 ②	668 ②	668 ②
	500	656	668	668	668	668
	667	875	875	875	875	875
14,400	144	100	110	120	135	160
	288	200	220	240	270	320
	432	300	330	360	405	480
	576	400	440	480	540	640 ②
	667	463	509	556	625 ②	668 ②
	833	578	636	668	668	668
19,920	200	100	110	120	135	160
	400	200	220	240	270	320
	667	335	369	402	452	536
34,500	690	200	220	240	270	320

① Requires bushings upgraded to 600 A.

② Requires bushings upgraded to 900 A.

③ Regulators are capable of carrying current corresponding to rated kVA when operated at 7200 V.

Note: Per IEEE® Std C57.15-2017™, single-phase regulators rated 668 A and below shall have the continuous current rating or 668 A, whichever is less, as shown in the table. To achieve 668 A, the bushings must be upgraded to 900 A.

Table 8. ADD-AMP capabilities of 50 Hz ratings

Voltage rating	Rated kVA	Load current rating (amperes)				
		Regulation range				
		±10%	±8.75%	±7.50%	±6.25%	±5%
11,000	110	100	110	120	135	160
	220	200	220 ①	240 ①	270 ①	320 ①
22,000	100	50	55	60	68	80
	220	100	110	120	135	160
	330	150	165	180	203 ①	240 ①
33,000	660	200	220 ①	240 ①	270 ①	320 ①

① Requires bushings upgraded to 600 A.

Note: Per IEEE Std C57.15-2017, single-phase regulators up to 19.9 kV rated 668 A and below shall have the continuous current rating or 668 A, whichever is less, as shown in the table. To achieve 668 A, the bushings must be upgraded to 900 A.

Bypass switch module (optional)

As with round tank regulators, bypassing a pad-mounted voltage regulator is an option in system operation. Installing or removing the pad-mounted voltage regulator from the circuit is accomplished with a stand-alone bypass switch module.

This switch module fits inside the secure regulator cabinet during normal operation. When the regulator needs to be removed, the bypass module provides hotstick-operable sectionalizing switches to disconnect the regulator from the system without causing interruption to the downstream load.

Table 9. Bypass switch ratings

Voltage rating	Current (amperes)	Bushings
All	200	200 A wells and 15 kV and 25 kV inserts with removable studs
	400	600 A integral bushings
	550	600 A integral bushings



Figure 6. Bypass switch module



Figure 7. Voltage regulator bypassing operation

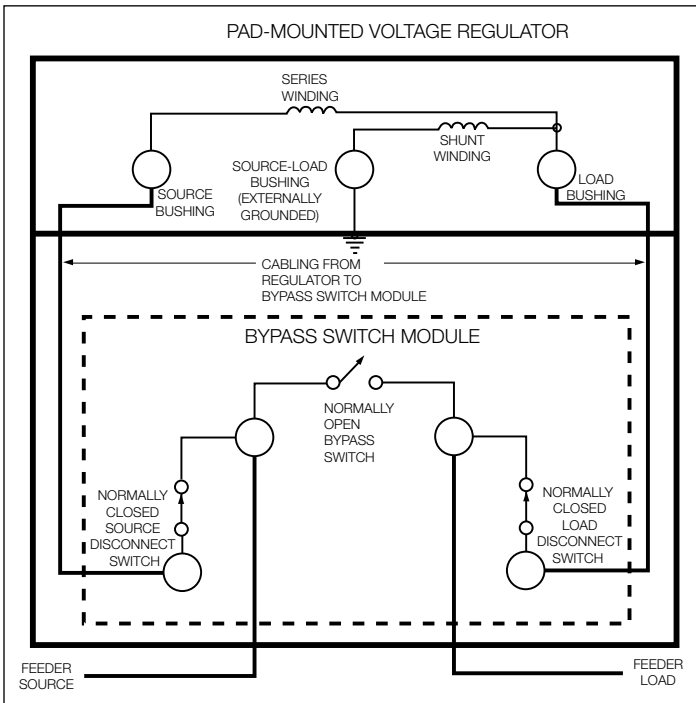


Figure 5. One-line diagram of pad-mounted regulator with bypass switch module for grounded-wye applications

CL-7 series control

- Source-side voltage calculated from tap position
- Internal-external voltage source switch
- Automatic/manual control switch
- Manual raise/lower toggle switch
- Position indicator drag hand reset switch
- Supervisory ON-OFF switch for use with SCADA
- Alphanumeric keypad
- 4x20 character display
- Multilingual display
- Three date formats
- Six-digit operations counter
- Voltage test terminals
- External voltage source terminals
- Neutral indicating dual LEDs
- Panel-mounted motor fuse
- Metering-PLUS™ one-touch, grouped-data display feature
- Tap-position tracking
- Voltage limiting (“First House Protection”)
- Line drop compensation settings
- SOFT-ADD-AMP feature with adaptive functionality
- Duty cycle monitor (DCM)
- TIME-ON-TAP™ tap position tracking feature
- Preventive maintenance tapping (PMT) feature
- Tap-to-neutral
- Voltage reduction with 5 modes
- Digital metering package (including instantaneous, demand and time-tagged demand)
- Data profiler
- Configurable status alarms
- Configurable data alarms
- Event record
- Local data retrieval USB front port
- PC data port
- Resident communications protocols: DNP3, IEC 60870-5, 2179, Modbus® Serial and Modbus TCP/IP
- Programmable I/O using logical equations
- Alternate configuration settings

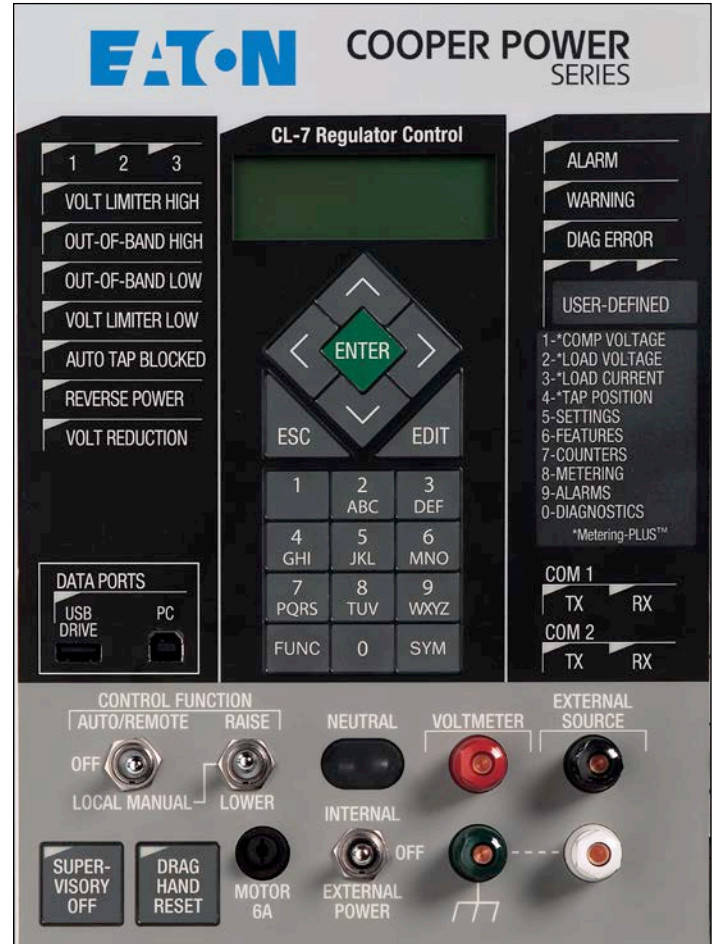


Figure 8. CL-7 regulator control

CL-7 optional accessories

- Multi-phase functionality
- Front panel overlays in alternate languages
- Serial communications interfaces:
 - RS-232
 - Fiber optic—ST
 - RS-485
- Ethernet communications interfaces:
 - Fiber optic—LC, MTRJ, ST, and SC
 - Copper—RJ45
- 8 input/8 output universal contacts
- 13.5 Vdc radio power supply
- 13 A-Hr control power battery backup
- 48/125 Vdc substation battery power interface
- 240 V external source interface
- Auxiliary analog input module (4–20 mA inputs)

Construction

Core and coil assembly

The coil assembly features aluminum strip in the series winding that achieves the optimum in ampere turn balance for exceptional strength under through-fault conditions.

Grain-oriented steel is used in the core, with a low reluctance lap joint. The rugged core clamp assembly secures the coil effectively and positions the core for the optimum in quiet operation and low core losses.

Quik-Drive tap changers

The load tap-changer product offering consists of three Quik-Drive™ tap changers; the most advanced tap changers in the industry. Each device is sized for a specific range of current and voltage applications and share many similarities in their construction.

The primary benefits of Quik-Drive tap changers are: direct motor drive for simplicity and reliability, high-speed tapping operation for faster voltage regulation operation and proven mechanical life (one million operations). Common Quik-Drive tap changer features include: neutral light switch, position indicator drive, safety switches and logic switches (back-off switches) and a motor holding switch. Quik-Drive load tap changers meet IEEE and IEC standards for mechanical, electrical and thermal performance.



Figure 10. QD-3 Quik-Drive tap changer

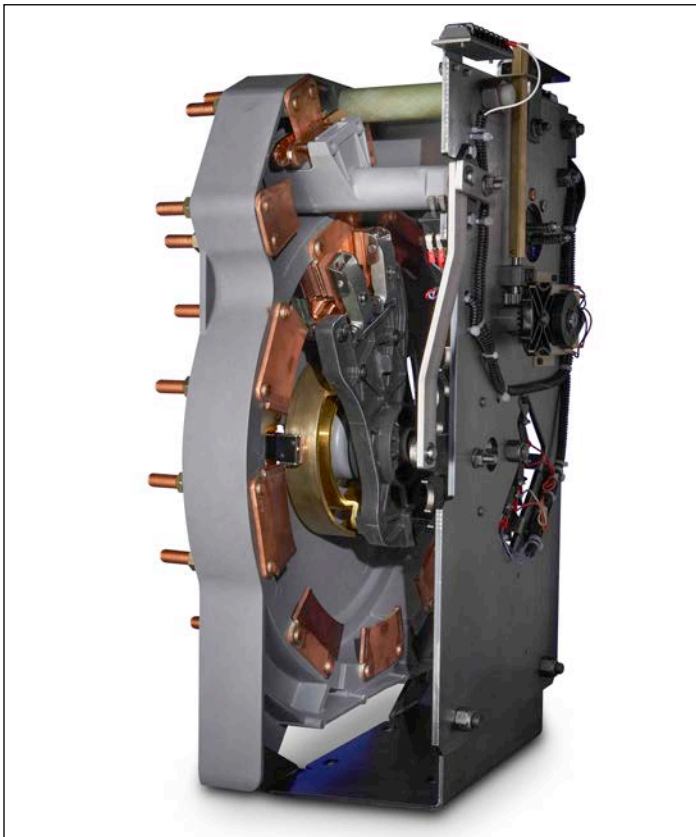


Figure 9. QD-8 Quik-Drive tap changer

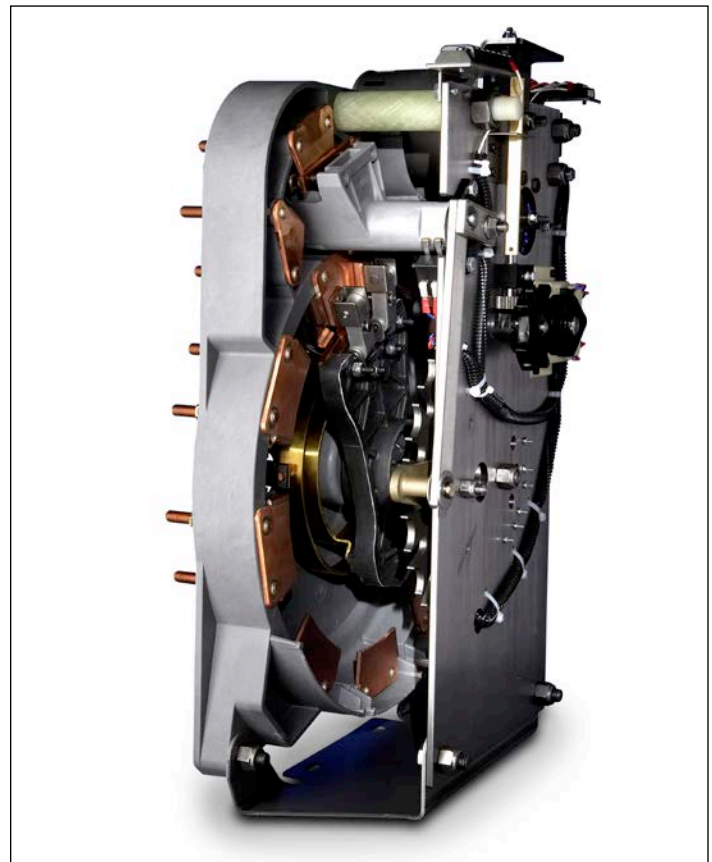


Figure 11. QD-5 Quik-Drive tap changer

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Printed in USA
Publication No. CA225002EN / Z27477
May 2023