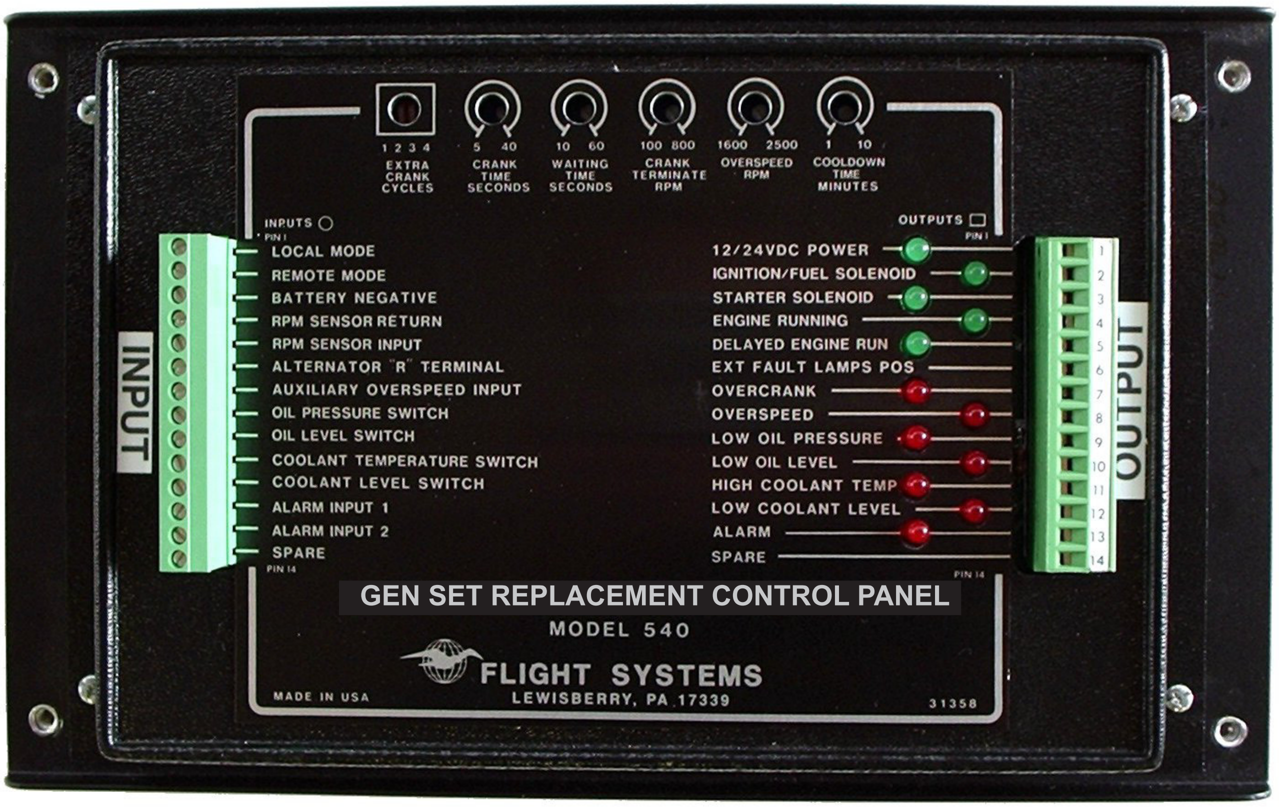
NFPA110 COMPLIANT
GEN SET REPLACEMENT CONTROL PANEL MODEL 540



INSTALLATION - OPERATION MANUAL

FLIGHT SYSTEMS

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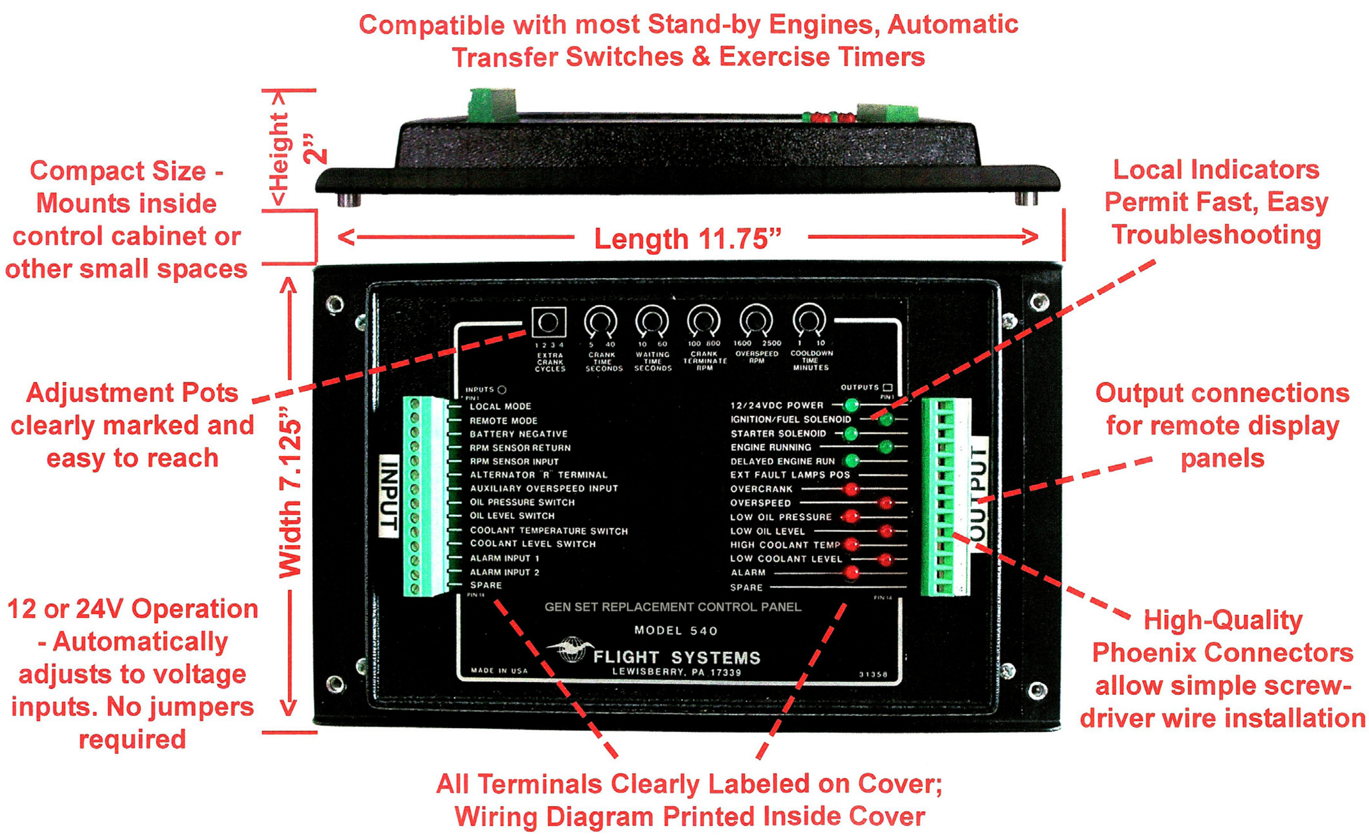
MODEL 540 - SIZE, LAYOUT AND REVIEW OF FEATURES



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APPLICATION INFORMATION – MODEL 540 GEN SET REPLACEMENT CONTROL PANEL

The Flight Systems Model 540 complies with National Fire Protection Assoc. (NFPA) Standard 110, 2005 edition, Level 2, section CV. Here are the listed requirements:

Overcrank – Built in
Low Water Temp. – Alarm Input 1
High Engine Temp. - Built in
Low Oil Pressure – Built in
Overspeed – Built In
Low Coolant Level – Built in
Lamp Test – Automatic on power-up
Remote & Local Alarm contacts – Built in
Air Shutdown Damper when used – Alarm Input 2

(An NFPA Guide is included at the end of this manual.)

INTRODUCTION AND PRODUCT DESCRIPTION:

The Model 540 Gen Set Replacement Control Panel was designed to combine in one unit the multiple functions normally required to implement an engine control and protection system for a fully automatic generator set, and other similar Gen Set Replacement Control Panel applications. In the past, these control functions have been implemented by combining various individual components into a system. These functions include: cycle cranking, crank termination, overspeed, engine protection with remote indicators, an alarm, starter and ignition/fuel relays, pre-alarm and cool-down timers. The use of individual components results in a system that consumes a great deal of space, required elaborate interconnect wiring, and is generally costlier to install and support in terms of initial cost, spares (often from several different sources) and training. Because of the complex interconnection of several components and a lack of diagnostics, on-site fault location is slow, resulting in increased downtime.

The Model 540 shows system status at a glance on its 12 LED indicators. Troubleshooting is simplified, and the entire control can be changed out in a few minutes, if necessary. The function of each circuit is shown on the front cover, thereby eliminating the need for a wiring diagram for simple troubleshooting. The wiring diagram appears inside of the cover so it will always be available to service personnel. Wiring to the units' connectors is done with an ordinary screwdriver, eliminating the need for special tools. Adjustments are conveniently located and well marked.

The unit is all solid-state with the exception of the two electromechanical output relays that are used for isolated switching of the starter and ignition/fuel circuits. This was done for safety and added flexibility in the system integration. The logic uses CMOS integrated circuits while the solid-state outputs use the latest FET power transistors. The internal 5 volt regulator utilizes an oversized heat sink bolted directly to the aluminum chassis for cooler operation and long life.

INSTALLATION:

1. Mechanical – the unit is designed to be mounted inside of the control panel enclosure or electrical cabinet that housed the other control components such as voltage/frequency monitors, transfer switches, etc. The unit mounts on any flat surface by means of bolts through the four corners of its aluminum chassis. See the Outline Drawing. It may be mounted in any position. The chosen location should provide easy access for adjustment and viewing of the LED status and fault indicators.

2. Wiring – Electrical connections are made to the two 14-position connectors by stripping the wires and inserting them into the clamp at each position and tightening the binding screw. Strip just enough insulation to permit the wire to enter the clamp fully (approximately ¼ inch). The connectors will accept a range of wire sizes from #18 to #14 AWG stranded. It is suggested that each wire be identified with a numbered wire marker as the connectors are wired. The connectors can be unplugged at any time without disturbing the wiring.

3. Mode Select Switch – The operating mode of the unit is selected by a single-pole three position switch, the positions being “LOCAL”, “OFF” and “REMOTE”. Primary power is fed to the unit via this switch and a fused control circuit (5 AMP MAX.). See the Wiring Diagram. This switch may be a toggle, rotary or key lock type and is located on the panel at the engine to be controlled. The switch is moved to the “LOCAL” position to start the engine for test or maintenance purposes and returned to the “REMOTE” position to arm the system for remote starting. The “OFF” position will prevent starting and will stop the engine if running from either the “LOCAL” or “REMOTE” modes. If the engine is started from the “REMOTE” mode, the cool-down feature is activated.

4. Remote Contacts – The remote contacts are located in the line monitor (or other monitoring equipment, i.e., pressure, etc.) that commands the engine to start. These contacts are connected between input terminals 1 and 2. Closure causes the start sequence to begin when the Mode Select Switch is in the “REMOTE” position. After the engine has been started in the remote mode, opening the remote contacts activates the cool-down feature, causing the engine to continue running until the cool-down period elapses.

5. RPM Signal – A reliable engine RPM signal is critical to the proper operation of the control. The RPM signal may be obtained from one of three sources: a magnetic pickup on the flywheel, a tachometer generator, or the battery-charging alternator. The magnetic pickup is the most reliable since it has no moving parts. It may be used on flywheels with 103 to 168 teeth. Clearance should be set to approximately 0.032 inch. Some late model engines, particularly diesels, are provided with a 5/8-18 SAE tapped hole in the bell housing for this purpose. Some engines may already have a magnetic type pickup installed for use with an electronic governor. The unit’s RPM input can usually be connected to an existing pickup if polarity is observed. In some cases, an isolation transformer may be necessary to prevent a ground loop or D.C. imbalance in the governor circuitry. A separate pickup is also an option. A suitable magnetic pickup is available as an accessory. See the ACCESSORIES section. The pickup is to be connected to RPM SENSOR and RPM SENSOR RETURN, input terminal 5 and 4, using shielded, twisted-par cable, with the shield connected to input terminal 3. No connection is made to the shield at the sensor end.

   If the tachometer generator is used, it is to be connected in the same way as the magnetic pickup and coupled to the tachometer drive take-off on the engine (7/8-18 SAE with 0.187 slotted shaft). This shaft should be turning at one-half crankshaft speed. The tachometer generator is comparable in cost with the magnetic pickup and, in many cases, is easier to install. Its use depends on the availability of an existing drive take-off on the engine.

   If the alternator “R” terminal is used, it is to be connected directly to ALTERNATOR “R” TERMINAL, input terminal 6, with no connection made to terminals 4 or 5. The system common negative on terminal 3 then serves as the return for the alternator signal. It is not necessary to shield this wire. This method is the most economical and convenient way to sense RPM if alternator equipped, however, it is subject to belt slippage and/or breakage and therefore is not as precise as the other two methods. IMPORTANT: THE ALTERNATOR MUST PRODUCE A USABLE SIGNAL AT THE “R” TERMINAL AT NORMAL CRANK TERMINATE RPM, OTHERWISE THE STARTER MAY REMAIN ENGAGED TOO LONG. Either 12 or 24 volt alternators can be used. SPECIAL NOTE: The RPM circuitry MUST BE CALIBRATED for each application. This is a simple procedure. See “ADJUSTMENTS”.

6. Engine Sensor Inputs – The engine sensors consist of switches for oil pressure, oil level, coolant temperature, and coolant level. These are connected to the corresponding SWITCH inputs on terminals 8, 9, 10 and 11, respectively. Any one or all are optional. An unused input is left unwired. A switch closure to common negative represents a fault (pressure and level switches close on fall, temperature switch closes on rise). Standard automotive switches of the 1-wire (grounded) or 2-wire type may be used. Inputs may be shorted to positive or negative without damage. Any sensor may be shorted to simulate a fault for test purposes. The current through each switch when closed is approximately 5 milliamperes. The voltage across an open switch is 5 volts.

7. Auxiliary Overspeed Input – The AUXILIARY OVERSPEED input is a means of connecting an additional external speedswitch to the 540. A contact closure to common negative of two seconds or more will trip the overspeed feature, turning on the OVERSPEED indicator and ALARM and shutting down the engine. If an auxiliary overspeed switch is used, it should be adjusted to trip at a somewhat higher RPM that the overspeed feature of the 540. The AUXILIARY overspeed input may be used as an external means of engine shutdown for any reason, even though actual overspeed has not occurred.

8. Alarm Inputs – ALARM INPUT #1 allows an external contact closure to common negative to activate the alarm circuit and prevent starting. This input is NOT latching and resets as soon as the external contacts open. This input may be used as an external means of shutting down the engine, provided that the contacts remain closed until the engine stops. A typical use would be for a battery monitor. A low battery condition would then activate the alarm on the remote panel and prevent starting. This also saves the cost of a separate indicator for the battery monitor. ALARM INPUT #2 works the same except it is activated by a contact closure to positive 12/24 volts. This difference allows increased flexibility in connecting to other systems.

9. Alarm Output – Alarm devices such as indicator lamps and audible indicators are connected between ALARM, output terminal 13, and common negative. Polarity must be observed when connecting LED and solid state audible indicators. More than one device may be connected provided that the total current does not exceed 0.5 AMPS. The alarm device(s) are activated by any engine fault during pre-start, run or cool-down, as well as an external contact closure on ALARM INPUTS #1 or #2. All engine faults cause the alarm to remain activated until the unit is reset by returning the mode select switch to “OFF”. Alarm devices must have appropriate voltage ratings.

10. Remote Engine Fault Indicators – Six remote engine fault indicators, lamps or LED’s, are connected to OVERCRANK, OVERSPEED, LOW OIL PRESSURE, LOW OIL LEVEL, HIGH COOLANT TEMP., and LOW COOLANT LEVEL, output terminal 7 through 12. All indicator positive terminals are to be connected to EXT FAULT LAMPS POS, output terminal 6. Any or all of the indicators are optional, depending on the needs of the remote control panel. Two or more indicators may be connected to a given terminal provided that the total current does not exceed 0.5 AMPS. Indicators must have appropriate voltage ratings and polarity must be observed in the case of LED types. Engine fault indicators, when tripped, remain on until reset by returning the mode select switch to the “OFF” position.

11. Engine Running Indicator – The “Engine Running” indicator, lamp or LED, is connected between ENGINE RUNNING, output terminal 4 and EXT FAULT LAMPS POS, output terminal 6.
The indicator is optional, must have an appropriate voltage rating and polarity must be observed in the case of LED types. The “Engine Running” indicator is activated anytime the engine RPM is above the set crank terminate RPM.

12. Delayed Engine Running Indicator – The "Delayed Engine Running" indicator, lamp or LED, is connected between DELAYED ENGINE RUN, output terminal 5, and common negative. This output can supply up to 0.5 AMPS to relays, solid-state devices or other systems. Polarity must be observed. This output is activated 60 seconds after the engine starts. It is used to enable other monitoring equipment after the engine has been running and voltage, frequency, etc. have been stabilized. The output is turned off if the mode selector switch is turned off, if the engine is shut down or stops. It remains activated as long as the engine is running in cool-down. See "SEQUENCE OF OPERATION" below.

13. Ignition/Fuel Solenoid Output – The ignition circuit positive is connected to IGNITION/FUEL SOLENOID, output terminal 2, on gasoline engines with solid state or conventional ignition. On LP gas engines, a safety fuel shut-off solenoid valve or other safety device will also be connected. On diesel engines, the fuel shut-off solenoid valve will be connected. The return in all cases is to common negative. Grounded (single-wire) solenoids may be used. Transient suppression, either diode/resistor or MOV type, is recommended across solenoid coils. When this output is activated, a pair of internal 5 Amp relay contacts closes between output terminals 1 and 2. Note that terminal 1, although located on the "output" connector, is really an input, and is the positive power source for the ignition and starter circuits. The IGNITION/FUEL SOLENOID output is activated when the mode selector switch is inhibited if an engine pre-start alarm exists (low oil or coolant level) or if ALARM INPUT #1 or #2 is activated. The output is inhibited if an engine fault or alarm condition appears during the LOCAL or remote run modes, or during cool-down (REMOTE mode only). See "SEQUENCE OF OPERATION" below.

14. Starter Solenoid Output – The starter solenoid or pilot (pony) relay circuit positive is connected to STARTER SOLENOID, output terminal 3. The return is to common negative. Grounded (single-wire) solenoids may be used. Transient suppression, either diode/resistor or MOV type, is recommended across all relay and solenoid coils. When this output is activated, a pair of internal 5 Amp relay contacts close between output terminals 1 and 3. The STARTER SOLENOID output is activated when the mode selector switch is placed in the LOCAL position or when the remote contacts close with the mode selector switch in the REMOTE position. Cycle cranking begins and terminates with engine start or overcrank. See "SEQUENCE OF OPERATION" below.

15. Primary Power and Noise Reduction – The Model 540 is designed to operate in systems with a 12 or 24 volt negative ground battery. The battery need not be actually connected to the engine block or other frame member as long as electrical integrity is maintained in the common negative return for all components. See Wiring Diagram (Pg 9). As noted above, the power for the IGNITION/FUEL and STARTER outputs is fed from terminal 1 on the OUTPUT connector and is relay isolated from all other circuits. To minimize the effects of solenoid and/or ignition noise, a separate battery positive lead should be run for this circuit. It may b operated at a voltage different from the control and indicators, if desired. For example, the starter and ignition could be 24 volts, while the remainder of the circuitry is 12 volts. The power for the internal logic of the control is powered via the mode selector switch (INPUT terminals 1 and 2). Although the internal power (5 volts) is well filtered and regulated, an effort should be made to keep electrical noise to a minimum on this circuit. In extreme cases, it may be necessary to insert a power line (hash) filter in the feed to the mode selector switch, and/or connect a large computer-type electrolytic capacitor (suggest 8000 or 10000 MFD at 50 VDC) from this point to common negative. The voltage on INPUT terminals 1 or 2 is allowed to dip momentarily to 7.0 volts minimum during cranking. It is not uncommon for the voltage to dip to 8 volts, or lower, when cranking a large diesel engine at low temperatures with an undersized 12 volt battery. The condition of the battery and specific gravity are also factors. This dip can be minimized by running a separate circuit directly from the battery to the mode selector switch.

ADJUSTMENTS

The unit has several adjustments (six external, two internal) to enable it to be tailored to individual system requirements. The RPM calibration must be done before the other adjustments are made.

1. RPM Calibration – NOTE: Factory RPM calibration is for a magnetic pickup on a 142 tooth flywheel. Remove the cover and locate the two RPM programming switches and potentiometer near TP- 1. See P.C. board detail drawing in Fig. 1 (Page 8). The switches are to be set according to the type of RPM signal source being used, as follows:

MAGNETIC PICKUP	**BOTH SWITCHES OFF**
ALTERNATOR “R”	**SW1 ON, SW2 OFF**
TACH. GENERATOR	**BOTH SWITCHES ON**

After the switches have been set, start the engine and stabilize the RPM at 1800. Adjust the RPM calibration potentiometer until 4.0 volts is obtained at TP-1.

2. Extra Crank Cycles – One crank cycle is always attempted. The four-switch group sets the number of EXTRA CRANK CYCLES attempted before the overcrank alarm is activated. Set ONLY ONE switch corresponding to the number desired. One to five cranking cycles are possible.

3. Cranking Time – The CRANKING TIME adjustment sets the duration of the cranking on each attempt. The adjustment range is 5 to 30 seconds, clockwise to increase. Cranking terminates automatically when the engine starts. A typical setting is 10 seconds.

4. Waiting Time – The WAITING TIME adjustment sets the elapsed time between cranking attempts when the engine does not start on the first attempt. The adjustment range is 10 to 40 seconds, clockwise to increase. A typical setting is 20 seconds.

5. Crank Terminate RPM – the CRANK TERMINATE RPM adjustment sets the engine RPM at which the starter is disconnected when the engine starts. The adjustment range is 100 to 800 RPM, clockwise to increase. A typical setting is 300 RPM.

6. Overspeed RPM – The OVERSPEED RPM adjustment sets the engine RPM at which an overspeed fault and alarm will be registered. Overspeed sensing is delayed for 2 seconds after engine start in order to prevent false tripping due to governor overshoot. The adjustment range is 1600 to 2500 RPM, clockwise to increase. A typical setting is 2100 RPM for a nominal 1800 RPM generator.

7. Cool-down Time – The COOL-DOWN TIME adjustment sets the length of time that the engine continues to run after the remote contacts open when the REMOTE mode is selected. The optimum setting may depend on load, engine size, cooling system capacity, ambient temperature, etc. The adjustment range is 1 to 10 minutes, clockwise to increase. A typical setting is 5 minutes.

DIAGNOSTIC LED INDICATORS

Twelve colored diagnostic LED indicators located on the front of the unit continuously display system status. The 5 green LED's show that the unit is receiving POWER, and if the IGNITION/FUEL STARTER, ENGINE RUNNING or DELAYED ENGINE RUNNING outputs are activated. The red LED's indicate an engine fault. The red ALARM LED will come on with any of the six engine faults. The LED's duplicate the action of the indicators on the remote panel. All red LED's are latching, and reset when the unit is reset. The LED's are very useful in quickly determining system status without the need for voltage readings on each circuit. They may act as a temporary substitute for the remote panel during installation, or may eliminate the need for some of the indicators at the remote location in certain cases.

SEQUENCE OF OPERATION

There are two modes of operation, LOCAL and REMOTE. The LOCAL mode is used for test and routine maintenance when an operator is present at the engine. Starting is initiated by placing the mode selector switch in the LOCAL position. Power is then applied to the unit via input terminal 1, turning on the green POWER LED. If no pre-start fault exists on oil or coolant level, and there is no alarm condition of ALARM #1 or #2, the IGNITION/FUEL and STARTER circuits and LED's are activated. Cranking continues until either the engine starts, or the set CRANK TIME elapses. If the engine does not start, a set WAITING TIME elapses before the next attempt, after which cranking resumes for the set time. This cycle continues until the engine starts, or the set number of CRANK CYCLES (1 to 5) has been exhausted. If this occurs, the OVERCRANK and ALARM indicators are turned on, the IGNITION/FUEL is turned off, and further start attempts are locked out until the unit is reset. If the engine starts, the starter is terminated and the ENGINE RUNNING LED comes on. Two seconds after engine start, overspeed sensing is enabled. This delay prevents false overspeed trip due to governor overshoot on initial start-up. After the engine has been running for 15 seconds, oil pressure sensing is enabled and the starter is locked out. This lockout feature prevents accidental engagement of the starter in the event of failure of the RPM signal or fuel supply. After the engine has been running for 30 seconds, coolant temperature sensing is enabled. This delay is to prevent tripping on coolant temperature overshoot when re-starting a hot engine. After the engine has been running for 60 seconds, the DELAYED ENGINE RUNNING LED and output are turned on.

If any engine fault develops, the corresponding LED and ALARM LED indicator (and remote indicator) will be turned on, and the IGNITION/FUEL will be turned off. If the engine stops for any reason other than a fault (such as fuel supply failure), an overcrank alarm will result. The engine may be stopped at any time by returning the mode selector switch to the OFF position.

Operation in the REMOTE mode is similar, except that the unit is already powered via input terminal 2, and the green POWER LED will be on. The engine is unattended and is armed for remote operation. The engine start cycle is initiated by closure of the remote contacts in the line monitor, or other external equipment. The sequence is then identical to that in the LOCAL mode until the remote contacts open. The engine will continue to run in cool-down for the duration of the set COOL-DOWN TIME. Engine faults during cool-down will result in alarms and shutdown. Engine stoppage for other than fault reasons during cool-down will result in an overcrank alarm. If the remote contacts re-close during cool-down, the engine will continue running with full protection, and the cool-down timer will be reset. This assures that a full cool-down time will be available regardless of how many times the remote contacts open and re-close. The engine may be stopped manually at any time by returning the mode selector to the off position.

TROUBLESHOOTING

Troubleshooting is relatively easy and is aided by the diagnostic LED indicators. All voltage readings are taken with respect to input terminal 3, battery negative. If the POWER LED does not light in either the LOCAL or REMOTE modes, check the source of 12/24 VDC power to the mode selector switch. Battery voltage should be present at input terminal 1 or 2 (depending on mode) and output terminal 6. If the ENGINE RUNNING LED does not come on when the engine is started, and/or the starter does not terminate, check the RPM sensor and connections. If 4.0 VDC cannot be obtained at TP-1 at 1800 RPM, re-check the RPM calibration. See ADJUSTMENTS above. If the starter disengages too soon or too late, adjust the CRANK TERMINATE RPM as necessary. If the overspeed trips on initial start-up, check the RPM calibration, OVERSPEED RPM setting and governor setting. Check for belt slippage on belt driven governors. Check the signal from any device that may be connected to the AUXILIARY OVERSPEED INPUT, input terminal 7. If the engine fault inputs do not respond properly, check the open circuit voltage at input terminals 8 through 12. This should be 5 VDC. Simulate a fault by grounding the input, except for ALARM INPUT #2, which requires a positive voltage (7 to 32 VDC).

Remember that in the case of oil pressure and coolant temperature, that delays of 15 and 30 seconds, respectively, must elapse after engine start before these inputs are enabled. In the case of oil pressure, an additional 5 seconds must elapse before a fault is registered. An alarm that comes on immediately and cannot be reset indicates a defective unit. If the action of the remote panel does not agree with the status and fault diagnostic LED's, check for wiring errors between the 540 and the remote panel. Remember that the DELAYED ENGINE RUN LED does not come on until 60 seconds after engine start. DO NOT apply voltages directly to the indicator outputs as damage may result.

TECHNICAL ASSISTANCE

If you require assistance during installation or operation of the Model 540, please call our Technical Service Department at 717 932 9900 from 8am to 5pm ET, M-F.

REPAIR SERVICE

Should the Model 540 suffer a problem when out of warranty, repair service is available from the manufacturer at reasonable rates. Ship unit to Flight Systems, 505 Fishing Creek Road, Lewisberry, PA 17339 USA. Attn: Dock 16

WARRANTY

The MODEL 540 is warranted to be free from defects in materials and workmanship for a period of two years from the date of shipment.

FLIGHT SYSTEMS' liability is limited to the repair or replacement of defective product within the warranty period, and does not cover installation or removal costs incurred or possible damage to other equipment (including generator sets and transfer switches) as a result of a malfunction of the GEN SET REPLACEMENT CONTROL.
If, in the opinion of FLIGHT SYSTEMS (or its authorized agent) the malfunction of the GEN SET REPLACEMENT CONTROL PANEL was caused by abuse, misuse or improper installation, the warranty claim will be disallowed and established repair rates shall apply.

Units should be shipped, freight charges prepaid, directly to FLIGHT SYS TEMS, 505 Fishing Creek Rd, Lewisberry, PA 17339, USA Attn: Dock 16

ACCESSORIES

Magnetic Pickup RPM sensor, 5/8-18 x 3”	57-A995-03
Audible alarm, solid-state, 12/24 V	57-9954-12
External mating connector, left (supplied)	57-9954-15
External mating connector, right (supplied)	57-9954-05
Application Information Manual	57-5400-01
Remote Annunciator Display	57-A550-57M1

COMPANION PRODUCTS

G.E.M. Generator Exercise Monitor	Model 325
Grasslin DIGI 20A-120 Exercise Timer	56-20A-102V

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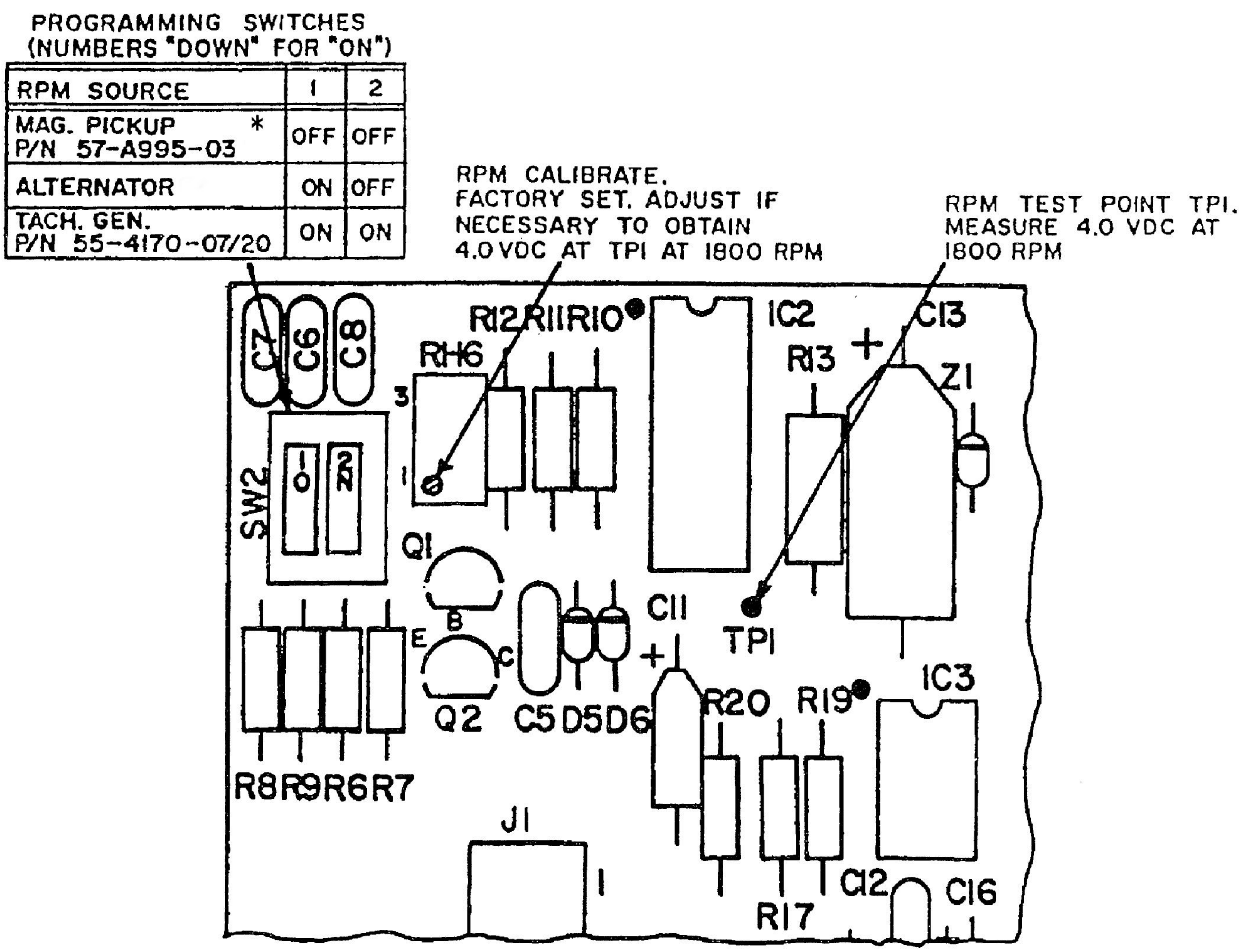
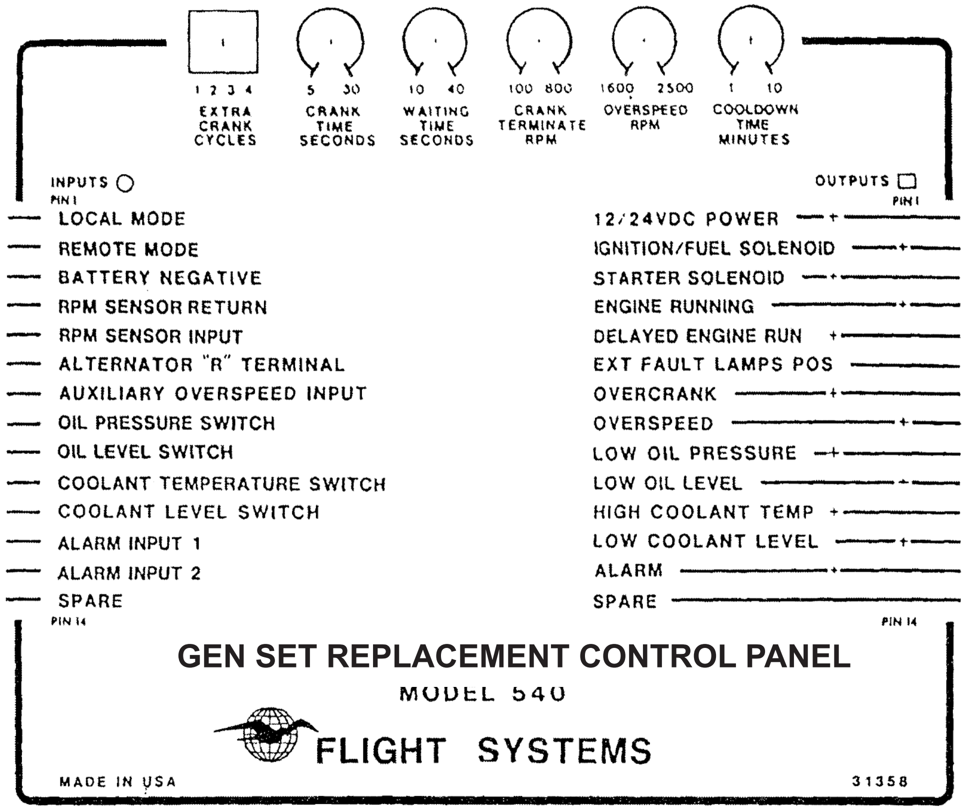
RPM PROGRAMMING AND CALIBRATION (Fig. 1)



* FACTORY SETTINGS

INPUTS & OUTPUTS AS SHOWN ON MODEL 540 FACEPLATE (Fig. 2)



WIRING DIAGRAM, INPUTS & OUTPUTS (Fig. 3)

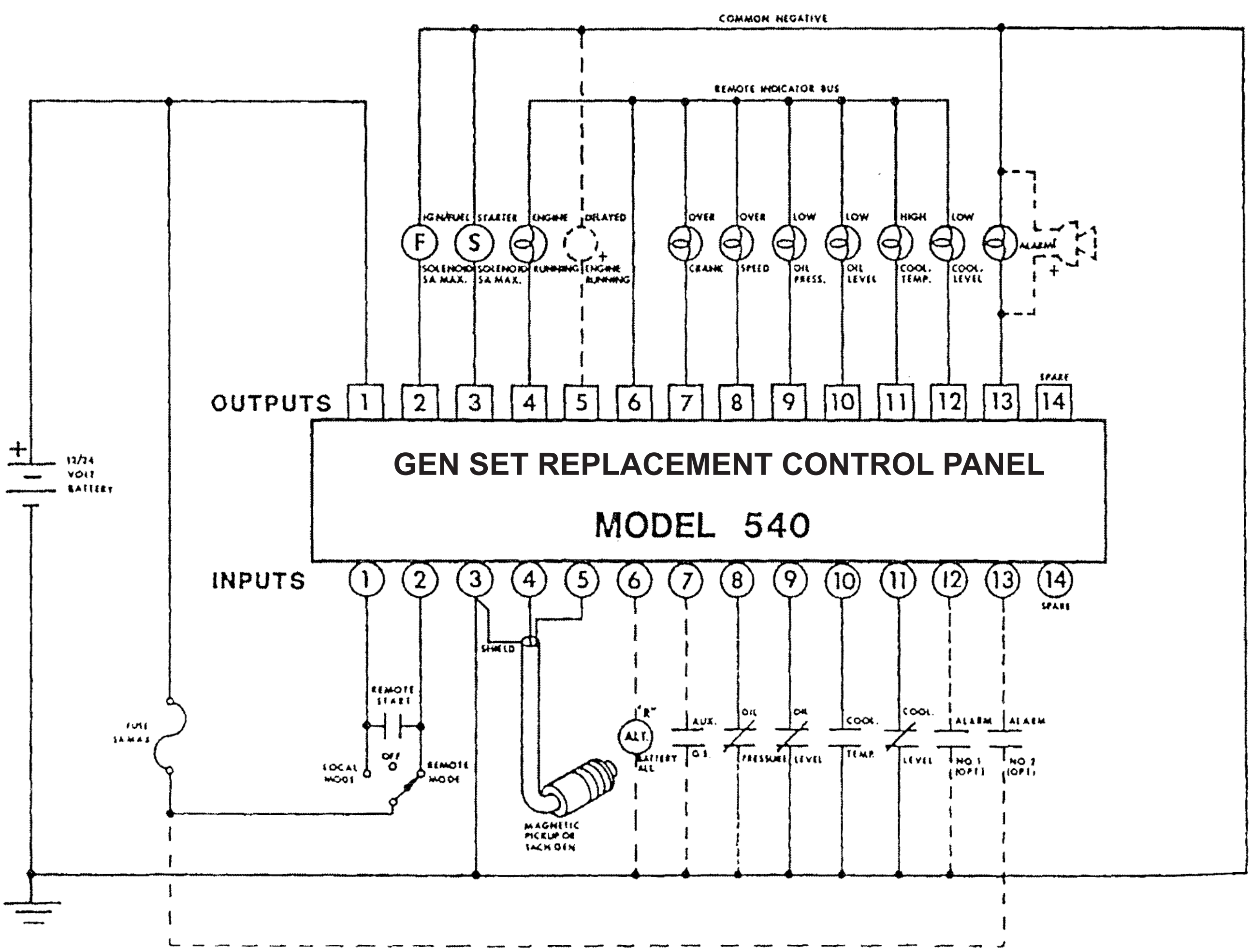


Chart One - NFPA 110 Table 5.6.5.5 Safety Indications and Shutdowns for Level 1 & Level 2 (2005 Edition)

		Level 1			Level 2		
Item	Indicator Function (at Battery Voltage)	CV	S	RA	CV	S	RA
a	Overcrank	X	X	X	X	X	O
b	Low water temperature	X	NA	X	X	NA	O
c	High engine temperature pre-alarm	X	NA	X	O	NA	NA
d	High engine temperature	X	X	X	X	X	O
e	Low lube oil pressure pre-alarm	X	NA	X	O	NA	NA
f	Low lube oil pressure	X	X	X	X	X	O
g	Overspeed	X	X	X	X	X	O
h	Low fuel main tank	X	NA	X	O	NA	O
i	Low coolant level	X	O	X	X	O	X
j	EPS supplying load	X	NA	NA	O	NA	NA
k	Control switch not in automatic position	X	NA	X	O	NA	NA
l	High battery voltage	X	NA	NA	O	NA	NA
m	Low cranking voltage	X	NA	X	O	NA	O
n	Low voltage in battery	X	NA	NA	O	NA	NA
o	Battery charger ac failure	X	NA	NA	O	NA	NA
p	Lamp test	X	NA	NA	X	NA	NA
q	Contacts for local and remote common alarm	X	NA	X	X	NA	X
r	Audible alarm silencing switch	NA	NA	X	NA	NA	O
s	Low starting air pressure	X	NA	NA	O	NA	NA
t	Low starting hydraulic pressure	X	NA	NA	O	NA	NA
u	Air shutdown damper when used	X	X	X	X	X	O
v	Remote emergency stop	NA	X	NA	NA	X	NA

Notes & Legend: CV = Control panel-mounted visual. S = Shutdown of EPS indication. RA = Remote audible. X = Required. O = Optional. NA = Not applicable.

1 Item (p) shall be provided, but a separate remote audible signal shall not be required when the regular work site in 5.6.6 is staffed 24 hours a day.
2 Item (b) is not required for combustion turbines.
3 Item (s) or (t) shall apply only where used as a starting method.
4 Item (j): EPS ac ammeter shall be permitted for this function.
5 All required CV functions shall be visually annunciated by a remote, common visual indicator.
6 All required functions indicated in the RA column shall be annunciated by a remote, common audible alarm as required in 5.6.5.5 (4).
7 Item (h) on gaseous systems shall require a low gas pressure alarm.
8 Item (b) shall be set at 11°C (20°F) below the regulated temperature determined by the EPS manufacturer as required in 5.3.1.

Chart Two - Sample building and structures seismic use group III and IV building codes, designate as essential facilities:

- **Hospital and other healthcare facilities with surgery and emergency treatment**
- **Power stations and other public utility facilities required for category III/IV structures**
- **Fire, rescue and police stations and emergency vehicle garages**
- **Structures containing max. allowable highly toxic materials per section 307 table 307.7 (2)**
- **Designated earthquake, hurricane or other emergency shelters**
- **Buildings and other structures having critical national defense functions**
- **911, communication, data, switching, operation centers**
- **Water treatment facilities required to maintain water pressure for fire suppression**

NFPA 110 Pertaining to Generator Systems Level 1 and 2
Information Sheet # 15

The National Fire Protection Association (NFPA) maintains several standards covering standby generators and automatic transfer switches (ATS). This information sheets is an overview of the topics covered in NFPA 110 levels 1 and 2.

"System designers must review the complete NFPA 110 document to determine exact NFPA 110 requirements."

The NFPA standard for generator set systems most frequently encountered by the designer is NFPA 110 – ***Standard for Emergency Power Supply Systems (EPSS)***. By definition, this consists of an engine-driven generator set connected to a system of conductors, disconnecting and over-current protection devices, transfer switches, supervisory and support devices (including fuel storage); up to and including the load terminals of the transfer equipment.

Local authorities, such as building inspectors or fire marshals, should always be consulted to determine if NFPA 110 compliance is required for a standby generator set application.

NFPA 110 details three categories in classifying an emergency power supply system:

The categories defined are Class, Type and Level. All need to be defined in any project specification to ensure that the proper configuration is quoted and supplied.

Class. This defines the minimum number of hours the generator set can operate at its rated load without refueling. Most commonly specified are: Class 48 (minimum of 48 hours) and sometimes Class 72 (minimum of 72 hours).

Note! Level 1 installations in high seismic risk areas (Zones 3 and 4) require a minimum of a 96 hour on-site fuel supply (i.e. Class 96). This fuel supply cannot be shared with any other purpose.

Buildings Included in Zones 3 and 4 Defined as Essential Facilties. *(See chart two detailing sample building and structures seismic use group III (IBC-2000) and use group IV (IBC-2003/2006) building codes, designate as essential facilities.)*

Type. This defines the maximum time, in seconds, from a utility outage until the standby generator is supplying power that the load terminals of the ATS can be without acceptable electrical power. For example Type 10 means that the standby system must provide power within 10 seconds.

Level. Level 1 is most stringent and imposed when failure of the standby system could result in loss of human life or serious injury. Level 2 is used when failure is less critical to human life and safety. Level 1 requires that additional generator features be included. *(See the preceding chart for details of Level One and Level Two)*

Site Testing and Maintenance of Generator Sets to NFPA 110:

Testing. NFPA 110 stipulates several different site tests which should be referred to in order to ensure compliance. Tests can be made at unity power factor, if the 0.8 power factor rated load testing of the complete unit was carried out by the manufacturer before shipment from the factory.

NFPA stipulates exhaust-stack temperatures to prevent wet stacking *(a field term indicating the presence of unburned fuel or carbon in the exhaust system)* based on the generator size. These can be given to technicians by the manufacturer of the generator set. If no more than 60% of generator rated output is available in building load, a resistive load bank must be used to test the generator at its full output capacity.

Maintenance and Operational Testing/Inspection. All EPSS with ancillary equipment, including transfer switches, must be inspected weekly and exercised under load at least monthly, for a minimum of 30 minutes, preferably with load. NFPA 110 also requires circuit breakers be exercised annually with EPS in "off" position. Breakers rated in excess of 600 volts should be exercised every six months and tested every two years under simulated overload conditions. This will require careful planning and diligent coordination. It is vital that all management and staff are aware when scheduled maintenance is arranged to be carried out. *A Level 1 EPSS must be tested for at least four hours, at least once every 36 months.* ATS's are subject to an annual maintenance program, including one major maintenance and three quarterly inspections. All data and readings should be recorded in the on-site maintenance log, for future inspection and reference.

For more information about NFPA 110

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