INSTRUCTIONS
for
POWERSTAT®
Variable Transformer Controller

FRM2000 Series

The following models are covered in this manual:
FRM2000-1, FRM2000-2, FRM2000-3
Revision D

Superior Electric reserves the right to make engineering changes on all its products. Such refinements may affect information given in the instructions. Therefore, USE ONLY THE INSTRUCTIONS THAT ARE PACKED WITH THE PRODUCT.

Superior Electric

213709-214 Rev. E

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INSPECTION

UNPACKING

When unpacking the unit, examine it carefully for any shipping damage. The "Damage and Shortage" instructions packed with the unit outlines the procedure to follow if any parts are missing or damaged.

DESCRIPTION

GENERAL

The FRM2000 series of Variable Transformer Controllers can be configured for one to three control channels. Each channel measures the output voltage from a variable transformer and controls the motor drive on the variable transformer to control the output voltage to a desired set point within a specified dead band. The unit can be programmed from an integral keypad or read and programmed remotely via a serial RS-232 port.

CONNECTIONS

Connect the FRM2000 series Variable Transformer Controller as shown on page 5.

MODEL NUMBER ASSIGNED

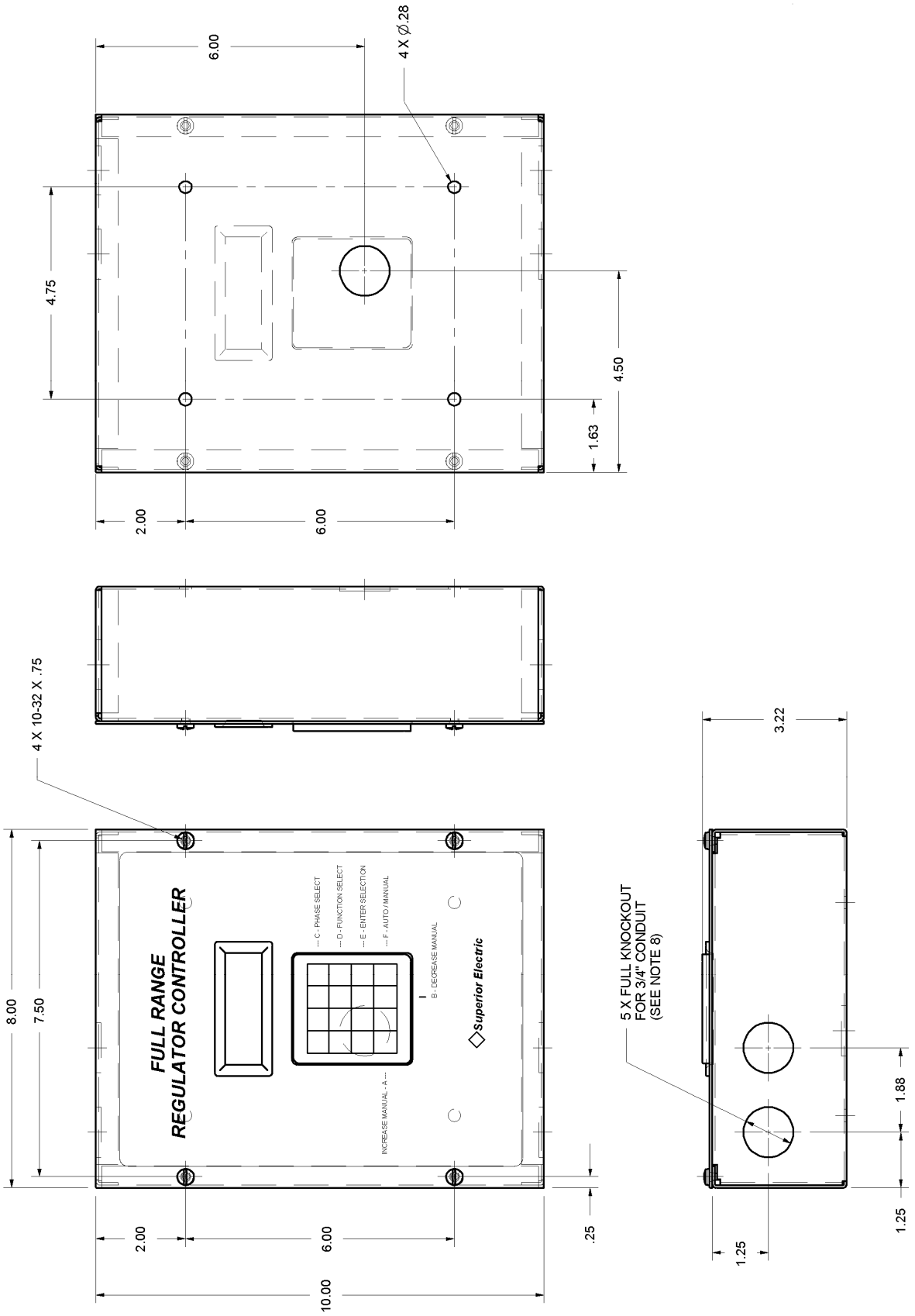
The model number for each FRM2000 Series Variable Transformer Controller identifies the various characteristics of that specific unit. All models can measure 4 channels and the number of motor drive the unit can control is determined by the model number. An RS232 serial interface is standard and an optional RS422 or RS485 can be provided on special models. The table below lists the characteristics and options for each model number.

Model Number	Controlled Motor Drives	Serial Interface
FRM2000-1	1	RS232
FRM2000-2	2	RS232
FRM2000-3	3	RS232
FRM2000-1B	1	RS422
FRM2000-2B	2	RS422
FRM2000-3B	3	RS422
FRM2000-1C	1	RS485
FRM2000-2C	2	RS485
FRM2000-3C	3	RS485

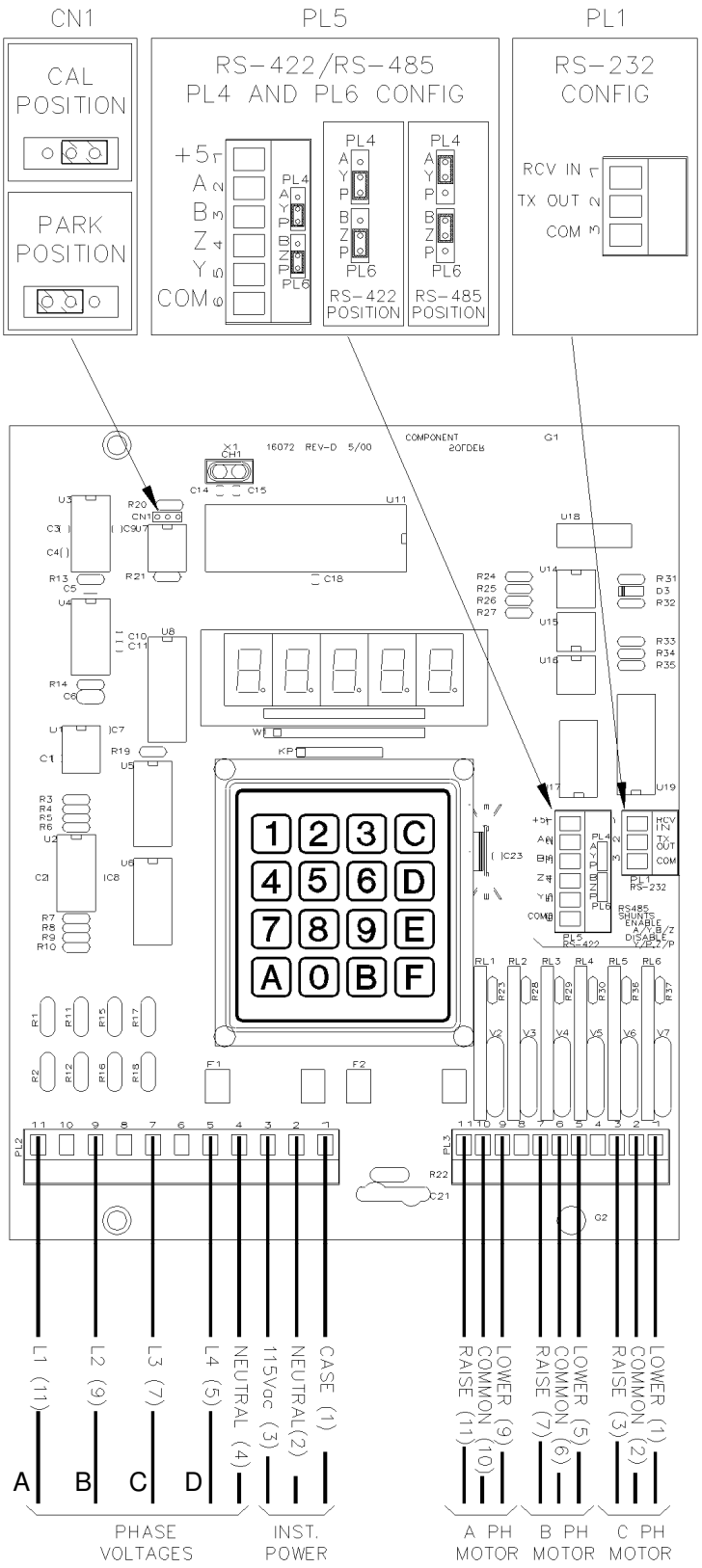
SPECIFICATIONS

CONFIGURATIONS	
Designed for	Single Phase 120, 240, or 277 line to neutral Three Phase 208Y/120, 240Y/138, 380Y/220, 480Y/277 or 600Y/346
INPUT VOLTAGE SIGNALS	
Measurement Controlled	0 to 500 VAC Line - Neutral
Instrument Power *	120 VAC @ 5 watts max
*Instrument Power source also supplies motor voltage.	
OUTPUT CONTROL	
Contact Closure	2 per motor drive
Type	Solid State Relay
Contact Ratings	3.0A, 240VAC
DISPLAY	
LED, 5 Digits, 0.5”H	XXX.X VAC
KEYPAD ENTRY	
Increase Manual	A
Decrease Manual	B
Phase Select	C
Function Select	D
Enter Selection	E
Auto/Manual	F
ACCURACY	
Voltage Display	±0.4VAC RMS
Serial Data	±0.4VAC RMS
RESPONSE TIME	Less than 0.1 sec
ENCLOSURE	
Type	NEMA 1
Size (H x W x D)	10.0” x 8.0” x 3.0”
ELECTRICAL CONNECTOR	PC Board Mount Header and Plug
FUSES	
Instrument Power	1/8 Amp
Motor Power, Total	4 Amps

OUTLINE


6.00
4 X ∅.28
4.75
4.50
1.63
2.00
6.00
4 X 10-32 X .75
FULL RANGE
REGULATOR CONTROLLER
C - PHASE SELECT
D - FUNCTION SELECT
E - ENTER SELECTION
F - AUTO / MANUAL
INCREASE MANUAL - A
B - DECREASE MANUAL
Superior Electric
8.00
7.50
2.00
6.00
10.00
.25
3.22
5 X FULL KNOCKOUT
FOR 3/4" CONDUIT
(SEE NOTE 8)
1.88
1.25
1.25

CONNECTIONS



CONTROL MODES AND FEATURES

Set Point — This is the value to which the unit controls the output of a variable transformer. To enter a set point, press the “D” key until the display says “A.”, on the left side, Enter a set point and then press “E”.

Dead Band — This is the tolerance around the set point to which the unit will keep the variable transformer. A dead band of 10 volts means ±5 volts around the set point. To enter a dead band, press the “D” key until the display says “Ad” on the left side. Enter a dead band in the form XX.X volts and then press “E”.

“A” — Phases A, B & C will all be controlled by the A phase control parameters (set point and dead band). To enter this mode, press the “D” key repeatedly until “A” appears on the display and then press the “E” key.

“AbC” — Phases A, B & C will be individually controlled by their respective control parameters (set point and dead band). To enter this mode, press the “D” key repeatedly until “AbC” appears on the display and then press the “E” key.

“bPASS” — Phases A, B, & C will be controlled to a set point equal to the voltage measured on channel D. The dead band will be set at 1.0V. While in this mode, the display will slowly step through the instantaneous voltage readings of each phase (A, B, C & D). What is displayed is not the instantaneous voltage; but instead the difference between the measured voltage on “D” phase and the set point for the phase that the display is currently showing. To enter this mode, press the “D” key repeatedly until “bPASS” appears on the display and then press the “E” key.

“F 50” — Used for operation on 50Hz power. To set the unit for 50Hz operation, press the “D” key repeatedly until “F 50” appears on the display and then press the “E” key.

“F 60” — Used for operation on 60Hz power. To set the unit for 60Hz operation, press the “D” key repeatedly until “F 60” appears on the display and then press the “E” key.

“HI XX” — Used for operation with high speed motors (motor speeds less than 10 seconds). XX is a 2 digit number entered from the keypad representing the voltage point above or below the set point at which slow speed pulsing begins. When the instantaneous voltage is approaching the set point and reaches this value, the motor transitions from moving continuously to moving in pulses in an effort to prevent an overshoot of the set point. To set the unit for a high speed motor, press the “D” key repeatedly until “HI” appears on the left side of the display; and then enter a 1 or 2 digit numerical value up to 25 representing volts. Press the ”E” key.

“LO XX” — Used for operation with low speed motors (motor speeds greater than 10 seconds). The explanation on why this is needed can be read in the explanation for “HI XX”. To set the unit for a low speed motor, press the “D” key repeatedly until ‘LO” appears on the left side of the display; and then enter up to a 1 or 2 digit numerical value up to 25 representing volts. Press the “E” key.

SERIAL COMMUNICATION

Serial interface is provided which can be used to remotely read and write the following:

READ

Voltage
set point
dead band
control
address

Write

set point
dead band
control
address
keypad lock toggle

Set Point — This is the value to which the unit controls the output of a variable transformer. To enter a set point, press the "D" key until the display says "A.", on the left side, Enter a set point and then press "E".

KEY FUNCTION DESCRIPTION

KEY	FUNCTION	DESCRIPTION
A	Increase Manual	With the "A" key depressed, the motor for the selected phase will run in the increase voltage direction. The instantaneous voltage display must be selected, and the unit must be in manual control mode. If the A phase parameters are used to control B & C phases (A mode), all three motors will operate simultaneously.
B	Decrease Manual	With the "B" key depressed, the motor for the selected phase will run in the decrease voltage direction, The instantaneous voltage display must be selected, and the unit must be in manual control mode. If the A phase parameters are used to control B & C phases (A mode), all three motors will operate simultaneously.
C	Phase Select	Pressing the "C" key will cause the display to step to the next phase (A, B, C or D) making it the active phase.
D	Function Select	Each press of the "D" key will step to the next function for the active phase.

LED DISPLAY	FUNCTION
AXXX.X	instantaneous voltage (default)
A.XXX.X	set Point
AdXX.X	dead band (total, 0.5V min.)
A	A mode
AbC	AbC mode
bPASS	bypass mode
F 60	60Hz
F 50	50Hz
HI XX	high speed.
LO XX	low speed { volts from set point at which slow speed pulsing begins. 25 volts max. }

After 10 seconds, the selected function will return to the default

E	Enter	Pressing the “E” key will lock in and store data that was entered or shown on the display i.e., (set point, dead band, frequency, voltage pulse point while in slow speed). Pressing the “E” key three times in succession within a span of about 2 seconds will toggle the keypad between locked and active.
F	Auto/Manual	Pressing the “F” key while the instantaneous voltage mode is displayed will toggle the selected phase between automatic and manual control modes. In manual mode the “A” & “B” keys may be used to raise and lower the voltage for the selected phase. If a phase is in manual mode, its instantaneous voltage display will flash quickly.

ASCII COMMUNICATIONS

Communication with the FRM2000 series Variable Transformer Controller is a simple ASCII protocol with defined commands and responses.

Communication Parameters: 9600 Baud, 8 Bits, No Parity, 1 Stop Bit

Message Format: All commands and responses have the same general format. The format is as follows: **STX ADDR CMD (DATA) ETX**

STX	An ASCII start of text control character, 02 Hex, control B, (^B).
ADDR	A meter’s unique character identification (address). A single hexadecimal character (0-9, A-F).
CMD	A two character command for which there is a defined response.
DATA	Information associated with the command, or response data as needed; some commands require no DATA.
ETX	An ASCII end of text control character, 03 Hex, control C, (^C).

The command string to the PVC does not contain spaces. Spaces only appear for purposes of readability in the document. Case sensitivity is not an issue.

READ/WRITE COMMANDS AND RESPONSES

RA (read address)
Cmd: STX 0[1] RA ETX
Rsp: STX ADDR ETX

[1] 0 is the universal address to which all controllers respond.

WA (write address)
Cmd: STX ADDR WA X[2] ETX
Rsp: STX WA ETX

[2] X is a character 1-9 or A-F representing the unit address.

RC (read control)
Cmd: STX ADDR RC ETX
Rsp: STX ADDR AA[3] BB[3] CC[3] F[4] Ø[5] S[6] XX[7] ETX

WC (write control)
Cmd: STX ADDR WC AA[3] BB[3] CC[3] F[4] Ø[5] S[6] XX[7] ETX
Rsp: STX WC ETX

[3] Two character per channel control code; The first or left most character is used to control the motor when in manual mode. The letters L, R & O are used respectively to cause the motor to run in the lower voltage direction (L), raise voltage direction (R) or off(O). The second character is either the letter A or M to put the channel in automatic control mode (A) or manual control mode (M). The default control codes are motor off in manual mode. i.e. letters OM

[4] "F" is the single digit 5 or 6 representing powerline frequency of 50Hz or 60Hz.

[5] "Ø" is either the letter I, S or B causing the phases to be individually controlled (I), controlled from "A" phase (S) or controlled from "D" phase (B) respectively.

[6] "S" is either the letter H or L representing high speed (H) or low speed (L) motors.

[7] XX is a 2 digit number representing the voltage point above or below the set point at which slow speed pulsing begins.

RD (read dead bands)
Cmd: STX ADDR RD ETX
Rsp: STX ADDR AA.A[8] BB.B[8] CC.C[8] ETX

WD (write dead bands)
Cmd: STX ADDR WD AA.A[8] BB.B[8] CC.C[8] ETX
Rsp: STX WD ETX

[8] AA.A BB.B CC.C are the channel A, B & C dead band setting; i.e. 00.5, 02.0,10.6

NOTE: When a dead band value is entered, the value represents the entire voltage width of the dead band. Example: A value of 5.0 is entered - this means ± 2.5V. The dead band minimum is .5V.

RS (read set points)
Cmd: STX ADDR RS ETX
Rsp: STX ADDR AAA.A[9] BBB.B[9] CCC.C[9] ETX

WS (write set points)
Cmd: STX ADDR WS AAA.A[9] BBB.B[9] CCC.C[9] ETX
Rsp: STX WS ETX

[9] AAA.A, BBB.B, CCC.C are the channel A, B & C voltage set point values. i.e. 002.0, 048.6, 322.9.

RV (read voltages)
Cmd: STX ADDR RV ETX
Rsp: STX ADDR AAA.A[10] BBB.B[10] CCC.C[10] DDD.D[10] ETX

[10] AAA.A, BBB.B, CCC.C, DDD.D are the channel A, B, C & D voltage values. i.e. 002.0, 048.6, 322.9

KL (keypad lock toggle)
Cmd: STX ADDR KL ETX
Rsp: STX KL ETX

NOTE: This lock method only prevents parameters from being changed. You can still view parameters with the phase and function select keys. The "E" key lock method prevents the entire keypad from being used except for the "E" key. In the event that serial communications are lost after the keypad has been locked via the serial port, a hardware lockout release is provided. Open the front cover and place the calibration jumper in the calibration position. Press the "E" key three times in succession within a span of 2 seconds to lock the keypad and perform this proceedure again to unlock both types of keypad locks. If the keypad was originally locked with the "E" key, the lockout release needs only to be performed once. Be sure to return the calibration jumper to the "park" position.

LINE-LINE TO LINE-NEUTRAL VOLTAGE TABLE

If you are sensing L-N and require a L-L voltage the table on the following two pages will ad in determining what the FRM2000 L-N setting should be.

LINE-LINE TO LINE-NEUTRAL VOLTAGE TABLE

VOLTAGE		VOLTAGE		VOLTAGE		VOLTAGE		VOLTAGE	
L-L	L-N	L-L	L-N	L-L	L-N	L-L	L-N	L-L	L-N
600	346.4	540	311.8	480	277.1	420	242.5	360	207.8
599	345.8	539	311.2	479	276.6	419	241.9	359	207.3
598	345.3	538	310.6	478	276.0	418	241.3	358	206.7
597	344.7	537	310.0	477	275.4	417	240.8	357	206.1
596	344.1	536	309.5	476	274.8	416	240.2	356	205.5
595	343.5	535	308.9	475	274.2	415	239.6	355	205.0
594	342.9	534	308.3	474	273.7	414	239.0	354	204.4
593	342.4	533	307.7	473	273.1	413	238.4	353	203.8
592	341.8	532	307.2	472	272.5	412	237.9	352	203.2
591	341.2	531	306.6	471	271.9	411	237.3	351	202.6
590	340.6	530	306.0	470	271.4	410	236.7	350	202.1
589	340.1	529	305.4	469	270.8	409	236.1	349	201.5
588	339.5	528	304.8	468	270.2	408	235.6	348	200.9
587	338.9	527	304.3	467	269.6	407	235.0	347	200.3
586	338.3	526	303.7	466	269.0	406	234.4	346	199.8
585	337.7	525	303.1	465	268.5	405	233.8	345	199.2
584	337.2	524	302.5	464	267.9	404	233.2	344	198.6
583	336.6	523	302.0	463	267.3	403	232.7	343	198.0
582	336.0	522	301.4	462	266.7	402	232.1	342	197.5
581	335.4	521	300.8	461	266.2	401	231.5	341	196.9
580	334.9	520	300.2	460	265.6	400	230.9	340	196.3
579	334.3	519	299.6	459	265.0	399	230.4	339	195.7
578	333.7	518	299.1	458	264.4	398	229.8	338	195.1
577	333.1	517	298.5	457	263.8	397	229.2	337	194.6
576	332.6	516	297.9	456	263.3	396	228.6	336	194.0
575	332.0	515	297.3	455	262.7	395	228.1	335	193.4
574	331.4	514	296.8	454	262.1	394	227.5	334	192.8
573	330.8	513	296.2	453	261.5	393	226.9	333	192.3
572	330.2	512	295.6	452	261.0	392	226.3	332	191.7
571	329.7	511	295.0	451	260.4	391	225.7	331	191.1
570	329.1	510	294.4	450	259.8	390	225.2	330	190.5
569	328.5	509	293.9	449	259.2	389	224.6	329	189.9
568	327.9	508	293.3	448	258.7	388	224.0	328	189.4
567	327.4	507	292.7	447	258.1	387	223.4	327	188.8
566	326.8	506	292.1	446	257.5	386	222.9	326	188.2
565	326.2	505	291.6	445	256.9	385	222.3	325	187.6
564	325.6	504	291.0	444	256.3	384	221.7	324	187.1
563	325.0	503	290.4	443	255.8	383	221.1	323	186.5
562	324.5	502	289.8	442	255.2	382	220.5	322	185.9
561	323.9	501	289.3	441	254.6	381	220.0	321	185.3
560	323.3	500	288.7	440	254.0	380	219.4	320	184.8
559	322.7	499	288.1	439	253.5	379	218.8	319	184.2
558	322.2	498	287.5	438	252.9	378	218.2	318	183.6
557	321.6	497	286.9	437	252.3	377	217.7	317	183.0
556	321.0	496	286.4	436	251.7	376	217.1	316	182.4
555	320.4	495	285.8	435	251.1	375	216.5	315	181.9
554	319.9	494	285.2	434	250.6	374	215.9	314	181.3
553	319.3	493	284.6	433	250.0	373	215.4	313	180.7
552	318.7	492	284.1	432	249.4	372	214.8	312	180.1
551	318.1	491	283.5	431	248.8	371	214.2	311	179.6
550	317.5	490	282.9	430	248.3	370	213.6	310	179.0
549	317.0	489	282.3	429	247.7	369	213.0	309	178.4
548	316.4	488	281.7	428	247.1	368	212.5	308	177.8
547	315.8	487	281.2	427	246.5	367	211.9	307	177.2
546	315.2	486	280.6	426	246.0	366	211.3	306	176.7
545	314.7	485	280.0	425	245.4	365	210.7	305	176.1
544	314.1	484	279.4	424	244.8	364	210.2	304	175.5
543	313.5	483	278.9	423	244.2	363	209.6	303	174.9
542	312.9	482	278.3	422	243.6	362	209.0	302	174.4
541	312.3	481	277.7	421	243.1	361	208.4	301	173.8

LINE-LINE TO LINE-NEUTRAL VOLTAGE TABLE

VOLTAGE		VOLTAGE		VOLTAGE		VOLTAGE		VOLTAGE	
L-L	L-N	L-L	L-N	L-L	L-N	L-L	L-N	L-L	L-N
300	173.2	240	138.6	180	103.9	120	69.3	60	34.6
299	172.6	239	138.0	179	103.3	119	68.7	59	34.1
298	172.1	238	137.4	178	102.8	118	68.1	58	33.5
297	171.5	237	136.8	177	102.2	117	67.5	57	32.9
296	170.9	236	136.3	176	101.6	116	67.0	56	32.3
295	170.3	235	135.7	175	101.0	115	66.4	55	31.8
294	169.7	234	135.1	174	100.5	114	65.8	54	31.2
293	169.2	233	134.5	173	99.9	113	65.2	53	30.6
292	168.6	232	133.9	172	99.3	112	64.7	52	30.0
291	168.0	231	133.4	171	98.7	111	64.1	51	29.4
290	167.4	230	132.8	170	98.1	110	63.5	50	28.9
289	166.9	229	132.2	169	97.6	109	62.9	49	28.3
288	166.3	228	131.6	168	97.0	108	62.4	48	27.7
287	165.7	227	131.1	167	96.4	107	61.8	47	27.1
286	165.1	226	130.5	166	95.8	106	61.2	46	26.6
285	164.5	225	129.9	165	95.3	105	60.6	45	26.0
284	164.0	224	129.3	164	94.7	104	60.0	44	25.4
283	163.4	223	128.7	163	94.1	103	59.5	43	24.8
282	162.8	222	128.2	162	93.5	102	58.9	42	24.2
281	162.2	221	127.6	161	93.0	101	58.3	41	23.7
280	161.7	220	127.0	160	92.4	100	57.7	40	23.1
279	161.1	219	126.4	159	91.8	99	57.2	39	22.5
278	160.5	218	125.9	158	91.2	98	56.6	38	21.9
277	159.9	217	125.3	157	90.6	97	56.0	37	21.4
276	159.3	216	124.7	156	90.1	96	55.4	36	20.8
275	158.8	215	124.1	155	89.5	95	54.8	35	20.2
274	158.2	214	123.6	154	88.9	94	54.3	34	19.6
273	157.6	213	123.0	153	88.3	93	53.7	33	19.1
272	157.0	212	122.4	152	87.8	92	53.1	32	18.5
271	156.5	211	121.8	151	87.2	91	52.5	31	17.9
270	155.9	210	121.2	150	86.6	90	52.0	30	17.3
269	155.3	209	120.7	149	86.0	89	51.4	29	16.7
268	154.7	208	120.1	148	85.4	88	50.8	28	16.2
267	154.2	207	119.5	147	84.9	87	50.2	27	15.6
266	153.6	206	118.9	146	84.3	86	49.7	26	15.0
265	153.0	205	118.4	145	83.7	85	49.1	25	14.4
264	152.4	204	117.8	144	83.1	84	48.5	24	13.9
263	151.8	203	117.2	143	82.6	83	47.9	23	13.3
262	151.3	202	116.6	142	82.0	82	47.3	22	12.7
261	150.7	201	116.0	141	81.4	81	46.8	21	12.1
260	150.1	200	115.5	140	80.8	80	46.2	20	11.5
259	149.5	199	114.9	139	80.3	79	45.6	19	11.0
258	149.0	198	114.3	138	79.7	78	45.0	18	10.4
257	148.4	197	113.7	137	79.1	77	44.5	17	9.8
256	147.8	196	113.2	136	78.5	76	43.9	16	9.2
255	147.2	195	112.6	135	77.9	75	43.3	15	8.7
254	146.6	194	112.0	134	77.4	74	42.7	14	8.1
253	146.1	193	111.4	133	76.8	73	42.1	13	7.5
252	145.5	192	110.9	132	76.2	72	41.6	12	6.9
251	144.9	191	110.3	131	75.6	71	41.0	11	6.4
250	144.3	190	109.7	130	75.1	70	40.4	10	5.8
249	143.8	189	109.1	129	74.5	69	39.8	9	5.2
248	143.2	188	108.5	128	73.9	68	39.3	8	4.6
247	142.6	187	108.0	127	73.3	67	38.7	7	4.0
246	142.0	186	107.4	126	72.7	66	38.1	6	3.5
245	141.5	185	106.8	125	72.2	65	37.5	5	2.9
244	140.9	184	106.2	124	71.6	64	37.0	4	2.3
243	140.3	183	105.7	123	71.0	63	36.4	3	1.7
242	139.7	182	105.1	122	70.4	62	35.8	2	1.2
241	139.1	181	104.5	121	69.9	61	35.2	1	0.6

Available Coast-To-Coast and Internationally

Voltage Control Components

POWERSTAT®	Variable Transformers
Volt-Pac®	Variable Transformers
LUXTROL®	Lighting Controls
5-WAY®	Binding Posts
SUPERCON®	Electrical Connectors

Power Quality Solutions

STABILINE®	Automatic Voltage Regulators
STABILINE®	Transient Voltage Surge Suppressors
STABILINE®	Uninterruptible Power Supplies
STABILINE®	Power Conditioners

Voltage Control Components are available worldwide through an extensive Authorized Stocking Distributor network. These Distributors offer literature, technical assistance and a wide range of models off-the-shelf for fastest possible delivery and service.

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