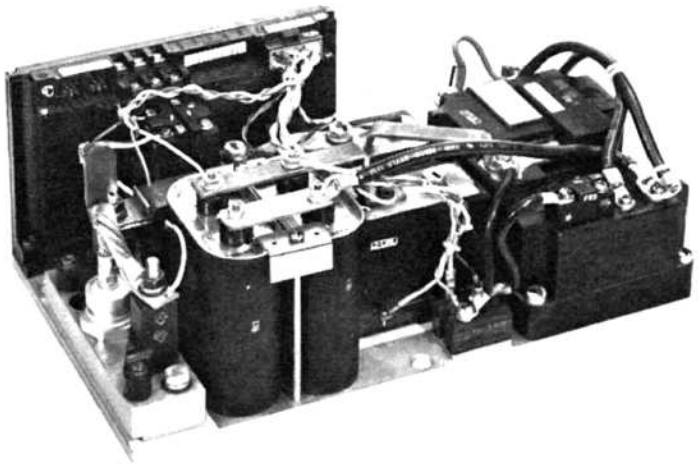
GENERAL ELECTRIC

EV100 EV200



PANEL REPLACEMENT PARTS LISTS & DIAGRAMS

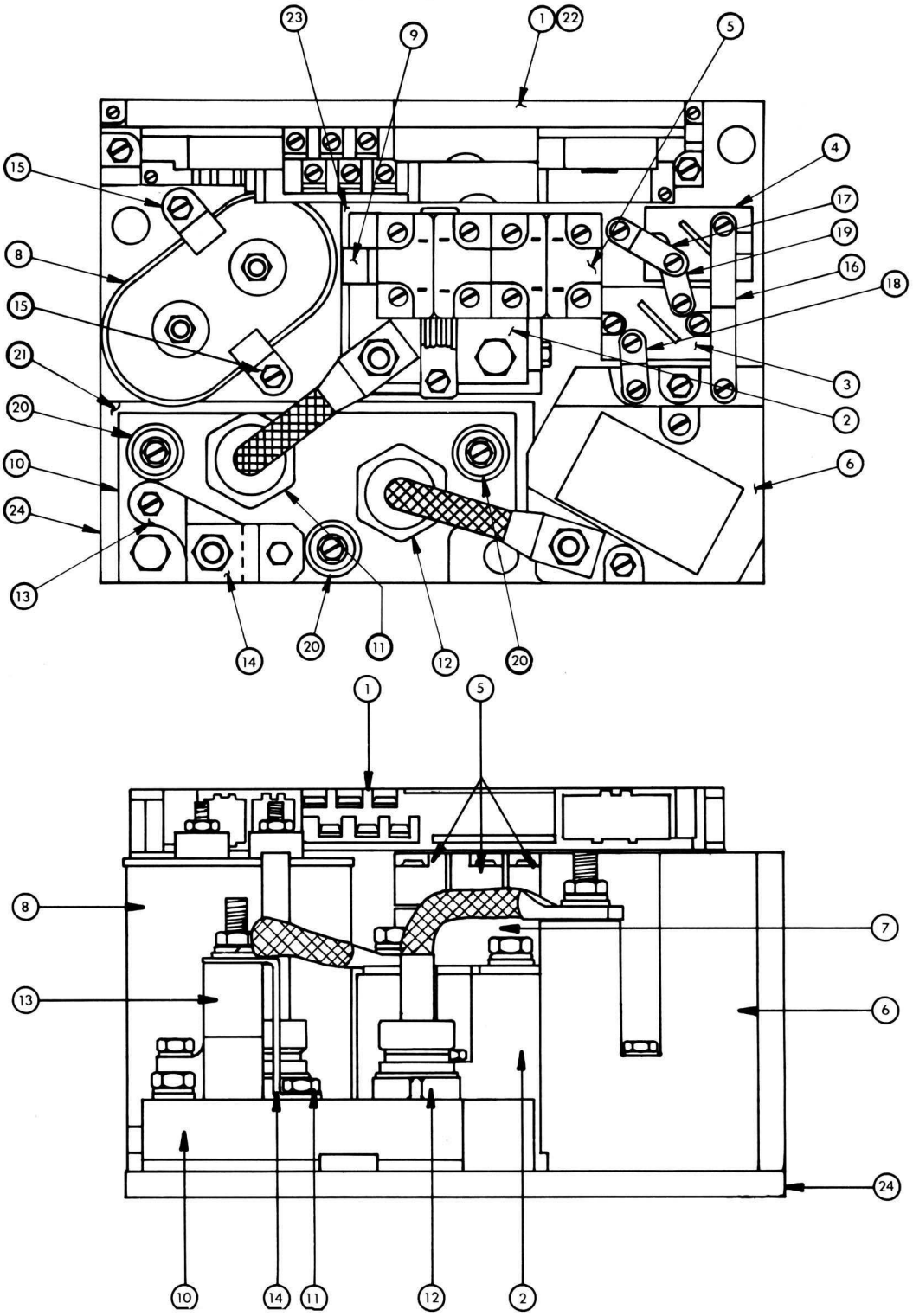
AND TROUBLESHOOTING/ TUNE-UP INSTRUCTIONS

FSIP

FLIGHT SYSTEMS
INDUSTRIAL PRODUCTS

PARTS PRICING/ORDER INFORMATION: 800-333-1194

EV-100 SCR PANEL



EV100 REPLACEMENT PARTS LIST

Listed by GE part number in ascending order

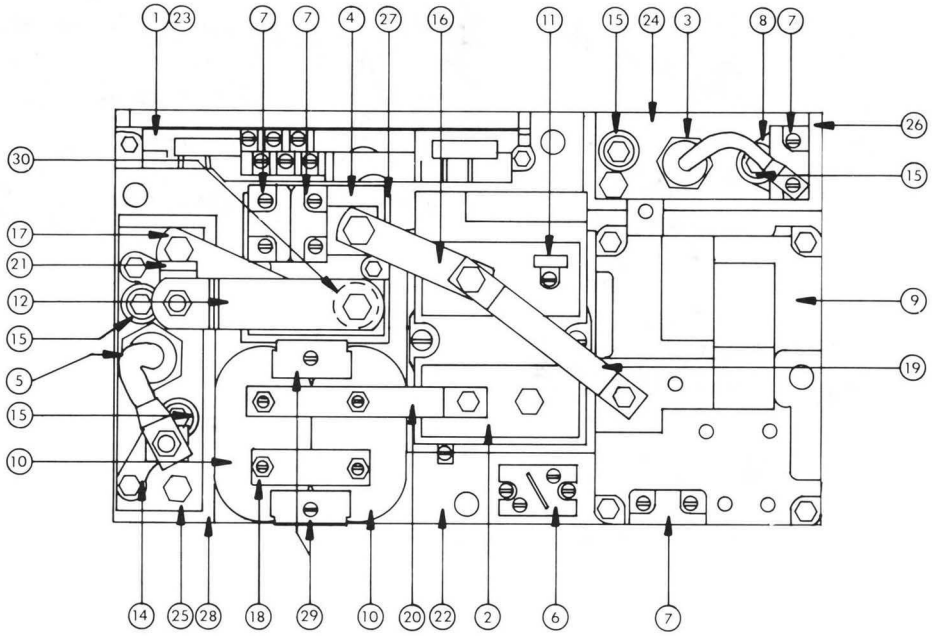
General Electric	Baker	Barrett	Clark	Crown	Hyster	Kalmar AC	Towmotor/ Caterpillar	Yale	Ref. No.	Description	Flight Systems Industrial Products
116C6951P1				103022	370157			5169158-08	10	Heatsink(3 & 4 Rec)	46-6951-01
148B5620DPP1				103016	1300312			5169238-25	16	Bus Bar	46-5620-01
148B5620DPP2				103017	1300313			5169238-26	17	Bus Bar	46-5620-02
148B5620DPP3				103019				5169238-28	18	Bus Bar	46-5620-03
148B5620DPP4				103018	1300315			5169238-27	19	Bus Bar	46-5620-04
158C3100EEP1				103002	1327422			5169128-08	24	Base Plate	46-3100-01
158C3234G1			910389	103009	368912			5182668-02	6	Reactor	46-3234-01
171B3912G1				103023	370158			5169148-05	13	Terminal Post	46-3912-01
171B3933G1		28507-009	610500	103011	379249		973100	5118768-05	7	Spider/Wire Assy	46-3933-01
171B3939G1		28507-011	910370	103003	368912			5169138-25	2	#1 Rectifier-Lo Pwr	Model 365L or 46-3939-01
			911102	105585	1300308						
171B3939G2			911249		1305690			5042232-36	2	#1 Rectifier-Hi Pwr	Model 365H or 46-3939-02
171B3954G1		28501-026	910481	103021	370159			5118838-03	14	Shunt Assy	46-3954-01
171B3954G4									14	Shunt Assy	46-3954-04
171B3940G1		28507-036	910371		368914			5169198-02	5	Snubber Assy	46-3940-01
171B3940G2											
205A7129P1	100018	A27788-17	1802210	76317	1199323	4905234	301773	1294980-39	8	Capacitor	33-9053-FS
	106304	B27140-57	889404	79812	274092	4910571	377087	1297270-08			
	110923	28507-14	895899		278931	4910919	377231	1301450-04			
	226MAW1		8994040		3052380	74905234		5118778-01			
	226MBC1		995138			74910571		5169178-02			
	26121-26125		995665			74910919		5169178-03			
	GE-SCR132		995417								
	GE-SCR152		998526								
		999095									
205A7130P1									8	Capacitor	33-9053-FS
259A3290P1		28507-028	999108		278941	4910932	377227	5180958-00	20	Insulator Bushing	14-3290-01
						74910932					
259A5523P1									8	Capacitor	33-9053-FS
259A5523P2									8	Capacitor	33-9053-FS
259A9053P1									8	Capacitor	33-9053-FS
259A9053P2									8	Capacitor	33-9053-FS
259A9208PXBR	110928	A27788-10	998519	79813	271909	4878269	377099	5169138-05	11 & 12	Diode (3 & 4 Rec)	
	110938	A27788-11	998520	79816	271912	4910566	377232	5169138-06			
	111995	27788-010			279809	4910567	3C7422				
		27788-011			300525	74878269					
					368924	74910566					
						74910567					
259A9208PXCR									11 & 12	Diode (3 & 4)	25-BB20-01
273A2523P8				103006				5182658-08	21	Insulator (3 & 4 Rec)	46-2523-08
273A2523P9			910502	103004	386025		933097	5182658-07	23	Insulator (1 Rec)	46-2523-09
44A717067-001		A28507-043	910375	103008	368919			5169138-28	4	#5 Rectifier	46-7067-01
44A717068-001			910376	103007	368918			5169138-27	3	#2 Rectifier	46-7068-01
44A718897-001				103015	1300311			5169228-05	15	Capacitor Mtg Strap	46-8897-01
44A723565-G01			910377	103012	1300310		973058	5169208-03	9	Thermal Protector	46-7235-05
			911104	105581	1300319						
44A727011-G01									9	Thermal Protector	46-7235-05
44A727011-G01									2	#1 Rectifier-Lo Pwr	Model 365L or 46-3939-01
44A727011-G02									2	#1 Rectifier-Hi Pwr	Model 365H or 46-3939-02

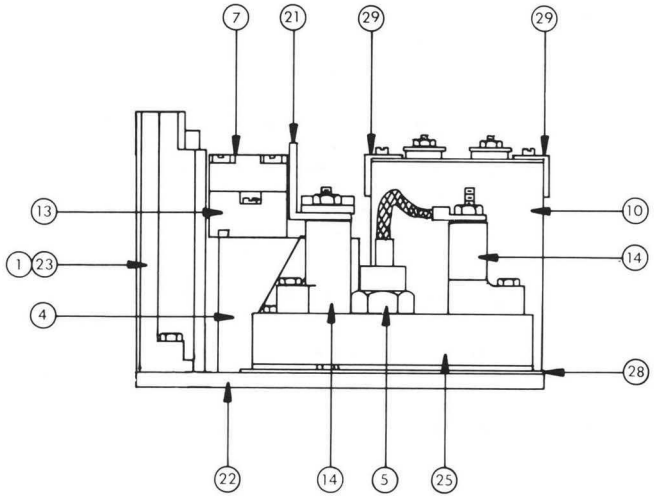
EV100 REPLACEMENT PARTS LIST

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
IC3645EVD1			913783		379234				1	LIS Card-Std Pwr	46-EVD1-00
IC3645EVD2							818600		1	LIS Card-Std Pwr	46-EVD2-00
IC3645EVF1									1	Fld Cntl/Aut Plg-Std Pwr	46-EVF1-00
IC3645EVF2									1	Fld Cntl/Aut Plg-Std Pwr	46-EVF2-00
IC3645EVF4			911238						1	Fld Cntl	46-EVF4-00
IC3645EVF6									1	OSC Card	46-EVF6-00
IC3645EVF7									1	OSC Card	46-EVF7-00
IC3645EVF9			913784						1	OSC Card	46-EVF9-00
IC3645EVL1			912412	103010				51969118-13	1	Spd Lmt/1 ADO-Std Pwr	46-EVL1-00 or EVL1-FO
IC3645EVL2									1	Spd Lmt/1 ADO-High Pwr	46-EVL2-00
IC3645EVM1									1	DU Mtr/Aut Plg-Std Pwr	46-EVM1-00
IC3645EVM2									1	DU Mtr/Aut Plg-High Pwr	46-EVM2-00
IC3645EVM3			912099						1	Dual Mtr-Std Pwr	46-EVM3-00
IC3645EVM4									1	Dual Mtr-High Pwr	46-EVM4-00
IC3645EVM5			916273	107695					1	DU Mtr-Spd Lmt-Std Pwr	46-EVM5-00
IC3645EVM6									1	DU Mtr-Spd Plg-Std Pwr	46-EVM6-00
IC3645EVM7									1	DU Mtr-Spd Plg-High Pwr	46-EVM7-00
IC3645EVM8			913786						1	Dual Mtr-Std Pwr	46-EVM8-00
IC3645EVM9									1	Dual Mtr-High Pwr	46-EVM9-00
IC3645EVP1					379547				1	Pump Cntl-Spd Pwr	46-EVP1-00 or 46-EVP1-F0
IC3645EVP2			911428	368925					1	Pump Cntl-High Pwr	46-EVP2-00 or 46-EVR1-F0
IC3645EVR1			912079	368921				5171136-41	1	Regen/FW Card-Std Pwr	46-EVR1-00 or 46-EVR1-F0
				368932				5184688-40			
				379546							
IC3645EVR2									1	Regen/FW Card-High Pwr	46-EVR2-00 or 46-EVR2-F0
IC3645EVS1									1	SER Cntl/Aut Plg-Std Pwr	46-EVS1-00
IC3645EVS2									1	SER Cntl/Aut Plg-High Pwr	46-EVS2-00
IC3645EVS3			911101				973343		1	SER Cntl/-Std Pwr	46-EVS3-00
IC3645EVS4									1	SER Cntl/-High Pwr	46-EVS4-00
IC3645EVS6									1	SER Cntl/Aut Plg-Std Pwr	46-EVS6-00
IC3645EVS7									1	SER Cntl/Aut Plg-High Pwr	46-EVS7-00
IC3645EVS8			913785						1	SER Cntl-Std Pwr	46-EVS8-00
IC3645EVS9			913784						1	SER Cntl-High Pwr	46-EVS9-00
IC3645EVT1			910378		379545		973088	5169118-11	1	OSC Card-Std Pwr	46-EVT1-00 or 46-EVT1-F0
			910489		368932			5184688-39	1		
IC3645EVT2									1	OSC Card-High Pwr	46-EVT2-00 or 46-EVT2-F0
IC3645EVT6									1	OSC Card	46-EVT6-00
WH7138R36G1			910379	103020	368922		973102	5042262-84	22	Wiring Harness	46-8R36-01
WH7138R36G2									22	Wiring Harness	46-8R36-02

EV-200 SCR PANEL





EV200 REPLACEMENT PARTS LIST
Listed by GE part number is ascending order

EV200 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
116C6961P1									25	Heatsink (#4 Rec)	46-6961-01
116C6975G1									13	Spider Assemby	46-6975-01
148B5620EPP1									19	Bus Bar	46-20EP-01
148B5620EPP2									20	Bus Bar	46-20EP-02
148B5620EPP3									21	Bus Bar	46-20EP-03
158C3100BYP1									22	Base Plate	46-31BY-01
171B3912G1				103023	370158			5169148-05	14	Thermal Post	46-3912-01
171B3939G1									4	#3 Rectifier	46-7011-05
171B3940G1		28507-036	910371		368914			5169198-02	7	Snubber Assemby	46-3940-01
171B3940G2					698916				7	Snubber Assemby	46-3940-01
171B3967P1									24	Heatsink (#2 Rec)	46-3967-01
171B3980G1									12	Shunt Assemby	46-3980-01
188A4381P7									30	Shunt Spacer	46-4381-07
195B4039G1			999109 999110			4910933 74910933	3772395 379310		8	Snubber Mount	14-4039-01
195B4039G2									8	Snubber Mount	14-4039-01
195B6250P2									16	Bus Strap	46-6250-02
195B6250P5	110937	A27788-28	998533	090272 90272	274100	4910910 74910910	377093	5169238-02 5169238-04	17	Flexible Bus	14-6250-05
202B1621P3									18	Capacitor Strap	14-1621-03
205A7129P1	100018 106304 10923 226MAW1 226MBC1 26121-26125 GE-SCR132 GE-SCR152	A27788-17 B27140-57	1802210 889404 895899 899404 995138 995665 995417 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	10	Capacitor	33-9053-FS
205A7130P1									10	Capacitor	33-9053-FS
259A3290P1		28507-028	999108	103005	278941	4910932 74910932	377227	5180958-00	15	Bushing	14-3290-01
259A5523P1									10	Capacitor	33-9053-FS
259A5523P2									10	Capacitor	33-9053-FS
259A8733P1						4910931			29	Capacitor Bracket	14-8733-01
259A9053P1									10	Capacitor	33-9053-FS
259A9053P2									10	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	#4 Rectifier	25-BB20-01
259A9208PXCR									5	#4 Rectifier	25-BB20-01
273A2523P9								5182658-07	27	Insulator (#3 Rec)	46-2523-11
273A2523P11									26	Insulator (#2 Rec)	46-2523-11
273A2523P12									28	Insulator (#4 Rec)	462523-12

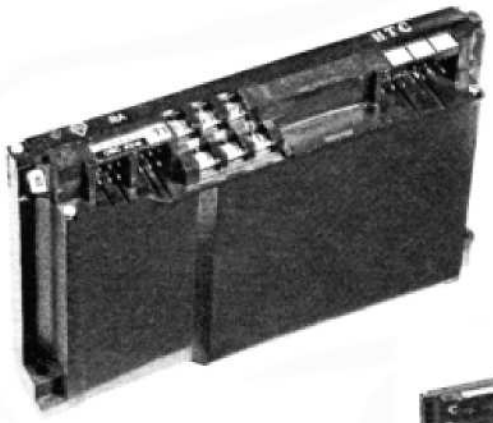
EV200 REPLACEMENT PARTS LIST

Listed by GE part number in ascending order

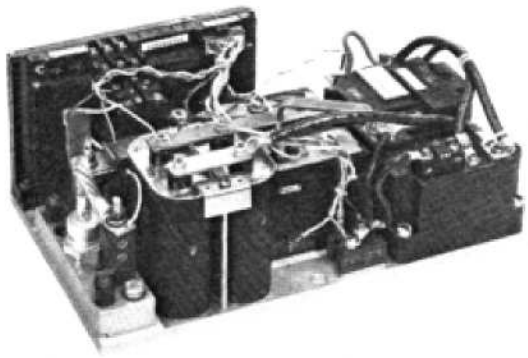
General Electric	Baker	Barrett	Clark	Crown	Hyster	Kalmar AC	Towmotor/ Caterpillar	Yale	Ref. No.	Description	Flight Systems Industrial Products
44A717068-001		28507-043	910376	103007	368919			5169138-27	6	#5 Rectifier	46-7068-01
44A723565-G01			910377 911104	103012 105581	1300310 1322385		973058	5169208-03	11	Thermal Protector	46-7235-05
44A727009-G01									11	Thermal Protector	46-7235-05
44A727011-G04					1308960				2	#1 Rectifier	46-7011-04
44A727011-G05									4	#3 Rectifier	46-7011-05
44A727028-001		28507-028	999108	103005	278941	74910932	377227	5180958-00	15	Bushing	14-3290-01
44A727038-G01									3	#2 Rectifier	46-7038-01
918D620G1	130333		999119		278930	491091 74910918	377248	5169188-02	9	Reactor	34-0620-01
IC3645EVD1			913783		379234				1	LIS Card-Std Pwr	46-EVD1-00
IC3645EVL2			912412						1	SPD LMT/1ADO-Std Pwr	46-EVL1-00 or 46-EVL1-F0
IC3645EVR1			912079	368921 368932 379546				517113-41 5184688-40	1	Regen/FW Card-Std Pwr	46-EVR1-00 or 46-EVR1-F0
IC3645EVS3			911101				973343		1	Ser Cntl-Std Pwr	46-EVS3-00
IC3645EVT1			910378 910489		379545 368932		973088	5169118-11 5184688-39	1	Osc Card-Std pwr	46-EVT1-00 or 46-EVT1-F0
WH7138R86G1			910379		103020		973102	5169268-15	23	Wiring Harness	46-ER36-01

FSIP REBUILDING SERVICES

EV-100 SCR CONTROLS



Oscillator Card



EV-200 Panel

EV-100 Panel

OEM P/N IC3645EV:	FUNCTION	VOLTAGE
D1	LIS CARD-SP	24-84V
D2	LIS CARD-HP	24-84V
F1	FLD CNTL/AUT PLUG-SP	24-84V
F2	FLD CNTL/AUT PLUG-HP	24-84V
F4	FLD CNTL	24-84V
F6	OSC CARD	24-84V
F7	OSC CARD	24-84V
F9	OSC CARD	24-84V
L1	SPD LMT/1ADO-SP	24-84V
L2	SPD LMT/1ADO-HP	24-84V
M1	DU MTR/AUT PLG-SP	24-84V
M2	DU MTR/AUT PLG-HP	24-84V
M3	DUAL MTR-SP	24-84V
M4	DUAL MTR-HP	24-84V
M5	DU MTR/SPD LMT-SP	24-84V
M6	DU MTR/AUT PLG-SP	24-84V
M7	DU MTR/AUT PLG-HP	24-84V
M8	DU MTR-SP	24-84V

OEM P/N	FUNCTION	VOLTAGE
M9	DU MTR-HP	24-84V
P1	PUMP CNTL-SP	24-84V
P2	PUMP CNTL-HP	24-84V
R1	REGEN/FW CARD-SP	24-84V
R2	REGEN/FW CARD-HP	24-84V
S1	SER CNTL/AUT PLG-SP	24-84V
S2	SER CNTL/AUT PLG-HP	24-84V
S3	SER CNTL-SP	24-84V
S4	SER CNTL-HP	24-84V
S6	SER CNTL/AUT PLG-SP	24-84V
S7	SER CNTL/AUT PLG-HP	24-84V
S8	SER CNTL-SP	24-84V
S9	SER CNTL-HP	24-84V
T1	OSC CARD-SP	24-84V
T2	OSC CARD-HP	24-84V
T6	OSC CARD	24-84V

COMPLETE EV100 PANEL
COMPLETE EV200 PANEL
TWO OPTIONS:

REPAIR AND RETEST

FULL DISMANTLE AND REBUILD

- Rebuilt cards and panels can be purchased on an exchange or outright basis depending upon core availability

- One year warranty on all repair services and rebuilt items

EV100/200
CIRCUIT OPERATION

BASICS OF CIRCUIT OPERATIONS (EV100T and EV100S controls)

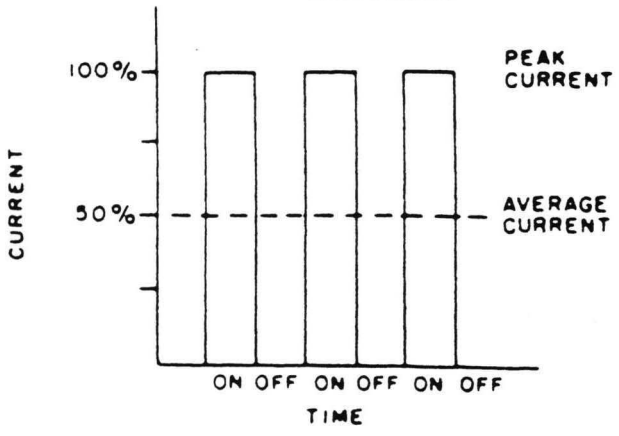
The control circuit is energized by closing the key switch, seat switch, and moving the forward or reverse lever to either position, and then depressing the accelerator closing the start switch. This applies power to the control card turning on the PMT driver (PMT drivers are external on all EV100T controls, except EV100T with "M" card option, and EV100S controls which have internal drivers), which will close the selected directional contactor and complete the circuits to the drive motor. (See elementary drawing.)

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

The control card then supplies a gate pulse to 1REC turning it on to a conducting state, allowing current to flow from the battery through 1REC, motor field, motor armature, sensor, and back to the battery. 5REC turns on and allows current to flow T4-T3, 1C, 1REC, 5REC to T4-T3. This current charges the bottom of 1C positive with respect to the battery positive bus. This charging cycle occurs in less than 1 millisecond (.001 sec.) and 5REC shuts off. This charge is now stored on the capacitor until it is time to turn off 1REC.

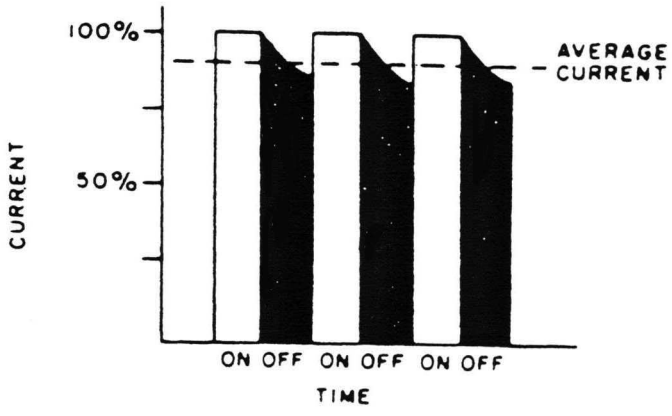
Current continues to flow in 1REC until the control card fires 2REC. When 2REC conducts, capacitor 1C discharges around the circuit composed of 1C, 1X, 2REC, and 1REC. This discharge current opposes the battery current through 1REC so that the resultant current is zero. With reverse voltage across 1REC, 1REC is turned off. Current continues to flow in the 2REC, 1C, motor and battery loop until the capacitor (card terminal 14) is fully charged negative. This charge exceeds battery voltage by an amount which is a function of peak motor current, and 2REC turns off. Figure 1 illustrates the pulsing of current from the battery.

Figure 1



Battery current

Figure 2



Motor current

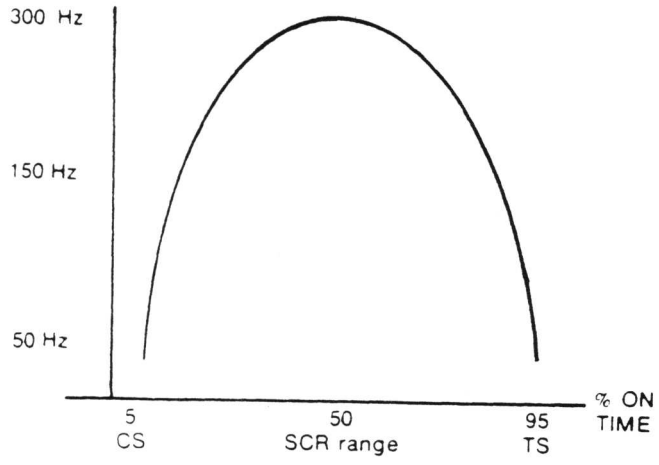
During the off time, the energy stored in the motor, by virtue of the motors inductance, will cause current to circulate through the motor around the loop formed by 3REC. Thus, providing what is called "flyback current". Figure 2 shows the nature of the motor current which is composed of both battery 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. This frequency of oscillation is controlled by the potentiometer in the accelerator and automatic circuitry in the card. Slow speed is obtained by having maximum ohms in the potentiometer. As the resistance in the potentiometer decreases, the speed of the motor increases. The SCR circuit is capable of delivering approximately 95% 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 and one fixed feature. With the accelerator potentiometer at maximum ohms, the creep speed can be adjusted by the "CREEP" trimpot on the card. Top speed is fixed by card design, and is obtained with the accelerator potentiometer at minimum ohms. 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 1.8 milliseconds ON time and 1.8 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. The frequency curve of the oscillator is shown in Figure 3.

Figure 3



Oscillator frequency curve

The rate at which the oscillator may increase its percent ON time is limited by "Controlled Acceleration". The minimum time required to go from creep speed to 80-85% on time point may be varied by the "C/A" trimpot on the card, adjustable from approximately 0.5 seconds to 3.5-4.5 seconds.

* 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 preset value. If heavy load currents are detected, this circuit overrides the oscillator and limits the average current to a value set by the C/L adjustment pot. The C/L setting is based on the maximum thermal rating of 1REC and the peak voltage on the capacitor. Because of the flyback current through 3REC, the motor current usually runs 2 to 3 times battery current. The current limit is set with the "C/L" trimpot on the card. See current limit curves for available current and adjustment range.

* PLUGGING - Slow down is accomplished when reversing by providing a small amount of retarding torque for deceleration. If the venicle is moving and the directional lever is moved from one direction to tne other, the motor field is reversed. The plug signal is initiated by tne fact that the directional switch has moved from one direction to the other. The motor armature, driven by the inertia of the vehicle, acts as generator. This generated current passes through 4REC and tne sensor. 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 1REC to regulate the generated motor current and bring the truck to a smooth stop and reversal.Tne accelerator potentiometer input will modulate plugging current. With tne accelerator potentiometer at minimum resistance, the plugging trimpot will enable adjustment of plugging current from max to min. current level. With tne accelerator potentiometer at maximum resistance, the plugging current will be reduced.

* RAMP START - this feature provides full SCR torque to restart a vehicle on an incline. The memory for this function is the directional switch. When stopping on an incline, the directional switch must be left in its original or off position to allow the control to assure full power when restarted. The accelerator potentiometer input will modulate ramp start current.

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

* 1A CONTROL - the contactor has two modes of control:
  (1) Timed Pickup - this feature works with the potentiometer in the accelerator. When the accelerator potentiometer is activated so that accelerator voltage is reduced to 0.5 volt or less, the 1A time is enabled. The time delay pickup of 1A is provided by a circuit in the card. This allows the truck to accelerate through the SCR range until 1A picks up, even if the accelerator potentiometer is actuated immediately.
  Tnis time delay is adjustable by means of the "1A" time trimpot on the card.
  (2) If motor current is reduced during cutback to a point where 1A pickup would cause a severe torque increase, the 1A timed pickup function will be disabled.

* 1A CURRENT DROP OUT (EV100T with "L" and "M" card option and EV100S) - This adjustable feature can be set to open the 1A contactor if the traction motor is subject to excessive currents. The dropout is adjustable with the "1A DO" trimpot. Once the control has dropped out the 1A contactor due to excess current, the directional or accelerator switch must be returned to neutral to unlock the dropout circuit to allow the control to pick up the 1A contactor again. Using this feature will reduce the 1A contactor tip life, thus it should be used only where needed to protect the motor. The feature can also be made available on all EV100 controls by adding the stand alone card IC4484B919.

* STATIC RETURN TO OFF - this built-in feature of the control is set up to make the driver 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 directional lever is returned to neutral. A time delay of approximately .75 seconds is built into the seat switch input to allow momentary opening of the seat switch if a bump is encountered.

* ACCELERATOR VOLTS HOLD-OFF (EV100S and EV100T with "M" card option) - This feature checks the voltage level at the accelerator input when ever the key switch or seat switch is activated. If the voltage is less than 2.5 volts the control will not start. This is to assure that the control is calling for low speed operation at start-up.

* COIL DRIVER MODULES - these modules are located typically on the contactor portion of the control on EV100T controls and are internal to the control card when using EV100T with "M" card option and EV100S controls. They are the power devices that operate F, R, 1A, D, FW, RB, and PS contactor coils. These modules open or close these coils on command from the control card. All modules are equipped with reverse battery protection in that if the battery is connected incorrectly, none of the contactors controlled can be closed electrically.

* 1A THERMAL HOLD OFF - this feature prevents the 1A contactor from closing when the truck is in severe thermal cutback to avoid torque jumps. When the control goes into severe cutback, the must pulse to time will inhibit the 1A timer.

* MUST PULSE TO TIME - this feature prevents the 1A timer from timing if the oscillation pulse rate has not reached a particular level of operation.

* PULSE MONITOR TRIP (PMT) - This feature contains three features which shuts down or locks out control operation if fault conditions exist that would allow uncontrolled (run away) speed of the vehicle:

    Look ahead
    Look again
    Automatic look again and reset

  The PMT circuit will not allow the control to start under the following conditions:

1.If 1REC is shorted or if 1A contactor is welded, the control will not allow the F or R contactor to close.
2.EV100S and EV100T with "M" option will not allow the control to operate if F and R internal coil drivers are shorted or if 3REC diode is shorted.

The PMT circuit will shut down operation of the control (opening of the F or R contactor) under the following conditions:

1.If 1REC fails to commutate (shut off), or if 1A power tips remain closed when they should be open. After opening the F or R contactor the PMT circuit will check for a fault and if none is found will reclose the directional contactor. If the fault still exist, the directional contactor will open 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 trip is due to random noise.

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

* THERMAL PROTECTOR - (TP) - this temperature sensitive device is mounted in the 1REC heat sink. If the 1REC temperature begins to exceed the design limits, the thermal protector will lower the maximum current limit and not allow 1REC 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.

* 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-100 control is designed for use down to 50 percent of a nominal battery volts of 36-84 V, and 75 percent of a nominal battery volts of 24 V. Lower battery volts may cause the control to not operate correctly; however the PMT should open the F or R contactor in the event of a commutation failure.

* FIELD WEAKENING (EV100T with "R" card option only) - 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.

* REGENERATIVE BRAKING (EV100T with "R" card option only)- if the vehicle is moving and the directional lever is moved from one direction to the other, this initiates a plugging signal by reversing the motor field. During the standard motoring mode and the plugging mode, the RB contactor remains picked up. In the plugging mode, the motor armature acts as generator. Once the generated current reaches a particular current level, the plugging mode transitions to regenerative braking mode.

Transitioning to regenerative braking mode, opens the RB contactor, disconnecting the motor armature from battery negative and inserting 7REC and REGEN SENSOR-2 in the regen circuit. During the 1REC on time, the field and armature current is increased. During the 1REC off time, the energy stored in the field and armature generates the regenerative current, which passes through 7REC, #2 sensor, battery, 3REC/4REC and back to motor field and armature.

The control will remain in regenerative mode as long as the regen current can maintain regenerative current limit. When the regenerative current cannot be maintained and drops below the level set by the regenerative current limit trimpot (RB C/L), the regenerative braking mode transitions back to plugging mode. During the transition back to plugging mode, the RB contactor will reclose enabling the control to function in plugging mode, regulating plugging currents to bring the vehicle to a smooth stop and reversal.
The accelerator potentiometer input will modulate plugging as well as regenerative braking current.

* DUAL MOTOR OPERATION (EV100T with T, D, and M card options) - This function is used to connect the motor armatures of a dual motor vehicle system in parallel during a " plug " if both motors are in operation at the time of the plug cycle. This prevents the fields from building flux in the opposite directions and prohibits the motors from acting as a series generator thereby causing uncontrollable plugging torques. This circuit require the addition of an armature shorting contactor (D contactor) and an additional 4REC diode (4REC-B). The D contactor only closes when both motors are energized during a plugging cycle.

* DUAL MOTOR IN-BOARD WHEEL REVERSAL (EV100T with "M" card option) - This feature allows for the control of the in-board traction motor while in a sharper turning condition. The in-board motor is controlled by inputs from limit switches located on the rear steering wheel which connect card input points to negative. Logic for turn switch operation is shown below:

LEFT TURN - L1 and L2 open - motor energized.
- L1 closed and L2 open - motor disabled.
- L1 and L2 closed - motor reversed from normal direction.

RIGHT TURN - R1 and R2 open - motor energized.
- R1 closed and R2 open - motor disabled.
- R1 and R2 closed - motor reversed from normal direction.

* DUAL MOTOR SHARP TURN SPEED LIMIT (EV100T with "M" card option) - This trimpot adjustable feature allows for the limiting of top speed when either the R1 and R2 or the L1 and L2 switches are both closed.

* TOP SPEED (MOTOR VOLTS) LIMIT (EV100T with "L" card option or use of stand alone card IC4484B919) - This feature provides a means to limit motor volts to three trimpot adjustable limits by limit switch closure between input points on the control card and negative. The lower motor volt limit always takes priority when more than one switch input is closed. This motor volt limit effects top speed of the SCR, but actual truck speed will vary at any set point depending on the loading of the vehicle.

* STEER PUMP CONTACTOR TIME DELAY (EV100T with "M" card option and EV100S) - This feature provides a 24 second time delayed drop out of the steer pump contactor wnen the Forward or Reverse directional switch is opened. This is overriden by a 2 second time delayed drop-out whenever the seat switch is opened. This feature is self contained on the EV100T with "M" card option and must be used with an external coil driver with the EV100S.

* CONSTANT CURRENT COIL DRIVERS AND INTERNAL COIL SUPRESSION (EV100T with "M" card option and EV100S) - This feature allows the use of 24 volt contactor coils on through the entire voltage range of the EV100 (24 volts to 84 volts) for the following contactors:

  EV100T witn "M" card - F,R,1A,D and SP.
  EV100S - F,R and 1A.

  This feature also allows the above contactors to operate cooler due to less current being applied to the coil after pick-up.

* AUTOMATIC PLUG BRAKING (EV100S)- This option will automatically reverse the direction contactors and cause the vehicle to plug brake to near zero speed, when the directional switch or the accelerator start switch is opened.

* HYDRAULIC SCR CONTROL (EV100P) - This hydraulic controller consist of the following features:

  * Three speeds adjustable from "0" volts to full motor volts.
  * Fixed speeds actuated by switch closure to negative.
  * 1A bypass contactor (if required)
  * Variable resistor input (5K-0 ohms).
  * PMT functions available with use of line contactor.
  * Current limit and controlled acceleration adjustable.
  * Battery Discharge Indicator interrupt compatible.

  Operation of voltage regulator card:

  This card provides the basic functions required for controlling the EV100 hydraulic control and optional contactors and PMT functions. Battery positive is applied through a main control fuse to the key switch, energizing the control card power supply input to TB4.

  When the line contactor is used, PMT operation is the same as outlined for the EV100 traction controllers.

  The four speed (motor volts) reference points TB2, TB3, TB5, and TB6 are selected by connecting these points independently to battery negative.

  The first speed is obtained by closing speed point 1, TB2, to SCR control negative. Speed point 1 is adjustable by SPEED 1 trimpot with a clockwise rotation to increase motor voltage from 0 to full motor volts. The specified motor volts will be regulated, however, the magnitude of motor current will vary depending on the loading of the vehicle.

  The second speed is obtained by closing speed point 2, TB3, to SCR control negative. Speed point 2 is adjustable by SPEED 2 trimpot with a clockwise rotation to increase motor voltage form 0 to full motor volts.

The third speed is obtained by closing speed point 3, TB5, to SCR control negative. Speed point 3 is adjustable by SPEED 3 trimpot with a clockwise rotation to increase motor voltage form 0 to full motor volts.

The fourth speed is obtained by closing speed point 4, TB6, to SCR control negative. Speed point 4 is non-adjustable and provides full control motor volts. Speed input 4 must be activated to enable the optional 1A contactor.

If more than one speed input is activated, the selected speed with the highest motor volts will override the low motor volt speed.

The 1A contactor is activated by closing the speed input switch connected to TB6 and SCR negative. This starts the time delay circuit of the 1A contactor. This time is trimpot adjustable from 1 to 4 seconds. A clockwise rotation of the trimpot will increase the time delay.

The current limit circuit is adjustable and operates the same as the traction SCR current limit. See current limit curves for limits and range.

The controlled acceleration circuit is adjustable and operates the same as the traction SCR circuit. Adjustment range is from .45 to 4.0 seconds.

The variable resistor input will override the fixed motor volt limits set by the three adjustable speed inputs. It will vary motor volts above the set limits up to full motor volts, as resistance is decreased.

The Battery Discharge Indicator (BDI) interrupt will disable the hydraulic controller if the connection between PB3 and PB6 is opened. If a BDI circuit is not used, a jumper must be placed between PB3 and PB6 to allow the hydraulic control to operate.

BASICS OF CIRCUIT OPERATIONS (EV100F)

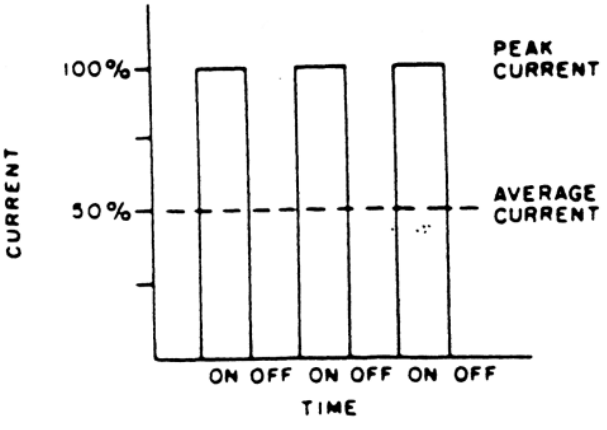
The control circuit is energized by closing the key switch, seat switch and moving the forward or reverse lever to either position and then depressing the accelerator closing the start switch. This applies power to the control card turning on the PMT driver, which will close the selected directional contactor and complete the circuits to the drive motor. (See elementary drawing.)

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

The control card then supplies a gate pulse to 1REC turning it on to a conducting state, allowing current to flow from the battery through 1REC, motor field, motor armature, sensor, and back to the battery. 5REC turns on and allows current to flow T4-T3, 1C, 1REC, 5REC to T4-T3. This current charges the bottom of 1C positive with respect to the battery positive bus. This charging cycle occurs in less than 1 millisecond (.001 sec.) and 5REC shuts off. This charge is now stored on the capacitor until it is time to turn off 1REC.

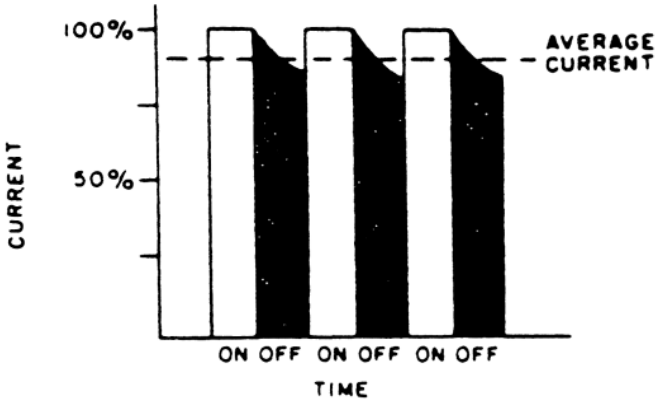
Current continues to flow in 1REC until the control card fires 2REC. When 2REC conducts, capacitor 1C discharges around the circuit composed of 1C, 2REC, 1X, and 1REC. This discharge current opposes the battery current through 1REC so that the resultant current is zero. With reverse voltage across 1REC, 1REC is turned off. Current continues to flow in the 2REC, 1C, motor and battery loop until the capacitor (card terminal 14) is fully charged negative. This charge exceeds battery voltage by an amount which is a function of peak motor current, and 2REC turns off. Figure 1 illustrates the pulsing of current from the battery.

Figure 1



Battery current

Figure 2



Motor current

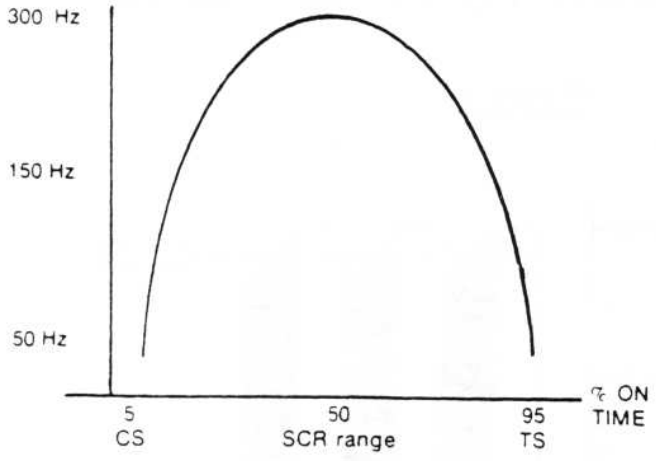
During the off time, the energy stored in the motor, by virtue of the motor's inductance, will cause current to circulate through the motor around the loop formed by 3REC, thus, providing what is called "flyback current". Figure 2 shows the nature of the motor current which is composed of both battery 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. This frequency of oscillation is controlled by the potentiometer in the accelerator and automatic circuitry in the card. Slow speed is obtained by having maximum ohms in the potentiometer. As the resistance in the potentiometer decreases, the speed of the motor increases One (1) second after the percent ON time of the oscillator reaches 90 percent, the 3A contactor is energized. The motor is now configured in the following manner. The armature is connected with current flowing from battery positive through FU1, 3A contactor, motor armature winding, sensor 1 and back to battery negative. The motor field is connected with current flowing from battery postive through FU1, 1REC, motor field winding, 3A contactor, sensor 2 and back to battery negative. The control and motor will remain in this configuation for top speed operation, field weakning and regenerative braking modes.

CONTROL FEATURES

* OSCILLATOR - the oscillator section of the card has two adjustable features and one fixed feature. With the accelerator potentiometer at maximum ohms, the creep speed can be adjusted by the "CREEP" trimpot on the card. Top speed is fixed by card design, and is obtained with the accelerator potentiometer at minimum ohms. 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 1.8 milliseconds ON time and 1.8 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. The frequency curve of the oscillator is shown in Figure 3.

Figure 3



Oscillator frequency curve

The rate at which the oscillator may increase its percent ON time is limited by "Controlled Acceleration". The minimum time required to go from creep speed to 80-90% on time point may be varied by trimpot "C/A" on the card, adjustable from approximately 0.5 seconds to 3.5-4.5 seconds.

* CURRENT LIMIT - This circuit monitors motor current by utilizing a sensor (SENSOR 1)in series with the armature and field during during series motor operation, and by sensors (SENSOR 1) in series with the armature and (SENSOR 2) in series with tne field during shunt motor operation. The information detected across the sensor is fed back to the card so current may be limited to a preset value. If heavy load currents are detected, this circuit overrides the oscillator and limits the average current to a value set by the "C/L" adjustment pot. The C/L setting is based on the maximum thermal rating of 1REC and the peak voltage on the capacitor. Because of the flyback current through 3REC, the motor current usually runs 2 to 3 times battery current. The current limit is set with the "C/L" trimpot on the card.

* PLUGGING - Slow down is accomplished when reversing by providing a small amount of retarding torque for deceleration. If the vehicle is moving at a speed less than than top speed in the series motor connection mode and the directional lever is moved from one direction to the other, the motor field is reversed. The plug signal is initiated by the fact that the directional switch has moved from one direction to the other. The motor armature, drive by the inertia of the vehicle, acts as generator. This generated current passes through 4REC and the sensor. 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 1REC to regulate the generated motor current and bring the truck to a smooth stop and reversal.The accelerator potentiometer input will modulate plugging current. With the accelerator potentiometer at minimum resistance, the plugging trimpot will enable adjustment of plugging current from max to min. current level. With the accelerator potentiometer at maximum resistance, the plugging current will be reduced.

* REGENERATIVE BRAKING - if the vehicle is moving and the 3A contactor is energized and the direction lever is moved from one direction to the other, this initiates a regenerative braking (RB) signal. During regen braking, current flows from motor terminal A1 to battery positive thru battery negative to SENSOR 1 and returns to motor A2.

  The control will remain in regenerative mode as long as the regen current can maintain regenerative current limit. Once the regenerative current cannot be maintained and drops below regenerative braking current limit (C/L) adjusted by the "RB C/L" trimpot. The control will de-energize the 3A contactor and the direction contactor, and will energize the selected direction contactor, and begin plug mode operation, regulating plugging current to bring the vehicle to a smooth stop and reversal.

  The accelerator potentiometer input will modulate the plugging current, as well as the regenerative braking current.

* RAMP START - this feature provides full SCR torque to restart a vehicle on an incline. The memory for this function is the directional switch. When stopping on an incline, the directional switch must be left in its original or off position to allow the control to assure full power when restarted. The accelerator potentiometer input will modulate ramp start current.

* STATIC RETURN TO OFF - this built-in feature of the control is set up to make the driver 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 lever is returned to neutral. A time delay is built into the seat switch input, 2.0 second, to allow momentary opening of the seat switch if a bump is encountered.

* THERMAL PROTECTOR - (TP) - this temperature sensitive device is mounted in the IREC heat sink. If the IREC temperature begins to exceed the design limits, the thermal protector will lower the maximum current limit and not allow IREC to exceed its temperature limits. As the panel cools, the thermal protector will automatically return the control to full power.

* FIELD WEAKENING - This function is accomblished by varying the ratio of field current to armature current. The base speed of the motor is when the field current and the armature current are the same value. When the field current is reduced to less than the armature current tne speed of the motor is increased, while the torque of the motor is reduced.

  The field weakening ratio for this control depends upon accelerator input voltage, and card trimpot "FW Ratio" adjustment. The FW Ratio adjustment is adjustable from 88 to 40 percent weak field in 12 percent steps.
  The accelerator voltage will vary the field weakening to 40 percent weak field.

Accelerator volts	Percent field current
Less than 1.4V	88 percent weak
Less than 1.2V	76 percent weak
Less than 1.0V	64 percent weak
Less than 0.8V	52 percent weak
Less than 0.6V	40 percent weak

  The FW Ratio trimpot will override the accelerator input voltage and limit the field weakening percent to the value set.

* MINIMUM FIELD CURRENT -The minimum field current trimpot sets the minimum value tne motor field current can be when operating with the 3A contactor energized.

  This adjustment may be used to limit the speed of the vehicle below the base speed and will also give automatic regenerative braking on an overhauling load. This feature will limit speed on grades and ramps when the vehicle is operated in the shunt motor mode (top speed).

* AUTOMATIC REGENERATIVE AND PLUG BRAKING - This option will automatically regen brake and than plug brake the vehicle to near zero speed, when the directional switch or the accelerator start switch is opened.

* 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-100 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.

* PULSE MONITOR TRIP (PMT) - This feature contains three features which shuts down or locks out control operation if fault conditions exist that would allow uncontrolled (run away) speed of the vehicle:

  Look ahead
  Look again
  Automatic look again and reset

  The PMT circuit will not allow the control to start under the following conditions:

  1.If 1REC is shorted or if 3A contactor is welded, the control will not allow the F or R contactor to close.
  2.Will not allow the control to operate if F and R internal coil drivers are shorted or if 3REC diode is shorted or if F or R contactor tips are welded.

  The PMT circuit will shut down operation of the control (open the F or R contactor) under the following conditions:

  1.If 1REC fails to commutate (shuts off). After opening the F or R contactor the PMT circuit will check for a fault and, if none is found, will reclose the directional contactor. If the fault still exist, the directional contactor will open and remain open.

  If 3A 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 trip is due to random noise.

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

* ACCELERATOR VOLTS HOLD-OFF - This feature checks the voltage level at the accelerator input when ever the key switch or seat switch is activated. If the voltage is less than 2.5 volts the control will not start. This is to assure that the control is calling for low speed operation at start-up.

* COIL DRIVERS - these devices are located internal to the control card. They are the power devices that operate F, R, and 3A contactor coils. These modules open or close these coils on command from the control card. All modules are equipped with reverse battery protection in that if the battery is connected incorrectly, none of the contactors controlled can be closed electrically.

* 3A THERMAL HOLD OFF - this feature prevents the 1A contactor from closing when the truck is in severe thermal cutback.

* STEER PUMP CONTACTOR TIME DELAY - This feature provides a 24 second time delayed drop out of the steer pump contactor when the Forward or Reverse directional switch is opened. This is overriden by a 2 second time delayed drop-out whenever the seat switch is opened. This feature must be used with an external coil driver.

* CONSTANT CURRENT COIL DRIVERS AND INTERNAL COIL SUPRESSION - This feature allows the use of 24 volt contactor coils only through the entire voltage range of the EV100 (24 volts to 84 volts) for the F, R and 3A contactors.

This feature also allows the above contactors to operate cooler due to less current being applied to the coil after pick-up.

DISTINGUISHING FEATURES OF EV100F

1. Control pulses all the time. No by-pass (1A) contactor. Has 3A contactor instead. The 3A contactor picks up at 85-90% "on" time of 1REC.

2. Speed controlled by ratio of field current to armature current above 90% "on" time. No field weakening contactor or resistor. Drive motor operates in separately excited mode, due to action of 3A contactor and 10REC.

3. Plugging same as EV100T below 90% "on" time.

4. Sensor #1 monitors armature/regen. current. Sensor #2 monitors field current when 3A contactor is energized.

5. If direction switch is opened above 90% (3A energized), 3A and direction remains energized. This initiates regenerative braking. SCR control regulates field current. Top armature terminal (A1) becomes more positive charging battery via 3A contactor. Regen. continues until armature current drops below RB C/L. 3A then drops out and truck coasts. If opposite direction was selected, plugging mode follows RB mode with selected direction contactor being picked up automatically when 3A drops out.

6. Accelerator modulates field weakening, regenerative and plug braking.

7. Arc blowout for 3A via 11REC and 3C.

8. Field weakening ratio adjustment (factory set).

9. Minimum field current adjustment (factory set).

10. 3A thermal holdoff (like 1A thermal holdoff).

11. 3A dropout on excessive armature current (like 1AD0).

12. Internal contactor drivers for F,R and 3A.

EV100 CONTROLS (EXCEPT EV100F) COMPARED TO EV1

1. All EV100 controls operate over a 24-84 range.

2. There are STANDARD and HIGH POWER versions.

3. EV100F, EV100S and EV100T with "M" card option have on-board constant current drivers for contactors listed below. All coils are 24 volt. Coil current is reduced after contactor picks up for cooler operation.

   EV100S - F,R and 1A
   EV100T w/M card - F,R, 1A, D and SP

4. Reactor instead of transformer to charge 1C capacitor.

5. 1A timer starts on accelerator voltage (0.5V). No 1A microswitch in accelerator. No demand 1A based on duty cycle only.

6. 1A dropout only on EV100S and EV100T with "L" or "M" card options.

7. Accelerator volts holdoff (EV100F, EV100S and EV100T with "M" card). Accelerator volts must be at least 2.5V when initial switch is closed.

8. PMT checks on-board contactor drivers for shorted condition (EV100F, EV100S and EV100T with "M" card) or shorted 3 REC.

9. Conventional field weakening available only with EV100T with "R" card option. Uses FW contactor and field shunting resistor.

10. Regenerative braking on EV100T with "R" card option. RB C/L trimpot sets level of regen, current. Direction change initiates plug with transition to RB (dropping out RB contactor) if regen. current is above RB C/L. Battery is charged via 7REC and #2 SENSOR during "off" time of 1 REC. Armature terminal A2 (bottom) becomes more positive. Automatic transition back to plugging when regen. current drops below RB C/L.

11. Dual motor in-board wheel reversal (EV100T with "M" card option, where applicable). Controlled by limit switches on steering.

12. Dual motor sharp turn speed limit (EV100T with "M" option, where applicable). Limits available top speed in sharp turns. Controlled by limit switches on steering.

13. Top speed limit (EV100T with "L" card option). Limits available top speed at three trimpot adjustable levels. Controlled by limit switches on mast.

14. Steer pump contactor time delay (EV100F, EV100S and EV100T with "M" option). Drops out steer pump contactor 24 seconds after neutral is selected unless seat switch is opened, in which case the delay is only 2 seconds.

15. Auto Plugging (EV100S only). Initiates a plug when the direction lever is moved to neutral. F/R drops when truck stops.

16. Physical differences (from EV1).

    Card box and means of connection to card.
    Reactor instead of transformer.
    2REC and 5REC packaging.
    Smaller snubbers.
    Snubber mounting block.
    Metric hardware and dimensions.

17. Pump control available as EV100P (see description).

IC3645EV100 SCR CONTROL

IC3645EV100	T	L1	T1	A
1	2	3	4	5

ARG 1 — BASIC CATALOG NUMBER

ARG 2 — APPLICATION

T	— TRACTION–STANDARD	USES T, R, L, D, M CARDS
P	— PUMP	USES P CARDS
S	— TRACTION–SERIES CONTROL	USES S CARDS

ARG 3 — 1 REC OPTION (POWER RATING)

L1	— STANDARD	250A STALL
H1	— HIGH POWER	350A STALL

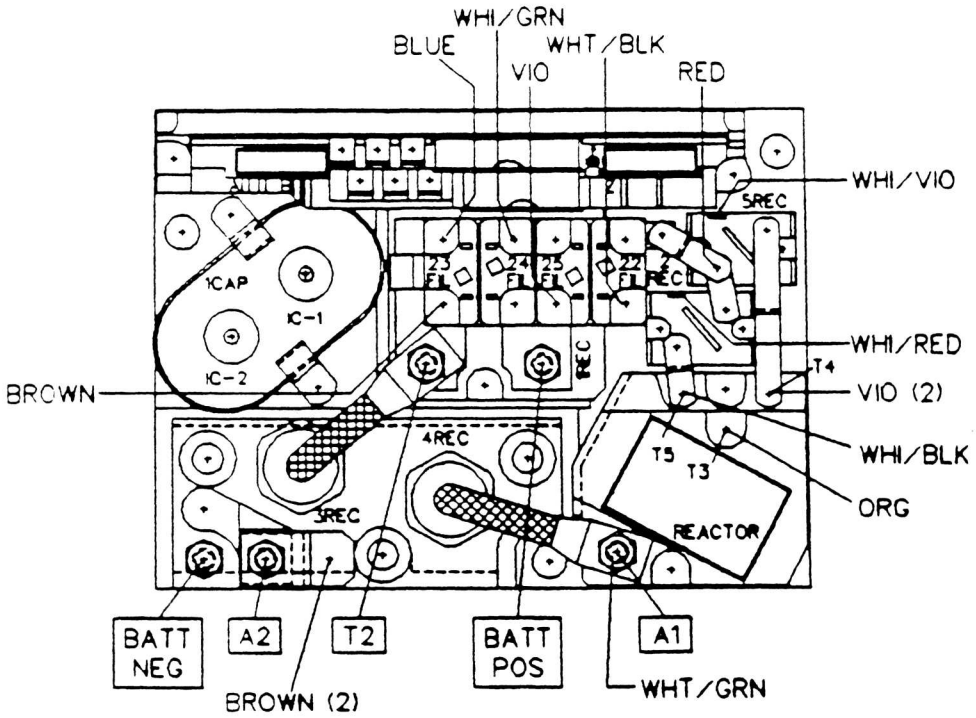
ARG 4 — OSCILLATOR CARD OPTION

T1	— TRACTION (STANDARD)	STANDARD POWER
T2	— TRACTION (STANDARD)	HIGH POWER
R1	— TRACTION (REGEN/FW)	STANDARD POWER
R2	— TRACTION (REGEN/FW)	HIGH POWER
D1	— TRACTION (LIS)	STANDARD POWER
D2	— TRACTION (LIS)	HIGH POWER
L1	— TRACTION (SPD LMT/1ADO)	STANDARD POWER
L2	— TRACTION (SPD LMT/1ADO)	HIGH POWER
M1,M6	— TRACTION (DU MTR/AUT PLG)	STANDARD POWER
M2,M7	— TRACTION (DU MTR/AUT PLG)	HIGH POWER
M3,M8	— TRACTION (DU MTR)	STANDARD POWER
M4,M9	— TRACTION (DU MTR)	HIGH POWER
M5	— TRACTION (DU MTR/SPD LMT)	STANDARD POWER
S1,S6	— TRACTION (SER CNTRL/AUT PLG)	STANDARD POWER
S2,S7	— TRACTION (SER CNTRL/AUT PLG)	HIGH POWER
S3,S8	— TRACTION (SER CNTRL)	STANDARD POWER
S4,S9	— TRACTION (SER CNTRL)	HIGH POWER
P1	— PUMP CONTROL	STANDARD POWER
P2	— PUMP CONTROL	HIGH POWER

ARG 5 — REVISION

A — CURRENT

WIRING FOR EV100T SCR CONTROL



WIRE COLOR & SIZE	FROM	TO	WIRE DESCRIPTION
BRN #22	PZ-2	3REC/4REC HS	259A9500P7 SEE NOTE 2
WHT #22	PZ-7	1 REC-A	259A9500P1
WHT/BLU #22	PZ-8	1 REC-G	259A9500P15 — TWISTED PAIRS
BLU #22	PZ-9	1 REC-C	259A9500P6 — TWISTED PAIRS
WHT/RED #22	PZ-10	2 REC-G	259A9500P12 — TWISTED PAIRS
RED #22	PZ-11	2 REC-C	259A9500P3 — TWISTED PAIRS
WHT/VIO #22	PZ-12	5 REC-G	259A9500P19 — TWISTED PAIRS
VIO #22	PZ-13	REACTOR-T4	259A9500P10 — TWISTED PAIRS
VIO #22	25 REC	REACTOR-T4	259A9500P10
WHT/BLK #22	22 REC	REACTOR-T5	259A9500P11
ORN #22	PZ-14	REACTOR-T3	259A9500P8
BRN #22	24 FIL	3REC/4REC HS	259A9500P7 SEE NOTE 2
WHT/GRN #22	24 FIL	REACTOR-A1	259A9500P13
BLK #10	IC-1	1 REC-A	288A893AA-P40
BLK #10	IC-2	REACTOR-T3	288A893AA-P40

NOTES:

1--ALL #22 TERMINALS MUST BE OF INSULATION GRIP TYPE.

2--TWIST GREEN AND YELLOW LEADS OF SHUNT SENSOR, THEN TWIST WITH BROWN NEGATIVE LEADS, THEN CONNECT TO DESIGNATED PLUG TERMINALS.

3--TWIST BLACK AND GRAY LEADS OF THERMAL PROTECTOR, THEN CONNECT TO DESIGNATED PLUG TERMINALS.

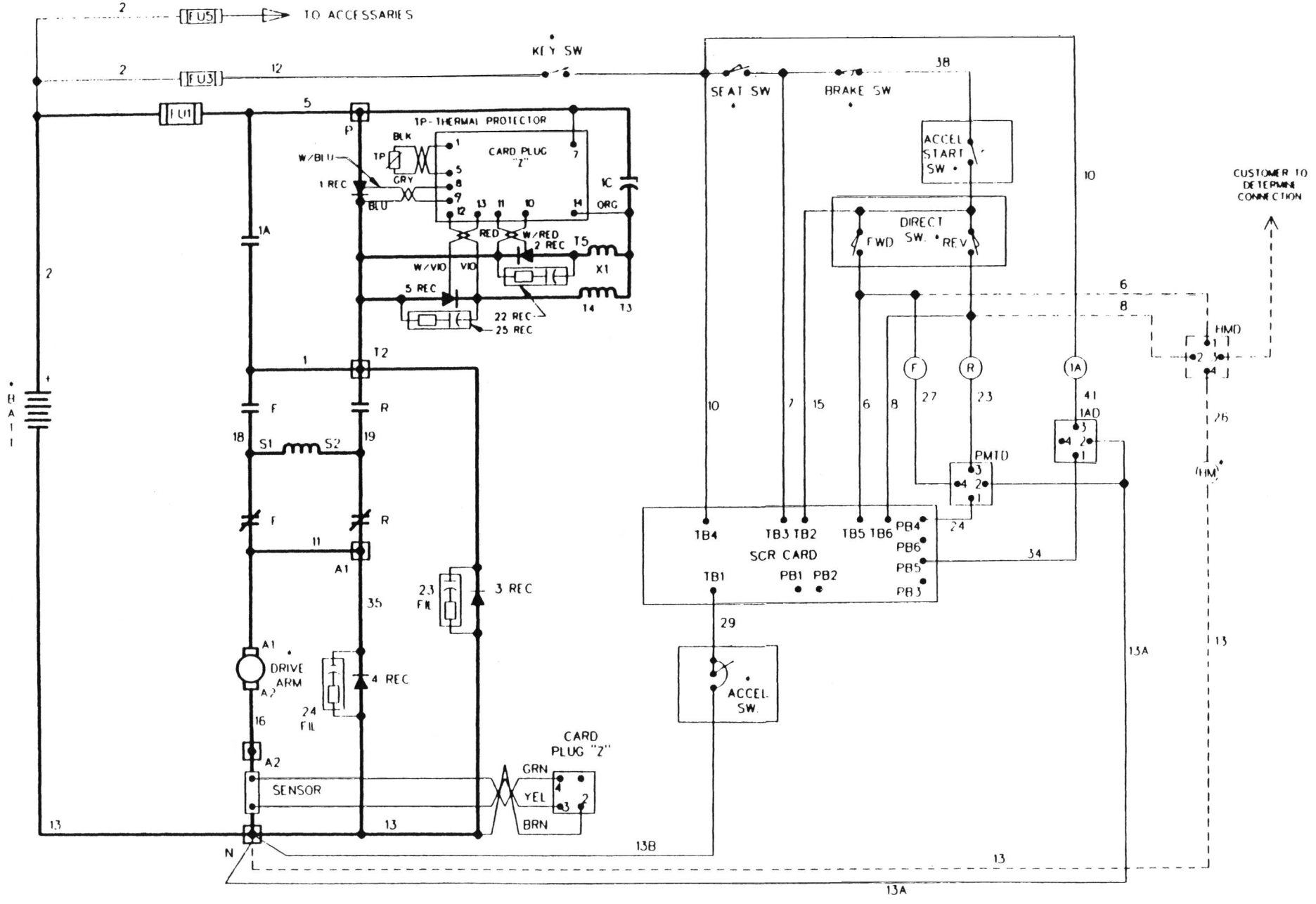
STD CONTROL FEATURES	EV100T	EV100F	EV100S	EV100P
CREEP SPEED	ADJUSTED BY TRIMPOT	ADJUSTED BY TRIMPOT	ADJUSTED BY TRIMPOT	NOT APPLICABLE
CURRENT LIMIT (SEE ATTACHED)	ADJUSTED BY TRIMPOT OPTIONAL CURVES AVAILABLE STANDARD/HIGH PERFORMANCE PRE-SET BY FACTORY FIELD ADJUSTMENT RANGE: MAX/MIN RATIO- 50%	ADJUSTED BY TRIMPOT HIGH PERFORMANCE ONLY PRE-SET BY FACTORY FIELD ADJUSTMENT RANGE: HIGH PERF-(+/-)25%	ADJUSTED BY TRIMPOT OPTIONAL CURVES AVAILABLE STANDARD/HIGH PERFORMANCE PRE-SET BY FACTORY FIELD ADJUSTMENT RANGES: STANDARD- (+/-)50% HIGH PERF-(+/-)25%	ADJUSTED BY TRIMPOT OPTIONAL CURVES AVAILABLE STANDARD/HIGH PERFORMANCE PRE-SET BY FACTORY FIELD ADJUSTMENT RANGE: MAX/MIN RATIO- 50%
CONTROLLED ACCELERATION	ADJUSTED BY TRIMPOT	ADJUSTED BY TRIMPOT	ADJUSTED BY TRIMPOT	ADJUSTED BY TRIMPOT
PLUGGING	ADJUSTED BY TRIMPOT REDUCE BY ACC POSITION	ADJUSTED BY TRIMPOT REDUCE BY ACC POSITION	ADJUSTED BY TRIMPOT REDUCE BY ACC POSITION	NOT APPLICABLE
RAMP START	STANDARD REDUCE BY ACC POSITION	STANDARD REDUCE BY ACC POSITION	STANDARD REDUCE BY ACC POSITION	NOT APPLICABLE
FULL POWER TRANSITION	STANDARD APPLICABLE WITH 1A ONLY	STANDARD (3A CONTACTOR)	STANDARD APPLICABLE WITH 1A ONLY	STANDARD APPLICABLE WITH 1A ONLY
1A TIMED PICK-UP	ADJUSTED BY TRIMPOT ACC POT VOLTS= .5V ACC POT= 200 OHMS	NOT APPLICABLE	ADJUSTED BY TRIMPOT ACC POT VOLTS= .5V ACC POT= 200 OHMS	ADJUSTED BY TRIMPOT REQUIRES SPD SW 4 CLOSURE WITH 1A CONTACTOR
1A THERMAL HOLD-OFF	STANDARD @ DEEP CUTBACK 20% ON	NOT APPLICABLE	STANDARD @ DEEP CUTBACK 20% ON	STANDARD(W/1A) @ DEEP CUTBACK 20% ON
1A PLUGGING HOLD-OFF	STANDARD	NOT APPLICABLE	STANDARD	NOT APPLICABLE
DELAY TO FIRST PULSE	STANDARD	STANDARD	STANDARD	STANDARD
PMT	STANDARD LOOK-AHEAD AND RESET 2 COUNTS	STANDARD LOOK-AHEAD AND RESET 2 COUNTS	STANDARD LOOK-AHEAD AND RESET 2 COUNTS	STANDARD(W/ P) LOOK-AHEAD AND RESET 1 COUNT

STD CONTROL FEATURES	EV100T	EV100F	EV100S	EV100P
THERMAL CUTBACK START @ 90C	STANDARD	STANDARD	STANDARD	STANDARD
STATIC RETURN TO OFF (SRO)	STANDARD 1 SECOND DELAY	STANDARD 1 SECOND DELAY	STANDARD 1 SECOND DELAY	NOT APPLICABLE
VOLTAGE RANGE	24-84VDC	24-84VDC	24-84VDC	24-84VDC
ACCELERATOR INPUT REQUIREMENTS	5000-0 OHMS 3.5-0 V	5000-0 OHMS 3.5-0 V	5000-0 OHMS 3.5-0 V	5000-0 OHMS 3.5-0 V
LOW BATTERY OPERATION	STANDARD 50%- 36-84V 75%- 24V	STANDARD 50%- 36-84V 75%- 24V	STANDARD 50%- 36-84V 75%- 24V	STANDARD 50%- 36-84V 75%- 24V
REVERSE BATTERY PROTECTION	STANDARD	STANDARD	STANDARD	STANDARD
AMBIENT TEMPERATURE	-30 TO +50 DEG C	-30 TO +50 DEG C	-30 TO +50 DEG C	-30 TO +50 DEG C
APPROXIMATE WEIGHT	12 POUNDS	12 POUNDS	12 POUNDS	12 POUNDS

OPT CONTROL FEATURES	EV100T	EV100F	EV100S	EV100P
DRIVERS REQUIREMENTS				
F/R	EXTERNAL*	ON-BOARD	ON-BOARD	N/A
1A	EXTERNAL*	N/A	ON-BOARD	EXTERNAL
FW	EXTERNAL	N/A	N/A	N/A
REGEN	EXTERNAL	ON-BOARD(3A)	N/A	N/A
P/PS	EXTERNAL*	EXTERNAL	EXTERNAL	EXTERNAL
	*ON-BOARD WITH "M" CARD			
SHORTED DRIVER PROTECTION	ON-BOARD ONLY	ON-BOARD ONLY	ON-BOARD ONLY	NO
F/R SWITCH LOADING	LOGIC I WITH "M" CARD COIL I WITH OTHERS	LOGIC I	LOGIC I	NOT APPLICABLE
1A SWITCH	NOT REQUIRED	NOT APPLICABLE	NOT REQUIRED	NOT REQUIRED
% ON 1A DEMAND PICK-UP	WITH "M" CARD OPTION ONLY 85% ON	NOT APPLICABLE	STANDARD 85% ON	NO
1A CURRENT HOLD-OFF	NO	NOT APPLICABLE	NO	NO
1A CURRENT DROP-OUT	TRIMPOT ADJUSTABLE 500-1400A STANDARD WITH "L" CARD OTHERS REQUIRE AUX CARD	NOT APPLICABLE	STANDARD TRIMPOT ADJUSTABLE 500-1400A	NO
DUAL MOTOR CONTROL STANDARD-PROPORTIONING-	OPTIONAL REQUIRES "D" OR "M" CARD REQUIRES AUX KIT	NOT AVAILABLE	NOT AVAILABLE	NOT APPLICABLE
DUAL MOTOR CONTROL STEERING LOGIC	REQUIRED FOR DM APPLICATION DIRECT SWITCH INPUT REQUIRES "M" CARD SERIES WITH COIL, DRIVER REQUIRES "D" CARD	NOT AVAILABLE	NOT AVAILABLE	NOT APPLICABLE

OPT CONTROL FEATURES	EV100T	EV100F	EV100S	EV100P
DUAL MOTOR CONTROL INSIDE WHEEL REVERSAL	OPTIONAL ON STANDARD DM REQUIRES "M" CARD SPEED CUTBACK OPTIONAL REQUIRES STEER SW CLOSURE STANDARD ON PROPORTIONING	NOT AVAILABLE	NOT AVAILABLE	NOT APPLICABLE
AUXILLIARY PLUGGING	OPTIONAL REQUIRES AUX KIT	STANDARD USES FIELD CONTROL	OPTIONAL REQUIRES AUX KIT	NOT APPLICABLE
REGENERATIVE BRAKING	OPTIONAL REQUIRES "R" CARD	STANDARD USES 3A CONTACTOR	NOT AVAILABLE	NOT APPLICABLE
FIELD WEAKENING	OPTIONAL REQUIRES "R" CARD	STANDARD USES FIELD CONTROL	NOT AVAILABLE	NOT APPLICABLE
SPEED LIMIT 3 SPEED RANGES CREEP-TOP SPEED	OPTIONAL STANDARD WITH "L" CARD AUX CARD FOR OTHERS TRIMPOT ADJUSTMENT BY SWITCH SELECTION	OPTIONAL REQUIRES AUX CARD TRIMPOT ADJUSTMENT BY SWITCH SELECTION	OPTIONAL REQUIRES AUX CARD TRIMPOT ADJUSTMENT BY SWITCH SELECTION	STANDARD TRIMPOT ADJUSTMENT 4 SPEED RANGES BY SWITCH SELECTION
STEER PUMP TIME DELAY D.O.-24 SEC(NEUTRAL) 2 SEC(SEAT)	OPTIONAL STANDARD WITH "M" CARD SW/TD/DRIVER FOR OTHERS- (5-15 SEC IN NEUTRAL)	STANDARD REQUIRES TD/DRIVER	STANDARD REQUIRES TD/DRIVER	NOT APPLICABLE
ACCELERATOR START-UP LOCK-OUT(ACC V LT 2.5V)	OPTIONAL REQUIRES "M" CARD	STANDARD	STANDARD	NOT APPLICABLE
AUTO BRAKING (PLUG)	OPTIONAL REQUIRES "M" CARD	OPTIONAL	OPTIONAL	NOT APPLICABLE
AUTO BRAKING (REGEN)	NOT AVAILABLE	OPTIONAL	NOT AVAILABLE	NOT APPLICABLE
BDI INTERRUPT	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	STANDARD

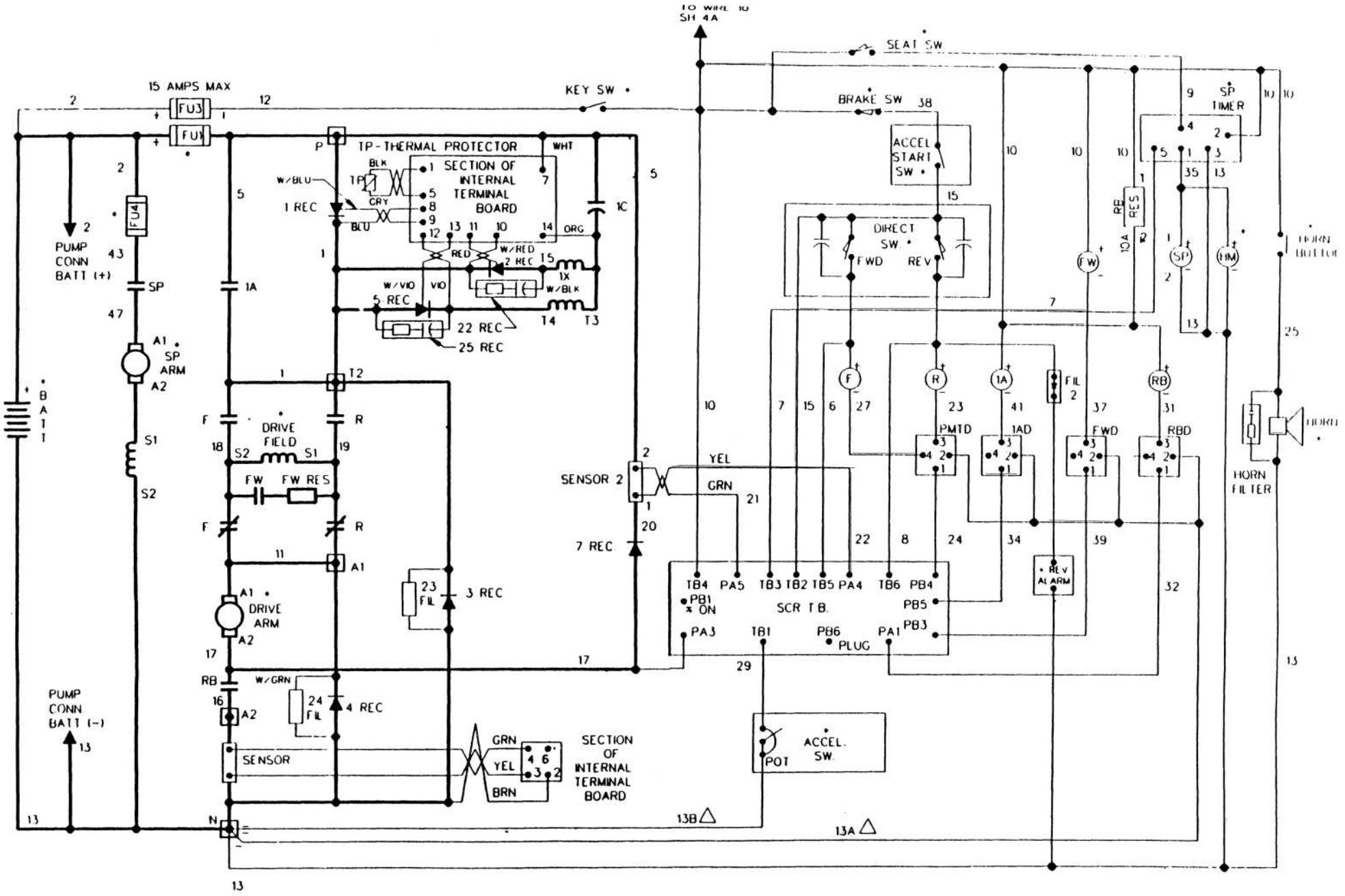
CONTROL RATING	EV100T	EV100F	EV100S	EV100P
VOLTAGE RANGE	24-84VDC	24-84VDC	24-84VDC	24-84VDC
FULL LOAD, FULL FIELD RUNNING MOTOR CURRENT @50% DUTY IN 1A	150 AMPS	150 AMPS PLUS	150 AMPS PLUS	150 AMPS
CONTINUOUS DUTY MOTOR CURRENT WITH 0.3 DEG C/WATT HEATSINK @ 40 DEG C AMBIENT	103 AMPS	103 AMPS PLUS	103 AMPS PLUS	103 AMPS
PLUG CURRENT LIMIT				
MIN-MAX @ 1 SEC	330/950 AMPS	330/950 AMPS	330/950 AMPS	NOT APPLICABLE
MIN-MAX @ 3 SEC	330/650 AMPS	330/650 AMPS	330/650 AMPS	
PEAK MOTOR C/L @ TYPICAL MOTOR IND				
MIN-MAX @30% ON-TIME	525/800 AMPS (STD)	NOT AVAILABLE (STD)	490/770 AMPS (STD)	510/680 AMPS (STD)
MIN-MAX @50% ON-TIME	420/695 AMPS (STD)	NOT AVAILABLE (STD)	370/660 AMPS (STD)	410/590 AMPS (STD)
MIN-MAX @70% ON-TIME	295/575 AMPS (STD)	NOT AVAILABLE (STD)	260/540 AMPS (STD)	320/495 AMPS (STD)
MIN-MAX @30% ON-TIME	525/800 AMPS (H/P)	570/840 AMPS (H/P)	570/840 AMPS (H/P)	510/680 AMPS (H/P)
MIN-MAX @50% ON-TIME	420/695 AMPS (H/P)	520/790 AMPS (H/P)	520/790 AMPS (H/P)	500/670 AMPS (H/P)
MIN-MAX @70% ON-TIME	420/695 AMPS (H/P)	490/750 AMPS (H/P)	490/750 AMPS (H/P)	500/670 AMPS (H/P)
AVERAGE MOTOR C/L @ TYPICAL MOTOR IND				
MIN-MAX @30% ON-TIME	450/675 AMPS (STD)	NOT AVAILABLE (STD)	405/640 AMPS (STD)	450/675 AMPS (STD)
MIN-MAX @50% ON-TIME	355/590 AMPS (STD)	NOT AVAILABLE (STD)	320/565 AMPS (STD)	355/590 AMPS (STD)
MIN-MAX @70% ON-TIME	260/510 AMPS (STD)	NOT AVAILABLE (STD)	230/495 AMPS (STD)	260/510 AMPS (STD)
MIN-MAX @30% ON-TIME	450/675 AMPS (H/P)	475/690 AMPS (H/P)	475/690 AMPS (H/P)	450/675 AMPS (H/P)
MIN-MAX @50% ON-TIME	355/590 AMPS (H/P)	455/685 AMPS (H/P)	455/685 AMPS (H/P)	355/590 AMPS (H/P)
MIN-MAX @70% ON-TIME	435/680 AMPS (H/P)	435/685 AMPS (H/P)	435/680 AMPS (H/P)	435/680 AMPS (H/P)
CONTROLLED ACCELERATION	.45-4.5 SECONDS	.45-4.5 SECONDS	.45-4.5 SECONDS	.2-2.5 SECONDS
1A TIMED PICK-UP	1-5 SECONDS	NOT APPLICABLE	1-5 SECONDS	.8-4.0 SECONDS



SCR POWER CONNECTION

• SUPPLIED BY CUSTOMER

EV100 WITH " T " CARD OPTION

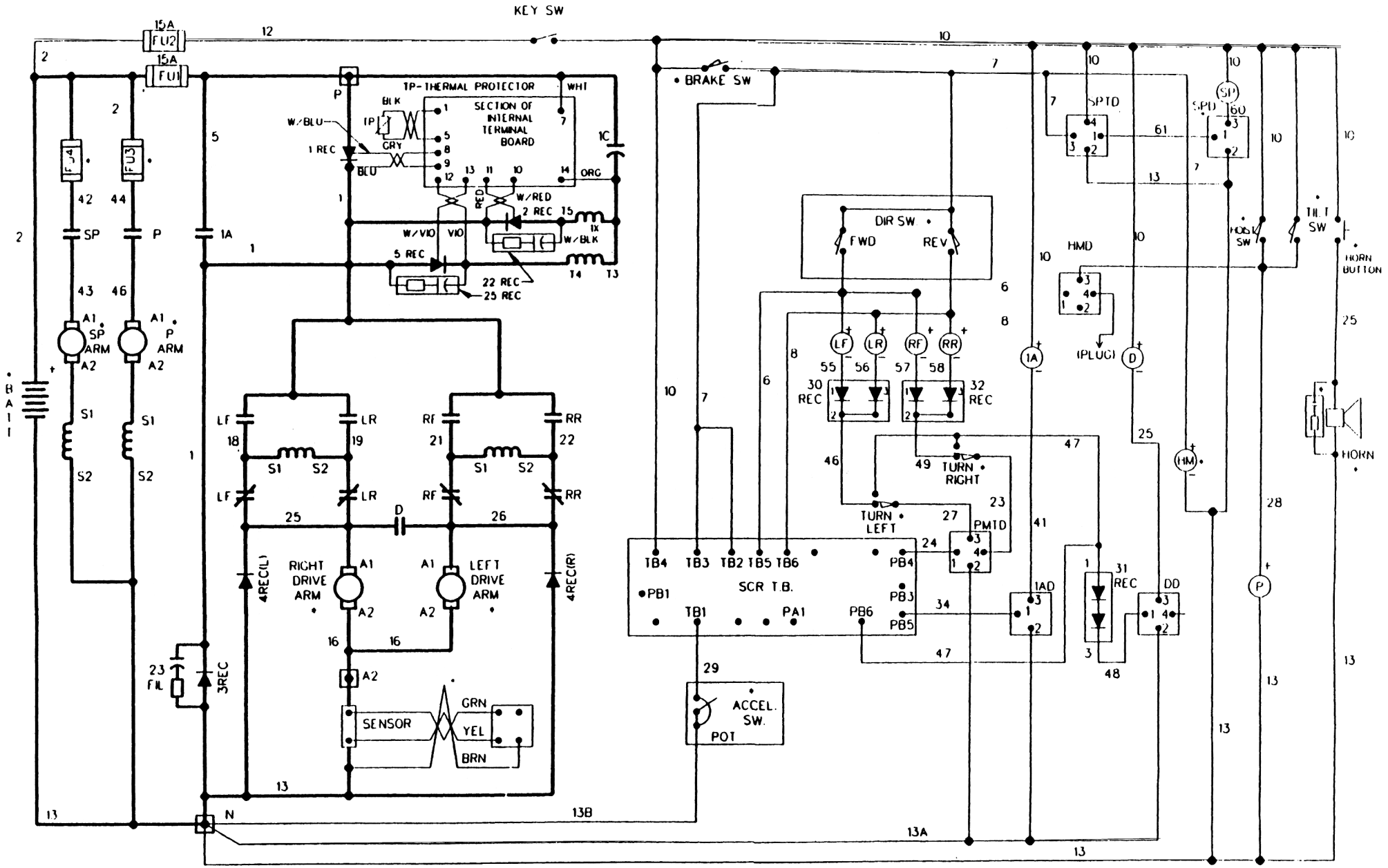


EV100 WITH " R " CARD OPTION

• SUPPLIED BY CUSTOMER

[ ] SCR POWER TERMINAL

△ CONNECTION MADE AT TRACTION CONTROL SCR POWER TERMINAL (NEG.)



SCR POWER TERMINAL

• SUPPLIED BY CUSTOMER

EV100 WITH "D " CARD OPTION

EV100T CUSTOMER TERMINAL FUNCTIONS
(ALL VOLTAGE MEASUREMENTS WITH RESPECT TO SCR NEG)
IC3645EV100T WITH T, D, and R CARD OPTIONS

TERMINAL	DESCRIPTION	CONDITION	NOMINAL VOLTAGE
TB1	ACCELERATOR POT INPUT	WITH KEY SW. OFF	0 V
		WITH KEY SW. ON AND ACC @	
		-CREEP SPEED	3-4.0V
		-TOP SPEED	0.5-0V
TB2	SRO, ACC START, AND BRAKE SW. INPUT. MUST BE HIGH AFTER TB3,4 ARE AT BV AND TB5,6 ARE LOW.	KEY, SEAT, START, OR BRAKE SW. OPEN	0V
		KEY, SEAT, START, BRAKE SW. CLOSED	BV
TB3	SEAT SWITCH INPUT	WITH KEY CLOSED, AND SEAT OPEN	0V
		WITH KEY CLOSED, AND SEAT CLOSED	BV
TB4	KEY SWITCH INPUT (MUST GO LOW TO RESET PMT)	WITH KEY SW. OPEN	0V
		WITH KEY SW. CLOSED	BV
TB5	FWD DIRECTIONAL SWITCH INPUT	WITH KEY, SEAT, START, AND BRAKE CLOSED, AND	
		-FWD IN NEUTRAL(OR REV)	0V
		-FWD SELECTED(F CLOSED)	BV
TB6	REV DIRECTIONAL SWITCH INPUT	WITH KEY, SEAT, START, AND BRAKE CLOSED, AND	
		-REV IN NEUTRAL(OR FWD)	0V
		-REV SELECTED(R CLOSED)	BV
PA1	RB DRIVER OUTPUT	WITH KEY SW. OPEN	0
		WITH KEY SW. CLOSED(RB CLOSED)	5-10 M/A
PA2	(NOT PRESENTLY USED)	-----	-----
PA3	REGENERATIVE BRAKING INPUT SIGNAL	SCR RUN MODE(RB CLOSED)	0V
		REGEN MODE(RB OPEN)	BV
PA4	RB SENSOR #2 NEGATIVE SIGNAL	ALL MODES	BV
PA5	RB SENSOR #2 POSITIVE SIGNAL	ALL MODES	BV
		NOTE:VOLTAGE DROP PA5-PA4 DURING REGEN ONLY	VARIES BY Im
PA6	(NOT PRESENTLY USED)	-----	-----

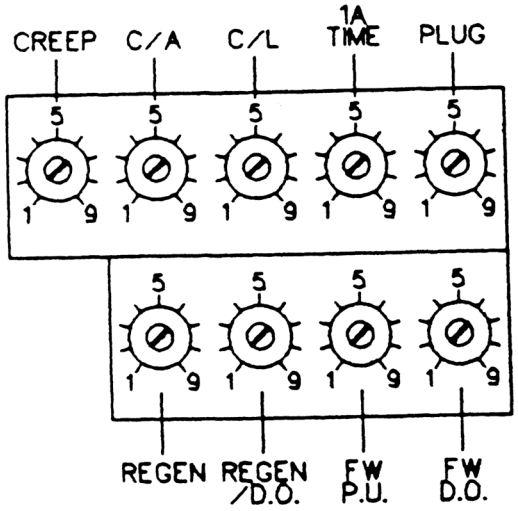
EV100T CUSTOMER TERMINAL FUNCTIONS
IC3645EV100T WITH T, D, and R CARD OPTIONS
(CONTINUED)

TERMINAL	DESCRIPTION	CONDITION	NOMINAL VOLTAGE
PB1	% ON-TIME OUTPUT	CREEP SPEED	2.5V
		TOP SPEED	6.5V
PB2	MOTOR CURRENT SENSOR OUTPUT	0 MOTOR CURRENT	1.80V
		500A AVG MOTOR CURRENT	3.30V
PB3	FW DRIVER OUTPUT	NO FW DEMAND(FW DROPPED OUT)	0
		FW DEMAND(1A PICKED UP, MOTOR CURRENT AT FWPU SETTING(FW PICKED UP)	5-10 M/A
PB4	PMT DRIVER OUTPUT	KEY, SEAT, START, BRAKE SW. CLOSED-	
		-FWD OR REV OPEN	0
		-FWD OR REV CLOSED (F OR R CLOSED)	5-10 M/A
PB5	1A DRIVER OUTPUT	NO 1A DEMAND(1A DROPPED OUT)	0
		1A DEMAND(TB1 @ .5V) (1A CLOSED)	5-10 M/A
PB6	PLUGGING OUTPUT	NOT IN PLUGGING MODE	0V
		IN PLUGGING MODE	12V

TRIMPOT LOCATION FOR EV100 LOGIC CARDS
IC3645EVR1 and R2

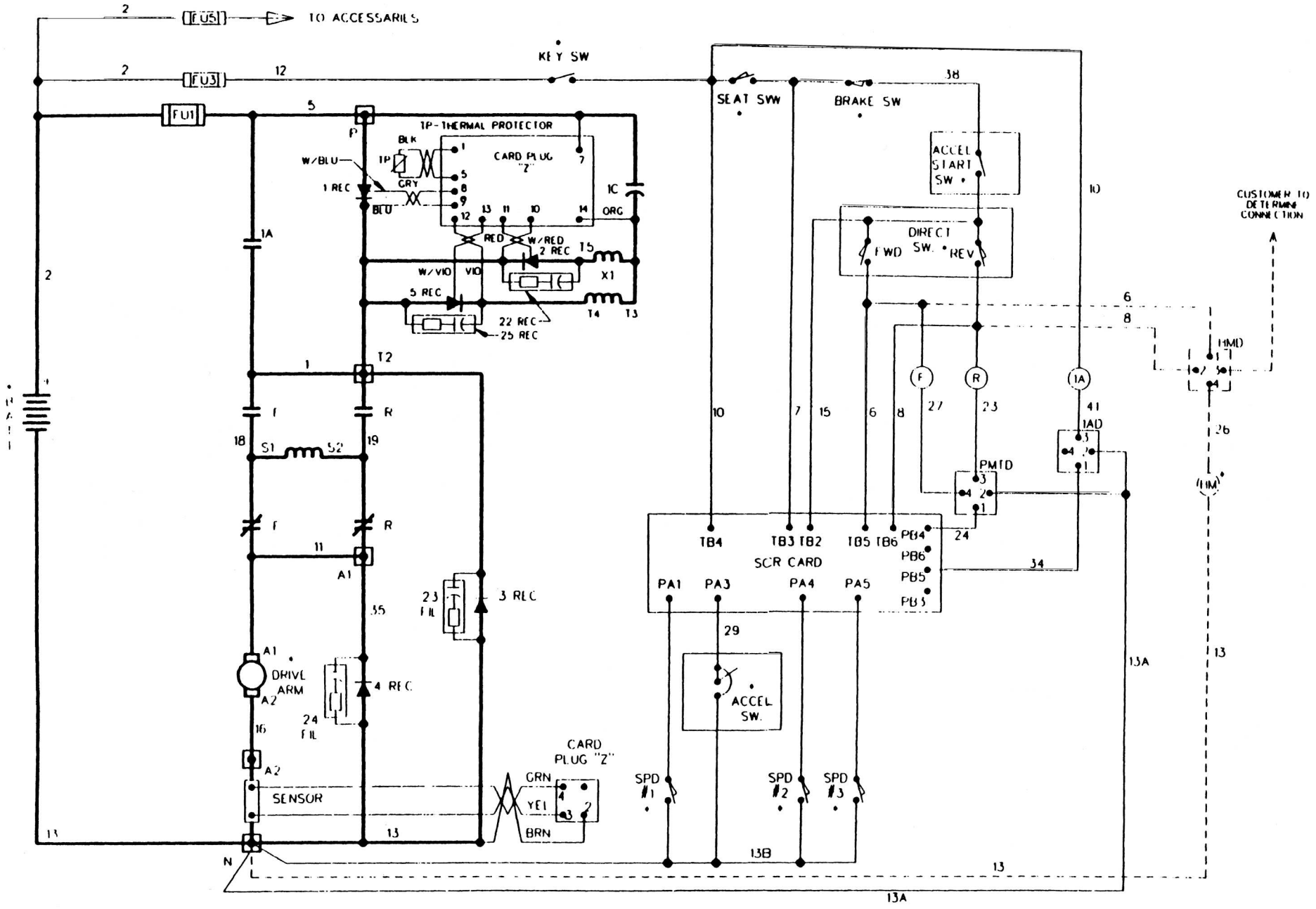
Panels are factory adjusted for a particular motor and truck and should not need adjustment. The card is suppied with single turn potentiometers with internal stops and the box is marked with "dial" settings.

The vehicle manufacturer should supply the "combination" setting for the particular model truck.



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

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



EV100 WITH " L " CARD OPTION

EV100T CUSTOMER TERMINAL FUNCTIONS
(ALL VOLTAGE MEASUREMENTS WITH RESPECT TO SCR NEG)
IC3645EV100T WITH L CARD OPTION

TERMINAL	DESCRIPTION	CONDITION	NOMINAL VOLTAGE
TB1	(NOT PRESENTLY USED)	-----	-----
TB2	SRO, ACC START, AND BRAKE SW. INPUT. MUST BE HIGH AFTER TB3,4 ARE AT BV AND TB5,6 ARE LOW.	KEY, SEAT, START, OR BRAKE SW. OPEN	0V
		KEY, SEAT, START, BRAKE SW. CLOSED	BV
TB3	SEAT SWITCH INPUT	WITH KEY CLOSED, AND SEAT OPEN	0V
		WITH KEY CLOSED, AND SEAT OPEN	BV
TB4	KEY SWITCH INPUT (MUST GO LOW TO RESET PMT)	WITH KEY SW. OPEN	0V
		WITH KEY SW. CLOSED	BV
TB5	FWD DIRECTIONAL SWITCH INPUT	WITH KEY, SEAT, START, AND BRAKE CLOSED, AND	
		-FWD IN NEUTRAL(OR REV)	0V
		-FWD SELECTED	BV
TB6	REV DIRECTIONAL SWITCH INPUT	WITH KEY, SEAT, START, AND BRAKE CLOSED, AND	
		-REV IN NEUTRAL(OR FWD)	0V
		-REV SELECTED	BV
PA1	SPEED 1 SELECT	SPD #1 SWITCH OPEN	8V
		SPD #1 SWITCH CLOSED	0V
PA2	(NOT PRESENTLY USED)	-----	-----
PA3	ACCELERATOR POT INPUT	KEY SWITCH OFF	0V
		KEY AND ANY SPD. SW. ON (ADJ TO MIN.), AND ACC POT SET TO-	
		-CREEP POSITION	3-4.0V
		-TOP SPEED POSITION	.5-0V
		NOTE:IF SPD. SW. SELECTED IS NOT SET TO MIN THEN VOLTAGE IS FUNCTION OF SPD. SW. SETTING OR ACC POT SETTING, WHICHEVER IS LOWER VOLTS(HIGHER SPEED)	

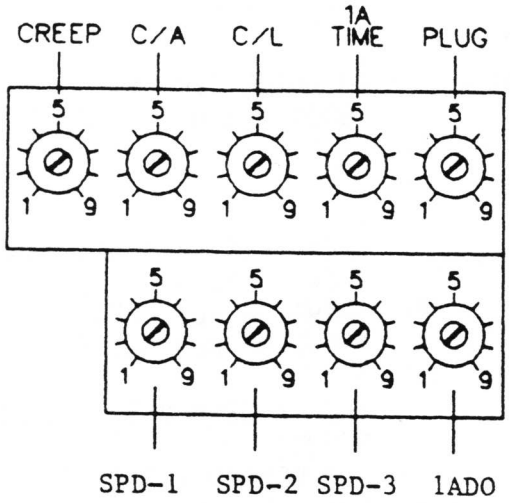
EV100T CUSTOMER TERMINAL FUNCTIONS
IC3645EV100T WITH L CARD OPTION
(CONTINUED)

TERMINAL	DESCRIPTION	CONDITION	NOMINAL VOLTAGE
PA4	SPEED 2 SELECT	SPD #2 SWITCH OPEN	8V
		SPD #2 SWITCH CLOSED	0V
PA5	SPEED 3 SELECT	SPD #3 SWITCH OPEN	8V
		SPD #3 SWITCH CLOSED	0V
PA6	(NOT PRESENTLY USED)	-----	-----
PB1	% ON-TIME OUTPUT	CREEP SPEED	2.5V
		TOP SPEED	6.5V
PB2	MOTOR CURRENT SENSOR OUTPUT	0 MOTOR CURRENT	1.80V
		500A AVG MOTOR CURRENT	3.30V
PB3	(NOT PRESENTLY USED)	-----	-----
PB4	PMT DRIVER OUTPUT	KEY, SEAT, START, BRAKE SW. CLOSED-	
		-FWD OR REV OPEN	0
		-FWD OR REV CLOSED	5-10 M/A
PB5	1A DRIVER OUTPUT	NO 1A DEMAND(1A DROPPED OUT)	0
		1A DEMAND(TB1 @ .5V) (1A CLOSED)	5-10 M/A
PB6	PLUGGING OUTPUT	NOT IN PLUGGING MODE	0V
		IN PLUGGING MODE	12V

TRIMPOT LOCATION FOR EV100 LOGIC CARDS
IC3645EVL1 and L2

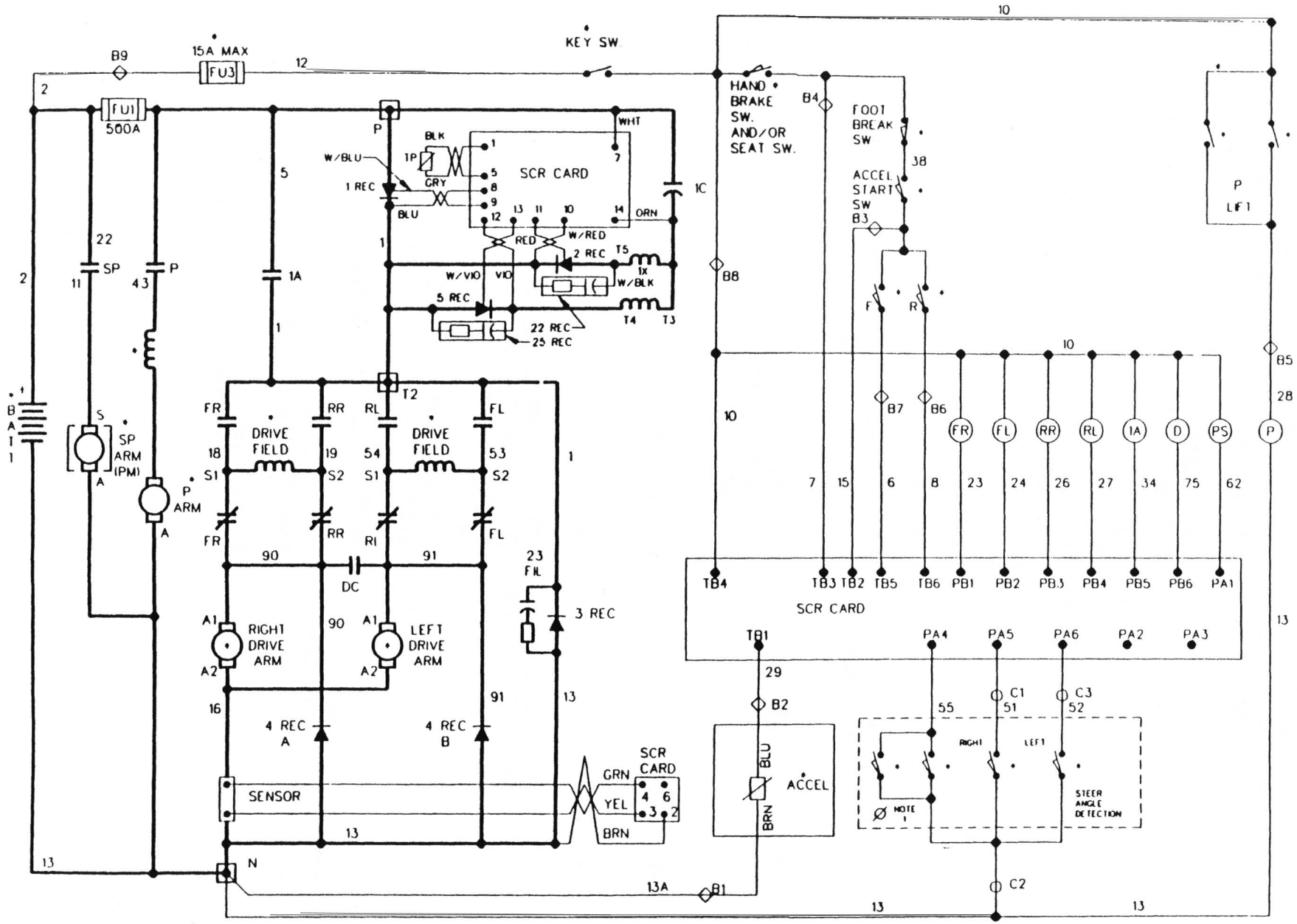
Panels are factory adjusted for a particular motor and truck and should not need adjustment. The card is suppied with single turn potentiometers with internal stops and the box is marked with "dial" settings.

The vehicle manufacturer should supply the "combination" setting for the particular model truck.



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

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



◇ RECP. CONNECTIONS B1 THRU B9.

○ RECP. CONNECTIONS C1 THRU C5.

Ø NOTE 1:
OPTIONAL SWITCHES FOR INSIDE WHEEL REVERSAL

EV100 WITH " M " CARD OPTION

◘ SCR POWER CONNECTIONS

• SUPPLIED BY CUSTOMER

EV100T CUSTOMER TERMINAL FUNCTIONS
(ALL VOLTAGE MEASUREMENTS WITH RESPECT TO SCR NEG)
IC3645EV100T WITH M CARD OPTION

TERMINAL	DESCRIPTION	CONDITION	NOMINAL VOLTAGE
TB1	ACCELERATOR POT INPUT	WITH KEY SW. OFF	0 V
		WITH KEY SW. ON AND ACC @	
		-CREEP SPEED	3-4.0V
		-TOP SPEED	0.5-0V
TB2	SRO, ACC START, AND BRAKE SW. INPUT. MUST BE HIGH AFTER TB3,4 ARE AT BV AND TB5,6 ARE LOW.	KEY, SEAT, START, OR BRAKE SW. OPEN	0V
		KEY, SEAT, START, BRAKE SW. CLOSED	BV
TB3	SEAT SWITCH/HAND BRAKE INPUT	WITH KEY CLOSED, AND SW. OPEN	0V
		WITH KEY CLOSED, AND SW. CLOSED	BV
TB4	KEY SWITCH INPUT (MUST GO LOW TO RESET PMT)	WITH KEY SW. OPEN	0V
		WITH KEY SW. CLOSED	BV
TB5	FWD DIRECTIONAL SWITCH INPUT	WITH KEY, SEAT, START, AND BRAKE CLOSED, AND	
		-FWD IN NEUTRAL(OR REV)	0V
		-FWD SELECTED	BV
TB6	REV DIRECTIONAL SWITCH INPUT	WITH KEY, SEAT, START, AND BRAKE CLOSED, AND	
		-REV IN NEUTRAL(OR FWD)	0V
		-REV SELECTED	BV
PA1	STEER PUMP TIME DELAY (TIMED DROP-OUT FUNCTION)	WITH KEY,SEAT CLOSED AND,	
		-FWD/REV IN NEUTRAL	BV
		-FWD/REV CLOSED(PS PICKED UP)	0V
		-SEAT OPEN, AFTER 2 SEC. (PS OPENS)	BV
		-FWD/REV IN NEUTRAL, AFTER 24 SEC. (PS OPENS)	BV
PA2	MOTOR CURRENT SENSOR OUTPUT	0 MOTOR CURRENT	1.80V
		500A AVG MOTOR CURRENT	3.30V
PA3	PLUGGING OUTPUT	NOT IN PLUGGING MODE	0V
		IN PLUGGING MODE	12V

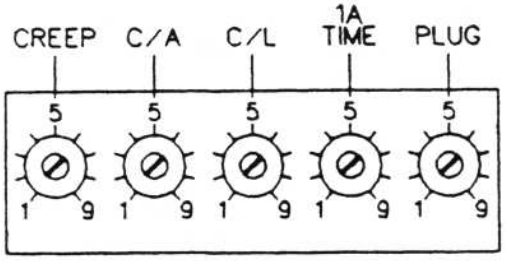
EV100T CUSTOMER TERMINAL FUNCTIONS
IC3645EV100T WITH M CARD OPTION
(CONTINUED)

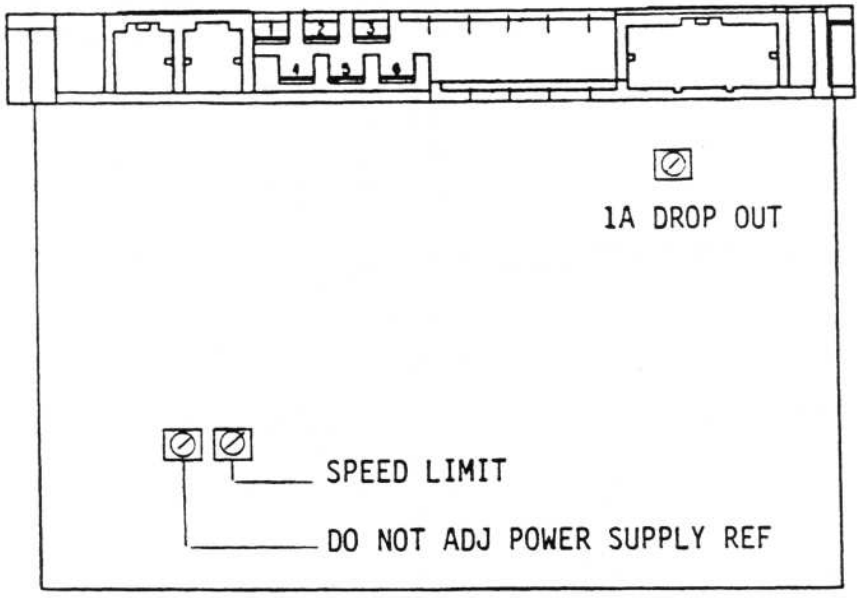
TERMINAL	DESCRIPTION	CONDITION	NOMINAL VOLTAGE
PA4	INSIDE WHEEL REVERSAL INPUT	RUNNING STRAIGHT	8V
		IN TURN	0V
PA5	RIGHT STEER ANGLE INPUT	RUNNING STRAIGHT	8V
		IN RIGHT TURN	0V
PA6	LEFT STEER ANGLE INPUT	RUNNING STRAIGHT	8V
		IN LEFT TURN	0V
PB1	FWD COIL INPUT-RIGHT SIDE	FWD SW. OR RIGHT TURN SW. OPEN	BV
		FWD SW., RIGHT TURN SW. CLOSED(CONTACTOR CLOSED)	0V
PB2	FWD COIL INPUT-LEFT SIDE	FWD SW. OR LEFT TURN SW. OPEN	BV
		FWD SW., LEFT TURN SW. CLOSED(CONTACTOR CLOSED)	0V
PB3	REV COIL INPUT-RIGHT SIDE	REV SW. OR RIGHT TURN SW. OPEN	BV
		REV SW., RIGHT TURN SW. CLOSED(CONTACTOR CLOSED)	0V
PB4	REV COIL INPUT-LEFT SIDE	REV SW. OR LEFT TURN SW. OPEN	BV
		REV SW., LEFT TURN SW. CLOSED(CONTACTOR CLOSED)	0V
PB5	1A DRIVER OUTPUT	NO 1A DEMAND(1A DROPPED OUT)	0
		1A DEMAND(TB1 @ .5V) (1A CLOSED)	5-10 M/A
PB6	DUAL MOTOR (D) CONTACTOR INPUT	NOT IN PLUGGING MODE, OR IN PLUGGING MODE AND ANY TURN SW. OPEN(D OPEN)	BV
		IN PLUGGING MODE AND ALL TURN SW. CLOSED(D CLOSED)	0V

TRIMPOT LOCATION FOR EV100 LOGIC CARDS
IC3645EVM1, M2, M3 and M4

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

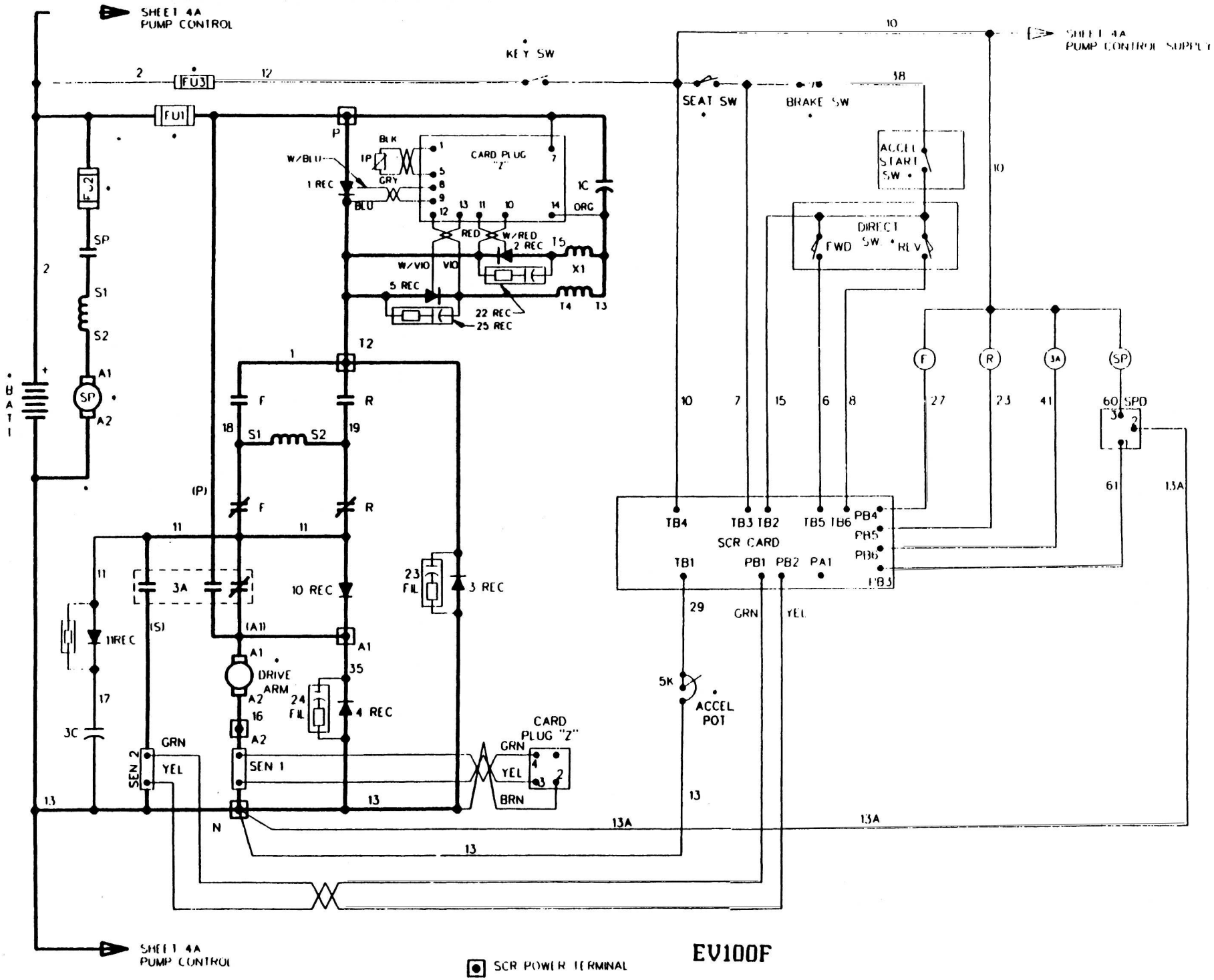
The vehicle manufacturer should supply the "combination" setting for the particular model truck.





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

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


SHEET 4A
PUMP CONTROL
KEY SW
FU3
FU1
FU2
SEAT SW
BRAKE SW
ACCEL
START
SW
DIRECT
FWD SW REV
CARD PLUG "Z"
1 REC
2 REC
5 REC
10 REC
3 REC
4 REC
22 REC
25 REC
T1
T2
T3
T4
T5
X1
SP
S1
S2
A1
A2
F
R
3A
DRIVE ARM
ACCEL POT
5K
SCR CARD
TB1
TB2
TB3
TB4
TB5
TB6
PA1
PB1
PB2
PB3
PB4
PB5
PB6
SEN 1
SEN 2
CARD PLUG "Z"
BAT
60 SPD
SHEET 4A
PUMP CONTROL
SHEET 4A
PUMP CONTROL SUPPLY
SCR POWER TERMINAL
• SUPPLIED BY CUSTOMER
EV100F

EV100F CUSTOMER TERMINAL FUNCTIONS
(ALL VOLTAGE MEASUREMENTS WITH RESPECT TO SCR NEG)
IC3645EV100F WITH F CARD OPTION

TERMINAL	DESCRIPTION	CONDITION	NOMINAL VOLTAGE
TB1	ACCELERATOR POT INPUT	WITH KEY SW. OFF	0 V
		WITH KEY SW. ON AND ACC @	
		-CREEP SPEED	3-4.0V
		-TOP SPEED	0.5-0V
TB2	SRO, ACC START, AND BRAKE SW. INPUT. MUST BE HIGH AFTER TB3,4 ARE AT BV AND TB5,6 ARE LOW.	KEY, SEAT, START, OR BRAKE SW. OPEN	0V
		KEY, SEAT, START, BRAKE SW. CLOSED	BV
TB3	SEAT SWITCH INPUT	WITH KEY CLOSED, AND SEAT OPEN	0V
		WITH KEY CLOSED, AND SEAT CLOSED	BV
TB4	KEY SWITCH INPUT (MUST GO LOW TO RESET PMT)	WITH KEY SW. OPEN	0V
		WITH KEY SW. CLOSED	BV
TB5	FWD DIRECTIONAL SWITCH INPUT	WITH KEY, SEAT, START, AND BRAKE CLOSED, AND	
		-FWD IN NEUTRAL(OR REV)	0V
		-FWD SELECTED(F CLOSED)	BV
TB6	REV DIRECTIONAL SWITCH INPUT	WITH KEY, SEAT, START, AND BRAKE CLOSED, AND	
		-REV IN NEUTRAL(OR FWD)	0V
		-REV SELECTED(R CLOSED)	BV
PA1	BRAKE POT INPUT-REQUIRES 5K OHM POTENTIOMETER FROM PA1 TO COMMON	WITH KEY SWITCH CLOSED-	
		-POT NOT USED(OPEN)	5V
		-POT CONNECTED(FULL OHMS)	1.67V
		-POT CONNECTED(ZERO OHMS)	0V
PA2	MOTOR CURRENT SENSOR OUTPUT	0 MOTOR CURRENT	1.80V
		500A AVG MOTOR CURRENT	3.30V
PA3	PLUGGING OUTPUT	NOT IN PLUGGING MODE	0V
		IN PLUGGING MODE	8.2V
PA4	% ON-TIME OUTPUT	CREEP SPEED	2.5V
		TOP SPEED	6.5V
PA5	CARD VOLTAGE BUS	KEY SWITCH OPEN	0V
		KEY SWITCH CLOSED	8.2V
PA6	FIELD CURRENT SENSOR OUTPUT	0 MOTOR CURRENT	2.5V
		500A AVG MOTOR CURRENT	4.0V

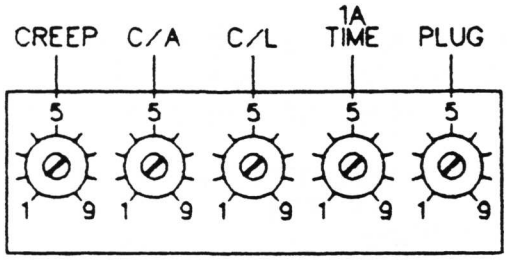
EV100F CUSTOMER TERMINAL FUNCTIONS
IC3645EV100F WITH F CARD OPTION
(CONTINUED)

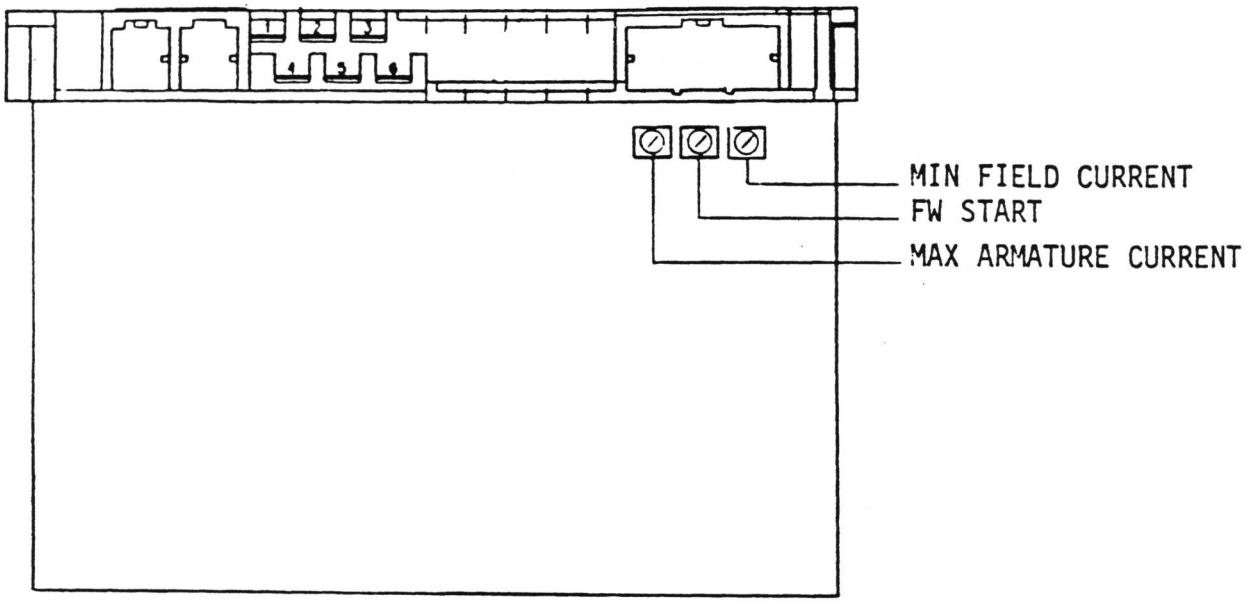
TERMINAL	DESCRIPTION	CONDITION	NOMINAL VOLTAGE
PB1	FIELD SENSOR POSITIVE SIGNAL	ZERO FIELD CURRENT	0V
		500 AMPS FIELD CURRENT	0.1V
PB2	FIELD SENSOR NEGATIVE SIGNAL	ALL MODES	0V
PB3	STEER PUMP TIME DELAY (TIMED DROP-OUT FUNCTION)	WITH KEY, SEAT CLOSED AND, -FWD/REV IN NEUTRAL	BV
		-FWD/REV CLOSED(PS PICKED UP)	0V
		-SEAT OPEN, AFTER 2 SEC. (PS OPENS)	BV
		-FWD/REV IN NEUTRAL, AFTER 24 SEC. (PS OPENS)	BV
PB4	COIL DRIVER FOR FORWARD	NEUTRAL	BV
		FORWARD, START CLOSED	BV-10V
PB5	COIL DRIVER FOR REVERSE	NEUTRAL	BV
		REVERSE, START CLOSED	BV-10V
PB6	COIL DRIVER FOR 1A	SCR OPERATION	BV
		1A CLOSED	BV-10V

TRIMPOT LOCATION FOR EV100 LOGIC CARDS
IC3645EVF1, F2, F3 and F4

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

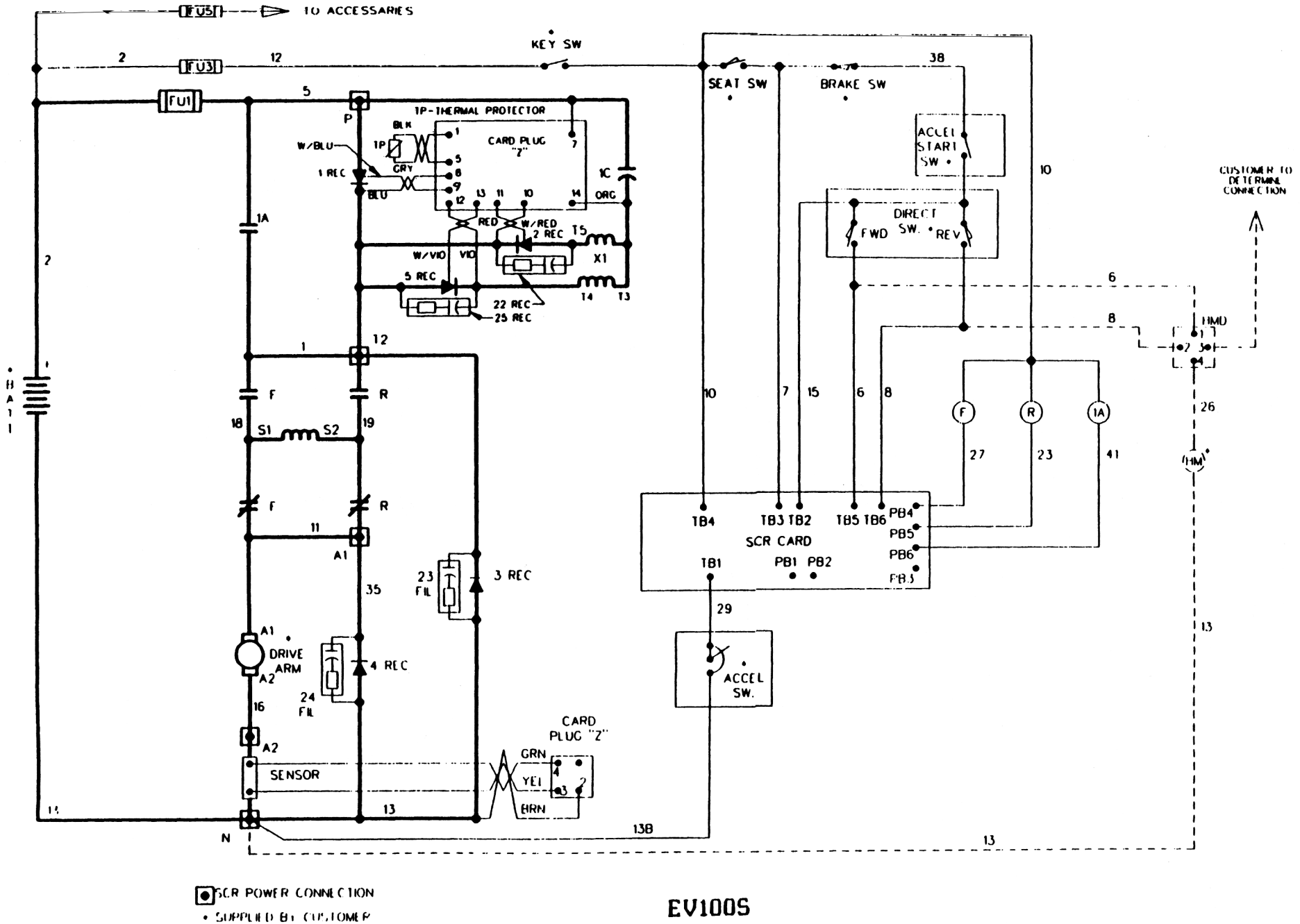
The vehicle manufacturer should supply the "combination" setting for the particular model truck.





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

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


FU5
TO ACCESSARIES
KEY SW
2
FU3
12
FU1
5
P
1P-THERMAL PROTECTOR
BLK
W/BLU
1P
GRY
1 REC
BLU
CARD PLUG "Z"
1C
ORG
RED
W/RED
2 REC
T5
W/VIO
VIO
X1
5 REC
22 REC
25 REC
T4
T3
1A
1
12
F
R
18
S1
S2
19
F
R
11
A1
35
23
FIL
3 REC
A1
DRIVE ARM
A2
4 REC
24
FIL
16
A2
SENSOR
GRN
YEL
BRN
CARD PLUG "Z"
14
13
N
13B
SEAT SW
BRAKE SW
38
ACCEL START SW
10
DIRECT
FWD
SW.
REV
CUSTOMER TO DETERMINE CONNECTION
6
8
HMD
26
HM
10
7
15
6
8
F
R
1A
27
23
41
TB4
TB3
TB2
TB5
TB6
PB4
PB5
PB6
PB3
SCR CARD
TB1
PB1
PB2
29
ACCEL SW.
13
13
SCR POWER CONNECTION
• SUPPLIED BY CUSTOMER

EV100S

EV100S CUSTOMER TERMINAL FUNCTIONS
(ALL VOLTAGE MEASUREMENTS WITH RESPECT TO SCR NEG)
IC3645EV100S WITH S CARD OPTION

TERMINAL	DESCRIPTION	CONDITION	NOMINAL VOLTAGE
TB1	ACCELERATOR POT INPUT	WITH KEY SW. OFF	0 V
		WITH KEY SW. ON AND ACC @	
		-CREEP SPEED	3-4.0V
		-TOP SPEED	0.5-0V
TB2	SRO, ACC START, AND BRAKE SW. INPUT. MUST BE HIGH	KEY, SEAT, START, OR BRAKE SW. OPEN	0V
	AFTER TB3,4 ARE AT BV AND TB5,6 ARE LOW.	KEY, SEAT, START, BRAKE SW. CLOSED	BV
TB3	SEAT SWITCH INPUT	WITH KEY CLOSED, AND SEAT OPEN	0V
		WITH KEY CLOSED, AND SEAT CLOSED	BV
TB4	KEY SWITCH INPUT (MUST GO LOW TO RESET PMT)	WITH KEY SW. OPEN	0V
		WITH KEY SW. CLOSED	BV
TB5	FWD DIRECTIONAL SWITCH INPUT	WITH KEY, SEAT, START, AND BRAKE CLOSED, AND	
		-FWD IN NEUTRAL(OR REV)	0V
		-FWD SELECTED(F CLOSED)	BV
TB6	REV DIRECTIONAL SWITCH INPUT	WITH KEY, SEAT, START, AND BRAKE CLOSED, AND	
		-REV IN NEUTRAL(OR FWD)	0V
		-REV SELECTED(R CLOSED)	BV
PA1	(NOT PRESENTLY USED)	-----	-----
PA2	MOTOR CURRENT SENSOR OUTPUT	0 MOTOR CURRENT	1.80V
		500A AVG MOTOR CURRENT	3.30V
PA3	PLUGGING OUTPUT	NOT IN PLUGGING MODE	0V
		IN PLUGGING MODE	8.2V
PA4	% ON-TIME OUTPUT	CREEP SPEED	2.5V
		TOP SPEED	6.5V
PA5	CARD VOLTAGE BUS	KEY SWITCH OPEN	0V
		KEY SWITCH CLOSED	8.2V
PA6	(NOT PRESENTLY USED)	-----	-----

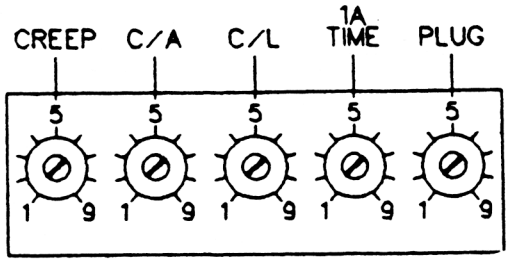
EV100S CUSTOMER TERMINAL FUNCTIONS
IC3645EV100S WITH S CARD OPTION
(CONTINUED)

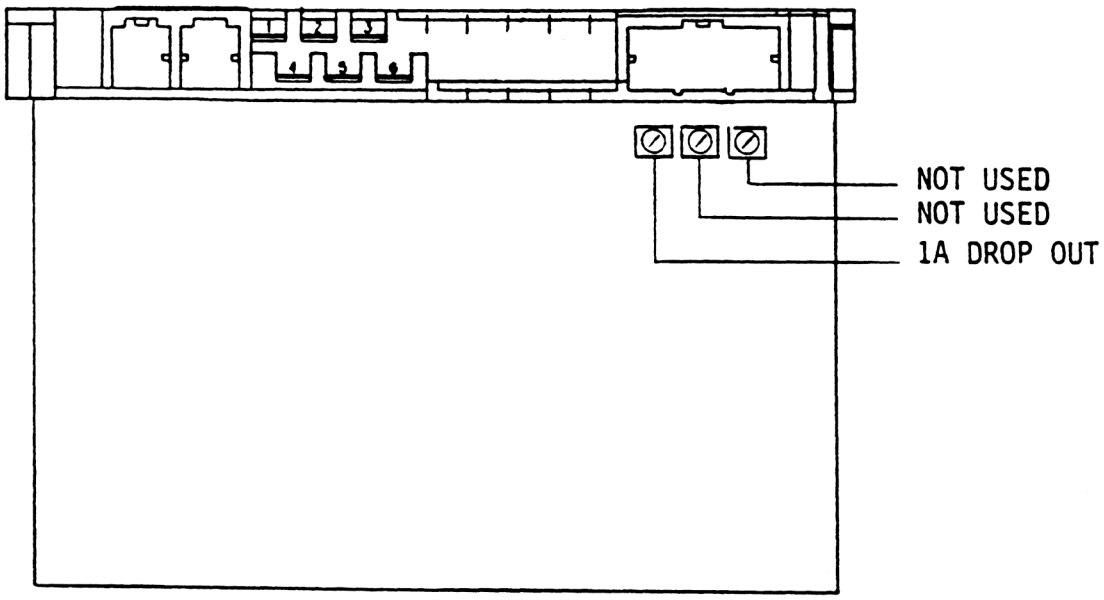
TERMINAL	DESCRIPTION	CONDITION	NOMINAL VOLTAGE
PB1	(NOT PRESENTLY USED)	-----	-----
PB2	(NOT PRESENTLY USED)	-----	-----
PB3	STEER PUMP TIME DELAY (TIMED DROP-OUT FUNCTION)	WITH KEY, SEAT CLOSED AND,	
		-FWD/REV IN NEUTRAL	BV
		-FWD/REV CLOSED(PS PICKED UP)	OV
		-SEAT OPEN, AFTER 2 SEC. (PS OPENS)	BV
		-FWD/REV IN NEUTRAL, AFTER 24 SEC. (PS OPENS)	BV
PB4	COIL DRIVER FOR FORWARD	NEUTRAL	BV
		FORWARD, START CLOSED	BV-10V
PB5	COIL DRIVER FOR REVERSE	NEUTRAL	BV
		REVERSE, START CLOSED	BV-10V
PB6	COIL DRIVER FOR 1A	SCR OPERATION	BV
		1A CLOSED	BV-10V

TRIMPOT LOCATION FOR EV100 LOGIC CARDS
IC3645EVS1, S2, S3 and S4

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

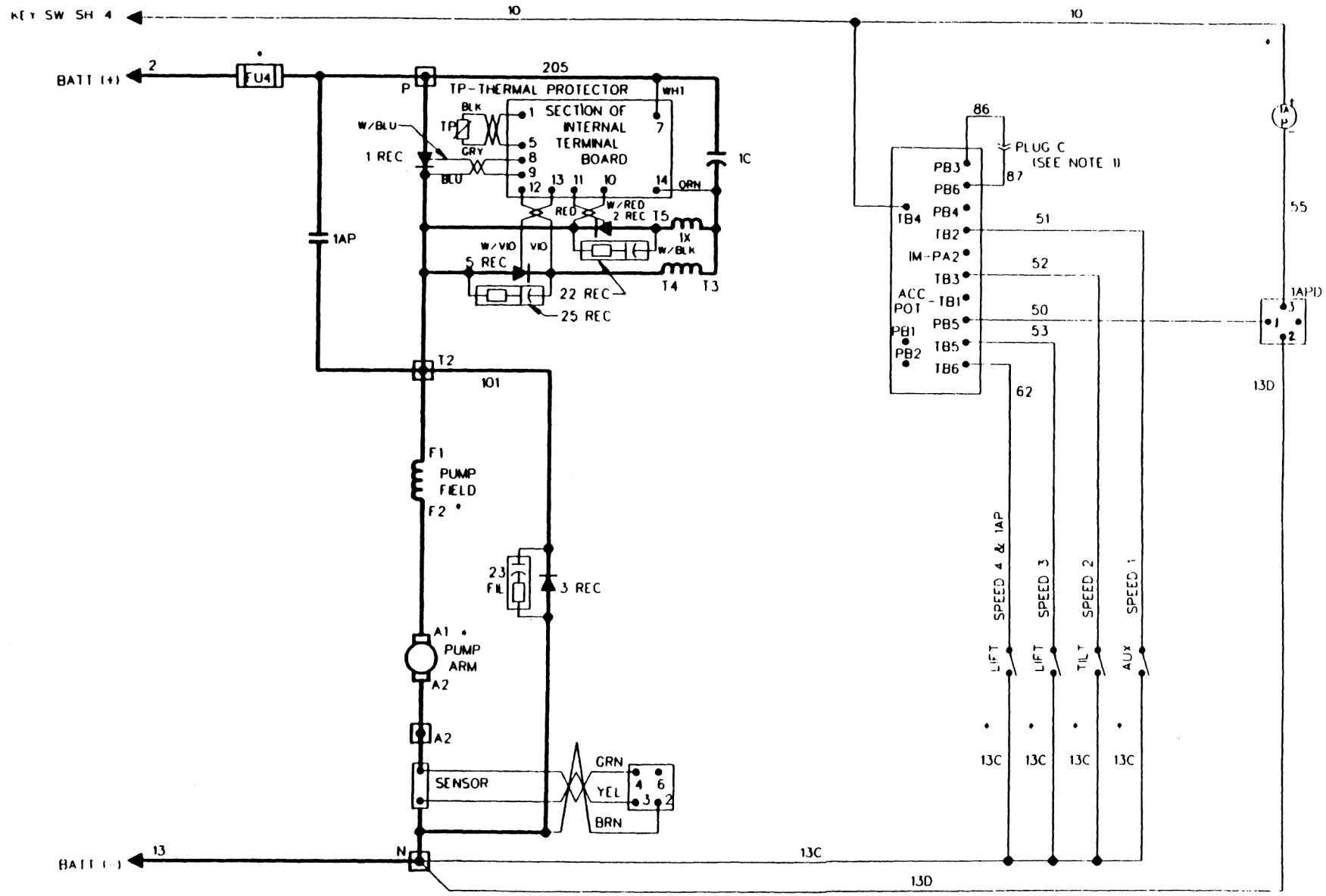
The vehicle manufacturer should supply the "combination" setting for the particular model truck.





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

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



NOTE 1 WHEN BDI (BATTERY DISCHARGE INDICATOR) USED, DISCONNECT PLUG C (WIRES 86 AND 87). CONNECT WIRES FROM BDI TO DISCONNECTED PLUG ENDS (WIRES 86 AND 87) IN REQUIRED POLARITY.

WHEN BDI IS NOT USED, CONNECT WIRES 86 AND 87 TOGETHER USING PLUG C.

EV100P

• SUPPLIED BY CUSTOMER

◉ SCR POWER TERMINAL

EV100P CUSTOMER TERMINAL FUNCTIONS
(ALL VOLTAGE MEASUREMENTS WITH RESPECT TO SCR NEG)
IC3645EV100P WITH P CARD OPTION

TERMINAL	DESCRIPTION	CONDITION	NOMINAL VOLTAGE
TB1	ACCELERATOR POT INPUT	WITH KEY SW. OFF	0 V
		WITH KEY SW. ON AND ACC @	
		-CREEP SPEED	3-4.0V
		-TOP SPEED	0.5-0V
TB2	SPEED 1 SWITCH INPUT	SPEED 1 SWITCH OPEN	8V
		SPEED 1 SWITCH CLOSED	0V
TB3	SPEED 2 SWITCH INPUT	SPEED 2 SWITCH OPEN	8V
		SPEED 2 SWITCH CLOSED	0V
TB4	KEY SWITCH INPUT (MUST GO LOW TO RESET PMT)	WITH KEY SW. OPEN	0V
		WITH KEY SW. CLOSED	8V
TB5	SPEED 3 SWITCH INPUT	SPEED 3 SWITCH OPEN	8V
		SPEED 3 SWITCH CLOSED	0V
TB6	SPEED 4/1A SWITCH INPUT	SPEED 4 SWITCH OPEN	8V
		SPEED 4 SWITCH CLOSED	0V
PA1	(NOT PRESENTLY USED)	-----	-----
PA2	MOTOR CURRENT SENSOR OUTPUT	ZERO MOTOR CURRENT	1.8V
		500 AMPS AVE MTR CURRENT	3.3V
PA3	(NOT PRESENTLY USED)	-----	-----
PA4	(NOT PRESENTLY USED)	-----	-----
PA5	(NOT PRESENTLY USED)	-----	-----
PA6	(NOT PRESENTLY USED)	-----	-----
PB1	72 VOLT JUMPER LOCATION	FOR 72V JUMPER TO NEG	0V
PB2	CARD COMMON (NEGATIVE)	OPTIONAL ACCELERATOR SWITCH COMMON	0V
PB3	BDI INTERRUPT INPUT	BDI CIRCUIT OPEN	0V
		BDI CIRCUIT CLOSED	8V

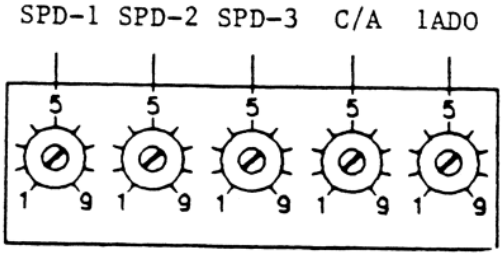
EV100P CUSTOMER TERMINAL FUNCTIONS
IC3645EV100P WITH P CARD OPTION
(CONTINUED)

TERMINAL	DESCRIPTION	CONDITION	NOMINAL VOLTAGE
PB4	PMT DRIVER OUTPUT	KEY SWITCH CLOSED-	
		-P OPEN	0
		-P CLOSED	5-10 M/A
PB5	1A DRIVER OUTPUT	NO 1A DEMAND(1A DROPPED OUT)	0
		1A DEMAND(TB1 @ .5V) (1A CLOSED)	5-10 M/A
PB6	BDI ENABLE (JUMPER TO PB3 WHEN BDI NOT USED)	KEY OPEN	0V
		KEY CLOSED	8V

TRIMPOT LOCATION FOR EV100 LOGIC CARDS
IC3645EVP1 and P2

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

The vehicle manufacturer should supply the "combination" setting for the particular model truck.



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], C/L, 1A TIME, stiffness of plug, FW PU and FW DO, stiffness of Regen reversal).

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 heat dissipating ability of the control, such as 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.

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 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 the 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.

	SYMPTOM	PROBABLE CAUSE
1C	Contactors close. NO power and NO SCR hum with accelerator in SCR range.	* Check power fuse at SCR positive Should be battery volts, if not, check power fuse. * (Regen braking only) Check to see if RB contactor is closed, if not see 3L. * Check volts at T2. Should be zero, if not, check volts at S1, S2, A1 and A2 to locate open circuit. * Check volts at TB1, should be 3-4 volts with accelerator at creep speed and reducing to 0.2 volts or less as the accelerator is pressed down towards top speed. If TB1 remains at about 4 volts, check accelerator output. * Check for an open thermal protector.(4J) * Check 1C volts at the orange wire, if more than 0.125 times the battery volts, check if 2REC will gate ON.(4G) If less than 0.125 times the battery volts, check if 1REC will gate ON.(4G) Check the green lead on the current sensor for a good connection to card input pin 4. * Check 23FIL for short.(4K) * Replace the control card.
1D	Contactors close. Little or no power. Normal SCR hum.	* Check 3REC for open circuit.(4H) * Check 4REC for short circuit.(4H)
1E	Contactors close. Little or no power. Abnormal SCR hum.	* Check 2REC for short circuit.(4G) * Check 5REC for short circuit.(4G) * Check 22REC and 25REC.(4M) Note: A 25REC which checks good with an ohmmeter can cause a mis-operation of 5REC under load.
1F	Contactors close. Little power. No SCR hum.	* Check 1C for low resistance.(4B)

ALL TESTING SHOULD BE DONE WITH TRUCK JACKED UP.

TABLE 1

FAILURES THAT 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.

SYMPTOM	PROBABLE CAUSE
1A. Contactors do not pick up. 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 pick up. Control volts present from positive to negative with proper polarity.	* Plug in the battery with the Key switch OFF. Volts on TB4 should be less than 4 volts. * Close Key switch and check volts at T2; this should read about 0 volts. If above 85% of battery volts, check for shorted 1A tips or shorted 1REC. * Close brake, start switches (all switches needed to close F or R contactor except the direction switch). Volts on TB4, TB3 and TB2 shold be at battery volts. Volts on TB5 and TB6 should be near zero volts. Wait one second, then close the forward directional switch. Volts at TB6 should remain at zero. Volts at TB5 and the TB5 side of the F contactor coil should be battery volts. If not, check the wiring and switches. * Connect a milliammeter (10 ma scale) from PMTD1 to PMTD2, you should read 5-10 milliamps. If not, open the Key switch, open the lead from PMTD1 to the PMT driver, reclose all the switches except the directional switch, wait one second and close the forward directional switch. If the reading is not 5-10 milliamps, replace the control card. If the reading is 5-10 milliamps, the coil or the wiring to the PMT driver is open or the PMT driver is defective. Check the PMT driver.(4E)

ALL TESTING SHOULD BE DONE WITH TRUCK JACKED UP.

TABLE 2

FAILURES THAT CAUSE FULL OR NO 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 TB1, should be 3-4 volts with accelerator at creep speed position. If near zero volts, check accelerator output (5000 ohms or 4 volts depending on type of accelerator switch) * Replace control card.
2B	Contactor close once or twice and then remain open. PMT trips	* Check 5REC for open circuit or open gate.(4G) * Check 1C for open and loose connections.(4B) * Check 1C for short.(4B) * Check 2REC for short.(4G) * Check 5REC for short.(4G) * Check 1X choke and reactor T3-T4.(4N) * Check PA3 wire for open (Regen circuit only) * 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 3. * Replace control card. (4A)

	SYMPTOM		PROBABLE CAUSE
1G	One contactor closes with normal operation but opposite contactor will not close.	*	Close key, brake and start switches (all switches needed to close F or R contactor except the direction switch). Volts on TB5 and TB6 should be near zero volts.Wait one second, then close the directional switch of the contactor that will not close. Volts at the other direction input (TB5 or TB6) should remain at zero volts. Volts at the non-closing direction (TB5 or TB6) and top of the contactor coil should be battery volts. If not, check wiring and swithes.
1H	PMT trips after operating in 1A and with accelerator 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.

	SYMPTOM	PROBABLE CAUSE
3D	1A contactor will not close. (continued)	* If milliamps from 1AD1 to 1AD2 are near zero when the 1A contactor should be closed, open the lead from 1AD1 to the driver and recheck. If good, there is a wiring short to negative in the lead from 1AD1 or the driver is defective.(4E) * Check the volts at TB1. Should reduce to less than 0.2 volts at top speed. If over 0.2 volts, check accelerator switch output. * Replace the control card.(4A)
3E	1A contactor will not close at SCR stall.	* Check volts at the GRAY lead to the thermal protector(TP). If volts are above 3.4 volts the control is in thermal cutback. Allow control to cool and recheck 1A function. * Turn 1A trimpot fully CCW and recheck. * Replace control card.(4A)
3F	1A will not open until start switch is opened.	* Check volts at TB1. Should be near 3 volts when accelerator is released. If not check accelerator output.
3G	FW contactor will not close after 1A pickup.	* Open lead to FWD1 and connect milliammeter from FWD1 to FWD2. When control signals FW to pick up, should read 5-10 milliamps. If near 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. * Reconnect lead to FWD1 and check volts at FWD1 when the FW contactor should pick up. If near 8 volts, check lead FWD2 to negative for an open, then replace driver. If about 2 volts, check volts at FWD3. Should be battery volts dropping to 2 volts or less when FW contactor should pick up. If volts are near zero, check wiring from positive to FW coil, FW coil and wiring to FWD3. If volts remain greater than 4 volts, replace driver.

ALL TESTING SHOULD BE DONE WITH TRUCK JACKED UP.

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 pin 2 (brown wire) for continuity to negative. * Replace control card.(4A)
3B	F or R contactor will close without returning the directional switch to OFF.	* Check location of TB2. Any open switch between TB2 and the directional switch will satify the SRO function. * Open the lead from PMTD1 to the driver. Close switches normally used to close the F or R contactor. If the F or R close, replace the driver. * Reconnect the lead to the driver. Close the key switch only. Volts at TB4 should be battery volts, volts at TB2, TB3, TB5 and TB6 should be near zero. Close the seat, brake and start switches. Volts at TB3 and TB2 should be battery volts. * Replace control card.(4A)
3C	PMT does not open F or R contactor.	* Operate the traction drive. Jumper PMTD1 to PMTD2. If contactor does not dropout replace PMT driver.
3D	1A contactor will not close.	* Connect a milliammeter from 1AD1 to 1AD2. Should read 5-10 milliamps when the 1A contactor should be closed. If near zero, see next step for improper input or control card. Check volts at 1AD3, should be battery volts decreasing to about 2 volts when the 1A contactor should be closed. If near zero, check coil and wiring to 1A3. If remains at battery volts, check wiring from PB5 to 1A1 and wiring from 1A2 to negative, then replace 1A driver.

	SYMPTOM	PROBABLE CAUSE
3N	Very soft reversal during Regen braking mode. Normal plug.	* Check for proper adjustment of Regen trimpot.(6) * Replace control card.
3O	RB contactor remains open after reversal.	* Check for open connection between Sensor-2 YELLOW lead and control card PA4. * Replace control card.
3P	Failure to transition to Regen braking mode.	* Check for proper adjustment of Regen trimpot.(6) * Replace control card.
3Q	RB contactor does not open during Regen braking mode.	* Check RB driver for short from RBD2 to RBD3. Disconnect the wire on RBD1 and close key switch, if RB contactor remains closed the driver is shorted. * Replace control card.
3R	Very soft reversal	* Check plug adjustment setting on control card. * Replace control card.(4A)
3S	Blown power fuse. Very hot power cables	* Check 3REC for short.(4H) (Possible damage also to 1REC.)

	SYMPTOM	PROBABLE CAUSE
3H	FW contactor will not drop out with increasing load.	* Check drop out setting on control card. * Check for shorted FWD driver. * Replace control card.(4A)
3J	Stiff plug.(Severe reversal)	* Check plug adjustment setting on control card. * Check yellow wire on current sensor for open. * Check 4REC for open circuit.(4H) * Replace control card.(4A)
3K	Hourmeter feed faults:	
(1)	Pump contactor closes when direction is selected.	* Diode shorted HMD3 to HMD4.(4H) Replace hourmeter block.
(2)	One direction okay; opposite direction picks up both directional contactors.	* Diode shorted HMD1 to HMD4 or HMD2 to HMD4.(4H) Replace hourmeter block.
(3)	Either direction picks up both directional contactors.	* Diode shorted HMD1 to HMD4 or HMD2 to HMD4.(4H) Replace hourmeter block.
3L	Regen contactor does not close.	* Close key switch. Connect milliammeter from RBD1 to RBD2, should read 5-10 milliamperes, If not, open key switch, and remove wire from RBD1 and place milliammeter between wire and RBD1 on the driver. Close key switch, reading should be 5-10 milliamperes, if not replace control card. If reading is good, check the contactor coil and wiring between coil and driver for open. If good RB driver is defective.(4E)
3M	Stiff reversal during Regen braking mode.	* Check for proper adjustment of Regen trimpot.(6) * Check for open connection between Sensor-2 GREEN lead and control card PA5. * Replace control card.

TABLE 4
CHECKING COMPONENTS

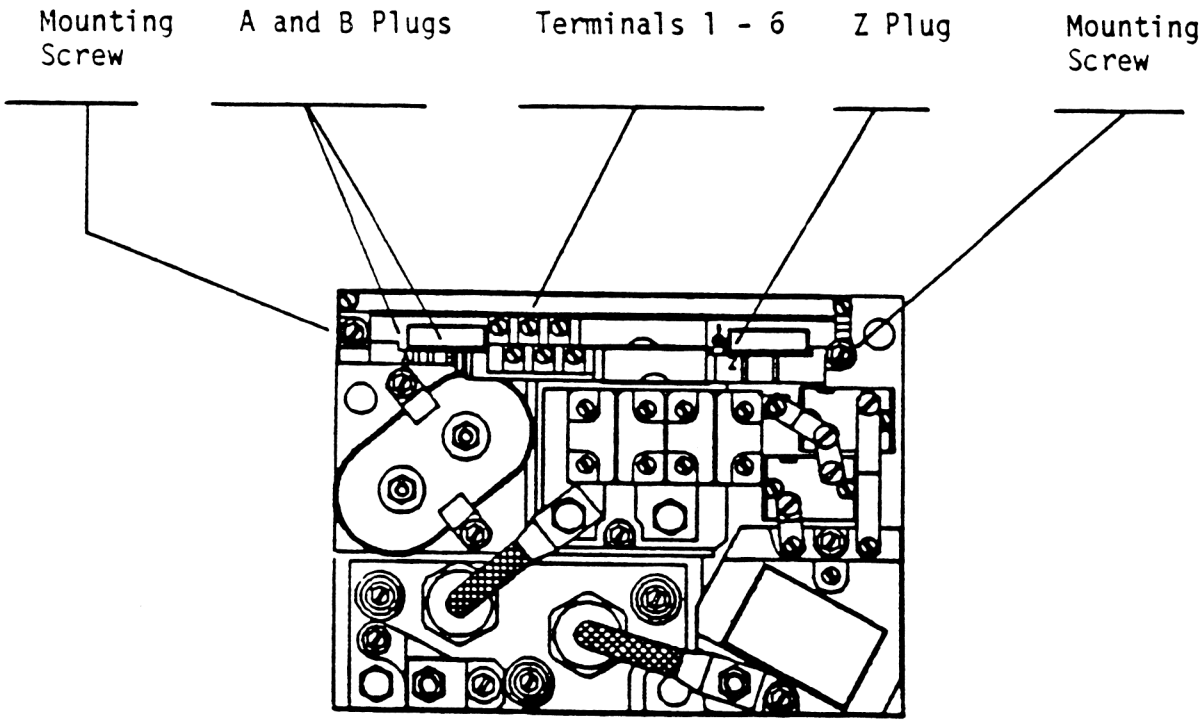
4A Main SCR Control Card

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

1. Instructions for Removal of Control Card.
   a. Remove control wires on the screw terminals 1 throught 6 as required.
   b. Unplug A, B, and Z plugs by pressing down on tab with wide blade screwdriver and rotating 90 degrees.
   c. Remove the two mounting screws and lift card box free.

      NOTE: Do not attempt to remove circuit broad from card box.

   d. Reverse procedures to install new control card.

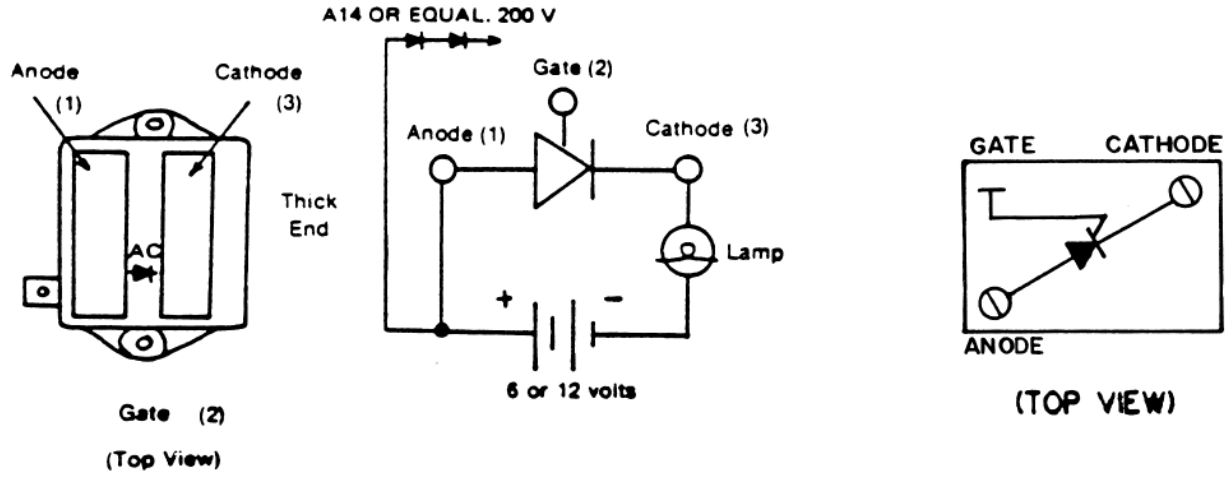


4G SCR's (1REC, 2REC,5REC)

These are silicon controlled rectifiers. Before checking, disconnect the battery and discharge capacitor 1C. Disconnect gate leads of SCR's at the SCR terminal.

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

Connect the positive lead to the anode, connect the negative lead to the cathode as shown below.



(1) The lamp should not light. If the lamp does light, the SCR is shorted and must be replaced.
(2) If check (1) was satisfactory, test the SCR for its ability to be turned on by the gate. Connect positive through two diodes to the gate terminal. If the gate is operative, the lamp will come on and 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.
(3) If the lamp cannot be lite under step (2) the SCR is open and must be replaced.

NOTE:

If you do not have a test light to check the SCR's as described above, they may be checked for shorts and 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 the gate terminal to the cathode and then from the cathode to the gate terminal (R x100 scale). If resistance reads either zero ohms (short) or infinity ohms (open), replace the SCR.

When reassembling SCR's, refer to TABLE 5.

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

When checking diodes, disconnect battery and discharge capacitor 1C. When replaing rectifiers, refer to TABLE 5. For 3REC and 4REC, disconnect one lead or flexible connection.

4B Capacitor 1C

Disconnect the battery and discharge the 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 the capacitor if above reading is not obtained.

4C Contactors F, R, 1A and P

150 ampere contactors(see specification sheet)
300 ampere contactors(see specification sheet)

NOTE:

(1) Control is arranged so that the F and R contactors do not break current. Check to see that the 1A contactor drops out before the F or R contactor.

(2) Most contactor coils are polarty senitive. The left-hand terminal must be connected to positive.

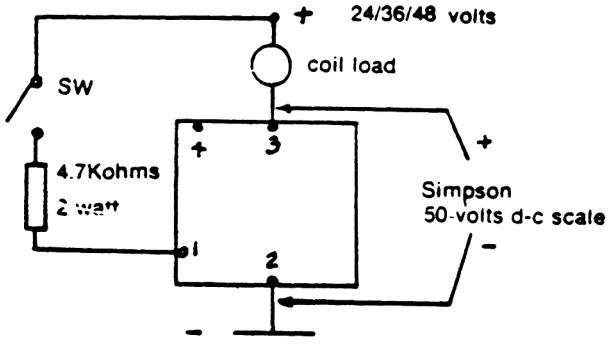
4D Potentiometer in Accelerator

To check operation of the potentiometer, disconnect the battery and disconnect the wire at control card TB1. Connect a VOM to the wire that was removed from TB1 and to negative. Place the VOM on the R x 100 scale. With the accelerator in the creep speed position, the ohms reading should be 4800 to 6000 ohms. With the accelerator in the top speed position, the ohm reading should be 50 ohms or less. With the wire disconnected as above, check for resistance of 1 megohm or higher from pot wire to the truck frame.

4E Coil Driver Module

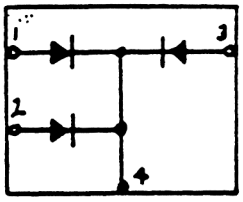
(1) Connect circuit as shown.
(2) Voltmeter should read battery volts with switch open.
(3) Close switch and meter reading should be 3 volts or less.
(4) Move load to terminal 4 and repeat steps (2) and (3).

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



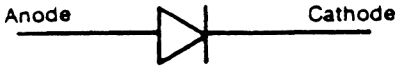
4F Hourmeter Module

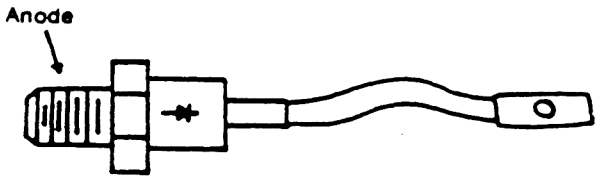
Check individual diode circuits with trouble light or VOM.(4H)



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

3REC and 4REC are diode with about 7 to 12 ohms in the conducting direction (anode to cathode) measure on the R x 100 scale, and 10,000 ohms or higher, in the non-conducting direction (cathode to anode) measured on the R x 10,000 scale.





4J Thermal Protector (TP)

Remove both the GRAY and BLACK wires from the "Z" plug that connects to the control card. Read the resistance between these two wires with the VOM set on the R x 100 scale. VOM should read 100 to 200 ohms if the 1REC heatsink is at room temperature (25C or 75F). Set the VOM to the highest ohm scale and read from each wires end to the 1REC heatsink, reading should be infinity.

4K Filter Block(23FIL,etc.)

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

4M Filter Block(23FIL,etc.)

Filter block test 4K is only to detect an open or shorted filter. If the control has sympotoms as in 1E, interchange 22REC and 25REC and try again. If the problem is corrected, the old 25REC is marginal and should be replaced. If the problem is not corrected, replace both filters.

4N 1X Choke and Reactor T3-T4

Refer to panel wiring diagram to locate windings. With VOM on R x 1 scale, measure choke or reactor winding, reading should be less than 1 ohm.

TABLE 5
REPLACEMENT OF EV-100 COMPONENTS

When replacing stud semiconductors such as 3REC and 4REC it is not necessary to torque these devices to a specific value.

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 1REC, 2REC or 5REC

(1) Remove all module connections. (As required)
(2) Remove module by backing out the two screws at the device sides.
(3) Clean the insulator surface with a clean rag and isopropyl alcohol.
(4) Inspect the insulator surface for tears or cracks. If defective, replace. Wipe a light layer of machine oil on the base and smooth the insulator into position.
NOTE: Insulator not required for 2REC and 5REC.
(5) Coat insulator with a light coat of heat-transfer grease similar to GE-350.
(6) Set new module on insulator and start screws back into base. Be sure to use the original screws and washers. run screws in to base "finger tight".
Check that the bottom of the module is flat against the insulator or base.
Alternately tighten the two screws by 1/4 turn until firm.
(7) Replace all connections removed in step 1.

5B Capacitor

(1) Remove nuts from capactor connections and remove wires.
(2) Remove hold down brackets and lift out.
(3) Reverse procedure to replace capacitor.

5C 22REC, 23REC and 25REC

(1) Remove mounting screws and lift out.
NOTE: When replacing these devices, use the original hardware in the same holes, as the inserts are used for electrical connections.

5D Reactor/Choke

(1) Disconnect all leads to the reactor.
(2) Remove the two mounting bolts and lift out.
(3) Set new reactor on SCR base and start screws back into base. Be sure to use the original screws and washers. run screws in to base "finger tight".
Check that the bottom of the reactor is flat against the base.
Alternately tighten the two screws by 1/4 turn until firm.
(4) Replace all connections removed in step 1.

EV-100 HYDRAULIC PUMP CONTROL
TROUBLESHOOTING

Trouble-shooting is based on using the voltmeter to determine if the proper voltages are available to permit the control to operate properly.

FAILURES THAT CAUSE REDUCED OR NO MOTOR TORQUE WITH SCR CONTROL

SYMPTOM	PROBABLE CAUSE
P1A. Hydraulic pump will not operate when any hydraulic hand lever is moved from the neutral position. 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.
P1B. Hydraulic pump will not operate. Control volts present from positive to negative with proper polarity.	* Plug in the battery with the Key switch OFF. Volts on T84 should be less than 4 volts. * Close Key switch and check volts at T2. Volts should be about 50% battery volts. If above 85% of battery volts, check for shorted 1A tips or shorted 1REC. * Check voltage at TB2, TB3 or TB6 when the hand lever is moved for that function. Volts should read 8.0 volts and decrease to zero volts when the switches are activated. If not, check the wiring and switch.
P1C. Hydraulic pump will not operate. Control volts present when the hand lever is moved to the position for that function.	* Connect a milliammeter (10 ma scale) from PB4 to pump SCR negative, you should read 5-10 milliamps. If not, replace the control card.

SYMPTOM	PROBABLE CAUSE
P1D. Hydraulic pump will not operate and control volts present. No power and no SCR hum.	* Check power fuse 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 and A2 to locate open circuit. * Check for an open thermal protector.(4J) * Check 1C volts at the orange wire, if more than 0.125 times the battery volts, check if 2REC will gate ON.(4G) If less than 0.125 times the battery volts, check if 1REC will gate ON.(4G) Check the green lead on the current sensor for a good connection to card input pin 4. * Check 23FIL for short.(4K) * Replace the control card.
P1E. Hydraulic pump will not operate. Litte or no power. Normal SCR hum.	* Check 3REC for open circuit.(4H)
P1F. Hydraulic pump will not operate. No power. Abnormal SCR hum.	* Check 2REC for short circuit.(4G) * Check 5REC for short circuit.(4G) * Check 22REC and 25REC.(4M) Note: A 25REC which checks good with an ohmmeter can cause a mis-operation of 5REC under load.
P1F. Hydraulic pump will not operate. Little power. No SCR hum.	* Check 1C for low resistance.(4B)

EV-100 HYDRAULIC PUMP CONTROL
TROUBLESHOOTING

FAILURES THAT CAUSE FULL OR NO MOTOR TORQUE WITH SCR CONTROL

SYMPTOM	PROBABLE CAUSE
P2A. Full SCR speed immediately with audible hum.	* Key switch on. Check volts at TB1, should be 3-4 volts with pump switch in neutral position. If near zero volts, check pump switch for welded tips. * Replace control card.
P2B. Full speed immediately with no hum and control can only be shut off by disconnecting the battery.	* Check 5REC for open circuit or open gate.(4G) * Check 1C for open and loose connections.(4B) * Check 1C for short.(4B) * Check 2REC for short.(4G) * Check 5REC for short.(4G) * Check 1X choke and reactor T3-T4.(4N) * Replace control card.(4A)

EV200 SCR CONTROLS

ORDERING INFORMATION FOR IC3645EV200 SCR MODULE

THE STRUCTURE OF THE ALPHA–NUMERIC PORTION OF THE CATALOG NUMBER AFTER THE BASIC PORTION (IC3645EV200) DEFINES THE PARAMETERS OF THE MODULE.

EXAMPLE---------IC3645EV200	T	L1	R1	A
ARGUMENT 01 02	03	04	05	06

ARG. NO. 01 AND 02 ---BASIC CATALOG NUMBER

ARG. NO. 03 ---APPLICATION (ALL MODULES RATED 24/84 VOLTS)

T – TRACTION (STANDARD) USE CARDS T1, R1, L1 AND (D1 SPECIAL) ARG. 05

S – TRACTION (SERIES CONTROL) USE CARDS S1, S2, S3 OR S4 (ARG. 05)

ARG. NO. 04 SCR MODULE (MAX AVG. BATTERY CURRENT)

L1 – 375 AMPS (STANDARD) (REACTOR)

ARG. NO. 05 – OSCILLATOR CARD

T1 – TRACTION ONLY.

R1 – TRACTION WITH REGEN.

D1 – TRACTION – DUAL MOTOR SPECIAL.

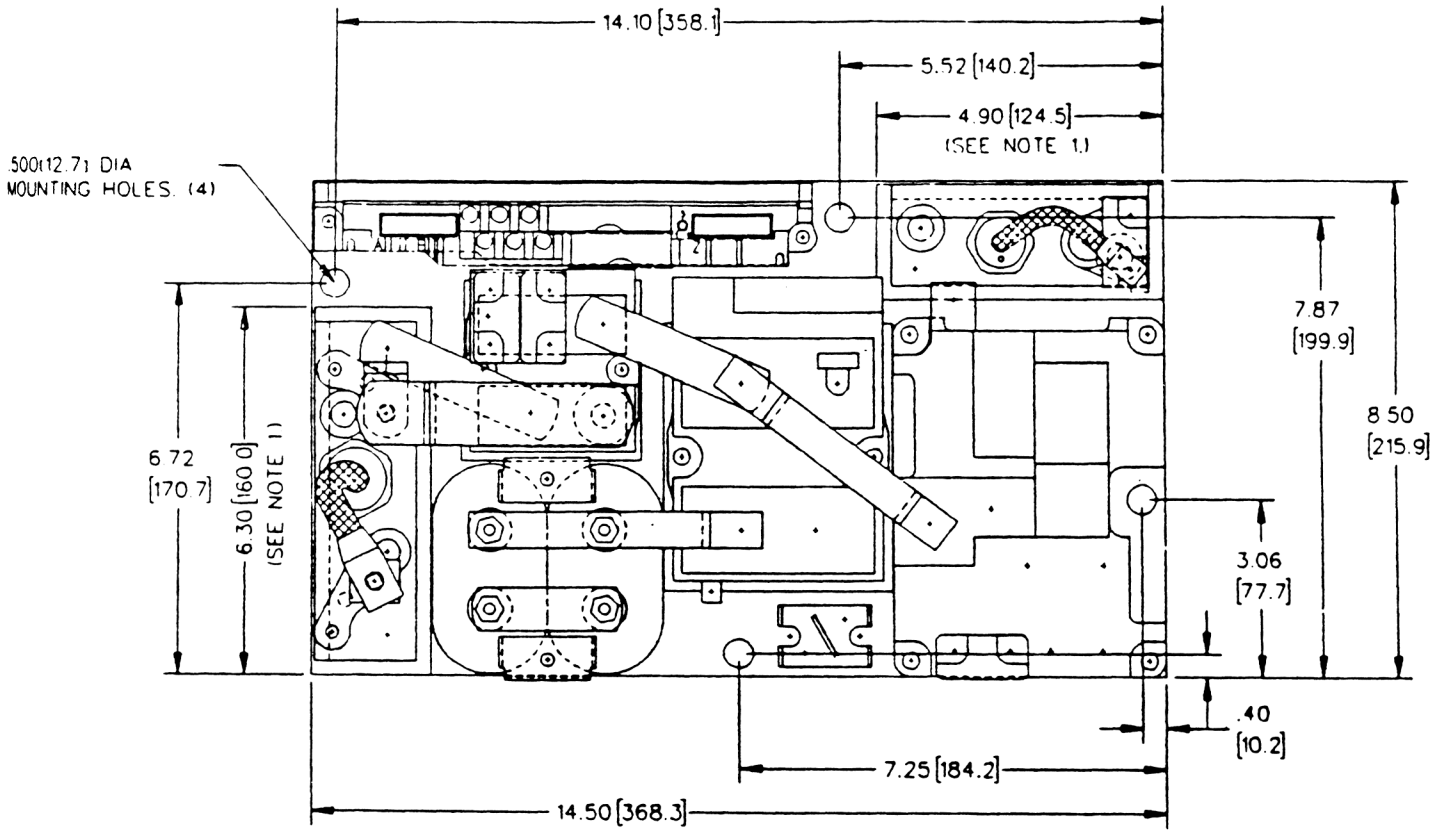
L1 – TRACTION WITH SPEED LIMIT/1A DROP OUT.

S3 – TRACTION – SERIES CONTROL (NO AUTO PLUG).

ARG. NO. 06 – VERSION CODE

A – ACTIVE

STANDARD EV200 OUTLINE



NOTE:

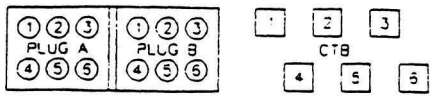
5.72 [145.3] IS THE MAX.
HEIGHT OF PANEL.

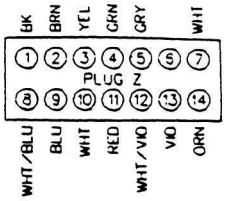
ALL CUSTOMER CONNECTIONS
ARE FOR M8 X 1.25 HARDWARE.

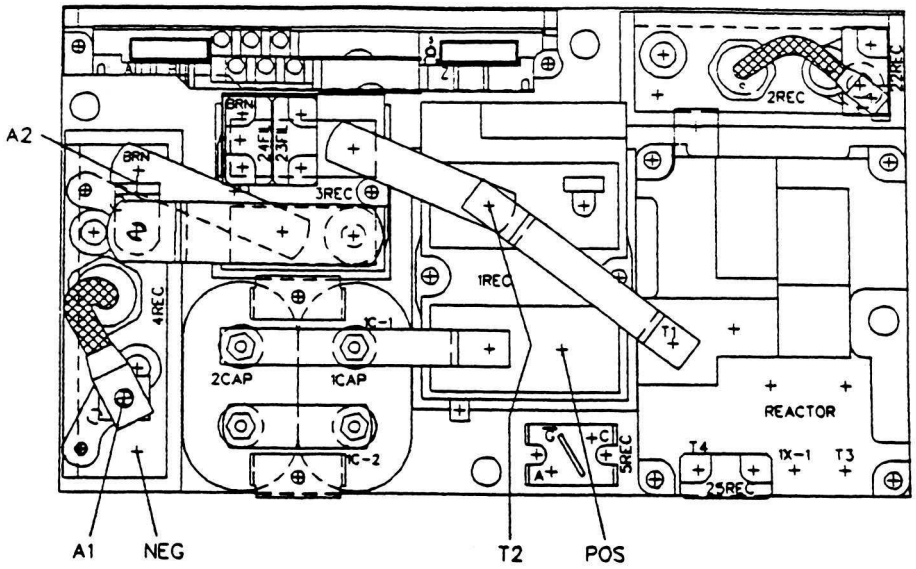
NOTE 1:

CUSTOMER TO MAINTAIN A CLEARENCE
OF .20 [5.08] TO EDGE OF BASE
THIS AREA.

STANDARD EV200 WIRING







WIRE COLOR AND SIZE		FROM	TO		
BRN	#22	PZ-2	4 REC HS	259A9500P7	(SEE NOTE 2)
WHT	#22	PZ-7	1C-1	259A9500P1	
WHT/BLU	#22	PZ-8	1 REC-G	259A9500P15	TWISTED PAIRS
BLU	#22	PZ-9	5 REC-A	259A9500P6	
WHT	#22	PZ-10	2 REC-G	LEADS SUPPLIED	TWISTED PAIRS
RED	#22	PZ-11	2 REC-C	WITH DEVICE	
WHT/VIO	#22	PZ-12	5 REC-G	259A9500P19	TWISTED PAIRS
VIO	#22	PZ-13	5 REC-C	259A9500P10	
ORN	#22	PZ-14	1C-2	259A9500P8	
BRN	#22	24 FIL	4 REC HS	259A9500P7	(SEE NOTE 2)
WHT/GRN	#22	24 FIL	4 REC-C(A1)	259A9500P13	
BLK	#22	THERMAL P.	PZ-1	LEADS SUPPLIED	SEE NOTE 3
GRY	#22	THERMAL P.	PZ-5	WITH DEVICE	
YEL	#22	SENSOR	PZ-3	LEADS SUPPLIED	SEE NOTE 2
GRN	#22	SENSOR	PZ-4	WITH DEVICE	
BLK	#6	1C-2	REACTOR T3	68A7541P68K19	
BLK	#6	REACTOR T3	2 REC HS	68A7541P68K19	
BLK	#6	2 REC-C (22REC)	REACTOR 1X-1	68A7541P68K19	
BLK	#8	5 REC-A	REACTOR T1	68A7541P88K49	
BLK	#8	5 REC-C	REACTOR T4 (25REC)	68A7541P88K49	

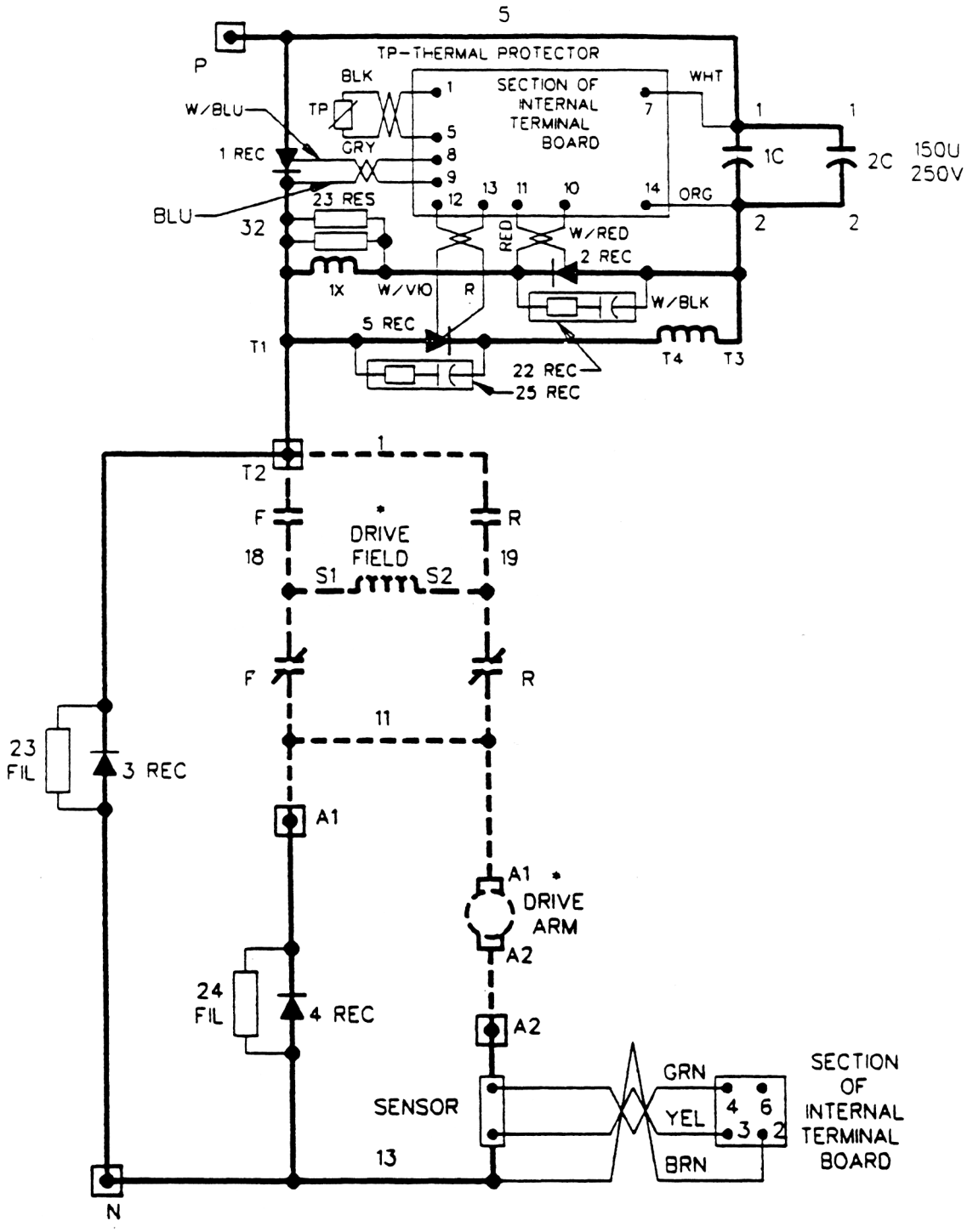
NOTES:

(1) ALL #22 TERMINALS MUST BE OF INSULATION GRIP TYPE.

(2) TWIST GREEN AND YELLOW LEADS OF SHUNT SENSOR, THEN TWIST WITH BROWN NEGATIVE LEADS, THEN CONNECT TO DESIGNATED PLUG TERMINALS.

(3) TWIST BLACK AND GRAY LEADS OT THERMAL PROTECTOR. THEN CONNECT

STANDARD EV200 POWER CIRCUIT

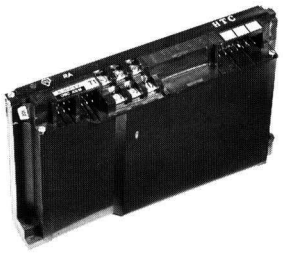


	MOTOR PEAK	BATT (MAX) AVG	FLLR IN 1A
(24-84V)	850	375	150-200

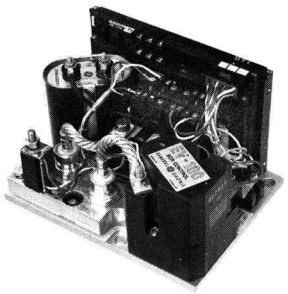
EV200 SPECIFICATIONS

STD CONTROL FEATURES	EV200T	EV200S
CREEP SPEED	ADJUSTED BY TRIMPOT	ADJUSTED BY TRIMPOT
CURRENT LIMIT (SEE ATTACHED)	ADJUSTED BY TRIMPOT PRE-SET BY FACTORY FIELD ADJUSTMENT RANGE: MAX/MIN RATIO- 50%	ADJUSTED BY TRIMPOT PRE-SET BY FACTORY FIELD ADJUSTMENT RANGES: MAX/MIN RATIO- 50%
CONTROLLED ACCELERATION	ADJUSTED BY TRIMPOT	ADJUSTED BY TRIMPOT
PLUGGING	ADJUSTED BY TRIMPOT REDUCE BY ACC POSITION	ADJUSTED BY TRIMPOT REDUCE BY ACC POSITION
RAMP START	STANDARD REDUCE BY ACC POSITION	STANDARD REDUCE BY ACC POSITION
FULL POWER TRANSITION	STANDARD APPLICABLE WITH 1A ONLY	STANDARD APPLICABLE WITH 1A ONLY
1A TIMED PICK-UP	ADJUSTED BY TRIMPOT ACC POT VOLTS= .5V ACC POT= 200 OHMS	ADJUSTED BY TRIMPOT ACC POT VOLTS= .5V ACC POT= 200 OHMS
1A THERMAL HOLD-OFF	STANDARD @ DEEP CUTBACK 20% ON	STANDARD @ DEEP CUTBACK 20% ON
1A PLUGGING HOLD-OFF	STANDARD	STANDARD
DELAY TO FIRST PULSE	STANDARD	STANDARD
PMT	STANDARD LOOK-AHEAD AND RESET 2 COUNTS	STANDARD LOOK-AHEAD AND RESET 2 COUNTS

STD CONTROL FEATURES	EV200T	EV200S
THERMAL CUTBACK START @ 90C	STANDARD	STANDARD
STATIC RETURN TO OFF (SRO)	STANDARD 1 SECOND DELAY	STANDARD 1 SECOND DELAY
VOLTAGE RANGE	24-84VDC	24-84VDC
ACCELERATOR INPUT REQUIREMENTS	5000-0 OHMS 3.5-0 V	5000-0 OHMS 3.5-0 V
LOW BATTERY OPERATION	STANDARD 50%- 36-84V 75%- 24V	STANDARD 50%- 36-84V 75%- 24V
REVERSE BATTERY PROTECTION	STANDARD	STANDARD
AMBIENT TEMPERATURE	-30 TO +50 DEG C	-30 TO +50 DEG C
APPROXIMATE WEIGHT	30 POUNDS	30 POUNDS

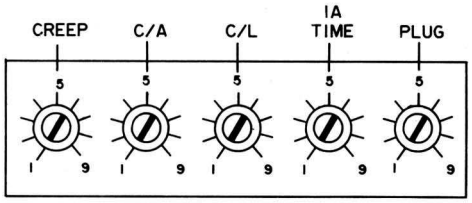


NUMBER ONE CARD TUNE-UP PROCEDURE
for
EV-100/200
SCR CONTROL



EV-100/200 Adjustment Characteristics

The GENERAL ELECTRIC EV-100/200 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-100/200 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-100/200 as Original Equipment

On new electric vehicles and lift trucks using the EV-100/200 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-100/200 equipped trucks in a similar application, it is 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-100/200 as a Conversion Installation

The EV-100/200 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-100/200 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-100/200 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 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 Acceleration)

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 (CW increases acceleration rate). 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-100/200 panel is the same as the EV-1 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 "HANDYMAN" manufactured by FLIGHT SYSTEMS that converts any standard VOM into a peak-reading voltmeter.) The positive or negative peak capacitor voltage must not exceed 200V on Models rated at 24-48V and 230V on Models rated at 48-84V.

1A Time

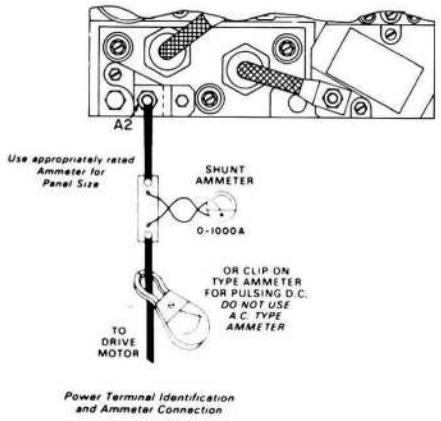
The timed 1A pick-up feature of the EV-100/200 control is accomplished without the use of the 1A microswitch in the accelerator unit. The timed 1A circuitry in the EV-100/200 control card is activated only when the accelerator voltage measured on TB1 of the control card (with respect to Bat Neg) decreases to less than .5 volts. The testing and initial setting of the timed 1A feature of the EV-100/200 control card can be performed as follows:

1. Make sure drive wheels are clear of floor.
2. Accelerate vehicle to one half SCR speed (determined by measuring T2 voltage on SCR panel with respect to Bat Neg). Example: One half SCR speed = one half battery voltage at T2.
3. Jumper TB1 on control card to battery negative while holding the accelerator for one-half SCR speed and note the time required for the 1A contactor to pull in.
4. Adjust 1A time on control card for the desired delay.
5. Remove jumper from TB1 on control card. The proper setting of the 1A time 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 number setting.

1A Time Setting	1	2	3	4	5	6	7	8	9
Delay in Seconds	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0

1A DO (1A DROP-OUT) L, M, S Type 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.



Power Terminal Identification and Ammeter Connection

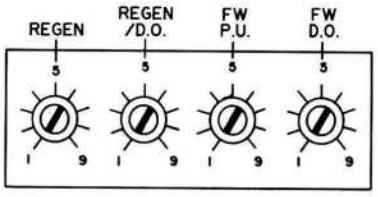
Connect a suitable ammeter as you would to set up current limit. Either armature current or battery current may be used for this test, as they are almost identical in by-pass. Turn the 1A DO full CCW. Accelerate into 1A, and load the vehicle either by climbing a ramp or applying the brakes. Note the 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. DO Amps EV-100	500	612	724	836	950	1062	1174	1286	1400
EV-200	675	855	1030	1210	1385	1565	1745	1920	2100

Plugging

The plugging pot on the EV-100/200 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: 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 reacceleration after a plug is obtained.



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

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 FW contactor, when energized, connects a FW resistor in parallel with the drive motor field winding. The FW 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 FW is only allowed to energize if the armature current has fallen below a pre-set value. This value is set by the FW PU Pot. If, after the FW is energized, the current increases, (such as would occur climbing a ramp) the FW contactor will drop out when the current reaches a second pre-set value. This value is set by the FW DO Pot. If the FW PU and FW DO are set too close together, it is possible that FW contactor "chatter" could result. The FW 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 1200 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 (It may be necessary to defeat the brake switch). Preset the FW PU FCCW and FW DO FCW. The following procedure is required to obtain a FW PU point with a value between 125 to 150% of the "level running" value. The vehicle must be in 1A with the accelerator fully depressed. Slowly apply the brakes until the motor has obtained the desired FW PU amps, **slowly** adjust the FW PU Pot CW until the FW contactor picks up. Increase the load on the motor until the desired FW DO value is reached and adjust the FW 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.

EXAMPLE:

If the normal level running current value is 125 Amps, then the FW PU value should be set between 125 to 150% (1¼ to 1½ times) of the normal level running current. (125% (1¼) times 125A = 156 Amps thru 150% (1½) times 125A = 187 Amps). The FW DO value is set between 175% to 300% (1¾ to 3 times) of the normal level current. (175% (1¾) times 125A = 218 Amps thru 300% (3) times 125A = 450 Amps). **[The maximum setting (300%) is not to exceed the 1A DO setting.]**

Regen Braking (Regen, Regen DO) R Type Cards

The Regen braking feature of the EV-100/200 control card allows the motor to operate as a generator for a small period of time and only during the plugging mode of the vehicle. The small amount of energy generated from the motor is re-cycled back into the battery to increase the working energy in the battery.

The initial adjustments are made when the vehicle is plugged from a one-half to three-quarter SCR speed condition to check proper sequence of the Regen contactor. Final adjustments are made when the vehicle is plugged from a top speed or 1A condition.

The Regen Pot (Regen) is normally adjusted so the Regen contactor drops out after the reversal of the direction contactors in the vehicle. (This usually occurs in a plugging condition.) The normal setting for the Regen Pot is approximately (3). The Regen DO Pot is adjusted so the Regen contactor picks up before the vehicle comes to a complete stop. The normal setting for the Regen DO Pot is approximately (8). The Regen adjustment setting will vary with vehicle size and weight.

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