Section C

Electrics

Section 1 - General Information
Section 2 - Care and Safety
Section 3 - Routine Maintenance
Section B - Body & Framework
Section C - Electrics
Section E - Hydraulics
Section F - Transmission
Section J - Track and Running Gear
Section K - Engine

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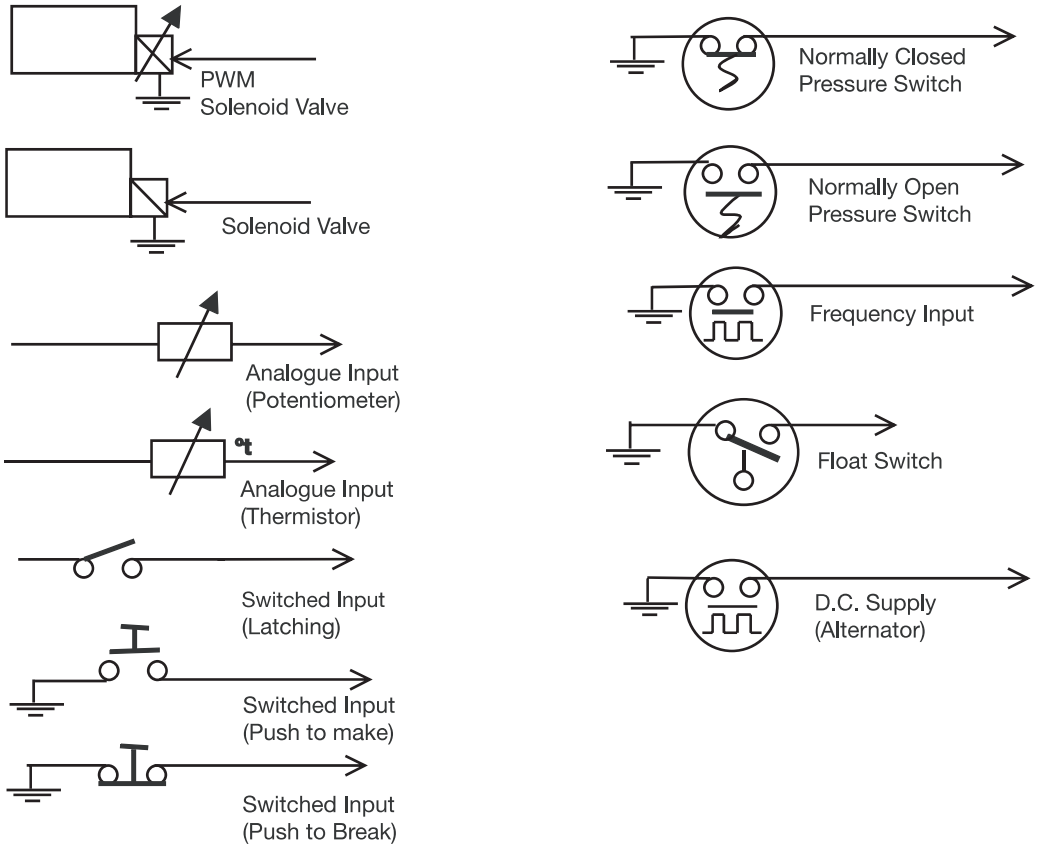
Basic System Operation

Circuit Symbols

TC-013

The following notations are used in the description circuit, drawings.



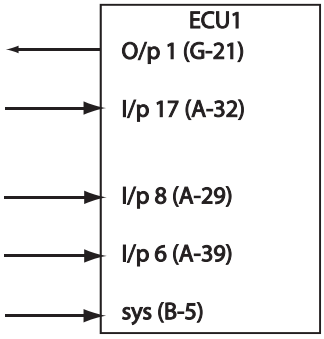
C005310GB-2

Fig 1.

Inputs and Outputs

The letters i/p and o/p refer to input and output.

The letters in brackets i.e. (C-21) refer to the connector and pin number.



C001660-2

Fig 2.

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Component Identification

JZ235/JZ255

Table 1.

Item	Part Number	Description
1	728/80071	Electronic control unit 1
2	728/80073	Electronic monitor system
3	701/80369	Facia switch panel
4		Fusebox
5	716/30155	Throttle dial
6	701/80184	Key switch
7	701/80214	Switch (limp mode)
8	30/926484	Air conditioner
9	30/926483	Heater
10	30/925588	Controller (air con)
11	701/60030	Switch body
12	701/58826	Switch cap (worklamp)
13	717/12900	Cigar lighter (12v)
14	717/09200	Radio cassette
15	701/80215	Limit switch (lever)
16	701/60041	Switch (cab light)
18	700/43900	Work lamp
19	700/50022	Work lamp
20	701/80374	Breaker pilot switch
21	25/221094	LH Lever switch
22	25/221095	RH Lever switch
24		
23	717/20154	Volt dropper
25	6900/0624	Wiper
26	6900/0587	Room lamp
27	716/30205	Battery relay
28	708/04100	Battery
29	KHR1589	Fuse link (25A)
30	KHR1592	Fuse link (60A)
31		
32	25/222203	Valve, 8 solenoid
33	25/220996	Valve, Dual solenoid
34	01/145194	Engine (JZ235/255 T3)

Item	Part Number	Description
35	701/80374	Pilot switch, upper
36	701/80375	Pilot switch, travel
37	701/80373	Pilot switch x 2 Swing and Boom
38		
39		
40	717/07700	Travel alarm
41	20/925502	Pump (JZ230 T3)
42	20/925546	Refuel pump
43	215/11950	Lower wiper
44	700/26700	Beacon
45	714/40226	Air con compressor
46	30/925618	Air con binary switch
47	717/20152	Horn
48	JHN0160	Washer bottle
49	716/30260	Pre-heat relay
50	716/30129	Temperature sensor
51	701/80328	Overheat switch
52	704/50186	Fuel level sensor
53	331/13929	Coolant level switch
54	JNH0070	Air filter clog switch
55	701/80192	Overload pressure switch
56	701/80372	Pilot switch, auto mode
57	701/80462	Pilot switch, auto boost
58	701/60000	Switch (radio mute)
59	701/60031	Switch (heated seat)
60	40/910552	Heated seat switch
61	JSJ0343	Direction control valve
62	25/220536	Valve, solenoid
63	25/222887	Priority Valve
64	721/10455	Harness Hammer Link
65	721/11632	harness Hammer /Auxiliary
66	701/80223	Switch
67	701/60032	Switch Body
68	721/10458	Harness Hammer/Auxiliary/Merged
69	701/58832	Switch Panel
70		
71	25/222397	Proportional Solenoid
72	721/12058	Harness, Main

Item	Part Number	Description
73	721/12059	Harness, Cab
74	721/11637	Harness, Facia
75	721/12060	Harness, Cab Engine
76		
77	JHR0174	Relay
78	701/80310	Switch-Refuelling Pump
79	721/11451	Harness, Low Flow
80	716/30259	Barometric Sensor
81	716/26100	Starter Safety Relay
82	716/30262	Air Intake Temp Sensor
83	728/80070	Engine ECU
84	17/926100	Fuel Lift Pump

Note: *Items 64 to 68 are part numbers for the bridging harnesses and switches for the option switch in the Right hand console*

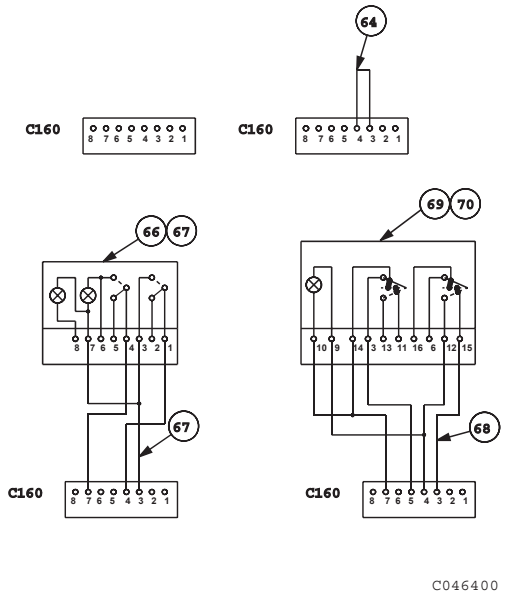

Fig 3.

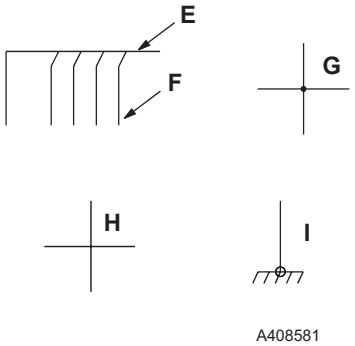

Fig 4.

E Multiple cables
F Single cables
G Cables joined
H Cable not joined
I Earth cables

Schematic Diagram

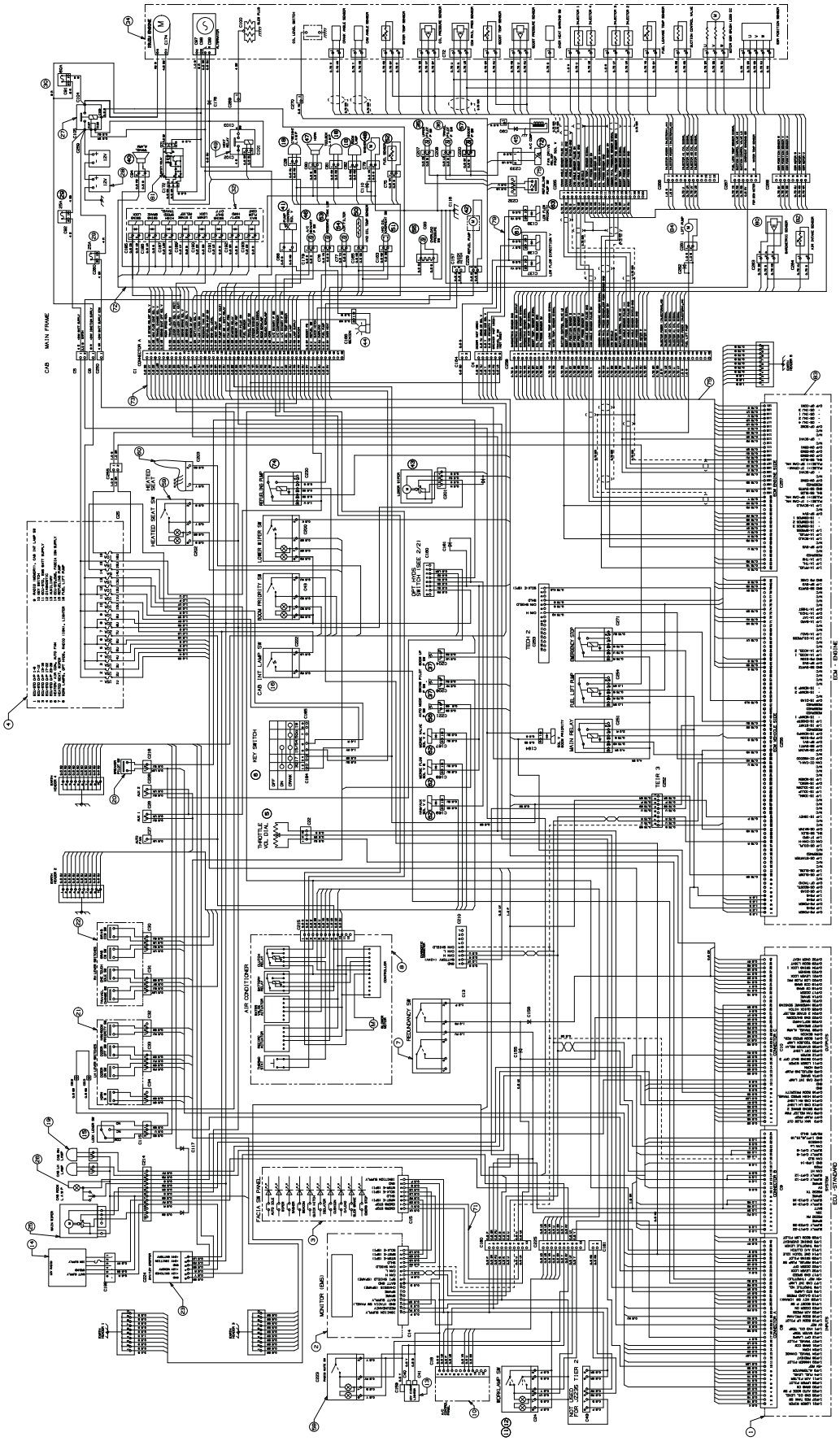

Fig 5. 331/42104 issue 2

A.M.S (Advanced Management System)

TC-011

Operation

The JCB A.M.S system is a whole machine electronic control system. The system controls engine speed, pump power, transmission, excavator functions, lights, wiper, auxiliary circuits, warning lamps, etc. The system is a 'CAN BUS' system which links Electronic Control Units (ECUs) on the vehicle. This stands for 'Controlled Area Network' and uses a special cable in the vehicle harness which consists of two signal wires twisted together covered by a metal foil to prevent any electrical interference. These signal wires form the CAN -BUS. The CAN - BUS is used to send text and fault codes between the ECUs. The electronic units receive inputs from switches and sensors and drive outputs such as solenoids, lamp bulbs and motors. The outputs of the ECUs are rated to the current requirement of the actuator.

The system comprises of the following main electronic components.

- **A** Electronic Control Unit -1 (ECU-1)
- **B** Electronic Monitoring System (EMS)
- **C** Fascia switch panel (FSP).
- **D** Engine Control Module (ECM)

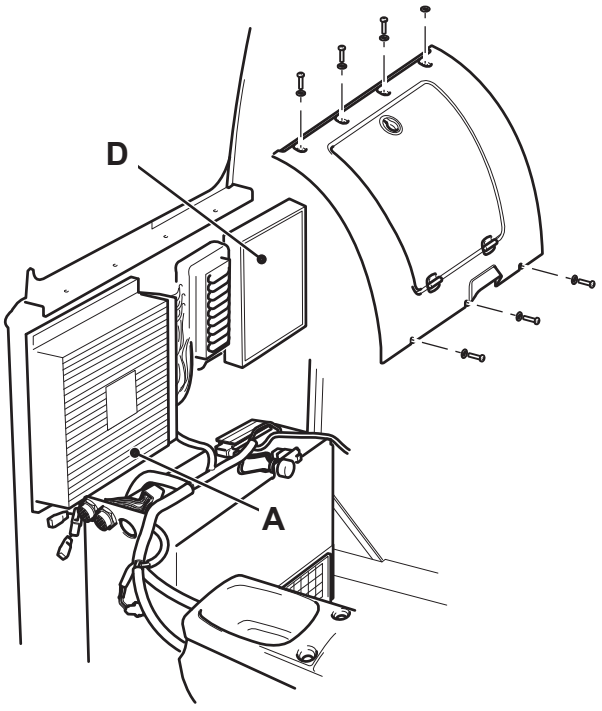

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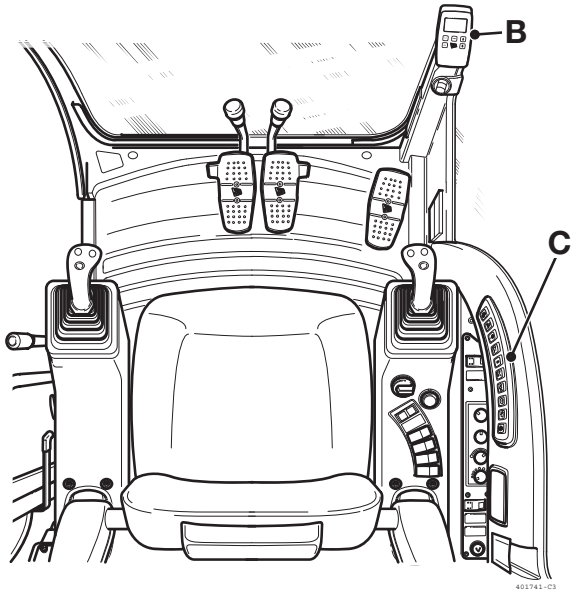
Fig 6.



401741-C3

401741-C4

Fig 7.

The AMS System

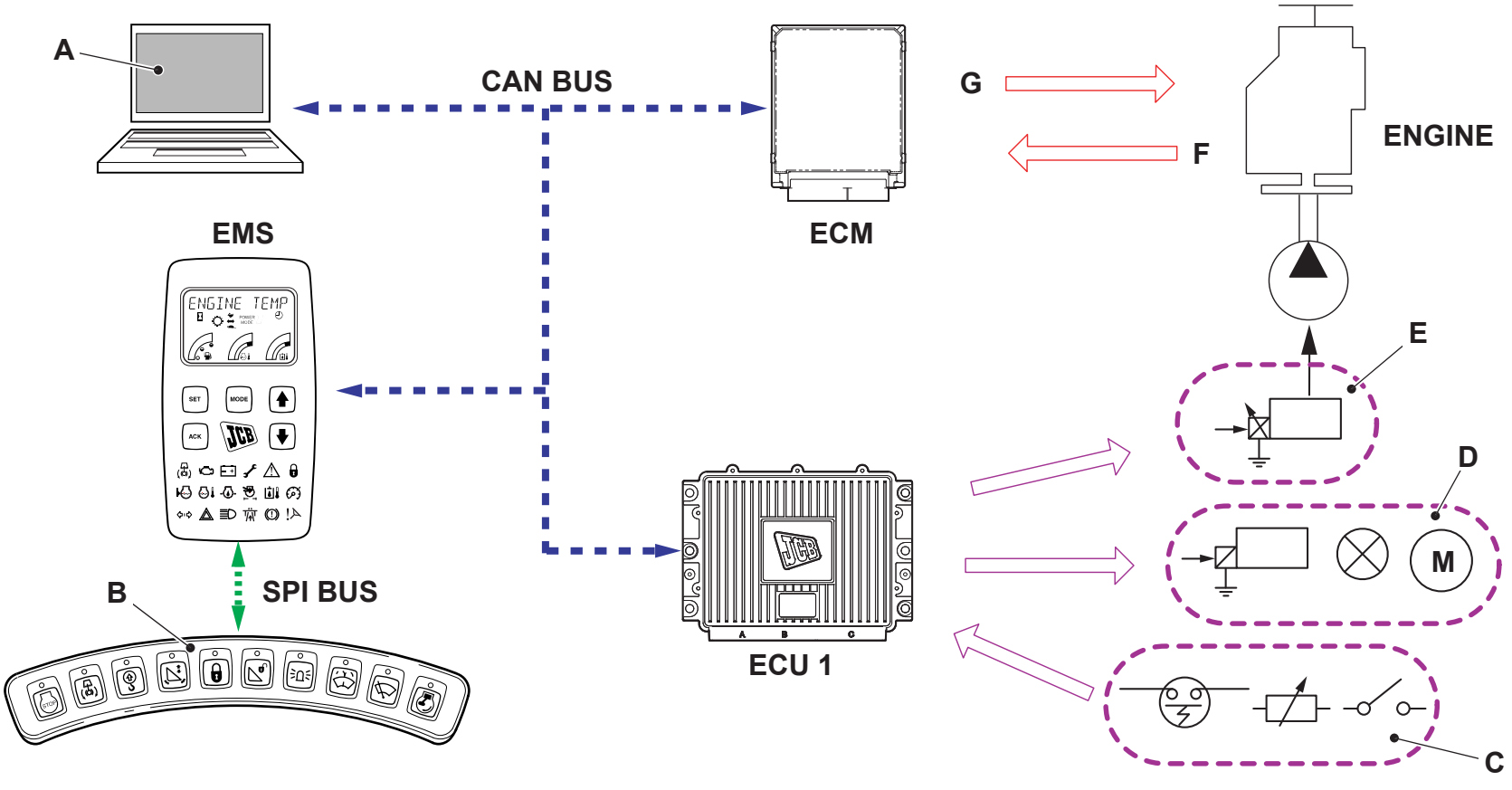


Fig 8.

key

- **A** Diagnostic port
- **B** Facia switch panel
- **C** Switches and sensors
- **D** Solenoid, lamps and motors
- **E** Pump solenoid
- **F** Inputs from switches and solenoids
- **G** Outputs to injectors and motors

Circuit Concepts

Inputs

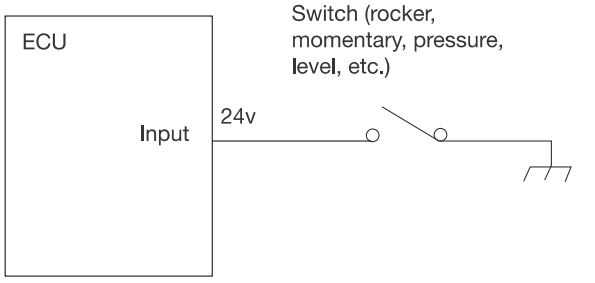
There are two main types of input, Digital and Analogue.

Digital type inputs are on/off type inputs (i.e. switches) and can be Low side inputs or High side inputs. Low side inputs are inputs that provide a ground to the ECU. High side inputs are inputs that provide a positive feed to the ECU.

Analogue Inputs are sensor type inputs that provide a varying type input to the ECU, this input could be a resistance or frequency type input.

Digital inputs (on/off switch type inputs)

1 Low side input. The low side input is the most frequently used input on the A.M.S system. The low side input can be in the form of rocker switches or pressure switches.



C007170GB-2

Fig 9.

2 High side input. The high side input is used on circuits that require a positive feed when the ignition is switched off, i.e. sidelights or hazard lights. The high side input is also used on the engine preheat circuit.

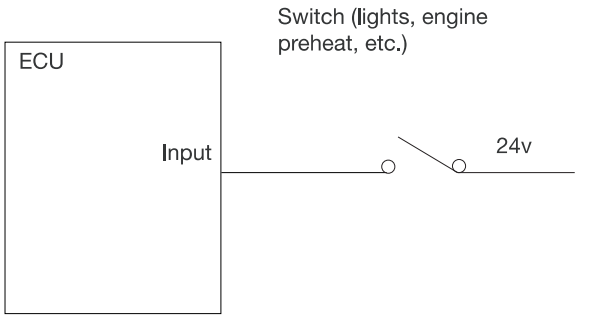


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Fig 10.

Analogue input (i.e. sensor type inputs)

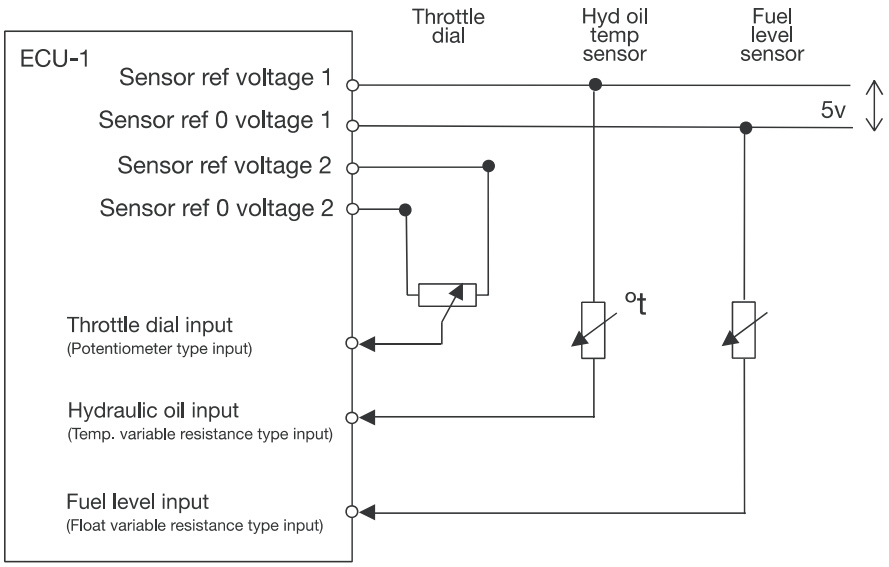

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Fig 11.

Outputs

There are three main types of outputs Low side output, High side output and Modulated output.

In the Low side output circuit the actuator (solenoid, relay etc.) which is being driven already has a positive feed available, the ECU then provides the ground side of the circuit.

In the High side output circuit the actuator which is being driven already has a ground available, the ECU provides the positive side of the circuit.

In the Modulated Output circuit the ECU provides a PWM (Pulse Width Modulation) signal to a proportional valve. As the ECU varies the duty cycle of the signal the proportional valve will select more or less depending on the change in duty cycle.

1 Low side output. Circuits using low side output are pre heat relay, stop solenoid relay and work lights.

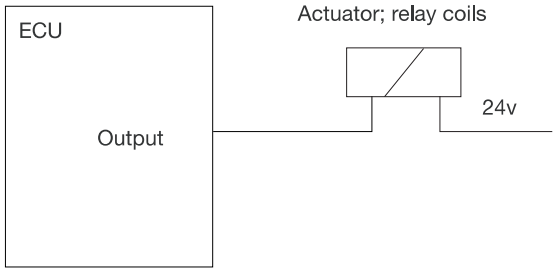

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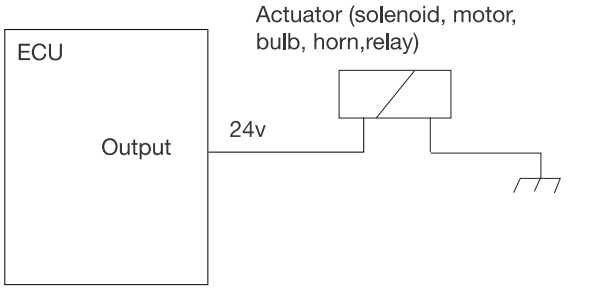
Fig 12.

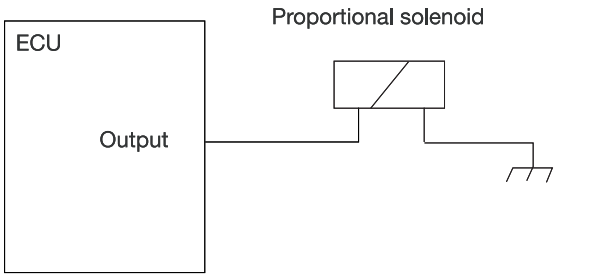
2 High side output. The high side output is used to operate solenoids, bulbs and horn.



C007230GB-2

Fig 13.

3 Modulated outputs. Circuits using the modulated output are throttle control, pump control and boom priority.



C007240GB-2

Fig 14.

Pulse Width Modulation (PWM)

Ohms law states that, the amount of current flow in a circuit is determined by the voltage, and the resistance. A 24v circuit with a resistance of 6 ohms, would draw a current of 4 amps. This would be the case for a standard solenoid, which is either on or off.

Once the voltage is applied to the circuit, it is present 100% of the time. This would be known as a 100% duty cycle. Therefore the circuit will draw 4 amps constantly.

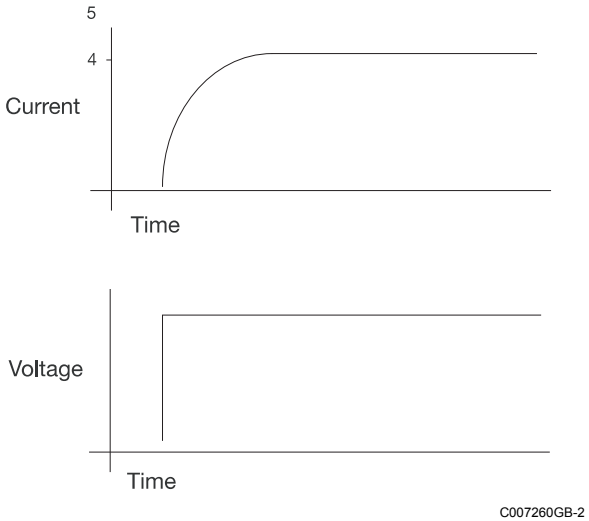


Fig 15.

A proportional solenoid requires differing amounts of current, depending on its condition. As the coil has a fixed resistance, changing the current rating can be done in either of two ways,

1 Having lots of different resistors switched in and out of the circuit at different times to change the current flowing.

2 To change the duty cycle of the solenoid.

It is easier, more economical, and more reliable to change the duty cycle of the circuit, especially using today's computer/ controller technology.

The duty cycle is the amount of time a component is switched on compared to the time it is switched off. If a solenoid is on for three seconds, then off for one second, on for three, off for one etc. this would be a 75% duty cycle.

The graph A although unstable would give a current rating of three amps. To stabilize the current in the circuit, the frequency would need to be increased. If the time scale on the graph A was one second, the frequency would be 4Hz (Hertz (cycles per second)). The graph B shows the same duty cycle, but at a higher frequency of 32 Hz. The proportional solenoids fitted to JS machines operate at a frequency of 75 Hz.

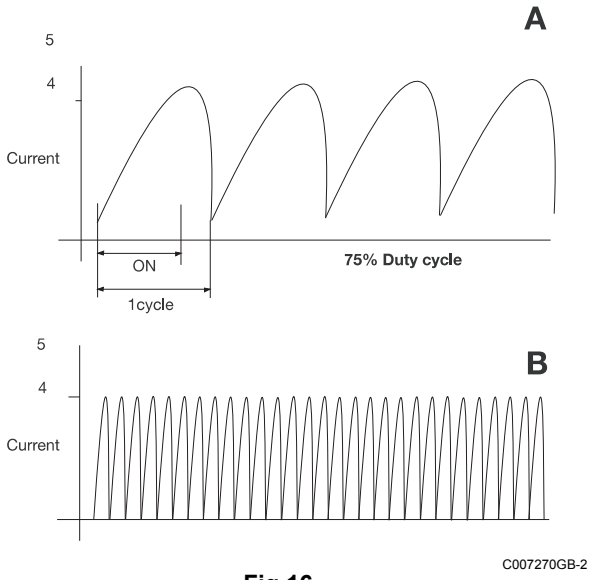


Fig 16.

ECU1/EMS/FACIA Power Supply and Network

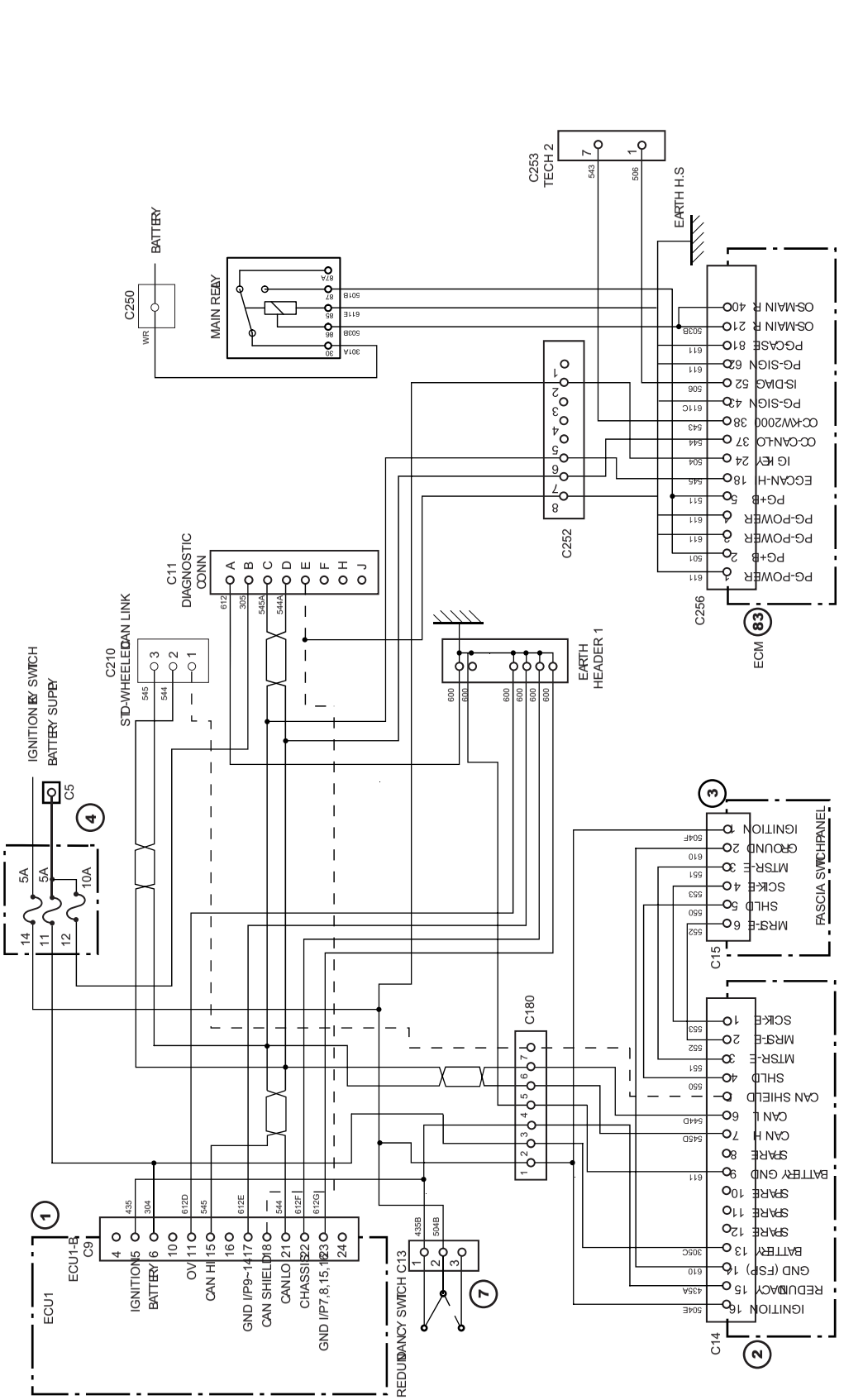


Fig 17.

ECU 1 Supply to Output Drivers

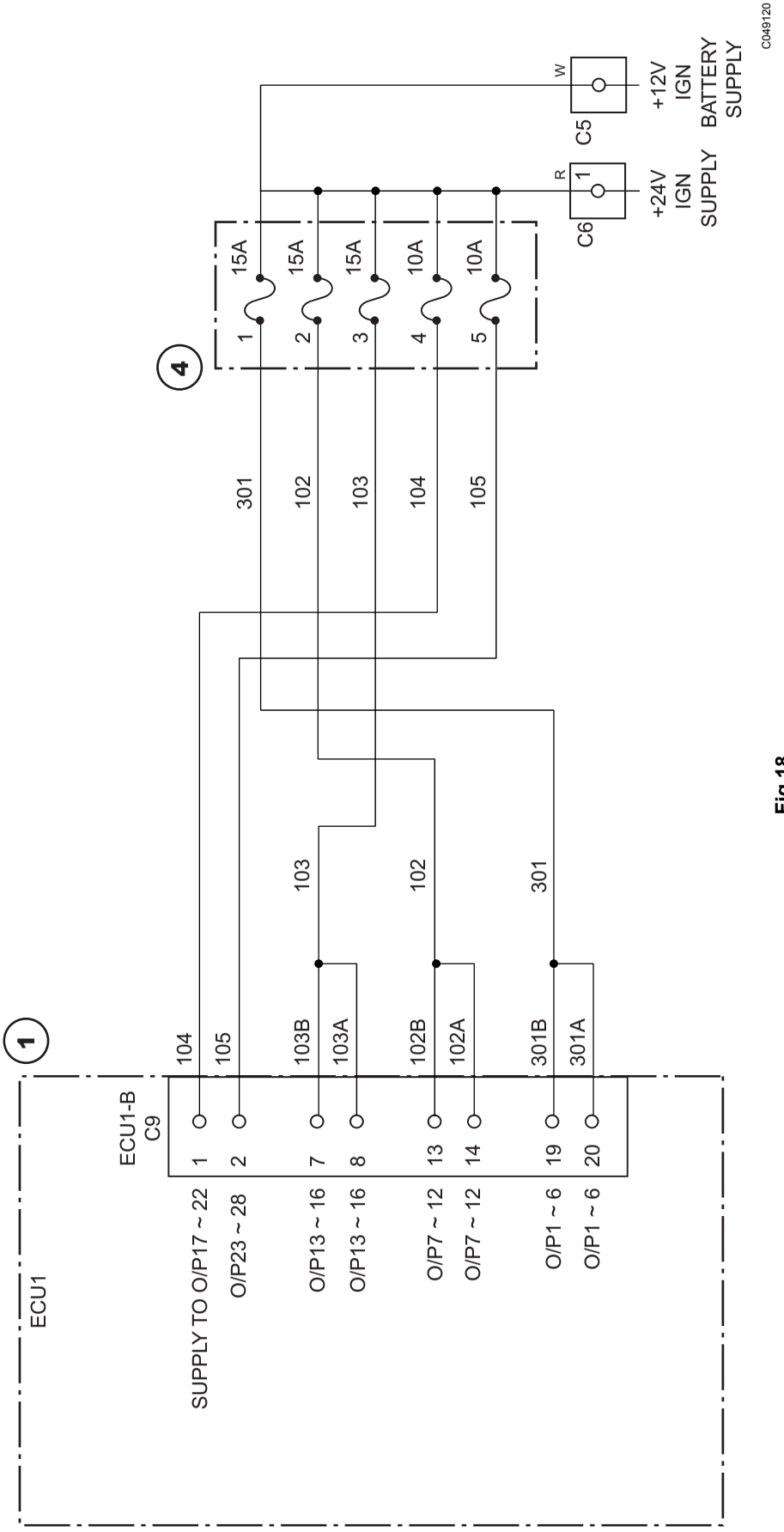


Fig 18.

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Engine Throttle Control

Operation

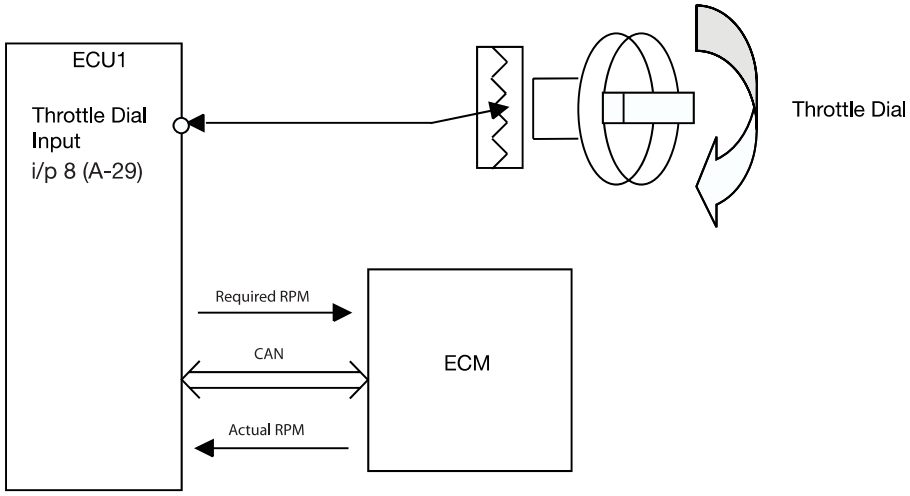

Fig 19.

The maximum rev/min value for each mode is specified in software. The maximum rev/min value is used as A mode maximum. E mode maximum is 100 rev/min less than A mode maximum. P & L mode maximum is 200 rev/min less than A mode maximum ⇨ *Fig 20. (C-17)*.

During calibration the ECU noted the maximum and mini - mum positions of the throttle position sensor. The maximum point became A mode maximum When the working mode is selected the ECU will scale the full deflection of the throttle dial (0~5v) to adjust the engine speed between the idle position and the maximum speed for the particular mode selected.

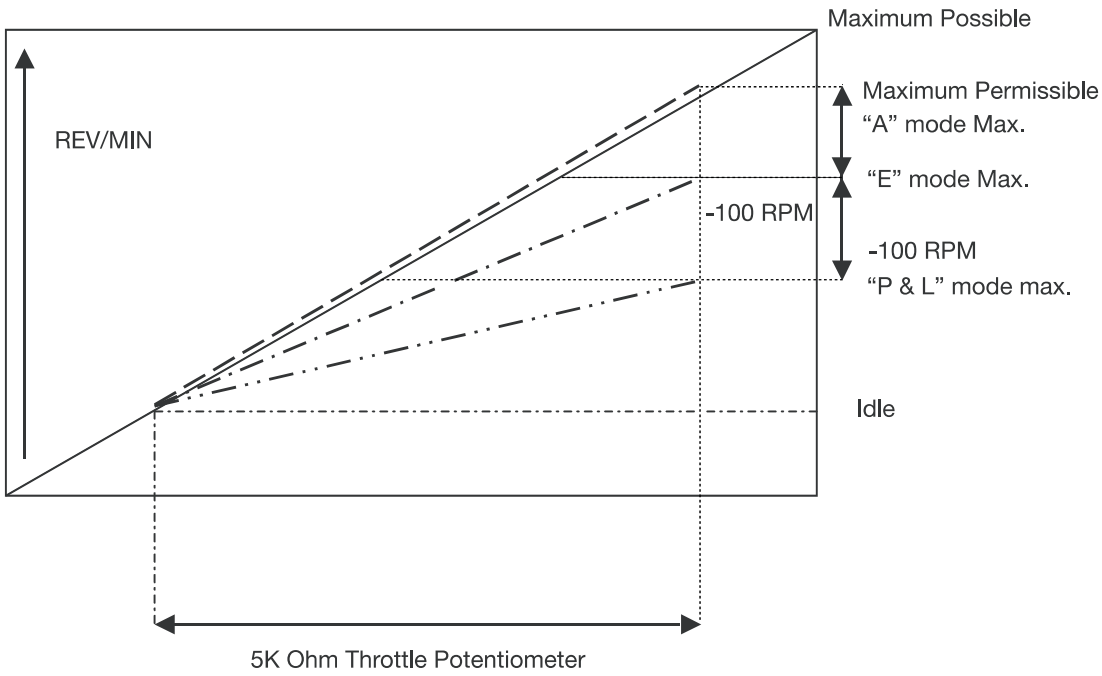
Maximum Possible
REV/MIN
Maximum Permissible
"A" mode Max.
"E" mode Max.
-100 RPM
-100 RPM
"P & L" mode max.
Idle
5K Ohm Throttle Potentiometer

Fig 20.

Engine Throttle Control for Each Mode

Operation

The JZ machine can operate in one of four different modes, depending upon the application required. The modes are selected by the "MODE" button on the EMS. The EMS displays the selected mode alongside the power mode legend. Selecting the different modes has the effect of setting the maximum possible engine speed for each working mode. Successive presses of the mode switch will cycle through the different modes in the order as shown below.

Note: *The last operating mode when the machine was stopped will be restored when the machine is restarted.*

Fig 21.

E	Economy
A	Auto
P	Precision
L	Lifting

"A" Auto Mode

In Auto mode the EMS displays "AUTO" and the letter "A" next to the power mode icon. The engine is allowed to operate over its selected rev range as defined by its programmed rev limit. The maximum rev limit is the same as the maximum permissible engine revolutions.

When in auto mode the auto idle feature is permanently active, if the throttle dial position is changed, the engine speed will not change until either the travel pressure switch (i/p 27), the upper pressure switch (i/p 26) or the auto mode pressure switch (i/p 25) are closed.

When the upper pressure switch is closed the engine speed will rise to full speed less 100 rpm (or in proportion to the throttle target input if less than 100%). When the upper pressure switch re-opens the engine speed will remain at this position for 3 seconds and then drop to 70% of the difference between auto and idle speed (plus idle speed) for the set auto idle time, after which it will drop to idle.

When the auto mode pressure switch is closed, the engine speed will rise to the full available engine speed. When the auto mode pressure switch re-opens the engine speed will drop to the full speed less 100 rpm for three seconds and then down to 70% of the difference between auto and idle speed (plus idle speed) for the set auto idle time, after which it will drop to idle.

When the travel pressure switch is closed, the engine speed will rise to the full available engine speed. When the travel pressure switch re-opens the engine speed will remain at full for three seconds, then will drop to the full speed less 100 rpm for the pre-set auto idle time, after which it will drop to idle

"E" Economy mode.

In standard mode the EMS displays "ECONOMY" and the letter "E" next to the power mode icon. The engine is allowed to operate over its selected rev range as defined by its programmed rev limit in direct proportion to the throttle input. However the maximum rev limit of 100 rpm less than the maximum permissible is imposed. Thus for a full throttle potentiometer setting the engine revolutions is 100 lower than it would be in the auto mode.

"P" Precision

In Precision mode the EMS displays "PRECISION" and the letter "P" next to the power mode icon. The engine is allowed to operate over its selected rev range as defined by its programmed rev limit in direct proportion to the throttle input. However the maximum rev limit of 200 rev/min less than the maximum permissible is imposed. Thus for a full throttle potentiometer setting the engine revolutions is 200 lower than it would be in the auto mode, the same as it is for lifting mode.

"L" Lifting mode

In Lifting mode the EMS displays "LIFTING" and the letter "L" next to the power mode icon. The engine is allowed to operate over its selected rev range as defined by its programmed rev limit in direct proportion to the throttle input. However the maximum rev limit of 200 rev/min. less than the maximum permissible is imposed. Thus for a full throttle potentiometer setting the engine revolutions is 200 lower than it would be in the auto mode, the same as it is for precision mode.

The engine speed will vary according to the following characteristic: ⇨ *Fig 22. (C-19)*

Machine	Auto	Economy	Intermediate	Auto Idle	Idle
JZ235/255	2050 rpm	1950 rpm	1635 rpm	1100 rpm	900 rpm

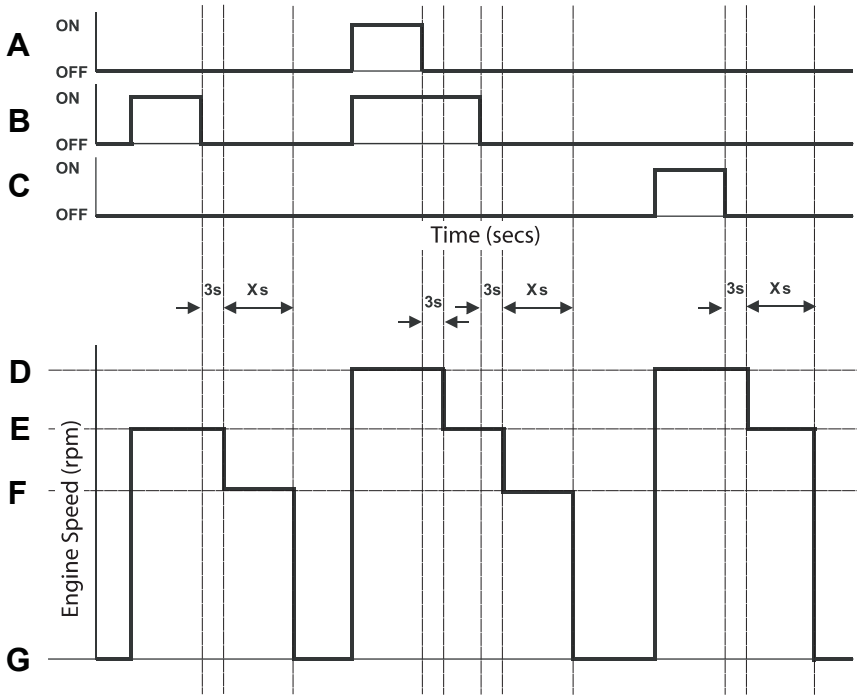

Fig 22.

Item	Auto Mode Pressure Switch
A	Auto Pressure Switch
B	Upper Pressure Switch
C	Travel Pressure Switch
D	Full Auto
E	Economy
F	Intermediate
G	Idle (or auto idle if enabled or in Auto mode)

Pump Control for Each Mode

Operation

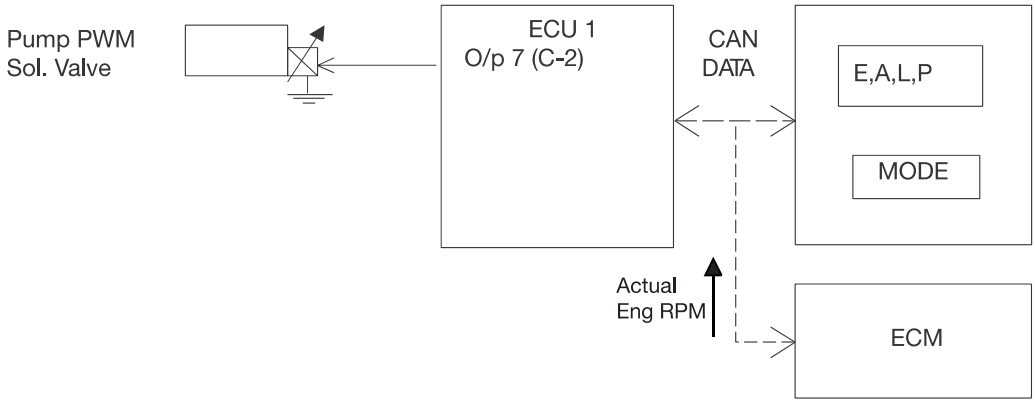

Fig 23.

The machine can operate in four different modes, depending upon the type of work required ⇨ ***Engine Throttle Control (C-16)***. The pump output horsepower is varied by means of a PWM signal to the pump control solenoid valve which varies for each mode.

Tier III machines are required to reduce the "range band" "**X** to **Y**" (pump milliamps) ⇨ ***Fig 25. (C-22)***, to improve engine stability dependant on specific factors which include:

- Barometric Pressure
- Fuel Temperature
- Air Intake Temperature
- Air Conditioning
- Engine and Hydraulic Temperature

These conditions are monitored by ECU1. Engine power and pump power are then varied to suit the operating conditions.

Each of the above factors has a value calculated by ECU1 of between 0 and 1. All values are then calculated to give a dynamic control factor (DCF) of 0 to 1 which will determine the pump output power and will vary the pump mA to suit.

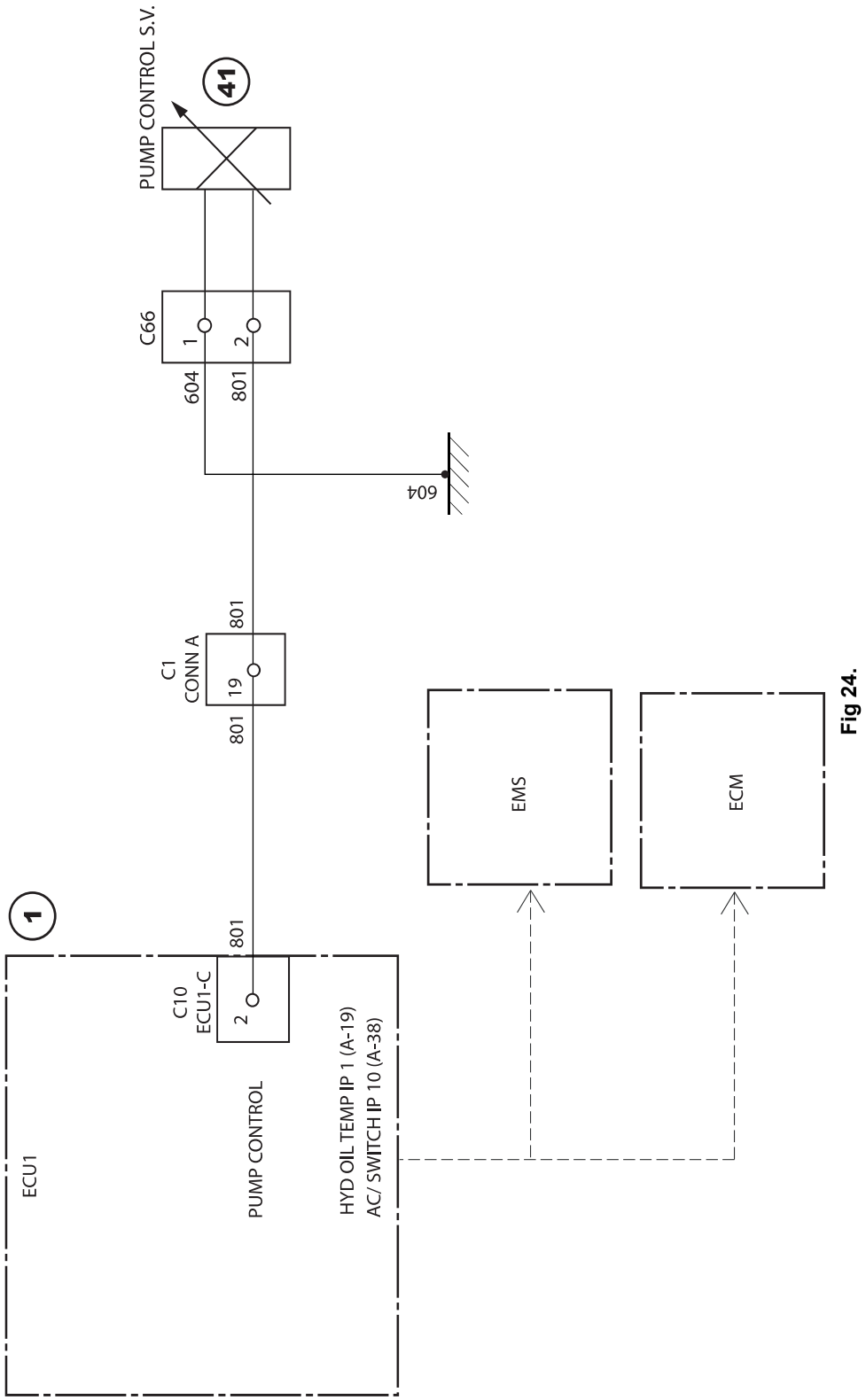
PUMP CONTROL S.V.
41
C66
1
2
604
801
604
C1
CONN A
801
19
801
EMS
ECM
1
801
C10
ECU1-C
2
ECU1
PUMP CONTROL
HYD OIL TEMP IP 1 (A-19)
AC/ SWITCH IP 10 (A-38)

Fig 24.

"A" Auto Mode

The pump control signal varies with engine speed according to the figure below:

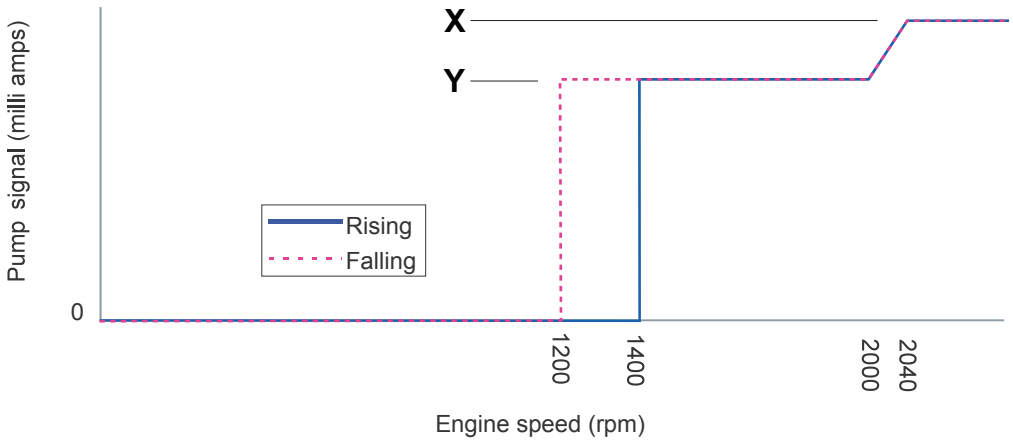

Fig 25. Pump Control for DCF of 1 (normal conditions) in "A" mode

X	490
Y	340

"E" Economy mode

The pump control signal varies with engine speed according to the figure below:

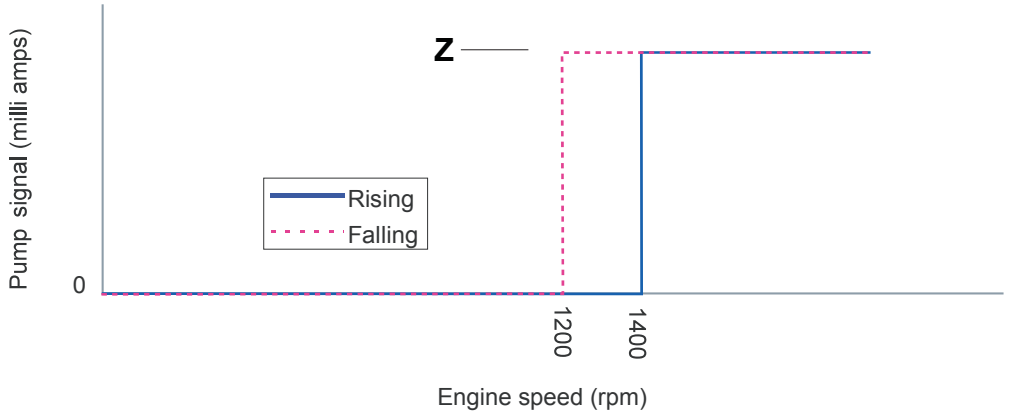

Fig 26. "E" mode

Z	290

"L" Lifting mode & "P" Precision mode

The pump control signal is set to zero PWM percent, regardless of engine speed.

RPM Setting Selection

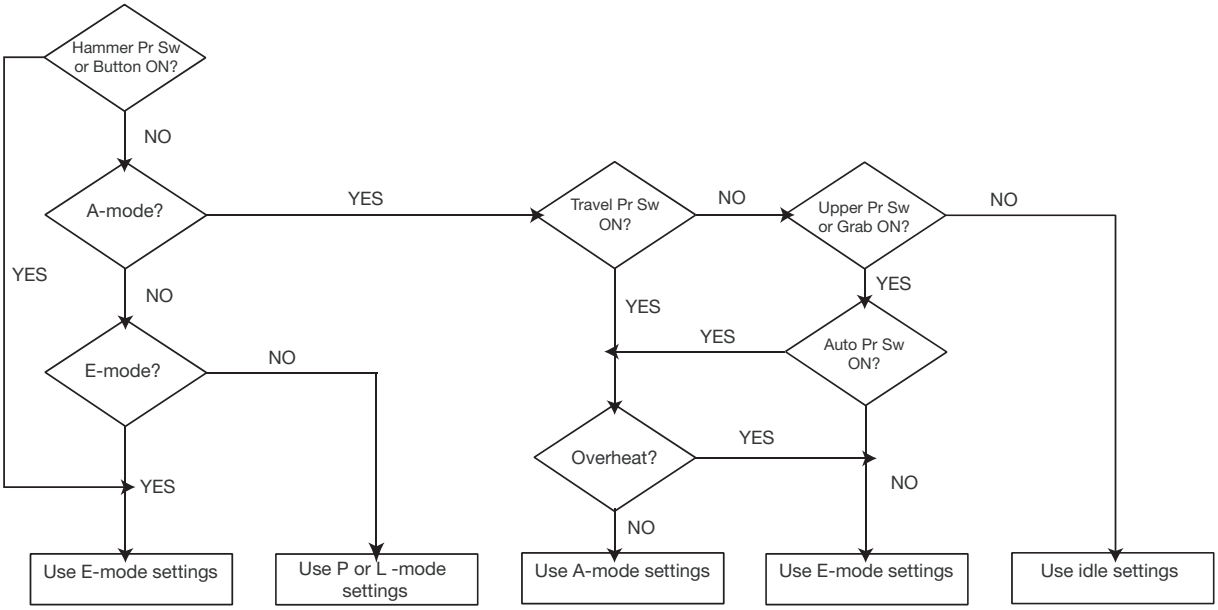

Fig 27.

mA Setting Selection

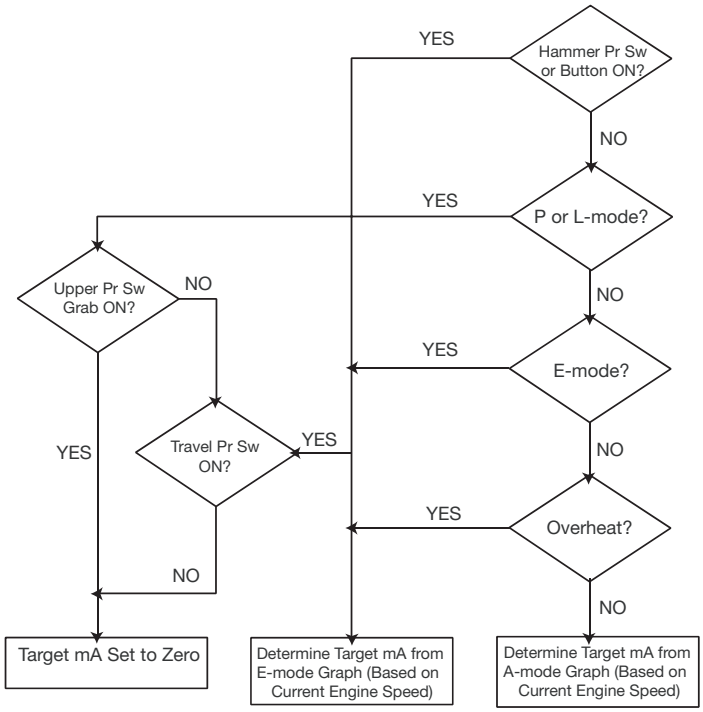

Fig 28.

Hydraulic Fan

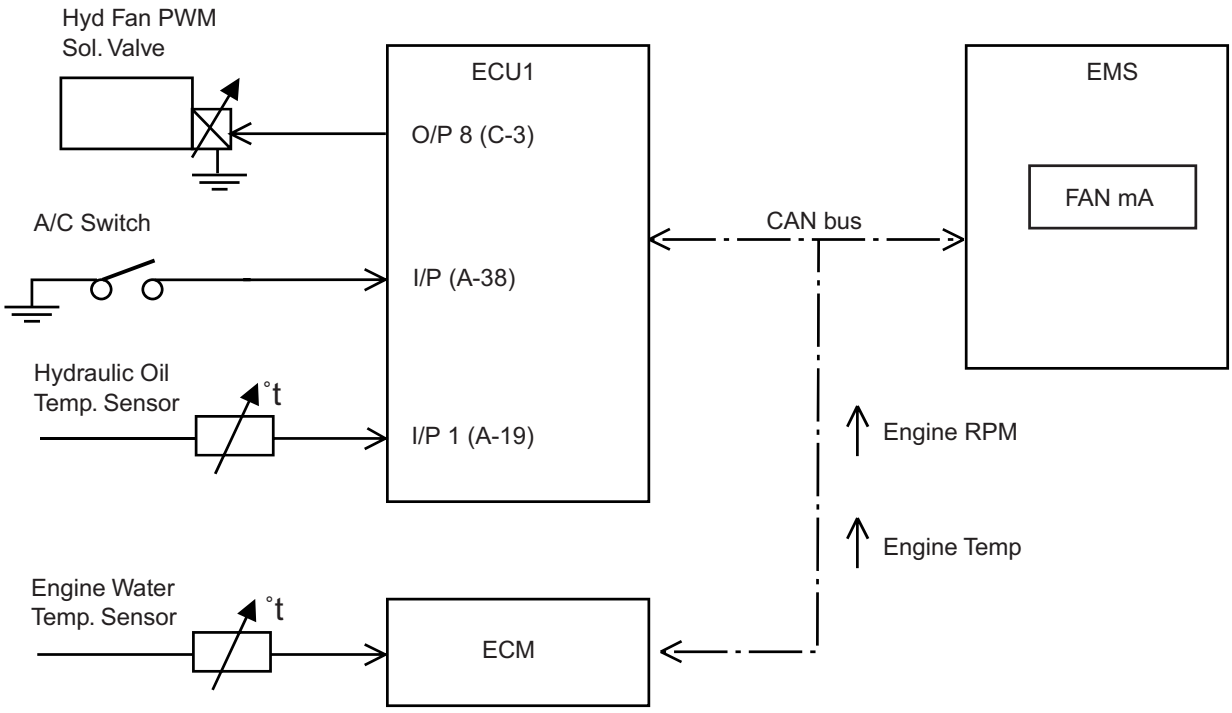

Fig 29.

Operation

The cooling pack temperature is controlled by a hydraulically driven fan. The hydraulic valve, which controls the fan speed, is controlled by a PWM solenoid.

As the temperature of both the engine and the hydraulics increase, an electrical signal is sent to the ECU1. The ECU1 will vary the PWM on the solenoid according to these readings so that the hydraulic fan will rotate at a given speed. If the temperature gets higher, then the fan RPM will also go higher.

Note: *The output duty cycle will operate the RPM of that set by the highest temperature. By default the fan speed will run at approximately 500RPM without air-con or 775RPM with air-con. The Milliamps will not change from 90(or 210 with air conditioning switched on) until the hydraulic oil temperature reaches 50°C or the engine water reaches 87°C.*

For Hydraulic Oil Temperature figures, without air conditioning and engine speed at 2200rpm, ⇨ ***Fig 30.*** ***(C-25)***.

For Engine Water Temperature figures, without air conditioning and engine speed at 2200rpm, ⇨ ***Fig 31.*** ***(C-25)***.

Note: *All figures are +/- 10% on graphs.*

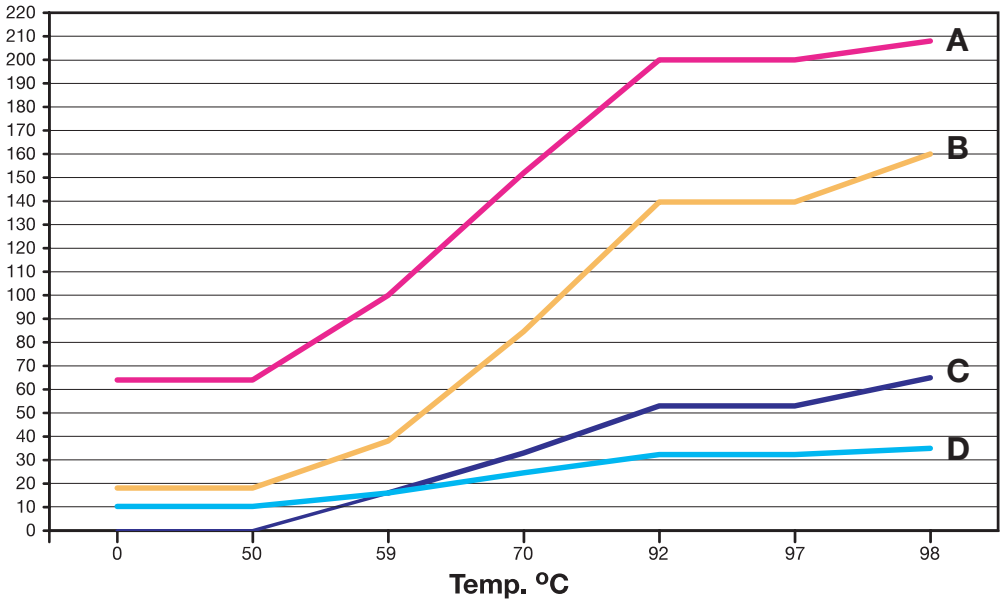

Fig 30.

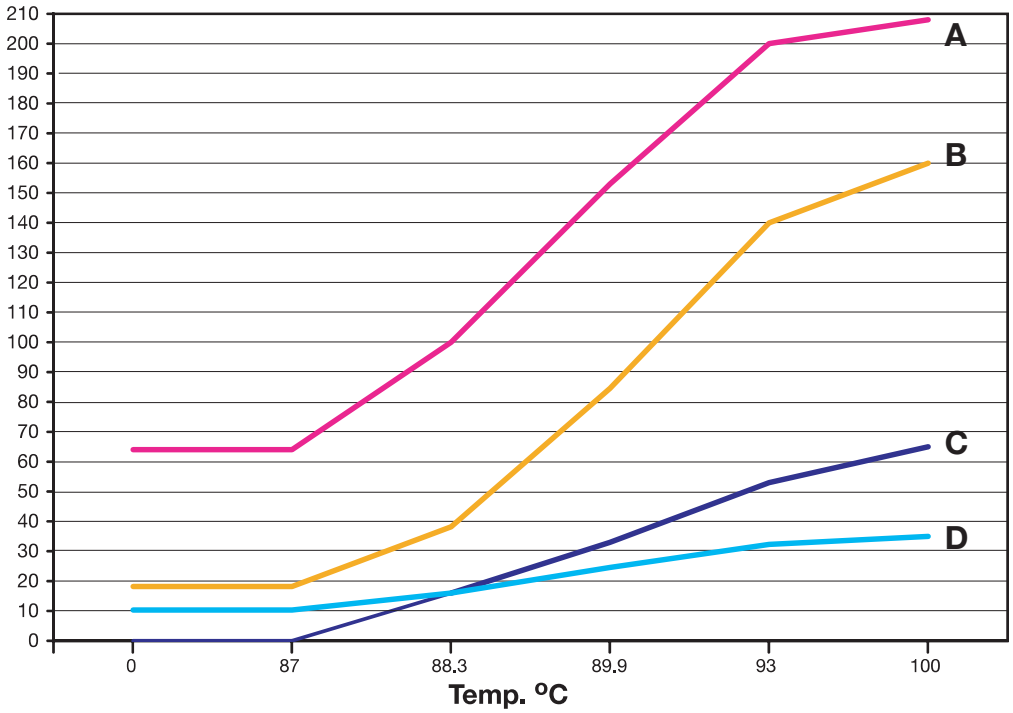

Fig 31.

A - Fan rpm x 10

B - Pressure (Bar)

C - Milliamps x 10

D - Flow (Lpm)