CATERPILLAR®

FORM NO. SENR3535-01

FOR USE IN SERVICE MANUAL:
ELECTRIC SET GENERATORS, SENR7958

# Service Manual

## Electronic Modular Control Panel (EMCP)

7C1000

# Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

**Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.**

**Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.**

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "WARNING" as shown below.

**⚠ WARNING**

The meaning of this safety alert symbol is as follows:

**Attention! Become Alert! Your Safety is Involved.**

The message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.

# Index

## Safety



## Schematics & Wiring Diagrams



## Systems Operation



## Testing And Adjusting



NOTE: A "C" in the left margin is an indication of a change from the former issue.

# SAFETY

**⚠ WARNING**

**Improper performance of lubrication or maintenance procedures is dangerous and could result in injury or death. Read and understand the lubrication and maintenance procedures, recommended by Caterpillar, that are outlined in the OPERATION GUIDE and/or OWNER'S MANUAL for this product before performing any lubrication or maintenance.**

**Do not operate this product unless you have read and understood the instructions. Improper operation is dangerous and could result in injury or death.**

The servicemen or mechanic may be unfamiliar with many of the components and systems of this product. This makes it important to use caution when performing service work. A knowledge of the system and/or components is important before the removal or disassembly of any component.

Because of the size of some components, the serviceman or mechanic should check the weights noted in this Manual. Use proper lifting procedures when removing any components.

Following is a list of basic precautions that should always be observed.

1. Read and understand all Warning plates and decals before operating, lubricating or repairing this product.
2. Make sure the work area around the product is made safe and be aware of hazardous conditions that may exist.
3. Always wear protective glasses and protective shoes when working. In particular, wear protective glasses when a hammer or sledge is used for pounding to make repairs. Use welders gloves, hood/goggles, apron and other protective clothing appropriate to the welding job being performed. Do not wear loose-fitting or torn clothing. Remove all rings from fingers when working on machinery.
4. If an engine must be started to make pressure or speed checks, be sure all guards and shields are installed. To help prevent an accident caused by parts in rotation, work carefully around machinery that has been put into operation.
5. If an engine has been running and the coolant is hot, loosen the filler cap slowly and let the pressure out of the cooling system, before any caps, plugs or lines are removed or disconnected.
6. Corrosion inhibitor contains alkali. Avoid contact with eyes. Avoid prolonged or repeated contact with skin. Do not take internally. In case of contact, immediately wash skin with soap and water. For eyes, flush with large amounts of water for at least 15 minutes. CALL PHYSICIAN. KEEP OUT OF REACH OF CHILDREN.
7. Do not smoke when an inspection of the battery electrolyte level is made. Never disconnect any charging unit circuit or battery circuit cable from the battery when the charging unit is operating. A spark can cause an explosion from the flammable vapor mixture of hydrogen and oxygen that is released from the electrolyte through the battery outlets. Do not let electrolyte solution make contact with skin or eyes. Electrolyte solution is an acid. In case of contact, immediately wash skin with soap and water. For eyes, flush with large amounts of water for at least 15 minutes. CALL PHYSICIAN. KEEP OUT OF REACH OF CHILDREN.
8. Disconnect battery and discharge any capacitors before starting any repair work. Hang "Do Not Operate" tag in the Operator's compartment or on the controls.
9. Do not work on anything that is supported only by lift jacks or a hoist. Always use blocks or proper stands to support the product before performing any service work.
10. Relieve all pressure in air, oil or water systems before any lines, fittings or related items are disconnected or removed. Be alert for possible pressure when disconnecting any device from a system that utilizes pressure. Do not check for pressure leaks with your hand. High pressure oil or fuel can pierce the skin.

A83265P1

## ⚠ WARNING

11. Never bend a fuel injection line, or install a line which has been bent. Keep the fuel injection lines and connections clean. Be sure to install caps and covers anytime a line is removed or disconnected.

12. During service work, do not hit the fuel injection lines with wrenches or other tools. When lines are installed, use the correct torque to tighten connections and be sure all clamps and dampers are correctly installed.

13. Make sure all fuel injection lines and pressure oil lines have enough clearance to prevent contact with any other component. Do not put any fuel or oil lines close to a hot component.

14. To avoid back injury use a hoist or get help when lifting components which weigh 50 lb. (23 kg) or more. Make sure all chains, hooks, slings, etc., are in good condition and are of the correct capacity. Be sure hooks are positioned correctly. Lifting eyes are not to be side loaded during a lifting operation.

15. To avoid burns, be alert for hot parts on products which have just been stopped and hot fluids in lines, tubes and compartments.

16. Be careful when removing cover plates. Gradually back off the last two bolts or nuts located at opposite ends of the cover or device and pry cover loose to relieve any spring or other pressure, before removing them completely.

17. Be careful when removing filler caps, breathers and plugs on the product. Hold a rag over the cap or plug to prevent being sprayed or splashed by liquids under pressure. The danger is even greater if the product has recently been stopped because fluids can be hot.

18. Always use tools that are in good condition and be sure you understand how to use them before performing any service work. Use only Caterpillar replacement parts.

19. Reinstall all fasteners with same part number. Do not use a lesser quality fastener if replacements are necessary.

20. Repairs which require welding should be performed only with the benefit of the appropriate reference information and by personnel adequately trained and knowledgeable in welding procedures. Make reference to "Techniques of Structural Repair Course" form number JEG03719. Determine type of metal being welded and select correct welding procedure and electrodes, rods or wire to provide a weld metal strength equivalent at least to that of parent metal.

21. Before doing electrical work, disconnect battery. Do not damage wiring during removal operations. Reinstall the wiring so it is not damaged nor will it be damaged in operation by contacting sharp corners, or by rubbing against some object or hot surface. Do not connect wiring to a line containing fluid.

22. Be sure all protective devices including guards and shields are properly installed and functioning correctly before starting a repair. If a guard or shield must be removed to perform the repair work, use extra caution. After the repair is completed, reinstall any guard or shield that was removed.

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## c Identification

Electronic Modular Control Panel (EMCP)

The model number of the Electronic Modular Control Panel (EMCP) is located on the name plate on the inside bottom of the control panel. The model number is based on panel options and generator ratings. This information is necessary for programming the ECM. There are seventeen characters in the model number and is similar to "EB3CAS3A1BASP1AE6"

The following is a description of the equipment which is specified by the model number.

NOTE: For the most accurate description and specifications, always check print 7C1000 that is included with the EMCP.

III. DESCRIPTION OF EQUIPMENT SPECIFIED BY MODEL NUMBER

1 — AN "E" AS THE FIRST CHARACTER OF THE MODEL NUMBER SPECIFIES THAT THE CONTROL PANEL IS AN ELECTRONIC MODULAR TYPE. AN "H" INDICATES THAT IT IS BUILT & TESTED TO MEET CANADIAN STANDARD ASSOC. (CSA) APPROVAL.
E=STANDARD PANEL
H=CSA APPROVED PANEL

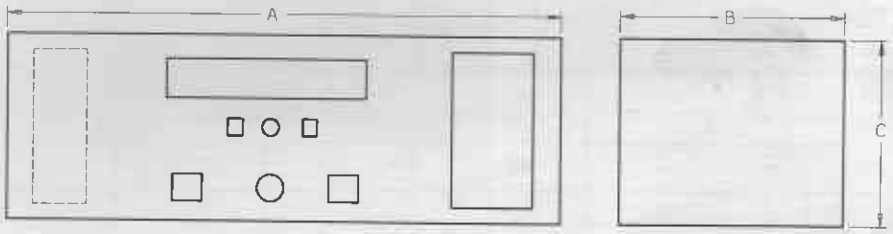
2 — THE SECOND CHARACTER OF THE MODEL NUMBER SPECIFIES THE GENERATOR FRAME SIZE, PANEL TYPE, & MOUNTING LOCATION. THE FRAME SIZE DETERMINES THE PHYSICAL DIMENSIONS OF THE CONTROL PANEL. SEE TABLE 1 AND FIGURE 1.

EB3CAS3A1BASP1VE6

TABLE 1

| | PANEL TYPE | GENERATOR FRAME SIZE | PANEL DIMENSIONS A | B | C | DUSTPROOF AS. | VANDAL DOOR AS. |
|---|---|---|---|---|---|---|---|
| A | STANDARD GEN TOP MTD | 360 | 603.2 | 323.8 | 323.8 | NOT REQ'D | REQUIRED |
| B | STANDARD GEN TOP MTD | 440/580 680/800 | 698.5 | 323.8 | 323.8 | NOT REQ'D | REQUIRED |
| C | DUSTPROOF GEN TOP MTD | 360 | 603.2 | 323.8 | 323.8 | REQUIRED | REQUIRED |
| D | DUSTPROOF GEN TOP MTD | 440/580 680/800 | 698.5 | 323.8 | 323.8 | REQUIRED | REQUIRED |
| E | STANDARD MTD WITHIN GEN TERMINAL BOX | ALL | 698.5 | 323.8 | 323.8 | NOT REQ'D | NOT REQ'D |
| F | DUSTPROOF MTD WITHIN GEN TERMINAL BOX | ALL | 698.5 | 323.8 | 323.8 | REQUIRED | NOT REQ'D |

FIGURE 1




3 — THE THIRD CHARACTER OF THE MODEL NUMBER SPECIFIES THE GENERATOR AC OPERATING VOLTAGE & THE RESULTING AC METERING MODULE VOLTMETER SCALING SELECTION.

MODEL EB3CAS3A1BASP1VE6

| | GENERATOR VOLTAGE(S) (LINE TO LINE) | VOLTMETER SCALING SELECTION SET MODULE SWITCH S2 AT: | JUMPER MODULE TERMINAL |
|---|---|---|---|
| 2 | 0 TO 350 VAC L-L | 2 | 7 TO 5 |
| 3 | 351 TO 599 VAC L-L | 0 | 6 TO 5 |
| 4 | 600 VAC L-L | 0 | 6 TO 5 |

C35801P1

Model Number – First, Second And Third Character

4 —— THE FOURTH CHARACTER OF THE MODEL NUMBER SPECIFIES THE AMMETER SCALING SELECTION AND CURRENT TRANSFORMER. (GENERATOR POWER RATING MUST BE LESS THAN OR EQUAL TO VALUES GIVEN IN TABLE BELOW.)

MODEL EB3CA53A1BASP1VE6

GENERATOR EKW OUTPUT TABLE CALCULATED FROM RATED OUTPUT VOLTAGE AT 0.80 POWER FACTOR WITH 15% MARGIN. (GENERATOR POWER RATING MUST BE LESS THAN OR EQUAL TO VALUES GIVEN IN TABLE BELOW.)

| | GENERATOR EKW RATING AT-VOLTAGES (L-L, RMS) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 200 VAC | 208 VAC | 220 VAC | 240 VAC | 300 VAC | 380 VAC | 400 VAC | 416 VAC | 440 VAC | 480 VAC | 600 VAC |
| C | 20EKW | 25EKW | 25EKW | 25EKW | 35EKW | 45EKW | 45EKW | 50EKW | 50EKW | 55EKW | 70EKW |
| D | 35 | 35 | 35 | 40 | 50 | 65 | 70 | 75 | 75 | 85 | 105 |
| E | 45 | 50 | 50 | 55 | 70 | 90 | 95 | 100 | 105 | 115 | 140 |
| F | 70 | 75 | 75 | 85 | 105 | 135 | 140 | 150 | 155 | 170 | 215 |
| G | 95 | 100 | 105 | 115 | 140 | 180 | 190 | 200 | 210 | 230 | 285 |
| H | 140 | 150 | 155 | 170 | 215 | 270 | 285 | 300 | 315 | 345 | 430 |
| J | 190 | 200 | 210 | 230 | 285 | 365 | 385 | 400 | 420 | 460 | 575 |
| K | 240 | 250 | 265 | 285 | 360 | 455 | 480 | 500 | 530 | 575 | 720 |
| L | 285 | 300 | 315 | 345 | 430 | 545 | 575 | 600 | 635 | 690 | 865 |
| M | 360 | 375 | 395 | 430 | 540 | 685 | 720 | 750 | 795 | 865 | 1080 |
| N | 480 | 500 | 530 | 575 | 720 | 915 | 960 | 1000 | 1060 | 1155 | 1445 |
| P | 600 | 625 | 660 | 720 | 900 | 1145 | 1205 | 1250 | 1325 | 1445 | 1805 |
| R | 720 | 750 | 795 | 865 | 1080 | 1370 | 1445 | 1500 | 1590 | 1735 | 2165 |
| S | 960 | 1000 | 1060 | 1155 | 1445 | 1830 | 1925 | 2005 | 2120 | 2310 | 2890 |

| | AMMETER (TRANSFORMER RATED) | | | CURRENT TRANSFORMERS | | | |
|---|---|---|---|---|---|---|---|
| | | | | ROUND | | SQUARE | |
| | QTY | SCALE | QTY | RATIO | | RATIO | |
| C | 1 | 0- 100 AMPS | 3 | 100:5 | | — | — |
| D | 1 | 0- 150 AMPS | 3 | 150:5 | | — | — |
| E | 1 | 0- 200 AMPS | 3 | 200:5 | | — | — |
| F | 1 | 0- 300 AMPS | 3 | 300:5 | | — | — |
| G | 1 | 0- 400 AMPS | 3 | 400:5 | | — | — |
| H | 1 | 0- 600 AMPS | 3 | 600:5 | | — | — |
| J | 1 | 0- 800 AMPS | 3 | 800:5 | | 800:5 | |
| K | 1 | 0-1000 AMPS | 3 | 1000:5 | | 1000:5 | |
| L | 1 | 0-1200 AMPS | 3 | 1200:5 | | 1200:5 | |
| M | 1 | 0-1500 AMPS | 3 | 1500:5 | | 1500:5 | |
| N | 1 | 0-2000 AMPS | 3 | 2000:5 | | 2000:5 | |
| P | 1 | 0-2500 AMPS | 3 | 2500:5 | | 2500:5 | |
| R | 1 | 0-3000 AMPS | 3 | 3000:5 | | 3000:5 | |
| S | 1 | 0-4000 AMPS | 3 | 4000:5 | | 4000:5 | |

NOTE: SQUARE CURRENT TRANSFORMERS TO BE SUPPLIED IF 5TH CHARACTER OF CONTROL PANEL MODEL NUMBER IS 0 THROUGH W (3412 AND 3500 PACKAGE GENERATOR SETS). ROUND CURRENT TRANSFORMERS TO BE SUPPLIED WITH ALL OTHER ENGINE SALES MODELS.

C35802P1

Model Number – Fourth Character

5 —— THE FIFTH CHARACTER OF THE MODEL NUMBER SPECIFIES THE PACKAGE GENERATOR SET ON WHICH THE PANEL WILL BE INSTALLED & SOME ENGINE CONTROL MODULE SETTINGS.

MODEL EB3CAS3A1BASP1VE6

| PACKAGE GENERATOR SET | CHARACTER | ENGINE CONTROL MODULE SETTINGS | | | | | |
|---|---|---|---|---|---|---|---|
| | | FAULT SHUTDOWN SETTINGS | | | | OIL STEP SPEED | CRANK TERMINATION SPEED |
| | | OIL PRESSURE | | COOLANT TEMP °C(°F) | OVER-SPEED | | |
| | | HI RPM KPA(PSI) | LOW RPM KPA(PSI) | | | | |
| 3114 PRIME | A | 206(30) | 68(10) | 107(225) | SAME AS 3208 | SAME AS 3208 | 400 RPM |
| 3116 PRIME | B | | | | | | |
| 3208 STANDBY | C | 206(30) | 68(10) | 98(209) | REF 3L0332 | REF 3L0332 | |
| 3208 PRIME | D | | | | | | |
| 3304 STANDBY | E | 82(12) | 68(10) | 98(209) | | | |
| 3304 PRIME | F | | | | | | |
| 3306 STANDBY | G | | | | | | |
| 3306 PRIME | H | | | | | | |
| 3406 STANDBY | J | 206(30) | 68(10) | 107(225) | | | |
| 3406 PRIME | K | | | | | | |
| 3408 STANDBY | M | | | | | | |
| 3408 PRIME | N | | | | | | |
| 3412 STANDBY | O | | | | | | |
| 3412 PRIME | P | | | | | | |
| 3508 STANDBY | R | 206(30) | 68(10) | 107(225) | | | |
| 3508 PRIME | S | | | | | | |
| 3512 STANDBY | T | | | | | | |
| 3512 PRIME | U | | | | | | |
| 3516 STANDBY | V | | | | | | |
| 3516 PRIME | W | | | | | | |

C35803P1

Current Model Number – Fifth Character

NOTE: The above fifth character information applies to current Electronic Modular Control Panels with "2" or greater as the seventeenth character of the model number. For the correct settings, always check print 7C1000 that is included with the generator set.

5 — THE FIFTH CHARACTER OF THE MODEL NUMBER SPECIFIES THE PACKAGE GENERATOR SET ON WHICH THE PANEL WILL BE INSTALLED & SOME ENGINE CONTROL MODULE SETTINGS.

MODEL EB3CAS3A1BASP1AE1

| PACKAGE GENERATOR SET | CHARACTER | ENGINE CONTROL MODULE SETTINGS | | | | | |
|---|---|---|---|---|---|---|---|
| | | FAULT SHUTDOWN SETTINGS | | | | OIL STEP SPEED | CRANK TERMINATION SPEED |
| | | OIL PRESSURE | | COOLANT TEMP | OVER-SPEED | | |
| | | HI RPM | LOW RPM | | | | |
| 3208 | A | 30PSI 206KPa | 10PSI 68KPa | 98°C 208°F | REF 3L0332 | REF 3L0332 | 400 RPM |
| 3304 | B | 12PSI 82KPa | 10PSI 68KPa | | | | |
| 3306 | C | | | | | | |
| 3406 | D | 30PSI 206KPa | 10PSI 68KPa | 107°C 225°F | | | |
| 3408 | E | | | | | | |
| 3412 | F | | | | | | |
| 3508 STANDBY | G | 30PSI 206KPa | 10PSI 68KPa | | | | |
| 3512 STANDBY | J | 30PSI 206KPa | 10PSI 68KPa | | | | |
| 3516 STANDBY | L | 30PSI 206KPa | 10PSI 68KPa | | | | |
| 3508 PRIME | M | 30PSI 206KPa | 10PSI 68KPa | 99°C 210°F | | | |
| 3512 PRIME | N | 30PSI 206KPa | 10PSI 68KPa | | | | |
| 3516 PRIME | P | 30PSI 206KPa | 10PSI 68KPa | | | | |

C35812P1

Earlier Model Number – Fifth Character

NOTE: The above fifth character information applies to earlier Electronic Modular Control Panels with "1" as the seventeenth character of the model number. For the correct settings, always check print 7C1000 that is included with the generator set.

NOTE: The above fifth character information also applies to earlier Electronic Modular Control Panels with "0" as the seventeenth character of the model number. Except for the following: character G is a 3508 prime, character J is a 3512 prime and character L is a 3516 prime. For the correct settings, always check print 7C1000 that is included with the generator set.

6—THE SIXTH CHARACTER OF THE MODEL NUMBER SPECIFIES THE TYPE OF THE ENGINE FUEL CONTROL SOLENOID.

MODEL EB3CAS3A1BASP1VE6

| | FUEL CONTROL SOLENOID TYPE | PROGRAM ENGINE CONTROL MODULE FOR: |
|---|---|---|
| R | ENERGIZED TO RUN | ENERGIZED TO RUN |
| S | ENERGIZED TO SHUTOFF | ENERGIZED TO SHUTOFF |
| L | LATCHING | ENERGIZED TO SHUTOFF |

NOTE: IF CONTROL PANEL MODEL NUMBER 5TH CHARACTER IS "M" THROUGH "P". AUXILIARY FUEL CONTROL RELAY GROUP IS INCLUDED.

C35808P1

Model Number – Sixth Character

7 — THE SEVENTH CHARACTER OF THE MODEL NUMBER SPECIFIES THE NUMBER OF TEETH ON THE FLYWHEEL OF THE GENSET THAT THE CONTROL PANEL WILL BE INSTALLED ON. IT IS IMPORTANT THAT THE CORRECT NUMBER OF TEETH BE PROGRAMED INTO THE ENGINE CONTROL MODULE TO ASSURE PROPER OPERATION.

MODEL EB3CAS3A1BASP1VE6

| | NUMBER OF FLYWHEEL TEETH | PACKAGE GANERATOR SET | GENERATOR FRAME SIZE |
|---|---|---|---|
| 1 | 183 | 3516,3512,3508 | ALL |
| 2 | 136 | 3412,3408 | ALL |
| 3 | 136 | 3406(#0 FLYWHEEL HOUSING) | 582/450 |
| 4 | 113 | 3406(#1 FLYWHEEL HOUSING) | ALL |
| 5 | 156 | 3306,3304 | ALL |
| 6 | 134 | 3208,3114,3116 | ALL |

REFER TO CHART 3L0332 TO ASSIST IN DETERMINING NUMBER OF FLYWHEEL TEETH.

8 — THE EIGHTH CHARACTER OF THE MODEL NUMBER SPECIFIES THE RATED SPEED AT WHICH THE GENERATOR SET WILL OPERATE.

MODEL EB3CAS3A1BASP1VE6

| | RATED SPEED (RPM) |
|---|---|
| A | 1000 |
| B | 1200 |
| C | 1500 |
| D | 1800 |
| | |
| | |

9 — THE NINTH CHARACTER OF THE MODEL NUMBER SPECIFIES CONTROL PANEL MOUNTED GOVERNOR OPTIONS, IF REQUIRED.

MODEL EB3CAS3A1BASP1VE6

| | GOVERNOR OPTION | GOVERNOR TYPE | GOV SW | SUPP. DIODE | GOVERNOR GP-ELECTRONIC | GOVERNOR FUSE PART # | GOVERNOR FUSE QTY |
|---|---|---|---|---|---|---|---|
| X | NONE, OR SHIPPED LOOSE CUSTOMER INSTALLED 2301A GOVERNOR | CAT HYDRA-MECH, 2301A LOAD SHARING | — | — | — | NOT REQUIRED | — |
| 1 | GOVERNOR SWITCH GP | CAT HYDRA-MECH PSG,3161 | REQUIRED | REQUIRED | — | NOT REQUIRED | — |
| 2 | 2301 GOVERNOR (W/PRE-REGULATOR) | 2301 SPEED SENSING | — | — | REQUIRED | REQUIRED | 1 |
| 3 | 2301 GOVERNOR | 2301 SPEED SENSING | — | — | REQUIRED | REQUIRED | 1 |
| 4 | 1724/8290 GOVERNOR (F/U/W 3114 AND 3116 ENGINES) | ELECTRONIC SPEED SENSING | — | — | REQUIRED | REQUIRED | 1 |
| 5 | 1724/8290 GOVERNOR | ELECTRONIC SPEED SENSING | — | — | REQUIRED | REQUIRED | 1 |
| 6 | 2301A GOVERNOR | 2301A SPEED SENSING | — | — | REQUIRED | REQUIRED | 1 |

NOTE : ABOVE CHARACTERS 2, 3, & 6 ARE NOT COMPATIBLE WITH THE CONTROL PANEL MODEL NUMBER 10TH CHARACTER D, E, F OR G (SYNC. LIGHT). ABOVE CHARACTERS 4 AND 5 ARE NOT COMPATIBLE WITH THE CONTROL PANEL MODEL NUMBER 10TH CHARACTER D, E, F, OR G (SYNC. LIGHT) UNLESS PROVIDED WITH OPTIONAL LOAD SHARE MODULE (NOT INSTALLED).

C35804P1

Model Number – Seventh, Eighth And Ninth Character

10— THE TENTH CHARACTER OF THE MODEL NUMBER SPECIFIES EITHER THE ALARM MODULES, SYNCHRONIZING LIGHT MODULE, SYNCHRONIZING LIGHT MODULE WITH GENERATOR REVERSE POWER PROTECTION OPTION, IF REQUIRED.

MODEL EB3CAS3A1BASP1VE6

| | MODULE TYPE | PART NO. | | | |
|---|---|---|---|---|---|
| | | MODULE OR CONTROL GP | REVERSE POWER RELAY | FILMS | COVER PLATE |
| X | NOT REQUIRED | NOT REQUIRED | NOT REQUIRED | NOT REQ'D | REQUIRED |
| A | ALARM (NFPA99) | REQUIRED | NOT REQUIRED | NOT REQ'D | NOT REQUIRED |
| B | ALARM (NFPA 110) | REQUIRED | NOT REQUIRED | NOT REQ'D | NOT REQUIRED |
| C | ALARM (SINGLE UNIT PRIME POWER) | REQUIRED | NOT REQUIRED | NOT REQ'D | NOT REQUIRED |
| D | SYNC. LIGHTS (0-480V L-L) | REQUIRED | NOT REQUIRED | NOT REQ'D | NOT REQUIRED |
| E | SYNC. LIGHTS (600V L-L) | REQUIRED | NOT REQUIRED | NOT REQ'D | NOT REQUIRED |
| F | SYNC. LIGHTS (0-480V L-L) WITH REVERSE POWER | REQUIRED | REQUIRED | REQUIRED | NOT REQUIRED |
| G | SYNC. LIGHTS (600V L-L) WITH REVERSE POWER | REQUIRED | REQUIRED | REQUIRED | NOT REQUIRED |
| | | | | | |

NOTE : ABOVE CHARACTERS D, E, F, & G ARE INCOMPATIBLE WITH THE CONTROL PANEL MODEL NUMBER 9TH CHARACTERS 2, 3, AND 6 (2301 GOVERNORS). REVERSE POWER RELAY SHALL BE SET AT APPROX. 15% OF GENERATOR RATING.
ABOVE CHARACTERS D, E, F, AND G ARE INCOMPATIBLE WITH THE CONTROL PANEL MODEL NUMBER 9TH CHARACTERS 4 AND 5 UNLESS PROVIDED WITH OPTIONAL LOAD SHARE MODULE (NOT INSTALLED).

11— THE ELEVENTH CHARACTER OF THE MODEL NUMBER SPECIFIES THE AUXILIARY RELAY OPTION, IF REQUIRED.

MODEL EB3CAS3A1BASP1VE6

| | RELAY | SOCKET |
|---|---|---|
| X | NOT REQUIRED | NOT REQUIRED |
| A | REQUIRED | REQUIRED |

12— THE TWELFTH CHARACTER OF THE MODEL NUMBER SPECIFIES THE STARTING AID SWITCH OPTION, IF REQUIRED.

MODEL EB3CAS3A1BASP1VE6

| | QTY | STARTING AID SWITCH | METER PANEL FILM |
|---|---|---|---|
| X | 0 | NOT REQUIRED | REQUIRED |
| S | 1 | REQUIRED MANUAL | REQUIRED |
| A | 1 | REQUIRED AUTOMATIC | REQUIRED |

NOTE: ABOVE CHARACTER A PERMITS INJECTION OF ETHER INTO ENGINE AFTER CRANK TERMINATION PROVIDED THAT JACKET WATER TEMPERATURE IS LESS THAN 70°F (52°C).

C35805P1

Model Number – Tenth, Eleventh And Twelfth Character

13 — THE THIRTEENTH CHARACTER OF THE MODEL NUMBER SPECIFIES THE OPTIONAL PANEL ILLUMINATION LIGHT GROUP, IF REQUIRED.

MODEL EB3CAS3A1BASPIVE6

| | QTY | LAMP HOUSING AS. | LAMP | SWITCH | PLUG BUTTON |
|---|---|---|---|---|---|
| X | 0 | NOT REQUIRED | NOT REQUIRED | NOT REQUIRED | NOT REQUIRED |
| | 2 | NOT REQUIRED | NOT REQUIRED | NOT REQUIRED | REQUIRED |
| P | 2 | REQUIRED | REQUIRED | — | NOT REQUIRED |
| | 1 | — | — | REQUIRED | NOT REQUIRED |

14 — THE FOURTEENTH CHARACTER OF THE MODEL NUMBER SPECIFIES THE NUMBER OF 24VDC STARTING MOTORS PROVIDED ON THE PACKAGE GENERATOR SET, TO BE CONTROLLED BY THE PANEL.

MODEL EB3CAS3A1BASPIVE6

| | | QTY | STARTER MOTOR MAGNETIC SWITCH(S) | CIRCUIT BREAKER | |
|---|---|---|---|---|---|
| | | | | 3114 & 3116 PRIME GENSETS (REF: MODEL • CHARACTER 5) | ALL OTHER GENSETS |
| 1 | SINGLE STARTING MOTOR | 1 | REQUIRED | REQUIRED | REQUIRED |
| 2 | DUAL STARTING MOTORS | 2 | REQUIRED | — | — |
| | | 1 | — | — | REQUIRED |

15 — THE FIFTEENTH CHARACTER OF THE MODEL NUMBER SPECIFIES THE PROPER VOLTAGE ADJUSTING POTENTIOMETER.

MODEL EB3CAS3A1BASPIVE6

CHARACTER CODE DEFINITION
A= 500 OHM
B= 1000 OHM
V= FOR USE WITH VR3 VOLT REG. (10K OHM)

| | EXCITATION | GENERATOR FRAME SIZE |
|---|---|---|
| V | ALL | 280 THRU 588 |
| A OR V | SELF EXCITED | 589 |
| B OR V | PERMANENT MAGNET | |
| A OR V | SELF EXCITED | 681 |
| B OR V | PERMANENT MAGNET | |
| A OR V | SELF EXCITED | 683 |
| B OR V | PERMANENT MAGNET | |
| A OR V | SELF EXCITED | 685 |
| B OR V | PERMANENT MAGNET | |
| A OR V | SELF EXCITED | 687 |
| B OR V | PERMANENT MAGNET | |
| A OR V | SELF EXCITED | |
| B OR V | PERMANENT MAGNET | |
| A OR V | SELF EXCITED | 689 |
| B OR V | PERMANENT MAGNET | |
| B OR V | ALL | 805 |
| B OR V | ALL | 806 |
| B OR V | ALL | 807 |
| B OR V | ALL | 808/809 |

C35806P1

Model Number – Thirteenth, Fourteenth And Fifteenth Character

16— THE SIXTEENTH CHARACTER OF THE MODEL NUMBER SPECIFIES THE UNITS USED IN DISPLAYING OIL PRESSURE & COOLANT TEMPERATURE ON THE ENGINE CONTROL MODULE.

MODEL EB3CAS3A1BASP1VE6

| | |
|---|---|
| E | ENGLISH UNITS (PSI, °F) |
| M | METRIC UNITS (kPa, °C) |

17— THE SEVENTEENTH CHARACTER OF THE MODEL NUMBER SPECIFIES THE CHANGE LEVEL OF THIS CHART TO WHICH THE PANEL WAS BUILT.

MODEL EB3CAS3A1BASP1VE6

FOR EXAMPLE THIS MEANS CHANGE LEVEL 6. REFER TO DRAWING TITLE BLOCK AND/OR CONTROL PANEL IDENTIFICATION TAG FOR ACTUAL CHANGE LEVEL.

C35807P1

Model Number – Sixteenth And Seventeenth Character

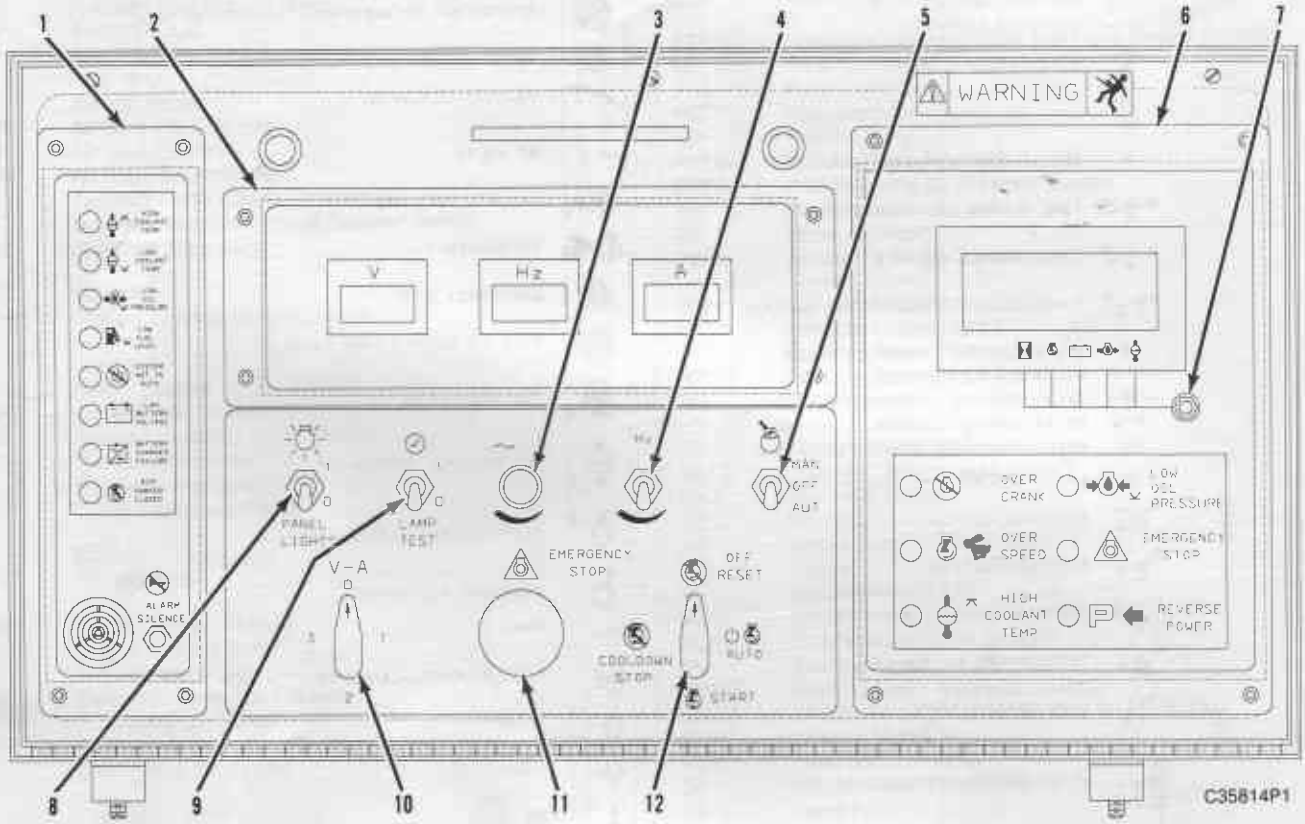
# Abbreviations

| | |
|---|---|
| A | Ammeter |
| ACM | AC Metering Module |
| ADS | Engine Combustion Air Damper Position Switch |
| AFCR | Auxiliary Fuel Control Relay |
| ALM | Alarm Module |
| ALS | Alarm Silence Push Button |
| ALT | Alternator |
| AR | Arming Relay |
| ASOS | Air Shut-Off Solenoid |
| ASR | Air Shut-Off Relay |
| ASSV | Air Start Solenoid Valve |
| AUX | Auxiliary Relay (Crank Termination) |
| AVS | Ammeter Voltmeter Phase Selector Switch |
| AWG | American Wire Gage |
| BATT | Battery |
| BCF | Battery Charger Failure Switch |
| C | Common |
| CB | Circuit Breaker |
| CCM | Cycle Crank Module |
| CDM | Engine Cooldown Timer Module |
| CIM | Customer Interface Module |
| CT | Current Transformer |
| CTR | Crank Termination Relay |
| D | Diode |
| DCV | DC Voltmeter |
| ECM | Engine Control Module |
| ECS | Engine Control Switch |
| EFL | Engine Failure Light |
| EGA | Electronic Governor Actuator |
| ENFR | Engine Failure Relay |
| ESPB | Emergency Stop Push Button |
| ESL | Emergency Stop Light |
| F | Fuse |
| FCR | Fuel Control Relay |
| FS | Fuel Solenoid |
| FSOS | Fuel Shut-Off Solenoid |
| GOV | Governor |
| GS | Governor Switch |
| GSM | Governor Synchronizing Motor |
| GSOV | Gas Shut-Off Valve |
| HZ | Frequency Meter |
| IC | Remote Start/Stop Initiate Contact |
| L | Load Leads |
| LFL | Low Fuel Level Light |
| LFLAS | Low Fuel Level Alarm Switch |
| LFS | Latching Fuel Control Solenoid |
| LOLAS | Low Oil Level Alarm Switch |
| LTS | Lamp Test Switch |
| LWLAS | Low Water Level Alarm Switch |
| LWTL | Low Water Temperature Light |
| MAN | Manual |
| MPU | Magnetic Speed Pickup |
| MSP | Manual Speed Adjust Potentiometer |
| NC | Normally Closed |
| OCL | Overcrank Light |
| OCT | Overcrank Timer |
| OP | Oil Pressure |
| OPG | Oil Pressure Gage |
| OPL | Oil Pressure Light |
| OSL | Overspeed Light |
| PEEC | Caterpillar Programmable Electronic Engine Control |
| PL | Panel Illumination Light |
| PLS | Panel Light Switch |
| POT | Potentiometer |
| PP | Prelube Pump |
| PPMS | Prelube Pump Magnetic Switch |
| PPPS | Prelube Pump Oil Pressure Switch |
| PR | Pre-Regulator |
| PS | Pinion Solenoid |
| PWM | Analog To PWM Converter |
| RAN | Remote Annuciator |
| RPL | Reverse Power Light |
| RPR | Reverse Power Relay |
| RPSR | Reverse Power Slave Relay |
| RR | Run Relay |
| SASV | Start Aid Solenoid Valve |
| SATS | Start Aid Temperature Switch |
| SAS | Start Aid Switch |
| SEC | Second |
| SHTC | Circuit Breaker Shunt Trip Coil |
| SIG | Signal |
| SL | Synchronizing Light |
| SLM | Synchronizing Light Module |
| SLR | Synchronizing Light Resistor |
| SM | Starting Motor |
| SMMS | Starting Motor Magnetic Switch |
| SMPS | 24VDC To 12VDC Switchmode Power Supply |
| SMR | Starting Motor Relay |
| SOR | Peec Shut-Off Relay |
| SP | Speed Adjust Potentiometer |
| SR | Slave Relay |
| SS | Synchronizing Switch |
| T | Generator Line Leads |
| TD | Time Delay Relay |
| TSC | Transfer Switch Position Indicating Contact |
| V | AC Voltmeter |
| VAR | Voltage Adjust Rheostat |
| WT | Water Temperature |
| WTG | Water Temperature Gage |
| WTL | Water Temperature Light |
| XDUCER | Transducer |
| Z | Zener Diode |
| 2301 | Electronic Governor (Speed Sensing) |

# Symbols

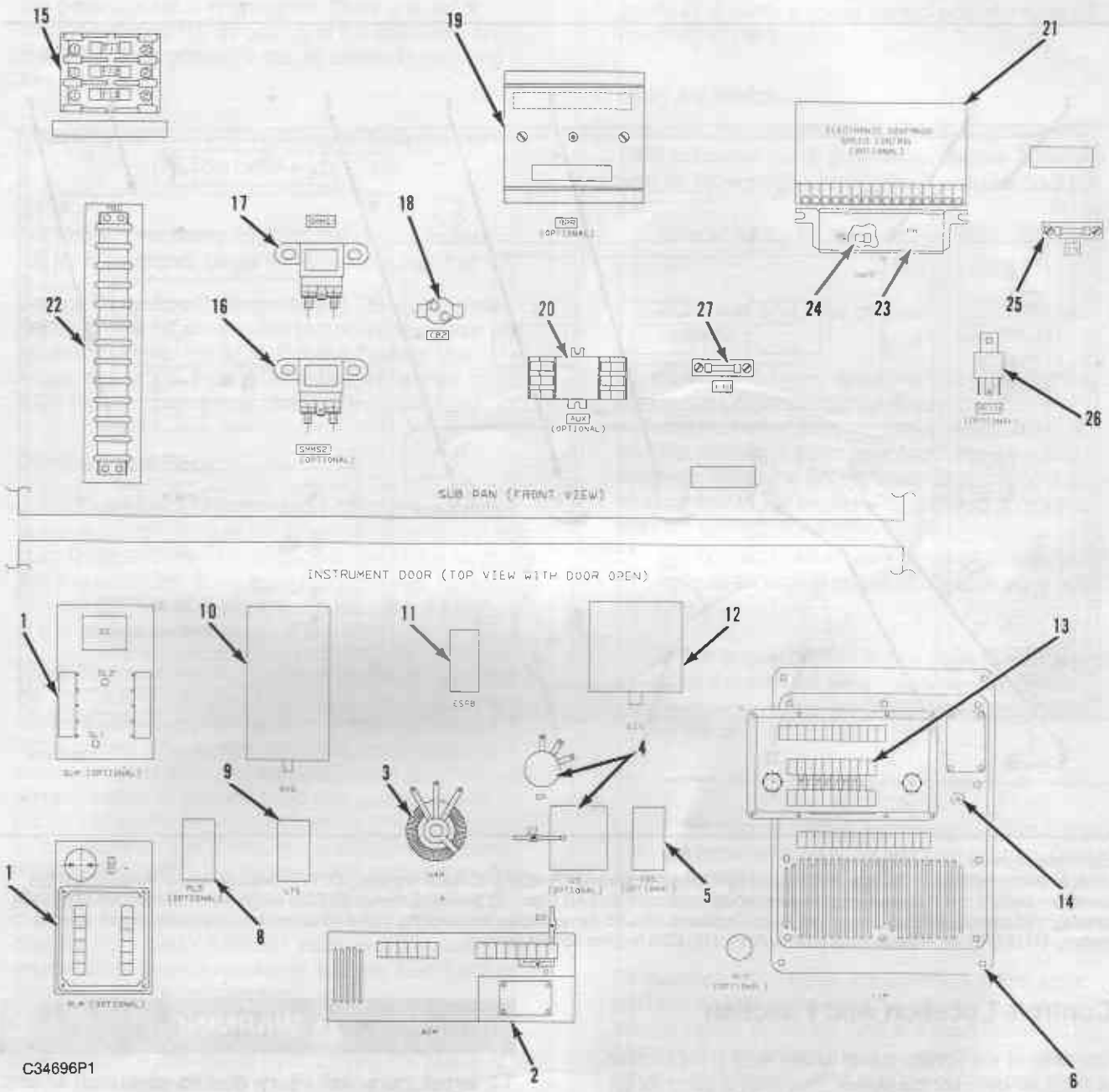

C34698P1

# Components Location



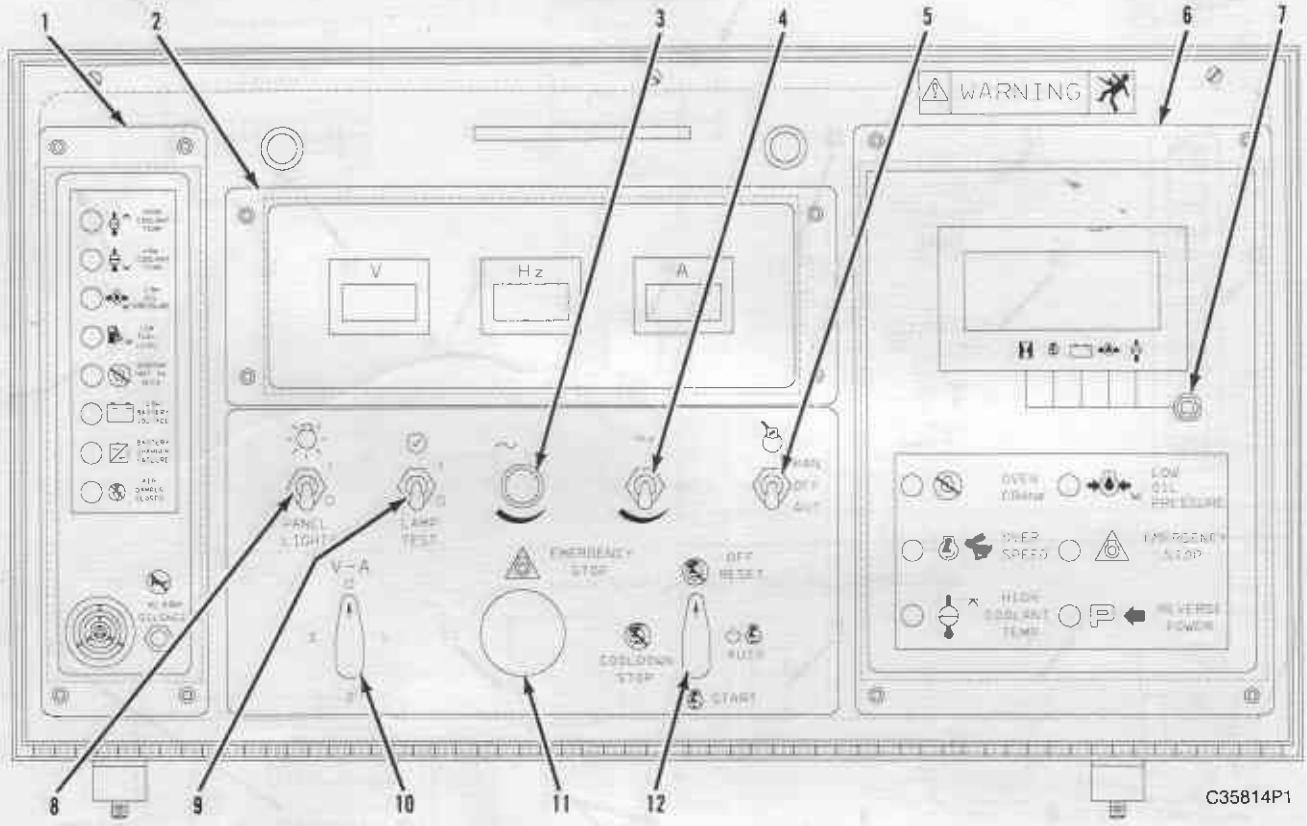

7C1000 Control Panel
(1) ALM (alarm module) or SLM (synchronizing light module) optional. (2) ACM (AC meter module). (3) VAR (voltage adjust rheostat). (4) GS (governor switch) or SP (speed adjust potentiometer) optional. (5) SAS (start aid switch) optional. (6) ECM (engine control module). (7) Switch (display hold switch). (8) PLS (panel light switch) optional. (9) LTS (lamp/display test switch). (10) AVS (ammeter - voltmeter phase selector switch). (11) ESPB (emergency stop push button). (12) ECS (engine control switch).

NOTE: For location and specifications on components located on the engine, make reference to the respective Engine Service Manual.




Control Panel Interior

(1) ALM (alarm module) or SLM (synchronizing light module) optional. (2) ACM (AC meter module). (3) VAR (voltage adjust rheostat). (4) GS (governor switch) or SP (speed adjust potentiometer) optional. (5) SAS (start aid switch) optional. (6) ECM (engine control module). (8) PLS (panel light switch) optional. (9) LTS (lamp/display test switch). (10) AVS (ammeter - voltmeter phase selector switch). (11) ESPB (emergency stop push button). (12) ECS (engine control switch). (13) Fuses (F1 through F8). (14) Switch (overspeed verify). (15) F11 through F13 (fuses). (16) SMMS2 (starter motor magnetic switch two) optional. (17) SMMS1 (starter motor magnetic switch one). (18) CB (circuit breaker). (19) RPR (reverse power relay) optional. (20) AUX (auxiliary relay) optional. (21) 2301 (electronic governor speed control) optional. (22) TBC (terminal board C). (23) PR (preregulator) optional. (24) Fuse. (25) F9 (fuse) installed if optional PR is not provided. (26) AFCR (auxiliary fuel control relay). (27) F10 (fuse) for AFCR.




Electronic Modular Control Panel (EMCP)
(1) ALM (alarm module) or SLM (synchronizing light module) optional. (2) ACM (AC meter module). (3) VAR (voltage adjust rheostat). (4) GS (governor switch) or SP (speed adjust potentiometer) optional. (5) SAS (start aid switch) optional. (6) ECM (engine control module). (7) Switch (display hold switch). (8) PLS (panel light switch) optional. (9) LTS (lamp/display test switch). (10) AVS (ammeter - voltmeter phase selector switch). (11) ESPB (emergency stop push button). (12) ECS (engine control switch).

## Controls Location And Function

The area of the control panel where ALM (1) is located, is used for different purposes. This area is used for an alarm module, a synchronizing lights module or a plain cover. These modules are described in the Optional Modules section.

NOTE: For point to point schematics and wiring diagrams, see the Schematics And Wiring Diagrams section.

### AC Meter Module (ACM)

AC meter module (ACM) (2) has displays for AC volts - V, frequency - Hz, and AC amps - A. These displays indicate the status of the generator output.

**⚠ WARNING**

**To avoid personal injury due to electrical shock, make sure jumpers are installed correctly on the AVS.**

Ammeter-voltmeter switch (AVS) (10) is used to select the phase of the volts and amps that are displayed on ACM (2). Positions 1, 2 and 3 of the AVS allow the operator to check generator output current and voltage for each of the phases 1, 2 and 3 respectively. Position 0 of the AVS removes generator voltages and currents from the ACM, however the ACM remains powered up.

If the voltage or current exceeds the programmed maximum, the display flashes the full scale value. Voltages below 1 VAC and currents below .1% of full scale are displayed as "0".

The frequency display (Hz) shows the frequency in hertz (cycles per second) of the electricity made when the generator set is in operation. There is a direct relation between the frequency of the electricity and the RPM of the generator set, as shown in following formula:

$$\text{frequency (hertz)} = \frac{\text{number of generator poles} \times \text{RPM}}{120}$$

For frequencies above 99.9 Hz, the display flashes "99.9". Frequencies below 45 Hz are displayed as "LO".

Service Procedure C (Programming The ACM) gives details on the full scale currents and voltages that are programmed into the ACM. See the Testing And Adjusting section. If the ACM shows all dashes, the ACM has an internal fault. Replace the ECM.

### Control Panel Face

Control switches ESPB (11) and ECS (12) are located below AC meter module (2). When red emergency stop push button (ESPB) (11) is pressed, the fuel is shut off and the air shutoff (if equipped) is activated. To restart, turn the ESPB until it releases. To the right of ESPB (11) is engine control switch (ECS) (12).

The ECS determines the status of the control panel. In the AUTOMATIC position (3 o'clock), the engine starts automatically whenever the remote initiating contact (IC) is closed. The engine also shuts down after the initiate contacts open. An adjustable cool down time is programmable to give a 0 to 30 minute cool down period before the engine shuts down. The cool down time is factory set at 5 minutes. In the MANUAL (run) position (6 o'clock), the engine starts and runs as long as the ECS is in this position. In the STOP position (9 o'clock), the fuel solenoid shuts the engine down after cool down. In the OFF/RESET position (12 o'clock), the engine shuts down immediately and any fault lights or diagnostic failure indicators are reset.

NOTE: The ECM and ALM do NOT turn off. If desired, battery drain is decreased by modifying the wiring of the ECS. When modified, the ECM and ALM turn OFF when the ECS is in the OFF/RESET position. To modify, remove the jumper wire which connects terminals 9 and 6 of the ECS. See the DC schematic (line 38) in the Schematics And Wiring Diagrams section.

Below ACM (2) is a row of control switches. Optional panel light switch (PLS) (8) turns ON and OFF the panel lamps. Lamp/display test switch (LTS) (9) turns ON all the control panel indicators, when in the TEST position. All lamps and display segments (displays show all 8's) in ECM (6), ACM (2) and in the optional alarm module (1) are lighted and the alarm horn in ALM (1) sounds for ten seconds maximum. Voltage adjust rheostat (VAR) (3) is used to adjust generator voltage to the desired level. Optional governor switch (GS) (4) is used to raise and lower engine speed when the governor has a speed adjust motor. If an electronic governor is used, a speed control potentiometer (SP) is mounted in this location.

### C Start Aid Switch

Start aid switch (SAS) (5) is an option that is present only on required generator sets. Two types SAS (5) exist:

Manual SAS – for metered shot ether start aid systems.

Automatic SAS – for continuous flow ether start aid systems.

On manual SAS types, when the SAS is placed and held in the ON position (momentary contact), the metered shot ether start aid system is activated. A specific amount of ether is metered into a holding chamber. When the SAS is released, a solenoid allows ether to flow to the engine. The metered shot ether start aid system deactivates when:

The contacts of the crank termination relay (CTR) open at an engine speed of approximately 400 rpm.

Or the engine coolant temperature is sufficient to open the start aid temperature switch (SATS).

Or the SAS is released.

---

NOTICE

**Crank the engine before activating (SAS in ON position) the metered shot ether start aid system. Damage to the system is possible by activating the system when the engine is not turning.**

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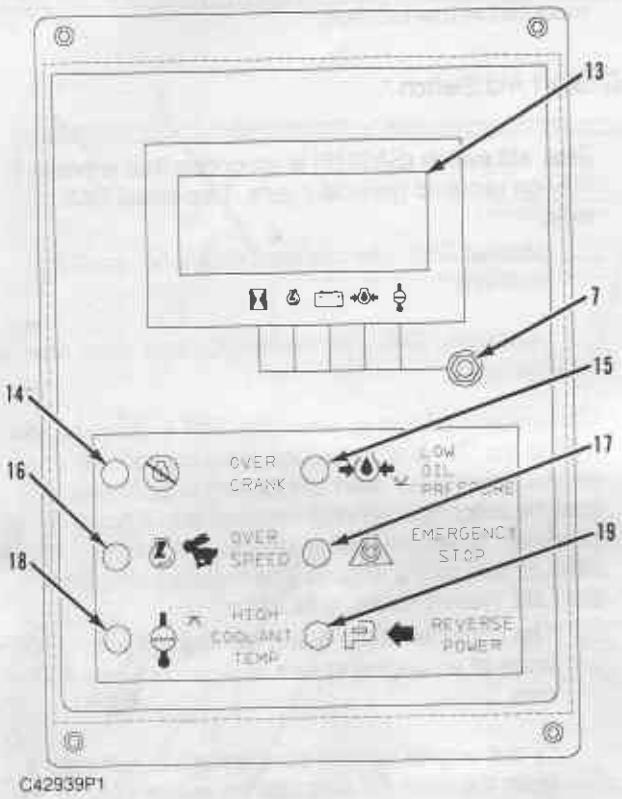
On automatic SAS types, the continuous flow ether start aid system operates in the automatic or the manual mode. When the SAS is placed in the AUTO position, the automatic mode is activated. The system automatically injects ether only during the crank cycle. When the SAS is placed and held in the MAN position (momentary contact), the manual mode is activated. This allows the operator to control the amount of time ether is injected during cranking. The manual mode also allows the operator to inject additional ether after crank termination (used on cold running engines which continue to detonate). The continuous flow ether start aid system deactivates when:

The contacts of the crank termination relay (CTR) open at an engine speed of approximately 400 rpm (automatic mode only).

Or the engine coolant temperature is sufficient to open the start aid temperature switch (SATS).

Or the SAS is returned to the OFF position.

## Engine Control Module (ECM)




Engine Control Module (ECM)
(7) Switch (display hold switch). (13) Display LCD. (14) Overcrank LED. (15) Low oil pressure LED. (16) Overspeed LED. (17) Emergency stop LED. (18) Overtemperature LED. (19) Reverse power LED.

The right side of the control panel contains engine control module (ECM) (6). This is the "brain" of the system and also displays fault conditions and key engine parameters.

Engine control module (ECM) (6) accepts information from the operator, magnetic speed pickup (MPU), pressure/temperature module and optional remote sources. This information is used to determine the "on/off" state of the engine's air, fuel and starting motor.

In the very basic operating conditions, the ECM receives a signal to run the generator set. The ECM then turns on the engine's fuel and starting motor. When the engine speed reaches the crank termination speed, the starting motor is disengaged. When the ECM receives a signal to stop the engine, it shuts the fuel off.

**Features of the ECM are:**

Cycle Crank - Programmable crank-rest-crank time periods (see Service Procedure A).

2301 Control - When the engine oil pressure increases past the low oil pressure setpoint, the ECM indicates to an electronic governor to increase the engine speed from idle to rated.

Cool Down - Upon receiving a signal to perform a normal shutdown, the ECM waits a preprogrammed amount of time and then the fuel control shuts the engine off.

Automatic Operation - While in the automatic mode, a remote initiate signal [when initiate contact (IC) closes] tells the ECM to start the engine. Upon loss of the signal, the ECM performs a normal shutdown.

Alarm Module Communication - The ECM transmits fault and alarm conditions to an alarm module.

Power Down - The electronic modular control panel (EMCP) system is designed to remove power from the ECM when the ECS is in the OFF/RESET position. On ETS systems, power down occurs approximately 70 seconds after 0 rpm is reached. On ETR systems, power down occurs immediately.

Fuel Solenoid Type - The ECM is programmed to work with either an energize to run (ETR) fuel system or an energize to shutdown (ETS) fuel system.

NOTE: For latching type fuel systems, the ECM is programmed in the ETS mode.

LED Display - Six LED's are located on front of the ECM to indicate overcrank shutdown, overspeed shutdown, low oil pressure shutdown, high coolant temperature shutdown, emergency stop and reverse power shutdown. The reverse power LED is a spare fault indicator when the reverse power relay option is not used.

Emergency Stop - If the ECM detects an emergency stop, the air and fuel control shut down the engine. LED (17) flashes.

Pressure/Temperature Module Malfunction - If the signal from the engine mounted oil pressure/temperature module is lost or unreadable, the fuel control relay (FCR) shuts down the engine and a diagnostic code is displayed. It is possible to program the ECM so that pressure/temperature module malfunctions are ignored (see Service Procedure A).

Speed Pickup Malfunction - If the ECM loses its magnetic pickup signal, the air and fuel control shut down the engine. A diagnostic code is displayed by the ECM.

**Overcrank Protection** - If the engine fails to start in a preprogrammed amount of time, the ECM halts the starting sequence and flashes LED (14). Another attempt at starting the engine is prevented until the ECS is turned to the OFF/RESET position.

**Liquid Crystal Display (LCD) (13)** - Service hours, engine speed, system battery voltage, engine oil pressure and engine coolant temperature are displayed in sequence in either English or metric units. Pressing switch (7) on the front of the ECM, stops the display on one of the engine parameters. Pressing the switch again resumes the display to normal sequencing. The display is also used to indicate diagnostic codes, to aid in troubleshooting. See Troubleshooting, Diagnosed Problems.

**Lamp Test** - When the ECM detects a lamp test, it turns ON all the LCD segments and LED's. If the lamp test signal lasts for more than 10 seconds, the ECM returns to normal operation.

**Overspeed Protection** - If the engine speed exceeds the overspeed setpoint, the air shut-off (if equipped) and fuel control solenoids shut down the engine. LED (16) flashes. The overspeed setpoint is lowered to 75% of its original value while the overspeed verify switch is depressed. To test the overspeed protection circuit, see Service Procedure H (Verify Overspeed Shutdown).

**Low Oil Pressure Protection** - If the engine oil pressure drops below the low oil pressure setpoint, the fuel control solenoid shuts down the engine. LED (15) flashes. There are two low oil pressure setpoints. One for when the engine speed is below the oil step speed. The other setpoint is for when the engine speed is above the oil step speed. See Service Procedure J (Verify Low Oil Pressure Shutdown).

**High Coolant Temperature Protection** - If the engine coolant temperature exceeds the high coolant temperature setpoint, the fuel control solenoid shuts down the engine. LED (18) flashes. See Service Procedure I (Verify High Coolant Temperature Shutdown).

### ECM Sequence Of Operation (Normal Start-Stop)

Upon receipt of a signal to start, the ECM checks to assure that:

a. An emergency stop signal is not present.

b. All faults are reset.

c. All sensors are connected and operating properly.

d. No abnormal engine control switch signals are present.

e. The engine is not already running.

f. The ECM microprocessor is functioning properly.

g. The ECM is not in the programming mode.

The ECM does NOT allow the start sequence to begin and displays the proper diagnostic code when applicable, if an above fault condition exists. However, once the ECM is satisfied that conditions are normal, it energizes the starting motor relay (SMR) and run relay (RR).

For latching type fuel systems, when the starting motor magnetic switch (SMMS) is energized the latching fuel control solenoid (LFS) is also energized to turn the fuel ON. This momentary current flow through a special latch mechanism on the solenoid holds the solenoid in the ON position.

For energized to run (ETR) type fuel systems, the ECM also signals to turn on fuel (or the electronic governor), by energizing the fuel control relay (FCR) and run relay (RR).

If the cycle crank feature is enabled, the ECM automatically cranks-rests-cranks the engine for the adjusted time periods. If the generator set fails to start within the selected total crank time, the ECM executes an overcrank fault. If a fault condition occurs while the engine is cranking, the ECM terminates and locks out cranking. The ECM displays the applicable diagnostic code or lights the appropriate LED.

After the engine starts and has achieved the proper crank termination speed, the ECM de-energizes the starting motor by de-energizing SMR and energizes the crank termination relay (CTR). Once safe low idle speed oil pressure is achieved, the ECM signals the optional electronic governor to accelerate the generator set to rated speed, by energizing the 2301 relay.

The generator set runs as long as operating conditions remain normal and a signal to run is received by the ECM. The digital display of the ECM shows in sequence (each for a two second period): the engine lube oil pressure, water temperature, RPM, service hours and system DC volts. At the same time, the ECM monitors for any fault or abnormal conditions.

Upon loss of the run signal, the engine continues to run for an adjustable cool down period if the cool down feature is utilized. However, if the cool down feature is not used or if the ECM receives an off/reset signal, it immediately de-energizes the run relay. For energize to shutdown (ETS) and latching type fuel systems, the fuel circuit is energized at this point. For energized to run (ETR) type (or 2301) fuel systems, the fuel circuitry is de-energized.

If the signal to run returns before the engine stops, on ETR and ETS fuel systems, the ECM immediately goes back to the running state. The fuel is turned back ON, but the starting motor does not energize. For latching type fuel systems, fuel is not turned ON because the fuel solenoid does not latch without energizing the starting motor relay (SMR).

If restart does not occur, RPM continues to drop and a run signal is present, the ECM initiates cranking upon reaching zero rpm. Assuming that the run signal does not return and the engine speed continues to diminish until zero rpm is reached, the crank termination relay (CTR) de-energizes. Now the ECM and fuel control relay (FCR) are ready for an instant restart. For energize to shutdown (ETS) and latching type fuel systems, the fuel control relay (FCR) of the ECM de-energizes 70 ± 10 seconds after zero rpm is reached and engine oil pressure is zero or immediately upon receiving a signal to run.

### ECM Sequence Of Operation (Fault Conditions)

If a fault condition occurs prior to starting the generator set, the ECM:

a. De-energizes and locks out the starting motor circuit.

b. Assures that fuel is shut off.

c. De-energizes the run relay (RR) circuit.

d. Energizes the fault shutdown circuitry, including the engine failure relay (ENFR).

If a fault condition occurs while the generator set is running, the ECM:

a. Shuts off fuel.

For energized to run (ETR) engines, the fuel control circuitry is de-energized.

For energized to shutdown (ETS) and latching engines, the fuel control circuitry is energized. Then de-energized 70 ± 10 seconds after the engine reaches zero rpm.

b. Shuts off air. Air shutoff relay (ASR) is energized for an overspeed, emergency stop, diagnostic codes 01, 04, 06 or if all six LED's are ON. The ASR is also energized if the engine remains running 10 seconds after the fuel is shut off. The ASR circuitry is de-energized 15 to 20 seconds after the engine reaches zero rpm.

c. Locks the starting motor relay (SMR) circuitry in the de-energized state.

d. De-energizes the run relay (RR) circuitry.

e. Energizes the fault shutdown circuitry, including the engine failure relay (ENFR).

If a fault occurs before or after the engine starts, the appropriate fault indicating LED flashes at 2 Hz or a diagnostic code is displayed to indicate the nature of the problem. The indicators remain on and the ECM remains in the fault mode until it receives a reset signal.

## Control Panel Sequence Of Operation

**NOTE:** The ECM and ALM do NOT turn off. If desired, battery drain is decreased by modifying the wiring of the ECS. When modified, the ECM and ALM turn OFF when the ECS is in the OFF/RESET position. To modify the wiring, remove the jumper wire which connects terminals 9 and 6 of the ECS. See the DC schematic (line 38) in the Schematics And Wiring Diagrams section.

### Normal Start-Stop Sequence

The four positions of the engine control switch (ECS) are: AUTO, RUN (MANUAL), COOL DOWN/STOP and OFF/RESET. The generator set cranks, terminates cranking and runs if: the ECS is in the AUTO position and a signal to run is received from a remote initiate contact (IC), or if the ECS is placed in the RUN position. If necessary and if the cycle crank feature is utilized, the generator set cycle cranks. Generator sets equipped with electronic governors run at low idle speeds until lube oil pressure has exceeded the low idle speed oil pressure setpoint. Then the 2301 relay contact of the ECM closes and the engine accelerates to rated speed. Generator sets with hydra-mechanical governors accelerate to rated speed immediately after crank termination.

When the generator is running, the ACM displays amps, volts and frequency. The operator makes voltage and frequency adjustment. The generator set runs until the signal to run is removed by either turning the engine control switch to COOL DOWN/STOP, OFF or the remote initiate contact (IC) opens. Once the ECS is moved to the OFF position, the generator set shuts down immediately. However, if the ECS is placed in the COOL DOWN/STOP position, or if in the AUTO position and the remote initiate contact opens, the generator set runs for a short time in the cool down mode, if the cool down feature was utilized. Otherwise, the generator set shuts down immediately. The generator set is then capable of immediate restart.

During a normal start, run, stop sequence of operation, the other optional features/functions operate as follows:

a. Prior to cranking, all displays are activated.

b. Prior to crank termination the ether start aid circuit is activated. The start aid switch (SAS) is now used by the operator to inject ether into the engine.

c. After crank termination:

The ether start aid circuit is deactivated, preventing ether injection.

The governor raise-lower switch (GS) circuit is activated, allowing changes to the governor speed setting.

The auxiliary relay is energized, to switch on customer high power loads such as exhaust fans.

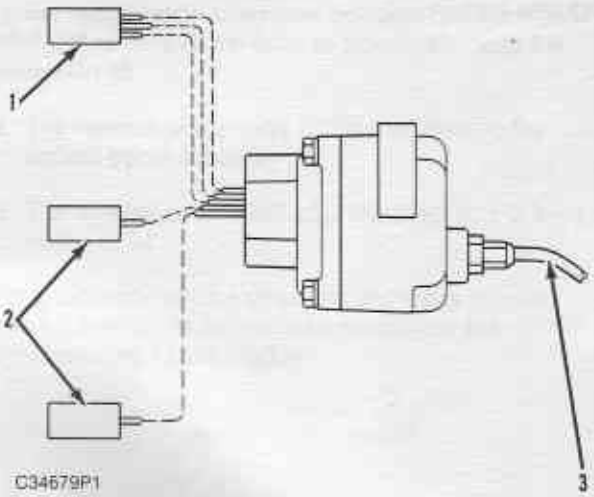
NOTE: On engines equipped with continuous flow ether start aid systems and the automatic start aid switch (SAS), the operator is allowed to inject ether after crank termination.

# c Pressure/Temperature Module

The pressure/temperature module receives engine coolant temperature and engine oil pressure information. The pressure/temperature module then sends engine coolant and engine oil pressure information to the ECM.

There are two different pressure/temperature modules: earlier and current.

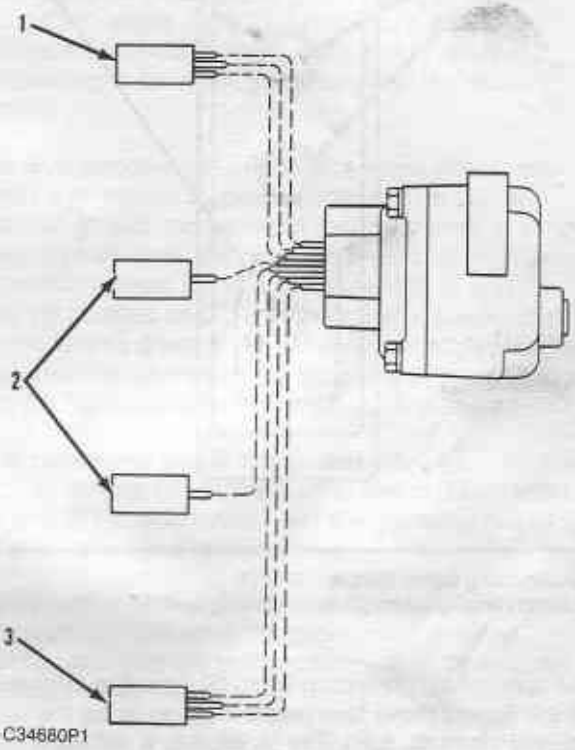
## Earlier Pressure/Temperature Module




Earlier Pressure/Temperature Module
(1) Connector to EMCP. (2) Connectors to coolant temperature sensor. (3) Oil line to engine.

On earlier pressure/temperature modules, the engine oil pressure transducer mounts within the module. Oil line (3) connects the transducer to the engine. Wires connect the module to the engine coolant temperature sensor and the EMCP.

## Current Pressure/Temperature Module

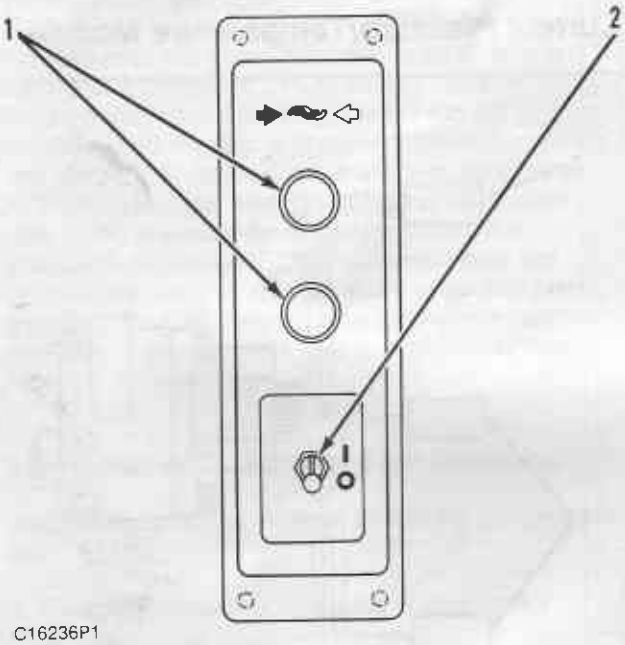



Current Pressure/Temperature Module
(1) Connector to EMCP. (2) Connectors to coolant temperature sensor. (3) Connector to engine oil pressure sensor.

On current pressure/temperature modules, the engine oil pressure transducer is NOT mounted within the module. Wires connect the module to the engine oil pressure sensor. The engine oil pressure sensor contains the transducer and mounts to the engine. Wires also connect the module to the engine coolant temperature sensor and the EMCP.

# Optional Modules

## Synchronizing Lights Module




Synchronizing Lights Module
(1) Synchronizing lights. (2) Synchronizing switch.

The optional synchronizing lights (SL) module is located on the control panel face (same location as for the optional alarm module). The SL module is not used when the panel is equipped with an electronic governor.

Synchronizing lights (SL) are used as an aid in manually paralleling generator units independent of load. Each of two lights are connected across the generator to the load side of the generator output circuit breaker. The voltage of two phases are measured and the lights indicate when the voltages are in phase. When the voltages are in phase, closing the circuit breaker puts the generator on-line with the other generator unit(s).

NOTE: For a complete explanation on how to parallel two units, make reference to the Operation and Maintenance Manual for SR4 Generators and Control Panels, Form No. SEBU6150.

### Synchronizing Module Installation

**⚠ WARNING**

**To avoid electrical shock and personal injury, shut down all on-line generator sets before installing or repairing the synchronizing module.**

NOTE: For connection of the synchronizing light module and connection of resistor taps in the module, see the Main Chassis Wiring Diagram in the Schematics And Wiring Diagrams section.

Make an orderly shut down of all generators connected to the system. Then connect synchronizing module wires to the terminals as follows:

a. Wire L1 to control panel terminal (L1).

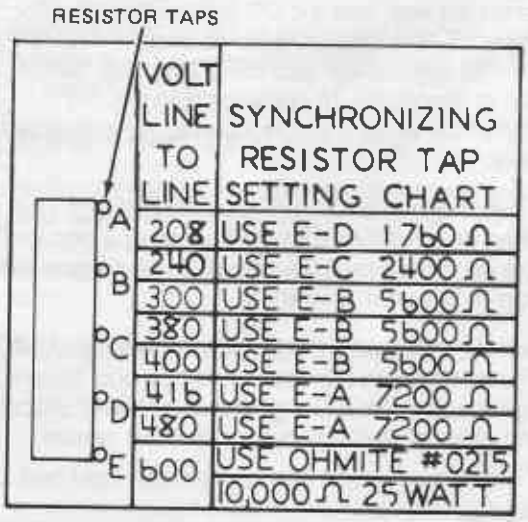
b. Wire L3 to control panel terminal (L3).

c. Wire T11 to the load side of fuse F11.

d. Wire T13 to the load side of fuse F13.

The customer is responsible for providing proper wire and fusing to connect L1 and L3 to the load side of the generator output circuit breaker. Refer to the AC Schematic in the Schematics And Wiring Diagrams section.

Adjust the connection of wires T11 and T13 on the taps of synchronizing resistors (SLR1) and (SLR2) respectively as required for the particular generator AC voltage. Refer to the following chart and the Main Chassis Wiring Diagram in the Schematics And Wiring Diagrams section.

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Synchronizing Resistor Tap Connection Chart

NOTE: Remove the synchronizing module cover for access to the resistor taps.

Example: For a generator with 400 volts line to line, T11 and T13 are connected to tap B on the respective SLR.

## Synchronizing Lights Module – With Reverse Power Relay

NOTE: The synchronizing lights module (with reverse power relay) option looks and operates the same as the module without the reverse power relay with the exception of:

a. The reverse power relay (RPR) mounted on the control panel subpan.

b. The reverse power fault LED mounted on the front of the ECM.

For information on the synchronizing lights module, make reference to the previous section on the Synchronizing Lights Module.

### Introduction

The reverse power relay (RPR) provides system protection when the generator set is in parallel with other units. If for some reason the engine loses power, the other parallel unit attempts to motorize (drive electrically) the engine and generator. As long as voltage is present at the generator leads, the voltage regulator maintains the field excitation. The engine and generator remain magnetically coupled and the generator then drives the engine. Instead of power going OUT, power flows INTO the failing generator. This reverse flow of power could possibly result in overloading of the other generators and the whole system.

The reverse power relay (RPR) is a single phase relay which is energized by power (amp-volts) in only one direction (power into generator instead of out). In a reverse power fault, the relay (RPR) (located on AC Schematic) closes its contact across RPR (5 and 6) (line 19) (located on DC Schematic). This causes the engine to shut down. If the generator output breaker is equipped with shunt trip, the generator is taken off line. See the Schematics And Wiring Diagrams section.

After the reverse power fault is corrected, the control is reset by turning the engine control switch (ECS) to the OFF/RESET position. Also reset the generator output breaker if equipped with shunt trip.

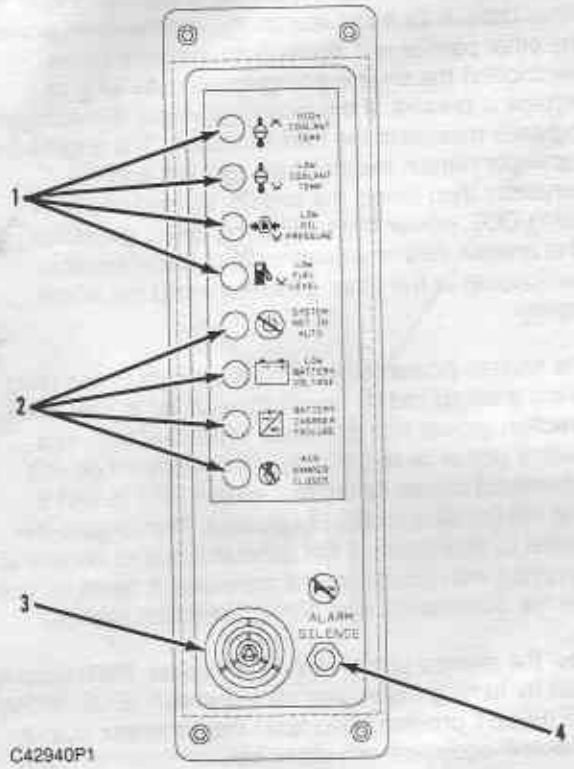
The operation of the RPR is tested by pushing the test button on the RPR while the generator is on load. Depress and hold the test button for 10 to 15 seconds (until time delay elapses).

**⚠ WARNING**

**To avoid personal injury from electrical shock, do NOT touch the high voltage terminal while adjusting the reverse power relay.**

The relay trip point is field adjustable, but is normally factory set at approximately 15% of the generator rated kW (for on-line generators operating at 15% or more of rated kW).

## Alarm Modules




Alarm Module (NFPA 110 ALM)
(1) Amber LED's. (2) Red LED's. (3) Horn.
(4) Acknowledge/silence switch.

The alarm module (ALM) is an attachment located on the control panel face. Red LED's (2) and amber LED's (1) are the visual indicators. Horn (3) is the audible indicator.

There are four versions of the basic module. The modules are either alarm modules or a remote annunciator. The nomenclature remote annunciator is required but, it is the same basic module. The versions are:

- Standby NFPA 99 alarm module.
- NFPA 99 remote annunciator, used with standby NFPA 99 alarm module.
- Standby NFPA 110 alarm module, used with NFPA 110 remote annunciator panel. See Remote Annunciator Panel (NFPA 110).
- Prime power alarm module.

The only differences between these modules is in the graphics film on the front of the panel and the jumper wires on the rear. See the DC schematic in the Schematics And Wiring Diagrams section. The NFPA 99 remote annunciator also has a lamp test switch. The following description of operation refers to the alarm/remote annunciator module as the annunciator module.

The purpose of the alarm modules (ALM) is to give a warning of conditions that are becoming a problem before conditions are bad enough to shut down the engine or keep it from starting.

If, with the ECS in the COOL DOWN/STOP or AUTO positions, an alarm condition develops prior to or while the generator set is running, that condition is indicated by the optional alarm module and/or the remote annunciator.

### Description Of Operation

NOTE: In the following description the word annunciator is used to mean either alarm module or remote annunciator module.

The annunciator module receives data from three sources: switch inputs, internal circuitry, and a serial data link from the engine control module.

#### Switch Inputs

Up to four inputs are available for switch (i.e., Low Fuel Level) connections. Switch inputs are activated when connected to battery negative (−B). See Table 1.

#### Internal Circuitry

Internal circuitry is used to determine and annunciate if the DC battery supply voltage is below the setpoint (factory set at 24 DCV).

#### Data Link

The annunciator module receives data from the engine control module by a serial data link. The items included in this data stream of information are:

1 - Coolant temperature has exceeded the high temperature alarm setpoint programmed into the engine control module.

2 - Oil pressure is below the low oil pressure alarm setpoint programmed into the engine control module.

3 - Coolant temperature is below the low temperature alarm setpoint programmed into the engine control module.

4 - The engine control switch is not in the AUTO or RUN position.

5 - Oil pressure is below the low pressure shutdown setpoint programmed into the engine control module.

6 - Coolant temperature has exceeded the high coolant temperature shutdown setpoint programmed into the engine control module.

7 - The engine failed to start (overcrank).

8 - The engine speed exceeded the overspeed setpoint programmed into the engine control module.

9 - The engine shut down due to a remote fault condition.

10 - The engine shut down due to a spare fault condition.

11 - The engine shut down due to an emergency stop condition.

12 - The engine shut down due to a diagnostic fault condition.

Data items 1 through 8 control the operation of the LED's and the horn as indicated in Table 1. Data items 9 through 12 control the operation of the horn only.

The maximum number of modules, alarm or CIM, connected to the serial data link is three. The maximum distance between a module and the ECM is 305 m (1000 ft).

## C LED And Horn Operation

**TABLE 1: LED AND HORN FUNCTION**

| No. LED Color | NFPA 99 ALM | NFPA 110 ALM | NFPA 99 RAN | Prime Power Single Engine | Prime Power Multi Engine |
|---|---|---|---|---|---|
| 1 Amber | High Coolant Temp Alarm LI,H,LAT,TD | High Coolant Temp Alarm LI,H,LAT,TD | Gen On Load SW (3) | High Coolant Temp Alarm LI,H,LAT,TD | High Coolant Temp Alarm LI,H,LAT,TD |
| 2 Amber | Low Coolant Temp Alarm LI,H,LAT | Low Coolant Temp Alarm LI,H,LAT | Low Coolant Temp Alarm LI,H,LAT | Low Coolant Level Alarm SW(4),H | Low Coolant Level Alarm SW(2),H |
| 3 Amber | Low Oil Pres Alarm LI,H,LAT | Low Oil Pres Alarm LI,H,LAT | Charger Malfunction SW(4),TIM | Low Oil Pres Alarm LI,H,LAT | Low Oil Pres Alarm LI,H,LAT |
| 4 Amber | Low Fuel Level SW(1),H | Low Fuel Level SW(1),H | Low Fuel Level SW(1),H | Low Oil Level SW(1),H | Low Oil Level SW(1),H |
| 5 Red | Not In Auto LI,H | Not In Auto LI,H | High Coolant Temp Shutdown [1] LI,H,TD | Low DCV INT,TIM | Not In Auto LI,H |
| 6 Red | Low DCV INT,TIM | Low DCV INT,TIM | Low Oil Pres Shutdown [1] LI,H | Spare SW(3) | Low DCV INT,TIM |
| 7 Red | Spare SW(3) | Charger Malfunction SW(4),TIM | Overcrank Shutdown [1] LI,H | Not Used | Spare SW(3) |
| 8 Red | Spare SW(4) | Air Damper Closed [2] SW(3),H | Overspeed Shutdown [1] LI,H | Not Used | Spare SW(4) |
| | SW(2) Not Used | SW(2) Not Used | SW(2) Not Used | SW(2) Not Used | |

Key:
[1] Latched by ECM.
[2] Air damper switch to be supplied by customer.
ALM = Alarm module.
H = Horn is sounded.
INT = The signal source is internal to the module.
LAT = "LATCHED" alarm condition.
LI = The data link from the engine control module is the signal source.
RAN = Remote annunciator.
SW = One of 4 switches is the signal source (The number in parentheses indicates which switch is the signal source).
TD = A 10 second delay occurs before the condition is annunciated.
TIM = A 60 second time delay occurs before the condition is annunciated.

When an alarm condition occurs, the LED corresponding to that condition flashes at 2 hertz and the horn sounds. If the alarm condition is NOT LATCHED, the LED and horn turn off as soon as the alarm condition ceases. If the alarm condition is LATCHED, the LED continues to flash until the acknowledge/silence input is activated. See Table 1 for LATCHED alarm conditions and the LED and horn functions for each operating mode.

Normally switch input 3 (terminal 10) and switch input 4 (terminal 11) only operate LED's 7 and 8. However, it is possible for switch inputs 3 and 4 to also operate the horn. To do so, connect terminal 10 (sw input 3) to terminal 3, and connect terminal 11 (sw input 4) to terminal 4.

### Acknowledge/Silence

Activating the acknowledge/silence switch (4) causes the horn to cease and the LED to stay on continuously.

### Data Link Malfunction

If the data link malfunctions, the LED's controlled by the data link flashes at 0.5 hertz. The switch controlled LED's function normally.

### Lamp Test

Activating the lamp test switch results in sounding the horn and turning on all LED's continuously for 10 seconds or until the switch is deactivated.

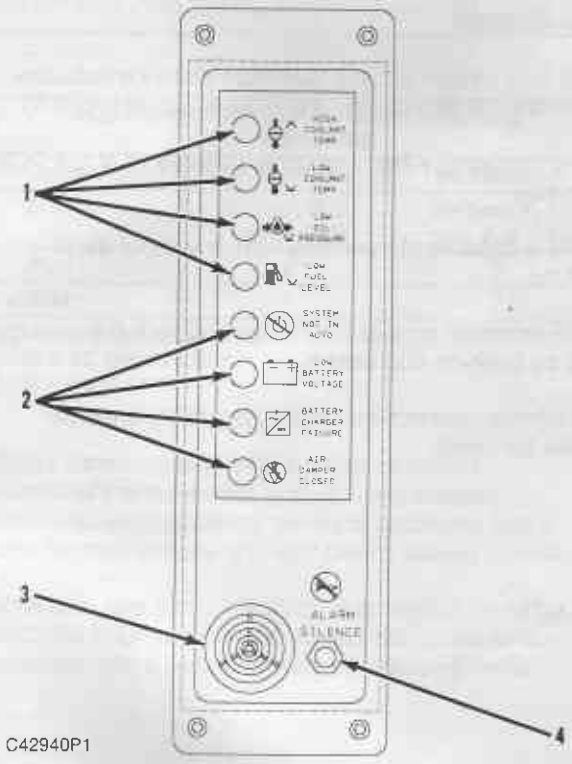
C Mode Selection

| TABLE 2: MODE SELECTION AND SWITCH INPUT CONNECTIONS | | | | | | |
|---|---|---|---|---|---|---|
| **Input** | **Mode SEL1** | **Mode SEL2** | **Switch 1** | **Switch 2** | **Switch 3** | **Switch 4** |
| **Terminal** | **5** | **6** | **8** | **9** | **10** | **11** |
| **Mode** | | | | | | |
| **NFPA 99 Alarm** | (Float) | (Float) | Low Fuel Level | (Float) | Spare | Spare |
| NFPA 110 Alarm | (Float) | (B –) | Low Fuel Level | (Float) | Air Damper Closed | Charger Malfunction |
| NFPA 99 Remote Annunciator | (B –) | (Float) | Low Fuel Level | (Float) | Gen On Load | Charger Malfunction |
| Prime Power Single Engine | (Float) | (Float) | Low Oil Level | (B –) | (Spare) | Low Coolant Level |
| Prime Power Multi Engine | (B –) | (B –) | Low Oil Level | Low Coolant Level | (Spare) | (Spare) |

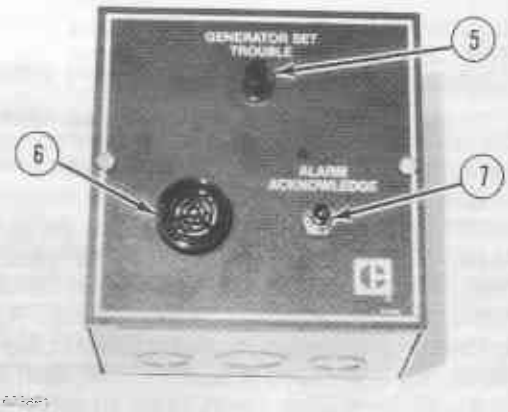
NOTE: Connections in parentheses are required to select the mode specified.

The annunciator module operates in one of the five modes described in Table 2. The modes are selected by connections made to the mode select inputs (terminals 5 and 6) and switch 2 input (terminal 9) as shown in Table 2.

## Remote Annunciator Panel – NFPA 110




Alarm Module (NFPA 110 ALM)
(1) Amber LED's. (2) Red LED's. (3) Horn.
(4) Acknowledge/silence switch.



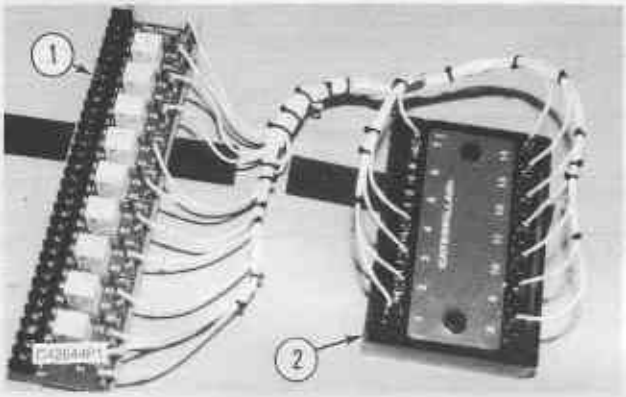

NFPA 110 Remote Annunciator Panel
(5) Trouble light. (6) Horn. (7) Acknowledge/silence switch.

This remote panel functions in conjunction with the NFPA 110 alarm module. The alarm module is mounted in the left side of the control panel. When an alarm occurs on the alarm module or a fault occurs on the ECM, horns (3) and (6) sound in both the alarm module and the remote annunciator. Trouble light (5) lights in the remote annunciator panel. The appropriate alarm LED also lights in the alarm module or the appropriate fault LED lights in the engine control module (ECM).

When alarm acknowledge/silence switch (4) or (7) is pressed on either the remote panel or the alarm module, the horns on both cease sounding. Also, trouble light (5) on the remote panel goes out. The LED on the alarm module or ECM remains on. Another fault or alarm condition reactivates the horns, LED and light as before.

Trouble light (5) also acts as a test switch on the remote panel. When light (5) is pushed, horn (6) and light (5) turn on. The alarm module is not affected by the test switch.

## C Customer Interface Module (CIM)




Customer Interface Module (CIM)
(1) Relay board. (2) Electronic control.

REFERENCE: For more information, see the Schematics And Wiring Diagrams section.

The CIM provides an interface (separate relay contacts) between the ECM and switchgear. The two major components of CIM are relay board (1) and electronic control (2). Electronic control (2) connects to the same serial data link as the alarm annunciator. CIM operation is similar to the alarm annunciator except that the data link information is decoded into discrete outputs. The outputs then drive the relays located on relay board (1). The relay contacts are used to sound a horn, flash a lamp or trigger some other action. Once an output is activated, it remains energized until the initiating conditions are cleared. If a malfunction in the serial data link occurs, all electronic control outputs (therefore all relays also) flash at 0.5 Hz.

The available serial data link information is:

- High coolant temperature alarm.
- Low oil pressure alarm.
- Low coolant temperature alarm.
- Engine control switch (ECS) NOT in auto.
- Low oil pressure shutdown.
- High coolant temperature shutdown.
- Overcrank.
- Overspeed.
- Diagnostic failure (ECM).

**Application Guidelines**

Lamp Test

When a lamp test signal is received, the CIM activates all outputs for 10 seconds or until test signal is deactivated. Two lamp test signals are possible, the CIM lamp test is activated when:

Terminal 5 is connected to terminal 7 of electronic control (2).

The ECM lamp test signal is received over the data link.

NOTE: CIM ignores the ECM lamp test signal when terminal 6 is connected to terminal 7 of electronic control (2).

Outputs:

- The relays on relay board (1) are fuse protected. The contacts are flashed silver and are rated at 1 amp 28 DCV. The relays draw 20 mA (at 24 DCV).

- The driver outputs of electronic control (2) are intended to drive incandescent lamps or relay loads. The driver outputs sink up to 600 mA (15 - 45 DCV).

Specifications:

- For CIM installation, the maximum distance between electronic control (2) and the ECM is 305 m (1000 ft).

- The operating voltage range is 15 to 45 DCV (24 DCV nominal)

- CIM is capable of operating with or without earth ground.

- The terminals on electronic control (2) are 6.4 mm (.25 in) push-on connectors.

- Customer connections at relay board (1) are 6-32 screw terminals.

# Testing And Adjusting

## Troubleshooting

### c Introduction

On the pages that follow are two lists of possible problems; Diagnosed Problems List and Undiagnosed Problems List. Before checking the list of problems, check the ECM display for any diagnostic codes. These codes aid in finding the problem (see Diagnosed Problems List).

NOTICE

Before checking the list of problems, check the battery voltage of all electronic controls. At the power terminal connections, the required voltage measured between battery positive (B+) and battery negative (B–) is from +15 to +45 DCV. It is possible for battery voltages below +15 DCV to cause temporary failures of the electronic controls. It is possible for battery voltages above +45 DCV to cause permanent damage of the electronic controls and require correcting before troubleshooting any further. To locate the power terminal connections, refer to the following chart and the Schematics And Wiring Diagrams section.

| ELECTRONIC CONTROLS POWER TERMINAL CONNECTIONS | | |
|---|---|---|
| **Component** | **B+ Terminals** | **B– Terminals** |
| ECM | B+ post, D, J, L, N, R, T, V | B– post, Y, 1, 2, 3 |
| ACM | 9 | 5 |
| ALM | 1 | 7 |

ECM = Engine Control Module
ACM = AC Meter Module
ALM = Alarm Module

Before replacing anything, inspect all control, component and harness connections. Loose connections could cause electrical problems. Make sure the connections are tight before testing continues.

More than one faulty component or control could cause electrical failures. Find and correct the cause of an electrical failure before making any replacements.

Identify the particular type of problem from the Problem List, then go directly to that problem. However, when beginning the procedure for that problem, start at Step 1 and follow through the step by step procedure. The Steps in a particular problem provide a definite sequence for a logical, one by one elimination of many variables. These steps are arranged in order from the more probable/easiest to check, to the less probable/more complex to check.

When the cause of the problem is found and corrected, stop the test. Do NOT continue through the complete procedure.

**⚠ WARNING**

**When servicing or repairing electric power generation equipment, do the following:**

**a. Make sure the unit is off-line (disconnected from utility power service and/or other generators), and either locked out or tagged DO NOT OPERATE.**

**b. Make sure the generator engine is stopped.**

**c. Make sure all batteries are disconnected.**

**d. Make sure all capacitors are discharged.**

**When power generation equipment is in operation to make tests and/or adjustments, high voltage and current are present. Make sure the testing equipment is designed for and correctly operated for the high voltage and current tests. Failure of improper test equipment presents a high voltage shock hazard to its user.**

**⚠ WARNING**

**When the engine-generator, or any source to which the engine-generator is synchronized to, is operating, voltages up to 600V are present in the control panel.**

**Do NOT short these terminals with line voltage to ground with any part of the body or any conductive material. Loss of life or injury could result from electrical shock or injury from molten metal.**

**⚠ WARNING**

**Do NOT connect generator to a utility electrical distribution system, unless it is isolated from the system. Personal injury or death is possible by electrical feedback into the distribution system.**

**Open and secure main distribution system switch or, if the connection is permanent, install a double throw transfer switch to prevent electrical feedback. Some generators are specifically approved by a utility to run in parallel with the distribution system and isolation is NOT required. Always check with the utility as to the applicable circumstances.**

## Test Instruments

**Caterpillar Digital Multimeter (6V7070) Or Equivalent** – is used for many of the voltage and resistance checks. Rectifiers are also checked with the special diode function. For further information on using the digital multimeter, see Special Instruction, Form No. SEHS7734.

NOTE: See the following WARNING if generator is rated over 600 volts.

**⚠ WARNING**

**On generators with higher than 600 volts rating, do NOT use direct-reading test equipment to measure the voltage or line current, (even though the instrument has higher voltage capacity). Only use voltage and current transformers with a high voltage reading. On power circuits higher than 600 volts, insulation failure is possible on direct reading meters and present a high voltage shock to the user.**

## Problems

The engine control module (ECM) provides built-in diagnostic capabilities. The diagnostics are designed to make service and maintenance of the system as simple as possible. Faults that are diagnosed by the ECM are listed in the Diagnosed Problems List. Faults that are NOT diagnosed by the ECM are listed in the Undiagnosed Problems List.

## Diagnosed Problems

For diagnosed problems, the diagnostic codes are displayed on the same display as the service hours, engine speed, battery voltage, engine oil pressure, and engine coolant temperature. When a diagnostic code is displayed, the arrow that indicates which of the above parameters are displayed is missing and a flashing "dIAG" is displayed. If several faults are present, the diagnostic codes are displayed in sequence. The diagnostic code is cleared from display by turning the engine control switch (ECS) to the OFF/RESET position. Before attempting a repair, move the ECS to the OFF/RESET position and restart engine to see if problem recurs.

### Diagnosed Problems List

Problem A - ECM Display = 01 dIAG, no magnetic speed pickup (speed sensor) signal.

Problem B - ECM Display = 02 dIAG, no oil pressure/temperature module signal.

Problem C - ECM Display = 03 dIAG, a problem with inputs from the ECS.

Problem D - ECM Display = 04 dIAG, loss of setpoints programmed into the ECM memory.

Problem E - ECM Display = 05 dIAG, engine shuts down with no shutdown command from the ECM.

Problem F - ECM Display = 06 dIAG, internal failure of ECM or unstable voltage supply.

Problem G - ECM Display = 07 dIAG, internal ECM programming switch does NOT match program.

Problem H - ECM Display = 08 dIAG, temperature probe problem.

Problem I - ECM Display = 09 dIAG, oil pressure probe problem. ECM displays high oil pressure when the engine is NOT running and has cooled down.

### Problem A

ECM Display = 01 dIAG, no magnetic speed pickup (speed sensor) signal.

#### Procedure

STEP 1. Disconnect the speed sensor leads from terminals 1 and 7 on the ECM. Measure the resistance between the speed sensor leads. Also measure the resistance between each speed sensor lead and ground.

- Resistance between leads is between 100 and 270 ohms. Also, the resistance between each lead and ground is above 5000 ohms.

  Speed sensor wiring is okay. Go to Step 2.

- Resistance is below 100 ohms.

  Short circuit in wiring or sensor. Repair wiring or replace speed sensor as needed.

- Resistance is above 270 ohms.

  Wire is broken or connector is defective. Repair broken wire or bad connection or replace speed sensor as needed.

- Resistance between sensor leads and ground is below 5000 ohms.

  Speed sensor is grounded. Repair wiring harness or replace speed sensor as needed.

STEP 2. Reconnect speed sensor leads to terminals 1 and 7 on the ECM. Measure the AC voltage across terminals 1 and 7 on the ECM while cranking the engine. In order to perform this Step, a crank speed of 250 rpm or greater is required.

- Speed sensor voltage is 1.0 ACV or greater.

  Attempt to start. If 01 dIAG reappears, replace speed sensor. If 01 dIAG still appears after replacing the sensor, replace ECM.

- Speed sensor voltage is below 1.0 ACV.

  Adjust speed sensor gap (see Service Procedure F). If speed sensor voltage is still low, replace speed sensor.

### C **Problem B**

ECM Display = 02 dIAG, no oil pressure/temperature module signal.

Problem B is divided into separate procedures for the two different style pressure/temperature modules used.

- Procedure B1 is used for the earlier pressure/temperature modules (engine oil line connects to the module).

- Procedure B2 is used for the current pressure/temperature modules (no engine oil line connects to the module, wires connect the engine oil pressure sensor to the pressure/temperature module).

NOTE: Without oil pressure protection the ECM shuts down the generator set. During troubleshooting or in an emergency situation, it is possible to operate with no oil pressure or coolant temperature protection by reprogramming the ECM (see Service Procedure A). Install oil pressure and coolant temperature gauges to give the operator an indication of engine conditions. After the problem is fixed, make sure to reprogram the ECM.

If the ECM is programmed to operate with no oil pressure and water temperature protection and the 02 dIAG occurs, it is possible the ECM does NOT reset. However, the engine continues to run. Check for loose connections or low battery voltage before replacing ECM.

#### Procedure B1

STEP 1. Measure the voltage between terminal 4 of the ECM and battery negative (B–). Disconnect the 3 pin connector at the press/temp module and again measure the voltage between terminal 4 and battery negative (B–). Disconnect the wire from terminal 4 and again measure the voltage between terminal 4 of the ECM and battery negative (B–).

- Voltage is between 11 and 15 DCV in all cases.

  The power supply is okay. Go to Step 2.

- Voltage is above 20 DCV in all cases.

  Replace ECM. It is likely that the press/temp module is damaged also.

- Voltage is above 15 DCV but below 20 DCV in all cases or below 11 DCV in all cases.

  Replace ECM.

- Voltage goes from below 11 DCV to between 11 and 15 DCV when the 3 pin connector is disconnected.

  Replace press/temp module.

- Voltage goes from below 11 DCV to between 11 and 15 DCV when wire to terminal 4 is disconnected.

  Repair grounded wiring between ECM and press/temp module.

- Voltage is above 15 DCV initially but is between 11 and 15 DCV when wire to terminal 4 is disconnected.

  Repair wiring between ECM and press/temp module. If wire is shorted to battery positive (B+), failure of the press/temp module is probable and replacement is advised.

STEP 2. Reconnect any wires that were disconnected in Step 1. Measure the voltage on terminal 5 of the ECM with respect to battery negative (B–).

- Voltage is 4 to 8 DCV.

  The voltage level is okay. Go to Step 3.

- Voltage is above 8 DCV.

  Go to Step 4.

- Voltage is below 4 DCV.

  Recheck supply voltage to the press/temp module (Step 1). If okay, disconnect wire to terminal 5 of ECM. If voltage at terminal 5 now goes above 8 DCV, replace the press/temp module. If voltage at terminal 5 remains low, replace the ECM.

STEP 3. Reconnect any wires that were previously disconnected. Disconnect the 3 pin connector at the pressure/temperature module. Measure the voltage between battery negative (B–) and pin 1 of the wiring harness connector. Also measure resistance between battery negative (B–) and pin 2 of this connector.

- Voltage is between 11 and 15 DCV and resistance is below 1 ohm.
  Supply to press/temp module okay. Replace press/temp module.
- Voltage is below 11 DCV.
  Repair wiring between ECM and press/temp module.
- Resistance is above 5 ohms.
  Repair wiring between press/temp module and battery negative (B–).

STEP 4. Reconnect any wires that were previously disconnected. Disconnect the 3 pin connector at the pressure/temperature module. Measure the voltage between battery negative (B–) and pins 1 and 3 of the wiring harness connector. Also measure resistance between battery negative (B–) and pin 2 of this connector.

- Voltage at pin 1 is below 11 DCV or voltage at pin 3 is below 8 DCV.
  Repair wiring between ECM and press/temp module.
- Resistance is above 5 ohms.
  Repair wiring between press/temp module and battery negative (B–).
- Voltage at pin 1 is between 11 and 15 DCV; and voltage at pin 3 is above 8 DCV; and resistance is below 1 ohm.
  Replace the press/temp module.

### Procedure B2

STEP 1. Measure the voltage between terminal 4 and battery negative (B–) of the ECM. Disconnect the 3 pin connector at the press/temp module and again measure the voltage between terminal 4 and battery negative (B–). Disconnect the wire from terminal 4 and again measure the voltage between terminal 4 of the ECM and battery negative (B–).

- Voltage is between 11 and 15 DCV in all cases.
  The power supply is okay. Go to Step 2.
- Voltage is above 20 DCV in all cases.
  Replace ECM. It is likely that the press/temp module is also damaged.
- Voltage is above 15 DCV but below 20 DCV in all cases or below 11 DCV in all cases.
  Replace ECM.
- Voltage goes from below 11 DCV to between 11 and 15 DCV when the 3 pin connector is disconnected.
  Replace press/temp module.
- Voltage goes from below 11 DCV to between 11 and 15 DCV when wire to terminal 4 is disconnected.
  Repair grounded wiring between ECM and press/temp module.
- Voltage is above 15 DCV initially but is between 11 and 15 DCV when wire to terminal 4 is disconnected.
  Repair wiring between ECM and press/temp module. If wire is shorted to battery positive (B+), failure of the press/temp module is probable and replacement is advised.

STEP 2. Reconnect any wires that were disconnected in Step 1. Measure the voltage on terminal 5 of the ECM with respect to battery negative (B–).

- Voltage is 4 to 8 DCV.
  The voltage level is okay. Go to Step 3.
- Voltage is above 8 DCV.
  Go to Step 4.
- Voltage is below 4 DCV.
  Recheck supply voltage to the press/temp module (Step 1). If okay, disconnect wire to terminal 5 of ECM. If voltage at terminal 5 now goes above 8 DCV, replace the press/temp module. If voltage at terminal 5 remains low, replace the ECM.

STEP 3. Reconnect any wires that were previously disconnected. Disconnect the 3 pin connector at the pressure/temperature module. Measure the voltage between battery negative (B–) and pin 1 of the wiring harness connector. Also measure resistance between battery negative (B–) and pin 2 of this connector.

- Voltage is between 11 and 15 DCV and resistance is below 1 ohm.
  Supply to press/temp module okay. Go to Step 5
- Voltage is below 11 DCV.
  Repair wiring between ECM and press/temp module.
- Resistance is above 5 ohms.
  Repair wiring between press/temp module and battery negative (B–).

STEP 4. Reconnect any wires that were previously disconnected. Disconnect the 3 pin connector at the pressure/temperature module. Measure the voltage between battery negative (B–) and pins 1 and 3 of the wiring harness connector. Also measure resistance between battery negative (B–) and pin 2 of this connector.

- Voltage at pin 1 is below 11 DCV or voltage at pin 3 is below 8 DCV.
  Repair wiring between ECM and press/temp module.

- Resistance is above 5 ohms.
  Repair wiring between press/temp module and battery negative (B–).

- Voltage at pin 1 is between 11 and 15 DCV. Also, voltage at pin 3 is above 8 DCV. Also, resistance is below 1 ohm.
  Go to Step 5.

STEP 5. Reconnect any wires that were previously disconnected. At the pressure/temperature module, disconnect the 3 pin harness connector that goes to the engine oil pressure sensor. At the module harness connector, measure the voltage between pin A (red power wire) and pin B (yellow ground wire).

- Voltage is less than 4.5 DCV.
  Repair wiring between module and pressure sensor. If a wiring problem is NOT found, replace the pressure/temperature module.

- Voltage is greater than 4.5 but less than 6.0 DCV.
  Replace the engine oil pressure sensor which is located on the engine.

- Voltage is greater than 6.0 DCV.
  Replace the pressure/temperature module. It is likely that the pressure sensor is also damaged.

**Problem C**

ECM Display = 03 dIAG, a problem with inputs from the ECS.

Procedure

The engine control switch (ECS) must connect ECM terminal 9 or 10 or 11 or 12 to battery negative (B–). If both 9 and 11 are connected to negative, auto start occurs. Any wiring error or loose connection causes an 03 dIAG code. Check ECS and wiring from ECS to ECM repair as needed.

- Wiring and ECS check okay.
  Replace the ECM.

- Wiring or ECS check bad.
  Repair or replace components as necessary.

**Problem D**

ECM Display = 04 dIAG, loss of setpoints programmed into the ECM memory.

Procedure

Reprogram the ECM (see Service Procedure A) and turn the ECS to reset.

- 04 dIAG does NOT recur.
  Problem solved.

- 04 dIAG recurs.
  Replace ECM.

**Problem E**

ECM Display = 05 dIAG, engine shuts down with no shutdown command from the ECM.

NOTE: The following Steps are labeled ETS and/or ETR. Perform the Steps which apply to the corresponding type of system. In the following procedures, consider latching fuel systems as ETS fuel systems. See Service Procedure A on how to identify energize to run (ETR) or energize to shutdown (ETS) systems.

Procedure

STEP 1 (ETS Or ETR System). Crank the engine by moving the ECS to the MANUAL position and observe the action of the governor and fuel rack. Also observe the position of the air shutoff (if so equipped). If engine does NOT crank, troubleshoot starting system according to Undiagnosed Problem 2.

If an electronic governor is used, measure the voltage supplied to the governor.

- Fuel rack and governor moves in Fuel On direction, and air shutoff lever is in RUN position.
  The problem is in the engine or fuel system. Refer to engine portion of the Service Manual.

- Fuel rack does NOT move or is NOT possible to observe. Governor does NOT move in Fuel On direction or is NOT possible to observe.
  Check fuel level. Fill and prime fuel system if level was low. Go to Step 2A (ETS) or Step 2B (ETR) if level was low.

- Air shutoff is in the SHUTOFF position.
  Reset air shutoff. Go to Step 4 if shutoff does NOT reset or if it trips on each attempt to start.

- An electronic governor is used and supply voltage is greater than 15 volts.
  Problem is in governor or actuator system. For Woodward 2301 Electric Governor, refer to SENR2928 service manual. For Woodward 2301A Speed Control, refer to SENR4676 service manual. For Woodward 2301A Load Sharing Governor, refer to SENR3585 service manual.

- An electronic governor is used and the supply voltage is less than 15 volts.
  Problem is in wiring to the electronic governor. Go to Step 3.

STEP 2A (ETS). Remove fuse F6 (fuse between terminals R and S) from back of ECM. Prepare to use manual shutoff if needed. Crank the engine.

- Engine starts and runs.
  The fuel relay (FCR) is energizing the shutoff (or latching) solenoid. Check resistance between terminals S and 23. If it is below 5 ohms, go to Service Procedure B. If not, look for wiring errors that might supply voltage to shutoff solenoid. On 3408 and 3412 engines, it is possible the auxiliary fuel control relay is energizing the fuel solenoid. Check relay contacts and wiring. Replace if necessary.

- Engine does NOT start.
  The shutoff solenoid is stuck or the fuel rack is stuck in the SHUTOFF position or solenoid is NOT correct for the application. Find the source of the problem and correct.

STEP 2B (ETR). Connect a jumper between terminals S and 23 of the terminal strips on the back of the ECM and crank the engine. Prepare to use manual shutoff if needed.

- Engine starts and runs.
  The fuel control relay (FCR) relay was NOT energizing the fuel solenoid. Check FCR (see Service Procedure B).

- Engine does NOT start.
  The fuel solenoid is defective or stuck, or solenoid is NOT correct, or the fuel rack is stuck in the SHUTOFF position. If there is no voltage at terminal S, check fuse F6 and replace if open. Find the source of the problem and correct.
  On 3408 and 3412 engines, it is possible the auxiliary fuel control relay is faulty. Check relay contacts and wiring. Replace if necessary. Also check fuses F6 and F10 on subpan. Replace if necessary.

STEP 3 (ETS or ETR System). Crank the engine and measure the DC voltage between the following points and battery negative (B–): the battery positive (B+) terminal on the preregulator (located under 2301 in control panel), terminal 1 of the F9 fuse if preregulator is NOT used, terminal 20 on the ECM, terminal M on the ECM and terminal L on the ECM.

- Voltage is below 15 DCV at all of these points.
  Battery voltage is low or wiring from battery to control panel is defective. Charge battery or repair wiring as needed.

- Voltage is above 15 DCV on terminal L of ECM only. Voltage is low at all other points.
  Fuse F4 is blown. Replace fuse.

- Voltage is above 15 DCV on terminals M and L of the ECM. Voltage is low at all other points.
  Run Relay contact is NOT closing. Check the ECM for diagnostic codes before checking the relay. (See Service Procedure B.)

- Voltage is above 15 DCV on terminals M and L and 20 of the ECM. Voltage is low at all other points.
  Check the wiring between terminal 20 of the ECM and the battery positive (B+) terminal on the preregulator or F9 fuse if preregulator is NOT used. Repair as needed.

- All voltages are above 15 DCV. The voltage at the electronic governor remains low.
  The preregulator fuse or the F9 fuse or the preregulator or wiring is defective. Repair as needed.

STEP 4. Check for another diagnostic code. If none is displayed, remove fuse F7 (between terminals T and U) from back of ECM.

- Air shutoff does NOT trip and engine starts.
  The air shutoff relay (ASR) is energizing the solenoid. Check resistance between terminals U and 24 on the ECM. If it is below 5 ohms, go to Service Procedure B. If not, look for wiring errors that might supply voltage to shutoff solenoid.

- Air shutoff continues to trip.
  The air shutoff is defective. See the air shutoff section of the Engine Service Manual.

- Air shutoff does NOT trip and engine does NOT start.
  Check diagnostic code and return to Step 1 if code 05 dIAG is still displayed.

### Problem F

ECM Display = 06 dIAG, internal failure of ECM or unstable voltage supply.

#### Procedure

Reset and wait 90 seconds. Restart to see if problem re-occurs. If it does, look for possible sources of electrical noise such as loose connections in supply to ECM. Install jumper between terminals D and F of the ECM. Reset and start engine.

- 06 dIAG recurs only when engine is running.
  Loose connection between battery positive (B+) or battery negative (B–) to ECM is still likely. Run separate supply wires. Replace ECM if this fails to correct problem.

- 06 dIAG recurs when engine is NOT running.
  Loose connection still possible but less likely. Replace ECM unless an external electrical noise source is identified.

- 06 dIAG does NOT recur.
  Check crank termination relay (CTR) or fuel control relay (FCR) contacts or leave jumper (D to F) connected if battery drain is NOT a problem.

- 06 dIAG reoccurs when engine is starting and engine cranks slowly or NOT at all.
  Battery voltage is low. Charge and/or replace batteries.

### Problem G

ECM Display = 07 dIAG, internal ECM programming switch does NOT match program.

The 07 dIAG code simply indicates that the setpoint value programmed into setpoint 02 does NOT match the position of the rotary switch.

NOTE: After programming, it is possible for the 07 dIAG code to appear if the system is NOT reset.

#### Procedure

Turn the ECS to the OFF/RESET position. Next, turn the ECS to the RUN position.

- 07 dIAG code is NOT present.
  There is no 07 dIAG code failure.

- 07 dIAG code is still present.
  The value of setpoint 02 does NOT match the rotary switch position. See Service Procedure A.

### Problem H

ECM Display = 08 dIAG, temperature probe problem.

#### Procedure

If ambient temperature is near –40°C (–40°F), use heaters to warm up the engine before startup. If temperature is warmer, check connectors between oil pressure/temperature transducer (sensor) and the temperature probe before going to Service Procedure G.

C

### Problem I

ECM Display = 09 dIAG, ECM displays high oil pressure when the engine is NOT running and has cooled down.

NOTE: Problem I (09 dIAG) applies only to the current pressure/temperature modules (no engine oil line connects to the module, wires connect the engine oil pressure sensor to the pressure/temperature module).

#### Procedure

Record the oil pressure the ECM is displaying. Disconnect the harness connector of the engine oil pressure sensor. Record the oil pressure the ECM is now displaying.

- Both pressures displayed are above 965 kPa (140 psi).
  In the wiring from the pressure/temperature module to the pressure sensor, check for a short between the green signal wire (pin C) and the red power wire (pin A).

- The first displayed pressure is above 480 kPa (70 psi) but below 760 kPa (110 psi). Also, the second displayed pressure is 0 kPa (0 psi).
  In the harness connector, check for an open ground circuit (pin B, yellow wire).

- The first displayed pressure is 965 kPa (140 psi). Also, the second displayed pressure is 0 kPa (0 psi).
  Check the pressure sensor wiring and correct as needed. If no wiring problem found, replace the engine oil pressure sensor.

- Both pressures are above 0 kPa (0 psi) but below 965 kPa (140 psi).
  Replace the pressure/temperature module.

## Undiagnosed Problems

Undiagnosed problems are those problems which are indicated by incorrect operation or the fault LED's on the ECM. Undiagnosed problems are NOT indicated on the LCD display of the ECM. When an undiagnosed problem occurs, see the Undiagnosed Problems List and perform the corresponding problem procedure.

### Undiagnosed Problems List

Problem 1 - Engine cranks but does NOT start or shuts down immediately after starting.

Problem 2 - Engine does NOT crank.

Problem 3 - Starting motor remains engaged or continues to run after engine has started.

Problem 4 - Engine shutdown occurs, all six LED fault indicators on the ECM flash.

Problem 5 - LED fault indicator on the ECM does NOT reset.

Problem 6 - Engine shutdown occurs, overcrank LED is lit.

Problem 7 - Engine shutdown occurs, overspeed LED is lit.

Problem 8 - Engine shutdown occurs, low oil pressure LED is lit.

Problem 9 - Engine shutdown occurs, high coolant temperature LED is lit.

Problem 10 - Engine shutdown occurs, emergency stop LED is lit.

Problem 11 - Engine shutdown occurs, reverse power relay LED is lit.

Problem 12 - No engine shutdown when a fault occurs.

Problem 13 - Engine shutdown with no LED's lit or diagnostic codes on ECM.

Problem 14 - Remote annunciator or control panel alarm module data link controlled LED's all flash at a rate of once per two seconds (0.5 Hz).

Problem 15 - ACM displays all dashes "---".

Problem 16 - ACM Hz displays "LO" and voltmeter displays "0".

### Problem 1

Engine cranks but does NOT start or shuts down immediately after starting.

#### Procedure

Look at the ECM Display.

- Overcrank LED's is lit (is on).

  Reset control and check cycle crank time and overcrank time setpoints (see Service Procedure A). Normally both times are 5 seconds or more. If engine does NOT start in 5 seconds, troubleshoot engine/fuel system/governor.

- Overcrank LED did NOT light (if off). If the engine started and then shut down, an 05 dIAG code is displayed.

  Go to Diagnosed Problem E, diagnostic code 05, regardless if 05 dIAG is displayed or not.

- Some other diagnostic code is displayed.

  Go to Diagnosed Problem List and do problem indicated by the diagnostic code.

### C Problem 2

Engine does NOT crank.

#### Procedure

STEP 1. Look at ECM Display.

- Display is completely blank regardless of the engine control switch setting.

  Go to Step 2.

- All 6 LED fault indicators are on.

  Go to Undiagnosed Problem 4, all six LED fault indicators are on.

- One or more but NOT all of the 6 LED fault indicators are flashing.

  There is a shutdown fault. Go to Undiagnosed Problem List and do the corresponding problem.

- A diagnostic code is displayed.

  Go to Diagnosed Problem List and do problem indicated by the diagnostic code.

- No LED fault indicators are lit and no diagnostic code is displayed.

  Defect is in the starting circuit. Allow five minutes for CB2 in control panel to cool down and automatically reset. Attempt to start the engine. If engine does NOT crank go to Step 4.

STEP 2. Turn the engine control switch to Stop. Measure the voltage and check the polarity at terminals 1 and F of the ECM. With the positive meter lead on terminal F and the negative meter lead on terminal 1, the correct voltage is between +15 and +45 DCV.

- Polarity and voltage are correct.
  Replace the ECM.

- Polarity is correct, but voltage level is below +15 DCV.
  Check the battery voltage and check the wiring from the battery to the ECM. As needed, recharge or replace the batteries and repair the wiring. Refer to the DC Schematic in the Schematics And Wiring Diagrams section.

- Polarity is NOT correct.
  Check and correct any improper connections between the battery and the ECM. Refer to the DC Schematic in the Schematics And Wiring Diagrams section. Go to Step 3.

STEP 3. Check the part number on the back of the relay housing located on the rear of the ECM.. The part number is 9W2126-XX, where XX is a number greater than 01.

- XX is the number 07 or less.
  Do NOT try to start the engine. Replace the ECM.

- XX is the number 08 or higher.
  Try to start the engine. If engine still does NOT crank and the display is not blank, go back to Step 1.

STEP 4. Look at the battery voltage displayed on the ECM Display.

- Voltage is low (1 to 20 volts).
  Charge the battery or repair loose connections between battery cable terminal and battery.

- Voltage is above 20 volts.
  Go to Step 5.

STEP 5. Prepare for the engine to crank. Momentarily connect a wire between terminals 1 and 5 on the generator mounted terminal strip (TS1).

- Engine cranks.
  Go to Step 6.

- Engine does NOT crank.
  Check to see if terminals 4 and 5 on TS1 are jumpered together. If so, the magnetic switch (see Service Procedure E) or the pinion solenoid or the starting motor is defective. Repair or replace as required.
  NOTE: Terminals 4 and 5 are NOT jumpered together when the optional prelube pump is installed. When oil pressure is 1 psi or greater during the cranking cycle, the prelube pump pressure switch closes. This connects terminal 4 and 5 together. First ensure that the prelube system operates properly. Then, go to Step 6. Refer to the Schematics And Wiring Diagrams section.

STEP 6. Attempt to start engine (ECS in manual) and measure voltage between ECM terminal 25 and battery negative (B–), terminal W and battery negative (B–), battery positive (B+) and battery negative (B–).

- All voltages are below 20 DCV.
  Battery or wiring to ECM is defective. Repair or replace defective parts.

- Only the voltage on terminal 25 is below 20 DCV.
  Check the starting motor relay (SMR) (see Service Procedure B).

- The voltage on terminals 25 and W are below 20 DCV. The battery voltage is above 20 DCV.
  Replace fuse F8. Also check wiring from terminal W to battery positive (B+).

### Problem 3

Starting motor remains engaged or continues to run after engine has started.

### Procedure

STEP 1. Turn the engine control switch to Stop. Check the polarity at terminals 1 and F of the ECM. With the positive meter lead on terminal F and the negative meter lead on terminal 1, the correct voltage is between +15 and +45 DCV.

- Polarity is correct.
  Go to Step 2.

- Polarity is NOT correct.
  Check and correct any improper connections between the battery and the ECM. Refer to the DC Schematic in the Schematics And Wiring Diagrams section. Replace the ECM.

STEP 2. Check for diagnostic codes on the ECM display and go to that respective problem. If no diagnostic codes are shown, shut the engine down and check the voltage between terminals 5 and 2 (5 is positive) on the generator terminal strip (TS1).

- Engine continues to crank and 15 DCV or more is measured.

  Go to Step 3.

- Engine no longer cranks.

  Check crank terminate setpoint (see Service Procedure A). If setpoint is okay, go to Diagnosed Problem A under 01 dIAG. If speed sensor signal is good and shielded wire is in good condition, replace the ECM.

- Engine continues to crank and there is less than 1 DCV between terminals 5 and 2.

  Problem is in magnetic switch (see Service Procedure E) or in starting motor or pinion solenoid. Repair as required.

STEP 3. Disconnect wire No. 5 on the generator terminal strip TS1.

- Engine no longer cranks and also the voltage between terminals 5 and 2 on generator terminal strip is still above 15 DCV.

  Check resistance between terminals W and 25 on ECM. If it is below 5 ohms, go to Service Procedure B. If not, check for shorts or incorrect wiring that supplies voltage to terminal 5.

- Engine continues to crank.

  Problem is in magnetic switch (see Service Procedure E) or in starting motor or pinion solenoid. Repair as required.

**Problem 4**

Engine shutdown occurs, and/or all six LED fault indicators on the ECM are on.

Procedure

Make sure that the control panel lamp test switch (LTS) is NOT activated. Disconnect wires from terminal 8 on the ECM. Measure the DC voltage between battery positive (B+) and battery negative (B–) on ECM.

- Fault LED's do NOT turn on.

  Test switch (LTS) or wiring is grounded. Correct the problem.

- Fault LED's remain ON. Battery voltage is 15 DCV or less.

  Battery voltage is low. Charge battery or correct wiring problem as required.

- Fault LED's remain ON. Battery voltage is above 15 DCV.

  Replace the ECM.

**Problem 5**

LED fault indicator on the ECM does NOT reset.

Procedure

Move the engine control switch (ECS) to the OFF/RESET position. If the LED does NOT go out, connect a jumper wire between terminal 12 on the ECM and battery negative (B–). Disconnect jumper wire.

- LED resets (goes out) when jumper wire is connected.

  Problem is in ECS or wiring to the ECS. Repair as required.

- LED does NOT reset (still lit).

  Make sure that the fault condition no longer exists. (Example: Engine high coolant temperature LED is lit and engine is cool). If fault does NOT reset, replace the ECM.

**Problem 6**

Engine shutdown occurs, overcrank LED is lit.

Procedure

Turn ECS to the OFF/RESET position. If the overcrank LED does NOT go out, do Undiagnosed Problem 5. If the LED goes out, do Undiagnosed Problem 1.

**Problem 7**

Engine shutdown occurs, overspeed LED is lit.

Procedure

Turn ECS to the OFF/RESET position. If the overspeed LED does NOT go out, do Undiagnosed Problem 5. If the LED goes out, check for possible causes of overspeed. If no causes are found, check the overspeed setpoint and the ring gear teeth setpoint according to Service Procedure A. Attempt to start engine by moving the ECS to the MANUAL position.

- Overspeed LED resets and engine starts and runs. Overspeed setpoint is correct.

  Hold the verify switch on back of the ECM in the VERIFY position and increase speed until shutdown occurs. If shutdown speed is 75% of overspeed setpoint, the overspeed function is okay. Look for governor or system problems. If shutdown speed is incorrect, go to Service Procedure F. Replace the ECM if no speed sensor problem is found.

- Overspeed LED resets and engine starts, but overspeeds again.

If speed goes above overspeed setpoint, repair governor or system problem. If speed does NOT go high, go to Service Procedure F. Replace the ECM if no speed sensor problem is found.

- Overspeed setpoint is below specifications.

  Program the correct setpoint according to Service Procedure A.

### C Problem 8

Engine shutdown occurs, low oil pressure LED is lit.

Problem 8 is separated into two procedures for the different pressure/temperature modules.

- Procedure 8A is used for the earlier pressure/temperature modules (engine oil line connects to the module).

- Procedure 8B is used for the current pressure/temperature modules (no engine oil line connects to the module, wires connect the engine oil pressure sensor to the pressure/temperature module).

#### Procedure 8A – Earlier Module

STEP 1. Monitor the low oil pressure LED. Turn ECS to the OFF/RESET position.

- The LED does NOT go out.

  Do Undiagnosed Problem 5.

- The LED goes out.

  Check for possible causes of low oil pressure. If no causes are found, go to Step 2.

STEP 2. Check that the following setpoints, which are programmed in the ECM, agree with the specified setpoints: oil step speed, idle speed oil pressure shutdown and rated speed oil pressure shutdown (see Service Procedure A).

- The setpoints agree.

  Go to Step 3.

- The setpoints do NOT agree.

  Reprogram the ECM to the specified setpoints. See Service Procedure A.

STEP 3.

NOTE: Without oil pressure protection the ECM shuts down the generator set. During troubleshooting or in an emergency situation, it is possible to operate with no oil pressure or coolant temperature protection by reprogramming the ECM (see Service Procedure A). Install oil pressure and coolant temperature gauges to give the operator an indication of engine conditions. After the problem is fixed, make sure to reprogram the ECM.

Install a reliable oil pressure gauge. Start the engine. At idle and rated speed, check to see if the gauge and ECM display are the same. If the oil pressure is low, do NOT continue. Shut the engine down and repair the problem in the engine lube system.

- Gauge and ECM display are the same.

  Go to Step 4.

- Gauge and ECM display are NOT the same.

  Check the wiring and oil supply to the pressure/temperature module. If no problem is found, replace the pressure/temperature module.

STEP 4. At idle and rated speed, compare the measured oil pressure to the programmed setpoints.

- Pressure is less than the setpoints.

  The problem is in the engine. Refer to the engine service manual.

- Pressure is the same or above the setpoints.

  Check the wiring and oil supply to the pressure/temperature module. If no problem is found, replace the ECM.

#### Procedure 8B – Current Module

STEP 1. Monitor the low oil pressure LED. Turn ECS to the OFF/RESET position.

- The LED does NOT go out.

  Do Undiagnosed Problem 5.

- The LED goes out.

  Check for possible causes of low oil pressure. If no causes are found, go to Step 2.

STEP 2. Check that the following setpoints, which are programmed in the ECM, agree with the specified setpoints: oil step speed, idle speed oil pressure shutdown and rated speed oil pressure shutdown (see Service Procedure A). The specified setpoints are shown in the Identification section (fifth character) and Service Procedure A.

- The setpoints agree.
  Go to Step 3.

- The setpoints do NOT agree.
  Reprogram the ECM to the specified setpoints. See Service Procedure A.

STEP 3.

**NOTE:** Without oil pressure protection the ECM shuts down the generator set. During troubleshooting or in an emergency situation, it is possible to operate with no oil pressure or coolant temperature protection by reprogramming the ECM (see Service Procedure A). Install oil pressure and coolant temperature gauges to give the operator an indication of engine conditions. After the problem is fixed, make sure to reprogram the ECM.

Install a reliable oil pressure gauge. Start the engine. At idle and rated speed, check to see if the gauge and ECM display are the same. If the oil pressure is low, do NOT continue. Shut the engine down and repair the problem in the engine lube system.

- Gauge and ECM display are the same.
  Go to Step 4.

- Gauge and ECM display are NOT the same.
  Go to Step 5.

STEP 4. At idle and rated speed, compare the measured oil pressure to the programmed setpoints.

- Pressure is less than the setpoints.
  The problem is in the engine. Refer to the engine service manual.

- Pressure is the same or above the setpoints.
  Replace the ECM.

STEP 5. A poor connection or short could cause the problem. Check, repair if necessary, the wiring and harness connector from the pressure/temperature module to the engine oil pressure sensor. Check if problem is still present.

- Problem is no longer present.
  The harness was the cause of the problem.

- Problem is still present.
  Replace the oil pressure sensor. If low oil pressure problem still exists, replace the press/temp module.

### Problem 9

Engine shutdown occurs, high coolant temperature LED is lit.

### Procedure

STEP 1. Turn ECS to the OFF/RESET position. Allow engine to cool down.

- The high coolant temperature LED does NOT go out after engine is cool.
  Perform Undiagnosed Problem 5.

- The high coolant temperature LED goes out.
  Check for possible causes for high coolant temperature. If no causes are found go to Step 2.

STEP 2. Check the coolant temperature setpoint programmed into the ECM (see Service Procedure A). Make sure it is set for the specific engine model. See the Identification section.

- The programmed coolant temperature setpoint is below the proper shutdown setpoint.
  Temperature setpoint is NOT correct. Reprogram setpoint. See Service Procedure A.

- The programmed coolant temperature setpoint agrees with the proper shutdown setpoint.
  Temperature setpoint is correct. Go to Step 3.

STEP 3. Install an accurate coolant temperature gauge with the sensing bulb in an area of high coolant flow, as close to temperature probe as possible.

**NOTE:** Without oil pressure protection the ECM shuts down the generator set. During troubleshooting or in an emergency situation, it is possible to operate with no oil pressure or coolant temperature protection by reprogramming the ECM (see Service Procedure A). Install oil pressure and coolant temperature gauges to give the operator an indication of engine conditions. After the problem is fixed, make sure to reprogram the ECM.

Start the engine and allow coolant temperature to stabilize. If necessary, apply a load to the generator.

- Temperature displayed by ECM and by gauge agree and it is above the temperature setpoint. Setpoint is correct and high coolant temperature LED is still lit.
  Engine is overheating. Troubleshoot cooling system.

- Temperature displayed by ECM is 5°C (9°F) or higher than the temperature displayed by the gauge.

  Check temperature probe (see Service Procedure G). If it is good, repeat test. Make sure the gauge is accurate. If ECM continues to read high, replace the pressure/temperature module.

- Temperature displayed by ECM and by gauge agree and are below the temperature setpoint.

  Go to Undiagnosed Problem 5.

- Temperature displayed on the ECM is the word "Hi" and the temperature on the gauge is below 98°C (208°F).

  Check for shorts in wiring to the pressure/temperature module. Also check the temperature probe (see Service Procedure G).

**Problem 10**

Engine shutdown occurs, emergency stop LED's is lit.

Procedure

Reset the emergency stop pushbutton by rotating the knob until it pops out. Turn the ECS to OFF/RESET position. Disconnect the wire from terminal 14 on the ECM if LED remains on after attempting to reset.

- Emergency stop LED goes out when wire is disconnected.

  Emergency stop switch is stuck closed or grounded or wire is grounded. Repair as required.

- Emergency stop LED remains on.

  Move ECS to reset and back to the MANUAL position. If LED remains on, go to Undiagnosed Problem 5.

**Problem 11**

Engine shutdown occurs, optional reverse power relay LED is lit.

Procedure

Turn the ECS to the OFF/RESET position. If the reverse power LED does NOT go out, disconnect wire from terminal 13 on the ECM.

- Reverse power LED goes out (resets) after resetting.

  Problem was reverse power fault. Control panel is okay.

- Reverse power LED goes out when wire is disconnected from terminal 13.

  Reverse power relay does NOT reset. Check wiring to reverse power relay. If required, replace the reverse power relay.

- Reverse power LED remains lit.

  Go to Undiagnosed Problem 5.

**Problem 12**

No engine shutdown when a fault occurs.

Look at the ECM Display. If there is a diagnostic code displayed or a fault LED lit and the engine is NOT shutdown, go to Procedure 1A (ETS) or Procedure 1B (ETR) or Procedure 1C (3500 engine with electronic governor). In the following procedures, consider latching fuel systems as ETS fuel systems. If there is no diagnostic code or fault displayed, go to Procedure 2.

Procedure 1A (ETS)

Check the DC voltage relative to battery negative (B–) on TS1 terminal 7 in the generator and on terminals 23, S and R on the ECM. During this procedure, the engine is running with a fault LED lit.

- All voltages are above 20 DCV.

  The wire from terminal 7 in generator to solenoid is open or fuel shutoff solenoid is defective or NOT adjusted correctly. Repair as required.

- Voltage at terminal 7 in generator is below 20 DCV. The other voltages are above 20 DCV.

  The wire from terminal 7 in generator to terminal 23 in the ECM is open. Repair wire or connection.

- Voltage of terminal 23 in ECM and terminal 7 in the generator is below 20 DCV. The other voltages are above 20 DCV.

  Check the FCR relay for stuck open contacts. Go to Service Procedure B.

- All voltages are below 20 DCV except for Terminal R on the ECM.

  Replace Fuse F6. If problem continues, check for shorted solenoid or grounded wiring. Repair as required.

- All voltages are below 20 DCV.

  Connection from battery positive (B+) to terminal R is defective. Repair as required.

Procedure 1B (ETR)

Remove fuse F6.

- Engine shuts down.

  Fuel control relay (FCR) contact is stuck closed. Check resistance between terminals S and 23 on ECM. If it is below 5 ohms, go to Service Procedure B. If not, look for wiring errors that might supply voltage to fuel control solenoid.

- Engine continues to run.
  Fuel control solenoid is stuck in the RUN position. Shut engine down manually and troubleshoot solenoid and linkage.

### Procedure 1C (3500 Engine With Electronic Governor)

Remove Fuse 4.

- Engine shuts down.
  Run relay (RR) contact is stuck closed. Check resistance between terminals M and 20 on ECM. If it is below 5 ohms go to Service Procedure B. If not, look for wiring errors that might supply voltage to electronic governor.

- Engine continues to run.
  Rack or electric actuator is stuck in fuel ON position. Shut engine down manually and troubleshoot governor linkage.

### Procedure 2 (No Code Or Fault Displayed)

Record all of the readings from the ECM display. Shut engine down and check the setpoint (see Service Procedure A) of the parameter that is supposed to shut the engine down.

NOTE: If setpoint 02 is programmed to 2 or 3, the engine does NOT shut down during an engine oil pressure or coolant temperature fault. See Service Procedure A.

- Readings from the display are within allowed setpoints.
  There is no problem.

- Readings from the display are NOT within allowed setpoints.
  Replace ECM.

### Problem 13

Engine shutdown with no LED's lit or diagnostic codes on ECM.

### Procedure

Check to make sure ECM terminal 15 is NOT receiving a signal to shutdown (connect to battery negative, B–).

- Terminal 15 connected to battery negative (B–).
  Problem is in wiring, find defect and repair or replace it.

- Terminal 15 NOT connected to battery negative (B–).
  If no other defects are found replace the ECM.

### C Problem 14

Remote annunciator or control panel alarm module, data link controlled LED's all flash at a rate of once per two seconds (0.5 Hz).

### Procedure

STEP 1. Momentarily disconnect the battery or wire 1 at TS1-1 that is used to power the ECM. If the LED's stop flashing after the battery is reconnected, the problem is solved. If the LED's still flash, check to make sure serial data link wire 18 has good continuity from ECM terminal 6 to alarm module terminal 2. Also, ensure that there is at least 20K ohms of resistance between wire 18 and both battery positive (B+) and battery negative (B–).

- Wire 18 is either open or has less than 20K ohms of resistance to B+ or B–.
  Repair or replace defective wire.

- Wire 18 has continuity and at least 20K ohms of resistance to both B+ and B–.
  Go to Step 2.

STEP 2. Measure the DC voltage between terminal 7 and terminal 1 on the annunciator (terminal 1 is positive).

- Terminal 1 measures +15 DCV or more.
  Go to Step 3.

- Terminal 1 measures less than +15 DCV.
  Check the battery voltage. Check the wiring between the battery, the ECM, and the annunciator. As needed, recharge or replace the batteries and repair the wiring. Refer to the DC Schematic in the Schematics And Wiring Diagrams section.

STEP 3.

NOTE: The maximum number of modules, alarm or CIM, connected to the serial data link is three. The maximum distance between a module and the ECM is 305 m (1000 ft). If these specifications are NOT met, it is possible for the alarm module LED's to flash. This indicates the alarm module is NOT reading the information from the data link. If NOT in compliance with the specifications, reduce the number of modules and/or shorten the distance.

If there is more than one annunciator connected to the ECM, replace the one that has the flashing LED's. Otherwise, measure the DC voltage between ECM terminal 6 and B– and also the DC voltage between annunciator terminal 2 and B–.

- Both voltages are above 8 DCV.
  Replace the ECM.
- Both voltages change from 2 to 10 DCV.
  Replace the annunciator.
- Both voltages are below 2 DCV.
  Go to Step 4.
- The two voltages are NOT the same.
  Wire 18 is faulty. Repair or replace wire 18.

STEP 4. Remove connections on terminal 2 of the annunciator. Measure the DC voltage between annunciator terminal 2 and B–.

- Voltage is above 8 DCV.
  Replace the ECM.
- Voltage is below 2 DCV.
  Replace the annunciator.

**Problem 15**

ACM displays all dashes "---".

Procedure

Disconnect the DC power to the ACM for a moment by turning the ECS to the OFF/RESET position. Start and run the engine if the dashes do NOT go away replace the ACM.

**Problem 16**

ACM Hz displays "LO" and voltmeter displays "0".

Procedure

STEP 1. Make sure the AVS is NOT in the 0 position. Check AC volts connections to ACM terminals 1 and 2 to make sure the generator AC voltage is present.

- Generator AC voltage is measured at terminals 1 and 2.
  Go to Step 2.
- Generator AC voltage is NOT measured at terminals 1 and 2.
  Check fuses F11, F12, F13 AVS and wiring for defect. Repair or replace any defective part.

STEP 2. With the engine started check the DC voltage connected to ACM terminals 5 and 12 (terminal 12 is positive). For this Step, the proper DC voltage is above 15 volts.

- DC voltage is below 15 volts.
  Check batteries and charging system for cause of low batteries.
- DC voltage is above 15 volts.
  Replace the ACM.

# Service Procedures

## Service Procedures List

- Service Procedure A – Programming the ECM.
- Service Procedure B – Relay Module.
- Service Procedure C – Programming the ACM.
- Service Procedure D – Alarm Module (DC Voltage Alarm Setpoint Adjustment).
- Service Procedure E – Magnetic Switch Test (24V).
- Service Procedure F – Speed Sensor Adjustment.
- Service Procedure G – Temperature Sensor Resistance.
- Service Procedure H – Verify Overspeed Shutdown.
- Service Procedure I – Verify High Coolant Temperature Shutdown.
- Service Procedure J – Verify Low Oil Pressure Shutdown.

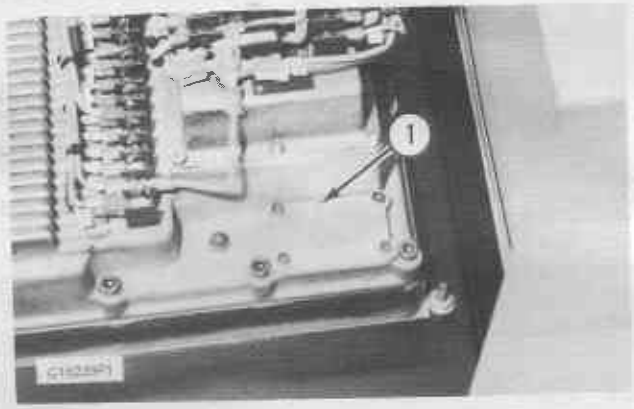
## Service Procedure A – Programming The ECM

| Tools Needed | | |
|---|---|---|
| 6V6640 | Gasket Maker | 1 |
| 8C4653 | Security Seal | 1 |
| 4C4029 | Trimmer Pots | 1 |

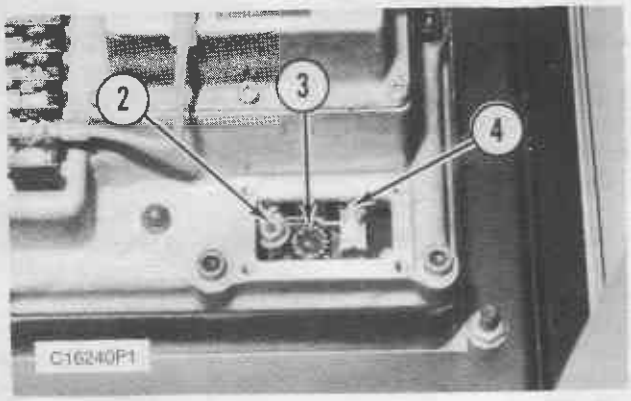
The set points programmed into the ECM are factory set. However, the set points are changed to conform to the appropriate specifications when the ECM is moved from one engine type to another or when a special setting (usually overcrank or cycle crank) is needed.

NOTE: For the correct setpoints, always check print 7C1000 that is included with the EMCP.

### Programmability




Programming Cover Location
(1) Cover.




Programming Components Location
(2) Potentiometer. (3) Rotary switch. (4) Momentary switch.

Setpoint information is stored then used in the control strategy of the ECM. To program, perform the following:

1. Turn the ECS to the STOP position.

NOTE: Do NOT open cover (1) in a humid environment. Replace cover (1) as soon as possible.

2. Remove access cover (1) on the backside of the ECM. Potentiometer (2), rotary switch (3) and momentary switch (4) are visible.

3. Note the position of rotary switch (3). Turn rotary switch (3) to the position that corresponds to the setpoint needing adjustment. The LCD display now shows the position of the rotary switch and the related data.

4. Press momentary switch (4). The data information corresponding to the position of the potentiometer flashes.

5. Adjust potentiometer (2) to change the flashing data as desired. Once the data is correct, press momentary switch (4). The data information stops flashing. Reprogramming of the setpoint is now complete.

6. Return the rotary switch to position 0 if the system has an energize to run fuel solenoid or position 1 if the system has an energize to stop fuel solenoid.

NOTE: The engine does NOT run when in the program mode or if the position of the rotary switch does NOT correspond to the operating mode programmed into setpoint 02. Consult Caterpillar Inc. concerning alterations to the specified setpoints for the engine.

7. Turn the ECS to the OFF/RESET position.

8. Apply a continuous bead of 6V6640 Gasket Maker to the seal surface of cover (1). Install cover (1). Install an 8C4653 Security Seal on access cover (1) to prevent unauthorized tampering.

### Setpoints

NOTE: For the correct setpoints, always check print 7C1000 that is included with the EMCP.

02 – ETR/ETS And Latching: This setpoint value describes the operating mode (type of fuel solenoid) of the ECM. The 6th character of the model number specifies the fuel solenoid setpoint. Refer to the Identification section.

0 or 2 programs the ECM to operate with an energize to run (ETR) fuel solenoid.

1 or 3 programs the ECM to operate with an energize to shutdown (ETS) fuel solenoid or latching fuel solenoid.

2 or 3 programs the ECM to ignore pressure/temperature module faults: i.e. high coolant temperature, low oil pressure and module malfunction do NOT shut down the engine.

03 – Metric/English: A setpoint value of 0 commands the ECM to display engine parameters in English units of measurement. A setpoint value of 1 displays metric units of measurement. The 16th character of the model number specifies the units setpoint. Refer to the Identification section. See the Table that follows for the units of measurement for each parameter.

| PARAMETER | METRIC/ENGLISH |
|---|---|
| Engine Oil Pressure | kPa/psi |
| Engine Coolant Temp. | Degrees C/Degrees F |
| DC Volts | Volts/Volts |
| RPM | RPM/RPM |
| Service Meter | Hours/Hours |

04 – Ring Gear Teeth: This setpoint value is the same as the number of teeth on the ring gear. The range of values are 110 to 260. The 7th character of the model number specifies this setpoint. Refer to the Identification section.

05 & 06 – Overspeed: The overspeed shutdown setpoint is programmed with the rotary selector switch in the 05 or 06 position. Position 05 has a range of 400 to 2890 rpm. Position 06 has a range of 2450 to 5000 rpm in increments of 10 rpm. Place the rotary selector switch in 05 or 06 position whichever corresponds with the specified overspeed shutdown setpoint. Program this position to the specified engine speed at which an overspeed shutdown occurs. The 5th character of the model number specifies the overspeed setpoint. Refer to the Identification section.

NOTE: After programming the 05 or 06 setpoint, both setpoints are the same value.
The overspeed is factory set at:

Overspeed = 1.18 × rated speed.

NOTE: On certain 50 Hz applications the overspeed setpoint is 1.25 × rated speed. These special 50 Hz generator set applications are: 3114 BSSB and PP; 3116 BSSB and PP; 3208 BSSB; 3306 BSSB; 3406 BSSB.

07 – Crank Termination Speed: Once the engine speed passes this setpoint, the starting motor is no longer energized. The range is 100 to 1000 rpm in increments of 10 rpm.

The crank termination speed is factory set at 400 rpm.

08 – Oil Step Speed: Once the engine speed increases past this setpoint, then the ECM considers the engine is above the low idle condition in regard to low oil pressure shutdown and alarm. The range is 400 to 1800 rpm in increments of 10 rpm. The 5th character of the model number specifies the crank termination setpoint. Refer to the Identification section.

| OIL STEP SPEED | | |
|---|---|---|
| **Engine Family** | **Rated Speed (rpm)** | **Setpoint (rpm)** |
| 3600 | 1000 | 755 |
| | 900 | 655 |
| | 750 | 555 |
| | 720 | 535 |
| 3500 | 1000 - 1300 | 808 |
| | 1500 - 1900 | 1208 |
| 3400 with 113 flywheel teeth [1] | 1000 - 1600 | 761 |
| | 1750 - 1800 | 1136 |
| | 1900 - 2100 | 1261 |
| 3400 with 136 flywheel teeth | 1000 - 1200 | 759 |
| | 1500 | 1134 |
| | 1800 - 2100 | 1359 |
| 3300 | 1400 - 1800 | 1133 |
| | 2000 - 2200 | 1258 |
| 3208 | 1500 - 2800 | 1334 |
| 3116 | 1500 - 2800 | 1334 |
| 3114 | 1500 - 2800 | 1334 |

[1] Exception: For 3412 engines with 113 flywheel teeth and a rated speed of 1500 or 1600 rpm, the oil step speed is 1360 rpm.

09 – Rated Speed Oil Pressure Shutdown: If the engine lube pressure drops below the setpoint and the engine speed exceeded the oil step speed for 9 seconds, then the ECM enters a low oil pressure shutdown condition. The range is 34 to 420 kPa (5 to 60 psi). Alarm signal sent to annunciator module occurs at 34 kPa (5 psi) above the shutdown. The 5th character of the model number specifies the rated speed oil pressure shutdown setpoint. Refer to the Identification section.

10 – Idle Speed Oil Pressure Shutdown: If the engine lube pressure drops below this setpoint and the engine has run for more than 9 seconds and the engine speed is below the oil step speed, then the ECM enters a low oil pressure shutdown condition. The range is 20 to 336 kPa (3 to 50 psi). The alarm signal sent to annunciator module occurs at 34 kPa (5 psi) above the shutdown. The 5th character of the model number specifies the idle speed oil pressure shutdown setpoint. Refer to the Identification section.

11 – High Coolant Temperature Shutdown: If the engine coolant temperature has exceeded the setpoint for 10 seconds, then the ECM enters a high coolant temperature shutdown condition. The range is 95 to 120°C (203 to 248°F). Alarm signal sent to annunciator module occurs at 6°C (11°F) below the shutdown temperature. The 5th character of the model number specifies the high coolant temperature shutdown setpoint. Refer to the Identification section.

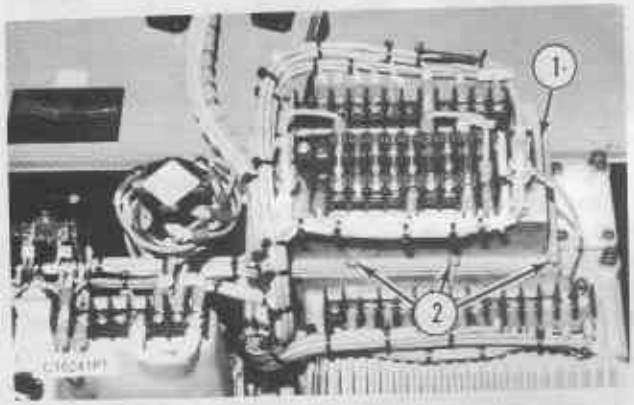
12 – Low Coolant Temperature Alarm: If the engine coolant temperature is less than this setpoint for two seconds, then the ECM sends an alarm signal to the annunciator module. The range is 10 to 30°C (50 to 86°F). Factory set at 21°C (70°F).

13 – Overcrank Time: Total time to start the engine (from when first asked to start until overcrank is indicated). The range is 5 to 120 seconds. Factory setting is 90 seconds.

14 – Cycle Crank: The amount of time the starting motor cranks. Also, the amount of time the starting motor rests during a cycle crank. The range is 1 to 60 seconds. Factory setting is 10 seconds.

15 – Cooldown: The amount of time the engine is allowed to run after initiation of a normal shutdown. The range is 0 to 30 minutes. Factory set at 5 minutes.

## Service Procedure B – Relay Module




Relay Housing Location (Typical Example)
(1) Relay housing. (2) Screws.

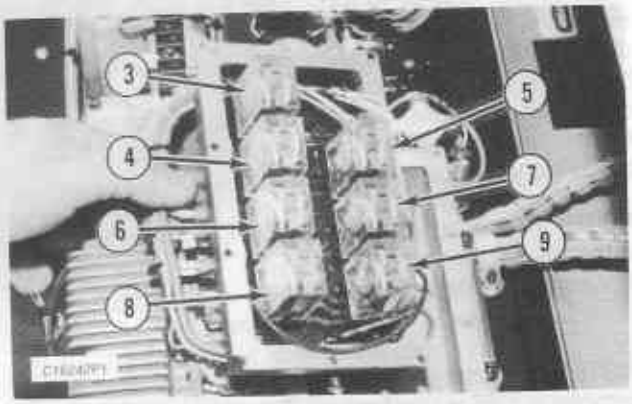
The relay module is the housing that contains the fuses and terminals 16-27 and is part of the back of the ECM.

1. Disconnect wire from terminal 1 in generator. Make sure there is NO voltage on the B+ terminal of the ECM. If necessary, remove some of the harness for easy accessibility. It is possible for moisture to enter the ECM when the relay housing is removed. Remove the relay housing in a dry environment. If relative humidity exceeds 60%, remove housing in an air conditioned area.

2. Remove screws (2) and washers that hold relay housing (1) to main housing. To open housing, install forcing screws in the two threaded holes. The threaded holes are on the ends of the housing flange and in the same bolt pattern as screws (2). Tighten the forcing screws. If necessary, insert a thin knife blade between relay housing (1) and the main housing. Drive it into the gap by tapping gently to break seal loose.

NOTE: On earlier relay housings (1), there are NO threaded holes as mentioned above. To open housing, insert a thin knife blade between the relay housing and main housing. Drive it into the gap by tapping gently to break seal loose.

3. Open the housing and locate the relay or relays that need changed. Relays are labeled K1 through K7 on the PC board.




Relay Locations (Typical Example)
(3) K7 - fuel control (FCR). (4) K6 - air shutoff (ASR). (5) K1 - 2301 Ramp (2301). (6) K5 - run (RR). (7) K2 - fault shutdown (ENFR) (8) K4 - starting motor (SMR). (9) K3 - crank termination (CTR).

4. Remove the relay clip and pull the relay straight out.

5. Do Relay Performance Test:

Check continuity with ohmmeter as follows:

A. With NO power on terminals 7 and 8, the correct resistance between terminals 1 and 5 is 1 ohm or less. The correct resistance between terminals 2 and 6 is 1 ohm or less. The correct coil resistance between terminals 7 and 8 is 140 to 180 ohms.

B. Apply 12 volts DC to terminals 7 and 8. The correct resistance between terminals 3 and 5 is 1 ohm or less. The correct resistance between terminals 4 and 6 is 1 ohm or less. The correct resistance between any other pairs of terminals is 100k ohm or more.

6. Replace the relay if it fails this test and put the clip back on.

7. Check the connector going from the main housing to the relay PC board to assure that it is still inserted properly.

8. If replacing the relay does NOT fix problem or if the relay is NOT defective, replace the entire relay module.

9. Clean and apply 6V1541 Primer to both housings' sealing surface.

10. Apply a continuous bead of 6V6640 Sealant to the main housing sealing surface.

11. Install relay housing (1) on the main housing and fasten with original washers and screws (2).

12. Reconnect the wires that were removed.