WARNING: DEVIATION FROM THESE INSTALLATION INSTRUCTIONS MAY LEAD TO IMPROPER ENGINE OPERATION WHICH COULD CAUSE PERSONAL INJURY TO OPERATORS OR OTHER NEARBY PERSONNEL.

1.0 OVERVIEW

1.1 The Altronic CPU-95 Digital Ignition system, model 791955-16, has been designed for application in conjunction with the Caterpillar Timing Control Module (TCM) on natural gas fueled engines. This system is designed to replace both the Altronic III and the Altronic Interface Box. New features include advanced spark control, primary and spark diagnostics, self diagnostics, pickup diagnostics and serial communications. The system consists of two main parts: an engine mounted Ignition Module (791955-16) and an optional user interface Display Module (791902-2).

1.2 This document provides instructions and descriptions to be used in the operation of the ignition system, and does not cover physical installation. Reference the installation instructions, form CPU-95 II-C, for instructions regarding installation and mounting.

WARNING: THE IGNITION SYSTEM MUST BE CONFIGURED PRIOR TO USE ON AN ENGINE. REFER TO SECTION 9.7 TO VIEW THE CURRENT CONFIGURATION. REFERENCE FORM CPU-95 PI FOR INSTRUCTIONS DESCRIBING HOW TO CONFIGURE THE IGNITION SYSTEM. VERIFY EEPROM PROGRAMMING PRIOR TO STARTING ENGINE.

2.0 IGNITION MODULE TIMING SWITCH, LED INDICATORS AND SERIAL PORT

2.1 A 16-position rotary switch is provided inside the CPU-95 Ignition. This switch is used in Mag-Cal mode of the Caterpillar TCM to adjust the retard from the Hall-effect signal to simulate the timing given formerly provided by the Altronic III at low engine RPM. Adjustment of this switch simulates rotating the Altronic III mechanical position. Timing range is 0 to 15 degrees with one degree resolution.

2.2 Five LED indicators are provided inside the Ignition Module for troubleshooting purposes.
- The red Power LED is on solid when the unit is powered and the microprocessor is running.
- The red Power LED flashes when the unit has power but is not operating correctly.
- The red Power LED is off to indicate that the unit has no power.
- The red TX LED flashes to indicate that the unit is transmitting on the RS-485 serial link.
- The red RX LED flashes to indicate that the unit is receiving on the RS-485 serial link.
- The red ALARM LED turns on to indicate that a warning or fault is present.
- The green H.E. PICKUP LED turns on when a magnet turns on the Hall-effect pickup.

2.3 One RS485 serial communications port is provided within the Ignition Module. This port is normally used for communication to the optional Display Module. A PC (personal computer) or a PLC (programmable logic controller) can be connected to the RS-485 port to perform remote monitoring or control functions. The Ignition Module can be operated in a stand-alone mode, but diagnostic and control features would not be accessible. This port is also used to configure the ignition system for its application using a PC and the CPU-95 PC terminal software.

3.0 THE DISPLAY MODULE USER INTERFACE AND INPUTS

3.1 The Display Module serves as the user interface for the CPU-95 system. An RS485 two wire serial communications format is used to connect the Display Module to the Ignition Module.

3.2 An alphanumeric 16-character x 2-line back-lit LCD display is used to provide output to the user. A sealed membrane keypad is used to accept user input. The LCD display and the key-pad function together to provide an interactive user interface which prompts the user as different functions are selected.

3.3 All actions and adjustments are immediate and are performed on an incremental basis using up and down arrow keys. All keypad adjustments, except individual offset timing adjustments are performed directly in non-volatile EEPROM memory. This EEPROM memory retains previous settings even after an engine shutdown, or an ignition power down.

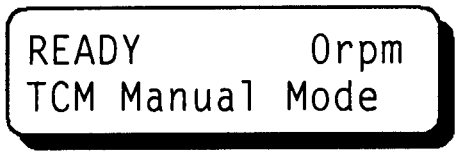
3.4 Capital letters are used on the LCD display screen to designate an active selection while lower case letters are used to indicate other possible options.

4.0 UNDERSTANDING THE HOME SCREEN

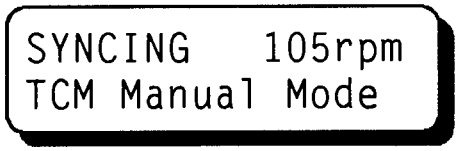
4.1 A series of "home" screens are used to describe the current status of the ignition system. The LCD display always reverts back to one of the home screens after a keypad operation is completed or times out. The home screen is designed to display the most critical operating parameters on one screen.

4.2 All of the home screens provide a status word in the upper left corner, the engine speed in the upper right corner and the timing control status of the TCM on the lower line.

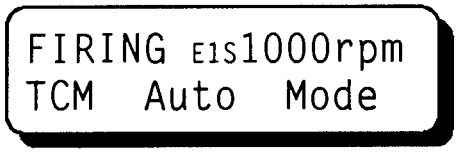
4.3 The READY message is displayed when the ignition is ready for the engine to crank for starting. The CAT Timing Control Module would normally also be in Manual Mode.



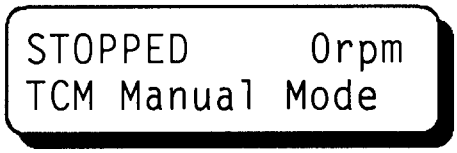
4.4 Once the engine begins turning, the SYNCING message is displayed while the ignition system verifies signals from the engine pickups. Proper signals can be identified in as few as two engine revolutions.



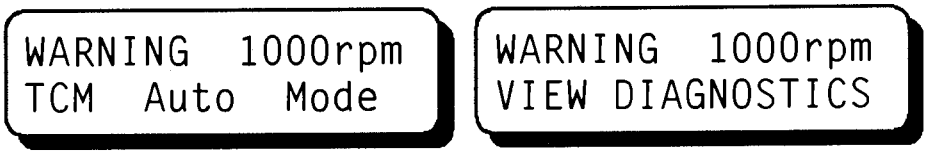
4.5 The FIRING message is displayed when the ignition begins firing. Additional data is provided on this screen to describe the selected mode of operation for the ignition. The energy mode (E1,E2,E3) and the single-strike / multi-strike type (S or M) are described in the middle of the upper line in small characters. The CAT TCM is depicted to be in auto timing mode here.



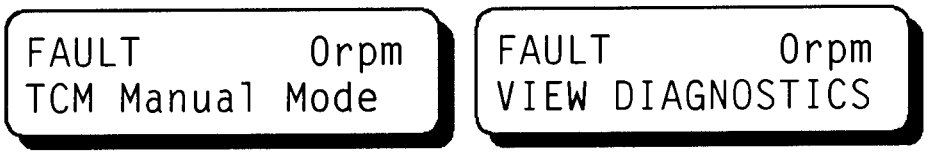
4.6 The STOPPED message is displayed when a loss of rotation is detected after the ignition is firing and neither a SHUTDOWN or FAULT has occurred. This signifies that the engine has stopped without any detected cause from the ignition system.



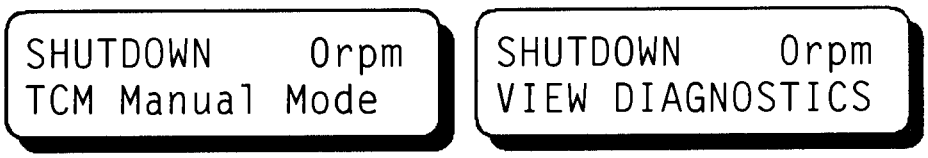
4.7 The WARNING message will supersede all of the above home screens if a diagnostic warning condition is present. When a diagnostic warning exists, a VIEW DIAGNOSTICS message will flash on the bottom line of the display. The Ignition Module will continue to operate under a warning condition while alerting the operator of a potential problem by turning on the Alarm LED in the Ignition Module, and by displaying the Warning message. The various types of diagnostic warnings are described in section 10.0.



4.8 The FAULT message will supersede all of the above home screens if a diagnostic fault condition is present. When a diagnostic fault exists, a VIEW DIAGNOSTICS message will flash on the bottom line of the display. The ignition system will stop operating under a fault condition and will alert the operator to the problem by turning on the alarm LED inside the Ignition Module, and by displaying the Fault message. The various types of diagnostic faults are described in section 10.0.



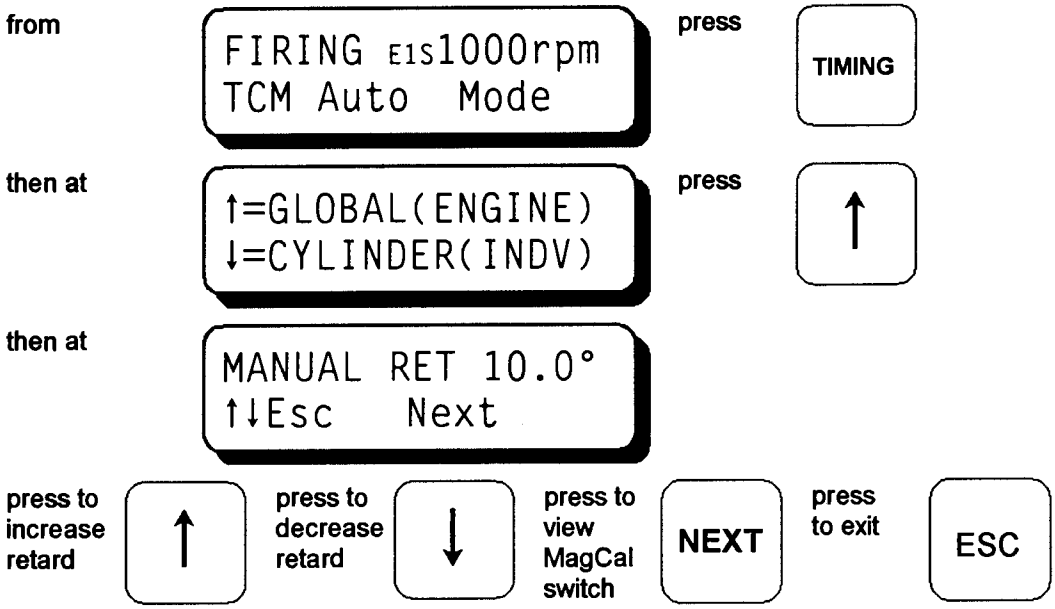
4.9 The SHUTDOWN screen will supersede all other home displays if the G-Lead of the output primary connector is grounded or was previously grounded and the engine had not stopped rotating. This screen indicates that the ignition is not firing because the G-lead was grounded to shutdown the engine. If a diagnostic fault or warning exists while the ignition is in shutdown, a VIEW DIAGNOSTICS message will flash on the bottom line of the display.



5.0 ADJUSTING GLOBAL / MANUAL MODE RETARD

5.1 Global retard is an adjustment affecting the timing of all cylinders equally. This adjustment affects the timing only when the system is in manual timing mode. The default setting for manual retard is 10 degrees. Adjustments made as described below will be in effect until another adjustment is made. Manual range for most engines is 0 to 20 degrees retard from the Mag-Cal timing. NOTE: This range is limited to 10 degrees on some engines.

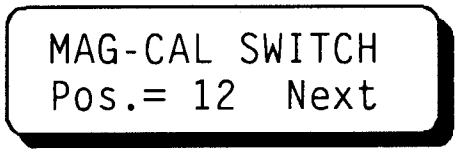
5.2 To adjust global retard:



5.3 The increment of timing change is dependent on the number of holes or teeth being sensed. With 183 teeth, timing resolution is 0.254 degrees.

6.0 VIEWING MAG CAL SWITCH POSITION

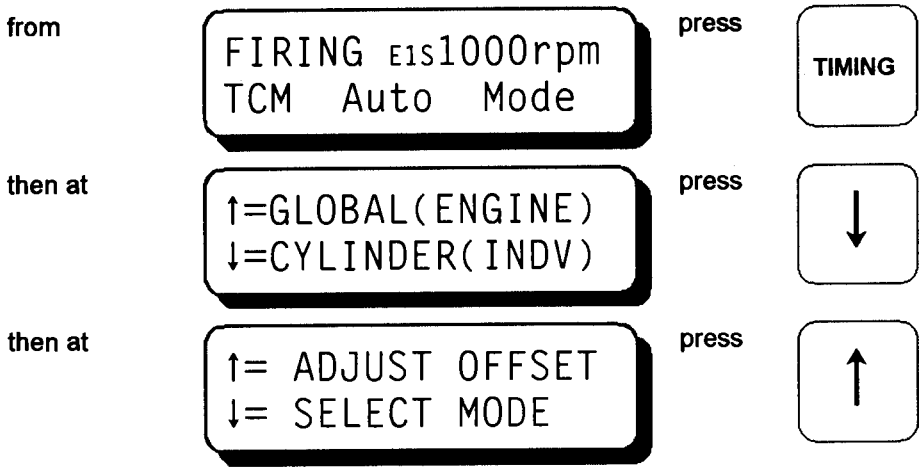
6.1 Pressing the NEXT key from the manual retard screen will display the Mag-Cal Switch position screen as shown below.



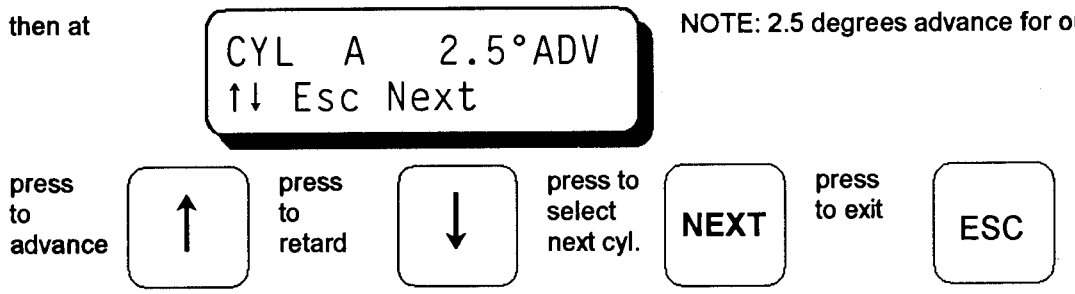
7.0 ADJUSTING INDIVIDUAL OFFSETS

7.1 The timing of individual cylinders can be offset by up to 3 degrees of advance or retard from the global timing of the engine. Adjustments made as described below should be considered temporary. The ignition will revert back to the values saved in EEPROM memory on every reset, start or power-up. To save temporary adjustments to EEPROM memory see section 8.0.

7.2 Enter the individual timing adjustment menu as described below.



7.3 The individual timing adjustment screen identifies the primary output to be adjusted, and the degrees of offset in use for the output.



7.4 The output identification characters will be provided as follows:

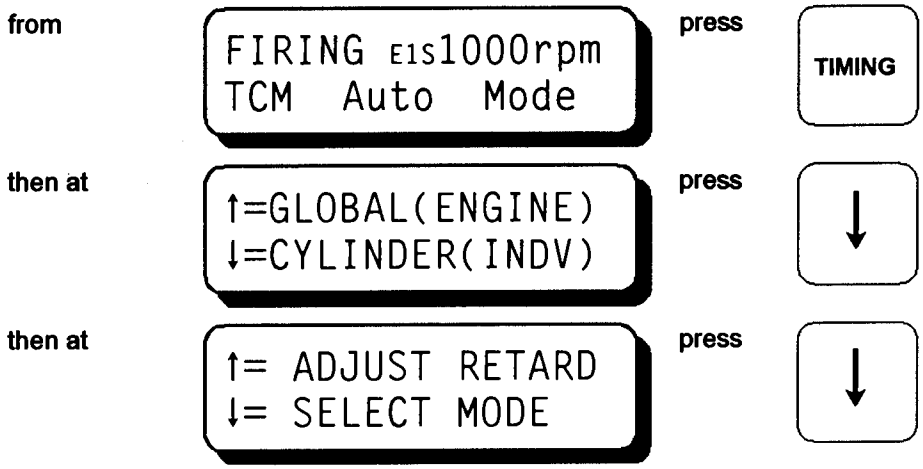
A B C D E F K L M N P R S T U V

This identification is based on the primary output connector / harness pin no.; match-up to the engine firing order to determine the engine cylinder number (also see section 9.7).

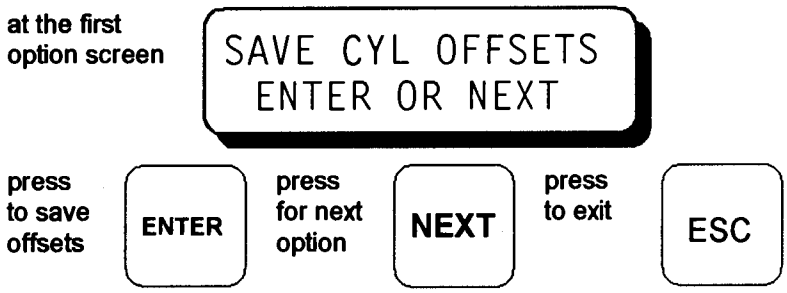
HARNESS:	A - B - C - D - E - F - K - L - M - N - P - R - S - T - U - V
G3508:	1 - 2 - 7 - 3 - 4 - 5 - 6 - 8
G3512:	1 -12 - 9 - 4 - 5 - 8 -11 - 2 - 3 -10 - 7 - 6
G3516:	1 - 2 - 5 - 6 - 3 - 4 - 9 -10 -15 -16 -11 -12 -13 -14 - 7 - 8

8.0 INDIVIDUAL CYLINDER OFFSET MODES

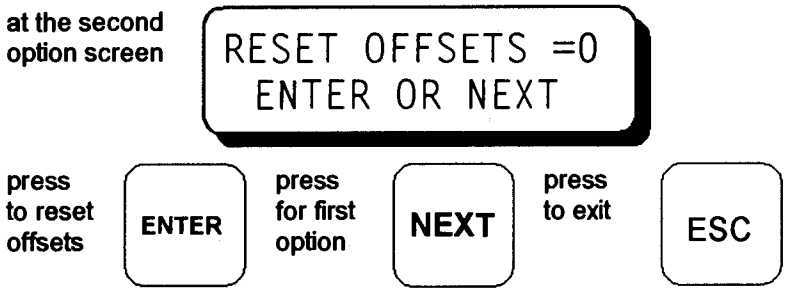
8.1 Two additional functions with regard to individual cylinder timing offsets are provided. These functions can be accessed from the individual timing mode menu which can be entered as described below.



8.2 The first function is used to save the current (temporary) individual offsets to EEPROM memory. When this is done, the ignition will load these offset settings every time the engine starts or reset is pressed. Reference section 7.0 to adjust individual (temporary) offsets.

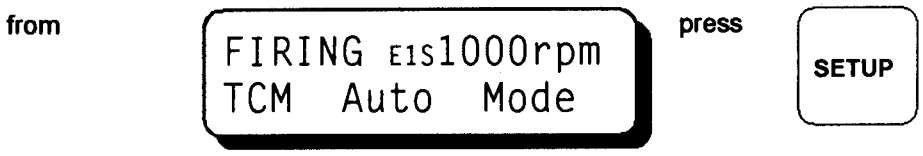


8.3 The NEXT mode function can be used to reset all cylinder offset values back to zero (both temporary memory and EEPROM memory).

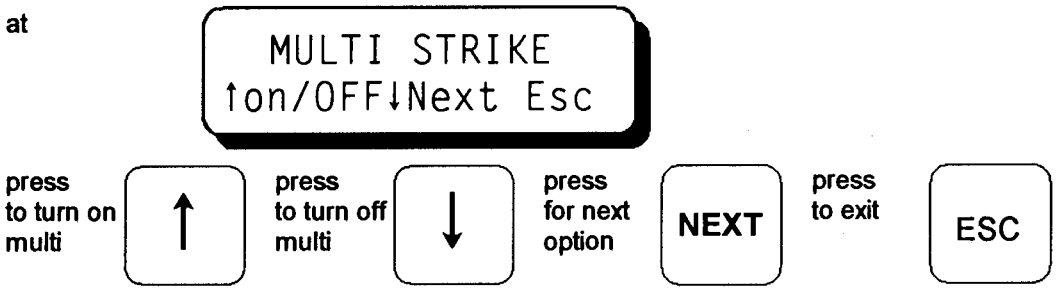


9.0 SETUP CONTROL OPTIONS

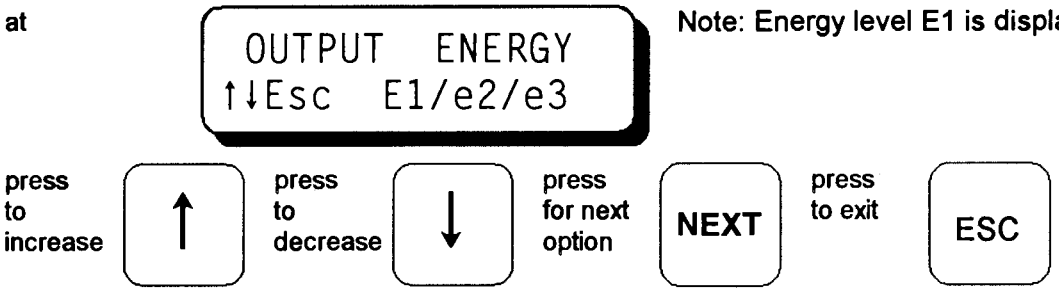
9.1 Additional control settings and display features can be accessed under the setup menu. Changes made under the Setup menu are stored in EEPROM and remain fixed until changed again. The Setup menu can be entered as described below.



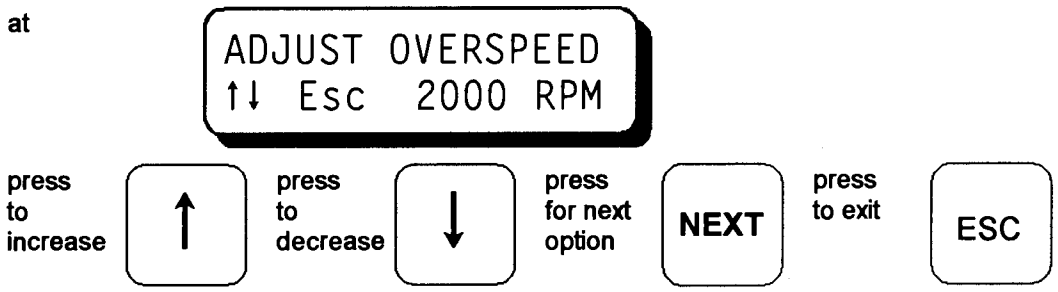
9.2 The first setup screen permits the operator to enable or disable the Multi-Strike feature.
Note 1: A special option can be selected to force Multi-Strike to be active below 250 rpm.
Note 2: The Multi-Strike feature is automatically turned off above 1050 rpm.
Note 3: Multi-Strike may tend to accelerate spark plug electrode erosion.
Note 4: The Multi-Strike feature fires the spark plug 2 times per event (~1100usec apart).



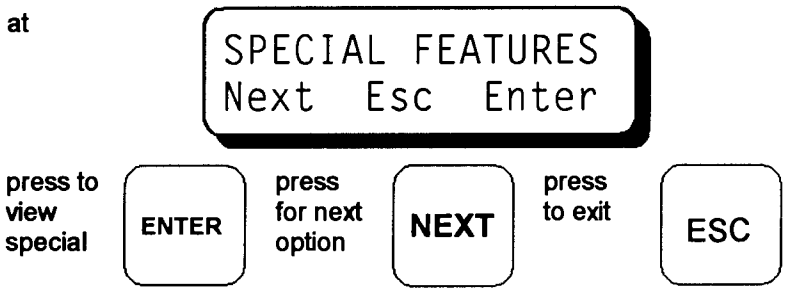
9.3 The next setup screen permits the operator to select one of three ignition energy levels (E1,E2,E3). The energy levels are 75 millijoules(E1), 100 millijoules(E2), 125 millijoules(E3).
Note 1: A special option can be selected to use the maximum energy level below 250 rpm.
Note 2: The energy is automatically limited to E2 when Multi-Strike is active.
Note 3: Higher spark energy may tend to accelerate spark plug electrode erosion.



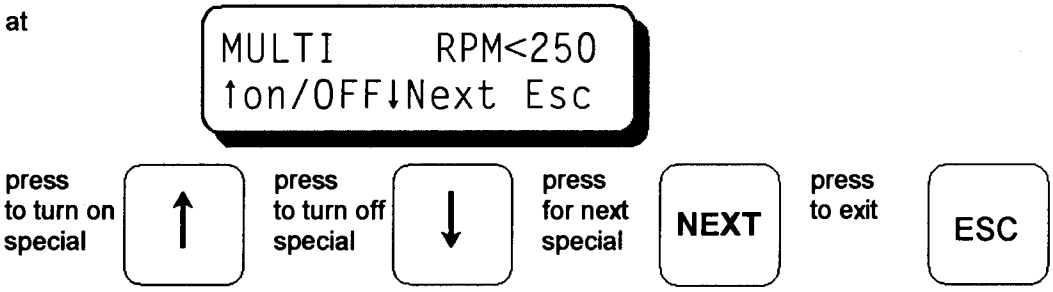
9.4 The next setup screen is used to adjust the engine overspeed setpoint. The setpoint can be adjusted in increments of 10 rpm to a maximum of 2550 rpm.



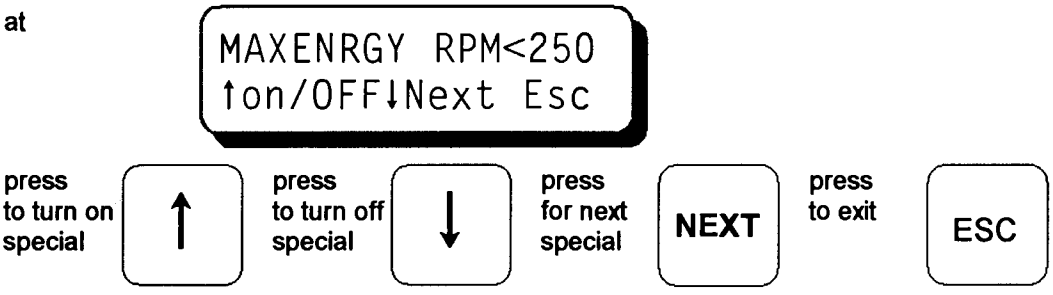
9.5 The next setup screen is used to configure the special features available for startup.



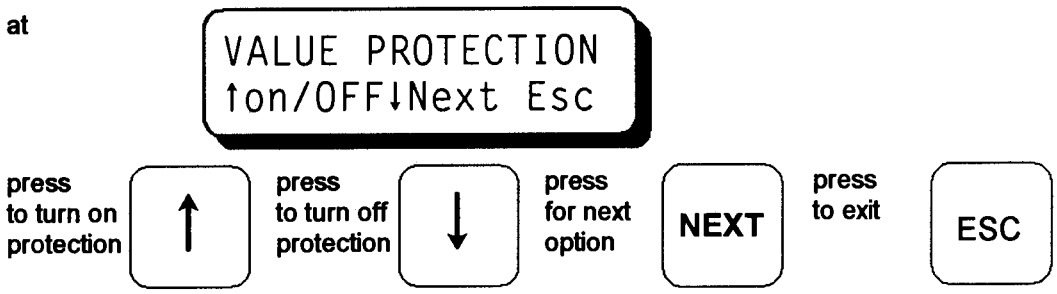
Pressing Enter displays the multi strike special feature. When turned on, the ignition will fire in multi-strike mode until the engine speed exceeds 250 rpm.



Pressing Next displays the max energy special feature. When turned on, the ignition will fire with the maximum permitted energy (E3 in single-strike or E2 in multi-strike) until the engine speed exceeds 250 rpm.

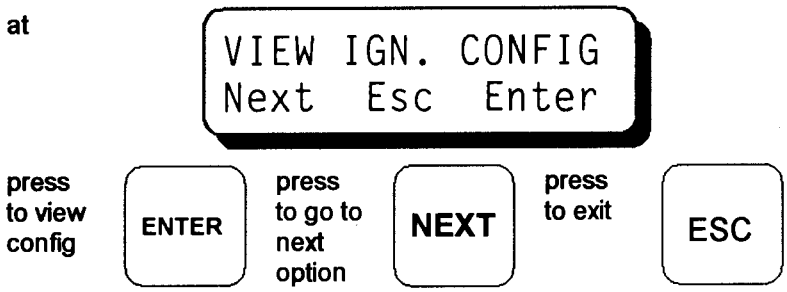


9.6 The next setup screen is used to enable or disable VALUE PROTECTION of all user values in the EEPROM memory. When protection is on, none of the EEPROM settings under the Setup or Timing menus can be changed. This feature can be used to provide limited protection from random changes by inexperienced operators.



9.7 The next setup screen can be used to view the configuration comments which describe the configuration of the ignition system. There are a total of 8 screens which can be rotated to the display using the NEXT key.

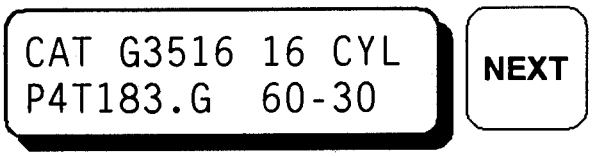
NOTE: Because EEPROMS can be reconfigured (using a PC and Altronic's configuration software), these comments should be viewed to identify and verify the configuration settings of the ignition prior to operation. Refer to the programming instructions, form CPU-95 PI, for further information on configuration.



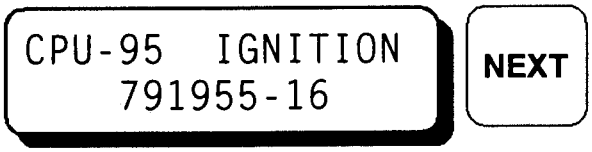
The configuration screens are shown starting on the next page.

The following types of screens can be viewed by pressing enter to start and next to advance.

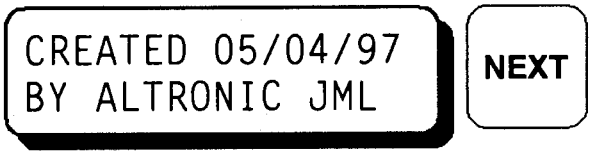
Engine Application
Firing Pattern Code



Ignition Description
Altronic Part Number

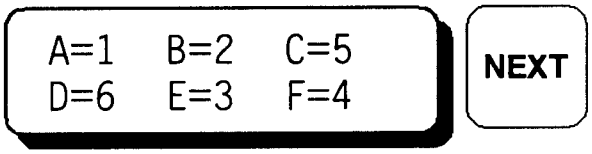


Date of Application Creation
Application Creator

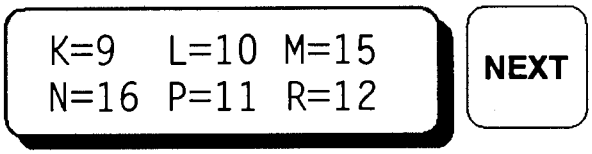


Application Special Notes
Firing order

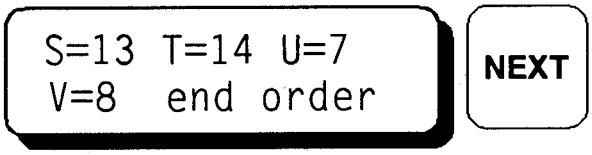
Firing order of the engine converted to the primary connector pin-out



Firing order of the engine converted to the primary connector pin-out

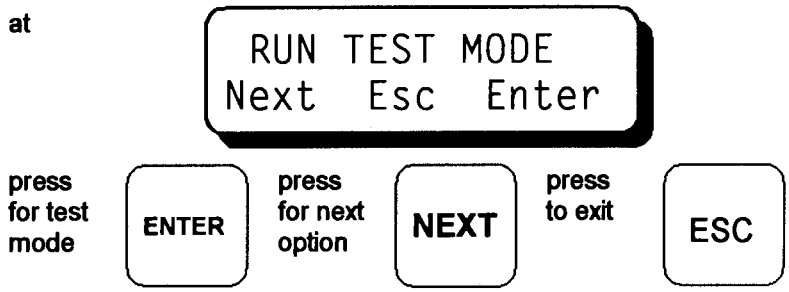


Firing order of the engine converted to the primary connector pin-out

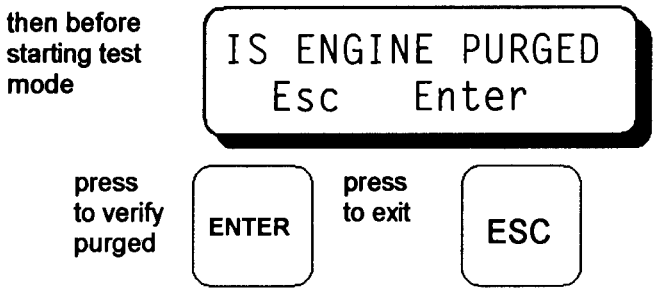


Special user comments area
User specified comments

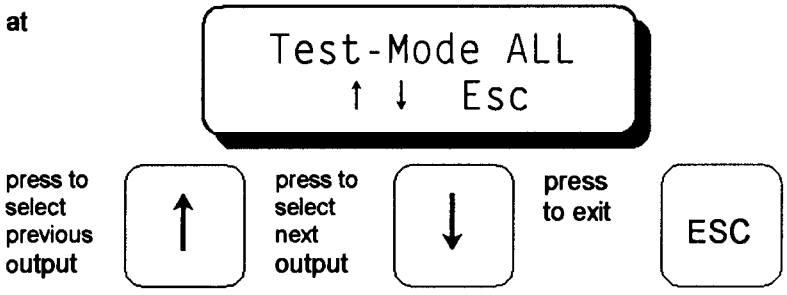
9.8 The last setup screen permits the operator to enter an ignition test mode. This test mode can fire all outputs in rotation, or individual outputs at a slow rate. This feature can be used to troubleshoot primary wiring and Ignition Module operation. Test mode will terminate if rotation of the engine is sensed. The Caterpillar TCM must command manual mode for test mode to operate. Diagnostic features do not function while in test mode.



WARNING: The operator MUST fully purge the engine of combustible mixtures prior to selecting the TEST MODE operation. Pressing the enter key again is a confirmation of this action.



Then the test mode screen indicates that the ignition is firing and permits the operator to select the output to be fired.



Test-Mode selection rotates as described below.

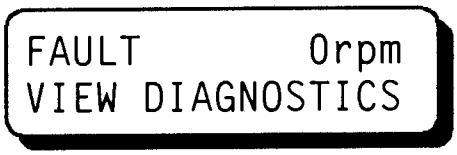
ALL, A, B, C, D, E, F, K, L, M, N, P, R, S, T, U, V, ALL

10.0 IGNITION SYSTEM DIAGNOSTICS

10.1 A diagnostic fault represents the most severe classification of problems. The presence of a diagnostic fault will inhibit the ignition from firing. When a fault is detected several things will occur:

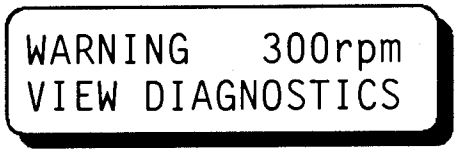
- The ignition will stop firing.
- The Alarm LED in the ignition unit will turn on.
- The home status will read FAULT, and the bottom line will flash VIEW DIAGNOSTICS.

NOTE: Diagnostic FAULTS will supersede diagnostic WARNINGS.

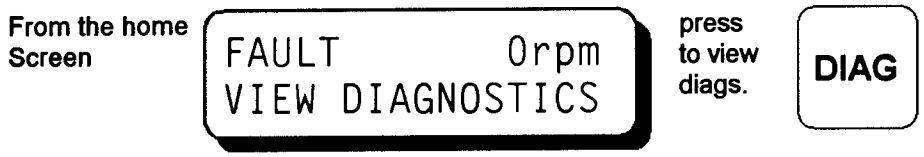


10.2 A diagnostic warning represents the least severe classification of problems. The ignition will continue to fire in the presence of a diagnostic warning. When a warning is detected, several things will occur:

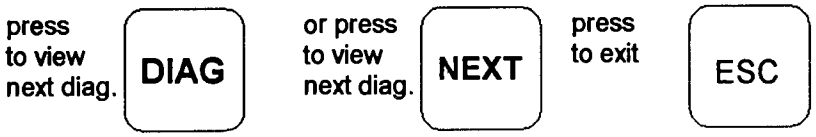
- The Alarm LED in the ignition unit will turn on.
- The home status will read WARNING, and the bottom line will flash VIEW DIAGNOSTICS.



10.3 When a fault or warning is present, the operator can display the actual cause of the diagnostic as depicted below.



Then from the diagnostic description screens use the following keys.

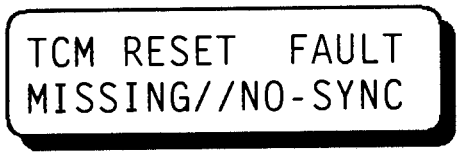


10.4 Diagnostic Fault screens, in order of display priority, are described below.

When zero gear-tooth pulses are seen between two Hall Effect pulses.

When too many gear-tooth pulses are seen without a Hall Effect reset pulse.

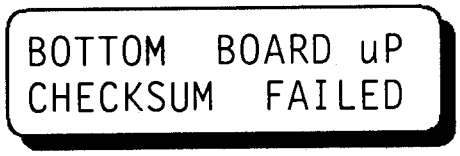
When the TCM reset signal is missing or not aligned properly with the Hall Effect signal. Active only in CAT TCM auto mode.



When too many or too few gear-tooth pulses are seen between Hall Effect reset pulses. The received number or pulses is displayed.

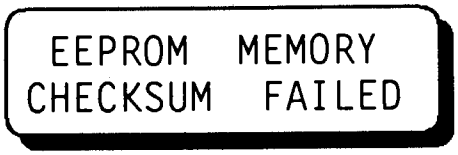
When the engine speed exceeds the overspeed setpoint.
Maximum observed speed is also displayed .

When the check-sum of microprocessor firmware cannot be verified.
Unit requires service.



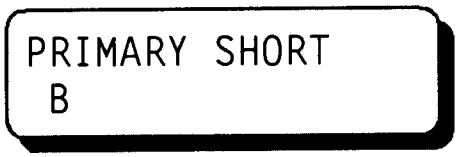
10.5 Diagnostic Warning screens in order of display priority are described below.

This screen indicates that the firing pattern configuration data saved in EEPROM memory is incorrect or incomplete. The EEPROM memory must be reprogrammed or replaced.



This screen indicates that diagnostics have identified an open circuit on the primary output pin "A". This would normally indicate faulty wiring or a failed coil.

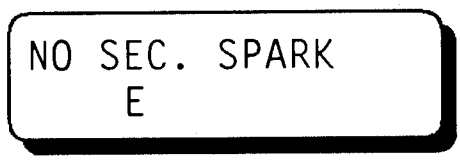
This screen indicates that diagnostics have identified a short circuit condition on the primary output pin "B". This would indicate the primary wire is shorted to ground perhaps in the conduit.



This screen indicates that the diagnostics have identified a low spark demand condition on the spark plug at the "C" coil. This can be caused by a failed spark plug or a shorted secondary wire.

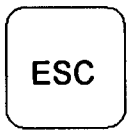
This screen indicates that the spark plug diagnostics have identified a high spark demand condition on the spark plug at the "D" coil. This is often caused by worn spark plugs.

This indicates that the diagnostics have identified a no spark condition on the spark plug at the "E" coil. No spark occurred since the demand was greater than output voltage capability of the coil.



10.6 After all of the diagnostics have been read, the user can reset the warnings and faults by pressing the reset key as pictured below.

press to exit



press

Pressing the reset key performs all of the following actions.

- Clears all diagnostic warnings from memory.
- Clears all diagnostic faults from memory.
- Clears a latched shutdown condition when the input is no longer grounded.
- Causes temporary cylinder timing offsets to be overwritten from EEPROM memory

11.0 UNDERSTANDING AND USING THE SECONDARY SPARK DIAGNOSTICS.

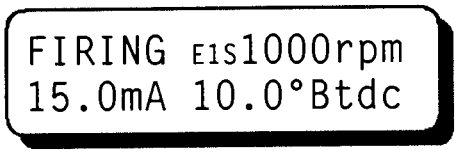
11.1. The spark reference number is a unitless number which correlates with voltage demand at the spark plug and is calculated for every firing of each cylinder. As the voltage increases, the reference number also increases. The number is non-linear and will increase faster at higher voltages (above 20kV). The usefulness of the number lies not in its absolute value, but rather in how the number changes over time as the spark plugs erode. With a little experience, the engine operator will be able to tell when spark plugs require changing. Abnormal conditions in the ignition system, such as open or short circuits in the primary and secondary wiring, can also be detected.

11.2 This reference "cylinder spark data" number can be viewed separately for each ignition output (cylinder) in two ways:

- An instantaneous value: 1st number in ( )
- An average value: 2nd number in ( ) AVG

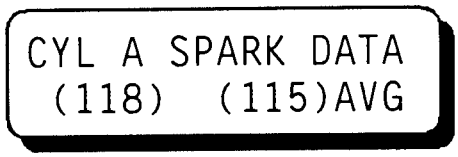
The user will probably find the average number more useful for most purposes.

from the home screen



press

The evaluation number is displayed for output A.

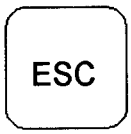


Then from the view data screen use the following keys to view the next CYL or to exit.

press to view next cyl.

or press to view next cyl.

press to exit



11.3 The spark reference number is used in conjunction with comparative thresholds to set diagnostic codes for several different ignition system and spark plug conditions. A "twice in a row" requirement is used to avoid flagging a diagnostic based on the data of only one firing event. The reference number is compared to the thresholds described below.

Open Primary	< 1
Shorted Primary	< 40
Low Spark Voltage	< user programmable threshold (default 60)
No Secondary Spark	> user programmable threshold (default 200)
High Spark Voltage	> user programmable threshold (typical 180)

The average value is used to compare against programmed thresholds. When a threshold is violated twice in a row, the corresponding diagnostic flag is set for the appropriate cylinder. The diagnostic flags are latching and will exist until the unit is restarted or until a reset or power-down occurs.

11.4 The above user programmable thresholds need to be adjusted based on the type of coil being used and on the operating characteristics (specifically, voltage demand) of the engine. There are known differences between various types of Altronic coils, and slight variations are normal between coils of the same type. In order to maximize the usefulness of the cylinder spark reference number, it is recommended that all coils be of the same type and vintage (production date). This will aid greatly in detecting variations in one cylinder vs. the general trend in the engine. The typical ranges to be expected in normal operation with new spark plugs are:

Older 591012 (red flange) coils:	110 to 150
Current 591012 (red flange) coils:	120 to 140
Current 591007 / 591011A / 591011B coils:	70 to 90

11.5 The indicated thresholds were designed to be adjustable so that the user can customize these diagnostics to fit the specific needs of each engine. It will take some testing and adjustment to obtain thresholds that optimize the use of these features. For maximum benefit, the spark reference number for each cylinder should be recorded at normal operating load with new spark plugs installed and then monitored over a period of time for changes. The HI SPARK VOLTAGE alarm level should be set (typically) at 180 initially and can be adjusted as experience dictates. A gradual increase in the spark reference number is expected over time as the spark plug electrodes erode.

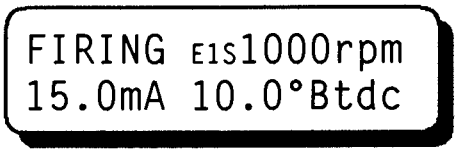
11.6 In addition to the diagnostic flags, the reference numbers can also be used for predictive purposes:

A. As the numbers increase toward the preset HI SPARK VOLTAGE threshold (see section 11.8), the operator knows that a change of spark plugs should be scheduled. With this information, this function can be determined on an actual need basis rather than a predetermined schedule. Also, unexpected engine misfiring or shutdowns can be avoided by tracking the reference numbers on a routine basis.

B. The reference numbers can provide an early warning of a difference in operation in a given cylinder(s). A reading higher (or lower) than the other cylinders, when such a difference is not normally present, tells the operator of a potential problem; this allows further troubleshooting and evaluation to take place before an unexpected operational problem develops.

11.7 The low voltage threshold can be viewed and adjusted as described below.

from the home screen



press F2

The threshold for low spark voltage is displayed

NOTE: Adjust to 0 to disable this diagnostic.

press to increase threshold ↑ press to decrease threshold ↓ press to view high voltage threshold NEXT press to exit ESC

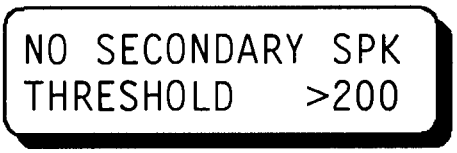
11.8 Select the other threshold screens by pressing the NEXT or F2 keys.

The threshold for high spark voltage is displayed

press to view no sec. spk. threshold NEXT

NOTE: Adjust to 255 to disable this diagnostic.

The threshold for no secondary spk is



press to view low voltage threshold NEXT

NOTE: Adjust to 255 to make this diagnostic least sensitive.

11.9 Other Information regarding the spark reference number::

A. The spark energy setting has only a small effect on the reference number if the spark plug fires correctly. Therefore, the high and low voltage thresholds should hold across the energy settings if the spark plugs continue to fire correctly. On the other hand, a worn plug may not fire consistently on energy setting E1 but will on energy setting E2; in this case there will be a significant difference in the reference number when the energy setting is changed. Operators may be able to increase spark plug life by operating initially with new spark plugs on E1 energy setting and use the HI SPARK VOLTAGE alarm as an indicator to increase the energy progressively to E3.

B. The spark reference number is designed to work with one coil per output. Where two coils are connected to the same primary lead, the number will tend to be an average of the conditions at the two spark plugs. While some of the benefits of the spark reference number can still be realized, the usefulness of the number in detecting deviations between cylinders (alarm levels) will be reduced.

SPECIFICATIONS:

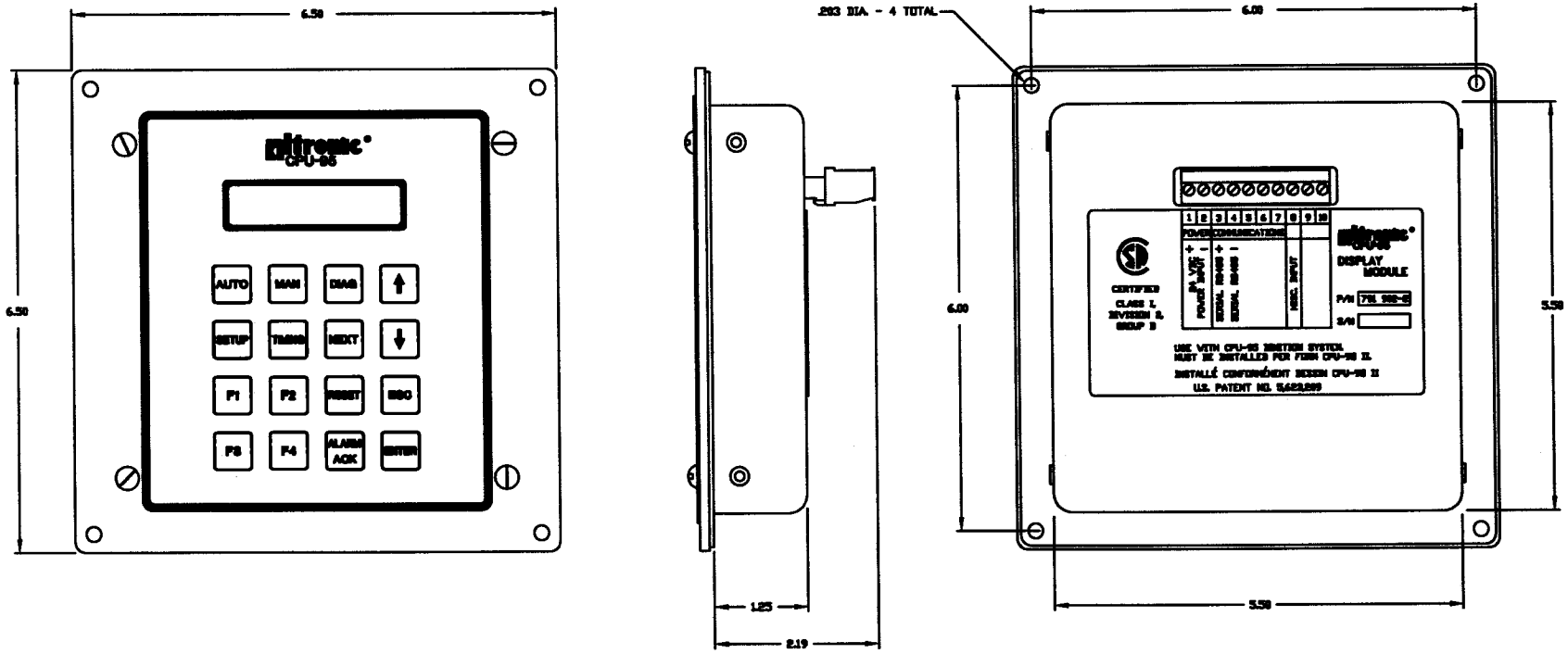
POWER: 24 VDC @ 150 mA NOMINAL, 32 VDC @ 250mA MAX.

ENCLOSURE: WEATHERPROOF, POWDER COATED ALUMINUM

FIELD CONNECTIONS: PLUG-IN TERMINAL STRIPS ON BACK

CONTROL INPUTS:

1. RS485 SERIAL COMMUNICATIONS PORT
2. MISCELLANEOUS INPUT - ONE STEP RETARD (DEFAULT), ALSO MULTI-STRIKE, MAX. ENERGY LEVEL (CONFIGURED THROUGH P.C.)
3. 4-20 mA CURRENT LOOP INPUT



REVISIONS			
NO.	DATE	BY	DESCRIPTION
1			
2			
3			
4			
5			

TOLERANCES (EXCEPT AS NOTED)
DECIMAL .XXX - ±.005 .XX - ±.020
FRACTIONAL
MATERIAL

ALTRONIC INC.

TITLE: SALES DRAWING 791902-2 DISPLAY MODULE

DRAWN BY: GT
DESIGNED BY:
APPROVED BY:
SCALE: FULL
DATE: 5-15-97
PART NUMBER: 799 051

799 051