

Single-Phase Step

GENERAL

McGraw-Edison® VR-32 single-phase step voltage regulators are tap-changing autotransformers. They regulate distribution line voltages from 10% raise (boost) to 10% lower (buck) in thirty-two steps of approximately 5/8% each. Voltage ratings are available from 2400 volts (60 kV BIL) to 34,500 volts (200 kV BIL) for 60 Hz and 50 Hz systems.

Internal potential winding taps and an external ratio correction transformer are provided on all ratings so that each regulator may be applied to more than one system voltage.

Smaller kVA sizes are supplied with support lugs for pole mounting and with substation or platform tie down provisions. Larger sizes are provided with substation bases with pad-mounting provisions.

Voltage is maintained within desired limits by controls that feature superior accuracy, reliability, and serviceability. Continuity of service is assured by rugged, service-proven tap changers and core-and-coil assemblies functioning with the control.

McGraw-Edison voltage regulators are available with a full complement of standard features for routine applications, as well as a full line of optional accessories for unique applications. In addition, the regulator offers desirable features that enhance operation and service.

STANDARD FEATURES

A sealed-tank construction allows the use of 65°C rise insulation system in 55°C rise rated designs to provide an additional 12% capacity above the nameplate rating without loss of normal insulation life. Additional load capacity is stated on the nameplate, this ADD-AMP™ feature is available as long as the tap changer's maximum current rating is not exceeded.

The unit construction cover suspends the internal assembly consisting of the core-and-coil assembly, tap changer, and the reactor for ease of inspection and maintenance.



Figure 1.
VR-32 Voltage Regulator with CL-5C control.

All McGraw-Edison regulators are manufactured and tested to the ANSI Standard C57.15.

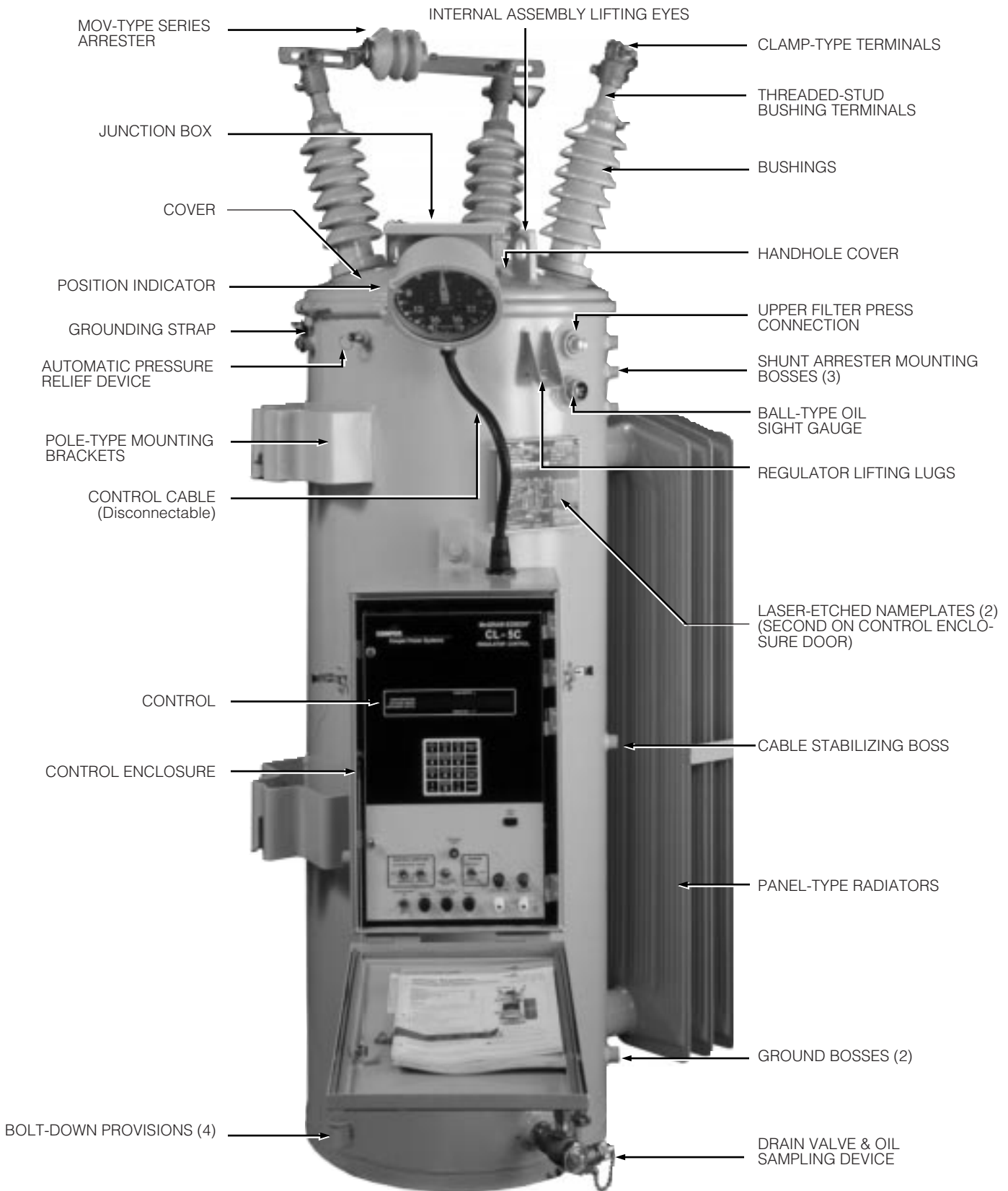


Figure 2.
VR-32 Voltage Regulator.

STANDARD FEATURES

- CL-2A control
- Tap changer with motor and power supply
- Position indicator with ADD-AMP adjustment
- Two laser-etched nameplates
- Lifting lugs
- Oil drain valve and sampling device
- Upper filter press connection
- Oil sight gauge
- Mounting provisions for shunt arresters
- High-creep bushings with clamp-type terminals
- Bolt-down provisions (overhead units)
- Pole-type mounting brackets (overhead units)
- Substation base (substation units)
- External series arrester
- Automatic pressure relief device
- Handhole
- Control cabinet with removable front panel
- Ratio correction transformer
- Conformally coated circuit boards

OPTIONAL ACCESSORIES

- Shunt arresters
- Extra-length control cables
- Elevating structure
- Control heater
- 4-hole NEMA H-spades
- Cooling fans
- Data reader
- Nameplates in alternate languages or metric units
- 240 volt external source
- Internal differential potential transformer for complete reverse power flow w/metering (requires CL-5C control)
- CL-5C control (optional accessories for control listed below)
 - SCADA relay
 - Fiber optic interface board (for digital communication)
 - CL-Interface program

ARRESTERS

Series Surge Arresters

All VR-32 Voltage Regulators are equipped with a bypass arrester connected across the series winding between the source (S) and load (L) bushings. This bypass arrester limits the voltage developed across the series winding during lightning strikes, switching surges and line faults. A MOV type series surge arrester of 3 kV offers series winding protection on all regulators except those rated 33000 V, which have a 6 kV MOV-type series surge arrester.

Shunt Arresters

A shunt arrester is an optional accessory on the VR-32 Voltage Regulator for protection of the shunt winding. The shunt arrester is a direct connected arrester mounted on the tank and is connected between the load bushing and ground. For additional protection, a shunt arrester may also be installed between the source bushing and ground. Shunt arrester application data is listed in Table 1.

TABLE 1
Shunt Arrester Application Data

Regulator Voltage Rating	Nominal System Voltages (volts)		Recommended MOV Shunt Arrester Ratings (kV)
	Delta or Single-phase	Multi-grounded Wye	
2500/4330Y	2400 2500	2400/4160 2500/4300	3
5000/8660Y	4160 4330 4800 5000	4160/7200 4330/7500 4800/8320 5000/8660	6
7620/13200Y	6900 7200 7620 7970	6900/11950 7200/12470 7620/13200 7970/13800	10
11000	11000		15
13800	12000 12470 13200 13800		15
14400/24940Y		13800/23900 14400/24940	18
19920/34500GrdY		19920/34500	27
22000	22000		27
33000	33000		36

*Note: Weights and dimensions are for reference only, and not for construction purposes. For exact dimensions, please contact Cooper Power Systems.

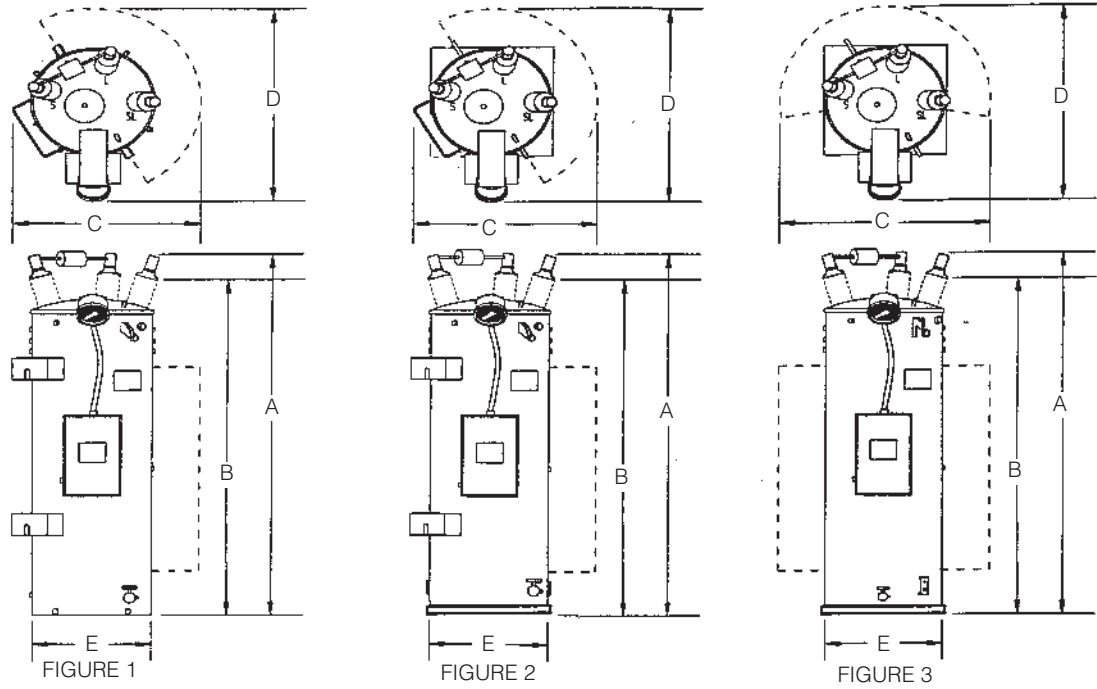


TABLE 2
Ratings and Dimensions – 50 Hz

Voltage (kV)	Load Current (Amperes)	kVA	Figure	Dimensions (mm)					Oil (Liters)	Untanking Weight (kgs.)	Total Weight (kgs.)
				A	B	C	D	E			
6.6	50	33	1	1893	1716	800	965	508	217	341	609
	100	66	1	1892	1715	813	965	508	231	341	609
95 kV BIL	150	99	1	Dimensions available at time of quotation/order.							
	200	132	2	1975	1818	915	1232	559	303	445	860
	300	198	3	Dimensions available at time of quotation/order.							
	400	264	3	Dimensions available at time of quotation/order.							
	500	330	3	Dimensions available at time of quotation/order.							
	600	396	3	Dimensions available at time of quotation/order.							
11.0	50	55	1	1994	1817	694	890	508	208	389	661
	100	110	1	1993	1818	864	1194	559	275	432	816
	150	165	1	2043	1869	1193	1161	610	370	560	1080
	200	220	2	2073	1920	1003	1320	635	360	649	1211
	300	330	3	2370	2208	998	1633	711	674	1007	1964
	400	440	3	2624	2462	1081	1784	838	1060	1059	2545
	500	550	3	Dimensions available at time of quotation/order.							
600	660	3	Dimensions available at time of quotation/order.								
15.0	50	75	1	Dimensions available at time of quotation/order.							
	100	150	1	2068	1869	1107	1110	610	344	573	1007
	150	225	2	2145	1971	1163	1278	660	479	707	1334
	200	300	3	2371	2209	1095	1445	711	555	910	1800
	300	450	3	2472	2310	1022	1701	762	791	1191	2252
	400	600	3	2700	2539	1275	1786	838	1098	1434	2904
500	750	3	Dimensions available at time of quotation/order.								
22.0	50	110	1	2093	1920	927	1270	635	371	455	945
	100	220	2	2174	2031	1005	1405	711	550	783	1494
	150	330	3	2326	2183	1075	1467	737	659	1005	1873
	200	440	3	2396	2234	1036	1704	762	765	1223	2243
	300	660	3	2675	2414	1330	1848	889	1213	1566	3086
33.0	50	165	3	2895	2754	799	1294	762	757	1080	1957
	100	330	3	3100	2947	1003	1585	965	1480	1638	3249
	150	495	3	3142	2981	1285	1839	965	1567	1765	3616
	200	660	3	3264	3086	1166	1921	965	1648	1835	3915

TABLE 3
Ratings and Dimensions – 60 Hz

Voltage (kV)	Load Current (Amperes)	kVA	Figure	Dimensions (in.)					Oil (Gallons)	Untanking Weight (lbs.)	Total Weight (lbs.)
				A	B	C	D	E			
2.5 60 kV BIL	200	50	1	71	64	30	39	20	51	615	1200
	300	75	1	80	74	36	47	25	106	745	1810
	400	100	1	80	74	37	52	25	108	803	1938
	668	167	1	95	89	40	49	24	132	110	2560
	1000	250	3	110	110	28	61	26	179	2435	4345
	1332	333	3	103	103	37	61	26	183	2450	4755
	1665	416	Dimensions available at time of quotation/order.								
5.0 75 kV BIL	100	50	1	71	64	30	39	20	51	625	1210
	200	100	1	75	68	35	49	22	71	823	1595
	250	125	Dimensions available at time of quotation/order.								
	334	167	1	75	75	36	53	22	84	986	2051
	500	250	3	98	92	36	59	24	141	1405	3250
	668	333	Dimensions available at time of quotation/order.								
	833	416	3	105	98	42	70	32	272	2305	5415
7.62 95 kV BIL	50	38	1	71	64	24	34	20	50	505	1030
	75	57	1	75	68	30	39	20	55	635	1185
	100	76	1	75	68	31	41	20	56	665	1265
	150	114	1	75	68	35	49	22	71	785	1585
	219	167	2	78	72	36	49	22	81	995	1975
	328	250	2	84	78	44	56	25	100	1285	2530
	438	333	3	97	91	38	61	26	153	1725	3525
	548	416	3	102	96	44	61	27	210	2075	4485
	656	500	3	100	93	40	67	30	224	2222	4934
	875	667	3	100	97	48	68	31	247	3060	5995
	1093	833	3	123	119	63	73	35	448	5620	10620
13.8 95 kV BIL	50	69	1	75	68	31	41	22	65	831	1538
	100	138	1	79	72	34	47	22	74	1070	1930
	150	207	1	81	74	40	54	25	104	1180	2550
	200	276	2	80	74	45	51	25	106	1425	2750
	300	414	3	94	87	53	62	28	177	3525	5790
	362	500	3	103	97	57	70	33	287	2550	6080
	400	552	Dimensions available at time of quotation/order.								
	483	667	Dimensions available at time of quotation/order.								
	604	833	Dimensions available at time of quotation/order.								
	14.4 150 kV BIL	50	72	1	75	68	32	43	22	66	767
100		144	1	77	70	39	54	25	85	1065	2080
200		288	2	82	76	45	52	25	97	1485	2760
231		333	3	92	86	34	61	27	145	1967	3700
289		416	3	92	85	49	62	28	168	2059	4186
300		432	3	92	86	60	63	29	204	2040	4475
347		500	3	102	95	46	68	33	257	2695	5410
400		576	3	104	97	40	66	30	233	2705	5460
463		667	3	108	102	51	71	33	289	3060	6265
500		720	3	108	102	51	71	33	285	3005	6420
578		833	3	107	101	53	73	35	318	3630	7125
19.92 150 kV BIL	50.2	100	1	79	72	39	41	24	95	1010	2010
	100.4	200	2	85	78	40	54	26	125	1475	2820
	167	333	3	94	87	42	55	28	165	2100	3875
	200.8	400	3	96	87	46	62	28	171	2155	4110
	250	500	3	104	97	46	68	33	263	2610	5520
	335	667	3	106	100	50	71	33	287	3095	6285
	418	833	3	107	101	60	73	35	324	3245	7115
	502	1000	3	118	109	46	75	38	311	4115	8645

CONTROLS

CL-2A

- Internal-external voltage source switch
- Automatic/manual control switch
- Manual raise/lower toggle switch
- Position indicator drag hand reset switch
- Neutral indicating light
- Six-digit operations counter
- Panel-mounted fuses
- Band edge indicators
- Voltage test terminals
- External voltage source terminals
- Control knob locking devices
- Set voltage adjustment
- Bandwidth adjustment
- Time delay adjustment
- Line drop compensator settings
- Resistance and reactance reverse polarity switch
- Provisions to allow remote override of regulator operation via discrete (analog) supervisory control

CL-5C

- 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)
- Neutral indicating light
- Six-digit operations counter
- Panel-mounted fuses
- Band edge indicators
- Voltage test terminals
- External voltage source terminals
- Set voltage adjustment
- Bandwidth adjustment
- Time delay adjustment
- Line drop compensator settings
- Resistance and reactance reverse polarity switch
- Digital metering package (including instantaneous, demand, and time-tagged demand)
- Profile recorder
- Tap position indication tracking capability
- Voltage limiting ("First house protection")
- Voltage reduction with 3 modes
- Reverse power flow detection
- Provisions to allow remote override of regulator operation via discrete (analog) supervisory control
- Digital communications capability
- Resident communications protocol (DATA 2179)
- Data port for data reader or personal computer attachment

CONSTRUCTION

Core and Coil Assembly

Ease of service is provided by the design of the core-and-coil, tap changer, and reactor assembly. The entire assembly is cover suspended for ease of removal from the tank for inspection or maintenance.

The coil assembly features an 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 butt joint. The rugged core clamp assembly secures the coil effectively and positions the core for the optimum in quiet operation and low core loss.

With sealed-tank construction, the external oxygen supply is eliminated from the tank environment. With the use of a 65°C rise insulation system and designs with a nameplate rating of 55°C, an additional 12 percent capacity is available from the McGraw-Edison 32-step regulator without any loss of insulation life.

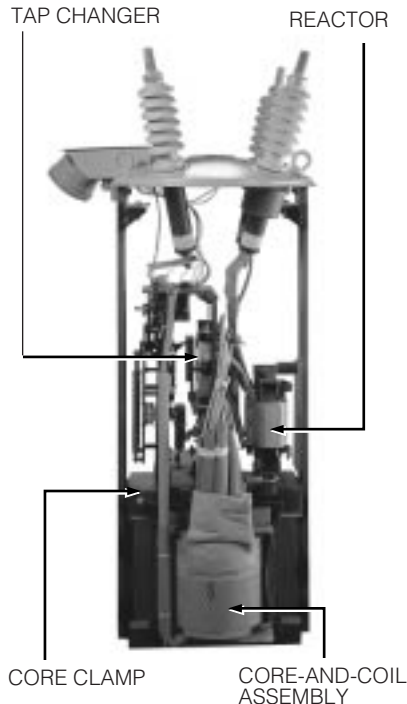


Figure 3. Core and coil, tap changer and reactor assembly.

Tap Changers

Spring-drive tap changers are typically used in regulators rated below 15 kV, 219 A and below; and units rated 19.92 kV, 100.4 A and below. A spring-drive tap changer is shown in Figure 4. In the larger sizes, the tap change is accomplished by a direct-drive mechanism. A direct-drive tap changer is shown in Figure 5. Smooth tap changes and long contact life are assured through careful design of speed controlling components.

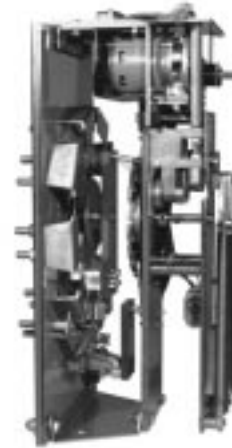


Figure 4. Spring-drive tap changer.



Figure 5. Direct-drive tap changer.

Position Indicator and ADD-AMP Capability

The position indicator is mounted on a junction box on the cover 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 zero. Zero designates 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 control front panel.

The ADD-AMP feature of VR-32 regulators allows increased current capacity by reducing the regulation range. This is accomplished by setting limit switches in the position indicator 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% regulation to alter the regulation range. The five possible load current ratings associated with the reduced regulation ranges are summarized in Tables 4 and 5. 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 unless reverse power is possible.



Figure 6.
Position Indicator.

TABLE 4
ADD-AMP Capabilities of 50 Hz Ratings

Rated Volts	Rated kVA	Load Current Ratings (Amperes) ¹				
		Regulation Range				
		±10% ¹	±8 3/4%	±7 1/2%	±6 1/4%	±5%
6600	33	50	55	60	68	80
	66	100	110	120	135	160
	99	150	165	180	203	240
	132	200	220	240	270	320
	198	300	330	360	405	480
	264	400	440	480	540	640
	330	500	550	600	668	668
	396	600	660	668	668	668
11000	55	50	55	60	68	80
	110	100	110	120	135	160
	165	150	165	180	203	240
	220	200	220	240	270	320
	330	300	330	360	405	480
	440	400	440	480	540	640
	550	500	550	600	668	668
	660	600	660	668	668	668
15000	75	50	55	60	68	80
	150	100	110	120	135	160
	225	150	165	180	203	240
	300	200	220	240	270	320
	450	300	330	360	405	480
	600	400	440	480	540	640
	750	500	550	600	668	668
	22000	110	50	55	60	68
220		100	110	120	135	160
330		150	165	180	203	240
440		200	220	240	270	320
660		300	330	360	405	480
33000		165	50	55	60	68
	330	100	110	120	135	160
	495	150	165	180	203	240
	660	200	220	240	270	320

¹ Additional 12% increase in capacity is available due to the use of 65° C winding rise insulation if the tap changer's maximum current rating has not been exceeded. For loading in excess of the above values please contact Cooper Power Systems customer service.

TABLE 5
ADD-AMP Capabilities of 60 Hz Ratings

Rated Volts	Rated kVA	Load Current Ratings (Amperes) ¹				
		Regulation Range				
		±10%	±8 3/4%	±7 1/2%	±6 1/4%	±5%
2500	25	100	110	120	135	160
	50	200	220	240	270	320
	75	300	330	360	405	480
	100	400	440	480	540	640
	125	500	550	600	668	668
	167	668	668	668	668	668
	250	1000	1000	1000	1000	1000
	333	1332	1332	1332	1332	1332
416.3	1665	1665	1665	1665	1665	
5000	25	50	55	60	68	80
	50	100	110	120	135	160
	100	200	220	240	270	320
	125	250	275	300	336	400
	167	334	367	401	451	534
	250	500	550	600	668	668
	333	668	668	668	668	668
	416.3	833	833	833	833	833
7620	38.1	50	55	60	68	80
	57.2	75	83	90	101	120
	76.2	100	110	120	135	160
	114.3	150	165	180	203	240
	167 ²	219/232	241/255	263/278	296/313	350/370
	250 ²	328/347	361/382	394/417	443/469	525/556
	333 ²	438/464	482/510	526/557	591/625	668
	416.3 ²	548/580	603/638	658/668	668	668
	500 ²	656/668	668	668	668	668
	667 ²	875/926	875/926	875/926	875/926	875/926
	833 ²	1093/1157	1093/1157	1093/1157	1093/1157	1093/1157
13800	69	50	55	60	68	80
	138	100	110	120	135	160
	207	150	165	180	203	240
	276	200	220	240	270	320
	414	300	330	360	405	480
	500	362	398	434	489	579
	552	400	440	480	540	640
	667	483	531	580	652	668
	833	604	664	668	668	668
	14400	72	50	55	60	68
144		100	110	120	135	160
288		200	220	240	270	320
333		231	254	277	312	370
416		289	318	347	390	462
432		300	330	360	405	480
500		347	382	416	468	555
576		400	440	480	540	640
667		463	509	556	625	668
720		500	550	600	668	668
833		578	636	668	668	668
19920		50	25.1	28	30	34
	100	50.2	55	60	68	80
	200	100.4	110	120	135	160
	333	167	184	200	225	267
	400	200.8	220	240	270	320
	500	250	275	300	338	400
	667	335	369	402	452	536
	833	418	460	502	564	668
34500	50	50	55	60	68	80
	100	100	110	120	135	160
	150	150	165	180	203	240
	200	200	220	240	270	320

¹ Additional 12% increase in capacity is available due to the use of 65° C winding rise insulation if the tap changer's maximum current rating has not been exceeded. For loading in excess of the above values please contact Cooper Power Systems customer service.

² Regulators are capable of carrying current corresponding to rated kVA when operated at 7200 volts.

