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**Legion Brothers**  
*Obsessed with innovations*

***Computerized Four Stroke Four Cylinder Water Cooled Diesel Engine  
Test Rig.***



**Legion Brothers**

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1 of 17

## Features

- Extensive range of Experiments
- Comprehensive teaching manual
- One year warranty
- Esthetically designed and finished Rig.
- High Quality instrumentation
- Speed governor for constant speed

## General Description

The Four Stroke Four Cylinder Water Cooled Diesel Engine is mounted on a self-contained centrally balanced base. The base frame is fabricated with mild steel "C" Channel and is provided with the anti-vibration mount. The dynamometer is directly coupled with the crankshaft of the engine and the engine can be loaded upto 10 Hp.

A standard air tank is fitted with a mass air flow sensor for measuring the Actual volume of air drawn into the cylinder. The exhaust gas calorimeter provided within the rig enables the students to conduct precise heat balance sheet. The thermocouple and necessary signal conditioner for the measurement of temperature at various points in the calorimeter are suitably provided.

The panel is fabricated with suitable SWG CR sheet and as per IS standard; the front portion of the panel consists of computer, Printer, UPS. The rear portion of the panel consists of all instrumentations and signal conditioner related components. Power and control wiring are suitably marked using farul for easy troubleshooting. The panel is finished with powder coating.

The loading of the engine is controlled by the computer, hence precise loading is achieved.

### **Instruction Manual**

Self-explanatory operating manuals are provided with each system. Detailed theory as well as practical exercises is included in the manual.

### Experiments

#### System Capabilities

1. Calculate Actual volume of Air.
2. Calculate Volumetric Efficiency.
3. Calculate specific fuel consumption (SFC).
4. Calculate brake Thermal Efficiency.
5. Calculate Brake power.
6. Heat Balance chart.
7. Calculate mechanical efficiency.
8. Calculate Frictional Power.
9. Calculate indicated Power.
10. PV and P- $\theta$  diagrams
11. Calculate 5% Mass Fraction Burnt Angle
12. Calculate 10% Mass Fraction Burnt Angle
13. Calculate 50% Mass Fraction Burnt Angle
14. Calculate 90% Mass Fraction Burnt Angle
15. Calculate 95% Mass Fraction Burnt Angle
16. Calculate 99% Mass Fraction Burnt Angle
17. Estimated End of Combustion Angle (EEOC)
18. Calculate Gross IMEP
19. Calculate Maximum Heat Release Rate
20. Calculate Maximum Heat Release rate crank angle
21. Calculate Maximum pressure rise rate
22. Calculate Maximum pressure rise rate crank angle
23. Calculate Maximum pressure
24. Calculate Maximum pressure crank angle
25. Calculate Start of Combustion
26. Calculate Total heat release

Software (Engine Test Express)

Windows based powerful software for real time data measurement, auto zoom graphs, analog and digital display of data in the computer, store indefinite no of graphs for analysis. Facilities to export data to Microsoft excel. The data acquisition software is developed by legion brothers.

Branded DUAL CORE computer, inkjet printer with suitable UPS as per below mentioned spec,

Installation and demo included

## Product / components Specification

Engine	
Make	Isuzu
No of Cylinder	Four
Cooling	Water
Fuel	Diesel
Speed	1400-1500RPM
HP	10 HP
Starting	Crank
Lubrication	Forced
Please Note: The engine capacity specified by the manufacturer is 40 BHP. The engine manufacturer tests the engine with the vehicle on a chassis dynamometer. There consider the applied load on wheel side and rpm on the engine side with the gear box. But ours is a stationery test bed without the gear box. The engines crank shaft is directly connected to the eddy current dynamometer and is been tested. The max BHP which can be achieved in our test setup is 10 HP. And also it is safer to run on lower RPM for students.	
Dynamometer	
Type:	
Make	PowerMag
Cooling	Air

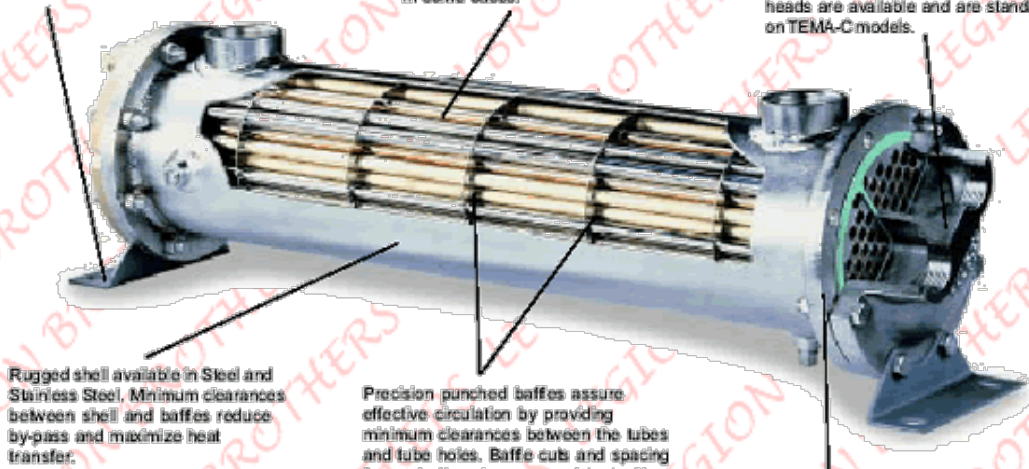
Load Measurement method	Strain Gauge
Max Speed	3000 rev/m
HP	10 HP
Coupling Type	Direct
<b>Exhaust Gas Calorimeter</b>	
Type	Shell and Tube
Material of Construction	Mild Steel
No of Temp measuring points in test rig	6
Outer Insulation	Asbestos Cloth
Thermocouple Type	“K”
Water flow Control Valve	Gate Valve

<b>Air Box</b>	
Type	Square (Size: 500mm X 500mm)
Material of Construction	Mild Steel

Heavy stamped steel brackets are standard and can be rotated and reversed for a variety of mounting needs. Cradle mounting is available on all models.

Tubes are available in Copper, 90/10 CuNi, Stainless Steel, Admiralty or Titanium. Tubes are roller expanded. Seal welding and grooving available in some cases.

End bonnets are of high quality cast Iron, Bronze or Stainless Steel in 1, 2 or 4-pass configurations. Fabricated heads are available and are standard on TEMA-C models.



Rugged shell available in Steel and Stainless Steel. Minimum clearances between shell and baffles reduce by-pass and maximize heat transfer.

Precision punched baffles assure effective circulation by providing minimum clearances between the tubes and tube holes. Baffle cuts and spacing for each diameter are consistent with best practices.

Thick Carbon Steel, Stainless Steel or 90/10 CuNi tubesheets are welded to the shell.

<b>Calorimeter</b>	
Type	Shell & Tube(Pipe in Pipe style)
Material of constructions	All wetted parts in SS

## Air Flow rate Measurement method

### Air Flow

Type/Description	
	Mass air flow sensor is used to measure the airflow rate. A hot wire mass airflow sensor determines the mass of air flowing into the engine's air intake system. This is achieved by heating a wire with an electric current that is suspended in the engine's air stream, not unlike a toaster wire. The wire's electrical resistance increases with the wire's temperature, which limits electrical current flowing through the circuit. When air flows past the wire, the wire cools decreasing its resistance, which in turn allows more current to flow through the circuit. As more current flows, the wire's temperature increases until the resistance reaches equilibrium again. The amount of current required to maintain the wire's electrical resistance is directly proportional to the mass of air flowing past the wire. The integrated electronic circuit converts the measurement of current into a voltage signal which is sent to the computer.
Range	0-99 m3/hr
Signal Conditioning	Standalone for each sensors

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6 of 17

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## Fuel flow rate Measurement method

Fuel Flow	
Type/Description	In the engine tests, the fuel consumption is measured as a mass flow per unit time $M_f$ . a more useful parameter is the specific fuel consumption (sfs)- the fuel flow rate per unit power output. It measures how efficiency an engine is using the fuel supplied to produce work. Fuel consumption is measured by using optical sensors. These optical sensors are capable of detecting any liquid and give an output in type of signals. The system consists of a burette fitted with two optical sensors one at the high level and the other at the low level. As the liquid passes through the higher-level optical sensor, the sensor gives a signal to the computer to start the time. Once the liquid reaches the lower level optical sensor, the sensor gives a signal to the computer to stop the time and refill the burette. The time taken for consumption of fuel for a fixed volume is calculated.
Range	0-99 Kgs/hr
Signal Conditioning	Standalone for each sensor

#### Speed measurement method

<b>Engine Speed</b>	
Type/Description	A non-contact PNP sensor is used to measure the engine RPM. A PNP sensor gives a pulse output for each revolution of the crankshaft. The frequency of the pulses is converted into voltage output and connected to the computer.
Range	0-9999 RPM
Signal Conditioning	Standalone frequency to voltage converter

#### Water Flow measurement method

<b>Water Flow</b>	
Type/Description	Acrylic Body Rotameter
Range	40-400 LPH for Engine cooling
Range	10-100 LPH for calorimeter Cooling

#### Torque or load measurement method

<b>Torque at Dynamometer</b>	
Type/Description	Torque is measured using a load cell transducer. The transducer is a strain gauge base. The output of the load cell is connected to the load cell transmitter. The output of the load cell transmitter is connected to the USB port through interface card.
Range	0-50 Kgs
Signal Conditioning/transmitter	Standalone

### Measurement of Temperatures at different points

Type	“K”
Range	0-300°C
Signal conditioning/transmitter	Standalone
Location	Inlet water temperature in calorimeter
Type	“K”
Range	0-300°C
Signal conditioning/transmitter	Standalone
Location	Outlet water temperature in calorimeter
Type	“K”
Range	0-1500°C
Signal conditioning/transmitter	Standalone
Location	Inlet exhaust gas temperature in calorimeter
Type	“K”
Range	0-1500°C
Signal conditioning/transmitter	Standalone
Location	Outlet exhaust gas temperature in calorimeter
Type	“K”
Range	0-300°C
Signal conditioning/transmitter	Standalone
Location	Inlet water temperature to engine
Type	“K”
Range	0-300°C
Signal conditioning/transmitter	Standalone
Location	Outlet water temperature from the engine cylinder
Type	“K”
Range	0-300°C
Signal conditioning/transmitter	Standalone
Location	Ambient

All the measured parameters from the sensor are connected to the computer

### Cylinder Pressure



### Cylinder Pressure

Type	Piezoelectric Transducer
Cooling	Air cooled
Signal Conditioning	Standalone

### TDC Marker

### Crank Angle

Type	Non-Contact (Inductive Type)
Cooling	Air
Signal Conditioning	Standalone

### Diesel Injection Pressure



Diesel Injection Pressure	
Type	Piezoresistive Transducer
Cooling	Air
Signal Conditioning	Standalone

Data Acquisition Card	
Resolution	12 bit
Specification	Operating 45 MHz 12 bit 8 channel ADC 12 bit 2 channel DAC 4 digital input 4 digital output USB Controller operating 24MHz.
Software	Windows based
Type	Run Time
Operating System	Windows XP

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## Technical Specification

- 12 Analog Inputs (12-16 Bits Depending on Speed)
- UE9-Pro Adds 24-bit Low-Speed ADC for 20-Bit Effective Resolution
- $\pm 5$  or 0-5 Volt Maximum Analog Input Range
- 2 Analog Outputs (12-Bit, 0-5 Volts)
- 23 Digital I/O
- Up to 2 Counters (32-Bits Each)
- Supports Software or Hardware Timed Acquisition
- Maximum Input Stream Rate of 50+ kHz (Depending on Resolution)
- Capable of Command/Response Times As Low As 1.2 Milliseconds
- Built-In Screw Terminals for Some Signals
- USB 2.0/1.1 Full Speed Interface
- Ethernet 10Base-T Interface
- Dual-Processor Design with 168 MHz of Total Processing Power
- Electrical Isolation Possible with Ethernet Interface
- No Power Supply Needed for USB Operation
- Includes USB and Ethernet Cable, Power Supply, and Screwdriver
- Enclosure Size Approximately 3" x 7" x 1" (75mm x 185mm x 30mm)
- Rated for Industrial Temperature Range (-40 to +85 Degrees C)

### Analog Inputs:

The Data acquisition card has 14 external [analog inputs](#) (AIN0-AIN13). AIN0-AIN3 are available on screw terminals and also on the DB37 connector. All 14 analog inputs are available on the DB37 connector.

Each analog input can be configured individually as unipolar (four ranges from 0-5 volts to 0-0.625 volts) or bipolar ( $\pm 5$  volts). Analog input resolution is 12-bits at max speed (12 us conversion time), increasing up to 16-bits at slower speeds (2.7 ms conversion time).

Command/response (software timed) analog input reads typically take 1.2+ ms depending on number of channels and communication configuration. Hardware timed input

streaming has a maximum rate that varies with resolution from 250 samples/s at 16-bits to 50+ ksamples/s at 12-bits.

### **Analog Outputs:**

The Data Acquisition Card has 2 [analog outputs](#) (DAC0 and DAC1) that are available both on screw terminals and the DB37 connector. Each analog output can be set to a voltage between 0 and 4.9 volts with 12-bits of resolution. The analog outputs are based on a true voltage reference.

The analog outputs are updated in command/response mode, with a typical update time of 1.2-4.0 ms depending on communication configuration.

### **Digital I/O:**

The Data Acquisition Card has 23 [digital I/O](#) channels which can be individually configured as input, output-high, or output-low. 8 of these lines are called flexible digital I/O (FIO) and can be software configured as up to 6 timers and 2 counters.

The first 4 FIO are available on screw terminals and the DB37 connector. All 8 FIO and 3 MIO are available on the DB37 connector, and 8 EIO and 3 CIO are available on the DB15 connector.

Command/response (software timed) reads/writes typically take 1.2-4.0 ms depending on communication configuration. The digital inputs can also be read in a hardware timed input stream where up to 16 inputs count as a single stream channel.

### **Counters:**

Up to 2 FIO can be configured as 32-bit [counters](#).

## **I/O Protection:**

All I/O lines on the Data Acquisition Card are protected against minor over voltages. The AIN lines can withstand continuous over voltage of  $\pm 15$  volts, the FIO lines can withstand up to  $\pm 10$  volts, while the EIO/CIO/MIO lines can withstand up to  $\pm 6$  volts.

## **Power Supply:**

Power can be provided by the USB cable or an external 5 volt supply (included). When only Ethernet is connected, and an isolated power supply is used (such as the included wall-wart), the entire Data Acquisition Card is electrically isolated.

## **Software Screen Shots**

Main sheet

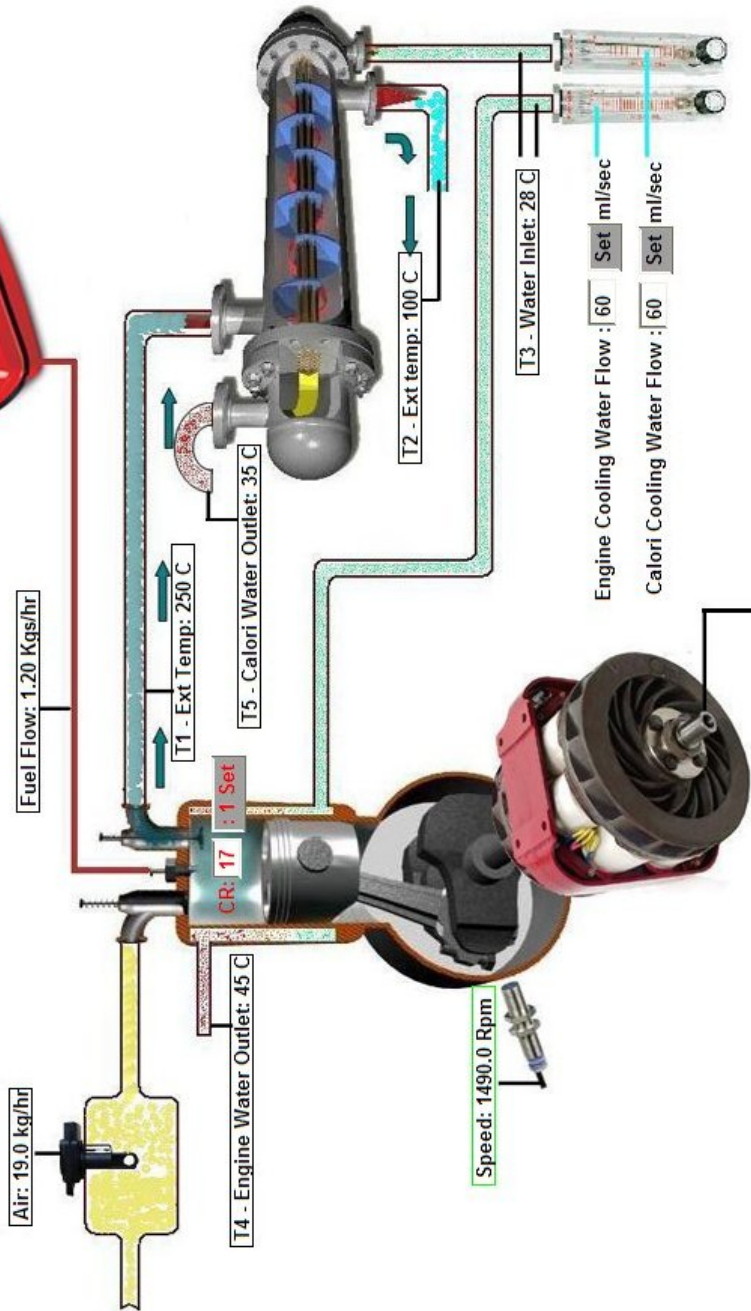
**EXIT**

**Alert: Please switch the mains "ON"**

Engine Test Express V5.76  
Product ID : 1215023699

Fuel Density: 0.86 Set gms/Cc  
CV: 44500 Set KJ/Kg

Set Export File Name: D:\test1.csv



BP:-0.0KW  
SFC:-0.00 Kg/Kwhr.  
VolEff:-0.00 %  
BTE:-0.00 %

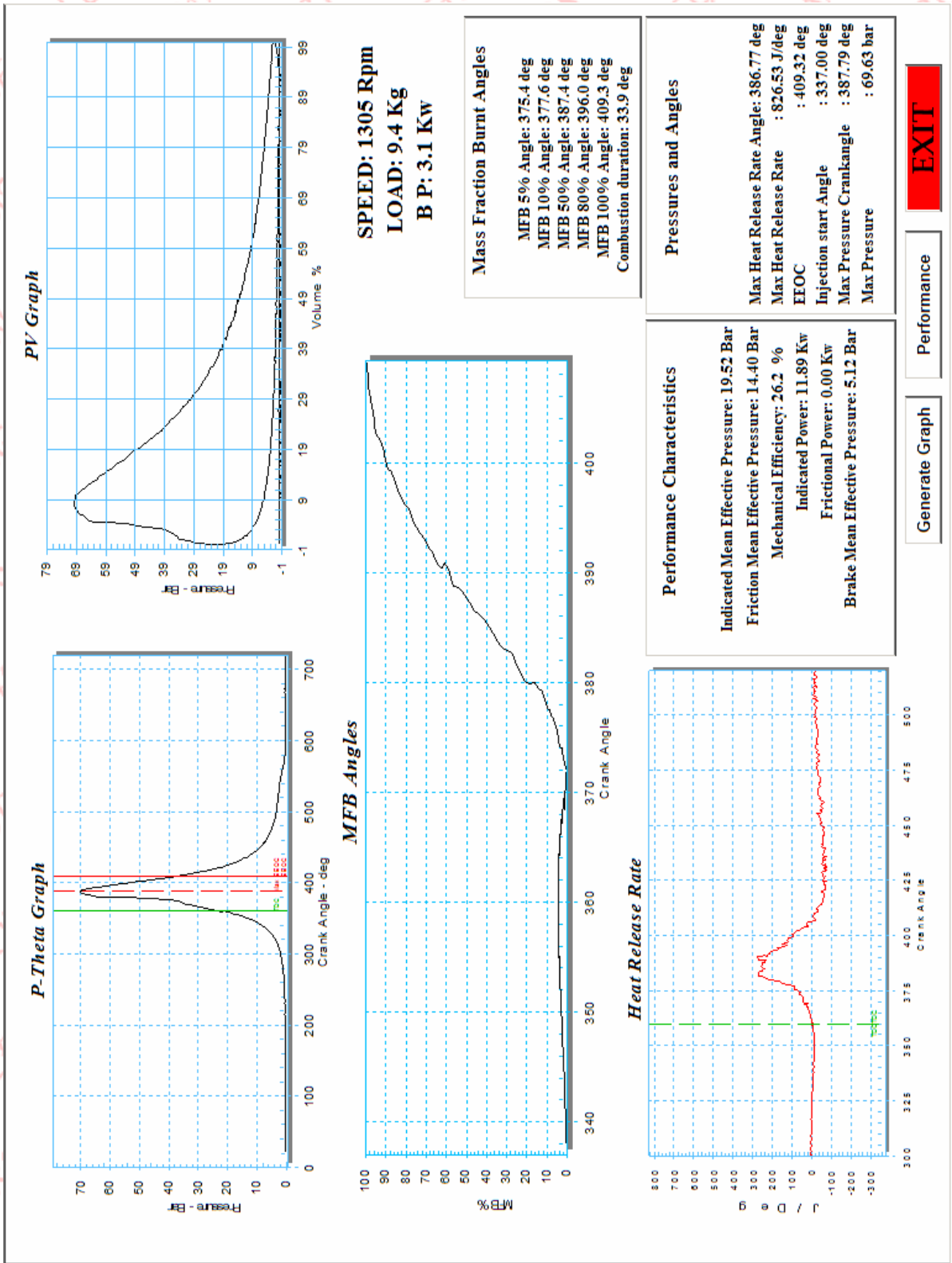
Set Operation Type: SI  
Achieved Load:-0.0 Kgs  
Set Load:-0.0 Kgs  
Emergency Unload

Test In Progress : 0:000

Combustion Page

Indicative screen only, do not refer values

This sheet presents the PV, P-Teta and the rate of pressure raise



Indicative screen only, do not refer values

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