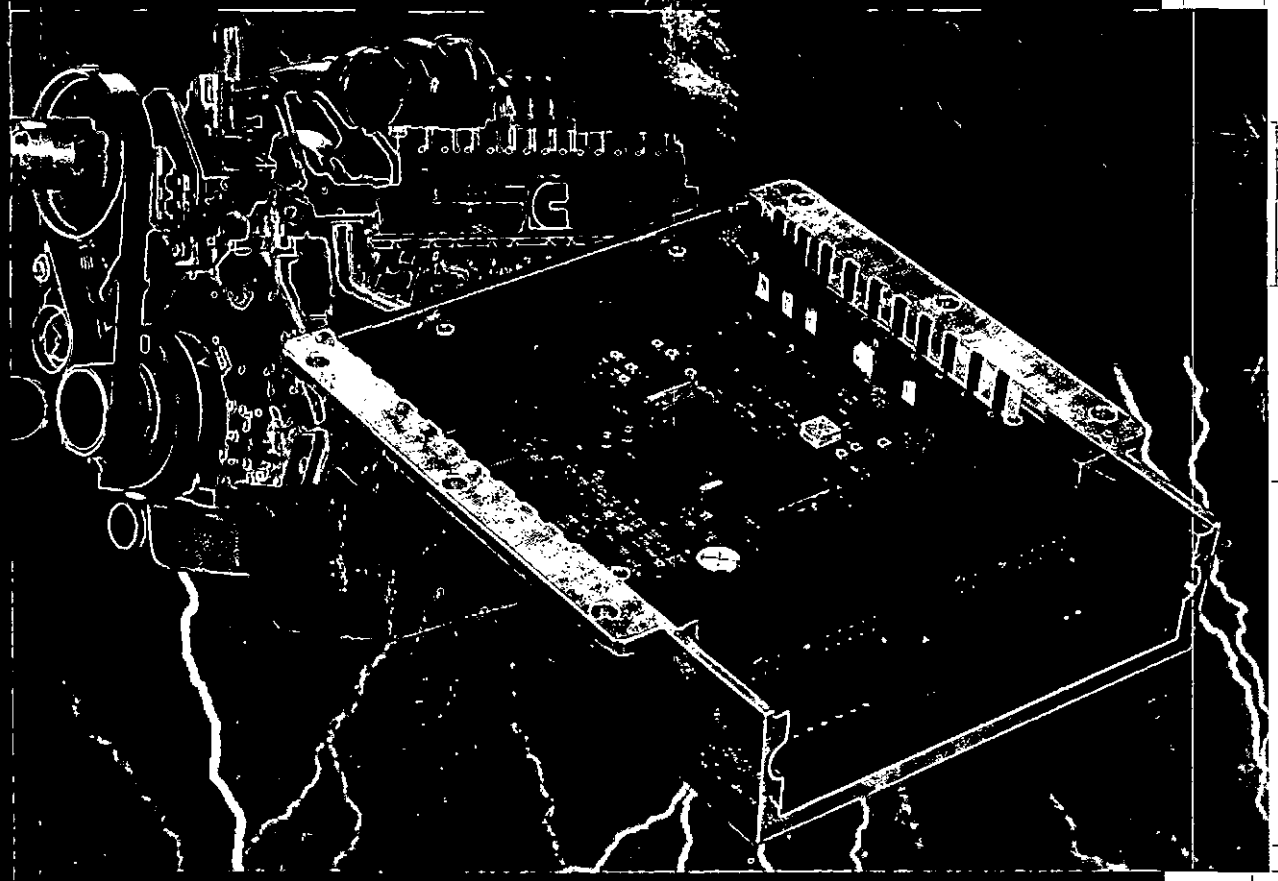
INNOVATION TO

A HIGHER POWER.

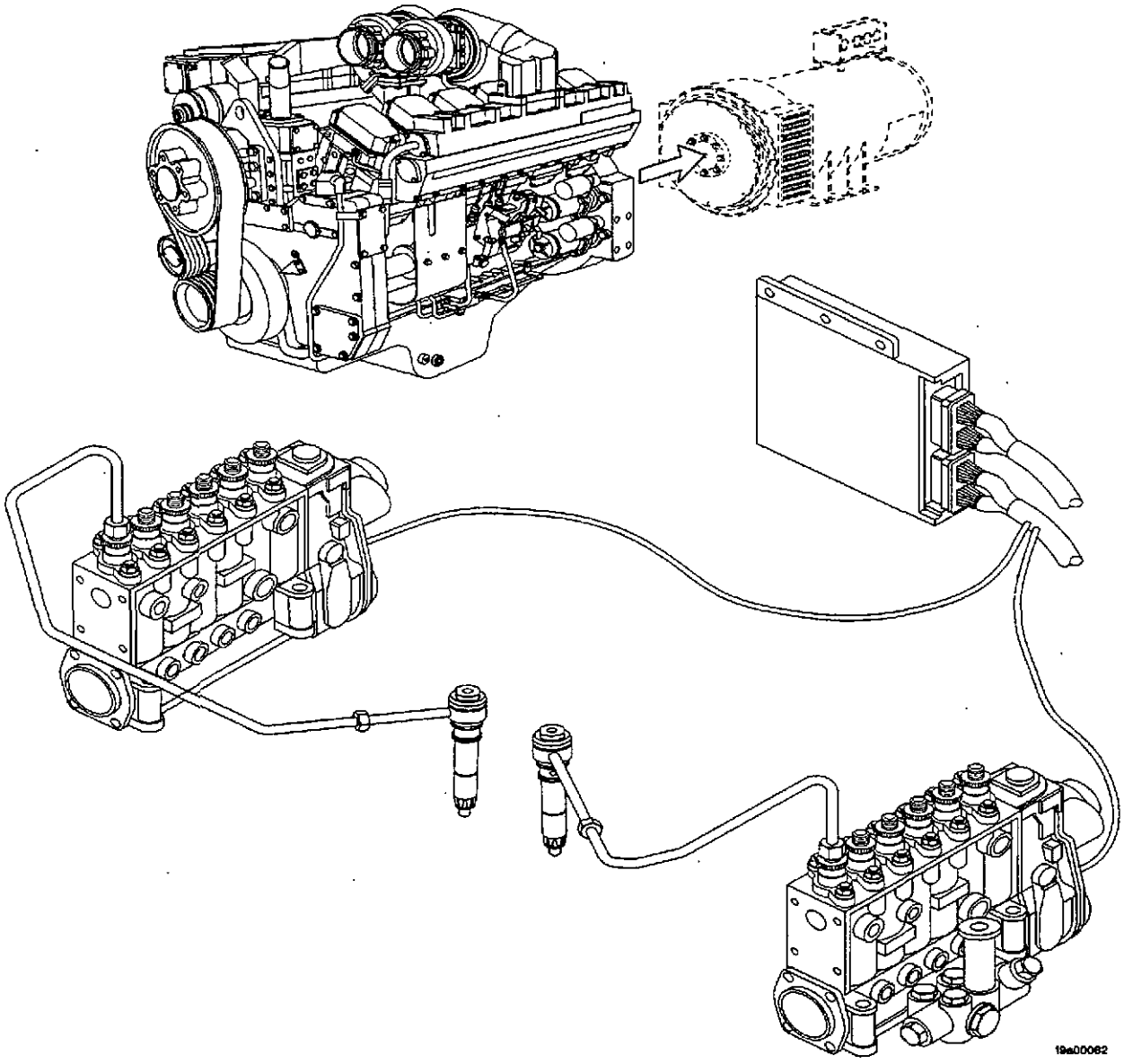
QSI30

GENERATOR DRIVE FUEL CONTROL GOVERNOR



VENTS FOR
EMERGENCY TANKS

QST30
Generator Drive
Fuel Control Governor



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Foreword

The QST30 Generator Drive Governor is used in conjunction with the Bosch fuel system. The governor can be adjusted for isochronous or droop governing applications. The governor is a normally closed (fail to the closed position) system upon loss of control voltage.

This publication contains the instructions for the installation, adjustment and troubleshooting of the Cummins QST30 governor in a generator drive application.

A series of specific service manuals (for example: Shop, Troubleshooting and Repair, and Specifications) are available and can be ordered by filling out and mailing the Literature Order Form located under Service Literature.

Cummins Engine Company, Inc. encourages the user of this manual to report errors, omissions, and recommendations for improvement. Use the postage paid, pre-addressed Literature Survey Form in the back of this manual for communicating your comments.

Questions are to be addressed to:

Cummins Engine Company, Inc.
Box 3005
Power Generation Customer Engineering Support
Mail Code 91800
Columbus, Indiana, U.S.A. 47202
Cable: CUMDIEX COLUMBUS

or call

1-800-DIESELS (1-800-343-7357).

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About the Manual

This manual contains information needed to understand, correctly operate and maintain your fuel system governors as recommended by Cummins Engine Company, Inc. Additional service literature (Operation and Maintenance, Shop Manual, Troubleshooting and Repair Manual, etc.) can be ordered by filling out and mailing the Literature Order Form located in the back of this manual.

This manual does **not** cover base engine maintenance procedures. Refer to the Operation and Maintenance Manual, Bulletin No. 3666134, for information.

This manual does **not** cover generator equipment maintenance or repair procedures. Consult the generator equipment manufacturer for specific maintenance and repair recommendations.

Both metric and U.S. customary values are listed in this manual. The metric value is listed first, followed by the U.S. customary in brackets.

Numerous illustrations and symbols are used to aid in understanding the meaning of the text. Refer to page 2 for a complete listing of symbols and their definitions.

Refer to page 89 for electrical symbols used on the wiring diagrams.

Refer to page 91 for a Glossary of Power Terms.

Symbols

The following symbols have been used in this manual to help communicate the intent of the instructions. When one of the symbols appears, it conveys the meaning defined below.

	**WARNING** - Serious personal injury or extensive property damage can result if the warning instructions are not followed.
	**CAUTION** - Minor personal injury can result or a part, an assembly, or the engine can be damaged if the caution instructions are **not** followed.
	Indicates a **REMOVAL** or **DISASSEMBLY** step.
	Indicates an **INSTALLATION** or **ASSEMBLY** step.
	**INSPECTION** is required.
	**CLEAN** the part or assembly.
	**PERFORM** a mechanical or time **MEASUREMENT.**
	**LUBRICATE** the part or assembly.
	Indicates that a **WRENCH** or **TOOL SIZE** will be given.
	**TIGHTEN** to a specific torque.
	**PERFORM** an electrical **MEASUREMENT.**
	Refer to another location in this manual or another publication for additional information.
	During this procedure, the **MAIN CIRCUIT BREAKER IS "CLOSED".** Normal power is supplied to the equipment.
	During this procedure, the **MAIN CIRCUIT BREAKER IS "OPEN".** Normal power is **not** supplied to the equipment.
	This procedure requires that the **GENERATOR SET IS "ON"** to supply power to the equipment.
	This procedure requires that the **GENERATOR SET IS "OFF".** Power is not supplied to the equipment.
	This procedure requires that **THE MAIN WIRING HARNESS MUST** be disconnected.
	The **PRESENCE of DANGEROUS VOLTAGE.** More that 40 volts A.C.
	The component weighs 23 kg. [50 lb.] or more. To avoid personal injury, use a hoist or get assistance to lift the component.

Simbolos

Los simbolos siguientes son usados en este manual para clarificar el proceso de las instrucciones. Cuando aparece uno de estos simbolos, su significado se especifica en la parte inferior.

	**ADVERTENCIA** - Serios daños personales o daño a la propiedad puede resultar si las instrucciones de Advertencia **no** se consideran.
	**PRECAUCION** - Daños menores puedin resultar, o de piezas del conjunto o el motor puede averiarse si las instrucciones de Precaución **no** se siguen.
	Indica un paso de **REMOCION o DESMONTAJE.**
	Indica un paso de **INSTALACION o MONTAJE.**
	Se requiere **INSPECCION.**
	**LIMPIESE** la pieza o el montaje.
	**EJECUTESE** una **MEDICION** mecánica o del tiempo.
	**LUBRIQUESE** la pieza o el montaje.
	Indica que se dará una **LLAVE DE TUERCAS** o el **TAMAÑO DE HERRAMIENTA.**
	**APRIETESE** hasta un par torsor especifico.
	**EJECUTESE** una **MEDICION** eléctrica.
	Para información adicional refiérase a otro emplazamiento de esta manual o a otra publicación anterior.
	Durante el procedimiento, **EL DISYUNTOR PRINCIPAL ESTA CERRADO.** Se suministra potencia normal al equipo.
	Durante esta procedimiento, **EL DISYUNTOR PRINCIPAL ESTA ABIERTO.** No se suministra potencia normal al equipo.
	Este procedimiento requiere que el **GRUPO ELECTROGENO ESTE CONECTADO** para suministrar potencia al equipo.
	Este procedimiento requiere que el **GRUPO ELECTROGENO ESTE DESCONECTADO.** No se suministrar potencia al equipo.
	Esta procedimiento requiere que debe desconectarse el **HAZ PRINCIPAL DE CONDUCTORES PREFORMADO.**
	Proporicona un aviso de precaución para evitar daños corporales causados por choques eléctricos o electrocución. El peligro está en la vecindad del alto voltaje c.a. sin aislamiento.
	El componente pesa 23 kg [50 lb] o mas. Para evitar dano corporal empleen una cabria u obtengan ayuda para elevar el componente.

Symbole

In diesem Handbuch werden die folgenden Symbole verwendet, die wesentliche Funktionen hervorheben. Die Symbole haben folgende Bedeutung:

	WARNUNG - Wird die Warnung nicht beachtet, dann besteht erhöhte Unfall- und Beschädigungsgefahr.
	VORSICHT - Werden die Vorsichtsmassnahmen nicht beachtet, dann besteht Unfall- und Beschädigungsgefahr.
	AUSBAU bzw. ZERLEGEN.
	EINBAU bzw. ZUSAMMENBAU.
	INSPEKTION erforderlich.
	Teil oder Baugruppe REINIGEN.
	DIMENSION - oder ZEITMESSUNG.
	Teil oder Baugruppe ÖLEN.
	WERKZEUGGRÖSSE wird angegeben.
	ANZUG auf vorgeschriebenes Drehmoment erforderlich.
	Elektrische MESSUNG DURCHFÜHREN.
	Weitere Informationen an anderer Stelle bzw. in anderen Handbüchern.
	Während des Arbeitsgangs ist der **HAUPTTRENNSCHALTER GESCHLOSSEN.** Das Gerät wird von der normalen Stromversorgung versorgt.
	Während des Arbeitsgangs ist der **HAUPTTRENNSCHALTER GEÖFFNET.** Das Gerät wird nicht von der normalen Stromversorgung versorgt.
	Der Arbeitsgang erfordert, daB der **LAUFENDE STROMVERSORGER** das Gerät mit Strom versorgt.
	Der Arbeitsgang erfordert, daB der **STROMVERSORGER ABGESCHALTET IST** und das Gerät nicht mit Strom versorgt wird.
	Dieser Arbeitsgang erfordert Abklemmen des **HAUPTKABELSTRANGS.**
	Unfallgefahr bedingt durch elektrischen Schlag. Nichtisolierte Hochspannungsleitungen in der Nähe.
	Das teil weigt 23 kg [50 lb] oder mehr. Zur vermeidung von koerperverletzung winde benutzen oder hilfe beim heben des teils in anspruch nehmen.

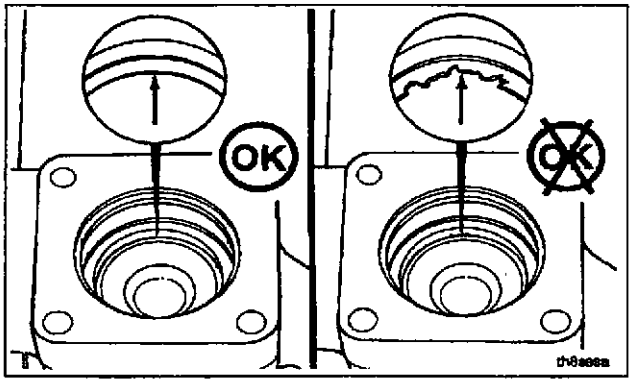
Symboles

Les symboles suivants sont utilisés dans ce manuel pour aider à communiquer le but des instructions. Quand l'un de ces symboles apparlaît, il évoque le sens défini ci-dessous:

	**AVERTISSEMENT -** De graves lésions corporelles ou des dommages matériels considérables peuvent survenir si les instructions données sous les rubriques "Avertissement" **ne** sont **pas** suivies.
	**ATTENTION -** De petites lésions corporelles peuvent survenir, ou bien une pièce, un ensemble ou le moteur peuvent être endommagés si les instructions données sous les rubriques "Attention" **ne** sont **pas** suivies.
	Indique une opération de **DEPOSE.**
	Indique une opération de **MONTAGE.**
	**L'INSPECTION** est nécessaire.
	**NETTOYER** la pièce ou l'ensemble.
	**EFFECTUER** une **MESURE** mécanique ou de temps.
	**GRAISSER** la pièce ou l'ensemble.
	Indique qu'une **DIMENSION DE CLE** ou **D'OUTIL** sera donnée.
	**SERRER** à un couple spécifique.
	**EFFECTUER** une **MESURE** électrique.
	Se reporter à un autre endroit dans ce manuel ou à une autre publication pour obtenir des infomations plus complètes.
	Pendant la procédure, le **DISJONCTEUR PRINCIPAL EST FERME.** L´équipement recoit l´alimentation normale.
	Pendant cette procédure, le **DISJONCTEUR PRINCIPAL EST OUVERT.** L´équipement ne recoit pas l´alimentation normale.
	Cette procédure nécessite que le **GROUPE ELECTROGENE SOIT EN MARCHE** pour alimenter l´équipement.
	Cette procédure nécessite que le **GROUPE ELECTROGENE SOIT EN ARRET.** L´équipement n´est pas alimenté.
	Cette procédure nécessite de déconnecter le **CABLAGE PRINCIPAL.**
	Avertit de prendre soin d´éviter des lésions corporelles provenant de décharge électrique ou d'électrocution. Il y a dans le voisinage une haute tension C.A. non isolée.
	Le composant pese 23kg [50 lb] ou davantage. Pour eviter toute blessure, employer un appariel de levage ou demander de l'aide pour le soulever.

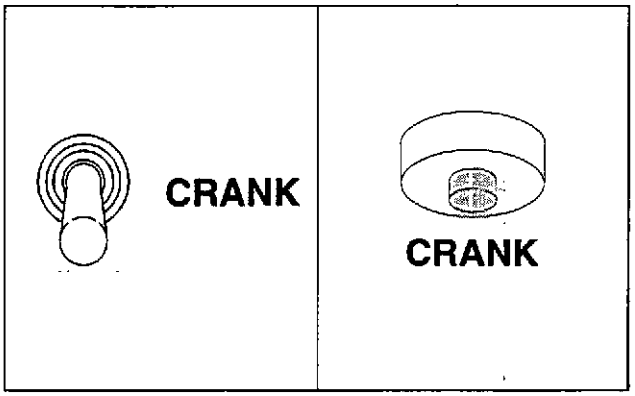
Illustrations

Some of the illustrations throughout this manual are generic and will **not** look exactly like the engine or parts used in your application. The illustrations can contain symbols to indicate an action required and an acceptable or **not** acceptable condition.



The illustrations included in this manual are intended to illustrate procedures performed or location of particular items.

The procedure performed or location of the product described will be the same even though the illustrations may vary.



General Safety Instructions

Important Safety Notice

⚠ WARNING ⚠

Improper practices or carelessness can cause burns, cuts, mutilation, asphyxiation or other bodily injury or death.

Read and understand all of the safety precautions and warnings before performing any repair. This list contains the general safety precautions that **must** be followed to provide personal safety. Special safety precautions are included in the procedures when they apply.

- Make sure the work area surrounding the product is dry, well lit, ventilated, free from clutter, loose tools, parts, ignition sources and hazardous substances. Be aware of hazardous conditions that can exist.
- **Always** wear protective glasses and protective shoes when working.
- Rotating parts can cause cuts, mutilation or strangulation.
- Do **not** wear loose-fitting or torn clothing. Remove all jewelry when working.
- Disconnect the battery (negative [-] cable first) and discharge any capacitors before beginning any repair work. Disconnect the air starting motor if equipped to prevent accidental engine starting. Put a "Do **Not** Operate" tag in the operator's compartment or on the controls.
- Use ONLY the proper engine barring techniques for manually rotating the engine. Do **not** attempt to rotate the crankshaft by pulling or prying on the fan. This practice can cause serious personal injury, property damage, or damage to the fan blade(s) causing premature fan failure.
- If an engine has been operating and the coolant is hot, allow the engine to cool before you slowly loosen the filler cap and relieve the pressure from the cooling system.
- Do **not** work on anything that is supported ONLY by lifting jacks or a hoist. **Always** use blocks or proper stands to support the product before performing any service work.
- Relieve all pressure in the air, oil, fuel and the cooling systems before any lines, fittings or related items are removed or disconnected. 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 cause personal injury.
- To prevent suffocation and frostbite, wear protective clothing and ONLY disconnect fuel and liquid refrigerant (freon) lines in a well-ventilated area. To protect the environment, liquid refrigerant systems **must** be properly emptied and filled using equipment that prevents the release of refrigerant gas (fluorocarbons) into the atmosphere. Federal law requires capturing and recycling refrigerant.
- To avoid personal injury, use a hoist or get assistance when lifting components that weight 23 kg [50 lb] or more. Make sure all lifting devices such as chains, hooks or slings are in good condition and are of the correct capacity. Make sure hooks are positioned correctly. **Always** use a spreader bar when necessary. The lifting hooks **must not** be side-loaded.
- Corrosion inhibitor, a component of SCA and lubricating oil, contains alkali. Do **not** get the substance in your eyes. Avoid prolonged or repeated contact with skin. Do **not** swallow internally. In case of contact, immediately wash skin with soap and water. In case of contact, immediately flood eyes with large amounts of water for a minimum of 15 minutes. IMMEDIATELY CALL A PHYSICIAN. KEEP OUT OF THE REACH OF CHILDREN.
- Naptha and Methyl Ethyl Ketone (MEK) are flammable materials and **must** be used with caution. Follow the manufacturer's instructions to provide complete safety when using these materials. KEEP OUT OF THE REACH OF CHILDREN.
- To avoid burns, be alert for hot parts on products that have just been turned off, and hot fluids in lines, tubes and compartments.
- **Always** use tools that are in good condition. Make sure you understand how to use them before performing any service work. Use ONLY genuine Cummins or Cummins ReCon® replacement parts.
- **Always** use the same fastener part number (or equivalent) when replacing fasteners. Do **not** use a fastener of lessor quality if replacements are necessary.
- Do **not** perform any repair when fatigued or after consuming alcohol or drugs that can impair your functioning.
- Some state and federal agencies in the United States of America have determined that used engine oil can be carcinogenic and can cause reproductive toxicity. Avoid inhalation of vapors, ingestion and prolonged contact with used engine oil.

General Repair Instructions

This engine incorporates the latest diesel technology at the time it was manufactured; yet, it is designed to be repaired using normal repair practices performed to quality standards.

- **Cummins Engine Company, Inc. does not recommend or authorize any modification or repairs to engines or components except for those detailed in Cummins Service Information. In particular, unauthorized repair to safety-related components can cause personal injury or death. Below is a partial listing of components classified as safety-related:**

Air Compressor
Air Controls
Air Shutoff Assemblies
Balance Weights
Cooling Fan
Fan Hub Assembly
Fan Mounting Bracket(s)
Fan Mounting Capscrews
Fan Hub Spindle
Flywheel
Flywheel Crankshaft Adapter
Flywheel Mounting Capscrews
Fuel Shutoff Assemblies
Fuel Supply Tubes
Lifting Brackets
Throttle Controls
Turbocharger Compressor Casing
Turbocharger Oil Drain Line(s)
Turbocharger Oil Supply Line(s)
Turbocharger Turbine Casing
Vibration Damper Mounting Capscrews

- **Follow all safety instructions noted in the procedures**

  — Follow the manufacturer's recommendations for cleaning solvents and other substances used during the repair of the engine. Some solvents and used engine oil have been identified by government agencies as toxic or carcinogenic. Avoid excessive breathing, ingestion and contact with such substances. **Always** use good safety practices with tools and equipment.

- **Provide a clean environment and follow the cleaning instructions specified in the procedures**

  — The engine and its components **must** be kept clean during any repair. Contamination of the engine components will cause premature wear.

- **Perform the inspections specified in the procedures**

- **Replace all components or assemblies which are damaged or worn beyond the specifications**

- **Use genuine Cummins new or ReCon® service parts and assemblies**

  — The assembly instructions have been written to use again as many components and assemblies as possible. When it is necessary to replace a component or assembly, the procedure is based on the use of new Cummins or Cummins ReCon® components. All of the repair services described in this manual are available from all Cummins Distributors and most Dealer locations.

- **Follow the specified disassembly and assembly procedures to avoid damage to the components**

Complete rebuild instructions are available in the shop manual which can be ordered or purchased from a Cummins Authorized Repair Location. Refer to Service Literature Section for ordering instructions.

Welding on a mobile or stationary generator-set with an Electronic Controlled Fuel System

△ CAUTION △

Disconnect both the positive (+) and negative (-) battery cables from the battery before welding on the unit. Attach the welder ground cable no more than 0.61 meters [2 feet] from the part being welded. Do not connect the ground cable of the welder to the ECM cooling plate or ECM. Welding on the engine or engine mounted components is not recommended.

General Cleaning Instructions

Solvent and Acid Cleaning

Several solvent and acid-type cleaners can be used to clean the engine parts. Experience has shown that the best results can be obtained using a cleaner that can be heated to 82 to 93 degrees Celsius [180 to 200 degrees Fahrenheit]. A cleaning tank that provides a constant mixing and filtering of the cleaning solution will give the best results. **Cummins Engine Company, Inc. does not recommend any specific cleaners. Always** follow the cleaner manufacturer's instructions.

Remove all the gasket material, o-rings, and the deposits of sludge, carbon, etc., with a wire brush or scraper before putting the parts in a cleaning tank. Be careful **not** to damage any gasket surface. When possible, steam clean the parts before putting them in the cleaning tank.

⚠ WARNING ⚠

Acid is extremely dangerous and can damage the machinery. Always provide a tank of strong soda water as a neutralizing agent.

Rinse all of the parts in hot water after cleaning. Dry completely with compressed air. Blow the rinse water from all of the capscrew holes and the oil drillings.

If the parts are **not** to be used immediately after cleaning, dip them in a suitable rustproofing compound. The rustproofing compound **must** be removed from the parts before installation on the engine.

Steam Cleaning

Steam cleaning can be used to remove all types of dirt that can contaminate the cleaning tank. It is a good way to clean the oil drillings.

⚠ WARNING ⚠

Wear protective clothing to prevent personal injury from the high pressure and extreme heat.
Do **not** steam clean the following parts:

1. Electrical Components
2. Wiring
3. Injectors
4. Fuel Pump
5. Belts and Hoses
6. Bearings
7. Electronic Control Module (ECM)
8. ECM connectors

Glass or Plastic Bead Cleaning

Glass or plastic bead cleaning can be used on many engine components to remove carbon deposits. The cleaning process is controlled by the size of the glass or plastic beads, the operating pressure, and the cleaning time.

△ CAUTION △

Do not use glass or plastic bead cleaning on aluminum piston skirts. Do not use glass bead cleaning on aluminum ring grooves. Small particles of glass or plastic will embed in the aluminum and result in premature wear. Valves, turbocharger shafts, etc. can also be damaged. Follow the cleaning directions listed in the procedures.

NOTE: Plastic bead blasting media, Part No. 3822735, can be used to clean aluminum ring grooves. Do **not** use any bead blasting media on pin bores or aluminum skirts.

Follow the equipment manufacturer's cleaning instructions. The following guidelines can be used to adapt to manufacturer's instructions:

1. Bead Size:
   - Use U.S. size No. 16-20 for piston cleaning with plastic bead media, Part No. 3822735.
   - Use U.S. size No. 70 for piston domes with glass media.
   - Use U.S. size No. 60 for general purpose cleaning with glass media.
2. Operating Pressure:
   - Glass: Use 620 kPa [90 psi] for general purpose cleaning.
   - Plastic: Use 270 kPa [40 psi] for piston cleaning.
3. Steam clean or wash the parts with solvent to remove all of the foreign material and glass or plastic beads after cleaning. Rinse with hot water. Dry with compressed air.
4. Do **not** contaminate the wash tanks with glass or plastic beads.

Acronyms and Abbreviations

A	Ampere
AC	Alternating Current
ABO	Area Business Organization
AWG	American Wire Gage
°C	Degree Celsius
cSt	Centistokes
COM	Communication
CTS	Cooling Temperature Sensor
CW	Clockwise
CCW	Counterclockwise
DC	Direct Current
DSR	Data Set Ready
DTR	Data Terminal Ready
ECM	Electronic Control Module
EPA	Environment Protection Agency
EPROM	Erasable Programmable Read Only Memory
EPS	Engine Position Sensor
ESS	Engine Speed Sensor
°F	Degree Fahrenheit
FSOV	Fuel Shutoff Valve
ft (FT)	Foot
GOEM	G-Drive Original Equipment Manufacturer
H_2O	Water
HCT	High Coolant Temperature
Hg	Mercury
hp	Horsepower
Hz	Hertz
in	Inch
Kg	Kilogram
kPa	Kilopascal
KW	Kilowatt
lb	Pound
LED	Light-Emitting Diode
LOP	Low Oil Pressure
mA	Milliampere
mm	Millimeter
N·m	Newton-meter
O/M	Owner-Operator Manual
OEM	Original Equipment Manufacturer
OPS	Oil Pressure Sensor
OSS	Over Speed Sensor
psi	Pounds Per Square Inch
PT	Potential Transformer
PWM	Pulse Width Modulator
rpm(RPM)	Revolutions Per Minute
RXD	Receive Data
SCA	Supplemental Coolant Additive
TDC	Top Dead Center
TXD	Transmit Data
V	Volts
VAC	Volts-Alternating Current
VDC	Volts-Direct Current

QST30 Governor Installation Tips

1. Recognize that all governor wiring must be connected "Point to Point".

2. There must be a minimum of 2.5 VAC (from magnetic pickup speed sensor) present between terminals 21 and 22 during cranking and anytime the engine is operating.

3. Follow all Cummins Service Bulletins and Installation Requirements (Ref.: QST30 G-Drive Engine Installation Requirements, 3884904).

4. Follow Installation Requirements for return fuel plumbing to prevent aeration of supply fuel.

5. Connector B of the customer built harness accepts 0.8 - 1.0mm [#20 - #18] wire.

6. Use 1.0 mm [#18] twisted wire for load sharing bias and voltage reference leads.

7. Follow instructions for proper twisting and shielding of wire.

8. When using Woodward and Barber-Colman modules for parallel operation of generator sets, properly calibrate the governor controller before adding the load sharing, auto-synchronizer and/or load command hardware, to the system. Insure that Barber-Colman and Woodward controls are calibrated per current and applicable supplier procedures.

9. For parallel systems, make certain the voltage regulators are equipped, and properly set, for parallel operation.

10. To avoid pin and harness damage, use the following test lead service parts when taking a measurement (Reference Page 101):

Weatherpack		Deutsch		Deutsch/Metri-Pac	
Male	3823995	Male	3823993 3824811	Male	3822758
Female	3823996	Female	3823994 3824812	Female	3822917

11. Install the governor controller within 12.7 m [50 ft.] (total harness length) of the engine connector (at the flywheel housing).

12. Install any customer supplied controls (that integrate with the QST30 ECM) within 12.7 m [50 ft.] (total harness length) of the ECM.

13. Do not mount the governor control box directly to the engine block or any engine component. The ECM is not warranted for engine mounting.

14. Do not use any battery negative or other voltages of the governor for relay or other electrical component's circuits.

15. Do not remove the ECM "A" or "B" connectors from the QST30 governor control box until power to the governor control box is switched off or removed.

16. Do not adjust the remote speed pot while in the idle mode.

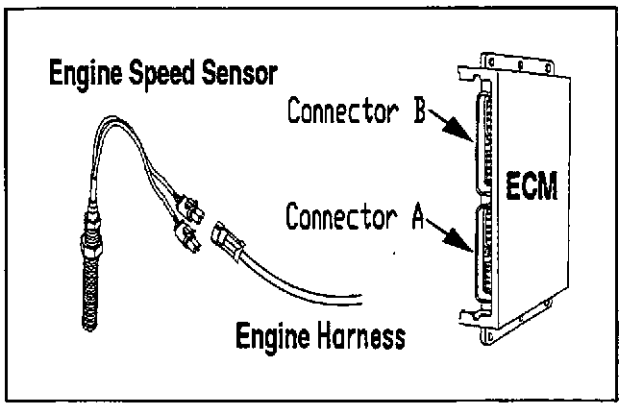
QST30 Governor Installation Tips (cont.)

17. Do not short out or overload the magnetic pickup output with speed switch or tachometer loads.

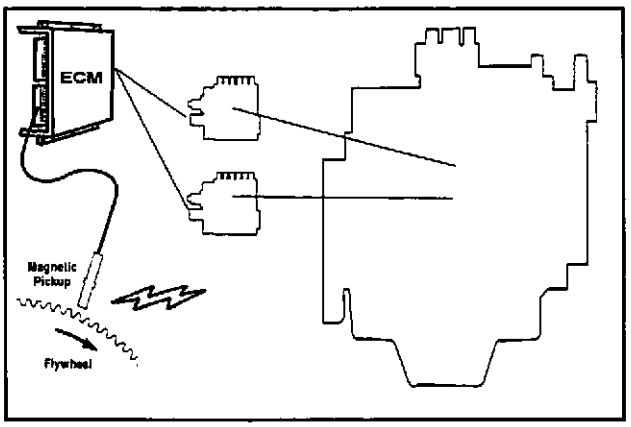
18. Do not use the ECM speed sensor (magnetic pickup) backup connector under any circumstance for customer instrumentation or loads. This connection is for engine speed backup only in the event the main coil connection fails. With both connectors hooked up, magnetic coupling between the coils may occur generating false data from the speed sensor to the ECM.

Governor Description

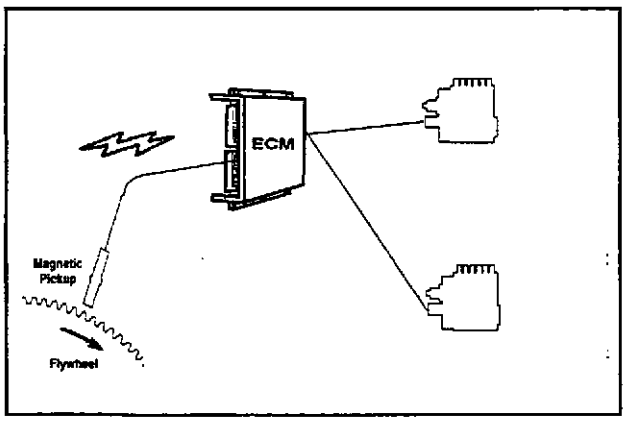
The Speed Governor contains an Engine Governor Control Module, Control Module Harness, an Engine Mounted Harness and an Engine Mounted Speed Sensor (magnetic pickup).



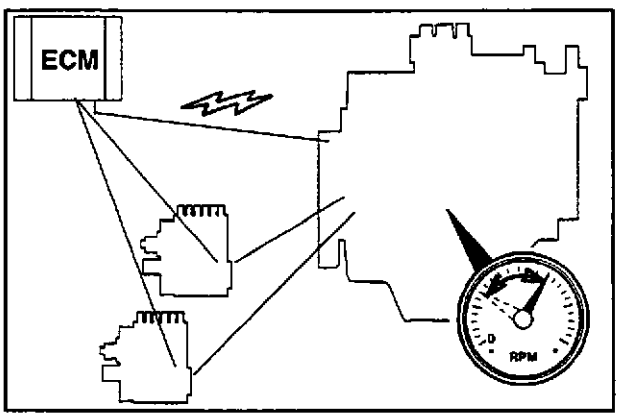
The QST 30 Governor is a normally closed system; that is, when voltage to the actuators is interrupted, the control rack is returned to the zero fuel position shutting the engine down.



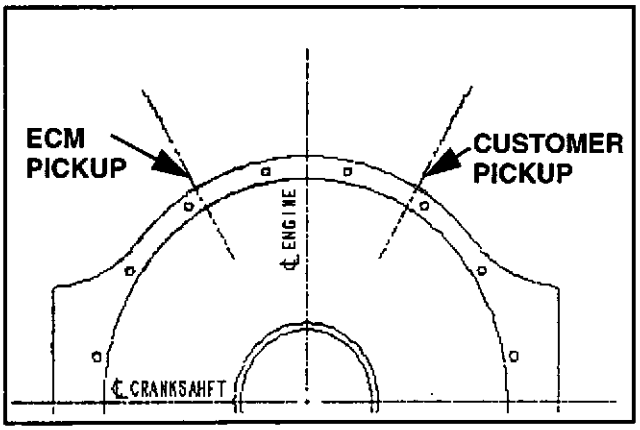
The magnetic pickup senses engine speed at the flywheel ring gear and sends an alternating current (AC) electrical signal to the governor control. The governor control compares the electrical signal from the magnetic pickup with a preset reference point. If there is a difference in the two signals, the control will adjust the voltage to the fuel pump actuators.



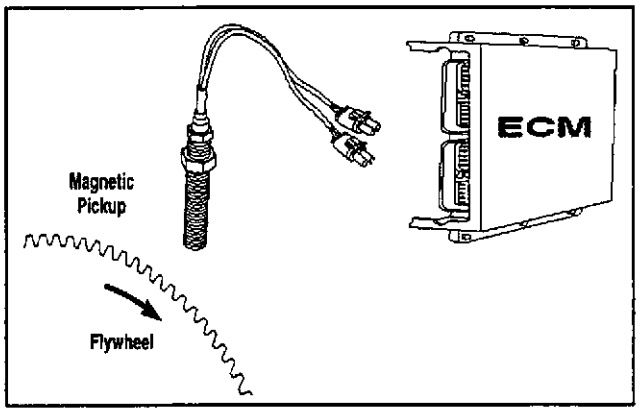
A change in voltage to the actuator coil will cause linear movement in the fuel pump control racks. The fuel flow, and engine speed or power, will change with the regulated position of the control racks.



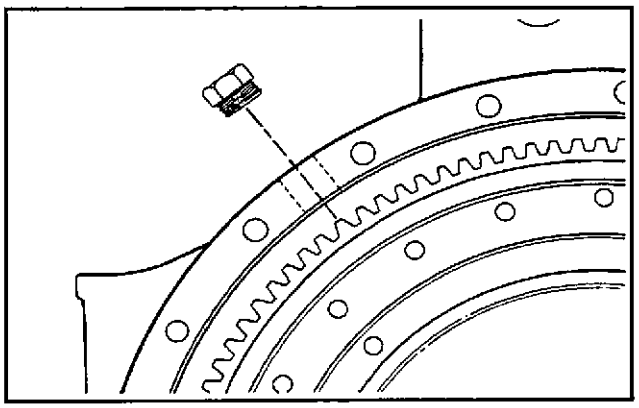
Magnetic Pickup Installation



The magnetic pickup is an electromagnetic speed sensing device mounted in the flywheel housing. The flywheel housing is set up with two magnetic pickup hole locations. When viewed from the rear (Generator side), the left-hand hole is for the ECM pickup, the right-hand hole is for the customer's use.

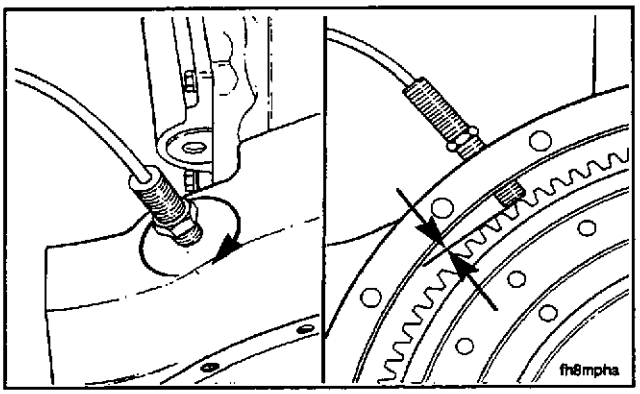


The ECM magnetic pickup will have two connectors. One connector is for the engine harness hookup. The other connector is for backup only. (The backup will have an additional plug seal). **DO NOT** use the back-up connector for other devices, as 'magnetic coupling' between the two connector coils could cause unreliable data from the speed sensor.



When installing the customer side magnetic pickup, first remove the pipe plug on the right-hand side of the flywheel housing.

Ensure that a ring gear tooth is centered under the magnetic pickup hole. Rotate the flywheel if necessary.

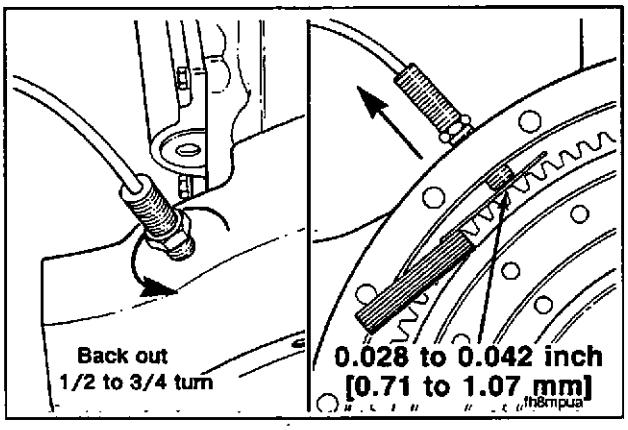


To install the magnetic pickup, screw the magnetic pickup in until it contacts the targeted gear tooth. The magnetic pickup will screw in very easily; do not use excessive pressure to install.

Note: If the magnetic pickup does not turn with finger pressure, check the hole and magnetic pickup threads. Chase threads with a tap if necessary. Using a magnet, remove any chips created by the tap.

Back the magnetic pickup out (counterclockwise) 1/2 to 3/4 turn.

If a feeler gauge can be inserted between the magnetic pickup and the flywheel ring gear tooth, back the magnetic pickup out 0.71 to 1.07 mm [0.028 to 0.042 in.] from the gear tooth.



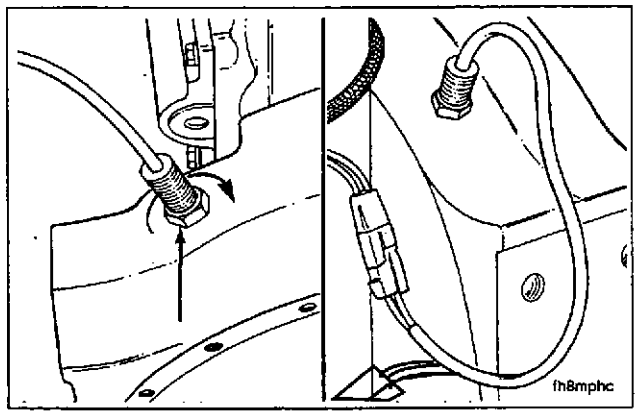
Tighten the jam nut on the flywheel housing. While holding the magnetic pickup, torque the jam nut to 34-47 N·m [25-35 ft-lb].

⚠ CAUTION ⚠

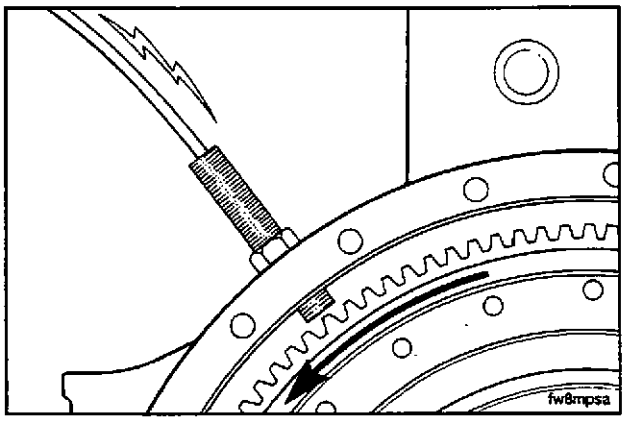
Jam nut over-torque will damage the magnetic pickup.

Plug the electrical connection into the magnetic pickup, when required.

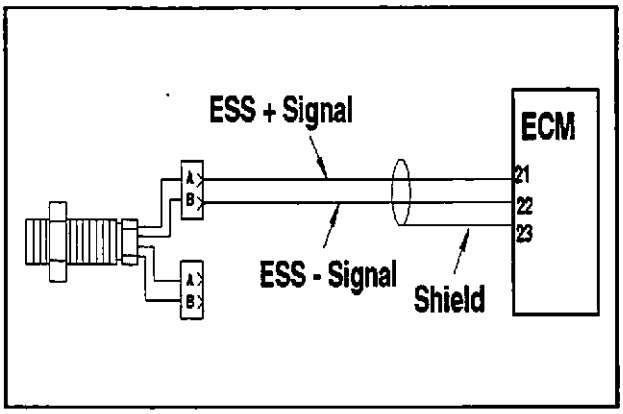
Install the main generator, if it was removed.

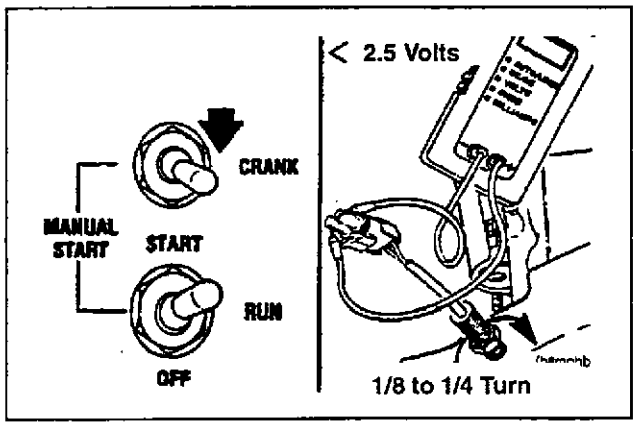


When a ring gear tooth passes the magnetic pickup, an AC voltage is induced producing the speed signal for the ECM. One cycle is induced for each gear tooth.

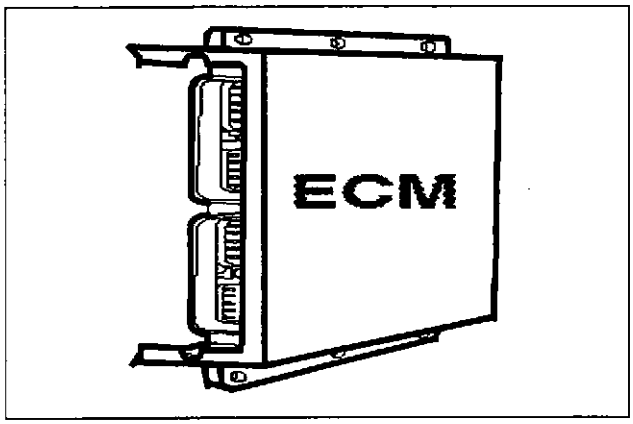


The speed signal voltage is connected to the ECM speed signal input pins (pins 21 and 22 of Connector A) via the engine and connecting harnesses. Voltage readings should be between 2.5 to 50 VAC under any running condition (cranking or run speeds).



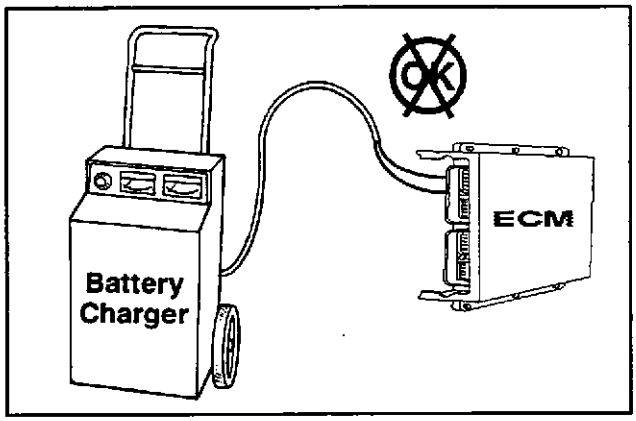


Check the magnetic pickup voltage at the pigtail connector designated for use. If the magnetic pickup signal is less than 2.5 VAC when cranking the engine, screw the pickup in (clockwise) 1/8 to 1/4 turn.



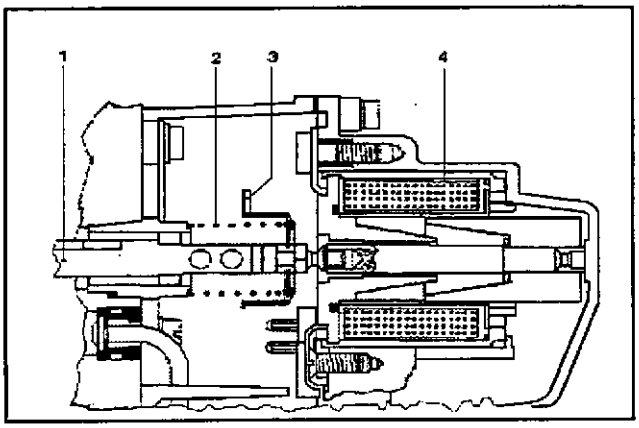
Power Source

The governor control is designed to operate between 22 to 34 VDC.



⚠ CAUTION ⚠

Do not connect the governor control to a battery charger. Due to the circuitry and method of operation of the chargers, the governor will not function properly. Connect the battery charger to the battery.



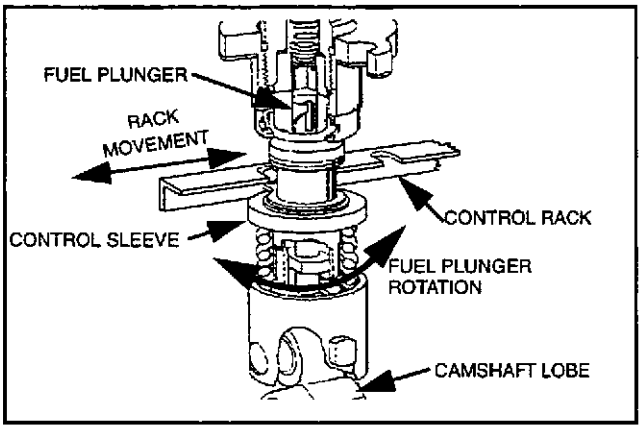
Governor Actuator Description

The Governor Actuator is an electromagnetic device located in each fuel pump (Bosch RE30 actuators). When the actuator coil (4) is energized by an ECM voltage it causes the actuator plunger (3) to move in a linear direction. The plunger, together with the return spring (2), controls the position of the fuel control rack (1) (in a linear direction).

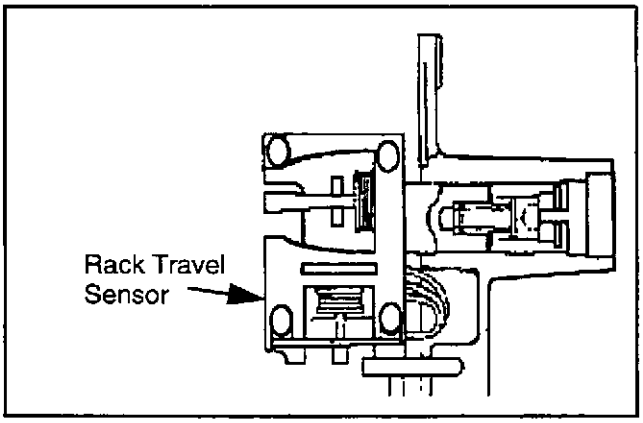
Linear rack movement causes the control sleeve to rotate the fuel plunger.

A camshaft moves the fuel plunger up and down.

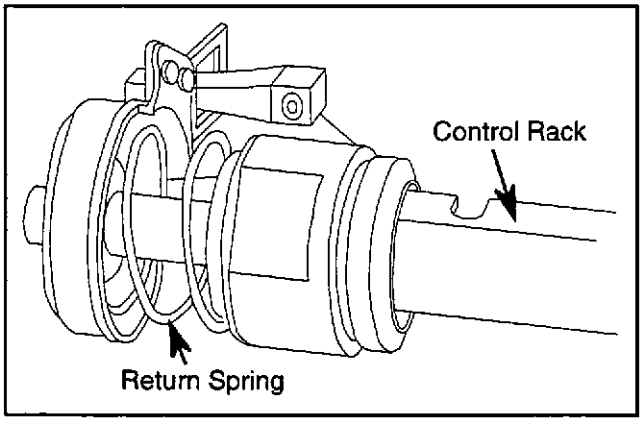
The rotational movement together with the up-and-down movement of the fuel plunger, meters the amount of fuel supplied to the injector.



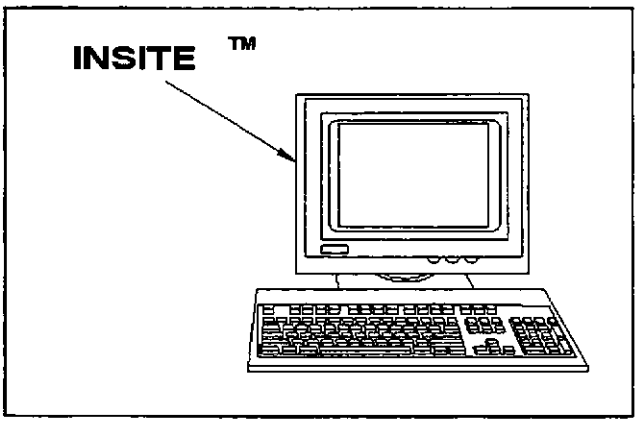
The Rack Travel Sensor sends a signal to the ECM verifying that the control rack has been properly positioned by the actuator.



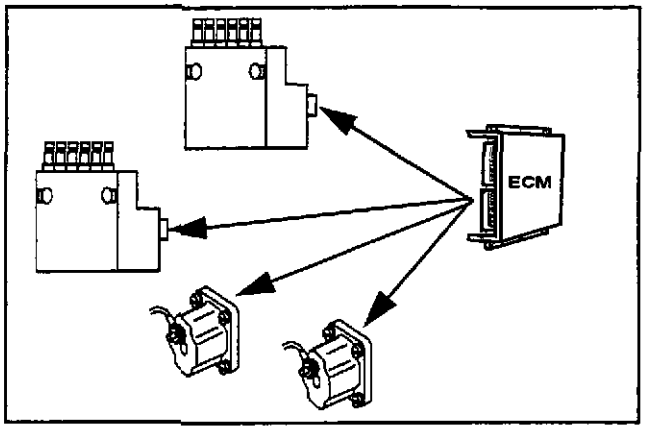
If the actuator is not energized, the return spring forces the control rack to the zero fuel position shutting the engine down. This action rotates the fuel plunger to the spill port which bypasses fuel through the overflow valve to the return line.



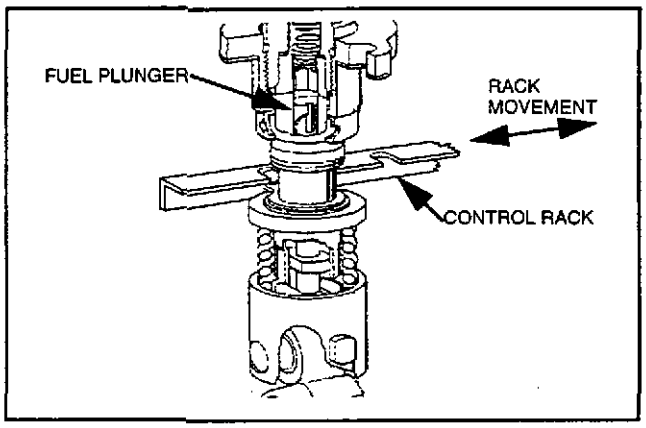
If a Service Tool is available, it can be used to perform a Fuel Pump Rack Test. (See Fuel Pump Rack Test page 46).



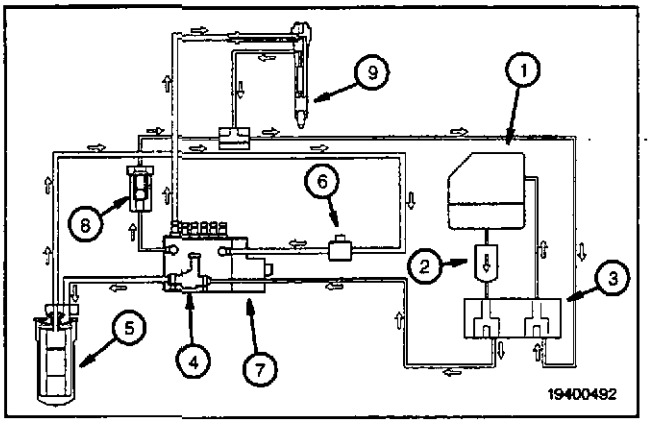
Fuel System Flow



Engine idle and run speeds are programmed into the ECM module. When the engine is in the 'IDLE' or 'RUN' mode, the ECM sends electronic signals to the fuel shutoff valves and governor actuators.

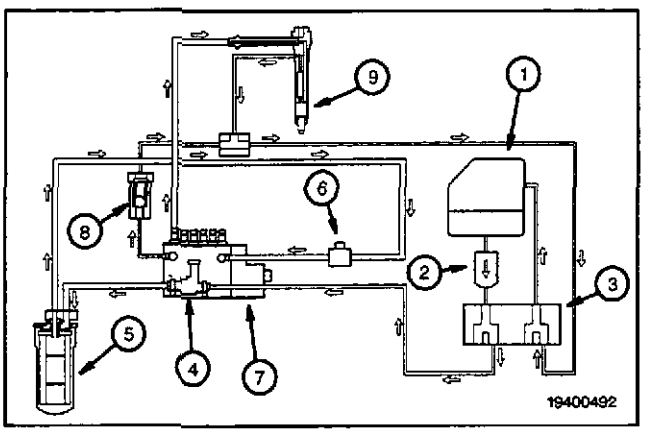


An electronic signal energizes and opens the *fuel shutoff valves, allowing fuel to flow to the* fuel pumps. Another electric signal energizes the actuators which forces the control racks in the fuel pumps to move. The movement of the control rack rotates the fuel plunger in each fuel pump metering the amount of fuel to the injectors.



With the shutoff valves open and the governor actuators positioned for the metering of fuel, fuel is allowed to flow from the fuel tank (1) through the prefilter (2) to the fuel connection block (3). The fuel connection block distributes fuel to each fuel lift (transfer) pump.

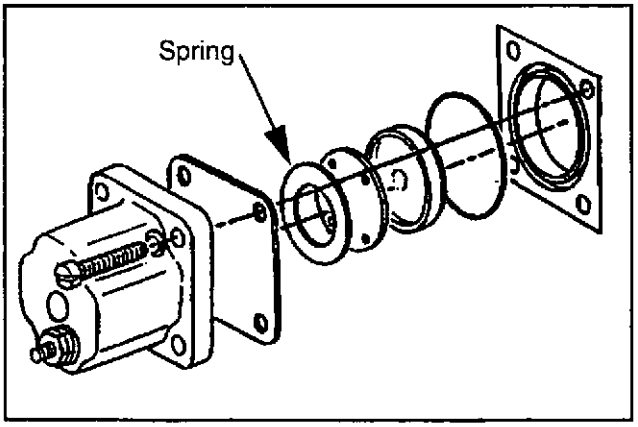
Note: The fuel tank, prefilter and connection block are common for both engine banks. For clarity the graphic representation shows fuel flow to one bank only.



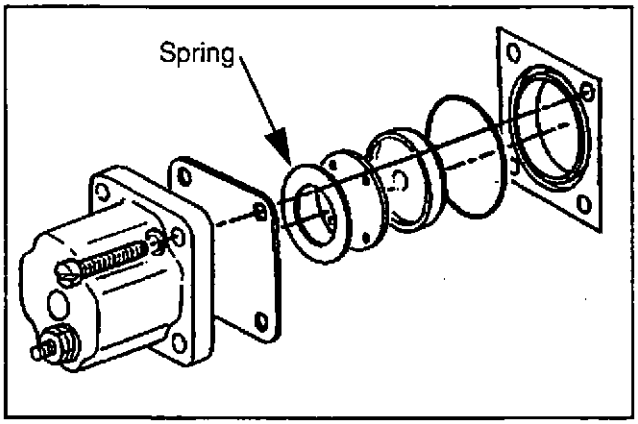
The following information applies to each engine bank: Fuel flows from the fuel connection block (3) to the lift pump (4) through the fuel filter (5) to the shutoff valve (6) and into the fuel pump (7). Fuel is metered, inside the fuel pump, to the injector where it is injected into the firing chamber. Excess fuel in the fuel pump is returned through an overflow valve (8) to the fuel connection block. The fuel connection block combines the excess fuel (from both fuel pumps and injector return lines) and returns it to the fuel tank.

When the 'RUN/STOP' switch is in the 'STOP' position, the electronic signals to the fuel shutoff valves and governor actuators are removed (zero voltage).

The shutoff valve(s) is an ON/OFF (open/closed) spring loaded valve. Without sufficient supply signal voltage, the spring in the valve(s) returns it to the CLOSED position. When in the closed position, fuel can not pass through the valve.

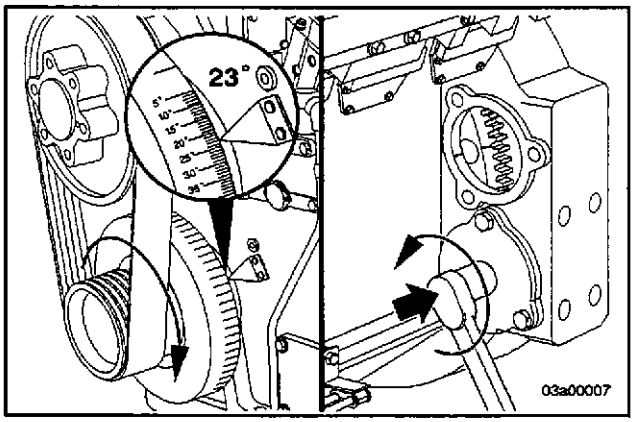


Without RUN or IDLE governing voltage, the return spring in the governor actuator(s) will return the fuel rack(s) to the zero fueling position stopping fuel flow to the injectors.



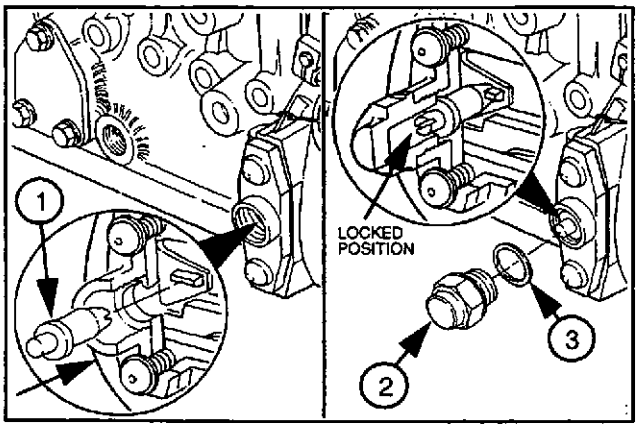
Fuel Pump Replacement (with coupling drive)

Rotate the engine slowly in a clockwise direction to align the timing mark (as stated on the data plate) on the crankshaft damper with the timing pointer. Ensure that the #1 cylinder (right bank) is on the compression stroke.



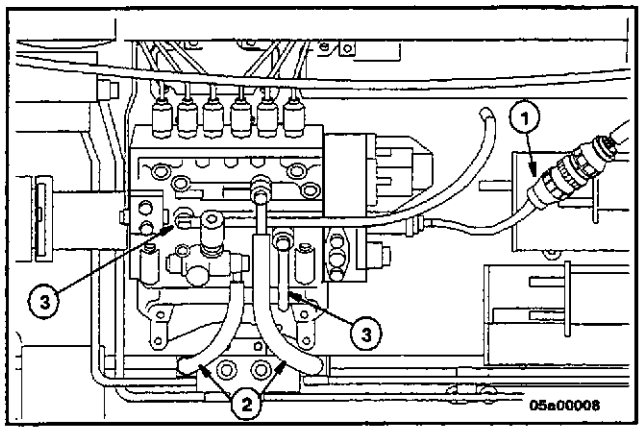
Lock Fuel Pump Timing (coupling drive)

Clean the debris from around the fuel pump timing pin cap. Remove cap (2), sealing washer (3) and timing pin (1). Reverse the timing pin and re-install in the locked position. Install cap and sealing washer.



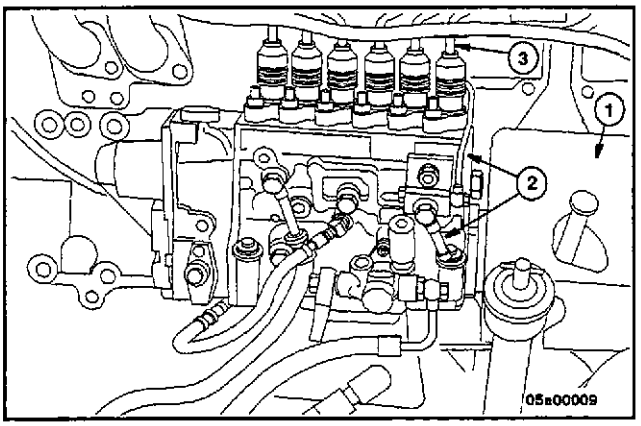
Torque Value

Timing Pin Cap	30 N·m [22 ft-lb]



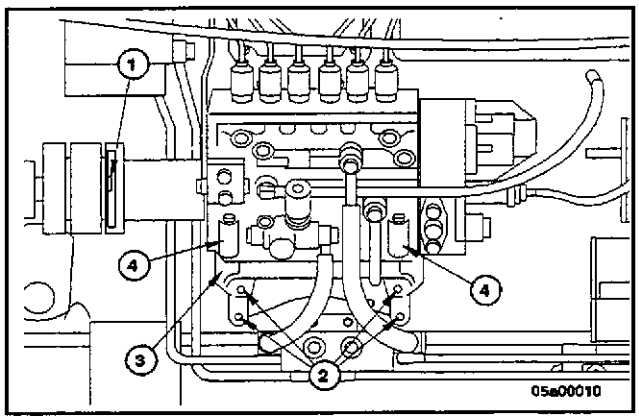
Fuel Pump Removal (coupling drive)

Clean the debris from around the in-line fuel injection pump. Disconnect the electrical connection (1), low pressure fuel lines (2) and oil lines (3).



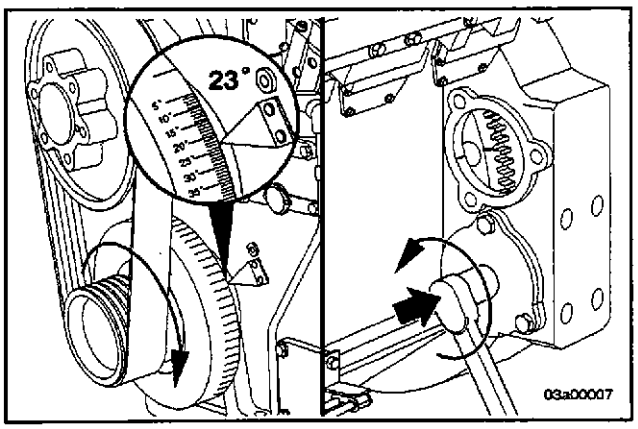
Remove the injection pump drive shaft cover (1). Disconnect the fuel pump drain line and fuel return tube (2) and the high pressure fuel lines (3).

Install protective covers to prevent any dirt or dust from getting into the discharge ports of the injection pump.



To remove the injection pump assembly from the engine:

- Disconnect the coupling bolts (1).
- Loosen the four injection pump bracket mounting bolts (2).
- Remove the injection pump and bracket (3) at an angle as one unit.
- Separate the fuel pump from the bracket by removing the mounting bolts (4).



Fuel Pump Installation (coupling drive)

Rotate the engine slowly in a clockwise direction to align the timing mark (as stated on the data plate) on the crankshaft damper with the timing pointer. Ensure that the #1 cylinder (right bank) is on the compression stroke.

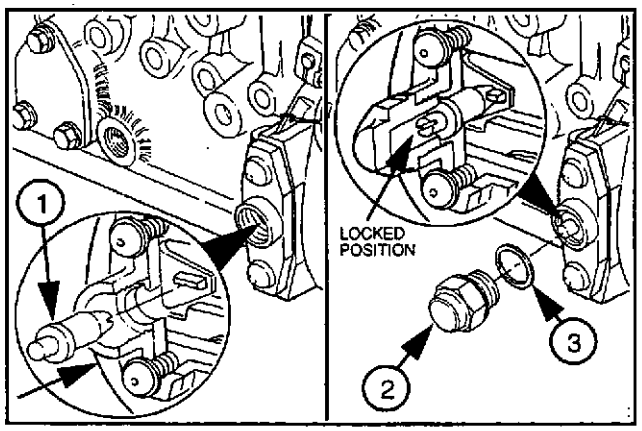
Note: Both the right bank and left bank fuel pumps are installed with the engine in this position.

Remove the fuel injection pump timing pin cap and verify that the pump is locked. .

Install the timing pin (1), cap (2) and sealing washer (3).

Torque Value

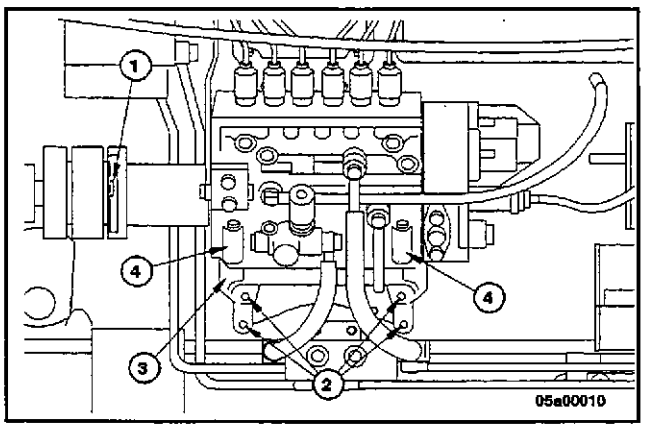
Timing Pin Cap 30 N·m [22 ft-lb]



Set the in-line fuel injection pump assembly in position. With the bracket partially installed on the fuel pump, set the assembly (3) at an angle and install on the engine. Tighten the four injection pump bracket mounting bolts (2) and four pump mounting bolts (4). Tighten the coupling bolts (1).

Torque Values

Pump Mounting Bolts	66 N·m [49 ft-lb]
Bracket Mounting Bolts	66 N·m [49 ft-lb]
Coupling Bolts	108 N·m [80 ft-lb]



Install the high pressure fuel lines (3)

Torque Value

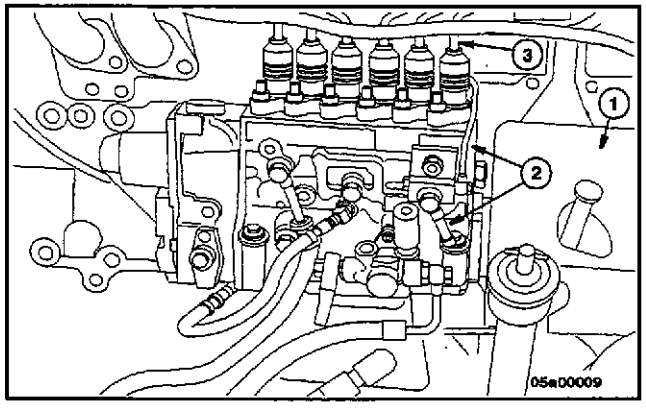
24 N·m [17 ft-lb]

Install the fuel pump drain line and fuel return tube (2).

Torque Value

9 N·m [80 in-lb]

Install the injection pump drive shaft cover (1).



Install the low pressure fuel lines (2).

Torque Value

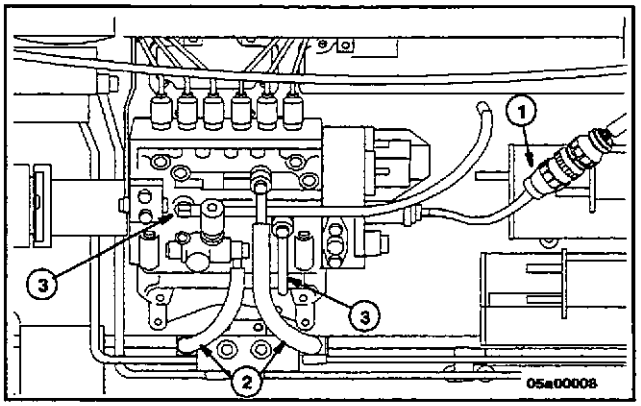
24 N·m [17 ft-lb]

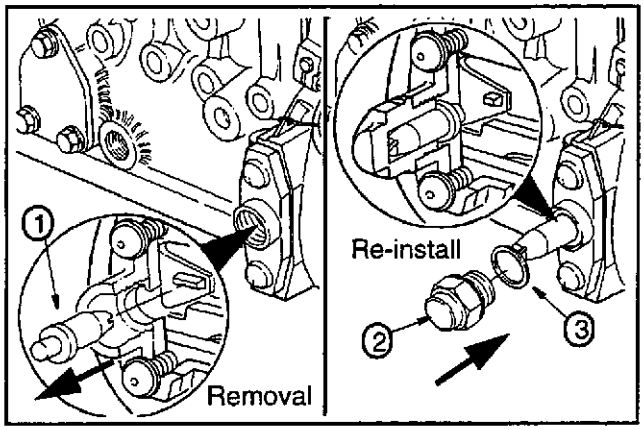
Install the oil lines (3).

Torque Value

27 N•m [20 ft-lb]

Install the electrical connection (1).





Unlock Fuel Pump Timing (coupling drive)

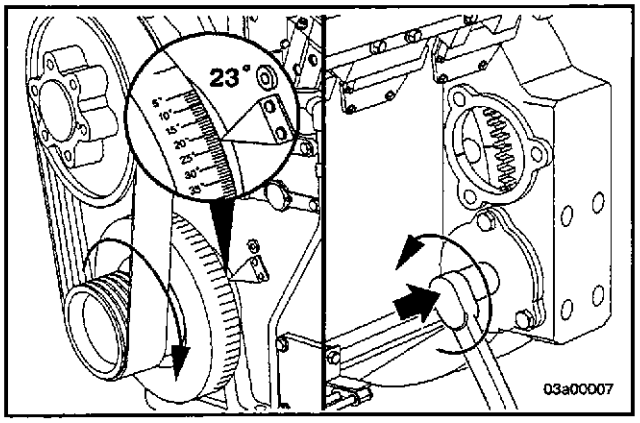
⚠ CAUTION ⚠

Severe damage to the fuel pump will occur unless the fuel pump is unlocked prior to operation.

Remove the fuel pump timing pin cap (2), sealing washer (3) and timing pin (1). Reverse the timing pin and re-install in the unlocked position. Install cap and sealing washer.

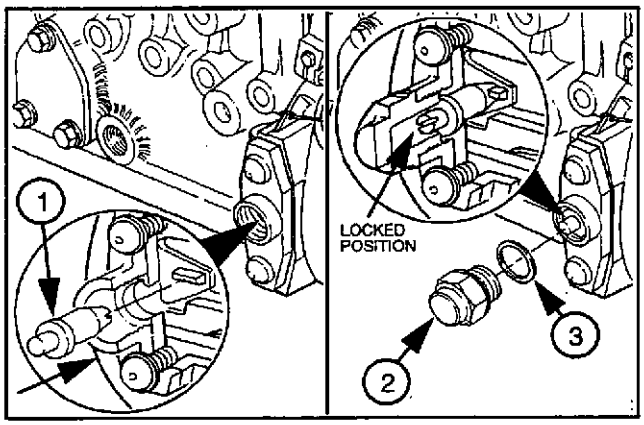
Torque Value

Timing Pin Cap	30 N·m [22 ft-lb]



Fuel Pump Replacement (with flange drive)

Rotate the engine slowly in a clockwise direction to align the timing mark (as stated on the data plate) on the crankshaft damper with the timing pointer. Ensure that the #1 cylinder (right bank) is on the compression stroke.

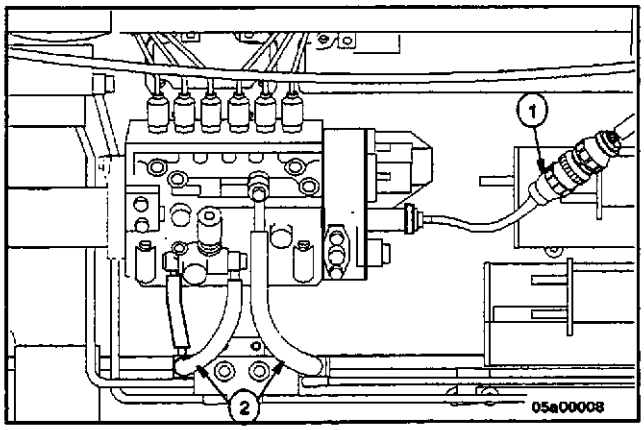


Lock Fuel Pump Timing (flange drive)

Clean the debris from around the fuel pump timing pin cap. Remove cap (2), sealing washer (3) and timing pin (1). Reverse timing pin and re-install in the locked position. Install cap and sealing washer.

Torque Value

Timing Pin Cap	30 N·m [22 ft-lb]

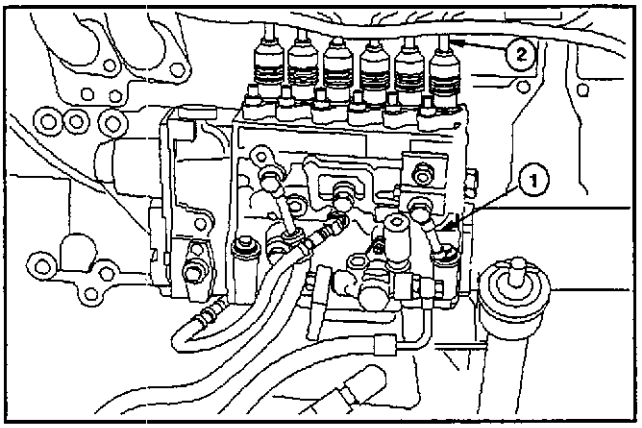


Fuel Pump Removal (flange drive)

Clean the debris from around the in-line fuel injection pump. Disconnect the electrical connection (1) and low pressure fuel lines (2).

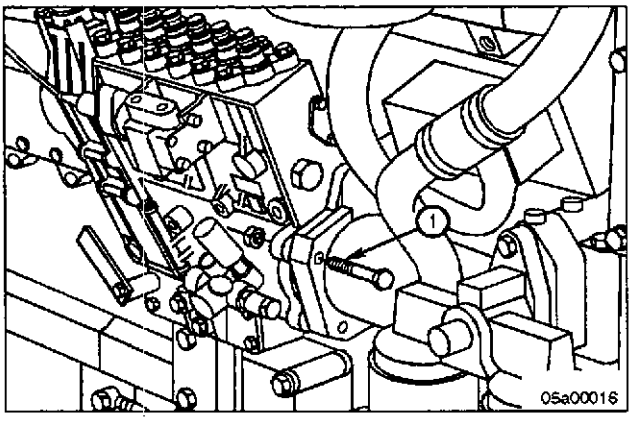
Disconnect the fuel pump drain line (1) and the high pressure fuel lines (2).

Install protective covers to prevent any dirt or dust from getting into the discharge ports of the injection pump.



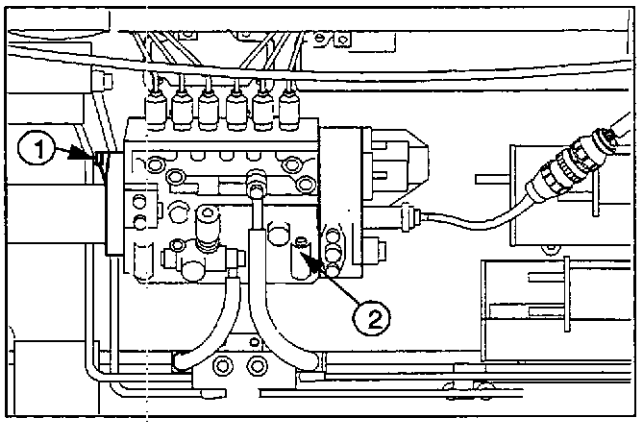
To remove the injection pump from the engine:

Remove the four capscrews (1), washers and nuts holding the pump to the drive housing.



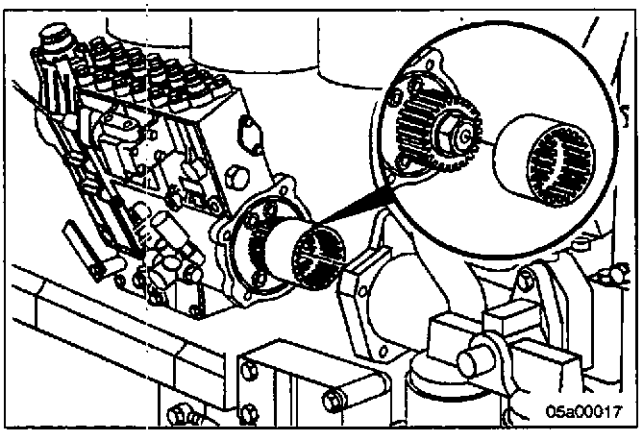
Remove the two front injection pump bracket mounting capscrews(1).

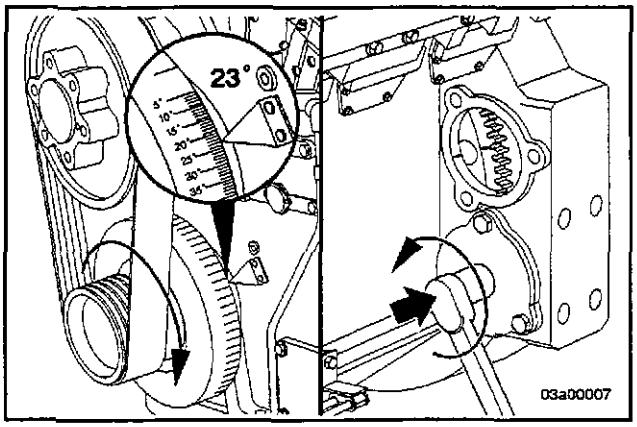
Remove the two bottom injection pump bracket mounting capscrews (2).



Remove the pump from the drive housing.

Disengage and remove the spline coupling from the pump driveshaft gear prior to delivery to the repair location. Use a standard 3 jaw puller kit if necessary.

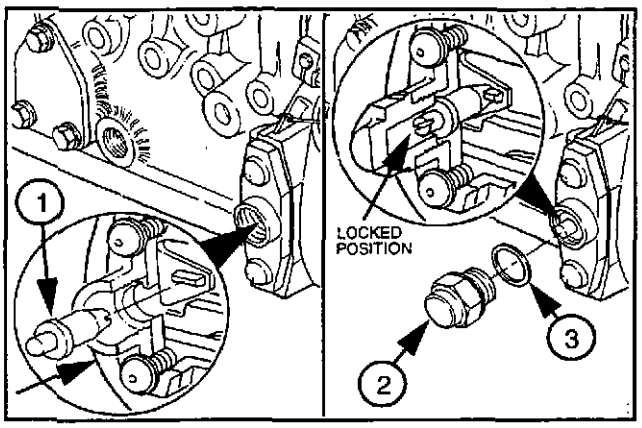




Fuel Pump Installation (flange drive)

Rotate the engine slowly in a clockwise direction to align the timing mark (as stated on the data plate) on the crankshaft damper with the timing pointer. Ensure that the #1 cylinder (right bank) is on the compression stroke.

NOTE: Both the right and left bank fuel pumps are installed with the engine in this position.

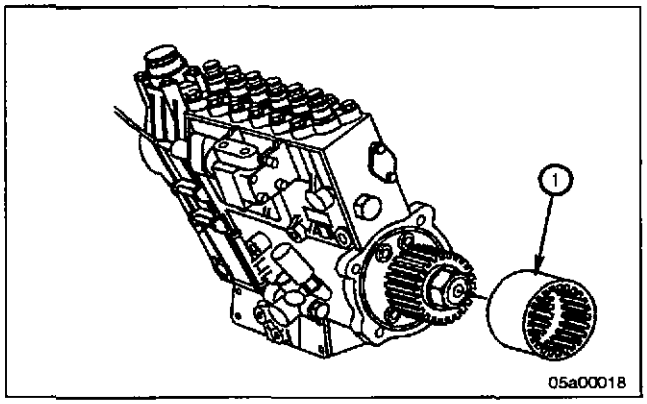


Remove the fuel injection pump timing pin cap and verify that the pump is locked.

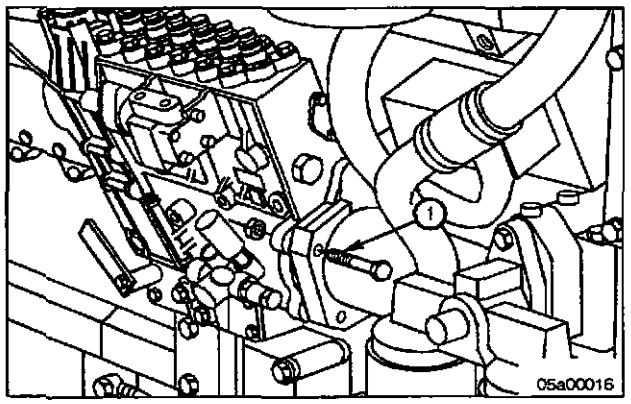
Install the timing pin (1), cap (2) and sealing washer (3).

Torque Value

Timing Pin Cap 30 N·m [22 ft-lb]



Install the spline coupling (1) onto the pump driveshaft gear.



Engage the spline coupling and install the pump driveshaft gear into the drive housing.

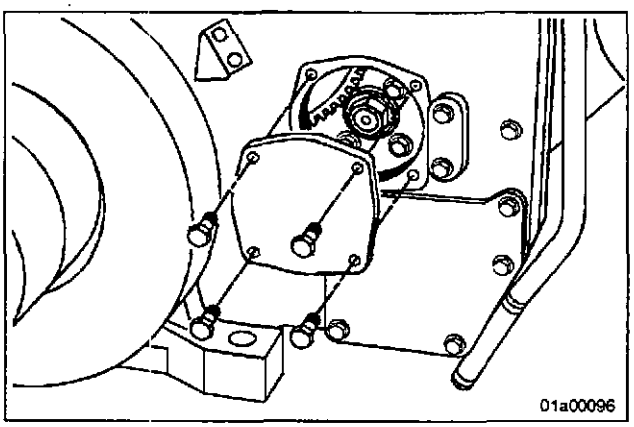
⚠ CAUTION ⚠

If the pump does not align, do NOT force the pump and driveshaft into alignment. Forcing will result in fuel pump damage.

Note: The injection pump assembly **must** be at an angle to the engine block and properly aligned with the front and bottom pump support brackets mounted to the engine block.

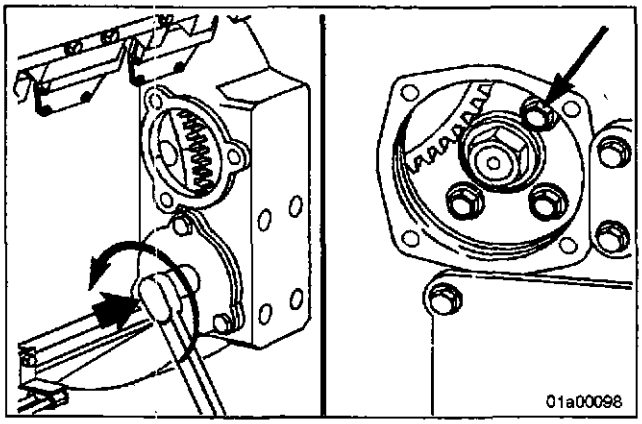
If the pump does not align, remove the cover plate on the front gear cover to gain access to the fuel pump drive gear.

Note: The fuel pump drive gear is a two-piece gear, secured by four capscrews. One of the four capscrews will be hidden from view by the larger idler gear.



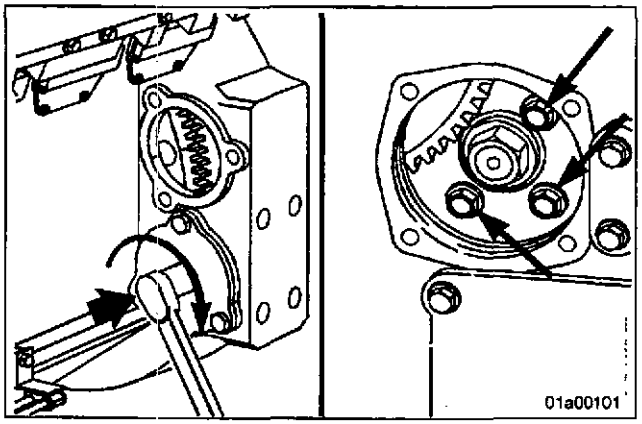
Before loosening **any** of the capscrews, rotate the crankshaft in the opposite direction of rotation until the fourth capscrew appears.

Loosen this capscrew **only** and tighten finger-tight **only.**



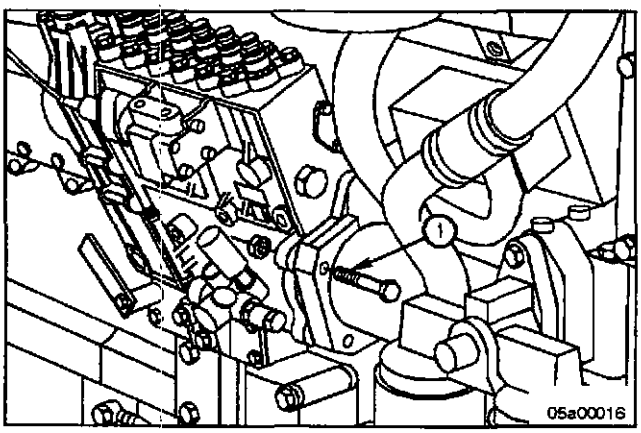
Rotate the engine clockwise until the crankshaft damper pointer aligns with the specified engine timing on the data plate.

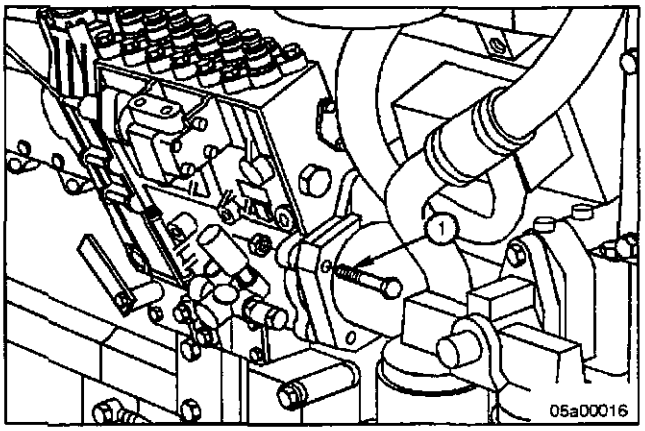
Loosen the remaining three capscrews, then tighten finger-tight **only.**



Engage the spline coupling and install the pump driveshaft gear into the drive housing.

The injection pump assembly **must** be at an angle to the engine block and properly aligned with the front and bottom pump support brackets mounted to the engine block.

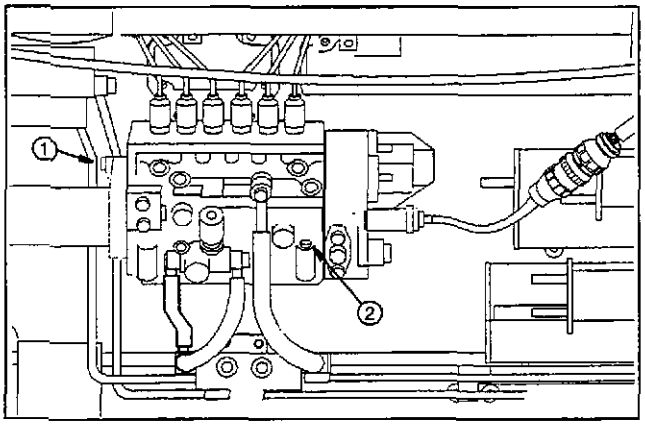




Install the four capscrews (1), washers and nuts that mount the pump to the drive housing and tighten.

Torque Value

66 N·m [49 ft-lb]

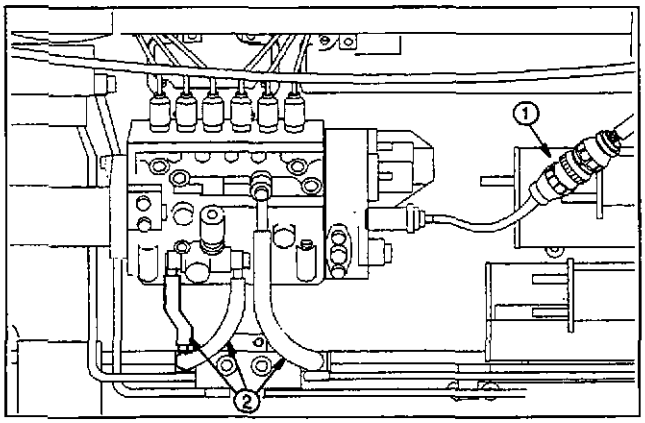


Install the two front injection pump bracket mounting capscrews (1) and tighten.

Install the two bottom injection pump bracket mounting capscrews (2) and tighten.

Torque Value

66N·m [49 ft-lb]

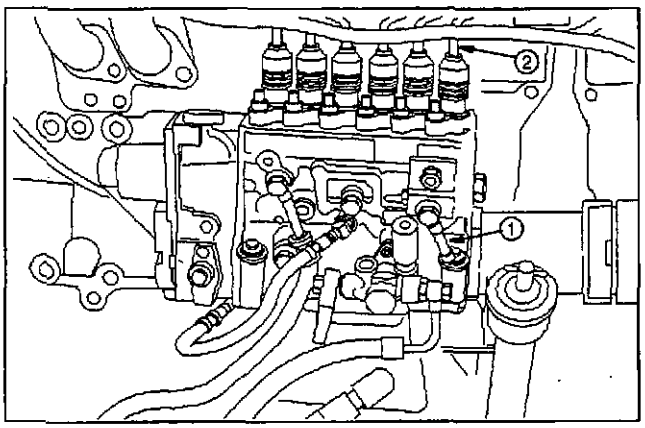


Install the low pressure fuel lines (2).

Torque Value

24 N·m [17 ft-lb]

Install the electrical connection (1).



Install the high pressure fuel line (2).

Torque Value

24 N·m [17 ft-lb]

Install the fuel pump drain line (1).

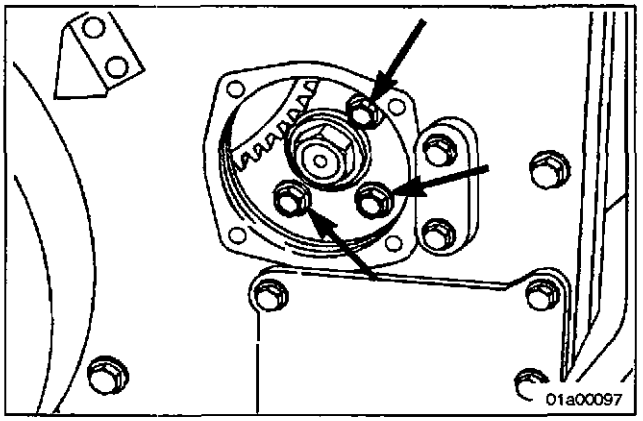
Torque Value

9 N·m [80 in-lb]

Tighten the three visible capscrews in the fuel pump drive gear.

Torque Value

115 N·m [84 ft-lb]



Unlock Fuel Pump Timing (flange drive)

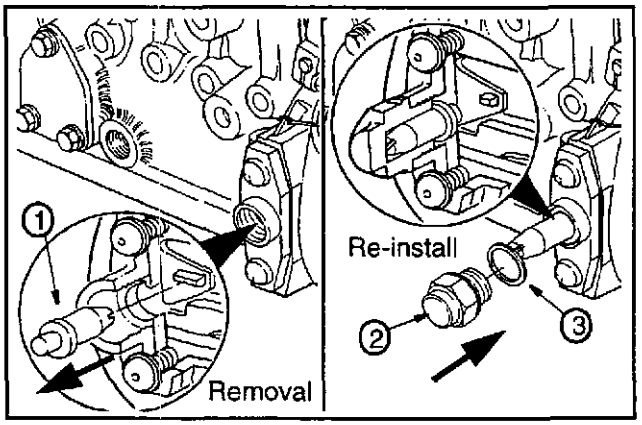
⚠ CAUTION ⚠

Severe damage to the fuel pump WILL occur unless the fuel pump is unlocked prior to operation.

Remove the fuel pump timing pin cap (2), sealing washer (3) and timing pin (1). Reverse the timing pin and reinstall in the unlocked position. Install cap and sealing washer.

Torque Value

Timing Pin Cap 30 N·m [22 ft-lb]

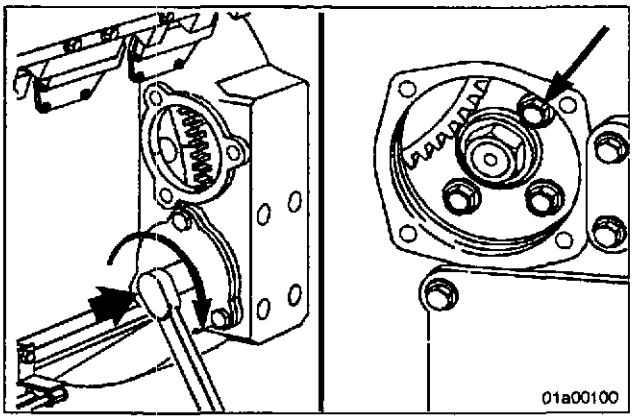


Rotate the engine one full revolution.

Tighten the fourth capscrew.

Torque Value

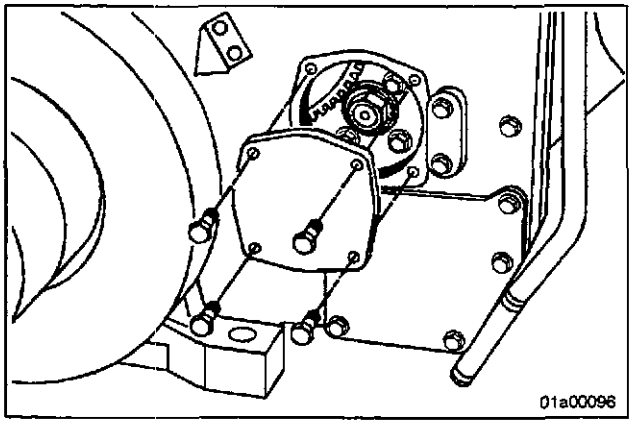
115 N·m [84 ft-lb]



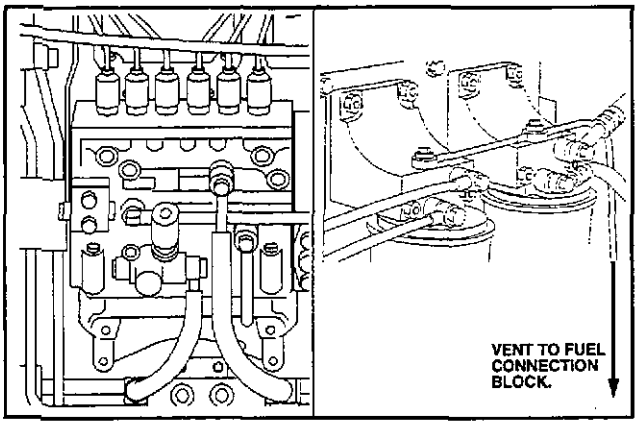
Re-Install the cover plate on the front gear cover.

Torque Value

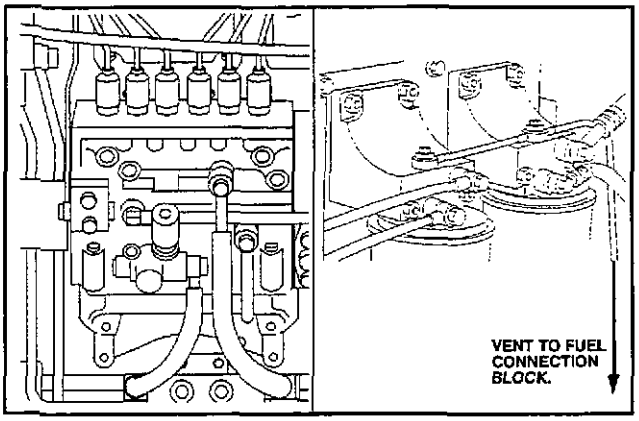
65 N·m [48 ft-lb]



Fuel Line Venting

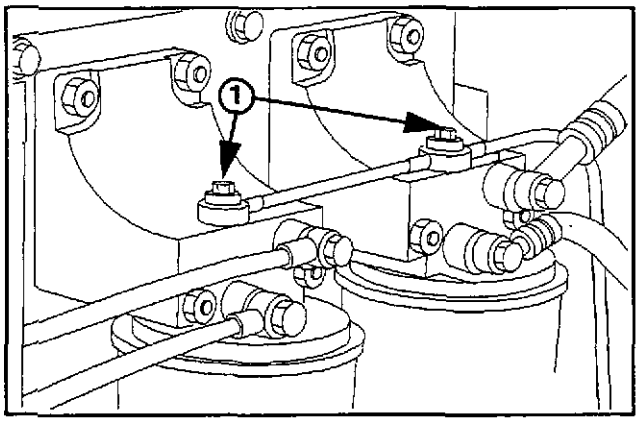


Controlled venting is provided at the fuel pump through the fuel drain manifold. Small amounts of air introduced when changing the fuel filters or fuel pump supply line will be vented automatically, if the fuel filter is changed in accordance with the instructions (O/M Manual).



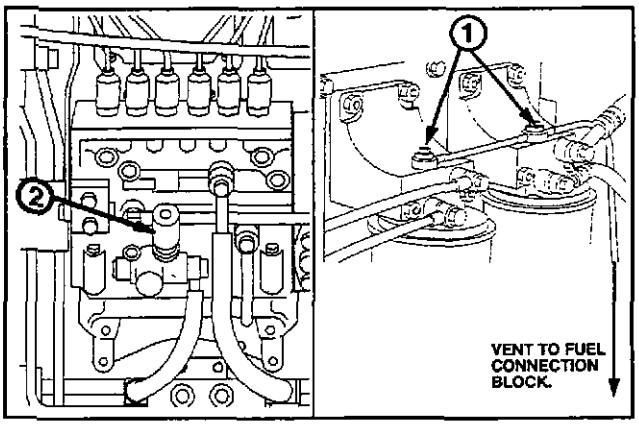
Note: Manual venting is required if:

- The fuel filter is **not** filled prior to installation.
- Fuel injection pump is replaced.
- *High pressure fuel line connections are* loosened or fuel lines replaced.
- Initial engine start-up or start-up after an extended period of no engine operation.
- Engine has been run until fuel tank emptied.



Low Pressure Fuel Line(s)

To vent the low pressure fuel lines, loosen the fuel filter head pressure relief banjo fittings (1) on top of the fuel filter head.



Operate the plungers (2) on the fuel lift pumps until the fuel flowing from the pressure relief fittings (1) is free of air. Tighten the banjo fittings (1).

Torque Value

8.8 N·m [6.5 ft-lb]

Pump(s)

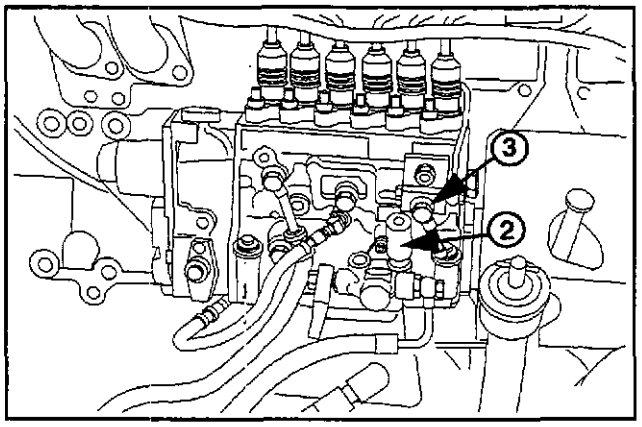
Loosen the fuel pump galley outlet line banjo fitting(s) (3).

Either

Energize the Fuel Pump Shutoff Valves (24VDC) and operate the plunger (2) on the fuel lift pump(s) until fuel bleeds from the line,

Or

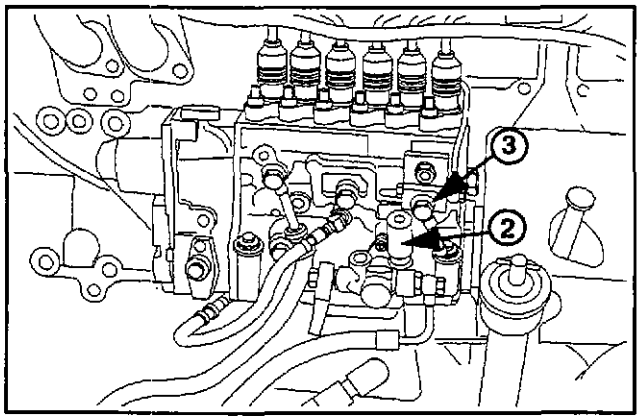
crank the engine (ensuring power is supplied to the ECM) until fuel bleeds from the line.



Tighten the fuel pump galley outlet line banjo fitting(s) (3).

Torque Value

23 N·m [17 ft-lb]



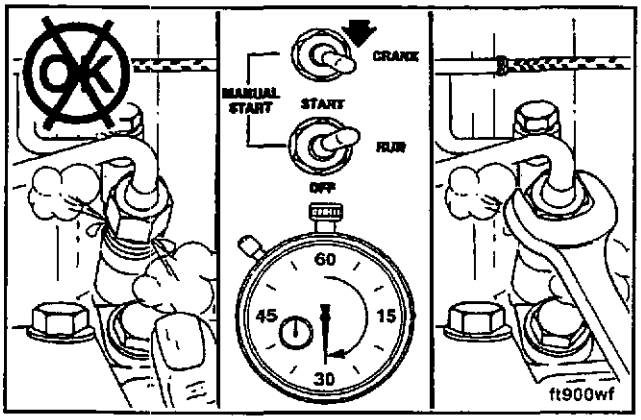
High Pressure Fuel Line(s)

⚠ WARNING ⚠

The pressure of the fuel in the line is sufficient to penetrate the skin and cause serious bodily harm. Carefully loosen the fittings to ensure there is still proper thread engagement and wear hand protection.

Loosen the fittings at the injectors. Crank the engine to allow the trapped air to bleed from the lines. Tighten the fittings.

Note: Do not engage the starter for more than 30 seconds each time when it is used to vent the system. Wait 2 minutes between engagements.

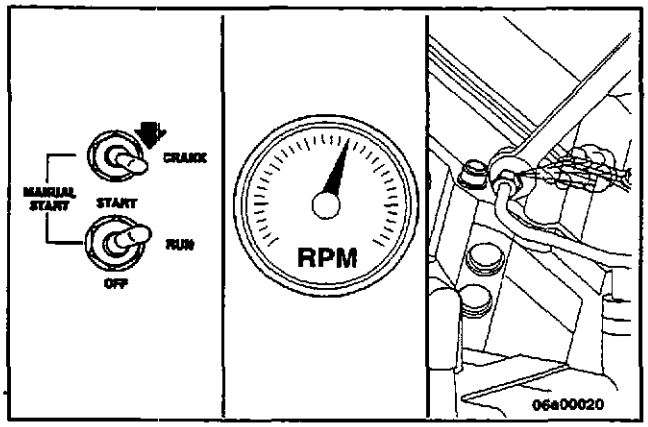


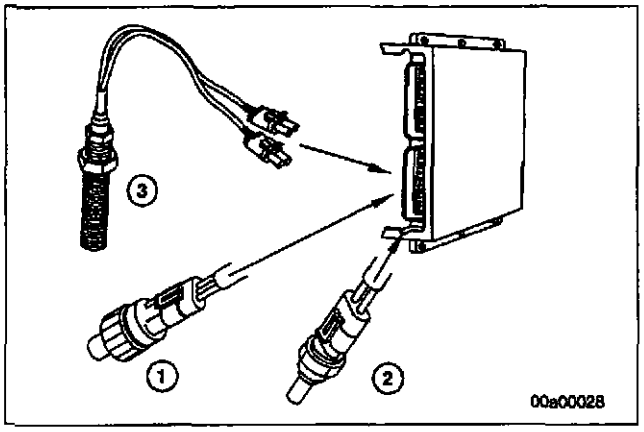
Start the engine.

⚠ WARNING ⚠

Turn the engine switch to the RUN position. Follow the engine safety precautions and the normal engine starting procedure (see page 69)**.**

After the engine starts, vent one line at a time until the engine runs smoothly.

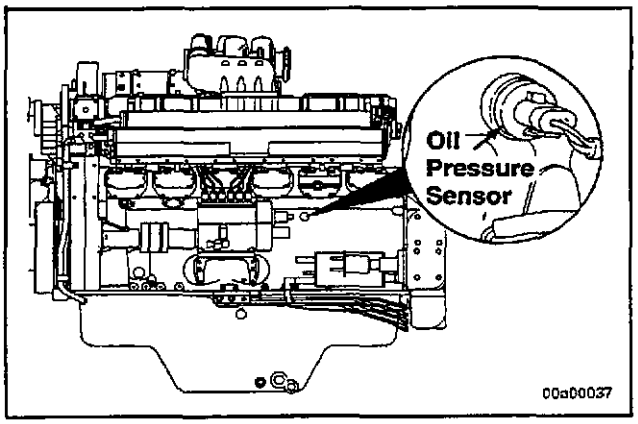




Engine Protection

The QST30 ECM provides engine protection for low oil pressure, high coolant temperature and overspeed conditions.

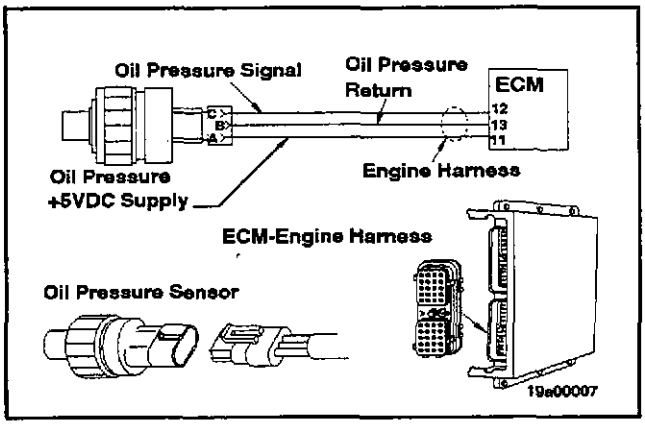
For a complete listing of engine protection warning, shutdown and factory defaults set-points, see Engine Protection Setpoints on page 32.



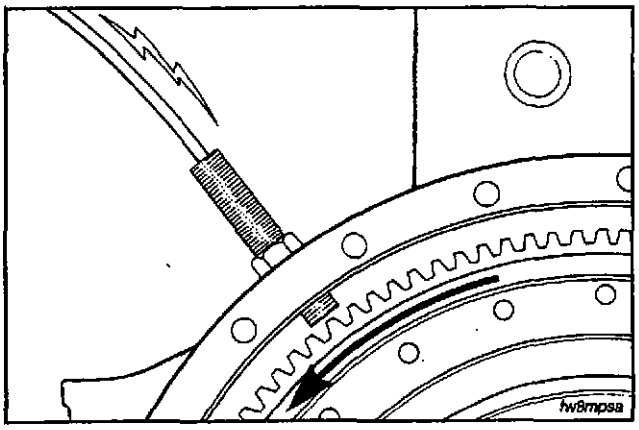
Engine Oil Pressure

The Oil Pressure Sensor (OPS) is located on the left bank side of the engine block to the rear of the fuel pump.

The OPS provides engine protection in the low lubricating oil pressure condition.



The Oil Pressure Sensor is used by the ECM to monitor the engine's lubricating oil pressure. The ECM monitors the voltage on the signal pin and converts this to a pressure value. If the OPS indicates oil pressure has fallen below the low oil pressure threshold, the engine will shut down and the Common Alarm output relay and Low Oil Pressure relay driver will energize.

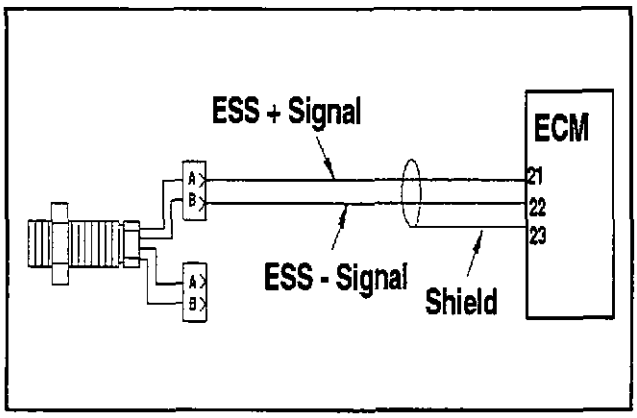


Engine Speed

The Engine Speed Sensor (ESS) is located on the left bank side of the engine in the flywheel housing.

The ESS provides engine protection in the overspeed and loss of speed signal conditions.

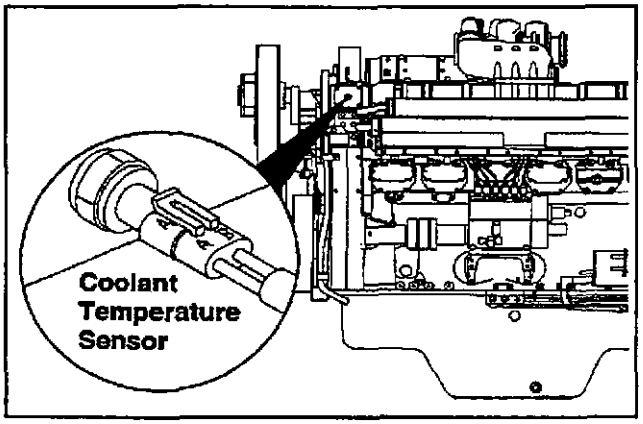
The Engine Speed Sensor is used by the ECM to monitor engine speed. If the ESS indicates engine speed has exceeded the engine over-speed threshold, or the ECM detects a loss of speed signal condition (<50 RPM), the engine will shut down and the Common Alarm output relay and Overspeed (if maximum RPM was exceeded) relay driver will energize.



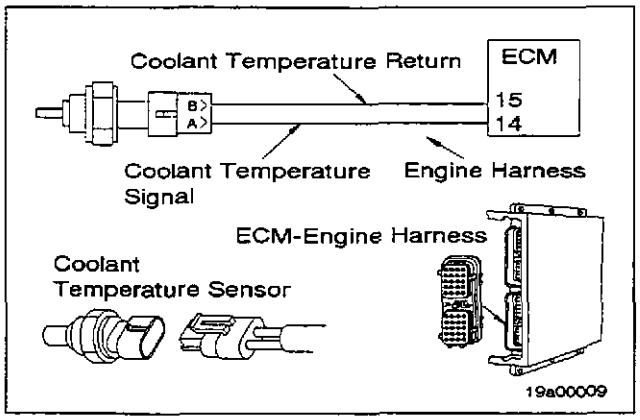
Engine Coolant Temperature

The Coolant Temperature Sensor (CTS) is located in the upper casing of the thermostat housing on the left bank side of the engine block.

The CTS provides engine protection in the high coolant temperature condition.



The Coolant Temperature Sensor is used by the ECM to monitor the temperature of the engine coolant. The ECM converts the voltage on the signal pin to a temperature value. If the CTS indicates the coolant has exceeded the high temperature threshold, the engine will shut down and the Common Alarm output relay and High Coolant Temperature relay driver will energize.



Engine Protection Setpoints

Engine Pre-Alarms (Warnings)

Engine Pre-Alarms	Adjustable Range	Default Value
Coolant Temperature Warning	-18 to 124 Deg. C [0 to 255 Deg. F]	97.2 Deg. C [207 Deg. F]
Oil Pressure Warning (Idle Speed)	0 to 689.5 kPa [0 to 100 PSI]	103.4 kPa [15 PSI]
Oil Pressure Warning (Rated Speed)	0 to 689.5 kPa [0 to 100 PSI]	275.8 kPa [40 PSI]
Fuel Pump Rack Position (vs. Commanded Rack Position)	Non-Adjustable	>0.20 VDC
High Voltage at Coolant Temperature Sensor	Existing Sensor Condition	
Low Voltage at Coolant Temperature Sensor	Existing Sensor Condition	
High Voltage at Oil Pressure Sensor	Existing Sensor Condition	
Low Voltage at Oil Pressure Sensor	Existing Sensor Condition	
Non-Critical ECM Memory Error	Existing ECM Condition	

Note: All Pre-Alarms energize the Common Warning Relay.

Engine Shutdowns (Alarms)

Engine Shutdowns	Adjustable Range	Default Value
Coolant Temperature Alarm	Non-Adjustable	105.6 Deg. C [222 Deg. F]
Oil Pressure Alarm (Idle Speed)	Non-Adjustable	68.9 kPa [10 PSI]
Oil Pressure Alarm (Rated Speed)	Non-Adjustable	275.8 kPa [35 PSI]
Engine Overspeed	1000-2070 RPM	2070 RPM
Loss of Engine Speed Signal	Non-Adjustable	< 50 RPM
Critical ECM Memory Error	Existing ECM Condition	

Note: All Engine Shutdowns energize the Common Alarm Relay.

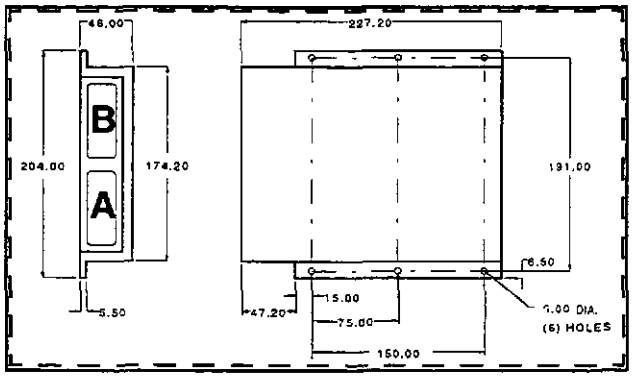
Default Values are factory preset values that are preprogrammed into all ECMs and are the parameter settings when the customer receives the ECM (unless the customer's local ABO informs of local resetting of specific parameters).

ECM Mounting

Electronic Control Module Mounting

The ECM is provided with (6) six mounting holes. There are three mounting holes on each rail, 6 mm in diameter and 75 mm apart. The hole distance between rails is 191 mm.

The ECM unit has a mass of 2.7 kg [6 lb].



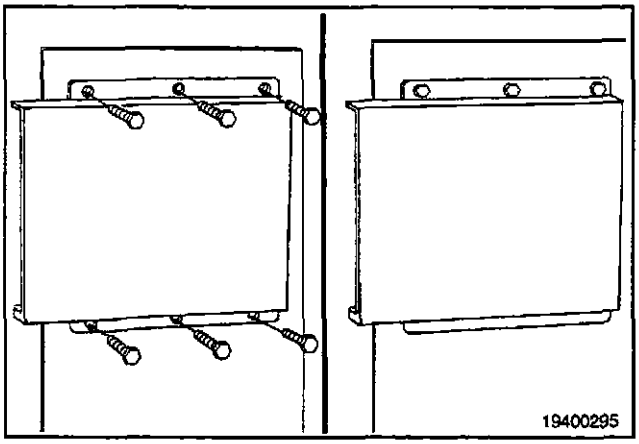
How to Mount the ECM

Determine the location for the ECM. Ensure that there is sufficient clearance for the wiring harnesses to be mounted to the ECM.

- Use all 6 mounting holes.
- Either machine and tap, or drill thru clearance holes for capscrews and nuts to secure the ECM to the mounting surface.

⚠ CAUTION ⚠

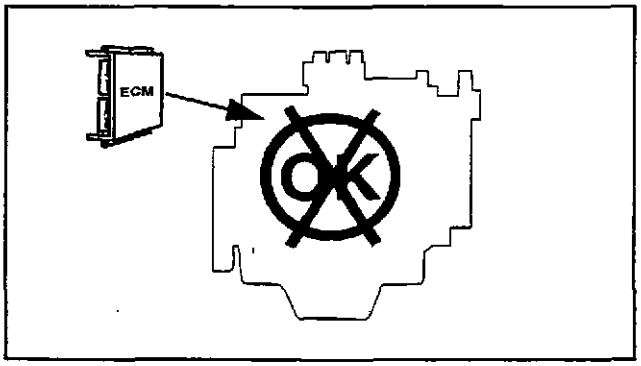
Make sure there is no grease or dirt on the ECM mounting surfaces. Properly tighten the 6 capscrews per the capscrew size/ grade torque recommendations to prevent mounting failures.



Where Not to Mount ECM

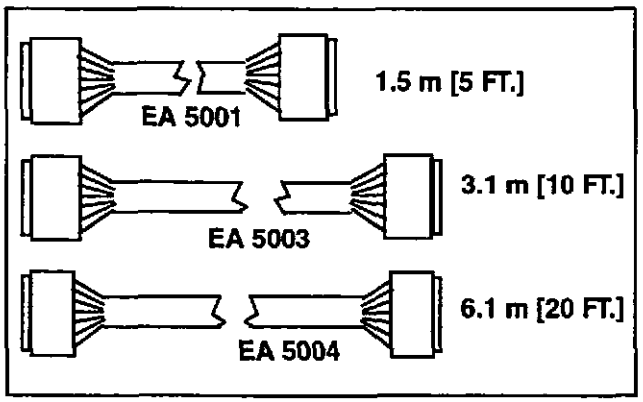
Do not mount the ECM directly to the engine block or to any engine block component without proper thermal and/or vibratory isolation.

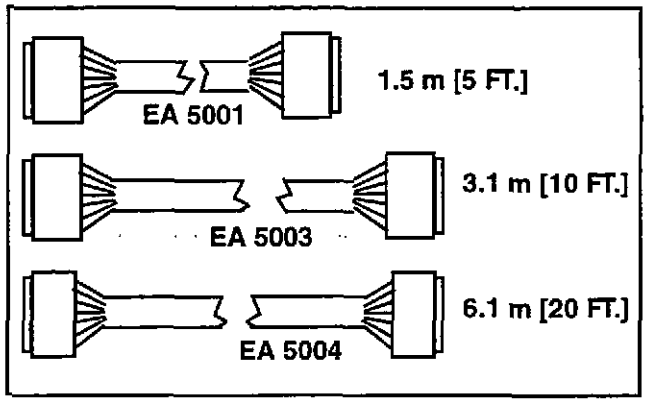
The ECM is **NOT** certified for block temperatures and vibration spectrums.



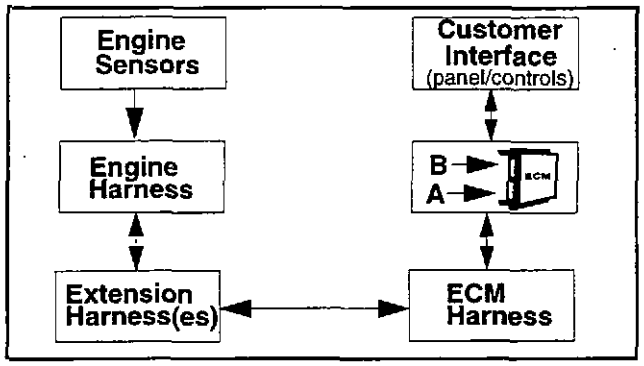
Engine Wiring Extension Harnesses

The ECM may be mounted up to 15.2 m [50 ft.] (total harness length) from the engine harness at the flywheel housing. Various extention harness lengths are available and may be combined to make up to a total of 15.2 m.



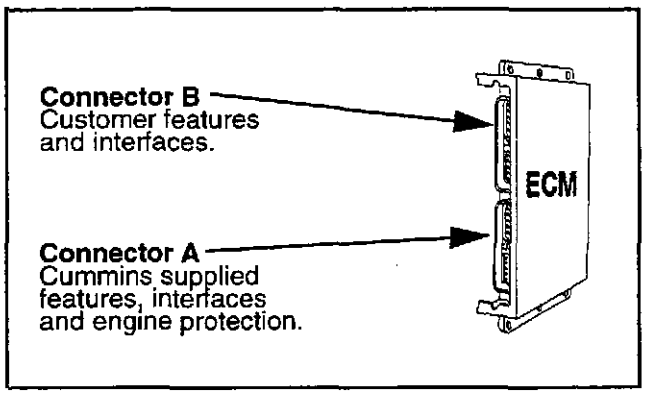


Every engine is supplied with a 1.5 m [5 ft.] ECM harness (included with the ECM). This harness interfaces the engine and/or extension harnesses to the ECM connector. This harness (in the ECM kit) must be included as part of the total 15.2 m of harness length (1.5m ECM harness plus up to 13.7 m [45 ft.] in extension harnessing equals 15.2 m maximum total harness length).



System Description

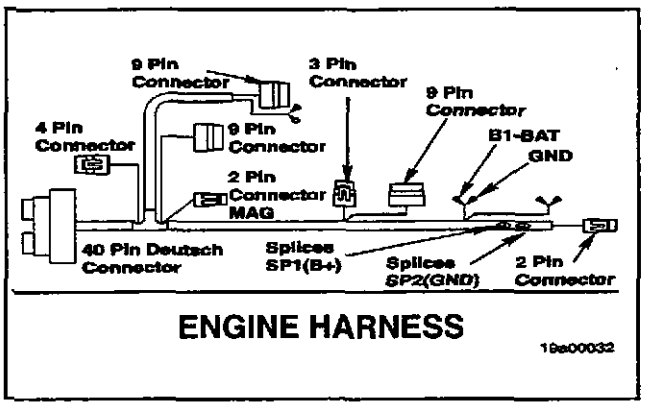
The QST30 G-Drive speed governing system consists of the ECM speed governor; ECM, engine and extension (when utilized) harnesses; engine water temperature, oil pressure and speed sensors; and customer supplied controls.



ECM Connectors

Cummins engine control and monitor functions are supplied between the engine harness and the ECM through Connector A.

Customer features and interfaces are obtained through connector B of the ECM.



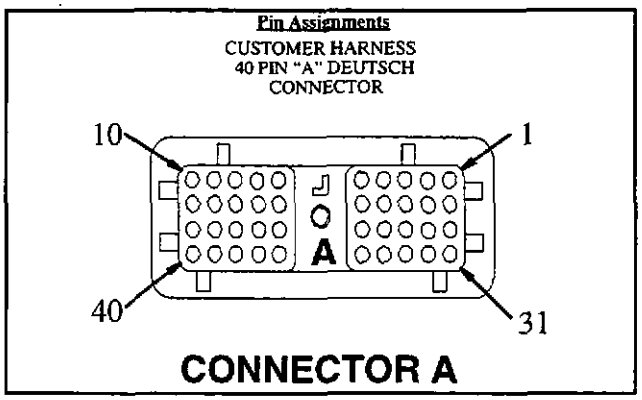
Engine Wiring

Engine Wiring Harness

Every Cummins QST30 G-Drive engine is shipped with a factory mounted engine wiring harness and a kit consisting of the ECM (for customer mounting) and ECM harness (which contains the A harness connector which mates with the ECM A connector).

The engine wiring harness provides the interface between the engine sensors and the ECM for sensor inputs. It also provides the interface between the ECM and the engine to govern speed and, when necessary, to shut down the engine for engine protection.

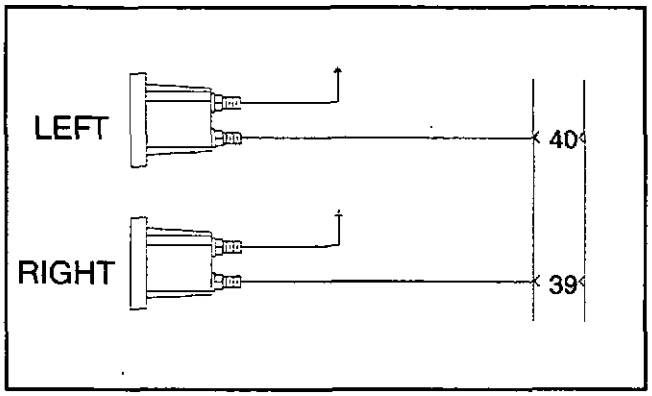
The engine wiring harness is connected to the engine control module through Connector A of the ECM (via engine extension harnessing and the ECM harness).



Fuel Shutoff Valves (FSOV)

The ECM provides +24VDC to both the left and right bank fuel shutoff valve solenoids (under proper running conditions) through pins 39 and 40.

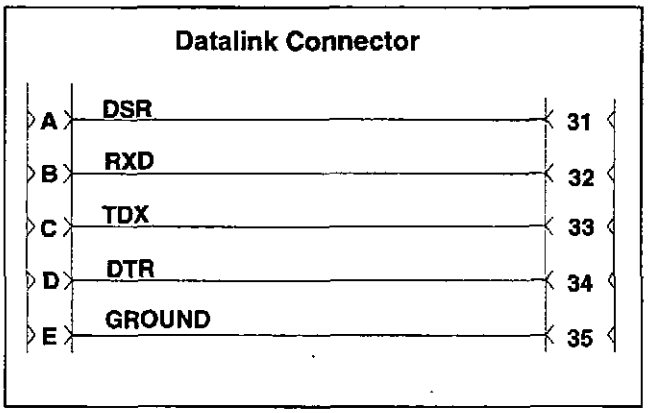
The FSOV solenoid ground post is only used on Isolated Ground solenoids. (See wiring diagram on page 37 for proper hookup).



Datalink Connector

Pins 31, 32, 33 and 34 are used to transfer data between the ECM and the PC electronic Service Tool (via a 9 pin round Deutsch connector).

PC Service Tool	P/N 3825145
PC Serial Port Interconnect Cable	P/N 3825183

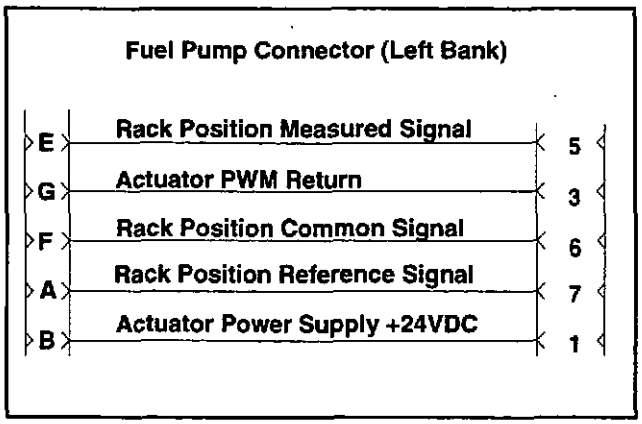


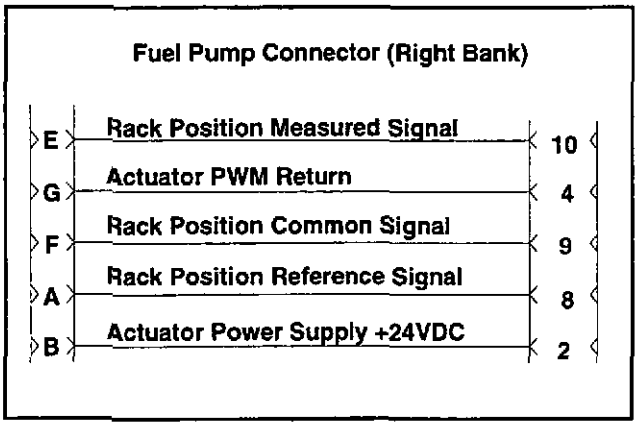
Fuel Pump Connector, Left Bank

Pin 5 is a signal supplied to the ECM.

Pins 3 and 6 are returns to the ECM.

Pins 1 and 7 are power and signals supplied by the ECM.



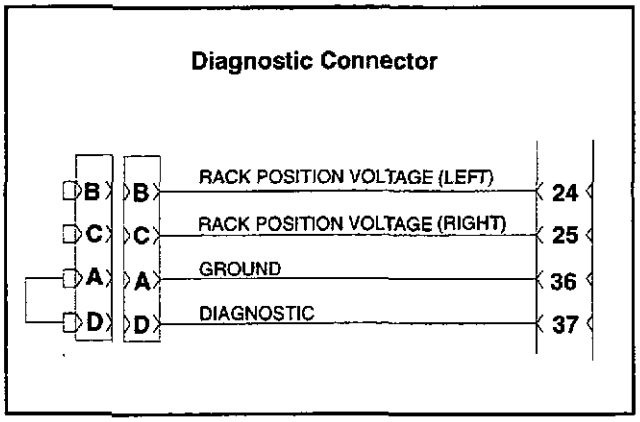


Fuel Pump Connector, Right Bank

Pin 10 is a signal supplied to the ECM.

Pins 4 and 9 are returns to the ECM.

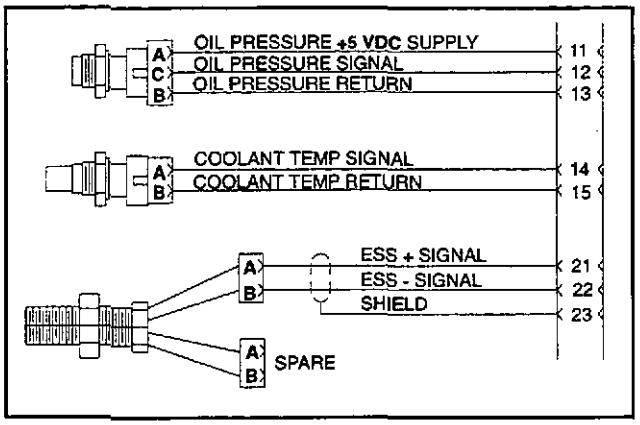
Pins 2 and 8 are power and signals supplied by the ECM.



Diagnostic Connector

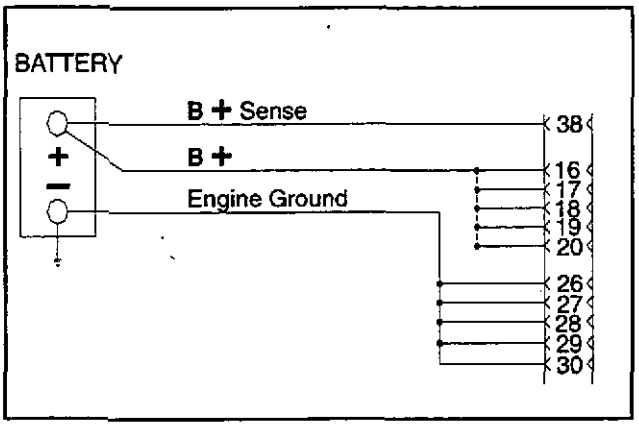
For the ECM to enter diagnostic mode, the diagnostic input (D) must be left open with respect to ground (A).

For discussion on diagnostic mode, see the INSITE™ for QST30 G-Drive (PC Service Tool) User's Manual, Bulletin No. 3666196.



Engine Sensors

The engine harness connects reference and sensor signals between the ECM and Oil Pressure, Coolant Temperature and Engine Speed sensors through their corresponding pins.



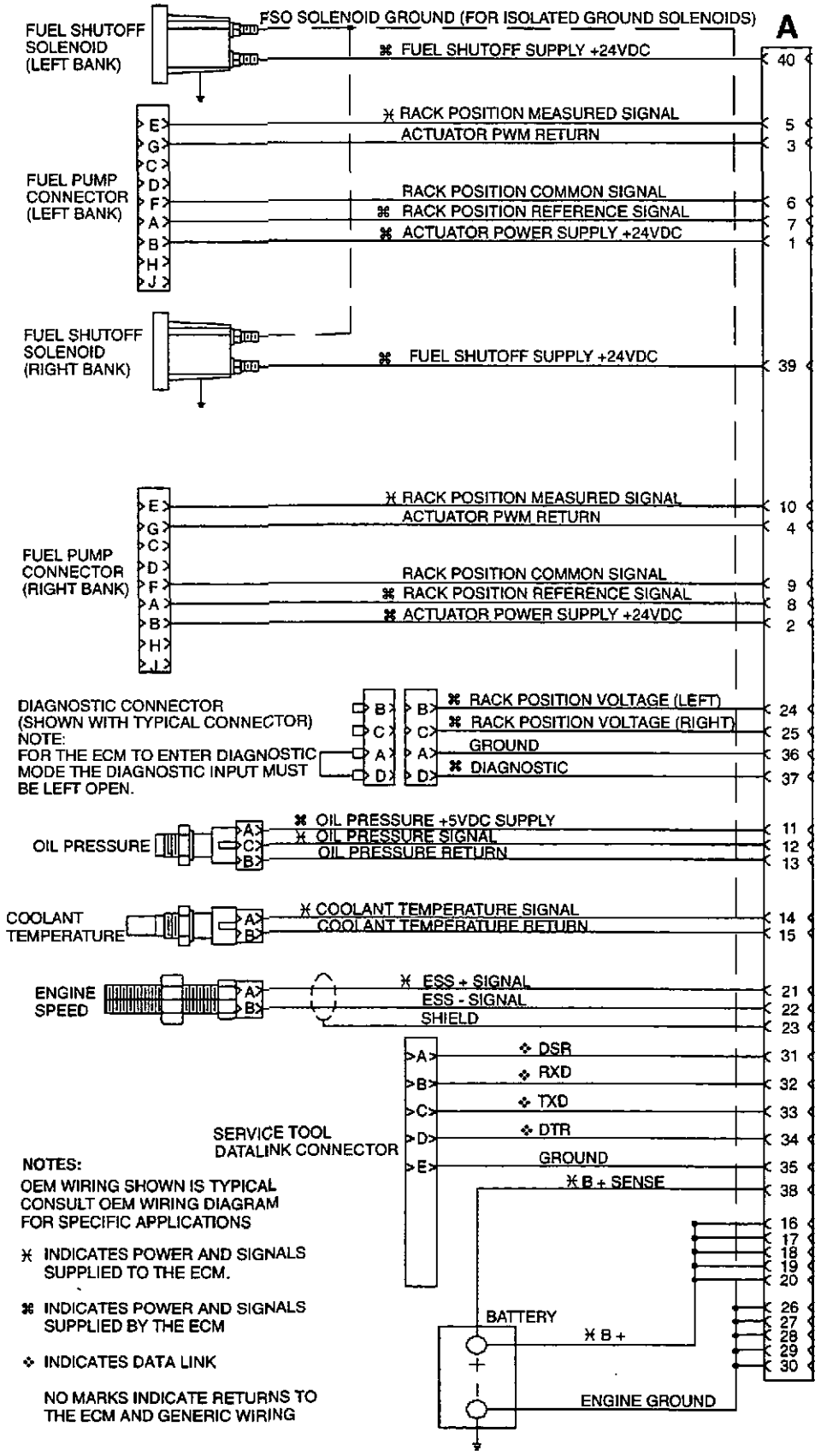
Power Supply and Ground

The engine harness provides B+ (un-switched +24VDC) power, B+ Sensing voltage and Battery Ground to the ECM.

Fuse protection is unnecessary and not provided as potentially affected circuits are controlled by current limiting devices within the ECM.

Pins 16 through 20 and 26 through 30 are jumpered internally in the ECM.

QST30 G-DRIVE WIRING DIAGRAM
ENGINE HARNESS



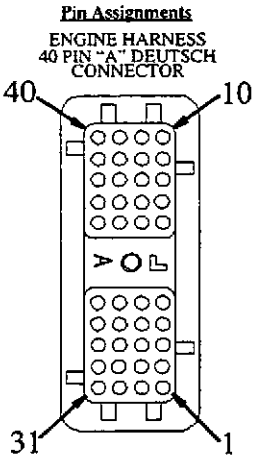
NOTES:
OEM WIRING SHOWN IS TYPICAL
CONSULT OEM WIRING DIAGRAM FOR SPECIFIC APPLICATIONS

⌘ INDICATES POWER AND SIGNALS SUPPLIED TO THE ECM.

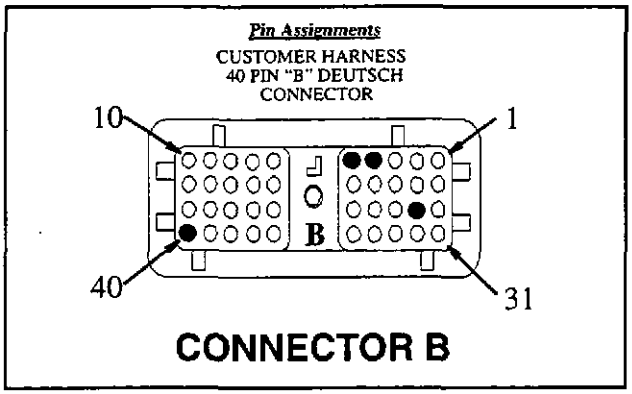
⌘ INDICATES POWER AND SIGNALS SUPPLIED BY THE ECM

❖ INDICATES DATA LINK

NO MARKS INDICATE RETURNS TO THE ECM AND GENERIC WIRING

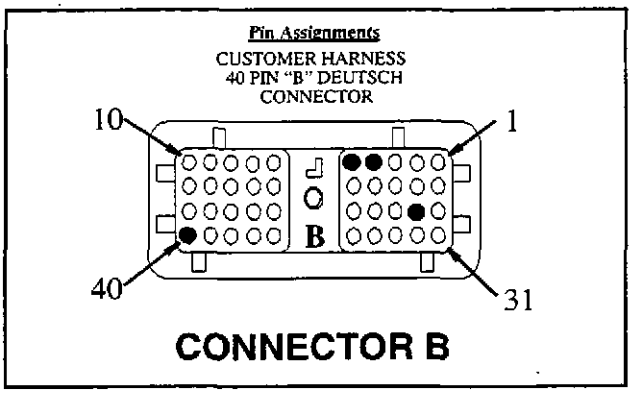


CONNECTOR A



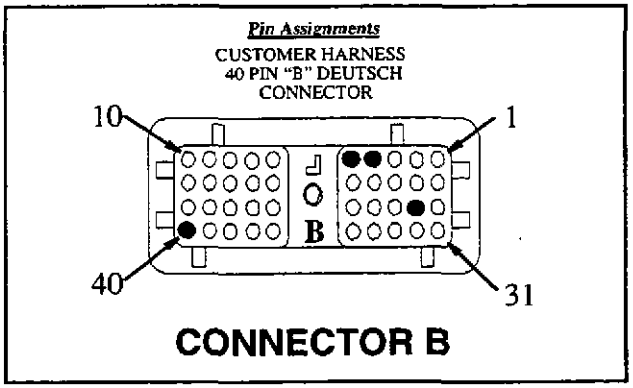
Customer Wiring

Customer features and interfaces are obtained through Connector B of the ECM. It is the customer's responsibility to build a wiring harness utilizing the B Connector. This wiring harness is limited to 15.2 m [50 ft.] total length, from the ECM to the customer controls.



B Connector Information

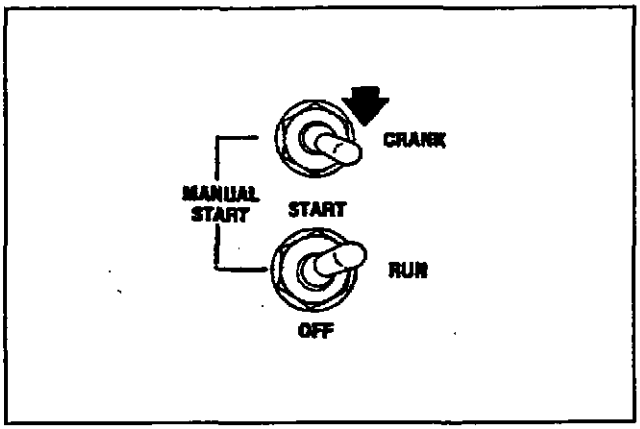
	Deutsch P/N	Cummins P/N
B Connector	DRC26-40SB-L011	3621208
Connector Socket	0462-201-20141	3656990
Cavity Plugs	0413-204-2005	3657034



B Connector Kits

Option Kit No.: EA 5005
Service Kit P/N: 3092340

Note: Kits contain a 40-pin Deutsch "B" connector, 40 sockets and 40 cavity plugs for customer build.

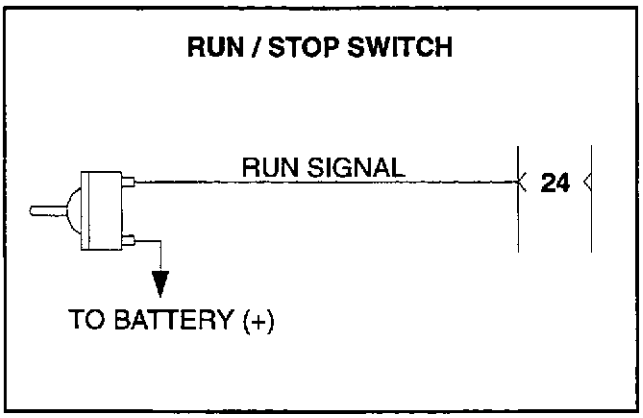


Start and Crank Circuit

It is the responsibility of the customer to provide their own Start and Crank circuit. See Cummins G-Drive Installation Guidelines for starting and cranking electrical circuits.

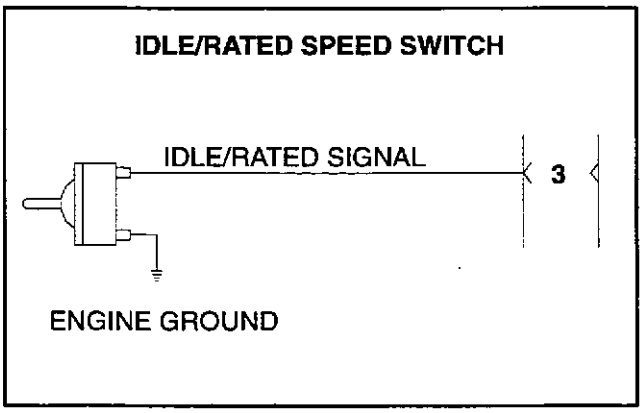
Run/Stop Switch

A customer supplied Run/Stop input supplies 24VDC Battery Positive (switched B+) to pin 24. B+ supplied to pin 24 allows the ECM to energize the FSOVs when cranking and to govern the engine speed when speed increases to >400 RPM.



Idle/Rated Speed Switch

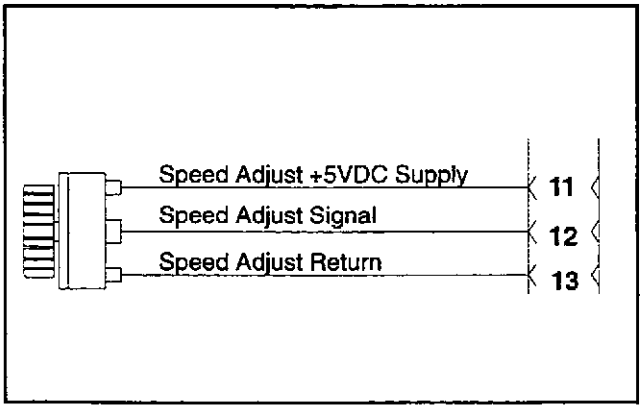
Idle speed mode is selected by grounding pin 3 via a customer supplied Idle/Rated switch. Idle or Rated speed mode can also be selected via the electronic Service Tool.



Remote Speed Adjust Potentiometer

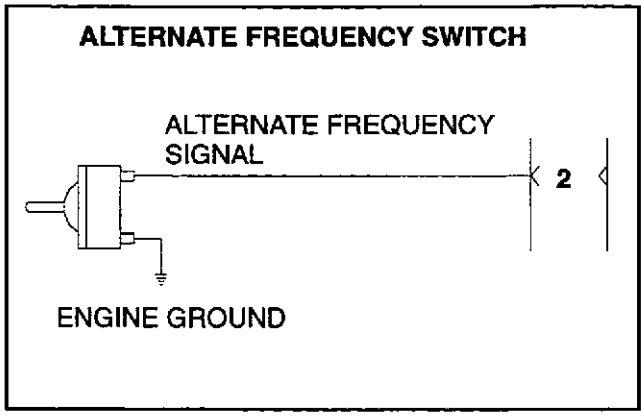
A customer supplied 5,000 ohm potentiometer provides for ± 6% engine speed adjustment around engine Run speed (Run speed = 1500 or 1800 RPM). Pin 12 is for the potentiometer's center wiper.

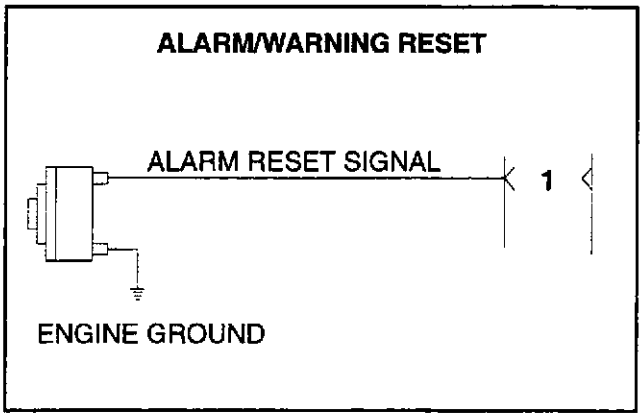
Note: The ECM must be calibrated (via the electronic Service Tool) to recognize if a remote speed adjust pot is being utilized between pins 11 through 13 (Remote Speed Adjust Enable).



Alternate Frequency Switch

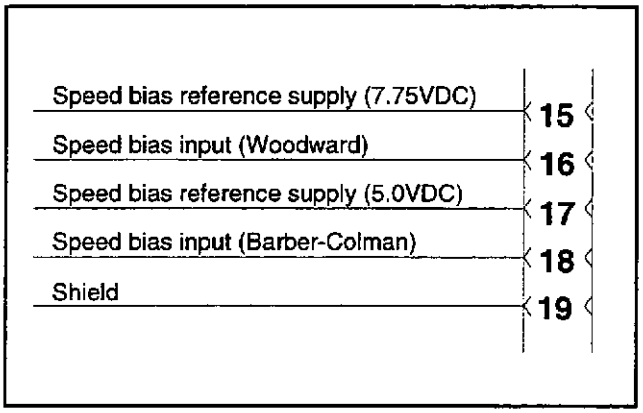
The Service Tool is used to set up Alternate Speed selections (see Adjustments on page 45). The Alternate (or second selection for rated engine speed) is selected by grounding pin 2 via a customer supplied switch.





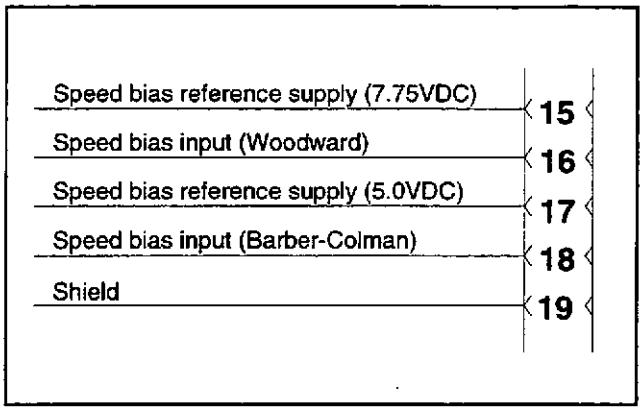
Alarm/Warning Reset Switch

A customer supplied switch resets all Alarm/ Warning functions and inactive Fault Codes by grounding pin 1. Warning relay drivers and relay contacts can be reset while the engine is running or shut down. Alarm shutdown relay drivers and contacts, and inactive fault codes, can be reset only when the engine is shut down. To restart the engine on an alarm shutdown, the Run/Stop switch must be moved to the OFF position then back to Run.



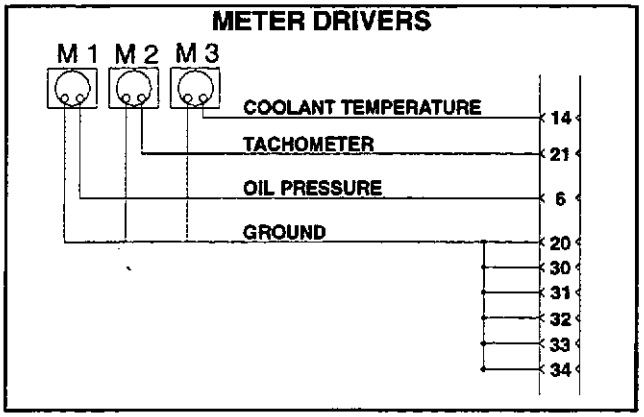
Barber-Colman & Woodward Speed Bias Inputs

Provides for integration with standard Barber-Colman and Woodward Load Sharing, Auto-Synchronizing, Load Commander, etc. hardware, both digital and analog (see Multiple Unit Wiring).



Woodward utilizes only the 5.0VDC reference supply while Barber-Colman utilizes both the 5.0 and 7.75VDC reference supplies.

Note: The QST30 ECM supplies the reference voltages (via internal 5.0 and 7.75VDC power supplies) to the Woodward or Barber-Colman load controls.



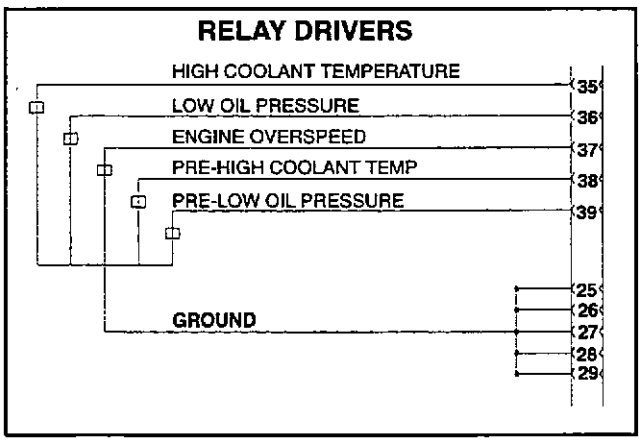
Meter Driver Outputs

Drivers for Coolant Temperature, Engine Speed and Engine Oil Pressure are provided for customer supplied meters rated at 0-1mA input. These meters can be calibrated and tested for accuracy with the electronic Service Tool.

Relay Driver Outputs

Relay drivers rated for 200mA maximum at 24VDC can be used to drive customer supplied LEDs, horns, or relays for HCT, LOP and Engine Overspeed conditions.

With the exception of Engine Overspeed, alarm shutdowns are non-adjustable. Pre-Alarms (Warnings) are adjustable via the Service Tool. See Engine Protection Setpoints on page 32 for adjustable ranges and factory settings.

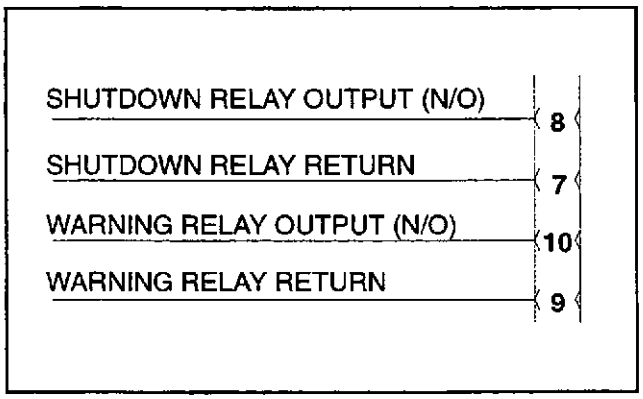


Common Alarm/Warning Relay Contacts

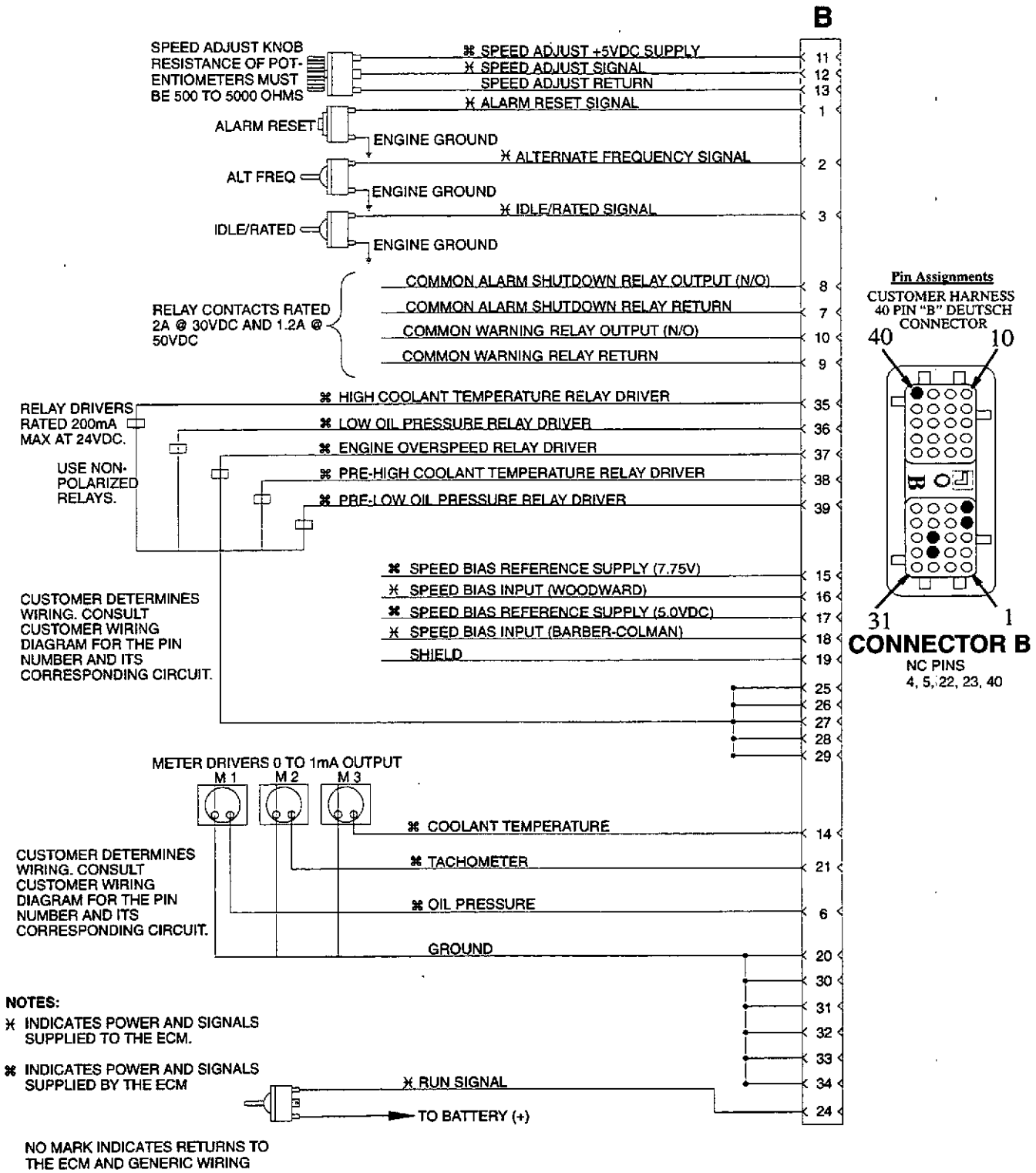
Any alarm (shutdown) or pre-alarm (warning) function will close a corresponding set of normally open (N/O) relay contacts for customer use.

Relay contacts are rated for 2A at 30VDC and 1.2A at 50VDC.

Note: See the Fault Code Table (page 106) for all fault conditions that energize the Alarm and Warning Relays.



QST30 G-DRIVE WIRING DIAGRAM
CUSTOMER/GOEM HARNESS



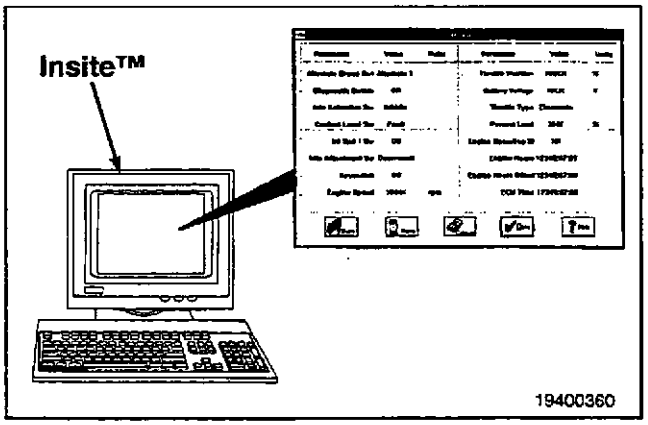
NOTES:

Ж INDICATES POWER AND SIGNALS SUPPLIED TO THE ECM.

⌘ INDICATES POWER AND SIGNALS SUPPLIED BY THE ECM

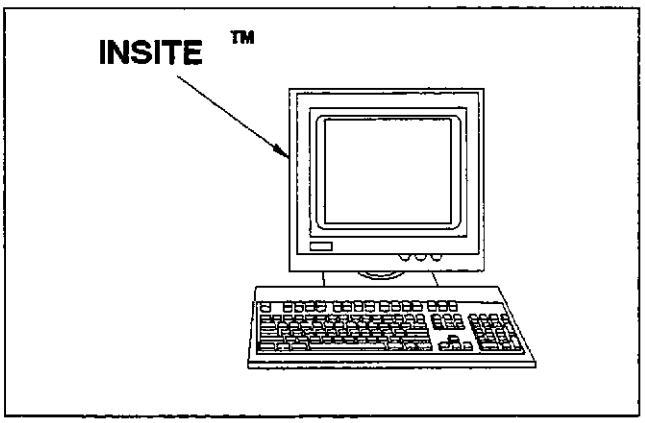
NO MARK INDICATES RETURNS TO THE ECM AND GENERIC WIRING

Electronic Service Tool



The electronic service tool, INSITE™ QST30 G-Drive (Part No. 3825145), is a Windows® 95 software application. The QST30 G-Drive service tool functions with all Cummins QST30 generator drive electronic control modules (ECMs) to diagnose and troubleshoot engine problems or modify an engine's operating settings.

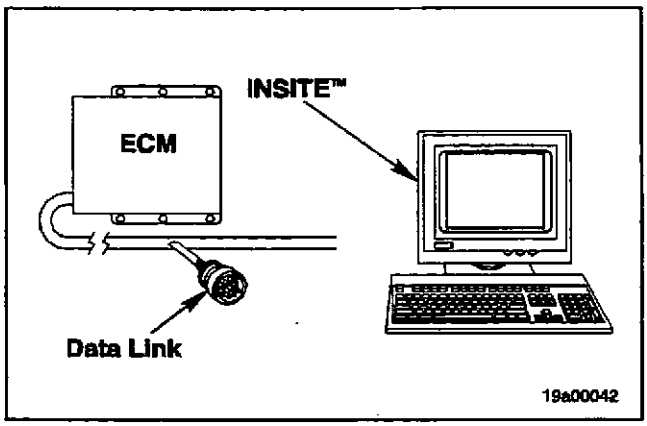
Note: The INSITE™ QST30 G-Drive electronic service tool is not to be confused with other Cummins INSITE™ service tools designed for industrial and automotive ECMs. The INSITE™ QST30 G-Drive tool is compatible **only with** QST30 generator drive ECMs and, conversely, other INSITE™ tools are incompatible with generator drive ECMs.



INSITE™ QST30 G-Drive is to be used on an IBM or compatible personal computer (desktop or portable) that is attached to an ECM with the proper serial interconnect cable (Part No. 3825183). The PC can then be used to retrieve the latest information about the engine, monitor data to assess the operation of the engine or make a number of customer selected adjustments to the engine.

Note: For further information on the INSITE™ QST30 G-Drive service tool, see the INSITE™ QST30 G-Drive User's Manual (Bulletin No. 3666196).

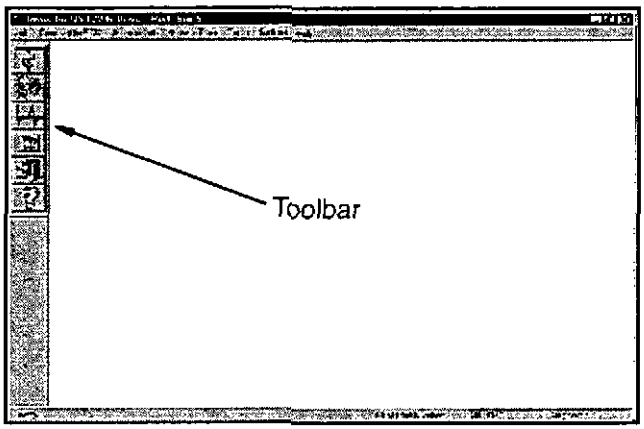
Establishing Communication with the ECM



Install the serial interconnect cable (3825183) to the back of the PC and the 9-pin Deutsch connector to the engine harness.

Power up the ECM by removing the cap on the 4-pin Weatherpack Diagnostic Connector (opening the circuit between pins 36 and 37 of the ECM's A-connector) in the engine harness. See Engine Harness Diagram on page 37.

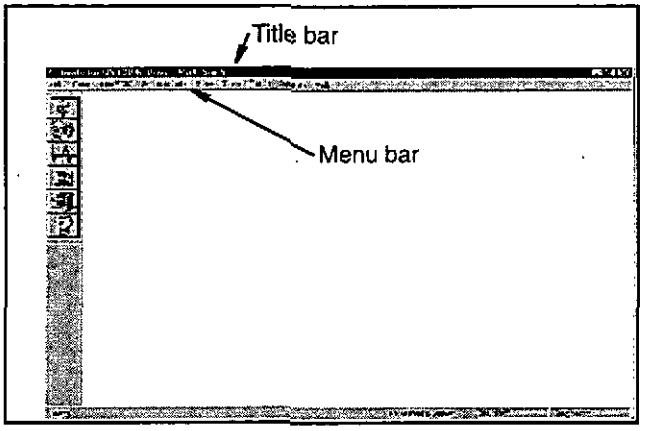
Note: Both the 9-pin Deutsch and 4-pin Weatherpack engine harness connectors are located near the flywheel housing on the left bank side of the engine.



Start the INSITE™ QST30 G-Drive program by opening the QST30 G-Drive application icon or, from the Windows® 95 Programs menu, highlighting the QST30 menu and clicking on INSITE for QST30 G-Drive (this will automatically establish communications with the ECM if everything is set up correctly).

Verify that communications have been established from the Main QST30 G-Drive Window. If any of the six buttons in the left hand toolbar are grayed out (three will gray out if there is a lack of data transfer) proper communications have **not** been established.

Note: Ensure (via the System User Option window) that communication is set to the correct serial port (e.g. Port 1, Port 4, etc.).

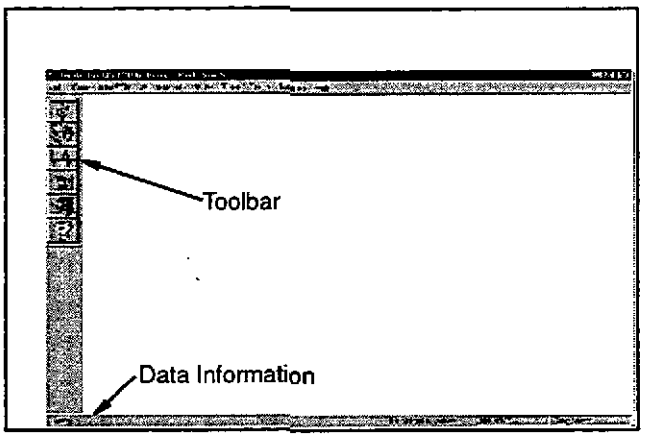


The Main INSITE™ for QST30 G-Drive Window

All functions are performed from the Main INSITE™ QST30 G-Drive Window. This window incorporates many of the standard operating techniques used in Windows® 95.

The **Title** bar displays the product name (INSITE for QST30 G-Drive) and the selected communication port.

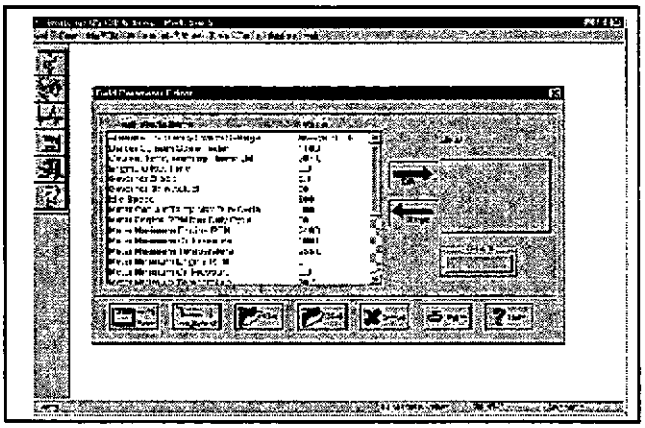
The **Menu** bar, below the Title bar, provides complete access to every function in the service tool through drop-down menus.



The **Toolbar**, at the left of the main window, contains buttons that can be clicked to quickly access the most frequently used commands.

The **Data Information Line,** near the bottom of the window, displays reference information about the current function, the active ECM part number and the current operating mode.

Adjustments (Features and Parameters)



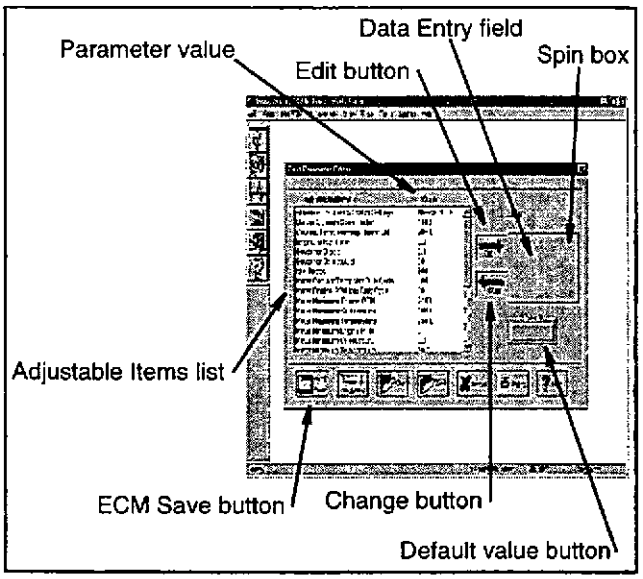
The Features and Parameters command in the Adjustments menu allows access to the Field Parameter Editor dialog box to view or edit (change the value of) any QST30 g-drive adjustable engine parameter.

For a **listing of all Adjustable Parameters,** and their ranges, see the Adjustable Parameters Listing on page 59.

Note: Access to, and adjustments from, this screen are only allowed when the engine is **not** running.

To change a parameter setting:

- From the list of Adjustable Items, highlight the parameter with the mouse then click the Edit button, or double click on the parameter.
- Edit the parameter value by either using the spin box; clicking in the data entry field, deleting the current setting and entering the desired value; or clicking on the Default value button.
- Click the Change button (or Enter) to change the parameter's value in the list of Adjustable Items.
- To permanently save parameter changes to the ECM, click on the ECM Save button at the bottom left of the screen.



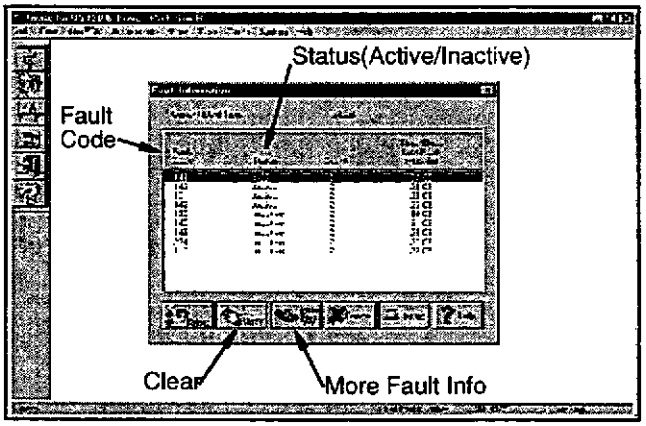
View (Fault Information)

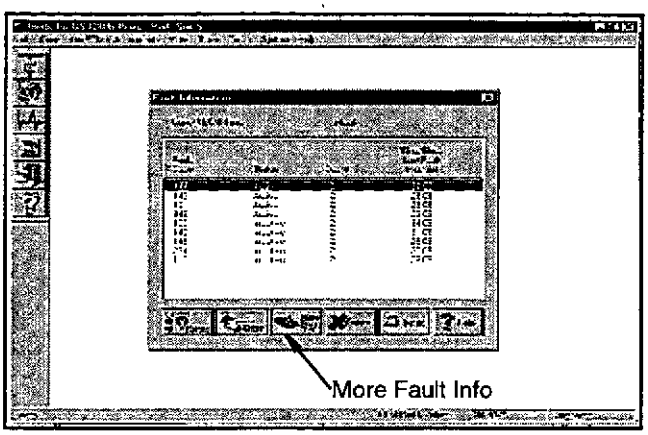
The Fault Information command in the View menu displays fault codes, fault information, and snapshot data as well as providing troubleshooting steps.

Each Fault Code indicates a particular malfunction or abnormal condition within the ECM, subsystem, or engine.

Active Faults indicate that the condition is present now. Inactive Faults indicate a condition that is not presently active.

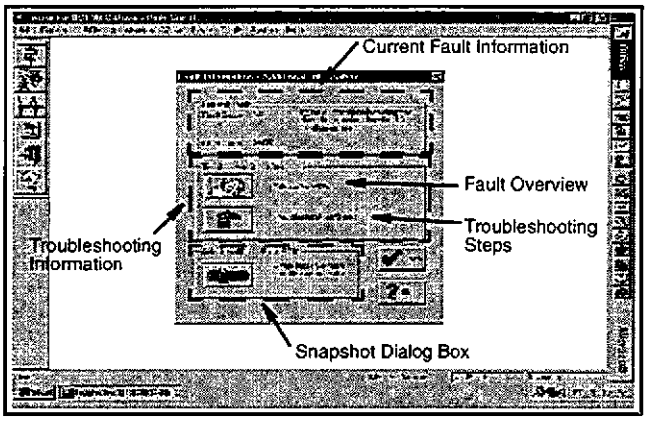
The Clear button erases all fault codes in the ECM. This button is **disabled** when the engine is running.



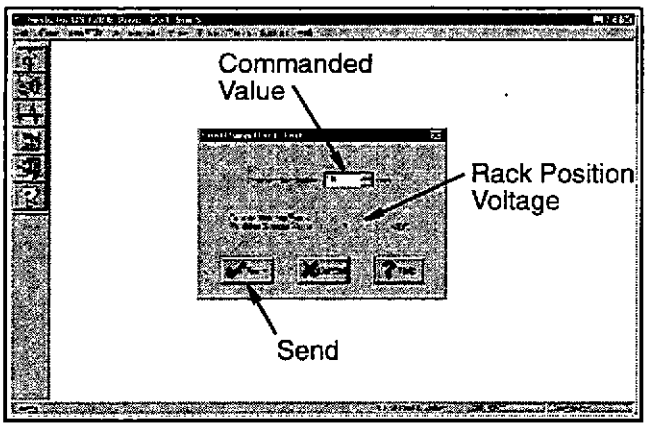


There are several dialog boxes associated with the Fault Information command:

- The **Fault Information** dialog box displays a summary list of fault data for an engine.
- The **Fault Information - Additional Information** dialog box allows selection of diagnostic information or more detailed fault data for display.



- The **Fault Overview** window describes each fault in detail.
- The **Troubleshooting Steps** window describe specific actions that can be taken to correct a fault.
- The **Snapshot** dialog box displays key engine sensor data and switch settings that were recorded at the first and last occurrence of each fault.



Tests (Fuel Pump Rack Test)

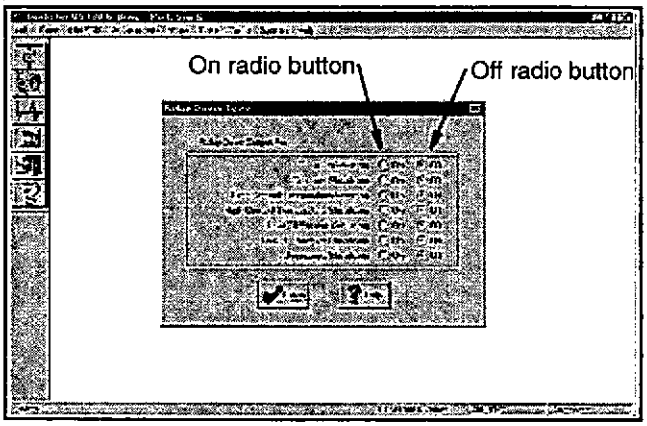
The Fuel Pump Rack Test command in the Tests menu allows testing of the fuel pump rack actuator circuits (both banks). This test can only be performed when the engine is **not** running.

This test allows positioning of the fuel pump racks between 0 and 20 mm of rack travel. For any position commanded, the test screen displays the voltage (VDC) which should be read on the rack position signal circuits in the engine harness diagnostic connector (pins B and C with respect to ground pin A). See Engine Harness Diagram on page 37.

Tests (Relay Driver Test)

The Relay Driver Test command in the Tests menu allows the available Relays and Relay Drivers to be toggled on or off. This test can be used for diagnostic testing of customer's fault indicator circuits. This test can also be used to help troubleshoot the ECM Relay contacts, ECM Relay Driver outputs, relays being driven, relay wiring and devices (lamps, alarms, etc.) being activated.

- Click the On radio button to energize an output for a parameter.
- Click the Off radio button to de-energize an output for a parameter.



Tests (Fault Simulation Test)

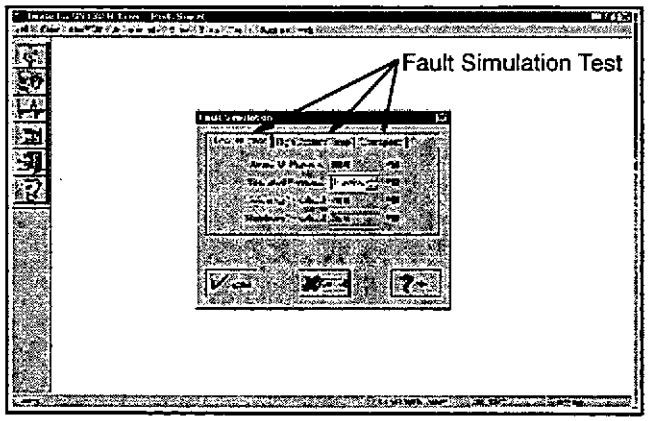
The Fault Simulation Test command in the Tests menu allows simulation of conditions in the engine that would cause faults. This is useful for testing and demonstrating proper operation of the engine protection system including sensors and ECM diagnostics.

There are three Fault Simulation Tests that can be performed while the engine **is** running:

- Low Oil Pressure Test
- High Coolant Temperature Test
- Engine Overspeed Test

⚠ CAUTION ⚠

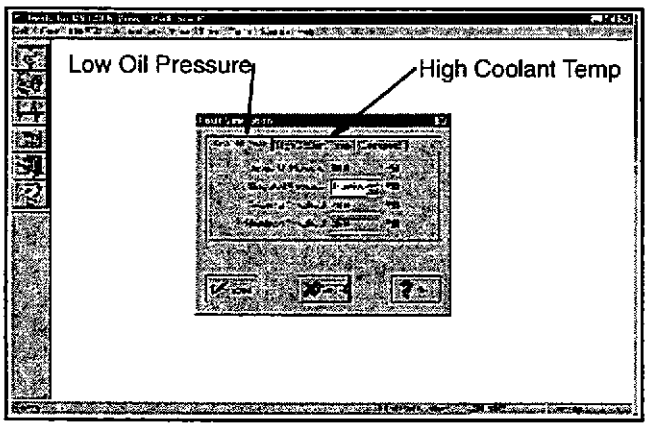
Fault Simulation tests should not be performed while the engine generator set is connected to any load or bus or equipment damage may result.

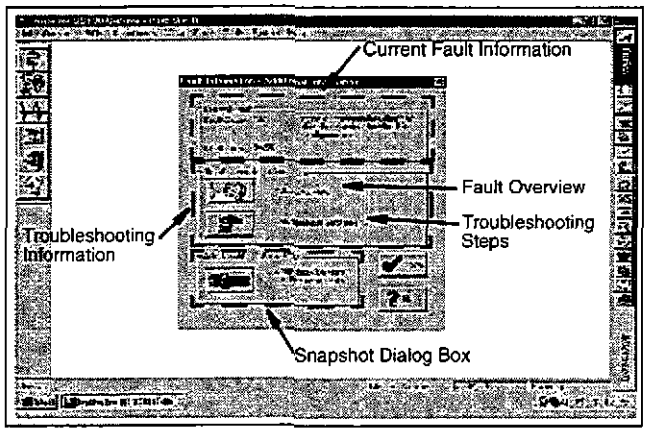


For Low Oil Pressure and High Coolant Temperature Fault Simulations, the engine's actual sensor outputs are temporarily overridden. To prevent the engine from being left in a defenseless condition (the ECM reading a safe condition during override instead of an actual condition), a timer cancels the Simulation Test after a 20 second time out. The timer is reset to 20 seconds after each adjustment to the simulated value. The timer is displayed in each dialog box when the Simulation is being run.

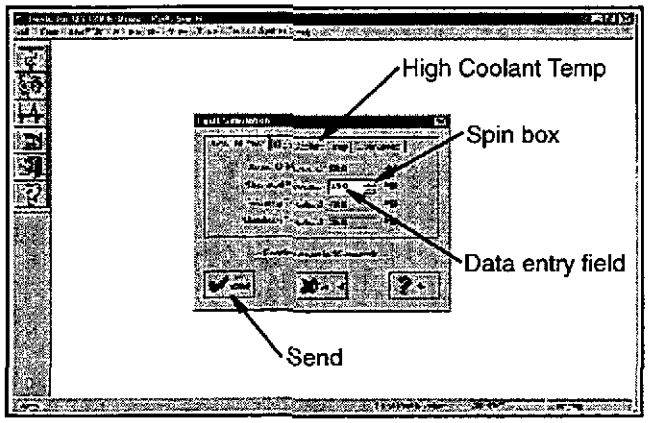
⚠ CAUTION ⚠

If the PC shuts down for any reason during Simulation, the engine must be powered off and restarted for the fault sensors to be reactivated.





After completing any Fault Simulation, use the Fault Information command in the View menu to check the results of the simulation. Fault Codes and associated Snapshot Data can be displayed.



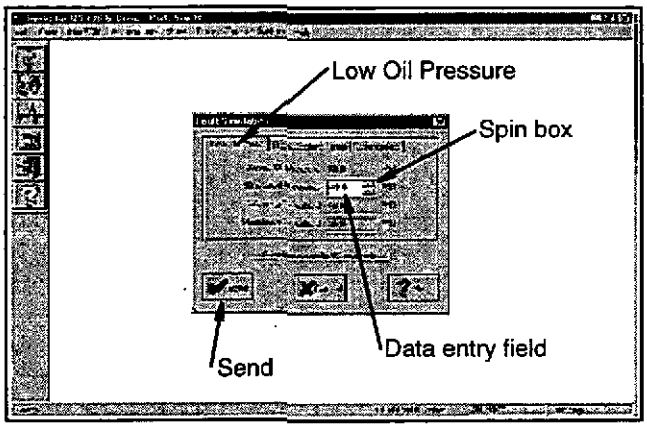
Fault Simulation Test - High Coolant Temperature

The High Coolant Temp tab dialog box under the Fault Simulation Test command allows simulating a High Coolant Temperature condition that would cause high coolant temperature faults. From this dialog box, the actual coolant temperature sensor input value to the ECM can be overridden by adjusting the Simulated Temperature value.

- Click the up or down arrow in the spin box to *change Simulated Temperature in one degree* increments,

or

- type the desired Simulated Temperature value in the data entry field then click the Send button to send the value to the ECM.



Fault Simulation Test - Low Oil Pressure

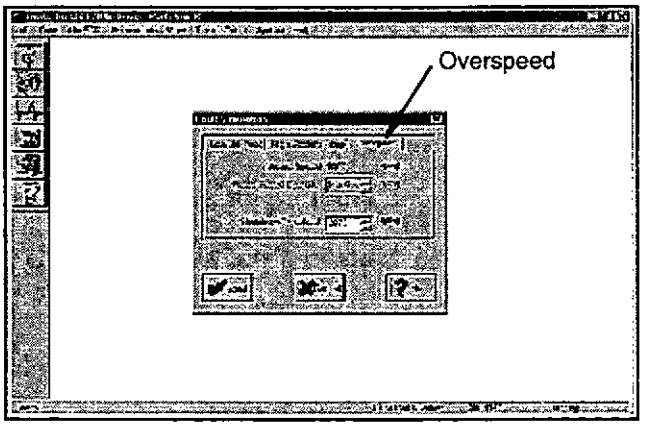
The Low Oil Press tab dialog box under the Fault Simulation Test command allows simulating of a Low Oil Pressure condition that would cause low oil pressure faults. From this dialog box, the actual oil pressure sensor input value to the ECM can be overridden by adjusting the Simulated Pressure value.

- Click the up or down arrow in the spin box to change Simulated Pressure in one PSI increments,

or

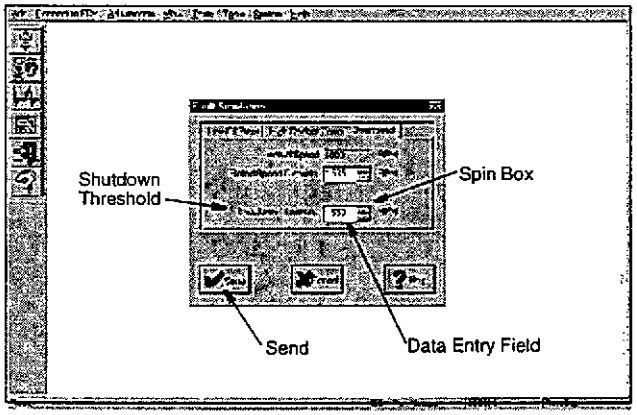
- type the desired Simulated Pressure value in the data entry field then click the Send button to send the value to the ECM.

Fault Simulation Test - Overspeed



The Overspeed tab dialog box under the Fault Simulation Test command allows creation of a safe Engine Overspeed condition that would cause an engine overspeed shutdown fault. From this dialog box, the Overspeed Shutdown Threshold can be temporarily changed to any desired value (within the Overspeed Shutdown adjustment range) and Rated Engine Speed can be overridden by adjusting the Rated Engine Speed Override value.

Note: Whenever acceptable, it is always desirable to perform overspeed shutdowns at a speed lower than the maximum Overspeed Shutdown Threshold, 2070 RPM, which is also the factory default value.

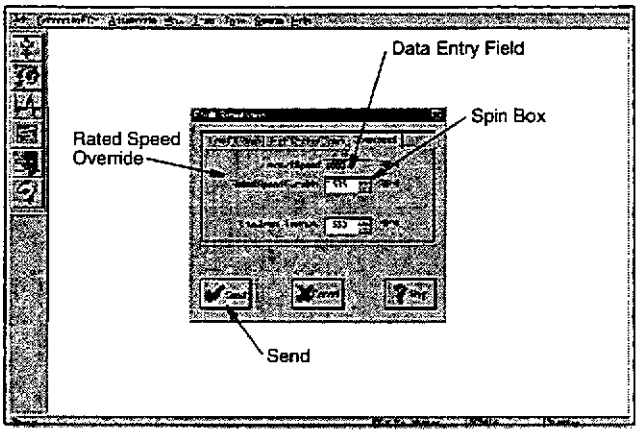


Adjust Shutdown Threshold:

- Click the up or down arrow in the spin box to change Shutdown Threshold in ten RPM increments,

or

- type the desired Shutdown Threshold value in the data entry field, Click the Send button to send the value to the ECM.



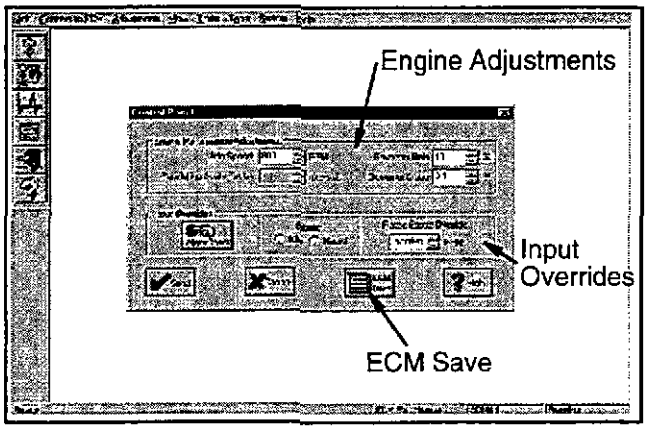
Adjust Rated Speed:

- Click the up or down arrow in the spin box to change Rated Speed Override in ten RPM increments,

or

- type the desired Rated Speed Override value in the data entry field then click the Send button to send the value to the ECM.

Note: When changing the Rated Speed Override commanded value, the audible change in engine speed may not be as smooth as the programmed ramp functions in the ECM. Service Tool commanded changes to Rated Engine Speed are governed from the service tool, not the ECM.

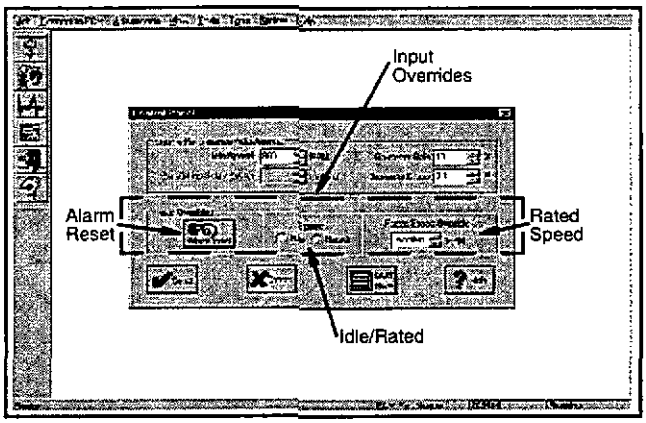


Tools (Control Panel)

The Control Panel command in the Tools menu allows control of a running engine directly from the INSITE™ QST30 G-Drive service tool. This is useful for either diagnostics or setting certain engine parameters while **running** versus changing parameters only when the engine **is not** running.

Engine Performance Adjustment parameters in the Control Panel screen can be permanently saved to the ECM using the ECM Save button.

Input Overrides allow for control of switched inputs from the service tool (Alarm Reset and Idle/Rated) and direct control of Rated Engine Speed (1000-2070 RPM).



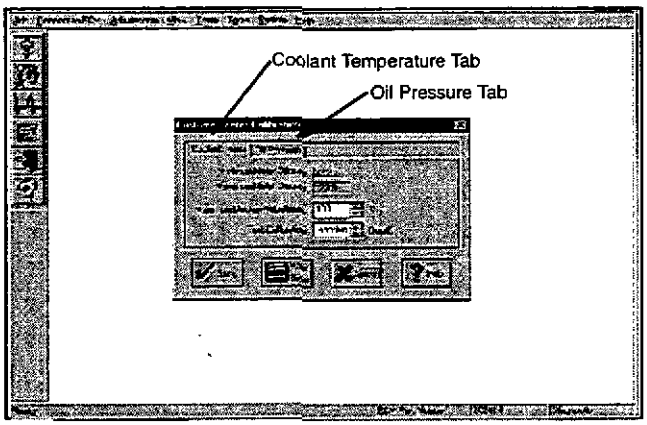
⚠ CAUTION ⚠

The Idle/Rated switching and Rated Speed Override control should only be used while the engine generator set is not connected to any load or bus, otherwise engine damage may result.

Note: When the Control Panel screen is exited, control will return to the external control inputs.

Note: When changing the Rated Speed Override commanded value, the audible change in engine speed may not be as smooth as the programmed ramp functions in the ECM. Service Tool commanded changes to Rated Engine Speed are governed from the service tool, not the ECM.

Tools (Meter Calibration)



The Meter Calibration command in the Tools menu allows proper setting of customer meter displays and verifying their correct functioning.

There are two meter calibrations that can be performed from the Meter Calibration command while the engine is **not** running:

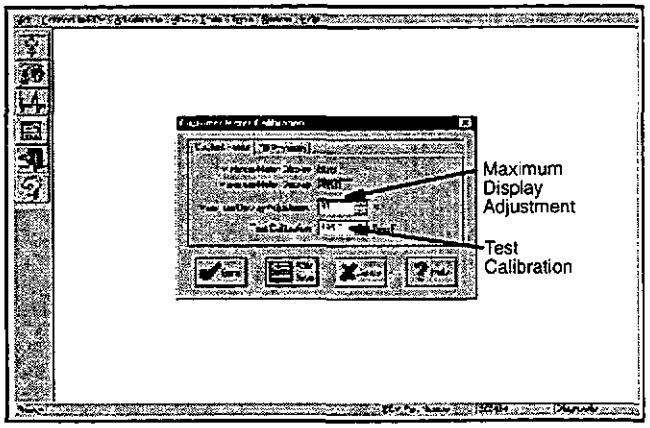
- Coolant Temperature
- Oil Pressure

Note: The engine must be shut down to perform these calibrations as sensor inputs are temporarily overridden. If allowed while the engine was running, improper functioning of the engine protection feature could result.

Meter Calibration - Coolant Temperature

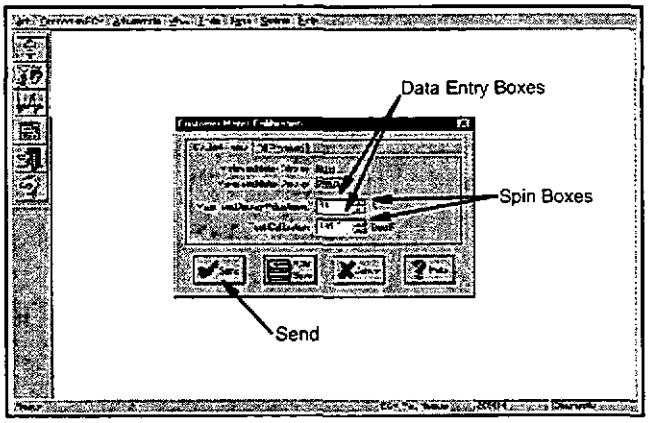
The Coolant Temp tab dialog box (under the Meter Calibration command) allows setting of a customer Coolant Temperature Meter display and is used to verify correct meter functioning.

The Maximum Display Adjustment field (meter driver % duty cycle) allows adjustment of the customer's Coolant Temperature meter for calibration. The Test Calibration field inputs a desired Coolant Temperature override signal in place of the sensor input.



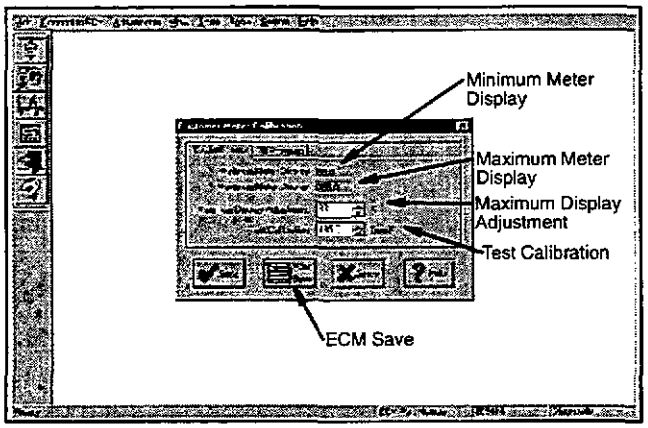
To change parameter settings:

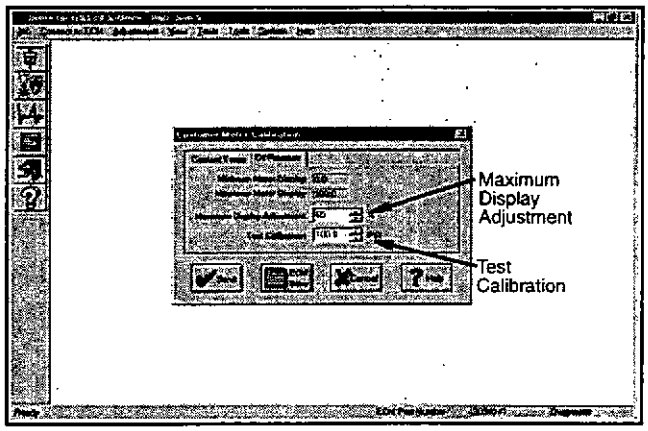
- Type values in the data entry boxes or click the up or down arrow in the spin boxes. Click the Send button to send the value to the ECM.



To calibrate the customer Coolant Temperature Meter:

- Ensure that the Minimum and Maximum Meter Display values are correct.
- Enter a Test Calibration value for the highest meter accuracy desired (e.g. 90.6° C [195 F]).
- If required, adjust the Maximum Display Adjustment value until the customer's meter display matches the Test Calibration value (e.g. if the meter reads too high a value, lower the percent duty cycle).
- If adjustment of the Maximum Display Adjustment was required to improve meter accuracy, save the most accurate percent duty cycle to the ECM by clicking the ECM Save button.

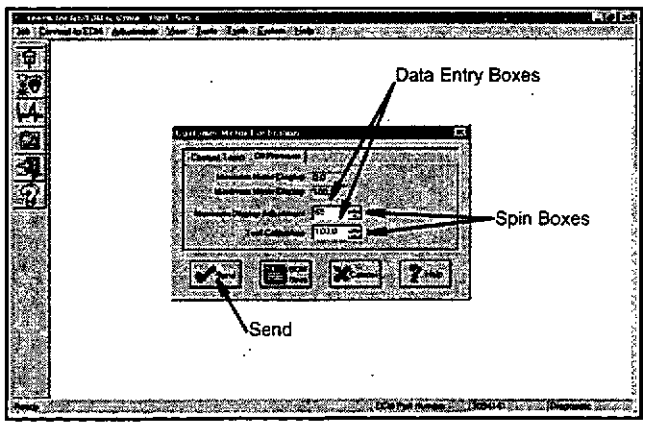




Meter Calibration - Oil Pressure

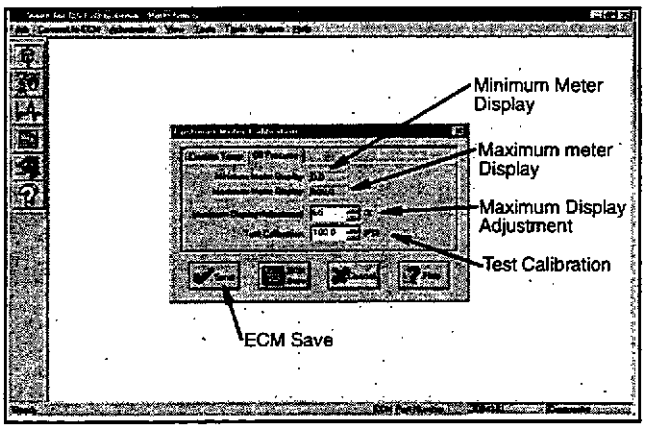
The Oil Pressure tab dialog box (under the Meter Calibration command) allows setting of a customer Oil Pressure Meter display and is used to verify correct meter functioning.

The Maximum Display Adjustment field (meter driver % duty cycle) allows adjustment of the customer's Oil Pressure meter for calibration. The Test Calibration field inputs a desired Oil Pressure override signal in place of the sensor input.



To change parameter settings:

- Type values in the data entry boxes or click the up or down arrow in the spin boxes. Click the Send button to send the value to the ECM.



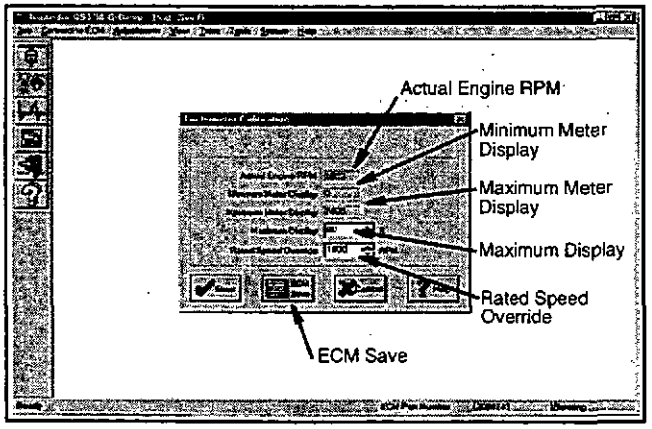
To Calibrate the customer Oil Pressure Meter:

- Check that the Minimum and Maximum Meter Display values are correct.
- Enter a Test Calibration value where the highest meter accuracy is desired (e.g. 414 kPa [60 PSI]).
- If required, adjust the Maximum Display Adjustment value until the customer's meter display matches the Test Calibration value (e.g. if the meter display reads too high a value, lower the percent duty cycle).
- If adjustment of the Maximum Display Adjustment was required to improve meter accuracy, save the most accurate percent duty cycle to the ECM by clicking the ECM Save button.

Tools (Tachometer Calibration)

The Tachometer Calibration command in the Tool menu allows for the setting of a customer Tachometer display and verifying its correct functioning. Calibration of the customer's tachometer is performed while the engine is **running** with the settings verified by varying Rated Engine Speed (1000-2070 RPM).

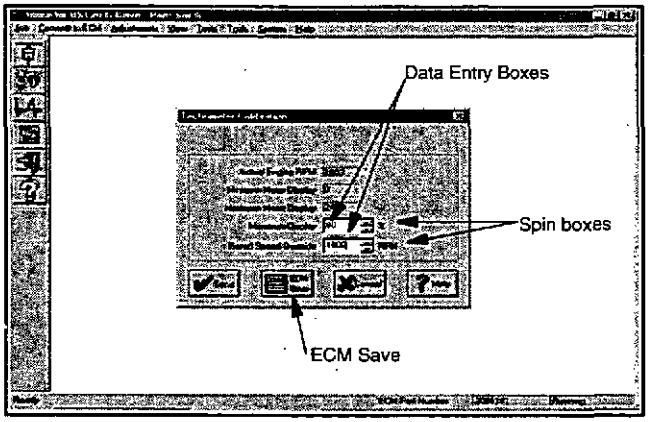
The Maximum Display field (meter driver % duty cycle) allows adjustment of the customer's Tachometer. for calibration. The Rated Speed Override field adjusts actual engine speed for meter accuracy verification.



To change parameter settings:

- Type values into the data entry boxes or click the up or down arrow in the spin boxes then click the Send button to send the value to the ECM.

Note: When changing the Rated Speed Override commanded value, the audible change in engine speed may not be as smooth as the program ramp functions in the ECM. During Service Tool commanded changes to Rated Engine Speed, speed ramping is governed from the Service Tool, not the ECM.

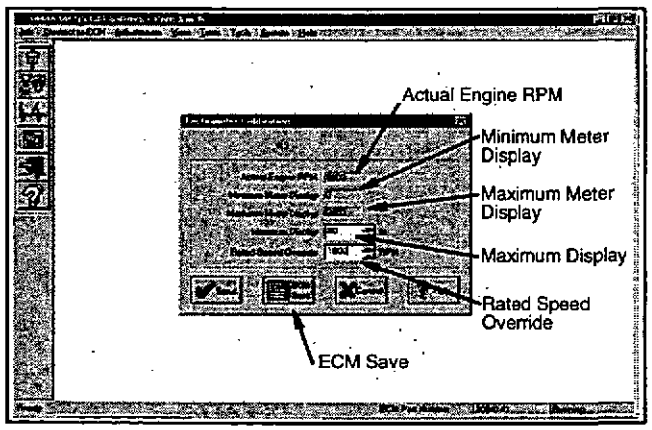


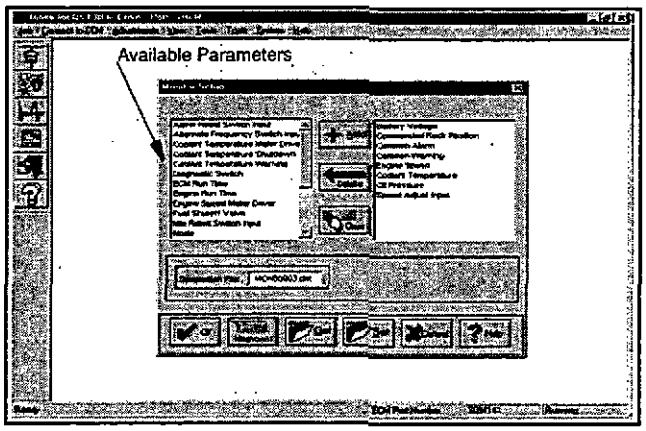
⚠ CAUTION ⚠

Rated Speed Override control should only be used while the engine generator set is not connected to any load bus or equipment damage may result.

To calibrate the Customer Tachometer:

- Check the Minimum and Maximum Meter Display values are correct.
- Enter a Rated Speed Override value where the highest meter accuracy is desired (e.g. 1500 or 1800 RPM).
- If required, adjust the maximum Display value until the customer's meter display matched the Actual Engine RPM value (e.g. if the meter reads too high a value, lower the percent duty cycle).
- If adjustment of the Maximum Display was required to improve meter accuracy, save the most accurate percent duty cycle to the ECM by clicking the ECM Save button.

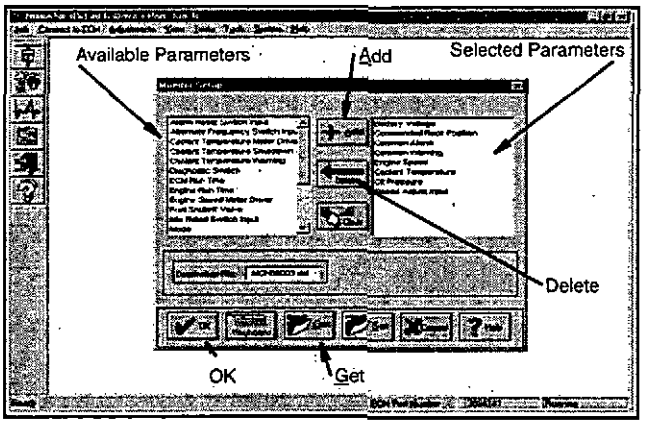




Tools (Monitor)

The Monitor command in the Tools menu allows the viewing of data for up to **sixteen** specific engine parameters of a running engine.

For a **listing of all Monitor Parameters**, see the Monitor and Data Logger Parameters Listing on page 60.



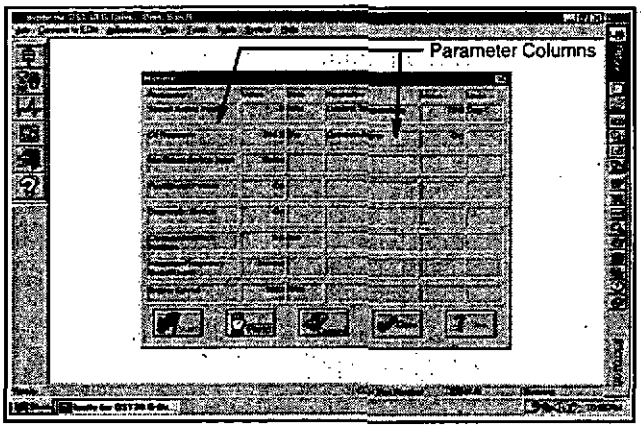
To specify a group of parameters to Monitor:

- **To add a parameter**, double click, or single click to highlight the parameter then click the Add button, on each desired parameter in the Available Parameters box,

  or

  retrieve a desired Monitor setup file using the Get button and selecting the desired file.

- **To delete a parameter**, double click, or single click to highlight then click the Delete button, on each non-desired parameter in the Selected Parameters box.

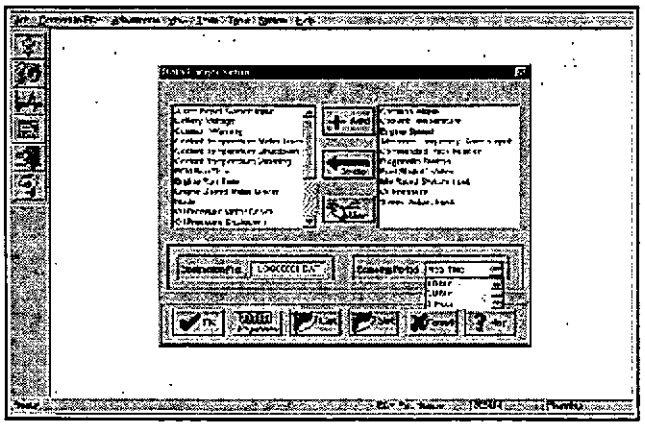


To begin Data Monitoring:

- Specify which engine parameters are to be Monitored.
- Click the OK button at the bottom of the Monitor Setup screen.

Note: To create Log setup files or to capture monitored data to a log file, see the INSITE™ QST30-G-Drive User's Manual (Bulletin No. 3666196).

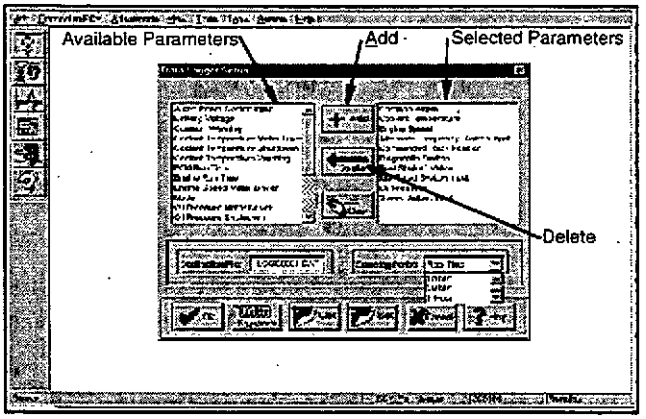
Tools (Data Logger)



The Data Logger command in the Tools menu allows the saving of up to **sixteen** specific engine parameters of a running engine to a data file. This data can be used to troubleshoot engine problems by isolating and analyzing specific operating parameters over time.

Available engine parameters for Data Logging are the same as those available in the Monitor command. For a **listing of all Data Logger Parameters**, see the Monitor and Data Logger Parameters Listing on page 60.

To specify a group of parameters to Data Log:



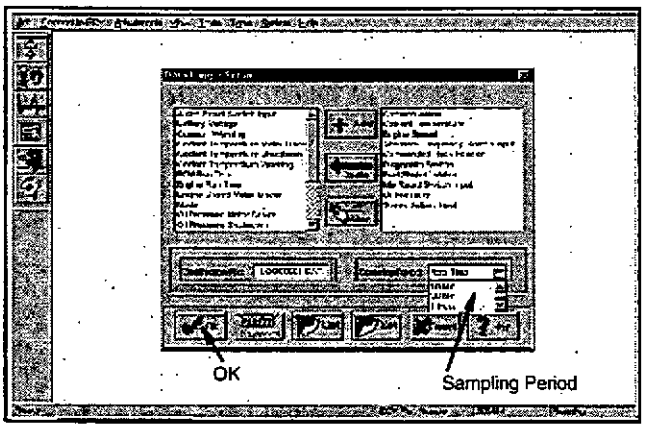
- **To add a parameter,** double click, or single click to highlight then click the Add button, on each desired parameter in the Available Parameters box,

  or

  retrieve a desired Log setup file using the Get button and selecting the desired file.

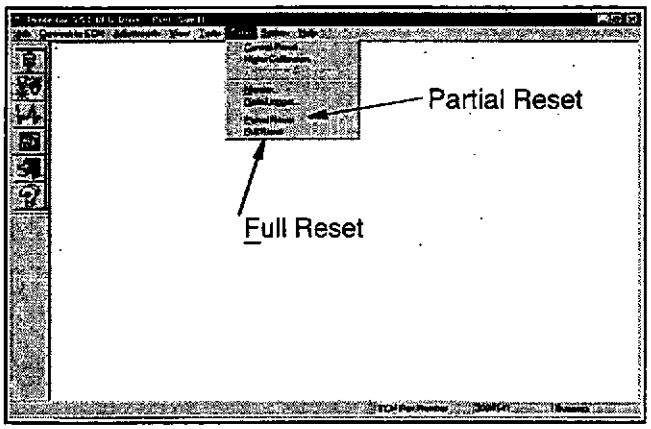
- **To delete a parameter**, double click, or single click to highlight then click the Delete button, on each non-desired parameter in the Selected Parameters box.

To begin Data Logging:



- Specify which engine parameters are to be Data Logged.
- Specify the desired Sampling Period (real time up to one hour) in the Sampling Period drop down box in the Data Logger Setup screen.
- Click the OK button in the Data Logger Setup screen.
- Add any desired comments then click the Start button in the Data Logger screen.

Note: To create Log setup files, see the INSITE™ QST30 G-Drive User's Manual (Bulletin No. 3666196).

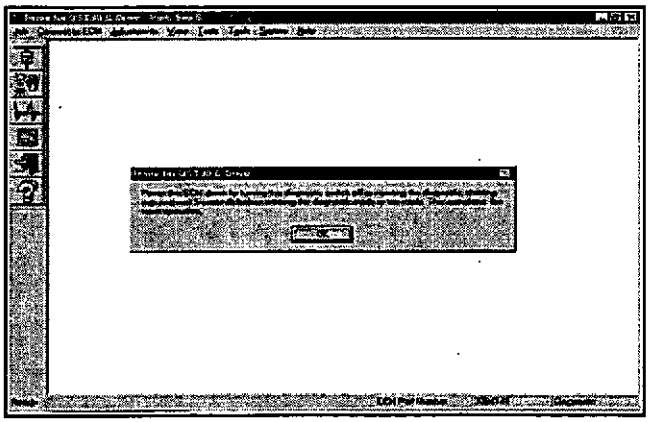


Tools (Partial and Full Reset)

The Partial Reset command in the Tools menu allows the resetting of features and functions in the ECM that **do not** affect customer-defined parameter settings (a Partial Reset **does not** erase any customer adjusted parameter settings).

The Full Reset command in the Tools menu allows the resetting of **all** features and functions in the ECM to their **default** settings (a Full Reset returns the ECM to its original factory settings and **does** erase all customer adjusted parameter settings).

Partial or Full Resets can only be performed while the engine is **not** running.

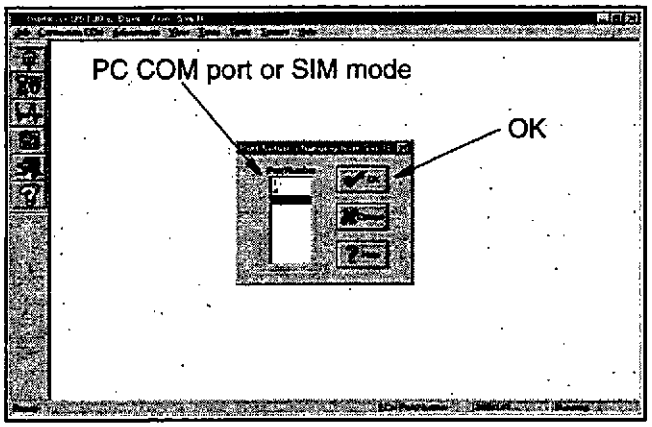


After selecting either Reset command, power to the ECM must be removed and then restored for the reset to take effect.

⚠ CAUTION ⚠

The Full Reset command erases all customer-defined settings from the ECM, such as parameter adjustments and meter calibrations.

Note: Partial or Full Resets should not be performed unless it is recommended by either the Fault Information (Troubleshooting) System in the Service Tool or the Fuel System Troubleshooting and Repair Manual.



System (User Options...)

The User Options command in the System menu allows the setting of the Communication Port on the Service Tool's PC or to place the Service Tool in a simulator mode. Simulator modes are provided to use and demonstrate INSITE™ QST30 G-Drive without being attached to an ECM.

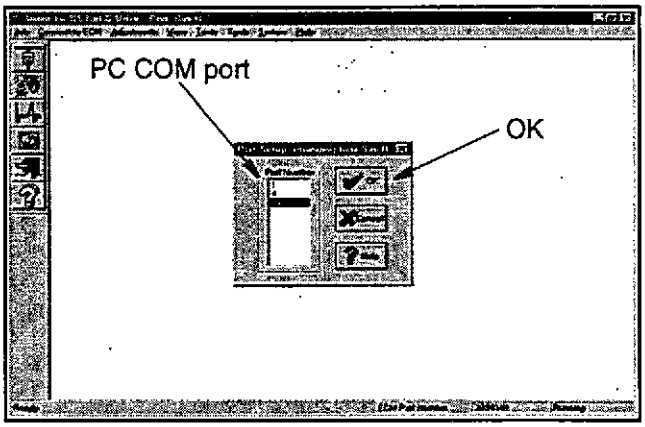
Selections available in the Port Setup dialog box (under User Options):

- Numerical selections (PC COM port numbers)
- Sim S (engine Shutdown/Diagnostic Simulator mode)
- Sim R (engine Run Simulator mode)

To select a COM port setting or Simulator mode:

- In the Port Setup dialog box, double click, or single click to highlight then click the OK button, on the desired COM port number or mode of simulation listed.

The selected setting or mode will activate immediately.

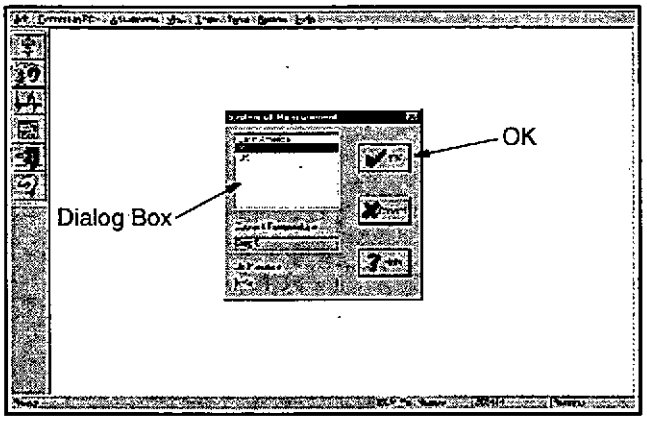


System (Units of Measure...)

The Units of Measure command in the System menu allows specifying desired measurement units for Coolant Temperature and Oil Pressure.

Selections available in the System of Measurement dialog box (under Units of Measure):

- Latin America (psi and Deg. C)
- Metric (kPa and Deg. C)
- US (psi and Deg. F)

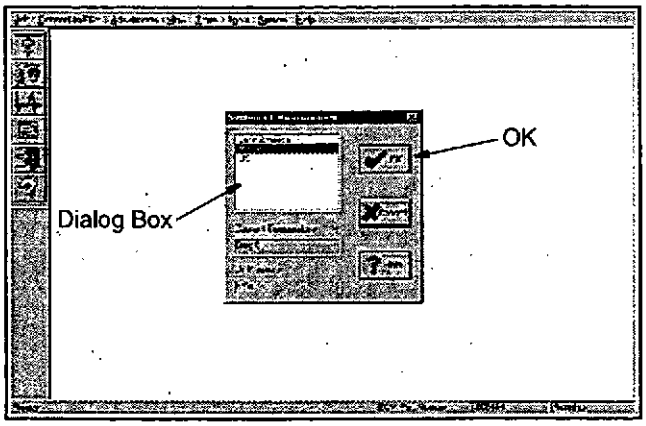


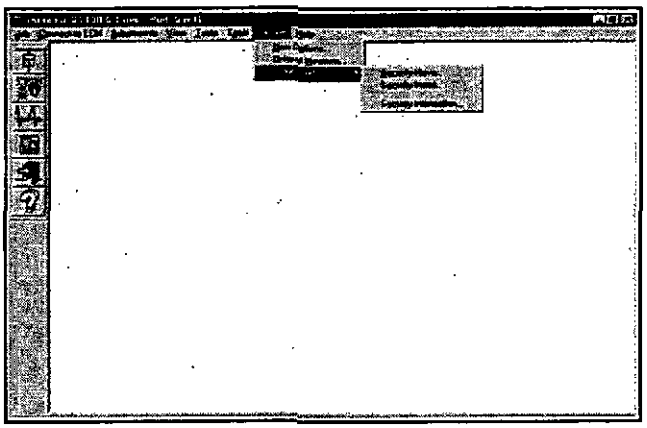
The measurement system that is highlighted when the System of Measurement dialog box is first opened under the Units of Measure command is the measurement system that is currently active.

To select a measurement system:

- In the System of Measurement dialog box, double click, or single click to highlight then click the OK button, on the desired measurement system listed.

The selected measurement system will activate immediately.



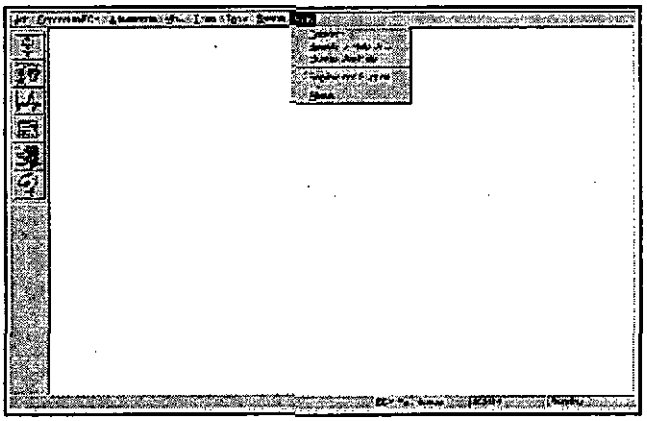


System (Administrator)

The Administrator submenu on the System menu allows moving, installing or viewing Security information for the Service Tool.

Administrator commands:

- The **Security Move** command moves the security key **to** or **from** the Service Tool's PC hard drive.
- The **Security Install** command installs a security key after the Service Tool has already been installed on the PC.
- The **Security Information** command identifies the location and serial number of the security key.



Help

The Help menu provides information about how to work with INSITE™ QST30 G-Drive.

Help commands:

- The **Contents** command displays the Table of Contents of the INSITE™ QST30 G-Drive Help System.
- The **Search for Help On** command allows selected keyword searches and displays related topics.
- The **How to Use Help** command provides instructions on how to use a Windows® Help system.
- The **Service and Support** command displays pertinent telephone numbers and addresses to obtain assistance and information about using INSITE™ QST30 G-Drive.
- The **About** command displays identifying information (serial and version numbers) about that particular INSITE™ QST30 G-Drive tool.

Adjustable Parameters Listing

Parameter	Range/Selections	Default Value
Alternate Frequency Switch Setting	50 Hz, Alt=60 Hz 60 Hz, Alt=50 HZ Always 50 Hz or Always 60 Hz	60 Hz, Alt=50 Hz
Barber-Colman Scale Factor	500 to 2000 rpm/volt	1100 rpm/volt
Coolant Temp. Warning Threshold	-18 to 124 °C [0 to 255 °F]	97.2 °C [207 °F]
Engine Offset Time	0 to 9,999,999 Hours	0 Hours
Governor Droop	0 to 10%	0% (Isochronous)
Governor Gain Adjust	1 to 100%	10%
Idle Speed	700 to 900 rpm	800 rpm
Meter Coolant Temp. Max. Duty Cycle	0 to 100%	100%
Meter Engine RPM Max. Duty Cycle	0 to 100%	100%
Meter Maximum Engine RPM	0 to 2400 rpm	2400 rpm
Meter Maximum Oil Pressure	0 to 689.5 kPa [0 to 100 psi]	689.5 kPa [100 psi]
Meter Maximum Temperature	-18 to 124 °C [0 to 255 °F]	124 °C [255 °F]
Meter Minimum Engine RPM	0 to 2400 rpm	0 rpm
Meter Minimum Oil Pressure	0 to 689.5 kPa [0 to 100 psi]	0 kPa [0 psi]
Meter Minimum Temperature	-18 to 124 °C [0 to 255 °F]	-18 °C [20 °F]
Meter Oil Press. Max. Duty Cycle	0 to 100%	100%
Oil Press. Warn. Threshold at Idle	0 to 689.5 kPa [0 to 100 psi]	103.4 kPa [15 psi]
Oil Press. Warn Threshold at Rated	0 to 689.5 kPa [0 to 100 psi]	275.8 kPa [40 psi]
Overspeed Shutdown RPM	1000 to 2070 rpm	2070 rpm
Ramp Time (Crank to Rated)	(See Table of Ramp Times)	0
Ramp Time (Idle to Rated)	(See Table of Ramp Times)	0
Speed Adjust Knob	Enabled or Disabled	Disabled
Speed Bias Input Type	Barber-Colman Woodward or Disabled	Disabled
Torque Curve Adjustment	0.0 to +1.0%	0%
Woodward Scale Factor	20 to 60 rpm/volt	36 rpm/volt

Default Values are factory set trims (calibrations) programmed into all ECMs and are the parameter settings when the customer receives the ECM (unless the customer's local ABO informs of local resetting of specific parameters).

Default Values may vary from the above set trims for reasons of specific engine rating or market requirements (example: Alternate Frequency Switch setting which determines engine run speed).

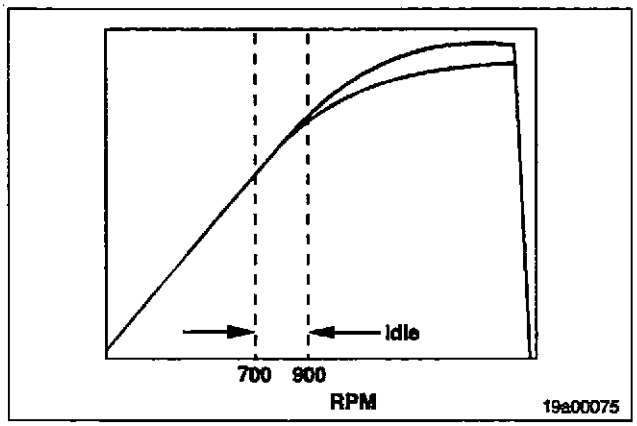
For additional engine specific **Default Value** information, consult the Customer Interface Software (DO) option section of the Sales Handbook.

Monitor and Data Logger Parameters Listing

Parameter	Value
Alarm Reset Switch Input	Either depressed (On) or released (Off)
Alternate Frequency Switch Input	Either Normal or Alternate
Barber-Colman Speed Bias	± RPM speed bias offset (from Barber-Colman controls)
Battery Voltage	Un-switched battery supply to ECM
Commanded Rack Position	Fuel rack position (mm) commanded by ECM
Common Alarm	Relay status: On or Off
Common Warning	Relay status: On or Off
Coolant Temperature	Value read from the ECM
Coolant Temperature Meter Driver	Percent (%) duty cycle
Coolant Temperature Shutdown	Relay Driver status: On or Off
Coolant Temperature Warning	Relay Driver status: On or Off
Diagnostic Switch	Either Diagnostic mode (On) or Running mode (Off)
ECM Run Time	Total ECM power up time read from the ECM (in hours:minutes)
Engine Run Time	Value read from the ECM (in hours:minutes)
Engine Speed	Value read from the ECM
Engine Speed Meter Driver	Percent (%) duty cycle
Fuel Shutoff Valve	Shutoff valves commanded status: On or Off
Idle Rated Switch Input	Either Idle or rated
Mode	The current operating state (Diagnostic or Run)
Oil Pressure	Value read from the ECM
Oil Pressure Meter Driver	Percent (%) duty cycle
Oil Pressure Shutdown	Relay Driver status: On or Off
Oil Pressure Warning	Relay Driver status: On or Off
Overspeed Shutdown	Relay Driver Status: On or Off
Run Stop Switch Input	Either Run or Stop
Speed Adjust Input	± RPM speed bias offset (from speed adjust potentiometer)
Speed Adjust Knob	Either Enable or Disable (for speed adjust potentiometer)
Speed Bias Input Type	Either Barber-Colman, Woodward, or Disabled
Version Number	ECM software version number
Woodward Speed Bias	± RPM speed bias offset (from Woodward controls)

Up to sixteen of the above engine and ECM parameters may be Monitored or Data Logged via the INSITE™ QST30 G-Drive electronic service tool.

System Adjustments



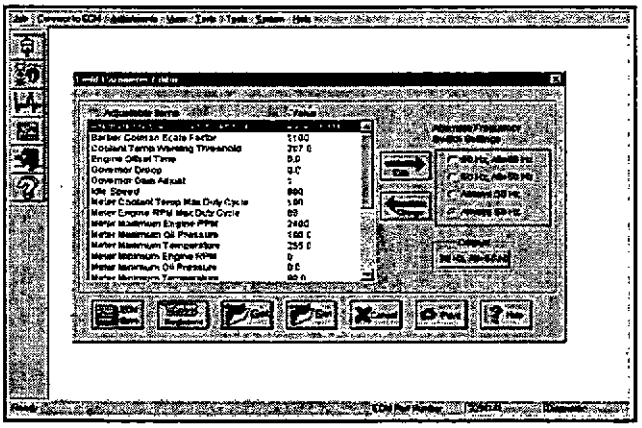
Idle Speed

Idle speed is adjustable between 700 and 900 RPM using the INSITE™ QST30 G-Drive electronic service tool. Refer to the following sections to adjust Idle Speed:

- Adjustments (Features and Parameters) on page 45.
- Tools (Control Panel) on Page 50.

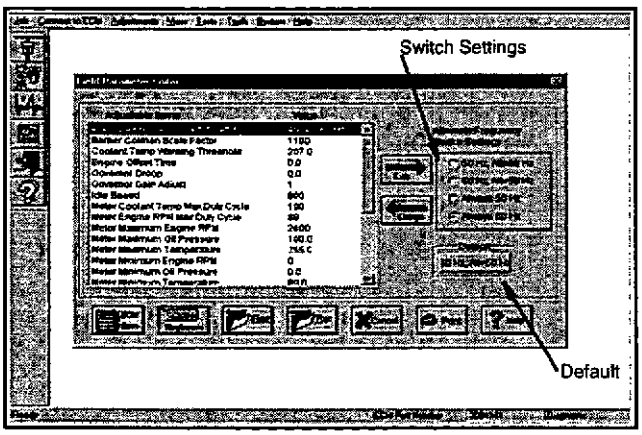
The factory **default setting** for the Idle Speed is **800 RPM**.

Rated Speed Selection



The selection of Rated Speed RPM (1500 or 1800 RPM) is made using the INSITE™ QST30 G-Drive electronic service tool. Refer to the Electronic Service Tool Adjustments (Features and Parameters) section on page 45 to select desired Rated Speed.

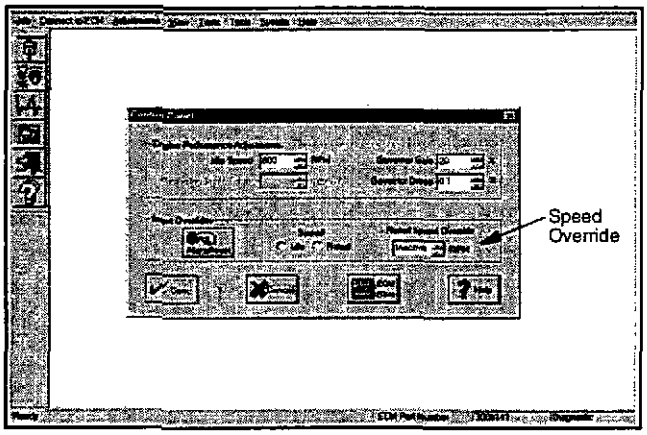
The Alternate Frequency Switch Setting (under the Features and Parameters command) determines what frequency/RPM will be Primary and which will be Alternate when used with a customer supplied Alternate Frequency Switch (see 50/60 HZ Operation). When no Alternate Frequency Switch is used, the ECM will govern Rated Speed at the Primary setting.



Available Alternate Frequency Switch Setting selections:

- 50 HZ (Primary), Alt=60 HZ
- 60 HZ (Primary), Alt=50 HZ
- Always 50 HZ
- Always 60 HZ

Consult the Customer Interface Software (DO) option section of the Sales Hand Book for the factory Alternate Frequency switch **default setting**.

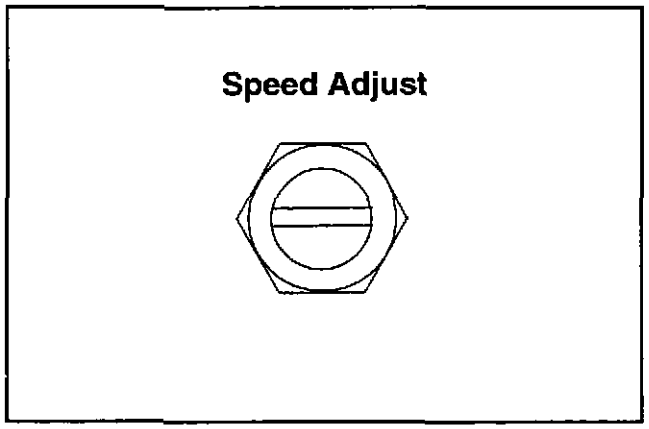


Rated Speed Adjustment

Rated Speed (Run speed) is non-adjustable (1500 or 1800 ± 0 RPM) except with the use of a customer supplied Remote Speed Adjust potentiometer (see Remote Speed Adjust) while in normal operation.

Temporary Rated Speed adjustments can be made with the INSITE™ QST30 G-Drive service tool for troubleshooting and test purposes. Refer to the following sections if temporary adjustments to Rated Speed are required:

- Fault Simulation - Overspeed on page 49.
- Tools (Control Panel) on page 50.
- Tools (Tachometer Calibration) on page 53.

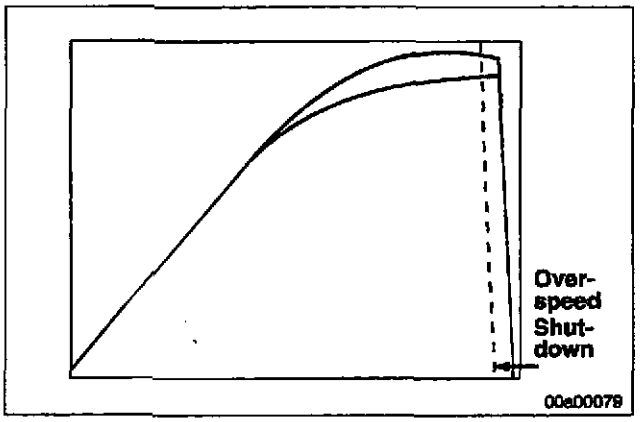


Remote Speed Adjustment

A customer supplied 5,000 ohm potentiometer provides for ± 6% adjustment around selected engine Run Speed. Refer to the Customer Wiring Remote Speed Adjust Potentiometer section on page 39 for proper wiring of a remote speed adjust potentiometer.

Note: The ECM must be calibrated to recognize if a remote speed adjust potentiometer is being utilized (Speed Adjust Knob **Enabled**).

The factory **default setting** for Speed Adjust Knob is **Disabled.**



Overspeed Shutdown RPM Setpoint

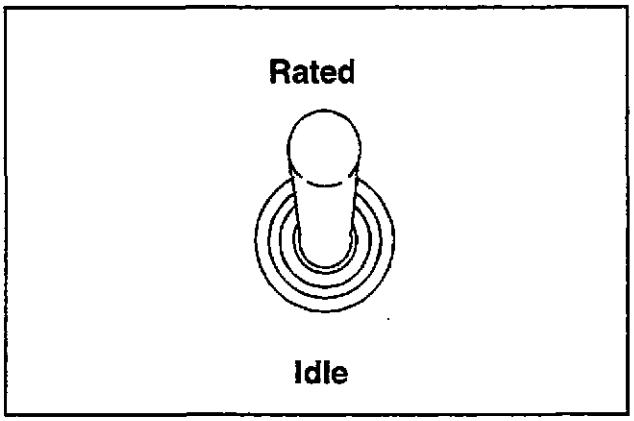
The Overspeed Shutdown RPM setpoint is adjustable between 1000 and 2070 RPM using the INSITE™ QST30 G-Drive electronic service tool. Refer to the following sections to adjust the Overspeed Shutdown setpoint, if required:

- Adjustments (Features and Parameters) on page 45.
- Fault Simulation - Overspeed on page 49.

The factory **default setting** for engine Overspeed Shutdown RPM is **2070 RPM.**

Idle/Rated Selection

A customer supplied Idle/Rated switch allows the selection of Idle or Rated speed mode. Refer to the Customer Wiring Idle/Rated Speed Switch section on page 39 for proper wiring of an Idle/Rated switch.

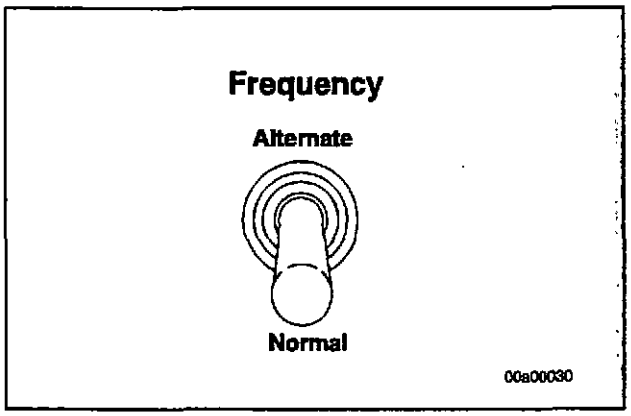


50/60 HZ Operation

A customer supplied Alternate Frequency Switch allows the selecting of 50 or 60 HZ Rated Speed operation without requiring an electronic service tool recalibration. Refer to the Customer Wiring Alternate Frequency Switching section on page 39 for proper wiring of an Alternate Frequency switch.

The Alternate Frequency Switch selects either the Primary or Alternate frequency/RPM the ECM is to govern at (see Rated Speed Selection).

Consult the Customer Interface Software (DO) option section of the Sales Hand Book for the factory Alternate Frequency switch **default setting**.

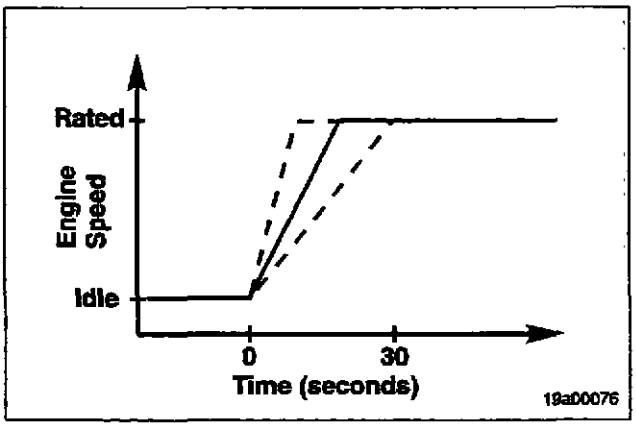


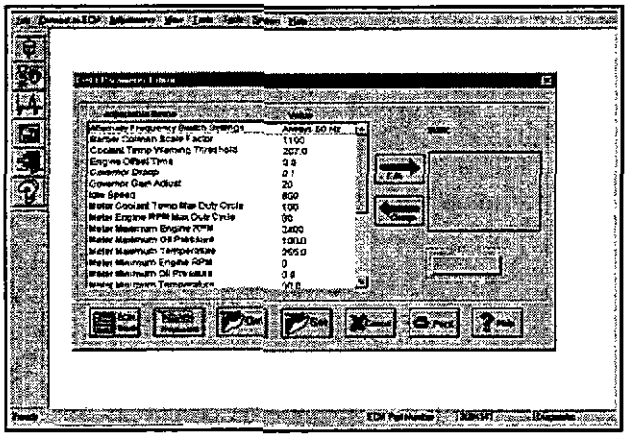
Speed Ramp Adjustments

The ECM provides for two speed ramp functions that are adjustable using the INSITE™ QST30 G-Drive electronic service tool:

- Ramp Time (Crank-to-Rated)
- Ramp Time (Idle-to-Rated)

Ramp Time (Crank-to-Rated) provides for speed ramping between Cranking and Rated speeds and Ramp Time (Idle-to-Rated) provides for speed ramping between Idle and Rated speeds.

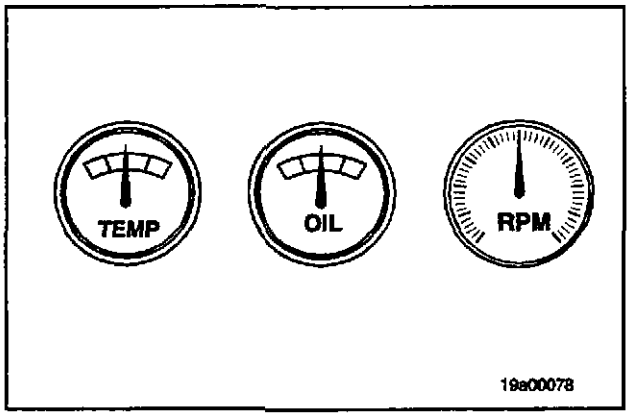




Refer to the Electronic Service Tool Adjustments (Features and Parameters) section on page 49 to select desired Ramp Times.

Note: Ramp times (in seconds) are dependent on Idle and Rated speed settings. Desired ramp times are selected by choosing Ramp #'s, **not** ramp times directly. Refer to the Table of Ramp Times on page 68 for ramp times (in seconds) based on RAMP # selections.

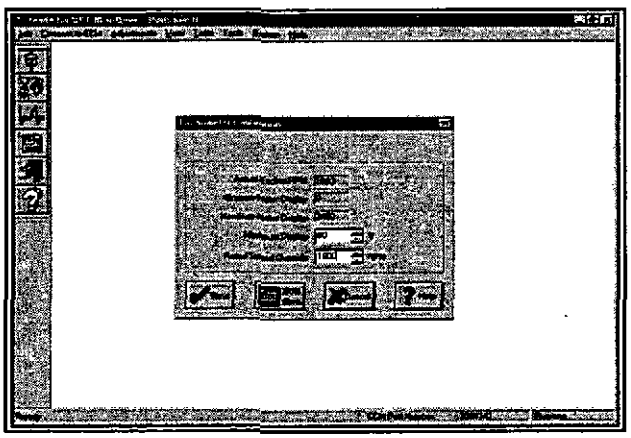
The factory **default setting** for both Ramp Times is Ramp # = **0**.



Meter Driver Calibrations

Meter Driver Duty Cycle is adjustable for the calibration of the following customer supplied meters (0-1 mA rated) using the INSITE™ QST30 G-Drive electronic service tool:

- Engine Coolant Temperature
- Engine Oil Pressure
- Engine Speed



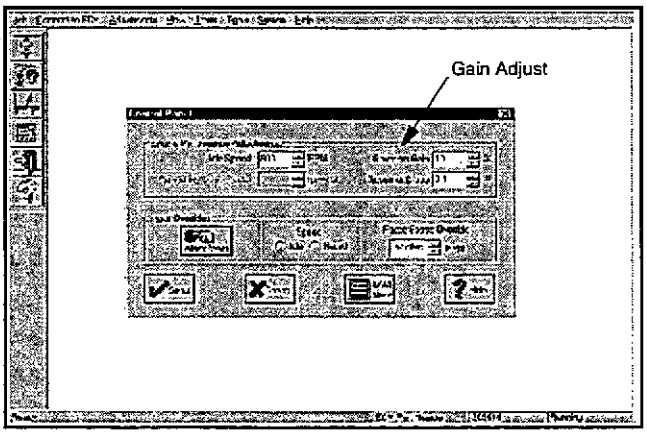
Refer to the following sections for proper Meter Driver Duty Cycle adjustments:

- Meter Calibration - Coolant Temp on page 51
- Meter Calibration - Oil Pressure on page 52
- Tools (Tachometer Calibration) on page 53

Governor Gain Adjustment

Governor Gain is adjustable between 1 and 100% using the INSITE™ QST30 G-Drive electronic service tool.

Typical QST30 engine-generator combinations will not require adjustments to the Governor Gain setting as both 1500 and 1800 RPM generator sets ordinarily exhibit satisfactory steady state stability and acceptable transient performance with the Gain value as set from the factory.

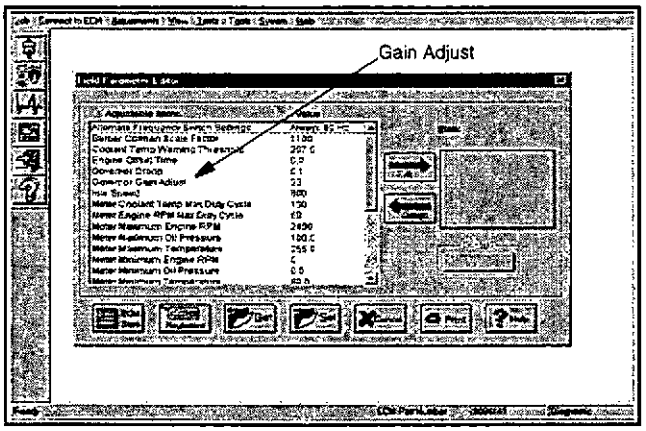


If required, refer to the following sections to adjust Governor Gain:

- Adjustment (Features and Parameters) on page 45
- Tools (Control Panel) on page 50

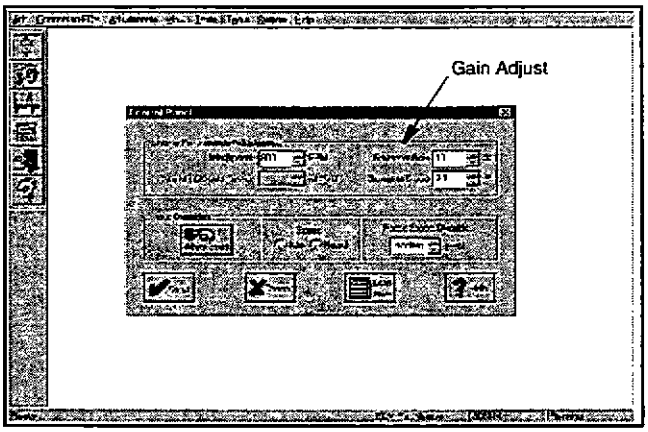
The factory **default setting** for Governor Gain Adjust is **10%**.

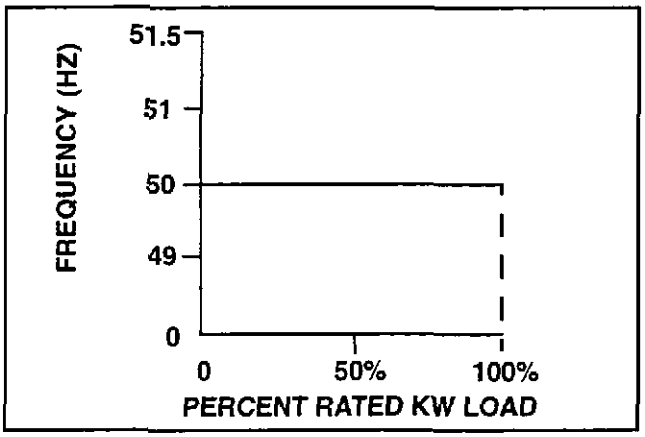
Note: Governor Gain Adjust settings of <3% may result in engine stall when started in Idle mode.



⚠ CAUTION ⚠

It takes a few seconds to initiate each service tool Gain adjustment. It is recommended that any increases in the Governor Gain setting be made in increments not exceeding 3% to prevent prolonged periods of unwanted instability.





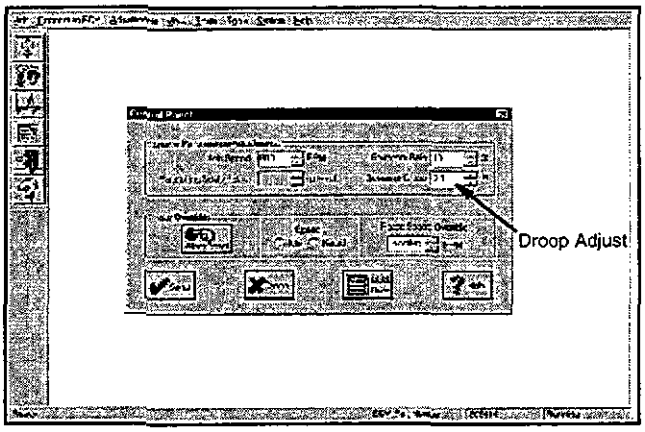
Governor Speed Droop Adjustment - Isochronous Mode

For Isochronous Speed operation, the Governor Droop setting needs to be set at zero (0)%.

The factory **default setting** for Governor Droop is **0%.**

If required, the Governor Droop setting can be adjusted using the INSITE™ QST30 G-Drive electronic service tool. Refer to the following sections to adjust *Governor Droop*:

- Adjustments (Features and Parameters) on page 45
- Tools (Control Panel) on page 50

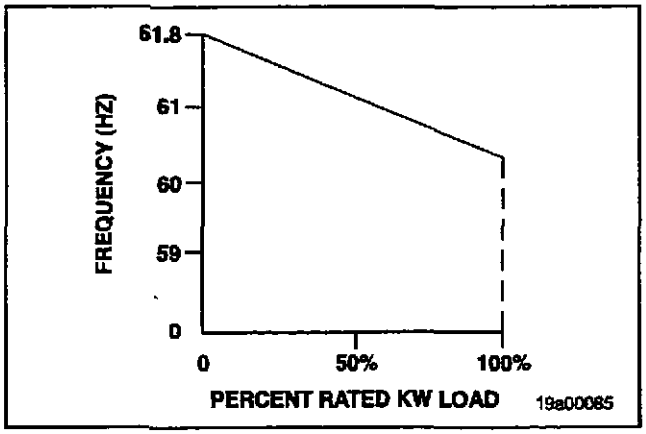


Governor Speed Droop Adjustment - Droop Mode

Governor Speed Droop is adjustable between 0 and 10% using the INSITE™ QST30 G-Drive electronic service tool. Refer to the following sections to adjust Governor Droop:

- Adjustments (Features and Parameters) on page 45
- Tools (Control Panel) on page 50

Note: Speed adjustments to obtain desired no-load Rated speeds **must** be made with a **Remote Speed Adjust** potentiometer (see Remote Speed Adjust).



Engine-generator sets which are to operate at 60 HZ full-load, must have the engine no-load governed speed adjusted to:

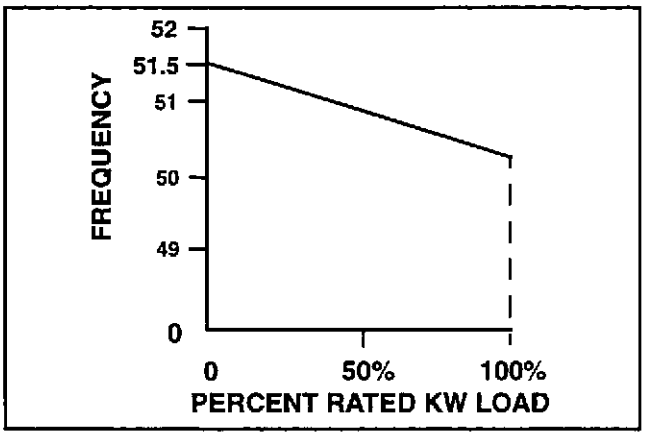
61.8 Hz (1854 RPM) for
3% Speed Droop

63.0 Hz (1890 RPM) for
5% Speed Droop

Engine-generator sets which are to operate at 50 Hz full-load, must have the engine no-load governed speed adjusted to:

51.5 Hz (1545 RPM) for
3% Speed Droop

52.5 Hz (1575 RPM) for
5% Speed Droop



Percent Speed Droop on the engine-generator set can be verified by noting no-load and full-load speeds and using the % Speed Droop formula found on page 96.

When full-load KW is not available, to calculate what the Droop Governed speed should be under the available load, use this formula.

$$S_{al} = S_{nl} - \left(\left(\frac{\text{Available KW Load}}{\text{Rated KW}}\right) X \left(S_{nl} - S_{fl}\right)\right)$$

Where:
S_{al} = Speed at Available KW Load
S_{fl} = Speed at Full KW Load
S_{nl} = Speed at No Load

Example:
Available KW Load = 400
Rated KW = 500
Speed at Full KW Load = 1800
Speed at No Load = 1854
$S_{al} = 1854 - \left(\left(\frac{400}{500}\right) X (1854 - 1800)\right)$
S_{al} = 1811 RPM

Table of Ramp Times

	1500 rpm Total Ramp Time			1800 rpm Total Ramp Time		
Ramp #	**From** *700 rpm Idle*	From Crank or *from 800 rpm Idle*	**From** *900 rpm Idle*	**From** *700 rpm Idle*	From Crank or *from 800 rpm Idle*	**From** *900 rpm Idle*
0	2 sec.	1 sec.	1 sec.	2 sec.	2 sec.	2 sec.
1	3 sec.	3 sec.	2 sec.	4 sec.	4 sec.	4 sec.
2	5 sec.	4 sec.	4 sec.	7 sec.	6 sec.	5 sec.
3	6 sec.	6 sec.	5 sec.	9 sec.	8 sec.	7 sec.
4	8 sec.	7 sec.	6 sec.	11 sec.	10 sec.	9 sec.
5	10 sec.	8 sec.	7 sec.	13 sec.	12 sec.	11 sec.
6	11 sec.	10 sec.	8 sec.	15 sec.	14 sec.	13 sec.
7	13 sec.	11 sec.	10 sec.	18 sec.	16 sec.	14 sec.
8	14 sec.	13 sec.	11 sec.	20 sec.	18 sec.	16 sec.
9	16 sec.	14 sec.	12 sec.	22 sec.	20 sec.	18 sec.
10	18 sec.	15 sec.	13 sec.	24 sec.	22 sec.	20 sec.
11	19 sec.	17 sec.	14 sec.	26 sec.	24 sec.	22 sec.
12	21 sec.	18 sec.	16 sec.	29 sec.	26 sec.	23 sec.
13	22 sec.	20 sec.	17 sec.	31 sec.	28 sec.	25 sec.
14	24 sec.	21 sec.	18 sec.	33 sec.	30 sec.	27 sec.
15	26 sec.	22 sec.	19 sec.	35 sec.	32 sec.	29 sec.
16	27 sec.	24 sec.	20 sec.	37 sec.	34 sec.	31 sec.
17	29 sec.	25 sec.	22 sec.	40 sec.	36 sec.	32 sec.
18	30 sec.	27 sec.	23 sec.	42 sec.	38 sec.	34 sec.
19	32 sec.	28 sec.	24 sec.	44 sec.	40 sec.	36 sec.
20	34 sec.	29 sc.	25 sec.	46 sec.	42 sec.	38 sec.
21	35 sec.	31 sec.	26 sec.	48 sec.	44 sec.	40 sec.
22	37 sec.	32 sec.	28 sec.	51 sec.	46 sec.	41 sec.
23	38 sec.	34 sec.	29 sec.	53 sec.	48 sec.	43 sec.
24	40 sec.	35 sec.	30 sec.	55 sec.	50 sec.	45 sec.
25	42 sec.	36 sec.	31 sec.	57 sec.	52 sec.	47 sec.
26	43 sec.	38 sec.	32 sec.	59 sec.	54 sec.	49 sec.
27	45 sec.	39 sec.	34 sec.	62 sec.	56 sec.	50 sec.
28	46 sec.	41 sec.	35 sec.	64 sec.	58 sec.	52 sec.
29	48 sec.	42 sec.	36 sec.	66 sec.	60 sec.	54 sec.
30	49 sec.	43 sec.	37 sec.	68 sec.	62 sec.	56 sec.

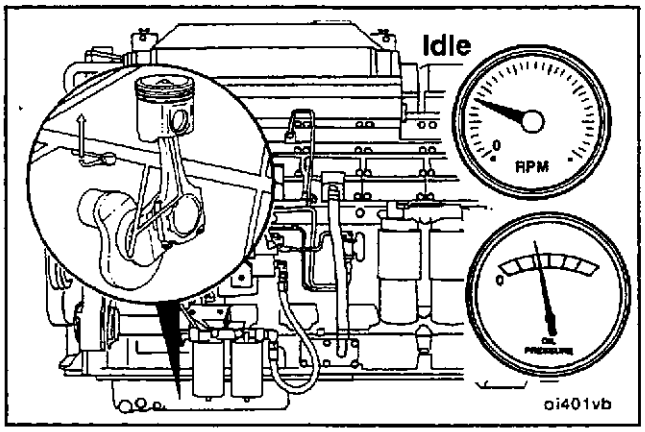
The **Ramp #** is **not** a unit measured in seconds, but a calibration (adjustable) parameter that delivers the time variables as stipulated in the table under the given conditions (from Crank or a given Idle RPM).

This table should be utilized to achieve a desired Ramp Time for both Crank to Rated and Idle to Rated ramp functions.

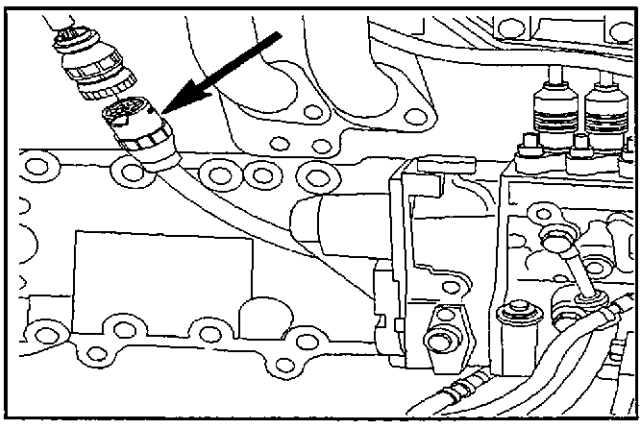
Starting Procedure After Extended Shutdown or Oil Change

GENERAL INFORMATION

Complete the following steps after each oil change or after the engine has been shut off for more than 120 hours. This will insure the engine receives the correct oil flow through the lubricating oil system.



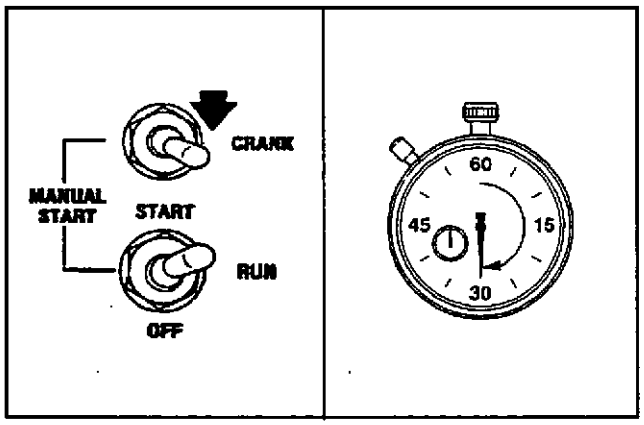
- Disconnect the multi-pin cable from both fuel pumps.
- Rotate the crankshaft, using the starting motor, until oil pressure appears on the gauge or the warning light goes out.
- Reconnect the multi-pin cable to both fuel pumps.
- Start the engine. Refer to normal starting procedures (see below).



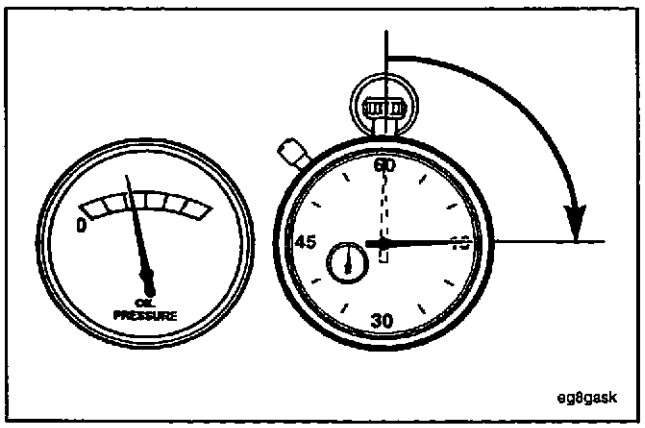
Engine Start-Up

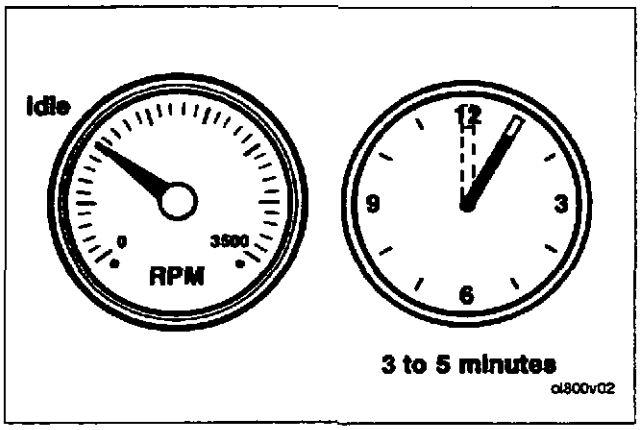
Start the engine with the IDLE/RUN switch (using the idle feature) in the idle position.

To prevent damage to the starter, **do not** engage the starting motor more than 30 seconds. For electrical starting motor(s) wait two (2) minutes between each attempt to start to prevent overheating of the starter motor(s).

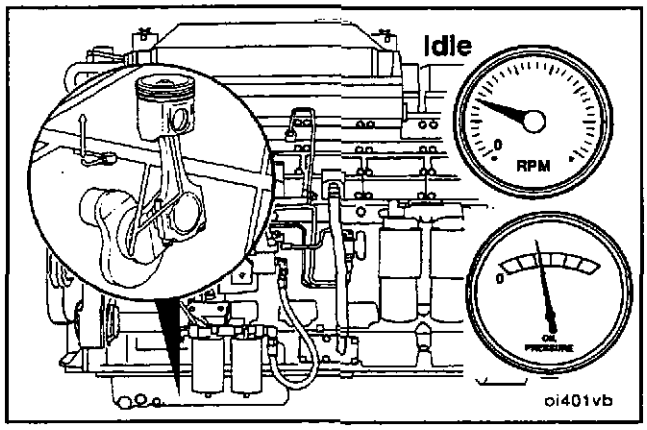


Engine oil pressure **must** be indicated on the gage within 15 seconds. If no pressure is observed shut off the engine immediately to avoid engine damage.

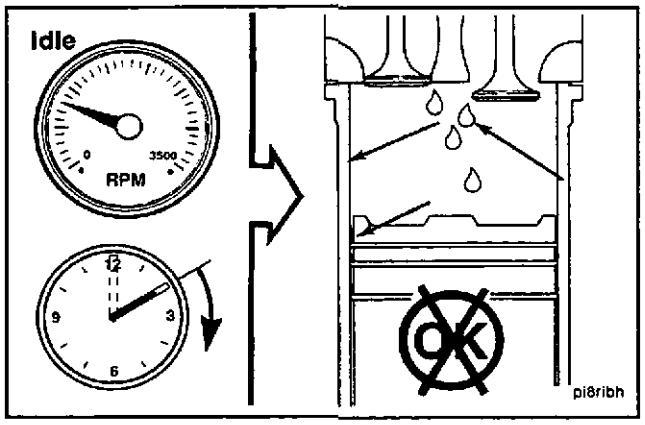




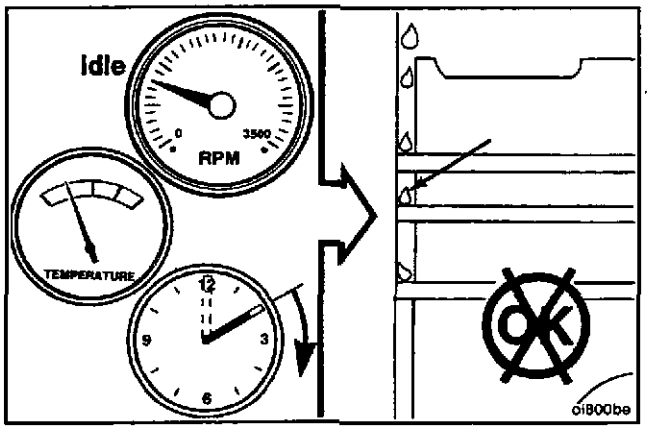
Idle the engine three to five minutes between 700 and 900 RPM (if using idle feature) before switching to Rated Speed RPM.



When starting a cold engine, increase the engine speed (RPM) slowly from Idle to Rated Speed to provide adequate lubrication to the bearings and to allow the oil pressure to stabilize.



Do **not** idle the engine for excessively long periods. Long periods of idling, for more than 10 minutes, can damage an engine because combustion chamber temperatures drop so low the fuel will **not** burn completely. This can cause carbon to clog the injector spray holes, buildup on piston rings and valves to stick.

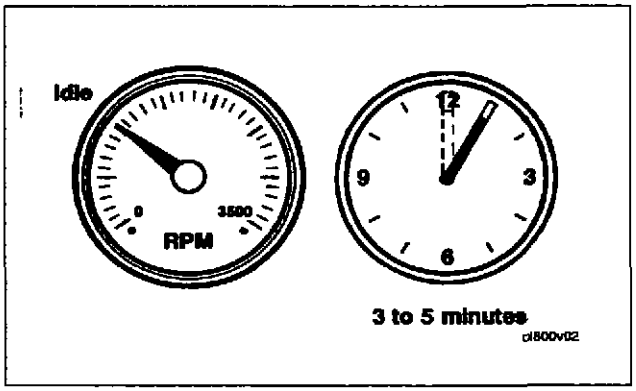


If the engine coolant temperature becomes too low, 60° C (140° F), raw fuel will wash the lubricating oil off the cylinder walls and dilute the crankcase oil; therefore, all moving parts of the engine will not receive the correct amount of lubrication.

Engine Shutdown

GENERAL INFORMATION

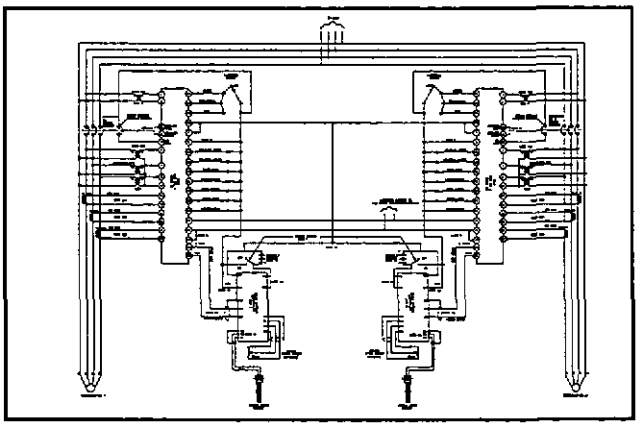
Allow the engine to idle three to five minutes after a full load operation before shutting it off. This allows the engine to cool gradually and uniformly.



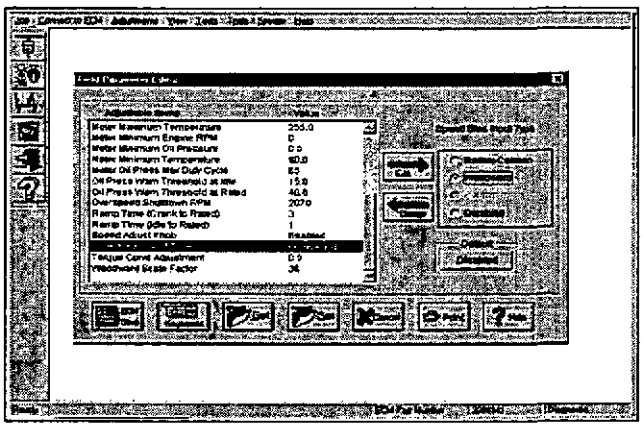
Engine-Generator Sets in Parallel

Speed Bias Input Type

Make necessary point-to-point connections as schematically shown in the Woodward and Barber-Colman Multi-Unit wiring sections in this bulletin.



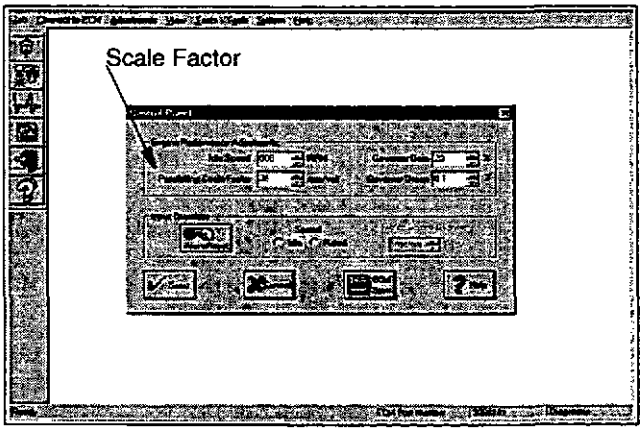
Change the Speed Bias Input Type to the correct setting using the INSITE™ QST30 G-Drive electronic service tool. Refer to the Electronic Service Tool Adjustments (Features and Parameters) section on page 45 to select the correct Speed Bias Input Type.

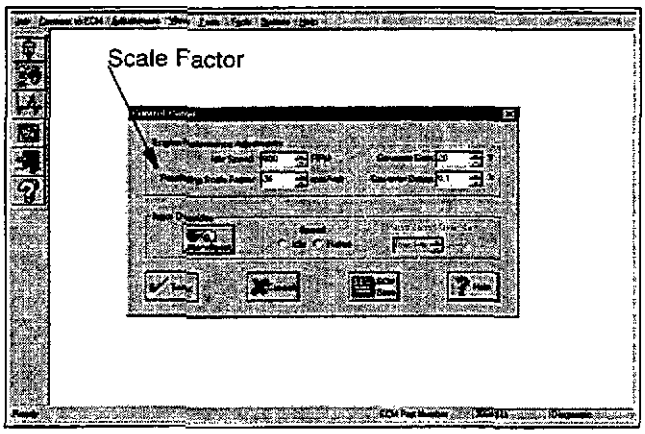


The factory **default setting** for Speed Bias Input Type is **Disabled**.

Speed Bias Scale Factors

Adjustments to the Woodward or Barber-Colman Scale Factors (similar to intermediate Woodward or Barber-Colman Gain adjustments) should not be made to improve system stability and/or response times, unless the individual QST30 ECM, and Woodward or Barber-Colman Gain adjustments fail to provide required performance.





If required, the Woodward and Barber-Colman Scale Factor settings can be adjusted using the INSITE™ QST30 G-Drive electronic service tool. Refer to the following sections to adjust these Scale Factors:

- Adjustments (Features and Parameters) on page 45
- Tools (Control Panel) on page 50

The factory **default setting** for Barber-Colman Scale Factor is **1100 rpm/volt**. The factory **default setting** for Woodward Scale Factor is **36 rpm/volt**.

DYNA II Analog ILS Generator Sets (Refer to Barber-Colman Analog diagram on page 75)

DYNA II Auto-Synchronizer

The DYNA II Auto-Synchronizer (P/N DYN2 90200) can be used with the Cummins QST30 G-Drive governor and DYNA II Analog Isochronous Load Sharing Control to automatically synchronize one generator with another or with a bus. The Auto-Synchronizer eliminates the risk of operator error inherent with manual synchronizing.

The figure illustrates the wiring of two engine generator sets having Cummins QST30 G-Drive governors, DYNA II Analog Isochronous Load Sharing controls and DYNA II Auto-Synchronizers. Additional engine generator sets can be paralleled by wiring them at the point designated, PARALLELING LINES TO OTHER SYSTEMS.

NOTE: The Cummins QST30 G-Drive governors provide independent overspeed protection for each individual engine control system.

Note For Auto-Synchronizer

1. a. Closing a contact between 12 and 13 allows the Auto-Synchronizer to perform as a speed matching unit. The speed and phase of the incoming generator are controlled and a contact is closed to drive a circuit breaker. Once the circuit breaker is closed the contact between 12 and 13 should be opened. Another method would be to use the "Output Hold" dip switch, SW1, on the front of the unit.

   b. Open contacts or no jumper between 12 and 13 allows the Auto-Synchronizer to still sense any error, but it does not provide any control or contact closure.

2. Phasing of voltage potential to the Auto-Synchronizer is necessary to keep each signal in its correct phase relationship. If the generator voltage is not the same as the voltage rating of the Auto-Synchronizer, step-down transformers are required. The step-down transformers require a nominal 7 VA/PHASE for the Generator input and 2 VA/PHASE for the Bus input.

3. Connections to terminals 1-3 or 2-3 and 4-6 or 5-6 of the Auto Synchronizer must be the same voltage potential. Applying generator voltage without applying bus voltage may cause the engine to run faster or slower than the desired speed. However, when bus voltage is applied, the Auto-Synchronizer will change engine speed to quickly match the generator to the bus frequency.

Notes for Isochronous Load Sharing Module

4. Select the ILS current transformers to provide 2.5 to 5.0 amperes at full rated load. Current transformers require nominal 12.5 VA/PHASE at 5.0 amperes.

5. Step-down potential transformers require a nominal 6 VA/PHASE for the ILS.

6. Observe current and potential transformer markings when wiring system because it is necessary to keep each signal in its correct phase relationship to each other.

7. If the "load pulse" function is not being used, set the "load pulse" potentiometer fully counterclockwise.

8. The Droop-isochronous switch is not required if the system is always operated in the isochronous mode.

Notes for Isochronous Load Sharing Module (continued)

9. The QST30 G-Drive controller has a built in adjustable ramp, which is automatically enabled when the Idle/Rated mode is switched to Run. Do not use the ramp built in the analog ILS.

10. *When neither terminal 17 or 18 are wired externally, jumper terminal 18 to ILS terminal 15.*

General System Notes

11. Power switch current rating: 10 amps.

12. System battery supply. If more than one engine is started using the same battery supply, use a separate battery supply for the governor system.

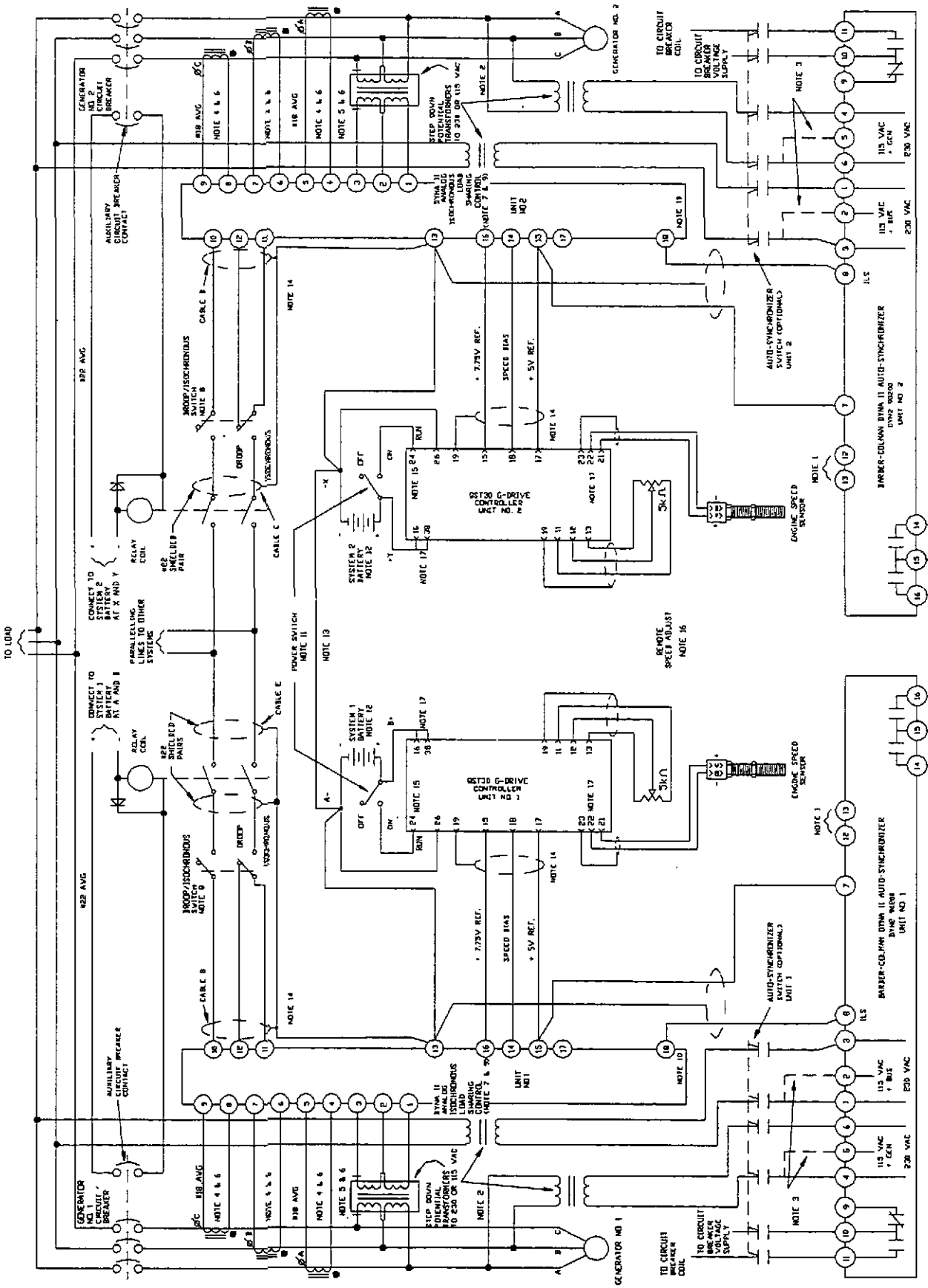
13. If each generator has a separate power supply, connect the negative of all power supplies together for a common reference.

14. Use shielded and twisted leads as shown.

15. Customer supplied 24 VDC ECM power supply for Run Signal via pin-24 in OEM/Customer ECM "B" connector.

16. To help avoid possible noise induced instabilities, it is recommended the customer use the customer supplied Quantum 30 remote speed adjust pot feature and avoid utilizing a DYNA II Analog ILS remote speed selector rheostat.

17. Pins 16, 21, 22, 23 and 38 on Cummins Supplied 'A' connector (B+, B+ Sensing and Engine Speed Sensor).



Load sharing control with customer mounted QST30 g-drive controllers, digital Barber-Colman auto-synchronizing and analog Barber-Colman isochronous load sharing control.

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DYNA II Digital ILS Generator Sets (Refer to Barber-Colman Digital Diagram on page 79)

DYNA II Auto-Synchronizer

The DYNA II Auto-Synchronizer (P/N DYN2 90200) can be used with the Cummins QST30 G-Drive governor and DYNA II Digital Isochronous Load Sharing Control to automatically synchronize one generator with another or with a bus. The Auto-Synchronizer eliminates the risk of operator error inherent with manual synchronizing.

The figure illustrates the wiring of two engine generator sets having Cummins QST30 G-Drive governors, DYNA II Digital Isochronous Load Sharing Controls, and DYNA II Auto-Synchronizers. Additional engine generator sets can be paralleled by wiring them at the point designated, PARALLELING LINES TO OTHER SYSTEMS.

NOTE: The Cummins QST30 G-Drive governors provide independent overspeed protection for each individual engine control system.

Notes For Auto-Synchronizer

1. a. Closing a contact between 12 and 13 allows the Auto-Synchronizer to perform as a speed matching unit. The speed and phase of the incoming generator are controlled and a contact is closed to drive a circuit breaker. Once the circuit breaker is closed the contact between 12 and 13 should be opened. Another method would be to use the "Output Hold" dip switch, SW1, on the front of the unit.

   b. Open contacts or no jumper between 12 and 13 allows the Auto-Synchronizer to still sense any error, but it does not provide any control or contact closure.

2. Phasing of voltage potential to the Auto-Synchronizer is necessary to keep each signal in its correct phase relationship. If the generator voltage is not the same as the voltage rating of the Auto-Synchronizer, step-down transformers are required. The step-down transformers require a nominal 7 VA/PHASE for the Generator input and 2 VA/PHASE for the Bus input.

3. Connections to terminals 1-3 or 2-3 and 4-6 or 5-6 of the Auto-Synchronizer must be the same voltage potential. Applying generator voltage without applying bus voltage may cause the engine to run faster or slower than the desired speed. However, when bus voltage is applied, the Auto-synchronizer will change engine speed to quickly match the generator to the bus frequency.

Notes For Isochronous Load Sharing Module

4. Select the ILS current transformers to provide 2.5 to 5.0 amperes at full rated load. Current transformers require nominal 12.5 VA/PHASE at 5.0 amperes.

5. Step-down potential transformers require a nominal 1 VA/PHASE for the ILS.

6. Observe current and potential transformer markings when wiring system because it is necessary to keep each signal in its correct phase relationship to each other.

7. If the "load pulse" function is not being used, set the "load pulse" potentiometer fully counterclockwise.

8. Droop-isochronous switch is not required if the system is always operated in the isochronous mode.

Notes For Isochronous Load Sharing Module (continued)

9. The QST30 G-Drive controller has a built in adjustable ramp, which is automatically enabled when the Idle/Run mode is switched to Run. Do not use the ramp built in the digital ILS.

10. When neither terminal 17 or 18 are wired externally, wire terminal 18 to ILS terminal 15.

General System Notes

11. Power switch current rating: 10 amps.

12. System battery supply. If more than one engine is started using the same battery supply, use a separate battery supply for the governor system.

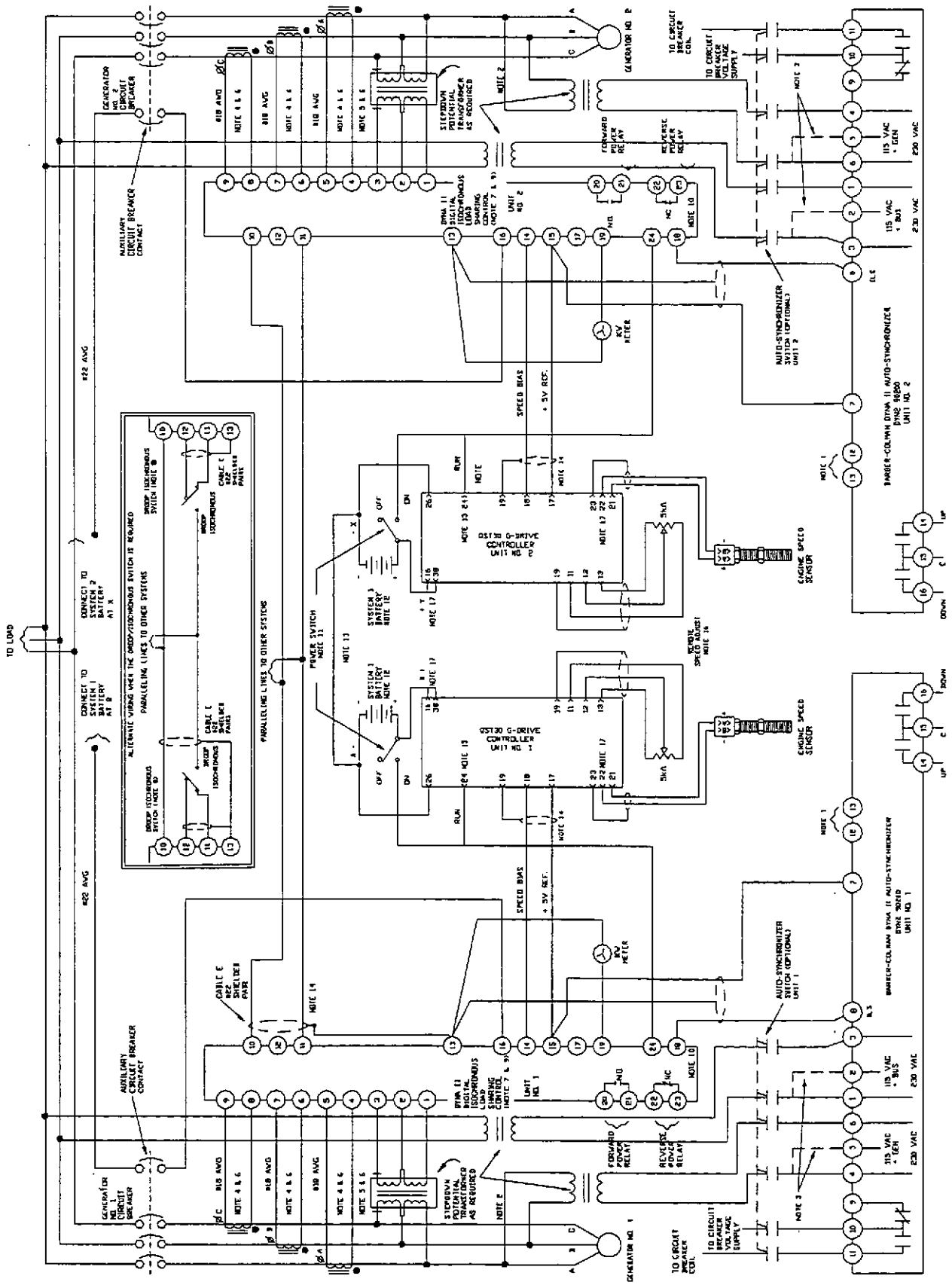
13. If each generator has a separate power supply, connect the negative of all power supplies together for a common reference.

14. Use shielded and twisted leads as shown.

15. Customer supplied 24 VDC ECM power supply for Run Signal via pin-24 in OEM/Customer ECM "B" connector.

16. To help avoid possible noise induced instabilities, it is recommended the customer use the customer supplied Quantum 30 remote speed adjust pot feature and avoid utilizing a DYNA II Digital ILS remote speed selector rheostat.

17. Pins 16, 21, 22, 23 and 38 on Cummins Supplied 'A' connector (B+, B+ Sensing and Engine Speed Sensor).



Load sharing control with customer mounted QST30 g-drive controllers, digital Barber-Colman auto-synchronizing and digital Barber-Colman isochronous load sharing control.

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Woodward Analog SPM-A and AGLC Generator Sets (Refer to Woodward Analog Diagram on page 83)

SPM-A Auto-Synchronizer

The SPM-A Auto-Synchronizer (P/N 9905-01) can be used with the Cummins QST30 G-Drive governor and the Analog Woodward Load Sensor Control to automatically synchronize one generator with another or with a bus. The SPM-A Synchronizer eliminates the risk of operator error inherent with manual synchronizing.

The figure illustrates the wiring of two engine generator sets having Cummins QST30 G-Drive governors, Load Sensor and AGLC load sharing controls and SPM-A auto-synchronizers. Additional engine generator sets can be paralleled by wiring them at the point designated, OTHER SYSTEM LOAD SHARING LINES.

NOTE: The Cummins QST30 G-Drive governors provide independent overspeed protection for each individual engine control system.

Notes for SPM-A Auto-Synchronizer

1. If the generator or bus voltages are not the same as the rating of the bus or generator sensing inputs, step-down transformers are required.

   Bus sensing step-down transformers (input terminals 6 thruogh 9) must be rated at a minimum of 0.1 VA and generator sensing step-down transformers (input terminals 2 through 5) must be rated at a minimum of 16.3VA/PHASE.

   Jumpers shown are for 115 VAC input. Consult Woodward for 190 to 260 VAC operation.

   Applying generator voltage without applying bus voltage may cause the engine to run faster or slower than the desired speed. However, when bus voltage is applied, the SPM-A will change engine speed to quickly match the generator to the bus frequency.

   NOTE: Minimum generator sensing PT rating allows for power draw of SPM-A, AGLC and Generator Load Sensor.

2. Proper phasing of voltage potential to the bus and generator PT's and SPM-A bus and generator inputs is necessary to keep each signal in its correct phase relationship. Failure to ensure proper phasing could potentially result in out-of-synch paralleling and subsequent hardware damage.

3. Breaker close relay contacts rated at 10 amps resistive and 6 amps inductive at 28 VDC, 3 Amps resistive and 2 amps inductive at 115 VAC, and 1.5 amps resistive and 1.0 amps inductive at 230 VAC.

Notes for Load Sensor and Automatic Load Control (AGLC)

4. Select current transformers to produce 5.0 amperes secondary current at full rated load. Current transformers require at least 0.1VA/PHASE at 5.0 amperes.

5. Observe current transformer markings as it is necessary to keep each signal in its correct phase relationship to each other.

6. Jumper 17 to 18 and 19 to 20 on Load Sensor when potential input terminals 1 through 3 is 95 to 130 VAC phase-to-phase (50 - 400 Hz.). Consult Woodward for 190 to 260 VAC option.

Notes for Load Sensor and Automatic Load Control (AGLC) (continued)

7. Terminals 15 and 16 on Load Sensor shown with jumper for isochronous load sharing. Open terminals 15 and 16 for droop load sharing.

8. Internal relay de-energizes to state shown when Unload Trip Level is reached on Unload to issue breaker open command. Breaker open relay contact ratings:

	Resistive	Inductive	Motor	Lamp
28VDC	10 Amp	6.0	3.0	1.0
115V, 400 Hz	5 Amp	2.5	3.0	0.8
115V, 60 Hz	3 Amp	2.0	1.5	0.5

9. Jumper 1 to 2 and 3 to 4 on AGLC for potential inputs of 105 to 132 VAC phase-to-phase. Consult Woodward for 210 to 264 VAC option.

General System Notes

10. Power switch current rating: 10 amps.

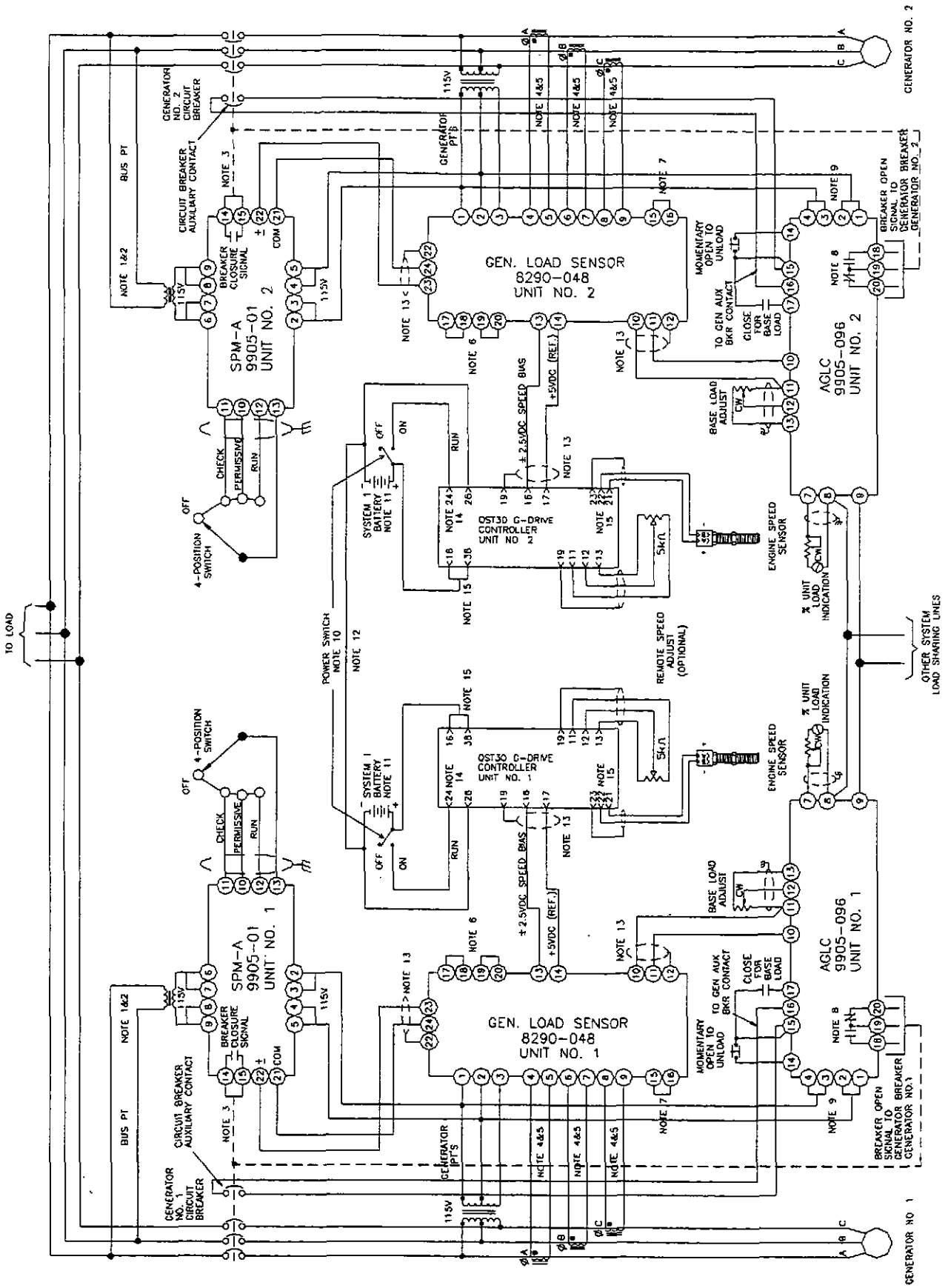
11. System battery supply. If more than one engine is started using the same battery supply, use a separate battery supply for the governor system.

12. If each generator has a separate power supply, connect the negative of all power supplies together for a common reference.

13. Use shielded and twisted leads as shown.

14. Customer supplied 24 VDC ECM power supply for Run Signal via pin-24 in OEM/Customer ECM "B" connector.

15. Pin 16, 21, 22, 23 and 38 on Cummins Supplied 'A' connector (B+, B+ Sensing and Engine speed Sensor).



Load sharing control with customer mounted QST30 G-Drive controllers, analog Woodward SPM-A auto-synchronizing, and analog Woodward Load Sensor and AGLC load sharing control.

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Woodward Digital DSLC Generator Sets (Refer to Woodward Digital Diagram on page 87)

DSLC (Digital Synchronizer and Load Control)

The Woodward DSLC Synchronizer and Load Controller can be used with the Cummins QST30 G-Drive governor to automatically synchronize one generator with another or with a bus. The DSLC eliminates the risk of operator error inherent with manual synchronizing. In addition to synchronizing, the DSLC provides load sensing, automatic generator loading /unloading along with isochronous load sharing.

The figure illustrates the wiring of two engine generator sets having Cummins QST30 G-Drive governors and DSLC Synchronizer and Load Controllers. Additional engine generator sets can be paralleled by wiring them at the point designated, LONWORKS NETWORK TO ALL DIGITAL GENERATOR CONTROLS. The diagram as drawn shows a 120 VAC Wye configuration. Other potential configurations are 240 VAC Wye, 120 VAC and 240 VAC Open Delta configurations. You should consult pertinent Woodward technical manuals for the proper wiring in the case of these other configurations.

NOTE: The Cummins QST30 G-Drive governors provide independent overspeed protection for each individual engine control system.

Notes for DSLC

1. If the generator voltage is not the same as the rating of the bus or generator voltage sensing inputs (65 - 150 VAC, 45 - 66 Hz.), step-down transformers are required. Bus or generator step-down transformers require at least 0.1 VA/PHASE. Applying generator voltage without applying bus voltage may cause the engine to run faster or slower than the desired speed. However, when bus voltage is applied, the DSLC will change engine speed to quickly match the generator to the bus frequency.

2. Proper phasing of voltage potential to the bus and generator PT's and DSLC bus and generator inputs is necessary to keep each signal in its correct phase relationship. Failure to ensure proper phasing could potentially result in out-of-synch paralleling and subsequent hardware damage.

3. Select current transformers to produce 5.0 amperes secondary current at full rated load. Current transformers require at least .01 VA/PHASE at 5.0 amperes.

4. Observe current transformer markings as it is necessary to keep each signal in its correct phase relationship to each other.

5. Breaker close and open functions may require customer supplied relay. DSLC relay drivers are rated at 18-40 VDC, 200 mA.

6. Required DSLC power supply input is 18 to 40 VDC continuous.

7. Termination jumpers (terminals 41 and 42) are required on units located on each end of LonWorks network.

8. Properly ground the DSCL chassis for proper safety and shielding (Woodward DSLC chassis provides for case grounding stud).

General System Notes

9. Power switch current rating: 10 amps.

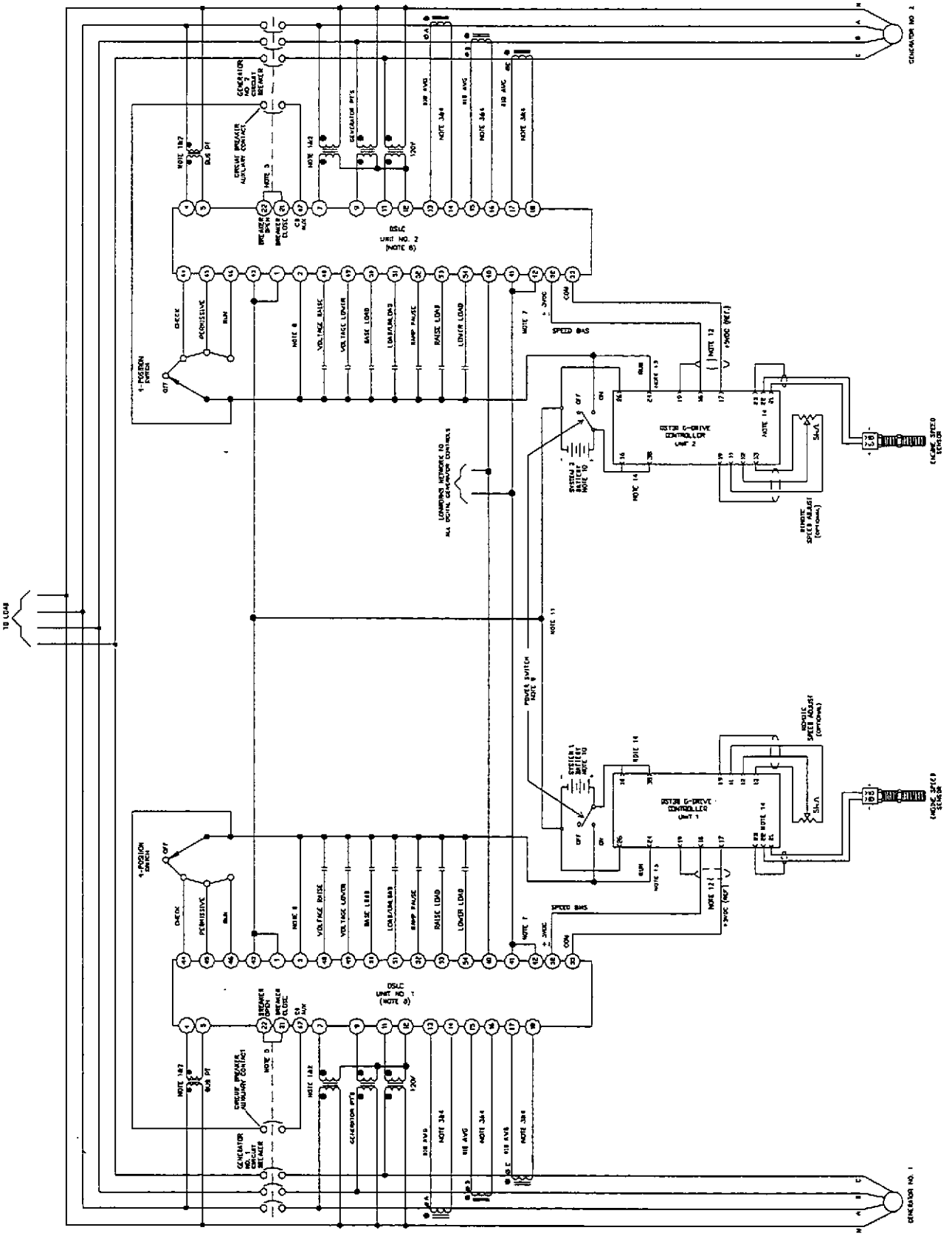
10. System battery supply. If more than one engine is started using the same battery supply, use a separate battery supply for the governor system.

11. If each generator has a separate power supply, connect the negative of all power supplies together for a common reference.

12. Use shielded and twisted leads as shown.

13. Customer supplied 24 VDC ECM power supply for Run Signal via pin-24 in OEM/Customer ECM "B" connector.

14. Pin 16, 21, 22, 23 and 38 on Cummins Supplied 'A' connector (B+, B+ Sensing and Engine Speed Sensor).



Load sharing control with customer mounted QST30 G-Drive controllers and digital Woodward auto-synchronizing and isochronous load sharing control (Woodward DSLC).

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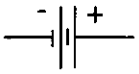
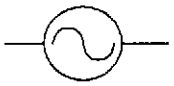
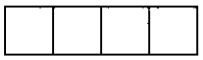
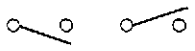
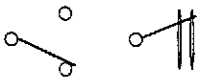
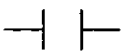
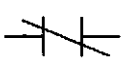
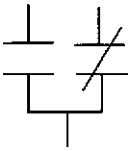
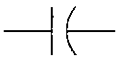
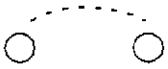
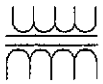
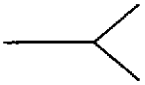
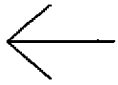
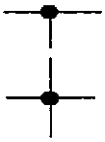
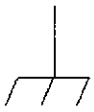
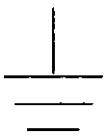
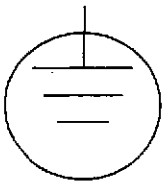
Electrical Symbols

Name	Symbol
Battery	
Alternator (Frequency Source)	
Resistor	
Variable Resistor (Potentiometer) — 3 Terminal Device	
Variable Resistor (Potentiometer) — 2 Terminal Device	
Terminal Strip	
Switches: (N.O.) Normally Open	
(N.C.) Normally Closed	
Transfer	
Transfer 3 position	
Relay Contact:	
(N.O.) Normally Open	
(N.C.) Normally Closed	

Name	Symbol
Transfer	
Capacitor	
Fuse	
Circuit Breaker	
Jumper Wire	
Coil	
Magnetic Core	
Transformer	
Variable Reluctance Magnetic Pickup	
Female Contact	
Male Contact	

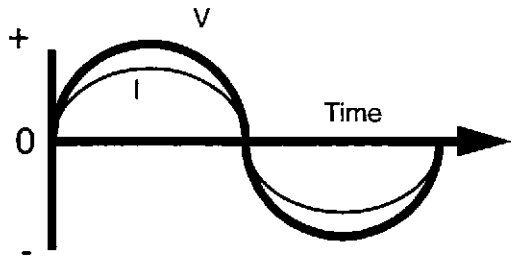
Name	Symbol
Shields:	
Shielded Wire	
Shielded Pair	
Crossing of Conductors (wires) not Connected	
Junction of Connected Conductors (wires)	
Grounded Chassis or Frame *Connection* Conducting connection to a chassis or frame, of equivalent chassis connection of a printed wiring board. The chassis or frame (or equivalent chassis connection of a printed wiring board) may be at a different potential than the earth or structure in which this chassis or frame (or printed wiring board) is mounted.	
Direct Conducting Connection to Circuit Return Conducting connection to a structure that services a function similar to that of an earth ground (that is, a structure such as a frame of an air, space or land vehicle that is not conductively connected to earth.)	

Name	Symbol
Earth Safety Ground ** This symbol may be used in place of symbol for direct conducting connection to circuit return to indicate a ground connection having a specified protective function (e.g., for protection against electrical shock in case of a fault). ** Ref. Electrical and Electronics Graphic Symbols and abbreviated name.	

Glossary of Power Terms

A.C. -- See Alternating Current.

Alternating Current -- Electrical current which repeatedly varies from zero to a positive maximum value to zero to a negative maximum value and back to zero at a periodic rate. Since the applied voltage continually reverses polarity, the resultant current flow alternates in direction within the circuit.



Alternating Current = I
Applied Voltage = V

AMP -- An abbreviation for the term Ampere.

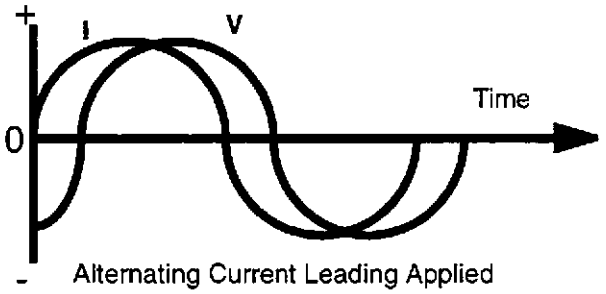
Ampere -- The unit of measure of electrical current flow. One ampere of current will flow when one volt of electrical potential is applied across one ohm of resistance.

Auto-Transformer -- A transformer of single coil construction in which both the primary and secondary connections are made on the same coil but use different taps.

B- -- Symbol used to designate the negative polarity of a D.C. voltage supply.

B+ -- Symbol used to designate the positive polarity of a D.C. voltage supply.

Capacitance -- The property of a device which resists changes in voltage. In an A.C. circuit, a capacitive load will cause the voltage to lag behind the current flow. Stated more conventionally, the current leads the applied voltage. A capacitive load is, therefore, a leading power factor load (see Power Factor).



Alternating Current Leading Applied Voltage Caused by Capacitive Load

Capacitor -- A device possessing the property of capacitance. A typical capacitor consists of two conducting surfaces separated by an insulating material. A capacitor stores electrical energy, blocks the flow of D.C. and permits the flow of A.C. to a degree largely dependent on the capacitance and the frequency of the applied A.C.

Circuit -- An electrical path through which an electric current may flow from a voltage supply to a load and return. A closed or complete circuit is one where current is flowing. An open circuit is where the path has been disrupted, such as an open switch or circuit breaker, thus stopping current flow.

Circuit Breaker -- A protective device for opening a circuit where current flow exceeds a predetermined value.

Circulating Current -- Also called Cross Current. Current which flows between paralleled generators, most apparent with no external load on the paralleled generators. Circulating current is caused (1) by unequal excitation of the generators (reactive current, which may be reduced by changing the voltage regulator adjustment or connections); and (2) by unequal power from the engines that are driving the generators real current (and power) which can be eliminated by governor adjustments.

Conductor -- A wire cable, bus, or other device intended to distribute current from the supply to the load. Technically, a conductor is any device which will permit the flow of current.

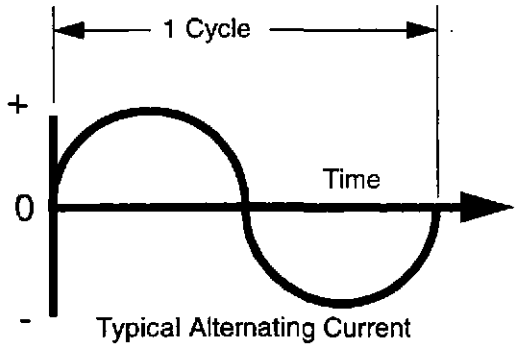
Contactor -- A device for opening and closing an electric circuit. Contactors are normally used in motor circuits where large amounts of current are controlled.

Cross Current -- See Circulating Current.

Cross Current Compensation -- A term, no longer approved, for a circuit arrangement that made paralleled generators share the reactive component of load current in proportion to the generator ratings. The circuit arrangement could also essentially eliminate the reactive component of circulating current flowing between paralleled generators (See Reactive Differential (Cross Current) Compensation and Reactive Droop Compensation).

Current (Electrical, Symbol I) -- The rate of transfer of electricity from one point to another. Current is usually a movement of electrons, but may also be a movement of positive ions, negative ions, or holes. Current is usually measured in amperes.

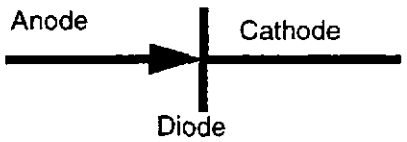
Cycle 00 -- A complete set of events before repetition occurs. In alternating current or voltage, a cycle starts at zero, continues to a maximum positive value returns to zero, continues to a maximum negative value, and is completed at zero.



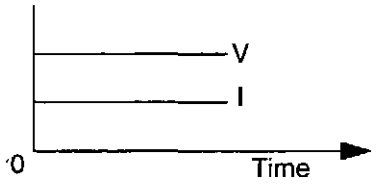
Typical Alternating Current
or Voltage Cycle

D.C. -- See Direct Current.

Diode -- A two terminal solid-state device which permits current to flow in one direction, but not in the other. In alternating current circuits, a diode will permit one half cycle to flow but will resist the flow of the opposite half cycle of current. Thus, alternating current is converted to direct current by a diode.



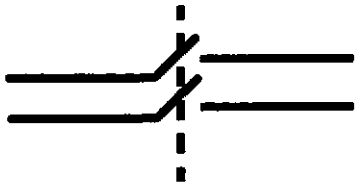
Direct Current (D.C.) -- An electric current that flows in one direction only. Conventional direct current is defined as flowing from positive to negative in the circuit outside the source (example: a battery or combination of diodes). Conventional current flows in the direction of the arrow through a diode. Electron flow and U.S. Navy designated current flow in the opposite diretion.



Direct Current I
Applied Voltage V

Distribution Panel -- A control panel containing circuit breakers, transfer switches, and other control devices which distribute the electrical power, such as from a generator set to the loads.

Double Pole Switch -- A switch which has two sets of contacts which operate on two independent circuits at the same time.



Typical Double Pole Switch Shown as a
Single Throw Type in the "Off" Position

Double Throw Switch -- A Switch which has a common pole that is closed to one contact and open to a second contact in one switch position. With switch operation, the first contact opens and the second contact closes to the common pole.

Typical Double Throw Switch
Shown as a Single Pole Type

E -- Symbol used to represent electrical potential (voltage).

Earth Ground -- An intentional connection made between the earth and the metallic frame of electrical equipment as a means to eliminate possible voltage hazards to personnel. Earth Ground also serves, in some cases, to reduce electrical interference in sensitive circuits such as television and radio equipment.

EMI -- An abbreviation for the term electromagnetic interference which is sometimes caused by SCR type devices and evident in radio and television operation.

Energy -- The capability of performing work.

Frequency -- The number of complete cycles of alternation current per unit of time. Typically, frequency is expressed in cycles per second or Hertz (HZ).

Frequency Droop -- A decrease in steady state frequency output of a generator caused by an increase in load. This decrease in frequency from the no load frequency is expressed as a percentage of the full load frequency or:

$$\%F_{Droop} = \frac{(F_{NL} - F_{FL})\ X\ 100}{F_{FL}}$$

Where: $\%\ F_{Droop}$ = *Percent Frequency Droop*
F_{NL} = *No Load Frequency*
F_{FL} = *Full Load Frequency*

A three percent frequency droop may be used to provide governor stability and for load sharing between paralleled generator sets.

Frequency Meter -- An instrument deigned to measure the frequency of an alternation current system.

Gain -- The increase in signal power that is produced by an amplifier, usually given as the ratio of output to input voltage, current, or power. In generator set systems, a low gain setting on the electric governor or voltage regulator provides a relatively small signal to correct variations of frequency or voltage. The frequency and/or voltage may wander or be slow in recovering to stable conditions after a load change. A high gain setting provides a relatively large signal to correct variations of frequency and/or voltage. If the gain is set too high, the electric governor or voltage regulator may over-correct. This may produce unacceptable hunting of the frequency and/or voltage.

Gate -- The third terminal of an SCR to which a voltage must be applied before the SCR will conduct.

Governor -- A device which controls engine speed and thus the generator output frequency.

Ground -- A connection, either accidental or intentional, between an electrical potential and the earth or some conducting body serving in place of the earth.

Heat Sink -- A device which absorbs heat from electrical devices such as diodes and SCR's and dissipates the heat to the surrounding air.

Hertz -- A term equivalent to cycles per second (See Frequency).

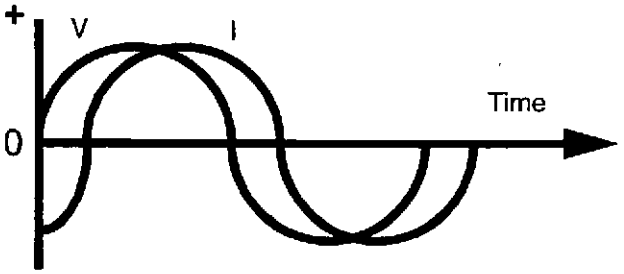
Hunting -- Oscillation in frequency or in voltage where steady state conditions are not reached, particularly after a load transient change.

I -- Symbol used to represent current.

Impedance -- The opposition to the flow of alternating current.

Induced Voltage -- The voltage which is produced by relative motion between a wire and a magnetic field.

Inductance -- The property of a device which resists changes in current. In an A.C. circuit, an inductive load will cause the current to lag behind the applied voltage. Stated more conventionally, the current lags the applied voltage. An inductive load is therefore a lagging power factor load (see Power Factor).



Alternating Current Lagging Applied Voltage Caused by Inductive Load

Inductor -- A device possessing the property of inductance. An inductor stores electrical energy, passes D.C., and opposes the flow of A.C. to a degree largely dependent on the inductance and the frequency of the applied A.C. A typical inductor consists of a coil of wire.

In Phase – Alternating currents or voltages are in phase with respect to each other if they cross through zero and reach their positive and negative maximum values together.

Insulation -- A non-conductive material such as rubber or plastic intended to prevent current from flowing. Technically, insulation is any material which stops the flow of current.

Isochronous – As it applies to engine governors, maintaining constant steady state speed regardless of the load within the rating of the engine. Thus, a generator set is said to be isochronous if the frequency remains the same regardless of load.

Normally Closed (Symbol N.C.) – As applied to a magnetically operated device such as a valve or the contacts of a relay, Normally Closed indicates that the valve or the relay contacts are closed when no power is supplied to the operating magnet.

Normally Open (Symbol N.O.) – As applied to a magnetically operated device such as a valve or the contacts of a relay, Normally Open indicates that the valve or the relay contacts are open when no power is supplied to the operating magnet.

Ohm -- The unit of measure of electrical resistance. One ohm of resistance will allow a current of one ampere to flow with an applied potential of one volt.

Ohmmeter – An instrument for measuring electrical resistance.

Ohm's Law – A fundamental law expressing the relationship between voltage, current, and resistance in electrical circuits. The law states that E = IR or voltage is equal to current times resistance.

Open Circuit -- 1) A circuit that does not provide a complete path for the flow of current. 2.) A condition of an electrical circuit caused by the breaking of continuity of one or more conductors of the circuit; often an undesired condition. 3) An arrangement of conductors and equipment that depends upon lack of continuity for operation, as open-circuit telegraphy; a circuit in which continuity is incomplete or interrupted.

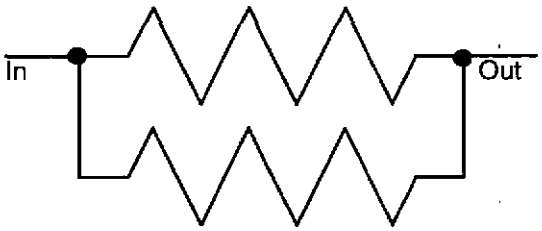
Oscillogram -- The permanent record produced by an oscillograph, or a photograph of the trace produced by an oscilloscope.

Oscillograph – A measurement device for determining waveform by recording the instantaneous values of a quantity such as voltage as a function of time.

Oscilloscope -- An instrument primarily for making visible the instantaneous value of one or more rapidly varying electrical quantities as a function of time or of another electrical or mechanical quantity.

Oscilloscope Dual Beam -- An oscilloscope in which the cathode-ray tube produces two separate electron beams that may be individually or jointly controlled.

Parallel Connection -- An electrical connection in which the input of one element is connected to the input of another element. The output connections are similarly connected together thus providing two or more paths for current to flow.



Parallel Connection

Parallel Operation – The method by which two or more generators having the same voltage and frequency characteristics are connected to a common load.

Permanent Magnet Generator – A generator which uses permanent magnets to create a magnetic field. As applied to Cummins Generators; a *permanent magnet generator, within the main generator*, supplies the power to the voltage regulator which in turn supplies the power to the exciter field. The permanent magnet generator still supplies power during a short circuit of the main generator. This permits the main generator to sustain high short circuit currents. The output of the permanent

magnet generator is electrically isolated from the main generator output and is not adversely affected by main generator output waveform distortion such as from SCR type loads.

PMG -- See Permanent Magnet Generator.

Polarity -- An electrical term which indicates the direction in which current flows in a conductor. In a direct current system, current flows in the same direction. In an alternating current system, current changes direction as the polarity of the A.C. voltage source changes.

Potential -- Another term to indicate voltage.

Potential Difference -- The difference in voltage between two points in a circuit.

Power -- Defined as the rate of performing work. Mechanical power is measured in horsepower or kilowatts. Electrical power is measured in kilowatts.

Power Factor -- The ratio of the true power (KW) requirements of a load to the apparent power (KVA) requirements of a load. The combined loads applied to a power source may have a resistive, capacitive, or inductive effect.

Resistive loads such as incandescent lighting or resistive heating elements cause no shift in the voltage/current wave forms and are, therefore, unity (1.0) power factor loads.

Inductive and capacitive loads, however, cause the voltage and current waveforms to shift with respect to one another. These types of loads are commonly called power factor loads (i.e., the power factor is less than 1.0).

See INDUCTANCE and CAPACITANCE for more information.

Power factor is frequently multiplied by 100 and expressed as a percentage.
The formula for power factor is:

$$Power\ Factor = \frac{True\ Power\ (KW)}{Apparent\ power\ (KVA)}$$

R -- Symbol used to represent resistance.

Reactive Differential (Cross Current) Compensation -- A circuit arrangement for operating generators in parallel with no generator voltage droop. Reactive Differential Compensation is accomplished by a differential interconnection of the secondaries of the generator current transformers used for Reactive Droop Compensation. This arrangement is not often used and is very difficult to set up when paralleling generators of different capacities.

Reactive Droop Compensation -- A circuit arrangement that creates a droop in generator output voltage that is proportional to the reactive load current. This circuit arrangement makes the paralleled generators share the reactive component of the load current in proportion to the generator ratings. It also can essentially eliminate the reactive component of circulating current which may flow between paralleled generators. The Reactive Droop Compensation arrangement is commonly called the Generator Paralleling Module.

Relay -- An electromechanical device having a magnetic coil which, when energized, opens or closes several sets of contacts.

Resistance -- Opposition to the flow of current.

Resistor (Symbol R) -- A device or component designed to have a definite amount of resistance. Resistors are used in circuits to limit current flow or to provide a voltage drop.

Resistor, Fixed -- A component which is used to control voltage and current by introducing a constant resistance of known value into the circuit.

Resistor, Variable -- Similar to a fixed resistor except the resistance value can be adjusted. The voltage adjust rheostat is a variable resistor.

Rheostat -- A variable resistor.

Series Connection -- An electrical connection in which the input of one element is connected to the output of another element providing only one path for current to flow.

Series Connection

Short Circuit -- An abnormal connection (including an arc) of relatively low resistance, whether made accidentally, or intentionally, between two points of different potential in a circuit. Equipment, not protected by fuse or circuit breakers, may be damaged by a short circuit.

Shunt Trip -- An electromechanical device which, when energized, trips the main line circuit breaker.

Single Pole Switch -- *A switch which has only one* set of contacts.

Typical Single Pole Switch Shown as a Single Throw Type in the "Off" Position

Single Throw Switch -- A switch which opens a set of contacts in one switch position and closes the contacts in the other position.

Typical Single Throw Switch Shown as a Single Pole Type in the "Off" Position

Speed Droop -- A decrease in steady state speed of an engine due to an increase in applied load. This decrease in speed from the no load speed is expressed as a percentage of full load speed or:

$$\%S_{Droop} = \frac{(S_{NL} - S_{FL}) \times 100}{S_{FL}}$$

Where: $\%S_{Droop}$ = *Percent Speed Droop*
S_{FL} = *Full Load Speed*
S_{NL} = *No Load Speed*

Solenoid -- An electromechanical device which when energized, acts on a movable core or plunger in the center of the energizing coil to perform mechanical work.

Solid-State -- A term which applies to electronic devices which are constructed using semiconductor material. Such devices include transistors, SCR's, and diodes.

Stability -- Freedom from undesired variations or oscillation. In generator set systems, the generator set is stable if it can maintain or quickly re-establish steady state conditions of voltage and frequency after a sudden load change.

Surge Suppressor -- A device capable of conducting current in either direction in the presence of high transient voltages thus protecting devices that could otherwise be damaged.

Synchronism -- The condition where two or more generators are operating at the same frequency and output voltage and are in phase with one another.

Synchronizing -- *The procedure of matching the* frequency, phase rotation, voltage, and phase relationship of one generator to another for purposes of paralleling the units onto a common bus.

Synchronous -- A generator whose output frequency is directly related (proportional) to the speed of the engine driving the generator.

Tachometer -- An instrument for measuring the rate of rotation expressed in revolutions per minute.

Temperature Drift -- A change in the value of a component caused by changes in operating temperature.

Terminal -- A mechanical device for making electrical connections.

Thyristor (SCR) -- A Silicon-Controlled Rectifier is a structure with an external connection (gate) to one of the inter layer. With no gate current, the SCR characteristic is that of a four-level diode.

Transformer -- Frequently, a device using a laminated iron core with a primary and secondary winding. A transformer changes some level of input (primary) voltage or current to a proportional output (secondary) voltage or current (see Current Transformer and Potential Transformer).

Transient -- A temporary change from the steady state conditions.

V -- Symbol used to represent voltage.

Volt -- The unit of measure of electrical potential (voltage). One volt of electrical potential will force a current of one ampere to flow through a resistance of one ohm.

Voltage -- Electrical potential or pressure which forces current to flow through a circuit.

Voltage Dip – A temporary reduction in voltage generally resulting from an increase in load.

Voltage Droop -- A decrease in steady state voltage of a generator due to an increase in load applied. This decrease in voltage from the no load voltage is expressed as a percentage of the full load voltage or

$$\%V_{Droop} = \frac{(V_{NL} - V_{FL}) \times 100}{V_{FL}}$$

Where: $\%V_{Droop}$ = *Percent Voltage Droop*
V_{NL} = *No Load Voltage*
V_{FL} = *Full Load Voltage*

Voltage Droop Compensation – A system which permits paralleled generators to share the currents of a load in proportion to the generator set ratings.

Voltage Regulator -- A device which controls the voltage output of a generator at a preset value regardless of the amount of load applied.

Voltmeter -- An instrument designed to measure electrical potential or voltage.

ELECTRICAL SPECIFICATIONS

ALL CONTINUITY CHECKS
- OK (no open circuit) if less than 10 Ω

SHORTS TO GROUND

ESS circuits
- OK (no short circuits) if more than 10 kΩ

all other circuits
- OK (no short circuits) if more than 10 kΩ

SHORT CIRCUIT TO EXTERNAL VOLTAGE
- OK if less than 1.5 VDC

ECM Power Source

9 to 40 VDC

5 V POWER SUPPLY (Sensor and Switch)

@ ECM
- 4.75 to 5.25 VDC

@ Harness
- 4.75 to 5.25 VDC

SOLENOIDS

Fuel Shutoff Valve - 24 VDC
- Coil Resistance = 28 to 32 Ohms
- Voltage = 24 VDC

ECM CONNECTOR

Allen Screw Torque = 3 N·m [25 in-lb]

SENSOR SPECIFICATIONS

ENGINE SPEED SENSOR

First Coil Resistance = 840 Ω ± 10%
Second Coil Resistance = 1320 Ω ± 10%

OIL PRESSURE SENSOR

Torque = 14 [10 ft-lb]

Pressure (kPa)	Pressure [psi]	Voltage (V)
0	0	0.42 to 0.58
172	24	1.42 to 1.58
344	50	2.42 to 2.58
517	75	3.42 to 3.58
689	100	4.42 to 4.58

COOLANT TEMPERATURE SENSOR

Torque = 14 N•m [10 ft-lb]

Temperature (C)	Temperature (F)	Resistance (ohms)
0	32	30k to 36k
25	77	9k to 11k
50	122	3k to 4k
75	167	1250 to 1500
100	212	600 to 675

Component Specifications

Governor Control (ECM)

Operation

Governor Mode	: Isochronous to 10% droop
Steady State Stability	: <± .25%
Operating Input Frequency Range	: 2.4K to 5.0K Hz
Rated Speed Input Frequency (ESS)	: 1500 RPM - 3550 Hz
	: 1800 Rpm - 4260 Hz
Idle Speed Input Frequency Range (ESS)	: 1657 - 2130 Hz

Power

Operating Voltage	: 22.0 to 34.0VDC; 24VDC Recommended
Ground Polarity	: (-) Negative
Nominal Operating Current	: 3.5 amps at 24VDC
Maximum Operating Current	: 4.5 amps at 24VDC
Quiescent Current Draw	: 30 milliamps

Environmental

Ambient Operating Temp.	: -40° to 85°C [-40° to 185°F]
Maximum Temperature Drift	: Self compensating over operating range
Relative Humidity	: 0 to 95% non- condensing
Storage Temperature Range	: -40° to 85°C [-40° to 185°F]

Physical

Dimensions	: 204 mm X 227 mm X 46 mm [8.0 X 8.9 X 1.8 in.]
Weight	: 2.7 Kg [6.0 lb.]
Mounting	: Any position, off engine, typically in enclosure
Case Material	: Die Cast Aluminum

Protection Features

High Voltage Protection	: 35VDC for 24 hours continuous
Reverse of Supply Polarity	: Yes
Surge Protection	: 80VDC, 10 msec transient
Vibration Protection	:(Remote Control) Entire printed circuit board sealed with silicon-filled epoxy.

Magnetic Pickup Specifications

Thread Size	: M22 X 1.5
Tap Drill Size	: 19.50 mm
Proximity to Gear Teeth	: 0.71 - 1.07 mm [0.028 - 0.042] (Approx. 1/2 to 3/4 turn)
Temperature Range	: -55° to 105°C [-67°to 222°F]
Output at Cranking Speed	: 2.5VAC minimum
Maximum Output	: 50VAC
Coil Resistance	: First coil 840 Ω ± 10% Second coil 1320 Ω ± 10%

Remote Potentiometer Specifications (recommended)

Resistance	: 5K Ohms ± 5%
Linearity	: .25%
Travel	: 360° X10
Power Rating	: 2 Watts @ 70°C [158°F]
Insulation Rating	: 1000 M Ohms @ 500 VDC
Dielectric Strength	: 100V RMS
Operating Temperature Range	: -55°C to 105°C [-67°F to 221°F]

Part No.	Description
3825145	INSITE™ for QST30 G-Drive Electronic Service Tool
3825183	Electronic Service Tool Interconnect Cable
3825189	QST30 G-Drive Engine Wiring Repair Kit
3865337	Oil Pressure Sensor Unit
3865346	Water Temperature Sensor
3865349	Magnetic Pickup, Thread: M22 X 1.5
3094439	G1 - ECM
3094141	G2 - ECM
3094440	G3 - ECM
*TBD	Other QST30-G Engine Models
3094470	Engine Harness
3094469	ECM Harness
WR5002	1.5 m [5 ft.] Extension Harness
WR5005	3.1 m [10 ft.] Extension Harness
WR5006	6.1 m [20 ft.] Extension Harness
WR5007	ECM B Connector Kit
3092340	ECM B Connector Service Kit P/N

ECM Structure

Customer Interface Software Mandatory	Engine Control Module Dependent
G1 - DO 5006	G1 - PH 5705
G2 - DO 5005	G2 - PH 5703
G3 - DO 5004	G3 - PH 5706
Other QST30-G Engine Models-TBD*	Other QST30-G Engine Models-TBD*

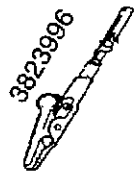
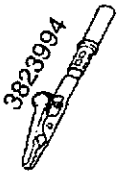
Each engine model and rating has an individual ECM P/N (PH option) programed with rating torque curves and fuel limits. The PH dependent option is driven by a customer selected DO option for correct engine rating.

* Check with your local Cummins Distributer for proper DO option selection and PH option structure.

Electrical Diagnostic Tools

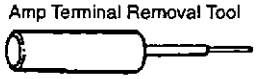
WHEN RUNNING DIAGNOSTICS OR TROUBLESHOOTING THE FUEL GOVERNING SYSTEM, THE FOLLOWING TOOLS SHOULD BE USED TO AVOID DAMAGE TO THE CONNECTIONS AND WIRING HARNESSES.

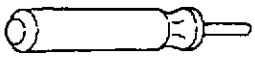
Test Leads

Weather-Pack	Deutsch	Deutsch Amp/Cannon Metri-Pack
Male		
 3823995	 3824811  3823993	 3822758
Female		
 3823996	 3824812  3823994	 3822917

If damaged connections or wires are found they may be repaired using the following tools and electrical repair items:

Repair Tools

Amp Terminal Removal Tool

3822759

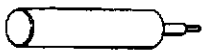
Weather-Pack Terminal Removal Tool

3822608

Deutsch Terminal Removal Tool

#20 Red 3824815
#16 Blue 3822760
#12 Yellow 3824816

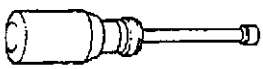
Braid Removal Tool

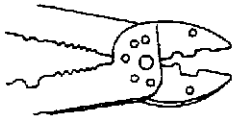
3822932

Amp Terminal Depth/Press. Gauge

3823383

Metri-Pack Terminal Pressure Gauge

3824792

Nut Driver

1/4 in. 3824244
7 mm 3823257

Wire Crimp Tool

3822930

Storage Box

3822933

Terminal Removal Tool Instructions 3377581

Terminal Connectors

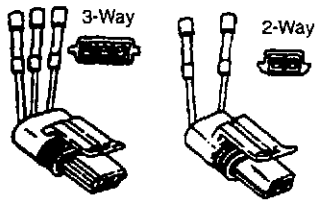
Deutsch 9-Terminal

Plug	Retainer	Receptacle Cap	Receptacle
3824016	3824017	3825184	3825182
Fuel Pump Connector		Service Tool Connector	

Weather pack

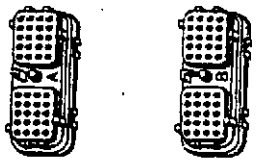
2-Way Tower	2-Way Shroud	4-Way Tower	4-Way Shroud
3823338	3823337	3823342	3823337
Speed Sensor (MPU) Connector		Diagnostic Connector	

Metri-Pack



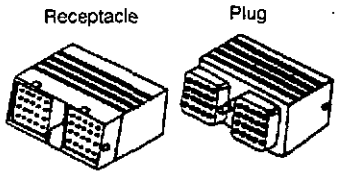
3-Way	2-Way
3823254	3823256
Lub Oil Pressure Sensor	Water Temperature Sensor

40 Terminal #20 Size



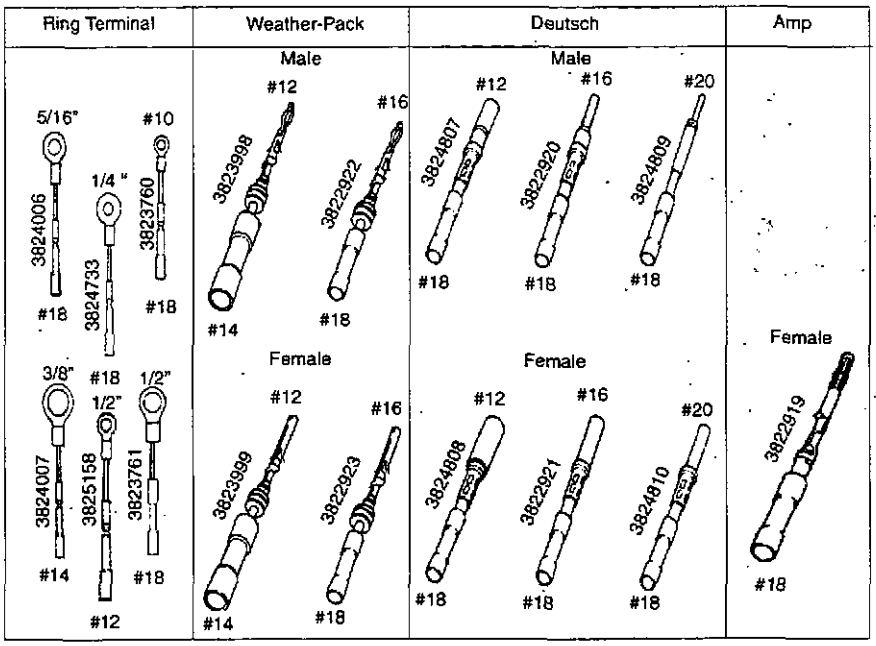
ECM A	ECM B
3824817	3824818
ECM Harness Connector	ECM Customer Harness Connector

40 Terminal #16 Size



Receptacle	Plug
3825179	3825180
ECM Harness In-Line Connector	Engine Harness In-Line Connector

Wire Repair



Miscellaneous Repairs

Connector Seals

Weather-Pack

4-Way

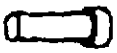
3824027

2-Way

3824025

Cavity Plugs

Weather-Pack
(Green)



3823343

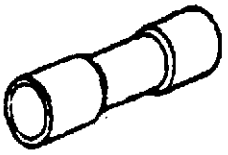
Deutsch
(White)

3824002

Butt Splice
(#18 - #22)

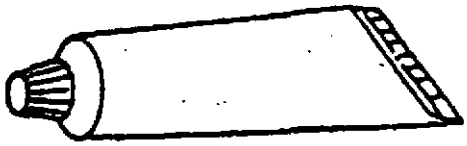
3823336

Butt Splice
(#14 - #16)



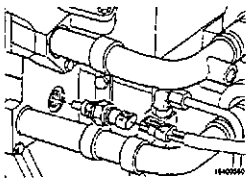
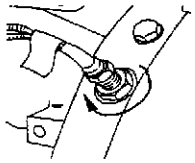
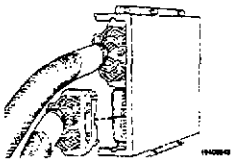
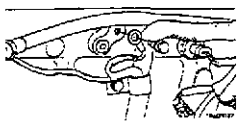
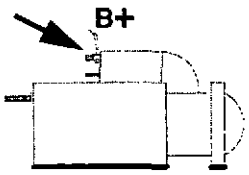
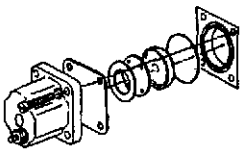
3824001

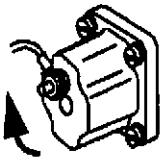
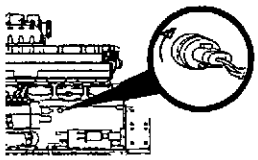
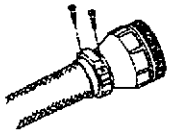
Lubricant



3822934

Electronic Engine Control - Torque Values

	Component or Assembly (Procedure)	Metric	U.S.
	**Coolant Temperature Sensor** Coolant Temperature Sensor	14 N·m	10 ft-lb
	**Engine Harness Connectors** *Deutsch Connector Allen Screw*	3 N·m	25 in-lb
	**Engine Speed Sensor (ESS)** Engine Speed Sensor Locknut	34 to 47 N·m	25 to 35 ft-lb
	**Customer and ECM Harness Connectors** Deutsch Connector Allen Screw	3 N·m	25 in-lb
	**Engine Block Ground Wire**	20 N·m	15 ft-lb
	**Engine Positive (B+) Wiring Connection** Starter Positive Terminal Post	27-34 N·m	20-25 ft-lb
	**Fuel Shutoff Valve (FSOV) Solenoid** Fuel Shutoff Valve Mounting Capscrew	8 N·m	72 in-lb

	Component or Assembly (Procedure)	Metric	U.S.
	**Fuel Shutoff Valve (FSOV) Solenoid** Shutoff Valve Solenoid Coil Terminal Nut	2 N·m	15 in-lb
	**Lubricating Oil Pressure Sensor** Lubricating Oil Pressure Sensor	14 N·m	10 ft-lb
	**Connector, 9-Pin** Cable Clamp Mounting Screws	0.75 N·m	6.6 in-lb

FAULT CODE TABLE

Fault Code	Reason	Effect
115	No engine speed signal detected between pins 21 and 22 of Engine Harness Connector.	Engine is shut down and cannot be run. Common Alarm output is energized.
135	High voltage detected at engine oil pressure sensor signal pin 12 of Engine Harness ECM Connector.	No effect on performance. Common Warning output is energized.
141	Low voltage detected at engine oil pressure sensor signal pin 12 of Engine Harness ECM Connector.	No effect on performance. Common Warning output is energized.
143	Engine oil pressure has dropped below the warning threshold for low oil pressure.	No effect on performance. Common Warning output is energized. Pre-low Oil Pressure relay driver is energized.
144	High voltage detected at engine coolant temperature sensor signal pin 14 of Engine Harness ECM Connector.	No effect on performance. Common Warning output is energized.
145	Low voltage detected at engine coolant temperature sensor signal pin 14 of Engine Harness ECM Connector.	No effect on performance. Common Warning output is energized.
146	Engine coolant temperature has exceeded the warning threshold for high coolant temperature.	No effect on performance. Common Warning output is energized. Pre-High Coolant Temperature relay driver is energized.
151	Engine coolant temperature has exceeded the alarm (shut down) threshold for high coolant temperature.	Engine will shut down. Common Alarm output is energized. High Coolant Temperature relay driver is energized.
171	Fuel pump rack position fault. One or both of the left bank or right bank fuel pump racks is not at the commanded position.	Performance could be sluggish or slow to respond. Common Warning output is energized.
234	Engine speed sensor signal on pins 21 and 22 of Engine Harness ECM Connector indicates engine speed greater than alarm (shut down) threshold.	Fuel shutoff valves are de-energized (valves closed). Common Alarm output is energized. Overspeed relay driver is energized.
342	The ECM has detected a memory checksum error in the memory containing critical engine parameters.	Engine will shut down. Common Alarm output is energized. (EMC data may be lost, including fault code data, adjustable parameter settings, ECM time, and engine run time.)
346	The ECM has detected a memory checksum error in the memory containing non-critical engine parameters.	None on performance. Common Warning output is energized. (ECM data may be lost, including fault code data, adjustable parameter settings, ECM time, and engine run time.)
415	Engine oil pressure has dropped below the alarm (shut down) threshold for low oil pressure.	Engine will shut down. Common Alarm output is energized. Low Oil Pressure relay driver is energized.

Troubleshooting Procedures and Techniques

⚠ WARNING ⚠

Troubleshooting presents hazards that can result in equipment damage, severe personal injury or death. Troubleshooting must be done by trained and experienced technicians.

A thorough analysis of the customer's complaint is the key to successful troubleshooting. The more information known about a complaint, the faster and easier the problem can be solved.

The Trouble Symptom Charts are organized so that a problem can be located and corrected by doing the easiest and most logical things first. Complete all steps in the sequence shown from top to bottom.

It **is not** possible to include all the solutions to problems that occur; however, these charts are designed to stimulate a thought process that will lead to the cause and correction of the problem.

Follow these basic troubleshooting steps:

- Get all the facts concerning the complaint
- Analyze the problem thoroughly
- Relate the symptoms to the basic engine systems and components
- Consider any recent maintenance or repair action that can relate to the complaint
- Double-check before beginning any disassembly
- Solve the problem by using the symptom charts and doing the easiest things first
- Determine the cause of the problem and make a thorough repair
- After repairs have been made, operate the engine to make sure the cause of the complaint has been corrected

Troubleshooting Symptoms Charts

Use the charts on the following pages to aid in diagnosing specific engine symptoms. Read each row of blocks from top to bottom. Follow through the chart to identify the corrective action.

For additional Troubleshooting Symptoms Charts pertaining to engine performance and the QST30 G-Drive Fuel System, see The QST Fuel System Troubleshooting and Repair Manual (Bulletin No. 3666184).

Symptom: Engine cranks but will not start (No Exhaust Smoke)

Cause	Correction
No fuel in tank or tank isolation valve closed	Add fuel to tank or check operation of isolation valve
OK ↓	
No battery voltage supply to ECM	Check wiring harness.
OK ↓	
Active fault code	Check for Oil Pressure, Engine Speed Sensor or Coolant Temperature Active Fault code.
OK ↓	
Engine Cranking speed to low	Check engine cranking speed with a hand held tachometer or electronic service tool. If the cranking speed is lower than 150 rpm, refer to the Engine Will Not Crank or Cranks Slowly symptom tree. Refer to Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Fuel Shutoff Valve closed	Check the Fuel Shutoff valve and circuit. Refer to Procedures 019-049 and 019-050.
OK ↓	
No fuel through feed pump	Break fuel line after feed pump, crank engine, observe fuel flow. Check for blockage in prefilter or connecting block. Replace or repair feed pump.
OK ↓	
Fuel pump not primed	Prime fuel pump (See procedure in Operator and Maintenance manual).
OK ↓	
No fuel to injectors	Check for blockage at overflow valve or fuel line Repair or replace. (Manual vent fuel system.)
OK ↓	

(Continue)

Symptom: Engine cranks but will not start (No Exhaust Smoke)(Continued).

Cause	Correction
Speed signal defective	Check Engine speed Sensor and wiring harness for defects.
OK ↓	
Air intake restriction.	Check the air intake system for restriction. Clean or replace the air filter and inlet piping as necessary. Refer to the operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Exhaust system restriction.	Check the exhaust system for restrictions.

Symptom: Engine cranks but will not start (Exhaust Smoke)

Cause	Correction
Fuel Level Low	Fill the supply tank.
OK ↓	
Active Fault Code	Check for Oil Pressure, Engine Speed Sensor or Coolant Temperature Active Fault code.
OK ↓	
Starting Aid is necessary for cold weather or starting aid is malfunctioning	*Check for correct operation of the starting aid.* Refer to the manufacturer's instructions. Refer to Cold Weather Starting Aids in the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Cranking speed is low	Check engine cranking speed with a hand held tachometer or electronic service tool. If the cranking speed is lower than 150 rpm, refer to the Engine Will Not Crank or Cranks Slowly symptom tree. Refer to Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Fuel inlet restriction	Check for fuel inlet restriction.
OK ↓	
Air in fuel	Check for air in the fuel system. Completely bleed air from the fuel system. Refer to the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Fuel transfer pump inlet screen is plugged	Clean or replace the fuel pump inlet screen.
OK ↓	

(Continue)

Symptom: Engine cranks but will not start (Exhaust Smoke)(Continued)

Cause	Correction
Air intake restriction	Check the air intake system for restriction. Clean or replace the air filter and inlet piping as necessary. Refer to the operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Exhaust restriction	Check the exhaust system for restrictions.
OK ↓	
Debris in fuel passage	Check the fuel tubes, fuel manifold, and cylinder head drilling for debris.
OK ↓	
Overhead adjustments are not correct	Adjust the overhead settings. Refer to the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Base engine problem	Check the engine for high crankcase pressure, low compression, static injection timing, damaged pistons, camshaft, and other parts.

Symptom: Engine will not reach rated speed (RPM).

Cause	Correction
Tachometer is **not** calibrated or is malfunctioning	Compare the tachometer reading with a hand tachometer or an electronic service tool reading. Calibrate or replace the tachometer as necessary. Refer to the OEM service manuals.
OK ↓	
Engine speed sensor (ESS) or circuit is malfunctioning	Check the ESS for correct adjustment and for debris on the sensor. Check the ESS circuit. Refer to Procedure 019-042 and 019-106.
OK ↓	
Engine parasitics are excessive	Check engine driven units for correct operation. Check the cooling fan for correct operation and cycle time. refer to the OEM service manual.
OK ↓	
Fuel inlet restriction	Check for fuel inlet restriction.
OK ↓	
Electronic fault codes active or high counts of inactive fault codes	Refer to Section TF in the Troubleshooting and Repair manual for fault code troubleshooting.
OK ↓	
Programmable parameters or selected features are not correct.	Check the programmable parameters and the selected features with an electronic service tool. Set the parameters and features again if necessary.
OK ↓	
Fuel grade is not correct for the application or the fuel quality is poor	Operate the engine from a tank of good fuel. Refer to Fuel Recommendations and Specifications in the Operation and Maintenance Manual QST30 Engine Bulletin No. 3666134.
OK ↓	
Load is excessive for engine horsepower rating	Reduce the load on the engine. *Refer to the OEM specifications.*
OK ↓	

(Continue)

Symptom: Engine will not reach rated speed (RPM)(Continued)

Cause	Correction
Over head adjustments are not correct	Adjust the overhead settings. Refer to the Operation and Maintenance Manual, QST30 Engine Bulletin No. 3666134.
OK ↓	
Fuel injection pump is malfunctioning	Remove and test the fuel injection pump. Replace the pump if necessary. Refer to the Operation and Maintenance Manual, QST30 Engine. Bulletin No. 36666134.
OK ↓	
Base engine problem	Check the engine for high crankcase pressure, low compression, static injection timing, damaged piston, camshaft, and other parts.

Engine Will Not Remain Running:

Cause	Correction
Electronic fault codes active or high counts of *inactive fault codes*	Refer to Section TF in the Troubleshooting and *Repair manual for fault code troubleshooting.*
OK ↓	
Emergency Stop Signal tripped	Check generator operator interface for Emergency Stop signal.
OK ↓	
If engine will **not** restart	Refer to the Engine Difficulty to Start or Will Not Start symptom tree in Troubleshooting and Repair Manual
OK ↓	
Battery voltage supply to the electronic control module (ECM) has been lost	Check The Battery connections. Refer to the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134. Check the un-switched battery supply circuit. Refer to Procedure 019-087.
OK ↓	
Run signal to the ECM has been lost	Check the Stop/Run switch and circuit. Refer to Procedures 019-014 and 019-015.
OK ↓	
Fuel shutoff valve(s) closed (electronic controlled injection)	Check the fuel shutoff valve and circuit. Refer to Procedures 019-049 and 019050.
OK ↓	
OEM engine protection system is malfunctioning	Isolate the OEM engine protection system. Follow the OEM service manuals to check for a malfunction.
OK ↓	
Fuel inlet restriction	Check for fuel inlet restriction.
OK ↓	

(Continue)

Engine Will Not Remain Running (Continued):

Cause	Correction
Air in the fuel system	Check for air in the fuel system. Completely bleed air from the fuel system. Refer to the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Fuel drain line restriction	Check the fuel drain lines for restriction. Clear or replace the fuel lines, check valves, or tank vents as necessary.
OK ↓	
Electronic control module (ECM) is malfunctioning	Replace the ECM. Refer to Procedure 019-031.
OK ↓	
Base engine problem	Check the engine for high crankcase pressure low compression, static injection timing, damaged piston, camshaft, and other parts.

Engine has rough performance:

Cause	Correction
Air in the fuel system	Check for air in the fuel system. Completely bleed air from the fuel system. Refer to the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Fuel inlet restriction	*Check for fuel inlet restriction.*
OK ↓	
Fuel drain line restriction	Check the fuel drain lines for restriction. Clear or replace the fuel lines, check valves, or tank vents as necessary.
OK ↓	
Fuel grade is **not** correct for the application or the fuel quality is poor	Operate the engine from a tank of good fuel. Refer to Fuel Recommendations and Specifications in the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Electronic fault codes active or high counts of inactive fault codes	Refer to Trouble shooting and Repair Manual section TF for fault code troubleshooting.
OK ↓	
Electronic control module (ECM) is **not** correct	Check the ECM part number and compare it to the Control Parts List, Bulletin No. 3379133. Replace the ECM if necessary. Refer to Procedure 019-031.
OK ↓	
Engine speed sensor (ESS) or circuit is malfunctioning	Check the ESS for correct adjustment and for debris on the sensor. Check the ESS circuit. Refer to Procedure 019-042 and 019-106.
OK ↓	
Overhead adjustments are **not** correct	Adjust the overhead settings. Refer to the Operation and Maintenance Manual, QST30 Engine, bulletin No. 3666134.
OK ↓	

(Continue)

Engine has rough performance (Continued):

Cause	Correction
Injector is malfunctioning	Replace the malfunctioning injector. Refer to the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Fuel pump overflow valve is malfunctioning	Check the overflow valve for correct operation.
OK ↓	
Fuel transfer pump is malfunctioning	Check the lift pump for correct operation. Check the pump output pressure. Replace the transfer pump if necessary. Refer to the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Debris in the fuel passages	Check the fuel tubes, fuel manifold, and cylinder head drilling for debris.
OK ↓	
Fuel injection pump is malfunctioning	Remove and test the fuel injection pump. Replace the pump if necessary. Refer to the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Static injection timing is not correct	Check the static injection timing when installing the fuel injection pump. Refer to the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Engine mounts are worn, damaged, or **not** correct	Visually check the engine mounts. Refer to the OEM service manual.
OK ↓	
Base engine problem	Check the engine for high crankcase pressure, low compression, static injection timing, damaged pistons, camshaft, and other parts.

Engine has Low Power:

Cause	Correction
Air in the fuel system	Check for air in the fuel system. Completely bleed air from the fuel system. Refer to the Operation and Maintenance Manual, QST30 Engine Bulletin No. 3666134.
OK ↓	
Engine parasitics are excessive	Check engine driven units for correct operation. Check the cooling fan cor correct operation and cycle time. Refer to the OEM service manual.
OK ↓	
Load is excessive for engine horsepower rating	Reduce the load on the engine. Refer to the OEM specifications.
OK ↓	
Engine is operating above recommended altitude.	Engine power decreases above recommended altitude. Refer to the Engine Data Sheet for specifications.
OK ↓	
Lubricating oil level is above specification	Check the oil level. Verify the dipstick calibration and oil pan capacity. Fill the system to the specified level. Refer to the Operation and Maintenance Manual, QST30 Engine Bulletin No. 3666134.
OK ↓	
Fuel level low in the tank	Fill the supply tank.
OK ↓	
Electronic fault codes active or high counts of inactive fault codes	Refer to Section TF for fault code troubleshooting.
OK ↓	
Programmable parameters or selected features are **not** correct	Check the programmable parameters and the selected features with an electronic service tool. Set the parameters and features again if necessary. Refer to the appropriate electronic service tool manual.
OK ↓	

(Continue)

Engine has Low Power (Continued):

Cause	Correction
Electronic control module (ECM) is **not** correct	Check the ECM part number and compare it to the Control Parts List, Bulletin No. 3379133. Replace the ECM if necessary. Refer to Procedure 019-031.
OK ↓	
Air intake system restriction	Check the air intake system for restriction. Clean or replace the air filter and inlet piping as necessary. Refer to the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Engine speed sensor (ESS) or circuit is malfunctioning	Check the ESS for correct adjustment and for debris on the sensor. Check the ESS circuit. Refer to Procedure 019-042 and 019-106.
OK ↓	
Fuel leaks	Check the fuel lines, fuel connections, and fuel filters for leaks. Check the fuel lines to the supply tanks.
OK ↓	
Fuel inlet restriction	Check for fuel inlet restriction.
OK ↓	
Fuel drain line restriction	Check the fuel drain lines for restrictions. Clear or replace the fuel lines, check valves or rank vents as necessary.
OK ↓	
Intake manifold air temperature is above specification	Check the aftercare element for coolant restriction and refer to the Coolant Temperature is Above Specification symptom trees in the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Intake manifold air temperature is below specification	Refer to the Coolant Temperature Below Normal symptom in the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	

(Continue)

Engine has Low Power (Continued):

Cause	Correction
Exhaust system restriction	Check the exhaust system for restrictions.
OK ↓	
Fuel pump overflow valve is malfunctioning	Check the overflow valve for correct operation.
OK ↓	
Fuel transfer pump is malfunctioning	Check the lift pump for correct operation. Check the pump output pressure. Replace the transfer pump if necessary. Refer to the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Fuel transfer pump inlet is plugged	Check the lift pump for correct operation. Check the pump pressure. Replace the transfer pump if necessary. Refer to the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Air intake or exhaust leaks	Visually inspect the air intake and exhaust systems for air leaks. Check for loose or damaged piping connections and missing pipe plugs. Check the turbocharger and exhaust manifold mounting.
OK ↓	
Turbocharger is **not** correct	Check the turbocharger part number and compare it to the Control Parts List (CPL), Bulletin No. 3379133. Replace the turbocharger if necessary.
OK ↓	
Fuel grade is **not** correct for the application or the fuel quality is poor.	Operate the engine from a tank of good fuel. Refer to Fuel Recommendations and Specifications. in the Operation and maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Fuel inlet temperature to pump is above specification	Fill the fuel tank, turn off or bypass the fuel heaters, and check the fuel cooler. Refer to the OEM service manuals.
OK ↓	

(Continue)

Engine has Low Power (Continued):

Cause	Correction
Static injection timing is **not** correct	Check the static injection timing when installing the fuel injection pump. Refer to the Operation and Maintenance manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Debris in the fuel passages	Check the fuel tubes, fuel manifold, and cylinder head drilling for debris.
OK ↓	
Injector is malfunctioning	Replace the malfunctioning injector. Refer to the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Overhead adjustments are not correct	Adjust the overhead settings. Refer to the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Fuel injection pump is malfunctioning	Remove and test the fuel injection pump. Replace the pump if necessary. Refer to the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Base engine problem	Check the engine for high crankcase pressure, low compression, static injection timing, damaged pistons, camshaft, and other parts.

Engine Acceleration or Response Poor

Cause	Correction
Verify the complaint	Test the engine operation while under load. Perform an engine acceleration test. Perform an engine load test. Observe the commanded rack position with INSITE™.
OK ↓	
Electronic fault codes active or high counts of inactive fault codes	Refer to Section TF for Fault code troubleshooting.
OK ↓	
Programmable parameters or selected features are **not** correct	Check the programmable parameters and the selected features with an electronic service tool. Set the parameters and features again if necessary. Refer to the appropriate electronic service tool manual.
OK ↓	
Engine parasitics are excessive	Check engine driven units for correct operation. Check the cooling fan for correct operation and cycle time. Refer to the OEM service manual.
OK ↓	
Load is excessive for engine horsepower rating	Reduce the load on the engine. Refer to the OEM specifications.
OK ↓	
Engine is operating above recommended altitude	*Engine performance decreases above recommended* altitude. Refer to the Engine Data Sheet for specifications.
OK ↓	
Intake manifold air temperature is below specification	Refer to the Coolant Temperature Below Normal symptom tree in the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Coolant temperature sensor is malfunctioning	Check the coolant temperature sensor. Refer to Procedure 019-019.
OK ↓	

(Continue)

Symptom: Engine Acceleration or Response Poor (continued):

Cause	Correction
Fuel inlet restriction	Check for fuel inlet restriction.
OK ↓	
Fuel transfer pump is malfunctioning	Check the lift pump for correct operation. Check the pump output pressure. Replace the transfer pump if necessary. Refer to the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Air in the fuel system	Check for air in the fuel system. Completely bleed air from the fuel system. Refer to the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Fuel drain line restriction	Check the fuel drain lines for restriction. Clear or replace the fuel lines, check valves, or tank vents as necessary.
OK ↓	
Air intake or exhaust leaks	Visually inspect the air intake and exhaust system for air leaks. Check for loose or damaged piping connections and missing pipe plugs. Check the turbocharger and exhaust manifold mounting.
OK ↓	
Air intake system restriction	Check the air intake system for restriction. Clean or replace the air filter and inlet piping as necessary. Refer to the Operation and Maintenance Manual QST30 Engine, Bulletin No. 3666134.
OK ↓	
Exhaust system restriction	Check the exhaust system for restrictions.
OK ↓	
Fuel grade is **not** correct for the application or the fuel quality is poor	Operate the engine from a tank of good fuel. Refer to Fuel Recommendations and Specifications in the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	

(Continue)

Engine Acceleration or Response Poor (continued):

Cause	Correction
Debris in the fuel passages	Check the fuel tubes, fuel manifold, and cylinder head drilling for debris.
OK ↓	
Fuel inlet temperature to pump is above specification	Fill the fuel tank, turn off or bypass the fuel heaters, and check the fuel cooler. Refer to the OEM service manuals.
OK ↓	
Debris in the fuel passage	Check the fuel tubes, fuel manifold, and cylinder head drilling for debris.
OK ↓	
Overhead adjustments are not correct	*Adjust the overhead settings. refer to the Operation* and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Fuel pump overflow valve is malfunctioning	*Check the overflow valve for correct operation.*
OK ↓	
Fuel transfer pump inlet screen is plugged	Clean or replace the fuel pump inlet screen.
OK ↓	
Fuel injection pump is malfunctioning	*Remove and test the fuel injection pump. Replace* the pump if necessary. Refer to the Operation and Maintenance Manual, QST30 Engine, Bulletin No. 3666134.
OK ↓	
Base engine problem	Check the engine for high crankcase pressure, low compression, static injection timing, damaged piston, camshaft, and other parts.

Symptom: Engine will not shut off

Cause	Correction
Electronic fault codes active or high counts of inactive fault codes	Refer to section TF for fault troubleshooting.
OK ↓	
Stop/Run switch circuit is malfunctioning	Check the Stop/Run switch circuit. Refer to Procedure 019-015.
OK ↓	
Engine is running on fumes drawn into the air intake.	Check the air intake ducts. Locate and isolate the source of the fumes. Repair as necessary. Refer to the OEM service manuals.
OK ↓	
Fuel Shutoff Valve is malfunctioning	Ground (short circuit) shutoff valve or remove FSOV Signal Wire. Refer to Procedures 019-014 and 019-015.
OK ↓	
Turbocharger oil seal is leaking	Check the turbocharger oil seals for leaks.

Publications

Available service/application literature is as follows:

Publication	Bulletin Number
• QST30-G1/G2/G3 Parts Manual	3672102
• QST30 Shop Manual	3666196
• QST30 O & M Manual	3666134
• QST30 G-Drive Wiring/Fault Code Diagram	3666185
• QST30 G-Drive Fuel System T & R Manual	3666184
• INSITE™ For QST30 G-Drive User's Manual	3666196
• QST30 G-Drive Pocket Fault Code Cards	3666242
• QST30 G-Drive Engine Installation Requirements	3884904

All of the literature listed above may be purchased from Gannett Direct Mail Services (GDMS) using

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Brazil and Mexico	Cummins Engine Co., Inc. International Parts Order Dept., MC 40931 Box 3005 Columbus, IN 47201-3005
Far East (excluding Australia and New Zealand)	Cummins Diesel Sales Corp. Literature Center 8 Tanjong Penjuru Jurong Industrial Estate Singapore
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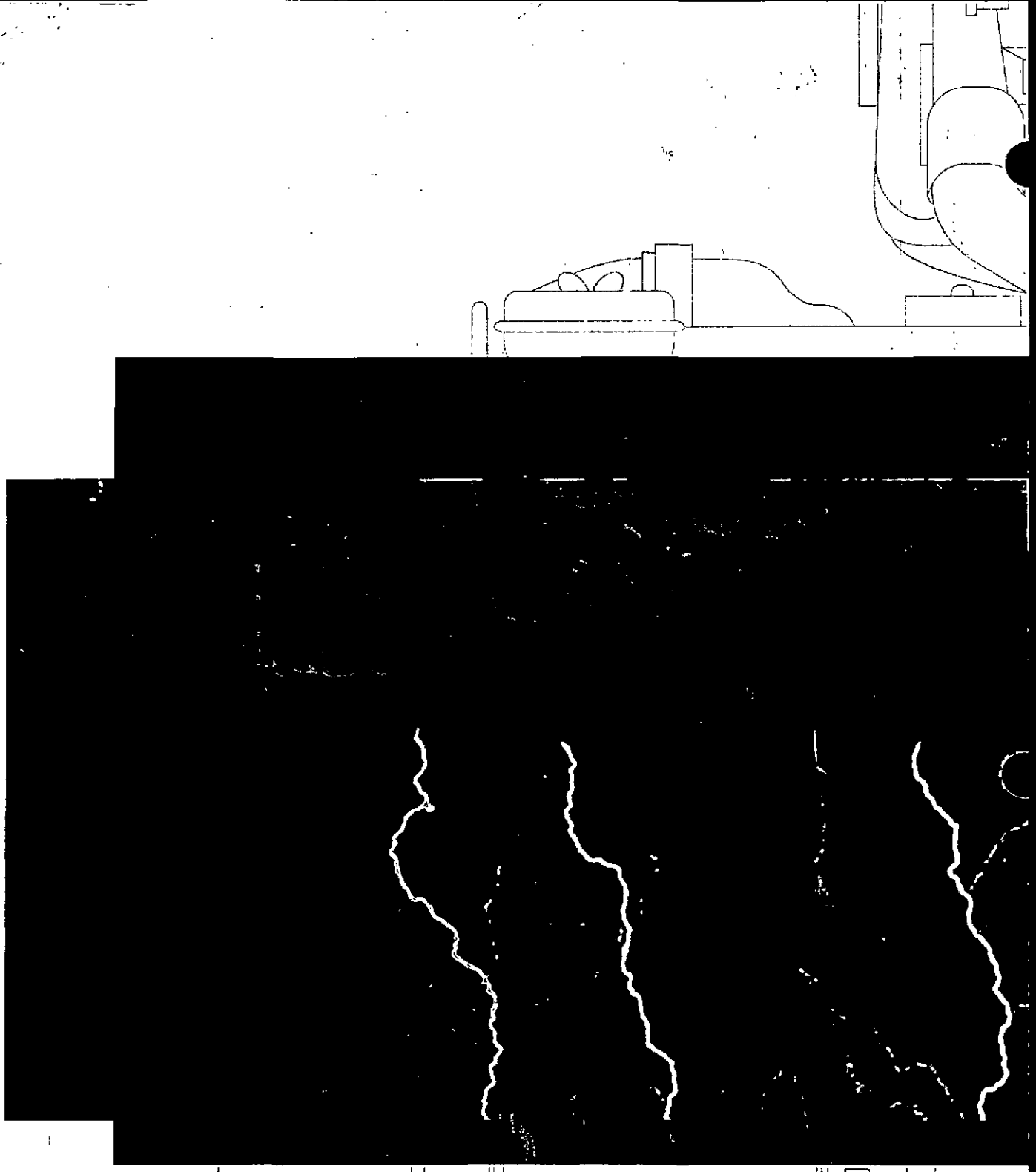

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