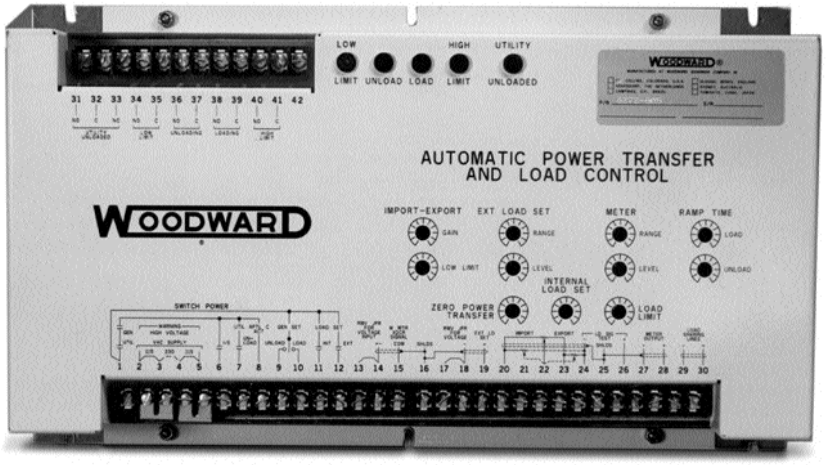
WOODWARD

Product Manual 82381
(Revision E)
Original Instructions



APTL Automatic Power Transfer and Load Control

Installation and Operation Manual

General Precautions

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.

Practice all plant and safety instructions and precautions.

Failure to follow instructions can cause personal injury and/or property damage.

Revisions

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, on the *publications page* of the Woodward website:

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Proper Use

Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.

Translated Publications

If the cover of this publication states "Translation of the Original Instructions" please note:

The original source of this publication may have been updated since this translation was made. Be sure to check manual *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, to verify whether this translation is up to date. Out-of-date translations are marked with ⚠. Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

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Important Definitions

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

- **DANGER**—Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
- **WARNING**—Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
- **CAUTION**—Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
- **NOTICE**—Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT**—Designates an operating tip or maintenance suggestion.

⚠WARNING

Overspeed / Overtemperature / Overpressure

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

⚠WARNING

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:

- **Eye Protection**
- **Hearing Protection**
- **Hard Hat**
- **Gloves**
- **Safety Boots**
- **Respirator**

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

⚠WARNING

Start-up

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

⚠WARNING

Automotive Applications

On- and off-highway Mobile Applications: Unless Woodward's control functions as the supervisory control, customer should install a system totally independent of the prime mover control system that monitors for supervisory control of engine (and takes appropriate action if supervisory control is lost) to protect against loss of engine control with possible personal injury, loss of life, or property damage.

NOTICE

Battery Charging Device

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.**

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual *82715*, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Follow these precautions when working with or near the control.

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

Chapter 1.
General Information

Description

The Automatic Power Transfer and Load Control (APTL) is used to eliminate power bumps or surges at the moment of connecting or separating a local generator system from the utility. While parallel with a utility, the APTL can be used to load or unload a generator system, using Woodward electronic controls, at controlled rates, as a base-load setting device, as an import/export control, or as a zero-power transfer control.

In operation, the APTL tracks the voltage on the load-sharing lines of the local generating system. When this generating system is paralleled to a utility, the APTL biases the system load-sharing lines with a voltage which holds the local generating system to the same power level as that being generated at the moment of paralleling.

The APTL prevents a load bump on either a loaded or unloaded local bus when the two systems are properly synchronized with other equipment for voltage, frequency, and phase, and the paralleling breaker is closed.

The level of power being generated at the moment of paralleling is maintained until changed by one of the following loading or unloading modes:

- External loading or unloading contacts
- Internal load set
- External load set, from a potentiometer, a computer, or other set-point controlling device
- Utility unload
- Import/Export

When using any of the first four modes, the load ramp can be set at any rate between 0 and 100% of full load in 5 seconds to a change from 0 to 100% of full load in 2 hours. The desired load and unload rates are obtained by setting an internal load-range dip switch to one of five overlapping ranges and then setting the load and unload ramp rate potentiometers for the rates desired.

In the Import/Export mode, the rate of load response change is controlled by the setting of the import! export gain. This adjustment is normally set for the best transient-load response.

In the Utility Unload mode, the load will be ramped up or down at the set rate until the zero-power-transfer set point is obtained. The control then automatically shifts to the Zero-Power Transfer mode, using the import/export response rate to maintain the zero-power set point within the capability of the generating system. The “Utility Unload” contacts change to indicate zero power transfer.

Indicators and Relay Contacts

The APTL has indicator lights and relay contacts for local indication and for use as remote indication or as logic contacts. Indications are: High Limit (red when at high limit); Low Limit (green when at low limit); Loading (amber while loading); Unloading (amber while unloading), and Utility Unloaded (green when no power is flowing through the transfer bus.)

The relays are energized and their circuits closed when the indicator lights are on. The Utility Unloaded relay is a single-pole, double-throw relay which provides closed circuits in both positions.

Construction

The APTL is contained in a sheet-metal enclosure. All electronics in the system are solid state, installed on a single, high-quality, printed-circuit board. All adjustments are available through holes in the front of the control except the selection of loading-ramp range which requires access to an SPST (single-pole, single-throw) four-rocker dip switch on the PC board.

The terminal board provides 41 connections for all inputs and outputs. (Not all connections will be required for any one system.) Terminals are provided for shields where required.

IMPORTANT

The APTL is not a synchronizer nor a speed control and must be used with load-sharing speed controls to control prime-mover speed and/or load. The APTL is an auxiliary device to be used with load-sharing governors.

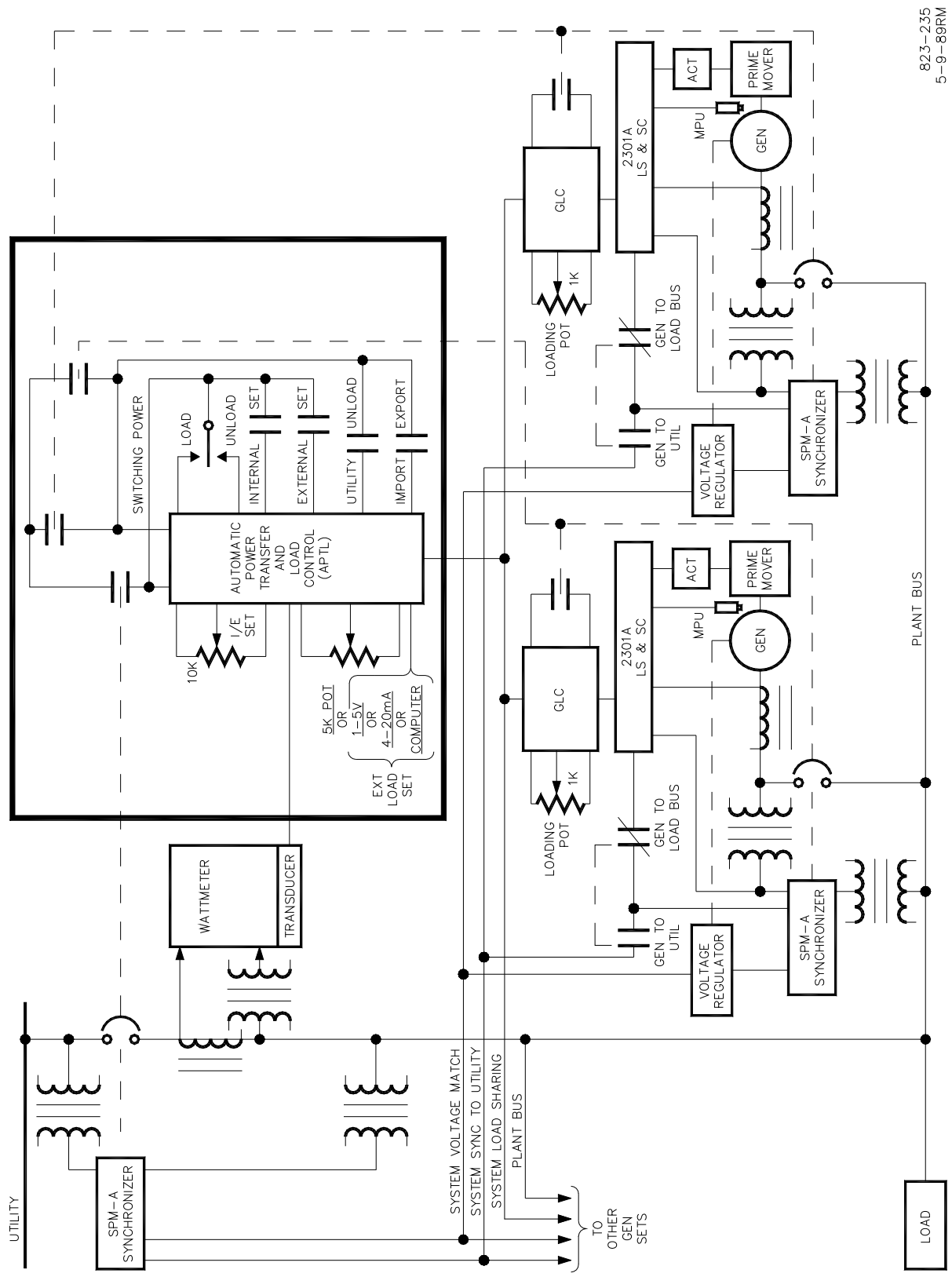


Figure 1-1. Typical Multiple Generator System with APTL Control

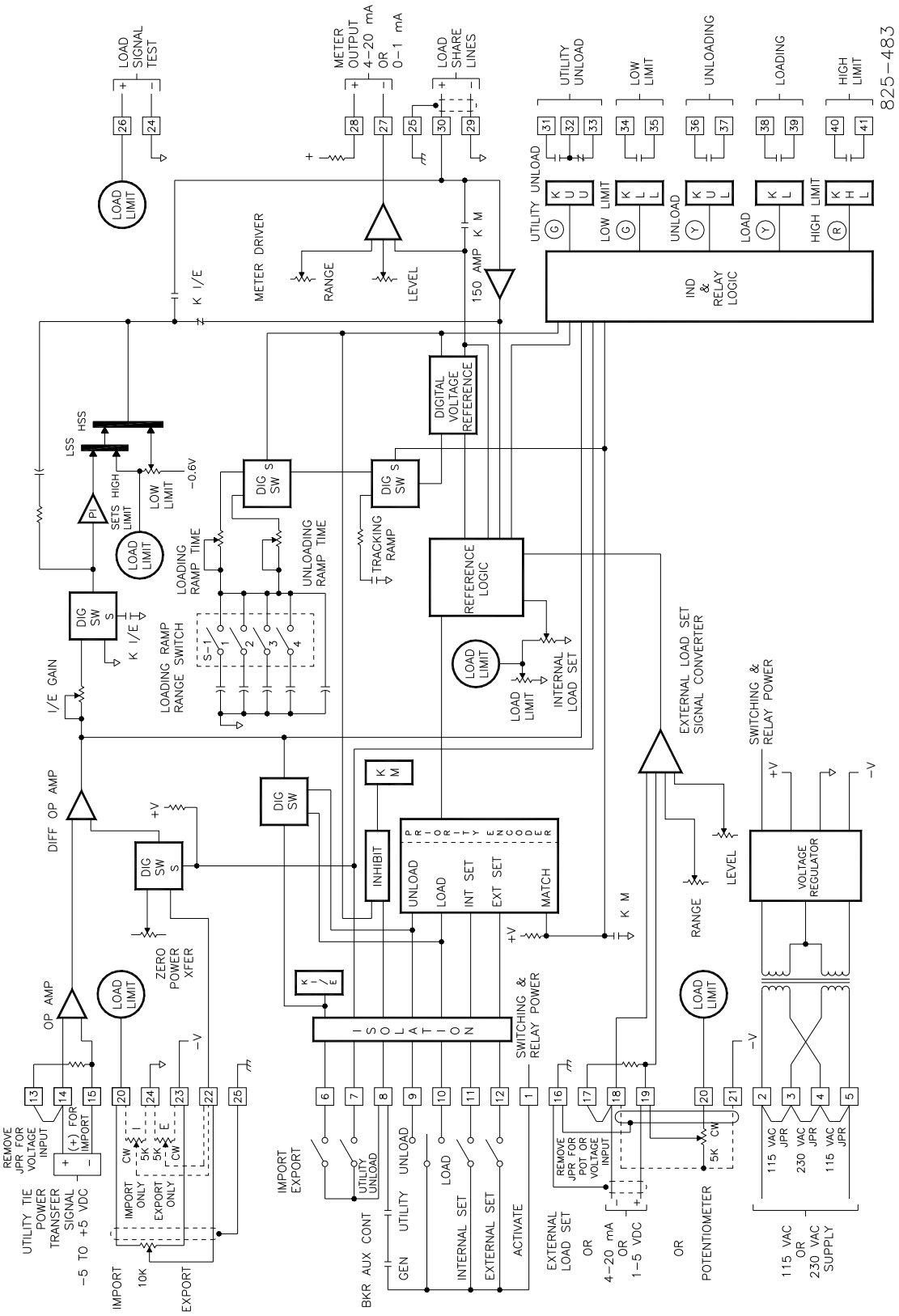


Figure 1-2. APTL Control Block Diagram

Chapter 2. Applications

Exercising Standby Generators

Proper exercising of a standby generator system requires that the standby system be started and brought to control speed, synchronized and paralleled with the utility, loaded with the plant load, disconnected from the utility, then reconnected to the utility and gradually unloaded before being disconnected from the utility and shut down.

The APTL, when combined with electronic load sharing and speed controls and special synchronizing equipment, provides an automatic method of exercising emergency generator or standby systems.

The emergency system is started and synchronized with the utility. Paralleling at no load on the standby generator is accomplished with the synchronizer. The APTL then holds the emergency generator at no load.

Switching logic (usually generator-circuit-breaker auxiliary contacts) will close the Utility Unload contacts in the APTL, causing the local load to be transferred from the utility to the emergency! standby the normal sequence of synchronizing, generator at the selected rate. When the transfer is completed the single-pole, double-throw Utility Unloaded contacts will operate. These contacts can then be used to initiate an automatic separation from the utility. After exercising the standby generators, a bumpless return to the utility will be accomplished through paralleling, and then using the unload mode and the low limit contacts in the APTL to initiate separation and shutdown of the standby system.

The APTL permits the transfer of the load back to the utility without the usual impulse or step-loading effect.

Computer Load Control

The “External Load Set” input is used with systems where a computer is to control the desired load. This input is compatible with 0 to 20 mAdc and 4 to 20 mAdc, or 0 to 5 Vdc and 1 to 5 Vdc signals (see Figure 4-4).

The control-signal input stage is a differential circuit with level and range adjustable to suit the input signal. The internal burden on the input signal is 250 Ω for the milliampere input and 10 kΩ for the voltage input.

Load and Unload Ramp Time

The rate of the APTL’s load-increase and load-decrease ramps can be varied from 20% of full load per second to 0.013% of full load per second. This translates to a 5-second ramp at one extreme and a 132-minute ramp at the other extreme. Ramp time is obtained by selecting a ramp-time range on an internal dip switch and then trimming this to the exact ramp rate desired with an adjustment available on the front of the APTL. The internal switch is set at the factory according to specifications on the APTL order. If no ramp rate or time is specified, the Load Ramp Range Switch will be set for 5 to 25 seconds with all four S1 switches open.

The range of the load-unload ramp is set with a dip switch. Separate load and unload ramp-time adjustments are available to trim this ramp within the selected range.

The load-change response in the import/export mode is controlled by the setting of the I/E gain on the front of the APTL. The I/E gain is normally set for optimum system response (the highest gain retaining good control-loop stability during transient loads.)

Utility Unload

The APTL can be used to force the power being transferred to or from the utility to zero before isolating the two systems. A transducer output, from the wattmeter monitoring the power transfer between the local bus and the utility, is used as an input to the APTL . Selecting the Utility Unload mode starts a sequence where the output of the APTL causes the load-sharing and speed controls to increase or decrease the local generating-system output until the power transferred between the two systems is zero. At that point the local generating system is supplying all the load on the local bus and none in excess.

The single-pole, double-throw utility unloaded contacts will operate to indicate that no power is flowing through the transfer bus. The contacts can be used to initiate the separation from the utility. Opening the utility auxiliary contacts returns the APTL to the tracking mode and the local generator system to isochronous or isochronous load share.

The operating mode of the APTL is changed to Gen Set Unload if the utility is to carry the plant load upon separating the local generating system from the utility. In this instance the local generating system will be unloaded at the rate set by the unload ramp. The low-limit relay will energize and the indication contacts close when the APTL has ramped the load down to the low limit. The low-limit contacts can be used to initiate separation of the local generating system from the plant load.

Import/Export Control

The APTL can be used as an import/export control. The ‘Import/Export’ contact is selected for this mode. To prevent overload the “Load Limit” is adjusted to limit the output signal from exceeding a 100% demand on the plant-generating system. Setting the “I/E Low Limit” to limit the output at a signal of zero or above, prevents a reverse-power condition. The control point for import or export is set by an external potentiometer. The import/export circuitry also tracks the load on the local generating system. When activated, the import/export function will change the load on the system at a response rate set by the I/E Gain control, up or down to satisfy the control set point. This permits an oncoming system to be loaded at a slow rate using one of the loading modes and then shifting to the Import! Export mode where the load-response rate is set for the best load response for the system.

If the system is to be used for zero power Import/Export control, the “Utility Unload” contacts are closed. This action shifts the control-point setting to the internal “Zero Power Transfer” adjustment. This internal setting has priority in case the Import/Export contacts and the Utility Unload contacts are both closed. If both contacts are selected at the same time the APTL will unload at the Import/Export rate and not at the slower Unload or Load Ramp time. The Utility Unload contacts also activate the circuitry controlling the Utility Unloaded relay for external indication of when there is no power passing through the tie line.

Switch Priority

Utility Unload: This switch takes precedence over all other switches. When Utility Unload is closed the APTL will be in the Utility Unload mode and will ramp the load up or down to obtain a match with the Zero Power Transfer set point. Once matched, the APTL will control the load at the Import/Export rate and maintain the Zero Power set point. While the Utility Unload function is being carried out the Generator Unload switch has priority. After Zero Power set point is reached the operating mode is switched to the Import/Export dynamics and the ramping mode, which includes the Unload switch function, is disabled.

Import/Export: When this contact is closed the APTL will be in the Import/Export mode. This contact has precedence over the Load/Unload modes. Utility Unload Zero Power Transfer set point has priority over the Import/Export set point.

Unload: This contact has precedence over the Load mode, the Internal set point, and the External set point.

Load: This contact has precedence over the Internal set point and the External set point modes.

Internal Set Point: This contact has precedence over the External set point mode.

External Set Point: This contact is in control only if all other load control contacts are open.

Meter Output

A meter output is provided from the APTL. This output is proportional to the voltage-reference level. A 0 to 1 mA or 4 to 20 mA meter can be connected to this output for indication of the demand on, or power level of, the local generating system. During isolated operation (separated from the utility) the meter output will be proportional to actual plant load. When paralleled to the utility the meter output will be proportional to the load demand on the plant generating system. Level and Range adjustments are provided for calibration of the meter output.

Compatibility

The APTL is designed for use with any of Woodward's load sharing and speed controls including 2301, 2301A, EGA, and EPG systems.

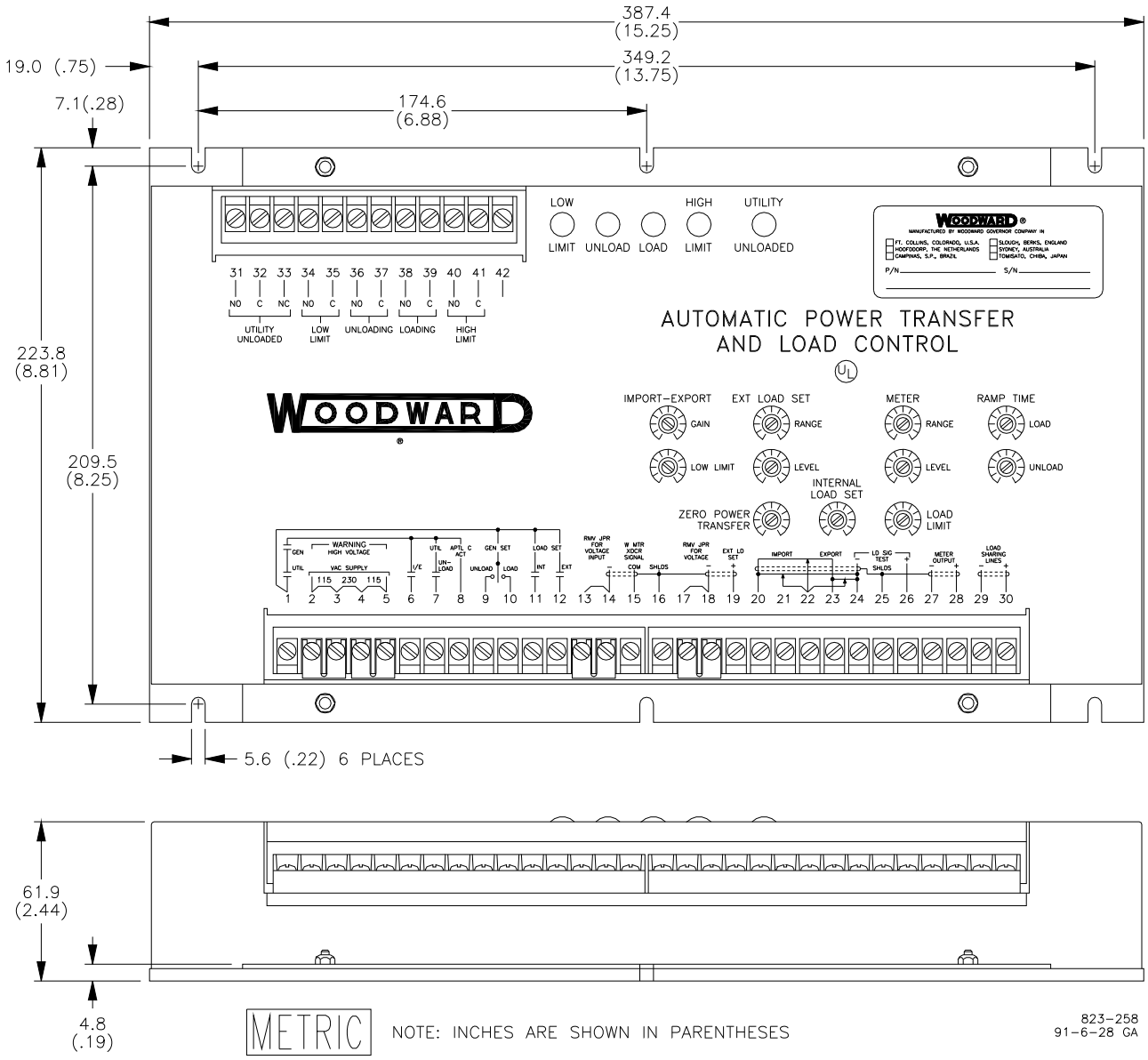


Figure 2-1. Outline Drawing of APTL

Chapter 3. Installation

Unpacking

Be careful when unpacking the control. Check the control for signs of damage such as bent or dented case, and loose or broken parts. If damage is found, notify the shipper immediately. The control may be stored in its original shipping container until it is ready for installation. Protect the control from weather and from extreme humidity or temperature fluctuations during storage. The control is shipped enclosed in a special plastic bag which protects it from accidental electrostatic-discharge damage. Do not remove the control from this special package until ready to install it on the control panel.

Power Requirements

The APTL requires a supply of either 115 Vac or 230 Vac power, either 50 or 60 Hz. The power supply must be uninterrupted while the APTL is being used in the generating system. The APTL may be connected to the local generating system for power.

Location Considerations

Carefully study Chapter 4 of this manual before choosing the location for the APTL. The APTL can have an extensive number of control options which must be accessed by the operator. The wiring of these options may influence the selection of a location for the APTL box.

Consider the following requirements when selecting the location:

- Adequate ventilation for cooling
- Space for servicing
- Protection from direct exposure to water or to a condensation-prone environment
- Protection from high-voltage or high-current devices, or devices which produce electromagnetic interference
- Avoidance of vibration
- A location that will provide an operating temperature range of –40 to +85 °C (–40 to +185 °F)

The APTL is usually installed in the control cabinet for convenient access to other plant controls and the various inputs which will be needed.

Shielded Wiring

All shielded cable must be twisted conductor pairs with either a foil or a braided shield. Do not attempt to tin a braided shield. All signal lines should be shielded to prevent picking up stray signals from adjacent equipment. Connect the shields to the control terminals as shown in the plant-wiring diagram (see Chapter 4). Wire exposed beyond the shield should be as short as possible, not exceeding two inches. The other end of the shields must be left open and insulated from any other conductor. Do not run shielded signal wires with other wires carrying large currents. See manual 50532, *EMI Control for Electronic Governing Systems*, for more information.

Installations with severe electromagnetic interference (EMI) may require shielded wire run in conduit, double shielded wire, or other precautions. Contact Woodward for more information.

Chapter 4.
Plant Wiring and Adjustments

Introduction

The following information is intended to expand on the requirements for plant-wiring options presented by the APTL. All wiring options are the responsibility of the installer and the instructions which follow are suggestions only.

IMPORTANT

Switch size and type, wire size and type, and potentiometer size and type suggested in this chapter will generally provide adequate operation of the APTL. Special problems which surround individual installations must be considered and allowed to overrule these suggestions. No consideration to hazardous environments or other special conditions have been made in offering these suggestions.

Power Supply and Operation Selections

Wire Size

Connect the control to the voltage source with a minimum of 20 AWG (0.5 mm²) insulated wire. Use minimum 20 AWG (0.5 mm²) wire to connect the internal switch power through logic switches and back to the control. Connect the wires to the control with crimp-on, insulated, number-6 connectors. If relay contacts are to be used for the full 5 A rating a minimum of 16 AWG (1 mm²) wire should be used.

Power Supply

Use solid plate-type jumpers to jumper terminals 2 to 3 and 4 to 5 if 115 Vac supply is being used. Use the same type of jumper to jumper terminals 3 to 4 if 220 Vac supply is to be used.

Woodward part number 1606-899 is the recommended jumper. Connect supply leads (either 230 or 115 Vac) to terminals 2 and 5, polarity is not important. If fused, use a 2 A fuse in series with the supply.

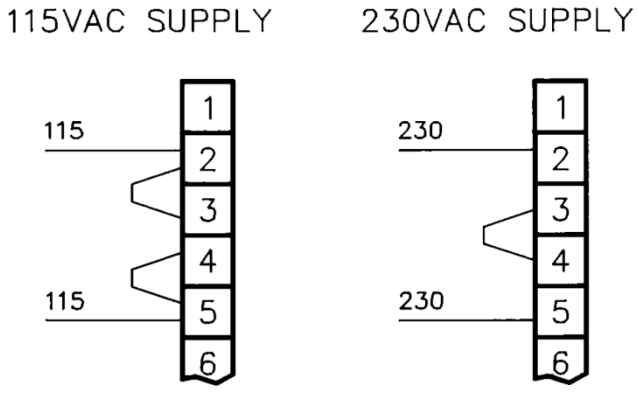


Figure 4-1. Electrical Supply Connections

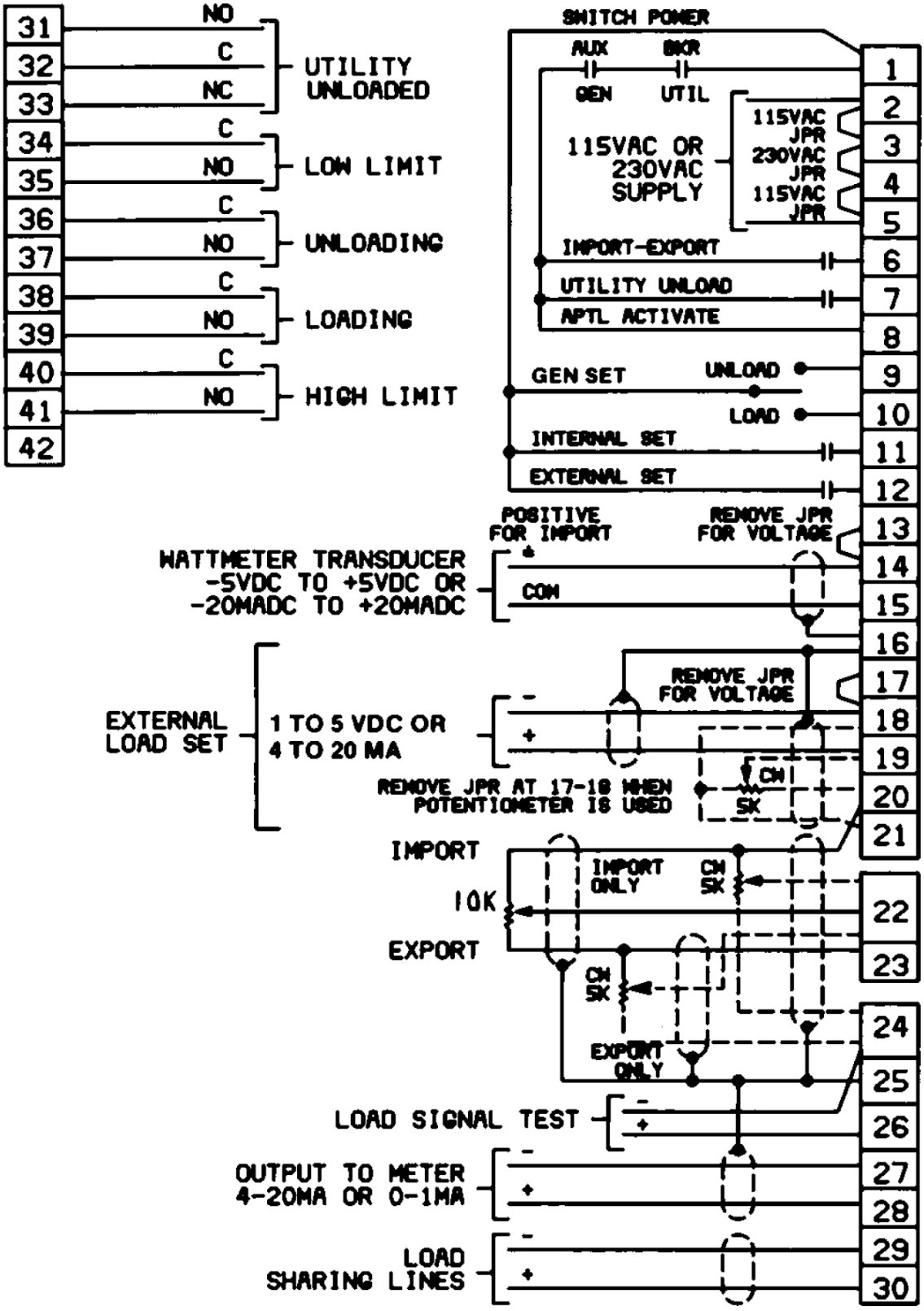


Figure 4-2. APTL Control Plant Wiring

Operation Selections

APTL Activate

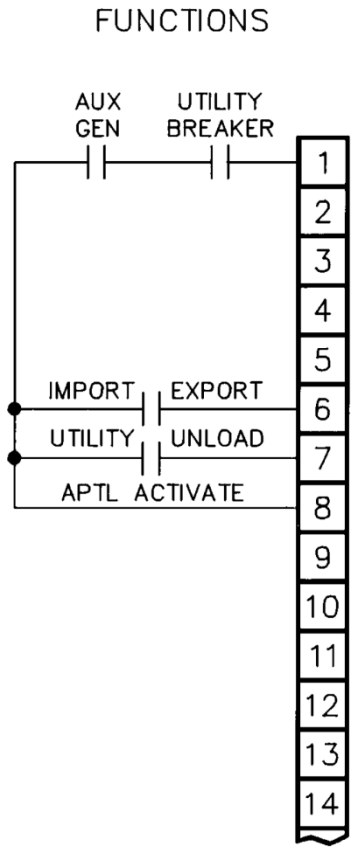
Install auxiliary breaker contacts to activate with the Generator and Utility Breakers. Wire the utility-auxiliary breaker contacts in series with the generator-auxiliary breaker contacts between terminal 1 (Switch Power) and terminal 8 with connections provided for I/E and Utility Unload, if used.

Import/Export

Connect terminal 6 through a single-pole, double-throw, 50 mA minimum switch to the generator auxiliary breaker/APTL lead or to terminal 8.

Utility Unload

Connect terminal 7 through a single-pole, double-throw, 50 mA minimum switch to the generator auxiliary breaker/APTL activate lead or to terminal 8.



Load/Unload

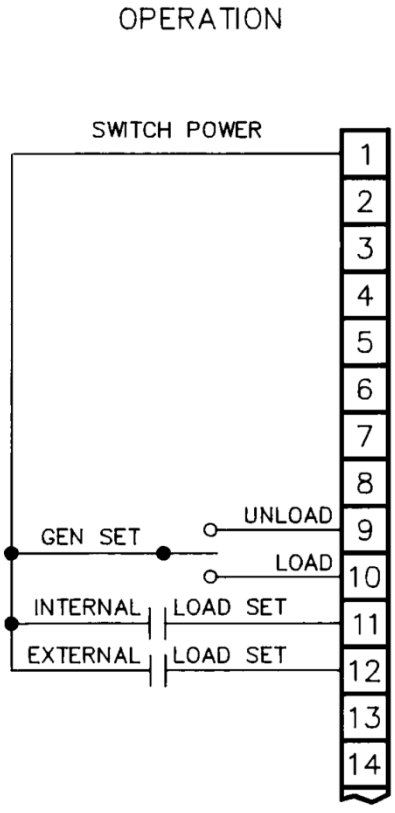
Provide a two pole, center-off, 50 mA minimum switch between the switch power line and the terminal board. One of the positions on this switch is wired to terminal 9 and marked “Unload.” The other position is connected to terminal 10 and marked ‘Load.” The center off position is open and marked “Off.”

Internal Load Set

Run a wire from terminal 1 (switch power) to terminal 11 through a single-pole, double-throw, 50 mA minimum switch or relay contact. Close the contact to select the Internal Load-Set mode.

External Load Set

Run a wire from terminal 1 (switch power) to terminal 12 through a single-pole, double-throw, 50 mA minimum switch or relay contact. Close the contact to select the External Load-Set mode.



Remote Signal Inputs

Wattmeter Transducer

Using shielded twisted-pair wiring, connect a -5 to +5 Vdc or -20 to +20 mA wattmeter transducer output to terminals 14 and 15. (If only import Is used, a single polarity input of 0 to +5, +1 to +5, 0 to +20 mA, or +4 to +20 mA may be used. If only export Is used a single polarity input of 0 to –5, –1 to –5, 0 to –20 mA, or –4 to –20 mA may be used.) Connect the ± line to terminal 14 and the common line to terminal 15. Tie the shield to terminal 16. Do not ground the shield at the wattmeter end. Use Woodward Jumper 1606-899 between terminals 13 and 14 If a mAdc wattmeter transducer signal Is being used. Remove the jumper between terminals 13 and 14 If the wattmeter transducer provides a –5 to +5 Vdc signal.

Import/Export

Connect a 10 K multiturn potentiometer, (good grade, cermet or wire wound, 1/2 W or higher) cw to terminal 20, wiper to terminal 22 and ccw to terminal 23. Connect the potentiometer with shielded wire and connect the shield to terminal 25. Do not ground the shield at the potentiometer. This potentiometer sets the Import/Export power level; cw for import, ccw for export.

For import control only, connect a 5 K multiturn potentiometer, (good grade, cermet or wire wound, 1/2 W or higher) cw to terminal 20 wiper to terminal 22 and ccw to terminal 24. Connect with shielded wire and tie the shield to terminal 25. Do not ground the shield at the potentiometer. This potentiometer sets the import power level only.

For export control only connect a 5 K multiturn potentiometer, (good grade, cermet or wire wound, 1/2 W or higher) cw to terminal 24, wiper to terminal 22 and ccw to terminal 23. Connect with shielded wire and tie the shield to terminal 25 of the control. Do not ground the shield at the potentiometer. This potentiometer sets the export power level only. See Figure 4-3.

External Load Set or Load Set Potentiometer

If used, connect the 1 to 5 Vdc or 4 to 20 mA external load-set to terminals 18 and 19. If a 1 to 5 Vdc signal is used remove any jumper between terminals 17 and 18. If a 4 to 20 mA signal is used a jumper must be used between terminals 17 and 18. Use shielded, twisted pair wire. Connect the (–) line to terminal 18 and the (+) line to terminal 19. Tie the shield to terminal 16. Do not ground the shield at the remote load-set-signal source.

If a potentiometer is to be used for the external load-set signal, rather than the remote source, attach a 5K, multiturn potentiometer, cw to terminal 20, wiper to terminal 19 and ccw to a connection between terminals 21 and 18. Use shielded three-conductor to connect the potentiometer to the APTL. Ground the shield to terminal 16. Do not ground the shield at the potentiometer.

Jumper terminal 17 to terminal 18 if the external signal provides a mA signal. Remove the jumper if the external load set is providing a 1 to 5 Vdc signal or the potentiometer is used. See Figure 4-4.

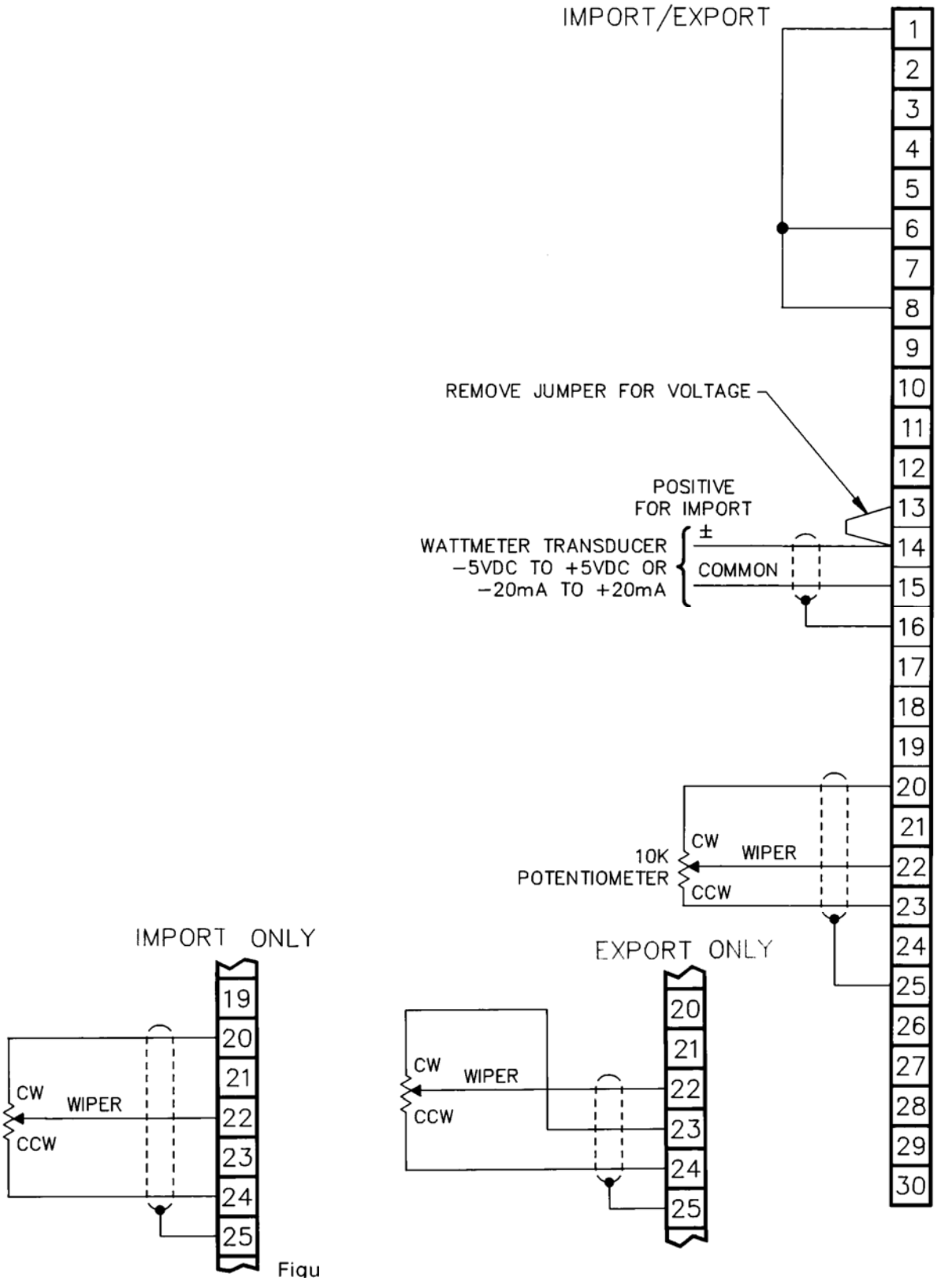


Figure 4-3. Import/Export

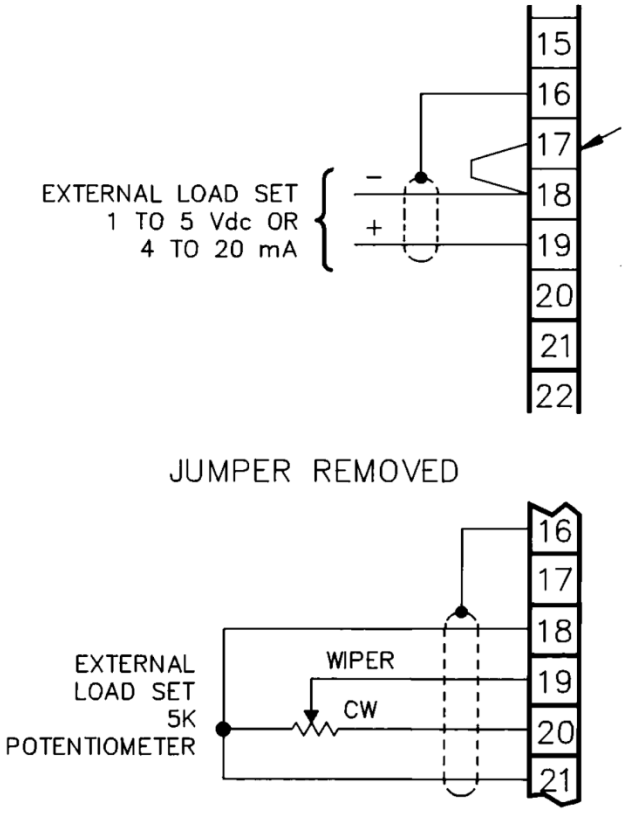


Figure 4-4. External Load Set Wiring

Load Signal Test

A voltmeter may be temporarily attached to terminal 24 (–) and terminal 26 (+) for setup purposes to monitor the setting of the Load Limit. Normally a setting of 6.0 V is used. 6.0 V will limit the APTL output to 3.0 V.

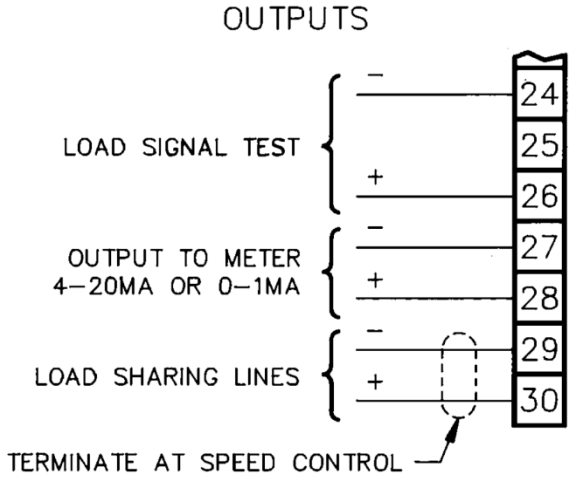


Figure 4-5. Outputs from APTL Control

Outputs

Output Meter

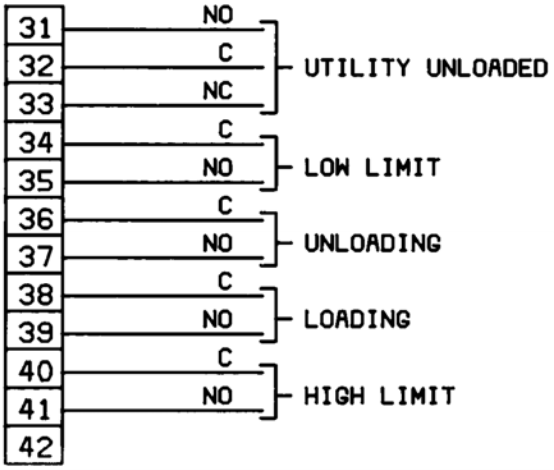
To monitor the power demand on, or the power level of the local generating system attach either a 4-20 mA or a 0-1 mA meter to terminal 27 (–) and to terminal 28 (+). Attach with shielded wire and tie the shield to terminal 25. Do not attach the shield at the meter. This output is proportional to the voltage-reference level and indicative of 0 to 100% system power level. During isolated operation the output will be proportional to the actual plant load. When paralleled to the utility the output will be proportional to the load demand on the local generating system. Meter level and range adjustments are used to calibrate the output to be compatible with either the 0–1 mA or the 4–20 mA meter movements.

Load Sharing Lines

Attach the system load-sharing (parallel) lines to terminals 29 (–) and 30 (+). Use shielded, twisted pairs and attach the shield to ground at the load-sharing and speed control.

Relays

Relay contacts accessible at terminals 31 through 41 are rated at 5 A resistive at 30 Vdc; 3 A resistive at 115 Vrms, 400 Hz; 2 A resistive at 115 Vrms, 60 Hz, and 2 A inductive at 28 Vdc.



Potentiometer Settings

Factory settings of the APTL are generally good starting points for an installation. Do not change these settings except to tune the unit to the Individual installation.

I/E GAIN	Mid
LOW LIMIT	0 V
METER	
RANGE	4–20 mA for 0–3 Vdc Load Sharing
LEVEL	4–20 mA for 0–3 Vdc Load Sharing
ZERO POWER	
TRANSFER	Set for 0 V
LOAD LIMIT	Set for 3.0 V

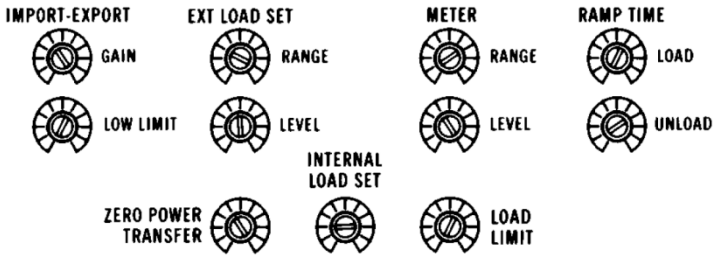
Adjustments

Ramp Rate Range

A 4-pole, single throw dipswitch (S1), accessible only by removing the cover, is used to set the load and unload ramp range.

Potentiometers

The potentiometers accessed through the cover provide all of the adjustments for the APTL. The Load Limit potentiometer must be set first. Others are set in an order appropriate for the use being made of the control features.



Control Point Adjustments

Three potentiometers, located directly below the eight paired potentiometers, set control points.

ZERO POWER TRANSFER—Sets the control point that the APTL recognizes as zero power transfer between the utility and the local generator system.

INTERNAL LOAD SET—Sets a base load control point.

LOAD LIMIT—Sets the maximum output voltage from the APTL.

There are 11 potentiometers accessed through the cover. Eight of these are in pairs.

Import/Export Gain and Low Limit

The Import/Export Gain potentiometer adjusts the response rate of the control while in the Import! Export mode. Turning the adjustment clockwise speeds up the response. The magnitude of the difference between the set point and the actual power level also enters into the response. The l/E Gain is normally set to obtain the best system response. (The point where the system controls the generator output during load changes as close to the set point as possible, without oscillating). Increasing Import/Export Gain increases the response of local generators to local load changes to maintain a constant l/E power level.

The Import/Export Low Limit potentiometer adjusts the minimum output voltage of the APTL while in the Import/Export control mode. It is normally set for zero output. The l/E low limit can be set for a given minimum system load where some load is required to protect against reverse power.

External Load Set Range and Level

Range adjusts the External Load Set input circuit for the maximum input.
Level adjusts the external load set input circuit for minimum input.

The adjustments interact, both will require adjustment if either one is changed.

Meter Range and Level

Range is adjusted to obtain the desired meter reading at maximum output.

Level is adjusted to obtain the desired meter reading at minimum output.

The adjustments interact, both will require adjustment if either one is changed.

Ramp Time

Load adjusts loading ramp time or rate within the range selected by the S1 position.

Unload adjusts the unloading ramp time or rate within the range selected by the S1 position.

Turning either adjustment cw will slow that ramp and increase the time to load or unload.

Checking Out the Installation

The generator system must be proven as operational before starting operation with the APTL. Operate the system without the APTL first, but with all of the inputs to the control functioning. Use a 0-5 Vdc meter on the load-sharing lines of the system and record the voltages. Then attach the load-sharing lines to terminals 29 and 30 on the APTL. The APTL will develop the same output voltages as present at terminals 29 and 30, and apply that voltage to those lines when activated.

Chapter 5 contains a “Bench Test” procedure for the APTL. This test should be completed for the portions of the APTL being used before starting operation of the system. The settings given in the “Bench Test” should provide adequate control of the system. Fine tuning can then be done with the generator system in operation.

Make sure all input and output connections are correct before starting the system.

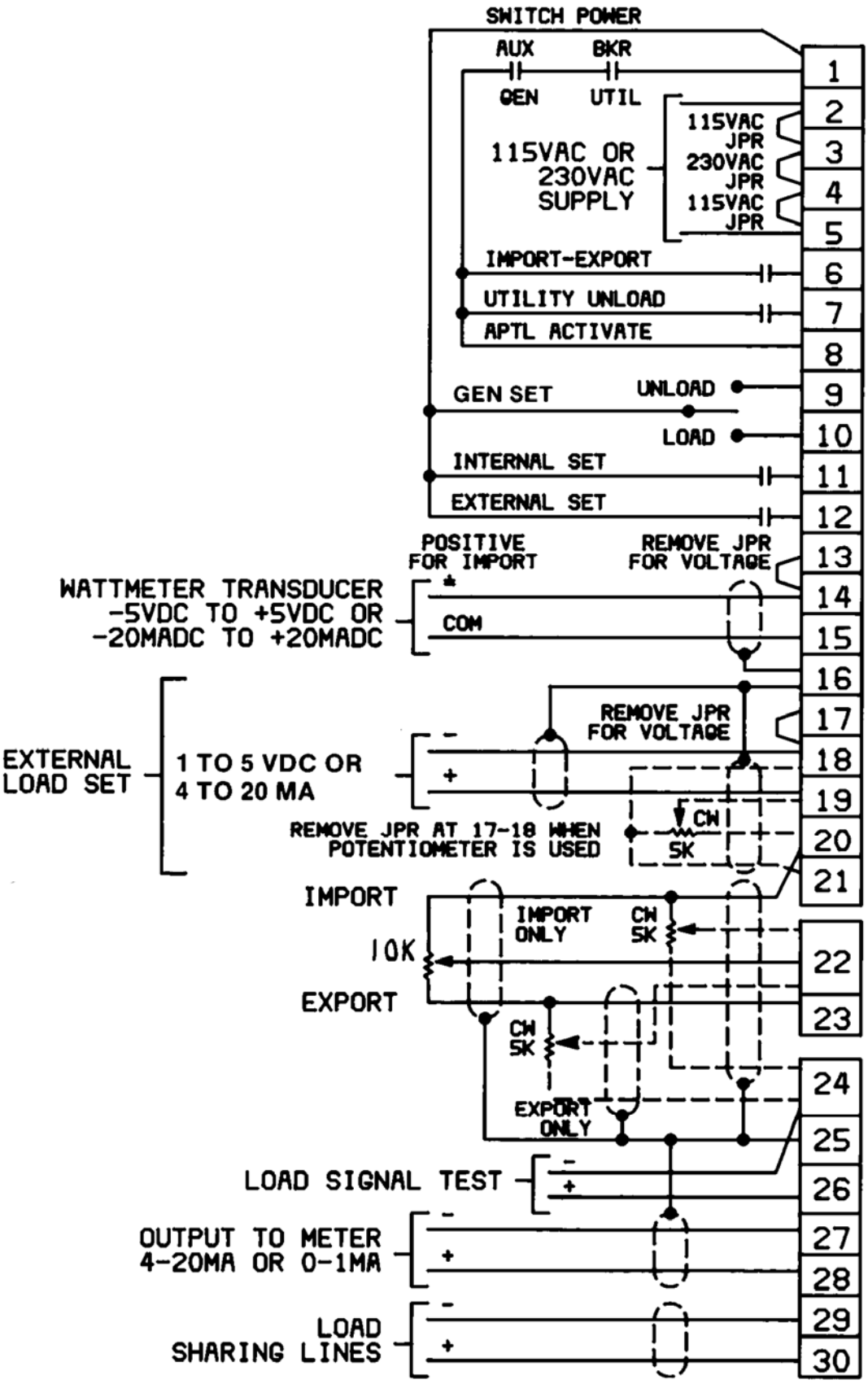


Figure 4-6. APTL Control Plant Wiring Diagram

Chapter 5. Troubleshooting

Introduction

When the APTL is properly installed and the various ramps and switch points have been established, operation is totally automatic. The lights and relays operate together, giving the operator a visual indication of change of function.

Troubleshooting

The following procedure is provided to permit bench testing of the APTL functions. All adjustments located on the printed circuits in the interior of the control, with the exception of the Load Ramp Range Switch, are accessible through the cover. The complete control must be returned to the factory for any repair.

The bench test requires that all ramp rates and set points be reset. The bench test should not be attempted unless the APTL is suspected as the cause of control system problems.

IMPORTANT

Inspect all other portions of the control system and inspect all of the APTL plant wiring and connections before determining that system problems are related to the APTL. Take particular care while inspecting the system wiring to be sure that all shields are in place and properly grounded according to installation instructions.

Bench Test Tools

The following tools will be needed to conduct the bench test:

- Ohmmeter
- 0–10 Vdc meter
- 0–5 Vdc meter
- –5 to +5 Vdc adjustable power supply
- 4–10 µF capacitor
- Seven single pole, single throw switches
- 0–20 mAdc meter
- 115 Vac power supply
- 3 Vdc power supply
- 0 to 5 K multiturn pot
- 0 to 10 K multiturn pot

APTL Control Bench Test

Resistance Check

1. Measure resistance from each terminal to terminal 16. The reading from terminal 25 should be zero. All other terminals should read 108 Ω or higher.

2. Measure resistance between terminals 13 to 15 and 17 to 19. Both should read 249 ±25 Ω.

3. Measure resistance between terminals 31 and 32, 32 and 33, 34 and 35, 36 and 37, 38 and 39, and 40 and 41. Terminals 32 to 33 should read zero, all others should be infinity.

Bench Test Setup

NOTICE

The APTL contains parts that are static-sensitive. To prevent damage to these parts, discharge body static before handling the control (touch a grounded surface and maintain contact while handling the control). Avoid all plastic, vinyl, and styrofoam around the control while the circuit board is exposed.

1. Remove the cover and record the position of the dip switches for return to their original setting following the bench test.

2. Set all four of the switches to open (the fastest range). Replace the cover.

3. Set the panel adjustments:

Import/Export Gain	Mid
Low Limit	ccw
Meter Range	Mid
Meter Level	c Ramp
Zero Power Transfer	ccw
Load Limit	cw
Ext. Load Set Range	Mid
Level	ccw
Ramp Time Unload	ccw
Time Load	ccw
Internal Load Set	ccw

4. Connect 5 single pole, single throw switches from terminal 1 to terminals 8, 9,10,11, and 12. Leave the switches open.

5. Connect 2 single pole, single throw switches from terminal 8 to terminals 6 and 7. Leave the switches open.

6. Connect a 0-10 Vdc meter across terminals 24 (–) and 26 (±), load signal.

7. Connect a 0-20 mAdc meter across terminals 27 (–) and 28 (+), meter output.

8. Connect a 0-5 Vdc meter across terminals 29 (–) and 30 (+), load share lines.

9. Connect a 115 Vac supply across terminals 2 and 5. Jumper across terminals 2 to 3 and 4 to 5

10. Connect a ±5 Vdc variable supply source across terminals 14 (±) and 15 (com) to represent the wattmeter transducer signal.

11. Connect a 0–10 K potentiometer cw to terminal 20, ccw to terminal 23 and wiper to terminal 22. (Import/Export set point.)

12. Connect a 0–5 K potentiometer ccw to terminals 18 and 21, cw to terminal 20, wiper to terminal 19. Set ccw. (External Load Set.)

Operational Tests

Activate APTL Control

1. Turn on the 115 Vac supply and close the switch from terminal 1 to terminal 8. The meter at terminals 29 and 30 should read zero and the Low Limit light should come on. The relay contacts at terminal 34 and 35 should be closed.

Loading

1. Close the switch from terminal 1 to terminal 10. Both meter readings should increase, the Loading light should come on, and the contacts at terminals 38 to 39 should close.

2. When the output at terminals 29-30 stops changing and the High Limit light comes on, record the reading at terminals 29-30. The reading should be at least 3 Vdc. Record the reading.

3. The reading at terminals 24 and 26 should be at least 6 Vdc, Record the reading.

4. Make sure that the High Limit contacts at terminals 40 and 41 are closed and the Loading light is off.

Load Limit

1. Turn the Load Limit adjustment fully ccw and read 0 Vdc ±0.01 at terminals 29 and 30 and 0 ±0.02 Vdc at terminals 24 and 26.

2. Adjust the Load Limit of the APTL so that the voltage measured across terminals 26 (+) and 24 (–) is equal to the voltage measured on the Load Signal Test points of the load sharing governor or load sensor module at 100% rated generator load. The voltage seen on these points is typically 6.0 Vdc at 100% load. The Load Limit adjustment on the APTL sets the maximum percentage output of the generator(s) for all operating modes of the APTL.

Unload

1. Close the switch from terminal 1 to 9. The Unloading Light should come on and the at terminals 36 and 37 should close. When the Low Limit is reached the Unloading Light should go out and the Low Limit Light should come on. The Low Limit contacts at terminals 34 and 35 should close.

Meter Output

1. With the output at the low limit, adjust the Meter Level for an indication of zero on the output meter used. (Either 0 or 4 mA).

2. Open the switch to terminal 9. (The switch to terminal 10 is still closed.) When the High Limit light comes on, adjust the Meter Range for a 100% indication on the output meter used. (1 mA or 20 mA.)

3. Repeat steps 1 and 2 to eliminate the affect of adjustment interaction.

Load Set

1 Open the switches to terminals 9 and 10. Close the switch to terminal 11. The output should not change. Turn the Internal Load Set slowly cw to the stop. The output should follow the potentiometer to 3.0 Vdc at the cw stop.

2. Remove the jumper between terminals 17 and 18 (if present).

3. Open the switch to terminal 11 and close the switch to terminal 12. The output should ramp to zero. Adjust the External Load Set Level for zero output by turning the potentiometer cw until the output starts to increase and then ccw slowly until the output just returns to zero.

4. Turn the 5 K potentiometer across 18-21, 20 and 19 slowly cw. The output should increase with the potentiometer setting. With potentiometer fully cw adjust the External Load Set Range for an output of 3.0 ±0.05 V.

5. Set the 5 K potentiometer fully ccw and adjust the External Load Set Level for zero output. Repeat steps 4 and 5 until no further adjustment is required.

6. Remove the potentiometer from terminals 18, 19, and 20-21 and connect a 0–5 Vdc source across terminals 18 (–) and 19 (+).

7. Set the voltage to 5.0 ±0.01 Vdc and adjust the External Load Set Range for an output of 3.0 ±0.01 Vdc at terminals 29 and 30.

8. Reduce the voltage to 1 ±0.01 Vdc and adjust the External Load Set Level for zero output. Repeat steps 7 and 8 until no further adjustment is necessary

9. Close the switches to terminals 11 and 12. With the voltage across terminals 18 and 19 at 5 Vdc and the Internal Load Set potentiometer cw the output should be 3.0 Vdc. Turn the Internal Load Set ccw. The output should follow the potentiometer setting.

10. Set the Internal Load Set ccw and close the switch to terminal 10. The output will ramp to 3.0 Vdc.

11. Close the switch to terminal 9. The output will ramp back to zero.

Ramp Rates

1. Open the switches at terminals 10, 11, and 12. After these three switches are open, open the switch at terminal 9. The output should be at zero.

NOTICE

The APTL contains parts that are static-sensitive. To prevent damage to these parts, discharge body static before handling the control (touch a grounded surface and maintain contact while handling the control). Avoid all plastic, vinyl, and styrofoam around the control while the circuit board is exposed.

2. Remove the APTL cover. Reset the ramp-rate switch to the original position (recorded in step 1 of the bench test setup). Replace the APTL cover.

3. Close the switch to terminal 10. The output should ramp up at less than a. Set the Ramp Time Load adjustment cw.

4. Close the switch to terminal 9. The output should ramp down at less than a. Set the Ramp Time Unload adjustment cw.

5. Open the switch to terminal 9. The output should ramp up at a rate greater than b.

6. Close the switch to terminal 9. The output should ramp down at a rate greater than b.

Select the a and b information from the following table.

Switch Location in step 2	a	b
S1-4 closed	0.12 V/min	0.023 V/min
S1-3 closed	0.53 V/min	0.099 V/min
S1-2 closed	2.50 V/min	0.450 V/min
S1-1 closed	9.00 V/min	1.650 V/min
	Ramp time 20 s	(Ramp time 1.8 min)
S1-1 through 4 open (no switch closed)	36.0 V/min	7.2 V/min
	Ramp time 5 s	Ramp time 25 s

7. Open the switches to terminals 9 and 10.

Import/Export

1. Turn on the ±1-5 Vdc supply at terminals 14 and 15 and set for 0 Vdc. Close the switch at terminal 7 (Utility Unload mode). (If necessary short terminals 15 to 24 to eliminate noise interference.)

2. Slowly turn the zero Power adjust cw until the Utility Unload light comes on. The Utility Unload contacts at terminals 31 and 32 should close and the ones at 32 to 33 open. Leave the Zero Power adjust at this setting.

3. Set the ±5 Vdc supply to +5 Vdc. Open and re-close the switch to terminal 8. The output will increase from zero at the rate recorded in step 3 under Ramp Rate.

4. Move the ±5 Vdc supply to zero. Open and close the switch at terminal 8 to reset the control. The Utility Unloaded light will come on and stay on. If the output has not ramped out, the rate will increase to the response time set by the Import/Export Gain Control.

5. Set the ±5 Vdc voltage to –0.5 ±0.2 Vdc. The output will decrease at the Import/Export rate.

6. Connect a 3 Vdc source to terminal 29 (–) and through a 500 K resistor to terminal 30 (+). Open and close the switch from terminal 1 to terminal 8. Leave the switch closed. The output at terminal 29 and 30 will ramp down at the rate recorded in step 4 under Ramp Rates.

7. Set the ±5 Vdc to zero. The Utility Unload light will come on and the unload rate should increase to the Import/Export response rate if not already at 3 V.

8. Open the switch to terminal 7 and close the switch to terminal 6 (Import/Export mode). Turn the external potentiometer across terminals 20, 22, and 23 fully ccw. Open the +3 Vdc line at terminal 30. The output voltage should go to 3 V.

9. Set the ±5 Vdc supply to -5 Vdc. Turn the external potentiometer across terminals 20, 22, and 23 fully cw. The output should move to about –0.6 Vdc. Set the I/E Low Limit adjust for 0 +0.01/-0.0 Vdc.

10. Set the external pot on 20, 22, 23 fully ccw. Reconnect the +3 Vdc line. Set the ±5 Vdc supply to +5 Vdc. The output should ramp quickly to 3 V.

11. Set the I/E Gain adjust ccw. Open the switch between terminal 1 and terminal 8 and set the ±5 Vdc supply to -5 Vdc. Close the switch. The voltage at the output should take about 5 seconds to go from 3 Vdc to about zero.

12. With the ± Vdc supply still set to –5 Vdc, set the I/E Gain adjust cw. Open and close the switch from terminal 1 to 8 to reset the control. The output voltage should drop rapidly to about zero.

13. Set the I/E Gain adjust to mid-position and leave it.

14. Set the ±5 Vdc input to zero. Remove the 3 Vdc supply across terminals 29 and 30. Connect the 4–10 µF capacitor across the two terminals. Turn the external potentiometer across terminals 20, 22, and 23 ccw. The output should ramp toward 3 Vdc.

15. Open the switch at terminal 6 and the output should stop ramping until the switch to terminal 6 Is closed.

This completes the bench test of the APTL. Should any portion of the APTL being used fail the test, the unit must be returned to Woodward for repair or replacement. If all essential portions of the test were completed successfully the APTL is operationally sound and can be reinstalled in the control system according to the Installation, Plant Wiring and Adjustment instructions.

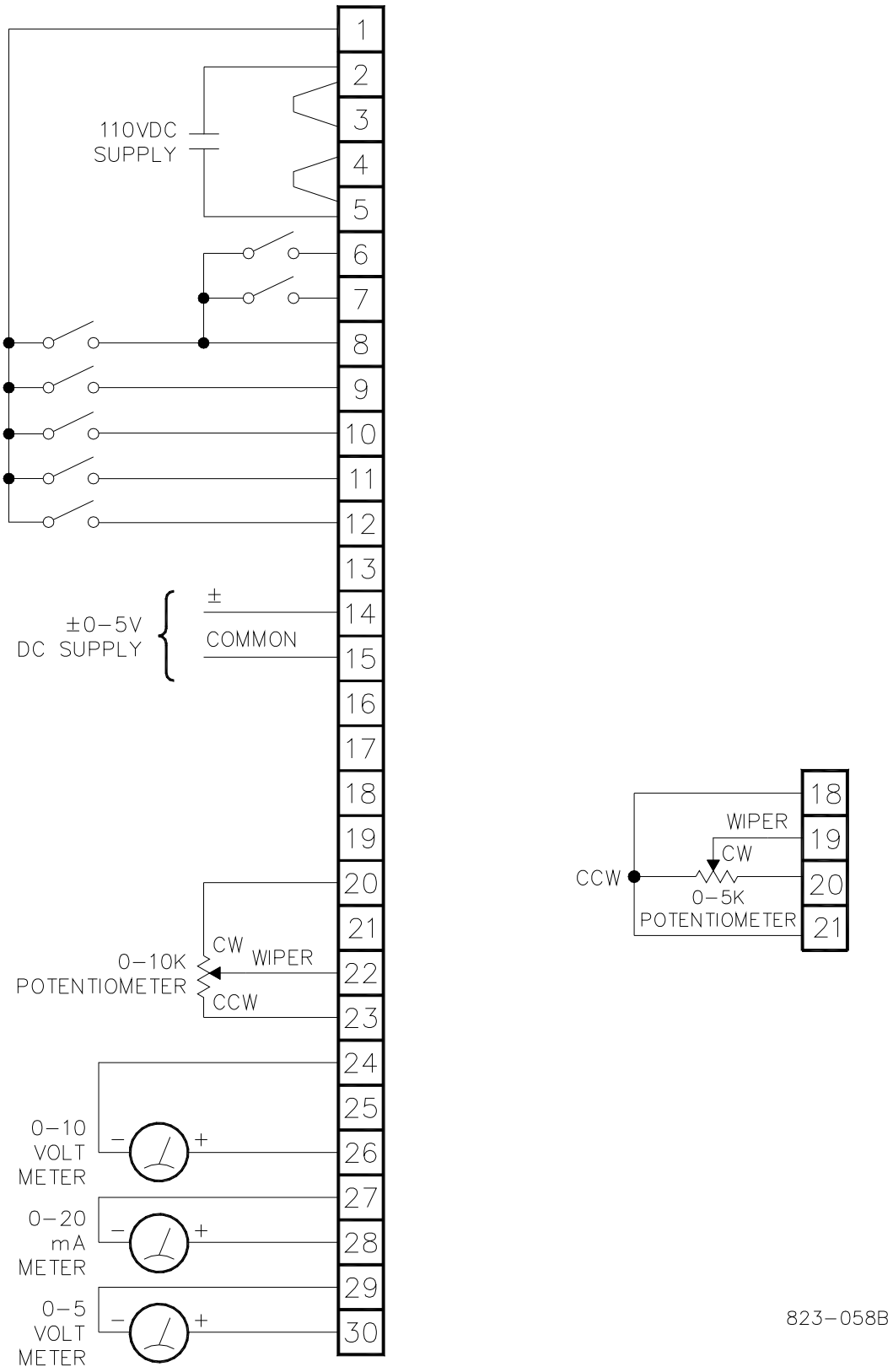


Figure 5-1. Test Wiring Diagram for APTL Control

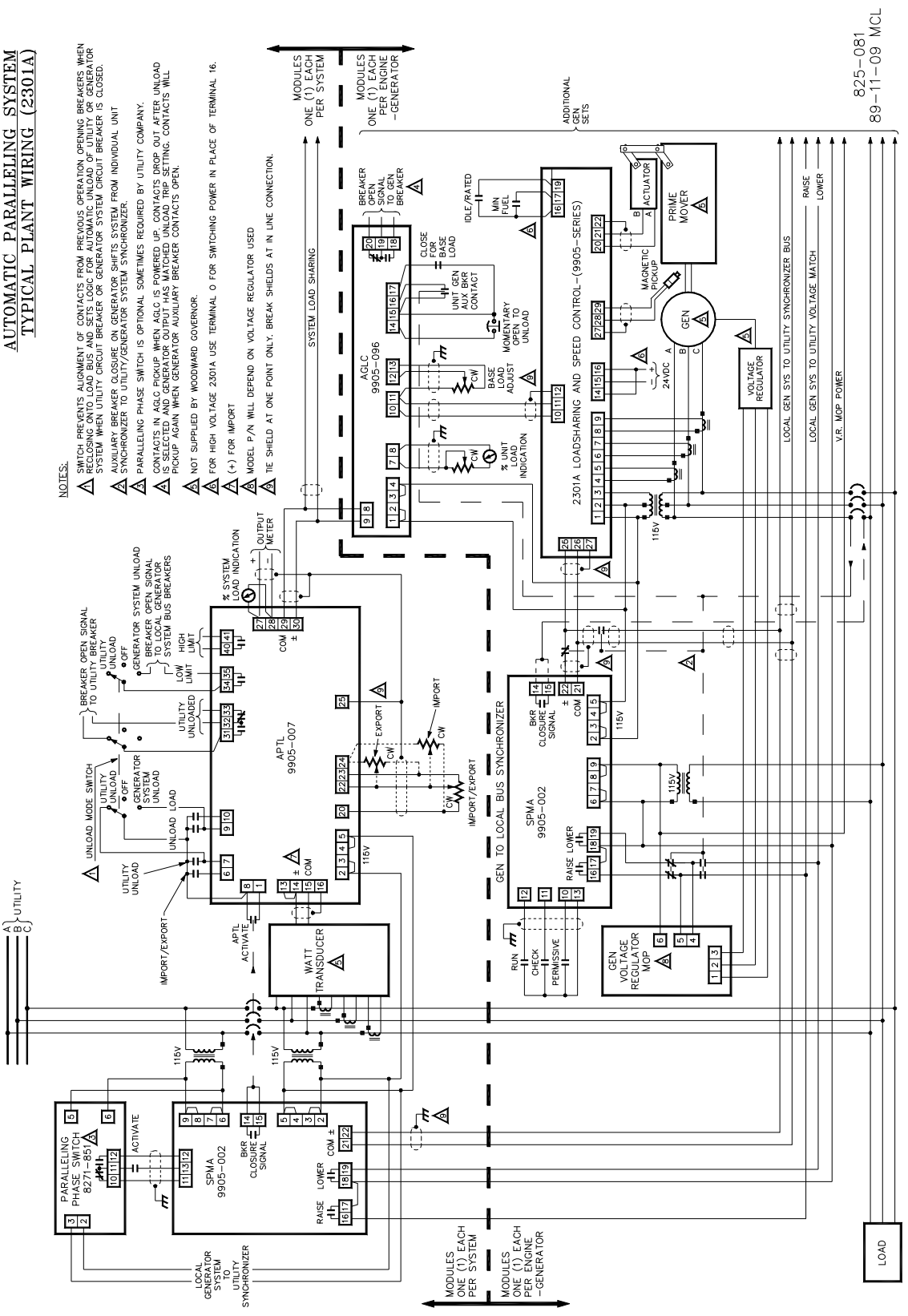


Figure 5-2. Typical Plant Wiring (for reference only)

Chapter 6.
Product Support and Service Options

Product Support Options

If you are experiencing problems with the installation, or unsatisfactory performance of a Woodward product, the following options are available:

1. Consult the troubleshooting guide in the manual.
2. Contact the **OE Manufacturer or Packager** of your system.
3. Contact the **Woodward Business Partner** serving your area.
4. Contact Woodward technical assistance via email (**EngineHelpDesk@Woodward.com**) with detailed information on the product, application, and symptoms. Your email will be forwarded to an appropriate expert on the product and application to respond by telephone or return email.
5. If the issue cannot be resolved, you can select a further course of action to pursue based on the available services listed in this chapter.

OEM or Packager Support: Many Woodward controls and control devices are installed into the equipment system and programmed by an Original Equipment Manufacturer (OEM) or Equipment Packager at their factory. In some cases, the programming is password-protected by the OEM or packager, and they are the best source for product service and support. Warranty service for Woodward products shipped with an equipment system should also be handled through the OEM or Packager. Please review your equipment system documentation for details.

Woodward Business Partner Support: Woodward works with and supports a global network of independent business partners whose mission is to serve the users of Woodward controls, as described here:

- A **Full-Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.
- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.
- A **Recognized Engine Retrofitter (RER)** is an independent company that does retrofits and upgrades on reciprocating gas engines and dual-fuel conversions, and can provide the full line of Woodward systems and components for the retrofits and overhauls, emission compliance upgrades, long term service contracts, emergency repairs, etc.

A current list of Woodward Business Partners is available at **www.woodward.com/directory**.

Product Service Options

Depending on the type of product, the following options for servicing Woodward products may be available through your local Full-Service Distributor or the OEM or Packager of the equipment system.

- Replacement/Exchange (24-hour service)
- Flat Rate Repair
- Flat Rate Remanufacture

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime.

This option allows you to call your Full-Service Distributor in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Full-Service Distributor.

Flat Rate Repair: Flat Rate Repair is available for many of the standard mechanical products and some of the electronic products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be.

Flat Rate Remanufacture: Flat Rate Remanufacture is very similar to the Flat Rate Repair option, with the exception that the unit will be returned to you in "like-new" condition. This option is applicable to mechanical products only.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned for repair, please contact your Full-Service Distributor in advance to obtain Return Authorization and shipping instructions.

When shipping the item(s), attach a tag with the following information:
- return number;
- name and location where the control is installed;
- name and phone number of contact person;
- complete Woodward part number(s) and serial number(s);
- description of the problem;
- instructions describing the desired type of repair.

Packing a Control

Use the following materials when returning a complete control:
- protective caps on any connectors;
- antistatic protective bags on all electronic modules;
- packing materials that will not damage the surface of the unit;
- at least 100 mm (4 inches) of tightly packed, industry-approved packing material;
- a packing carton with double walls;
- a strong tape around the outside of the carton for increased strength.

NOTICE

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Replacement Parts

When ordering replacement parts for controls, include the following information:
- the part number(s) (XXXX-XXXX) that is on the enclosure nameplate;
- the unit serial number, which is also on the nameplate.

Engineering Services

Woodward's Full-Service Distributors offer various Engineering Services for our products. For these services, you can contact the Distributor by telephone or by email.

- Technical Support
- Product Training
- Field Service

Technical Support is available from your equipment system supplier, your local Full-Service Distributor, or from many of Woodward's worldwide locations, depending upon the product and application. This service can assist you with technical questions or problem solving during the normal business hours of the Woodward location you contact.

Product Training is available as standard classes at many Distributor locations. Customized classes are also available, which can be tailored to your needs and held at one of our Distributor locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability.

Field Service engineering on-site support is available, depending on the product and location, from one of our Full-Service Distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface.

For information on these services, please contact one of the Full-Service Distributors listed at **www.woodward.com/directory**.

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory published at **www.woodward.com/directory**.

You can also contact the Woodward Customer Service Department at one of the following Woodward facilities to obtain the address and phone number of the nearest facility at which you can obtain information and service.

Products Used In Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany:	
Kempen	+49 (0) 21 52 14 51
Stuttgart	+49 (711) 78954-510
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Products Used In Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (711) 78954-510
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Products Used In Industrial Turbomachinery Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

For the most current product support and contact information, please visit our website directory at **www.woodward.com/directory**.

Technical Assistance

If you need to contact technical assistance, you will need to provide the following information. Please write it down here before contacting the Engine OEM, the Packager, a Woodward Business Partner, or the Woodward factory:

General

Your Name _____

Site Location _____

Phone Number _____

Fax Number

Prime Mover Information

Manufacturer _____

Engine Model Number _____

Number of Cylinders _____

Type of Fuel (gas, gaseous, diesel, dual-fuel, etc.) _____

Power Output Rating _____

Application (power generation, marine, etc.)

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Control/Governor #2

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Control/Governor #3

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Symptoms

Description _____

_____

If you have an electronic or programmable control, please have the adjustment setting positions or the menu settings written down and with you at the time of the call.

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 82381E.

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Complete address / phone / fax / email information for all locations is available on our website.

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