

Instrument Cluster Service Guide



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1	All	7-11-06	Diesel Specs for MY07 Clusters
2	4.1.1	7-14-06	Updated Coolant temperature curves per customer request.

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1. SCOPE

This document describes the functions of the instrument cluster for Diesel Workhorse Custom Chassis.

2. CONFIGURATION

As described in the hardware specification 103390, different cluster versions are available.

The software is **divided into gas, diesel and LF72 part numbers**. Configuration data is used to create the different versions, **but are limited by whether it is gas, diesel or LF72 software**.

This document describes the Diesel Configuration without LF72 particularities. By default an Allison 1000 transmission is selected. Each time the [ETC2](#) message is received correctly, this transmission is set.

Configuration is set in the cluster through data link programming (see diagnostic section).

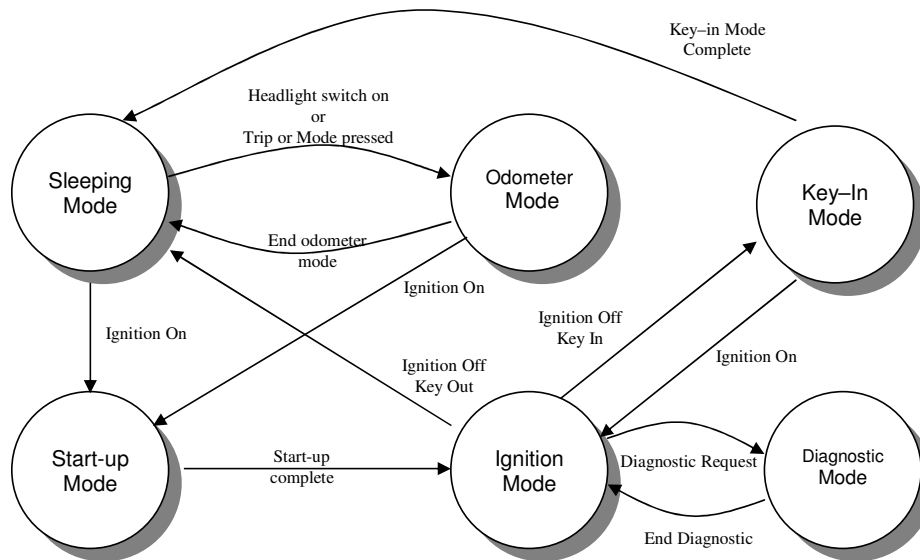
Configuration Byte:

Bit #	0	1	2	3	4	5	6	7
0	No PRND	No CTC	No CTP	US	Gas	Not used	Not used	Not used
1	PRND321	CTC	CTP	Metric	Diesel	Not used	Not used	Not used

CTC: Trip Computer

CTP: Power train data display

3. CLUSTER OPERATION MODES



3.1. Odometer Mode

The odometer is readable with the ignition off if the vehicle headlights are on or if the trip or mode buttons are pressed. If the headlight switch is used, the odometer turns on and off with the switch without a delay. If the trip or mode switches are used, the odometer will be visible for 15 seconds and then the cluster goes to Sleep Mode.

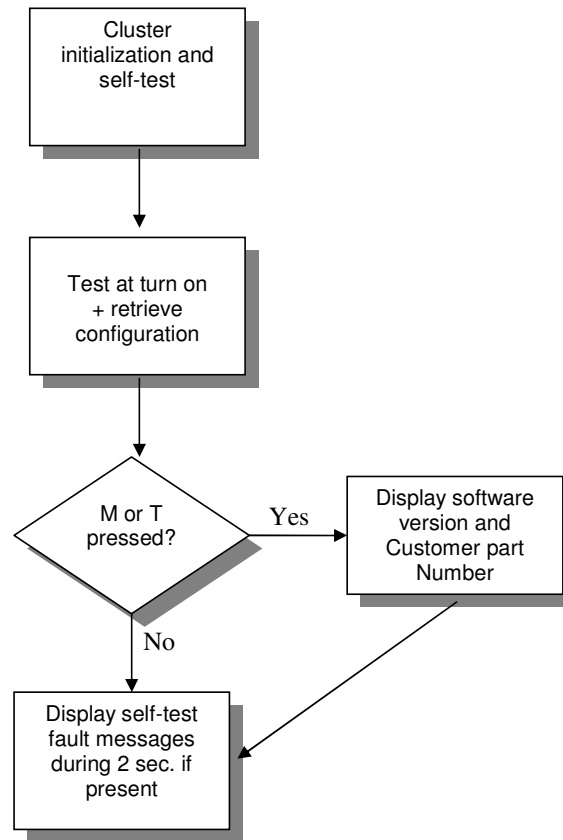
3.2. Key in Ignition Reminder Mode

When the ignition goes from on to off and the key is left in the ignition switch, for a 60 second period the chime (see chime section) will sound if the door ajar input is low (door open). The chime will continue to sound until either the driver's door is closed or the key is removed from the ignition or the 60-second period has elapsed.

During the 60-second period the odometer is visible.

3.3. Startup Mode

The cluster enters start up mode when the ignition input is active.



3.3.1. Test at turn on

The test at turn on will have a maximum duration of 3 seconds.

During this time the followings actions must take place simultaneously:

- All the tell-tales, except turn signals, must be turned on for 2 seconds then turned off.
- All the gauges must reference themselves and then go to the position corresponding to their current reading.

3.3.2. Retrieve configuration

The cluster, using the configuration byte and other methods, retrieves its environment.

- Two warning lights apply only when an automatic transmission is used: Check Transmission and Range Inhibit.

3.4. Ignition Mode

The ignition mode is active when the ignition switch is on.

The ignition mode is the normal operation mode of the cluster.

When the ignition switch is turned off, the following current settings of the cluster must be stored in non-volatile memory:

- Accumulated odometer, trip1 and trip2 values.
- The user selection of US or Metric units on the message display.
- The last message selection being displayed on the second line of the message display.
- The LCD contrast setting.

After storing these settings, the cluster goes to sleep mode after a delay of 3 seconds.

3.5. Diagnostic Mode

The cluster enters diagnostic mode when a start diagnostic request is made.

The start diagnostic request is sent either by a diagnostic tool through the CAN data link or by selecting the diagnostic option by setting the park brake and depressing the mode button for longer than five seconds.

3.6. Sleeping Mode

When the cluster is in sleep mode the microprocessor is stopped.

The cluster exits sleep mode when one of the wake-up inputs is active. When the cluster wakes up, it first begins to control its own power supply by activating the power supply maintain output, then it decides depending on which wake up input is active what mode must be active.

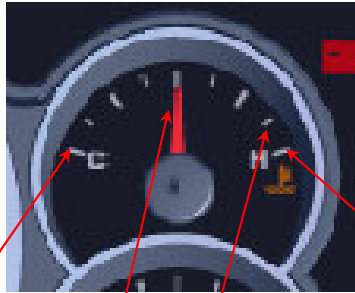
When the cluster goes back to sleep, it simply deactivates the power supply maintain output.

4. IGNITION MODE

4.1. Gauges

4.1.1. Engine Coolant temperature

Engine coolant temperature (ECT) is read from [J1939](#). Pointer remains in last active position w/ignition off, or when communication is lost.



Hot line = 115 degrees Celsius
7/8ths mark = 113 degrees Celsius
Centerline (50%) = 88 to 108 degrees Celsius
Cool line = 40 degrees Celsius

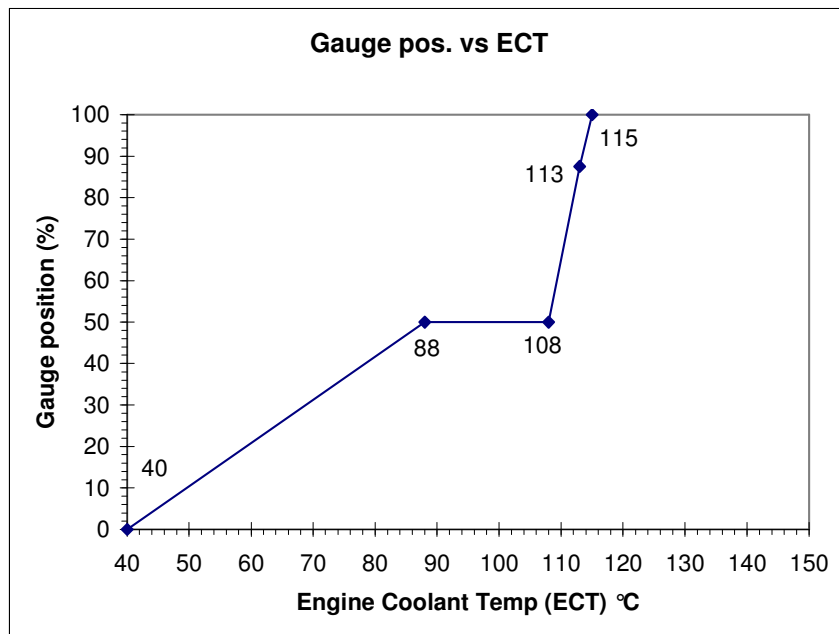


Chart 1: Diesel Engine Coolant Temperature versus Gauge position

4.1.2. Fuel

Diesel engines will read from the Fuel Sender.

The following table summarizes how to display the fuel level upon the tank type 30 or 40 gallons.

Fuel tank size.	% Volume filled at 5° above the "F" mark	% Volume filled at "F" mark	% Volume filled at "3/4" mark	% Volume filled at "1/2" mark	% Volume filled at "1/4" mark	Alarm Level On <=	% Volume filled at "E" mark	% Volume filled at 3° below the "E" mark	Alarm Level Off >=
Fuel Level	100%	93%	69%	46%	25%	20%	10%	0%	23%
Fuel Sender 30 gal	>= 243Ω	236Ω	159Ω	106Ω	63Ω	51Ω	31Ω	30Ω	
Fuel Sender 40 gal	>= 243Ω	220Ω	129Ω	84Ω	49Ω	39Ω	31Ω	30Ω	

Range: Distinct markings at E, ¼, ½, ¾, F.

Pointer remains in last active position w/ignition off or when communication is lost

4.1.3. Speedometer

Vehicle speed is read from J1939. If the information is not received or available, vehicle speed is read from a frequency input at the rate of 4000 pulses/mile.

Range: US/Metric 0-100mph (primary) 0-160 km/h (secondary)

Pointer returns to zero w/ignition off

The pointer returns to zero when all communication is lost without frequency input.

4.1.4. Tachometer

Engine speed is read from [J1939](#). If no J1939 information is available, the value is read from a frequency input at the rate of 4 pulses /rev.

Range 1: Diesel 0-3000 RPM

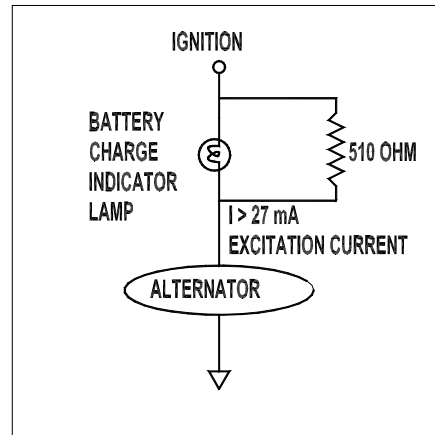
Pointer returns to zero w/ignition off

The pointer returns to zero when communication is lost.

4.2. Warning Lights

4.2.1. Battery Charge Indicator (red)

The battery charge indicator is on when the battery charge indicator input is on (logic low).
The indicator is switched off when the condition is off.



4.2.2. Low oil pressure (red)

The low oil pressure indicator is on when flag is set from [J1939](#). It is off when the flag is off.

4.2.3. Check Transmission (yellow)

For all vehicles with an Allison transmission fitted [TO](#), the message is read from [J1939](#).

Check transmission is switched off if no DTC is received during 5 seconds with the Transmission controller ECU still alive (Gear selected or engaged received), or this DTC is not received.

4.2.4. Cruise control on (green)

Indicator is read from Cruise Control State [J1939](#) or from [Cruise Control Switch State](#).

4.2.5. Left turn (green)

Is on when the left turn signal is on (logic high).

4.2.6. Right turn (green)

Is on when the right turn signal is on (logic high).

4.2.7. High beam (blue)

Is on when the high beam input is on (logic high).

4.2.8. SVS (yellow)

Is on when the check tires/SVS input is on (logic low)

4.2.9. ABS (yellow)

When the [J1939](#) message is received and available, or when a DM1 message is received from the ABS with the Warning Status Lamp active, otherwise switch on when the ABS signal is on (logic low). The ABS input is read from an analog input. The indicator is on < 2.6V and off >4.5V.

4.2.10. Park Brake on/ Brake System Failure (red)

When the park brake is set (logic low) and the vehicle speed is > 3 mph, the park brake indicator will flash. When the park brake is set and the vehicle speed ≤ 3mph, the indicator is on steady accompanied by a reminder beep.

The brake indicator comes on when the engine is running after a 10 second delay at ignition on if the brake failure input is < 2.0V. It goes off when the input is > 4.0V.

The brake indicator comes on when a brake system failure [Hydraulic Fluid Pressure](#) is detected from the ABS (if the ABS message is received and available). The brake system failure warning takes precedence over the applied park brake warning. See ([Appendix D: Brake Fail Selection](#)) for selection.

4.2.11. Seat belt (red)

When the ignition is being switched on and after completion of the start-up mode, if the driver's seat belt is not fastened (the seat belt's input is low when the seat belt is unfastened), the indicator is on for 60 seconds. The indicator will be constant for the first 20 seconds, and then flash for the remaining 40 seconds. If the seat belt is buckled (pulled high) during the first 8 seconds, the indicator turns off.

If the driver's seat belt is unbuckled before the end of the initial 8-second period, the indicator will turn on for the balance of the 60-second delay.

4.2.12. Service engine soon (yellow)

Is on when the service engine soon input is on (logic low).

4.2.13. Daylight Running Lamp (green)

Is on when the daylight running lamps input is on (logic low).

The daytime running light is canceled when park brake is set (on vehicle only).

4.2.14. High Idle (yellow)

Read from [J1939](#) or from the high idle input if J1939 is not available. The high idle warning led is on when the high idle input is on (logic low).

4.2.15. Range inhibit (red)

For vehicles with an Allison transmission fitted [Transmission Option](#), the message is read from [J1939](#).

4.2.16. Overdrive Off (yellow)

On Allison transmissions, is on when the overdrive off input is on (logic low) and requested gear is 4th.

4.2.17. Wait To Start (yellow)

Diesel engines will read from [J1939](#) or from the Wait to Start input (logic high) .

Wait for grid heaters/glow plugs. The warning stays on at least 5 seconds even if the inputs are switched off. The warning stays on an additional 2 seconds after ignition on indicator self test.

4.2.18. Stop Engine (red)

Diesel engines will read from [J1939](#) or from engine Shutdown by [J1939](#). The warning stays on when the status lamp from a DMI message is set on or when engine shutdown by J1939.

When the Engine Approaching Shutdown is just received the warning will blink with a 640ms cycle time.

The Warning is switched off if no DTC is received during 5 seconds with the Engine controller ECU still alive (At least one message from Engine ECU is received), or this lamp status is off and when all other origins are not received or in an inactive state.

4.2.19. Air Suspension (red)

Is on when the Air Pressure Warning input is on (logic high).

4.3. Tone Generator

4.3.1. Buzzer

A continuous buzzer will alert a driver to specific warning conditions. Activation requires the appropriate message input or the Buzzer Call input active. The buzzer is normally associated with warning messages or warning lamps.

4.3.1.1. High engine coolant temperature

With a “Check Coolant Temperature” message, the buzzer sounds for 3 seconds or until acknowledged by depressing the trip-reset switch. Read from [J1939](#).

4.3.1.2. Low oil pressure

With a “low oil pressure” [J1939](#) message, the buzzer sounds until acknowledged by depressing trip-reset switch, or oil pressure rises to the acceptable pressure.

4.3.1.3. Low fuel

When the fuel tank is at or below 20% of tank capacity during at least 60 seconds, the buzzer sounds for 3 seconds, or until acknowledged by depressing trip switch. (Turns on at 20% and off at 23%).

The fuel level is read from the fuel sender. *(The J1939 message FUEL ECONOMY must be received for validating the Fuel sender Value)*

Comment [M1]: During at least 60 seconds

Comment [M2]: PMes 7/8/5 For now 23%

4.3.1.4. Low Engine Coolant

With engine running and “low coolant” [J1939](#) message, the buzzer sounds until acknowledged by depressing the trip reset switch.

The Buzzer is switched off if no DTC ([J1939](#)) is received during 5 seconds with the Engine controller ECU still alive, or this DTC is not received.

4.3.1.5. Low voltage

With engine running and battery voltage < 11.0 V for a continuous period of 30 seconds, the LCD displays “Check Bat Voltage” message and buzzer sounds until acknowledged by depressing trip reset switch. Voltage is read from [J1939](#) or from the ignition analog input if not available.

4.3.1.6. High voltage

With engine running and battery voltage > 16 V for a continuous period of 5 seconds, the buzzer sounds until acknowledged by depressing trip-reset switch. Voltage is read from [J1939](#) or from the ignition analog input if not available. See ([Appendix E: Battery Voltage Selection](#)) for selection.

4.3.1.7. Charging problem

With the Battery Charge warning light on, (logic low), the buzzer sounds for 3 seconds or until acknowledged by depressing trip reset switch.

4.3.1.8. Brake System Failure

With the brake system failure input on (switched to ground) or [Hydraulic Fluid Pressure](#) warnings detected from the ABS, the buzzer sounds until acknowledged by depressing trip-reset switch. See ([Appendix D: Brake Fail Selection](#)) for selection.

4.3.1.9. Buzzer Call

With the buzzer call input on (switched to ground) and stable for 2 sec and engine running the buzzer sounds until acknowledged by depressing trip-reset switch.

During the first 10 seconds after the ignition rises up the sound is not generated. Also, during the first 3 seconds after the engine is started the alarm is not available.

4.3.1.10. Engine Shutdown - Protection

For Diesel engines only when one of the following origins is in an active state: from [J1939](#), “Approaching Shutdown” or “Engine Shutdown”, the buzzer sounds and can’t be acknowledged by depressing trip-reset switch.

4.3.1.11. Check Air Pressure

With the Air Pressure warning light on, the buzzer sounds for 3 seconds or until acknowledged by depressing trip reset switch.

4.3.1.12. Water in Fuel

With the “Water In Fuel” message sent via [J1939 DM1](#), the buzzer sounds for 3 seconds or until acknowledged by depressing trip reset switch.

4.3.2. Chime

A pulsed chime will remind a driver to specific conditions if the Buzzer Enable input is not active.

4.3.2.1. Park Brake Reminder

The chime will sound when the park brake is set and vehicle speed is above 3 mph.

4.3.2.2. Seat Belt Reminder

When the ignition is being switched on and after completion of the start-up mode, if the driver's seat belt is not fastened, the chime is audible for 8 seconds. If the seat belt is buckled during this 8-second period, the audible warning turns off.

If the driver's seat belt is unbuckled before the end of the initial 8-second period, the chime will turn on for the balance of the 8-second delay.

4.3.2.3. Turn Signal Reminder

The chime will sound at turn signal flasher rate when both of the following conditions are met:

- Left or right only turn signal switch is active (hazard not active).
- A turn signal is blinking for a distance of more than .75 mile.

4.3.2.4. Headlights On Reminder

If the ignition is off and the headlights are on, the chime will sound until the headlight switch is turned off or the trip reset button is pressed.

4.3.2.5. Key-In Ignition Reminder

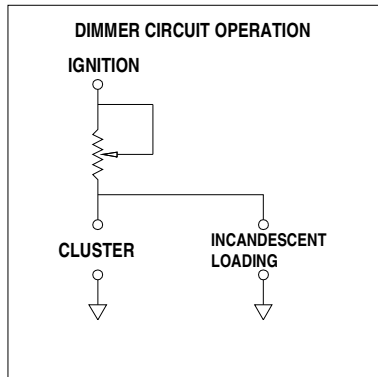
The chime will sound when all of the following conditions are met:

- The key-in ignition input is active (switched to ground).
- The ignition has gone from on to off.
- Open door (door ajar input is switched to ground) within 60 seconds of ignition off.

The chime will continue to sound until either the driver's door is closed or the key is removed from the ignition or the 60-second period has elapsed.

4.4. Dimming

When the headlights are on, the gauges, gauge pointers and LCD will dim together in accordance with the dimmer rheostat position. A selection in the diagnostic menu on the message display will allow resetting to the original factory value (this value is calculated with no load connected in parallel with the back-lighting input). If the headlights are off, the LCD backlighting will be on full bright. Rheostat is $7.2\Omega \pm 1.2\Omega$



4.5. Message Display

4.5.1. Default Screens Overview

Trip Computer option (no PRND321)

Line #	Font Size	Left part of the screen	Font Size	Right part of the screen
1	16	ODOMETER / TRIP	8	Battery Voltage
2	16	OIL / Trip		

Large Font Option (no PRND321)

Line #	Font Size	Left part of the screen	Font Size	Right part of the screen
1			10	Battery Voltage
2	20	Odometer/Trip		

4.5.2. Menu Overview

Menus have 4 lines.

The highlighted line is shown in reverse video.

To highlight a line, the trip switch is used to scroll up and the mode switch is used to scroll down.

Once high-lighted, a menu item can be selected in either of two ways:

1. Depressing and then releasing the trip and the mode switches at the same time chooses the item.
2. Or after 3 seconds of inactivity, the line shown in reverse video is automatically chosen. Then, the display exits from the menu to the previous display.

4.5.3. Momentary Switches Overview

The Trip Reset and Mode switch contacts are used to operate the message display.

Both switches are also available on the cluster connector for remote operation.

4.5.3.1. Trip switch

- Selects and resets trip odometers
- Scrolls menu up
- Used along with “Mode switch” to select menu line and to toggle units (US/metric).
- Wake up cluster, while the ignition is off, to display the odometer.

4.5.3.2. Mode switch

- Enters inquiry mode
- Scrolls menu down
- Used along with “Trip switch” to select menu line and to toggle units (US/metric).
- Wake up cluster, while the ignition is off, to display the odometer.

4.5.4. Standard (base) messages

The messages below are standard.

4.5.4.1. Odometer accumulated

Maximum display is 999,999.9 miles. Odometer will not roll over.

Odometer mileage accumulates in the cluster in miles and is incremented by reading the [J1939](#) message or by the vehicle speed frequency input at the rate of 4000 pulses/mile. See [\(Appendix C: Vehicle Speed Selection\)](#) for Selection.

During normal operation the odometer value is stored in the EEPROM at each mile rollover. This allows the cluster to retain the value within 1 mile should there be an abnormal loss of power to the cluster. At a normal shutdown the fully accrued odometer value will be stored in the EEPROM.

The odometer is readable for 15 seconds with the ignition off by pressing the “trip reset” or “mode” buttons. The odometer is also readable with the ignition off if the vehicle headlights are turned on or the key is placed in the ignition.

4.5.4.2. Trip odometer 1 and Trip odometer 2

Two independently operating trip odometers are available.

Maximum display is 9,999.9 miles. Trip odometer will then roll over.

Comment [M3]: Vehicle speed is read from J1939. If the information is not received or available, vehicle speed is read from a frequency input at the rate of 4000 pulses/mile. If the frequency input is not available, vehicle speed is read from [J1850](#) in high or [Low Resolution](#). See [\(Appendix F: Vehicle Speed Selection\)](#) for selection.

The individual trip counters are independently reset by depressing and holding “Trip” switch.

4.5.4.3. Battery voltage

Diesel engines will read from the [J1939](#) message or from the ignition analog input. Voltage will be displayed in upper right hand corner of LCD, and on the bottom line of the screen if the “Battery Voltage “ menu has been selected.

Comment [M4]: Read from J1939, if not received then read from the analog input

4.5.4.4. Units selection

New Units

Select either US or Metric units by pressing and releasing the trip and mode switches simultaneously.

4.5.5. Priority interrupt messages

Priority messages can be generated by the power train, engine and transmission controllers and are available on all clusters where applicable.

Priority interrupt messages will interrupt the bottom line of the LCD in order to provide the vehicle operator with priority information.

A priority message is removed from the display only if its source expires or if the Trip switch acknowledges it. Each message must be acknowledged. If acknowledged, it remains removed from the display during any particular ignition cycle. If the IGN is turned off and then back on and the same priority message is active, the message will display again.

If more than one priority message is active, each message will be displayed one after the other for three seconds each.

If the bottom line of the LCD is displaying the PRND321 when a priority message occurs, the PRND321 will move to the upper right hand corner of the LCD over writing battery voltage.

4.5.5.1. Door Ajar

This message will be displayed when the door ajar input is on (logic low).

4.5.5.2. Water in Fuel

Diesel engines will read from [J1939](#) or the water in fuel input (logic low).

4.5.5.3. Low Fuel

Turn on at 20% or less of fuel tank capacity. (Turns on at 20% and off at 23%).

Comment [M5]: Below 20% during at least 60 seconds

4.5.5.4. Oil Pressure Low

Message will appear is the [J1939](#) flag is set. Switch off when it is off.

Comment [M6]: Off at 23%

4.5.5.5. Check Engine Oil level

Message will appear is the [J1939](#) flag is set. Switch off when it is off.

4.5.5.6.No J1939 Activity

Diesel engines will report missing data bus activity after 2.5 seconds of inactivity. [J1939](#).

4.5.5.7.Check Coolant Temperature

Read from [J1939](#) DM1 message “Coolant Temp Warning”.

Comment [M7]: Read first from J1939, if the information is not received by J1939 then read from J1850 or from the engine coolant temperature for a LU3 engine

4.5.5.8.Low coolant

Diesel engines will read from [J1939](#) with a DTC or. For J1939 when no DTC is received after 5 seconds the flag is cleared if the engine Controller is still alive (no message received) See [Flowchart](#) for selection.

4.5.5.9.Maintenance

Diesel engines will read from [J1939](#). If only the Water in Fuel DTC is received setting this status lamp, the maintenance message is not displayed.

4.5.5.10.Engine Shutdown

Diesel engines will read from [J1939](#).

4.5.5.11.Check Battery

Diesel engines read battery voltage from [J1939](#) or an analog input. The message is displayed when the voltage is less than 11.0V or greater than 16V. See ([Appendix E: Battery Voltage Selection](#)) for Selection.

Comment [M8]: Read from J1939, if not received then read from the analog input

4.5.5.12.Brake Failure

This message will be displayed when the Brake Failure input is on (logic low) or a [Hydraulic Brake Pressure warning](#) is received from the ABS. See ([Appendix D: Brake Fail Selection](#)) for selection.

4.5.5.13.Wait to Start

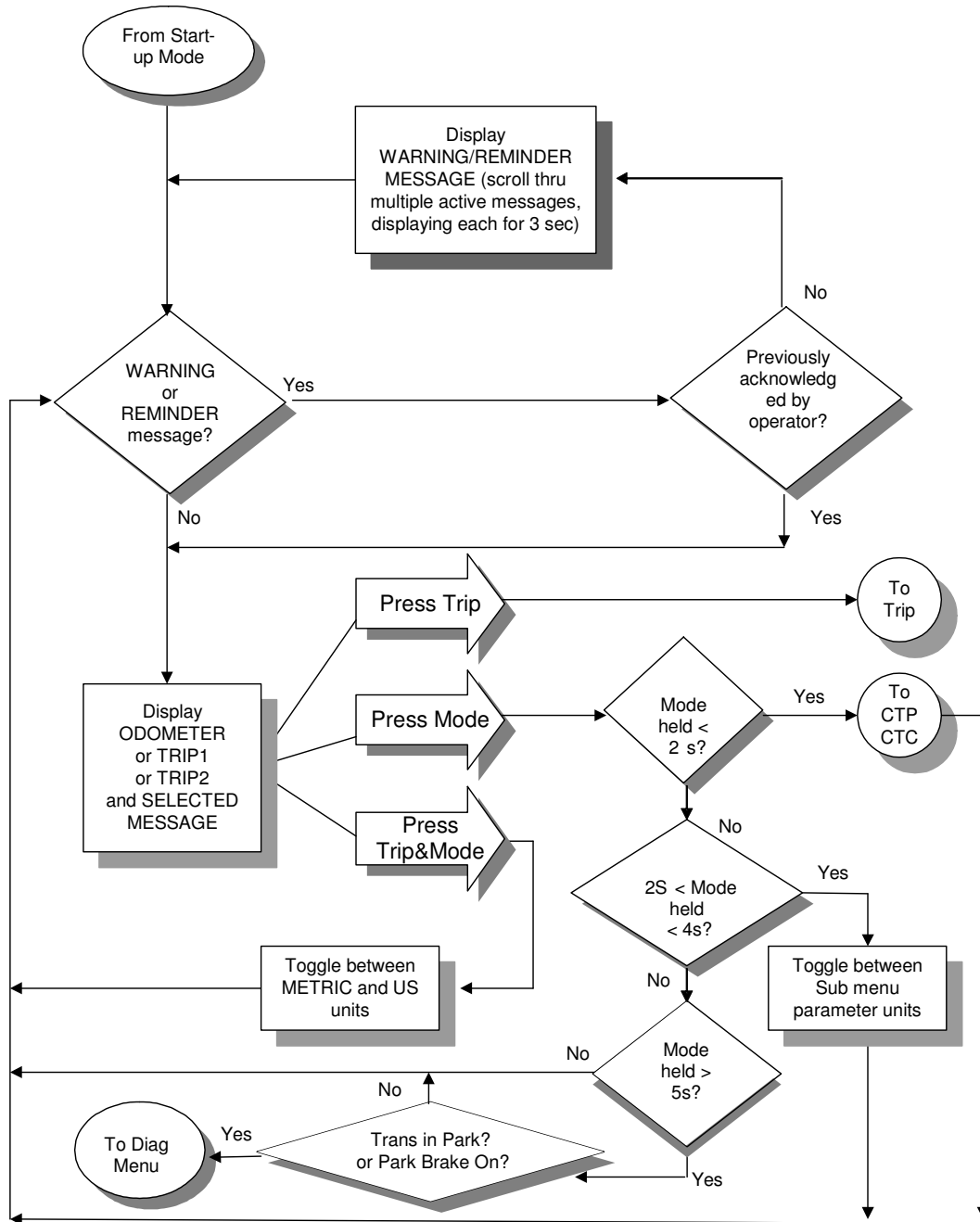
When the Wait to Start input or the flag read from [J1939](#) is active on Diesel engine, the “WAIT TO START ” message is displayed on the LCD. The message continues until conditions become inactive after 5 seconds or by depressing the Trip switch.

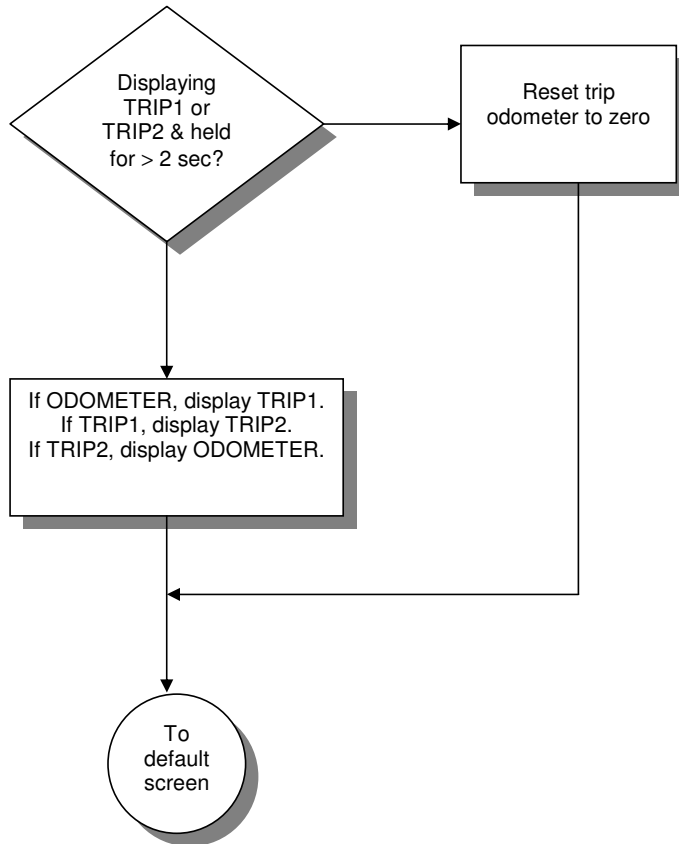
4.5.5.14.Low Brake Fluid level

When the Low Fluid level flag read from [J1939](#) is active on Diesel engine, the “LOW FLUID LEVEL” message is displayed on the LCD. The message continues until conditions become inactive or by depressing the Trip switch.

4.5.5.15.Buzzer Call

With the buzzer call input on (switched to ground) and stable for 2 sec and engine running, the “BUZZER CALL” message is displayed on the LCD. The message continues until conditions become inactive or by depressing the Trip switch. For the first 10 seconds after the ignition on state, the Buzzer Call is inhibited, and also 3 seconds after the engine has just started.





4.5.6. Trip Computer Option Messages

The messages below are available with the Trip Computer Option.

4.5.6.1. Instantaneous Fuel Consumption (liters per hour)

Read from [J1939](#). At 0 mph. “--.-“ is displayed when the engine is not running.

If the vehicle is moving or the engine is running depending on the Sub Toggle unit selection, the value can be displayed in liters per 100Km or in Km per liter for metric units.

For English units the value is displayed in mpg.

4.5.6.2. Average Fuel Consumption

Calculated from the [J1939](#) message Cumulative Fuel Consumption over the last 50miles distance traveled. New clusters are pre-programmed at 9.25 mpg. Same as above for the displaying by using the sub menu toggle Mode Switch.

4.5.6.3. Average Vehicle Speed

Calculated in cluster based on time and distance traveled since last reset by Trip switch.

4.5.6.4. Outside Temperature

Read from external NTC ambient air temperature sender.

Temperature range displayed is -25°C (-13°F) to 55°C (131°F).

If the sender is not connected, this menu selection is not available in the trip computer.

4.5.7. Large Font Option Messages

After selecting the large font option, the following messages can be scrolled through using the trip button. Screen availability will be dependant on cluster configuration.

4.5.7.1. Large Font Odometer

Large font (20 bit) odometer will display on lower line, and a smaller font battery voltage will be displayed in the upper right.

4.5.7.2. Large Font Trip Meters

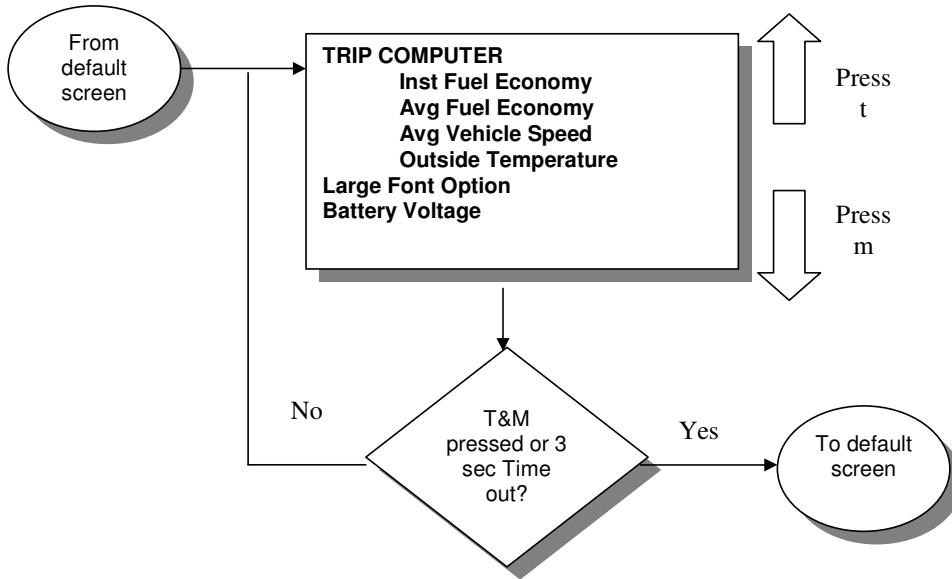
Trip 1 and Trip 2 are available on bottom line by toggling using the “trip” button.

Odometer will display in upper left of LCD.

4.5.8. Battery Voltage

When this option is chosen, the Battery Voltage is displayed on the bottom line of the display in large font.

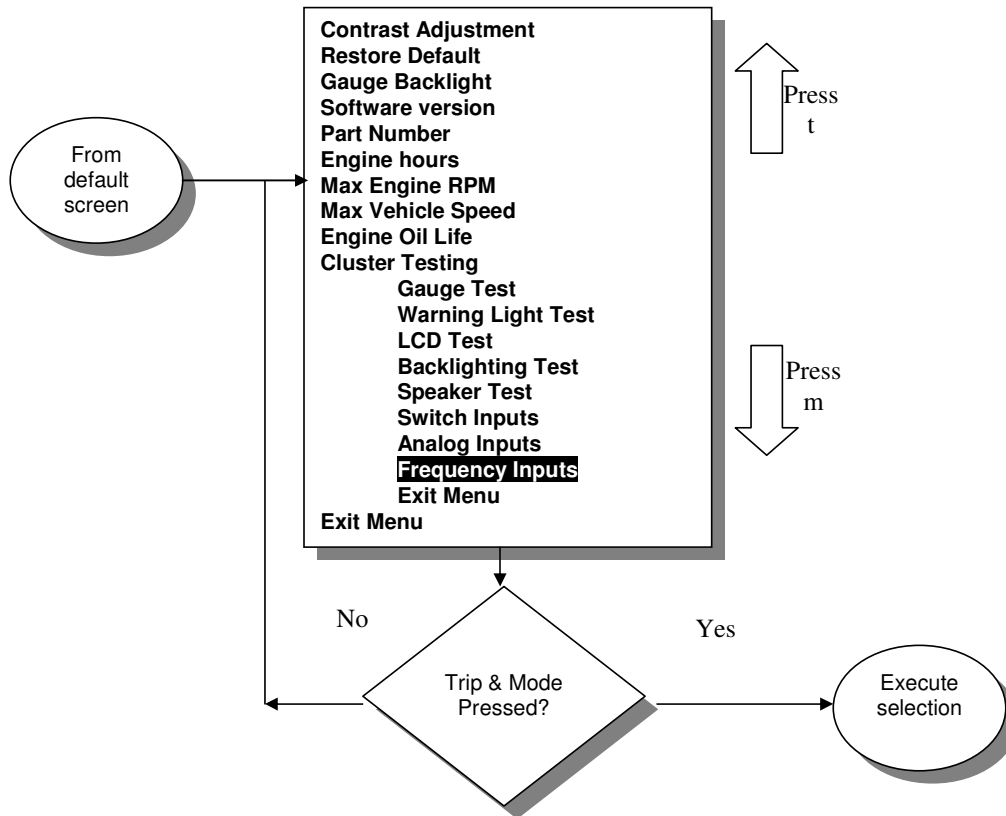
The Battery Voltage is read from [J1939](#) or analog input if J1939 message is not available.



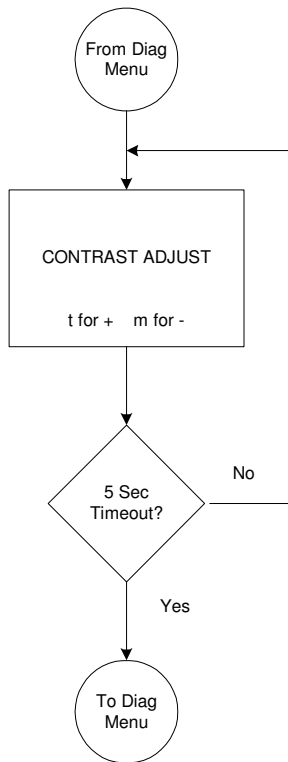
5. DIAGNOSTIC

5.1. On Board Diagnostic

On-board diagnostic functions can be initiated and executed with transmission in park, the park brakes is set, (logic low) and the Mode switch is depressed for longer than 5 seconds.

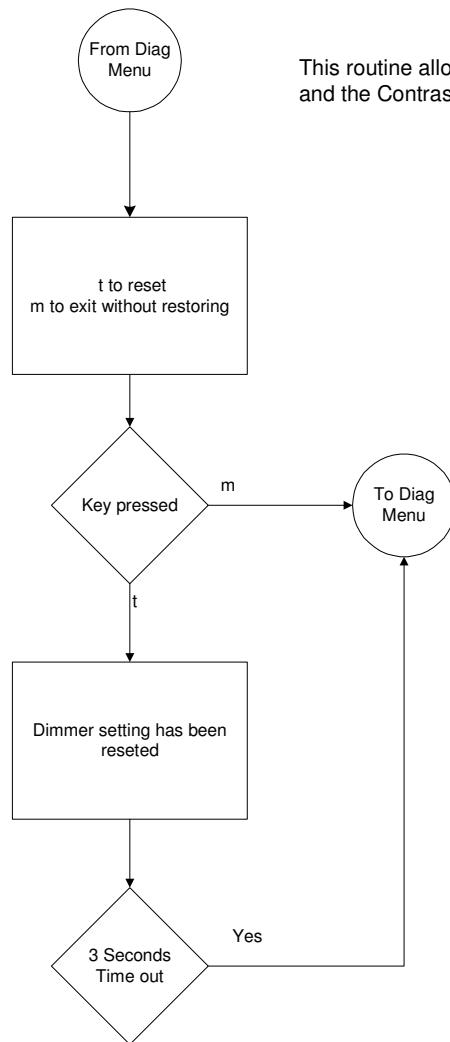


5.1.1. Contrast Adjustment



This routine adjusts the contrast of the LCD display. The new setting is stored in non volatile memory. (Contrast cannot be adjusted outside the range of visibility.)

5.1.2. Restore Default



This routine allows the user to restore the setting of the Dimmer and the Contrast to the original factory value.

5.1.3. Gauge Backlight

Opens a menu for user selectable backlight colors. Pointers will remain Amber, and LCD backlight remains white. The color options can be scrolled through using the “trip” button. Pressing the “Mode” button exits the selection menu and automatically sets the Gauge Backlight color to the last highlighted selection. Available colors are as follows:

- Blue Backlight
- Yellow Backlight
- Lt. Blue Backlight
- White Backlight
- Red Backlight
- Green Backlight

5.1.4. Software version

Display the software part number and version programmed into the micro controller.

Pressing the mode switch exits to the diagnostic menu. (The message "m to exit" appears on the screen).

5.1.5. Part Number

Display the part number programmed into the micro controller.

Pressing the mode switch exits the diagnostic menu. (The message "m to exit" appears on the screen).

5.1.6. Engine hours

Display the engine hours read from [J1939](#) or calculate the total hours based on when the engine is running if the J1939 information is not available.

Pressing the mode switch exits the diagnostic menu. (The message “m to exit” appears on the screen).

5.1.7. Max Engine RPM

Display the maximum engine RPM that was sustained for > 3 seconds.

Pressing the mode switch exits the diagnostic menu. (The message “m to exit” appears on the screen).

5.1.8. Max Vehicle Speed

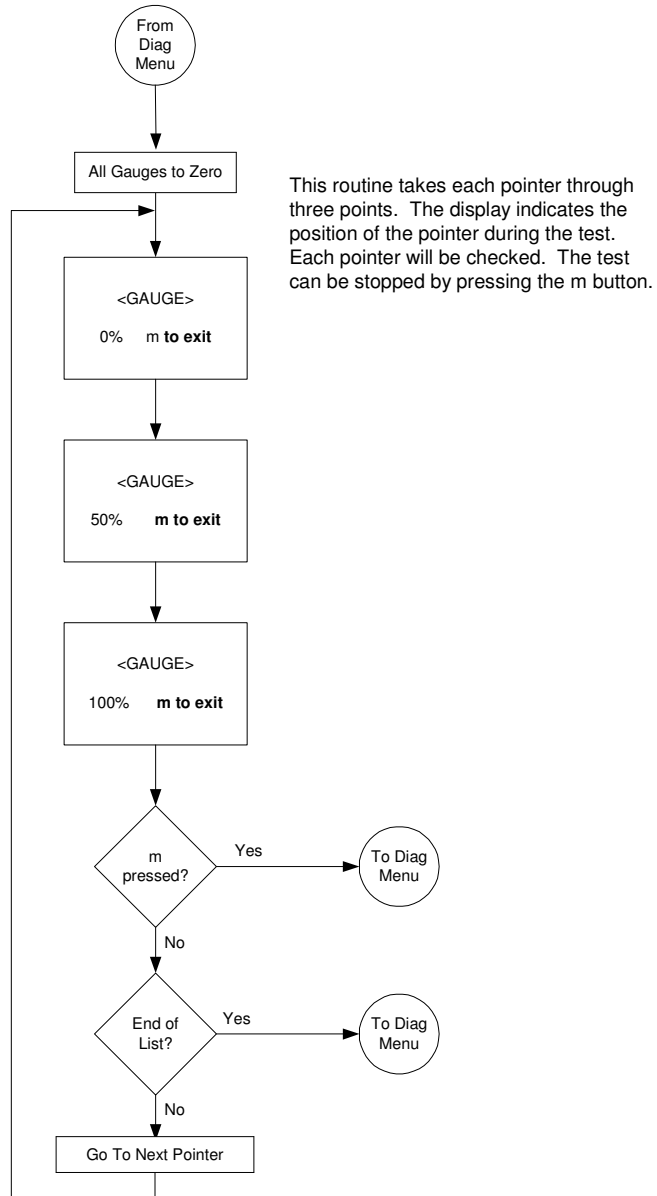
Display the maximum vehicle speed that was sustained for > 5 seconds.

Pressing the mode switch exits the diagnostic menu. (The message “m to exit” appears on the screen).

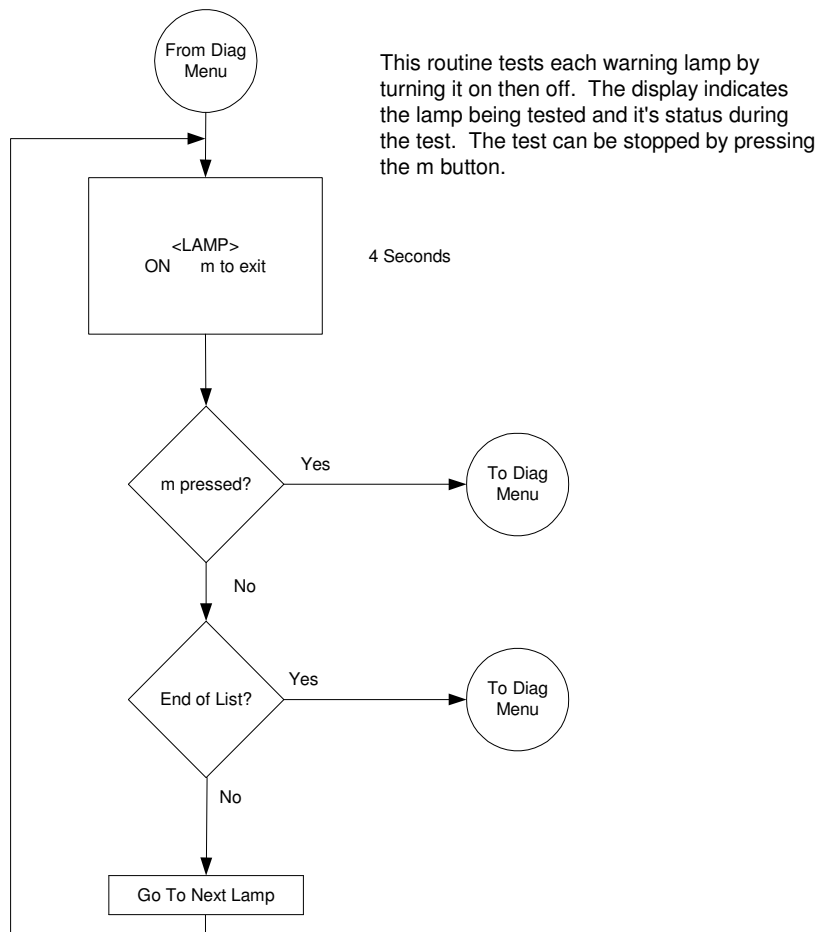
5.1.9. Cluster Diagnostic

By selecting this Menu option, internal cluster diagnostics can be accessed through the following options.

5.1.9.1. Gauge Test



5.1.9.2. Warning Lamps Test

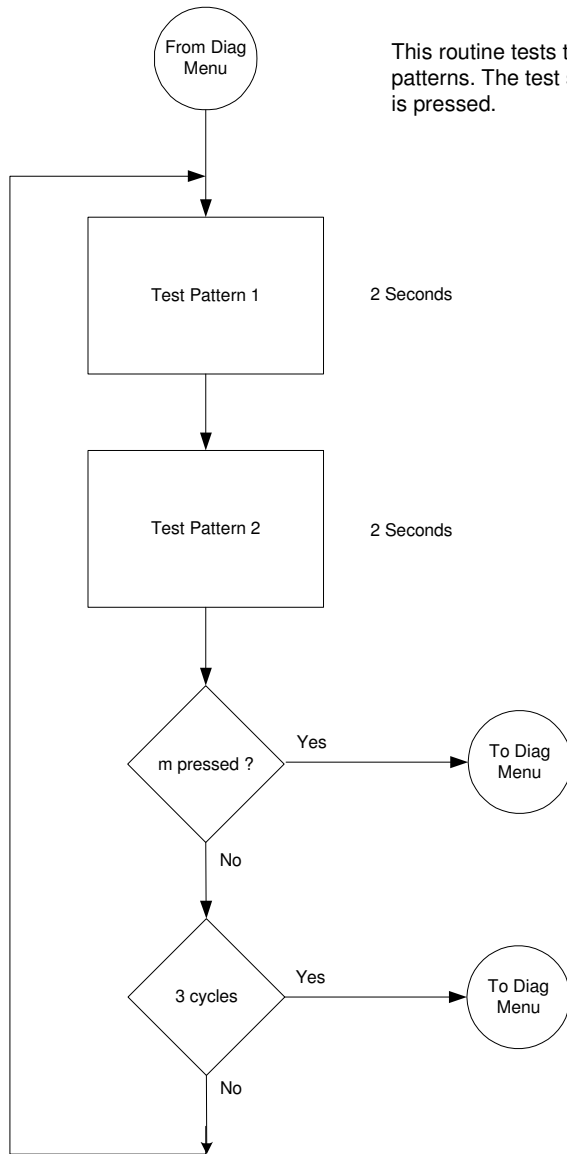


Diesel Warning Lamp List:

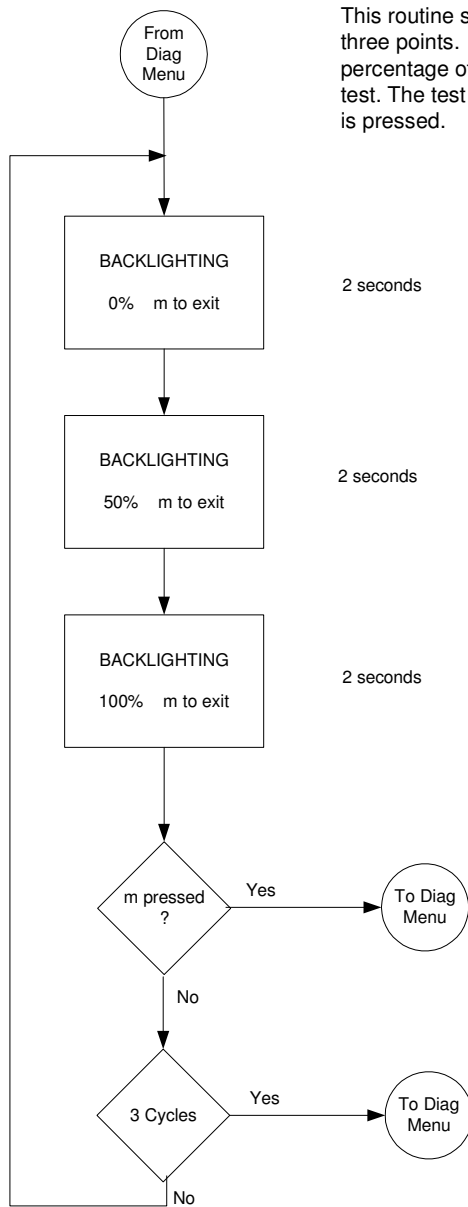
Stop Engine	>	Wait To Start	>	ABS	>
S.V.S.	>	Check Trans	>	Cruise ctrl	>
Brake	>	High Beam	>	Left Turn	>
Right Turn	>	Charge Indicator	>	Low Oil Pressure	>
Daylight lamp	>	Seat belt	>	Service Engine	>
Range Inhibit	>	High Idle	>	Overdrive Off	>
Air Suspension					

5.1.9.3.LCD Test

This routine tests the LC Display using test patterns. The test stops after 3 cycles or if m is pressed.

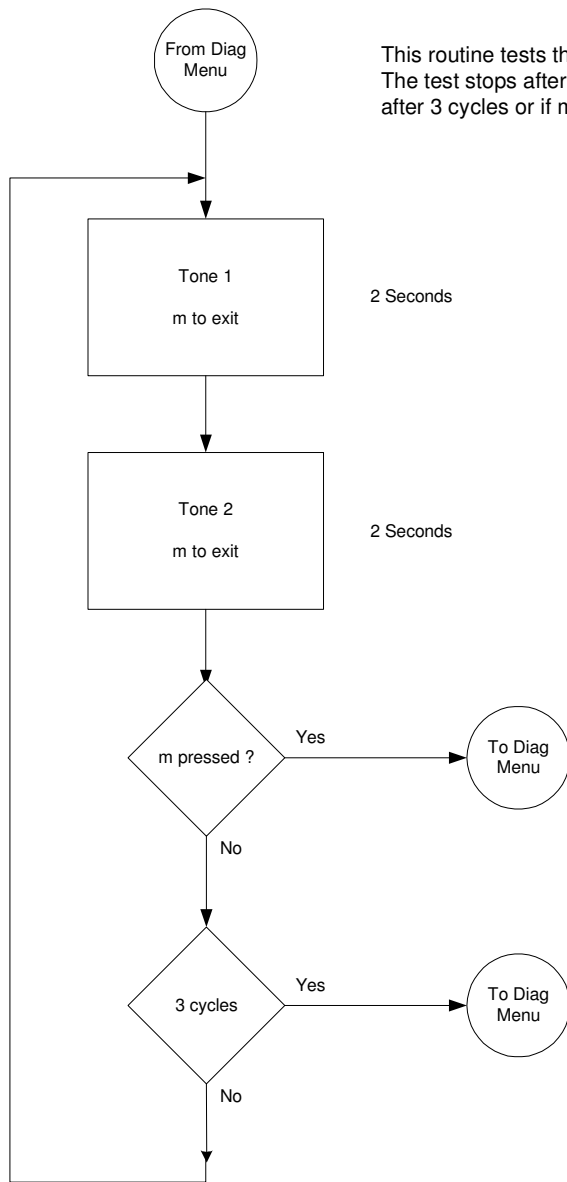


5.1.9.4. Backlighting Test



This routine set the backlighting through three points. The display indicates the percentage of the backlighting during the test. The test stops after 3 cycles or if m is pressed.

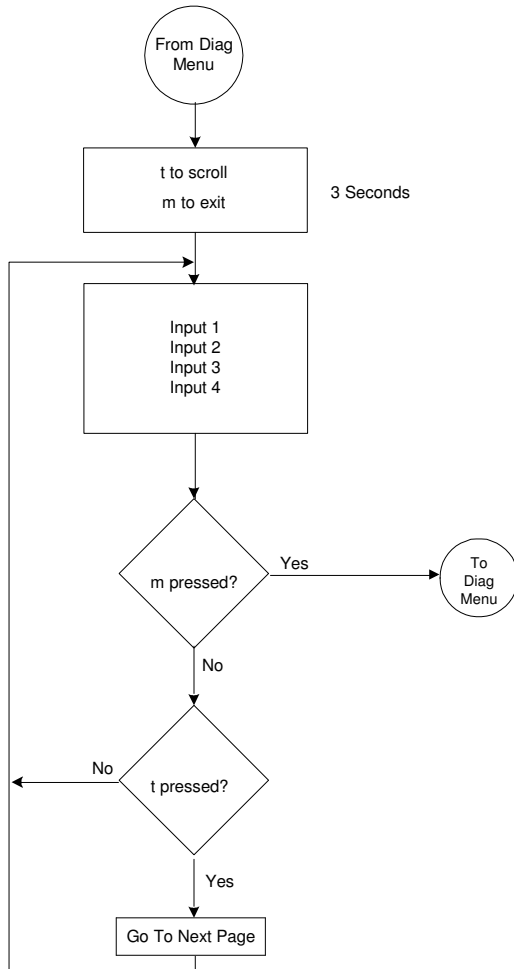
5.1.9.5. Speaker Test



This routine tests the speaker using 2 tones. The test stops after 3 cycles. The test stops after 3 cycles or if m is pressed.

5.1.9.6. Switch Inputs

This routine tells the operator the status of each switch input. The display indicates the switch input by descriptive name and the status level (ON/OFF) at the pin. Four inputs are shown per screen page. The level status reflects the active state of the input. For example, if an input is active to ground, and the input level is 0 volts, then the status will be ON.



Diesel Vehicle Inputs List:

Day Light	Buzzer Call	S.V.S	Air Pres.Warn
High Idle	Service	Wait To Start	Seat Belt
Park Brake	Head Light	Right Turn	Left Turn
High Beam	Key In Ign	Door Ajar	Overdrive Off
Charge Ind	Water in fuel		

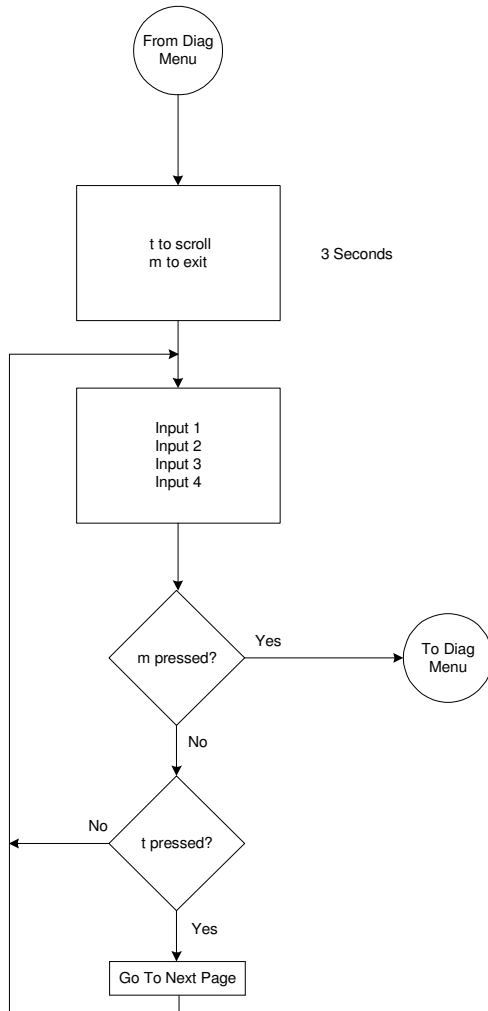
5.1.9.7. Analog Inputs

The analog inputs are displayed in function of the engine type.

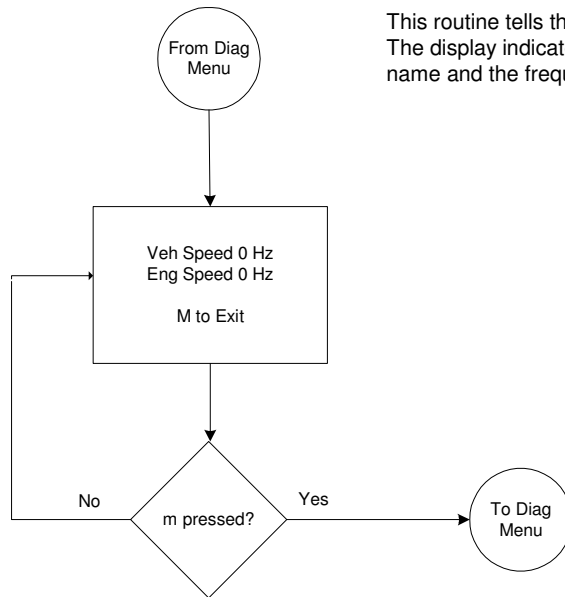
This routine tells the operator the status of each analog input. The display indicates the analog input by descriptive name and the voltage at the pin. Four inputs are shown per screen page.

Diesel Inputs list:

Fuel Level	Dimmer	Ignition	Brake Fail
External Temperature		ABS	



5.1.9.8. Frequency Inputs



This routine tells the operator the status of each frequency input. The display indicates the the frequency input by descriptive name and the frequency at the pin.

5.2. Data Link Diagnostics

Data link diagnostics is done through the cluster CAN channel.
It requires a PC and RS232-to-CAN interface hardware.
The capabilities are the following.

5.2.1. Diagnostic Session

Start diagnostic session
End diagnostic session

5.2.2. Reprogram Microprocessor

Flashing shall not change odometer value.

5.2.3. Current Value Monitor

Show in real time the state of the cluster inputs.

- A/D Inputs
- Logic Inputs
- Frequency Inputs

5.2.4. Set Parameters

Clear "maximum RPM"

Clear "maximum vehicle speed"

Set odometer (eliminates odometer statements). Actia and WCC will be able to write any value into the odometer. For everyone else, the odometer value can only be changed once to a higher value than the value currently saved in the cluster. A secure method will be used to set the odometer.

Calibrate gauges.

Cluster configuration.

5.2.5. Master Mode

Control the outputs of the cluster.

- LCD pixels
- Individual warning lights
- Gauge back lighting
- Individual gauges
- Speaker

6. DATALINK MESSAGES

6.1. J1939 MESSAGES

All Bytes in frames are identified from byte1 to byte8 and bits from Bit1(LSB) to Bit 8 (MSB).

6.1.1. WATER IN FUEL

The value is read from the DTC every second on CAN by the PGN 18 FECA-65226 coming from the engine (Address = 00). If the message received contains a Suspected Parameter Number (SPN) equal to 97 with a FMI (failure Mode Identifier) equal to 0 (Data valid but above normal operational range - Water has been detected in fuel system) (Cummins ISX02 and ISM02 Engines CM870 software P52/66 Appendix B)

6.1.2. LOW FUEL

The value is calculated upon the fuel sender measured and analog inputs. No impact on J1939.

6.1.3. LOW ENGINE OIL PRESSURE

The value is read from the DTC every second on CAN by the PGN 18 FECA-65226. If the message received contains a Suspected Parameter Number (SPN) equal to 100 with a FMI (failure Mode Identifier) equal to 18 (oil Pressure signal indicates oil pressure below the low oil level engine protection limit) (Cummins ISX02 and ISM02 Engines CM870 software P49/66 Appendix B)

6.1.4. CHECK ENGINE OIL LEVEL

The value is read from the DTC every second on CAN by the PGN 18 FECA-65226. If the message received contains a Suspected Parameter Number (SPN) equal to 1380 with a FMI (failure Mode Identifier) equal to 17 (Low oil level was detected in the make-up oil tank) (Cummins ISX02 and ISM02 Engines CM870 software P49/66 Appendix B)

6.1.5. NO J1939 ACTIVITY

When no J1939 messages are received during 2.5 seconds, the priority message is displayed.

6.1.6. CHECK TRANSMISSION

6.1.7. CHECK TRANSMISSION TEMPERATURE

The first byte received from an Allison Transmission, contains information about the transmission. If bit4&3 are equal to 01 then the warning lamp status is on, and this set the warning led Check Transmission.

Added to that, the data received (DTC) are decoded to check the type of failure.

The Diagnostic Trouble Code associated to the transmission temperature from the Allison Transmission may be read by decoding the DTCs received, PGN 0x18 FECA with the source Address = 0x03 (transmission #1) with the Suspected Parameter Number (SPN) equal to 2003 and a FMI equal to 31 indicating that the transmission temperature exceeds a critical value.

6.1.8. ENGINE COOLANT TEMPERATURE

The coolant temperature is broadcast every second on CAN by the PGN 0x18FEEE00 = 65262. Byte 1 contains the coolant temperature from 0 to 255 (-40 to 215 Centigrade degrees (-40 offset)).

6.1.9. CHECK ENGINE COOLANT TEMP

The Priority message is displayed when the ECU receives the DTC relevant to the engine coolant temperature alarm.

By reading the Diagnostic Trouble Code associated to the Engine coolant temperature by decoding the DTCs received, PGN 0x18 FECA with the Suspected Parameter Number (SPN) equal to 110 with a FMI (failure Mode Identifier) equal to 0 (Coolant temperature signal indicates coolant temperature above critical threshold) (Cummins ISX02 and ISM02 Engines CM870 software P49/66 Appendix B)

6.1.10. LOW COOLANT LEVEL

The value is read from the DTC broadcast every second or on change on CAN by the PGN 18 FECA-65226. If the message received contains a Suspected Parameter Number (SPN) equal to 111 with a FMI (failure Mode Identifier) equal to 18 (Coolant level low warning) (Cummins ISX02 and ISM02 Engines CM870 software P49/66 Appendix B), then the priority message is displayed.

6.1.11. MAINTENANCE**6.1.12. STOP ENGINE**

This information is contained in the first byte of the DM1 message. The value is read from the DTC broadcast every second or on change on CAN by the PGN 18FECA-65226 with Source Address = 0.

The first byte received contains two bits (bit2&1) reflecting the state or Engine Protect information or Maintenance.

So if the value of bit2&1 is 01 then the Maintenance Lamp is switched on, otherwise switched off.

The first byte contains two bits (6&5) reflecting the state or Stop Engine Lamp. So if the value of bit6&5 is 01 then the Stop Engine Lamp is switched on, otherwise switched off.

(Cummins ISX02 and ISM02 Engines CM870 software P24/66).

6.1.13. ENGINE SHUTDOWN

Two flags are available:

- Engine Protection System approaching Shutdown
- Engine Protection System has Shutdown engine.

Broadcast every second on CAN by the PGN 00FEE4-65252 SHUTDOWN. (Cummins ISX02 and ISM02 Engines CM870 software P27/66 Appendix B).

The byte5 contains bit4&3 indicating if equal to 01 that Engine protection Approaching Shutdown and bit2&1 indicating if equal to 01 that Engine protection has Shutdown the engine.

The two flags are used for displaying the ENGINE SHUTDOWN.

6.1.14. WAIT TO START

(Same as above) Broadcast every second on CAN by the PGN 00FEE4-65252 SHUTDOWN. (Cummins ISX02 and ISM02 Engines CM870 software P27/66 Appendix B).

The byte4 contains bit2&1 indicating the state of the wait to start lamp. The value is 01 if the wait to start lamp is active with ignition ON and engine not running

6.1.15. VEHICLE SPEED

6.1.16. CRUISE CONTROL ACTIVE

6.1.17. CRUISE CONTROL SWITCH STATE

6.1.18. HIGH IDLE

6.1.19. ODOMETER

The vehicle Speed is read by the PGN 0x18FEF100 – 65265 CRUISE CONTROL/VEHICLE SPEED broadcast every 0.1 seconds. (J1939-71d-v981001 5.2.2.18 P172)

The byte2&3(Msb) contains the Wheel Based Vehicle speed (1/256 kph per bit) from 0 to 250.996 kph. (J1939-71d-v981001 5.2.1.11)

If the value received exceeds $250.996 * 256 = 0xFAFF$ then the speed value is considered corrupted.

The Byte 4 has two bits (bit4&3) defining the state of the CRUISE CONTROL SWITCH STATE (00 = OFF, 01=ON 10=ERR 11 = NOT AVAILABLE) (J1939-71d-v981001)

The Byte 7 has his three high bits (bit8-6) defining the state of the CRUISE CONTROL ACTIVE (000 = OFF, 111 = NOT AVAILABLE) (J1939-71d-v981001 5.2.2.18 P41)

If the cruise control state is not equal to 000 and not equal to 111 then it is considered ON.

The Byte 7 has his five low bits (bit5-1) defining the state of the PTO device. (J1939-71d-v981001 5.2.2.19 P41)

If the value of these bits is 0 then the High Idle warning light is Off.

If the value of these bits is between 1 and 17 then the High Idle warning light is On.

The Odometer is incremented by using the vehicle speed. The vehicle speed must be converted in miles per hour for the compliance with the Gasoline vehicle.

6.1.20. ENGINE SPEED

The vehicle Speed is read by the PGN 0x0CF00400– 61444 ELECTRONIC ENGINE CONTROLLER #1 EEC1 broadcast upon the engine speed (At a maximum rate of 0.02 seconds). (J1939-71d-v981001 5.3.7)

The byte 4&5(Msb) contains the Engine Speed (0.125 rpm per bit) from 0 to 8031.875rpm.

If the value received exceeds $8031.875/0.125 = 0xFAFF$ (normally MSB byte = 0xFE) then the engine speed value is considered corrupted.

The value may be converted in rpm by divided it by 8.

6.1.21. SHIFT (RANGE) INHIBIT

The shift inhibit is sent by the ETC7 Electronic Transmission Controller#7 from an Allison transmission.

It is read by the PGN 0x0CFE4A03– 65098 (Source Address = 0x03 (transmission#1) ELECTRONIC TRANSMISSION CONTROLLER #7 ETC7 broadcast every 0.1 second. (Allison Transmission Data Link Communication June2001 Page B-53)

Byte 2 contains the Shift inhibit indicator bit 8&7. If the value is 0x00 then the Shift Inhibit Indicator is inactive, if the value is 01 then the Shift Inhibit Indicator is active

6.1.22. CHECK BATTERY

For a diesel vehicle the battery voltage is read from the J1939 message.

6.1.23. BATTERY VOLTAGE

The Battery voltage is read by the PGN 0x018FEF7– 62271 VEHICLE ELECTRICAL POWER broadcast every second (J1939-71d-v981001 4.3.37)

The byte 5&6 contains the Electrical potential voltage (0.05V per bit) from 0 to 3215.75Volts.

If the value received exceeds $3215.75/0.05 = 0xFAFF$ (normally MSB byte = 0xFE) then the Battery voltage is considered corrupted.

The value may be converted in 1/10 volts by divided it by 2.

6.1.24. ABS STATE**6.1.25. ABS WARNING**

The ABS and EBS status is read by the PGN 61441 (0C F001 0B) transmitted from the ABS ECU (SA=0x0B) Electronic Brake Controller #1 broadcast every 0.1 second (J1939-71d-v981001 5.3.4)

The byte 6 contains two bits bit6&5 reflecting the state of the ABS/EBS amber warning state. When this value is equal to 01 the warning led is switched on otherwise switched off

6.1.26. HYDRAULIC BRAKE FAILURE OR WARNING**6.1.27. LOW HYDRAULIC FLUID LEVEL****6.1.28. BUZZER CALL**

The Hydraulic Brake Failure is read by the PGN 64998 (0C FDE6 0B) HBS Hydraulic Brake System broadcast every 0.1 second from the ABS (Wabco J193910V10.PDF)

Byte 3 contains bits by pairs:

- Bit8&7 Indicates if the Hydraulic Brake Pressure in circuit#2 is reliable for supporting continuous braking
- Bit6&5 Indicates if the Hydraulic Brake Pressure in circuit#1 is reliable for supporting continuous braking
- Bit4&3 Indicates if the Hydraulic Brake Pressure in circuit#2 is below warning level
- Bit2&1 Indicates if the Hydraulic Brake Pressure in circuit#1 is below warning level

If one of these bits is set to 01 then the Brake Failure warning is activated

Byte 4 contains:

- Bits bit4&3 reflecting the state of the Fluid Level (00: Not Sufficient, 01=Correct). When this value is equal to 00 the warning led is switched on otherwise switched off
- Bits bit2&1 reflecting the state of a Warning Buzzer (00: Audible Warning Off, 01= Audible Warning on). When this value is equal to 01 the Buzzer call must also be requested.

6.1.29. TRANSMISSION GEAR SELECTED**6.1.30. TRANSMISSION GEAR ENGAGED**

The gear selected and the current gear are read by the PGN 61445 (0C F005 03) Electronic Transmission Controller ETC #2 broadcast every 0.1 second (J1939-71d-v981001 5.3.8) with source address = 0x03 indicating the Allison Transmission origin.

The byte 5 and 6 contains the selected gear and the byte 6 and 7 the current gear.

The first byte may be the ASCII character 'N' 'P' 'D' 'R' and the second character specifies the gear from space character for Neutral or Park, or "1" to "9" for Drive or Reverse, for example 'D'2' means Drive gear number 2.

Allison Transmission send on the byte 5 for Gear Engaged or current gear, and in the byte 7 for the selected gear a value in an ASCII character between: P R N D L 1 2 3

6.1.31. ENGINE OIL PRESSURE

The engine oil pressure is read by the PGN 65263 (18 FEEF 00) ENGINE FLUID LEVEL PRESSURE broadcast every 0.5 second (J1939-71d-v981001 5.3.29)

Byte4 contains the engine oil pressure on one byte from 0 to 1000Kpa (0 to 145Psi) 4Kpa per bit.

6.1.32. INSTANTANEOUS FUEL CONSUMPTION

6.1.33. AVERAGE FUEL CONSUMPTION

The Fuel rate, instantaneous fuel economy and average fuel economy are read by the PGN 65266 (18 FEF2 00) FUEL ECONOMY broadcast every 0.1 second (J1939-71d-v981001 5.3.32)

Bytes 3&4 (MSB) contains the INSTANTANEOUS FUEL ECONOMY, the current fuel economy at current vehicle velocity in kilometer per liter. This value may be used when the vehicle is running. 1/(512 km/L) per bit. When the value exceeds FAFF then it's not available.

Bytes 5&6 (MSB) contains the AVERAGE FUEL ECONOMY, in kilometer per liter. This value may be used when the vehicle is running. 1/(512 km/L) per bit. When the value exceeds FAFF then it's not available.

6.1.34. INTAKE AIR TEMPERATURE

6.1.35. MANIFOLD BOOST PRESSURE

The intake air temperature and Boost Pressure are read by the PGN 65270 (18 FEF6 00) INLET/EXHAUST CONDITIONS broadcast every 0.5 second (J1939-71d-v981001 5.3.36)

Byte3 contains the intake manifold temperature in degree centigrade. This value is from -40 to 210 degrees with 1 degree per bit.

Byte2 contains the Boost Pressure from 0 to 500Kpa (0 to 72.5 Psi) with 2 Kpa per bit. If the value exceeds 0xFA, the boost pressure is not available.

6.1.36. ENGINE HOURS

The engine hours are read by the PGN 65270 (18 FEE5 00) ENGINE HOURS/REVOLUTIONS broadcast on request (J1939-71d-v981001 5.3.19)

Bytes from byte1 to byte4(MSB) define the engines hours with 0.05 Hours per bit, from 0 to 210554060.75 Hours.

If the value received exceeds 0xFAFFFFFF then the value is not available.

The value recorded in EEPROM for the gasoline vehicle is expressed in 0.08second period's time, so it will be multiply by 2250 to stay compliant with the gasoline vehicle.

7. APPENDIX A: E2PROM MAPPING

Block #	Parameter #	ucIdxFirstData	ucDataLength	*pucParameter	Writing Allowed	Comments
0	0	0	1	&stApp_eConfig1_E2p.byte	1	
0	1	1	1	&ucApp_eTripOdo_E2p	1	
0	2	2	1	&ucApp_eParameter_E2p	1	
0	3	3	1	&stApp_eConfig_Param.byte	1	
0	4	4	1	&ucApp_eKDimmer_E2p	1	
0	5	5	1	&ucApp_eVLCDConPWM_E2p	1	
0	6	6	1	&ucApp_eTankType_E2p	1	
0	7	7	2	(unsigned char *) (&uiApp_eMaximumSpeedValue_E2p)	0	
0	8	9	2	(unsigned char *) (&uiApp_eMaximumRpmValue_E2p)	0	
0	9	11	4	(unsigned char *) (&ulApp_eEngineHours_E2p)	0	
0	10	15	4	(unsigned char *) (&ulApp_eTrip1_E2p)	1	
0	11	19	4	(unsigned char *) (&ulApp_eTrip2_E2p)	1	
0	12	23	2	(unsigned char *) (&uiApp_eAvgFuelCons_E2p)	1	
0	13	25	4	(unsigned char *) (&ulApp_eTimeTravel_E2p)	1	
0	14	29	1	(unsigned char *) (&ucApp_eAvgFuelConsReminder_E2p)	1	
1	0	0	8	(unsigned char *) (&ucApp_eClusterSerialNumber_E2p[0])	1	Serial Number
1	1	8	1	(unsigned char *) (&stXSM_eDataGauge[0].ucXSM_eZeroCalOffset_Param)	1	
1	2	9	1	(unsigned char *) (&stXSM_eDataGauge[1].ucXSM_eZeroCalOffset_Param)	1	
1	3	10	1	(unsigned char *) (&stXSM_eDataGauge[2].ucXSM_eZeroCalOffset_Param)	1	
1	4	11	1	(unsigned char *) (&stXSM_eDataGauge[3].ucXSM_eZeroCalOffset_Param)	1	
1	5	12	8	(unsigned char *) (&ucApp_eManufacturingData_E2p [0])	1	Manufacturing Date
1	6	20	4	(unsigned char *) (&ulApp_eDistanceTravel_E2p)	1	
1	7	24	6	(unsigned char *) (&ucApp_eClusterPartNumber_E2p[0])	1	Actia Part Number
2	0	0	7	Not Used	1	
2	1	7	2	(unsigned char *) (&uiApp_iDistanceDone_E2p)	1	
2	2	9	2	(unsigned char *) (&uiApp_iFuelTankSize_E2p)	1	
2	3	11	12	(unsigned char *) (&ucApp_eCustomerPartNumber_E2p[0])	1	Customer Part Number
3	0	0	16	(unsigned char *) (&ucApp_eClusterWorkOrder_E2p[0])	1	Work Order Number

8. APPENDIX B: FLOWCHART FOR RANGE INHIBIT AND CHECK TRANS WARNING LIGHTS

The flowcharts in this document contains Allison Transmission’s RANGE INHIBIT and CHECK TRANS telltales display requirements when J1939 Data link is used as the source of information for these telltales, as described in document, Allison Transmission Data link Communications – April, 2003, The flowcharts show the requirements as interpreted and to be implemented by Workhorse Custom Chassis. The purpose of the document is to clarify the requirements, not to define specific software coding.

The first flowchart shows the process of determining if the J1939 Data link in healthy. This routine will display the message, “No J1939 Data”, when it has determined that the J1939 communication link has failed. This failure status will remain active until the ignition is cycled or a valid heartbeat message is received. This process should run once every 100ms as the time base for the heartbeat message, ETC2 is 100ms.

The second flowchart shows the control of the RANGE INHIBIT telltale. Note that this process will not display a J1939 data error message when an error is detected in the data of the message. This process will run periodically once the above initialization is complete. A time base of 100ms is suggested, as the ETC7 PGN is sent every 100ms.

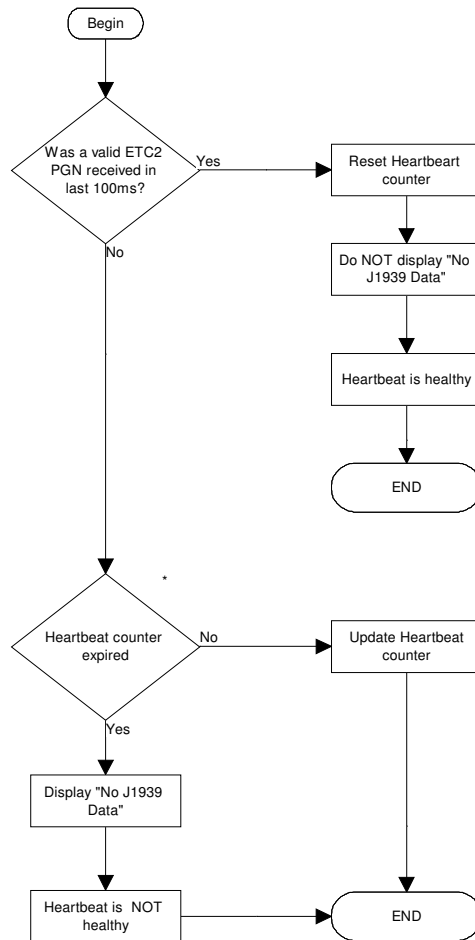
The third flowchart shows the control of the CHECK TRANS telltale. Note that this process will not display a J1939 data error message when an error is detected in the data of the message. This process will run periodically once the above initialization is complete. A time base of 1s may be used, as the DM1 PGN is sent every 1s as long as there is an active Diagnostic Trouble Code (DTC) that requires the CHECK TRANS telltale to be illuminated. Note that the IP Cluster software must evaluate the Amber Lamp data as well as the SPN in the DM1 PGN. Also note that the SPN is sent least significant byte first. WCC will not illuminate the CHECK TRANS for a high sump temperature condition, since the IP Cluster will display a “Check Trans Temp” message, based on the transmission fluid temperature received from the J1850 data bus. See below for an example of the CHECK TRANS active DM1 PGN.

DM1 MESSAGE CONTENT DURING AN ACTIVE 'CHECK TRANS' INDICATION								
Byte	1	2	3	4	5	6	7	8
Hex value	\$F7	\$FF	\$D3	\$07	\$1F	\$7F	\$FF	\$FF
Parameter	Value							Meaning
Malfunction Indicator Lamp Status	11 ₂							Not available
Red Stop Lamp Status	11 ₂							Not available
Amber Warning Lamp Status	01 ₂							On
Protect Lamp Status	11 ₂							Not available
SPN	2003							General transmission fault
FMI	31							Unknown
SPN conversion method	0							SAE version 4
Occurrence count	1111111 ₂							Unknown

Figure 22 – DM1 Content During an Active 'Check Trans' Indication

Heartbeat Health Check

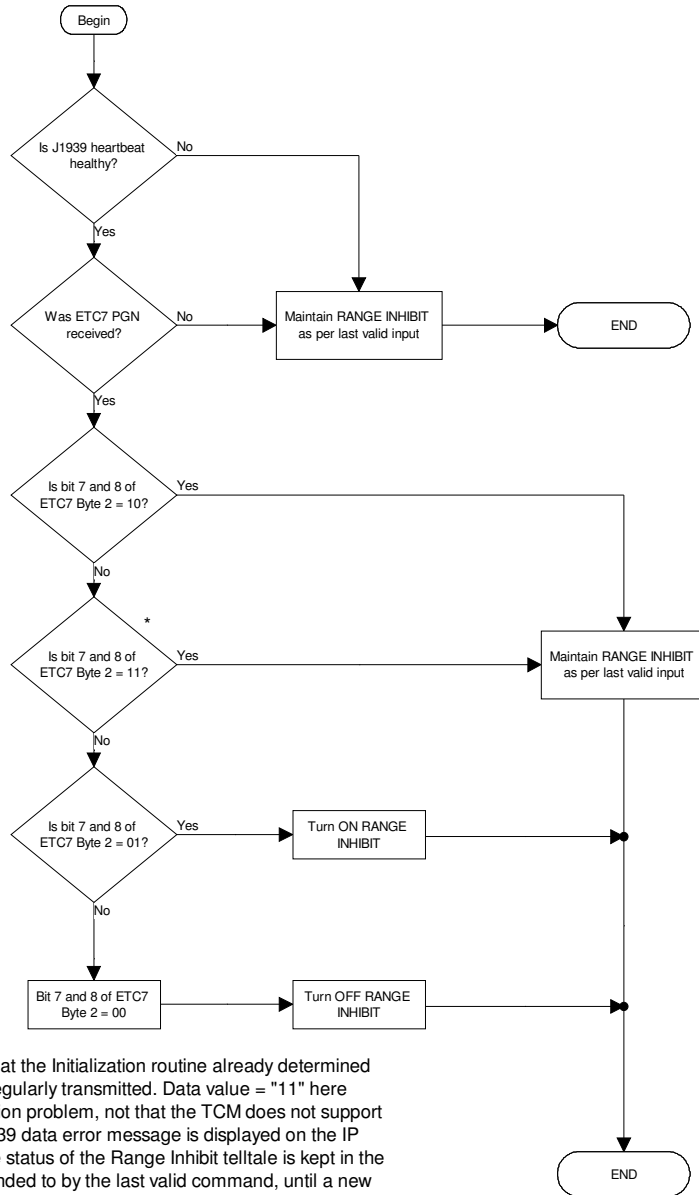
Note: The Heartbeat check algorithm runs on a 100ms timebase



* The Heartbeat counter expires when IP Cluster fails to receive the designated heartbeat message (ETC2) for a period greater than or equal to 10x the heartbeat message's SAE-defined broadcast rate (100ms). Once the counter has expired the IP Cluster will set the flag to display that the J1939 communication link is not healthy until a valid heartbeat (ETC2) message is received or the vehicle key switch is cycled.

RANGE INHIBIT Telltale Control

Note: Run time test for RANGE INHIBIT on J1939

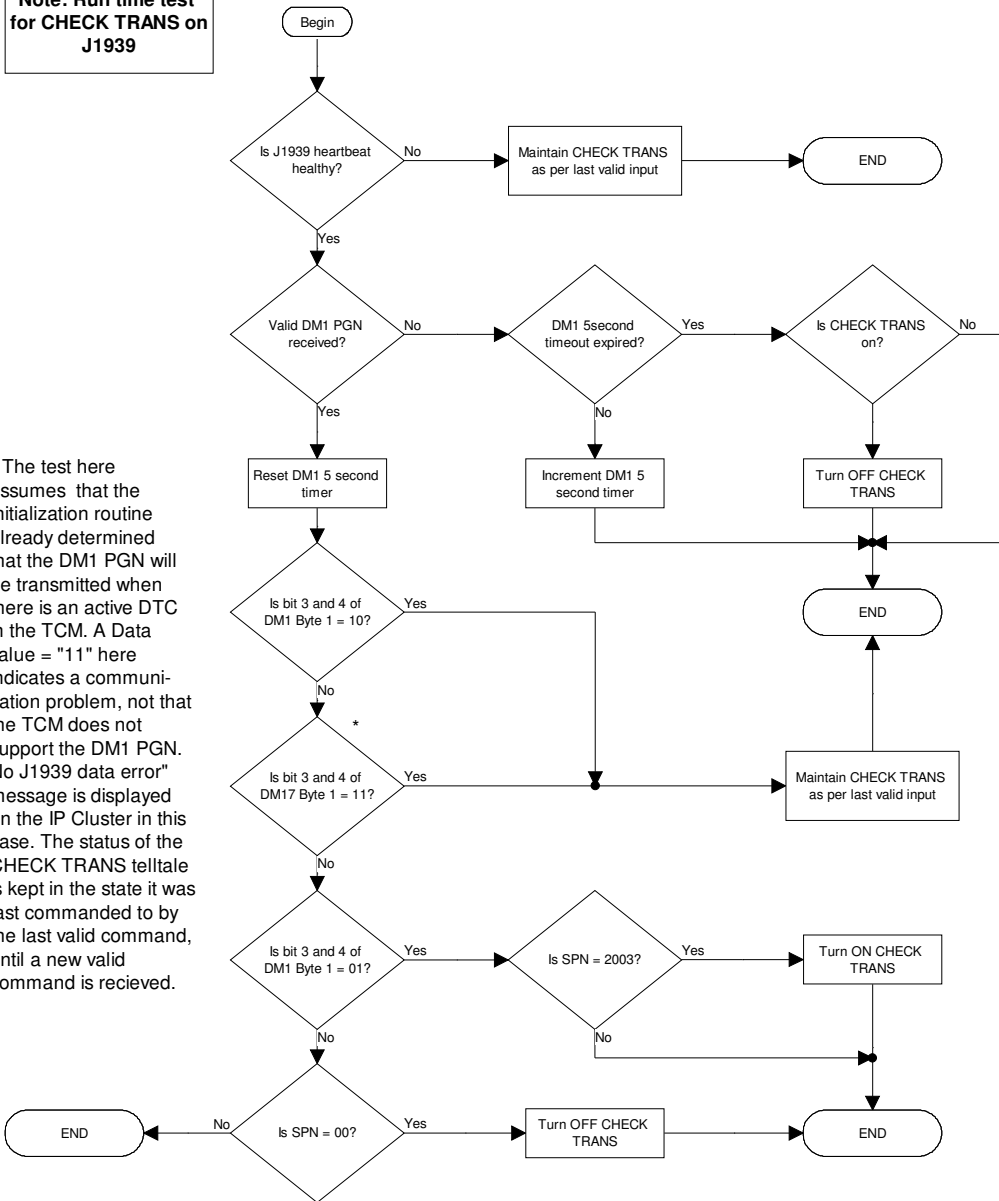


* The test here assume that the Initialization routine already determined that the ETC7 PGN is regularly transmitted. Data value = "11" here indicates a communication problem, not that the TCM does not support the ETC7 PGN. No J1939 data error message is displayed on the IP Cluster in this case. The status of the Range Inhibit telltale is kept in the state it was last commanded to by the last valid command, until a new valid command is recieved.

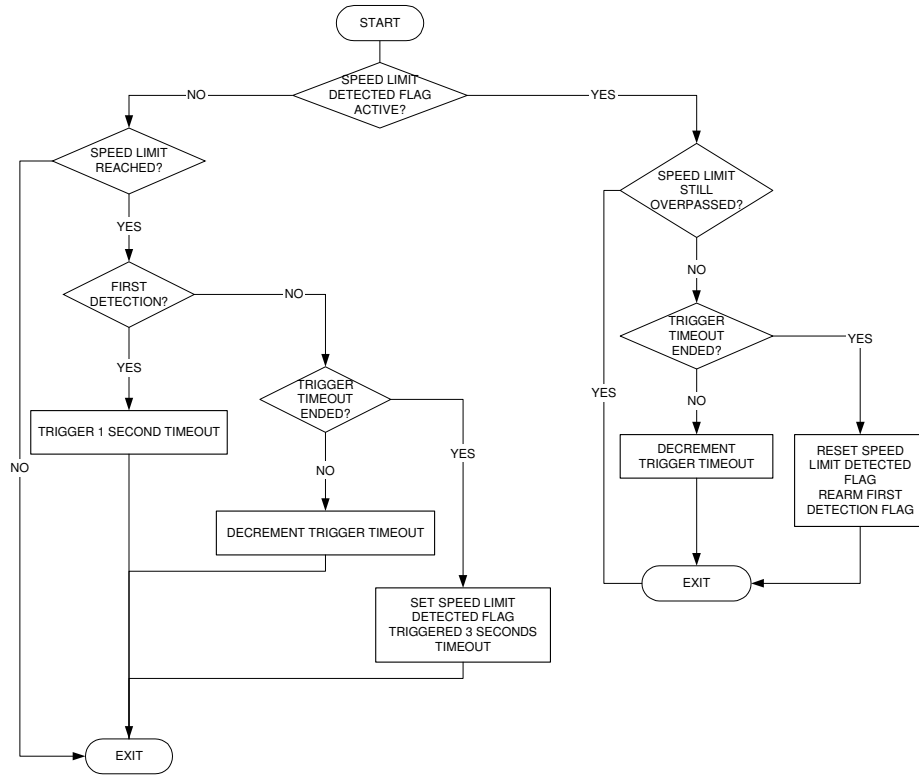
CHECK TRANS Telltale Control

Note: Run time test for CHECK TRANS on J1939

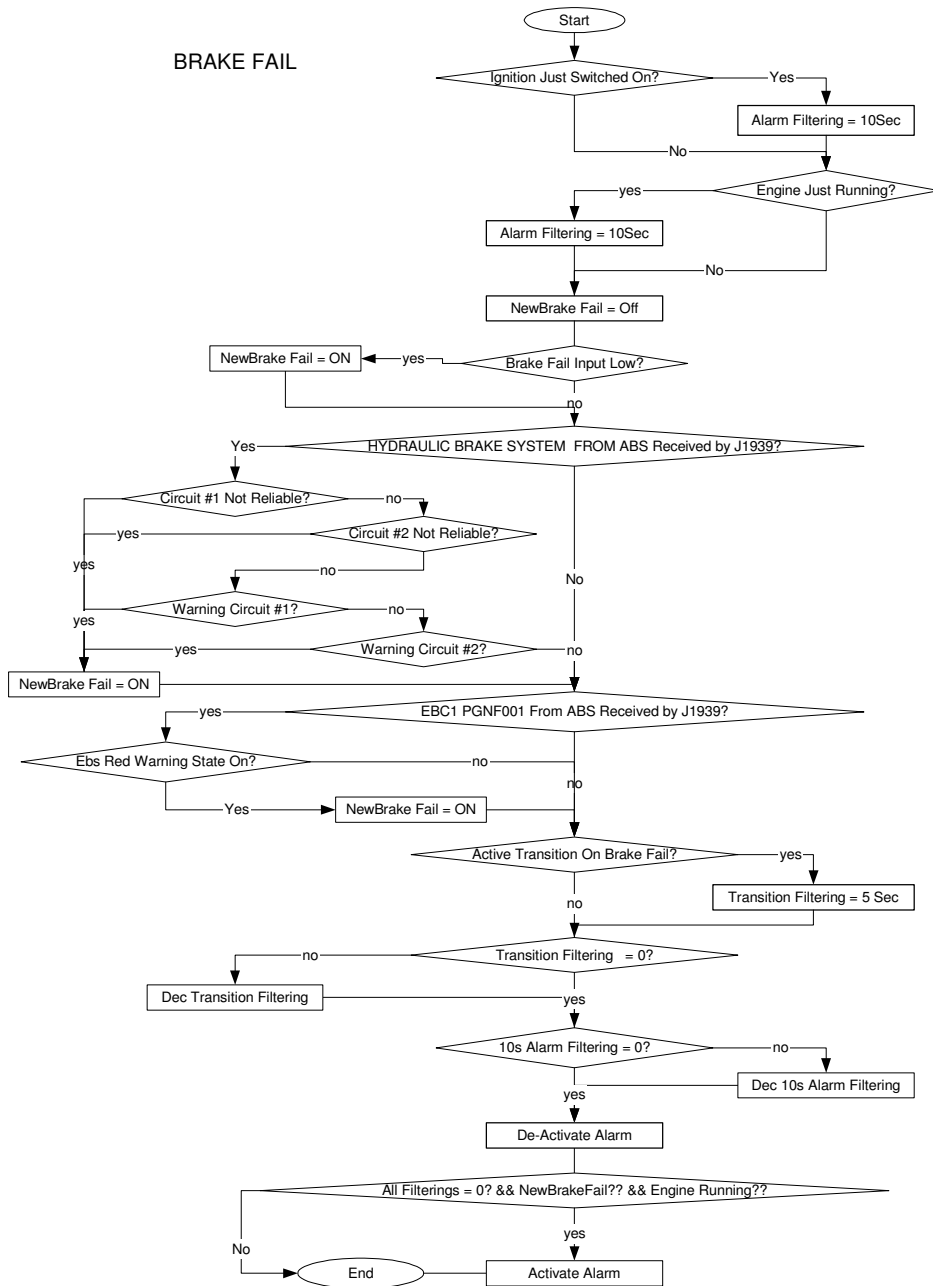
* The test here assumes that the Initialization routine already determined that the DM1 PGN will be transmitted when there is an active DTC in the TCM. A Data value = "11" here indicates a communication problem, not that the TCM does not support the DM1 PGN. No J1939 data error* message is displayed on the IP Cluster in this case. The status of the CHECK TRANS telltale is kept in the state it was last commanded to by the last valid command, until a new valid command is recieved.



9. APPENDIX C: VEHICLE SPEED CONTROL



10. APPENDIX D: BRAKE FAIL SELECTION



11. APPENDIX E: BATTERY VOLTAGE SELECTION