DOLPHIN PROPULSION SYSTEM

SERVICE MANUAL

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SECTION I

INTRODUCTION

This manual covers the Dolphin propulsion system (Figure 1-1) which consists of a power control unit (PCU) (Figure 1-2) and an ac induction traction motor (Figure 1-3). The Dolphin system possesses important features such as performance, efficiency, safety, low maintenance and ease of conversion, in addition to the environmental considerations of zero emission transportation. The electronic matching of the PCU and motor as well as the off–throttle regeneration and regenerative braking all contribute to the high efficiency of the Dolphin propulsion system. The Dolphin propulsion system includes safety features such as, built-in interlocks as well as circuitry to monitor battery isolation for high voltage protection. The dolphin propulsion system itself requires no regular maintenance. In addition, the Dolphin propulsion system reduces brake wear (due to the off–throttle regeneration) and also extends the life of the accessory battery by keeping a slow trickle charge on the battery. This propulsion system is adaptable to a variety of internal combustion engine automobiles using the existing cooling and +12 Vdc electrical systems as well as the transmission. The conversion would also require propulsion battery packs and a 110/220 Vac chassis assembly for charging.

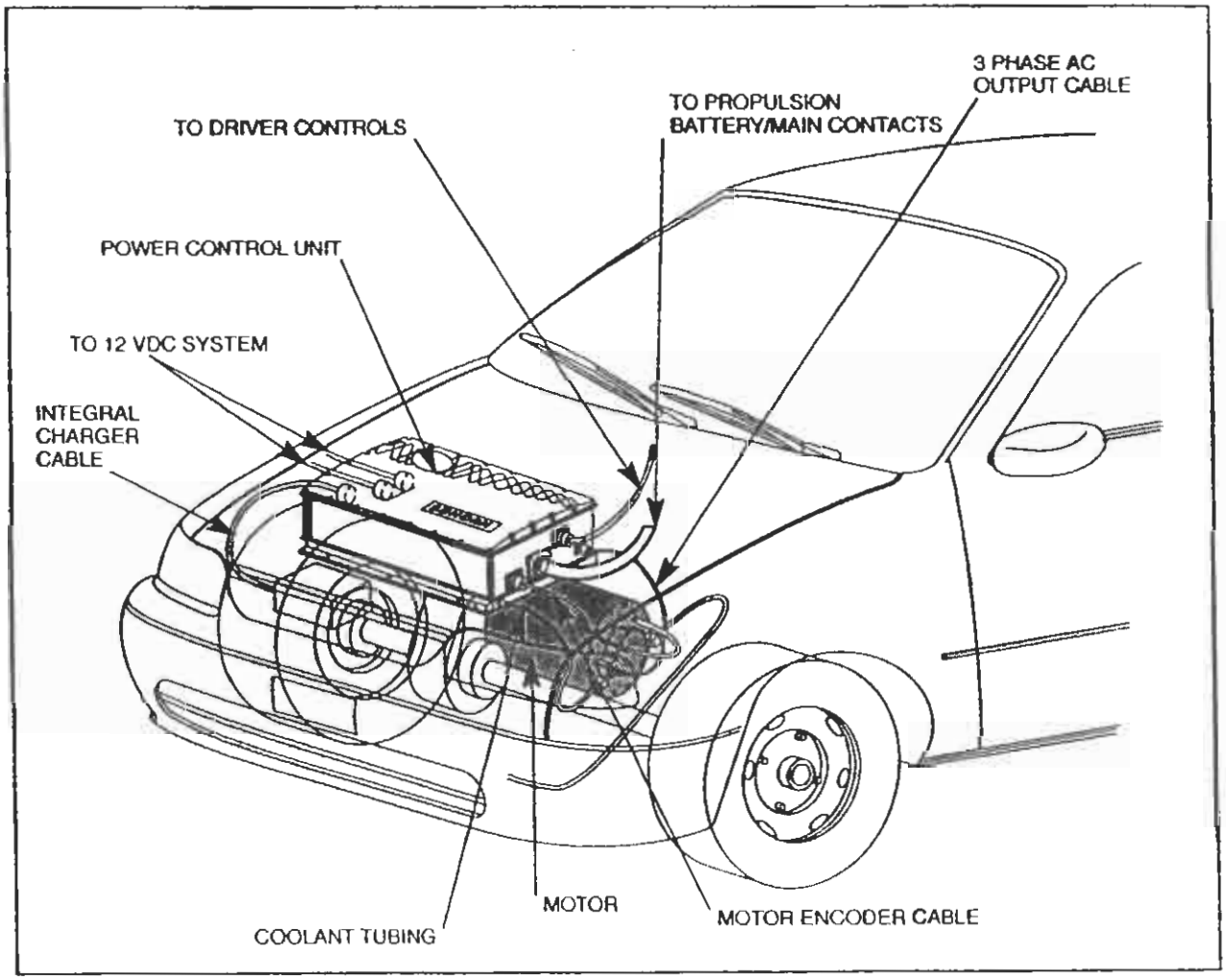


Figure 1-1. Dolphin Propulsion System and Interfaces

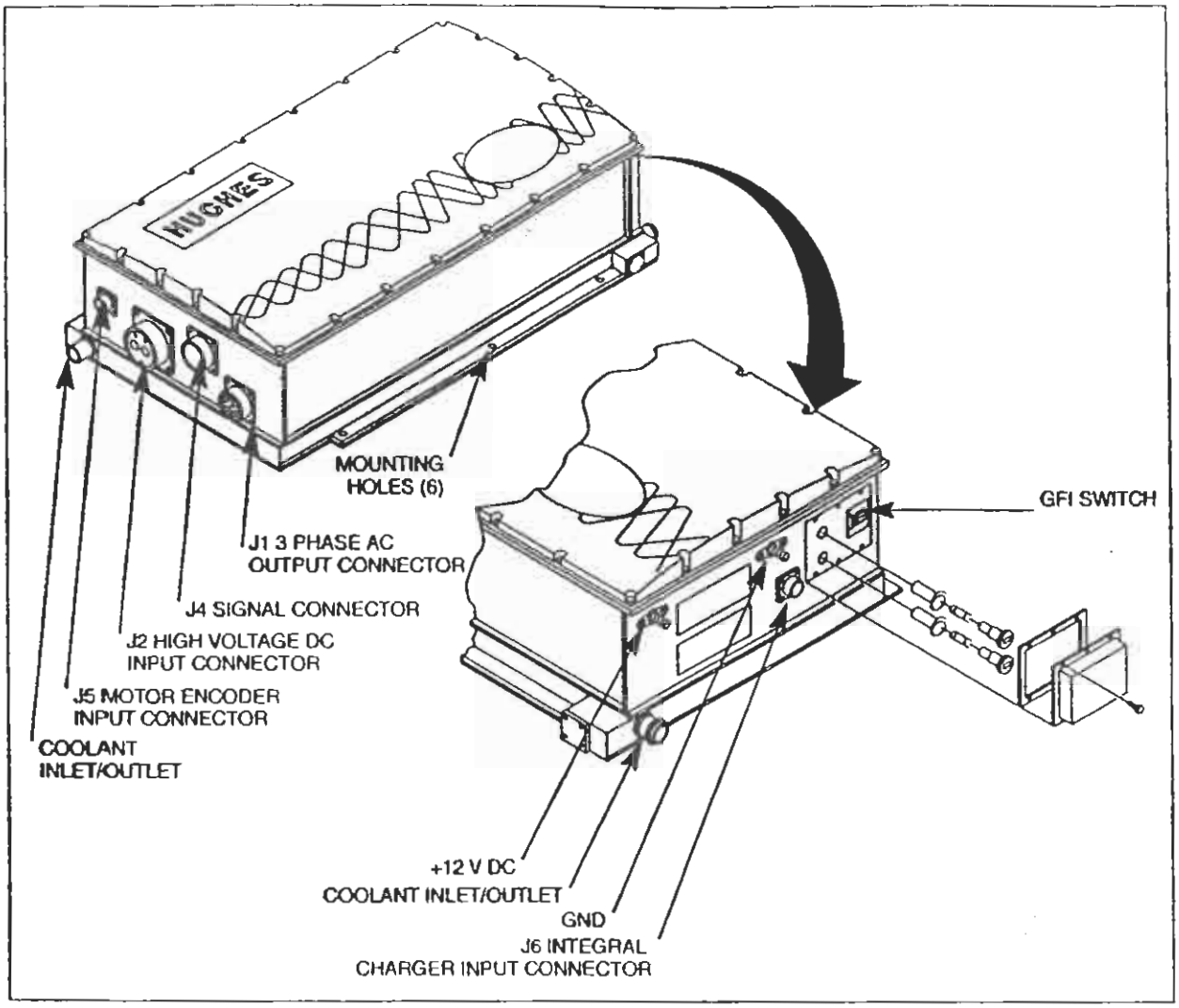


Figure 1-2. Dolphin Power Control Unit (PCU)

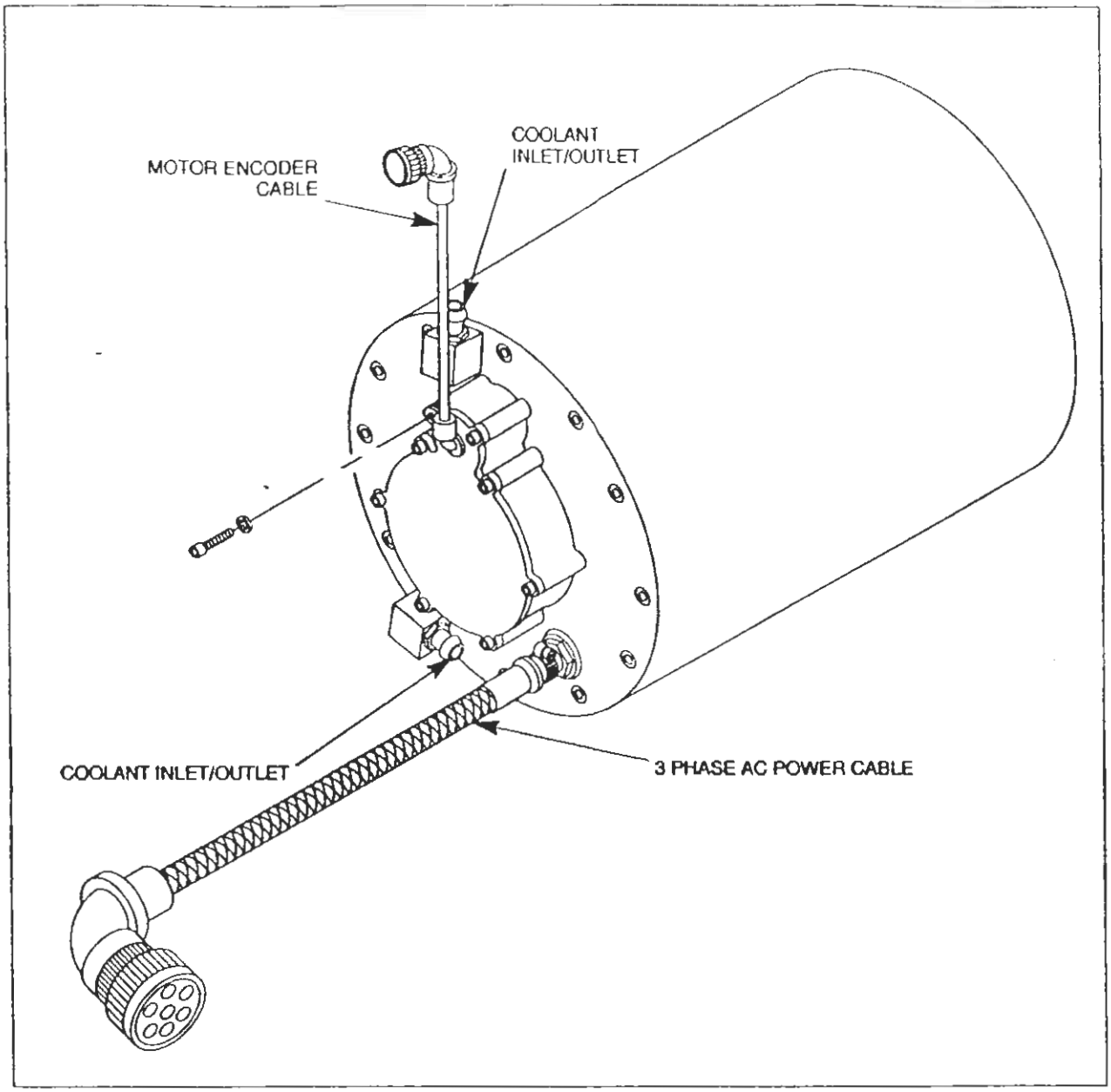


Figure 1-3. Dolphin AC Induction Traction Motor

SECTION II

OPERATION

NORMAL MOTORING OPERATION

Normal operating procedure is as follows:

1. Insert car key into start switch.
2. Turn key to on position.
3. Fault indicator appears for approximately 2 seconds and then turns off.
4. The ready indicator will then be lit.
5. Car is now ready for normal operation.

NORMAL CHARGING OPERATION

Normal charging procedure is as follows:

1. Turn main battery switch on.
2. Ensure start switch is in off position.
3. Insert 110/220 V ac single-phase line into charger receptacle.
4. Charger indicator blinks during charge cycle.
5. When charging is complete, charge indicator is continuously lit.
6. Disconnect 110/220 V ac single-phase line from charger receptacle.

NORMAL OPERATING TEMPERATURE RANGES

It is normal for the temperature gauge to fluctuate from minimum to maximum depending upon the load and ambient temperature conditions to which the Dolphin propulsion system is subjected. The Dolphin propulsion system is designed to operate in an environment where coolant temperature is maintained between −30 to +65°C. The power control unit (PCU) shuts down when the temperature of its coldplate is greater than +65°C.

SECTION III
MAINTENANCE

SERVICE SAFETY

CAUTION: Before removing or installing any electrical unit or when a tool or equipment could easily come in contact with "live" exposed electrical terminals, disconnect the negative auxiliary battery cable to help prevent personal injury and/or damage to the vehicle or components. Unless instructed otherwise, the key switch and the main battery pack external on/off switch shall be in the "off" position.

HANDLING ELECTROSTATIC DISCHARGE (ESD) SENSITIVE PARTS

Many solid state electrical components can be damaged by electrostatic discharge (ESD). Some will display a label as shown in figure 3-1, but many will not.

NOTICE

Figure 3-1. Electrostatic Discharge Sensitive Parts Label

NOTICE: Before any servicing is performed on the Dolphin Propulsion system, proper ESD precautions should be taken. The following are some of the precautions that should be taken:

1. Use one hand to touch the chassis before proceeding. This will discharge any build up of static charge on your person.
2. Always wear an anti-static wrist strap that is attached to a secure ground when handling any component of the Dolphin propulsion system before they have been properly installed.
3. Do Not use a static strap when voltage levels higher than 50 volts are present.
4. Do not touch exposed electrical terminals on components or connectors with your finger or any tools.
5. Never jumper, ground or use test equipment probes on any components or connectors unless specified in diagnostics.
6. Do not remove the solid state component from its protective packaging until you are ready to install the part.

SCHEDULED MAINTENANCE PHILOSOPHY

The Dolphin propulsion system requires no scheduled maintenance, however, to maintain peak operating efficiency the coolant and interface cables should be checked regularly. These items interface with the Dolphin propulsion system and can directly degrade the system's efficiency. It is highly recommended that the scheduled maintenance for these items be followed (table 3-1).

CORRECTIVE MAINTENANCE PHILOSOPHY

The Dolphin propulsion system corrective maintenance procedures can be used to troubleshoot down to the field replaceable unit (FRU). The FRUs are the power control unit (PCU), traction control motor, motor encoder, motor encoder cable or other system within the vehicle (i.e. battery, cooling or +12 Vdc electrical system etc.). All FRU failures should be removed and replaced by a qualified technician. Fuses are serviceable on–site and do not require the removal of an FRU. The troubleshooting procedures are written for manual or computer-assisted troubleshooting, however it is strongly advised that a diagnostic computer be used for troubleshooting the Dolphin propulsion system. Figure 3-2 is the system electrical interface diagram.

CORRECTIVE MAINTENANCE

GENERAL DESCRIPTION

POWER CONTROL UNIT

The PCU integrates a three-phase ac power inverter, dc/dc converter and an integral charger into one main assembly. The PCU power inverter converts high voltage dc into three-phase ac power for the motor. The dc/dc converter provides a trickle charge for the +12 Vdc auxiliary battery. The integral charger is compatible with 110/220 Vac single phase 15 amp service.

MOTOR

The Dolphin propulsion system uses an ac induction traction motor with an environmentally sealed housing. The traction motor can be coupled to a standard transmission that is fixed in first or second gear. The traction motor is electronically matched (tuned) to the output of the power inverter of the power control unit (PCU), increasing the power transfer to the road.

MOTOR ENCODER

The motor encoder is located within the motor housing where it monitors the rotation of the motor spindle. The motor encoder translates the rotation of the motor spindle into electrical impulses and is relayed through the motor encoder cable to the PCU. The PCU then calculates the speed of the car from the electrical impulses.

MOTOR ENCODER CABLE

The motor encoder cable carries +5 volts, motor encoder signals and temperature signals. The +5 volt signal powers the motor encoder circuitry housed within the motor housing. The motor encoder signals relay motor speed information to the PCU. The temperature signal is a voltage between 0 and 5 volts that is analogous to the temperature of the motor.

REQUIRED TOOLS AND TEST EQUIPMENT

DIAGNOSTIC COMPUTER

The diagnostic computer is a 486 microprocessor-based PC computer (preferably a laptop style) that is compatible with the Hughes Power Systems diagnostic software. The diagnostic computer must also have the capability to communicate with the PCU via RS–232 or SAE J1850 serial interface.

DIAGNOSTIC SOFTWARE

The only software that shall be used to troubleshoot the Dolphin propulsion system is the diagnostic software written by Power Control Systems.

COMPUTER CABLING

- 9-pin RS–232 cable

TEST EQUIPMENT

- Digital Multi–meter, Beckman 310 or equivalent (Required)
- A 80486 class PC compatible computer loaded with Hughes Power Control Systems diagnostic software with a RS–232 cable. (Optional)

Table 3-1. Scheduled Maintenance

ITEM	SERVICE INTERVAL	RECOMMENDED ACTION
Coolant		
• Check Coolant Level	Every 2 Weeks	Top off with 50/50 ethylene glycol or water with a corrosion inhibitor
• Replace Coolant	Every 12 Months	Replace with 50/50 ethylene glycol or water with a corrosion inhibitor
Cables		
• Check Cable Connectors	Every Week	Visual inspection of cable connectors
• Check for Cable Chaffing	Every 2 Months	Visual inspection of cables

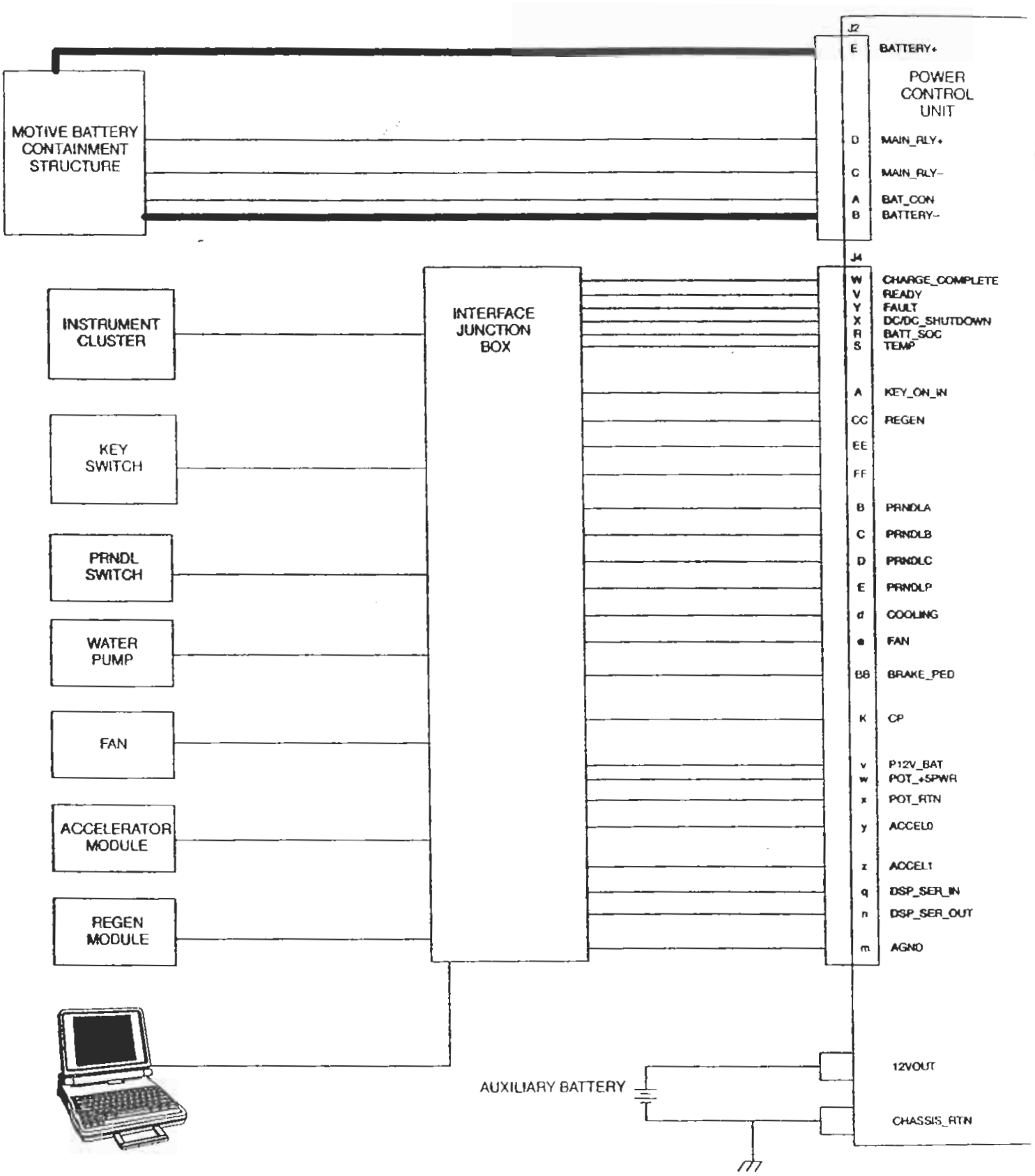


Figure 3-2. Dolphin Propulsion System Block Diagram (Sheet 1 of 2)

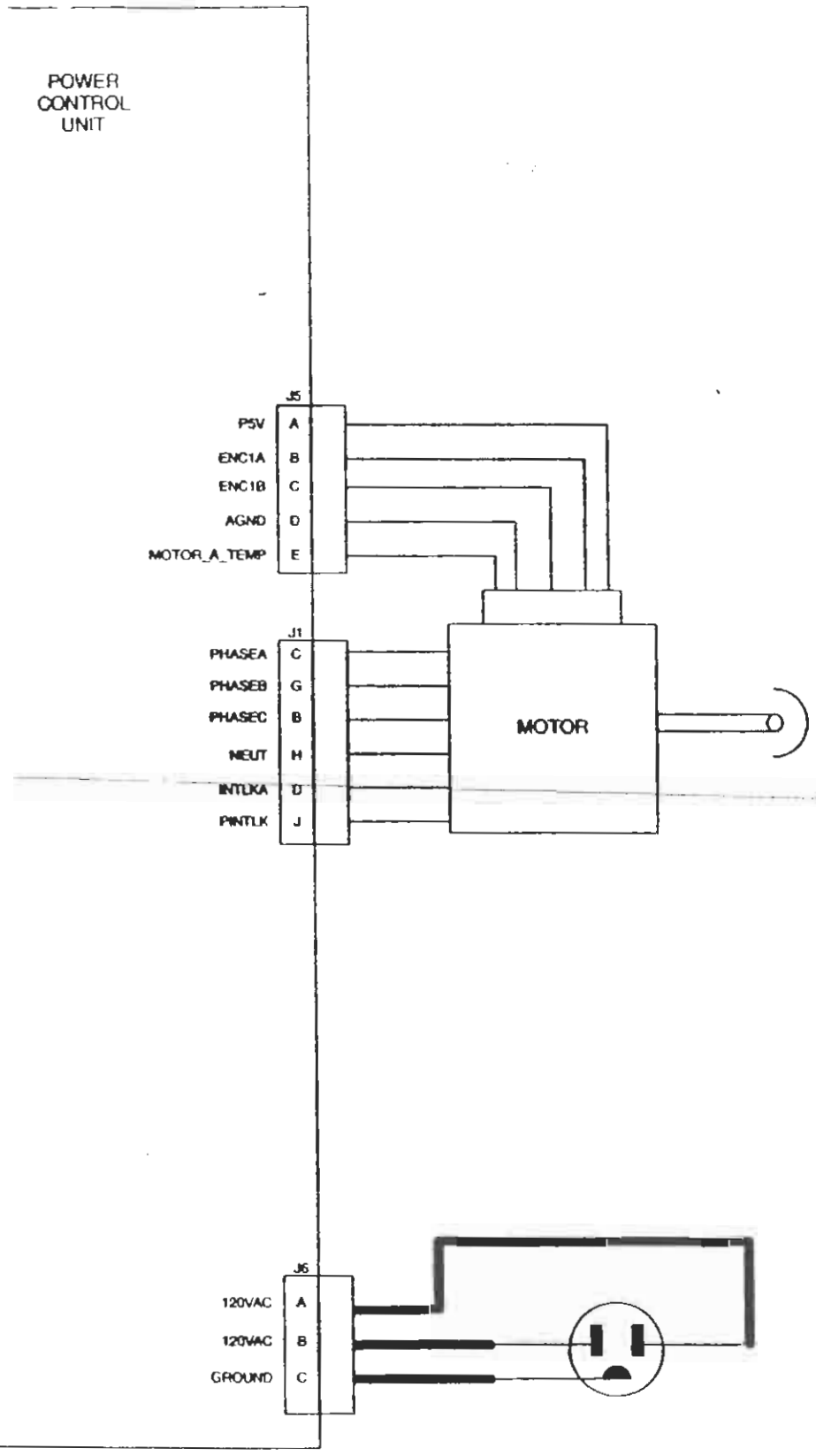


Figure 3-2. Dolphin Propulsion System Block Diagram (Sheet 2 of 2)

DOLPHIN DIAGNOSTICS

Table 3-2. Diagnosis of Dolphin Propulsion System

PROBLEM	POSSIBLE CAUSE	CORRECTION
Start-up Fault – No Indicator Lights (Reference no indicator lights diagnostic procedure (part 1 of 2) Figure 3-10)	1. Cables to PCU are loose or disconnected.	1. Disconnect and reconnect all cables to PCU.
	2. US Electricar auxiliary power system fault.	2. Refer to US Electricar auxiliary power system diagnostic procedure.
	3. 12 Vdc line fuse blown.	3. Replace blown fuse.
	4. PCU fault.	4. Refer to computer diagnostic program. Replace PCU if necessary.
	5. Indicator lights may be burned out.	5. Refer to US Electricar indicator diagnostics procedure.
Start-up Fault – Fault Indicator Remains On (Reference fault indicator remains on diagnostic procedure (part 1 of 2) Figure 3-14)	1. Cables to PCU are loose or disconnected.	1. Disconnect and reconnect all cables to PCU.
	2. Main battery pack external on/off switch is off.	2. Turn switch to on position.
	3. Accelerator pedal not in fully off position.	3. Reposition accelerator pedal to off position.
	4. Pre-charge fuse blown.	4. Refer to US Electricar auxiliary power system diagnostic procedure.
	5. Low auxiliary battery.	5. Check auxiliary battery voltage with volt meter or diagnostic computer; charge battery if necessary.
	6. Fuse inside PCU integral charger is blown.	6. Check fuse, replace if necessary.
	7. US Electricar auxiliary power system fault.	7. Refer to US Electricar auxiliary power system diagnostic procedure.
	8. PCU fault.	8. Refer to diagnostic computer. Replace PCU if necessary.
Start-up Fault – No Ready Indicator (Reference no ready indicator diagnostic procedure Figure 3-16)	1. Cables to PCU are loose or disconnected.	1. Disconnect and reconnect all cables to PCU.
	2. US Electricar auxiliary power system fault.	2. Refer to US Electricar auxiliary power system diagnostic procedure.
	3. Accelerator is not fully off.	3. Reposition accelerator to off position.
	4. Main power relay may not be engaging.	4. Refer to US Electricar main power diagnostic procedure.
	5. PCU fault.	5. Refer to computer diagnostic program. Replace PCU if necessary.

Table 3-2. Diagnosis of Dolphin Propulsion System (CONT.)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Motoring Fault – Car Will Not Move	1. Cables to PCU are loose or disconnected. 2. Main power relay may not be engaging. 3. Motor interlock is open or motor fault. 4. PCU fault. 5. Transmission fault.	1. Disconnect and reconnect all cables to PCU. 2. Refer to US Electricar main power diagnostic procedure. 3. Refer to the motor diagnostic procedure Figure 3-19. 4. Refer to computer diagnostic program. Refer to PCU remove and replacement procedure if PCU replacement is necessary. 5. Refer to US Electricar transmission diagnostic procedure.
Motoring Fault – Miles Per Charge Has Degraded	1. Low air pressure in tires. 2. Main batteries pack not fully charged. 3. State of charge meter fault. 4. High impedance in the power circuit causing voltage drop. 5. Integral charger within PCU is not fully charging the batteries. 6. Main batteries fault. 7. Motor fault.	1. Inflate tires to proper pressure level. 2. Charge main battery pack. 3. Refer to US Electricar indicator diagnostic procedure. 4. Refer to US Electricar main power diagnostic procedure. 5. Refer to integral charger diagnostic procedure Figure 3-17. 6. Refer to US Electricar main power diagnostic procedure. 7. Refer to motor diagnostics procedure Figure 3-19.
Motoring Fault – Vehicle Slips Into Charge Mode While Motoring	1. PCU fault.	1. Replace PCU. Refer to PCU removal and replacement procedure.
Motoring Fault – Vehicle Indicators Will Not Turn Off When Key Is In Off Position **To shut-off the vehicle in this condition you must:** 1. Turn-off main battery switch or, 2. Open one of the PCU interlocks.	1. Fused main power relay. 2. Bad ignition switch. 3. PCU fault	1. Refer to US Electricar main power diagnostic procedure. 2. Refer to US Electricar auxiliary power system diagnostics procedure. 3. Replace PCU. Refer to PCU removal and replacement procedure.

Table 3-2. Diagnosis of Dolphin Propulsion System (CONT.)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Motoring Fault – Vehicle Powers Down Unexpectedly	1. Loose connector.	1. Disconnect and reconnect all PCU cables.
	2. Thermal shutdown.	2. Refer to the temperature problems diagnostic procedure (part 1 of 2) Figure 3-5.
	3. Low auxiliary battery.	3. Check auxiliary battery voltage with volt meter or diagnostic computer; charge battery if necessary.
	4. Motor fault.	4. Refer to the motor diagnostic procedure Figure 3-19.
	5. PCU fault.	5. Refer to the computer diagnostic procedure. Replace PCU if necessary.
Motoring Fault – Temperature Problems	1. Low coolant.	1. Refill coolant reservoir with proper coolant mixture.
	2. Water pump fault.	2. Refer to US Electricar water pump diagnostic procedure.
	3. Fan fault.	3. Refer to US Electricar fan diagnostic procedure.
	4. PCU fault.	4. Refer to the temperature problems diagnostic procedure (part 1 of 2) Figure 3-5. Replace PCU if necessary.
Motoring Fault – Unusual Noise During Motoring	1. Motor noise –	1. Repair as necessary.
	a. Loose motor mounting bolts.	a. Tighten motor mounting bolts. See motor replacement procedure for specifics.
	b. Motor fault.	b. Refer to motor removal and replacement procedure.
	2. PCU noise –	2. Repair as necessary.
	a. Loose PCU mounting bolts.	a. Tighten PCU mounting bolts. See PCU replacement procedure for specifics.
	b. PCU fault.	b. Refer to PCU removal and replacement procedure.
	3. Other car noise	3. Refer to US Electricar noise diagnostic procedure.

Table 3-2. Diagnosis of Dolphin Propulsion System (CONT.)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Motoring Fault – Vehicle movements Are Not Normal	1. Cables to PCU are loose or disconnected.	1. Disconnect and reconnect all cables to PCU.
	2. Main battery pack not fully charged.	2. Charge main battery pack.
	3. Main battery pack fault.	3. Refer to US Electricar main power diagnostic procedure.
	4. Integral charger is not fully charging main battery pack.	4. Refer to integral charger diagnostic procedure Figure 3-17.
	5. High impedance in the power circuit causing voltage drop.	5. Refer to US Electricar main power diagnostic procedure.
	6. Motor encoder fault.	6. Refer to motor encoder diagnostic procedure Figure 3-7.
	7. Motor fault.	7. Refer to motor diagnostic procedure Figure 3-19.
	8. PCU fault	8. Refer to computer diagnostic procedure. Replace PCU if necessary.
Charging Fault – Charge Indicator Never Lights	1. Cables to PCU are loose or disconnected.	1. Disconnect and reconnect all cables to PCU.
	2. Indicator is burned out.	2. Refer to US Electricar indicator diagnostic procedure.
	3. Fuse within integral charger is blown.	3. Replace fuse.
	4. GFI switch has been tripped.	4. Reset GFI switch.
	5. PCU fault.	5. Replace PCU.
Charging Fault – Charge Indicator Does Not Blink During Charge Mode or Fault Light On and Charge Light Blinks	1. Cables to PCU are loose or disconnected.	1. Disconnect and reconnect all cables to PCU.
	2. Indicator is burned out.	2. Refer to US Electricar indicator diagnostic procedure.
	3. Start key is in ON position.	3. Turn start key to OFF position.
	4. Pre-charge fuse blown.	4. Refer to US Electricar auxiliary power system diagnostic procedure.
	5. GFI switch has been tripped.	5. Reset GFI switch.
	6. PCU fault.	6. Replace PCU.

Table 3-2. Diagnosis of Dolphin Propulsion System (CONT.)

PROBLEM	POSSIBLE CAUSE	CORRECTION
Charging Fault – Main Battery Pack Not Fully Charging (Reference integral charger diagnostic procedure Figure 3-17)	1. Charge cable from power source is not fully connected.	1. Disconnect and reconnect charge cable plug.
	2. Loose connectors to PCU.	2. Disconnect and reconnect all connectors to PCU.
	3. High impedance in the power circuit causing voltage drop.	3. Refer to US Electricar main power diagnostic procedure.
	4. Integral charger is not producing enough current.	4. Use diagnostic computer or current probe to measure output current of the integral charger. Replace PCU if necessary. Refer to PCU removal and replacement procedure.
	5. Main battery pack fault.	5. Refer to US Electricar main power diagnostic procedure.
Charging Fault – 12 Volt Auxiliary Battery Loses Its Charge (Reference PCU 12 vdc auxiliary charger diagnostic procedure Figure 3-18)	1. Cable connection between auxiliary battery and PCU is loose.	1. Tighten connections at PCU and auxiliary battery.
	2. Bad power cable between PCU and auxiliary battery.	2. Refer to US Electricar auxiliary power system diagnostic procedure. Replace cable if necessary.
	3. 12 volt auxiliary battery fault.	3. Refer to US Electricar auxiliary power system diagnostic procedure. Replace battery if necessary.
	4. DC/DC converter is faulty.	4. Refer to PCU 12 vdc auxiliary charger diagnostics procedure Figure 3-18. Replace PCU if necessary.

DOLPHIN PROPULSION SYSTEM DIAGNOSTICS

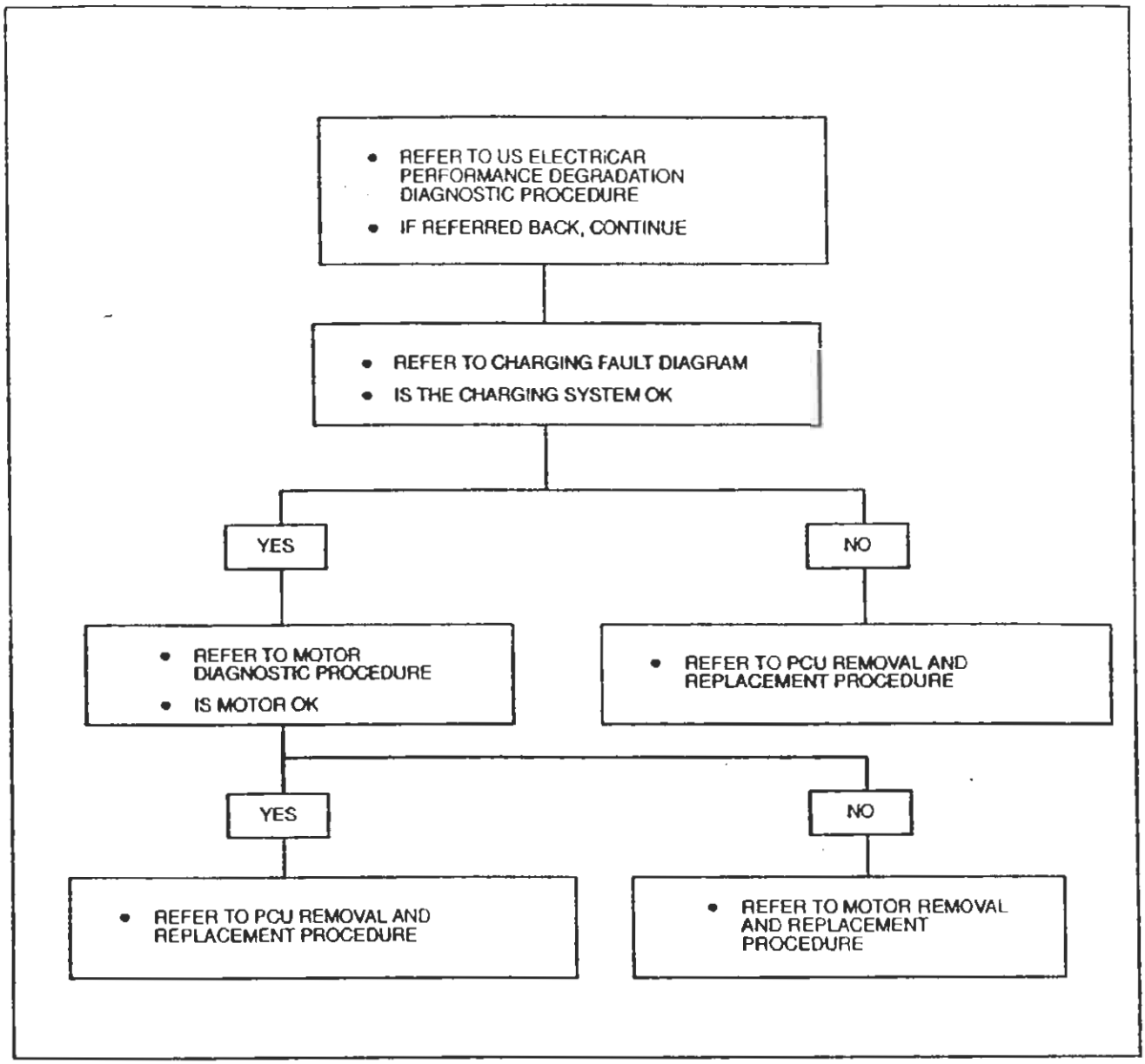


Figure 3-3. Miles Per Charge Has Degraded Diagnostic Procedure

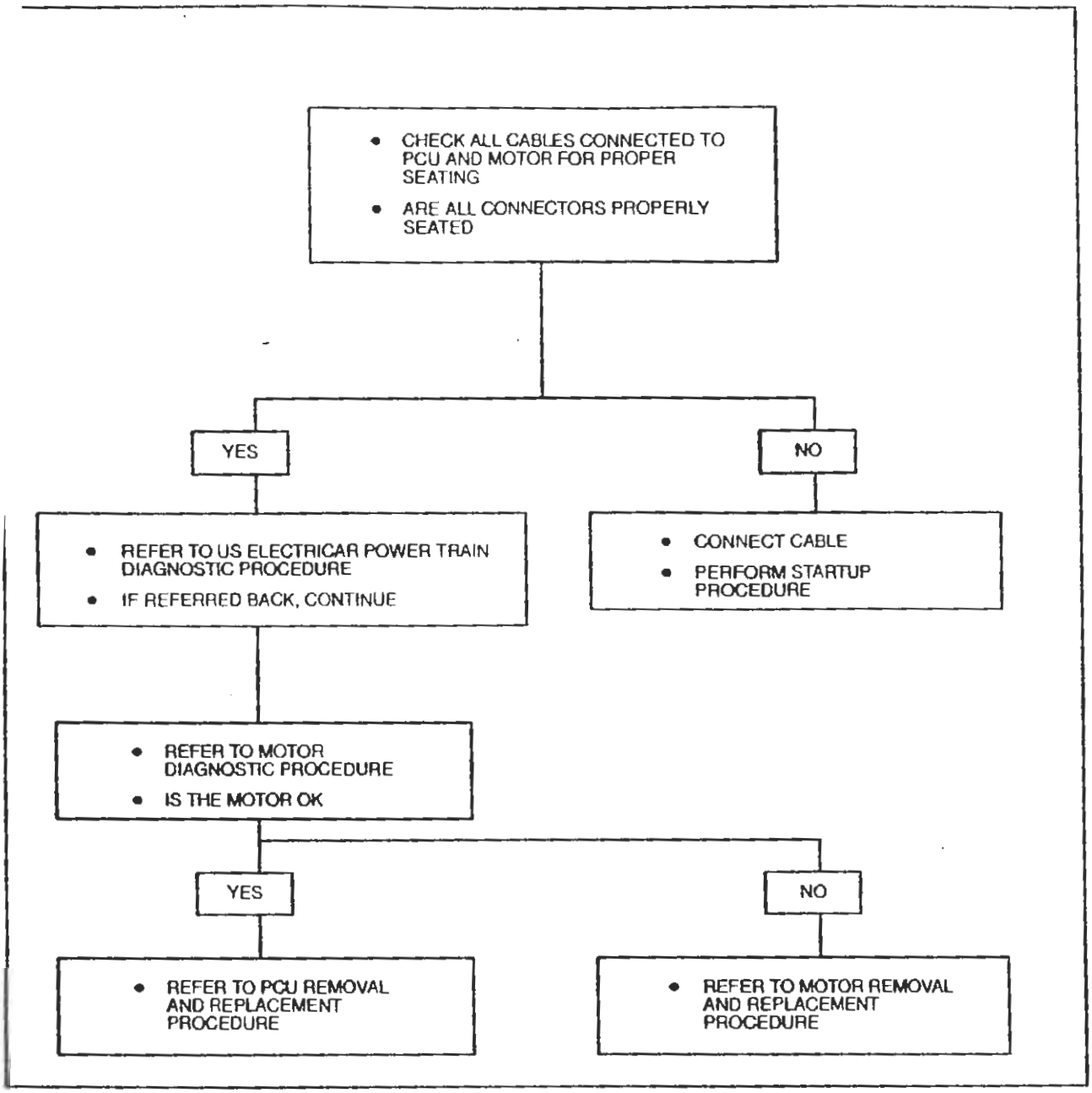


Figure 3-4. Vehicle Powers Down Unexpectedly Diagnostic Procedure

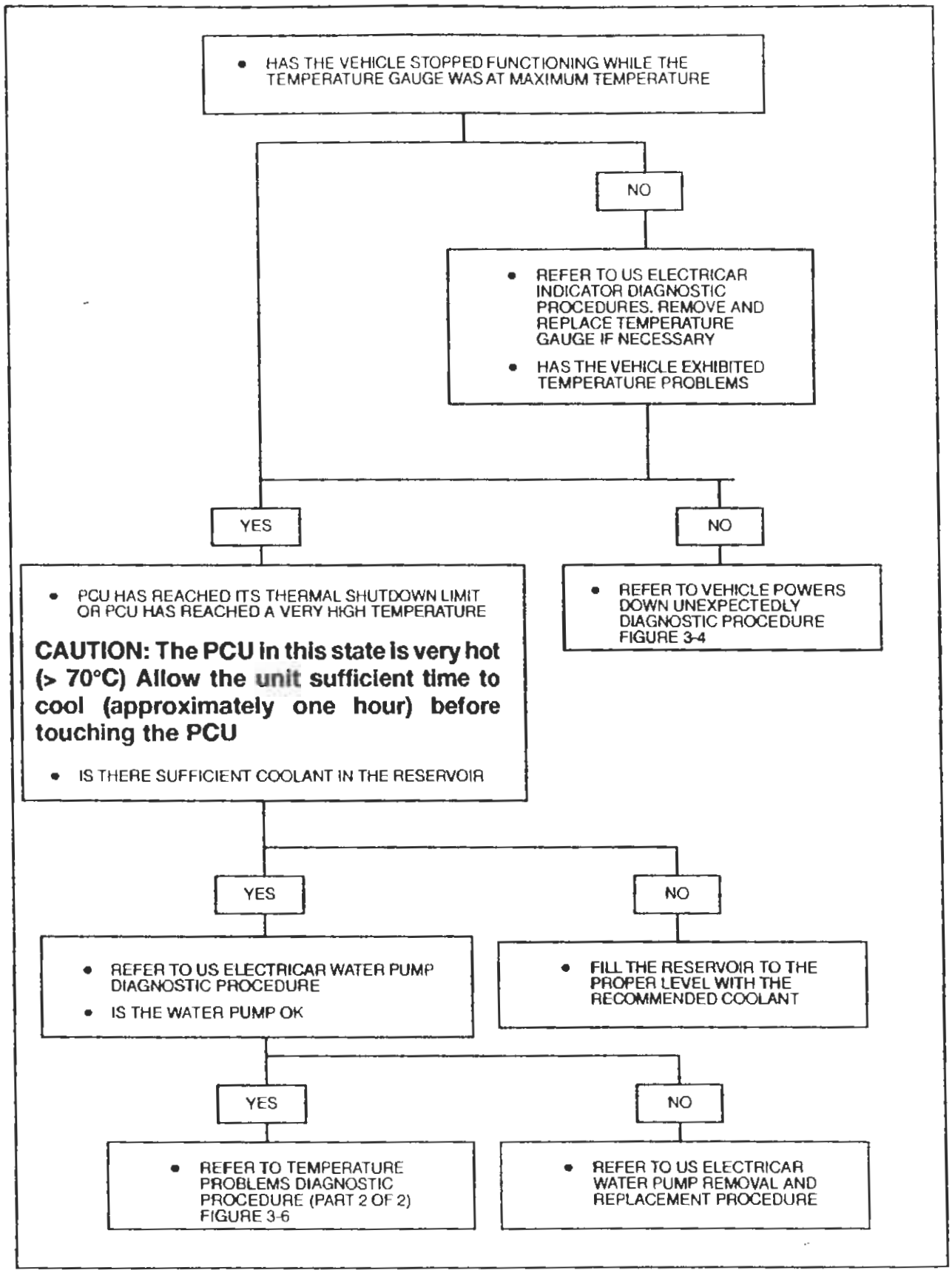


Figure 3-5. Temperature Problems Diagnostic Procedure (Part 1 of 2)

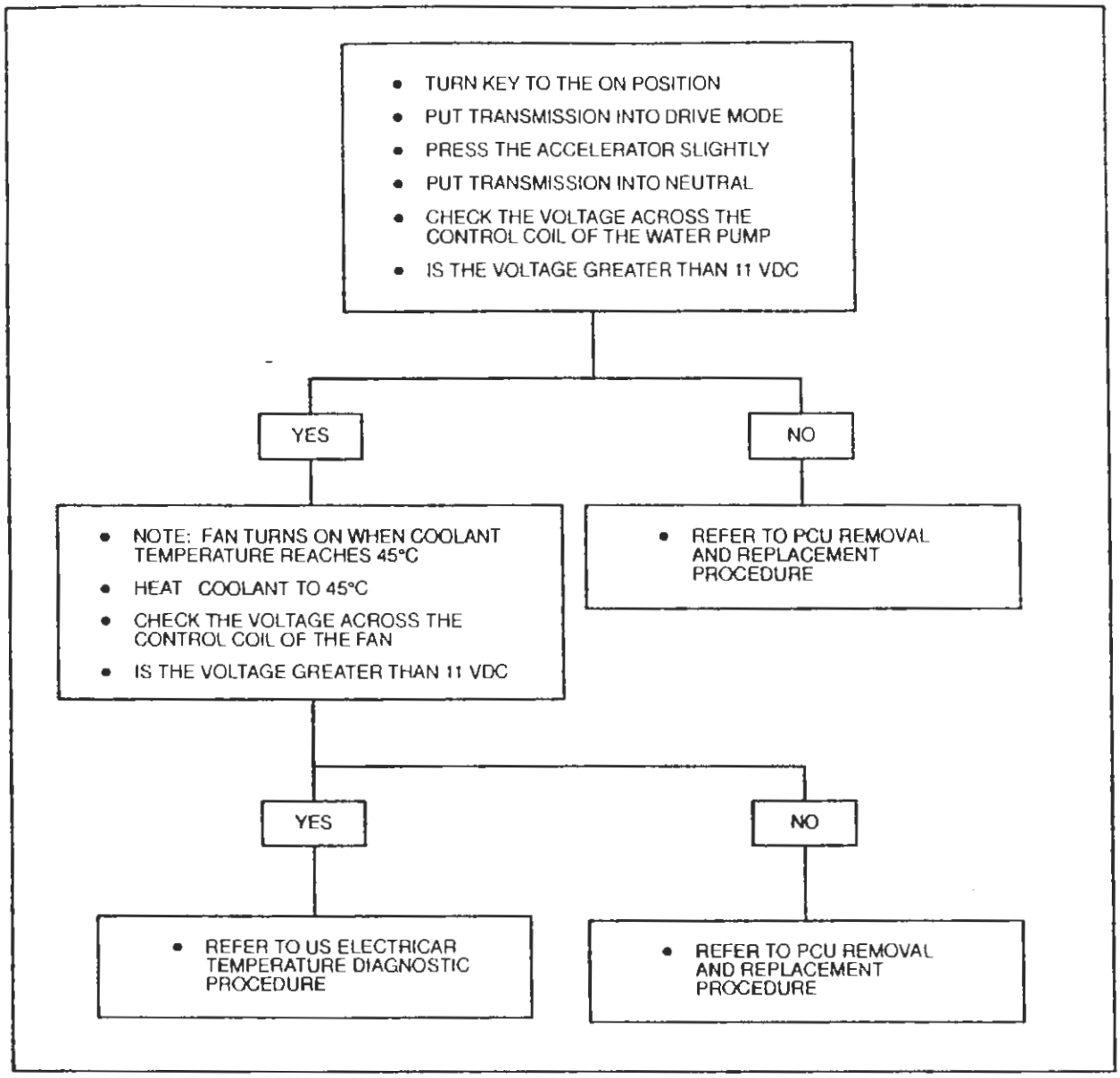


Figure 3-6. Temperature Problems Diagnostic Procedure (Part 2 of 2)

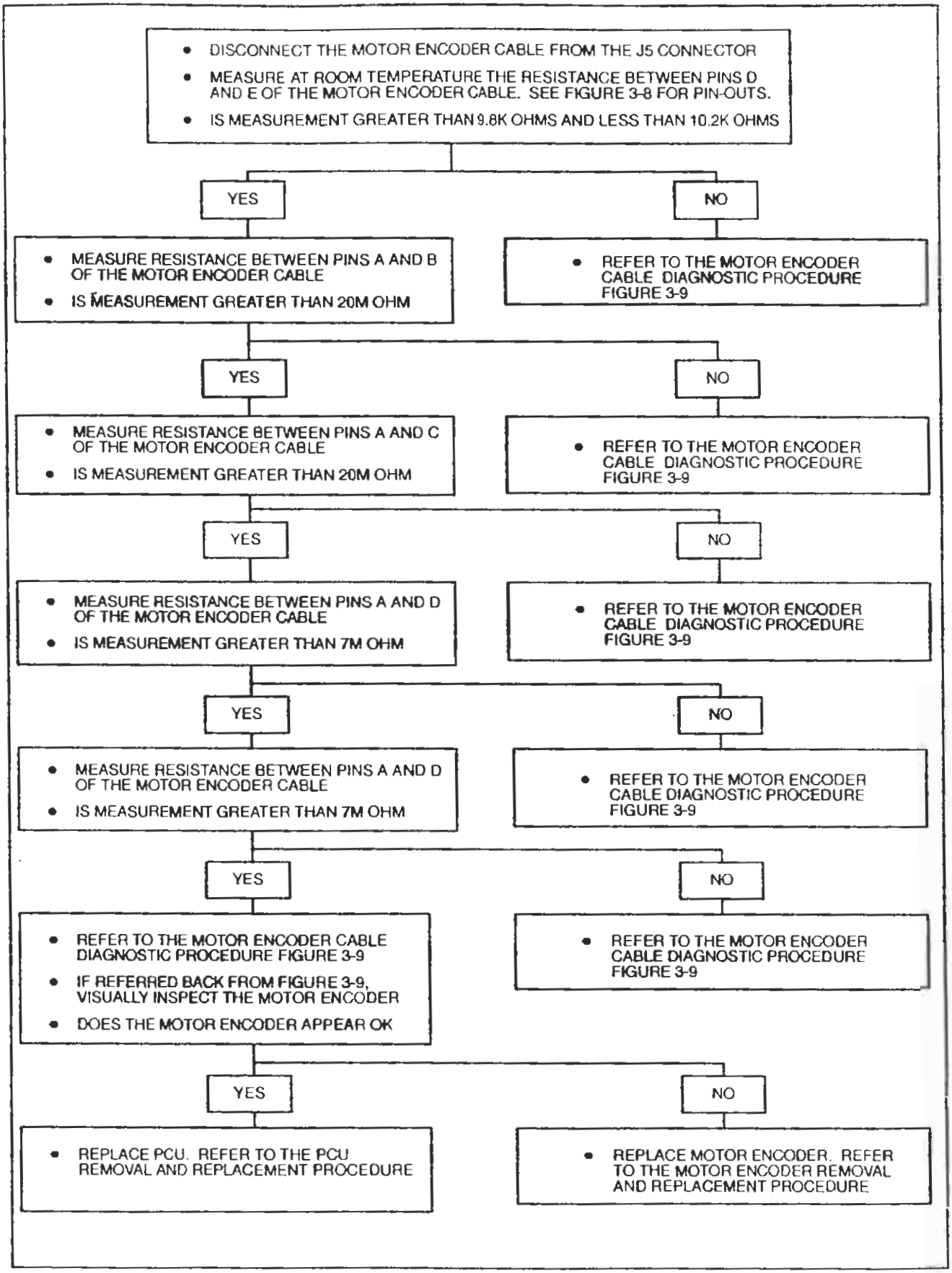


Figure 3-7. Motor Encoder Diagnostic Procedure

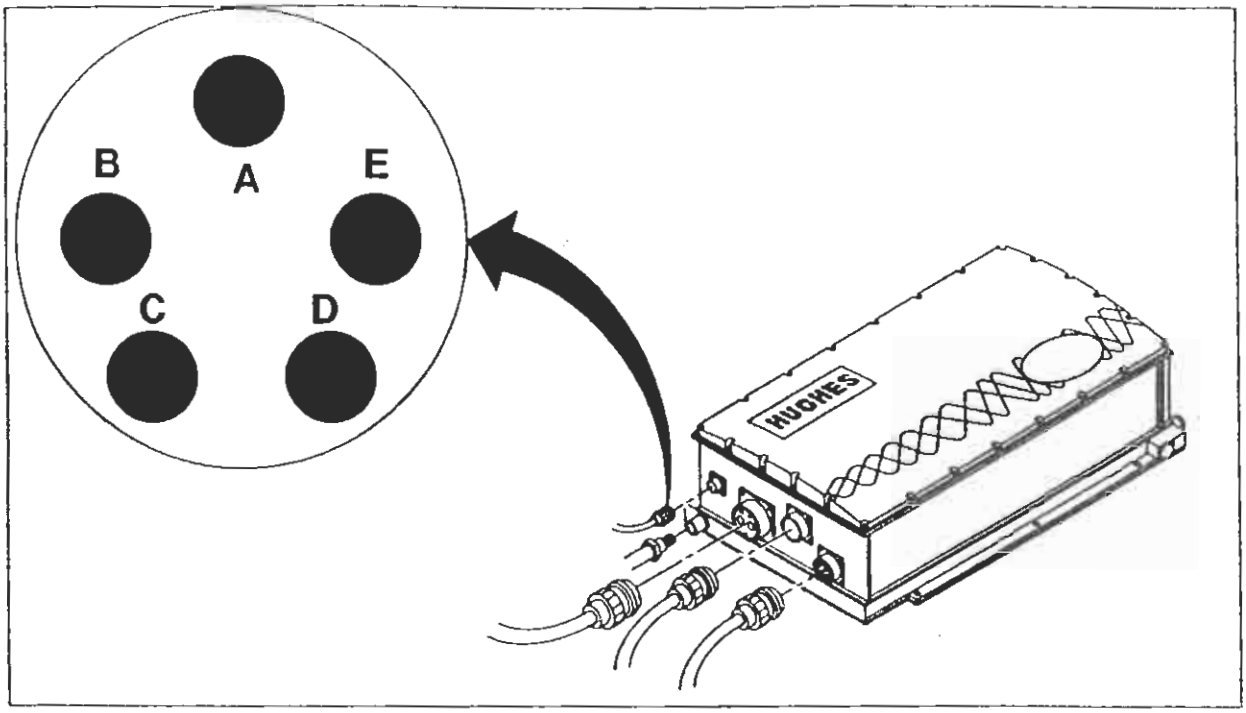


Figure 3-8. Motor Encoder Cable Pin-Out

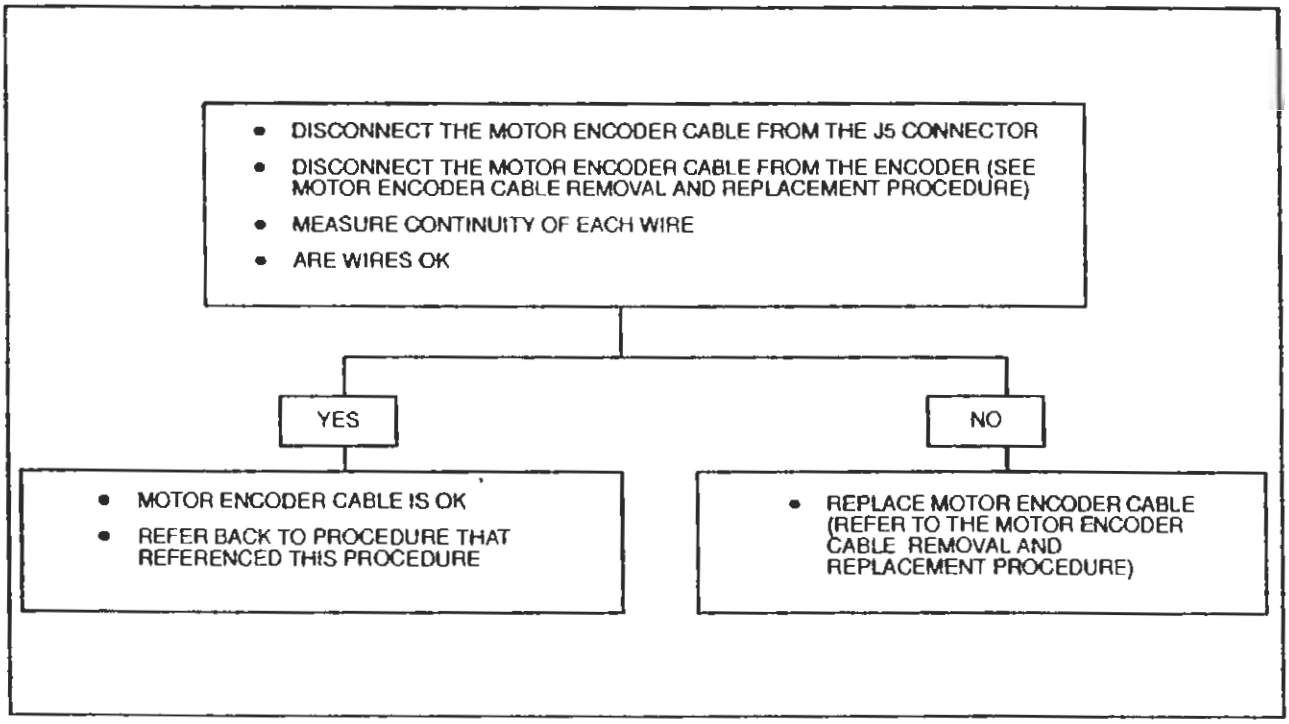


Figure 3-9. Motor Encoder Cable Diagnostic Procedure

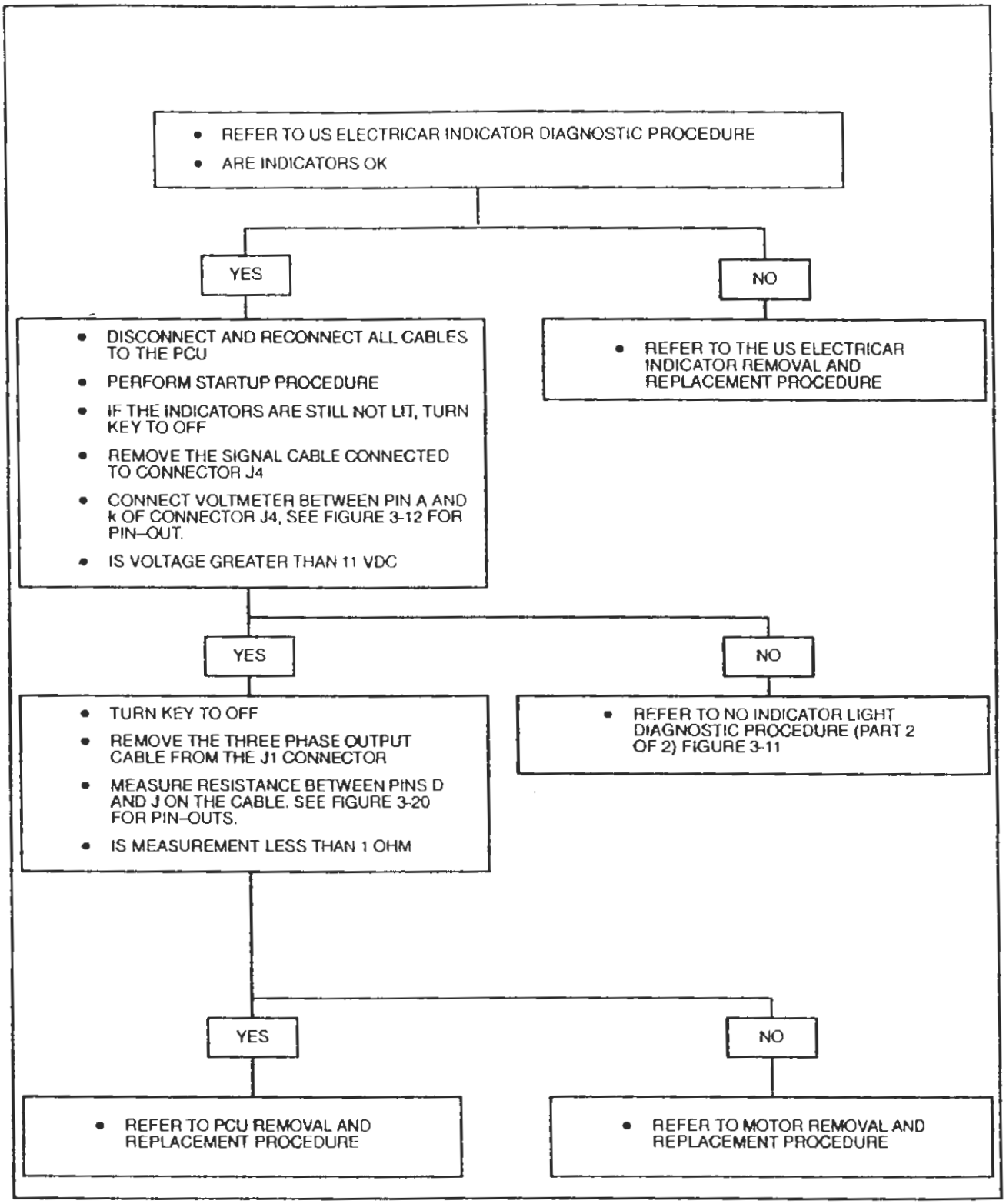


Figure 3-10. No Indicator Lights Diagnostic Procedure (Part 1 of 2)

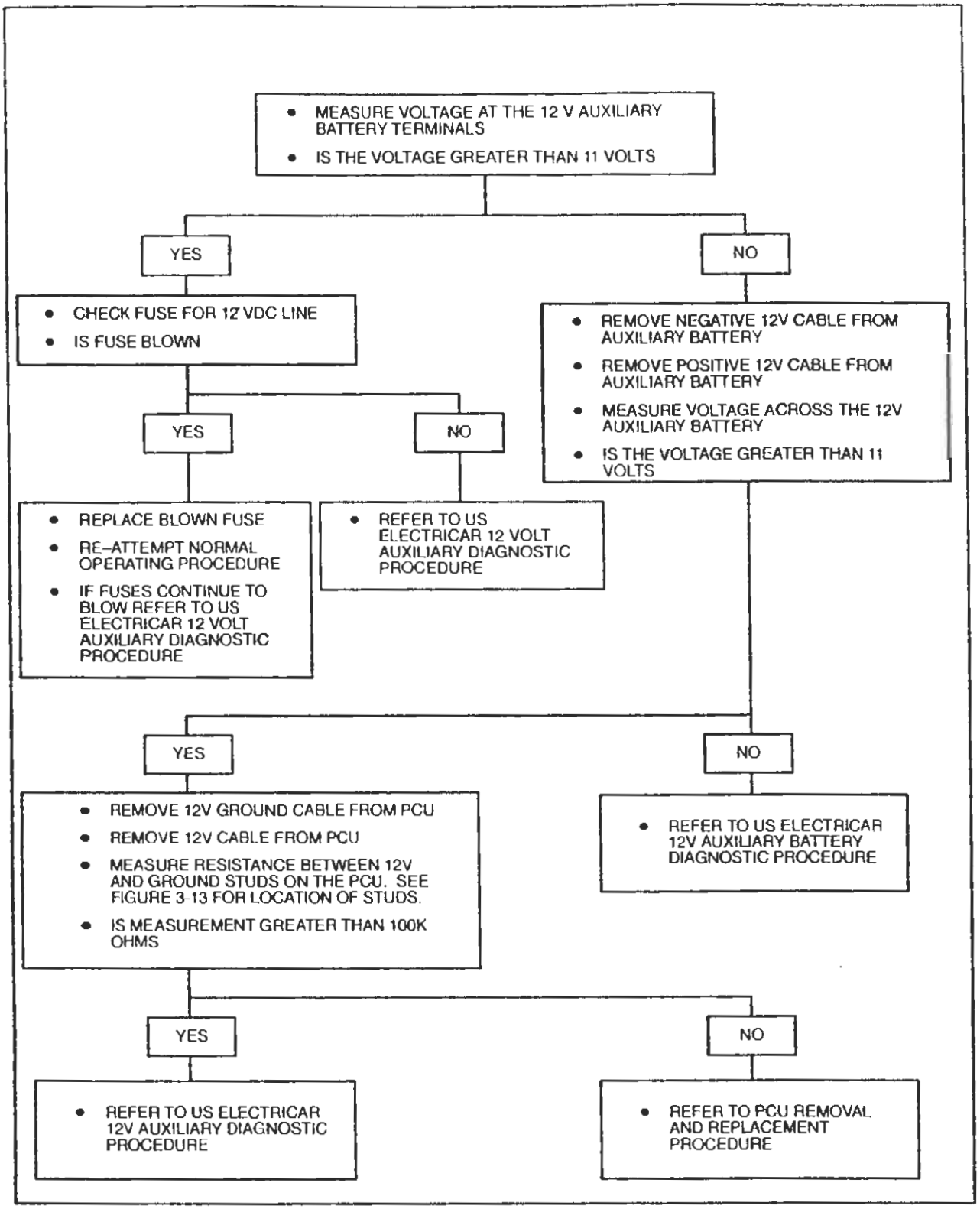


Figure 3-11. No Indicator Lights Diagnostic Procedure (Part 2 of 2)

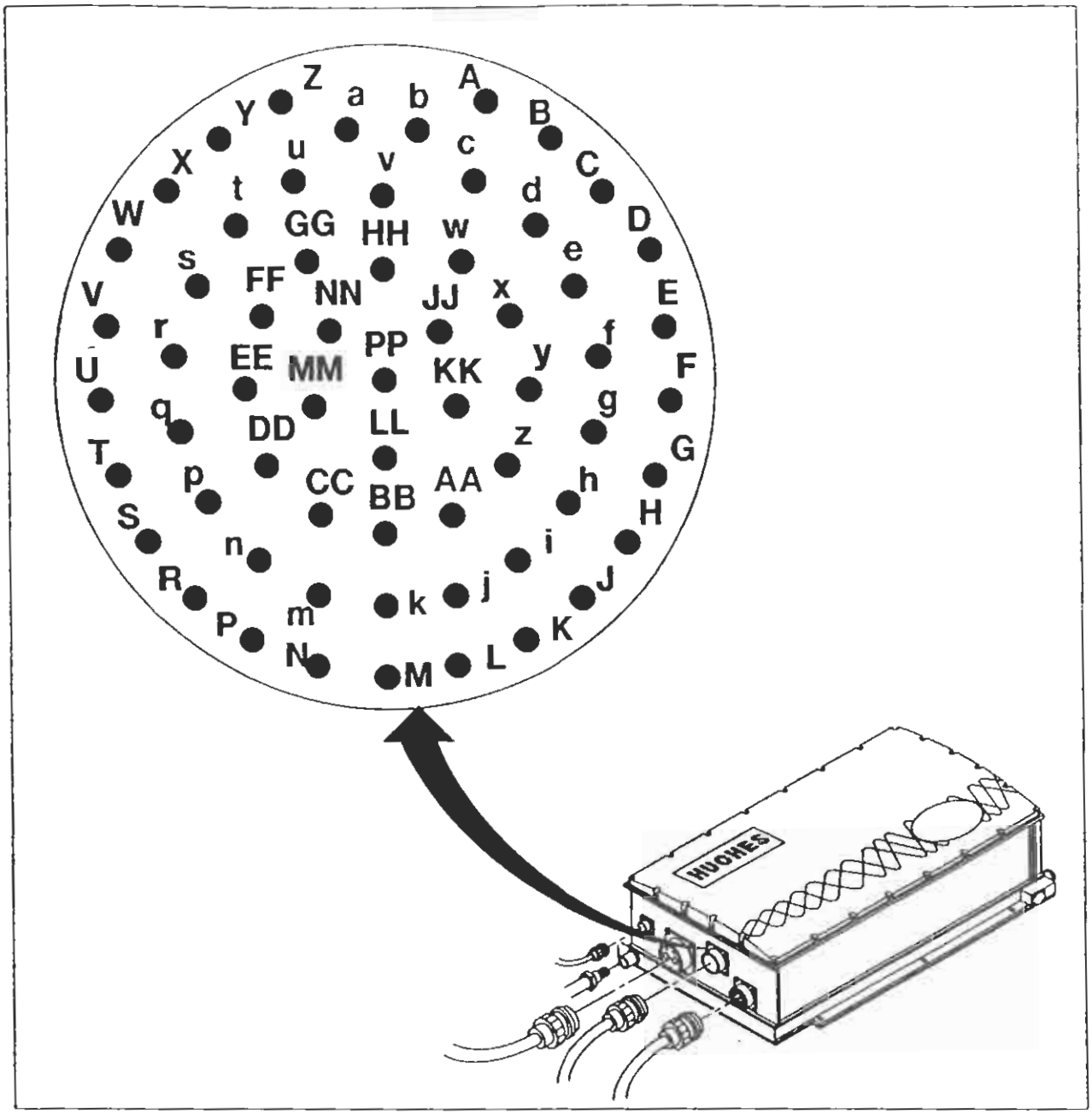


Figure 3-12. Signal Connector J4 Pin-Out

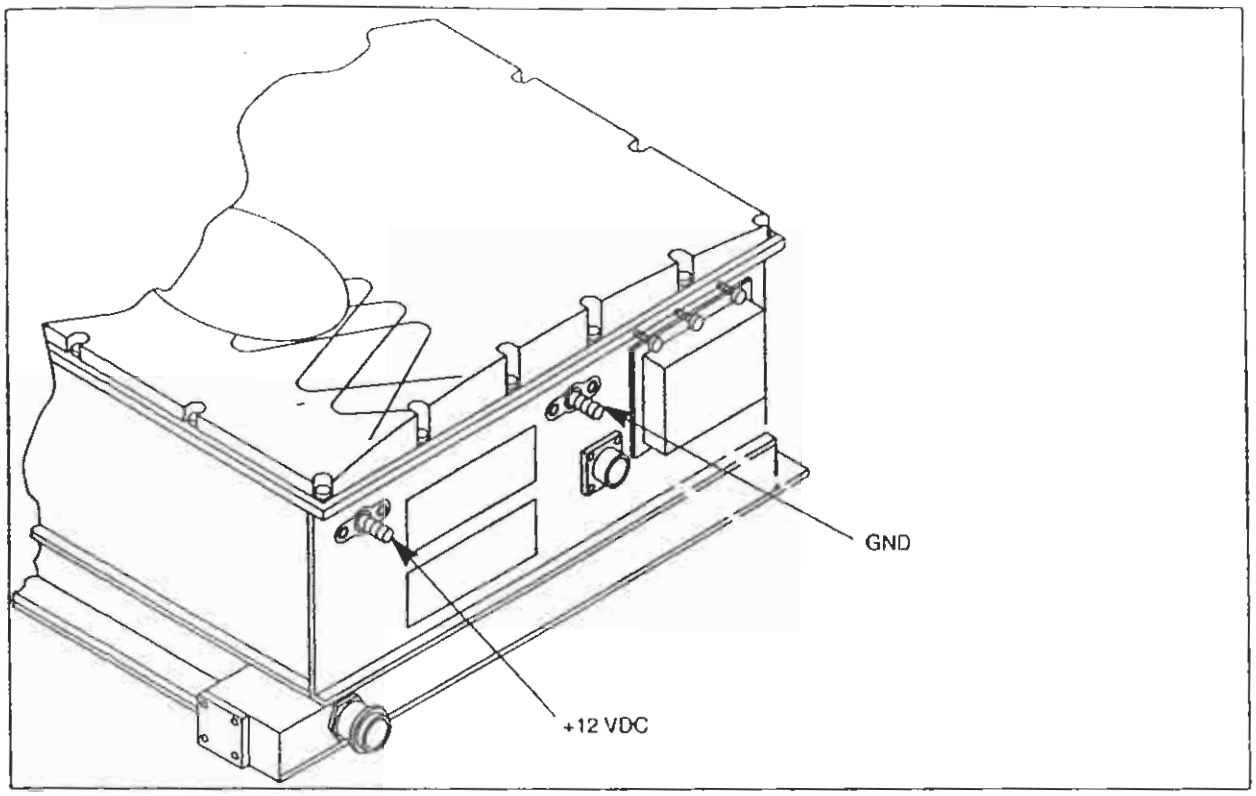


Figure 3-13. 12 VDC Power Location

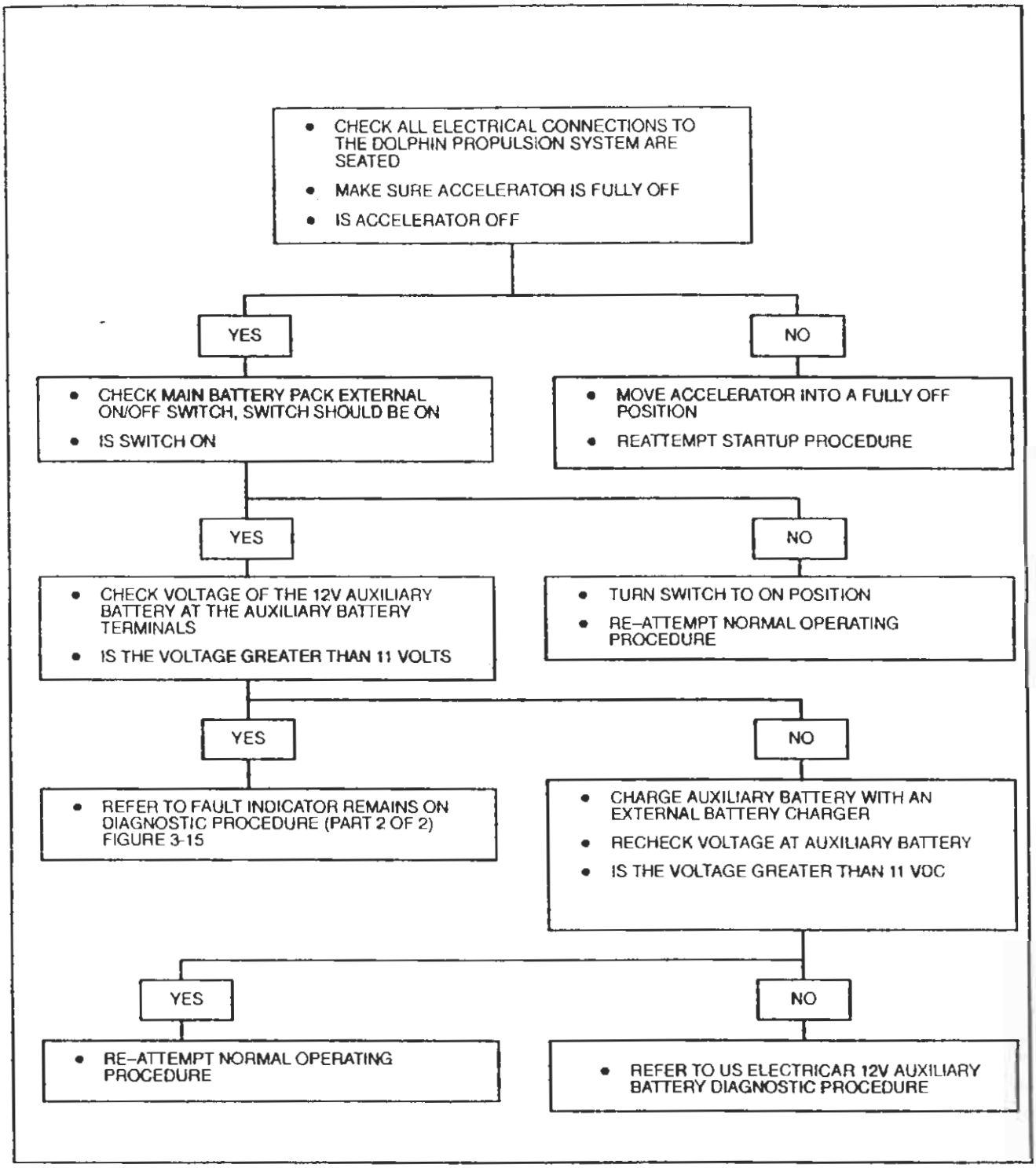


Figure 3-14. Fault Indicator Remains On Diagnostic Procedure (Part 1 of 2)

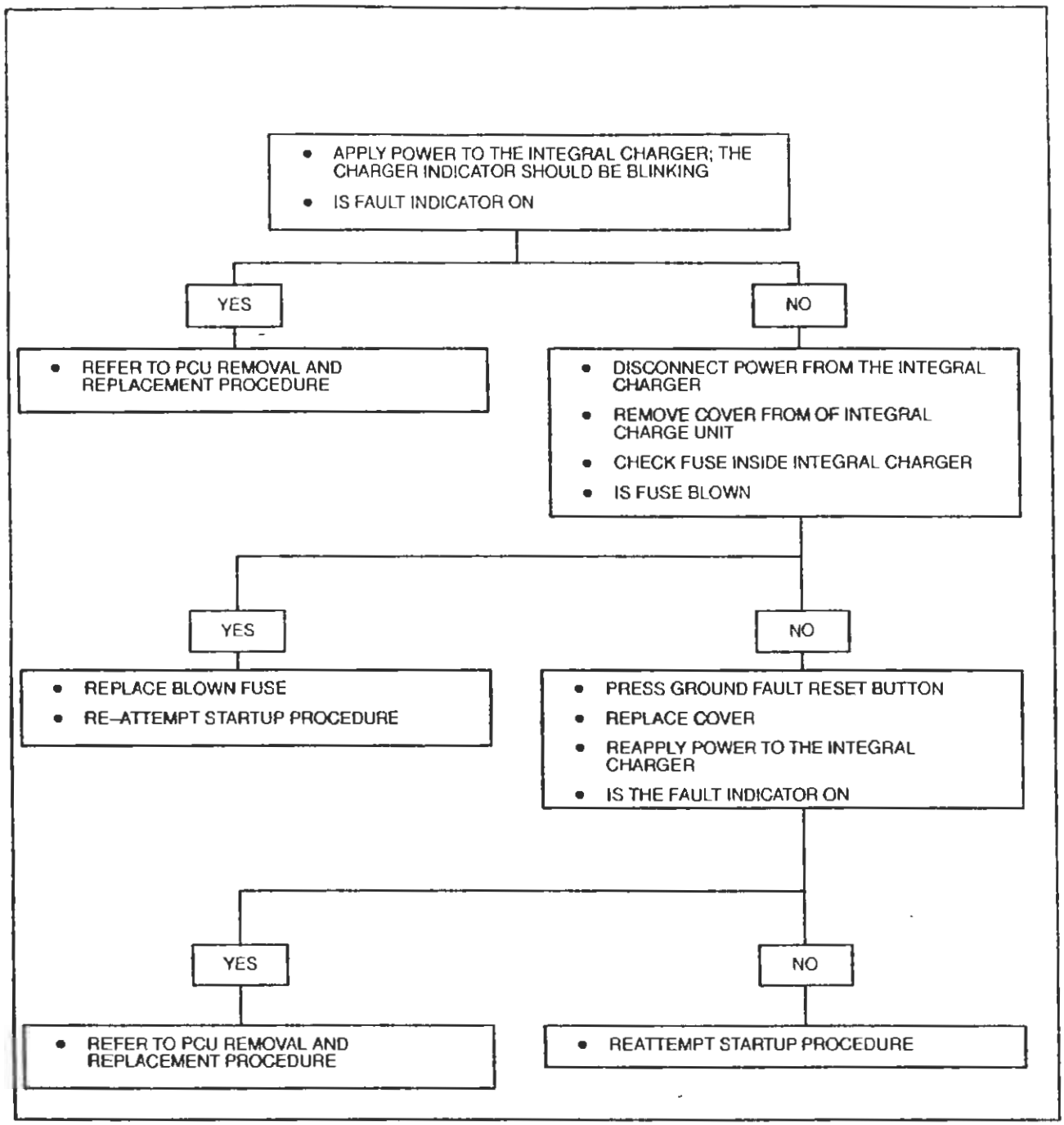


Figure 3-15. Fault Indicator Remains On Diagnostic Procedure (Part 2 of 2)

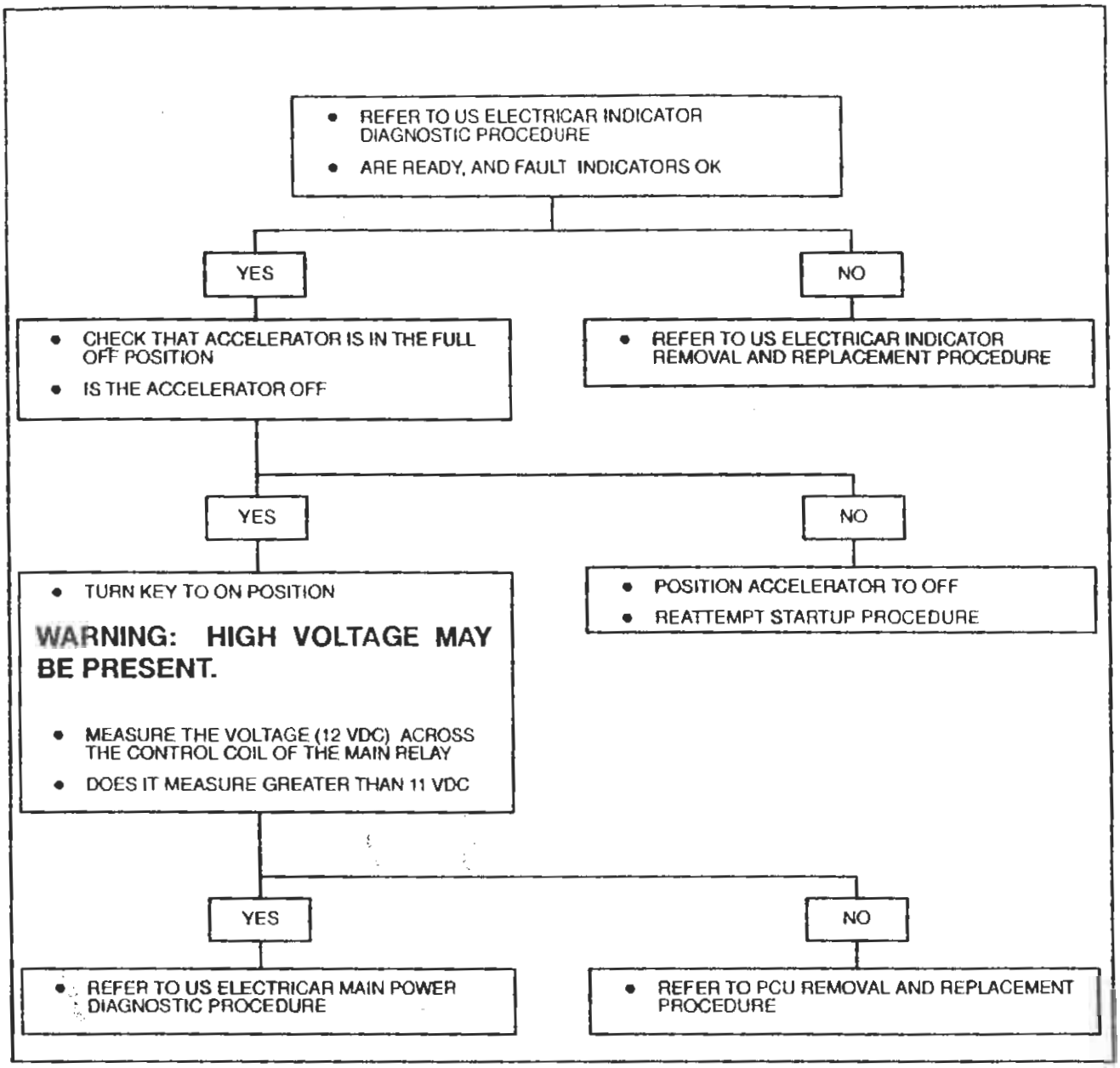


Figure 3-16. No Ready Indicator Diagnostic Procedure

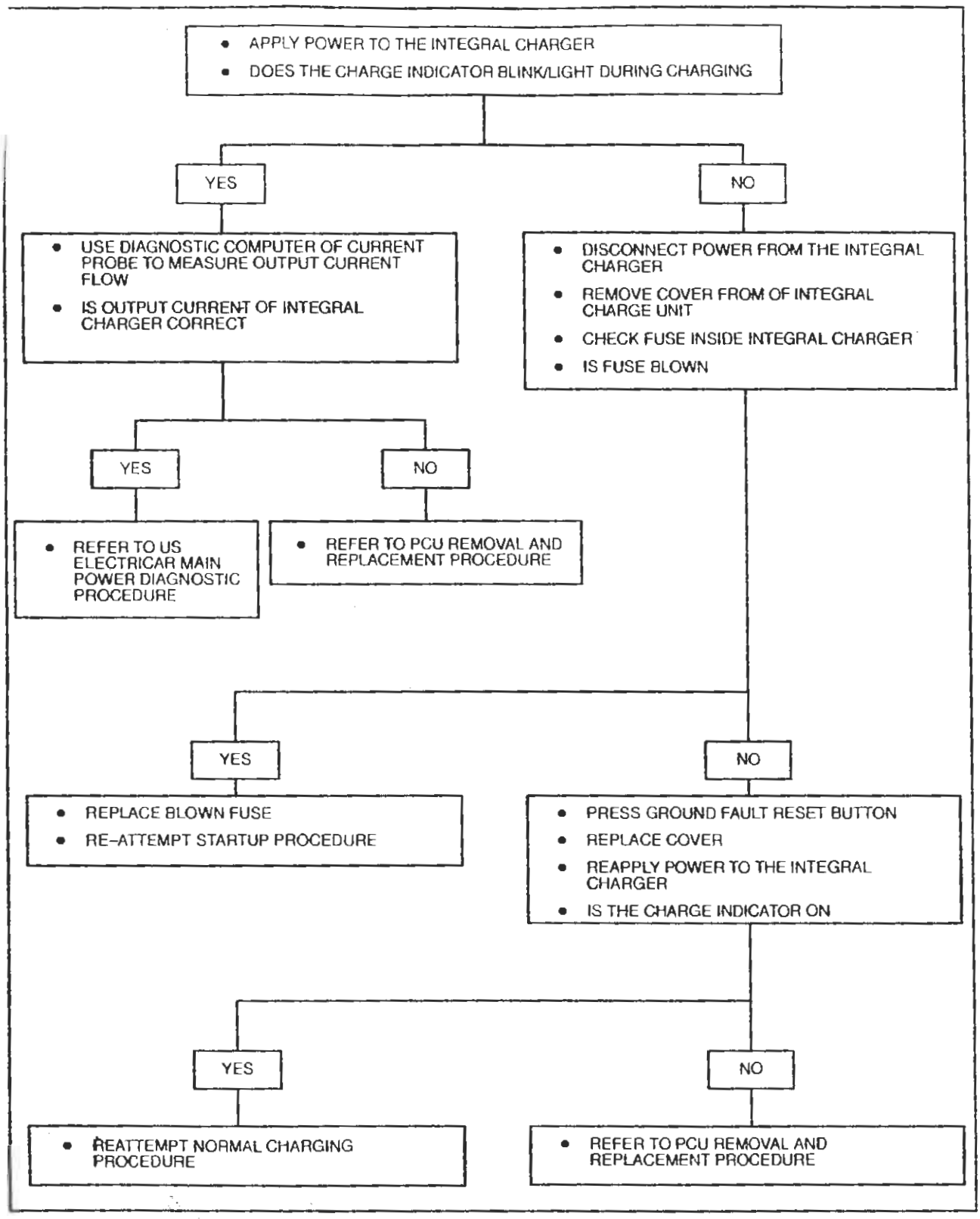


Figure 3-17. Integral Charger Diagnostic Procedure

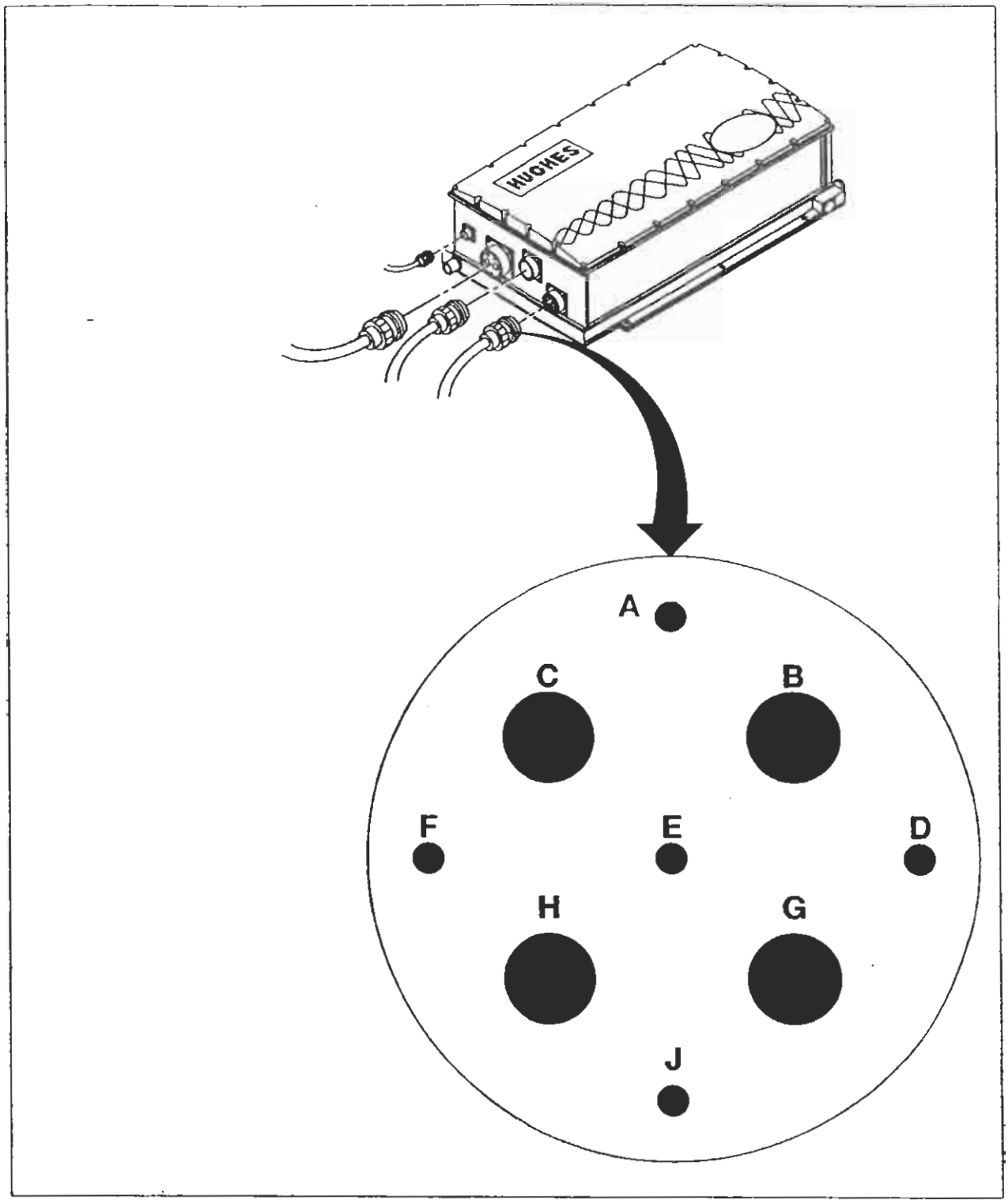


Figure 3-20. Three Phase AC Output Cable Pin-Out

TROUBLESHOOTING WITH DIAGNOSTIC COMPUTER PROCEDURE

- Note that the term drive A is only a reference. Depending on the set–up of the computer used substitute the drive and directory (if applicable) of the location where the Dolphin diagnostic program is located. Furthermore, the procedure will assume that there is a pointing device such as a mouse or trackball, keyboard equivalents will be given in parenthesis. To select an item the pointing device must be clicked once. The keyboard equivalents are usually two key combination that are selected simultaneously ie. Alt–D requires the user to press the ALTERNATE key and the D key simultaneously. Full explanation of each field in the motoring or charging display begins on page .

The diagnostic procedure is as follows:

1. Plug–in the RS–232 cable into the RS–232 port of the Dolphin PCU and computer.
2. Initiate and run the diagnostic program on the computer.
   a. Put the Dolphin test software disk into the A drive of the laptop.
   b. Log–onto drive A. The screen should look similar to Figure 3-21.
   c. Initiate the diagnostic program by typing DOLCOM. The screen should look similar to Figure 3-22.
   d. The initial diagnostic screen will look similar to Figure 3-23.
   e. Move the pointing device to the DATA menu and selected it (Alt–D). The screen should look similar to Figure 3-25.
   f. Select DISPLAY (D) and the screen should look similar to Figure 3-26 (motoring mode) or Figure 3-27 (charge mode). This is the diagnostics display.
3. Read the fault description and DSP status words and match the bits to the bits listed in table 3-3 or refer to the specific troubleshooting diagram for use with the laptop.
4. To exit the diagnostics program press 0 to return to the initial screen. See Figure 3-28.
5. To exit the program entirely, move the pointing device to the FILE menu and select it (ALT–F). The select EXIT (X). See Figure 3-29.

Figure 3-21. DOS Prompt

Figure 3-22. Computer Diagnostics Executable Program

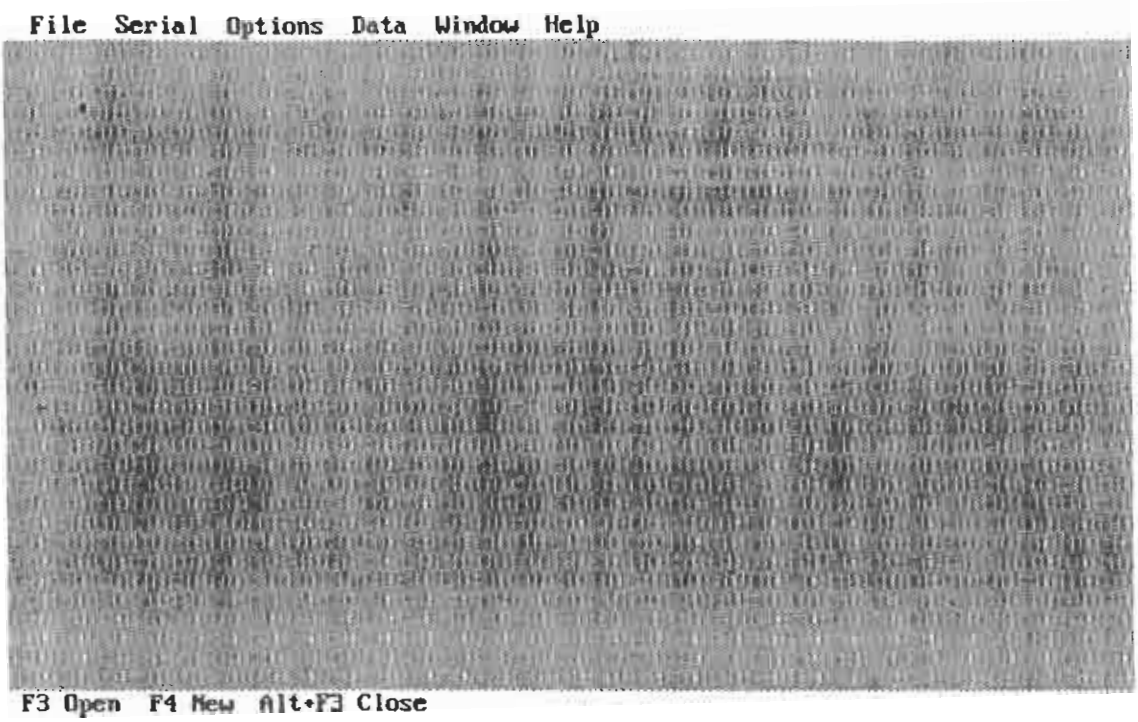


Figure 3-23. Computer Diagnostic Program Opening Screen

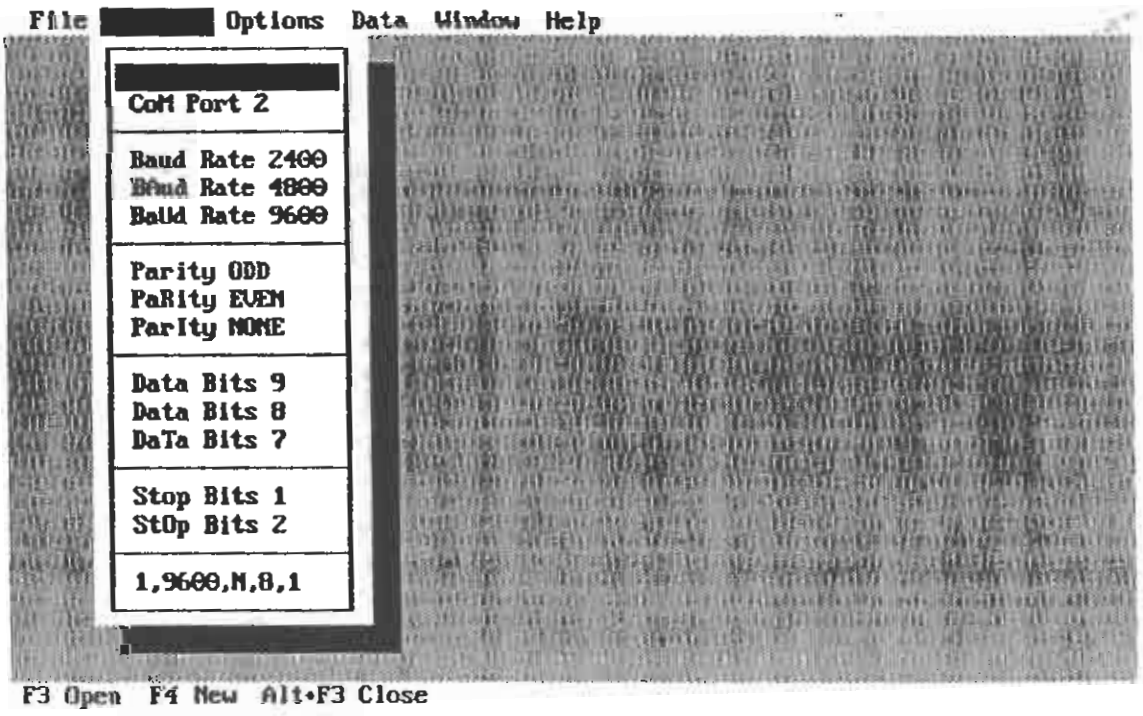


Figure 3-24. Serial Communication Set-up Screen

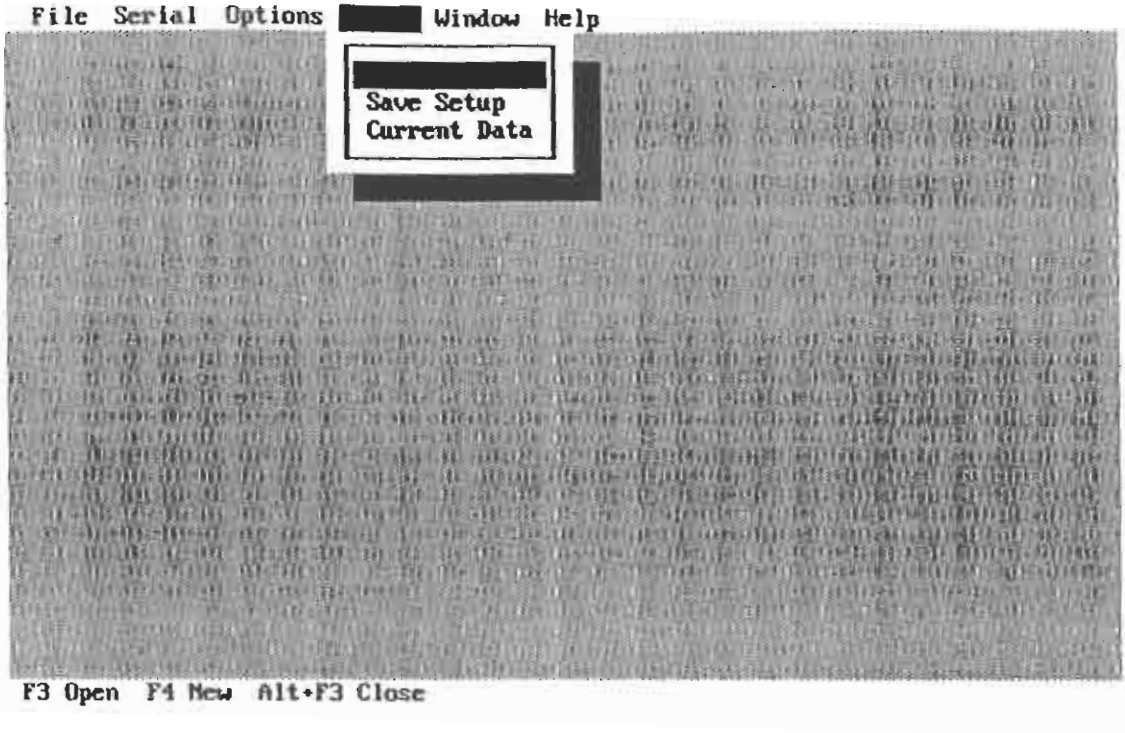


Figure 3-25. Diagnostic Display Initiate

*** DATA RAM EDIT SCREEN		MOTORING MODE ***		
STATUS	->	0 = Fault	31 = Accell	
Fault	->	1 = Status	32 = Accell1	
Veh Inf	->	2 = an0 (VBatt)	33 = Vregen	
Velocity (RPM)	->	3 = an1 (IBatt)	34 = id	
Velocity (MPH)	->	4 = an2 (Acc 0)	35 = iq	
Battery V	->	5 = an3 (Acc 1)	48 = batI	
Command Direction	->	-->	6 = an4 (Acc 2)	52 = Power
MOTOR Direction	->	7 = an5 (Brake)	64 = Vel Cmd	
12V Bias	->	8 = an6 (Regen)	132 = Anmintflt	
User Defined	->	9 = an7 (Isolation)	133 = Anmaxflt	
Battery Current	->	10 = an8 (P12V)	134 = Anmin Offset	
Power In	->	11 = an9 (Line Vac)	135 = isov	
Current Command %	->	12 = anA (Line Iac)	137 = Vmin	
Address User	->	14 = iop	145 = fwdlim	
		15 = Regen Gain	147 = batonmin	
		19 = position	151 = Slip < Base	
Cold Plate Temp	->	22 = Fault Delay	182 = Regen Drive	
		24 = vel1	183 = Regen Low	
Time Seconds	->	28 = BatI Offset	184 = Regen Two	
0: Exit		29 = vmul	206 = Slip	
1: Dolphin Unit Memory Read		30 = Brake	224 = SOC Out	
2: Vehicle Interface Memory Read		Enter Choice -->		

Figure 3-26. Motoring Mode Diagnostics Display

FINITIONS

RAM ADD 0			
3	X		Key On
2	X	Correlation	TBD
1	X	Brake	TBD
0	X	Accelerator	TBD

INITIONS

RAM ADD 1		
3	Park (1)	220/110 VAC
2	Internal	Vmode (1)
1	Stable (1)	Stable (1)
0	Enable (1)	Charge Port

EXPLANATION OF MOTORING MODE DISPLAY FIELDS

Turn Key to ON position, the "DATA RAM EDIT SCREEN MOTORING MODE" screen will show up with data filled in as follow;

*** DATA RAM EDIT SCREEN	MOTORING MODE ***		
STATUS ->	0000 1000 1011 0110	0 = Fault	31 = Accell
Fault ->	0000 0000 0000 0101	1 = Status	32 = Accell1
Veh Inf ->	1000 0000 0000 1011	2 = an0 (VBatt)	33 = Vregen
Velocity (RPM) ->	0.00	3 = an1 (IBatt)	34 = id
Velocity (MPH) ->	0.00	4 = an2 (Acc 0)	35 = iq
Battery V ->	335.40	5 = an3 (Acc 1)	48 = batI
Command Direction ->	DRIVE	6 = an4 (Acc 2)	52 = Power
MOTOR Direction ->	FORWARD	7 = an5 (Brake)	64 = Vel Cmd
12V Bias ->	11.32	8 = an6 (Regen)	132 = Anminflt
User Defined ->		9 = an7 (Isolation)	133 = Anmaxflt
Battery Current ->		10 = an8 (P12V)	134 = Anmin Offset
Power In ->	0.00	11 = an9 (Line Vac)	135 = isov
Current Command % ->	0.00	12 = anA (Line Iac)	137 = Vmin
Address User ->		14 = iop 145 = fwdlim	
	15 = Regen Gain	147 = batonmin	
	19 = position	151 = Slip < Base	
Dolphin Unit Temp ->	35	22 = Fault Delay	182 = Regen Drive
	24 = vel1	183 = Regen Low	
Time Seconds ->	1.5	28 = BatI Offset	184 = Regen Two
0: Exit	29 = vmul	206 = Slip	
1: Dolphin Unit Memory Read	30 = Brake	224 = SOC Out	
2: Vehicle Interface Memory Read	Enter Choice ->		
Accel Correl			

VEH INF FIELD

The *Veh Inf* field consists of 16 bits in combination of 0s or 1s. Each 0 or 1 represents different vehicle interface status. The left most bit represents the most significant bit (MSB); the right most bit represents the least significant bit (LSB). The following table explains each status bit:

Bit F (bit 15)	–	Dolphin Unit fault status
	1	Dolphin unit has fault
	0	Dolphin unit is fine
Bit E (bit 14)	–	Overheat status
	1	Dolphin unit or/and motor is overheated
	0	Dolphin unit or/and motor is not overheated
Bit D (bit 13)	–	Not implemented yet
Bit C (bit 12)	–	Not implemented yet
Bit B (bit 11)	–	Not implemented yet
Bit A (bit 10)	–	Not implemented yet
Bit 9	–	Charge port status
	1	Charge port is being used
	0	Charge port is not being used
Bit 8	–	Not implemented yet
Bit 7	–	Park Brake Status
	1	Parking brake is on
	0	Parking brake is off
Bit 6	–	Brake High Switch Status (If installed)
	1	High limit brake switch on by pressing on the brake
	0	No high limit brake switch on
Bit 5	–	Brake Low Switch Status (If installed)
	1	Low limit brake switch on by pressing on the brake
	0	No low limit brake switch on
Bit 4	–	*PRNDLP Switch Status
	1	PRNDLP switch on
	0	PRNDLP switch off
Bit 3	–	*PRNDLC Switch Status
	1	PRNDLC switch on
	0	PRNDLC switch off
Bit 2	–	*PRNDLB Switch Status
	1	PRNDLB switch on
	0	PRNDLB switch off
Bit 1	–	*PRNDLA Switch Status
	1	PRNDLA switch on
	0	PRNDLA switch off
Bit 0	–	Key on Status
	1	Key is ON position
	0	Key is OFF

* *Combination of PRNDLP, PRNDLC, PRNDLB, and PRNDLA switches determines the transmission selection*

VELOCITY (RPM) FIELD

The *Velocity (RPM)* field represents the motor speed in revolutions per minutes while the vehicle is in motion.

VELOCITY (MPH) FIELD

The *Velocity (MPH)* field represents the vehicle speed in miles per hour while the vehicle is in motion.

BATTERY V FIELD

The *Battery V* field represents the battery voltage in Volts.

COMMAND DIRECTION FIELD

The *Command Direction* field represents the transmission selection.

MOTOR DIRECTION FIELD

The *MOTOR Direction* field represents the state of the motor direction.

12V BIAS FIELD

The *12V Bias* field represents the 12V bias supply voltage in Volts.

USER DEFINED FIELD

The *User Defined* field prints out the value of the Dolphin Unit processor memory location that user specified. Following is how to read the memory location:

1. Type 1 or **2 (DO NOT HIT RETURN)**

   1 – To read the Dolphin Unit controller memory location (Memory location and its usage is already on the screen, also refer to RAM description table)

   2 – To read the vehicle interface controller memory location (None on screen, refer to RAM description table)

2. Type memory location address and return field
3. The value will show up in the *User Defined*

BATTERY CURRENT FIELD

The *Battery Current* field represents the battery current in Ampere.

POWER IN FIELD

The *Power In* field represents the power going into the motor while the accelerator pedal is depressed and the vehicle is moving.

CURRENT COMMAND % FIELD

The *Current Command %* field represents current command in use.

ADDRESS USER <UNIT|VEH> FIELD

The *Address User <UNIT|VEH>* field prints out the memory address that the user specified. Either *UNIT* or *VEH* prints out depends on the user selection.

DOLPHIN UNIT TEMP FIELD

The *Dolphin Unit Temp* field represents the temperature of the Dolphin Unit in Celsius.

TIME SECONDS FIELD

The *Time Seconds* field represents how long the communication between the PC and the Dolphin Unit been up. This field does not updates unless communication link is connected, therefore, if this field is not updating, then the communication link is not connected.

MOTOR TEMP FIELD

The *Motor Temp* field is a hidden field. To read the motor temperature:

1. Type **1 (DO NOT HIT RETURN)**
2. Type **238** and **RETURN**
3. The *Motor Temp* field shows up with the motor temperature in Celsius line after the Dolphin Unit Temp

To hide the *Motor Temp* field:

1. Type **1 (DO NOT HIT RETURN)**
2. Type **any memory address** and **RETURN**
3. The *Motor Temp* field will hide

FAULT DESCRIPTION FIELD

In the very last line, all the fault description prints out, if any fault occurs. In the example screen above, the **Accel** and **Correl** faults shows.

EXPLANATION OF EACH FIELD ON SCREEN IN CHARGING MODE

Plug in the INDUCTIVE CHARGE Paddle to the charge port, or connect the AC plug to the power outlet, the following screen will show up:

```
*** DATA RAM EDIT SCREEN  CHARGE MODE ***
STATUS   ->   0001 1100 1001 0010        0 = Fault          147 = Bat On Min
FAULT    ->   0000 0000 0000 0000        1 = Status         160 = Vchrgslope
Veh Inf  ->   0000 0000 0000 0000        2 = Battery V      161 = Vchrgoff
                                         3 = Battery I      162 = Vchrgstart
Vac Peak          ->   155.56            9 = Isolation      163 = Vmulmax
Iac Peak          ->   3.02              11 = Line Vac      164 = Vchrgmx
VBat              ->   329.24            12 = Line Iac      165 = IREF Offset
IBat              ->   -1.05             14 = IOP(dsp in)   166 = VAC min off
Vac * Iac         ->   234.90            15 = Regen Gain    167 = Bat min On
User Defined      ->                     22 = Delay         168 = Max Current
P12V              ->   11.45             28 = Batl offset   169 = VAC Min
Dolphin Unit Temp ->   38                29 = vmul          170 = VBATMx LtchOff
                                         48 = Batl          171 = IAC Min LtchOFF
Address User      ->                     52 = Power         173 = Trickle Ref
                                         54 = Chrg Scale    174 = 120VAC Ref
                                         55 = vacmax        175 = 220VAC Ref
Charge Mode       ->   NORMAL            56 = iref 176 = chrselmx
AC Relay          ->   CLOSED            58 = iacmax        177 = Vmode Delay
Time Seconds      ->   3.2               135 = Isov         178 = Imode Delay
0: Exit                138 = Bat Off Min
1: Dolphin Unit Memory Read
2: Vehicle Interface Read              Enter Choice ->
```

STATUS FIELD

The *STATUS* field consists of 16 bits in combination of 0s or 1s. Each 0 or 1 represents different status of vehicle. The left most bit represents the most significant bit (MSB); the right most bit represents the least significant bit (LSB). The following table explains each status bit:

Bit F (bit 15)	–	Not implemented yet
Bit E (bit 14)	–	Test (Used in testing Dolphin Unit)
	1	Test mode
	0	Regular motoring mode
Bit D (bit 13)	–	Charge Complete Status
	1	Charge complete
	0	Charge in process
Bit C (bit 12)	–	Charge Mode
	1	Charge mode
	0	Motoring mode
Bit B (bit 11)	–	Main Relay Status
	1	Main Relay Closed
	0	Main Relay Opened
Bit A (bit 10)	–	AC Relay Status
	1	AC Relay Closed
	0	AC Relay Opened
Bit 9	–	Not implemented yet
Bit 8	–	Not implemented
Bit 7	–	PreCharge Relay Status
	1	PreCharge Relay Closed
	0	PreCharge Relay Opened
Bit 6	–	Not implemented yet
Bit 5	–	Not implemented yet
Bit 4	–	NORMAL Charge Mode Status
	1	Normal charge mode
	0	Trickle charge mode
Bit 3	–	220/110 VAC Selection Status
	1	220 Selected
	0	110 Selected
Bit 2	–	Not implemented yet
Bit 1	–	Dolphin system status
	1	Stable
	0	Not stable (Vehicle will not move)
Bit 0	–	Charge Port Selection Status
	1	Charge port is being used
	0	Charge port is not being used

FAULT FIELD

The *Fault* field consists of 16 bits in combination of 0s or 1s. Each 0 or 1 represents different fault status of vehicle. The left most bit represents the most significant bit (MSB); the right most bit represents the least significant bit (LSB). The following table explains each status bit:

Bit F (bit 15)	–	Not implemented yet
Bit E (bit 14)	–	Isolation fault status
	1	Isolation fault exist
	0	No isolation fault
Bit D (bit 13)	–	Battery High fault status
	1	Battery voltage is too high (higher than 370 Volts)
	0	No battery high fault
Bit C (bit 12)	–	Battery Low fault status
	1	Battery voltage is too low (lower than 270 Volts)
	0	No battery low fault
Bit B (bit 11)	–	IGBT fault status
	1	IGBT fault exist
	0	No IGBT fault
Bit A (bit 10)	–	P12V fault
	1	12 volts bias supply is too low (lower than 10 Volts)
	0	12 volts bias supply is fine
Bit 9	–	Power Down Status bit
	1	Power down sequence has been activated in the Dolphin Unit
	0	No power down sequence activated
Bit 8	–	Not implemented yet
Bit 7	–	AC Voltage Low Status
	1	AC in voltage is low
	0	AC in voltage is O.K.
Bit 6	–	Overheat
	1	Dolphin Unit or/and Motor is overheated
	0	No overheat condition
Bit 5	–	Interlock fault status
	1	Interlock fault exist (interlock is opened)
	0	No interlock fault (interlock is closed)
Bit 4	–	Charge Port status
	1	Charge port is being utilized
	0	Charge port is not being used
Bit 3	–	Key ON status
	1	Key is ON position
	0	Key is OFF
Bit 2	–	Not implemented yet
Bit 1	–	Not implemented yet
Bit 0	–	Not implemented yet

VEH INF FIELD

The *Veh Inf* field consists of 16 bits in combination of 0s or 1s. Each 0 or 1 represents different vehicle interface status. The left most bit represents the most significant bit (MSB); the right most bit represents the least significant bit (LSB). The following table explains each status bit:

Bit F (bit 15)	–	Dolphin Unit fault status
	1	Dolphin unit has fault
	0	Dolphin unit is fine
Bit E (bit 14)	–	Overheat status
	1	Dolphin unit or/and motor is overheated
	0	Dolphin unit or/and motor is not overheated
Bit D (bit 13)	–	Not implemented yet
Bit C (bit 12)	–	Not implemented yet
Bit B (bit 11)	–	Not implemented yet
Bit A (bit 10)	–	Not implemented yet
Bit 9	–	Charge port status
	1	Charge port is being used
	0	Charge port is not being used
Bit 8	–	Not implemented yet
Bit 7	–	Park Brake Status
	1	Parking brake is on
	0	Parking brake is off
Bit 6	–	Brake High Switch Status (If installed)
	1	High limit brake switch on by pressing on the brake
	0	No high limit brake switch on
Bit 5	–	Brake Low Switch Status (If installed)
	1	Low limit brake switch on by pressing on the brake
	0	No low limit brake switch on
Bit 4	–	*PRNDLP Switch Status
	1	PRNDLP switch on
	0	PRNDLP switch off
Bit 3	–	*PRNDLC Switch Status
	1	PRNDLC switch on
	0	PRNDLC switch off
Bit 2	–	*PRNDLB Switch Status
	1	PRNDLB switch on
	0	PRNDLB switch off
Bit 1	–	*PRNDLA Switch Status
	1	PRNDLA switch on
	0	PRNDLA switch off
Bit 0	–	Key on Status
	1	Key is ON position
	0	Key is OFF

* *Combination of PRNDLP, PRNDLC, PRNDLB, and PRNDLA switches determines the transmission selection*

VAC PEAK FIELD

The *Vac Peak* field represents the peak voltage of the AC line in.

IAC PEAK FIELD

The *Iac Peak* field represents the peak current of the AC line in.

VBAT FIELD

The *VBat* field represents the battery voltage in Volts.

IBAT FIELD

The *IBat* field represents the battery current in Ampere.

VAC * IAC FIELD

The *Vac * Iac* field represents the calculated charging power.

USER DEFINED FIELD

The *User Defined* field prints out the value of the Dolphin Unit processor memory location that user specified. Following is how to read the memory location:

1. Type **1** or **2 (DO NOT HIT RETURN)**

   1 – To read the Dolphin Unit controller memory location (Memory location and its usage is already on the screen, also refer to RAM description table)

   2 – To read the vehicle interface controller memory location (None on screen, refer to RAM description table)

2. Type memory location address and return
3. The value will show up in the *User Defined* field

12V BIAS FIELD

The *12V Bias* field represents the 12V bias supply voltage in Volts.

DOLPHIN UNIT TEMP FIELD

The *Dolphin Unit Temp* field represents the temperature of the Dolphin Unit in Celsius.

ADDRESS USER <UNIT|VEH> FIELD

The *Address User <UNIT|VEH>* field prints out the memory address that the user specified. Either *UNIT* or *VEH* prints out depends on the user selection.

CHARGE MODE FIELD

The *Charge Mode* field represents the charge mode, either NORMAL mode or TRICKLE mode.

AC RELAY FIELD

The *AC Relay* field represents the status of the AC Relay, either CLOSED or OPEN.

TIME SECONDS FIELD

The *Time Seconds* field represents how long the communication between the PC and the Dolphin Unit been up. This field does not updates unless communication link is connected, therefore, if this field is not updating, then the communication link is not connected.

MOTOR TEMP FIELD

The *Motor Temp* field is a hidden field. To read the motor temperature

1. Type **1 (DO NOT HIT RETURN)**
2. Type **238** and **RETURN**
3. The *Motor Temp* field shows up with the motor temperature in Celsius line after the Dolphin Unit Temp

To hide the *Motor Temp* field,

1. Type **1 (DO NOT HIT RETURN)**
2. Type **any memory address** and **RETURN**
3. The *Motor Temp* field will hide

FAULT DESCRIPTION FIELD

In the very last line, all the fault description prints out, if any fault occurs.

DRIVER CONTROLS

DRIVER CONTROLS DIAGNOSTICS

See drive controls section of the US Electricar manual.

COOLING SYSTEM

COOLING SYSTEM DIAGNOSTICS

See cooling system section of the US Electricar manual.

PCU REMOVAL AND REPLACEMENT

PCU REMOVAL PROCEDURE

Figures 3-30, 3-31 ,and 3-32

Important

- Turn the main battery switch to the off position

Remove or Disconnect

1. 12 volt positive auxiliary cable from auxiliary battery.
2. 12 volt auxiliary ground cable (1).

Remove or Disconnect

3. 12 volt auxiliary battery cable (3).
4. J6 (2).
5. J2 (7).
6. J1 (9).
7. J5 (5).
8. J4 (8).
9. Coolant hoses (4,6).
10. Six nuts or bolts (depending upon the configuration of the mounting bracket).

Install or Connect

11. Coolant caps to hoses.
12. Coolant caps to inlet/outlet.

Remove or Disconnect

13. PCU.

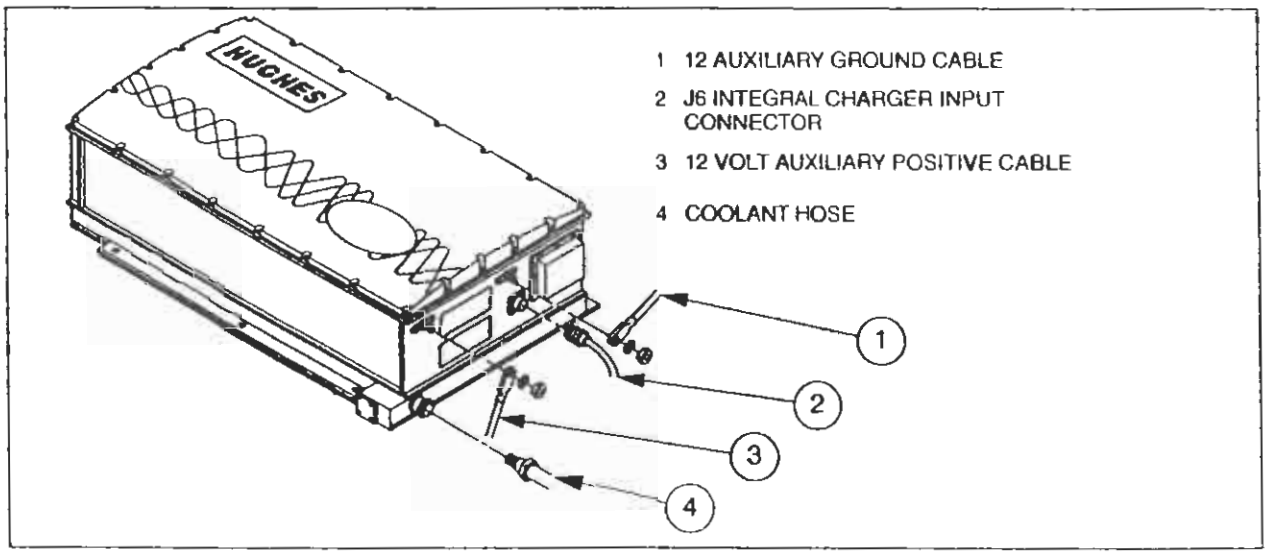


Figure 3-30. PCU Connections

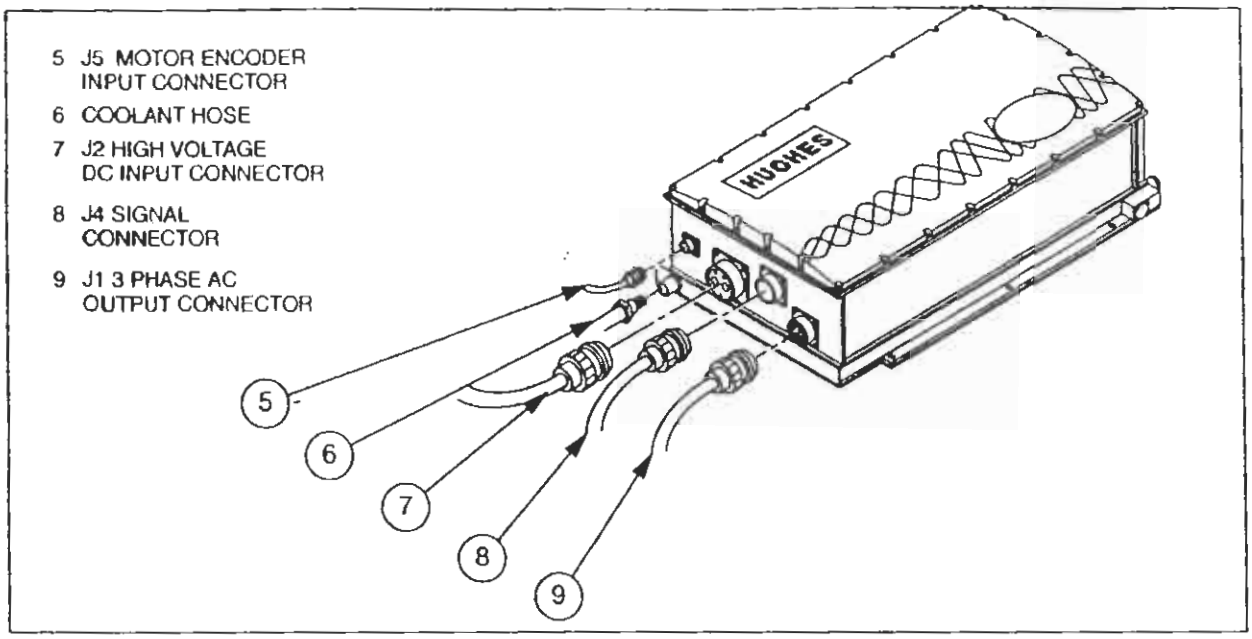


Figure 3-31. PCU Connections

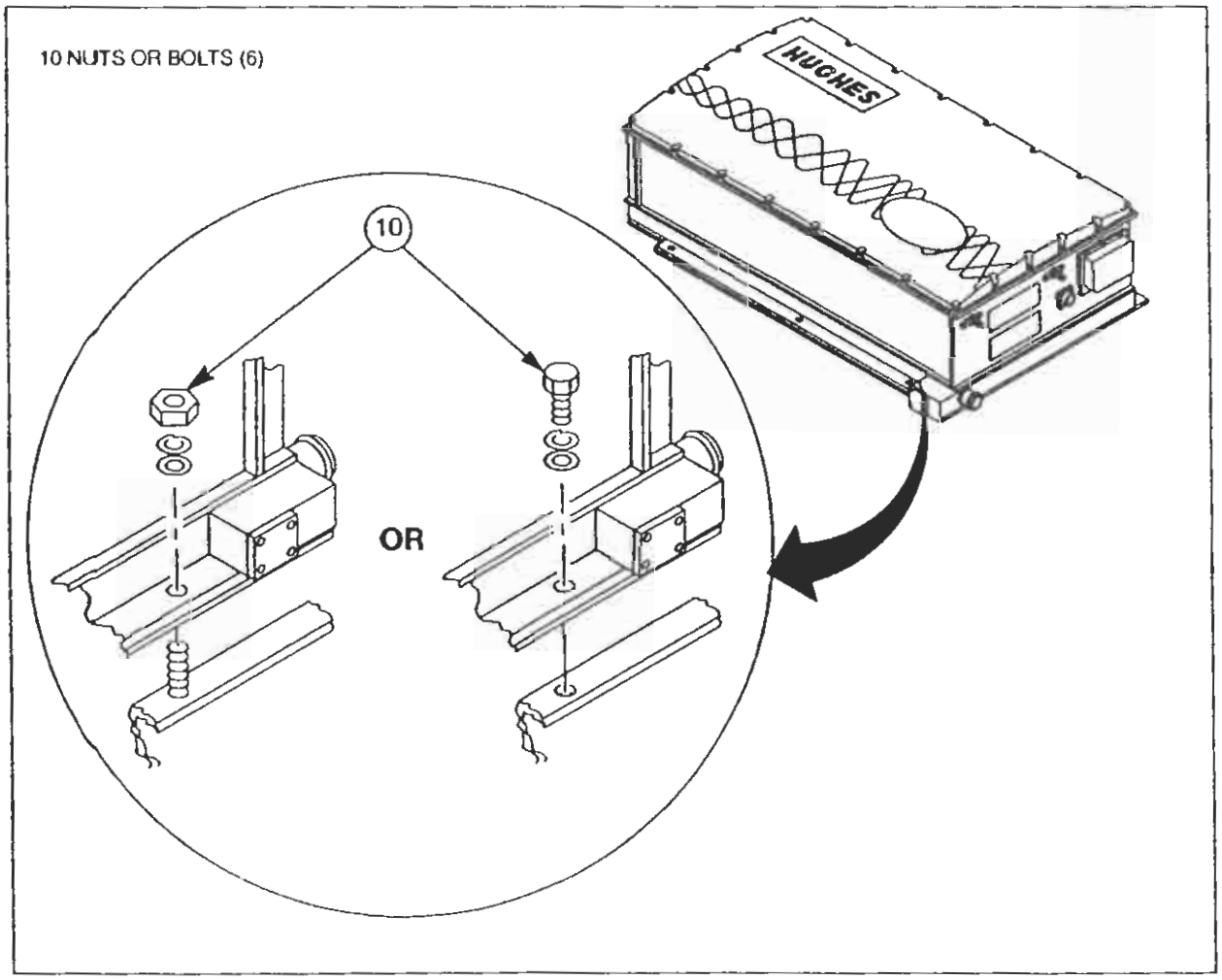


Figure 3-32. PCU Mounting

COOLANT REMOVAL PROCEDURE

1. Move PCU to an appropriate location for coolant disposal.

Remove or Disconnect

2. Coolant caps.
3. Coolant.

PCU REPLACEMENT PROCEDURE

Figures 3-30, 3-31, and 3-32

Important

- Turn the main battery switch to the off position

Remove or Disconnect

1. 12 volt positive auxiliary cable from auxiliary battery.

Install or Connect

2. Inverter on the bracket.

Tighten

- Six mounting nuts/bolts to 32 Nm (24 lb–ft.).

3. Mounting nuts or bolts (10).

Remove or Disconnect

4. Coolant caps from PCU.
5. Coolant caps from coolant hose (if applicable).

Install or Connect

6. Coolant hoses (4, 6).
7. High voltage cable to J2 (7).
8. Signal cable to J4 (8).
9. 3 phase output cable to J1 (9).
10. Motor encoder cable to J5 (5).
11. Integral charge input cable to J6 (2).
12. 12 volt auxiliary battery positive cable (3).
13. 12 volt auxiliary battery ground cable (1).
14. 12 volt positive auxiliary cable to auxiliary battery.

MOTOR REMOVAL AND REPLACEMENT

MOTOR REMOVAL PROCEDURE

Remove or Disconnect

Refer to US Electricar motor removal procedure.

MOTOR REPLACEMENT PROCEDURE

Install or Connect

Refer to US Electricar motor replacement procedure.

MOTOR ENCODER CABLE REMOVAL AND REPLACEMENT

MOTOR ENCODER CABLE REMOVAL PROCEDURE

Figure 3-33

Important

- CARE SHOULD BE TAKEN TO NOT DAMAGE THE GASKET BETWEEN THE motor ENCODER LID AND MOTOR.

Disassemble

1. Motor encoder lid (6) from motor (1).
   a. Eight mounting bolts (10).

Inspect

2. Gasket, replace if required.

Remove or Disconnect

3. Motor encoder connector (5) from motor encoder (3).
4. Thermistor (4).
5. Grommet (7) from encoder lid cutout.
6. Motor encoder cable (9) and connector (5) through cutout of motor encoder lid (6).

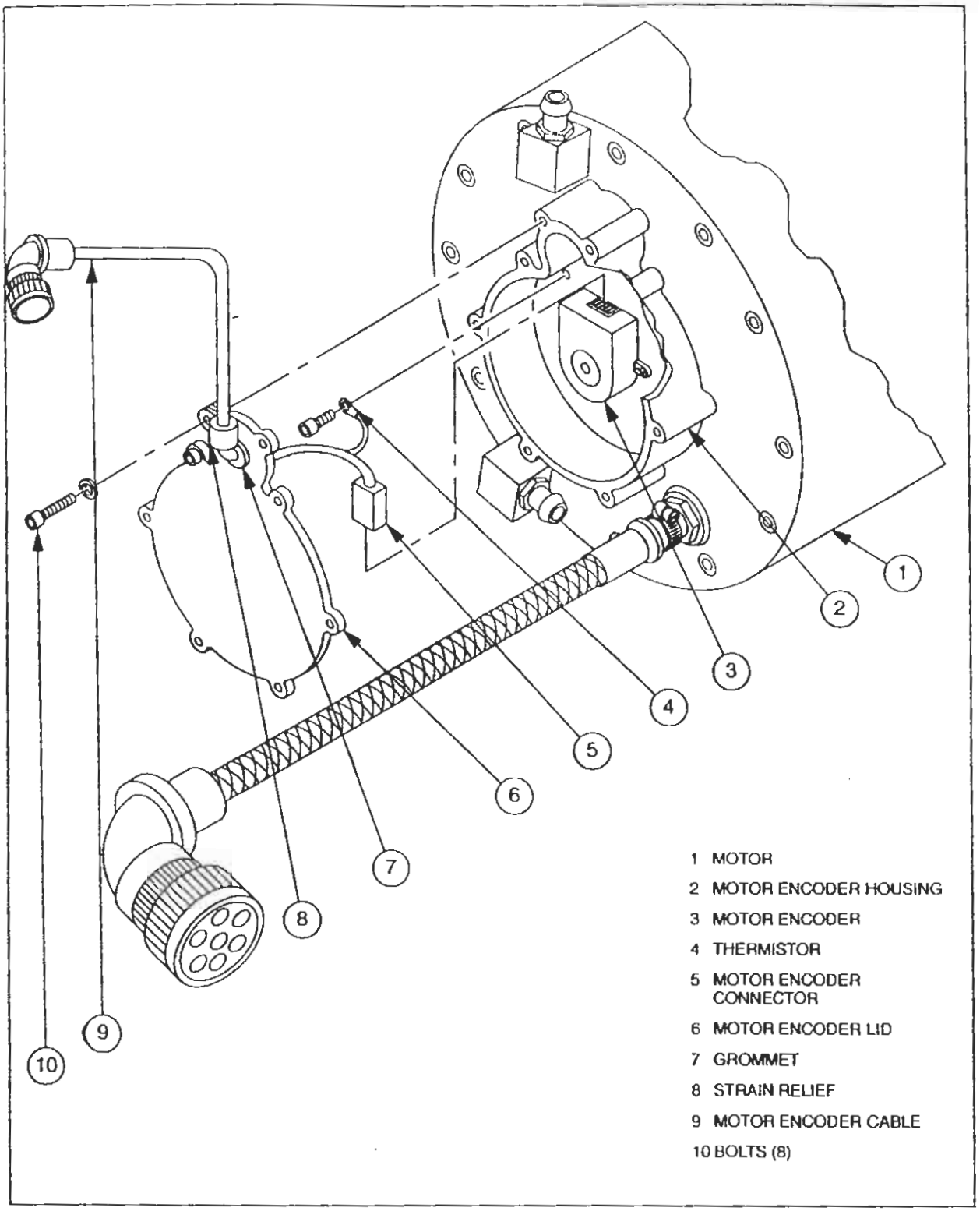


Figure 3-33. Motor Encoder and Cable Assembly

MOTOR ENCODER CABLE REPLACEMENT PROCEDURE

Assemble

1. Motor encoder cable (9) and connector through grommet (7).
2. Motor encoder cable (9) and connector through cutout of encoder lid.

Install or Connect

3. Grommet (7) in encoder lid cutout.
4. Motor encoder cable (9) to motor encoder (3).
5. RTV (Ultra Black 598 RTV silicone or equivalent) into area between grommet (7) and motor encoder cable (9).

Important

- Be sure to use enough RTV to seal the gap between the grommet and motor encoder cable.
- Allow Sufficient time for RTV to cure.

Assemble

6. Motor encoder lid (6) to motor (1).
7. Strain relief onto mounting bolt (10).

Tighten

8. Eight mounting bolts (10) in a star pattern.

MOTOR ENCODER REMOVAL AND REPLACEMENT

MOTOR ENCODER REMOVAL PROCEDURE

Figure 3-33 and 3-34

Important

- CARE SHOULD BE TAKEN TO NOT DAMAGE THE GASKET BETWEEN THE MOTOR ENCODER LID AND MOTOR.

Disassemble

1. Motor encoder lid (6) from motor (1).
   a. Eight mounting bolts (10).

Inspect

2. Gasket, replace if required.

Remove or Disconnect

3. Motor encoder connector (5) from motor encoder (3).

Disassemble

4. Motor encoder mounting bolts (11).

Remove or Disconnect

5. Motor encoder (3).

MOTOR ENCODER REPLACEMENT PROCEDURE

Clean

- Inside of motor encoder housing (2).

Remove or Disconnect

1. Cardboard protector from new motor encoder.

Assemble

2. Motor encoder (3) onto shaft.

Important

- Be sure to add Loctite to motor encoder mounting bolts (11).
- Partially tighten motor encoder mounting bolts (11).

3. Motor encoder (3) with motor encoder mounting bolts (11).

4. Center motor encoder (3) around shaft.

Tighten

- Motor encoder mounting bolts (11) down.
- Adjustment screw with motor encoder wheel adjustment tool (12) in a clockwise direction finger tight.

Remove or Disconnect

5. Remove motor encoder adjustment tool (12).

Important

- Push alignment notch (15) in a clockwise direction with tweezers until bottom alignment dot (14) aligns with top alignment dots (13).
- Spin motor shaft to ensure that motor encoder wheel does not rub against Motor encoder housing.

Assemble

6. Motor encoder lid (6) to motor (1).
7. Strain relief (8) onto mounting bolt (10).

Tighten

8. Eight mounting bolts (10) in a star pattern.

Table 3-4. Part Identification and Information

NAME	MANUFACTURE'S PART NUMBER
PCU	A04601AA0
Motor Assembly	A04731AA0
Motor Encoder Cable (W14)	A4706AA0
Optical Encoder Module (basic motor only)	HEDT-9100 F00
11.0MM Opt Rad Code Wheel (basic motor only)	HEDS-5120F13
Grommet	MS35489-8
Motor Encoder Lid Gasket	A04705FX0
Motor Assembly	A04731AA0-1
Motor Encoder Cable (W14)	A4706AA0-1
Optical Encoder Module (-1 motor only)	QEDS-5922
Grommet	MS35489-8
Motor Encoder Lid Gasket	A04705FX0

RE-SHIPPING FAILED MODULES FOR REPAIR

See warranty information and shipping instructions in section IV.

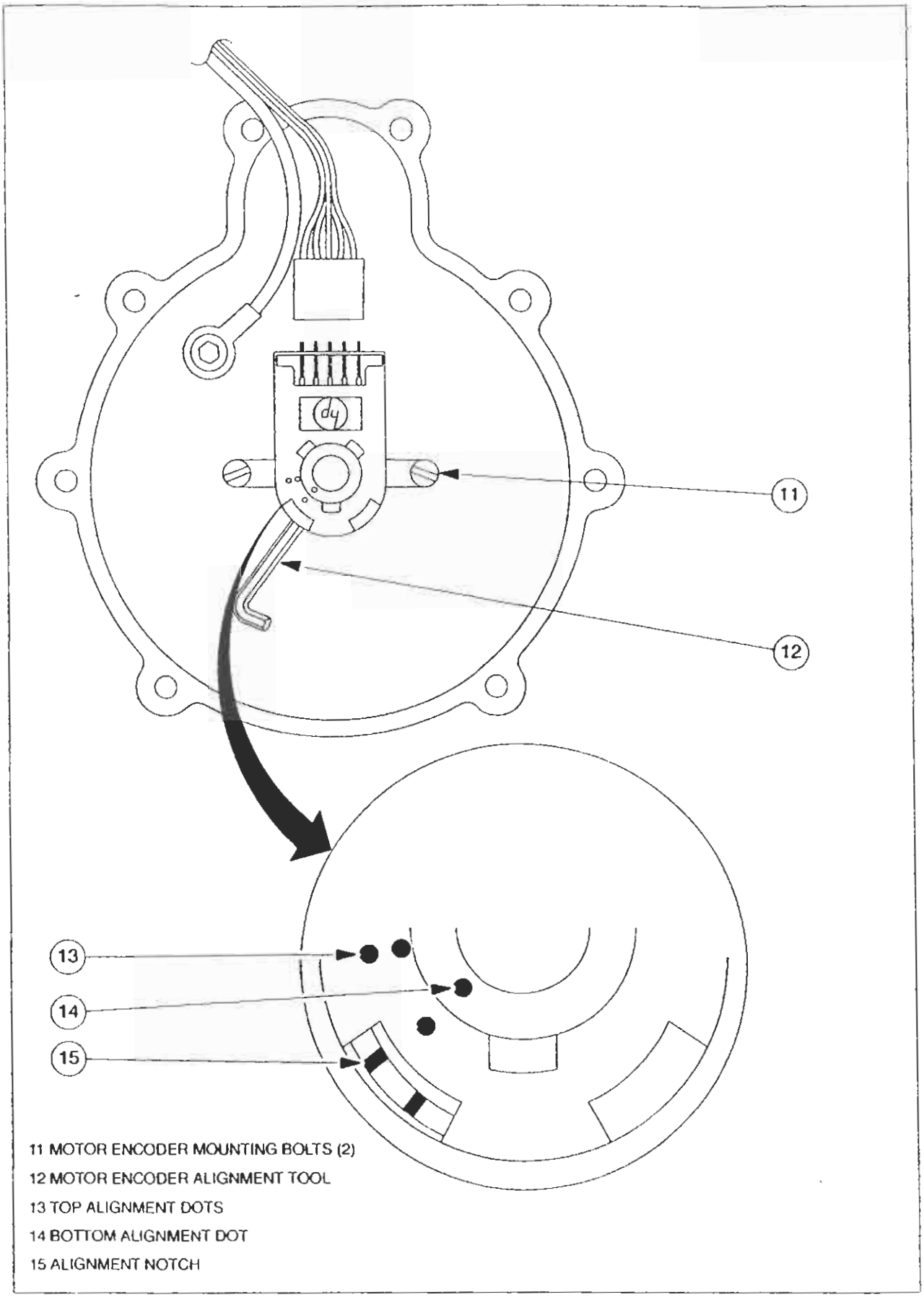


Figure 3-34. Motor Encoder Assembly

Dolphin™	Field Event Report (FER)	GMH POWER CONTROL SYSTEMS

Note: A completed FER form, with a valid Return Authorization MUST accompany any item sent back to PCS for repair, replacement, credit, or other service.

Call 1(800) 482–6644 for Telephone Service Assistance and Return Authorization.

Return Authorization: _____ Initiator Name: _____ Phone: _____

Driver/Owner Contact: _____ Phone: _____

Vehicle Description: _____ Identification #: _____

Odometer Mileage: _____ Location: _____

Part Name: _____ Part #: _____ Serial #: _____

Briefly describe the event / incident / problem. (What happened or didn't happen?)

What was happening just before the event occurred? (For example, driving up hill at 35 mph, or vehicle at battery charger overnight)

Any other comments?

FER Form / LD 27 Jan 94

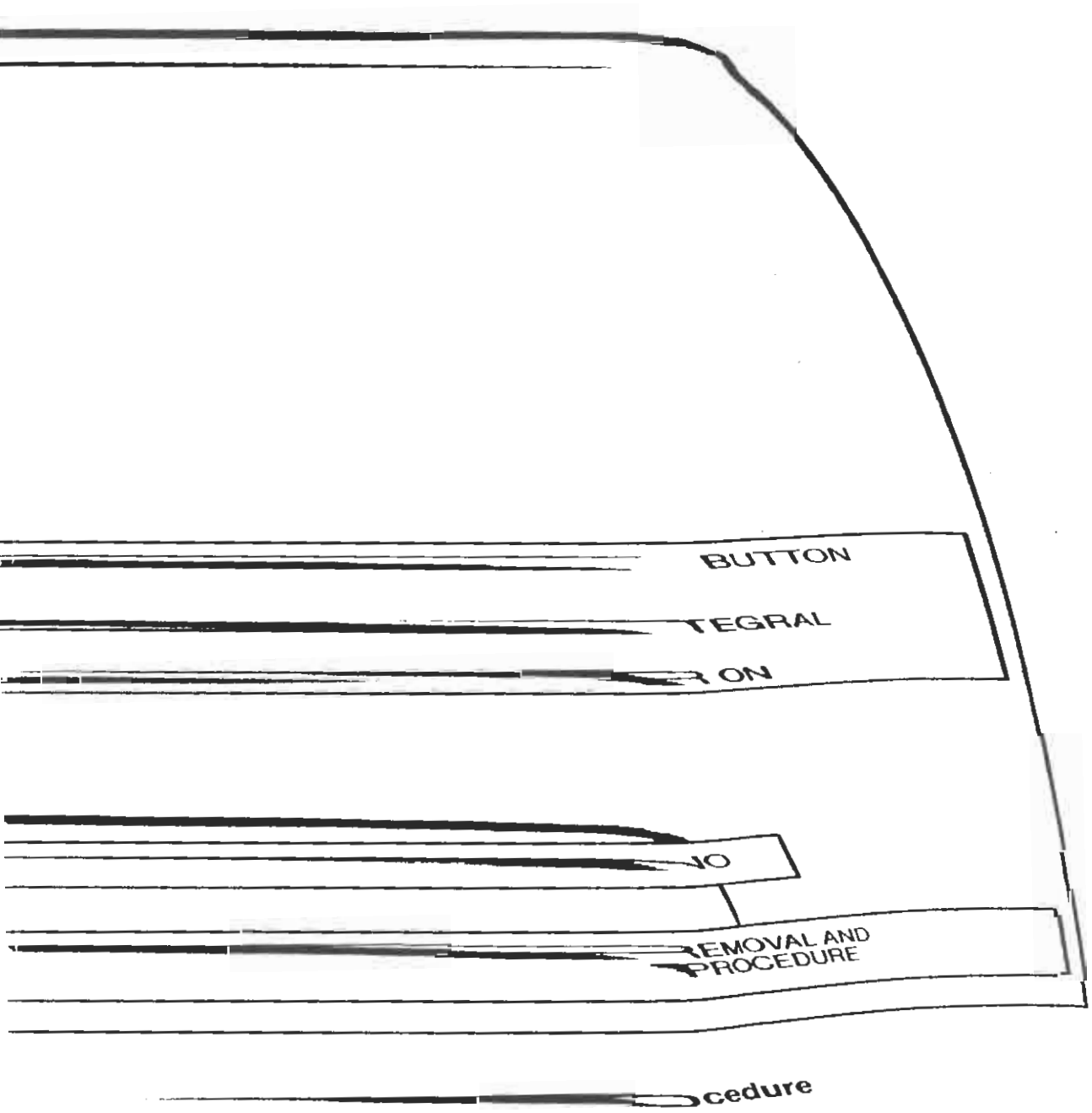
SECTION IV

WARRANTY INFORMATION

FER Form Instructions

Please follow these instructions completely to speed service

Return Authorization:	Call the PCS service number (800) 482–6644 for telephone assistance before filling out the form. We may be able to solve your problem over the phone. If we are not able to solve your problem, you will need to have a valid Return Authorization to receive prompt service.
Initiator:	Please enter your name and a phone number where you can be reached during normal business hours.
Driver / Owner Contact:	Please enter the name of the driver or owner contact who may be able to provide additional detail about the event in case we need that information.
Vehicle Description:	Please enter the make and model of the vehicle, e.g., Geo Prizm.
Identification #:	Please enter the Vehicle Identification number – found under the windshield on the driver's side.
Odometer Mileage:	Please enter the mileage from the vehicle's odometer at the time of the event.
Location:	Where did the event occur? City and state.
Part Name:	What's the name of the suspected part? (e.g., Power Control Unit)
Part #:	Please enter the part number of the suspect unit from the nameplate.
Serial #:	Enter the serial number from the nameplate.
"Briefly describe the event . . ."	What happened or didn't happen that caused you or the driver to think there was a problem? Please include as much detail as possible.
"What was happening just before the event occurred?"	Please describe the situation that led up to the event. What was the vehicle doing? Provide as much detail as possible.
"Any other comments?"	This is your opportunity to provide us with any other comments you would like to offer about the event, the Dolphin system, our service or anything you would like to say to PCS.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