

EV-T6

EV-T6P

INSTRUCTIONS
TROUBLESHOOTING
STATUS CODES

PARTS PRICING/ORDER INFORMATION: 800-333-1194



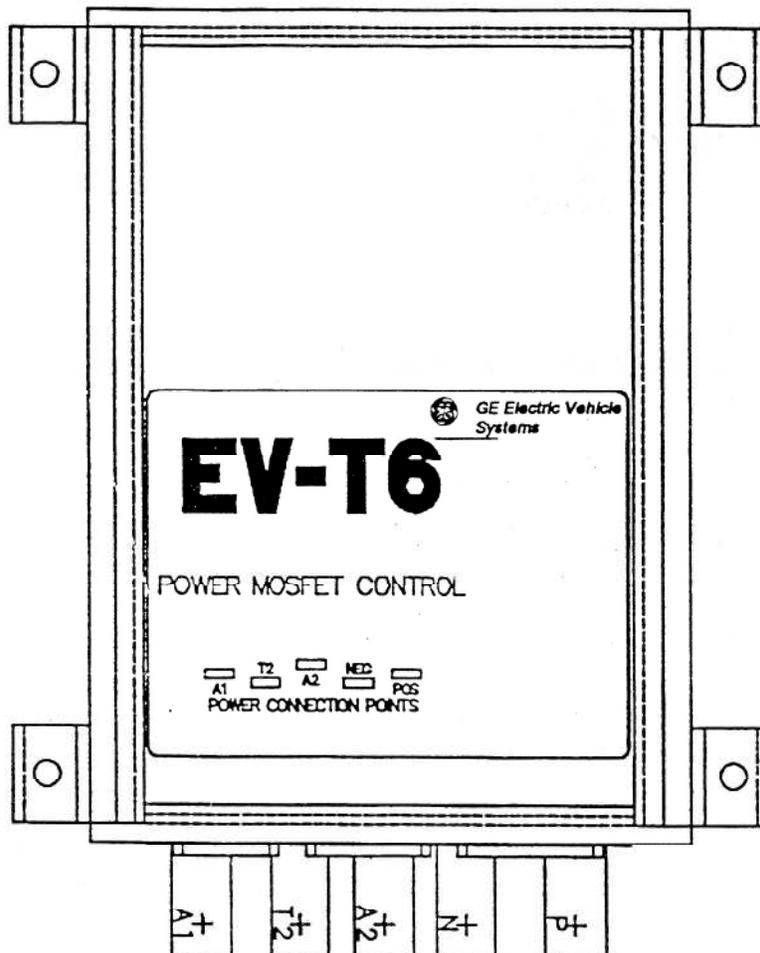
FLIGHT SYSTEMS
INDUSTRIAL PRODUCTS

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GE Electric Vehicle
Systems

INSTRUCTIONS
EV-T6 MOSFET
CONTROL



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

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

ORDERING INFORMATION FOR EV-T6 MOSFET

EV-T6 MOSFET CONTROL

EXAMPLE-----	IC3645EVT6	1	TA	XA	A
ARGUMENT NO.	01	02	03	04	05

ARGUMENT NO. 01 -BASIC CATALOG NUMBER

ARGUMENT NO. 02 -OPERATING VOLTAGE

1 - 24 TO 48 VDC

ARGUMENT NO. 03 -POWER BASE RATING

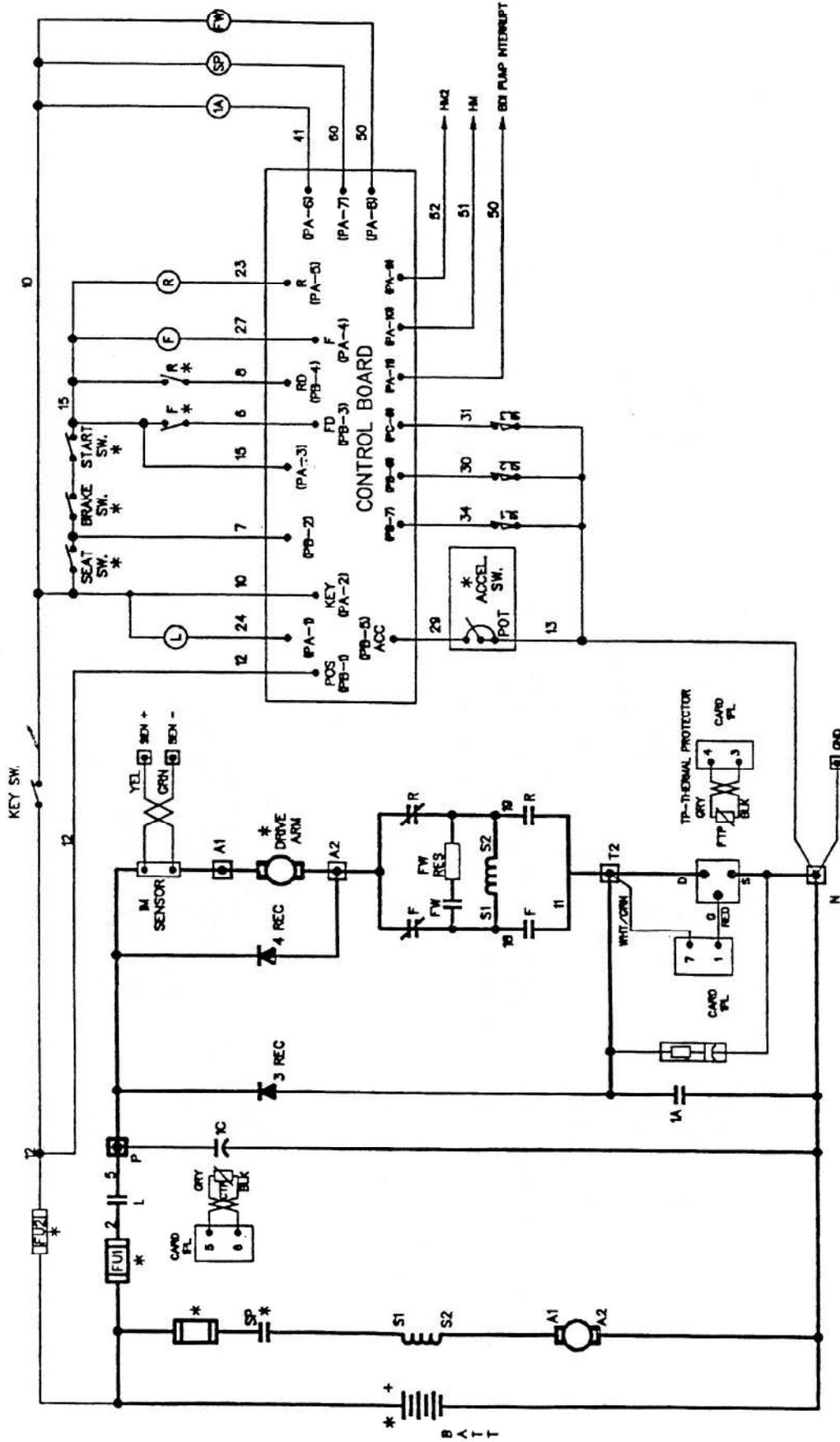
TA -	TRACTION UNIT:	350 AMP C/L, 450 AMP PLUG
TB -	TRACTION UNIT:	450 AMP C/L, 450 AMP PLUG
PC	PUMP UNIT:	350 AMP C/L, 450 AMP PLUG
PD -	PUMP UNIT:	450 AMP C/L, 450 AMP PLUG

ARGUMENT NO. 04 -OSCILLATOR CARD

XA -	STANDARD TRACTION
XC -	STANDARD TRACTION WITH BDI OPTION
XE -	STANDARD PUMP

ARGUMENT NO. 05 -CURRENT CARD REVISION

A - AS OF APRIL 1992

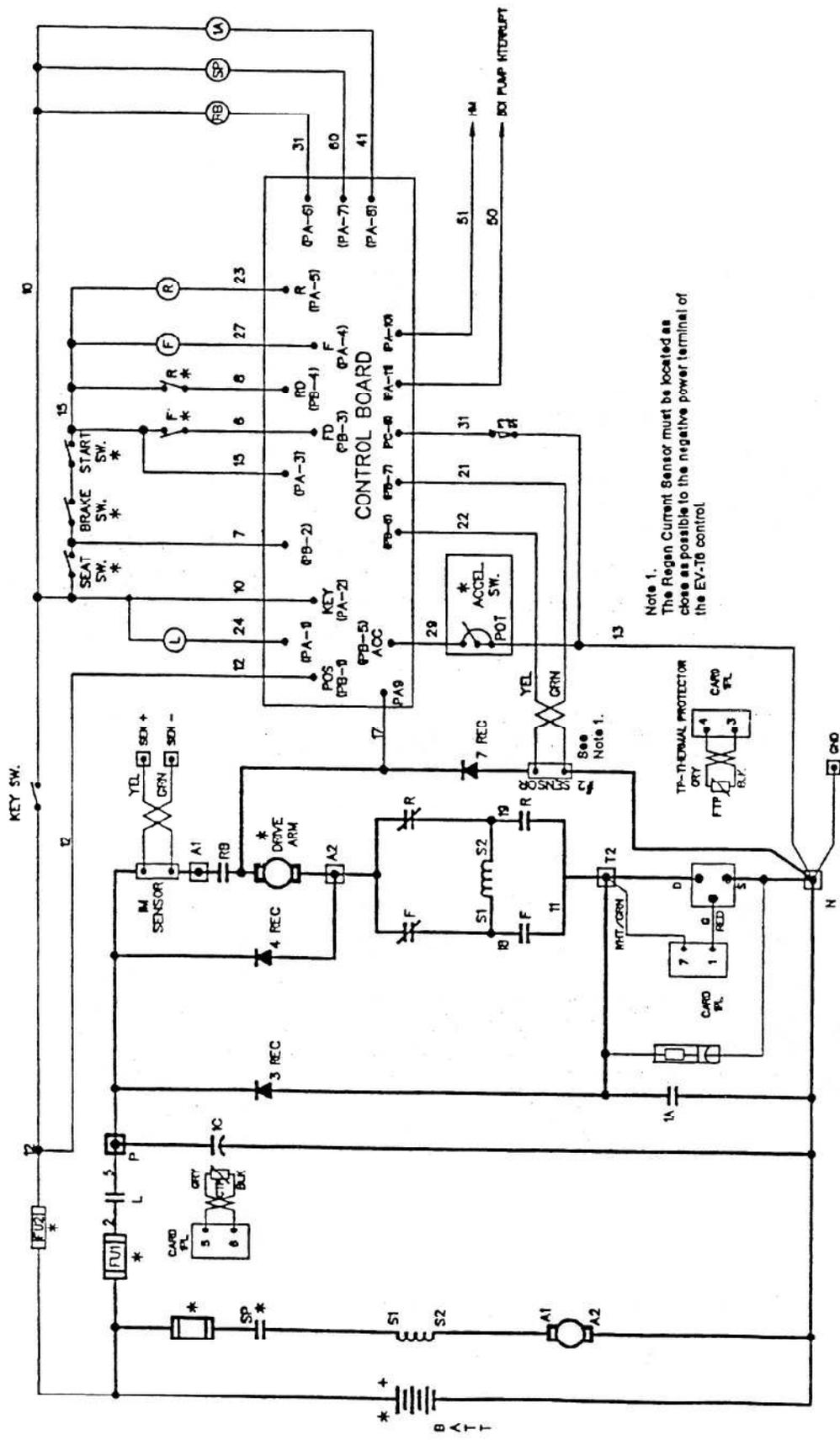


ENG. NOTE:

- PA = 11 PIN (REVERSER)
- PB = 7 PIN (CUSTOMER)
- PC = 9 PIN (ANODESET/DDI)

- MOSFET POWER CONNECTIONS.
- * SUPPLIED BY CUSTOMER.

EV-T6 ELEMENTARY



Note 1.
The Regen Current Sensor must be located as close as possible to the negative power terminal of the EV-T6 control

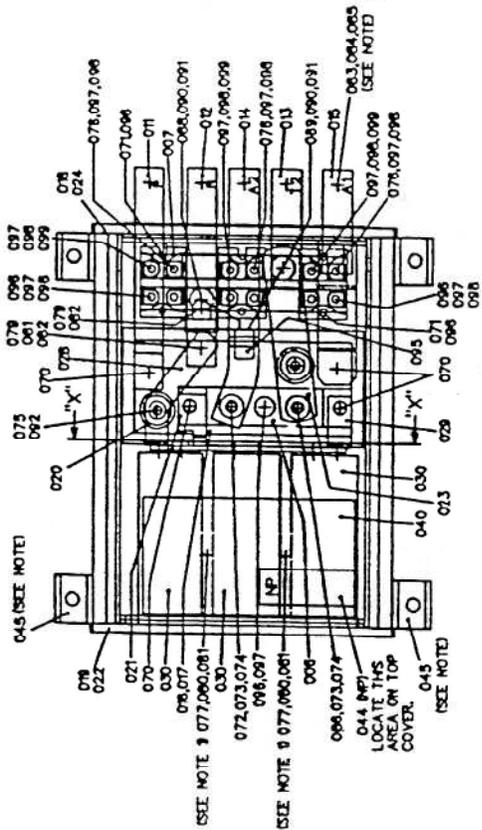
ENC. NOTE:

- PA = 11 PIN (REVERSER)
- PB = 7 PIN (CUSTOMER)
- PC = 9 PIN (HANDSET/001)

□ MOSFET POWER CONNECTIONS.

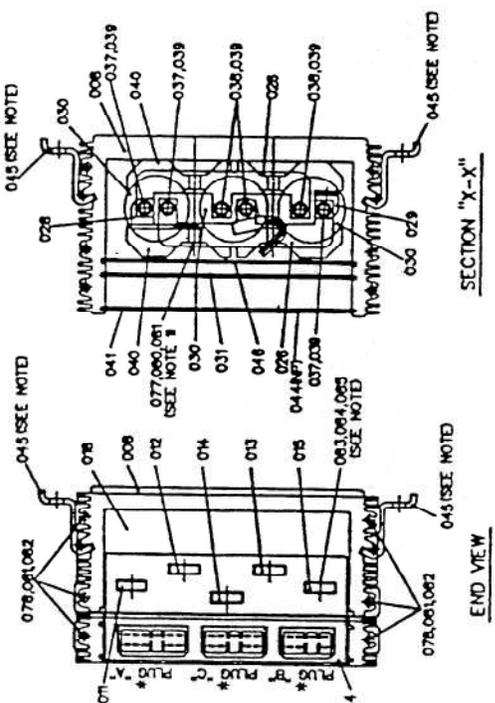
* SUPPLIED BY CUSTOMER.

EV-T6 ELEMENTARY (With Regen)



TOP VIEW

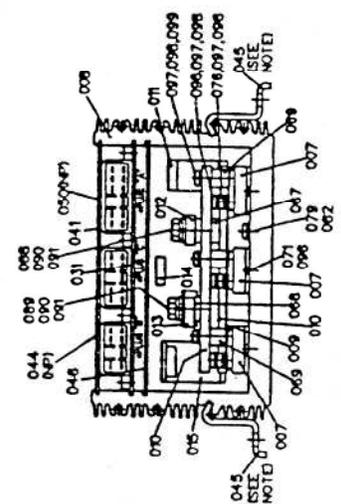
COVER (PT. 041), CARDOPT. 0311, AND SHIELD (PT. 046) HAVE BEEN REMOVED TO SHOW COMPONENTS BELOW.



SECTION "X-X"

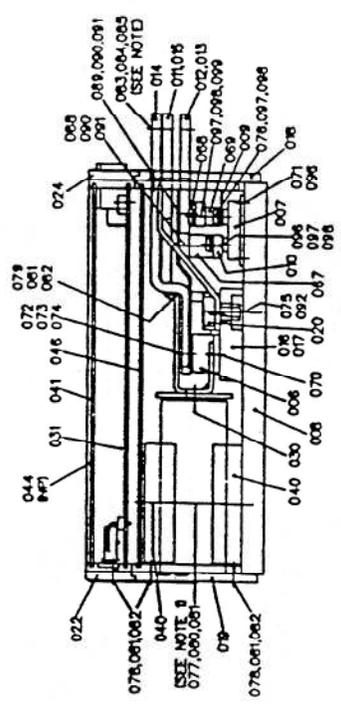
NOTES:

1. CUSTOMER HARDWARE KIT—44A727056-G02 INCLUDES QTY'S. OF PTS. 045, 083, 084, AND 085. KIT IS AVAILABLE FOR SEPARATELY SHIPPED EV-T6 CONTROL.
2. TORQUE HARDWARE TO 8-8 N-LBS.
3. USE WHITE SILICON GREASE (DOC/342 OR GE#649 BETWEEN THE FINNED HEATSINK (PT008) AND FETIS) (PT007).
4. USE DOW CORNING G-N METAL ASSEMBLY PASTE BETWEEN DIODE (PT006) AND HEATSINK (PT016/017).
5. * USE OF PLUG "A", PLUG "B" AND/OR PLUG "C" DEPENDS ON CARD TYPE.
6. WHEN MOUNTING DIODE MODULE, PT. 006, ORIENT THE MODULE WITH VENDOR IDENTIFICATION MARKINGS FACING THE TERMINAL END OF THE CONTROL.



END VIEW

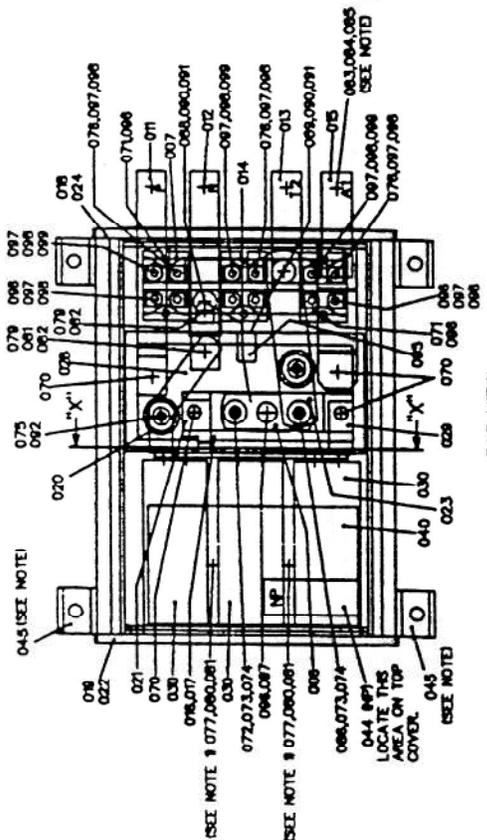
END VIEW-END COVERS REMOVED.



SIDE VIEW-SIDE REMOVED.

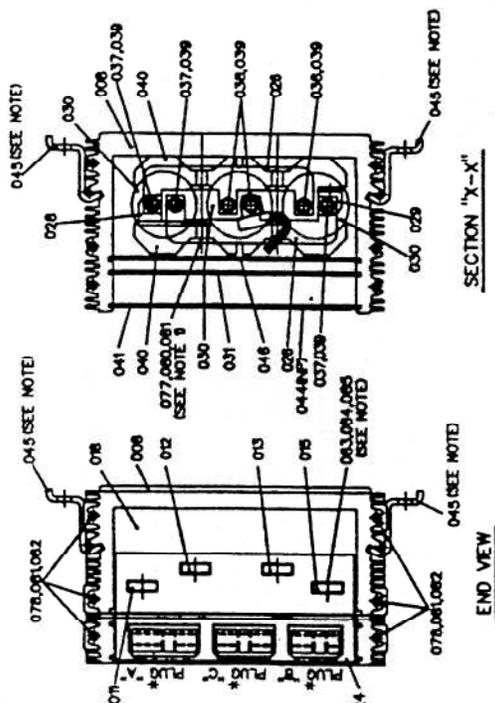
002

EV-T6 COMPONENT IDENTIFICATION



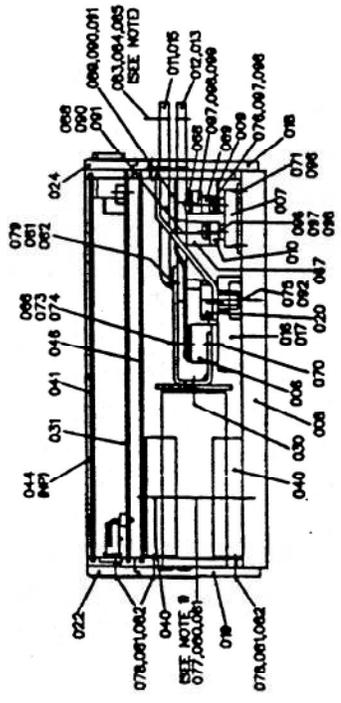
TOP VIEW

COVER IPT. 043, CARDIPT. 031, AND S-SHELD IPT. 046) HAVE BEEN REMOVED TO SHOW COMPONENTS BELOW.



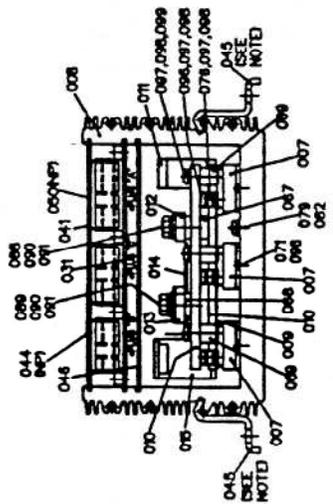
END VIEW

SECTION "X-X"



SIDE VIEW-SIDE REMOVED.

002



END VIEW-END COVERS REMOVED.

NOTES:

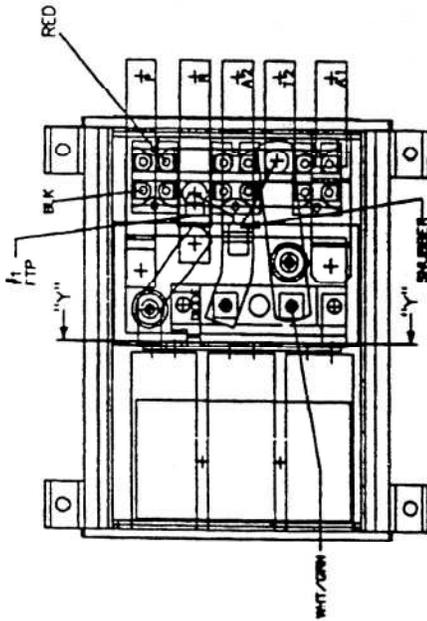
1. CUSTOMER HARDWARE KIT—44727056-002 INCLUDES QTY'S. OF PTS. 045, 083, 084, AND 085. KIT IS AVAILABLE FOR SEPARATELY SHIPPED EV-T6 CONTROL.
2. TORQUE HARDWARE TO 6-8 IN.-LBS.
3. USE WHITE SILICON GREASE (DOC#342 OR GE#641 BETWEEN THE FINNED HEATSINK (PT008) AND FETIS) (PT007).
4. USE DOW CORNING G-H METAL ASSEMBLY PASTE BETWEEN DIODE (PT008) AND HEATSINK (PT016/DT1).
5. * USE OF PLUG "A", PLUG "B" AND/OR PLUG "C" DEPENDS ON CARD TYPE.
6. WHEN MOUNTING DIODE MODULE, PT. 008, ORIENT THE MODULE WITH VENDOR IDENTIFICATION MARKINGS FACING THE TERMINAL END OF THE CONTROL.

EV-T6P COMPONENT IDENTIFICATION

EV-T6 COMPONENT IDENTIFICATION

Part Number	Description	Part Number	Description
006	Diode Module, 3/4 REC	046	Shield
007	Transistor Module	048	Pot Adjustment Cover
008	Base	050	Logo Nameplate
009	Gate Bus Bar	067	Spacer (NEG)
010	Transistor Bus Bar	068	Spacer (T2)
011	Bus Bar (P)	069	Spacer (Transistor Bus)
012	Bus Bar (NEG)	070	Bolt, M6 x 1.0 x 14mm
013	Bus Bar (T2)	071	Lock Washer, M4
014	Bus Bar (A2)	072	Bolt, 1/4 - 20 x .625" Lg.
015	Current Shunt Assembly	073	Flat Washer, 1/4"
016	Heat Sink	074	Lock Washer, 1/4"
017	Heat Sink Insulation	075	Screw, M5 x .8 x 30mm
018	Front Bottom End Plate	076	Screw, M4 x .7 x 8mm
019	Rear Bottom End Plate	077	Screw, M5 x .8 x 55mm
020	Insulating Bushing	078	Screw, M5 x .8 x 20mm
021	Bus Bar	079	Screw, M5 x .8 x 14mm
022	Rear Top End Plate	080	Belleville Washer, .375"
023	Flexible Bus	081	Flat Washer, M5
024	Front Top End Plate	082	Lock Washer, M5
026	Bus Bar	083	Screw, M8 x 20mm
028	Bus Bar	084	Flat Washer, M8
029	Bus Bar	085	Lock Washer, M8
030	Capacitor	086	Bolt, 1/4 - 20 x .44" Lg.
031	Logic Card	088	Bolt, M6 x 1.0 x 28mm
037	#10-32 x .5" Lg. Sems Unit	089	Bolt, M6 x 1.0 x 20mm
038	#10-32 x .375" Lg. Sems	090	Flat Washer, M6
039	Flat Washer #10	091	Lock Washer, M6
040	Capacitor Mounting Clamp	092	Flat Washer, M5
041	Top Cover	093	Screw, #6-32 x .25" Lg.
042	Wire Harness	095	Snubber
044	Nameplate	096	Screw, M4 x 0.7 x 12mm
045	Mounting Clamp	097	Lock Washer, M4
		098	Flat Washer, M4
		099	Screw, M4 x 0.7 x 21mm

Note: Customer hardware kit – 44A727056-G02 to include Qtys. of parts 045, 083, 084 and 085 as indicated.

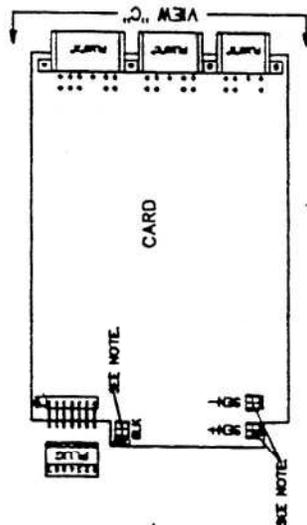


TOP VIEW

COVER, CARD AND SHIELD HAVE BEEN REMOVED TO SHOW CONNECTIONS BELOW.

RED	1
OPEN	2
BLK	3
FTP	4
GRY	5
CTP	6
GRN	7
WHT/GRN	8

PLUG (WIRE SIDE)

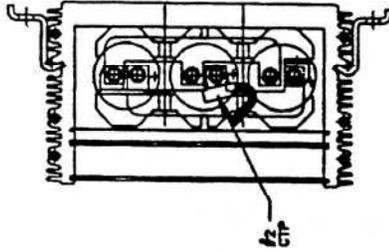


NOTE: USE SCREW N57P9004B6 (PT. 93, SEE MJI TO FASTEN YEL, GRN AND BLK WIRES TO CARD.

PLUG "A" REFERENCE NUMBERS	
TEST/CUSTOMER	
PLUG	AMP#170224-1
PN	AMP#170189-1

PLUG "B" REFERENCE NUMBERS	
TEST/CUSTOMER	
PLUG	AMP#170223-1
PN	AMP#170189-1

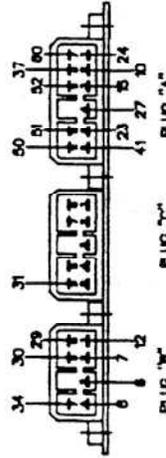
PLUG "C" REFERENCE NUMBERS	
TEST/CUSTOMER	
PLUG	AMP#170223-1
PN	AMP#170189-1



SECTION "Y-Y"

TWISTED PAIR

WIRE	CONNECTION SEQ. #22 259A9500P2 (BLU)
BLK	CARD GND., FET BUS
WIRE	CONNECTION SEQ. #22 259A9500P3 (RED)
RED	FET-1 GATE, PLUG 7
WIRE	CONNECTION SEQ. #22 259A9500P13 (WHT/GRN)
WHT/GRN	DIODE, PLUG 1

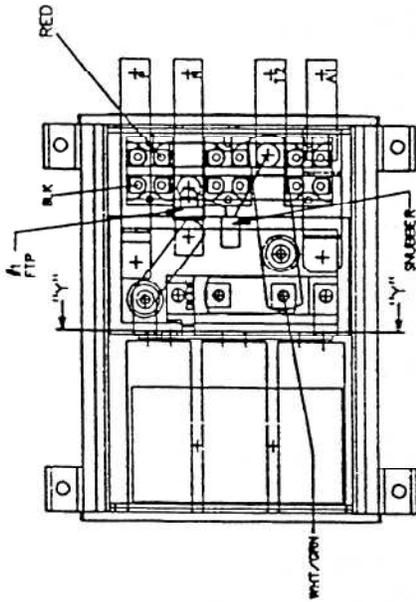


VIEW "C"

CUSTOMER PLUG WIRING.

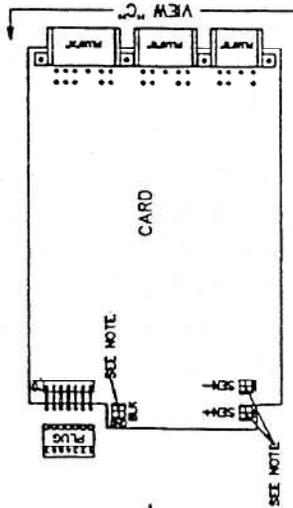
WIRE	CONNECTION SEQ.
YEL	CARD SEN+, SENSOR
GRN	CARD SEN-, SENSOR
BLK	FTP, PLUG 5
GRY	FTP, PLUG 4
BLK	CTP, PLUG 2
GRY	CTP, PLUG 3

EV-T6 INTERNAL WIRING



TOP VIEW

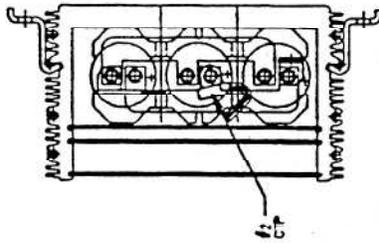
COVER, CARD AND SHIELD HAVE BEEN REMOVED TO SHOW CONNECTIONS BELOW.



NOTE:
USE SCREW NS7P9004B6 (PT. 93,
SEE M1) TO FASTEN YEL, GRN
AND BLK WRES TO CARD.

PLUG "A" REFERENCE MARKERS		PLUG "B" REFERENCE MARKERS	
TEST/CUSTOMER	TEST/CUSTOMER	TEST/CUSTOMER	TEST/CUSTOMER
PLUG	AMP#172024-1	PLUG	AMP#172025-1
PN	AMP#170189-1	PN	AMP#170189-1

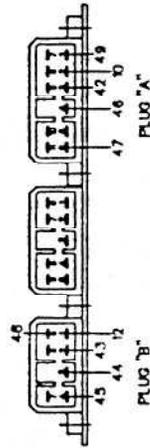
PLUG "C" REFERENCE MARKERS	
TEST/CUSTOMER	TEST/CUSTOMER
PLUG	AMP#170189-1
PN	AMP#170189-1



SECTION "Y-Y"

TWISTED PAIR

WIRE	CONNECTION SEQ. #22	259A9500P2 (BLK)
BLK	CARD GND., FET BUS	
WIRE	CONNECTION SEQ. #22	259A9500P3 (RED)
RED	FET-1 GATE, PLUG 7	
WIRE	CONNECTION SEQ. #22	259A9500P13 (WHT/GRN)
WHT/GRN	DIODE, PLUG 1	



WIRE	CONNECTION SEQ.
YEL	CARD SEN+, SENSOR
GRN	CARD SEN-, SENSOR
BLK	FTP, PLUG 5
GRY	FTP, PLUG 4
BLK	CIP, PLUG 2
GRY	CIP, PLUG 3

EV-T6 SPECIFICATIONS

FEATURES

Voltage Range (VDC)	24/36/48 VDC
Mtr Current Limit (Option).....	450A
Mtr Current Limit (Option).....	350A
1 Hour Rating (Amps)	220A
Max. Plug Current (Option)	450A
Max. Plug Current (Option)	350A
Ambient Temperature	-40C +50C
Thermal Protection	LINEAR 90C
Accelerator Input	5k-0,3.5v-0
Dimensions (HxLxW)	96x254x161
Repair	FIELD/RET
Power Device	MOSFET
Logic Card.....	MICRO
Frequency	5KHZ
Modulation	PWM and FM
Creep Speed Adj	2-15%
Current Limit Adj	100-Max
Controlled Acceleration Adj	1-22 SEC
Plugging Adj	200A-Max Plug
Pedal Plug Adj	100A-Max Plug
1A Time Adj	C/A + .2 SEC
Steer Pump Time Adj	5-63 SEC
Adj Method	SOFTSET
Bypass (1A) Operation	OPTIONAL
Arcless (1A) Bypass	UP TO Max C/L
Bypass (1A) Dropout	300-1100A
Field Weakening.....	User Select
Regenerative Braking	OPTIONAL
Chopping Drivers	YES
On-Board Coil Suppressors	YES
PMT	YES
SRO.....	YES
Shorted 3REC Protection	YES
Shorted Capacitor Protection	YES
Controlled Capacitor Pre-Charge	YES
Low Current Control Switches.....	YES
Accelerator Volts Hold-Off	YES
Speed Limit (Variable)	YES
Speed Limit C/A.....	ADJUSTABLE
Ramp Start.....	YES
Reversed Battery Protection.....	LINE CTR
Diagnostics	DISPLAY
Hourmeter	TWO (wo Regen)
15 Stored Status Codes	OPTIONAL
Battery Indication	OPTIONAL

BASICS OF CIRCUIT OPERATION

The control is energized by plugging in the battery. A capacitor charging circuit charges capacitors (1C) to battery volts in approximately 2 seconds. When the key and brake switches are closed, the control then makes the following start-up checks before the control is allowed to operate:

- 1) Insures that the voltage at T2 is between 12 percent and 88 percent of battery volts. This checks for shorted forward, reverse, and 1A contactor drivers, shorted 3 REC and power MOSFETs, welded forward, reverse, and 1A contactors.
- 2) Checks for open F and R switch inputs, Voltage at PB-3 and PB-4 should be 0 volts.
- 3) Checks for accelerator volts at PB-8 to be greater than 2.5 volts.

If all the above start-up checks are satisfied and if the capacitor 1C is fully charged, the line contactor will close and normal vehicle operation can begin.

Selecting either forward or reverse direction will close the proper direction contactor completing the power circuit to the drive motor. The card then supplies gate voltage to the power transistors, turning them on. Current flows from the battery through the motor armature, motor field, power transistors back to battery negative. When gate voltage at the transistors is removed, they turn off. 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 providing what is called flyback current. The battery current continues to flow from battery positive through 1C to negative during the entire off time due to the high frequency of oscillation. The control converts battery current at battery voltage into a higher motor current at lower motor volts. This is why measured motor current will be greater than battery current except when control is operating at 100% on time.

The time for the next ON and OFF cycle to start is determined by the time the control card takes to oscillate. This frequency of oscillation is controlled by the speed input signal in the accelerator and automatic circuitry in the card. Slow speed is obtained by having maximum ohms or volts from the speed input signal. As the resistance or voltage decreases, the speed of the motor increases. The transistor circuit is capable of delivering approximately 100% battery volts. For full speed operation, the 1A contactor is closed to apply full battery voltage across the motor.

Figure 1 and 2 show battery and motor current paths during the on and off times for a typical running condition of 100 amps motor at 50% on time (half speed).

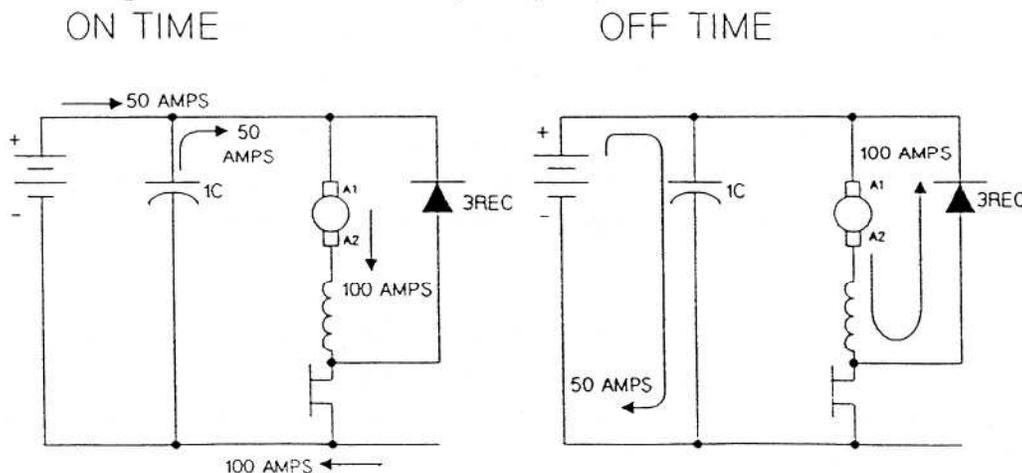
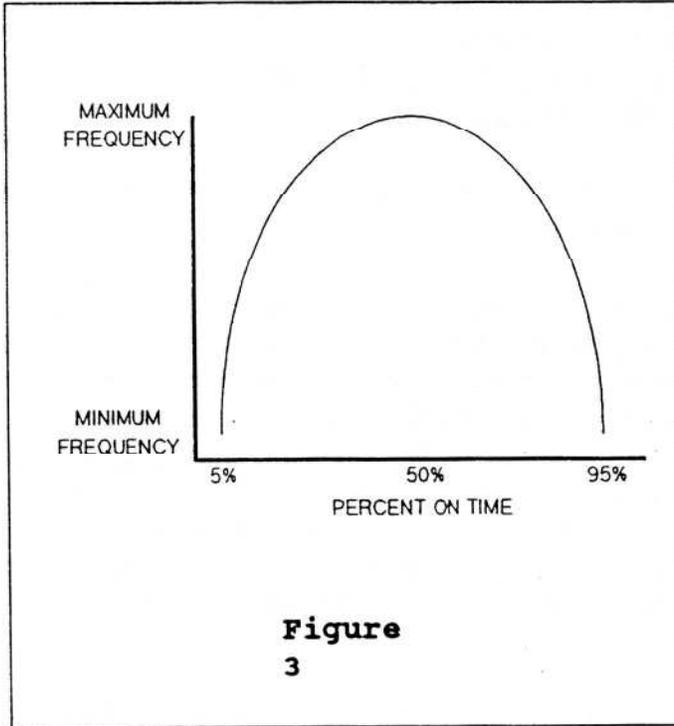


FIG 1

FIG 2

CONTROL FEATURES

Oscillator - The oscillator section of the card has two adjustable features and one fixed feature. With the accelerator at maximum ohms or volts, the creep speed can be adjusted by Function 2 of the Handset. Top speed is fixed and is obtained with the accelerator at minimum ohms or volts. The % ON time has a range of approximately 0 to 95 percent. The center operating condition of the oscillator is at 50 percent



ON time and a 50 percent OFF time. This corresponds to the maximum control operating frequency. At creep the ON time will decrease to approximately 5% while the OFF time will become in the order of 95% off. At full transistor 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 transistors range. The frequency curve of the oscillator is shown in Figure 3. Note that depending on the current rating of the control, the maximum operating frequency may change.

Plugging - slows the vehicle to a stop when reversing, by providing a small amount of retarding torque for deceleration. The oscillator circuit regulates braking at an adjustable plug current limit level to bring the vehicle to a smooth stop and reversal.

Pedal Position Plug - regulates plugging distance based on pedal position. Maximum plug current is obtained with the accelerator in the top speed position.

Ramp Start - provides full control 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 neutral position to allow the control to assure full power when restarted.

Full Power Transition - provides smooth transition from control to 1A bypass. This is accomplished by the control continuing to pulse until the 1A contactor power tips close.

Control Acceleration and 1A Time - allows for adjustment of the rate of time it takes for the control to accelerate to 96% applied battery voltage to the motor on hard acceleration. The 1A contactor will automatically close .2 seconds after the controlled acceleration stops and the accelerator input is less than .5 volts or less than 50 ohms.

1A Current Dropout - can be set to open the 1A contactor if the traction motor is subject to excessive currents. 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.

Accelerator Volts Hold-Off - checks the voltage level at the accelerator input whenever the key switch or seat switch is activated. If the voltage is less than 2.5 volts the control will not operate. This is to insure low speed operation at start up.

Static Return to Off (SRO) - 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 1.5 seconds is built into the seat switch input to allow momentary opening of the seat switch if a bump is encountered.

Pulse Monitor Trip (PMT) - The PMT circuit will not allow the control to start if main transistors are shorted or if the 1A contactor is welded, (uncontrolled top speed conditions), the control will not allow the F or R contactor to close.

The PMT circuit will shut down operation of the control (opening of the F or R contactor), if the main transistors fail to shut off , or if 1A power tips remain closed when they should be open. 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) - These are temperature sensitive devices that are mounted on the transistors heat sink and filter capacitors. If the transistors or capacitors temperature begins to exceed the design limits, the thermal protector will lower the maximum current limit and not allow the devices 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.

Reverse Battery Protection - An external line contactor protects the control if the battery connections are reversed. Proper operation will begin when the connections are corrected.

Shorted 3REC Protection - prevents the control from operating if the flyback diode (3REC) is in a shorted condition

Shorted Capacitor Protection - prevents the line contactor from closing if the capacitors are shorted.

Controlled Capacitor Pre-Charge - prevents high in-rush current which could cause battery plug damage.

Low Current Control Switches - can be used for the directional input switches, the only coil current carrying switches are the key, brake, seat and start switches.

Coil Driver Modules and Coil Suppression - the drivers are internal to the logic card and are current limited for short circuit protection. These drivers open or close these coils on command from the logic card. This feature allows the use of 24 volt contactor coils on through the entire voltage range of the control (24 volts to 48 volts) for the F, R, 1A, FW, Line, Regen and SP contactors allowing the contactors to operate cooler due to less current being applied to the coil after pick-up.

1A Thermal Hold Off - 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, this feature will inhibit the 1A timer.

Low Voltage - Batteries under load, particularly if undersized or more than 80 percent discharged, will produce low voltages at the control terminals. The control is designed for use down to 13V. Lower battery volts may cause the control to not operate correctly; however the PMT will open the F and R contactor when battery volts drop below 13 volts.

High Frequency Operation - This feature provides a bell shaped oscillation curve that ranges from 1KHZ at creep speed to 5KHZ at mid-speed to 1KHZ at top speed. The high oscillation rate of the control allows quieter operation, higher average motor current with lower peak motor currents, less ripple current at the motor, and less motor heating.

Tip Bounce Timer and Arcless 1A - Tip Bounce Timer synchronizes the contactors and the power base so that under normal operating conditions, the forward and reverse contactors do not make or break current.

Under normal operating conditions, the 1A contactor makes current but does not have break current. Arcless interruption greatly increases 1A tip life.

Top Speed (Motor Volts) Limit - provides a means to limit motor volts by a variable resistive input or by limit switches opening between input points on the control card and negative and inserting a resistive value. The lower motor volt limit always takes priority when more than one switch input is closed. This motor volt limit affects top speed of the control, but actual truck speed will vary at any set point depending on the loading of the vehicle.

Top Speed (Motor Volts) Limit Controlled Acceleration - when a speed limit switch is activated, a new controlled acceleration rate may also be activated at that time. This new C/A rate is adjustable by the handset.

Steer Pump Time Delay - provides two options for SP time delay. Option 1 provides a .5 to 63.5 second time delayed drop out of the steer pump contactor when the Forward or Reverse directional switch is opened. This is overridden by a 1.5 second time delayed drop-out whenever the seat switch is opened. Option 2 provides a .5 to 64.5 second time delayed drop out of the SP contactor when the seat switch is opened .

Hours of Operation Storage - Two hourmeters (only one hourmeter if the Regen option is used) record hours of use of the traction control and one other circuit. These readings are displayed to the dash display each time the key switch is turned off

Internal Resistance Compensation - is used when the Battery Discharge Indicator is present. Adjustment of this function will improve the accuracy of the BDI.

Truck Management Module (TMM1) - is a multi-function accessory card that provides the OEM the ability to provide status codes or operator warning codes that will be displayed on the dash display whenever a normally open switch or sensor wire provides a negative signal to the card. Typically the TMM1 can be used to display over temperature of motors, hydraulic systems or any other switch that closes at the desired temperature. The TMM1 can also be used to monitor and display motor brush wear warnings when the motor brushes require replacement.

Truck Management Module (TMM2) - is a multi-function accessory card that provides a horn alarm circuit which blows the horn when the truck is left unattended without the park brake being set, and also provides an external controlled acceleration adjustment for use by the operator.

15 Stored Status Code - furnishes a function register that contains the last 15 faults that shut down vehicle operation (PMT type fault that is reset by cycling the key switch). The first of the 15 status codes will be overwritten each time a new status code occurs. This register can be cleared from memory by using the handset.

Field Weakening - Field weakening is a method of attaining higher running speed for the vehicle in level operation.

Regenerative Braking - is activated when 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. Once the generated current reaches a particular current level, the plugging mode transitions to regenerative braking mode. 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, the regenerative braking mode transitions back to plugging mode. The major advantage of regen is longer motor life due to reduced motor heating.

On-board Diagnostics - detects the system's current operating status which can be displayed to either the Dash Display or the Handset. There are currently over 50 status codes that are available with systems using Traction controls and Truck Management Module (TMM). Along with the status code displayed from the TMM, the logic card is capable of reducing the speed of the vehicle to alert the operator of a critical fault condition.

Battery Discharge Indication - uses the latest in microprocessor technology to provide accurate battery state of charge information and supplies passive and active warning signals to the vehicle operator.

- Displays 100 to 0 percent charge
- Display blinks at 20% charge
- Disables pump circuit with 10% charge
- Auto ranging for 36/48 volt operation
- Adjustable for use on 24 to 48 volts

Handset - This is a multi-functional tool to be used with the EV-T6 controls. The Handset consist of a Light Emitting Diode (LED) display and a keyboard for data entry.

Features and functions:

- Monitor existing system status code for both traction and pump systems
- Monitor intermittent random status code
- Monitor battery state of charge
- Monitor hourmeter reading on traction and pump systems
- Monitor or adjust the control functions.

HYDRAULIC CONTROL (EV-T6P) - This hydraulic controller consist of the following features:

- Four speeds adjustable from 5% volts to full motor volts.
- Fixed speeds actuated by switch closure to positive.
- 1A bypass contactor (if required)
- Variable resistor input (5K-0 ohms).
- PMT functions available with use of pump 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 EV-T6P pump 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 PB1.

When the pump contactor is used, PMT operation is the same as outlined for the EV-T6 traction controllers.

The four speed (motor volts) reference points PA3, PB2, PB3 and PB4 are selected by connecting these points independently to battery positive.

The first speed is obtained by closing speed point 1, PA3, to control positive. Speed point 1 is adjustable by function 11 to adjust 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, PB2, to control positive. Speed point 2 is adjustable by function 12 to adjust motor voltage from 0 to full motor volts.

The third speed is obtained by closing speed point 3, PB3, to control positive. Speed point 3 is adjustable by function 13 to adjust motor voltage from 0 to full motor volts.

The fourth speed is obtained by closing speed point 4, PB4, to control positive. Speed point 4 is adjustable by function 14 to adjust motor voltage from 0 to full motor volts. 1A will close .2 seconds after C/A is reached 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 current limit circuit is adjustable and operates the same as the traction current limit.

The controlled acceleration circuit is adjustable and operates the same as the traction circuit. Adjustment range is from .1 to 5.5 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, and closes 1A as resistance is decreased to less than 200 ohms.

The Battery Discharge Indicator (BDI) interrupt will disable the hydraulic controller if the connection at PB10 loses the 12 volt signal from the traction control. BDI interrupt can be disabled by function 17. Select card type with or without BDI function.

The following are the input/output terminals for the pump control.

PB5	Accelerator pot input
PA3	SL1 input
PB2	SL2 input
PB1	Battery Positive
PA2	Key input
PB3	SL3 input
PB4	SL4 input and 1A enable
PA10	BDI enable signal
PA4	PMT driver
PA6	1A driver

GENERAL MAINTENANCE INSTRUCTIONS

The transistor 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 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 vehicle 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 MOSFET 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 MOSFET control package cooler. The use of a heat-transfer grease (Dow Corning 340) is recommended.

Control wire plugs and other exposed transistor 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. 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

Trouble-shooting the EV-T6 control should be quick and easy by following the instructions outlined in the following status code instruction sheets.

If mis-operation of the vehicle occurs, a status code will be displayed on the Dash Display for vehicles equipped with a Dash Display or by plugging a Handset into the logic card's plug "C" location and then reading the status code.

With the status code number, follow the procedures outlined in the status code instruction sheets to determine the problem.

Checking and replacement of components are also outlined in sections of this instruction book. Please refer to these section as needed.

Important Note: Due to the interaction of the logic card with all vehicle functions, almost any status code or control fault could be caused by the logic card. After all other status code procedures have been followed and no problem is found, the logic card should then be replaced as the last option to correct the problem.

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 Power POS terminal to the Power NEG terminal. Check resistance on Rx1000 scale from frame to 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.

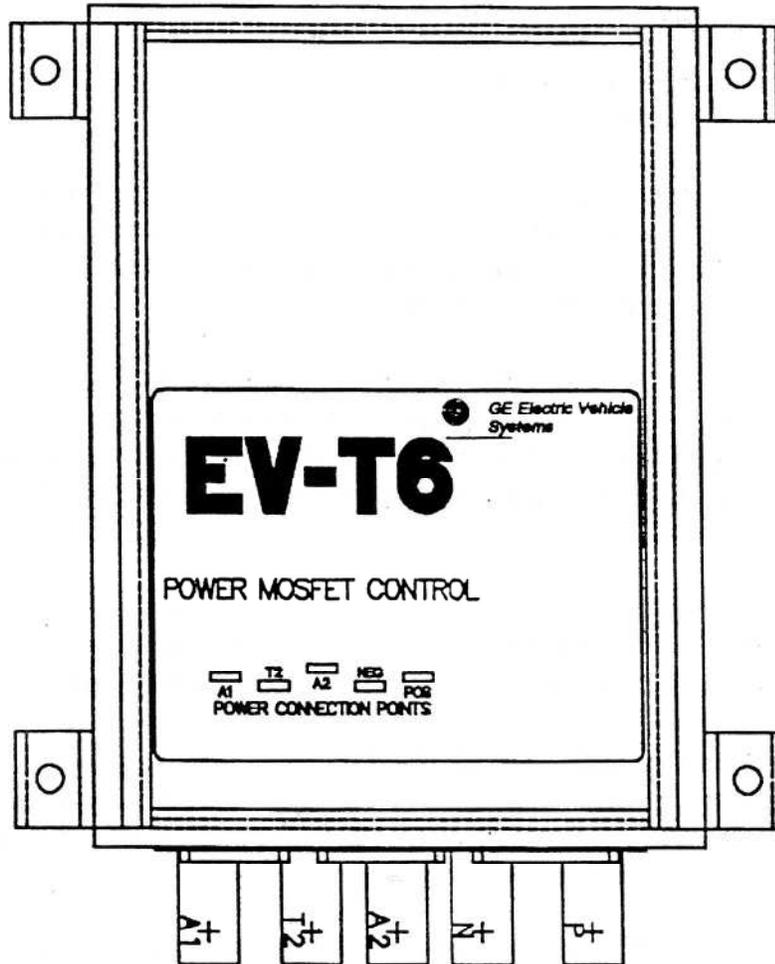
Before proceeding, visually check for loose wiring, misaligned linkage to the accelerator switch, signs of overheating of components, etc.

Tools and test equipment required are: clip leads, volt-ohm meter (20,000 ohms per volt) and general hand tools.



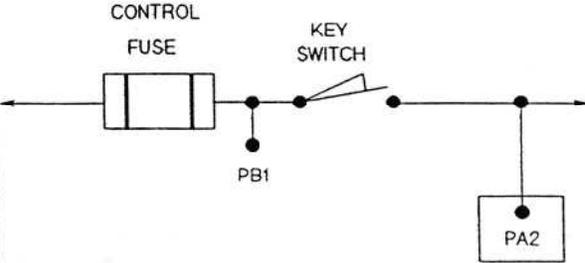
GE Electric Vehicle
Systems

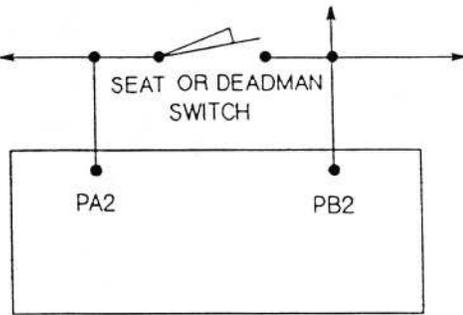
INSTRUCTIONS STATUS CODES



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

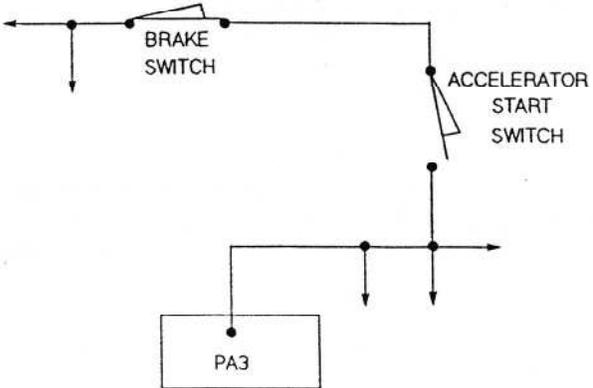
Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purpose, the matter should be referred to the vehicle manufacturer through his normal service channels, not directly to the General Electric Company.

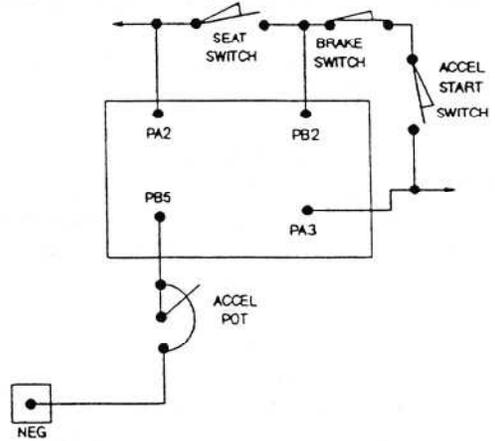
STATUS CODE BLANK DISPLAY	DESCRIPTION	MEMORY RECALL	No
	Segments do not illuminate on Dash Display or Handset		CONTROL TYPE
<p>SYMPTOM Display screen on Dash Display or Handset is blank.</p> <p>POSSIBLE CAUSE Positive or negative control voltage is missing.</p> <ul style="list-style-type: none"> · Insure that the key switch is closed and voltage is present between PB1 and control negative (Power Terminal "N"), and that voltage is present between PA2 and control negative. <p>Open circuit between logic card plug "C" and Dash Display or Handset.</p> <ul style="list-style-type: none"> · Check for a loose connection or open wire between logic card plug "C" and Dash Display or Handset. <p>Defective Dash Display or Handset</p> <ul style="list-style-type: none"> · Replace Dash Display or Handset. 		 <p style="text-align: center;">Figure 1</p> <p>STATUS INDICATION CRITERIA This indicates a lack of input voltage to the logic card and/or display unit.</p>	

STATUS CODE -01	DESCRIPTION	MEMORY RECALL	No
	No seat/deadman switch input.		CONTROL TYPE
<p>SYMPTOM Forward or Reverse contactor will not close.</p> <p>POSSIBLE CAUSE Mis-adjusted or defective seat/deadman switch.</p> <ul style="list-style-type: none"> · Check seat/deadman switch to insure proper closure. <p>Open circuit between battery positive and PB2.</p> <ul style="list-style-type: none"> · Check for loose connections or broken wires between seat/deadman switch and PB2, and between key switch and the positive side of seat/deadman switch, and between seat/deadman switch and PA2. · On vehicles without a seat/deadman switch, check for loose connection or broken wire from PA2 to PB2. 		 <p style="text-align: center;">Figure 1</p> <p>STATUS INDICATION CRITERIA This status code will be displayed when PB2 is less than 50% battery volts.</p>	

STATUS CODE -02	DESCRIPTION	MEMORY RECALL	No
	Forward directional switch is closed on initial power up.		CONTROL TYPE
<p>SYMPTOM Forward contactor will not close because of Static Return to Off (SRO) lock out.</p> <p>POSSIBLE CAUSE Forward directional switch is closed on initial start up (i.e. closure of battery, key switch or seat/deadman switch).</p> <ul style="list-style-type: none"> Return directional switch lever to neutral and then return lever to forward position. <p>Forward directional switch is welded closed or mis-adjusted to be held closed.</p> <ul style="list-style-type: none"> Replace or adjust directional switch to insure that it opens when the directional switch is returned to neutral. <p>Short circuit between PA3 and PB3.</p> <ul style="list-style-type: none"> Disconnect the wire from PB3 and check for a short circuit between PA3 and the wire. <p>Defective logic card.</p> <ul style="list-style-type: none"> Replace the logic card. 		<p style="text-align: center;">Figure 1</p>	
		<p>STATUS INDICATION CRITERIA This status code will be displayed when PB3 is greater than 60% of battery volts on initial start up.</p>	

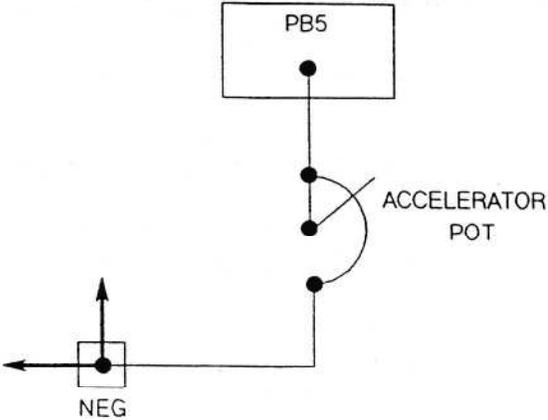
STATUS CODE -03	DESCRIPTION	MEMORY RECALL	No
	Reverse directional switch is closed on initial power up.		CONTROL TYPE
<p>SYMPTOM Reverse contactor will not close because of Static Return to Off (SRO) lock out.</p> <p>POSSIBLE CAUSE Reverse directional switch is closed on initial start up (i.e. closure of battery, key switch or seat/deadman switch).</p> <ul style="list-style-type: none"> Return directional switch lever to neutral and then return lever to reverse position. <p>Reverse directional switch is welded closed or mis-adjusted to be held closed.</p> <ul style="list-style-type: none"> Replace or adjust directional switch to insure that it opens when the directional switch is returned to neutral. <p>Short circuit between PA3 and PB4.</p> <ul style="list-style-type: none"> Disconnect the wire from PB4 and check for a short circuit between PA3 and the wire. <p>Defective logic card.</p> <ul style="list-style-type: none"> Replace the logic card. 		<p style="text-align: center;">Figure 1</p>	
		<p>STATUS INDICATION CRITERIA This status code will be displayed when PB4 is greater than 60% of battery volts on initial start up.</p>	

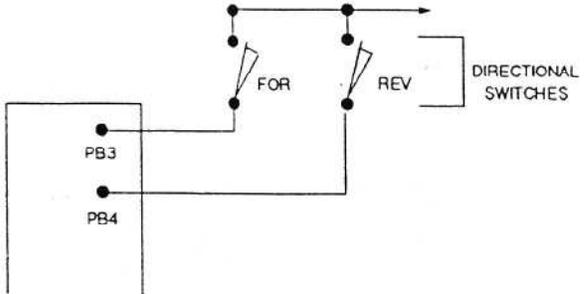
STATUS CODE	DESCRIPTION	MEMORY RECALL	No
		-04	Start switch input low after initial start up
<p>SYMPTOM</p> <p>Forward or reverse contactor will not pick-up.</p> <p>POSSIBLE CAUSE</p> <p>Forward or reverse directional switch closed on initial start up.</p> <p>Depress accelerator to close start switch. Status code will change to 03 if reverse directional switch or to 02 if forward directional switch is closed. If either of these codes appear, return directional switch to neutral and then select the desired direction.</p> <p>Excessive leakage from PA3 to battery negative.</p> <p>Check voltage at PA3 with key and seat (deadman) switches closed and directional switch in neutral. Voltage should be greater than 60% of battery voltage.</p> <p>If less than 60% battery voltage. Remove wire and measure ohmic value from wire to SCR negative. Value should be less than 22k ohms.</p>		 <p style="text-align: center;">Figure 1</p> <p>STATUS INDICATION CRITERIA</p> <p>This status code is displayed when PA3 voltage is less than 60% of battery volts at initial start-up (seat switch closure).</p>	

STATUS CODE	DESCRIPTION	MEMORY RECALL	No
		-05	Start switch or brake switch fails to close.
<p>SYMPTOM</p> <p>Forward or reverse contactor will not pick up.</p> <p>POSSIBLE CAUSE</p> <p>Defective brake switch circuit.</p> <p>Check brake switch to insure closure with brake pedal released.</p> <p>Check for open circuit or loose connections in wiring from brake switch to seat switch and PB2, and from brake switch to start switch.</p> <p>Defective start switch circuit.</p> <p>Check start switch to insure closure when accelerator is depressed.</p> <p>Check for open circuit or loose connections in wiring from brake switch to start switch and from PA3 to start switch.</p>		 <p style="text-align: center;">Figure 1</p> <p>STATUS INDICATION CRITERIA</p> <p>This status code is when PB5 is less than 2.5 volts and PA3 is less than 60% battery volts.</p>	

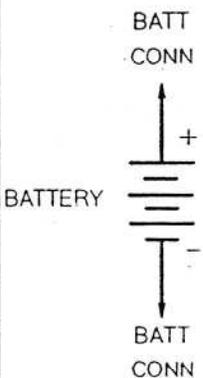
STATUS CODE	DESCRIPTION	MEMORY RECALL	No
	-06	Accelerator depressed with no direction selected.	CONTROL TYPE
<p>SYMPTOM Forward or reverse contactor will not pick up.</p> <p>POSSIBLE CAUSE Accelerator pedal is depressed before closing forward or reverse directional switch. Status code will disappear when directional switch is closed or when accelerator pedal is released.</p> <p>Defective directional switch Check forward or reverse switch to insure closure when direction is selected.</p> <p>Open circuit between directional switch(s) and battery positive or between directional switch(s) and PB3 or PB4. Check all control wires and connections shown in Figure 1.</p>		<p>Figure 1</p>	
		<p>STATUS INDICATION CRITERIA This status code will be displayed when PB3 and PB4 are less than 60% of the battery volts, and PB5 is less than 2.5 volts.</p>	

STATUS CODE	DESCRIPTION	MEMORY RECALL	No
	-07	Accelerator input voltage too high.	CONTROL TYPE
<p>SYMPTOM Forward or reverse contactor picks up but control will not operate when accelerator pedal is depressed or status code -07 is displayed then disappears when the vehicle starts to accelerate.</p> <p>POSSIBLE CAUSE Accelerator input mis-adjusted or defective. Input voltage at PB5 should be less than 3.7 volts. Adjust or replace accelerator unit to insure that the voltage at PB5 will vary from 3.5 volts to less than .5 volts when the pedal is depressed.</p> <p>Open circuit between battery negative and PB5 in accelerator input circuit. Check for broken wires or loose connections or open potentiometer / voltage supply in the circuit shown in Figure 1.</p> <p>Short circuit from battery positive to wiring in accelerator input circuit. Disconnect wire from PB5 and measure voltage at wire to negative. Should be zero volts for potentiometer type and less than 3.7 volts for solid state type accelerator input.</p>		<p>Figure 1</p>	
		<p>STATUS INDICATION CRITERIA This status code will be displayed when the accelerator input voltage at PB5 is higher than 3.7 volts, and a directional contactor is picked up.</p>	

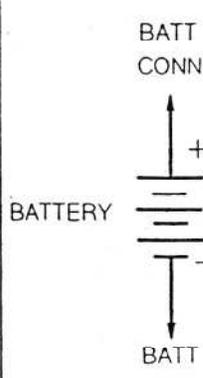
STATUS CODE -08	DESCRIPTION	MEMORY RECALL	No
	Accelerator input voltage too low on power up after initial key switch closure.		CONTROL TYPE
<p>SYMPTOM Forward or reverse contactor does not pick up.</p> <p>POSSIBLE CAUSE Accelerator input mis-adjusted or defective. Input voltage at PB5 should be more than 3.0 volts. Adjust or replace accelerator unit to insure that the voltage at PB5 is more than 3.0 volts before depressing pedal.</p> <p>Short circuit between battery negative and PB5 in accelerator input circuit. Disconnect wire from PB5. Check for short circuit from wire to battery negative. Resistance should be greater than 4.7K ohms.</p> <p>Defective Card Disconnect wire from PB5. Measure voltage from PB5 to negative. Voltage should be greater than 4.5 volts, if not, replace card.</p>		 <p>Figure 1</p> <p>STATUS INDICATION CRITERIA This status code will be displayed when the accelerator input voltage at PB5 is less than 3.0 volts, and any of the following connections are opened and closed, battery plug or seat switch or key switch.</p>	

STATUS CODE -09	DESCRIPTION	MEMORY RECALL	No
	Both forward and reverse directional switches are closed at the same time.		CONTROL TYPE
<p>SYMPTOM Forward or reverse contactor will not pick up.</p> <p>POSSIBLE CAUSE Forward or reverse directional switch welded closed or mis-adjusted to be held closed. Replace or adjust directional switches to insure that they open when directional switch is returned to neutral.</p> <p>Short circuit between battery positive and PB3 and/or PB4. Disconnect wires from PB3 and PB4 and check wire for short circuit to positive side of directional switch.</p> <p>Defective card Disconnect wires and measure voltage at PB3 and PB4. Voltage should be less than 60% of battery volts.</p>		 <p>Figure 1</p> <p>STATUS INDICATION CRITERIA This status code will be displayed when PB3 and PB4 are greater than 60% of battery volts at the same time.</p>	

STATUS CODE -15	DESCRIPTION	MEMORY RECALL	No
	Battery volts too low.		CONTROL TYPE

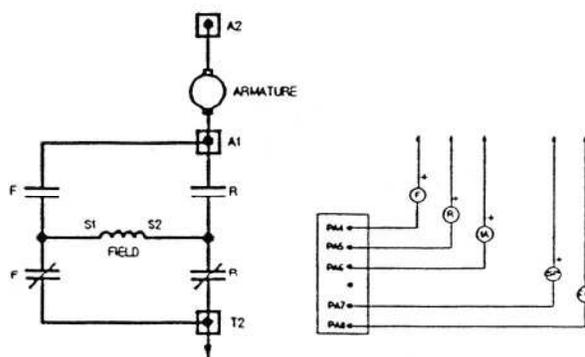
<p>SYMPTOM Forward or reverse contactor will not pick up.</p> <p>POSSIBLE CAUSE</p> <p>Discharged battery Check battery for proper open circuit voltage as outlined in figure 1 and charge battery if required.</p> <p>Defective battery Check each battery cell for proper voltage (greater than 1.95 volts at cell). Replace or repair battery.</p> <p>Incorrect control card adjustment. Check function 15 for proper adjustment for battery being used. See handset instruction sheet for details. Adjust to proper settings.</p>	 <table border="1" data-bbox="1136 336 1429 693"> <thead> <tr> <th colspan="2">TABLE A</th> </tr> <tr> <th>NOMINAL BATTERY VOLTS</th> <th>MINIMUM LIMIT VOLTS @ 1.95</th> </tr> </thead> <tbody> <tr> <td>24</td> <td>23.4</td> </tr> <tr> <td>36</td> <td>35.1</td> </tr> <tr> <td>48</td> <td>46.8</td> </tr> <tr> <td>72</td> <td>70.2</td> </tr> <tr> <td>80</td> <td>78.0</td> </tr> </tbody> </table> <p style="text-align: center;">Figure 1</p>	TABLE A		NOMINAL BATTERY VOLTS	MINIMUM LIMIT VOLTS @ 1.95	24	23.4	36	35.1	48	46.8	72	70.2	80	78.0
TABLE A															
NOMINAL BATTERY VOLTS	MINIMUM LIMIT VOLTS @ 1.95														
24	23.4														
36	35.1														
48	46.8														
72	70.2														
80	78.0														
<p>STATUS INDICATION CRITERIA This status code is displayed when the battery volts are less than 1.95 volts per cell at initial start up. (See table in figure 1).</p>															

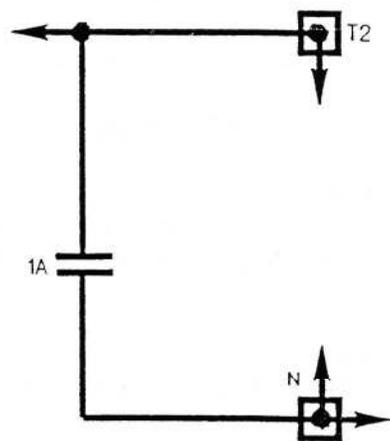
STATUS CODE -16	DESCRIPTION	MEMORY RECALL	No
	Battery volts too high.		CONTROL TYPE

<p>SYMPTOM Forward and reverse contactor will not pick up.</p> <p>POSSIBLE CAUSE</p> <p>Incorrect control card adjustment Check function 15 for proper adjustment for battery being used. See handset instructions for details. Adjust to proper setting.</p> <p>Battery over charged or incorrect battery used. Check battery for proper open circuit voltage per table in figure 1. If voltage excessive-check battery charger for proper output voltage.</p>	 <table border="1" data-bbox="1136 1281 1429 1638"> <thead> <tr> <th colspan="2">TABLE A</th> </tr> <tr> <th>NOMINAL BATTERY VOLTS</th> <th>MAXIMUM LIMIT VOLTS @ 2.40</th> </tr> </thead> <tbody> <tr> <td>24</td> <td>28.8</td> </tr> <tr> <td>36</td> <td>43.2</td> </tr> <tr> <td>48</td> <td>57.6</td> </tr> <tr> <td>72</td> <td>86.4</td> </tr> <tr> <td>80</td> <td>96.0</td> </tr> </tbody> </table> <p style="text-align: center;">Figure 1</p>	TABLE A		NOMINAL BATTERY VOLTS	MAXIMUM LIMIT VOLTS @ 2.40	24	28.8	36	43.2	48	57.6	72	86.4	80	96.0
TABLE A															
NOMINAL BATTERY VOLTS	MAXIMUM LIMIT VOLTS @ 2.40														
24	28.8														
36	43.2														
48	57.6														
72	86.4														
80	96.0														
<p>STATUS INDICATION CRITERIA This status code is displayed when the battery volts are greater than 2.40 volts per cell at initial start up. (See table in figure 1.)</p>															

STATUS CODE	DESCRIPTION	MEMORY RECALL	No
	-17	Invalid card type selection.	CONTROL TYPE
<p align="center">SYMPTOM</p> <p>Forward or reverse contactors will not close.</p> <p align="center">POSSIBLE CAUSE</p> <p>Invalid card type selection. Review function 17 in the Handset Instruction sheets. Adjust and set card type value as instructed by OEM service manual.</p>		<p align="center">Figure 1</p> <p align="center">STATUS INDICATION CRITERIA</p> <p>This status code is displayed when the card type selection value is set to an invalid number.</p>	

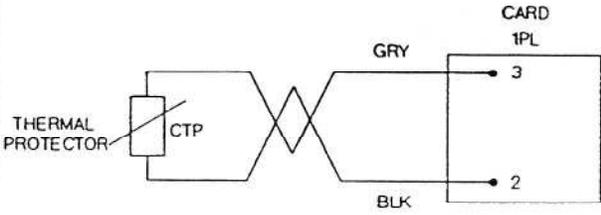
STATUS CODE	DESCRIPTION	MEMORY RECALL	No
	-23	Forward and reverse contactor coil current low.	CONTROL TYPE
<p align="center">SYMPTOM</p> <p>Forward or reverse contactor will not pick up. Status code may alternate between code 23 and code 24. Complete check for code 23, if the problem is not found, perform check for code 24.</p> <p align="center">POSSIBLE CAUSE</p> <p>Defective F and R contactor coil circuit. Check for open circuit or loose connection between PA4 and positive side of F contactor coil and between PA5 and positive side of R contactor coil.</p> <p>Remove plug A. Check ohmic value from PA4 to positive side of F coil. Value should be 10-14 ohms. Make same check for R coil.</p> <p>Defective 1A, SP, or FW contactor coil. Remove plug A. Check ohmic value from positive side of each coil to its respective plug connection. Value should be 10-14 ohms.</p>		<p align="center">Figure 1</p> <p align="center">STATUS INDICATION CRITERIA</p> <p>This status code is displayed when the current draw in the forward or reverse contactor coil circuit is less than 100 ma.</p>	

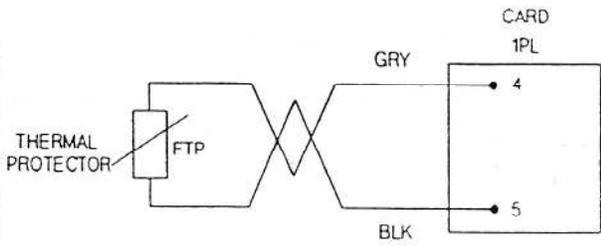
STATUS CODE -24	DESCRIPTION	MEMORY RECALL	No
		T2 voltage low. (Less than 88% battery volts.)	CONTROL TYPE
<p>SYMPTOM Control does not operate. Status code may alternate between code 23 and code 24. Complete checks for 24, if the problem is not found, perform code 23 check.</p> <p>POSSIBLE CAUSE Defective F or R contactor. F or R power tips fail to close because: 1) Welded normally closed power tips. 2) Binding contactor tip assembly. 3) Defective F or R contactor coil. (See status code 23)</p> <p>Open motor circuit Check for open circuit or loose connection in motor circuit from the A1 connection to the A2 connection on the control panel.</p> <p>Defective 1A, SP or FW contactor Perform checks as outlined in status 23.</p>		 <p style="text-align: center;">Figure 1</p> <p>STATUS INDICATION CRITERIA This status code is displayed when T2 volts is less than 88% of battery volts and the F and R driver is energized.</p>	

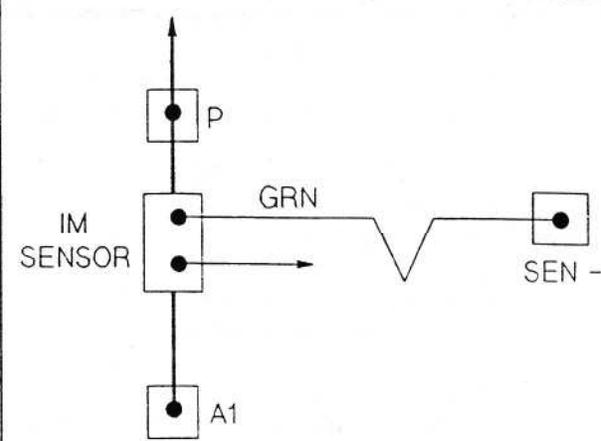
STATUS CODE -25	DESCRIPTION	MEMORY RECALL	Yes
		1A contactor does not drop out or drops out slowly.	CONTROL TYPE
<p>SYMPTOM Short tip life on F and R or 1A contactor. Status code 46 displayed and no fault found.</p> <p>POSSIBLE CAUSE Note: This status code can only be found by using the handset and looking at function 1. This status code is furnished as a troubleshooting aid for status code 46.</p> <p>Defective 1A contactor Check 1A contactor for binding or slow operation when dropping out.</p>		 <p style="text-align: center;">Figure 1</p> <p>STATUS INDICATION CRITERIA This status code is displayed when 1A contactor drop out time exceeds .060 seconds.</p>	

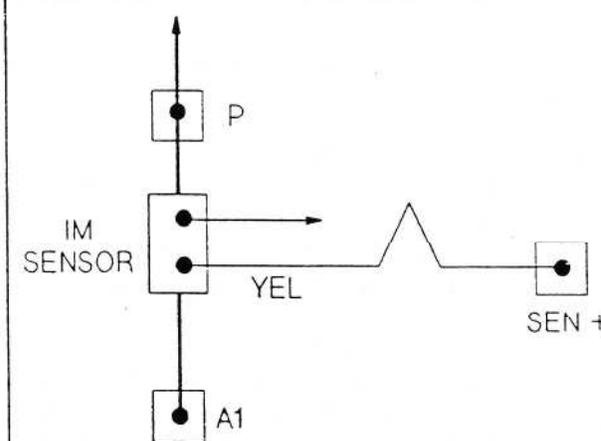
STATUS CODE -26	DESCRIPTION	MEMORY RECALL	No
	Shorted coil driver for SP or FW contactor.		CONTROL TYPE
<p>SYMPTOM SP or FW contactor picks up immediately when key switch is closed.</p> <p>POSSIBLE CAUSE Defective coil driver internal to logic card. Replace logic card.</p>		<p style="text-align: center;">Figure 1</p>	
		<p>STATUS INDICATION CRITERIA This status code is displayed when there is a shorted RB, SP or FW coil driver.</p>	

STATUS CODE -27	DESCRIPTION	MEMORY RECALL	Yes
	Logic card power supply is less than 10 VDC.		CONTROL TYPE
<p>SYMPTOM Forward or reverse contactors open and close, then can only be closed by opening and closing the key switch.</p> <p>POSSIBLE CAUSE</p> <p>Discharged Battery Check battery to insure proper state of charge. Voltage may be dropping below 10 VDC under load.</p> <p>Loose connection at PB1. Insure that the wire connection at PB1 is tight.</p> <p>Defective logic card Replace logic card.</p>		<p style="text-align: center;">Figure 1</p>	
		<p>STATUS INDICATION CRITERIA This status code is displayed when the logic card power supply is less than 10 volts.</p>	

STATUS CODE -40	DESCRIPTION	MEMORY RECALL	Yes
	Open thermal protector (CTP) or capacitor over temperature.	CONTROL TYPE	Traction
<p>SYMPTOM Forward or reverse contactors open and close, then can only be closed by opening and closing the key switch.</p> <p>POSSIBLE CAUSE Open thermal protector circuit. Check for loose connection or broken wire between: Black wire-Thermal proctor and IPL-2 Gray wire-Thermal proctor and IPL-3.</p> <p>Defective thermal protector. Disconnect wires from IPL-2 and IPL-5. At room temperature (25°C or 75°F) measure resistance between black and gray wire. Replace CTP if ohmic value is greater than 300 ohms.</p> <p>Control is in thermal cut-back. Allow control to cool, status code should disappear.</p>		 <p style="text-align: center;">Figure 1</p> <p>STATUS INDICATION CRITERIA This status code is displayed when the voltage between IPL-2 and IPL-3 is greater than 1.8 volts.</p>	

STATUS CODE -41	DESCRIPTION	MEMORY RECALL	No
	Open thermal protector (FTP) or transistor over temperature.	CONTROL TYPE	Traction
<p>SYMPTOM Reduced or no power to traction motor in control range.</p> <p>POSSIBLE CAUSE Open thermal protector circuit. Check for loose connection or broken wire between: Black wire-Thermal proctor and IPL-5 Gray wire-Thermal proctor and IPL-4.</p> <p>Defective thermal protector. Disconnect wires from IPL-4 and IPL-5. At room temperature (25°C or 75°F) measure resistance between black and gray wire. Replace CTP if ohmic value is greater than 300 ohms.</p> <p>Control is in thermal cut-back. Allow control to cool, status code should disappear.</p>		 <p style="text-align: center;">Figure 1</p> <p>STATUS INDICATION CRITERIA This status code is displayed when the voltage between IPL-4 and IPL-5 is greater than 1.8 volts.</p>	

STATUS CODE	DESCRIPTION	MEMORY RECALL	No
		-42	Control motor current sensor input missing.
<p>SYMPTOM No power to traction motor in control range.</p> <p>POSSIBLE CAUSE Open sensor wire circuit to SEN - Check for loose connection or broken wire (green wire) from current sensor to SEN - on the logic card.</p>		 <p style="text-align: center;">Figure 1</p>	
		<p>STATUS INDICATION CRITERIA This status code is displayed when voltage between TP6 and negative is greater than 1.6 volts with no current flowing in the motor circuit.</p>	

STATUS CODE	DESCRIPTION	MEMORY RECALL	No
		-43	Control motor current sensor input missing.
<p>SYMPTOM No power to traction motor in control range.</p> <p>POSSIBLE CAUSE Open sensor wire circuit to SEN +. Check for loose connection or broken wire (green wire) from current sensor to SEN + on the logic card.</p>		 <p style="text-align: center;">Figure 1</p>	
		<p>STATUS INDICATION CRITERIA This status code is displayed when voltage between TP6 and negative is less than .84 volts with no current flowing in the motor circuit.</p>	

STATUS CODE	DESCRIPTION	MEMORY RECALL	Yes
		CONTROL TYPE	Traction
-44	Transistor did not turn off properly.		
<p>SYMPTOM Forward or reverse contactors open and close, then can only be closed by opening and closing the key switch.</p> <p>POSSIBLE CAUSE Transistor defective. Turn off time for transistor is out of specification. No field test is possible. Replace transistor.</p> <p>Check for open circuit or loose connections between the transistor and IPL-8. (RED wire)</p>		<p>Figure 1</p>	
		<p>STATUS INDICATION CRITERIA This status code is displayed when, during control operation, the transistor fails to turn off.</p>	

STATUS CODE	DESCRIPTION	MEMORY RECALL	Yes
		CONTROL TYPE	Traction
-45	Transistor did not turn on properly.		
<p>SYMPTOM Forward or reverse contactor will open and close, then open and then can only be closed by opening and closing the key switch.</p> <p>POSSIBLE CAUSE Defective transistor circuit. Check for open circuit or loose connections between the transistor and IPL-8. (RED wire)</p> <p>Check for open circuit or loose connection between T2 and IPL-9. (WHT/GRN wire)</p> <p>Defective transistor. Intermittent or open transistor gate. Field test may or may not show defect. Replace transistor after above checks, show no problem found.</p>		<p>Figure 1</p>	
		<p>STATUS INDICATION CRITERIA This status code is displayed when the transistor fails to gate on.</p>	

STATUS CODE -44	DESCRIPTION	MEMORY RECALL	Yes
	Transistor did not turn off properly.	CONTROL TYPE	Traction

SYMPTOM
Forward or reverse contactors open and close, then can only be closed by opening and closing the key switch.

POSSIBLE CAUSE

Transistor defective.
Turn off time for transistor is out of specification.
No field test is possible. Replace transistor.

Check for open circuit or loose connections between the transistor and IPL-8. (RED wire)

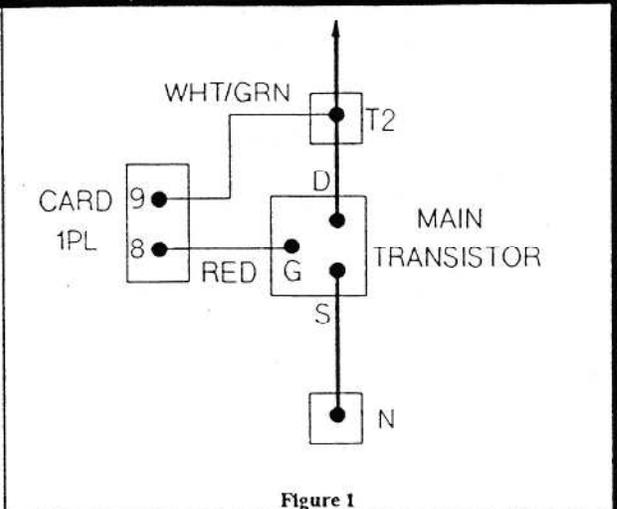


Figure 1

STATUS INDICATION CRITERIA
This status code is displayed when, during control operation, the transistor fails to turn off.

STATUS CODE -45	DESCRIPTION	MEMORY RECALL	Yes
	Transistor did not turn on properly.	CONTROL TYPE	Traction

SYMPTOM
Forward or reverse contactor will open and close, then open and then can only be closed by opening and closing the key switch.

POSSIBLE CAUSE

Defective transistor circuit.
Check for open circuit or loose connections between the transistor and IPL-8. (RED wire)

Check for open circuit or loose connection between T2 and IPL-9. (WHT/GRN wire)

Defective transistor.
Intermittent or open transistor gate. Field test may or may not show defect. Replace transistor after above checks, show no problem found.

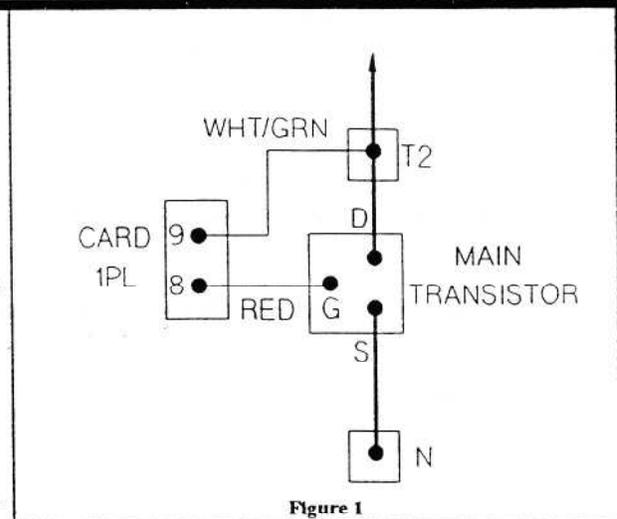
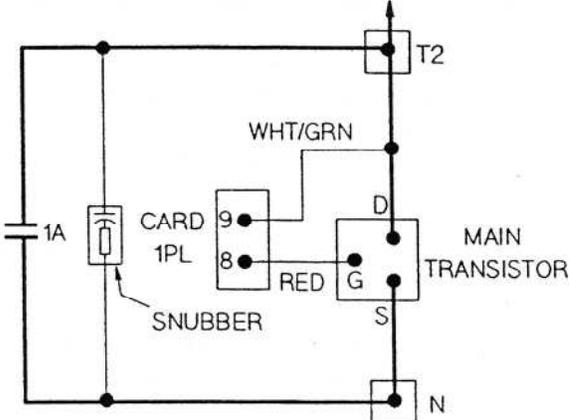
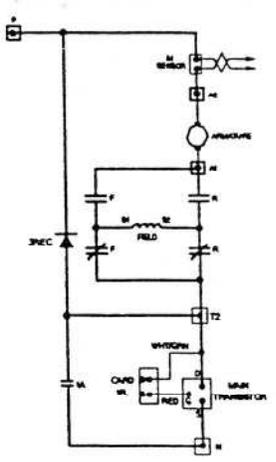
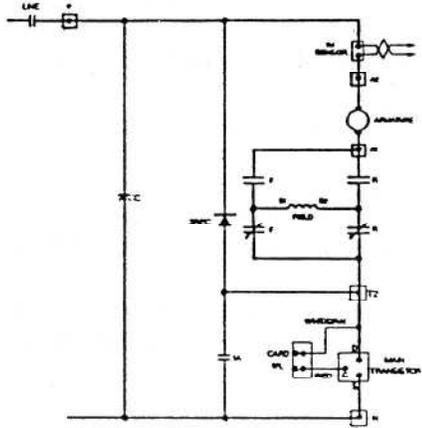


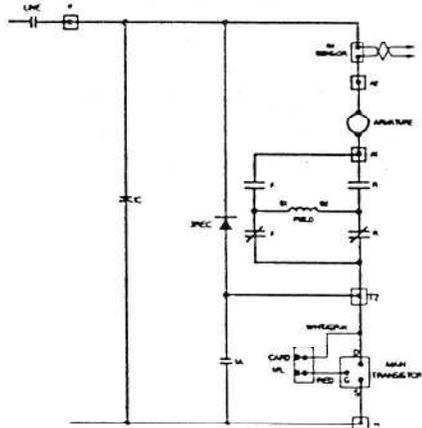
Figure 1

STATUS INDICATION CRITERIA
This status code is displayed when the transistor fails to gate on.

STATUS CODE	DESCRIPTION	MEMORY RECALL	No
		CONTROL TYPE	Traction
-46	Look ahead test for T2 volts. (Less than 12% of battery volts)		
<p>SYMPTOM Forward or reverse contactor will not pick up.</p> <p>POSSIBLE CAUSE Defective transistor. Check for shorted transistor.</p> <p>Defective 1A contactor. Check for welded 1A contactor power tips.</p> <p>Defective Snubber. Check for shorted snubber.</p>		 <p style="text-align: center;">Figure 1</p> <p>STATUS INDICATION CRITERIA This status code is displayed when the voltage at T2 is less than 12% of battery volts.</p>	

STATUS CODE	DESCRIPTION	MEMORY RECALL	No
		CONTROL TYPE	Traction
-48	Look ahead test for T2 volts. (Greater than 88% of battery volts)		
<p>SYMPTOM Forward or reverse contactor will not pick up.</p> <p>POSSIBLE CAUSE Defective forward or reverse contactor. Check for welded forward or reverse contactor power tips.</p> <p>Check for sluggish operation of forward or reverse contactor.</p> <p>Defective 3 REC circuit. Check for shorted 3 REC.</p>		 <p style="text-align: center;">Figure 1</p> <p>STATUS INDICATION CRITERIA This status code is displayed when the voltage at T2 is greater than 88% of battery volts.</p>	

STATUS CODE	DESCRIPTION	MEMORY RECALL	No
	-50	Capacitor volts low after line contactor closes.	CONTROL TYPE
<p>SYMPTOM</p> <p>Forward or reverse contactor picks up. Control does not operate.</p> <p>POSSIBLE CAUSE</p> <p>Defective Line contactor. Check for open line contactor power tips.</p> <p>Check for loose or open connections in cables from battery positive to control positive circuit.</p> <p>Defective Power fuse. Check power fuse for open circuit.</p>		 <p>Figure 1</p>	
		<p>STATUS INDICATION CRITERIA</p> <p>This status code is displayed when capacitor volts less than 85% of battery volts at initial start up.</p>	

STATUS CODE	DESCRIPTION	MEMORY RECALL	No
	-51	Capacitor volts low before line contactor closes. (Precharge)	CONTROL TYPE
<p>SYMPTOM</p> <p>Line contactor does not close.</p> <p>POSSIBLE CAUSE</p> <p>Defective capacitor. Check capacitor bank per component checking section.</p> <p>Check for loose or open connections in capacitor circuit.</p> <p>Defective control fuse. Check control fuse for open circuit.</p> <p>Defective logic card Replace logic card.</p>		 <p>Figure 1</p>	
		<p>STATUS INDICATION CRITERIA</p> <p>This status code is displayed when capacitor volts less than 85% of battery volts at initial start up.</p>	

STATUS CODE -53	DESCRIPTION	MEMORY RECALL	Ycs
	Transistor fails to turn off during plugging.	CONTROL TYPE	Traction

SYMPTOM
Forward or reverse contactors open and close, then can only be closed by opening and closing the key switch.

POSSIBLE CAUSE
Transistor defective.
Turn off time for transistor is out of specification.
No field test is possible. Replace transistor.

Check for open circuit or loose connections between the transistor and 1PL-8. (RED wire)

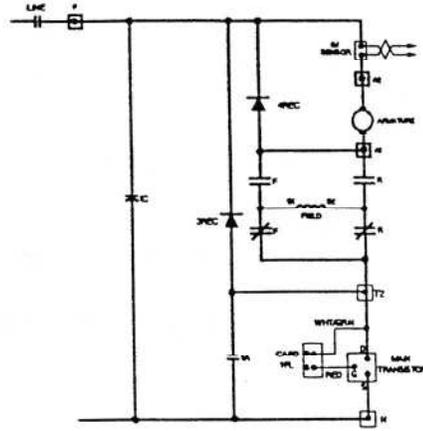


Figure 1

STATUS INDICATION CRITERIA
This status code is displayed when the transistor fails to turn off during plugging.

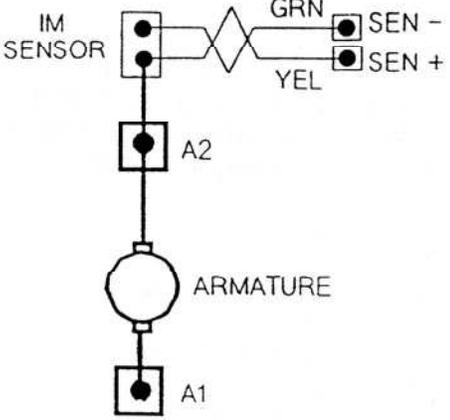
STATUS CODE -54	DESCRIPTION	MEMORY RECALL	No
	Shorted F, R or 1A contactor coil driver.	CONTROL TYPE	Traction

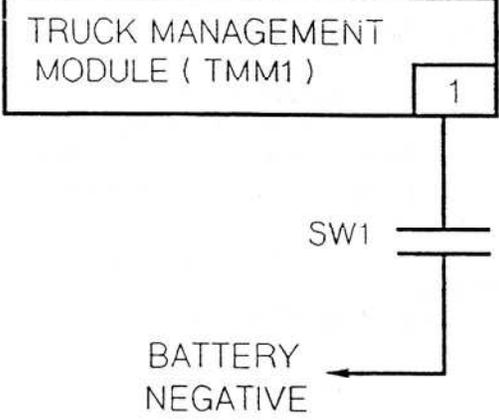
SYMPTOM
Control will not operate.

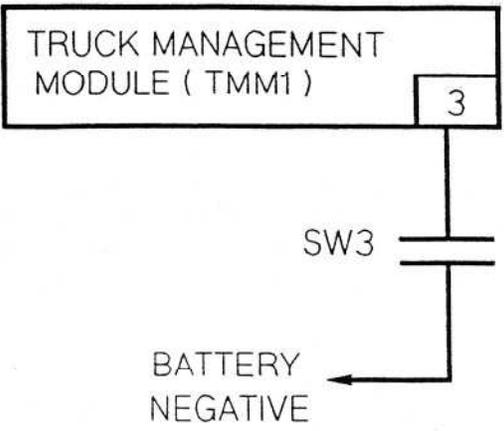
POSSIBLE CAUSE
Defective logic card.
Replace logic card.

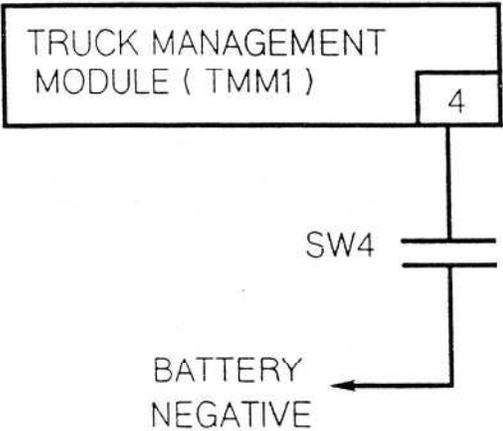
Figure 1

STATUS INDICATION CRITERIA
This status code is displayed when either the forward, reverse or 1A contactor coil driver is shorted internal to the logic card.

STATUS CODE -57	DESCRIPTION	MEMORY RECALL	No
	Current sensor input voltage polarity check.		CONTROL TYPE
<p>SYMPTOM Forward or reverse contactors open and close, then can only be closed by opening and closing the key switch.</p> <p>POSSIBLE CAUSE Reversed yellow and green current sensors wires. Insure that the green wire connects to SEN - with no open circuits and that the yellow wire connects to SEN + with no open circuits or loose connections.</p> <p>Reversed power cable connection. Insure that the battery positive cable connects to control P and the motor A2 cable connects to control A2.</p>		 <p style="text-align: center;">Figure 1</p>	
		<p>STATUS INDICATION CRITERIA This status code is displayed when the voltage input to SEN + and SEN - is the wrong polarity.</p>	

STATUS CODE -90	DESCRIPTION	MEMORY RECALL	No
	User defined staus code - see OEM instructions manual.		CONTROL TYPE
<p>SYMPTOM Status code flashes on and off.</p> <p>POSSIBLE CAUSE User defined status code is displayed by switch closure or motor brush sensor closure to negative. See OEM instruction manual for corrective action required.</p> <p>Other Causes: Terminal 1 shorted to negative. Defective input switch (shorted). Defective TMM1 card.</p>		 <p style="text-align: center;">Figure 1</p>	
		<p>STATUS INDICATION CRITERIA This status code is displayed when the voltage at terminal 1 of TMM1 is at zero volts.</p>	

STATUS CODE -91	DESCRIPTION	MEMORY RECALL	No
	User defined status code - see OEM instructions manual.		CONTROL TYPE
<p>SYMPTOM Status code flashes on and off.</p> <p>POSSIBLE CAUSE User defined status code is displayed by switch closure or motor brush sensor closure to negative. See OEM instruction manual for corrective action required.</p> <p>Other Causes: Terminal 3 shorted to negative. Defective input switch (shorted). Defective TMM1 card.</p>		 <p style="text-align: center;">Figure 1</p>	
		<p>STATUS INDICATION CRITERIA This status code is displayed when the voltage at terminal 3 of TMM1 is at zero volts.</p>	

STATUS CODE -92	DESCRIPTION	MEMORY RECALL	No
	User defined status code - see OEM instructions manual.		CONTROL TYPE
<p>SYMPTOM Status code flashes on and off.</p> <p>POSSIBLE CAUSE User defined status code is displayed by switch closure or motor brush sensor closure to negative. See OEM instruction manual for corrective action required.</p> <p>Other Causes: Terminal 4 shorted to negative. Defective input switch (shorted). Defective TMM1 card.</p>		 <p style="text-align: center;">Figure 1</p>	
		<p>STATUS INDICATION CRITERIA This status code is displayed when the voltage at terminal 4 of TMM1 is at zero volts.</p>	

STATUS CODE -93	DESCRIPTION	MEMORY RECALL	No
	User defined staus code - see OEM instructions manual.	CONTROL TYPE	Traction

SYMPTOM
Status code flashes on and off.

POSSIBLE CAUSE
User defined status code is displayed by switch closure or motor brush sensor closure to negative. See OEM instruction manual for corrective action required.

Other Causes:
Terminal 5 and 6 shorted to negative.

Defective input switch (shorted).

Defective TMM1 card.

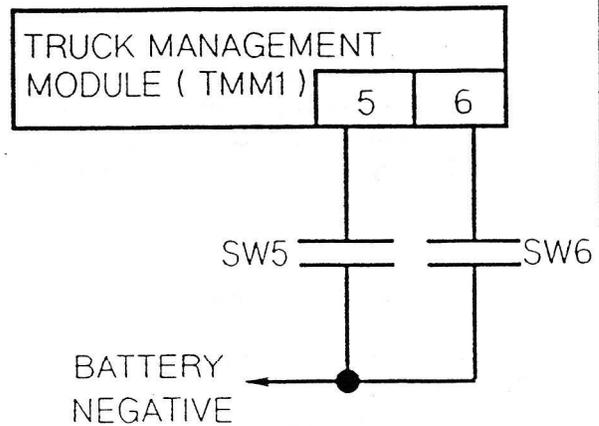


Figure 1

STATUS INDICATION CRITERIA
This status code is displayed when the voltage at terminal 5 and 6 of TMM1 is at zero volts.

STATUS CODE -94	DESCRIPTION	MEMORY RECALL	No
	User defined staus code - see OEM instructions manual.	CONTROL TYPE	Traction

SYMPTOM
Status code flashes on and off.

POSSIBLE CAUSE
User defined status code is displayed by switch closure or motor brush sensor closure to negative. See OEM instruction manual for corrective action required.

Other Causes:
Terminal 8 and 10 shorted to negative.

Defective input switch (shorted).

Defective TMM1 card.

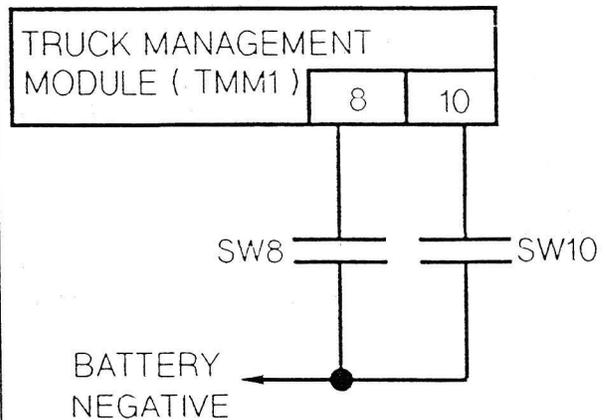
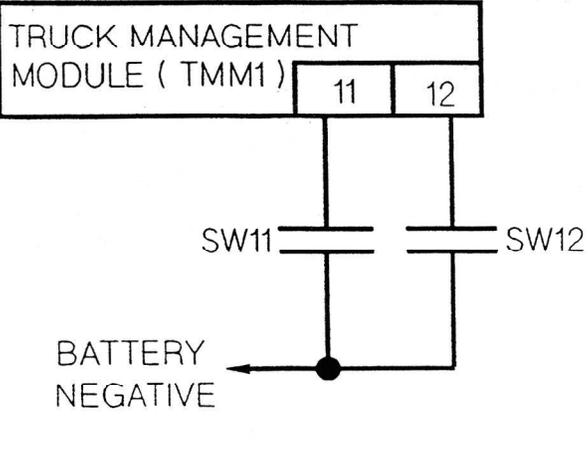
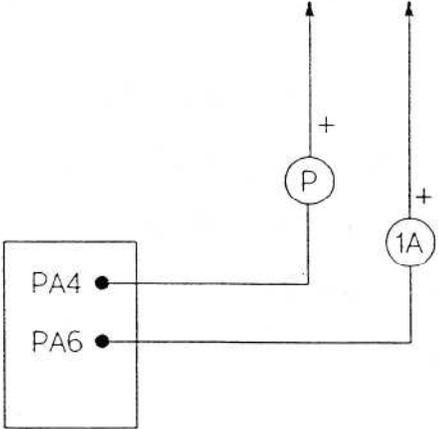


Figure 1

STATUS INDICATION CRITERIA
This status code is displayed when the voltage at terminal 8 and 10 of TMM1 is at zero volts.

STATUS CODE	DESCRIPTION	MEMORY RECALL	No
-95	User defined status code - see OEM instructions manual.	CONTROL TYPE	Traction
		<p style="text-align: center;">SYMPTOM</p> <p>Status code flashes on and off.</p> <p style="text-align: center;">POSSIBLE CAUSE</p> <p>User defined status code is displayed by switch closure or motor brush sensor closure to negative. See OEM instruction manual for corrective action required.</p> <p>Other Causes:</p> <ul style="list-style-type: none"> Terminal 11 and 12 shorted to negative. Defective input switch (shorted). Defective TMM1 card. 	 <p style="text-align: center;">Figure 1</p>
	<p style="text-align: center;">STATUS INDICATION CRITERIA</p> <p>This status code is displayed when the voltage at terminal 11 and 12 of TMM1 is at zero volts.</p>		

STATUS CODE	DESCRIPTION	MEMORY RECALL	No
	-117	Invalid card type selection.	CONTROL TYPE
<p>SYMPTOM Pump contactor will not close.</p> <p>POSSIBLE CAUSE Invalid card type selection. Review function 17 in the Handset Instruction sheets. Adjust and set card type value as instructed by OEM service manual.</p>		<p align="center">Figure 1</p> <p>STATUS INDICATION CRITERIA This status code is displayed when the card type selection value is set to an invalid number.</p>	

STATUS CODE	DESCRIPTION	MEMORY RECALL	No
	-123	Forward and reverse contactor coil current low.	CONTROL TYPE
<p>SYMPTOM Pump contactor will not pick up. Status code may alternate between code 23 and code 24. Complete check for code 23, if the problem is not found, perform check for code 24.</p> <p>POSSIBLE CAUSE Defective Pump contactor coil circuit. Check for open circuit or loose connection between PA4 and positive side of Pump contactor coil. Remove plug A. Check ohmic value from PA4 to positive side of F coil. Value should be 10-14 ohms. Defective 1A contactor coil. Remove plug A. Check ohmic value from positive side of coil to its plug connection. Value should be 10-14 ohms.</p>		 <p align="center">Figure 1</p> <p>STATUS INDICATION CRITERIA This status code is displayed when the current draw in the pump contactor coil circuit is less than 100 ma.</p>	

STATUS CODE	DESCRIPTION	MEMORY RECALL	No
	-124	T2 voltage low. (Less than 88% battery volts.)	CONTROL TYPE

SYMPTOM
Control does not operate. Status code may alternate between code 23 and code 24. Complete checks for 24, if the problem is not found, perform code 23 check.

POSSIBLE CAUSE
Defective Pump contactor.
Pump power tips fail to close because:
1) Welded normally closed power tips.
2) Binding contactor tip assembly.
3) Defective Pump contactor coil.
(See status code 23)

Open motor circuit
Check for open circuit or loose connection in motor circuit from the A1 connection to the A2 connection on the control panel.

Defective 1A contactor.
Perform checks as outlined in status 23.

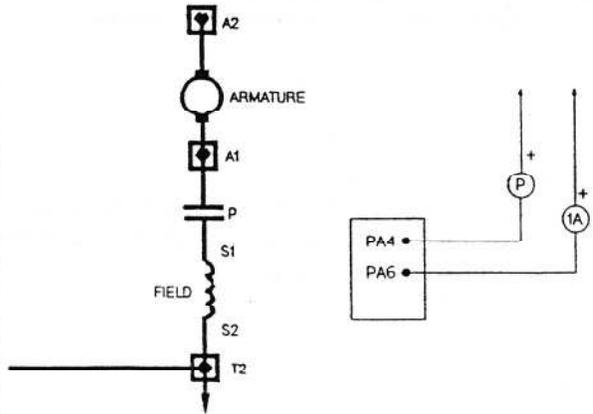


Figure 1

STATUS INDICATION CRITERIA
This status code is displayed when T2 volts is less than 88% of battery volts and the Pump driver is energized.

STATUS CODE	DESCRIPTION	MEMORY RECALL	No
	-125	1A contactor does not drop out or drops out slowly.	CONTROL TYPE

SYMPTOM
Short tip life on Pump or 1A contactor. Status code 46 displayed and no fault found.

POSSIBLE CAUSE
Note: This status code can only be found by using the handset and looking at function 1. This status code is furnished as a troubleshooting aid for status code 46.

Defective 1A contactor
Check 1A contactor for binding or slow operation when dropping out.

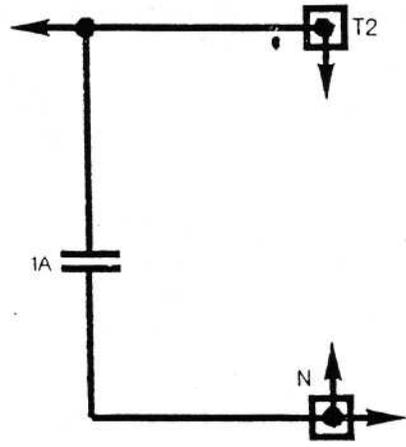
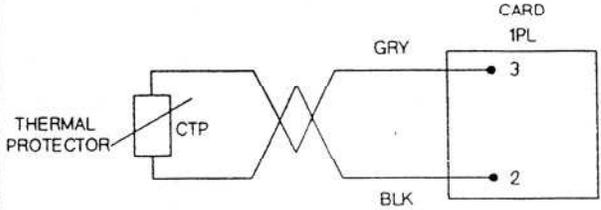
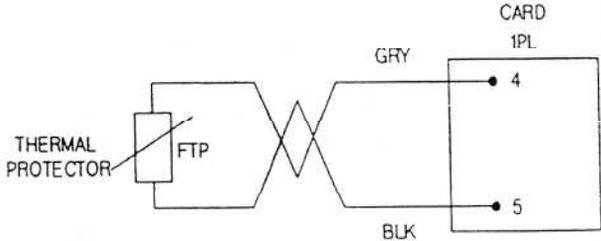


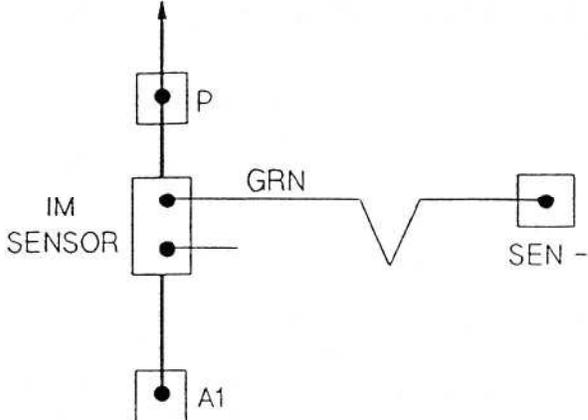
Figure 1

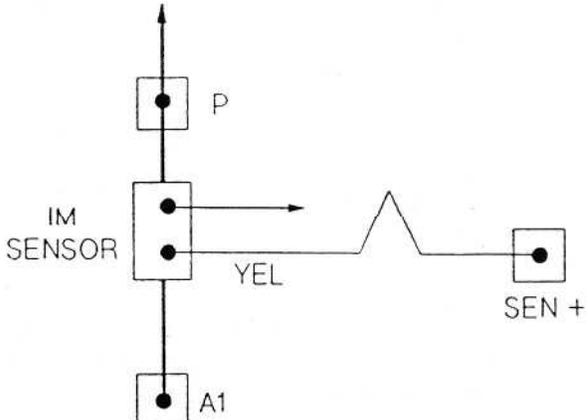
STATUS INDICATION CRITERIA
This status code is displayed when 1A contactor drop out time exceeds .060 seconds.

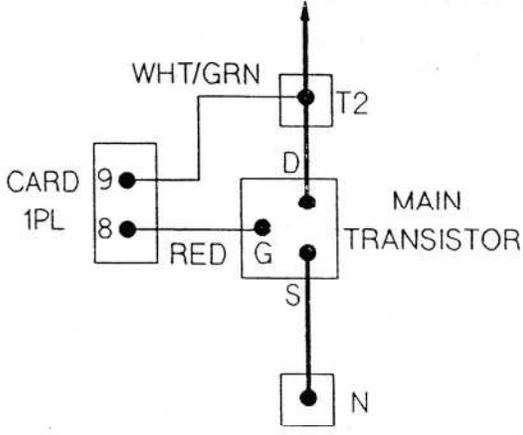
STATUS CODE	DESCRIPTION	MEMORY RECALL	Yes
-127	Logic card power supply is less than 10 VDC.	CONTROL TYPE	Pump
		<p style="text-align: center;">SYMPTOM</p> <p>Pump contactors open and close, then can only be closed by opening and closing the key switch.</p> <p style="text-align: center;">POSSIBLE CAUSE</p> <p>Discharged Battery Check battery to insure proper state of charge.</p> <p>Loose connection at PB1. Insure that the wire connection at PB1 is tight.</p> <p>Defective logic card Replace logic card.</p>	
		<p style="text-align: center;">STATUS INDICATION CRITERIA</p> <p>This status code is displayed when the logic card power supply is less than 10 volts.</p>	

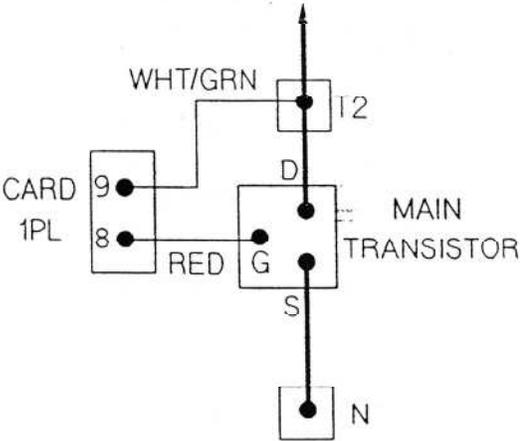
STATUS CODE	DESCRIPTION	MEMORY RECALL	Yes
		-140	Open thermal protector (CTP) or capacitor over temperature.
<p>SYMPTOM</p> <p>Pump contactor open and close, then can only be closed by opening and closing the key switch.</p> <p>POSSIBLE CAUSE</p> <p>Open thermal protector circuit.</p> <p>Check for loose connection or broken wire between:</p> <p>Black wire-Thermal proctor and 1PL-2 Gray wire-Thermal proctor and 1PL-3.</p> <p>Defective thermal protector.</p> <p>Disconnect wires from 1PL-2 and 1PL-5. At room temperature (25°C or 75°F) measure resistance between black and gray wire. Replace CTP if ohmic value is greater than 300 ohms.</p> <p>Control is in thermal cut-back.</p> <p>Allow control to cool, status code should disappear.</p>		 <p style="text-align: center;">Figure 1</p> <p>STATUS INDICATION CRITERIA</p> <p>This status code is displayed when the voltage between 1PL-2 and 1PL-3 is greater than 1.8 volts.</p>	

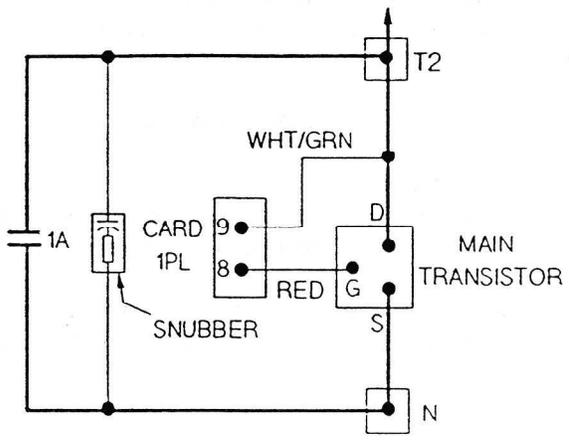
STATUS CODE	DESCRIPTION	MEMORY RECALL	No
		-141	Open thermal protector (FTP) or transistor over temperature.
<p>SYMPTOM</p> <p>Reduced or no power to pump motor in control range.</p> <p>POSSIBLE CAUSE</p> <p>Open thermal protector circuit.</p> <p>Check for loose connection or broken wire between:</p> <p>Black wire-Thermal proctor and 1PL-5 Gray wire-Thermal proctor and 1PL-4.</p> <p>Defective thermal protector.</p> <p>Disconnect wires from 1PL-4 and 1PL-5. At room temperature (25°C or 75°F) measure resistance between black and gray wire. Replace CTP if ohmic value is greater than 300 ohms.</p> <p>Control is in thermal cut-back.</p> <p>Allow control to cool, status code should disappear.</p>		 <p style="text-align: center;">Figure 1</p> <p>STATUS INDICATION CRITERIA</p> <p>This status code is displayed when the voltage between 1PL-4 and 1PL-5 is greater than 1.8 volts.</p>	

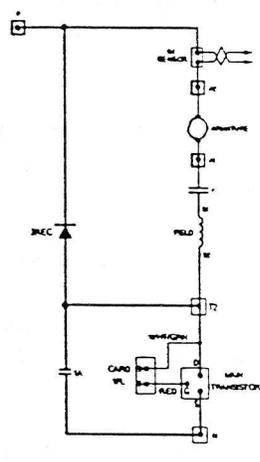
STATUS CODE	DESCRIPTION	MEMORY RECALL	No
	-142	Control motor current sensor input missing.	CONTROL TYPE
<p>SYMPTOM No power to pump motor in control range.</p> <p>POSSIBLE CAUSE Open sensor wire circuit to SEN - . Check for loose connection or broken wire (green wire) from current sensor to SEN - on the logic card.</p>		 <p>Figure 1</p>	
		<p>STATUS INDICATION CRITERIA This status code is displayed when voltage between TP6 and negative is greater than 1.6 volts with no current flowing in the motor circuit.</p>	

STATUS CODE	DESCRIPTION	MEMORY RECALL	No
	-143	Control motor current sensor input missing.	CONTROL TYPE
<p>SYMPTOM No power to pump motor in control range.</p> <p>POSSIBLE CAUSE Open sensor wire circuit to SEN + Check for loose connection or broken wire (green wire) from current sensor to SEN + on the logic card.</p>		 <p>Figure 1</p>	
		<p>STATUS INDICATION CRITERIA This status code is displayed when voltage between TP6 and negative is less than .84 volts with no current flowing in the motor circuit.</p>	

STATUS CODE	DESCRIPTION	MEMORY RECALL	Yes
		-144	Transistor did not turn off properly.
<p>SYMPTOM Pump contactor open and close, then can only be closed by opening and closing the key switch.</p> <p>POSSIBLE CAUSE Transistor defective. Turn off time for transistor is out of specification. No field test is possible. Replace transistor.</p> <p>Check for open circuit or loose connections between the transistor and 1PL-8. (RED wire)</p>		 <p style="text-align: center;">Figure 1</p>	
		<p>STATUS INDICATION CRITERIA This status code is displayed when, during control operation, the transistor fails to turn off.</p>	

STATUS CODE	DESCRIPTION	MEMORY RECALL	Yes
		-145	Transistor did not turn on properly.
<p>SYMPTOM Pump contactor will open and close, then open and then can only be closed by opening and closing the key switch.</p> <p>POSSIBLE CAUSE Defective transistor circuit. Check for open circuit or loose connections between the transistor and 1PL-8. (RED wire)</p> <p>Check for open circuit or loose connection between T2 and 1PL-9. (WHT/GRN wire)</p> <p>Defective transistor. Intermittent or open transistor gate. Field test may or may not show defect. Replace transistor after above checks, show no problem found.</p>		 <p style="text-align: center;">Figure 1</p>	
		<p>STATUS INDICATION CRITERIA This status code is displayed when the transistor fails to gate on.</p>	

STATUS CODE	DESCRIPTION	MEMORY RECALL	No
	-146	Look ahead test for T2 volts. (Less than 12% of battery volts)	CONTROL TYPE
<p>SYMPTOM Pump contactor will not pick up.</p> <p>POSSIBLE CAUSE Defective transistor. Check for shorted transistor. Defective 1A contactor. Check for welded 1A contactor power tips. Defective Snubber. Check for shorted snubber.</p>		 <p style="text-align: center;">Figure 1</p>	
		<p>STATUS INDICATION CRITERIA This status code is displayed when the voltage at T2 is less than 12% of battery volts.</p>	

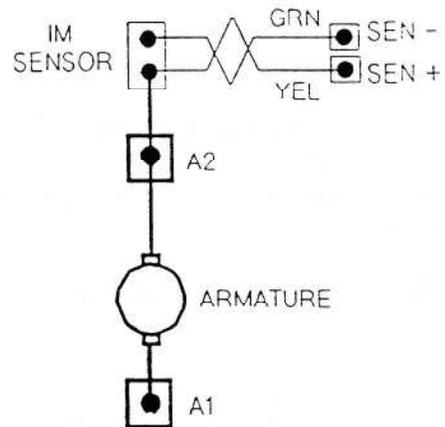
STATUS CODE	DESCRIPTION	MEMORY RECALL	No
	-148	Look ahead test for T2 volts. (Greater than 88% of battery volts)	CONTROL TYPE
<p>SYMPTOM Pump contactor will not pick up.</p> <p>POSSIBLE CAUSE Defective forward or reverse contactor. Check for welded forward or reverse contactor power tips. Check for sluggish operation of forward or reverse contactor. Defective 3 REC circuit. Check for shorted 3 REC.</p>		 <p style="text-align: center;">Figure 1</p>	
		<p>STATUS INDICATION CRITERIA This status code is displayed when the voltage at T2 is greater than 88% of battery volts.</p>	

STATUS CODE -150	DESCRIPTION	MEMORY RECALL	No
	Capacitor volts low after line contactor closes.		CONTROL TYPE
<p>SYMPTOM Pum contactor picks up. Control does not operate.</p> <p>POSSIBLE CAUSE</p> <p>Defective Line contactor. Check for open line contactor power tips.</p> <p>Check for loose or open connections in cables from battery positive to control positive circuit.</p> <p>Defective Power fuse. Check power fuse for open circuit.</p>		<p>Figure 1</p>	
		<p>STATUS INDICATION CRITERIA This status code is displayed when capacitor volts less than 85% of battery volts at initial start up.</p>	

STATUS CODE -151	DESCRIPTION	MEMORY RECALL	No
	Capacitor volts low before line contactor closes. (Precharge)		CONTROL TYPE
<p>SYMPTOM Line contactor does not close.</p> <p>POSSIBLE CAUSE</p> <p>Defective capacitor. Check capacitor bank per component checking section.</p> <p>Check for loose or open connections in capacitor circuit.</p> <p>Defective control fuse. Check control fuse for open circuit.</p> <p>Defective logic card Replace logic card.</p>		<p>Figure 1</p>	
		<p>STATUS INDICATION CRITERIA This status code is displayed when capacitor volts less than 85% of battery volts at initial start up.</p>	

STATUS CODE -154	DESCRIPTION	MEMORY RECALL	No
	Shorted Pump or 1A contactor coil driver.		CONTROL TYPE
<p>SYMPTOM Control will not operate.</p> <p>POSSIBLE CAUSE Defective logic card. Replace logic card.</p>		Figure 1	
		<p>STATUS INDICATION CRITERIA This status code is displayed when either the forward, reverse or 1A contactor coil driver is shorted internal to the logic card.</p>	

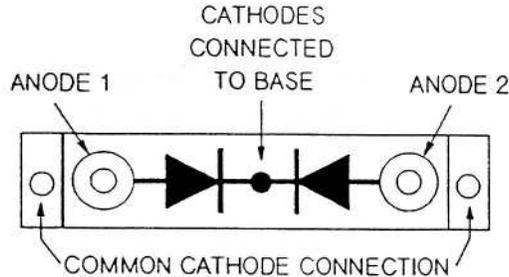
STATUS CODE -157	DESCRIPTION	MEMORY RECALL	No
	Current sensor input voltage polarity check.		CONTROL TYPE
<p>SYMPTOM Pump contactors open and close, then can only be closed by opening and closing the key switch.</p> <p>POSSIBLE CAUSE Reversed yellow and green current sensors wires. Insure that the green wire connects to SEN - with no open circuits and that the yellow wire connects to SEN + with no open circuits or loose connections.</p> <p>Reversed power cable connection. Insure that the battery positive cable connects to control P and the motor A2 cable connects to control A2.</p>		Figure 1	
		<p>STATUS INDICATION CRITERIA This status code is displayed when the voltage input to SEN + and SEN - is the wrong polarity.</p>	



COMPONENT TESTING

DIODE MODULE (3/4REC)

3REC and 4REC diodes measure about 5 to 15 ohms in the conducting direction (anode to cathode) on the R X 100 scale and 10,000 ohms or higher, in the non-conducting direction (cathode to anode) on the R X 10000 scale.

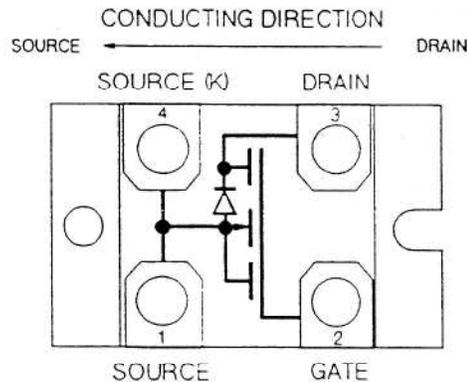


TRANSISTOR TEST

The transistors are power modules and should measure infinity ohms on any scale in the conducting direction. In the non-conducting direction, 5K to 20K ohms should be read on the R X 10000 scale.

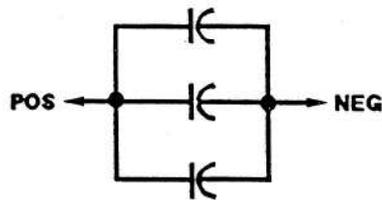
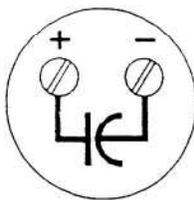
2nd test, R X 10000 scale from gate to drain should read infinity in both directions.

3rd test, R X 10000 scale from gate to source should read infinity in both directions.



CAPACITOR TEST

Electrolytic capacitors can store a significant amount of charge (energy) and must be shorted (discharged) by placing a 100 ohm 2 watt resistor between positive(+) and negative(-) for three seconds or greater.



Capacitor Bank Test

Measure ohms thru the capacitor using the R x 100 scale. Meter should swing toward zero then reverse and swing slowly to above 2000 ohms. Meter polarity is not critical.

Caution: **One shorted capacitor in bank, fails test .**
 One open capacitor in bank, bank passes test. Must check individually
 for open circuit test.

Single Capacitor Test

Measure ohms thru the capacitor using the Rx100 scale. Meter should swing toward zero then reverse and swing slowly to above 200 ohms. Meter polarity is not critical.

THERMAL PROTECTOR TEST

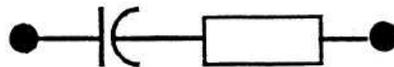
Read the resistance between the gray and black wires at the card plug (inside female connector) for each Thermal Protector. Reading should be less than 200 ohms at room temperature.

CURRENT SENSOR TEST

Should read zero ohms from green to yellow wires on the R x 1 scale.

SNUBBER TEST

The snubber is a resistor/capacitor filter assembly. Using a R x 100 scale across the two terminals, the meter will briefly swing toward zero and then quickly back to infinity.





GE Electric Vehicle Systems

EV-T6 HANDSET QUICK REFERENCE GUIDE

The Handset is a tool with many functions. It can be used with the EV100/200 LX and EV-T6 series of GE Solid-State controllers. The Handset is used to monitor traction or pump motor system functions and status or to adjust the settings of the control cards.



WARNING

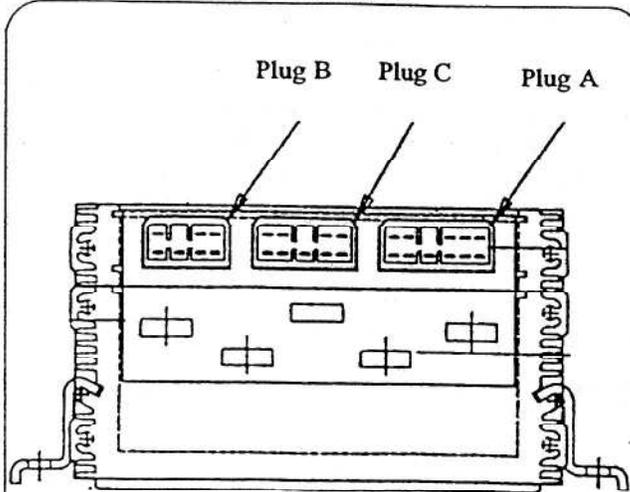
"Make sure you understand the information in the Service Manual, available from the dealer or manufacturer, before attempting to do any troubleshooting, service or adjustments. Incorrect adjustments can cause vehicle operation that is not expected, an injury or component damage."

Before connecting or disconnecting the handset to the control card, make sure to raise the drive wheel(s). Move the key switch to the OFF position, disconnect the battery and discharge capacitor(s) IC by placing a 100 ohm 2 watt resistor from the positive power terminal to the negative power terminal of the control.

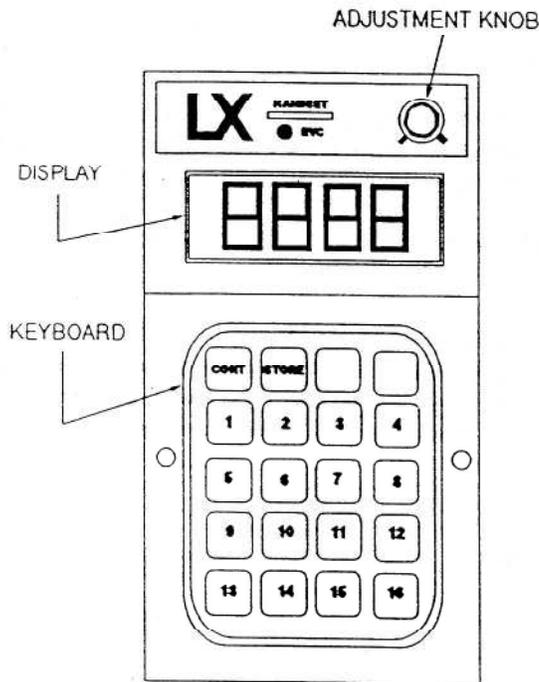
FUNCTION CODE	DESCRIPTION
FOR TRACTION CARDS	
1	Stored status code
2	Creep speed
3	Controlled Acceleration
4	Current Limit
5	Plugging Distance (Current)
6	1A Drop Out Current
7	Field Weakening Pick Up
7	PA4 Input Switch Selection
8	Field Weakening Drop Out
11	Speed Limit (SL1)
12	Speed Limit (SL2)
13	Speed Limit (SL3) (or TMM1 speed limit)
14	Internal Resistance Compensation
15	Battery Volts
16	Pedal Position Plug
17	Card Type Selection
18	Steer Pump Time Delay
FOR PUMP CARD	
1	Stored status code
2	Internal Resistance Compensation Start
3	Controlled Acceleration and 1A Time
4	Current Limit
7	Internal Resistance Compensation Rate
11	Speed Limit 1 (SL1)
12	Speed Limit 2 (SL2)
13	Speed Limit 3 (SL3)
14	Speed Limit 4 (SL4)
16	Internal Resistance Compensation
17	Card Type Selection

STATUS CODE	DESCRIPTION
CARD INPUTS	
BLANK	No input voltage to card and/or display.
-01	No seat deadman switch input.
-02	FWD switch closed on initial start.
-03	REV switch closed on initial start.
-04	Start switch input low after start.
-05	Start or brake switch did not close.
-06	Accelerator depressed and no direction selected.
-07	Accelerator input voltage too high.
-08	Accelerator input voltage too low on power up after initial key switch closure.
-09	Both FWD and REV switches closed at the same time.
-15	Battery volts too low.
-16	Battery volts too high.
-17	Wrong card type selection.
CONTACTOR PANEL	
-23	Forward or Reverse contactor coil current low.
-24	Voltage at T2 too low.
-25	1A contactor does not drop out or drop out too slowly.
-26	Shorted coil driver for RB, SP or FW contactor.
-27	Logic card power supply less than 10 VDC
TRACTION CONTROL	
-40	Open thermal protector or capacitor over temperature.
-41	Open thermal protector or control over temperature.
-42	Motor sensor input missing (green wire).
-43	Motor sensor input missing (yellow wire).
-44	Transistor did not turn off correctly.
-45	Transistor did not turn on correctly.
-46	T2 volts too low.
-48	T2 volts too high.
-50	1C volts low after line contactor closes.
-51	1C volts low before line contactor closes. (Pre-charge)
-53	Transistor does not turn off during plugging.
-54	Shorted F, R or 1A driver.
-57	Current sensor input voltage polarity check.
-90-95	Defined by truck manufacturer.
PUMP CONTROL	
-117	Wrong card type selection.
-123	Pump contactor coil current low.
-124	Voltage at T2 too low.
-125	1A contactor does not drop out or drops out too slowly.
-140	Open thermal protector or capacitor over temperature.
-141	Open thermal protector or control over temperature.
-142	Motor sensor input missing (green wire).
-143	Motor sensor input missing (yellow wire).
-144	Transistor did not turn off correctly.
-145	Transistor did not turn on correctly.
-146	T2 volts too low.
-148	T2 volts too high.
-150	1C volts low after line contactor closes.
-151	1C volts low before line contactor closes.
-154	Shorted Pump or 1A driver.
-157	Current sensor input voltage polarity check.

DESCRIPTION AND LOCATION



EV-T6



HANDSET

Ordering Note:

Handsets with case, cable and instructions are available for either EV100/200/LX or EV-T6. The Handset unit is the same device for all controls but the cable and the instructions are different. Cables and instructions can be purchased separately to upgrade existing Handsets.

IC3645LXHS1EC6 EV-T6 Handset, case & cable

328A1550AJP1 EV-T6 Cable only

DESCRIPTION OF FUNCTION NUMBERS:

Traction Control

FUNCTION 1 STORED FAULT CODE (Push 1) (FW Card)

This function register contains the last fault that shut down vehicle operation (PMT type fault that is reset by cycling the key switch). This fault code will be over written each time a new fault occurs and can be cleared from memory by adjusting the value to zero.

FUNCTION 1 SPEED LIMIT CONTROLLED ACCELERATION (Push 1) (Regen Card)

This function allows for the adjustment of the rate of time it takes for the control to accelerate to 96% applied battery voltage to the motor on hard acceleration when a speed limit switch is activated.

Range .27 to 68.0 seconds
Set 0 to 255
Resolution .27 seconds per set unit
Example: Setting of 20 = 5.67 seconds C/A

FUNCTION 2 CREEP SPEED (Push 2)

This function allows for the adjustment of the creep speed of the vehicle. A constant creep speed frequency will be maintained when an accelerator input voltage between 3.7 and 3.5 volts or an accelerator ohmic input between 6K and 4.7K ohms is provided.

Range 2% to 15% on time
Set 0 to 255
Resolution .05% per set unit
Example: Setting of 20 = 3% on time

FUNCTION 3 CONTROLLED ACCELERATION AND 1A TIME (Push 3)

This function allows for the adjustment of the rate of time it takes for the control to accelerate to 96% applied battery voltage to the motor on hard acceleration. The 1A contactor will automatically close .2 seconds after the controlled acceleration stops and the accelerator input is less than .5 volts or less than 50 ohms.

Range .27 to 68.0 seconds
Set 0 to 255
Resolution .27 seconds per set unit
Example: Setting of 20 = 5.67 seconds C/A
and 5.87 1A time.

FUNCTION 4 CURRENT LIMIT (Push 4)

This function allows for the adjustment of the current limit of the control. The rating of the control will determine the range of adjustment for this function. Please refer to the operating instructions for the control used in your vehicle.

Range See control C/L curves
Set 0 to 255
Example: 0 = min. current, 255 = max. current

FUNCTION 5 PLUGGING DISTANCE (CURRENT) (Push 5)

This function allows for the adjustment of the plugging distance of the vehicle. The larger the current setting, the shorter the stopping distance.

Range 50 to 450 amps
Set 0 to 255
Resolution 1.57 amps per set unit
Example: Setting of 20 = 81 amps

Warning: Plug settings must be in accordance with control operating instructions. Too high of setting could cause damage to control system or traction motor.

FUNCTION 6 1A DROP OUT CURRENT (Push 6)

This function allows for the adjustment of the 1A contactor drop out current. The 1A contactor will be dropped out and the vehicle motor torque will be limited to control current limit when the set drop out current is reached.

Range 300 to 1130 amps
Set 0 to 250
Resolution 3.32 amps per set unit

Settings above 250 set units will disable 1A drop out function (1A will not drop out).

Example Setting of 20 = 366 amps

FUNCTION 7 FIELD WEAKENING PICK UP (Push 7)

This function allows the adjustment of field weakening contactor pick up current. This setting allows the FW contactor to pick up when the vehicle has returned to about 150% of its full load level running current after acceleration.

Range 52 to 466 amps
Set 0 to 255
Resolution 1.6 amps per set unit
Example Setting of 20 = 84 amps

**FUNCTION 8 FIELD WEAKENING DROP OUT
(Push 8)**

This function allows for the adjustment of the field weakening contactor drop out current. This setting allows the FW contactor to drop out when the vehicle requires greater than 300% of the full load level running current for greater torque.

Range 65 to 895 amps

Set 0 to 255

Resolution 3.25 amps per set unit

Example Setting of 20 = 130 amps

**FUNCTION 9 REGEN BRAKING C/L
(Push 9)**

This function allows for the adjustment of the Regen braking current limit. The higher the current the shorter the stopping distance.

Range 38 to 250 amps

Set 0 to 255

Resolution .831 amps per set unit

Example: Setting of 20 = 45.6 amps

**FUNCTION 10 REGEN START
(Push 10)**

This function allows for the adjustment of the percent on time at which the control will start to regen. Adjustment of this function allows the OEM to set the regen start speed of the vehicle to eliminate regen attempts when motor regen current is low.

Range 0 to 95% on time

Set 0 to 255

Resolution .37% per set unit

Example: Setting of 20 = 7.4% on time

**FUNCTION 11 SPEED LIMIT 1 (SL1)
(Push 11)**

This function allows for the adjustment of the speed limit (maximum battery volts to the motor) when the SL1 limit switch input signal is received by the control card. SL1 limit switch is a normally closed switch connected to battery negative, the switch opening enables speed limit.

Range 96% to 0% battery volts

Set 0 to 180

Setting of 0 set units will disable speed limit function and allow top speed with no limit switch connected.

**FUNCTION 12 SPEED LIMIT 2 (SL2)
(Push 12)**

Same as Function 11 except using SL2 limit switch for input.

**FUNCTION 13 SPEED LIMIT 3 (SL3)
(Push 13)**

Same as Function 11 except using SL3 limit switch for input.

The SL3 set speed limit is activated by the Truck Management Module fault code 93. See instructions for IC3645TMM1A Truck Management Module for details.

**FUNCTION 14 INTERNAL RESISTANCE
COMPENSATION
(Push 14)**

This function is used when the Battery Discharge Indicator is present. Adjustment of this function will improve the accuracy of the BDI. In order to make this setting the voltage drop of the battery under load must first be determined by following the steps listed below.

1. Record open circuit voltage (V_o) by measuring the voltage at the control positive and negative power terminals.
2. Load the traction motor to 100 amps in 1A and record the voltage (V_L) at the control positive and negative power terminal.
3. Calculate voltage drop (V_{Drop}) as follows:
$$V_{Drop} = V_o - V_L$$
4. Use the table below to determine the setting using the calculated V_{Drop} as a reference.

**INTERNAL RESISTANCE COMPENSATION
TABLE**

Setting	V_{Drop}	Setting	V_{Drop}
2	11.44	17	01.34
3	07.60	18	01.27
4	05.72	19	01.20
5	04.57	20	01.14
6	03.81	21	01.09
7	03.27	22	01.04
8	02.86	23	00.99
9	02.54	24	00.95
10	02.28	25	00.91
11	02.08	26	00.88
12	01.90	27	00.85
13	01.76	28	00.82
14	01.63	29	00.79
15	01.52	30	00.76
16	01.43	31	00.74

**FUNCTION 15 BATTERY VOLTS
(Push 15)**

This function allows for the adjustment of voltage range for controls equipped with the Battery Discharge Indication function. In order for the BDI to operate properly, the setting as shown in the table must be entered .

Battery volts	Set units
24 volts	Between 0 and 31
36 volts	Between 32 and 44
48 volts	Between 45 and 69
72 volts	Between 70 and 80 (Later)
84 volts	Between 81 and 183 (Later)
36/48 volts	Between 184 and 250
No BDI	Between 251 and 255

The following functions have function numbers larger than the numbers on the Handset keyboard. To access these function, push the CONT key and the number shown in the following instructions at the same time.

**FUNCTION 16 PEDAL POSITION PLUG
(Push CONT 1)**

This function will allow the adjustment of the pedal position plug range. Pedal position will reduce the plugging current to the current value set by this function as the accelerator is returned to the creep speed position. Maximum plug current is obtained with the accelerator in the top speed position.

Range	50 to 450 amps
Set	0 to 255
Resolution	1.57 amps per set unit
Example	Setting of 50 = 79 amps

To disable the pedal position plug function, adjust the current value to the same current value as the plug distance current.

Example: If plug distance current Function 5 is set at 350 amps, then set pedal plug current at 350 amps. With this setting pedal position will have no effect on plugging distance.

**FUNCTION 17 CARD TYPE SELECTION
(Push CONT 2)**

This function allows for the selection of the card type used for your vehicle's application. The table below shows the setting to select card application type depending on which control card is used.

FW Card Settings

Function	Standard with FW	Speed Limit
STD C/L	0 to 4	20 to 24

Regen Card Settings

Function	Standard	Speed Limit	Regen
STD C/L	0 to 4	20 to 24	40 to 44

Settings for these functions should be made in between the values shown.

Warning: These setting must be changed by authorized personnel only, following instructions supplied by the manufacturer. Card type selection must be made within the capabilities of the control panel used and the supporting electro-mechanical devices. Failure to to comply with proper application standards could result in misoperation or damage to the control and/or motors.

**FUNCTION 18 STEER PUMP TIME DELAY
(Push CONT 3)**

This function allows for the selection of steer pump contactor pick up input, either seat/deadman switch or directional switch closing and adjustment of the time delay for the contactor drop out.

Pick up on seat/deadman switch closure and time delay drop out on seat/deadman switch opening.

Range	1.5 to 65 seconds
Setting	Between 0 and 128
Resolution	.5 seconds per set unit
Example:	Setting of 149 = 10.5 seconds

Pick up on directional switch closure and drop out time delay adjustment on directional switch opening.

Range	.5 to 63 seconds
Setting	129 to 255
Resolution	.5 seconds per set unit
Example:	Setting of 149 = 10.5 seconds

Drop out will be 1.5 seconds after the seat switch opens.

**DESCRIPTION OF FUNCTION NUMBERS FOR:
Pump Control Card**

**FUNCTION 1 STORED FAULT CODE
(Push 1)**

This function register contains the last status code that shut down vehicle operation (PMT type fault that is reset by cycling the key switch). This statuscode will be over written each time a new fault occurs and can be cleared from memory by adjusting the value to zero.

**FUNCTION 2 INTERNAL RESISTANCE
COMPENSATION START
(Push 2)**

This function allows for the adjustment of the current level at which the internal resistance compensation feature (Function 16) will take effect.

Range 0 to 1666 amps
Set 0 to 255
Resolution 6.5 amps per set unit

Example: Setting of 50 = 325 amps

**FUNCTION 3 CONTROLLED ACCELERATION
AND 1A TIME
(Push 3)**

This function allows for the adjustment of the rate of time it takes for the control to accelerate to 96% applied battery voltage to the motor on hard acceleration. The 1A contactor will automatically close .2 seconds after the controlled acceleration stops and the accelerator input is less than .5 volts or less than 50 ohms.

Range .27 to 68 seconds
Set 0 to 255
Resolution .27 seconds per set unit
Example: Setting of 20 = 5.67 seconds C/A
 and 5.87 seconds 1A time.

**FUNCTION 4 CURRENT LIMIT
(Push 4)**

This function allows for the adjustment of the current limit of the control. The rating of the control will determine the range of adjustment for this function. Please refer to the operating instructions for the control used in your vehicle.

Range See control C/L curves
Set 0 to 255
Example: 0 = min. current, 255 = max. current

**FUNCTION 7 INTERNAL RESISTANCE
COMPENSATION RATE
(Push 3)**

This function allows for the adjustment of the rate of time it takes for the control to add the internal resistance compensation voltage that is applied to the motor. This function will add .375 volts to the motor at the rate of time adjusted until the total IR compensation voltage has been added.

Range .0015 to .383 seconds
Set 0 to 255
Resolution .0015 seconds per set unit
Example: Setting of 20 = .032 seconds

For example, if you had selected 2.08 volts from Function 16 to be added to the motor. This example would take .18 seconds to add a total of 2.08 volts. $(2.08/.375).032$

**FUNCTION 11 SPEED LIMIT 1 (SL1)
(Push 11)**

This function allows for the adjustment of the speed limit (maximum battery volts to the motor) when the SL1 limit switch input signal is received by the control card. SL1 limit switch is a normally open switch connected to battery negative; the switch closing enables speed limit.

Range 0% to 100% battery volts
Set 0 to 255
Resolution .375 volts per set unit
Example Setting of 50=18.75 volts

**FUNCTION 12 SPEED LIMIT 2 (SL2)
(Push 12)**

Same as Function 11 except using SL2 limit switch for input.

**FUNCTION 13 SPEED LIMIT 3 (SL3)
(Push 13)**

Same as Function 11 except using SL3 limit switch for input.

**FUNCTION 14 SPEED LIMIT 4 (SL4)
(Push 14)**

Same as Function 11 except using SL4 limit switch for input.

The following functions have function numbers larger than the numbers on the handset keyboard. To access these functions, push the CONT key and the number shown in the following instructions at the same time.

**FUNCTION 16 INTERNAL RESISTANCE
COMPENSATION
(Push CONT and 1)**

This function is used to stabilize pump speed at heavy loads. This function is set using information obtained from the speed torque curve of the motor used. See OEM service manual for your vehicle for this setting.

Warning: These setting must be changed by authorized personnel only, following instructions supplied by the manufacturer. Card type selection must be made within the capabilities of the control panel used and the supporting electro-mechanical devices. Failure to comply with proper application standards could result in misoperation or damage to the control and/or motors.

**INTERNAL RESISTANCE COMPENSATION
TABLE**

Setting	Voltage Drop	Setting	Voltage Drop
2	11.44	17	01.34
3	07.60	18	01.27
4	05.72	19	01.20
5	04.57	20	01.14
6	03.81	21	01.09
7	03.27	22	01.04
8	02.86	23	00.99
9	02.54	24	00.95
10	02.28	25	00.91
11	02.08	26	00.88
12	01.90	27	00.85
13	01.76	28	00.82
14	01.63	29	00.79
15	01.52	30	00.76
16	01.43	31	00.74

**FUNCTION 17 CARD TYPE SELECTION
(Push CONT and 2)**

This function allows for the selection of the card type used for your vehicle's application. The table below shows the setting to select card application type depending on which control card is used.

Function	With Pump Ctr/PMT	Without Pump Ctr/PMT
STD C/L	0 to 8	36 to 44
High C/L	9 to 17	45 to 53
STD C/L		
BDI (Lockout)	18 to 26	54 to 62
High C/L		
BDI (Lockout)	27 to 35	63 to 71

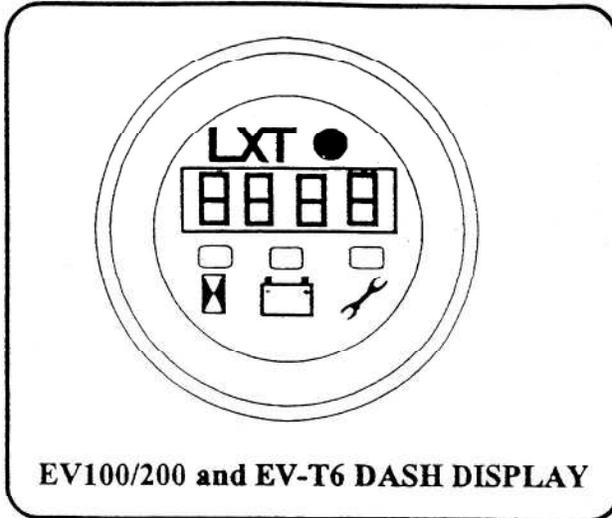
BDI Lockout means that the BDI signal from the traction control must be present in order for the pump control to operate. This control will stop operation when the battery state of charge reaches 10%.

Settings for these functions should be made in between the values shown.



GE Electric Vehicle
Systems

SPECIFICATIONS DASH DISPLAY



APPLICATION

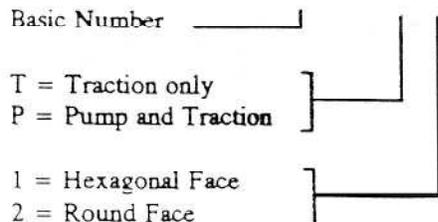
The Dash Display is a four segment Light Emitting Diode (LED) display that displays the status codes, hourmeter readings and Battery Discharge Indication from the EV100/200 LX/LXT and EV-T6 Series of controls.

The Dash Display is available in two models and two face shapes (hexagon and round), one is for use with the traction control only and the other one is for use with both the traction and pump controls. LED's above symbols indicate readout mode.

Connections are made to the Dash Display by means of five 22-gage wires to Plug "Y" or Plug "C" of each control. Shielded cable is required to eliminate signal interference.

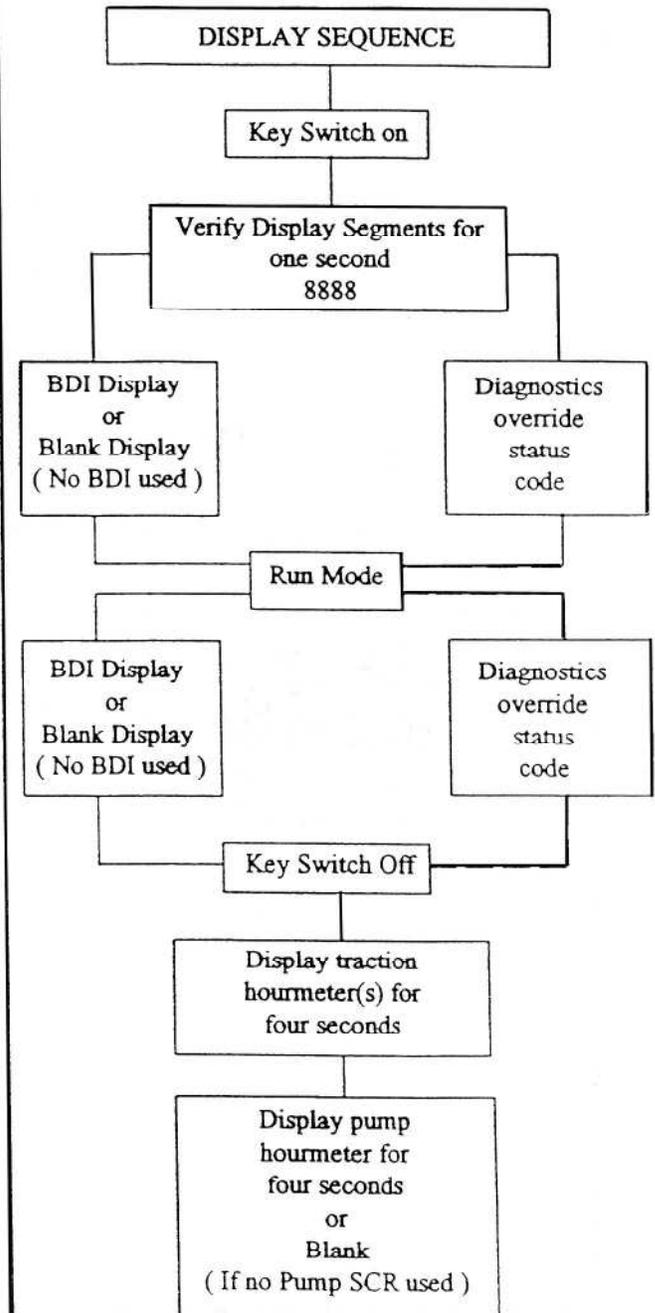
PART NUMBER

IC3645LXTDD T 1



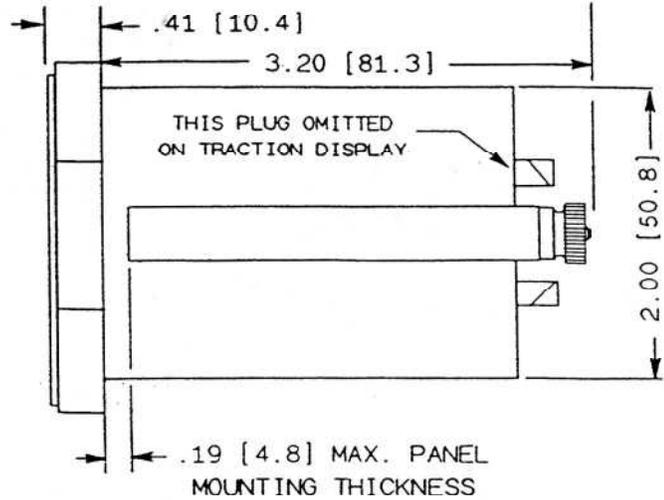
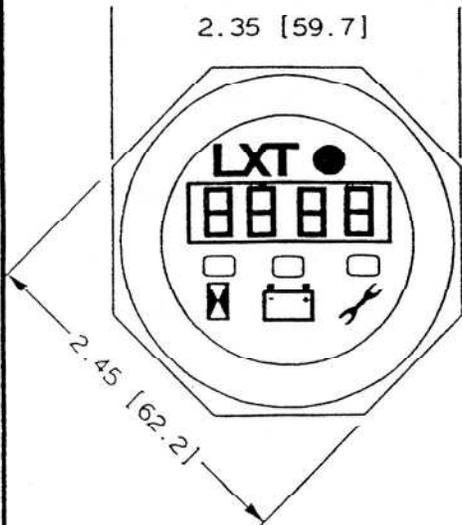
REFERENCE

AMP#102241-3	Dash Display mating plug
AMP#1-87195-8	Dash Display mating pin
44A723596-G09	Dash Display Plug Kit
328A1544ADP1	"Y" Plug
AMP#102103-3	"Y" Plug receptacle
AMP#171892-1	"C" Plug
AMP#170189-1	"C" Plug receptacle

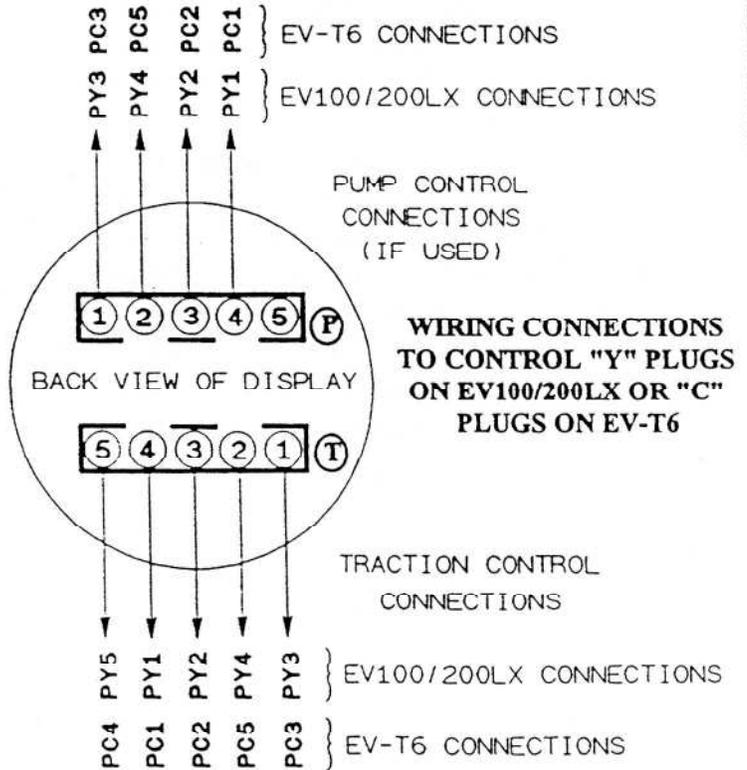
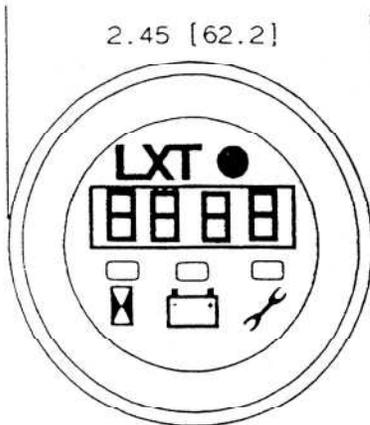


DASH DISPLAY OUTLINE AND CONNECTION DRAWING

DASH DISPLAY OUTLINE WITH HEXAGON FACE



OPTIONAL ROUND FACE DISPLAY





TECHNICAL SERVICES