Generic Boat
Model Year 2000

Electrical &
Functional Specification

Approvals:

John Gaydos_____Date:_____

Don Hopkins_____Date:_____

Wilt Rogers_____Date:_____

Tom Ruckman_____Date:_____

Jay Burke _____Date:_____

Mike Gharagozloo_____Date:_____

1 Table of contents

2 Scope

This specification defines the electrical and functional characteristics for the VDO North America Marine Instrument Cluster 2000.

3 History

Revision	Revision Date	Description
1.0	April 1, 1999	MY2000, for project team & customer review.
1.1	April 22, 1999	revisions from team input & comments, add digital inputs sec.
1.2	May 3, 1999	Fix misc. typos; Refine Flowcharts; 10 bit Seawater a/d; Add button timing in section 4.3.1
1.3	June 9, 1999	Fix misc. typos and wordings; added Seawater Scale / Accuracy table (section 5.16.2)
1.4	August 31, 1999	Revised voltage out of range behavior, trim input, and misc. other analog electrical specs. New Four Winns speed sensor pulse/mile spec. Added front panel programming section. 1st release to Document Control.

4 Overview

The Instrument Cluster is used to communicate information on the operation and performance of the craft to the operator. At the same time it is designed to issue warnings if abnormal conditions occur.

4.1 Cluster Versions

There are multiple cluster versions. The biggest difference is between the versions for inboard engine craft (I/O) and outboard engine craft (O/B). The features of each cluster version are dependent on the particular application and customer.

4.2 Cluster Functions

4.2.1 Electrical Characteristics

	Condition	min.	typ.	max.
Operation Current (amps) * depth display ON (1 tell tale ON)	Ignition	0.1	0.2	1.0
Ignition Off, up to 21 days (milliamps)	Battery	3	5	18
After 21 days (milliamps)	Battery		0.035	0.100
Operating Voltage (v)		10	13.8	16
Operating Temperature (°C)		-10		+70

4.2.2 I/O Cluster functions:

- Speedometer - 270° crosscoil movement

  options: 80 mph maximum dial face with non-linear scale
  60 mph maximum dial face with linear scale
  50 mph maximum dial face with linear scale

- Tachometer (6000 rpm) - 270° crosscoil movement
- Fuel Level - 90° crosscoil movement, Low Fuel Telltale
- Oil Pressure - 90° crosscoil movement, Low Pressure Telltale
- Coolant Temperature - 90° crosscoil movement, High Temp. Telltate
- Voltage Level - 90° crosscoil movement, Voltage Warning Telltale
- Trim - 90° crosscoil movement
- Audible alarm - Continuous tone unit, minimum of $100dB_{sp}$, engine signal warnings & system fault conditions.

- Depth Sounder - single row 4 digit, 7 segment, LC display and Telltales for FEET or METERS, shallow water alarm
- Mode and Adj button inputs - Select modes and update display
- Clock - HH:MM, 7 segment, LCD
- Odometer & Trip Odometer - 0.0 to 9999 mi or km, 7 segment, LCD
- Engine Hours & Trip Hours - 0:00 to 9999 hrs., 7 segment, LCD
- Seawater Temperature - 30.0 to 104.0°F or –1.0 to 40.0°C, 7 segment LCD

4.2.3 O/B Cluster functions:

- Speedometer - 270° crosscoil movement

  options: 80 mph maximum dial face with non-linear scale

  60 mph maximum dial face with linear scale

  50 mph maximum dial face with linear scale
- Tachometer (7000 rpm) - 270° crosscoil movement with non-linear scale
- Engine System Monitior - RED warning tell tales and audible alarm for:

  low oil tank level

  high engine temperature

  no oil pressure

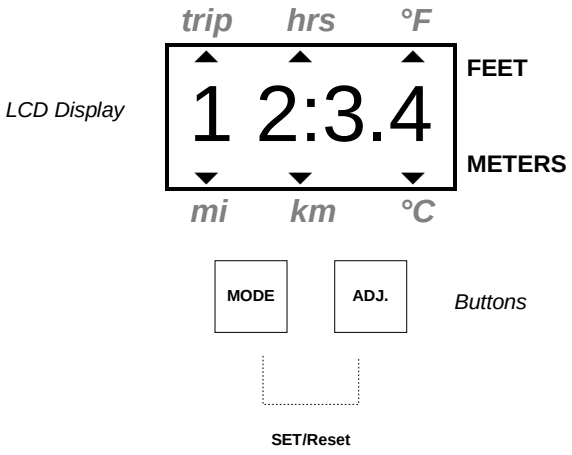
  check engine
- Fuel Level - 90° crosscoil movement, Low Fuel Telltale
- Voltage Level - 90° crosscoil movement, Voltage Warning Telltale
- Trim (Optional) - 90° crosscoil movement
- Audible alarm - Continuous tone unit, minimum of $100dB_{sp}$, engine signal warnings & system fault conditions.
- Depth Sounder - single row 4 digit, 7 segment, LC display and Telltales for FEET or METERS, shallow water alarm
- Mode and Adj button inputs - Select modes and update display
- Clock - HH:MM, 7 segment, LCD
- Odometer & Trip Odometer - 0.0 to 9999 mi or km, 7 segment, LCD
- Engine Hours & Trip Hours - 0:00 to 9999 hrs., 7 segment, LCD

- Seawater Temperature - 30.0°F to 104.0°F or –1.0°C to 40.0°C, 7 segment LCD

4.3 Operator Interface

A four character, seven segment LCD and two dashboard mounted buttons make up the operator interface. The LCD also has a colon for clock display and a decimal point to show finer resolution values.

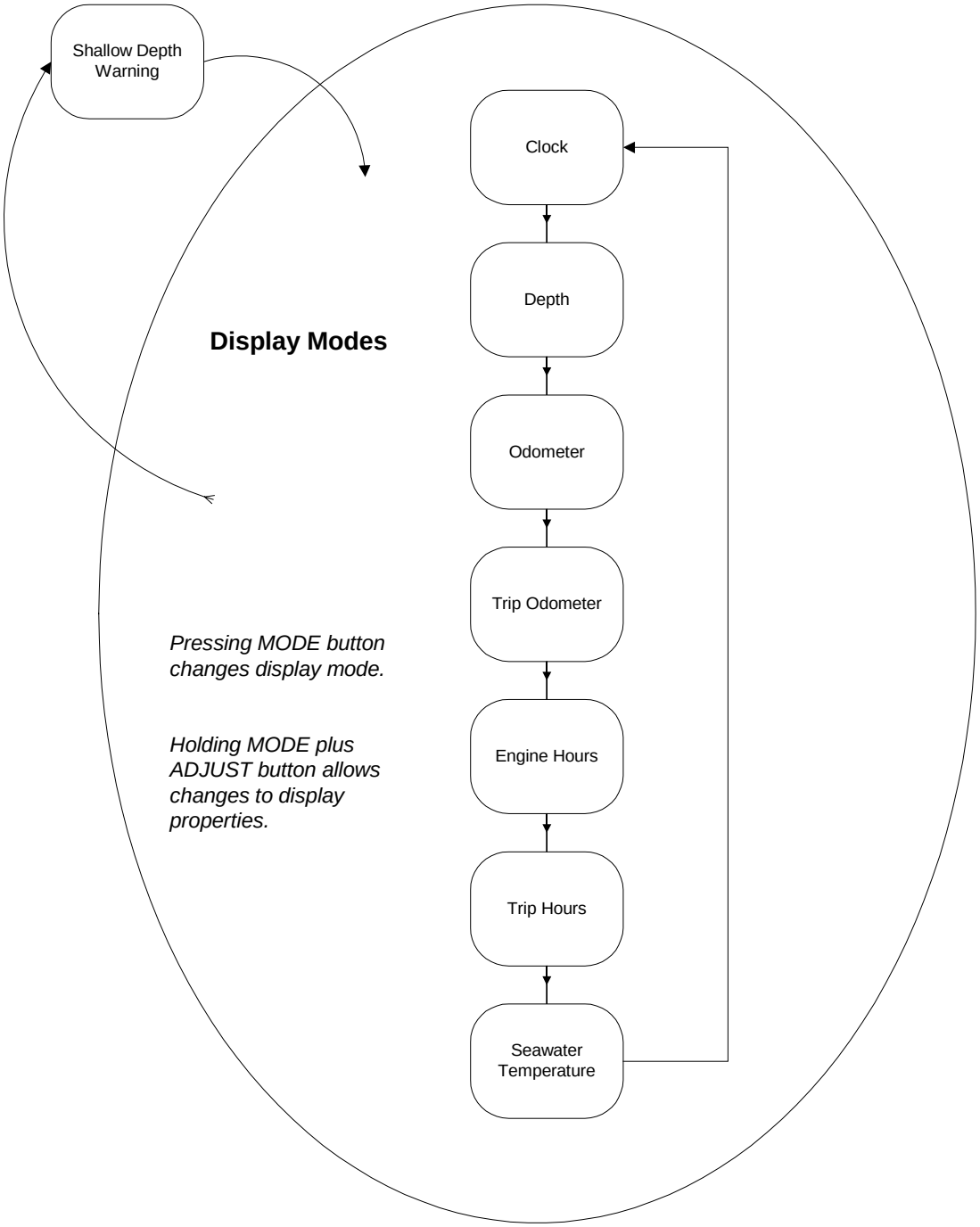
Various information types can be displayed on the LCD. The operator advances through the available displays by pressing the MODE button. Dial legends surrounding the LCD are highlighted by pointer symbols above and below the numeric segments. Depth sounder mode is indicated by lighting the FEET or METERS telltale to the right of the LCD.



4.3.1 Mode and Adj. Button Timing

- Single Press Debounce Time: 0.150 Seconds to recognize button press
- Hold Time, MODE plus ADJ: 1.5 Seconds before Set/Reset performed
- Hold Time before Repeating: 2.0 Seconds
- Top Level MODE Repeat Rate: 1.0 Second, Mode to Mode
- Field Update Repeat Rate: 0.175 Seconds between characters (~5.7 chars/sec)

4.4 Interface Display Modes



4.5 Alert conditions, general

4.5.1 Warning Conditions.

All clusters have defined conditions for the ignition voltage and fuel level gauges that result in a warning alert to the operator. If the conditions are met, the operator is alerted with an audible alarm and a warning tell tale (no audible alarm for low fuel warning).

All warning indications are signaled to the operator by: The alarm buzzer will sound continuously for 10 seconds, and the tell tale will be ON for at least 30 seconds. The tell tale will remain ON until the warning condition has been corrected. The specific conditions for each indicator's warning are described in their respective sections of this document.

4.5.1.1 I/O

Inboard clusters have additional warning indications for the oil pressure and coolant temperature indicators.

4.5.1.2 O/B

Outboard clusters have additional warning indicators as components of the outboard system monitor functions as defined in section 5.8..

4.5.2 System Fault Conditions.

Sensor faults and out of range conditions can be detected on **all clusters** for the ignition voltage and fuel level indicators. If the conditions are met, the operator is alerted with an audible alarm and warning tell tale. Voltage faults result in the cluster turning itself off, see section 5.6.3 for details.

All system fault indications (except voltage) are signaled to the operator by: The alarm buzzer will sound ON & OFF once per second for 10 total seconds. The corresponding telltale blinks ON & OFF at least 10 seconds then stops when the system fault condition is corrected. As further indication of a system fault, each indicator's pointer will move to a predefined position for that particular function. The specific conditions for each indicator's fault detection are described in their respective sections of this document

4.5.2.1 I/O

Inboard clusters have additional system fault detection for the Oil Pressure and Coolant Temp. indicators.

4.5.2.2 O/B

Additional system fault detection for outboard clusters is replaced by the engine system monitor power on self-test.

4.5.3 Audible alarm priorities.

The audible alarm signals three different alert conditions: engine related warnings, sensor & system faults, and shallow depth alarms. In the instance of simultaneaus occurrence, the alarms will be prioritized as:

1. shallow depth alarm (when set & active)
2. engine operating signal warnings
3. system and sensor faults

5 Functional Specifications

5.1 Speedometer Gauge Indication

5.1.1 General Function

Boat speed is measured by a pulse generating paddle wheel. Speed indicates statute mph or km/h depending on the dial scale. Speed is measured and calculated based on the pulse input from the speed sensor and indicated by a crosscoil movement driven pointer on a 270° scale. Appropriate software filtering ensures a smooth movement of the pointer.

The paddle wheel switches between ground and the supply voltage at a nominal rate of 3 Hz per Statute Mile/Hr(10800 Pulses Per Mile (PPM)). The pulse width to speed conversion is non-linear. Software allows correction of up to ±50% using a 5 point linear interpolation. The paddle-wheel ***must be*** a 2 magnet (1 North and 1 South pole) paddle-wheel.

NOTE: Four Winns specifically uses a 5.9722 Hz per Statute Mile/Hr (21500 PPM) paddle wheel. This system is limited to the 60 mph speedometer scale.

5.1.2 Scale / Accuracy / Calibration

min. indicated speed	0 MPH
max. indicated speed	80 MPH
Speedometer accuracy	±1.5 mph up to 40 mph, ±3 mph over 40 mph

Paddlewheel Sensor Characteristic

Speed (mph)	Uncompensated input frequency (Hz)		Pointer deflection angle * (calibration points in EEPROM)			Dial graduation (mph)
	@ 3Hz per mph (10800 PPM)	@ 5.9722Hz per mph (Four Winns) (21500 PPM)	scale (mph)			
			50 (Linear)	60 (Linear)	80 (Non-Linear)	
0	0	0	0° *	0° *	0° *	0
10	30	59.7	54°	45°	45°	10
20	60	119.4	108° *	90° *	90° *	20
30	90	179.2	162° *	135°	135°	30
40	120	238.9	216° *	180° *	180° *	40
50	150	298.6	270 *	225° *		50
60	180	358.3		270° *	225° *	60
80	240				270° *	80

5.1.3 Fault Modes

Speed below f_{min} : Pointer positioned to zero.

Speed above f_{max} : Keep pointer at maximum valid measurement until detection of a new valid measurement or ignition off.

5.2 Tachometer Gauge Indication

5.2.1 General Function

Engine speed is measured and calculated based on the period of the tachometer input signal. Revolutions/minute is indicated on a ~270° scale with a crosscoil movement. Appropriate software filtering ensures a smooth movement of the pointer.

The tachometer input is designed to operate on the signal from the primary side of an ignition coil, a 12 volt signal (20-80% duty cycle) from an electronic ignition, or O/B alternator output. Refer to section 6.3.3 for details.

The pulses/revolution for the engine is configured via the serial data link and programmed into the cluster EEPROM. Available options are 1-10 pulses/rev.

5.2.2 Scale / Accuracy / Characteristics

min. indicated engine speed f_{min}	325 rpm

max. indicated engine speed f_{max}	6000 rpm for I/O and 7000 rpm for O/B
Tachometer accuracy	±140 rpm up to 5000 rpm, ±280 rpm over 5000 rpm for O/B application

Tachometer Characteristics

	APPLICATION : NUMBER PULSES / REVOLUTION								**pointer deflection angle (°)** * (calibration points in EEPROM)	
	1	**2**	**3**	**4**	**5**	**6**	**9**	**10**		
Dial Graduation (rpm x1000)	*2 cyl.*	*4 cyl. / 4 pole*	*6 cyl. / 8 pole*	*8 cyl. / 8 pole*	*10 cyl.*	*12 cyl. 12 pole*	*18 pole*	*20 pole*	*I/O 6000 rpm Linear scale*	*O/B 7000 rpm Non-Linear scale*
0	0	0	0	0	0	0	0	0	0 *	0 *
1	16.7	33	50	66.7	83.3	100	150	166.7	45	45
2	33	66.7	100	133.3	166.7	200	300	333.3	90	90
3	50	100	150	200	250	300	450	500	135 *	135
4	66.7	133.3	200	266.7	333.3	400	600	666.7	180	180
5	83.3	166.7	250	333.3	416.7	500	750	833.3	225	225 *
6	100	200	300	400	500	600	900	1000	270 *	247.5
7	116.7	233.3	350	466.7	583.3	700	1050	1166.7		270 *
	FREQUENCY (Hz)									

5.2.3 Fault Modes

Engine speed below f_{min} : Pointer positioned to zero.

Engine speed above f_{max} : Keep pointer at maximum valid measurement until detection of a new valid measurement or ignition off.

5.3 Fuel Gauge Indication

5.3.1 General Function

The fuel gauge displays the amount of fuel remaining in the tank. A low fuel threshold is stored in non-volatile memory. Below the threshold for ten seconds the **low fuel tell tale** will come ON and remains ON until valid readings above 1/6 tank for ten seconds continuously. The threshold is set at 183 (±3) Ohms for a U.S. standard sensor and 57 (±1) Ohms for a VDO sensor (approximately 1/6 tank).

The fuel sensor input signal type is resistive. The measured value is indicated on a ~90° scale with a crosscoil movement (clockwise rotation).

Acquired fuel sensor data is filtered and dampened by a software routine that does not allow the pointer to swing past its target position. The dampening constant is stored in the non-volatile memory and is configured during manufacturing. A four point calibration is done in manufacturing, and the resulting corrections are stored in EEPROM. Different fuel senders may be used if they have the same basic characteristic curve.

5.3.2 Scale / Accuracy / Calibration

Fuel Sensor Characteristic

Dial graduation	Angle	U.S. standard sensor		VDO sensor		Calibration
		Resistance [Ω]	Tolerance [Ω]	Resistance [Ω]	Tolerance [Ω]	* (calibration points in EEPROM)
E	0°	240	+7	10	–0.5	Pointer Placed Start Calibration *
(1/4)	22.5°	153	±6	77	±2.5	Ascending *
(1/2)	45°	103	±5	127	±3	Calculated *
(3/4)	67.5°	67	±4	156	±3	Interpolated
F	90°	33	–9	180	+8	Ascending *

5.3.3 Fault Conditions

- fuel sensor signal less than 15Ω with a tolerance of +2Ω for U.S. sensor, 3Ω with a tolerance of +2Ω for VDO sensor for longer than 5 sec
- fuel sensor signal more than 280Ω with a tolerance of –3Ω for U.S. sensor, 210Ω with a tolerance of -3Ω for VDO sensor for longer than 5 sec

When a fault is detected, the cluster alerts the operator with a system fault condition as described in section 4.5.2. During the fault condition, the pointer moves back to its zero position ('EMPTY') and stays there. When a valid reading is detected for 5 seconds, the pointer resumes normal display and the fault indication is cleared.

5.4 Coolant Temperature Gauge Indication

5.4.1 General Function

Engine coolant temperature is measured and calculated based on resistance of the coolant temperature sensor input signal. The measured value is indicated on a ~90° scale with a crosscoil movement (clockwise orientation).

Acquired temperature sensor data is filtered and dampened by a software routine that does not allow the pointer to swing past its target position. The dampening constant is stored in the non-volatile memory and configured during manufacturing. A four point calibration is done in manufacturing and the resultant calibration curve stored in EEPROM.

A high engine temperature threshold is stored in non-volatile memory. If the input signal from the temp sensor is above the threshold for 10 seconds, a **high engine temperature warning** is signaled to the operator as described in section 4.5.1. The threshold is set at 64(±3) Ohms for a U.S. standard sensor and 37(±1) Ohms for a VDO sensor (approximately 213° F, edge of red zone). Valid readings for ten seconds below the temperature threshold clear the warning condition. Indications to the operator follow the description in 4.5.1.

5.4.2 Scale / Accuracy / Calibration

		U.S. standard sensor		VDO sensor			
Dial graduation	**Angle**	**Resistance** [Ω]	**Tolerance** [Ω]	**Resistance** [Ω]	**Tolerance** [Ω]	**Temp.** [°f]	**Calibration** * (calibration points in EEPROM)
Cold	0°	298	±27	190	±21	120°	Start Cal *
	22.5°	179	±18	116	±9	145°	Interpolated *
	45°	128	±9	92	±3.5	160°	Ascending
	67.5°	70	±4	46	±1	195°	Calculated *
Hot	90°	46.5	±3	34	±1	220°	Set Pointer Ascending *

5.4.3 Fault Conditions

- coolant sensor signal less than 37Ω with a tolerance of +3Ω for U.S. sensor, 27Ω with a tolerance of +3Ω for VDO sensor for longer than 5 sec.
- high resistance or open circuits faults will be reported due to the sensor going above 880Ω-U.S., 500Ω-VDO for longer than 5 sec.

When a fault is detected, the cluster alerts the operator with a system fault condition as described in section 4.5.2. During the fault condition, the pointer moves to its MAX position ('HOT') and stays there. When a valid reading is detected for 5 seconds, the pointer resumes normal display and the fault indication is cleared.

5.5 Oil Pressure Gauge Indication

5.5.1 General Function

Oil pressure is measured and calculated based on resistance of the oil pressure sensor. The measured value is indicated on a ~90° scale crosscoil movement (clockwise orientation).

Acquired oil pressure sensor data is filtered and dampened by a software routine that does not allow the pointer to swing past its target position. The dampening constant is stored in the non-volatile memory and configured during manufacturing. A four point calibration is done in manufacturing and the resultant calibration curve stored in EEPROM.

A low oil pressure threshold is stored in non-volatile memory. If the input signal from the pressure sensor is below the threshold for 2 seconds, a **low oil pressure warning** is signaled to the operator as described in section 4.5.1. The threshold is set at 200(±3) Ohms for a U.S. standard sensor and 30(±1) Ohms for a VDO sensor (approximately 6 PSI), center of red zone. Edge of red zone is about 180 Ohms (approximately 14 PSI). Valid readings for two seconds above the pressure threshold clear the warning condition. Indications to the operator follow the description in 4.5.1.

5.5.2 Scale / Accuracy / Calibration

		U.S. standard sensor		VDO sensor			
Mark	**Angle**	**Resistance [Ω]**	**Tolerance** [Ω]	**Resistance [Ω]**	**Tolerance** [Ω]	**Pressure [psi]**	**Calibration** * (calibration points in EEPROM)
LOW	0°	240	±7	10	±0.5	0	Pointer Placed Start Cal. *
	22.5°	153	±6	80	±3	20	Ascending *
	45°	103	±5	125	±3	40	Calculated *
	67.5°	69.5	±6	155	±5	60	Interpolated
HIGH	90°	33	±9	180	±8	80	Ascending *

5.5.3 Fault Conditions

- pressure sensor resistance below 15Ω with a tolerance of +2Ω for U.S. sensor, 3Ω with a tolerance of +2Ω for VDO sensor for longer than 5 sec
- pressure sensor resistance above 280Ω with a tolerance of -3Ω for U.S. sensor, 210Ω with a tolerance of -3Ω for VDO sensor for longer than 5 sec

When a fault is detected, the cluster alerts the operator with a system fault condition as described in section 4.5.2. During the fault condition, the pointer moves to its zero position ('LOW') and stays there. When a valid reading is detected for 5 seconds, the pointer resumes normal display and the fault indication is cleared.

5.6 Voltage Gauge Indication

5.6.1 General Function

Voltage is measured and calculated based on cluster ignition voltage. The measured value is indicated on a ~90° scale with a crosscoil movement (clockwise orientation). Acquired voltage data is filtered and dampened by a software routine that does not allow the pointer to swing past its target position. The dampening constant is stored in the non-volatile memory and configured during manufacturing. A three point calibration is done at the factory during manufacturing and is stored in EEPROM.

A high and low voltage threshold is stored in non-volatile memory. If the signal from the ignition input is outside of the threshold limits for 10 seconds, an **ignition voltage warning** is signaled to the operator as described in section 4.5.1. The voltage warnings are below 11(±0.2)V or above 16(±0.2)V. Red zones are below 11.5V and above 14.5V

5.6.2 Scale / Accuracy / Calibration

Dial Graduation	Angle	Voltage [V]	Tolerance [V]	Calibration * (calibration points in EEPROM)
10	0°	10	±0.5	Pointer Placed Start Cal. *
	22.5°	11.5	±0.5	Interpolated
	45°	13	±0.5	Ascending *
	67.5°	14.5	±0.5	Interpolated
16	90°	16	±0.5	Ascending *

5.6.3 Other Conditions

- voltage below 7.5V with a tolerance of +0.2V
- voltage above 16.5V with a tolerance of –0.2V

When the ignition voltage input is below 7.5 volts, this is interpreted as ignition off, and the cluster enters sleep mode. All cluster functions except clock are suspended. The cluster will remain in this state until voltage is approximately 8.5v.

** Cluster performance is not defined for BATTERY voltage below 7.5 volts. Recovery from low BATTERY voltage may be a reset (clock, odometer, and engine hourmeter data is lost – maximum 1 mile for odometer and 15 minutes for hourmeter).

If the ignition voltage input is over 16.5 volts, the cluster will partially shut down to reduce supply current and protect against damage. All cluster functions except clock are suspended. When the voltage drops below approximately 15.5 volts the cluster will reset.

5.7 Trim Gauge Indication

5.7.1General Function

Power trim position is measured and calculated from the varying sensor resistance or voltage, depending on the system. The measured value is indicated on a 90° scale with a crosscoil movement (clockwise Down to Up orientation).

Acquired trim sensor data is filtered and dampened by a software routine that does not allow the pointer to swing past its target position. The dampening constant is stored in the non-volatile memory and is configured during manufacturing. A four point calibration is also done in manufacturing and the resultant calibration curve stored in EEPROM.

5.7.2 Scale / Accuracy / Calibration

		MERC (all) / OMC (I/O)		OMC (O/B)		
Mark	**Angle**	**Resistance [Ω]**	**Tolerance [Ω]**	**Resistance [Ω]**	**Tolerance [Ω]**	**Calibration** * (calibration points in EEPROM)
UP	90°	60	±5	1	+9/-1	Ascending *
	67.5°	35	±5	22	±5	Calculated *
Mid Point	45°	26	±4	44	±4	Interpolated
	22.5°	16.7	±5	67	±5	Ascending *
DOWN	0°	11	±1	90	±10	Pointer Placed Start Cal. *

		Honda (O/B only)		Yamaha (O/B only)		
Mark	**Angle**	**Voltage [v]**	**Tolerance [v]**	**Voltage [v]**	**Tolerance [v]**	**Calibration** * (calibration points in EEPROM)
UP	90°	3.04	±.05	5.00	±.05	Ascending *
	67.5°	2.50	±.05	4.18	±.05	Calculated *
Mid Point	45°	1.93	±.05	2.80	±.05	Interpolated
	22.5°	1.34	±.05	2.13	±.05	Ascending *
DOWN	0°	0.77	±.05	0.95	±.05	Pointer Placed Start Cal. *

* NOTE: The Four Winns trim gauge is a counter clockwise scale from Down to Up. Pointer placement is at the UP position.

5.8 Outboard System Monitor (O/B clusters ONLY)

The clusters for outboard engine craft include the outboard engine system monitor. It provides warning tell tales and an audible alarm for the Oil Pressure, Engine Temp, Oil Level, and Check Engine signals for an OMC System Check sensor equipped outboard engine.

5.8.1 OIL PRESSURE

The tell tale shall turn on any time the Oil Pressure warning switch contact closes and the ignition is on. The tell tale shall remain on for a minimum of 30 seconds, and it will remain on until the fault is corrected and the sensor contact opens or the ignition is turned off.

5.8.2 ENGINE TEMPERATURE

The tell tale shall turn on any time the Engine Temp. warning switch contact closes and the ignition is on. The tell tale shall remain on for a minimum of 30 seconds, and it will remain on until the fault is corrected and the sensor contact opens or the ignition is turned off.

5.8.3 CHECK ENGINE

The tell tale shall turn on any time the Check Engine switch contact closes and the ignition is on. The tell tale shall remain on for a minimum of 30 seconds, and it will remain on until the fault is corrected and the sensor contact opens or the ignition is turned off.

5.8.4 OIL LEVEL

The tell tale shall turn on any time the Oil Level switch contact closes and the ignition is on. The tell tale shall remain on for a minimum of 30 seconds, and it will remain on until the fault is corrected and the sensor contact opens or the ignition is turned off.

5.8.5 AUDIBLE ALARM CONTROL

This audible alarm shall sound upon the occurrence of any of the four described alert conditions, while the engine is running at or higher predetermined RPM. The alarm horn shall sound for 10 seconds and then turn off.

5.8.6 SELF TEST

When the ignition is turned on, the Outboard System Monitor shall perform a self test. The self test shall be a ½ second beep by the audible alarm horn. All four of the Outboard System Monitor warning tell tales shall turn on. Upon conclusion of the test, the four tell tales shall turn off at 0.5 second intervals in the following sequence:

1. Check Engine
2. Oil Level
3. Oil Pressure
4. Engine Temperature

5.9 Depth Sounder

5.9.1 General Function

Water depth is measured using an external transducer (not provided by VDO North America). It works by measuring the reflected energy of a 200 kHz pulses as it bounces off the bottom. Depth measurement is based on the speed of sound in fresh water at 25°C. Small errors result from salinity and temperature.

The display indicates depth in feet or tenths of meters. Accuracy beyond 200' depends on bottom conditions, salinity, transom angle, transducer installation and aiming of the transducer. The displayed value is updated every 300 milliseconds. (NOTE: VDO North America has no control over depth transducer installation , and does not warrant its operation. The 200' operation is in salt water, with the transducer pointed fully down. Performance of the transducer at speed is affected by air bubbles in the water and the ability of the transducer to maintain contact with the wake).

A shallow water depth alarm feature can be set in increments of 1' (0.3m). The operator sets the value by pressing dashboard mounted MODE and ADJUST buttons. Entering shallow water causes a continuous chirping sound and blinking up/down arrow segments.

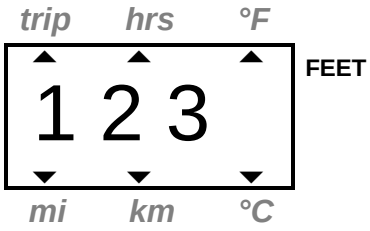
The shallow water alarm setting is displayed as blinking digits. Current depth is displayed as steady (not blinking) digits. If the alarm screen is blank no shallow water alarm is set. If the depth screen shows dashes the depth is zero or indicates a bad sensor reading.

For details on display and operation refer to section 5.9.4.

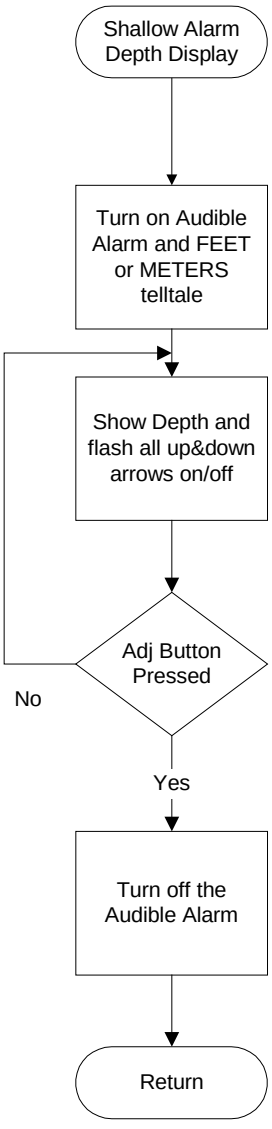
5.9.2 Specifications

Range:	1 to 200 feet (0.3 to 60.9 meters)
Sensor:	200 KHz
Display Resolution:	1 ft. (0.1from 1.0 to 9.9 ft) or 0.1 meters
Display Units:	FEET or METERS, operator selectable w/EEPROM default

5.9.3 Shallow Water Alarm Display Properties



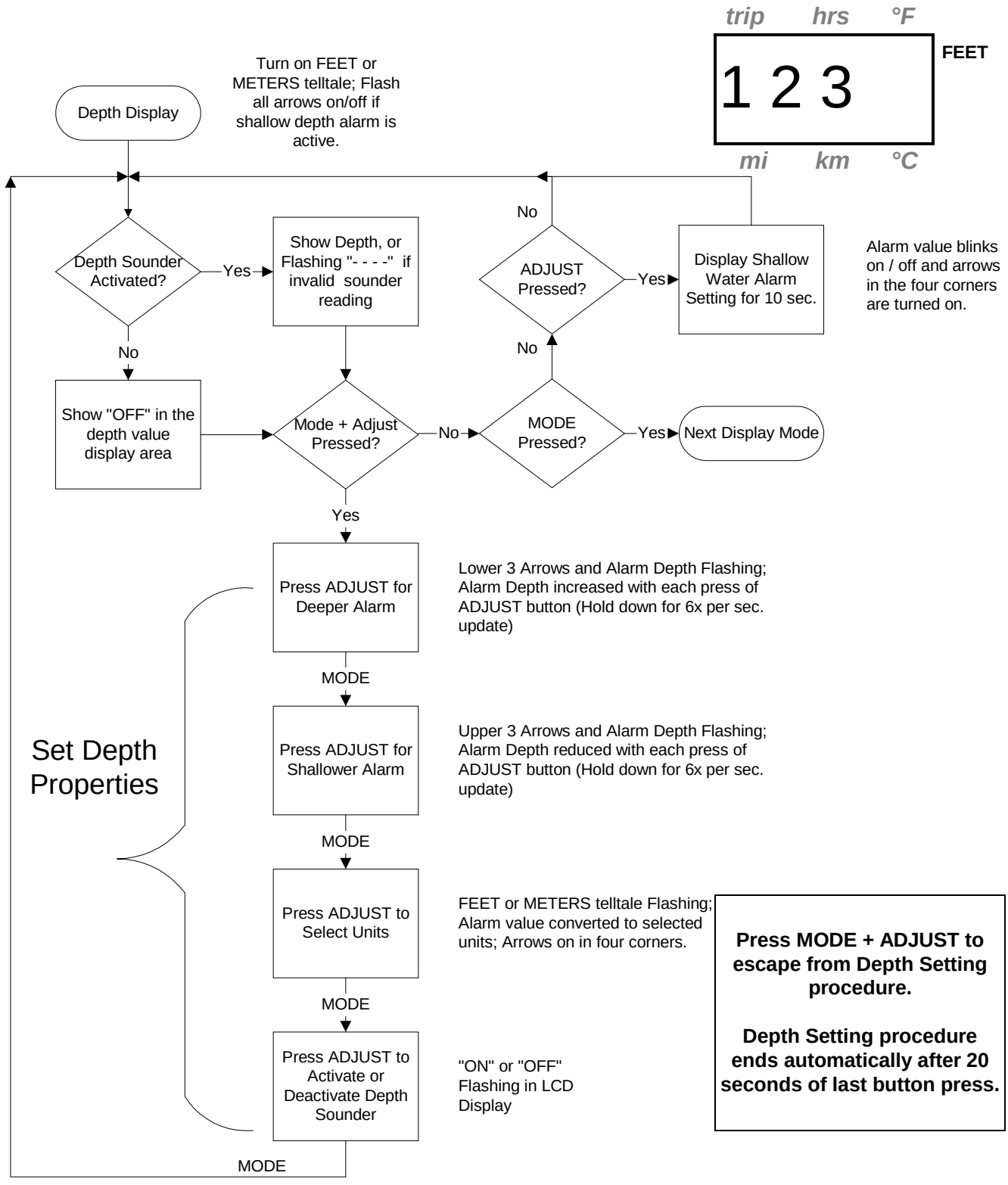
All Arrows Up / Down Flashing



Entry here upon transition from no alarm to active shallow water alarm condition.

Resume last active Display Mode

5.9.4 Depth Display Properties



5.10 Clock Display

5.10.1 General Function

The Clock display is selected by pressing the MODE button. During Clock display the colon blinks once per second.

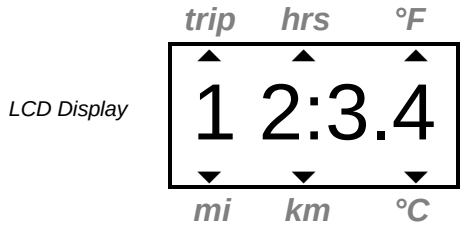
Time of day is set by holding MODE and ADJUST for 1.5 seconds while in the Clock Display mode. MODE is then used to advance through the time set features. Hours are set first, then minutes, then 12/24 hour mode. The selected digits blink while being set. While in set mode ADJUST is pressed to increment the selected unit. Hours is set in the 24 hour format, rolling to zero at 24. Minutes rolls to zero at 60. While setting the 12/24 hour feature, 24 is displayed in the hours position and 12 is displayed in the minutes position. The current mode blinks (i.e. in 24 hour mode the "24" blinks).

MODE and ADJUST are debounced for 3/8 of a second. If the ADJUST button is held for 2 seconds while setting a numeric value the key auto repeats at a rate of 6 per second.

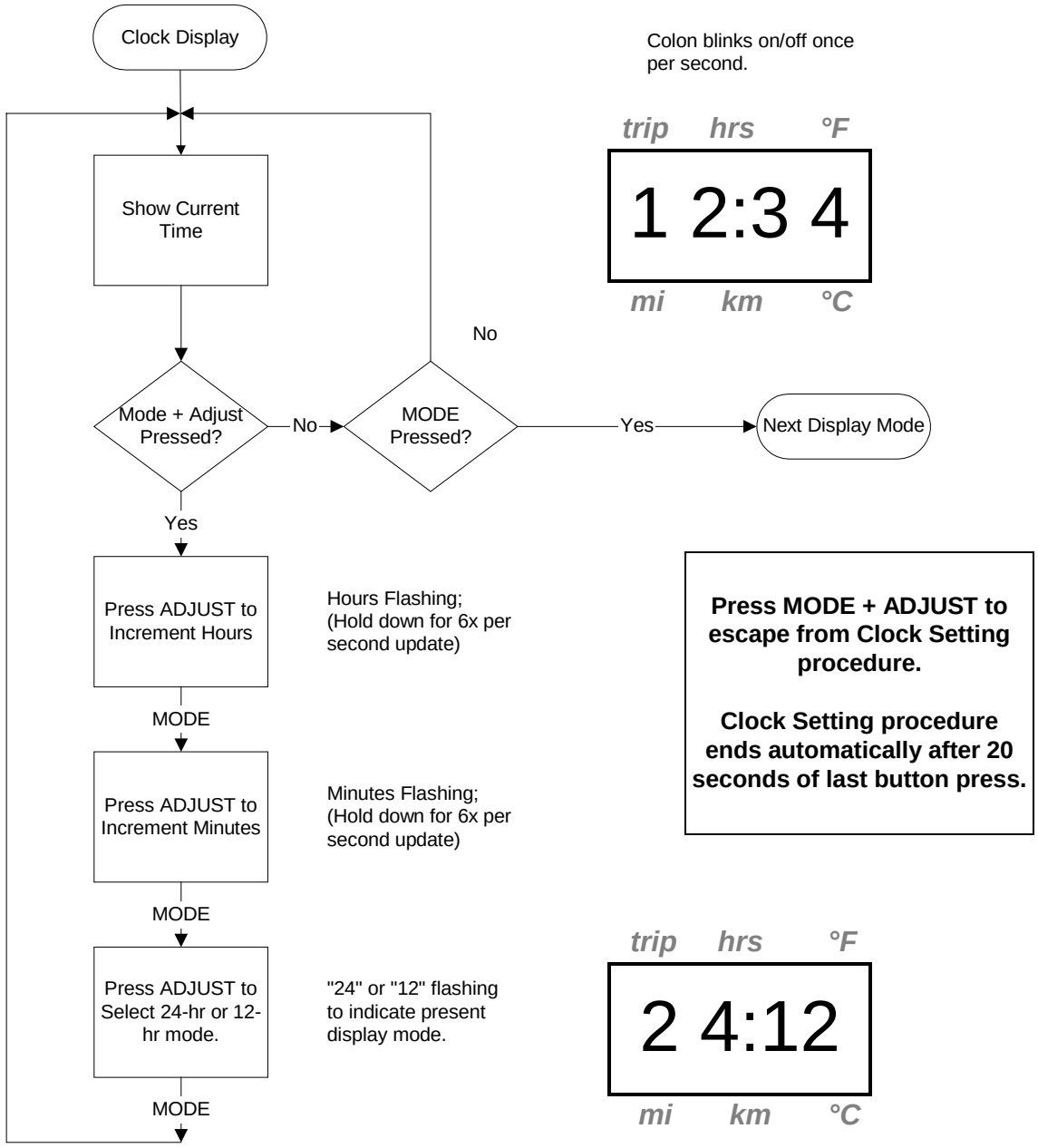
When the ignition is turned off the present mode is saved and the LCD displays time of day. Time setting functions are not available with the ignition off. When the ignition is turned on the LCD returns to its prior display mode.

The clock keeps time up to approximately 21 days after ignition is turned off. During this time the system is in its power saving state. After 21 days the cluster shuts down to conserve battery power. When ignition is turned on after 21 days, the clock restarts at midnight in the mode active at ignition off. Time of day must be set again.

LCD Display (The graphics do not reflect the display design.)



5.10.2 Clock Display Properties



5.11 Telltales

The cluster has nine telltales. Some are optional, depending on configuration.

Telltale Legend	Activation Conditions	Input To Controller
1. METERS	Depth Sounder mode, metric units	None
2. FEET	Depth Sounder mode, English units	None
3. High Engine Temp.	**I/O:** Engine Temp. sensor threshold exceeded **O/B:** High Engine Temp.Warning sw. to gnd.	**I/O:** Analog **O/B:** digital interpretation
4. Oil Pressure Low	**I/O:** Below Oil Pressure sensor threshold **O/B:** Low Oil Pressure Warning switch to gnd.	**I/O:** Analog **O/B:** digital interpretation
5. Oil Level Low (O/B only)	Low Oil Level Warning switch to gnd.	digital
6. Voltage Range	Ignition Voltage reading out of range	Analog
7. Fuel Level Low	Fuel Level Sensor reading below threshold	Analog
8. Check Engine (O/B only)	Check Engine Warning switch to gnd.	digital
9. (Spare)		

5.12 Odometer

Life to date distance is maintained by the cluster. It uses non volatile EEPROM storage to record distance in statute miles. Updates are performed every mile. Display is operator selectable in miles or kilometers.

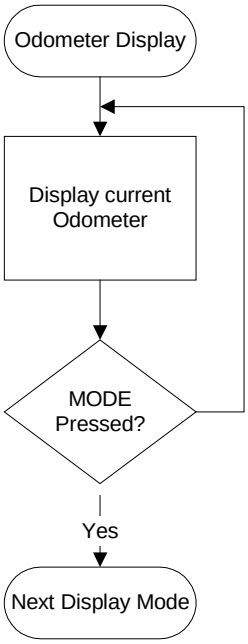
5.12.1 Specifications

Range:	9999 miles or 9999 km.
	Freezes at 9999 miles or 9999 km.
Sensor:	See section 5.1 for speed sensor characteristics
Display Properties:	First 1000 miles or km: 0.0 to 999.9 mi or km.
	Above 1000 miles or km: 1000 to 9999 mi or km.
Display Resolution:	0.1 miles or 0.1 kilometers
Display Units:	MI or KM, operator selectable w/EEPROM default at battery reset
Calibration:	Maximum 16,000 pulses per mile, factory set in EEPROM
EEPROM updated:	Every 1.0 mile
EEPROM resolution:	1 mile
RAM resolution:	Pulses accumulated towards next mile

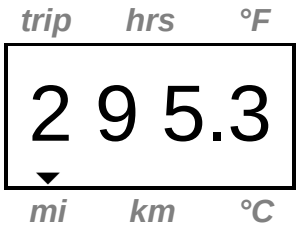
NOTE:

Fractional parts of a mile are kept in volatile RAM storage. Removal of battery power results in maximum distance loss of just less than 1.0 miles.

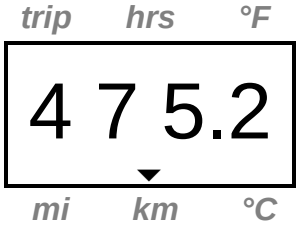
5.12.2 Odometer Display Properties



Range is 000.0 to 999.9 and then 1000 to 9999. Value freezes at 9999.



OR...



Note:

Odometer Reset is a Factory operation only.

Odometer Units follow depth selection:

Feet => MI

METERS => KM

5.13 Trip Odometer

An operator resettable odometer is provided. It keeps track of distance in statute miles traveled since the last operator reset. Display is operator selectable in miles or km.

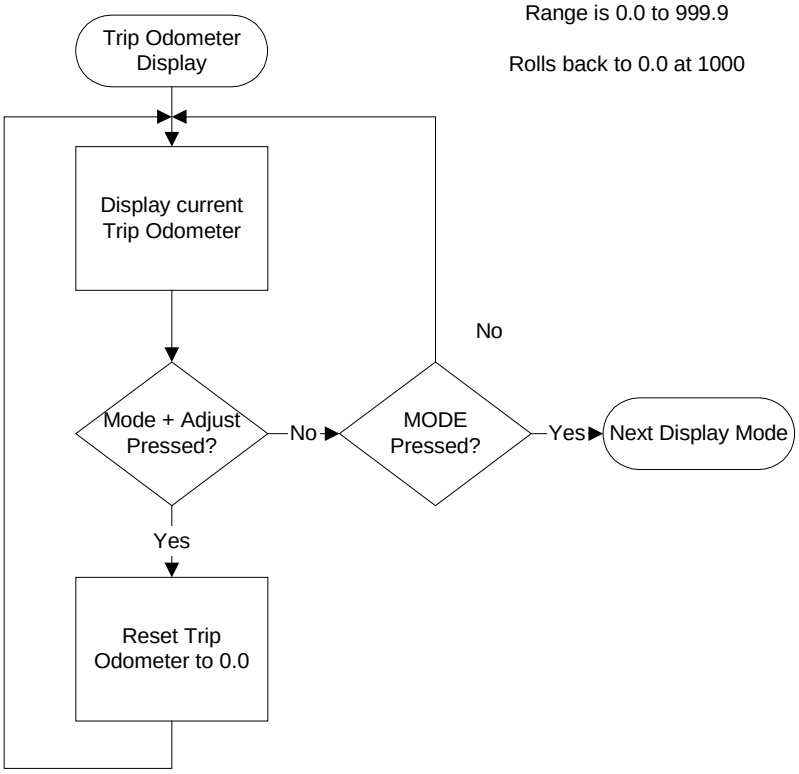
5.13.1 Specifications

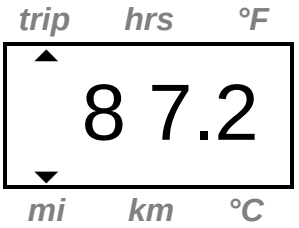
Range:	1000 miles or 1000 km.
	Rolls back to 0.0 miles or km. every 1000 miles or km.
Sensor:	See section 5.1 for speed sensor characteristics
Display Properties:	0.0 to 999.9 mi or km.
Display Resolution:	0.1 miles or 0.1 kilometers
Display Units:	MI or KM, operator selectable w/EEPROM default at battery reset
Calibration:	Uses odometer calibration

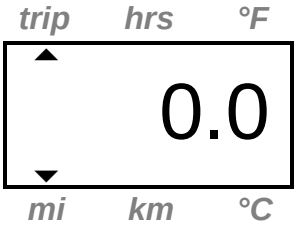
NOTE:

Trip distance is stored in volatile RAM storage. Removal of battery power resets Trip Distance to 0.0.

5.13.2 Trip Odometer Display Properties







Trip Odometer Units follow depth selection:

Feet => MI

METERS => KM

5.14 Total Engine Hours

Life to date engine hours is maintained by the cluster. It uses non-volatile EEPROM storage to record the total amount of time the engine has been running. Updates are performed every fifteen minutes.

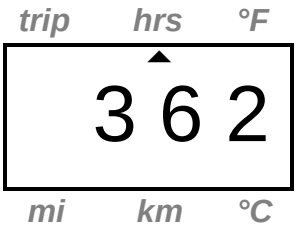
5.14.1 Specifications

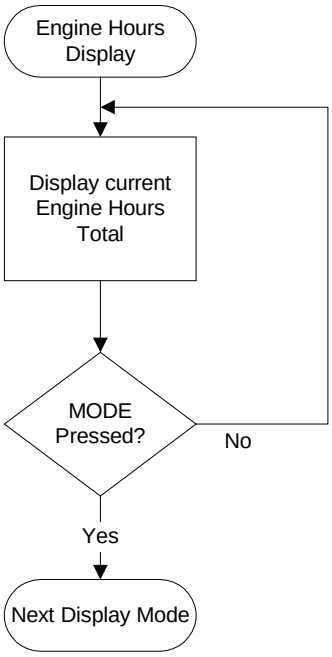
Range:	9999 hours
	Total freezes at 9999 hours.
Minimum Speed:	Time below 325 rpm not counted..
Sensor:	See section 4.2 for tachometer sensor characteristics
Display Properties:	0 to 9999 hours
Display Resolution:	1 hour
Display Units:	hours
EEPROM updated:	Every 15 minutes of engine running time.
EEPROM resolution:	15 minutes
RAM resolution:	seconds accumulated towards next 15 minute increment

NOTE:

Seconds are kept in volatile RAM storage. Removal of battery power results in maximum time loss of just less than 15 minutes.

5.14.2 Engine Hours Display Properties





Range is 0 to 9999.
Display freezes at
9999 hours.

Note:

Total Hours only updated when Engine Running.

5.15 Trip Engine Hours

An operator resettable engine hours timer is provided. It keeps track of engine hours accumulated since the last operator reset.

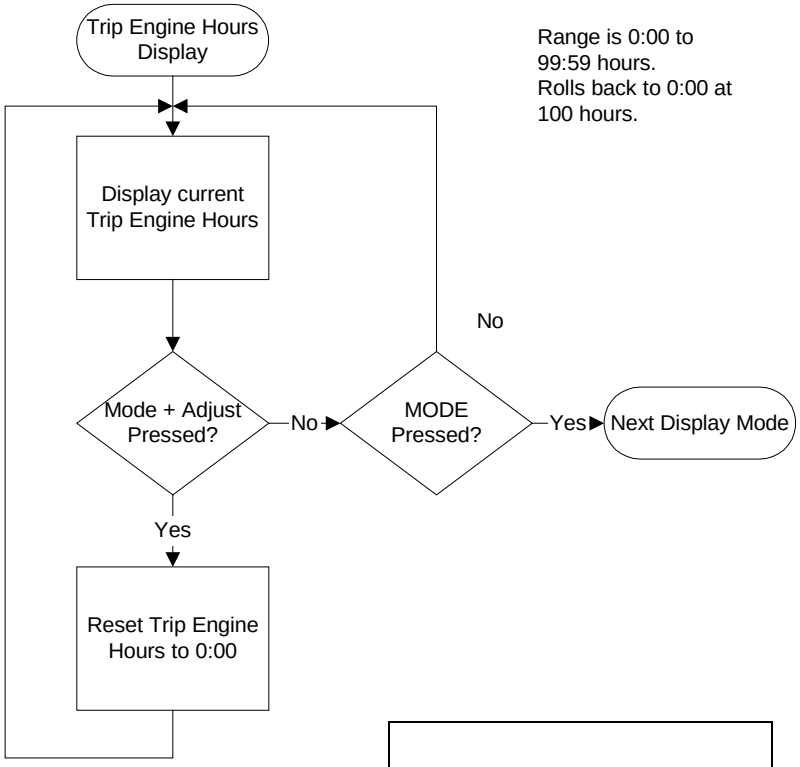
5.15.1 Specifications

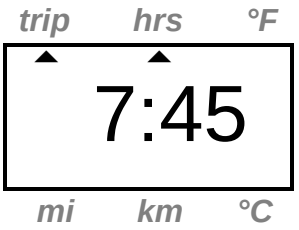
Range:	100 hours
Minimum Speed:	Time below 325 rpm not counted.
Sensor:	See section 4.2 for tachometer sensor characteristics
Display Properties:	0:00 to 99:59
Display Resolution:	1 minute
Display Units:	hours and minutes

NOTE:

Trip Engine Hours is kept in volatile RAM storage. Removal of battery resets Trip Engine Hours to 0:00.

5.15.2 Trip Engine Hours Display Properties





Note:

Trip Hours only updated when Engine Running.

5.16 Seawater Temperature

Seawater temperature is displayed in digital format on the cluster's four character, seven segment LCD display.

5.16.1 Specifications

Range:	30 °F to 104 °F
	-1 °C to 40 °C
Display Properties:	30.0 to 104.0 °F or –1.0 to 40.0 °C
Display Resolution:	0.5 °F or 0.5 °C
Display Units:	°F or °C Operator Selectable
Sensor Type:	NTC thermistor, 10KΩ @ 25°C

5.16.2 Characteristics

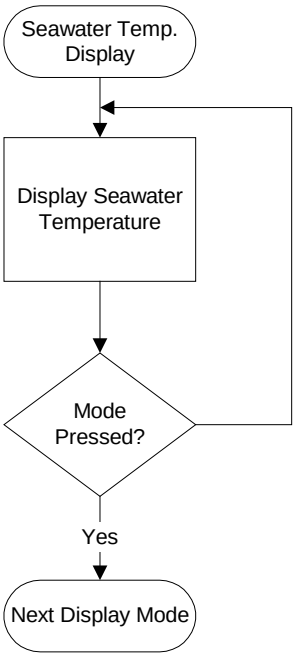
Displayed Temperature		Display Tolerance		Resistance [Ω] ±100
°C	°F	°C	°F	
-1.0	30.0	+1.0 / -0	+2.0 / -0	34400
13.0	55.0	±1.0	±2.0	16800
22.0	71.5	±1.0	±2.0	11200
33.0	91.0	±1.0	±2.0	6900
40.0	104.0	+0 / -1.0	+0 / -2.0	5300

5.16.3 Fault Conditions

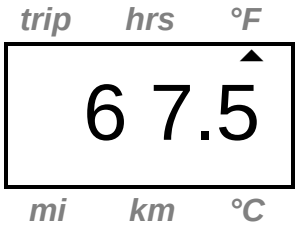
- Seawater sensor signal less than 4700 (+200) Ω for more than 5 sec.
- Seawater sensor signal greater than 37800 (-200) Ω for more than 5 sec.

When a fault is detected, the cluster alerts the operator with dashes ("----") on the LCD readout. When a valid reading is detected for 5 seconds, the LCD readout resumes normal display and the fault indication is cleared.

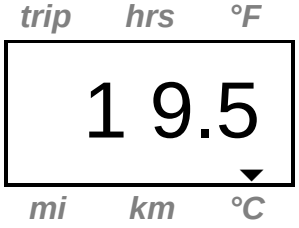
5.16.4 Seawater Temperature Display Properties



Range is 30°F to 104°F
or -1°C to 40°C



OR...



Temperature Units follow depth selection:

Feet => °F

METERS => °C

6 Front Panel Programming

This section defines built-in Front Panel Programming for the VDO North America Marine Instrument Cluster 2000.

6.1 Overview

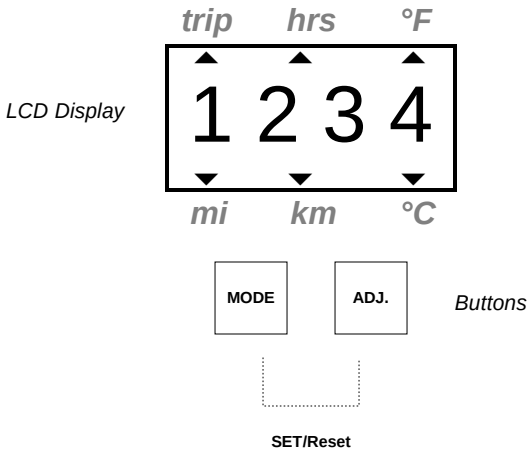
A limited range of field adjustments can be made to the cluster. The process is carried out by special button press sequences. Access to the front panel re-programming features is only possible upon ignition on and requires the operator to simultaneously hold down both the MODE and ADJ buttons for 5 seconds.

Setup/Programming Features:

- Tachometer Pulses per Engine Revolution, from 1 to 10
- Speedometer Pulses per Mile adjusted from – 50% to + 50%
- Trim Sensor Selection for 9 Engine/Trim Types
- Fuel Sensor Selection: VDO or US
- Coolant Sensor Selection: VDO or US
- Oil Pressure Sensor Selection: VDO or US

6.2 Operator Interface

A four character, seven segment LCD display and two dashboard mounted buttons provide an operator interface. Three “Up” arrows indicate that pressing/holding the ADJ button causes the configurable setting to increase. Three “Down” arrows indicate that pressing/holding the ADJ button decreases the value. MODE is used to step through the available programming options.



ADJ Button States:

- **Pressed**: Button pushed down for 0.15 to 1.175 seconds and then released.

  Displayed value increments (up arrows shown) or decrements (down arrows shown).

  Upon release, the arrows flip to the opposite direction.

- **Held**: Button held down for 1.2 seconds or more.

  Upon reaching the “held” duration, the displayed value increments or decrements, depending on arrow direction, at the rate of two counts per second.

  Upon release, the arrows flip to the opposite direction.

MODE Button States:

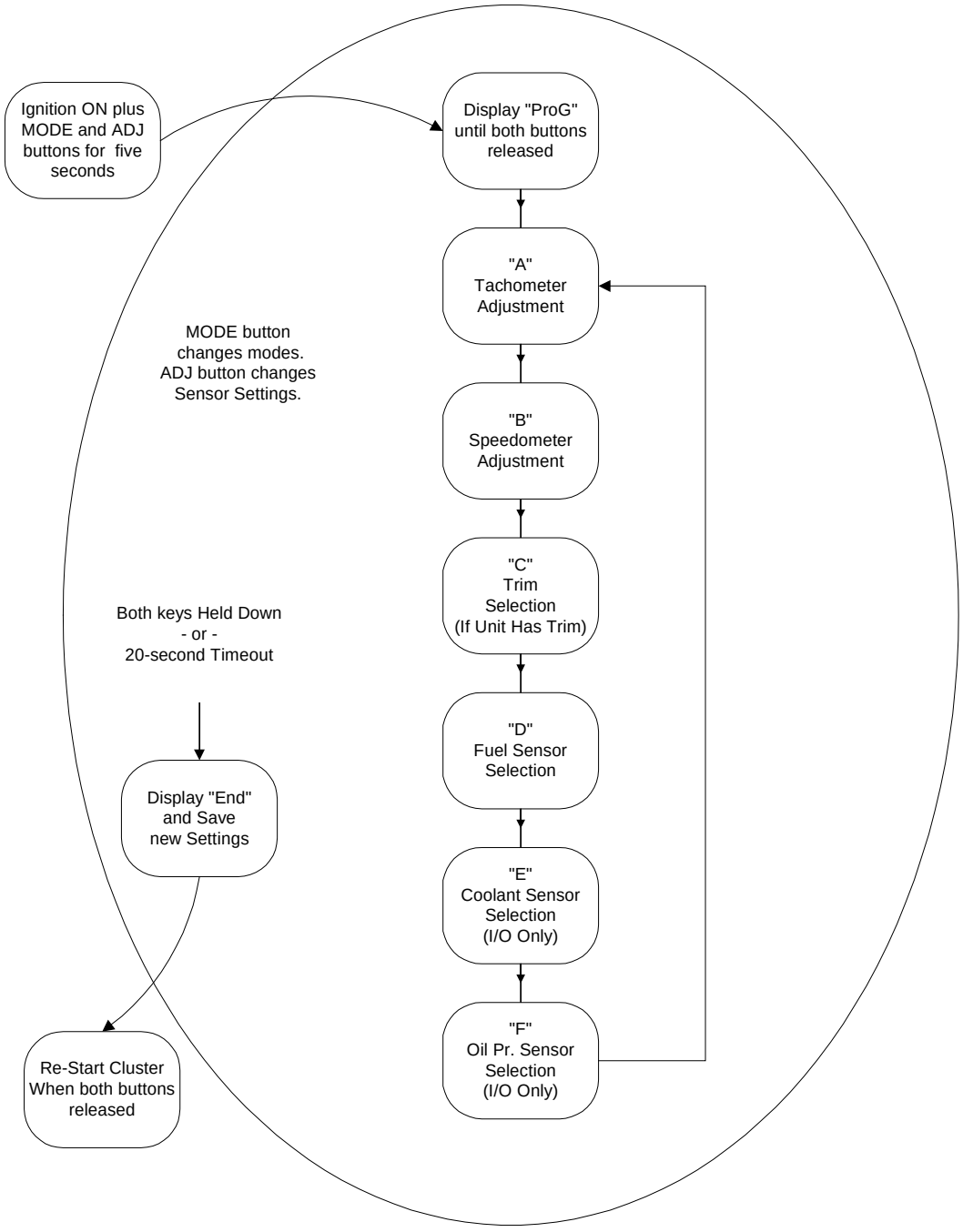
- **Pressed**: Button pushed down for 0.15 to 1.175 seconds and then released.
  Advances to the next programming option: A -> B -> C…

- **Held**: Button held down for 1.2 seconds or more.
  Upon reaching the "held" duration, programming options advance at the rate of two steps per second.

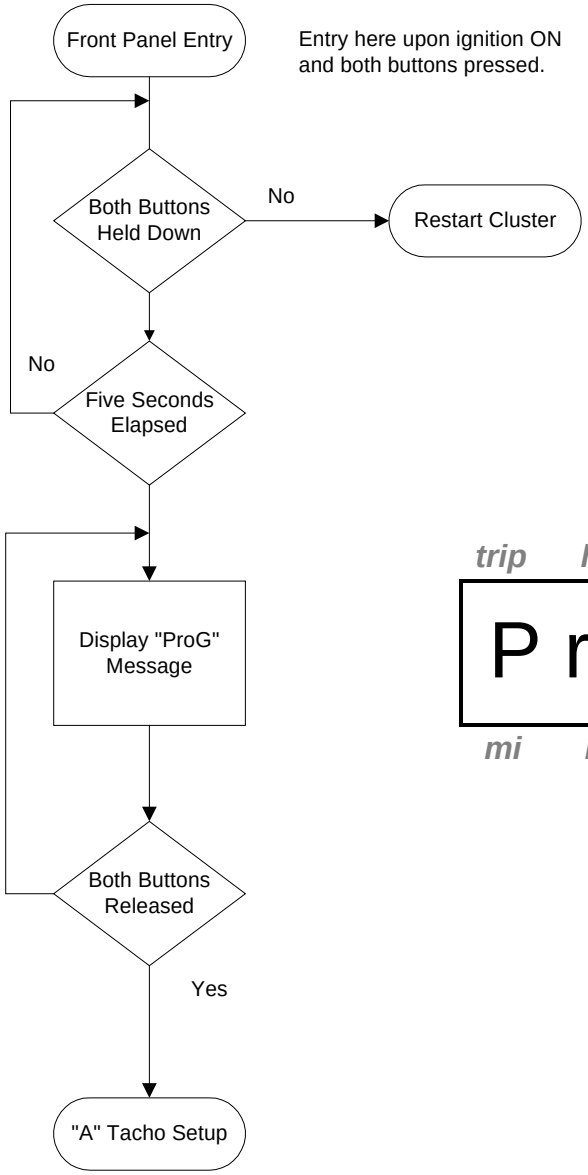
Combined Button States:

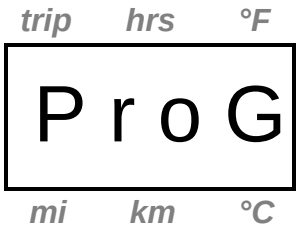
- **Held**: Both buttons held down for 1.2 seconds or more.
  Ends the Front Panel Programming process and saves any changed settings.

6.3 Programming Modes Overview

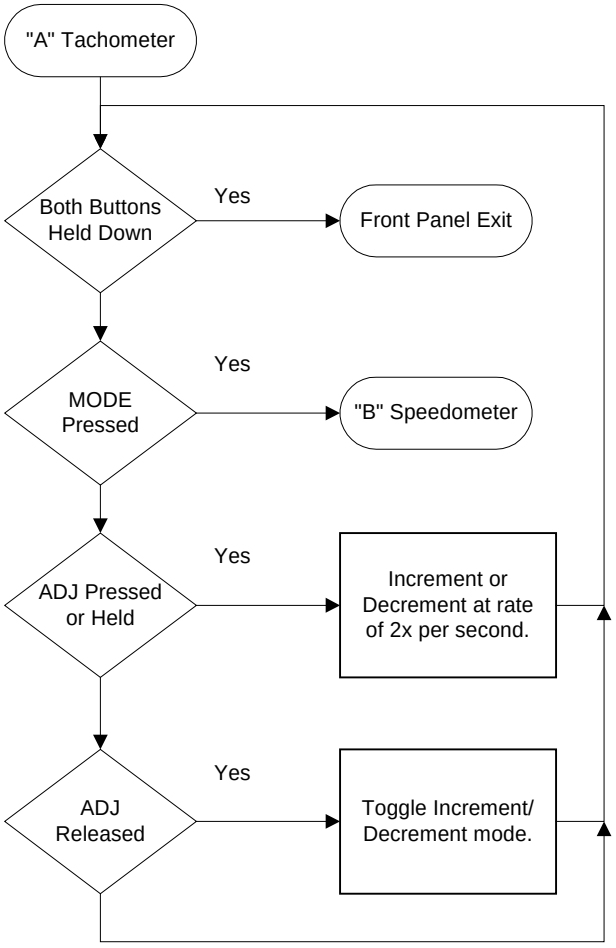


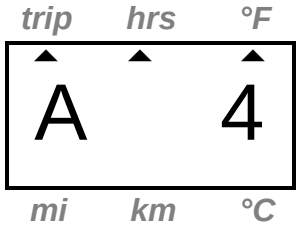
6.3.1 Entry To Front Panel Programming



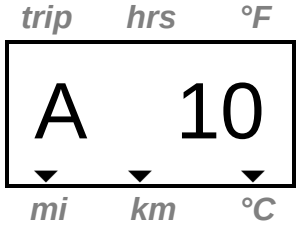


6.3.2 “A” Tachometer Adjustment





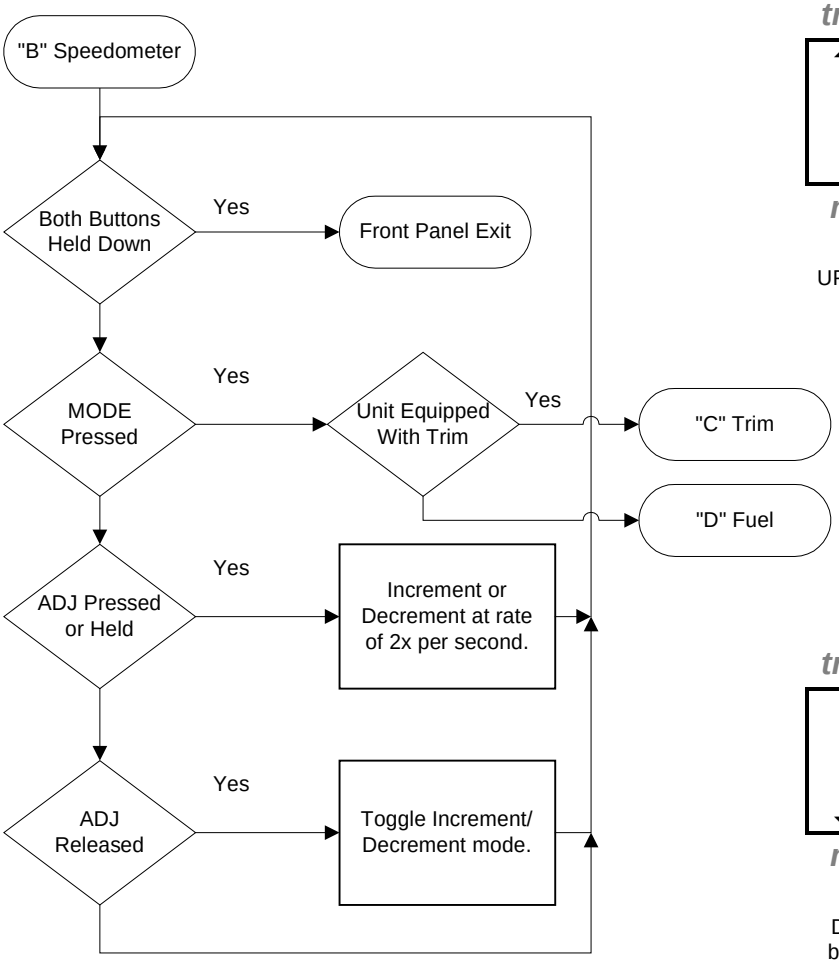
UP arrows indicate ADJ button increments the value to maximum 12 pulses per rev.

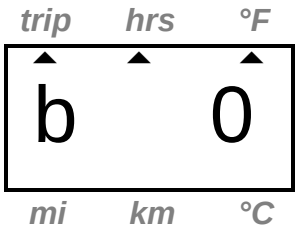


DOWN arrows indicate ADJ button decrements the value to minimum of 1 pulse per rev.

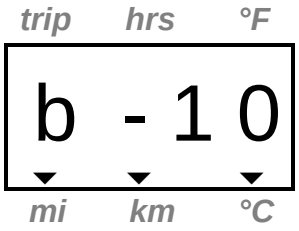
Pulses Per Engine Rev.
Minimum: 1
Maximum: 12

6.3.3 “B” Speedometer Adjustment





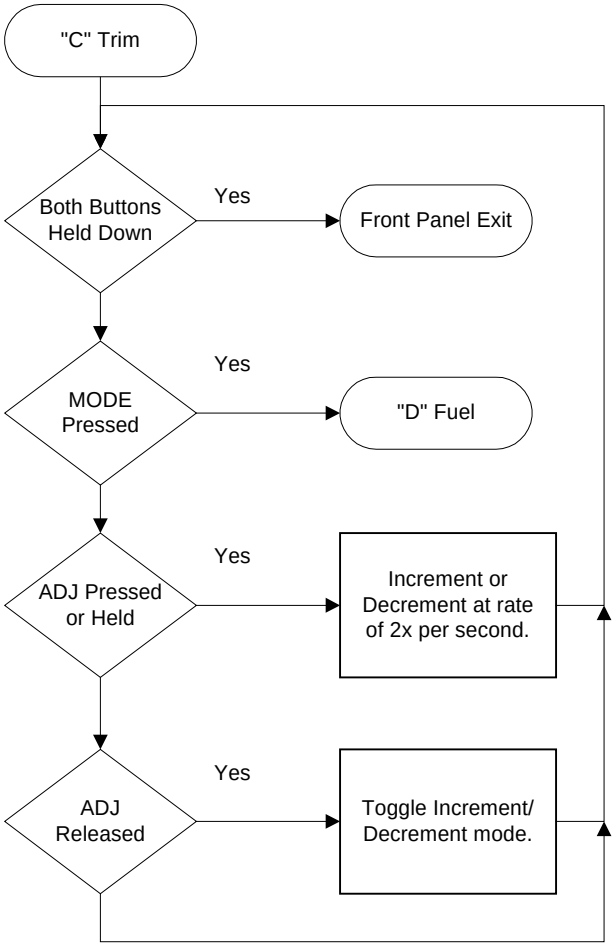
UP arrows indicate ADJ button increments the value to maximum of 50%.

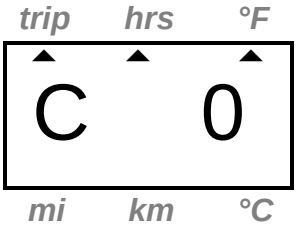


DOWN arrows indicate ADJ button decrements the value to minimum of - 50%.

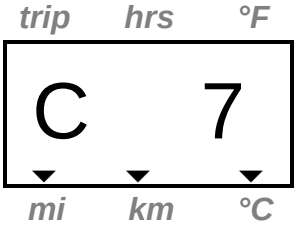
Speed Adjustment Range
- 50% to + 50%
of Original Setting

6.3.4 “C” Trim Sensor Selection





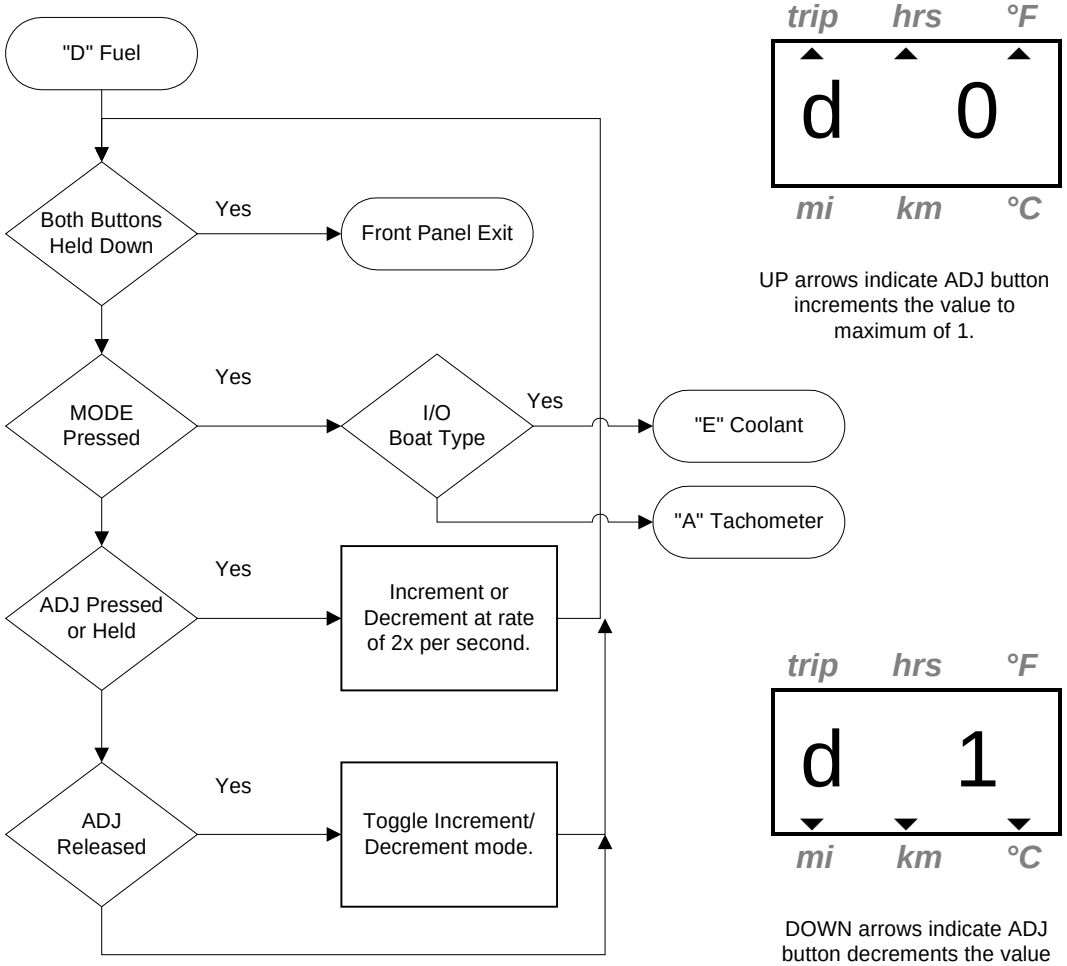
UP arrows indicate ADJ button increments the value to maximum of 8.



DOWN arrows indicate ADJ button decrements the value to minimum of 0.

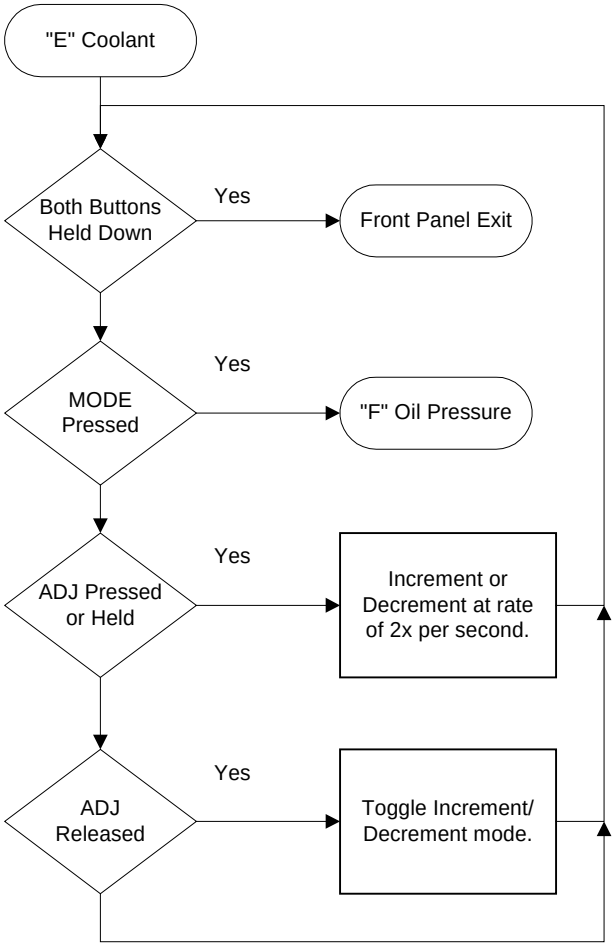
No.	Description
0	Mercury I/O
1	Mercury O/B
2	OMC Cobra I/O
3	Volvo DP/SX I/O
4	OMC O/B
5	Evinrude O/B
6	Johnson O/B
7	Honda O/B
8	Yamaha O/B

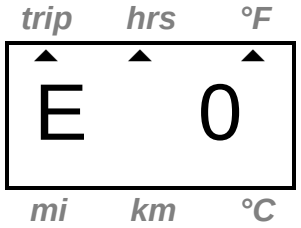
6.3.5 “D” Fuel Sensor Selection



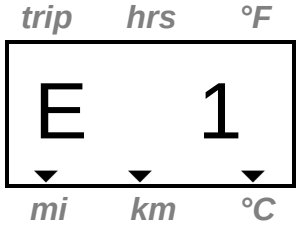
No.	Description
0	VDO
1	US

6.3.6 “E” Coolant Sensor Selection





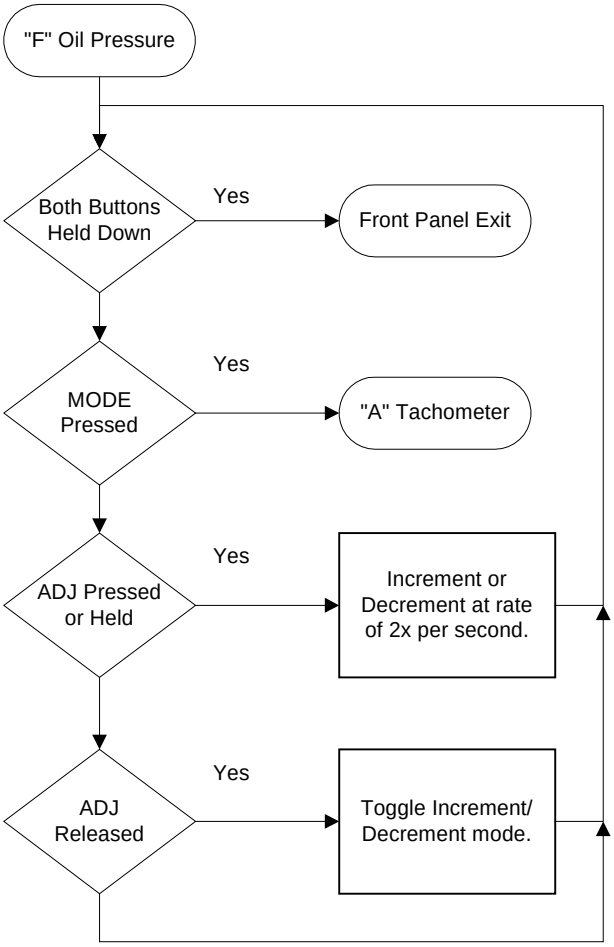
UP arrows indicate ADJ button increments the value to maximum of 1.

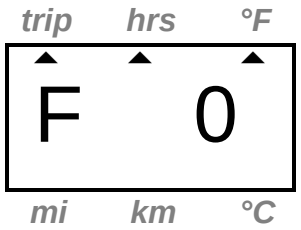


DOWN arrows indicate ADJ button decrements the value to minimum of 0.

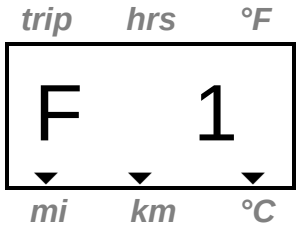
No.	Description
0	VDO
1	US

6.3.7 “F” Oil Pressure Sensor Selection





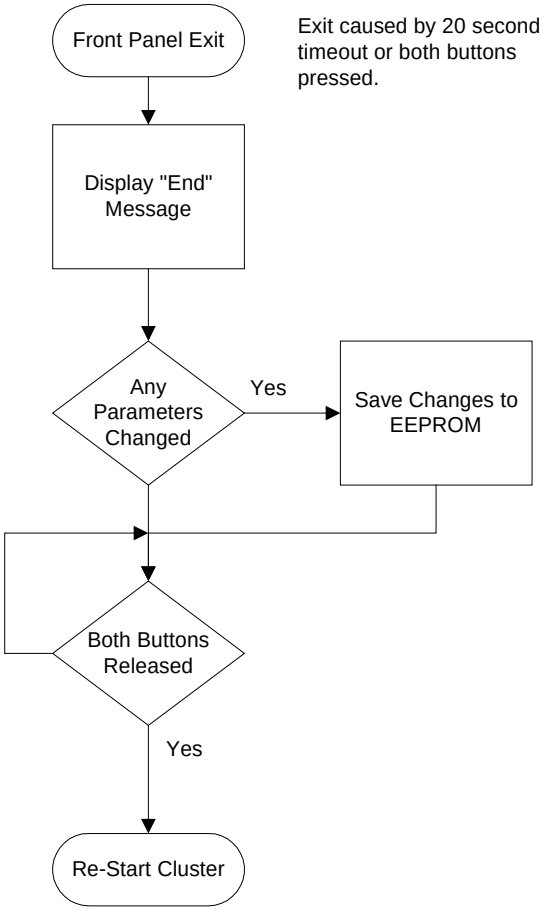
UP arrows indicate ADJ button increments the value to maximum of 1.

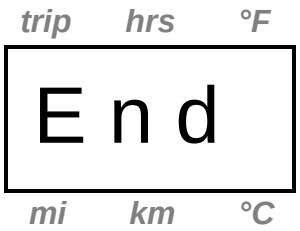


DOWN arrows indicate ADJ button decrements the value to minimum of 0.

No.	Description
0	VDO
1	US

6.3.8 Exit Front Panel Programming





7 Electrical Interconnection

7.1 Connector

The cluster connector is an Amp Mate-N-Lok.

12	11	10	9	8	7	6	5	4	3	2	1
24	23	22	21	20	19	18	17	16	15	14	13

Front view of Connector

7.1.1 Electrical Pinout

Pin No.	Signal	Pin No.	Signal
1	Depth transducer signal	13	Depth transducer return
2	GND (depth)	14	Depth Shield
3	GND (signal)	15	Spare (TEST/PGM Signal Prototypes only)
4	GND (Power)	16	Seawater Temperature
5	Lighting Input	17	Check Engine Warning Switch (O/B only)
6	Trim Input	18	Oil Level Warning Switch (O/B only)
7	Serial TX	19	Mode Push-button
8	Serial RX	20	Adjust Push-button
9	Fuel Input	21	Speed sensor (+), 12v out
10	Oil Pressure Input (I/O) or, Oil Pressure Warning Switch (O/B)	22	Ignition (B+)
11	Engine Temperature Input (I/O) or, Engine Temp. Warning Switch (O/B)	23	Battery
12	Tach Input	24	Speed Input

7.2 Input Signals

7.2.1 Overview

PIN #	Input Signal	Type	Referenced to	Pulled to	Switch to	By	Comment
1, 13	Depth Transducer	Pulse Delay	Floating			200 kHz transducer	transom or hull mounted
5	Illumination	Voltage or PWM	GND		Battery	external	dash mounted control
6	Trim	Resistance or Voltage	GND	Ignition		external sensor	trim drive system mounted
8	Serial RX	9600 baud	GND	internal +5 v		TTL levels	serial data link
9	Fuel	Resistance	GND	Ignition		external sensor	fuel tank mounted
10	Oil Pressure	Resistance **(I/O)**	GND	Ignition		external sensor	engine mounted
		Switch **(O/B)**	GND	Ignition	GND	warning switch	engine mounted
11	Engine Temperature	Resistance **(I/O)**	GND	Ignition		external sensor	Temperature Sender
		Switch **(O/B)**	GND	Ignition	GND	warning switch	engine mounted
12	Engine Speed	Frequency	GND	Ignition or 5v..12v electronic	GND	Ignition **(I/O)**	points, breakerless, or electronic
				floating	Battery	alternator **(O/B)**	
16	Seawater Temperature	Resistance	GND	Ignition		External sensor	thermistor
17	**O/B**: Check Engine	Switch	GND	Ignition	GND	warning switch	engine mounted
18	**O/B**: Low Oil	Switch	GND	Ignition	GND	warning switch	engine mounted
19	MODE button	Switch	GND	Dash power (Battery)	GND	TTL levels	Push-button
20	ADJUST button	Switch	GND	Dash power (Battery)	GND	TTL levels	Push-button
22	Ignition Voltage	Voltage	GND		+14 V	External	Ignition Switch
24	Boat Speed	Frequency	GND	Ignition	GND	external sensor	paddle-wheel hall-effect sensor

7.2.2 Analog Inputs

7.2.2.1 Trim

The trim signal is a either resistance or voltage signal from the trim sender. On resistance systems, the input is excited by ignition voltage across a voltage divider and the resultant voltage is routed to an 8 bit A/D. On voltage systems, the input is routed directly to the A/D.

7.2.2.2 Fuel

The fuel signal is a resistance signal from the fuel sender. The input is excited by ignition voltage across a voltage divider and the resultant voltage is routed to an 8 bit A/D.

7.2.2.3 Engine Temperature (I/O only)

The engine temperature signal is a resistance signal from the temperature sender. The input is excited by ignition voltage across a voltage divider and the resultant voltage is routed to an 8 bit A/D.

7.2.2.4 Oil Pressure (I/O only)

The oil pressure signal is a resistance signal from the pressure sender. The input is excited by ignition voltage across a voltage divider and the resultant voltage is routed to an 8 bit A/D.

7.2.2.5 Seawater Temperature

The seawater temperature signal is a resistance signal from the temperature sender. The input is excited by ignition voltage across a voltage divider and the resultant voltage is routed to a 10 bit A/D.

7.2.2.6 Voltage

The ignition voltage is measured directly at the ignition power input of the cluster. The input is divided down to 5 volts maximum and routed to an 8 bit A/D.

7.2.3 Digital Inputs

7.2.3.1 Oil Pressure (O/B) only

The active LOW Oil Pressure warning signal is provided by an engine mounted pressure switch. The switch contacts are normally open and close to Ground to provide the oil pressure warning signal. The input is pulled to ignition to produce a normally HIGH signal. The signal is routed to an 8 bit A/D where the acquired data is compared to HIGH & LOW digital signal thresholds.

7.2.3.2 Engine Temperature (O/B only)

The active LOW Engine Temperature warning signal is provided by an engine mounted temperature switch. The switch contacts are normally open and close to Ground to provide the high temperature warning signal. The input is pulled to ignition to produce a normally HIGH signal. The signal is routed to an 8 bit A/D where the acquired data is compared to HIGH & LOW digital signal thresholds

7.2.3.3 Check Engine (O/B only)

The active LOW Check Engine warning signal is provided by an engine mounted switch. The switch contacts are normally open and close to Ground to provide the check engine warning signal. The floating and isolated input is pulled to internal 5v logic power to produce a normally HIGH signal. The signal is routed to a polled digital input port.

7.2.3.4 Low Oil Level (O/B only)

The active LOW Oil Level warning signal is provided by an engine oil level switch. The switch contacts are normally open and close to Ground to provide the oil level warning signal. The floating and isolated input is pulled to internal 5v logic power to produce a normally HIGH signal. The signal is routed to a polled digital input port.

7.2.3.5 MODE button

The active LOW Mode button signal is provided by a dash mounted button or switch The switch contacts are normally open and close to Ground when activated by the operator. The floating and isolated input is pulled to internal 5v logic power to produce a normally HIGH signal. The signal is routed to a polled digital input port.

7.2.3.6 ADJUST button

The active LOW Adjust button signal is provided by a dash mounted button or switch. The switch contacts are normally open and close to Ground when activated by the operator. The floating and isolated input is pulled to internal 5v logic power to produce a normally HIGH signal. The signal is routed to a polled digital input port.

7.2.4 Frequency Inputs

7.2.4.1 Speedometer Signal

The speedometer signal input is driven from a paddle wheel sensor and is nominally 12,429 pulses per nautical mile (10,800 pulses per statute mile). The pulses are a 12 volt square wave and are filtered by a signal conditioning circuit.

Speedometer Signal Definition		** Four Winns
Hertz per mph (nominal)	3.00	5.9722
pulses per statute mile (nominal)	10,800 pulses	21,500 pulses
Input duty cycle	10 – 90 %	
max. indicated speed	80 mph	60 mph
max. frequency (nominal +50%)	360 Hz	538 Hz
min. speed	0 mph	0 mph
min. frequency	0 Hz	0 Hz

7.2.4.2 Tachometer Signal (I/O)

The I/O tachometer signal is taken from the engine's ignition. Inboard ignition can be standard points, breakerless, or electronic. The signal tapping point for points and breakerless systems is typically the negative (-) terminal of the coil. The signal tapping point for electronic systems can be the (-) terminal or a special conditioned pulse output terminal depending on the system. The signal frequency is a function of the number of engine cylinders (2, 4, 6, 8, 10, or 12), and is expressed as 'n' pulses per revolution.

I/O Tachometer Signal Definition	
pulses per engine revolution	1, 2, 3, 4, 5, & 6
max. indicated engine speed	6000 rpm
max. frequency	600 Hz (6 ppr @ 6000 rpm)
min. indicated engine speed	325 rpm
min. frequency	5.4 Hz (1ppr @ 325 rpm)

7.2.4.3 Tachometer Signal (O/B)

The O/B tachometer signal input is taken from the engine's alternator. The signal tapping point is the rectifier output terminal. The signal frequency is a function of the number of magnetic poles in the alternator(4, 6, 8, 12, or 20), and it is expressed as 'n' pulses per revolution.

O/B Tachometer Signal Definition	
pulses per engine revolution	2, 3, 4, 6, & 10 pulses
max. indicated engine speed	7000 rpm
max. frequency	1166.7 Hz (10ppr @ 7000 rpm)
min. indicated engine speed	325 rpm
min. frequency	10.8 Hz (2ppr @ 325rpm)

7.2.5 Depth Sounder Receive

The depth sounder signal and operation is discussed in detail in section 5.9.

7.3 Output Signals

7.3.1 Overview

PIN#	Output Signal	Type	Signal Parameters	Referenced to	Comment
1, 13	Depth Transducer	sonar pulse	200KHz	Floating	200 kHz Transducer
7	Serial TX	9600 baud	TTL levels	GND	serial data link
21	Speed Sensor +12v supply	DC	Ignition	GND	protected & filtered

7.3.2 Speed Sensor Power Supply

The cluster provides a protected and filtered ignition supply tap for the paddle wheel speedometer sensor.

7.3.3 Depth Sounder Transmit

The depth sounder signal and operation is discussed in detail in section 5.9.