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## TECHNICAL MANUAL

# GM350

REV. 4

4/01

# **GM350 GenMaster™ GENERATOR CONTROL MANUAL**

## **GENERAL DESCRIPTION**

The **GM350** Generator Control System is a micro processor based, digital read out control system consisting of:

### **ENGINE CONTROL BOARD**

The Engine Control Board houses the Engine Control Relays, Engine Interconnect Receptacles, Speed Sensing, Power Supply, and Signal Conditioning. The control utilizes a Magnetic Pickup, for speed sensing. The Engine Control Relays for fuel solenoid and cranking motor relay shall be rated at 10 Amps. Standard automotive senders are used for temperature, fuel level, and pressure readings and safety set point monitoring. Speed sensor and sender out of tolerance monitoring as pre-alarms along with engine Cooldown are standard. Out of tolerance conditions are logged in EEPROM and displayed until corrective action is taken. There is a 10 Amp dry relay closures for Pre-alarm and Fault annunciation.

### **AC MONITORING BOARD**

The AC Monitoring Board senses the AC Voltage, and AC Current through its respective plugs. The AC Monitoring Board is internally connected to the Engine Control Board, and shall accept full rated AC voltage.

The **GM350** Control System is available for diesel, natural gas, LP, and gasoline engines with either 12 or 24 VDC battery. The engine vitals: Oil Pressure, Running Time, Engine Temperature, Battery Voltage, and Safeties are monitored on the large two line Super Twist, extended temperature, Back-Lighted LCD display. Automotive type senders are provided with the control system. Generator AC Voltage, AC Amperage, and Frequency are also displayed on the LCD display. Current transformers are provided with the Generator Control System.

The Oil Pressure, Water Temperature, Frequency, and Battery Voltage are displayed constantly, with AC Volts and AC Amps are scrolled, Phase 1-2, Phase 2-3, and Phase 3-1. Emergency Stop, Over/Under Voltage, Over/Under Frequency, Under Speed, Overcurrent, Fuel Level features with pre-alarm and fault set points are included as standard features.

The **GM350** is housed in a rugged, vibration isolated enclosure or vertical face plate mounting with Oil Pressure Sender, Engine Temperature Sender, Current Transformers, and mating plug included for ease of maintenance.

The **GM350** has a pre-programmed custom message display with diagnostics for safety set points and sender condition. A digital input is used to defeat the sender monitoring during test.

## **INSTALLATION INSTRUCTIONS**

**NOTE: BEFORE INSTALLATION MAKE CERTAIN THAT THE ENGINE BATTERY IS DISCONNECTED AND THAT THE ENGINE SELECTOR TOGGLE IS IN THE OFF POSITION**

### **TOOLS REQUIRED**

Drills, punch, 16 AWG wire, wire fittings, cutters, crimpers, and nut drivers.

1. Install GenMaster™ on generator "J" box or mount vertical face plate.
2. Install Oil Pressure Sender and temperature sender in engine block.
3. Install Magnetic Pickup in fly wheel housing if used.
4. Install Current Transformers.

5. Connect harness wires, per schematic, to the in-line fuse, Engine Fuel System. If the fuel system draws more than 5 amps add a slave relay to the fuel system. Cranking Motor Slave Relay, Senders, AC Voltage connections, AC Amperage connections, Magnetic Pickup or Generator Winds for speed signal. There should be a suppression DIODE connected across the Cranking Motor Slave Relay, and the Fuel System coil. (See technical notes.) If a delta connected system is required contact factory for modifications.
8. After checking that the Engine Selector is in the **OFF** position, connect the Battery Positive (+) and Negative (-) per schematic.

**NOTE:**

**THE GenMaster™ CONTROL SYSTEM IS DESIGNED TO OPERATE ON A GROUNDED “Y” CONNECTED GENERATOR. FAILING TO GROUND THE NEUTRAL WILL CAUSE DAMAGE TO THE CONTROL SYSTEM.**

**ENGINE SEQUENCE OF OPERATION**

- A. With the Selector Toggle in OFF the LCD display will pulse NOT IN AUTO.
- B. An amber Pre-alarm LED will turn on.
- C. The Pre-alarm relay will close.
- D. Engine Temperature, Fuel Level and Battery Voltage will be displayed

**SELECTOR SWITCH IN RUN POSITION**

Placing the Selector Switch in the RUN mode will initiate the start sequence:

- A. The engine Start Contact will close battery positive (+), to the Cranking Motor Slave Relay.
- B. The Engine Fuel Contact will close battery positive (+) to the Fuel system. If the fuel system draws more than 5 amps, install a slave relay.
- C. The LCD display will read STARTING ENGINE during cranking. There are multiple Crank and Crank Rest cycles. The default is 5 cranking cycles 10 seconds on and 10 seconds of crank rest. The LCD display will read Crank Rest between cranks.
- D. When Crank Termination is reached the Start Contact will open, disengage the Cranking Motor Slave Relay and lock out the starting circuit. The LCD display will read Oil Pressure Bypass. Should the Speed Sender fail during cranking. The Secondary crank termination will activate and disconnect the Cranking Motor Slave Relay. The engine will continue to run with Speed Sender Failure pre-alarm message unit scrolled on the LCD display, and hertz reading “0”. The engine can be restarted utilizing the secondary method of crank termination, but it is advised that the speed sender be replaced ASAP.
- E. Upon Crank Termination the GM350 enters Oil Pressure Bypass and checks for false crank termination. The START CHECK™ feature monitors the engine speed immediately after crank termination. If a false start is detected the GenMaster™ will wait for zero speed and a restart sequence will be initiated.
- F. After Oil Pressure Bypass and START CHECK™ the GM350 displays engine and generator information.
- G. The Oil Pressure, Fuel Level, Water Temperature, Frequency and Battery Voltage are displayed while the AC volts and amperage values are scrolled. Should a monitored Pre-

alarm condition occur the Pre-alarmed value will flash on the display, an amber LED will turn on, and the Pre-alarm relay will close.

- H. Should a monitored Fault occur, the Fuel Contact will be opened and locked out. The LCD display will display the Fault Condition with its' associated value, the red LED will turn on, and the Fault Relay will close. Manual Reset is required before a Restart can be initiated.
- I. Placing the spring loaded toggle in the RT position will display the accumulated RUNNING TIME. Continuing to hold the RT toggle will scroll the custom message units, safety set points and sender condition on the LCD display.
- J. Placing the spring loaded toggle in the SL or maintained position will lock the AC scrolling on a specific phase. The SL toggle must be placed in the OFF position during engine starting.

### **SELECTOR IN THE AUTO POSITION**

Placing the selector in the Auto position, the LCD display will read the following:

- A. GenMaster™ IN AUTO with Temperature, Fuel Level, and Battery Voltage displayed.
- B. Closing ground to the Remote Start Terminal will start the RUN SEQUENCE as described above. Removing the Remote Start signal will stop the Generator placing the GM350 back into the Automatic mode awaiting another Remote Start signal.
- C. If any faults occur in Auto, a manual reset is required before a restart can be initiated.

### **FAULT TEST PROCEDURE**

#### **OVERCRANK**

Disconnect the Fuel system and place toggle switch in RUN position. The engine will crank 5 times with 10 seconds cranking efforts with 10 seconds rest. The crank Relay and Fuel Relay will lock out, the Fault Relay will close, the red LED will turn on, and the LCD display will read FAULT OVERCRANK. Manual reset is required before restart can be initiated. It is recommended that the cranking motor also be disconnected while doing the test to preserve cranking battery charge.

#### **OVERSPEED**

Place the Engine selector in the RUN position allowing the engine to run. Manually increase the fuel until OVERSPEED speed is achieved. The Fuel Contact will open and lock out, the Fault Relay will close, the red LED will turn on, and the LCD will display FAULT OVERSPEED. Manual reset is required before another start can be initiated.

#### **HIGH ENGINE TEMPERATURE FAULT**

**NOTE:** Ground the digital input, as referenced on the drawings, to deactivate the sender fault feature for testing. Place the Engine Selector in the RUN position allowing the engine to run. Manually ground the Engine Temperature Sender to the engine block. The Fuel Contact will open and lock out, the Fault Relay will close, the red LED will turn on, and the LCD will display FAULT HIGH ENGINE TEMPERATURE. Manual reset is required before a restart can be initiated. There is a 5 second delay on this fault.

#### **LOW OIL PRESSURE FAULT**

**NOTE:** Ground the digital input, as referenced on the drawings, to deactivate the sender fault feature for testing. Place the Engine Selector in the RUN position allowing the engine to run. Manually remove the Oil Pressure Sender wire. The Fuel Contact will

lock out, the Fault Relay will close, the red LED will turn on, and the LCD will display FAULT LOW OIL PRESSURE. Manual reset is required before a restart can be initiated. There is a 5 second delay on this fault.

#### DIGITAL INPUTS

A contact closure to ground will activate individual inputs. The inputs will be as follows depending upon customer definition:

- A. Pre-Alarm at all times or when running only.
- B. Pre-Alarm when selector is in OFF or AUTO, Fault when engine is running.
- C. Fault when engine is running only.

#### EMERGENCY STOP

A contact closure to ground will activate Emergency Stop. The fuel will be turned off, the fault relay will close, the red LED will turn on, and the display will read EMERGENCY STOP. If a push to Emergency Stop and pull to reset type push button is used, reset of the push button is required prior to manual reset of the GenMaster™ before restart..

#### SENDER FAILURE

**NOTE:** Follow the same procedure for shut downs, but without the deactivation digital grounded. Grounding the sender will scroll a sender failure pre-alarm message on the LCD read out. The running Time of the failure will be stored in Sender Condition section of the custom message readout display. The diagnostic screen will be cleared and the message unit corrected when the engine is started and run with in-tolerance senders.

#### CALIBRATION PROCEDURES

All units are calibrated at the factory. If field adjustment is required follow the procedure listed below.

#### SPEED SET OPTION

After the generator has started manually bring the generator to 1800 RPM using an external speed measuring device. When the speed is at 1800 RPM depress the Speed Set push button with the wooden dowel while holding the **scroll lock** toggle in the scroll lock position to set the speed. Place the plastic plug in the hole. If Speed Set is required and the LCD is mounted on the top of the engine board contact the factory for instructions.

#### AC VOLTAGE

Should AC Volts require adjustment, there is a single 20 turn pot located on the AC Monitor board. Turning the pot clockwise raises voltage.

#### AC AMPS

Should AC Amps require adjustment, there is a single 20 turn pot adjustment located on the AC Monitor board. Turning the pot clockwise raises amperage.

#### DC VOLTAGE

Should DC Volts require adjustment, there is a single 20 turn pot adjustment located on the Engine Monitor board, assessable through a hole on the AC board. Turning the pot clockwise raises voltage.

## **TEST PROCEDURE FOR OPTIONAL FEATURES IF ACTIVATED**

### **UNDERSPEED MONITORING AND PROTECTION**

Underspeed does not activate until the programmed speed set point is reached. The default activation set point on a 60 Hz unit would be 56 Hz. This allows the engine to be started and idled without Underspeed monitoring.

When the programmed set point is reached the Underspeed protection is activated for the duration of the engine run. The default set point on a 60 Hz unit would be 55 Hz for 15 seconds. Should the engine speed drop and stay below the Underspeed set point. The engine will be shut down and require manual reset. The GenMaster™ will pre-alarm Underspeed until shut down occurs.

Underspeed can be tested by reducing engine speed to below the programmed set point.

### **OVER/UNDER VOLTAGE PROTECTION**

Over/Under Voltage does not activate until the programmed set point is achieved. The default activation set point on a 60 Hz unit would be 55 Hz. This allows the engine to be started and idled without Over/Under Voltage monitoring.

When the programmed speed set point and time delay are met the Over/Under Voltage protection is automatically activated for the duration of the engine run. A typical set point would be plus 10% and minus 15% for 10 seconds. If an Over/Under Voltage condition exists the generator will shut down and require manual reset. The GenMaster™ will pre-alarm Over/Under Voltage until shut down occurs.

Over/Under voltage can be tested by turning the AC volts calibration pot on the AC board.

### **OVER/UNDER FREQUENCY**

Over/Under Frequency does not activate until the programmed speed set point is achieved. The default activation set point on a 60 Hz unit would be 55 Hz. This allows the engine to be started and idled without Over/Under Frequency monitoring.

When the programmed speed set point and time delay are met the Over/Under Frequency pre-alarm is activated. The LCD display will indicate the pre-alarm. The percentage of Over and Under Frequency is set the EEPROM along with the time delay before pre-alarms. A typical setting is +/- 1.0 Hz.

Over/Under Frequency can be tested by adjusting the electronic governor.

### **OVERCURRENT PROTECTION**

The default activation set point on a 60 Hz unit would be 55 Hz. Overcurrent is automatically set for each run based on the operating voltage for that run. This allows for customer changing voltage between runs. i.e. 480 or 208 The GenMaster will pre-alarm the Overcurrent until shut down occurs. The GenMaster™ will pre-alarm Overcurrent until shut down occurs.

Overcurrent can be tested by turning the Amps calibration pot on the AC board.

### **COOLDOWN**

Cooldown will keep the engine running, for a timed period, after the transfer switch engine run contact is opened. When running the engine locally Cooldown will keep the engine running, for a timed period after the toggle switch is placed in the Off or Auto position. The Cooldown timer can be manually cancelled by placing the Running Time Toggle in the Scroll Lock position. Remember to place the Scroll Lock Toggle in the center position after canceling Cooldown. Typical Cooldown is 5 minutes

## **NOTE: 1**

THE CONTROL YOU HAVE PURCHASED IS A HIGH QUALITY ELECTRONIC INSTRUMENT, THE HEART OF WHICH IS DESIGNED TO RUN ON 5 VOLTS DC.

THE MOST COMMON INSTALLATION PROBLEMS THAT OUR CUSTOMERS HAVE RELATED TO EITHER LACK OF OR A POOR GROUND AND ELECTRONIC NOISE FROM SPARK IGNITED ENGINES. WHEN ANY ELECTRONIC CONTROLS ARE USED THE MOST IMPORTANT CONNECTION IS THE GROUND. THE BEST GROUND IS DIRECTLY TO THE NEGATIVE BATTERY POST.

IT IS ALSO IMPORTANT TO CONNECT THE POSITIVE CONNECTION AS CLOSE TO THE POSITIVE BATTERY POST AS POSSIBLE TO AVOID VOLTAGE DROPS AND PROVIDE THE BEST POWER TO THE CONTROLS AS POSSIBLE.

IF YOU HAVE EXPERIENCED ANY PROBLEM WITH THE INSTALLATION FEEL FREE TO CALL OUR ENGINEERING STAFF, AT (330) 239-4345, BUT FIRST CHECK THE FOLLOWING:

1. Make sure that the neutral is bonded to ground when you load bank the unit. Failure to do this may result in erroneous read outs to the control. When the generator is shipped into the field your customer may ground the neutral differently than you did, as long as they follow the NEC there will not be a problem.
2. If the control faults out at crank termination (when the engine starts) the suppression diode may not be installed on the cranking motor relay. If the diode is not installed on the cranking motor solenoid and the fuel relay large negative voltage spikes approaching 300 volts may be generated. These voltage spikes can cause either a glitch or damage to electronic controls, including electronic governors.
3. On spark ignited engines ignition noise is especially high. Make certain that none of the wires to the electronic control are touching the spark plug wires. Air is the best insulator. The high voltage noise from spark ignited engines can cause the microprocessor to crash. With proper installation the noise problem can be eliminated.
4. Our control system requires 2 battery positive connections. This is done to prevent voltage drop to the microprocessor during cranking. Remember that the battery positive connection should be as close to the battery post as possible. If one battery connection is used to feed both battery positives on the control engine board make certain that the conductor is large enough to prevent voltage drop caused by current draw and inrush.
5. Our control system requires that the neutral be grounded on WYE connected generators. If the neutral is not grounded it will float causing recirculating current on the neutral. Since the control system is grounded the current on the neutral will seek a ground through our control. We have installed a fuse on the neutral wire in our harness to help prevent damage caused by not grounding the neutral. Damage caused by not grounding the neutral will not be covered under warranty. We also have a special DELTA kit for delta connected generators.
6. Please review all of the manuals, technical notes, and schematics. If you have done so and still are experiencing problems please check our web site for additional technical information [www.controlsinc.com](http://www.controlsinc.com) or call us at 330-239-4345 for assistance.

We at Controls Inc. strive to manufacture leading edge technology based control systems. Our controls systems are manufactured and tested under the strictest quality control procedures available to us. Our

products are designed specifically for the industrial environment that engines and generators are used for. When properly applied and installed Controls Inc. products will provide years of reliable service.

## TECHNICAL BULLETIN #3

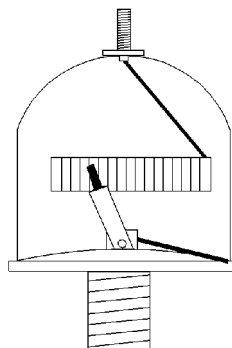
### *OIL PRESSURE SENDERS*

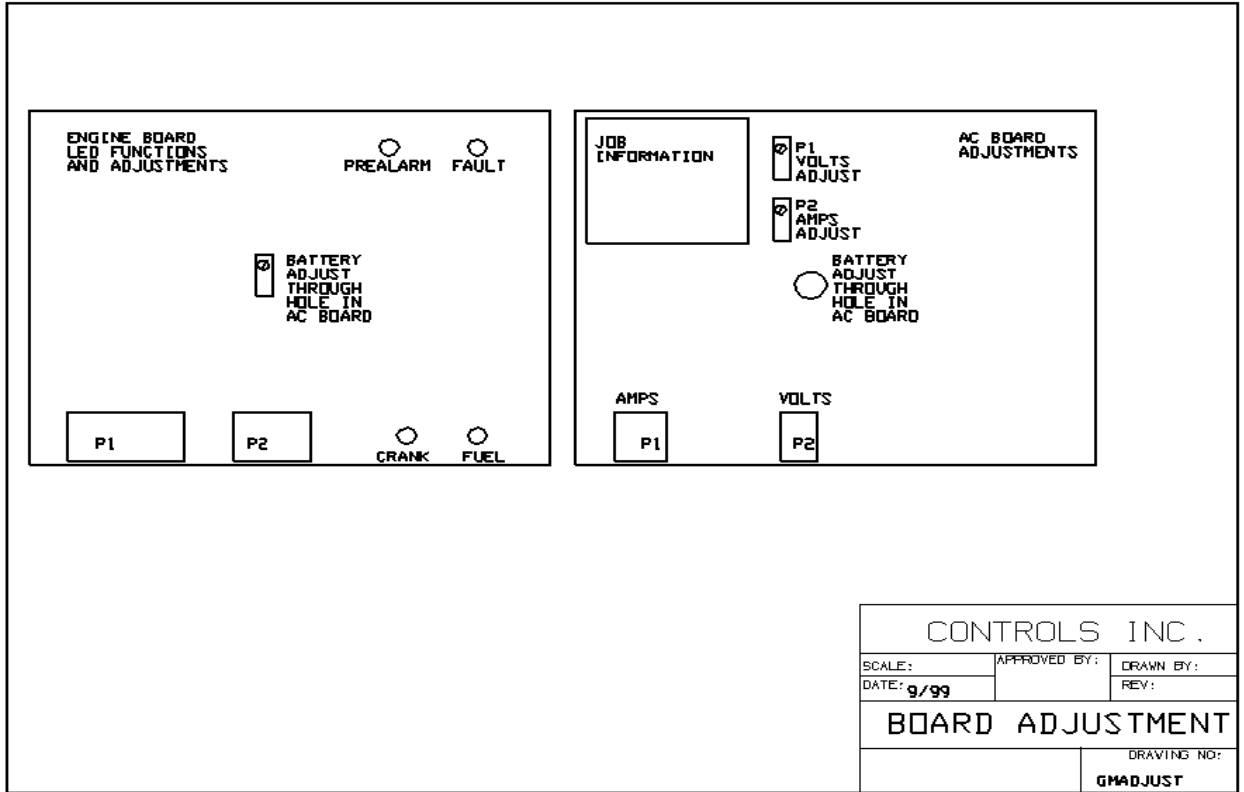
The typical automotive oil pressure sender utilizes the engine block as a ground reference. The pressure change is measured through a small restricting orifice to a diaphragm which moves a wiper across a resistor. The resistor may be Thick Film, Ceramic or Wire Wound. The typical resistance change, using a Stewart Warner curve for 0 – 100 lb., is 230-240 ohms equal 0 pounds and 29-33 ohms equal 100 pounds pressure.

Oil pressure readings may vary slightly from sender to sender. Pressure readings from gauge to gauge will also vary slightly depending upon the specific gauge. Pressure readings will also vary if the readings are taken from difference ports on the engine. As the wiper moves across the resistor, the reading may vary depending on the arm sweep and which segment of the resistor the arm is resting on.

Some engines may have enough vibration to cause a sender to fail prematurely. The wiper may wear a specific portion of the resistor, or cause the wiper to bounce on the resistor. If this occurs the pressure will read lower than actual. If a total failure occurs, it will be to 0 pounds pressure. In some application a rubber or nylon hose may be required to dissipate the vibration. In some prime power applications the oil pressure sender may fail due to dirt buildup caused by constant speed or the engine not allowing the wiper to clean itself across the resistor by starting and stopping.

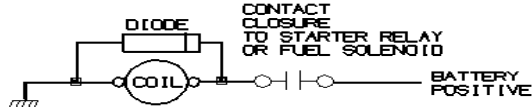
If the engine has a harmonic vibration that caused the oil pressure sender to fail frequently or precise oil pressure measurement is desired. A Strain Gauge can be considered for these specific applications. The Strain Gauge is relatively expensive, but the accuracy and long life in these applications are well worth the expense. Strain Gauges are available from Controls Inc.





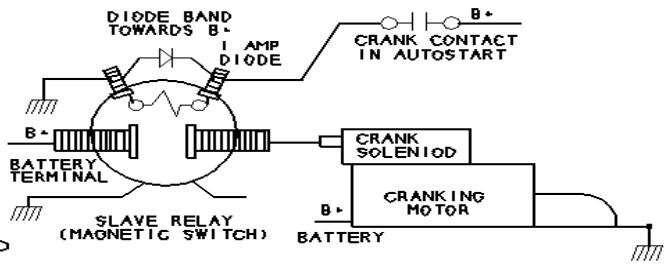
### DIODE INSTALLATION

NOTE: BAND OF DIODE GOES TO THE POSITIVE SIDE OF THE COIL



WHEN THE SWITCH IS OPENED THE DIODE CLAMPS THE REVERSE NEGATIVE VOLTAGE SPIKE GENERATED WHEN THE COIL FIELD COLLAPSES. THIS PREVENTS GLITCHES TO THE MICROPROCESSOR

### ENGINE STARTING SYSTEM



## LIMITED WARRANTY

CONTROLS, INC. is herein called "Seller". The person, firm or corporation to whom or which the sale is made is herein called "Buyer".

Seller warrants to the Buyer that all products furnished under this order will conform to Seller's specification, drawings as described in its current catalog or quotation and will be free from defects in materials and workmanship. Other special requirements asked for by the Buyer in its purchase order must be approved in writing by Seller. Parts replaced or repaired in the warranty period shall carry the unexpired portion of the original warranty. The foregoing is subject to the provisions that in no case will the total warranty period extend beyond twelve (12) months from date seller ships equipment from point of sale.

The Liability of Seller thereunder is limited to replacing or repairing at Seller's factory or on job site at Seller's option, any part or parts which have been returned to the Seller and which are proved by buyer as defective or not conforming to Seller's specifications, drawings or other written descriptions, accepted by Seller, provided that such part or parts are returned by the buyer within thirty (30) days after such defect is discovered. The Seller shall have the sole right to determine if the parts are to be repaired at the job site or whether they are to be returned to the factory for repair or replacement. All items returned to Seller for repair or replacement must be sent freight prepaid to its factory. Buyer must obtain Seller's Return Goods Authorization prior to returning items. The above conditions must be met if warranty is valid. Seller will not be liable for any damage done by unauthorized repair work, unauthorized misapplication in non suitable environment.

In no event shall the Seller be liable for loss, damage, or expense directly or indirectly arising from the use of the units, or from any other cause, except as expressly stated in the warranty. Seller makes no warranties, express or implied, including any warranty as to merchantability of fitness for a particular purpose or use. Seller is not liable for and buyer waives any right or action it has or may have against seller for any consequential or special damages arising out of any breach of warranty, and for any damages buyer may claim for damage to any property or injury or death to any person arising out of its purchase or the use, operation or maintenance of the product. Seller will not be liable for any labor subcontracted or performed by buyer for preparation of warranted item for return to Seller's factory or for preparation work for field repair or replacement. Invoicing of Seller for labor either performed or subcontracted by buyer will not be considered as a liability by the Seller.

This warranty shall be exclusive of any and all other warranties express or implied and may be modified only by a writing signed by an officer of the Seller. With respect to accessories supplied by Seller, but manufactured by others, there is no warranty of any kind, express or implied, and specifically there is no warranty of merchantability or fitness, except as may be set forth in any warranty the manufactures have made to Seller and which can be passed to the Buyer.

Buyer has not relied and shall not rely on any oral representation regarding the products sold thereunder and any oral representation shall not bind seller and shall not be part of warranty.

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