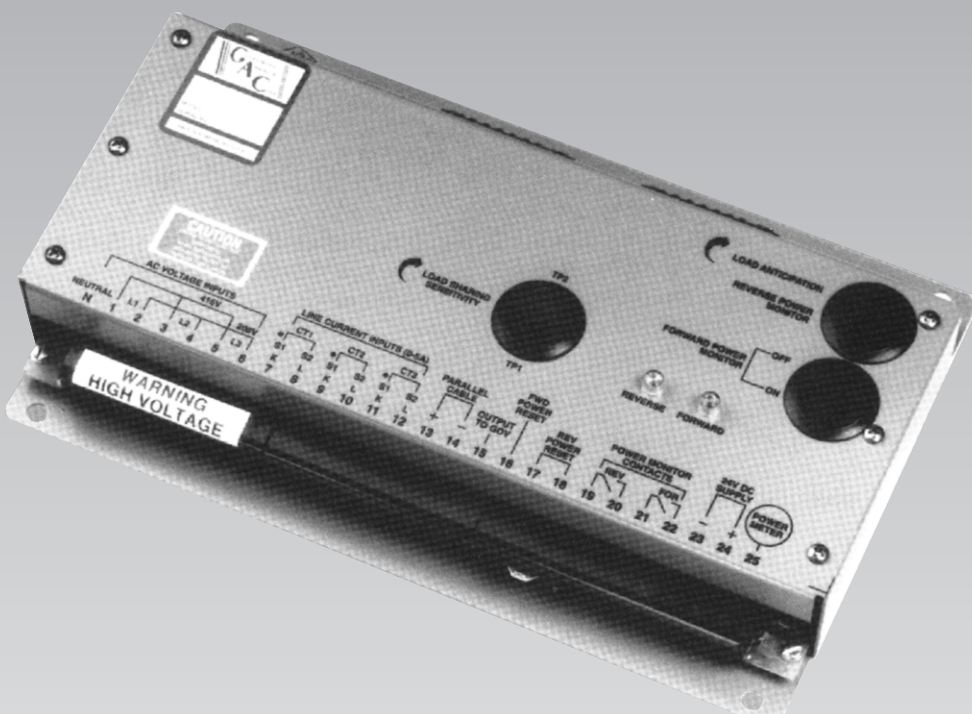
GOVERNORS AMERICA CORP.

ENGINE GOVERNING SYSTEMS

LSM672



LOAD SHARING MODULE

CE

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LSM672 LOAD SHARING MODULE	PRODUCT TECHNICAL INFORMATION	PTI 4000 / AUGUST 1997 MPC

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PRODUCT TECHNICAL INFORMATION

PTI 4000

AUGUST 1997
MPC

INTRODUCTION

The function of the Load Sharing Module is to proportionally share load between two or more generator sets while the system frequency is held constant. As an accessory to the Electronic Governing System, the LSM 672 measures the true power current, and through a parallel cable interconnection, continuously controls the governor system. A neutral "N" terminal is provided for connection to Wye type generator sets. This reduces third order harmonic errors in power and load sharing controls. The Load Sharing Module can share load with the utility's main bus by using various droop and power control connections. In addition to its primary function of load sharing, the unit also contains adjustable monitors for forward and reverse power. When a reverse power condition or a forward power limit are reached, a relay closure output is provided. A load anticipation circuit is also included to maximize transient performance in single or parallel operation.

DESCRIPTION

Engine generator sets with isochronous governors maintain the requested speed very precisely. If synchronous generators are electrically paralleled to increase the total generated power capability, a system to apportion the load is required. Even the finest electric governors will have minor frequency differences among units to be paralleled which would cause power variations. For this reason, one generator set will continuously increase the power it produces, while the other sets will decrease the power they produce. This condition eventually leads to motorizing one or more of the generator/engines. The load sharing system continuously adjusts the governor speed settings so that no average power difference exists. The generators are locked together through electrical synchronizing torques, and they act as though they are tightly connected through a gear drive.

The Load Sharing Module measures the power that the generator supplies to the bus. Voltage inputs accept two ranges of three phase voltage and cover most applications (See table in the specifications). In the design of polyphase generators, the presence of a third harmonic is possible. This odd harmonic may cause errors in load sharing systems. To minimize this error and improve load sharing, Terminal N should be connected to the neutral of a Wye configuration generator.

The line current measurements are usually taken from CTs existing in the equipment such as those used for ammeter circuits. The load sharing module adds an additional burden of only 6.25 VA to each transformer. Added cable resistance may also increase the burden. i.e. a 0.1 ohm additional cable resistance will result in 2.5 VA of additional CT capability rating.

The power measurement circuit develops a signal across the isolated parallel cable. The magnitude and sensitivity of the load sharing is adjustable through the SENSITIVITY control in the module. Test points, adjacent to this control may be used to measure the polarity and magnitude of the signal on the parallel cable. This measurement is very important when initially installing a system and these test points may also be used in troubleshooting the system. A measure of 0 to 7.5 VDC represents the zero load to full load (5 Amps in CTs) range for 3 phase systems. The SENSITIVITY adjustment can control the parallel cable voltage and test point voltage over the same 0 to 7.5 VDC range.

The parallel cable is the interconnection between each generator set. Across this cable each generator sends its load signal to a common point when the parallel cables circuit breakers contacts are closed. With all the parallel cables connected a current flows in the cable that is proportional to any imbalance of load between the generators. This imbalance is detected by the individual LSMs and a correction sent to each governor to minimize the differences. Since this parallel cable is a sensitive signal, shielded cables are recommended.

The load anticipation feature (load pulse) provides a signal that is a derivative function. A CW adjustment of the LOAD ANTICIPATION will make the governor more responsive to transient loads on the generator.

For convenience, independent Forward and Reverse Power Monitors are included in the Load Sharing Module.

When reverse power is sensed by the internal electronic circuits the internal relays 10 Amp contacts are closed. An LED on the cover will also light to indicate the reverse power condition. The trip point for the circuit is adjustable and has a range of 0.5 to 20% of reverse power. An inverse time delay of 2 seconds is built into the unit.

An adjustable forward power monitor features both "ON" and "OFF" set points which may be adjusted independently. Isolated N.O. 10 Amp relay contacts are provided along with an LED to indicate closure of the contacts. A CW adjustment of the "ON" control increases the trip point from 20 to 100%. A CW adjustment of the "OFF" control increases the trip point from 0 to 80%. A minimum 20% difference between the "ON" and "OFF" set points must be maintained. All load percentages are based on a 5 Amp CT current = 100% unity power factor load. The forward power monitor includes a 2 second time constant and may be manually reset.

An internal 5.1 VDC reference is adjusted to match the Load Sharing Module to various governors speed controls. For all GAC speed controls a factory setting at 5.1V is required. This reference adjustment is the adjustment located closest to terminal 24. See "Reference Adjustment Setting Procedures" further in this publication.

SPECIFICATIONS

PERFORMANCE

Load Sharing . . . . Adjustable to within ±2% between sets
Performance . . . . Isochronous and droop paralleling and power control
Reverse Power Monitor . . . . Adjustable from 0.5-20% with a 2 second inverse time constant

Forward Power Monitor . . . . "ON" trip point adjustable from 20-100%
"OFF" trip point adjustable from 0-80%
Normally open contacts with a 2 second inverse time constant
Power Output Signal . . . . 0 to 7.5 Volts DC representing 0-100%'load

All performance specifications are based on 5 amps from the current transformer (CT) secondaries at full load unity P.F.

POWER INPUT

AC Input Signals . . . . 208 or 416 Volt nominal line to line and 5 Amp CTs with a minimum 6.25 VA rating.
. . . . Internal 0.25 ohm burden resistors
Line to Line Voltages . . . . per table below

HZ	LOW RANGE	HIGH RANGE
50	140-250 VAC	260-420 VAC
60	170-260 VAC	340-500 VAC
400	170-260 VAC	340-500 VAC

DC Supply . . . . 18 - 36 VDC (Transient and reverse voltage protected)
For 12 VDC applications use LSM 672-12
Polarity . . . . Negative ground (case isolated)
DC Power Consumption . . . . 70 ma continuous
Power Output Signal . . . . 0 - 7 Volts based on 5 amps of C.T. output

ENVIRONMENTAL

Temperature Range . . . . 40º F to + 175º F (-40º C to +80º C)
Relative Humidity . . . . 100% - Circuit board heavily conformal coated
All Surface Finishes . . . . Fungus proof and corrosion resistant

PHYSICAL

Dimensions . . . . See Diagram 1
Weight . . . . 5.2 Lbs. (2.36 Kgs)
Mounting . . . . Any position, vertical preferred

RELIABILITY

Testing . . . . 100% Functional tested
Vibration . . . . 1 g @ 20-100 Hz
Shock . . . . 10 gs

Special Versions

LSM 672-C . . . . AC VOLTAGE INPUT NOMINALLY 120 VAC LINE TO LINE
LSM 672A-1 . . . . TERMINAL 25, POWER OUTPUT SIGNAL WITH RESPECT TO TERMINAL 16
(TERMINAL 16 FUNCTION DISABLED) OUTPUT= 0 to 7 VDC FORWARD
POWER AND 0 to -2 VDC REVERSE POWER.
LSM 672-1 . . . . FOR MAINS POWER CONTROL OPERATION. See publication PT14003

INSTALLATION

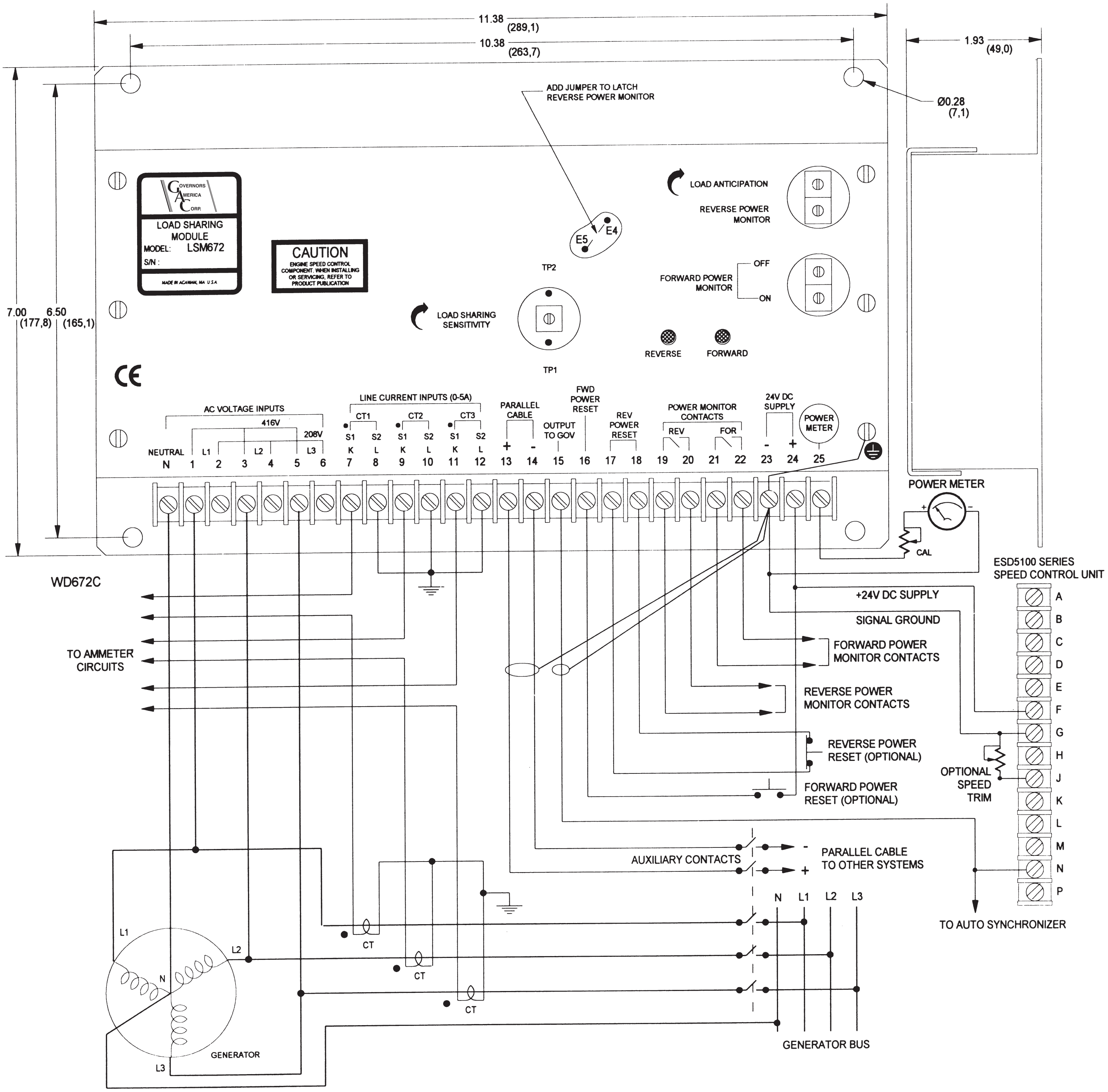
The unit is typically mounted in the generator set control cabinet with the other dedicated control equipment. Position the unit so that the natural flow of cooling air is not obstructed. The unit's three large burden resistors will dissipate up to 6.25 watts each.

WIRING

Electrical connections are illustrated in Diagram 2. Choice of the proper wire size is dependent on the maximum current expected at specific terminals of the load sharing module. Terminals 7-12 can reach a maximum of 5 amps. All others are less than 50 ma, with the exception of the relay contacts which are rated up to 10 Amps.

Terminal N is the neutral connection for a 3 phase voltage, "Wye," configuration generator.

Diagram 1. SYSTEM WIRING/OUTLINE



Terminals 1-6 accept for the 3 PHASE VOLTAGE inputs. Selection of the proper 3 terminals is dependent on the generator voltage. See Specification, page 2.

CAUTION.
HIGH VOLTAGE PRESENT AT TERMINALS N & 1-6 TERMINAL STRIP COVER MUST BE IN PLACE WHEN IN OPERATION

Terminals 7-12 accepts the 3 PHASE CURRENT input from 5 amp current transformers. Series connections can be made from instrument panel CTs providing the VA rating is adequate. The CT burden of the load sharing module is 6.25 VA for each phase. This will add to the burden rate of the panel instruments and wiring on the CTs. Note the common CT connections at terminals 8,10 and 12. This is required for CE approved applications.

Terminals 13 and 14 are the PARALLEL CABLE connections which link all load sharing modules together. Proper polarity must be observed. If these cables are longer than 3 ft. (1 m) they must be shielded with the shield grounded at Terminal 23. The relay contacts used must be suitable for low current levels, < 1 ma (Dry contacts).

Terminal 15 is the load sharing OUTPUT TERMINAL to the governor system speed control unit. If this cable connection is longer than 3 ft (1 m), it must be shielded. Ground the shield at Terminal 23.

Terminal 16 is the FORWARD POWER RESET A momentary connection to a +10 VDC source on the governor speed control using a normally open switch will automatically reset the forward power relay to the OFF condition. Connecting Terminal 16 to battery negative turns on the monitor. The forward power monitor may also have programmed switch points through Terminal 16. Connecting a 1 megaohm resistor between Terminal 16 and battery minus (terminal 23) shifts a 100% ON/40% OFF setting down to a 85% ON/5% OFF setting. If different programming is required, consult GAC's engineering for assistance.

Terminals 17 and 18 are for a REVERSE POWER RESET momentary switch. The unit is factory shipped with a jumper connected, for automatic reset. This automatic reset will cause the internal relay will remain energized only when the reverse power level is above the reverse power set point.

The reverse power relay can be setup to latch and then be manually reset by an external switch at terminals 17 to 18 with the following modification. Install a soldered wire link between posts E4 and E5 on the circuit board. The posts are accessible by removing the unit's cover. See Diagram 1 for post positions.

Replace the factory installed jumper between Terminals 17 and 18 with a N.C. momentary switch. The reverse power relay and sensing circuit will reset to the OFF condition when switch is opened.

Terminals 19 and 20 are the REVERSE POWER RELAY OUTPUT TERMINALS. Contacts are N.O. and rated for 10 amps (LED lights).

Terminals 21 and 22 are the FORWARD POWER RELAY OUTPUT TERMINALS. Contacts are N.O. and rated for 10 amps (LED lights).

Terminal 23 is the battery negative connection and is connected to the ground reference terminal at the control unit. Do Not connect directly to battery minus or a ground loop will be formed.

Terminal 24 is connected to the positive side of a 24 volt battery supply.

Terminal 25 provides a D.C. voltage proportional to the power output of the generator set. Ground reference is Terminal 23. Further information may be found in the section on the Power Output Signal.

PRE-PARALLELING CHECKS

1. Load Sharing Sensitivity adjustment — Full clockwise position.
2. Load Anticipation adjustment — 1/4 turn from full counterclockwise (OFF) position.
3. Governor Speed Set point — trim to desired speed setting.
4. CT Phasing check requires DC voltage measurements. Measure across the test posts (TP1 and TP2) observing instrument polarity, TP1, the lower post, is (+). This voltage is directly proportional to unity P.F. load. A voltage of 0 to 7.5 VDC can be expected, depending on load, Load Sharing Sensitivity adjustment, and CT ratios.

With the generator set under load, check the CT phasing momentarily and sequentially short each CT one at a time, with an insulated lead at Terminals 7-8, 9-10, or 11-12. Each time a CT is independently shorted, the voltage reading will be reduced by 1/3. If the voltage change is not 1/3, this very likely indicates improper CT or voltage phasing. Corrections to CT phasing must be performed while the generator set is not running.

CAUTION
DO NOT OPEN CIRCUIT CT CONNECTIONS WHILE THE GENERATOR SET IS RUNNING, HIGH VOLTAGE WILL BE PRESENT. INSURE TO REPLACE, TERMINAL BLOCK COVER AFTER ALL WIRING IS COMPLETED.

ADJUSTMENTS

With the generator paralleled to the other generator(s) and with no load on the system, adjust each generators speed setting using the governor speed trim control for zero power as indicated on each generator sets wattmeter and proper system frequency (50,60 or 400 Hz). Also, adjust the generators AC voltage regulators setting for zero circulating AC current. Electrical load can now be applied to the system.

Load Sharing

All generator sets in the system should be sharing the system load proportionately. The generator set carrying less than its share of the load should be adjusted to accept more of the system load. Move the appropriate LOAD SHARING SENSITIVITY adjustment counterclockwise to increase its contribution of load.

Load Anticipation

LOAD ANTICIPATION adjustment is factory set at 1/4 turn from full counterclockwise. To improve transient response, gradually advance the adjustment clockwise while the engine generator sets are in parallel. The transient response improvement can be observed with engine load changes. Instability may result if the adjustment is advanced too far clockwise. A conservative adjustment is suggested.

Droop

Droop operation may be required under certain circumstances. To obtain droop, disconnect the parallel cable connections from Terminals 13 and 14. Place a jumper between Terminals 13 and 14. Turn the LOAD SHARING SENSITIVITY adjustment clockwise to increase the percentage of droop. Or connect a 100K variable resistor across the open parallel cable terminals 13 and 14. Adjustable droop of about 5% can be obtained. See the Power Control Bulletins for further information on droop operation.

Reverse Power

Reverse Power monitor adjustment is factory set at full clockwise for the highest trip point setting. Adjust the Reverse Power monitor counterclockwise to set the reverse power relay trip point. The range of this adjustment is 0.5% to 20% based on 5 Amp CT secondary output. With the desired level of real or simulated reverse power applied to the generator, set the reverse power relay trip point.

Note: Reversing the polarity connections of each CT and then applying normal electric load simulates a reverse power condition. After adjustment, correctly replace all CT connections.

If a longer inverse time constant is desired, add a 10 mfd capacitor to posts E3 and E4 (+). This doubles the time constant, making it approximately 4 seconds.

Forward Power

The Forward Power Monitor is typically used as an action signal for an additional engine to start when the power demand increases or to signal an engine to shut off when the power demand is reduced.

The Forward Power monitor “ON” adjustment is factory set full clockwise (>100%). The Forward Power monitor “OFF” adjustment is factory set full counterclockwise (<20%). The “ON” adjustment must always precede the “OFF” adjustment.

Slowly raise the engine generator set load to the desired “ON” forward power relay trip point. Rotate the “ON” adjustment counterclockwise until the forward power LED lights and the relay energizes. Slowly reduce the engine load to the desired “OFF” forward power relay trip point. Rotate the “OFF” adjustment CCW until the forward power LED extinguishes and the relay de-energizes.

Adding a 10 mfd capacitor between posts E6 and E7 (+) doubles the inverse time constant to 4 seconds.

The load percentages referred to are based on a 5 Amp CT secondary current at full engine load and are approximate.

POWER OUTPUT SIGNAL

A DC signal proportional to the power measured is available at Terminal 25. The voltage range is 0 to 7.5 VDC based on a 0 to 5 Amp CT current range. The impedance of Terminal 25 is 1 K ohms and Terminal 23 is the ground reference. This output is a voltage based signal.

This signal may be used to drive a 0-1 MA meter movement if the meter and a 10K ohm calibration potentiometer are connected in series between Terminal 25 and 23.

SYSTEM TROUBLESHOOTING

1.0 Reconfirm the 3 phase AC Voltages are present and within specification. Also confirm that a neutral connection to the generator has been made.

2.0 With DC applied to terminals 23 and 24, measure the units output voltage from terminals 15 and 23. This should be 5.0 VDC ± 0.1 VDC.

3.0 Measure the parallel cables voltages at No Load.
13 to 14 Nominally 0 VDC ±- .05 VDC
13 to 23 Nominally 5.0 VDC
14 to 23 Nominally 5.0 VDC

4.0 Recheck the CT phasing. Measuring the AC voltage across each CT input will also confirm equal CT currents.

5.0 If instability is present when the generator sets are in parallel, equally reduce the Load Sharing Sensitivity adjustment of each load sharing module. Rotate the adjustments in small increments counterclockwise on all of the load sharing modules in the system until stability is restored. If the Load Sharing Sensitivity adjustment is reduced to less than 25%, poor load sharing may result. Further check to insure that the Load Anticipation adjustment is at the factory setting of 1/4 turn from full counterclockwise.

6.0 If the instability still persists, open the parallel cable and add a jumper across the parallel cable connection, Terminals 13 and 14, of each unit. Droop will be present, but the system should be stable. If not, check the generator voltage regulator stability.

SPECIAL APPLICATIONS

In addition to load sharing, the LSM672 is capable of generator power control and main bus power management. Request the applicable publication.

PT14002 Generator Power Control
An LSM672 may be used to control the generation of power from engines tied to a main bus. A simple manual adjustment sets all engines to deliver constant power to a main bus.

PT14003 Mains Incoming Power Control
The LSM672 can monitor a main bus and signal the generators to adjust their contribution to the system load to hold constant or limit the mains power.

PT14040 Using the Power Ramp Control
The PRC100A Power Ramp Control from GAC can be used to ramp the generator load. Import and/or Export control, or individual generator control can be achieved with the PRC100A to smoothly ramp the generator(s) on or off the main bus.

Internal Post Functions
Post E1 and E2 may be connected with a jumper to convert to the 3.1 V reference used by some competitive governor systems.

Post E8 allows checking of the 5.1V reference supply.

Post E9, E10, E11 and E12 are used to invert the signal of the output circuit. The normal configuration is for E9 and E10 to be jumpered and for E11 and E12 to be jumpered.

Peak Shaving (LSM672-1)
For peak shaving applications, remove the E9 to E10 and E11 to E12 jumper wires. Install a jumper wire between posts E9 and E11. Install a 42.2K ohm resistor between posts E10 and E12. The unit is now an LSM672-1. Refer to PTI 4003 for application instructions.

REFERENCE ADJUSTMENT CALIBRATION

To adjust and calibrate the internal reference bias, apply DC and AC voltages to the LSM 672. At no load, remove Terminal 15 to the speed control unit. Measure Terminals 15 and 23. Adjust this voltage for 5.0 VDC.