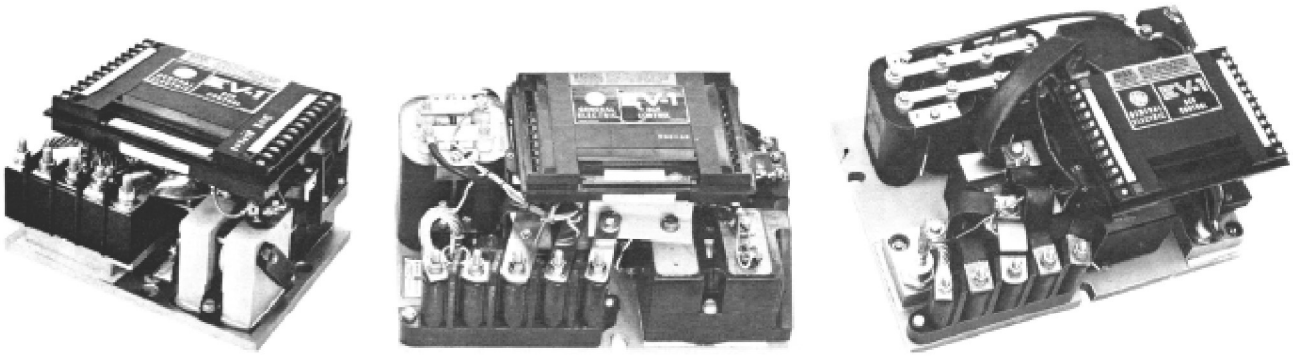
GENERAL ELECTRIC

EV-1 B, C, D



PANEL REPLACEMENT PARTS LISTS & DIAGRAMS

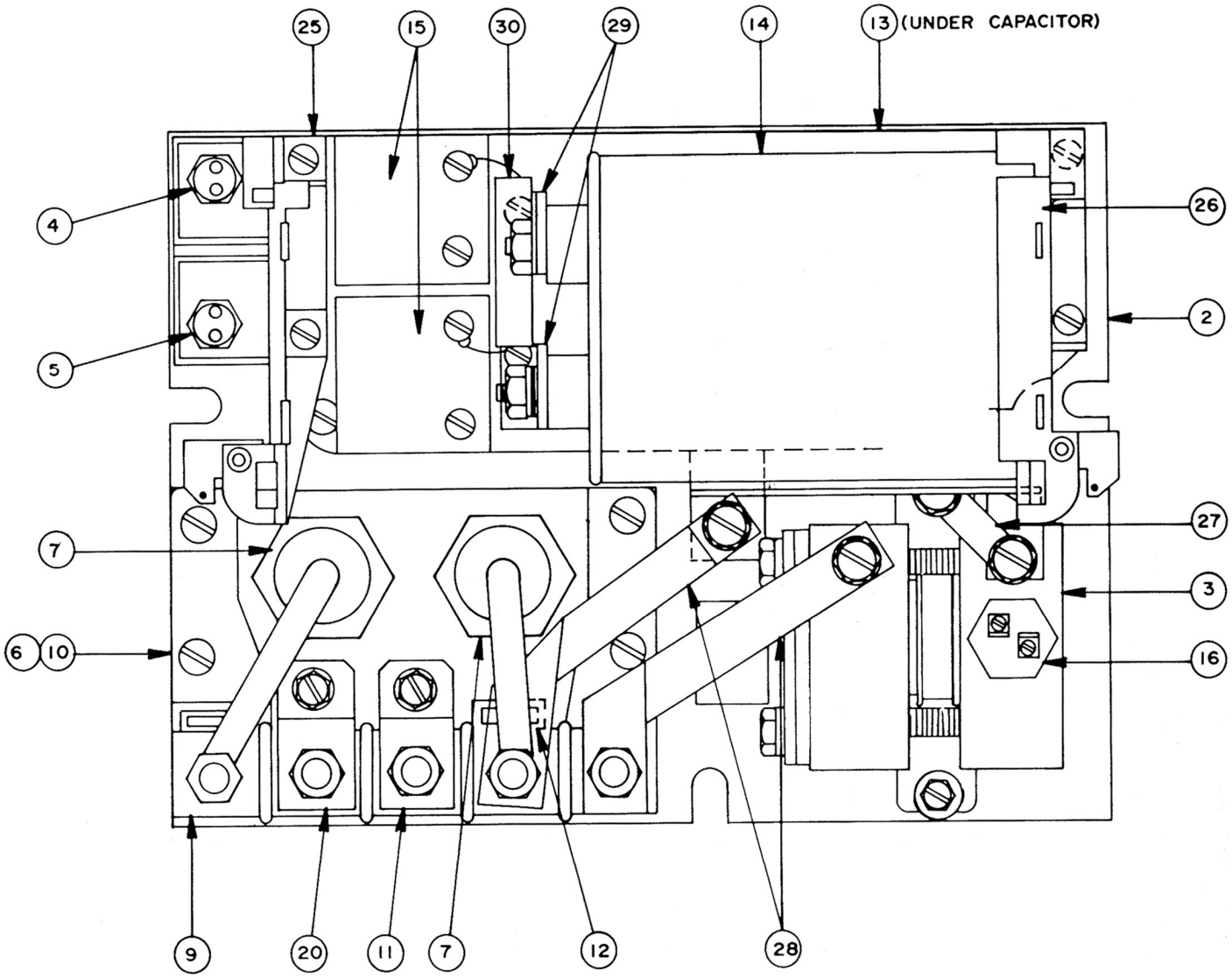
AND TROUBLESHOOTING/ TUNE-UP INSTRUCTIONS

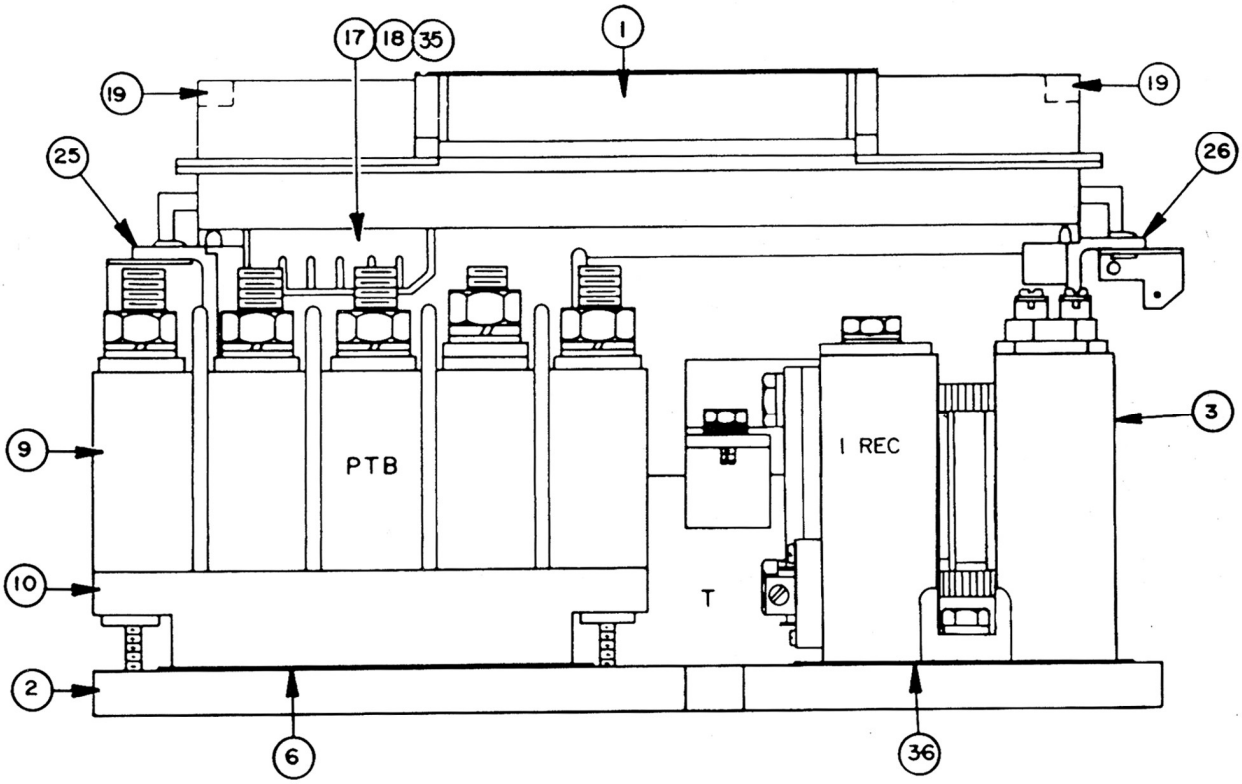
PARTS PRICING/ORDER INFORMATION: 800-333-1194

FSIP

FLIGHT SYSTEMS
INDUSTRIAL PRODUCTS

EV1B SCR PANEL





EV1B REPLACEMENT PARTS LIST

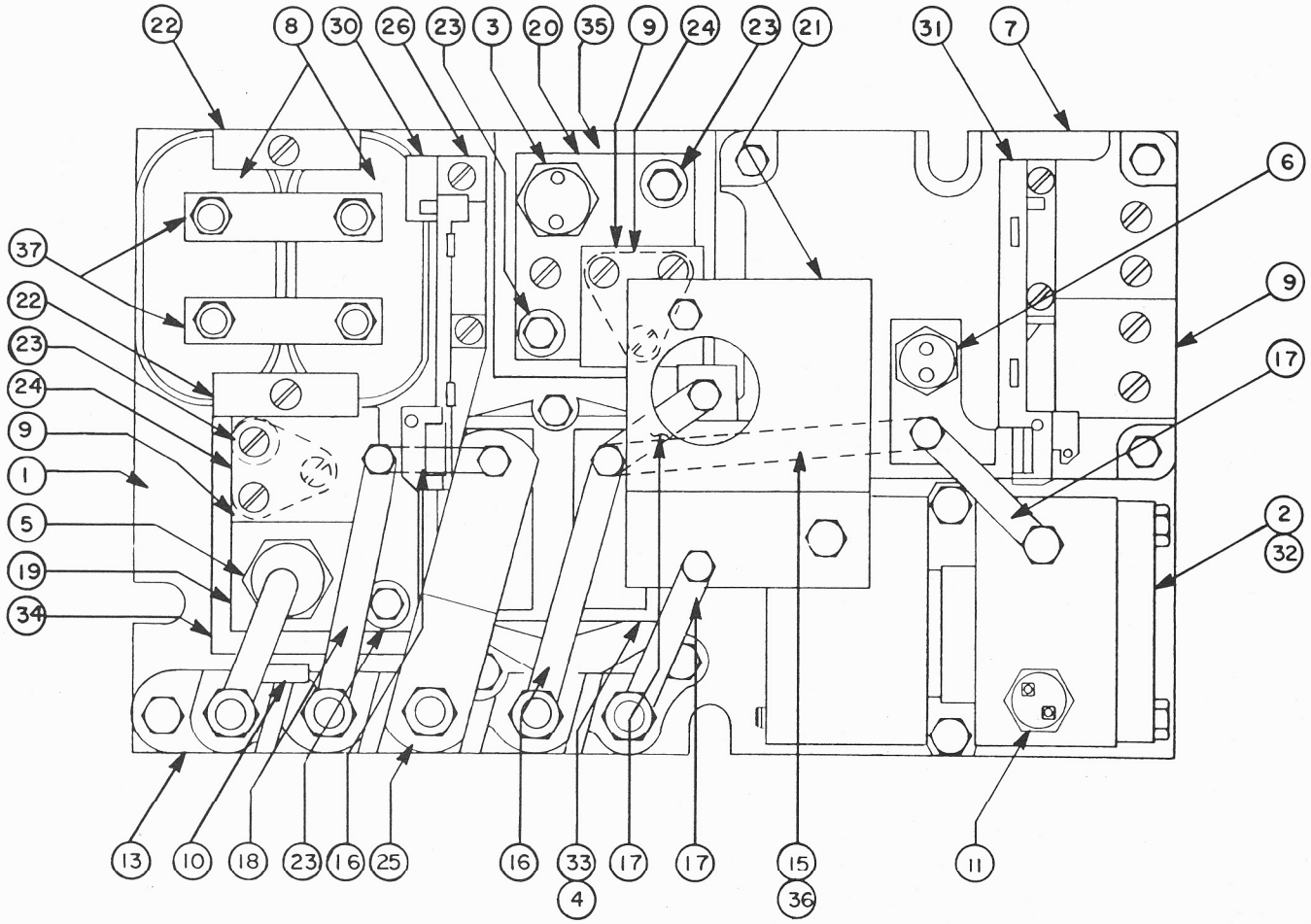
Listed by GE part number in ascending order

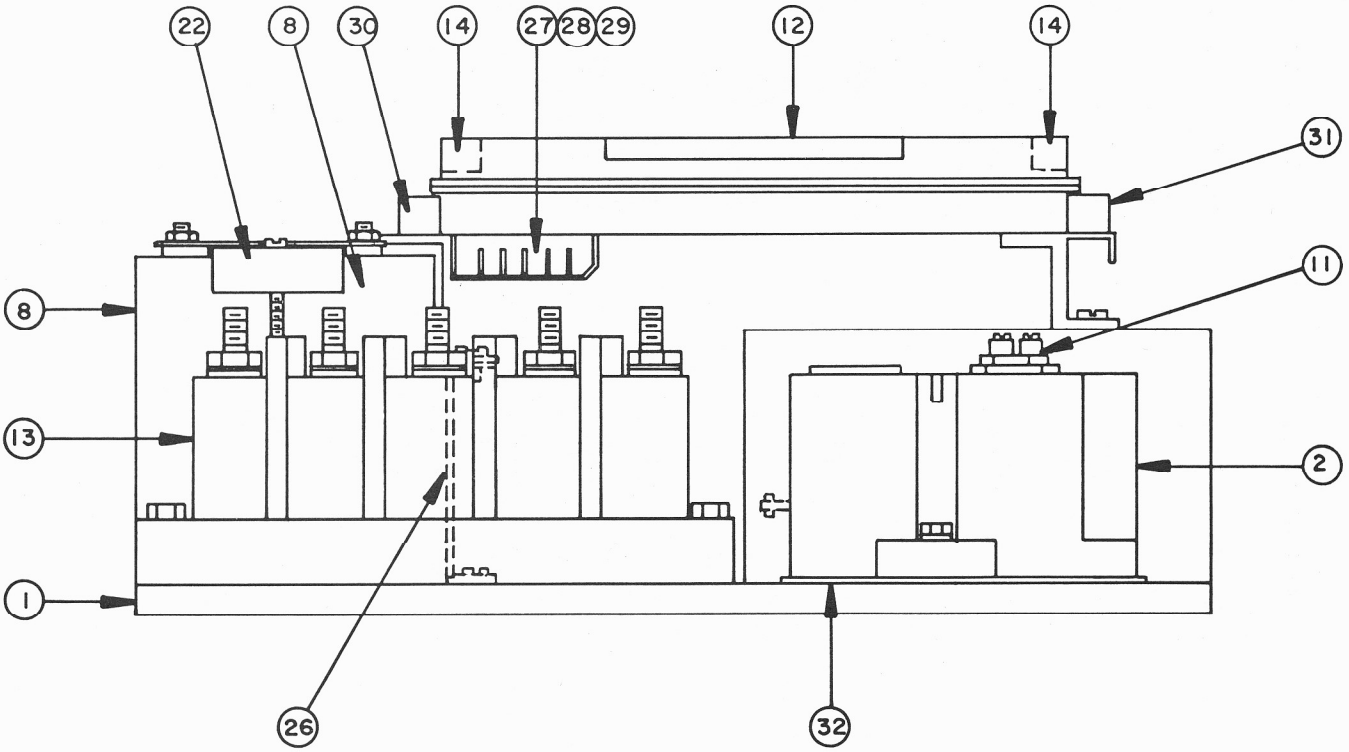
General Electric	Baker	Barrett	Clark	Crown	Hyster	Kalmar AC	Towmotor/ Caterpillar	Yale	Ref. No.	Description	Flight Systems Industrial Products
136C2305G1	110931	A27788-12	998521	84564	274101	4910903 74910903	377098	5169148-01	9	Power Terminal Block	14-2305-01
136C2306G1	110924	A227788-16	998524	79793	271899	4910570 74910570	377086	516918-01	13	Transformer	34-2306-01
136C2306G2									13	Transformer	34-2306-01
194B5373P1	110922	A27788-3				4910900 74910900	377081	5169128-01	2	Baseplate	145373-F1
194B5393G1	110925	A27788-18	998527	79805	271900	4910572 74910572	377088	5169198-01	15	Snubber	14-5393-01
194B5395P1		A27788-13	998702	84562 84671	274103 279810	4910904 74910904	377097	5169158-01	10	Heat Sink (3 & 4 Rec.)	14-5395-F1
194B5395P2									10	Heat Sink (3 & 4 Rec.)	14-5395-F1
194B5399G1	110926	A27788-4	998515	84669	279808 271901	4910562 74910562	377082 388914	5169138-01 5169138-13 5192688-00	3	Rectifier Assy. (1 Rec.)	Model 364
194B5399G2									3	Rectifier Assy. (1 Rec.)	Model 364
194B6376G1	110932 116298 129728	A27788-19 A28504-8	998528 999096	79807 84867	271902	4910573 4910922 74910573 74910922	377228	5169208-01 5169208-02	16	Thermal Protector	37-6376-F2
194B6376G2									16	Thermal Protector	37-6376-F2
194B6385G1	110934 110935	A27788-20 A27788-22	999099	79808	271903	4890408 4890409 74890408 74890409	377089	5169148-03	19	Terminal Strip	14-6385-F1
194B6388G1			998098 999098	79809	278695	4910905 74910905	377242	5169148-02	17	Control Terminal Block	14-6388-F1
195B4037G1									15	Snubber	14-5393-F1
195B6250P10		A2778827	998532		274095	4910909 74910909	377092	5169238-01	27	Flexible Bus	14-6250-10
195B6250P5	110937	A27788-28	998533	90272	274100	4910910 74910910	377093	5169238-02	28	Flexible Bus	14-6250-05
205A7129P1	100018 106304 110923 226MAW1 226MBC1 26121-26125 GE-SCR132 GE-SCR152	A27788-17 B27140-57	1802210 889404 895899 899404 995138 995417 995665 998526 999095	76317 79812	1199323 274092 278931	4905234 4910571 4910919 74905234 74910571 74910919	301773 377087 377231	1294980-39 1297270-08 1301450-04 5118778-01 5169178-02 5169178-03	14	Capacitor	33-9053-FS
205A7130P1									14	Capacitor	33-9053-FS
245A6979P1		A27788-21	998529	84563	278694	4910906	972665	5169218-01	18	Cover/Terminal Block	14-6979-F1
245A6991G1	119819	A27788-14	998522	84565 84672	274106 279811	4910568 74910568	377101		11	Shunt Assembly	14-6991-01
245A6996P1		A27788-29	998534	107832	274093	4910911 74910911	377094	5169238-03	29	Bus	14-6996-F1

General Electric	Baker	Barrett	Clark	Crown	Hyster	Kalmar AC	Towmotor/ Caterpillar	Yale	Ref. No.	Description	Flight Systems Industrial Products
245A6998G1	119820	A27788-25	998530	84559	274096	4910907 74910907	377237	5169228-01	25	Card Support (Left)	14-6998-F1
245A6998G2	119821	A27788-26	998531	84560	274104	4910908 74910908	377238	5169228-02	26	Card Support (Right)	14-6998-F2
259A2135G1	110927	A27788-5	998517	79810	271905	4910563 74910563	377083	5169138-02	4	Rectifier Assy. (2 Rec.)	26-3B20-01
259A2138G1	110929	A27788-6	998518	79811	271906	4910564 74910564	3377084	5169138-03	5	Rectifier Assy. (5 Rec.)	26-1F10-02
259A3241G1									2	Baseplate	14-5373-F1
259A5523P1									14	Capacitor	33-9053-FS
259A5523P2									14	Capacitor	33-9053-FS
259A8709G1	111916	A27788-30	998535	84561	274110	4910969 74910969	377103	5169248-01	30	Resistor Assy.	14-8709-FS
259A8750G1	110930 111917	A27788-15	998523	79815	271911	4910569 74910569	377100	516178-01	12	Capacitor/Filter	14-8759-F1
259A8759G1									12	Capacitor/Filter	14-8759-F1
259A8783G1									3	Recitifier/Assy. (1 Rec.)	Model 364
259A8783G2									3	Recitifier/Assy. (1 Rec.)	Model 364
259A8783G8				106125	291565				6	Insulator	43-N395-F1
259A9053P1									14	Capacitor	33-9053-FS
259A9053P2									14	Capacitor	33-9053-FS
259A9208PXBR	110928 110928 111995	A27788-10 A27788-11	998519 998520	79813 79816	271909 271912 279809 300525	4878269 4910566 4910567 74878269 74910566 74910567	377099 377232 3C7422	5169138-05 5169138-06	7	Diode (3 & 4 Rec.)	25-BB20-01
259A9208PXCR									7	Diode (3 & 4 Rec.)	25-BB20-01
259A9209PXD									5	Rectifier Assy. (5 Rec.)	26-1F10-02
259A9210PXC									4	Rectifier Assy. (2 Rec.)	26-3B20-01
273A2523P2				105519	2986846	4910973 74910973	972951	5192688-03	36	Insulator	43-N783-01
7126R12G1		A27788-2	998273 998703	86219	2191567	4910912 74910912	9122245	5169268-01	35	Wiring Harness	14-6R12-F1
IC3650SC1A3	110933 116295		999245 999302 999616	79814	271910 279807 292300 314534 382683	4910575 74910575	369277 377247 387830	5169118-02 5169118-04 5169118-05 5169118-07 5184688-32	1	Card 24-84V w/FW	13-05E9-00
IC36450SC1A4									1	Card 24-84V w/FW	13-05E9-00
IC36450SC1B3									1	Card 24-84V w/FW	13-05E9-00
IC36450SC1B4									1	Card 24-84V w/FW	13-05E9-00
IC36450SC1C3									1	Card 24-84V w/FW	13-05E9-00
IC36450SC1D3									1	Card 24-84V w/FW	13-05E9-00
IC36450SC1E3									1	Card 24-84V w/FW	13-05E9-00
IC36450SC1E4									1	Card 24-84V w/FW	13-05E9-00
IC36450SC1E9									1	Card 24-84V w/FW	13-05E9-00
IC36450SC1F4	118103	A27788-1	906626 907064 908017 999874	84670 84760	291564 840383	4916277 74916277	972658	5169118-01 5169118-03 5184688-07	1	Card 24-84V w/o FW	13-05H9-00
IC36450AC1H3									1	Card 24-84V w/o FW	13-05H9-00

General Electric	Baker	Barrett	Clark	Crown	Hyster	Kalmar AC	Towmotor/ Caterpillar	Yale	Ref. No.	Description	Flight Systems Industrial Products
IC36450SC1H9									1	Card 24-84V w/o FW	13-05H9-00
IC36450SC2E9									1	Card 24-84V w/ FW	13-05E9-00
IC36450SC2H9									1	Card 24-84V w/o FW	13-05H9-00
IC36450SC3E9									1	Card 24-84V w/o FW	13-05E9-00
IC36450SC3H9									1	Card 24-84V w/o FW	13-05H9-00
IC36450SC4E9									1	Card 42-84V w/ FW	13-05E9-00
IC36450SC4H9									1	Card 24-84V w/o FW	13-05H9-00
IC36450SC5H9									1	Card 24-84V w/ FW	13-05E9-00
IC36450SC5E9									1	Card 24-84V w/o FW	13-05H9-00
See Our P/N									20	Negative Bus	

EV1C SCR PANEL





EV1C REPLACEMENT PARTS LIST

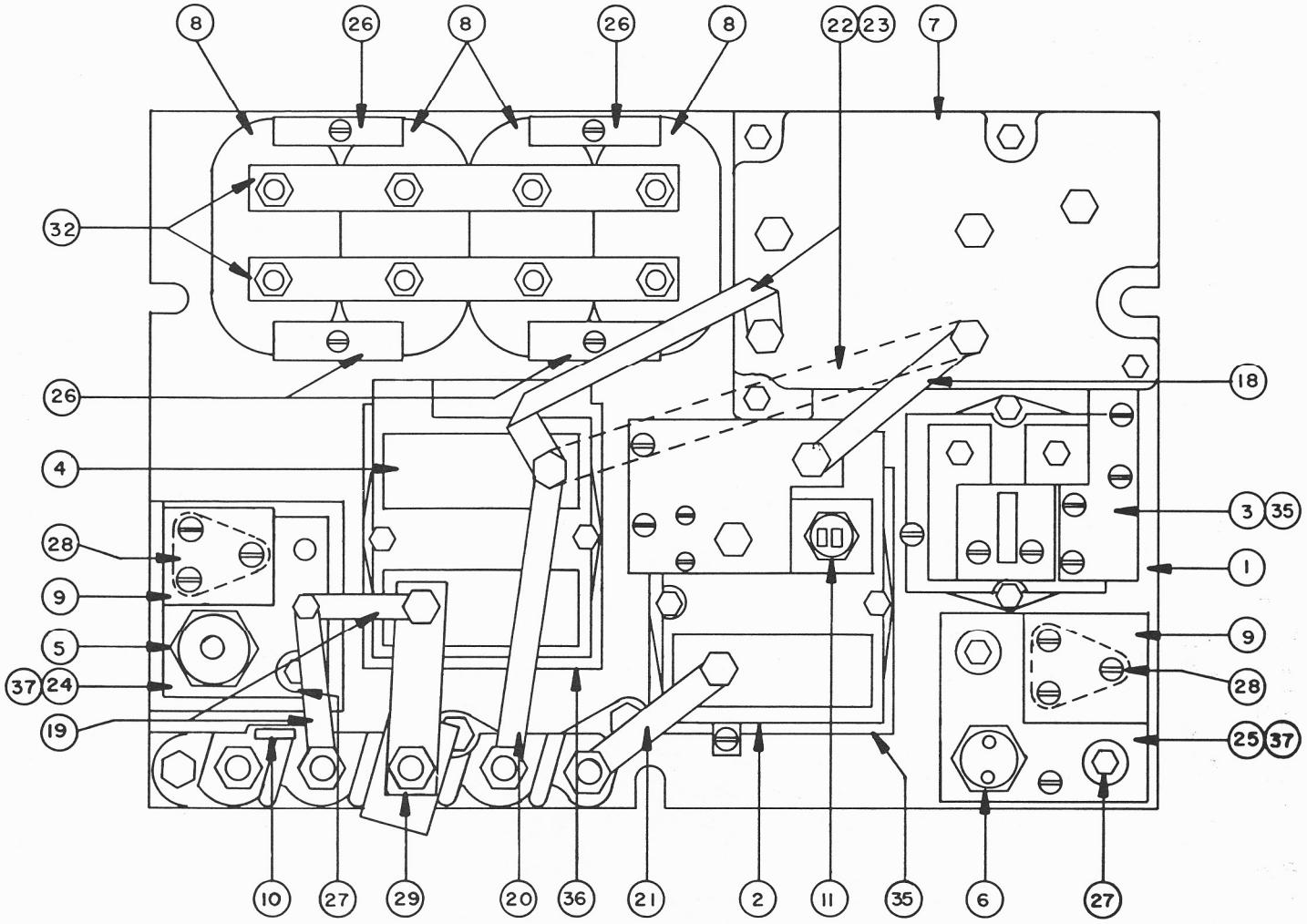
Listed by GE part number in ascending order

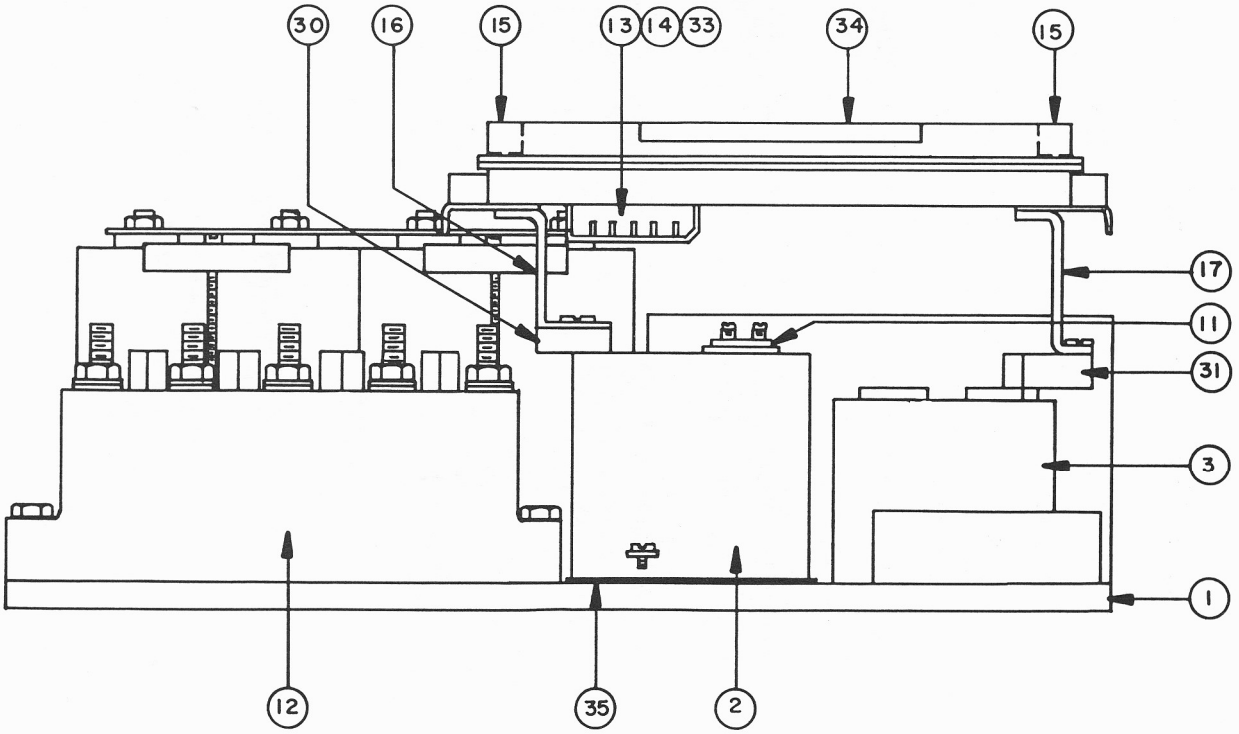
General Electric	Baker	Barrett	Clark	Crown	Hyster	Kalmar AC	Towmotor/ Caterpillar	Yale	Ref. No.	Description	Flight Systems Industrial Products
157C8160G5	130239		9991115		278926 280576	4910914 74910914	377245 385201	5169138-07	2	Recifier Assy. (1 Rec.)	42-8783-03
157C8162G1			999097			4910923 74910923	377246	516918-04	13	Power Terminal Block	14-8162-01
194B5393G1	110925	A27788-18	998527	79805	271900	4910572 74910572	377088	5169198-01	9	Snubber	14-5393-01
194B5399G5			999117		278928 295331	4910916 74910916	377233 385202	5169138-09	4	Recifier Assy. (3 Rec.)	Model 463
194B6376G1	110932 116298 129728	A27788-19 A28504-8	998528 999096	79807 84867	271902	4910573 4910922 74910573 74910922	377288	5169208-01 5169208-02	11	Thermal Protector	37-6376-F2
194B6376G2									11	Thermal Protector	37-6376-F2
194B3685G1	110937 110935	A27788-20 A27788-22	999099	79808	271903	4890408 4890409 74890408 74890409	377089	5169148-03	14	Terminal Strip	14-6385-F1
194B6388G1			998098 999098	79809	278695	4910905 74910905	377242	5169148-02	29	Terminal Block	14-6388-F1
195B4029P1									1	Baseplate	14-4029-F1
195B4037G1									9	Snubber	14-5393-01
195B4038P1			999105				377236	5169158-02	19	Heatsink (4 Rec.)	14-4038-F1
195B4038P2			999106				377254	5169158-03	20	Heatsink (2 Rec.)	14-4038-F2
195B4039G1			999109 999110			4910933 74910933	377239 379310		24	Snubber Mount	14-4039-01
195B4039G2									24	Snubber Mount	14-4039-01
195B6250P1									17	Flexible Bus	14-6250-01
195B6250P5	110937	A27788-28	998533	90272	274100	4910910	377093	5169238-02	16	Flexible Bus	14-6250-05
195B6250P8									18	Flexible Bus	14-6250-08
195B6250P11									15	Flexible Bus	14-6250-11
202B1621P1									37	Capacitor Strap	14-1621-03
205A7129P1	100018 106304 110923 226MAW1 226MBC1 26121-26125 GE-SCR132 GE-SCR152	A27788-17 B27140-57	1802210 889404 895899 899404 995138 995417 995665 998526 999095	76317 79812	1199323 274092 278931	4905234 4910571 4910919 74905234 74910571 74910919	301773 377087 377231	1294980-39 1297270-08 1301450-04 5118778-01 5199178-02 5169178-03	8	Capacitor	33-9053-FS
205A7130P1									8	Capacitor	33-9053-FS
245A6979P1		A27788-21	998529	84563	278694	4910906 74910906	972665	5169218-01	28	Terminal Block Cover	14-6979-F1
245A6998G1	119820	A27788-25	998530	84559	274096	4910907 74910907	377237	5169228-01	30	Card Support (Left)	14-6998-F1
245A6998G2	119821	A27788-26	998531	84560	274104	4910908 74910908	377238	55169228-02	31	Card Support (Right)	14-6998-F2

General Electric	Baker	Barrett	Clark	Crown	Hyster	Kalmar AC	Towmotor/ Caterpillar	Yale	Ref. No.	Description	Flight Systems Industrial Products
259A2135G2	130330		999118		278929	4910917 74910917	377241	5169138-10 5169138-16	6	Rectifier Assy. (5 Rec.)	26-3J20-02
259A2135G3									6	Rectifier Assy. (5 Rec.)	26-3J20-02
259A2191P9									36	Bus Insulator	14-2191-09
259A3246G3	130331		905974			4910921 74910921	972950	5188278-01	10	Filter Assy.	14-3246-F3
259A3289P1			999123			4910935 74910935	377240		26	Card Bracket Support	14-3289-F1
259A3290P1		28507-028	999108	103005	278941	4910932 74910932	377227	5180958-00	23	Heatsink Screw Ins.	14-3290-01
259A3292G1			999122			4910934 74910934	377243	5169168-02	25	Shunt Assy.	14-3292-01
259A5523P1									8	Capacitor	33-9053-FS
259A5523P2									8	Capacitor	33-9053-FS
259A8733P1									22	Cap Bracket Support	14-8733-01
259A8783G3									2	Recifier Assy. (1 Rec.)	42-8783-03
259A8783G5									4	Recifier Assy. (3 Rec.)	Model 463
259S8783G9					296648				34 & 35	Insulator (2 & 4 Rec.)	43-2523-F3
259A9053P1									8	Capacitor	33-9053-FS
259A9053P2									8	Capacitor	33-9053-FS
259A9208PXBR	110928 110938 111995	A27788-10 A27788-11	998519 998520	79813 79816	271909 271912 279809 300525	4878269 4910566 4910567 74878269 74910566 74910567	377099 377232 3C7422	5169138-05 5169138-06	5	Rectifier Assy. 3 & 4 Rec.)	33-9053-FS
259A9226PXC	130332		999116		278927	4910915 74910915	377244	5169138-08	3	Rectifier Assy. (2 Rec.)	26-AB40-03
259A9208PXCR									5	Rectifier Assy. (3 & 4 Rec.)	25-BB20-01
259A9210PXE									6	Rectifier Assy.	26-3J20-02
273A2409P1									21	Sheild	14-2409-01
273A2523P2				105519	296846	4910973 74910973	972951	5192688-03	33	Insulator (3 Rec.)	43-N783-01
273A2523P3					196648				34 & 35	Insulator (2 & 4 Rec.)	43-2523-F3
273A2523P6									32	Insulator (1 Rec.)	43-8063-10
44A293315-003									34 & 35	Insulator (2 & 4 Rec.)	43-2523-F3
7126R30G1			999246			4910937 7490918	385008		27	Wiring Harness	14-6R30-F1
918D620G1	130333		999119		278930	4910918	377248	5169188-02	7	Transformer	34-0620-01
IC36450SC1A3	110933 116295 117743		999245 999302 999616	79814	27191 279807 292300 314534 381348 382683	4910575 74910575	369277 377247 387830	5169118-02 5169118-04 5169118-05 5169118-07 5184688-32	12	Card 24-84V w/FW	13-05E9-00
IC36450SC1A4									12	Card 24-84V w/FW	13-05E9-00
IC36450SC1B3									12	Card 24-84V w/FW	13-05E9-00
IC36450SC1B4										Card 24-84V w/FW	13-05E9-00
IC36450SC1C3										Card 24-84V w/FW	13-05E9-00
IC36450SC1D3										Card 24-84V w/FW	13-05E9-00
IC36450SC1E3										Card 24-84V w/FW	13-05E9-00
IC36450SC1E4										Card 24-84V w/FW	13-05E9-00

General Electric	Baker	Barrett	Clark	Crown	Hyster	Kalmar AC	Towmotor/ Caterpillar	Yale	Ref. No.	Description	Flight Systems Industrial Products
IC36450SC1E9									12	Card 24-84 w/FW	13-05E9-00
IC36450SC1F4	118103	A27788-1	906626 907064 908017 999874	84670 84760	291564 840383	4916277 74916277	372658	516118-01 5169118-03 5184688-07	12	Card 24-84 w/o FW	13-05H9-00
IC36450SC1H3									12	Card 24-84V w/0 FW	13-05H9-00
IC36450SC1H9									12	Card 24-84V w/o FW	13-05H9-00
IC36450SC2E9									12	Card 24-84V w/FW	13-05E9-00
IC36450SC2H9									12	Card 24-84V w/0 FW	13-05H9-00
IC36450SC3E9									12	Card 24-84V w/FW	13-05E9-00
IC36450SC3H9									12	Card 24-84V w/o FW	13-05H9-00
IC36450SC4E9									12	Card 24-84V w/o FW	13-05E9-00
IC36450SC4H9									12	Card 24-84V w/o FW	13-05H9-00
IC36450SC5E9									12	Card 24-84V w/FW	13-05E9-00
IC36450SC5H9									12	Card 24-84V w/o FW	13-05H9-00

EV1D SCR PANEL





EV1D REPLACEMENT PARTS LIST

Listed by GE part number in ascending order

General Electric	Baker	Barrett	Clark	Crown	Hyster	Kalmar AC	Towmotor/ Caterpillar	Yale	Ref. No.	Description	Flight Systems Industrial Products
157C8160G3			999092			4910941 74910941		5169138-14	4	Rectifier Assy. (3 Rec.)	42-8783-06
157C8160G6			999090			4910939 74910939		5169138-13	2	Rectifier Assy. (1 Rec.)	42-8783-04
157C8163G1			999097			4910923 74910923	377246	5169148-04	12	Power Terminal Block	14-8162-01
157C8163G1			999094			4910943 74910943			7	Transformer	34-8163-01
194N5393H1	110925	s27788-18	998527	79805 103013	271900	4910572 74910572	377088	5169198-01	9	Snubber	14-5393-01
194B5399G6			999091			4910940 74910940		5169138-11	3	Rectifier Assy. (2 Rec.)	42-8783-07
194B6376G1	110932 116298 129728	A27788-19 A28504-8	998528 999096	79807 84867	271902	4910573 4910922 74910573 74910922	377228	5169208-01 5169208-02	11	Thermal Protector	37-6376-F2
194B6376G2									11	Thermal Protector	37-6376-F2
194B6385G1	110934 110935	A27788-20 A27788-22	999099	79808	271903	4890408 4890409 74890408 74890409	377089 972928	5169148-03	15	Terminal Strip	14-6385-F1
194B6388G1			998098 999098	79809	278695	4910905 74910905	377242	5169148-02	13	Control Terminal Block	47-6388-F1
195B4037G1									9	Snubber	14-5393-01
195B4038P1			999105			4910929	377236	516158-02	24	Heatsink (4 Rec.)	14-4038-F1
195B4038P2			999106			4910930	377254	5169158-03	25	Heatsink (5 Rec.)	14-4038-F2
195B4039G1			999109 999110			4910933 74910933	377239 379310		28	Snubber Mount	14-4039-01
195B4039G2									28	Snubber Mount	14-4039-01
195B4040P1						4910938 74910938			1	Baseplate	14-4039-01
195B6250P5	110937	A27788-28	998533		274100	4190910 74910910	377093	5169238-02 5169238-04	18	Flexible Bus	14-6250-05
202B1621P1									32	Capacitor Strap	14-1621-01
205A7129P1	100018 106304 110923 226MAW1 226MBC1 26121-26125 GE-SCR132 GE-SCR152	A27781-17 B27140-57	1802210 8894040 895899 899404 995138 995417 995665 998526 999095	76317 79812	1199323 274092 278931	4905234 4910571 4910919 74905234 74910571 74910919	301773 377087 377231	1294980-39 1297270-08 1301450-04 5118778-01 5169178-02 5169178-03	8	Capacitor	33-9053-FS
205A7130P1									8	Cpacitor	33-9053-FS
245A6979P1		A27788-21	998529	84563	278694	4910906 74910906	972665	516218-01	14	Terminal Block Cover	14-6979-F1
245A6998G1	119820	A27788-25	998530	84559	274096	4910907	377237	5169228-01	16	Card Support (Left)	14-6998-F1

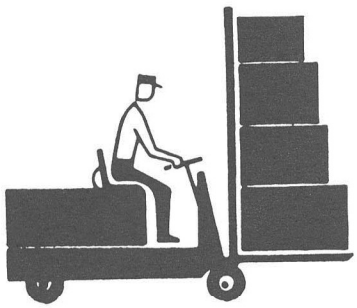
General Electric	Baker	Barrett	Clark	Crown	Hyster	Kalmar AC	Towmotor/ Caterpillar	Yale	Ref. No.	Description	Flight Systems Industrial Products
245A6998G2	119821	A27788-26	998531	84560	274104	4910908 74910908	377238	5169228-02	17	Card Support (Right)	14-6998-F2
259A2191P3									23	Bus Insulator	14-2191-03
259A3246G3	130331		905974			4910921 74910921	972950	5188278-01	10	Filter	14-3246-F3
259A3290P1		28507-028	999108	103005		4910932 74910932	377277	5180958-00	27	Bushing	14-3290-01
259A5523P1									8	Capacitor	33-9053-FS
259A5523P2									8	Capacitor	33-9053-FS
259A8733P1									26	Capacitor Support	14-8733-01
259A8753P1			999113			4910950 74910950			30	Card Box Bracket (LT)	14-8753-01
259A8753P2						4910949 74910949			31	Card Box Bracket (RT)	14-8753-02
259A8754P3									19	Flexible Bus	14-8754-03
259A8754P5									20	Flexible Bus	14-8754-05
259A8754P7									21	Flexible Bus	14-8754-07
259A8754P11									22	Flexible Bus	14-8754-11
259A8783G4									2	Rectifier Assy. (1 Rec.)	42-8783-04
259A8783G6									4	Rectifier Assy. (3 Rec.)	14-8783-06
259A8783G7									3	Rectifier Assy. (2 Rec.)	42-8783-07
259A8783G9					296648	74910972			37	Insulator (4 & 5 Rec.)	43-2523-F3
259A9053P1									8	Capacitor	33-9053-FS
259A9053P2									8	Capacitor	33-9053-FS
259A9208PXBR	110928 110938 111995	A27788-10 A27788-11	998519 998520	79813 79816	271909 271912 279809 3000525	4878269 4910566 4910567 74878269 74910566 74910567	377099 377232 3C7422	5169138-05 5169138-06	5	Rectifier Assy. (4 Rec.)	25-BB20-01
259A9208PXCR									5	Rectifier Assy. (4 Rec.)	25-BB20-01
259A9226PXE			999093			4910942 74910942		5169138-12	6	Rectifier Assy. (5 Rec.)	26-4K40-01
259A9226PXM									6	Rectifier Assy. (5 Rec.)	26-4K40-01
273A2523P2				105519 93524	296846	4910973 74910973	972951	5192688-03	36	Insulator (3 Rec.)	43N783-01
273A2523P3									37	Insulator (4 & 5 Rec.)	43-2523-F3
273A2523P6									35	Insulator (1 & 2 Rec.)	43-8063-10
44A293315-003									37	Insulator (4 & 5 Rec.)	43-2523-F3
577A519G2									22	Flexible Bus	14-8754-11
577A521G1			999111			4910948 74910948			29	Shunt	14-0521-01
7126R50G1			999553						33	Wiring Harness	14-6R50-F1
IC36450SC1A3	110993 116295 117743		999245 999302 999616	79814	271910 279807 292300 314534 381348 382683	4910575 74910575	369277 377247 387830	5169118-02 5169118-04 5169118-05 5169118-07 8184688-32	34	Card 24-84V w/FW	13-05E9-00
IC36450SC1A4									34	Card 24-84V w/FW	13-05E9-00
IC36450SC1B3									34	Card 24-84V w/FW	13-05E9-00
IC36450SC1B4									34	Card 24-84V w/FW	13-05E9-00

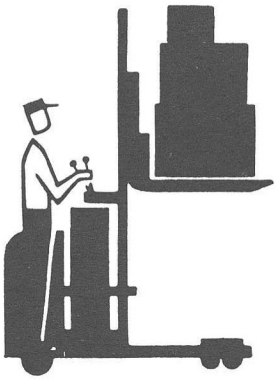
General Electric	Baker	Barrett	Clark	Crown	Hyster	Kalmar AC	Towmotor/ Caterpillar	Yale	Ref. No.	Description	Flight Systems Industrial Products
IC36450SC1C3									34	Card 24-84V w/FW	13-05E9-00
IC36450SC1D3									34	Card 24-84V w/FW	13-05E9-00
IC36450SC1E3									34	Card 24-84V w/FW	13-05E9-00
IC36450SC1E4									34	Card 24-84V w/FW	13-05E9-00
IC36450SC1E9									34	Card 24-84V w/FW	13-05E9-00
IC36450SC1F4	118103	A27788-1	906626 907064 908017 999874	84670 84760	291564 840383	4916277 74916277		4169118-01 5169118-03 5184688-07	34	Card 24-84V w/o FW	13-05H9-00
IC36450SC1H3									34	Card 24-84V w/o FW	13-05H9-00
IC36450SC1H9									34	Card 24-84V w/o FW	13-05H9-00
IC36450SC2E9									34	Card 24-84V w/ FW	13-05E9-00
IC36450SC2H9									34	Card 24-84V w/o FW	13-05H9-00
IC36450SC3E9									34	Card 24-84V w/ FW	13-05E9-00
IC36450SC3H9									34	Card 24-84V w/o FW	13-05H9-00
IC36450SC4E9									34	Card 24-84V w/ FW	13-05E9-00
IC36450SC4H9									34	Card 24-84V w/o FW	13-05H9-00
IC36450SC5E9									34	Card 24-84V w/ FW	13-05E9-00
IC36450SC5H9									34	Card 24-84V w/o FW	13-05H9-00

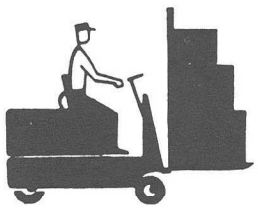
OPERATING & MAINTENANCE
INSTRUCTIONS

MODELS EV-1A, EV-1B, EV-1C, EV-1D
VOLTS 24-48, 48-84

EV-1* SCR CONTROL FOR ELECTRIC VEHICLES







CONTENTS

*Trademark of General Electric Company

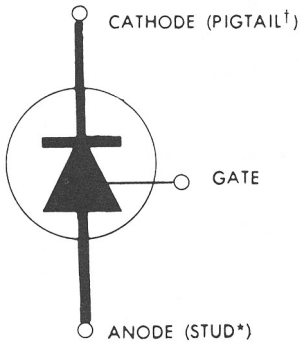
The information contained herein is intended to assist truck users and dealers in the servicing of SCR control furnished by the General Electric Company. It does not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance.

Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purpose, the matter should be referred to the truck manufacturer through his normal service channels, not directly to General Electric Company.

GENERAL ELECTRIC

WHAT IS AN SCR?

Since the heart of the control is a silicon controlled rectifier (SCR), a general understanding of the characteristics of the device will be helpful. The SCR is a semi-conductor rectifier used as a latching switch; i.e., it may assume either a conducting or nonconducting state (On or Off).



The SCR can be turned On by a momentary application of control current to the gate. To turn it Off, it is necessary in addition to removing the turn-on signal from the gate, either to remove all power from the SCR or to apply momentary reverse voltage between cathode and anode.

† Typical of SCR as used in GE control for electric vehicles.

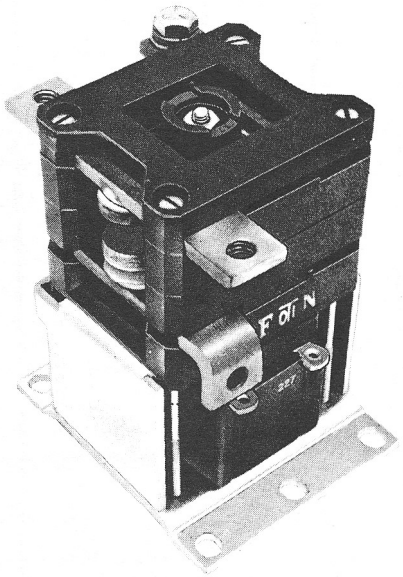


Fig. 2. Typical contactor

PHOTOS OF CONTROL

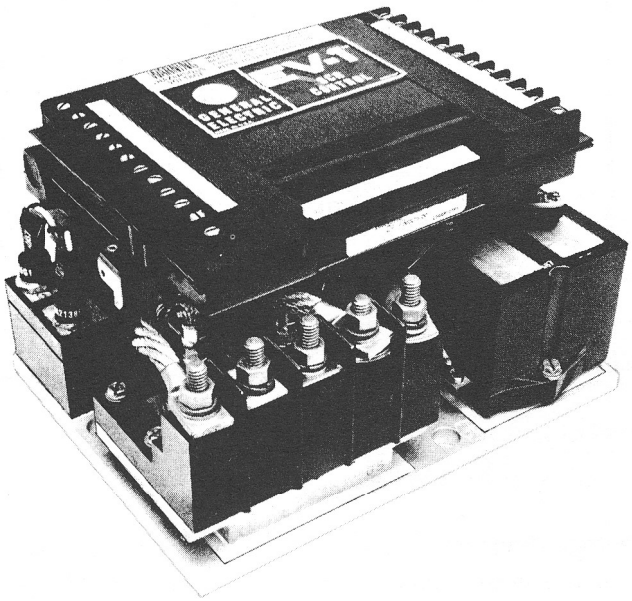


Fig. 1. Typical SCR static panel

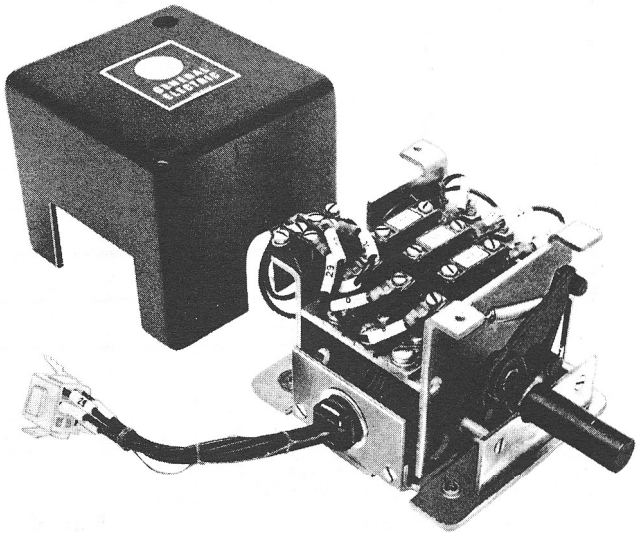
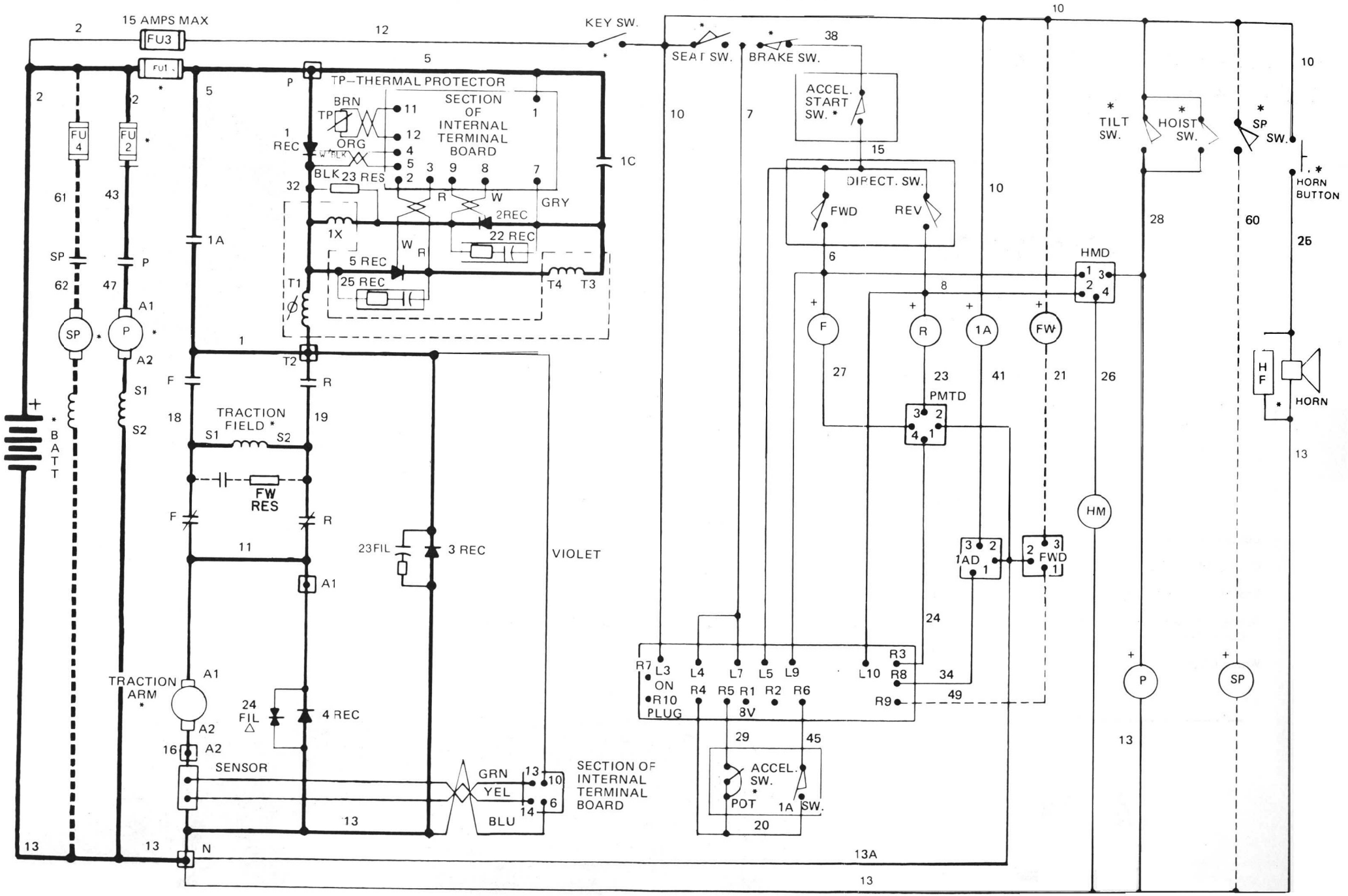
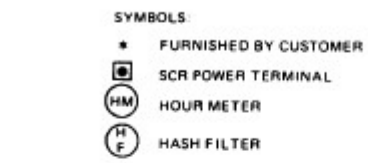


Fig. 3. Typical accelerator switch with cover removed

ELEMENTARY DIAGRAM





Note: A) BROKEN LINES DENOTE ACCESSORIES.
B) EV-1 CONTACTOR COILS HAVE INTERNAL SUPPRE
C) Δ 24 FIL ON MODELS C AND D ONLY
D) ϕ ON REACTOR MODELS OMIT PRIMARY T1-T2

Fig. 4. Elementary diagram, General Electric EV-1 control for typical sit-down truck. Refer to the manufacturer's instruction book for diagram for your specific truck.

CIRCUIT OPERATION (SEE FIG. 4)

The control circuit is energized by closing the Key switch, Seat switch, and moving the Forward or Reverse lever to either position and then depressing the accelerator, thus closing the Start switch. This applies power to the control card and, if the static return to OFF and pulse monitor trip requirements are satisfied, turns on the PMT driver, which will close the selected directional contactor, completing the circuit to the traction motor.

The control card supplies a gate pulse to 2 REC, turning it on to a conducting state, allowing current to flow from the battery through 1C, 2 REC, 1X, motor field, motor armature, current sensor, and back to the battery. After 1C charges, 2 REC shuts OFF due to lack of current. The control card checks that 1C is charged and unlocks the gates to 1 REC and 5 REC.

The control card then supplies a gate pulse to 1 REC, turning it ON to a conducting state, allowing current to flow from the battery through 1 REC, motor field, motor armature, sensor, and back to the battery. 5 REC turns ON and allows current to flow T4-T3, 1C, 1 REC, 5 REC back to T4-T3. This current charges 1C positive (card terminal 7 is now positive). This charge is now stored on the capacitor until it is time to turn OFF 1 REC. This charging cycle occurs in less than 1 millisecond (0.001 seconds) and 5 REC shuts OFF.

Current continues to flow in 1 REC until the control card turns ON 2 REC. When 2 REC conducts, capacitor 1C discharges around the circuit composed of 1C, 2 REC, 1X and 1 REC. This discharge current opposes the battery current through 1 REC until the resultant current is zero.

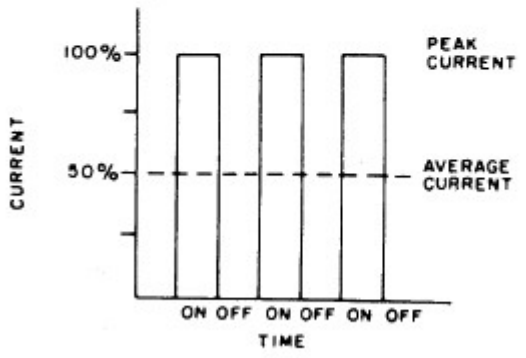


Fig. 5. Battery current

With reverse voltage across 1 REC, 1 REC is turned OFF. Current continues to flow in 1C, 2 REC, motor and the battery loop until the capacitor (card terminal 7) is fully charged negative. This charge exceeds battery voltage by an amount which is a function of motor current, and 2 REC turns OFF. Figure 5 illustrates the pulsing of current from the battery.

During the OFF time, the energy stored in the motor, by virtue of its inductance, will cause current to circulate through the motor around the loop formed by 3 REC, thus providing what is called "flyback current". Figure 6 shows the nature of the motor current, which is composed of both battery current and the inductive flyback current. It should be noted that the average motor current measured will be greater than the average battery current. The SCR control, in effect, converts battery current at battery volts into a higher motor current and a lower motor volts.

The time for the next On and Off cycle to start is determined by the time that the control card takes to oscillate. The oscillation times are controlled by the potentiometer in the accelerator. Slow speed is obtained by having maximum ohms in the potentiometer. As the resistance in the potentiometer decreases, the speed of the motor increases. With level operation, the SCR circuit is capable of delivering approximately 85 to 90 percent speed. For full-speed operation, the 1A contactor is closed to apply full battery voltage across the motor.

CONTROL FEATURES

- OSCILLATOR — The oscillator section of the card has two adjustable features, creep speed and controlled acceleration, and one fixed feature, top speed.

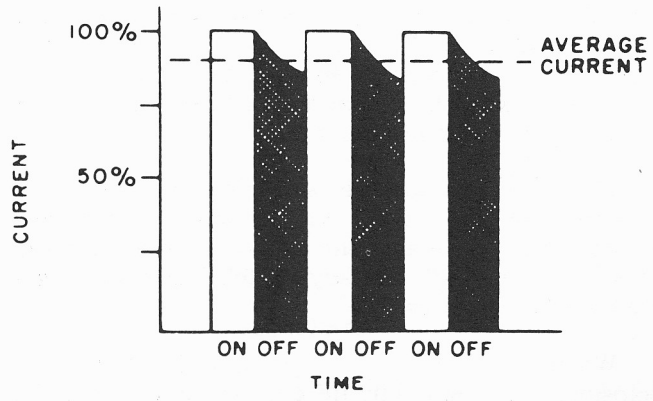


Fig. 6. Motor current

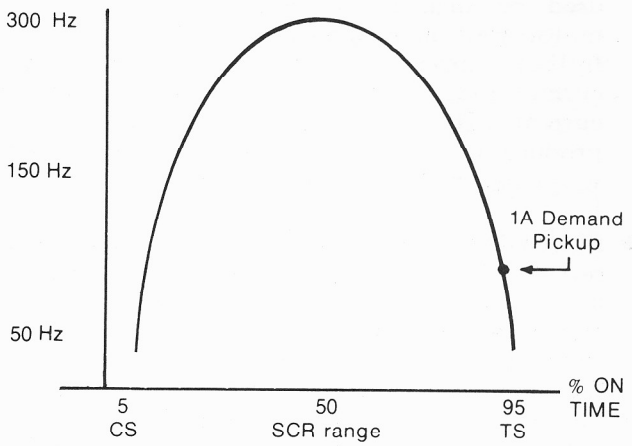


Fig. 7. Oscillator frequency curve

With the accelerator potentiometer at maximum ohms, the creep speed can be adjusted with a trimpot on the card. Top speed is fixed by card design, and is obtained with the accelerator potentiometer at minimum ohms.

The rate at which the oscillator may increase its % ON time is limited by "Controlled Acceleration". The minimum time required to go from creep speed to the 1A pickup point may be varied by an indexed trimpot (C/A) on the card, adjustable from approximately 0.5 seconds to 1.0 seconds.

The % ON time has a range of approximately 5 to 95 percent. The center operating condition of the oscillator is at 50 percent ON time with a nominal 1.7 milliseconds ON time and 1.7 millisecond OFF time. This corresponds to a maximum operating frequency of about 300 hertz. At creep the ON time will decrease to approximately 0.8 milliseconds while OFF time will become in the order of 20 milliseconds. At full SCR operation, this condition will be reversed (short OFF time, long ON time). This variation of ON and OFF time of the oscillator produces the optimum frequencies through the SCR range. See Fig. 7.

- CURRENT LIMIT — This circuit monitors motor current by utilizing a sensor in series with the armature. The information detected across the sensor is fed back to the card so current may be limited to a maximum safe value. If heavy load currents are detected, this circuit overrides the oscillator and limits the average current. An indexed trimpot for the current limit (C/L) adjustment is provided to maintain the peak voltage on the capacitor within its rating when

used on high source inductance and/or low motor resistance applications. Because of the flyback current through 3 REC, the motor current usually runs 2 to 3 times the battery current. The (C/L) trimpot adjustment will produce little or no variation of battery current when used with high resistance motors.

- PLUGGING — Slowdown is accomplished when reversing by providing a small amount of retarding torque for deceleration. If the vehicle is moving and the directional lever is moved from forward to reverse, the motor field is reversed, the motor armature is driven by the inertia of the vehicle and acts as generator. This generated current passes through 4 REC and the current sensor. When the plug signal is initiated, the oscillator circuit regulates at a plug current limit level as set by the Plug trimpot on the control card. This controls the pulse rate of 1 REC to regulate the generated motor current and bring the truck to a smooth stop and reversal.

- RAMP START — This feature provides SCR torque to restart a vehicle on an incline. The memory for this function is the directional logic in the card. When stopping on an incline, the Directional switch must be left in its original or OFF position to allow the control to assume full power when restarting in the same direction. The "C/L" trimpot affects this torque.

- FULL-POWER TRANSITION — This built-in feature provides smooth transition from SCR to 1A bypass. This is accomplished by the SCR continuing to pulse until the 1A contactor power tips close.

- 1A CONTROL — The 1A contactor has 6 modes of control:

  1. DEMAND PICKUP (fixed feature of the card) — If the oscillator has attained a % ON time equivalent to a motor voltage of 80 to 85 percent of the available battery volts, the 1A contactor will automatically pick up. The 1A switch in the accelerator is not necessary for this function. On "H3" cards, this feature may be eliminated by adding a jumper from R9 to R4.

  2. TIMED PICKUP — This feature works with the 1A switch in the accelerator. The time-delay pickup of 1A is provided by a circuit in the card. This feature allows 1A to be picked up after a time delay without reaching the demand point, and is normally used to apply full power at near stall conditions. This time delay is adjustable by means of a 1A time trimpot on the card.

  3. 1A THERMAL HOLDOFF — This feature prevents the 1A contactor from closing as a function of time when the truck is in severe thermal cutback to avoid torque jumps. When a truck starts to go into thermal cutback, the 1A time will rapidly increase to infinity as the control goes deeper into thermal cutback. On "E" and later cards, this feature may be eliminated by adding a jumper from R2 to R4.

  4. 1A CURRENT HOLDOFF — This feature is obtained by not wiring in the 1A switch in the accelerator. 1A will not pick up until the vehicle can accelerate to a point where the demand pickup will close the 1A contactor.

  5. 1A PLUGGING HOLDOFF — This built-in feature is designed to prevent 1A closure anytime during plugging.

  6. 1A DROPOUT (1A DO) — This adjustable feature can be set to open the 1A contactor if the traction motor is subjected to excessive currents. The dropout is adjustable with the (1A DO) trimpot. The directional or Accelerator switch must be returned to NEUTRAL to unlock the dropout circuit. Using this feature will reduce the 1A contactor tip life, thus it should be used only where needed to protect the motor.

- PULSE MONITOR TRIP — This function contains three features: The look ahead, the look again, and the automatic look again reset.

If 1 REC is shorted or 1A is welded, PMT will look ahead and prevent F or R from closing if either condition exists.

If 1 REC fails to commutate, or if 1A power tips remain closed when they should be open, the control will open F or R contactor. PMT will then look again by testing for a fault and, if none, reclose F or R. If the fault still exists, the F or R will reopen and remain open.

If 1A closes before a second commutation failure, the look again counter will automatically reset. This eliminates the inconvenience of resetting the PMT with the key switch if the tripping is due to random noise.

When the PMT circuit prevents F or R from closing, the PMT circuit can be reset only by opening the Key switch.

- STATIC RETURN TO OFF — This built-in feature of the control requires the operator to return the directional lever to NEUTRAL anytime he leaves the vehicle and returns. If the Seat switch or Key switch is opened, the control will shut off and cannot be restarted until the Directional switch is returned to NEUTRAL. A time delay (0.5 seconds) is built into the Seat switch input to allow momentary opening of the Seat switch. This same delay requires the Directional switch not be closed until both the Key switch and the Seat switch have been closed for 0.5 seconds.

- TIP BOUNCE TIMER — After F or R are closed or 1A opens, the oscillator card checks that the capacitor has been charged by 2 REC, the battery volts appear across 1 REC, and an interval of time has elapsed before 1 REC and 5 REC can be gated.

- COIL DRIVE MODULES — These modules are typically located on the contactor portion of the control. They are the power devices that operate F, R, 1A and FW contactor coils. These modules pick up or drop out these coils on command from the control card. All modules are equipped with reverse battery protection so that if the battery is connected incorrectly, none of the contactors controlled can be closed electrically.

- THERMAL PROTECTOR (TP) — This temperature-sensitive device is mounted in the 1 REC heat sink. If the 1 REC temperature exceeds design limits, the thermal protector will lower the maximum current limit and not allow 1 REC to exceed its temperature limits. Even at a reduced current limit, the vehicle will normally be able to reach sufficient speed for full 1A operation, thereby allowing the panel to cool. As the panel cools, the thermal protector will automatically return the control to full power.

- FIELD WEAKENING (optional) — If the vehicle is supplied with a field weakening circuit, the FW PU and FW DO trimpot adjustments will be on the SCR control card. Field weakening is a method of attaining higher running speed for the vehicle in level operation. The normal settings for this feature are: pickup of FW contactor from 125 to 150 percent of normal full-load running current (1A), and dropout of FW contactor from 275 to 300 percent current. The dropout puts the motor back to the 1A range to climb ramps and inclines.

- FW WITH 1A CURRENT HOLDOFF — The 1A switch in the accelerator has to close to allow the FW circuit to operate. To allow the two functions to operate, the 1A switch has to be rewired per Fig. 8.

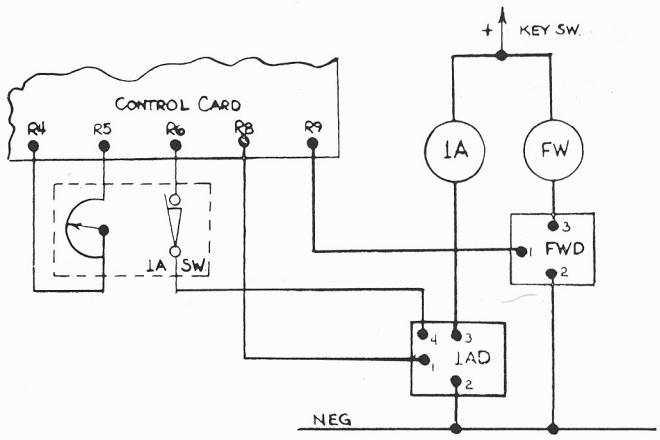


Fig. 8. FW with current 1A holdoff

- LOW VOLTAGE — Batteries under load, particularly if undersized or more than 80 percent discharged, will produce low voltages at the SCR control terminals. The EV-1* control is designed for use down to 50 percent of the nominal battery volts. Low battery volts may cause the control to not operate correctly but the PMT should open the F or R contactor in the event of a commutation failure.

- ACCESSORIES — Other functions and equipment available with SCR control for electric vehicles and their instruction references are:

IC3645	System Analyzer	GEK-40725
IC3645	Pump Time Delay	GEK-73400
IC4482	Contactors	GEH-4469
IC4484	Auxiliary Plugging Control	GEK-64881
IC4484	Battery Discharge Indicator	GEK-73401
IC4484	Dual Motor Control	GEK-64882
IC4485	Accelerator Switch	GEH-4470

- OSCILLATOR CARD CHANGES

Card IC3645	Volts	FW	Features (Described on page 8) 1	2	3	4	5	6	7
OSC1A3	24-48	Yes	X	X	X		X	X	
A4	48-84	Yes		X	X	X	X	X	
B3	24-48	No	X	X	X		X	X	
B4	48-84	No		X	X	X	X	X	
C3	24-48	Yes					X*	X	
D3	24-48	No					X*	X	
E3	24-48	Yes							
E4	48-84	Yes							
F4	48-84	No							
H3	24-48	No							X

*Only on cards up to Rev. B-2 (see card nameplate)

- OSCILLATOR CARD CHANGE FEATURES

1. Optional reduced current limit.
   Adding a connector from R1 to R2 will reduce motor current (by about 50 amperes when used with the EV-1B control.)

2. Low thermal cutback.
   Reduction in current limit is adequate only when the panel is mounted on a good heat sink. 1A thermal holdoff occurs at a low temperature. The low temperature thermal protector (group 1) must be used with this card.

3. No PMT look again reset.
   The PMT look again counter will not reset when 1A closes.

4. Motor current output signal location.
   IM Output is located at R2 instead of L6.

5. 1 REC synch circuit.
   1 REC synchronizing circuit shuts off 1 REC gate pulse causing failure to gate 1 REC with certain motors.

6. Non-optional 1A thermal holdoff.
   The provisions for disabling 1A thermal holdoff by adding a connector from R2 to R4 is not available.

7. Optional no 1A on demand and soft ramp start. Adding a connector from R9 to R4 softens the initial torque on ramp start on some applications, and also prevents 1A from picking up on demand.

GENERAL MAINTENANCE INSTRUCTIONS

The SCR control, like all electrical apparatus, does have some thermal losses. The semiconductor junctions have finite temperature limits above which these devices may be damaged. For these reasons, normal maintenance should guard against any action which will expose the components to excessive heat, such as steam cleaning; or which will reduce the heat dissipating ability of the control, such as restricting air flow.

The following DO'S and DON'TS should be observed:

- Any controls that will be used in ambients of 100 F (40 C) or over should be brought to the attention of the truck manufacturer.

- All external components having inductive coils must be filtered. Refer to vehicle manufacturer for specifications.

- The control should not be steam cleaned. In dusty areas, use low-pressure air to blow off the control. In oily or greasy areas, a mild solution of detergent or denatured alcohol can be used to wash off the control and then blow completely dry with low-pressure air. The control can also be cleaned with Freon TF† degreaser.

- For the SCR panel to be most effective, it must be mounted against the frame of the truck. The truck frame, acting as an additional heat sink, will give improved truck performance by keeping the SCR control package cooler. The use of a heat-transfer grease (Dow Corning 340) is recommended.

- Terminal boards and other exposed SCR control parts should be kept free of dirt and paint that might change the effective resistance between points.

  CAUTION: The truck should not be plugged when the truck is jacked up and the drive wheels are in a free wheeling position. The higher motor speeds can create excessive voltages that can be harmful to the control.

- Do not hipot (or megger) the control. Unless the terminals of each semiconductor and card are connected together, the control may be damaged. Refer to control manufacturer before hipotting.

- Use a lead-acid battery with the voltage and ampere hour rating specified for the vehicle. Follow normal battery maintenance procedures, recharging before 80 percent discharged and with periodic equalizing charges.

†Registered trademark of the E.I. duPont de Nemours & Company

TROUBLE-SHOOTING INSTRUCTIONS

The pulsing of the main SCR is too fast for conventional instruments to measure. When the control is functioning properly, a low hum can be heard.

Malfunctions of the SCR will generally fall into one of two categories. They are either no power (Table 1) or full power (Table 2), when operating in the SCR control range.

These simple and easy-to-follow tables outline the various symptoms and the corrective action to be taken.

The same device designations have been maintained on different controls but the wire numbers may vary. Refer to the elementary and wiring diagrams for your specific control. The wire numbers shown on the elementary diagram will have identical numbers on the corresponding wiring diagrams for a specific truck, but these numbers may be different from the numbers referenced in this publication.

WARNING: Before trouble-shooting, jack up wheels, disconnect the battery and discharge capacitor 1C. Reconnect the battery as needed for the specific check.

If capacitor 1C terminals are not accessible, discharge capacitor by connecting from SCR POS terminal to 2 REC anode. Check resistance on RX1000 scale from frame to SCR power and control terminals. A resistance of less than 20,000 ohms can cause misleading symptoms. Resistance less than 1000 ohms should be corrected first.

Before proceeding, visually check for loose wiring, maladjusted linkage to accelerator switch, signs of overheating of components, etc.

Tools and test equipment required are: (a) 6-volt lamp, 6-volt battery, two A14 diodes (1 Amp 400V), clip leads, volt-ohm meter (20,000 ohms per volt) and general hand tools, or (b) EV-1 System Analyzer, volt-ohm meter (20,000 ohms per volt) and general hand tools. If the system analyzer is used, refer to the analyzer instruction book.

Note: To test an EV-1 Model D, 1 REC, use a 12-volt battery and test lamp.

FUNCTION OF EV-1 CARD TERMINALS FOR IC3645OSC1E3 AND E4 CARDS

TERMINAL (Voltage measurements with respect to negative, SCR power terminal.)	DESCRIPTION	CONDITION	VOLTS NOMINAL	VOLTS THRESHOLD† E3	VOLTS THRESHOLD† E4
L1	Not presently used				
L2	Not presently used				
L3	Card power supply input must be low to satisfy PMT reset.	Key open Key closed	0 BV	4.1	4.1
L4	SRO Input. When used ignores open switch between L4 and L5.	Key or seat open Key and seat closed	0 BV		
L5	Accelerator Start and Brake switch input. Must be high after L3 and L7 are at battery volts for over 0.5 seconds and while L9 and L10 are low to complete SRO logic.	Key, seat, brake, or start open.	0		
		Key, seat, brake, and start closed.	BV		
		Key, seat, and direction closed.	0.07 BV (E3) 0.17 BV (E4)	4.1	18
		Key and seat closed, start and direction open.	0.9 BV (E3) 0.5 BV (E4)	4.1	18

†Threshold is the voltage ± approx. 5% below which the logic is the same as for zero volts.

TERMINAL	DESCRIPTION	CONDITION	VOLTS		
			NOMINAL	THRESHOLD †	
				E3	E4
L6	Motor current sensor output	No current	1.8		
		500 Amps average motor current model "B"	3.3		
L7	Seat switch input	Key open	0	8.2	19
		Key and seat closed.	BV		
L8	Not presently used				
L9	Direction switch input from positive side of "F" coil.	Key open	0		
		Key, seat, start, brake and direction "F" closed.	BV	8.2	19
L10	Direction switch input from positive side of "R" coil.	Key open	0		
		Key, seat, start, brake and direction "R" closed.	BV	8.2	19
R1	Card power supply	Key off	0		
		Key on	8.2		
R2	1A thermal holdoff control jumper to R4 to disable 1A thermal holdoff.	Key on, cold T/P	0		
		Key on, thermal cutback	0.66 or more		
R3	Output to PMT Driver	Key off	0 Volts		
		Key, seat, start, brake and direction selected. See Note 1.	5-10 milliamps		
R4	Common return to card for accelerator pot and 1A switch	Key off, use VOM and read from TBR4 to "Neg."	Less than 1 ohm		
R5	Accelerator pot input	Key on and accelerator at "creep".	3-4		
		Key on and accelerator at top speed.	0-.2		
R6	1A switch input	Key on, 1A switch open	8		
		Key on, 1A switch closed	0	2.0	2.0
R7	% ON time output. See Note 2.	Creep speed	2.2		
		Top speed	6.2		
R8	1A driver output	1A contactor open	0 Volts		
		Top SCR Speed. See Note 1.	5-10 milliamps		
R9	FW driver output	FW contactor open	0 Volts		
		1A closed high speed. See Note 1.	5-10 milliamps		
R10	Plugging output logic	Not plugging mode.	0 Volts		
		Plugging mode.	8 Volts		

NOTE 1: Connect milliammeter from terminal to R4. If contactor picks up during this test replace driver. If zero milliamps open lead and recheck to eliminate possible driver short from terminal 1 to 2.

NOTE 2: If B card is used, remove wire to R7 when checking voltage.

†Threshold is the voltage ± approx. 5% below which the logic is the same as for zero volts.

ALL TESTING SHOULD BE DONE WITH TRUCK JACKED UP.

TABLE 1
FAILURES WHICH CAUSE REDUCED OR NO MOTOR TORQUE WITH SCR CONTROL

Trouble-shooting is based on using the voltmeter to determine if the proper voltages are available to permit the control to operate properly. Refer to table pages 9 and 10 for theshold voltages. Check for leakage in switches if voltage is close to the threshold.

SYMPTOM	PROBABLE CAUSE
1A. Contactors do not pickup. No control voltage from positive to negative.	• Check power and control fuses. • Check battery for low specific gravity and connections for looseness or broken fittings.
1B. Contactors do not pickup. Control volts present from positive to negative with proper polarity.	• Plug in battery with Key switch OFF. Volts on L3 should be less than 4 volts. • Close Key switch. Check volts at T2 (pin 10). Should be about 50% of battery volts. Above 70% locks out 1 REC. (Control card contains a 10 K bridge from pin 5 to L3 and pin 6). If near battery volts, check for shorted 1A tips or a shorted 1 REC. If near zero volts, check for shorted 3 REC. (4G). • Close Brake, Start switches (all switches needed to close F or R contactor except the Direction switch). Volts on L3, L5, L7 should be battery volts. Volts on L9 and L10 should be near zero. Wait for one second, then close FORWARD Direction switch. Volts at L10 should remain near zero. Volts at L9 and L9 side of F coil should be battery volts. If not, check wiring and switches. • Connect milliammeter (10 ma scale) from R3 to R4. Should read 5-10 milliamps. If not, open Key switch, open lead from R3 to PMT driver, reclose all switches except Direction switch, wait over one second and close FORWARD Direction switch. If reading is not 5-10 milliamps, replace control card. If reading is good, the coil or wiring to the PMT driver is open or the PMT driver is defective. Check driver. (4E)
1C. Contactors close. NO power and NO SCR hum with accelerator in SCR range.	• Check volts at SCR positive. Should be battery volts. If not, check power fuse. • Check volts at T2. Should be zero. If not, check volts at S1, S2, A1, and A2 to locate open circuit.

SYMPTOM	PROBABLE CAUSE
1C. Contactors close. NO power and NO SCR hum with accelerator in SCR range. (Cont'd.)	• Check volts at R5. Should be 3-4 at creep reducing to 0.2 or less at top speed. If R5 remains about 4 volts, check accelerator. If R5 is zero, check volts at R1. Should be 8-8.5 volts. If R1 is above 10 or near zero and L3 is battery volts, replace control card and check PMT driver for short. (4E) • Check volts at R7. Should be 2-2.5 when Key switch closed. When F or R contactor is closed and accelerator depressed, should increase to about 6.2 volts. If remains near 2 volts, check volts at 1C (grey wire or 2 REC anode). If more than 0.125 BV, check if 2 REC will gate on. (4G) If less than 0.125 BV, check if 1 REC will gate on. (4G) Check current sensor green lead to card input pin 13. • Check 23 FIL for shorted resistor. • Replace control card. (4A)
1D. Contactors close. Little or no power. Normal SCR hum.	• Check 3 REC for open circuit. (4H) • Check 4 REC for short. (4H) • Check for open thermal protector. (4J)
1E. Contactors close. Little or no power. Abnormal SCR hum.	• Check 2 REC for short. (4G) • Check 5 REC for short. (4G) • Check 22 REC and 25 REC. (4M) **Note:** A 25 REC which checks good with an ohmmeter can cause a mis-operation of 5 REC under load, and can cause 1A to close on demand at lower than normal motor volts.
1F. Contactors close. Little power. No SCR hum.	• Check 1C for low resistance (4B).
1G. One contactor closes with normal operation but opposite contactor will not close.	• Close Key, Brake, Start switches (all switches needed to close F or R contactor except the direction switch.) Volts on L9 and L10 should be near zero. Wait for one second, then close Direction switch in the direction that contactor will not close. Volts at other direction input (L9 or L10) should remain near zero. Volts at non-closing direction (L9 or L10) and top of coil should be battery volts. If not, check wiring and switches. • Close switches as above. Check volts at negative side of coil or corresponding terminal of PMT driver. Zero volts indicates open coil, battery volts indicates open driver. (4E) • Replace control card. (4A)
1H. PMT trips after operating in 1A and acceleration is returned to SCR range.	• Check for cause of long 1A dropout time, i.e., defective 1A driver, low resistance in 1A filter, shorted turns in 1A coil, or low voltage coil.

TABLE 2

FAILURES WHICH CAUSE FULL MOTOR TORQUE WITH SCR CONTROL

SYMPTOM	PROBABLE CAUSE
2A. Contactors close. Full SCR speed immediately with audible hum. NO PMT trip.	• Key switch on. Check volts at R5. Should be 3-4 volts at creep position. If near zero, check Accelerator potentiometer. (4D) • Replace control card. (4A)
2B. Contactors close once or twice and then remain open. PMT trips.	• Check 5 REC for open circuit or open gate. (4G) • Check 1C for open and connections. (4B) • Check 1C for dead short. (4B) • Check 5 REC for short. • Check 2 REC for short. • Check 1X choke and transformer T3-T4. (4N) • Replace control card. (4A)
2C. Contactors close. Stall currents, under SCR operation, higher than normal and uncontrollable with C/L trimpot. Contactors may open once or twice and then remain open.	• Check current sensor yellow lead from negative end of sensor to card input pin 14. • Replace control card. (4A)

TABLE 3
MISOPERATION OF OTHER FEATURES

SYMPTOM	PROBABLE CAUSE
3A. 1A or FW contactors close with Key switch.	• Check drivers for short from terminals 2 to 3 by disconnecting wires to terminal 1 on the driver. (4E) • Check resistance from R4 to SCR negative. If not zero, the control card has been damaged, probably by a high-current input to R4 burning open a run on the card. Check for possible shorts and improper leads being connected to this terminal. Normally only the accelerator pot, 1A switch from R6, and B card use R4 as a negative. • Replace control card. (4A)
3B. F or R will close without returning Direction switch to OFF.	• Check location of L5. Any open switch between L5 and Direction switch will satisfy SRO. • Open lead from R3 to driver. Close switches normally used to close F or R. If F or R close, replace driver. • Reconnect lead from R3. Close Key switch only. Volts at L3 should be BV, volts at L5, L7, L9, L10 should be near zero. Close Seat, Brake and Direction switches. Volts at L7 should be BV. Volts at L5 should be about 0.07 BV (0.17 BV on E4 card). If near 4.1 volts, (18 on E4 card) check Start switch leakage. Close Start switch. If contactor picks up, replace control card. (4A)
3C. PMT does not open F or R contactor.	• Operate traction drive. Jumper R3 to R4. If contactor does not drop out, replace PMTD driver. • Operate traction motor in low speed SCR range. Be sure wheels are turning freely. Push 1A tips closed manually. F or R should open. If not, replace control card. (4A)
3D. 1A will not close at run (percent pickup).	• Connect a milliammeter from R8 to R4. Should read 5-10 milliamps when 1A should be closed. If near zero, see later steps for improper inputs or control card. Check volts at terminal 3 of 1A driver. Should be battery volts decreasing to about 2 volts when 1A should be closed. If near zero, check coil and wiring to terminal 3. If remains battery volts, check wiring from R8 to terminal 1 and terminal 2 to negative, then replace 1AD driver.

SYMPTOM	PROBABLE CAUSE
3D. 1A will not close at run (percent pickup). (Cont'd.)	• If milliamps from R8 to R4 are near zero when 1A should be closed, open lead from R8 to 1A driver and recheck. If now good, there is a wiring short to negative in the lead from R8 or defective driver. (4E) • Check volts at R7. Should be greater than 6 at top speed. If less than 5.7 volts, 1A will not close on demand. Check volts at R5, should reduce to less than 0.2 volts at top speed. If over 0.2 volts, check accelerator. If less than 0.2 volts, check that creep trimpot is not turned too far CCW. • Check continuity of violet wire from T2 to pin 10. • Replace control card. (4A)
3E. 1A will not close at SCR stall (time pickup). (Check truck diagram to see if 1A switch closes card circuit R4 to R6.)	• Check 1A switch circuit. Key switch on. Volts at R6 should drop to less than 2 volts when 1A switch is closed. • Check volts at orange lead to TP. If volts are above 1.6 (0.06 on OSC1A and OSC1B cards), control is in thermal cutback. Allow to cool, and recheck 1A function. • Turn 1A trimpot fully CCW and recheck. • Check continuity of violet wire from T2 to pin 10. • Replace control card. (4A)
3F. 1A will not open until start switch is opened.	• Check volts at R6. Should be near 8 volts when 1A switch is open. If not, check wiring and 1A switch.
3G. FW contactor will not close after 1A pickup.	• Check volts at R6. After 1A contactor closes, this point must be less than 2 volts. If not, check 1A switch and wiring. • Open lead to R9 and connect milliammeter from R9 to R4. When control signals FW to pick up, should read 5-10 milliamps. If remains at zero, turn FW PU trimpot fully CW and recheck. If remains zero, replace control card. (4A) If reads 5-10 ma, reset FW PU trimpot. (6)

SYMPTOM	PROBABLE CAUSE
3G. FW contactor will not close after 1A pickup. (Cont'd.)	• Reconnect lead to R9 and check volts at R9 when FW should pick up. If near 8 volts, check lead from R9 to terminal 1 of FW driver and R2 to negative for open, then replace driver. If about 2 volts, check volts at terminal 3 of FW driver. Should be battery volts dropping to 2 volts or less when FW should pick up. If volts are near zero, check wiring from positive to FW coil, FW coil, and wiring to terminal 3 of FW driver. If volts remain greater than four volts, replace driver.
3H. FW contactor will not drop out with increasing load.	• Check dropout setting on card. (6) • Replace control card. (4A)
3J. Stiff plug. Severe reversal.	• Check plug adjustment setting on card. (6) • Check 4 REC for open circuit. (4H) • Replace control card. (4A)
3K. Very soft reversal.	• Check plug adjustment setting on card. (6) • Replace control card. (4A)
3L. Blown power fuse. Very hot power cables.	• Check 3 REC for short. (4H) (Possible damage also to 1 REC and transformer module.)
3M. Hourmeter feeder faults:	
(1) Pump contactor closes when either F or R direction is selected.	• Diode shorted 3 to 4. (4H) Replace hourmeter block.
(2) One direction okay; opposite direction picks up *both* F and R.	• Diode shorted 1 to 4 *or* 2 to 4. (4H) Replace hourmeter block.
(3) Either direction selected picks up *both* F and R.	• Diode shorted 1 to 4 *and* 2 to 4. (4H) Replace hourmeter block.

TABLE 4
CHECKING COMPONENTS

4A. Main SCR Control Card

All trouble-shooting is written to check all outside devices and eliminate them as the source of symptoms. The conclusion being then that the card is faulty.

1. Instructions for Removal of Card
   a. Remove the four (4) screws shown in Fig. 9.
   b. Jack out the right- and left-hand terminal board, using a screwdriver in the slots, (leaving the wires intact) as shown in Fig. 10.
   c. Pry open the latches carefully with a screwdriver as shown in Fig. 11.
   d. Jack out the bottom plug with a screwdriver as shown in Fig. 12.

The card can be removed by hinging 10 degrees and pulling out, or, if panel components (not related to card hinge mountings) are to be replaced, disregard all instructions above except "C" and the card will hinge up to 90 degrees.

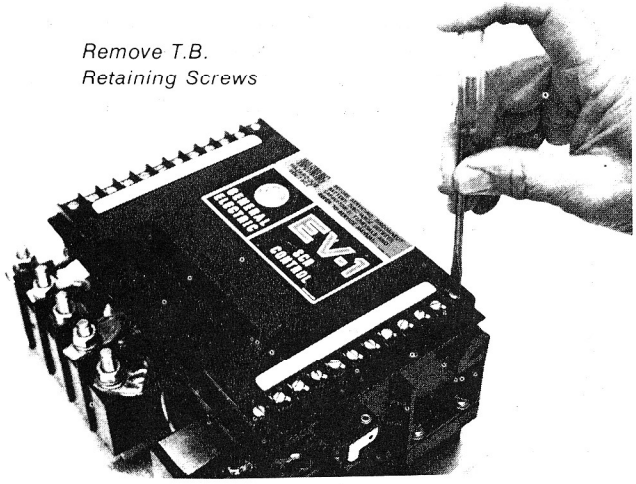


Fig. 9.

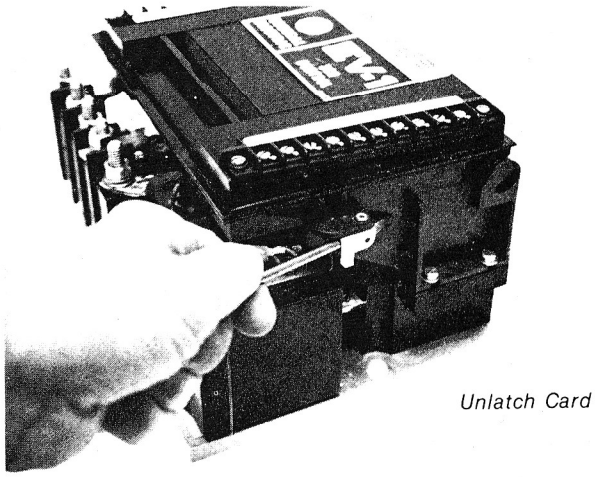


Fig. 11.

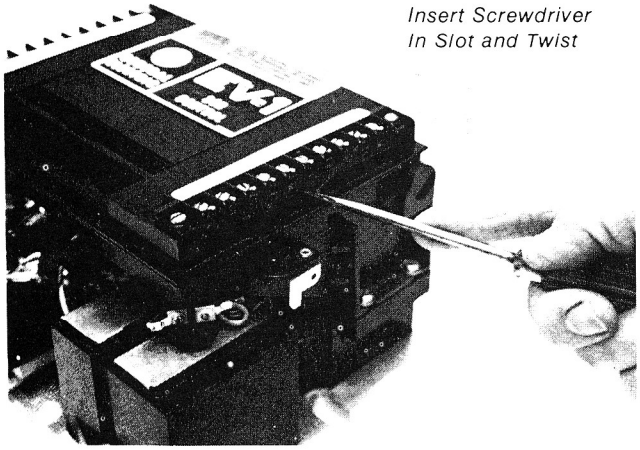


Fig. 10.

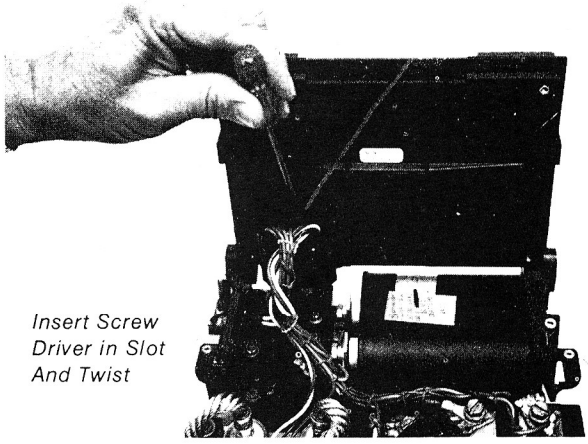


Fig. 12.

4B. Capacitor 1C

Disconnect battery and discharge capacitor. Measure ohms through the capacitor using the R x 10,000 scale. Meter should read zero and then swing slowly to above 100,000 ohms. Replace capacitor if above reading is not obtained.

4C. Contactors F, R, 1A, and P

75-ampere contactors (see GEH-3099)
150-ampere contactors (see GEH-4469)
300-ampere contactors (see GEH-4469)

NOTE 1. Control is arranged so that F and R do not break current. Check to see that 1A drops out ahead of F or R.

NOTE 2. Most contactor coils are polarity sensitive. The left-hand terminal must be connected to positive.

4D. Potentiometer in Accelerator

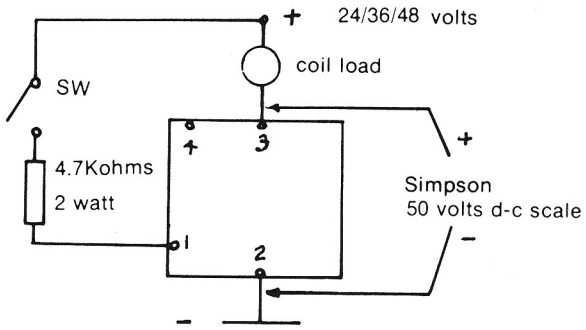
To check operation of the potentiometer, disconnect battery and disconnect wires at card terminal R4 and R5. Connect a VOM to wire removed with scale set to R x 100. With accelerator in creep speed position, the ohms reading should be 4800 to 6000 ohms. With accelerator in top speed position, reading should be 200 ohms or less. With wire disconnected as above, check for resistance of 1 megohm or higher from pot wires to truck frame.

4E. Driver Module

(IC3645CPM1RDA2 and IC3645CPMIRDB2)

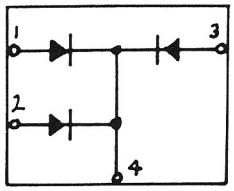
(a) Connect circuit as shown.
(b) Voltmeter should read battery volts with switch open.
(c) Close switch and meter reading should be 3 volts or less.
(d) Move load to terminal 4 and repeat steps (b) and (c).

NOTE: For 72 volt, use 8.2 Kohms 2-watt resistor.



4F. Hourmeter Module

Check individual diode circuits with trouble light or Simpson. (4H)



4G. SCRs (1 REC, 2 REC, 5 REC)

These are silicon control rectifiers. Before checking, disconnect battery and discharge capacitor 1C. Disconnect one power connection on the rectifier. Disconnect gate leads of SCRs at the card plug.

To check an SCR, it is necessary to have a 6-volt battery, a 6-volt lamp and 2 A-14 diodes.

NOTE: Models C and D require 12-volt battery and 12-volt lamp.

Connect the positive lead to the anode (1), connect negative lead to the cathode (3) as shown in Figure 13.

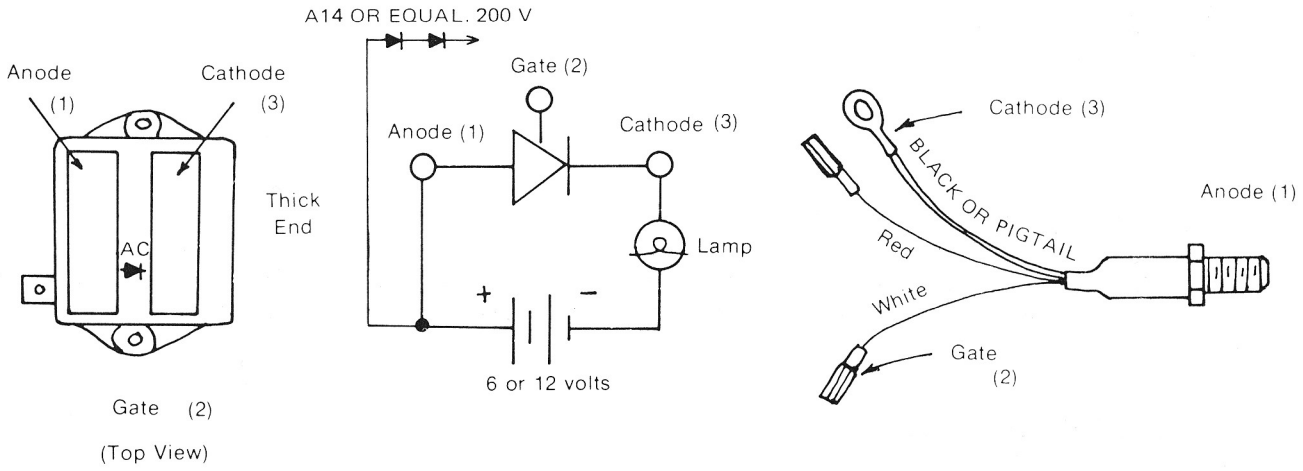


Fig. 13.

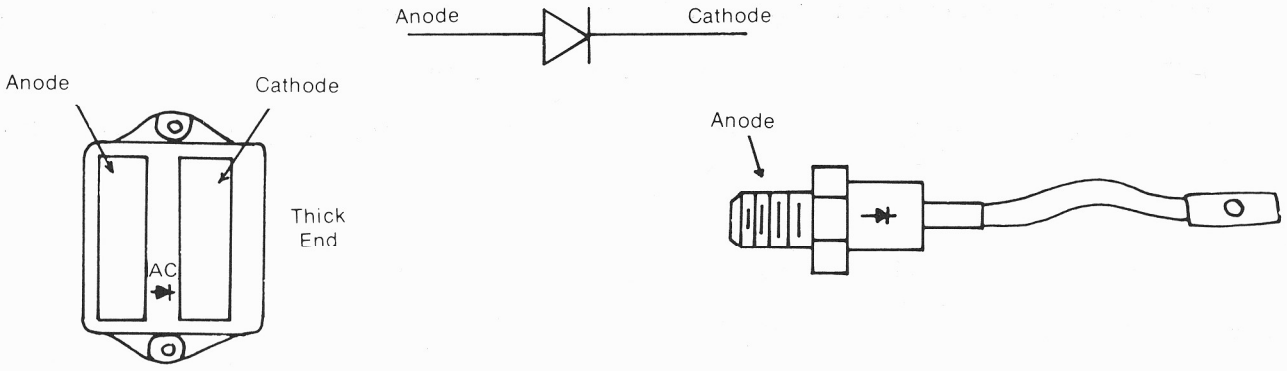
(a) The lamp should not light. If the lamp does light, the SCR is shorted and must be replaced.
(b) If check (a) was satisfactory, test the SCR for its ability to be turned on by the gate. Connect positive through two diodes to gate (point 2). If gate is operative, the lamp will come on and should remain on when the gate is removed. Some SCR's will operate correctly even if the lamp does not remain on, particularly with a weak battery.
(c) If lamp cannot be lit under step (b) the SCR is open and must be replaced.
(d) If the SCR is a stud-type device, check continuity between the red and black cathode leads.

NOTE: If you do not have a test light to check the SCRs as described above, they may be checked for shorts or opens by use of the VOM.
(1) Measure resistance from anode to cathode (R x 100 scale). If SCR is shorted (zero ohms), it must be replaced.
(2) Measure resistance from gate lead (white lead) to cathode and then from cathode to gate lead (R x 1 scale). If resistance reads either zero ohms (shorted) or infinity ohms (open), replace the SCR.
When reassembling SCRs, refer to TABLE 5.

4H. Rectifiers (3 REC, 4 REC, Diode Blocks)

When checking diodes, disconnect battery and discharge capacitor 1C to prevent burning out the ohmmeter. When replacing rectifiers, refer to TABLE 5. For 3 and 4 REC, disconnect one lead or

flexible connection. 3 and 4 REC are diodes with about 7 to 12 ohms in the conducting direction (+ ——▶|—— −) measured on the R x 1 scale, and 10,000 ohms or higher, in the non-conducting direction (− ——▶|—— +) measured on the R x 10,000 scale.



4J. Thermal Protector (TP)

Remove both connections from TP and with a VOM read between 100 and 200 ohms terminal to terminal, if heat sink is at room temperature. Set VOM to highest ohm scale and check pins to heat sink, reading should be infinity.

4K. Filter Block (HF), 23 FIL, etc.

To check, disconnect all wires from filter block. With VOM on R x 10,000 scale, touch the lead to the filter terminals to charge the filter. After a few seconds, reverse the meter leads and touch the filter terminals. The VOM needle will deflect and return to infinity. If this capacitor action is not observed, replace the filter block.

4L. Filter Block — 23 RES, etc.

Should these filters fail, it will be evidenced visually by severe cracking.

4M. Filter Block — 22 REC, 25 REC.

The capacitor filter test, as in 4K, is valid for 22 REC and 25 REC only to detect an open or shorted filter. If control has symptoms as in 1E, interchange 22 REC and 25 REC and try again. If problem is corrected the old 25 REC is marginal. If problem is not corrected, replace both filters with known good filters.

4N. IX Choke — Transformer Secondary T3-T4

Refer to panel wiring diagrams, page 24 thru 27, to locate windings. With VOM on RX-1 scale, check choke winding or transformer secondary, reading should be zero ohms.

TABLE 5
REPLACEMENT OF EV-1 COMPONENTS

When replacing stud semiconductors such as 2, 3, 4, or 5 REC, it is not necessary to torque these devices to a specific value. However, the device should be screwed into the heat sink and tightened to a snug fit. SCR gates, not screw connected, terminate inside card plug. Remove card connector for access to stab terminals.

The use of a heat-transfer grease (such as GE Versilube G-350-M or equivalent) is recommended.

5A. When replacing module semiconductors such as 1 REC (Models A and B), 1 REC and 3 REC (Model C), and 1 REC, 2 REC and 3 REC (Model D):

(1) Remove all module connections.
(2) Remove module by backing out the two screws at the device sides.
(3) If a 1 REC, remove the thermal protector.
(4) Clean the insulator surface with a clean rag and isopropyl alcohol.
(5) Inspect insulator surface for tears or cracks. If defective, replace. Wipe a light layer of machine oil on base and smooth insulator into position.
(6) Coat insulator with a light coat of heat-transfer grease similar to GE-350.
(7) Install thermal protector in new module. Tighten until snug.
(8) Set new module on insulation and start screws back into the base. Be sure to use original screws and washers. Run screws in to "finger tight."
Check to see the bottom of the heat sink is flat against the insulator.
Alternately tighten the two screws by 1/4 turn until firm.
(9) Replace all connections removed in Step 1.

5B. Capacitor (EV-1A and B)

(1) Remove card completely.
(2) Remove card box right support.
(3) Remove nuts from capacitor connections and slide capacitor to the right.
(4) Reverse procedure to install new capacitor.

5C. 22 REC and 25 REC, 23 FIL (Models C and D)

When replacing these devices, use original hardware in the same holes, as the inserts are used for electrical connections to the transformer.

5D. Transformer/Choke

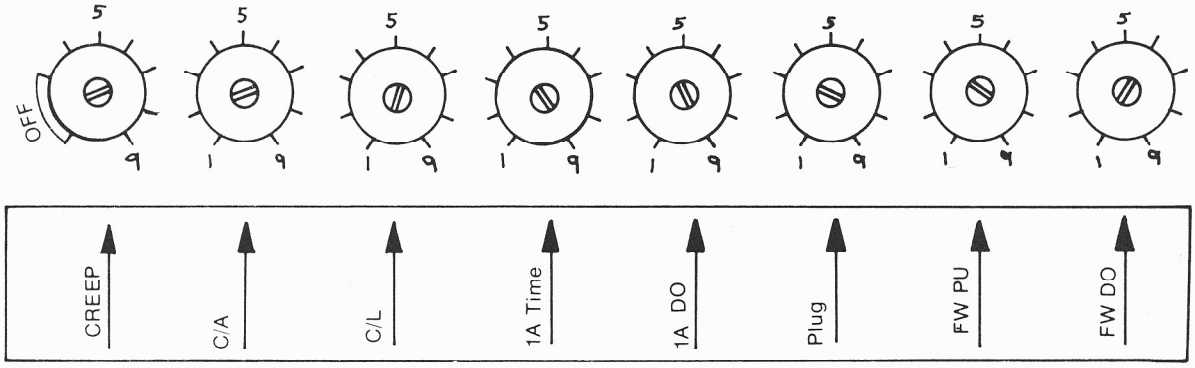
(1) Remove card box and card supports.
(2) Remove capacitor (Models A and B).
(3) Disconnect all transformer leads.
(4) Remove 2 REC, 5 REC, and snubbers as needed.
(5) Remove 4 mounting bolts and lift transformer free.
(6) Reverse procedure to reassemble.

TABLE 6
TUNEUP FOR NEW OR MISTUNED CARD 1

Panels are factory adjusted for a particular motor and truck and should not need adjustment. The card is supplied with single turn potentiometer with internal stops and the box is marked with "dial" setting.

The truck manufacturer should supply the "combination" setting for the particular model truck. The following is for explanation only and should not be used for setting your control:

Creep 7, C/A 7, C/L 5-1/2, 1A Time 4, 1A DO 9, Plug 8, FW PU 3-1/2, FW DO 6

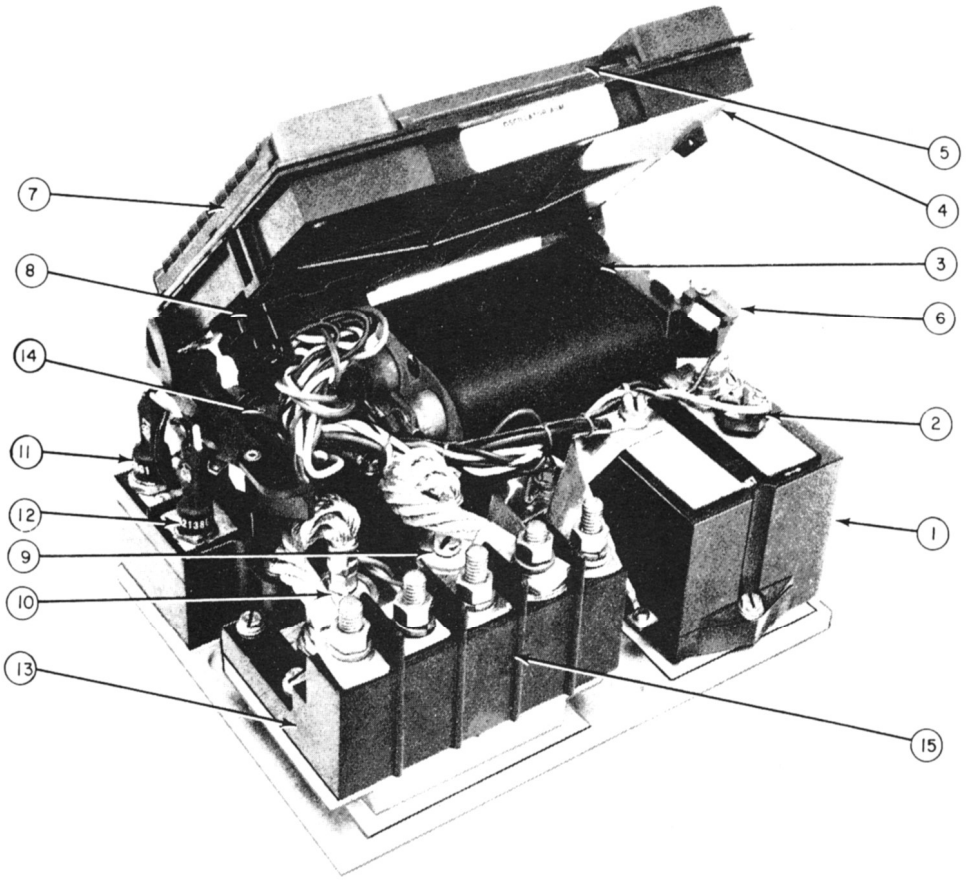


With a new card, turn all pots fully CCW to "1". Then set each pot to the setting for the particular truck.

Turning pots CW increases the particular function (i.e., CW adjustment increases creep speed, acceleration rate [C/A Pot], C/L, 1A Time, 1A DO, stiffness of plug, FW PU, FW DO).

TYPICAL PHYSICAL ARRANGEMENT AND IDENTIFICATION OF COMPONENTS

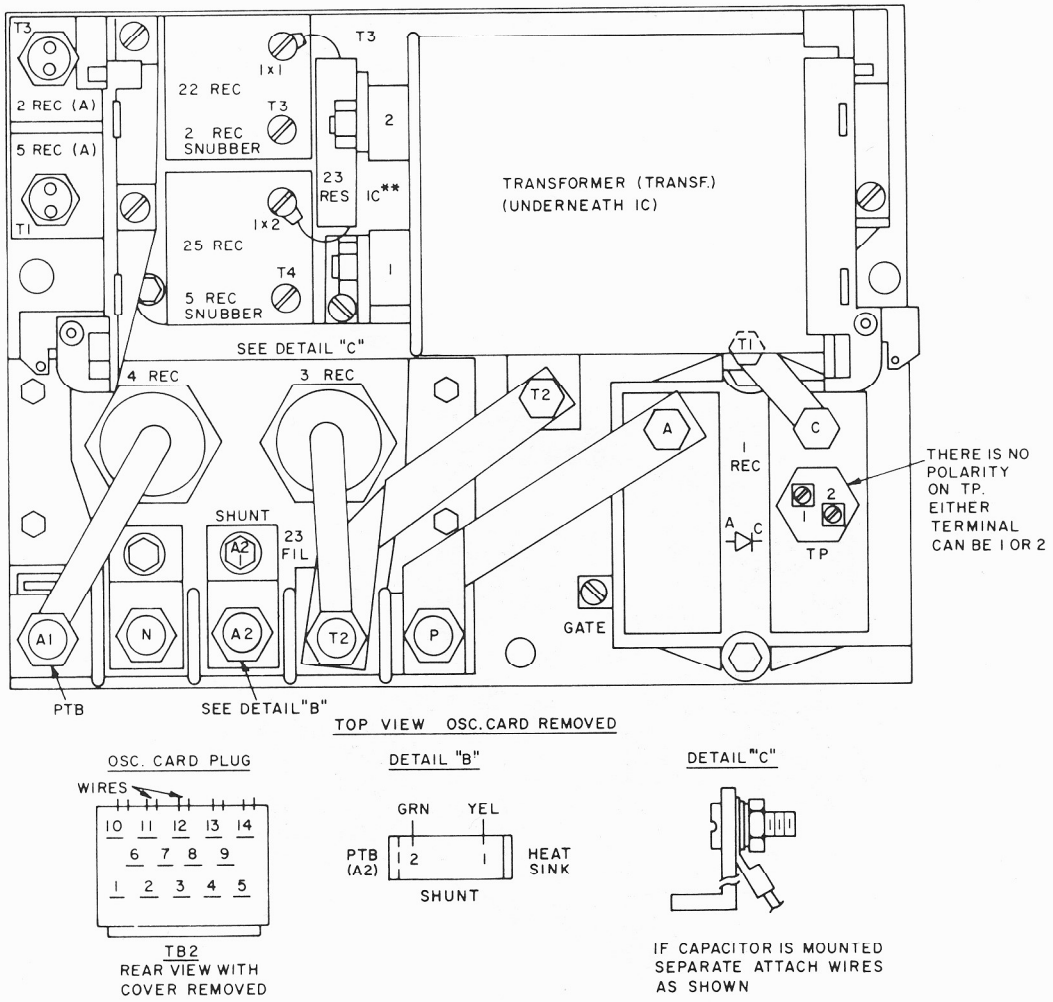
(Refer to wiring diagram furnished with truck for precise arrangement of components.)



(1) Main SCR (1 REC)
(2) Thermal Protector
(3) Commutating Capacitor
(4) Oscillator Card
(5) Card Adjustments
(6) Quick Card Release
(7) Card Connection Block
(8) Card Connector
(9) Flyback Diode (3 REC)
(10) Plugging Diode (4 REC)
(11) Turn-off SCR (2 REC)
(12) Charging SCR (5 REC)
(13) Power Connections
(14) Filters for 2 and 5 REC
(15) Motor Current Sensor
(Located behind middle power connector)

Transformer and choke (1X) located in encapsulated block under capacitor. 3 REC filter (23 FIL) located under pigtail of the diode.

Fig. 14. Typical EV-1 SCR panel (Model A or B)



	WIRE TABLE					
	WIRE NO OR SIZE	WIRE COLOR	FROM DEVICE	FROM TERM	TO DEVICE	TO TERM
	BUS		TRANSF	T1	1 REC	C
	BUS		PTB	P	1 REC	A
	BUS		PTB	T2	T	T2
	#10	BLK	1 REC	A	1C **	1
	2 REC LEAD	BLK	2 REC	C	22 REC	1X1
	5 REC LEAD	BLK	5 REC	C	25 REC	14
	SHUNT LEAD	YEL	SHUNT	2	TB2	14
TWIST	SHUNT LEAD	GRN	SHUNT	1	TB2	13
	#22	BLU	PTB	A2-1	TB2	6
	#22	BRN	TP	1	TB2	11
TWIST	#22	ORN	TP	2	TB2	12
	2 REC LEAD	RED	2 REC	C	TB2	9
TWIST	2 REC LEAD	WHT	2 REC	GATE	TB2	8
	#22	GRY	1C **	2	TB2	7
	#22	VIO	1	T2	TB2	10
	#22	BLK	1 REC	C	TB2	5
TWIST	#22	WHT/BLK	1 REC	GATE	TB2	4
	5 REC LEAD	RED	5 REC	C	TB2	3
TWIST	5 REC LEAD	WHT	5 REC	G	TB2	2
	#22	WHT/RED	1C **	1	TB2	1

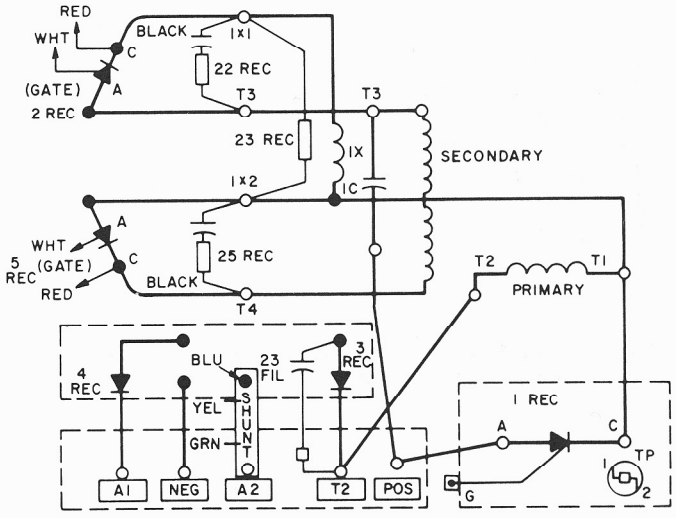
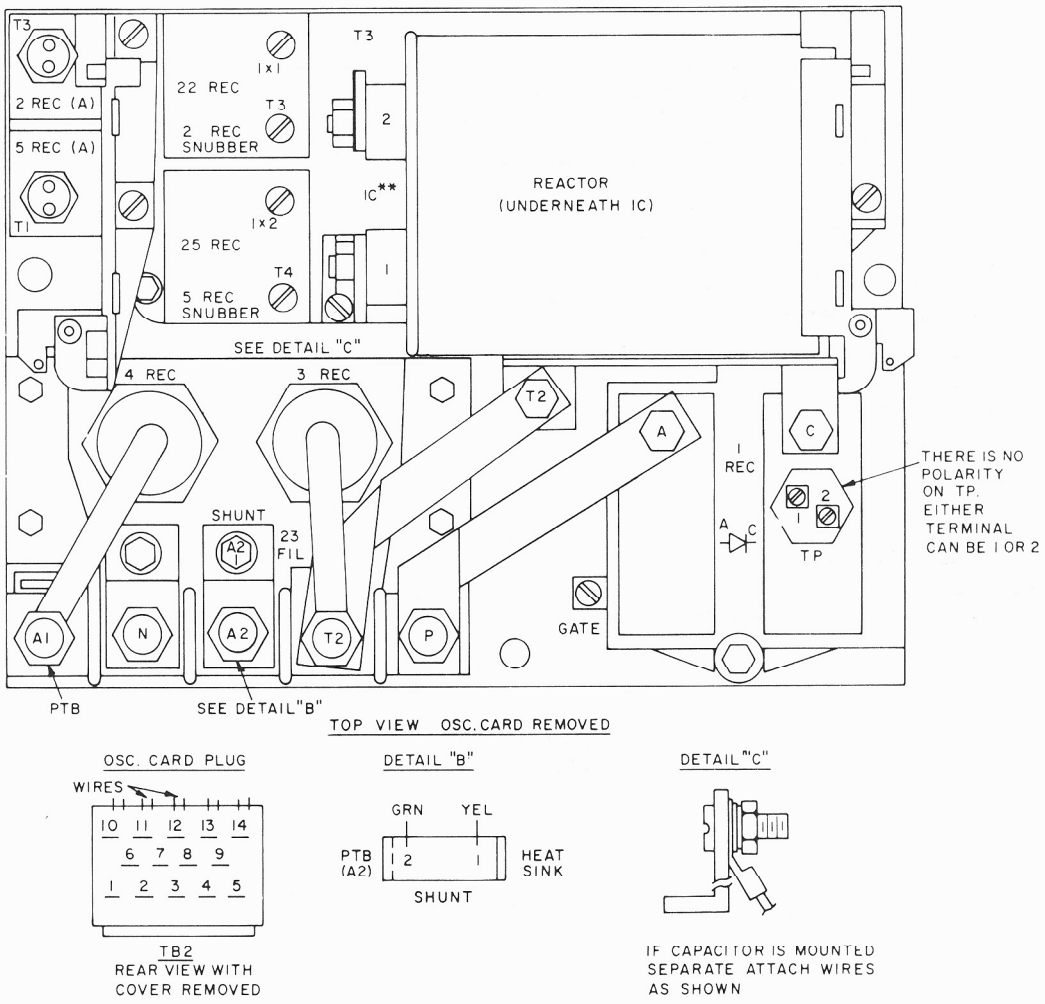


Fig. 15. Model A and B wiring diagram (transformer)



WIRE TABLE

	WIRE NO. OR SIZE	WIRE COLOR	FROM DEVICE	FROM TERM	TO DEVICE	TO TERM
	BUS		REACTOR	T1	1 REC	C
	BUS		PTB	P	1 REC	A
	BUS		PTB	T2	T	T2
	#10	BLK	1 REC	A	1C**	1
	2 REC LEAD	BLK	2 REC	C	22 REC	1X1
	5 REC LEAD	BLK	5 REC	C	25 REC	T4
TWIST	SHUNT LEAD	YEL	SHUNT	2	TB2	14
TWIST	SHUNT LEAD	GRN	SHUNT	1	TB2	13
	#22	BLU	PTB	A2-1	TB2	6
TWIST	#22	BRN	TP	1	TB2	11
TWIST	#22	ORN	TP	2	TB2	12
TWIST	2 REC LEAD	RED	2 REC	C	TB2	9
TWIST	2 REC LEAD	WHT	2 REC	GATE	TB2	8
	#22	GRY	1C**	2	TB2	7
	#22	VIO	1	T2	TB2	10
TWIST	#22	BLK	1 REC	C	TB2	5
TWIST	#22	WHT/BLK	1 REC	GATE	TB2	4
TWIST	5 REC LEAD	RED	5 REC	C	TB2	3
TWIST	5 REC LEAD	WHT	5 REC	G	TB2	2
	#22	WHT/RED	1C**	1	TB2	1

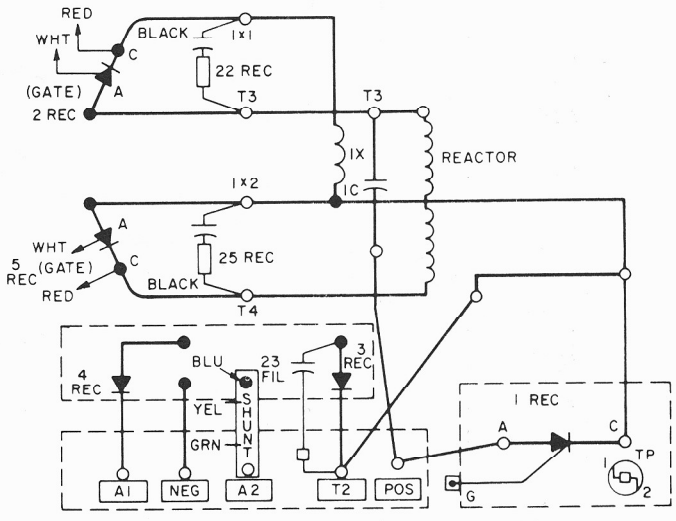
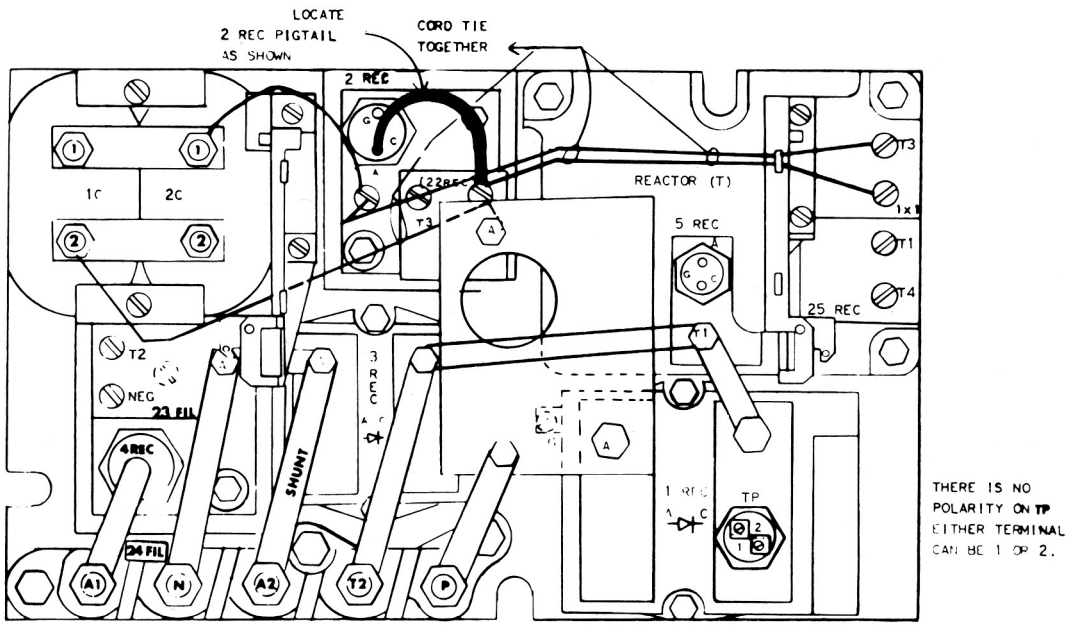
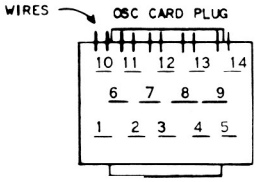


Fig. 16. Model A and B wiring diagram (reactor)



TOP VIEW (OSC CARD REMOVED)



TB2
REAR VIEW WITH
COVER REMOVED

WIRE TABLE

	WIRE NO. OR SIZE	WIRE COLOR	FROM DEVICE	FROM TERM	TO DEVICE	TO TERM
	BUS		4 REC	A	3 REC	A
	BUS		PTB	T2	3 REC	C
	BUS		4 REC	A	PTB	N
	BUS		1 REC	C	T	T1
	BUS		1 REC	A	PTB	P
	BUS		3 REC	C	T	T1
ROUTE AS SHOWN ABOVE. *	#8	BLK	22 REC	1X1	T	1X1
ROUTE AS SHOWN ABOVE. *	#8	BLK	2 REC	A	T	T3
ROUTE AS SHOWN ABOVE. *	#8	BLK	2 REC	A	2C	1
ROUTE AS SHOWN ABOVE. *	#8	BLK	1 REC	A	2C	2
	4 REC LEAD		4 REC	C	PTB	A1
	2 REC LEAD		2 REC	C	22 REC	1X1
	5 REC LEAD		5 REC	C	22 REC	T4
TWIST	SHUNT LEAD	YEL	SHT	2	TB2	14
TWIST	SHUNT LEAD	GRN	SHT	1	TB2	13
	#22	BLU	3 REC	A	TB2	6
TWIST	#22	ORN	THY	2	TB2	12
TWIST	#22	BRN	THY	1	TB2	11
	#22	VIO	3 REC	C	TB2	10
TWIST	2 REC LEAD	RED	2 REC	C	TB2	9
TWIST	2 REC LEAD	WHT	2 REC	G	TB2	8
	#22	GRY	2C	1	TB2	7
TWIST	#22	BLK	1 REC	C	TB2	5
TWIST	#22	WHT/BLK	1 REC	G	TB2	4
TWIST	5 REC LEAD	RED	5 REC	C	TB2	3
TWIST	5 REC LEAD	WHT	5 REC	G	TB2	2
	#22	WHT/RED	1C	2	TB2	1
	#22	WHT/GRN	23 FIL	T2	3 REC	C

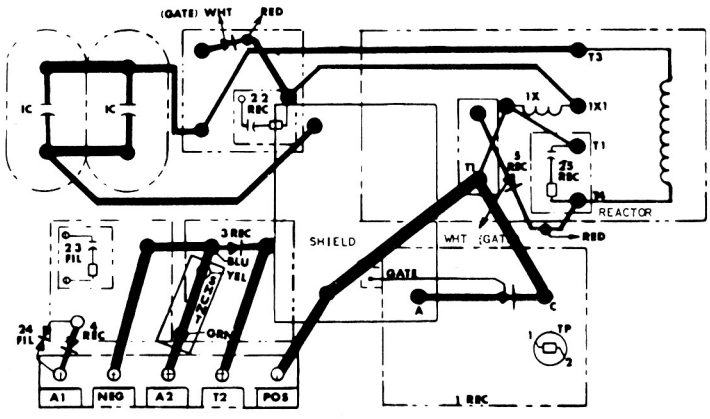
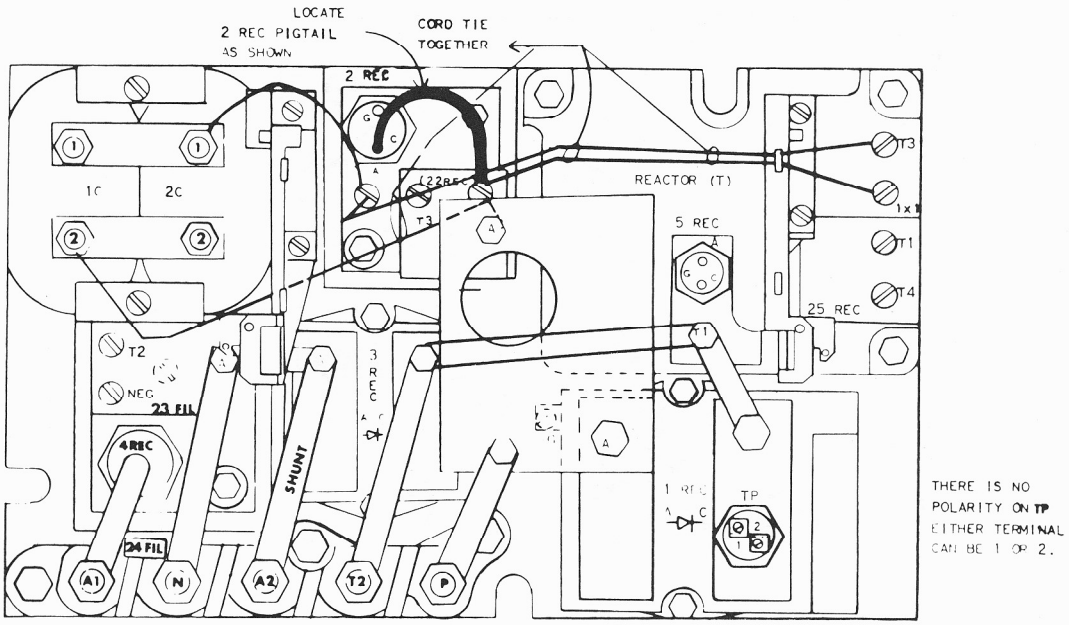
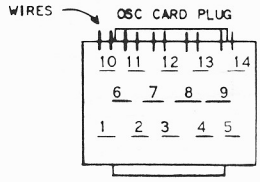


Fig. 18. Model C wiring diagram (reactor)



TOP VIEW (OSC CARD REMOVED)



TB2
REAR VIEW WITH
COVER REMOVED

WIRE TABLE

	WIRE NO. OR SIZE	WIRE COLOR	FROM DEVICE	FROM TERM	TO DEVICE	TO TERM
	BUS		4 REC	A	3 REC	A
	BUS		PTB	T2	3 REC	C
	BUS		4 REC	A	PTB	N
	BUS		1 REC	C	T	T1
	BUS		1 REC	A	PTB	P
	BUS		3 REC	C	T	T1
ROUTE AS SHOWN ABOVE. *	#8	BLK	22 REC	1X1	T	1X1
*	#8	BLK	2 REC	A	T	T3
*	#8	BLK	2 REC	A	2C	1
*	#8	BLK	1 REC	A	2C	2
	4 REC LEAD		4 REC	C	PTB	A1
	2 REC LEAD		2 REC	C	22 REC	1X1
	5 REC LEAD		5 REC	C	22 REC	T4
TWIST	SHUNT LEAD	YEL	SHT	2	TB2	14
TWIST	SHUNT LEAD	GRN	SHT	1	TB2	13
	#22	BLU	3 REC	A	TB2	6
TWIST	#22	ORN	THY	2	TB2	12
TWIST	#22	BRN	THY	1	TB2	11
	#22	VIO	3 REC	C	TB2	10
TWIST	2 REC LEAD	RED	2 REC	C	TB2	9
TWIST	2 REC LEAD	WHT	2 REC	G	TB2	8
	#22	GRY	2C	1	TB2	7
TWIST	#22	BLK	1 REC	C	TB2	5
TWIST	#22	WHT/BLK	1 REC	G	TB2	4
TWIST	5 REC LEAD	RED	5 REC	C	TB2	3
TWIST	5 REC LEAD	WHT	5 REC	G	TB2	2
	#22	WHT/RED	1C	2	TB2	1
	#22	WHT/GRN	23 FIL	T2	3 REC	C

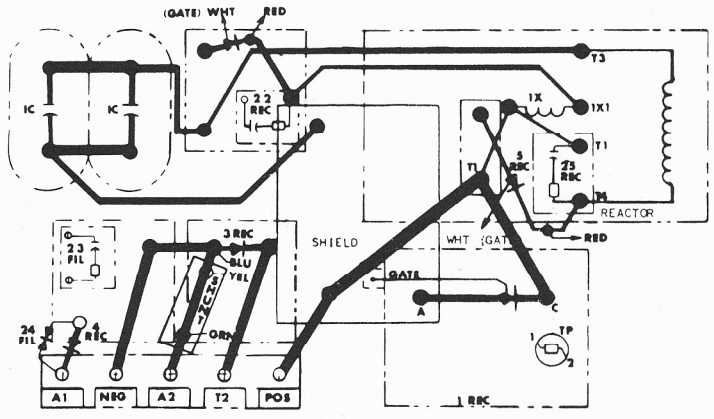
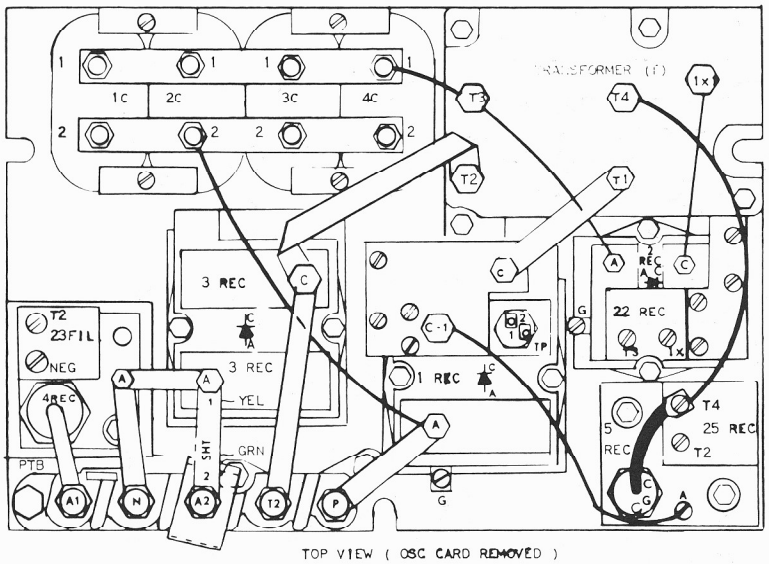
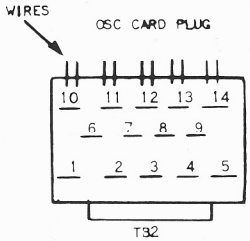


Fig. 18. Model C wiring diagram (reactor)



TOP VIEW (OSC CARD REMOVED)

NOTE -
THERE IS NO POLARITY ON THERMAL PROTECTOR (TP). EITHER TERMINAL CAN BE 1 OR 2.



REAR VIEW WITH COVER REMOVED

	WIRE NO.	COLOR NO. LENGTH ***	FROM DEVICE	FROM TERM	TO DEVICE	TO TERM
ROUTE AS SHOWN	#6	5" LONG	2 REC	C	T	1X1
	#4	3 1/4" LONG	T	T3	4C	1
	#6	5" LONG	T	T3	2 REC	A
	#6	9" LONG	25 REC	T4	T	T4
	#6	7 3/4" LONG	5 REC	A	1 REC	C-1
	#4	9 3/4" LONG	1 REC	A	2C	2
	4 REC LEAD		4 REC	C	PTB	A1
	5 REC LEAD		5 REC	C	25 REC	T4
TWIST	SHUNT LEAD	YEL	SHT	2	TB2	14
	SHUNT LEAD	GRN	SHT	1	TB2	13
	#22	BLU	3 REC	A	TB2	6
TWIST	#22	ORN	THY	2	TB2	12
	#22	BRN	THY	1	TB2	11
	#22	VIO	3 REC	C	TB2	10
TWIST	2 REC LEAD	RED	2 REC	C	TB2	9
	2 REC LEAD	WHT	2 REC	G	TB2	8
	#22	GRY	4C	1	TB2	7
TWIST	#22	BLK	1 REC	C	TB2	5
	#22	WHT/BLK	1 REC	G	TB2	4
TWIST	5 REC LEAD	RED	5 REC	C	TB2	3
	5 REC LEAD	WHT	5 REC	G	TB2	2
	#22	WHT/RED	2C	2	TB2	1
	#22	WHT/GRN	23 FIL	T2	3 REC	C
	BUS		4 REC	A	PTB	N
	BUS		4 REC	A	3 REC	A
	BUS		3 REC	C	PTB	T2
	BUS		1 REC	A	PTB	P
	BUS		3 REC	C	T	T2
	BUS		1 REC	C	T	T1

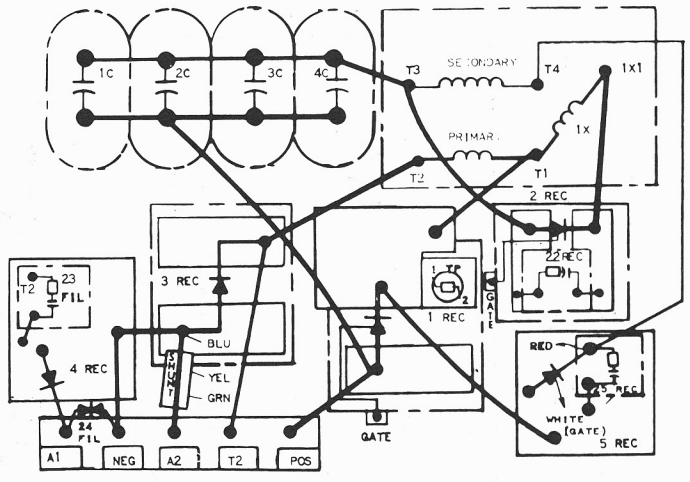
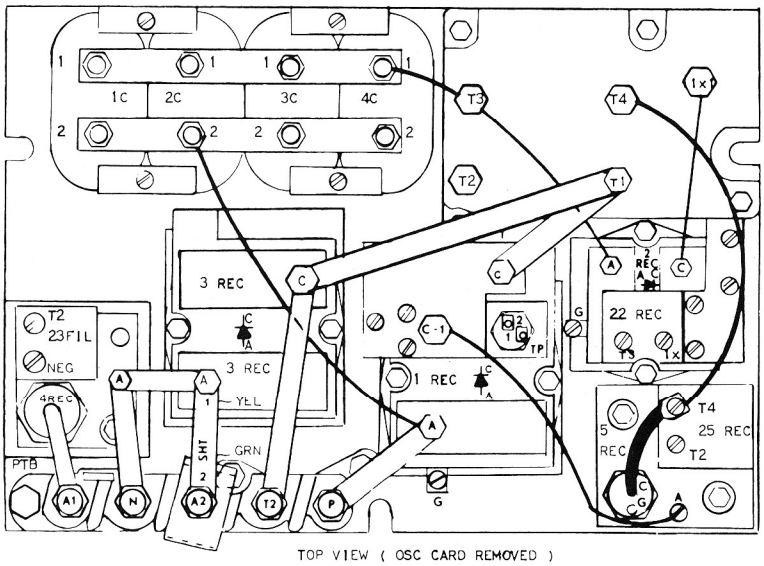
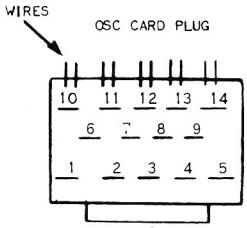


Fig. 19. Model D wiring diagram (transformer)



TOP VIEW (OSC CARD REMOVED)

NOTE+
THERE IS NO POLARITY ON THERMAL PROTECTOR (TP). EITHER TERMINAL CAN BE 1 OR 2.



T32
REAR VIEW WITH COVER REMOVED

WIRE TABLE

	WIRE NO.	COLOR NO. LENGTH ***	FROM DEVICE	FROM TERM	TO DEVICE	TO TERM
ROUTE AS SHOWN	#6	5" LONG	2 REC	C	T	1x1
	#4	3 1/4" LONG	T	T3	4C	1
	#6	5" LONG	T	T3	2 REC	A
	#6	9" LONG	25 REC	T4	T	T4
	#6	7 3/4" LONG	5 REC	A	1 REC	C-1
	#4	9 3/4" LONG	1 REC	A	2C	2
	4 REC LEAD		4 REC	C	PTB	A1
	5 REC LEAD		5 REC	C	25 REC	T4
TWIST	SHUNT LEAD	YEL	SHT	2	TB2	14
TWIST	SHUNT LEAD	GRN	SHT	1	TB2	13
	#22	BLU	3 REC	A	TB2	6
TWIST	#22	ORN	THY	2	TB2	12
TWIST	#22	BRN	THY	1	TB2	11
	#22	VIO	3 REC	C	TB2	10
TWIST	2 REC LEAD	RED	2 REC	C	TB2	9
TWIST	2 REC LEAD	WHT	2 REC	G	TB2	8
	#22	GRY	4C	1	TB2	7
TWIST	#22	BLK	1 REC	C	TB2	5
TWIST	#22	WHT/BLK	1 REC	G	TB2	4
TWIST	5 REC LEAD	RED	5 REC	C	TB2	3
TWIST	5 REC LEAD	WHT	5 REC	G	TB2	2
	#22	WHT/RED	2C	2	TB2	1
	#22	WHT/GRN	23 FIL	T2	3 REC	C
	BUS		4 REC	A	PTB	N
	BUS		4 REC	A	3 REC	A
	BUS		3 REC	C	T	T1
	BUS		1 REC	A	PTB	P
	BUS		3 REC	C	PTB	T2
	BUS		1 REC	C	T	T1

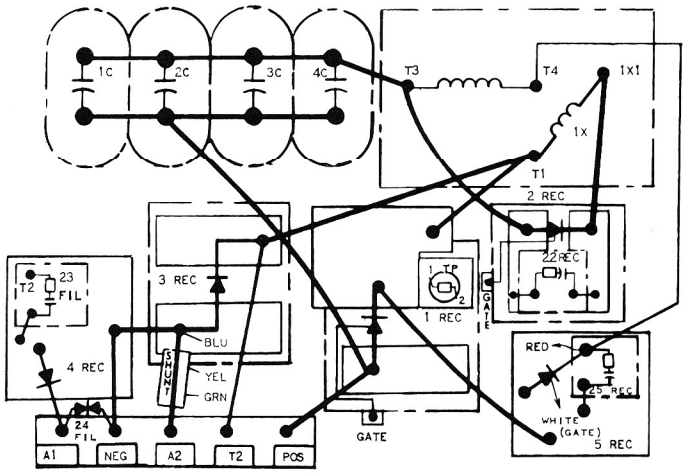
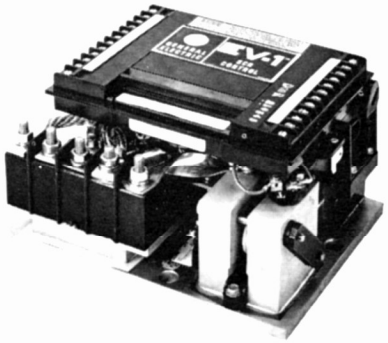


Fig. 20. Model D wiring diagram (reactor)

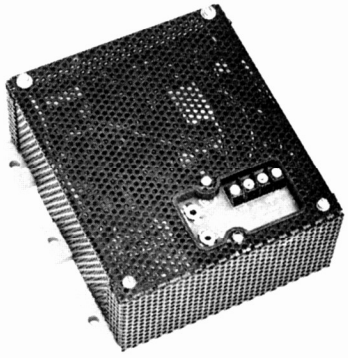
FSIP REBUILDING SERVICES

FOR EV1 SERIES CARDS AND PANELS

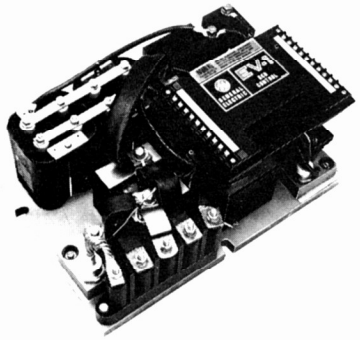
Oscillator Control Card



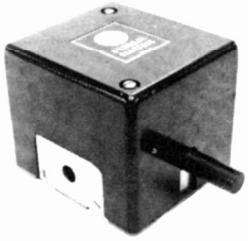
EV1B Panel



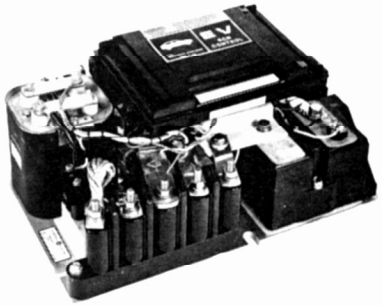
DC To DC Converter



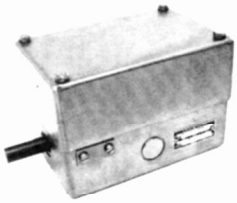
EV1D Panel



Black Box Accelerator



EV1C Panel



Gold Box Accelerator

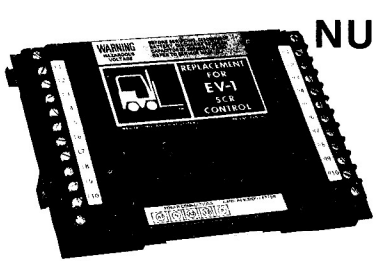
OEM P/N	FUNCTION	VOLTAGE
IC36450SC:		
1A3	OSCILLATOR/FIELD WEAKENING	24-48V
1A4	OSCILLATOR/FIELD WEAKENING	48-84V
1B3	OSCILLATOR CONTROL CARD	24-48V
1B4	OSCILLATOR CONTROL CARD	84-84V
1C3	OSCILLATOR/FIELD WEAKENING	24-48V
1D3	OSCILLATOR CONTROL CARD	24-48V
1E3	OSCILLATOR/FIELD WEAKENING	24-48V
1E4	OSCILLATOR/FIELD WEAKENING	48-84V
1E5	OSCILLATOR/FIELD WEAKENING	84-144V

OEM P/N	FUNCTION	VOLTAGE
IC36450SC:		
1F4	OSCILLATOR CONTROL CARD	48-84V
1H3	OSCILLATOR/DEMAND 1A DEFEAT	24-48V
IC3645AUX:		
1L5	AUXILIARY CONTROL CARD	84-144V
IC36450SC:		
1T3	OSCILLATOR CONTROL CARD	24-48V
1T4	OSCILLATOR CONTROL CARD	48-84V
1T9	NEW DESIGN OSCILLATOR	24-84V
1E9	NEW DESIGN OSC./FIELD WEAKENING	24-84V
2E9	NEW DESIGN OSC./FIELD WEAKENING	24-84V
3E9	NEW DESIGN OSC./FIELD WEAKENING	24-84V
4E9	NEW DESIGN OSC./FIELD WEAKENING	24-84V
5E9	NEW DESIGN OSC./FIELD WEAKENING	24-84V
1H9	NEW DESIGN OSCILLATOR	24-84V
2H9	NEW DESIGN OSCILLATOR	24-84V
3H9	NEW DESIGN OSCILLATOR	24-84V
4H9	NEW DESIGN OSCILLATOR	24-84V
5H9	NEW DESIGN OSCILLATOR	24-84V
RGN501	REGENERATIVE BRAKING CONTROL	36-80V
IC4484:		
E700	DUAL MOTOR CONTROL CARD	24-84V
E701	AUXILIARY PLUGGING CARD	36-84V
E702	AUXILIARY PLUGGING CARD	84-144V
IC448CNV:		
1A1	DC TO DC CONVERTER	36-80V
1B1	DC TO DC CONVERTER	36-80V
2B1	DC TO DC CONVERTER	36-80V

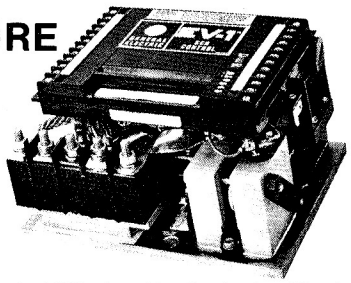
ACCELERATORS:	
IC4485ACC	EV1 BLACK BOX ACCELERATOR
IC4485ACC	EV1 BLACK BOX ACCELERATOR
IC4485ACL	EV1 BLACK BOX ACCELERATOR

COMPLETE EV1A/EV1B PANEL	RETEST FULL DISMANTLE & REBUILD
COMPLETE EV1C PANEL	REPAIR & RETEST FULL DISMANTLE & REBUILD
COMPLETE EV1D PANEL	REPAIR & RETEST FULL DISMANTLE & REBUILD
COMPLETE EV1 PUMP CONTROL	REPAIR & RETEST FULL DISMANTLE & REBUILD

- New cases & covers are free with each EV1 control card repair (if needed).
- Rebuilt cards & panels can be purchased on an exchange or outright basis depending upon core availability.
- One year warranty on all repair services & rebuilt items.

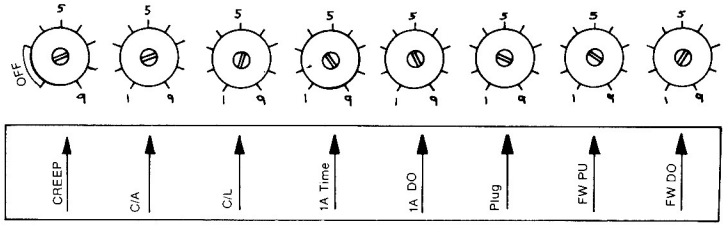


NUMBER ONE CARD TUNE-UP PROCEDURE
for
EV-1
SCR CONTROL



EV-1 Adjustment Characteristics

The GENERAL ELECTRIC EV-1 series of SCR panels have been designed to make the adjustment procedure as easy as possible for the electric vehicle dealer or end user. Unlike earlier models where mal-adjustment could easily cause "lock-up", shut down, or full speed of the vehicle, the EV-1 control card is free from pot adjustment interaction and "lock-up" problems. Single-turn potentiometers are non-critical to adjust, are readily accessible and for convenience, are graduated in marks from 1 to 9.



The electronics of the card have been designed so that the same number setting always produces the same response from the card. For example, if a control card was replaced, and the plugging pot was set to "6" on the original card, setting the plugging pot to "6" on the new card will produce the same plugging action on the vehicle. This same principle also applies to the other adjustments.

EV-1 as Original Equipment

On new electric vehicles and lift trucks using the EV-1 control, the original equipment manufacturer (O.E.M.) has carefully worked out the potentiometer settings for each model that give the best performance under average conditions. These settings may be used for initial set-up of the card, and will guarantee that the vehicle will run satisfactorily. Some final touch-up adjustment may have to be done at the users plant if job conditions demand. For example, the end user may demand extra slow creep speed, or fast acceleration, etc. If these conditions are known in advance, or if the user has other EV-1 equipped trucks in a similar application, it is often possible to pre-set all adjustments to their final settings on the 1-9 scale prior to delivery. If no information on proper pot settings is available for this vehicle, you may use the procedure outlined below as a guide.

EV-1 as a Conversion Installation

The EV-1 SCR system has been fitted to many makes of older lift trucks in order to provide the advanced features of new equipment at a fraction of the cost of a new vehicle. Since installation is beyond the scope of this procedure, it will be assumed here that the installation of the EV-1 system was done properly and that the panel is working and ready for adjustment. The exact order in which the adjustments are made is not critical since interaction has been eliminated from all adjustments except field weakening. The order of adjustment given below is preferred for simplicity. The procedure below has been compiled from our experience in EV-1 conversions and may be used as a guide for initial set up. Final adjustment will depend on user preference and working conditions.

Creep Speed

The creep speed adjustment has an "off" position when in its full CCW position. Pulsing is inhibited until the creep pot is turned clockwise past the number 2 mark. The setting of this pot will depend to a large extent on user preference and job conditions. As a general rule, the heavier the vehicle, the higher the setting for a given creep speed in M.P.H. It is always safe to start with a setting of 5 and trim up or down, as required. When adjusting, make sure that the accelerator has been moved just far enough to close the initial microswitch and no farther.

C/A (Controlled Acceleraton)

The controlled acceleration adjustment determines how fast the vehicle accelerates from rest to top SCR speed when the speed control is "floored". The setting of this pot depends on vehicle weight and to some extent on working conditions. A lighter vehicle (2000 lb. lift truck) will use a higher number setting (say 7 or 8), while a heavier lift truck (10,000 lb. and up) will use a lower number setting, (say 2 or 3). Lower numbers would also be indicated if the load is stacked or lifted high or if there isn't much maneuvering space. In a large open warehouse operation, a higher number setting could probably be used. The vehicle should be operated on the floor, loaded, in order to obtain a proper setting.

C/L Current Limit

The design of the current limit sensing circuitry on the EV-1 panel is quite different from previous models, and, with few exceptions, inherently **protects the panel** against overcurrent, even when the C/L pot is set full clockwise. However, as in the past, the exact setting of the C/L pot is to be done by measuring motor armature current with a shunt type ammeter (or clip-on type designed for use on pulsating D.C.) The current limit should be set with the 1A contactor blocked and the drive motor fully stalled, at a value not to exceed the one minute rating of the motor, or as directed by the vehicle manufacturer. Start with the pot fully CCW and turn slowly CW. A typical 4000 lb. lift truck would be set at 275A. to 300A. Due to the effects or variations in motor characteristics, it is impossible to give a correlation of pot number settings vs. current limit amperage. While it is possible to get consistent results from card to card and vehicle to vehicle of the same make and model using the same number setting, it is definitely **not** possible to get the same results on different types of vehicles without re-adjustment.

On older vehicles where drive motor resistance and inductance is likely to be significantly higher than more recent designs, it is possible to encounter a situation where the C/L pot appears to have little or no effect on the ammeter reading at stall. This condition will occur whenever the SCR "percent on" exceeds 65-70% at stall. When this condition is present, the C/L pot should be set full CCW and then adjusted CW, if necessary, to achieve satisfactory ramp start performance. Bear in mind that the SCR panel itself (primarily the 1 REC) will always be protected; but the drive motor may be in danger if the panel is oversized for the vehicle.

In addition to verifying that the stall current is limited to a safe value, it is necessary to measure the peak 1 C capacitor voltage at stall. Both positive and negative peaks are to be measured. These voltages must be measured with either an oscilloscope or a peak-reading voltmeter. (A built-in module is available in the MODEL 269 "HANDY MAN" manufactured by FLIGHT SYSTEMS, INC. that converts any standard VOM into a peak-reading voltmeter.) The positive or negative peak capacitor voltage must not exceed 200V on Models A thru D rated at 24-48V or Model A, 48-84V and 230V on Models B, C, or D rated at 48-84V.

1A Time

This adjustment applies **only** if the 1A switch in the accelerator is wired. (See page 6 of G.E. instruction booklet GEK 40724). This mode is called "timed pickup" of 1A, and functions exactly as the previous models; that is, it determines the time delay between closure of the 1A switch and the pick-up of the 1A contactor. The proper setting of the 1A time pot depends on vehicle weight, job conditions, and to some extent the setting of the C/A pot. A representative setting for an average 4000 lb. lift truck would be about number 4. Heavier vehicles require higher number settings. The table below gives approximate values of 1A delay in seconds for each numbersetting.

1A Time Setting	1	2	3	4	5	6	7	8	9
Delay in Seconds	0.5	.81	1.13	1.44	1.75	2.06	2.38	2.69	3.0

Since the 1A contactor will pick up on DEMAND at 83% of SCR speed regardless of the operation of the 1A microswitch, it is very difficult or impossible to adjust the 1A time **unless** the following procedure is used:

1) Make sure drive wheels are clear of floor.
2) Disconnect the wire going to terminal R6 (usually wire #45)
3) Accelerate to approx. one-half SCR speed.
4) Jumper terminal R4 to terminal R6 while holding one-half speed and note time required for 1A contactor to pull in.
5) Adjust 1A TIME for desired delay.
6) Re-connect wire to terminal R6.

1A DO (1A DROP-OUT)

The 1A Drop-out function is unique to the EV-1 SCR Panel and is built-in. (This function is available for older GE panels by adding various auxiliary cards.) The purpose of this feature is to provide full-time current monitoring and protect the motor from near-stall type burnouts when operating in 1A. This possibility exists during such operations as climbing ramps and pushing heavy loads. Since its primary purpose is to **protect the drive motor,** adjustment techniques should reflect this philosophy. Remember that loads considerably in excess of the continuous rating of a motor can be safely handled if the loads are **short** in duration **and** the motor is allowed to cool sufficiently in between such loads. The 1A drop-out feature allows operation in 1A at a current level **above** the C/L setting of the panel, but **below** some threshold of current as set by the 1A DO Pot.

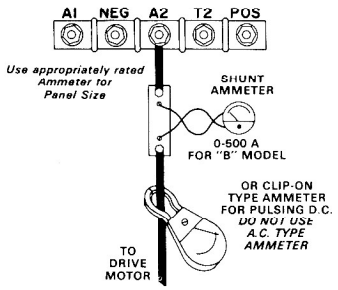


Figure 7

Power Terminal Identification and Ammeter Connection

Connect a suitable ammeter as you would to set up current limit. Either armature current or battery current may be used for this test, as they are almost identical in by-pass. Turn the 1A DO full CCW. Accelerate into 1A, and load the vehicle either by climbing a ramp or applying the brakes. Note the ammeter reading just before the 1A contactor drops out and adjust the 1A DO pot clockwise a little at a time until the desired 1A drop-out amperage is reached. CAUTION: Since there is a built-in delay on the 1A current sensing, it is important to bring the load up gradually toward the drop-out point. The final setting should be verified for ramp-climbing performance with the vehicle loaded if possible. Always use the lowest setting possible that will still give satisfactory vehicle performance under actual working conditions. The 1A DO setting will always be a trade-off between available H.P. and degree of motor protection. The table below may be used as a guide:

1A DO Setting	1	2	3	4	5	6	7	8	9
Approx. D.O. Amps EV-1B	450	570	685	805	925	1045	1160	1280	1400
EV-1C	675	855	1030	1210	1385	1565	1745	1920	2100
EV-1D	900	1135	1375	1615	1850	2085	2325	2565	2800

Plugging

The plugging pot on the EV-1 panel is an adjustment for "plugging severity". What was previously known as "plugging threshold" or "coarse plugging" is now an internal and automatic function of the card and requires no adjustment. The number setting of the plug pot (CW to increase severity) will depend on the weight of the vehicle and the type of loads to be carried. Fragile cargo, slippery objects that can slide off easily, or high lifts are situations demanding a soft plugging action. A heavier vehicle/load combination will require a higher number setting for the same stopping distance. If in doubt, start with a setting of 5 and trim up or down as required until the desired plugging action and stopping distance is achieved. It is important to simulate loads when making these tests, as inertia and traction are key factors in arriving at a satisfactory setting. Note: Larger vehicles may not accelerate properly after a plug if the plugging pot is set full CCW.

Note: *Certain dual motor and high capacity vehicles may not accelerate properly after a plug (or direction change) if the plugging pot is set full CCW. In these cases, turn the pot CW until satisfactory re-acceleration after a plug is obtained.*

FW PU, FW DO (Field Weakening Pick-Up, Drop-Out)

These adjustments are not required unless vehicle is equipped with field weakening.

Field weakening is sometimes added in order to obtain increased top speed when already in 1A. It is **not** used during SCR operation. An auxiliary F.W. contactor, when energized, connects a F.W. resistor in parallel with the drive motor field circuit. The F.W. contactor is driven by a driver module and a special section of the control card. To protect the drive motor, it is important that the F.W. is only allowed to energize if the armature current has fallen below a pre-set value. This value is set by the F.W. PU Pot. If, after the F.W. is energized, the current increases, (such as would occur climbing a ramp) the F.W. contactor will drop out when the current reaches a second pre-set value. This value is set by the F.W. DO Pot. If the F.W. PU and F.W. DO are set too close together, it is possible that F.W. contactor "chatter" could result. The F.W. pick-up value of current is, of course, lower than the drop-out value. Both **must** be below the 1A DO value of current.

The following procedure is designed to set the field weakening pick-up and drop-out points as a percentage of the current drawn under conditions of running on the level in 1A with a normal load. Make sure that the battery is charged to at least 1.200 S.G., and that the vehicle is carrying a normal load. Measure the battery or armature amperage after fully accelerated in 1A on a **level** surface. (Smooth concrete is preferred). This test **cannot** be done properly with the wheels jacked up. After obtaining this reading, the vehicle may be jacked up and the adjustments made using the brakes to simulate the load. Also, set FWPU full CCW and FWDO full CW. (It may be necessary to defeat the brake switch). Now set the F.W. PU at a value between 125% and 150% of the "level running" value by starting with F.W. PU at full CCW and dragging brake **after** 1A is closed (accelerator must be floor boarded and making the 1A switch). When the brake has loaded the motor to the desired F.W. PU amps, **slowly** adjust the F.W. PU pot CW until the FW contactor picks up. Increase the load on the motor until the desired F.W. DO value is reached and adjust the F.W. DO pot **slowly** CCW until the FW contactor drops out (maximum 300% of level running). Recheck both pick up and drop out settings since there is some interaction of these pots. It is impossible to give actual 1-9 "number" settings for these adjustments, since drive motor characteristics vary widely.

It is suggested that a record be made of **all** settings and this information kept on the vehicle or in a convenient place for future reference.*

Installation/Removal of Control Card

The EV-1 control card has been designed to facilitate easy replacement **without** the need to disconnect any wires. This feature saves time and eliminates the chance of an accidental wrong connection. To remove the card from the panel, proceed as follows:

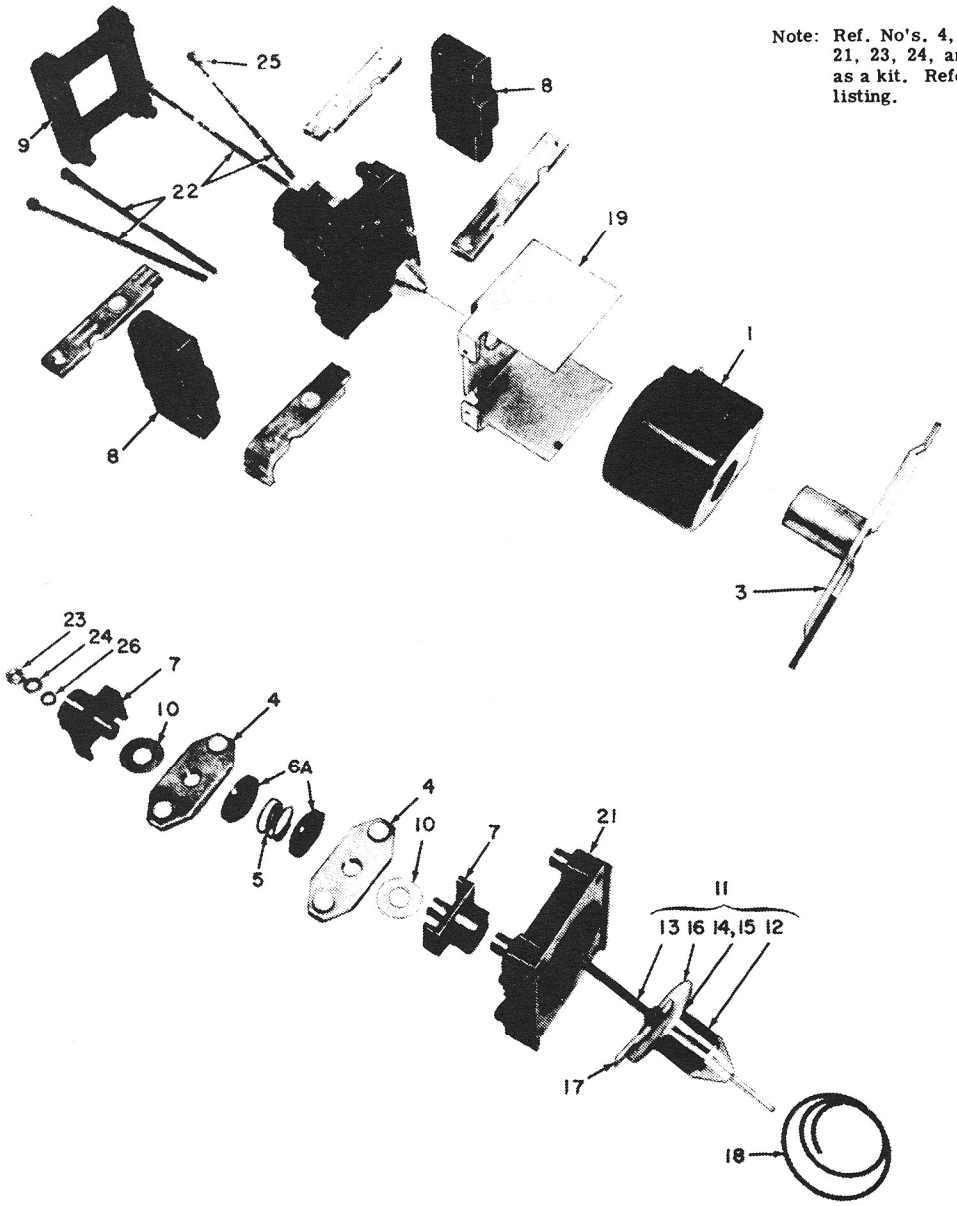
1. Disconnect battery.
2. Loosen **only** the two terminal strip hold-down screws located at the extreme end of the right and left terminal strips. These screws are captive and complete removal is not necessary. (4 screws total).
3. Using screwdriver slots on side, lift out the right and left terminal strips.
4. Release the spring locking devices at each end of the card. (These flip out).
5. Swing the card away from the panel and disengage tabs from panel bracket slots.
6. Discharge Capacitor(s).
7. Release side locking tabs, and with the aid of a screwdriver withdraw the 14-pin panel plug from the underside of the card.

To install a control card, exactly reverse above procedure.

*For your convenience, pressure sensitive labels have been provided with this booklet for the purpose of recording the proper control card settings on the vehicle. We hope you will find these labels a helpful service aid. Additional labels are available free. Call or write FLIGHT SYSTEMS at any of our locations.

RENEWAL PARTS

IC4482-CTRA CONTACTORS
EV-1 * SCR CONTROL



Note: Ref. No's. 4, 5, 6, 6A, 7, 10, 11, 18, 21, 23, 24, and 25 may be purchased as a kit. Refer to back page for kit listing.

* Trademark of General Electric Co.

When ordering renewal parts, give quantity, catalog number, description of each item required, and complete nameplate reading.

GENERAL ELECTRIC

IC4482-CTRA CONTACTORS

REF. NO. 1 OPERATING COILS (1 REQUIRED)*

NOTE: The operating coil is identified by the number following the terminal configuration in the IC designation.
EXAMPLE: IC4482-CTR-A-700-AA-202-A-1 requires coil number 202 Cat. No. 393B258G202.

For IC4882-CTR-700, 710 Only		For IC4482-CTR-800, 810 Only		For IC4482-CTR-701, 702, 711, 712, 801, 802, 811, 812 Only	
Coil Number	Catalog Number	Coil Number	Catalog Number	Coil Number	Catalog Number
202	393B258G202	201	393B257G201	301	393B257G301
203	G203	202	G202	302	G302
204	G204	203	G203	303	G303
205	G205	205	G205	305	G305
206	G206	207	G207	306	G306
207	G207	208	G208	307	G307
208	G208	210	G210	308	G308
210	G210	212	G212	309	G309
212	G212			312	G312
				314	G314
				315	G315

ELECTRICAL INTERLOCKS (1 REQUIRED WHEN USED)

NOTE: The electrical interlock is determined by the last letter and number in the IC designation.
EXAMPLE: IC4482-CTR-A-700-AA-202-A-1 requires letter A with 1 interlock contact Cat. No. 119A4259P3.

Form Letter	No. of Contacts	Switch Catalog Number
A	1	194B6393A1
A	2	194B6393A2
X	0	----------

Ref. No.	Number Required for IC4482-CTR-A-												Catalog Number	Description
	700	701	702	710	711	712	800	801	802	810	811	812		
3	1	-	-	1	-	-	-	-	-	-	-	-	245A8482G2	Magnet assembly
3	-	1	1	-	1	1	1	1	1	1	1	1	245A8482G1	Magnet assembly
*4	1	-	2	1	-	2	-	-	-	-	-	-	245A8490G2	Movable tip assembly
*4	-	2	-	-	2	-	-	-	-	-	-	-	259A5047G2	Movable tip assembly
*4	-	-	-	-	-	-	1	-	2	1	-	2	245A8490G1	Movable tip assembly
*4	-	-	-	-	-	-	-	2	-	-	2	-	259A5047G1	Movable tip assembly
5	1	1	1	1	1	1	-	1	1	-	1	1	259A3238P1	Spring for movable tip (gold)
5	-	-	-	-	-	-	1	-	-	1	-	-	259A3202P1	Spring for movable tip (red)
†6	1	-	-	1	-	-	1	-	-	1	-	-	259A1298P1	Retainer for movable tip spring
6A	-	2	2	-	2	2	-	2	2	-	2	2	259A8703P1	Spring cup
7	1	2	2	1	2	2	1	2	2	1	2	2	259A3200P1	Movable tip carrier
8	2	-	-	2	-	-	2	-	-	2	-	-	259A3220P1	Tip clamp, lower
8	-	2	2	-	2	2	-	2	2	-	2	2	259A8702P1	Tip clamp, lower
9	-	1	1	-	1	1	-	1	1	-	1	1	259A3225P1	Tip clamp, upper
10	1	2	2	1	2	2	1	2	2	1	2	2	245A8495P2	Tip shim
11	1	-	-	1	-	-	-	-	-	-	-	-	259A3237G2	ΔArmature assembly
11	-	1	1	-	1	1	-	1	1	-	1	1	259A3237G6	ΔArmature assembly
11	-	-	-	-	-	-	1	-	-	1	-	-	259A3237G1	ΔArmature assembly
11	1	-	-	1	-	-	-	-	-	-	-	-	259A3237G5	øArmature assembly
11	-	1	1	-	1	1	-	1	1	-	1	1	259A3237G3	øArmature assembly
11	-	-	-	-	-	-	1	-	-	1	-	-	259A3237G4	øArmature assembly
12	1	-	-	1	-	-	-	-	-	-	-	-	259A5018G1	Core assembly
12	-	1	1	-	1	1	1	1	1	1	1	1	245A8487G1	Core assembly
13	1	-	-	1	-	-	1	-	-	1	-	-	245A8486G1	Stud and nut assembly
13	-	1	1	-	1	1	-	1	1	-	1	1	245A8486G2	Stud and nut assembly
14	1	1	1	1	1	1	1	1	1	1	1	1	245A8494P1	Core head
15	1	1	1	1	1	1	1	1	1	1	1	1	245A8495P1	Shim for core head
16	1	1	1	1	1	1	1	1	1	1	1	1	245A8494P2	Bumper plate
17	1	1	1	1	1	1	1	1	1	1	1	1	259A5239P1	ΔGuide and interlock operator
17	1	1	1	1	1	1	1	1	1	1	1	1	259A5239P2	øGuide
*18	1	-	-	1	-	-	-	-	-	-	-	-	259A3239P1	Return spring for armature (gold)
*18	-	1	1	-	1	1	-	1	1	-	1	1	259A8708P1	Return spring for armature (green)
*18	-	-	-	-	-	-	1	-	-	1	-	-	259A3201P1	Return spring for armature (blue) (for 800 AA or AH only)
19	1	-	-	1	-	-	-	-	-	-	-	-	259A5014P1	Magnet frame
19	-	1	1	-	1	1	1	1	1	1	1	1	245A8481P1	Magnet frame
†20	-	-	-	2	2	2	-	-	-	2	2	2	259A8746G1	Arc vane assembly (must be ordered together)
20A	-	-	-	2	2	2	-	-	-	2	2	2	N605P13008C6	Thread cutting screw (6-32, 1/2 in. pan hd, pro. fin.)
21	1	1	1	1	1	1	1	1	1	1	1	1	194B6365P1	Stationary tip carrier
22	4	-	-	4	-	-	-	-	-	-	-	-	N57P15048B6	Mounting screw for lower tip clamp (8-32, 3 in. pan hd slotted)
22	-	4	4	-	4	4	-	4	4	-	4	4	N57P15075B6	Mounting screw for lower tip clamp (8-32, 4.68 in. pan hd slotted)
22	-	-	-	-	-	-	4	-	-	4	-	-	273A2097P1	Mounting screw for lower tip clamp (8-32, 3.56 in. pan hd slotted)
23	1	1	1	1	1	1	1	1	1	1	1	1	205A4030P3	Lock nut #10-32 hex
24	1	1	1	1	1	1	1	1	1	1	1	1	N405P39C6	Lock washer for No. 10 screw, medium
25	4	4	4	4	4	4	4	4	4	4	4	4	N405P38C6	Lock washer for No. 8 screw
26	1	1	1	1	1	1	1	1	1	1	1	1	N402P9B6	Plain washer for No. 10 screw
	-	-	-	-	-	-	-	-	-	-	-	-	----------	Terminals and stationary contacts (see Terminal Configurations and table on page 3)

Δ Order when electrical interlock operator is used.
ø Order when no electrical interlock operator is used.
† Not shown.
* Parts recommended for normal stock.

INSTRUCTIONS

GEH-4469

150- AND 300-AMPERE ELECTRIC-VEHICLE CONTROL CONTACTORS

IC4482-CTR A700, A800 SERIES

Before any adjustments, servicing, parts replacement or any other act is performed requiring physical contact with the electrical working components or wiring of this equipment, DISCONNECT THE BATTERY, DISCHARGE CAPACITOR(S), AND JACK WHEELS OFF FLOOR.

DESCRIPTION

GENERAL

These d-c contactors are designed for low-voltage, intermittent-duty operation such as found in battery truck service.

PURPOSE OF INSTRUCTIONS

The purpose of these instructions is to instruct the user on proper care and maintenance to obtain satisfactory service from these devices. The manufacturer of the electric vehicle has tested and applied these contactors according to the requirements of his vehicle. No modifications or changes should be made in the layout, physical arrangement or electrical connections without his permission.

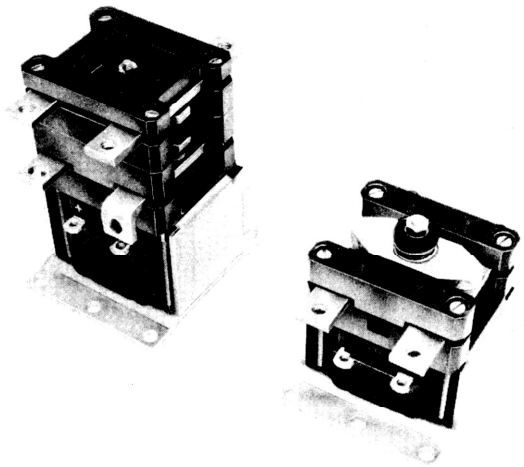


Fig. 1. Right - Single-pole, single-throw type (one normally open contact)
Left - Single-pole, double-throw type (one normally open and one normally closed contact)

MOUNTING

These contactors are designed to mount on a vertical surface or on a horizontal surface.

DISASSEMBLY AND ASSEMBLY

Two main categories of these contactors are available. The single-pole normally open types, and the single-pole double-throw types which have one normally open and one normally closed contact (Fig. 1). The assembly and disassembly of these devices will be covered individually.

Single-pole, Double-throw Type (One Normally Open and One Normally Closed Contact)

DISASSEMBLY

(Refer to Fig. 2, page 2 for exploded view and parts index).

1. Remove all electrical connections and remove the contactor from the vehicle for easier servicing.

2. Loosen the four long bolts in each corner, remove the top contact retainer, and the long bolts.

3. Remove the two top stationary normally closed contacts.

4. Remove the two contact spacers.

5. Remove the two bottom stationary contacts.

6. Remove armature and movable-contact assembly.

7. Remove magnet frame and coil from base.

8. Loosen and remove the 10-32 nut from the armature and movable-contact assembly using a 3/8-inch socket or nut driver. Note the order in which the parts are removed from the stud.

PARTS INDEX

1. Long bolt with #8 lock washer
2. Top contact retainer
3. Top stationary contact
4. Contact spacer
5. Bottom stationary contact
6. Armature and movable-contact assembly
   a. 10-32 nut
   b. No. 10 lock washer
   c. No. 10 flat washer
   d. Movable-contact carrier
   e. Shim
   f. Movable contact
   g. Spring cup (snaps into 6f)
   h. Contact spring
   i. Bottom stationary-contact support
   j. Armature
   k. Spiral return spring
7. Magnet frame
8. Coil
9. Base
10. Bus connector

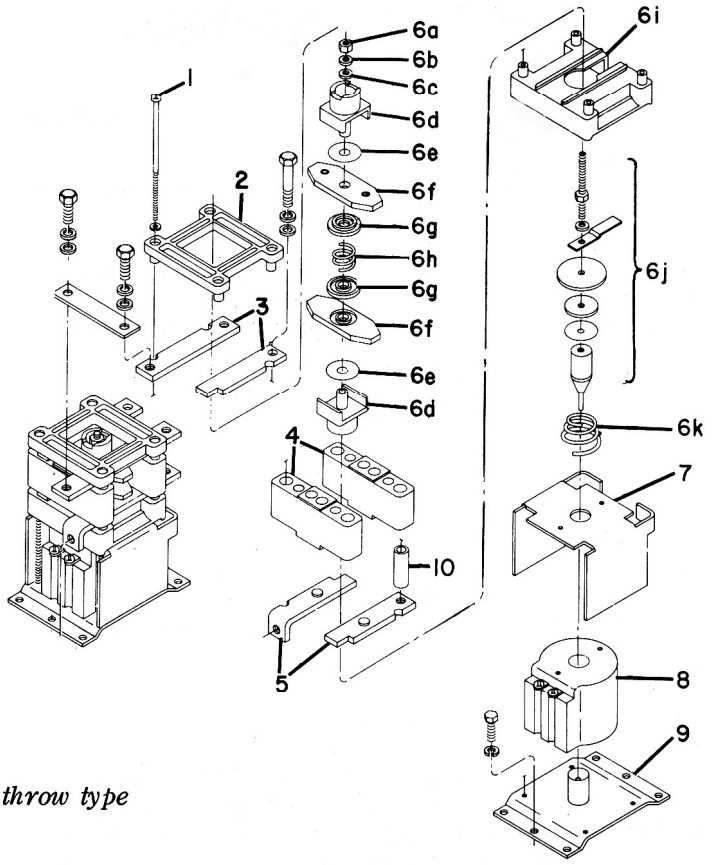


Fig. 2. Assembly of single-pole, double-throw type

PARTS INDEX

1. Long bolt with #8 lock washer
2. Contact spacer
3. Stationary contacts
4. Armature and movable-contact assembly
   a. 10-32 nut
   b. No. 10 lock washer
   c. No. 10 flat washer
   d. Contact spring retainer
   e. Contact spring
   f. Movable contact
   g. Shim
   h. Movable-contact carrier
   i. Stationary-contact support
   j. Armature
   k. Spiral return spring
5. Magnet frame
6. Coil
7. Base

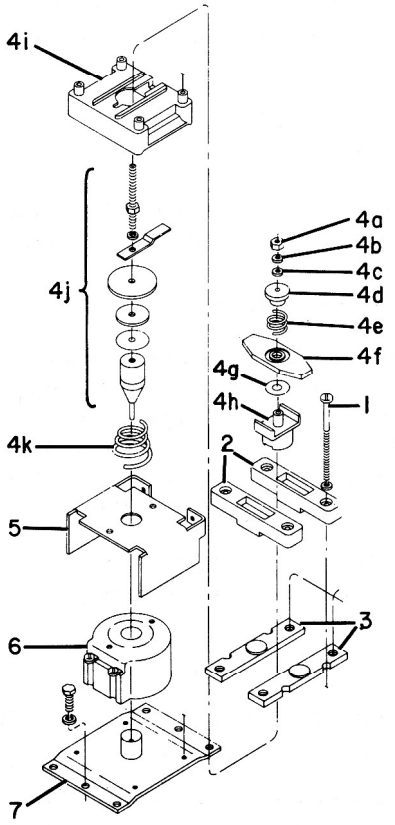


Fig. 3. Assembly of single-pole, single-throw type

ASSEMBLY

(Refer to Fig. 2, page 2 for exploded view and parts index).

Before assembly, all parts should be cleaned, inspected for wear and replaced if required. Assembly is performed in reverse order from disassembly with the following precautions required:

1. Force the small end of the spiral spring over the small diameter on the armature assembly. See Fig. 4, page 3.

2. Reassemble the armature parts 6a to 6k and tighten the 10-32 nut to 14 to 18 inch-pounds torque (1.6 to 2.0 Newton meters).

3. Locate the projections on the magnet frame in the indentations on top of the coil with frame oriented as in Fig. 2.

4. Add the armature and moveable-contact assembly.

5. Properly seat the stationary contacts in the slots of the molded stationary contact support and add the two contact spacers.

6. Add the two top stationary contacts and top contact retainer. Insert bus connector before proceeding to Step 7.

7. Tighten the four long bolts in a uniform manner using a diagonal tightening sequence. Tighten the bolts with 14 to 18 inch-pounds torque (1.6 to 2.0 Newton meters).

DISASSEMBLY AND ASSEMBLY

Single-pole, Single-throw Type (One Normally Open Contact)

DISASSEMBLY

(Refer to Fig. 3, page 2 for exploded view and parts index).

1. Remove all electrical connections and remove the contactor from the vehicle for easier servicing.

2. Loosen the four long bolts in each corner and remove the two contact spacers.

3. Remove the two stationary contacts.

4. Remove armature and movable-contact assembly.

5. Remove magnet frame and coil from the base.

6. Loosen and remove the 10-32 nut from the armature and movable contact assembly using a 3/8-inch socket or nut driver. Note the order in which the parts are removed from the stud. See Fig. 3, page 2.

ASSEMBLY

(Refer to Fig. 3, page 2 for exploded view and parts index).

Before assembly all parts should be cleaned and inspected for wear and replaced if required. The assembly is performed in the reverse order from the disassembly with the following precautions required:

1. Force the small end of the spiral spring over the small diameter on the armature assembly. See Fig. 4, page 3.

2. Reassemble the armature parts 4a to 4k and tighten the 10-32 nut to 14 to 18 inch-pounds torque (1.6 to 2.0 Newton meters).

3. Locate the projections on the magnet frame in the indentations on top of the coil with frame oriented as in Fig. 3.

4. Add the armature and moveable-contact assembly.

5. Properly seat the stationary contacts in the slots of the molded stationary-contact support and add the two contact spacers.

6. Tighten the four long bolts with 14 to 18 inch-pounds torque (1.6 to 2.0 Newton meters).

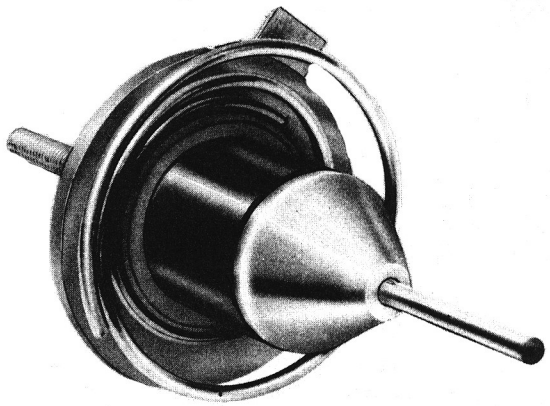


Fig. 4. Spiral spring attached to small diameter on cone head

AUXILIARY CONTACTS

Auxiliary contacts or electrical interlocks are available for the contactors as shown mounted on the contactor in Fig. 5. The auxiliary contact block is operated by de-energizing the contactor. Figures 6 and 7, page 4, illustrate the operations.

To obtain proper operation of the contact block, the gap between the auxiliary contact operator and the button on the contact block should be as shown in Fig. 7. This gap can be obtained by loosening the adjustment screws and moving the interlock support. The slots in the support permit this adjustment. The screws should be retightened to 14 to 18 inch-pounds torque (1.6 to 2.0 Newton meters).

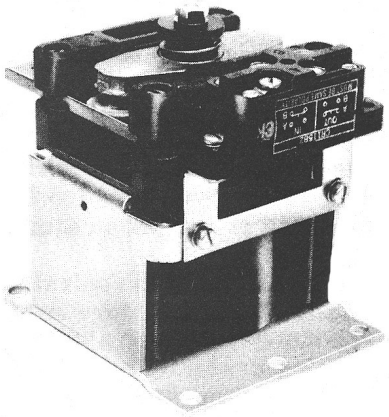


Fig. 5. Contactor with an auxiliary contact

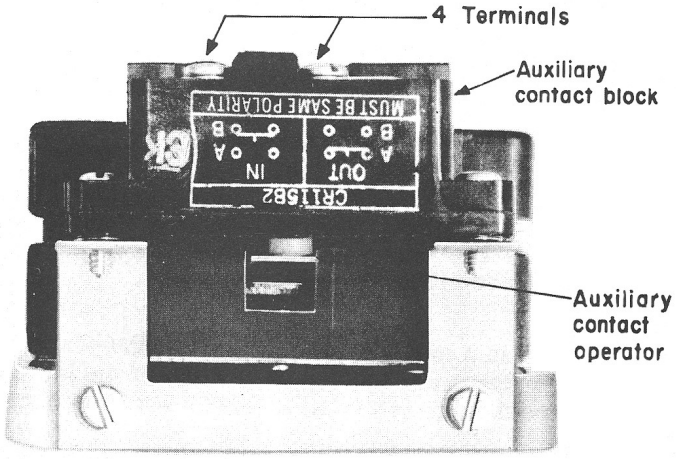


Fig. 6. Auxiliary contact shown in the operated position by the de-energized contactor

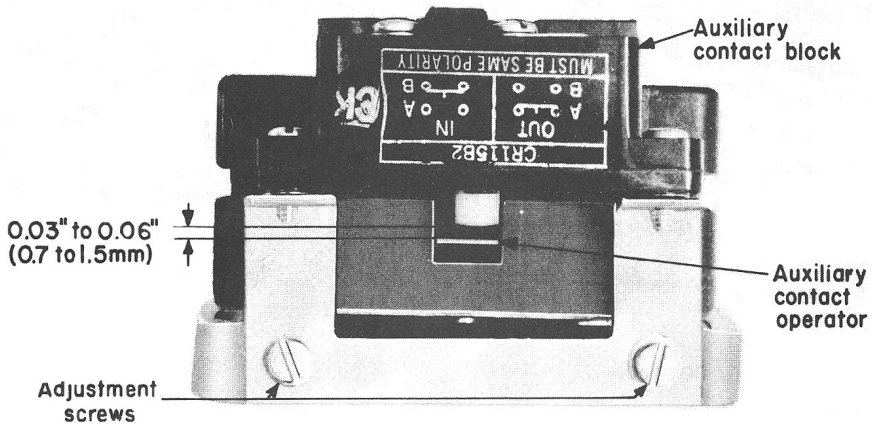


Fig. 7. Auxiliary contact shown in the normal position by the energized contactor

Maintenance And Inspection Of Parts

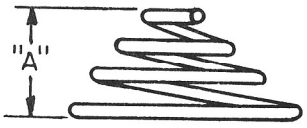
CONTACTS

Contacts must be replaced before they have worn through contact button to the base copper material.

SPIRAL RETURN SPRING

The free length should be between the limits shown in the table and should be replaced if it shows signs of corrosion.

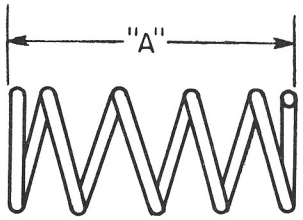
Contactor	Free Length "A" In inches (mm)
700, 710	0.73 to 0.79 (18.5 to 20.1)
701, 711, 712, 801, 702, 802, 811, 812	0.67 to 0.73 (17.3 to 18.5)
800, 810	0.80 to 1.00 (20.3 to 25.5)



CONTACT SPRING

The free length should be between the limits shown in the table and should be replaced if it shows signs of having been overheated or of corrosion.

Contactor	Free Length "A" In inches (mm)
700, 701, 711, 712, 801, 702, 802, 811, 812	0.38 to 0.40 (9.6 to 10)
800, 810	0.37 to 0.39 (9.4 to 9.9)



COILS

CAUTION: *The coils have voltage suppression cast integral with the coil. If a test voltage is applied in the wrong direction or if the coil is connected backwards, permanent damage may result. Observe the polarity mark on the coil during maintenance.*

If the contactor fails to operate, measure the voltage being applied to the coil terminals. The coils on the contactor have been designed to actuate the contactor on reduced battery voltage and with approximately three volts drop in the electronic circuit so that all contactors should operate at or below 65 percent of rated battery voltage. Replace the coil if the contactor does not operate to the full stroke on 65-percent voltage or if the coil shows signs of being overheated.

RENEWAL PARTS

Only factory specified parts should be used. These parts should be obtained from the truck manufacturer through his normal service channels.

FIELD WEAKENING SYSTEM

IC4484B201 FOR 36–48-VOLT OPERATION

IC4484B200 FOR 72–80-VOLT OPERATION

Before any adjustments, servicing, parts replacement or any other act is performed requiring physical contact with the electrical working components or wiring of this equipment, DISCONNECT THE BATTERY AND DISCHARGE CAPACITOR 1C.

GENERAL

Field weakening (FW) is supplied for truck applications where more speed is desired than is available with the motor directly across the battery (with 1A closed).

After 1A is closed, card 2 senses the truck speed by sensing the current in the series field. After a suitable speed has been attained on full field, the field current drops to a low value. The FW contactor is then energized to insert field-weakening resistor 3 RES in parallel with the drive-motor field. If current in the motor increases, as when going up a grade, card 2 drops out the FW contactor, reapplying full field to the motor.

CHECKING OPERATION

To check the field-weakening circuit, connect an ammeter and shunt between battery negative and 1 REC. Connect the battery and depress the accelerator slightly to assure that a positive deflection of the meter is obtained. Follow steps A thru C (below) to determine full load running current.

(A) Insert a piece of paper between the power tips of the FW contactor.

(B) Operate the truck with full-rated load in 1A speed to determine the full-load running amperes.

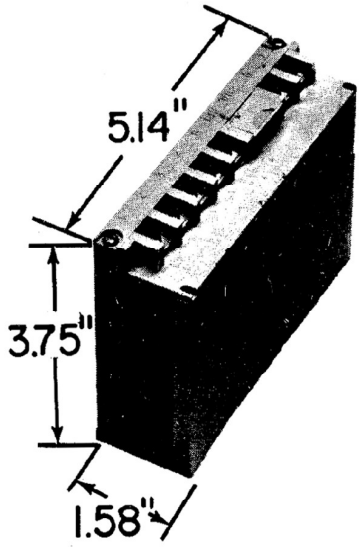


Fig. 1.

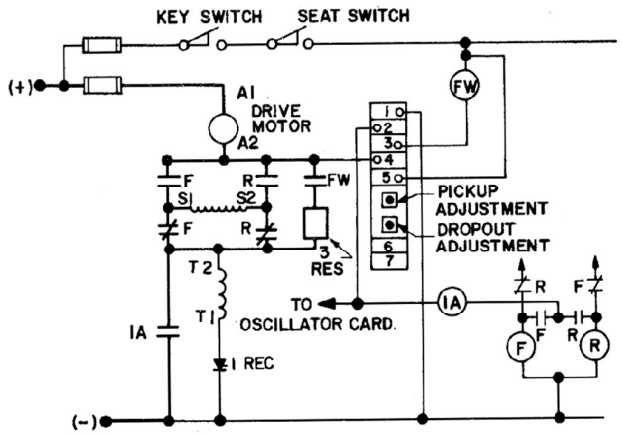


Fig. 2. Typical control connection on diagram

The information contained herein is intended to assist truck users and dealers in the servicing of SCR control furnished by the General Electric Company. It does not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance.

Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purpose, the matter should be referred to the truck manufacturer through his normal service channels, not directly to General Electric Company.

CHECKING OPERATION (CONT'D)

(C) Remove the paper from between the power tips of the FW contactor.

Accelerate the loaded truck on the level. The FW contactor should close about one second after 1A closes or when the current reduces to about 125 to 150 percent of the full load running current. See Fig. 2.

Decelerate the loaded truck by going up a ramp or by applying the brake (with the brake switch jumpered out). The FW contactor should drop out when the current increases to about 300 percent of loaded-level motor current.

If field weakening is not properly set, the card should be adjusted as described under tuneup procedure.

TUNE-UP PROCEDURE

Set up a shunt and ammeter, and determine the full load running current as described in the "CHECKING OPERATION" section. Jack the drive wheels up. Then proceed as follows:

(1) Turn the dropout adjustment fully clockwise.

(2) Turn the pickup adjustment fully counterclockwise.

(3) Partially depress the brake and move the accelerator to full speed.

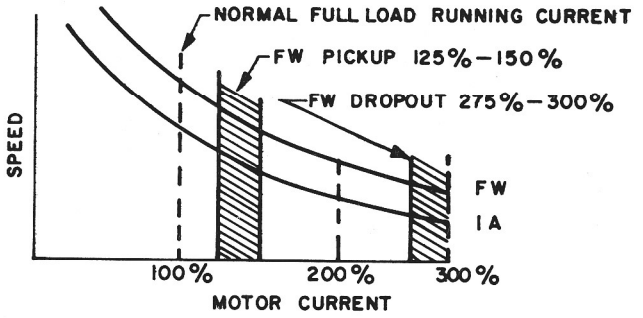


Fig. 3. Pickup and dropout ranges for FW contactor based on full-load-level running speed (1A)

(4) Load the truck motor to correct pickup amperes (usually 135 percent of full load running amperes). Turn the pickup adjustment clockwise until the FW contactor picks up.

(5) Load the truck to the correct drop-out amperage (usually about 300 percent of full load running amperes). Turn the dropout adjustment counterclockwise until the FW contactor drops out.

NOTE: *This card contains filters with long time constants. Hold the current about one second before making adjustments. Turn the trimpot slowly. The pickup adjustment affects dropout, but the dropout adjustment does not affect pickup.*

GENERAL ELECTRIC COMPANY
INDUSTRIAL CONTROL PRODUCTS DEPARTMENT
SALEM, VA. 24153

GENERAL ELECTRIC

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INSTRUCTIONS — SCR ELECTRIC VEHICLE CONTROL

IC4484 AUXILIARY PLUGGING CONTROL

E-701 (36-84 VOLTS) E-702 (84-144 VOLTS) RESISTOR AND NORMALLY OPEN CONTACTORS

WARNING

Before any adjustments, servicing, parts replacement or any other act is performed requiring physical contact with the electrical working components or wiring of this equipment, DISCONNECT THE BATTERY AND DISCHARGE CAPACITOR 1C.

FUNCTION

The function of the auxiliary plugging control, Fig. 1, or "B" kit is to insert a resistor in series with the motor armature during a "plugging" operation. This resistor dissipates most of the energy used in stopping the vehicle and forces the field current to approach the armature current thus reducing armature current and improving commutation.

OPERATION

The auxiliary plug card is connected in the EV-1 SCR circuit as shown in Fig. 2. The logic in the "B" card energizes the "B" coil when positive voltage is applied to the "B" coil, pin 6 of the "B" card and no "plug" signal occurs at R10. During normal running, the "B" contactor is closed and the "B" resistor is by-passed.

When the truck is plugged, a "plug" signal occurs at R10 which de-energizes the "B" coil and a negative signal is produced at A1 by the motor armature. The logic in the "B" card clamps R7 to zero. Near the end of the plug, the negative signal at A1 becomes zero and the logic in the "B" card puts a positive voltage into R7 (as adjusted by the trimpot on the "B" card). CW reduces the speed in the new direction needed to cancel the plug signal which re-energizes the "B" coil.

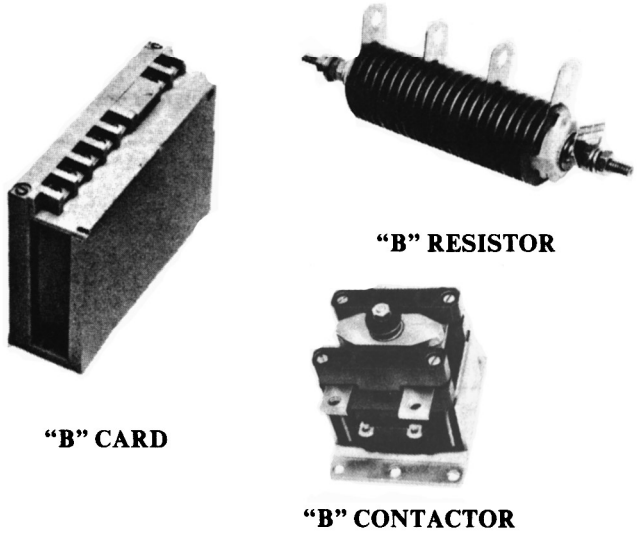

Fig. 1. IC4484 Auxiliary plugging control

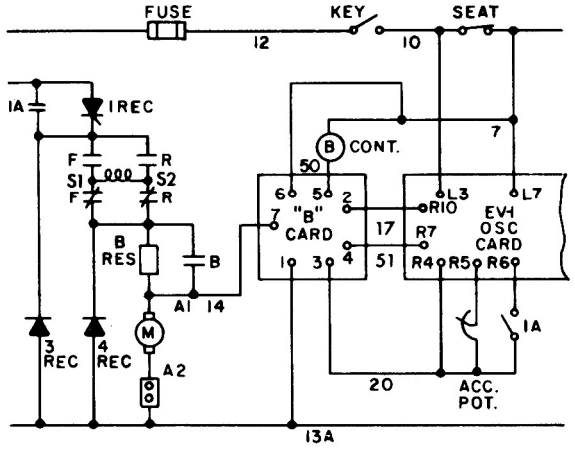

Fig. 2. EV-1 SCR circuit showing connection of auxiliary plug card

FUNCTION OF B CARD TERMINALS FOR E-701 (36-84 VOLT)

TERMINAL	DESCRIPTION	CONDITION	VOLTS
1	Common input to card	Key off, use VOM and read from card terminal 1 to "NEG".	Less than 1 OHM
2	Plugging input logic.	Not plugging mode Plugging mode	0 volts 8 volts
3	Common return to card through Oscillator card.	Key off, use VOM and read from terminal 3 to "NEG".	Less than 1 OHM
4	% on time input running.	Not plugging Plugging	2.2 to 6.2 volts 1.5 volts
5	"B" contactor common input.	Key or seat switch open Key & seat switch closed Plugging	0 volts 0 volts Battery volts
6	Card power supply input.	Key open Key closed	0 volts Battery volts
7	"B" contactor hold off input.	Running not plugging mode Plugging mode	POS volts NEG volts (POS volts will vary depending on speed 0-BV volts.)
			(NEG volts will vary -1 to -15 depending on plugging current.)

The information contained herein is intended to assist truck users and dealers in the servicing of SCR control furnished by the General Electric Company. It does not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance.

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