automotive
mannesmann
VDO

Bayliner
Model Year 2001

Electrical &
Functional Specification

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2 Scope

This specification defines the electrical and functional characteristics for the Bayliner Marine Instrument Cluster 2001.

3 History

Revision	Revision Date	Description
1.0	Nov. 15, 1999	Initial Release for Custome Review
1.1	Jan. 07,1999	Added Tell Tales and Feature/Factory programming Connector
1.2	Mar 02,2000	Updated and removed unused table data
1.3	Apr 07,2000	Updated coolant sensor data and removed unused table data
1.4	Nov 8,2000	Added Data for Pitot Sensor Connector
1.5	Feb 5,2001	Corrected test LED connection for Pitot Function

4 Overview

The Instrument Cluster is used to communicate information on the operation and performance of the craft to the operator.

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.

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 (60 mph) - 270° crosscoil movement
- Tachometer (6000 rpm) - 270° crosscoil movement
- Fuel Level - 90° crosscoil movement
- Oil Pressure - 90° crosscoil movement
- Coolant Temperature - 90° crosscoil movement
- Voltage Level - 90° crosscoil movement
- Trim - 90° crosscoil movement
- Depth Sounder - single row 4 digit, 7 segment, LC display and Telltales for FEET or METERS, shallow water indication
- 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

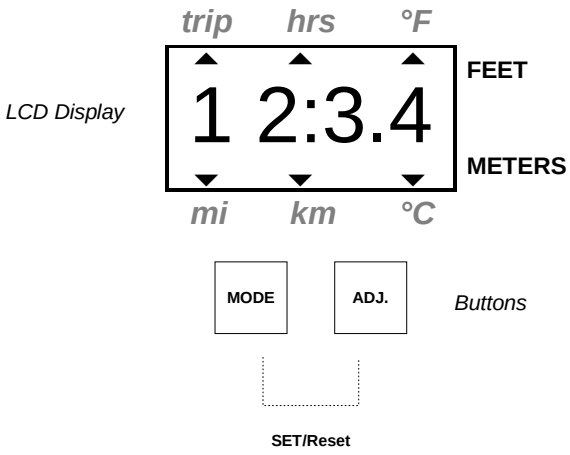
4.2.3 O/B Cluster functions:

- Speedometer (60 mph) - 270° crosscoil movement
- Tachometer (6000 rpm) - 270° crosscoil movement with non-linear scale
- Fuel Level - 90° crosscoil movement
- Voltage Level - 90° crosscoil movement
- Trim (Optional) - 90° crosscoil movement
- Depth Sounder - single row 4 digit, 7 segment, LC display and Telltales for FEET or METERS, shallow water indication
- 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.

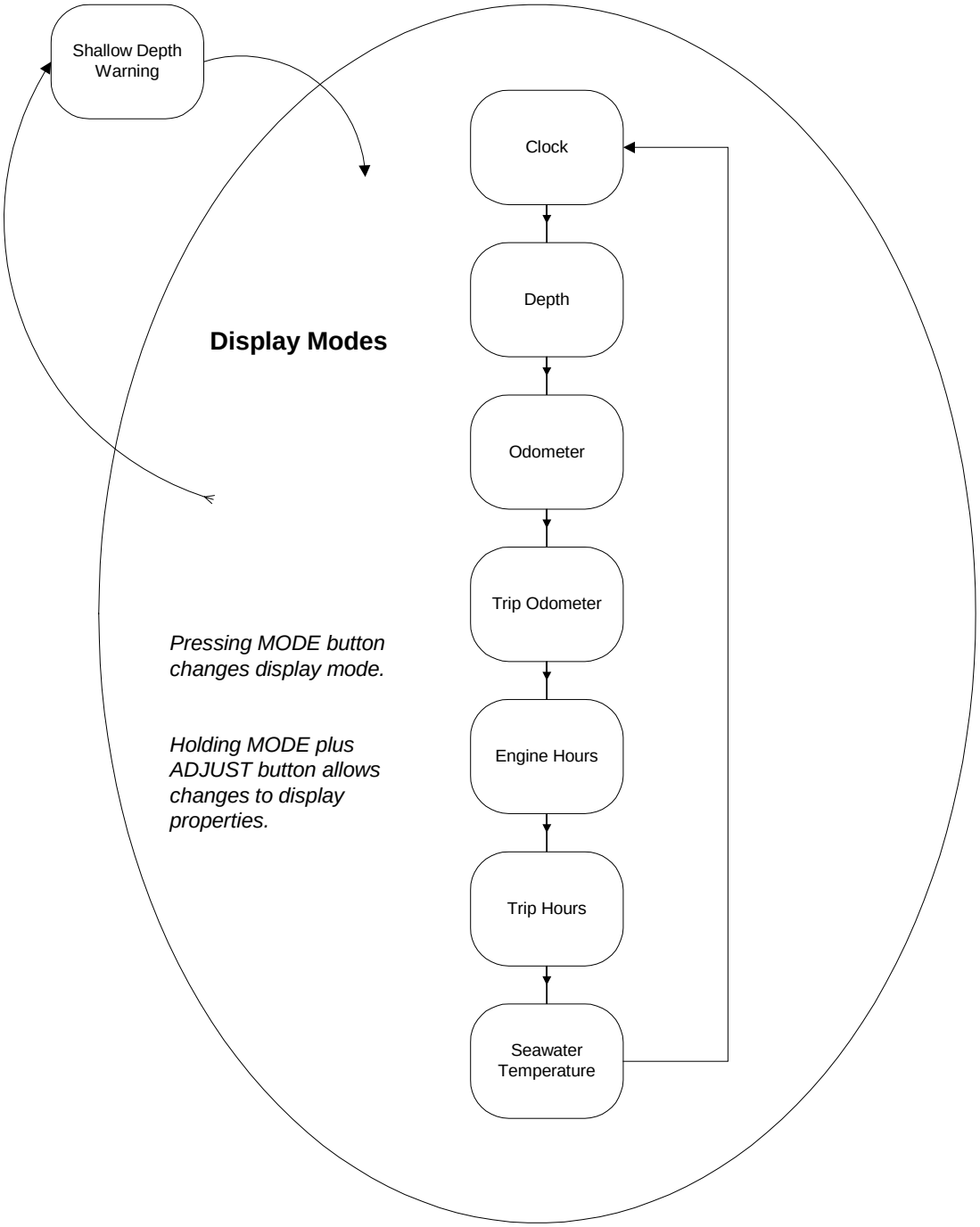
Various information types can be displayed on the LCD. The operator advances through the available displays by pressing the MODE button. Dial legends surrounding the LCD are highlighted by pointer symbols above and below the numeric segments. Depth sounder mode is indicated by lighting the FEET or METERS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



5 Functional Specifications

5.1 Speedometer Gauge Indication

5.1.1 General Function

Boat speed can be measured by either a pulse generating paddle wheel or by Pitot tube by using factory installed electronic Pitot speed measuring system with the aid of an external analog sensor (this technology is patent pending by VDO North America LLC). The cluster automatically detects when the Pitot analog sensor system is in use and displays speed based on the pressure from the Pitot tube. The Pitot system also linearizes the pressure to speed curve.

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.

5.1.2 Pitot Speed Sensor Input / Nulling

If a Pitot speed sensor is used the following steps needs to be taken to null the sensor. If the Adjust Switch is pressed down during the power up sequence Microcontroller looks for activation of this input and will store the voltage from the sensor (as read by the ADC) to indicate the zero position (zero speed) and will save the null data in a non-volatile memory for reference. The null (calibration) procedure will take place automatically every time the module is powered up, the only difference is, if the null input is not detected the data will not be saved in the non-volatile memory.

5.1.3 Scale / Accuracy / Calibration

min. indicated speed	0 MPH
max. indicated speed	60 MPH
Speedometer accuracy	±1.5 mph up to 40 mph, ±3 mph over 40 mph

5.1.4 Paddlewheel Sensor Characteristic

Speed (mph)	Uncompensated input @ 3Hz per mph (10800 PPM)	Pointer deflection angle (calibration points in EEPROM) *	Dial graduation (mph)
0	0	0° *	0
10	30	45°	10
20	60	90° *	20
30	90	135°	30
40	120	180° *	40
50	150	225° *	50
60	180	270° *	60

5.1.5 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
Tachometer accuracy	±140 rpm up to 5000 rpm, ±280 rpm over 5000 rpm

5.2.3 Tachometer Characteristics

Dial Graduation (rpm x1000)	*4 cyl. / 4 pole*	*6 cyl. / 6 pole*	*8 cyl. / 8 pole*	*I/O 6000 rpm Linear scale*
	Frequency (Hz)			
0	0	0	0	0 *
1	33	50	66.7	45
2	66.7	100	133.3	90
3	100	150	200	135 *
4	133.3	200	266.7	180
5	166.7	250	333.3	225
6	200	300	400	270 *

5.2.4 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.

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		Calibration
		Resistance [Ω]	Tolerance [Ω]	* (calibration points in EEPROM)
E	0°	240	+7	Pointer Placed Start Calibration *
(1/4)	22.5°	153	±6	Ascending *
(1/2)	45°	103	±5	Calculated *
(3/4)	67.5°	67	±4	Interpolated
F	90°	33	–9	Ascending *

5.3.3 Fault Conditions

- fuel sensor signal less than 15Ω with a tolerance of +2Ω for U.S. sensor.
- fuel sensor signal more than 280Ω with a tolerance of –3Ω for U.S. sensor.

When a fault is detected the pointer moves 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.

5.4.2 Scale / Accuracy / Calibration

U.S. Standard Sensor					
Dial graduation	**Angle**	**Resistance** [Ω]	**Tolerance** [Ω]	**Temp.** [°f]	**Calibration** * (calibration points in EEPROM)
Cold	0°	441	±27	100°	Start Cal *
	22.5°	206	±18	137°	Interpolated *
	45°	107	±9	175°	Ascending
	67.5°	58	±4	213°	Calculated *
Hot	90°	35	±3	250°	Set Pointer Ascending *

5.4.3 Fault Conditions

- coolant sensor signal less than 22Ω with a tolerance of +3Ω for U.S. sensor for longer than 5 sec.
- high resistance or open circuits faults are NOT reported.

When a fault is detected 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.

5.5.2 Scale / Accuracy / Calibration

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

5.5.3 Fault Conditions

- pressure sensor resistance below 15Ω with a tolerance of +2Ω for U.S. sensor.
- pressure sensor resistance above 280Ω with a tolerance of -3Ω for U.S. sensor.

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.

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

5.7.1 General 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)				
Mark	**Angle**	**Resistance [Ω]**	**Tolerance [Ω]**	**Calibration** * (calibration points in EEPROM)
UP	90°	60	±5	Ascending *
	67.5°	35	±5	Calculated *
Mid Point	45°	26	±4	Interpolated
	22.5°	16.7	±5	Ascending *
DOWN	0°	11	±1	Pointer Placed Start Cal. *

5.8 Depth Sounder

5.8.1 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 blinking up/down arrow segments.

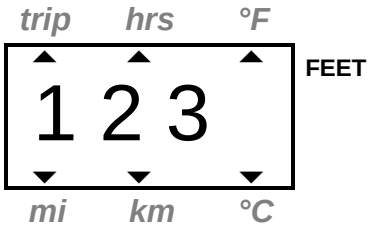
The shallow water alarm setting is displayed as blinking digits. Current depth is displayed as steady (not blinking) digits. If the alarm screen is blank no shallow water alarm is set. If the depth screen shows dashes the depth is zero or indicates a bad sensor reading.

For details on display and operation refer to section 5.9.4.

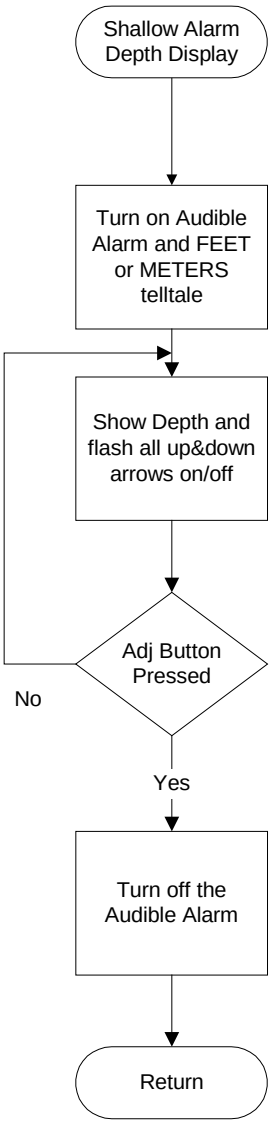
5.8.2 Specifications

Range:	1 to 300 feet (0.3 to 91.4 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

5.8.3 Shallow Water Alarm Display Properties



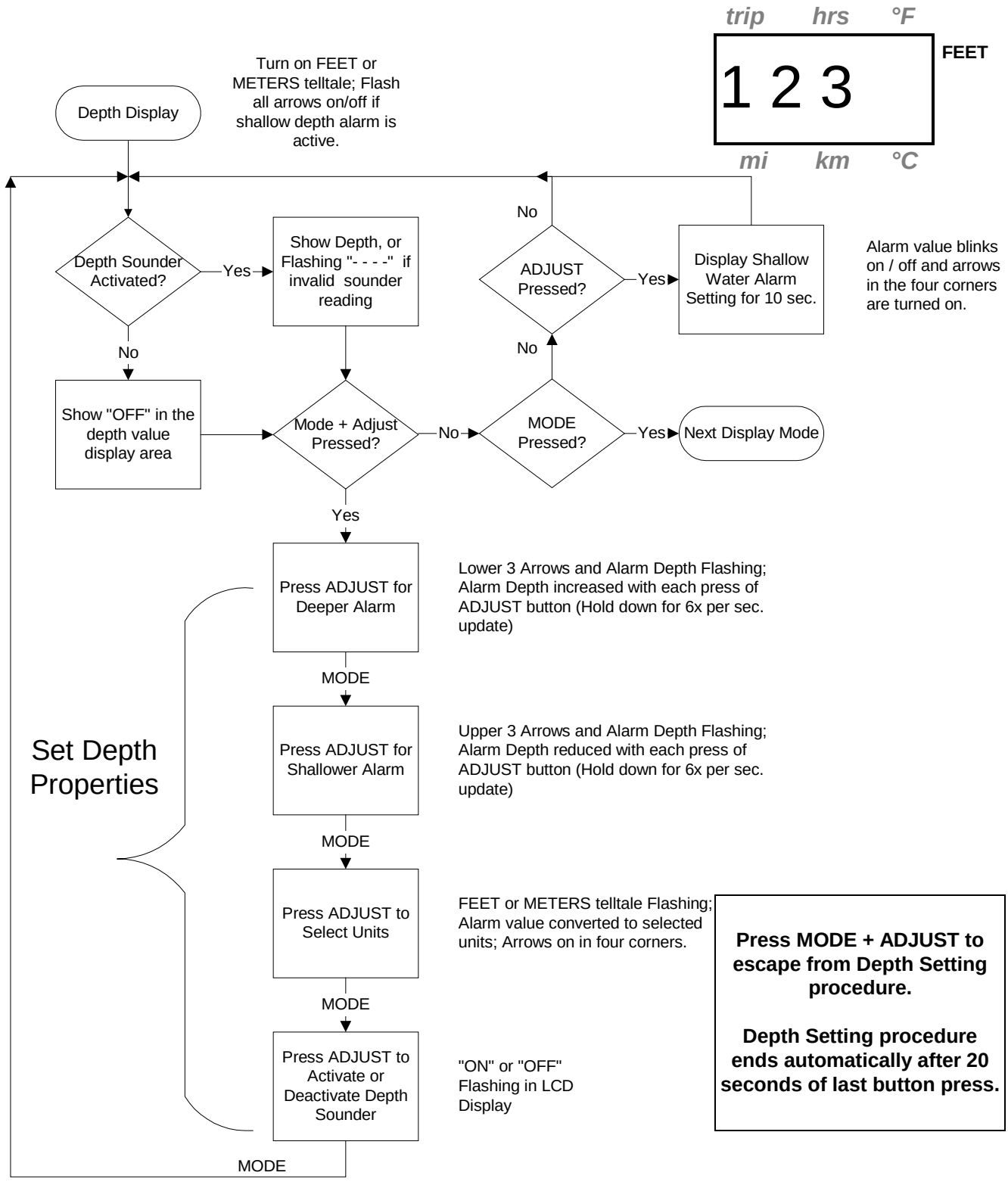
All Arrows Up / Down Flashing



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

Resume last active Display Mode

5.8.4 Depth Display Properties



5.9 Clock Display

5.9.1 General Function

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

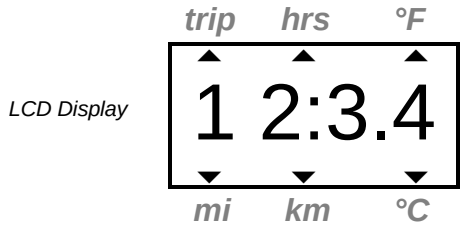
Time of day is set by holding MODE and ADJUST for 1.5 seconds while in the Clock Display mode. MODE is then used to advance through the time set features. Hours are set first, then minutes, then 12/24 hour mode. The selected digits blink while being set. While in set mode ADJUST is pressed to increment 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.

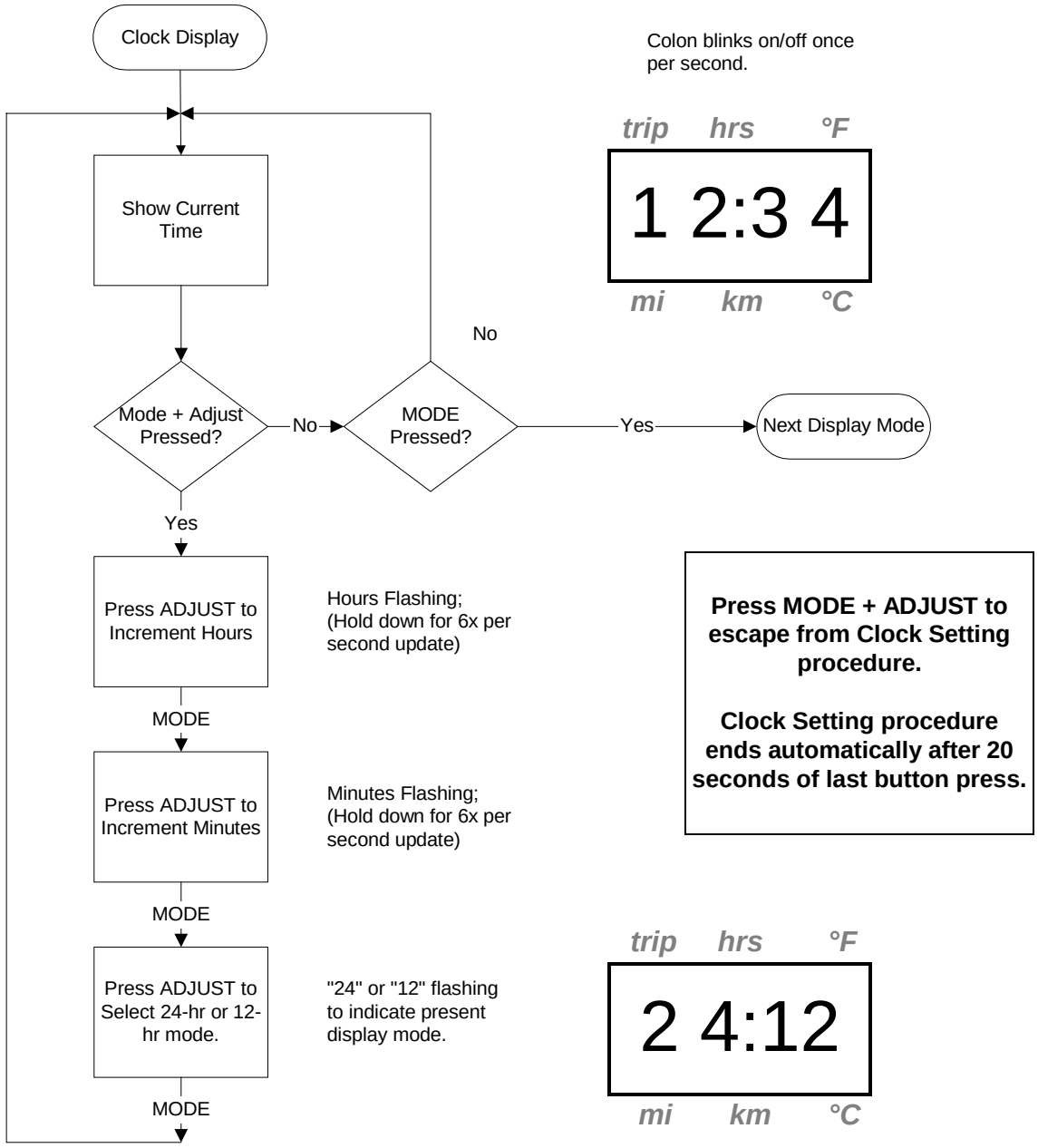
When the ignition is turned off the present mode is saved and the LCD displays time of day. Time setting functions are not available with the ignition off. When the ignition is turned on the LCD returns to its prior display mode.

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.)



5.9.2 Clock Display Properties



5.10 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.

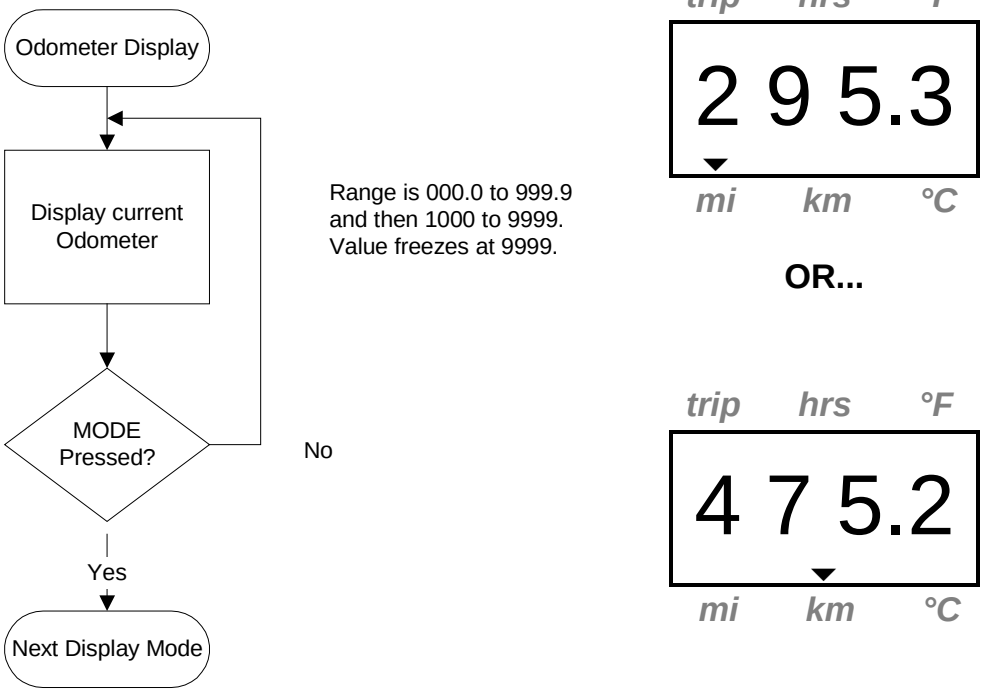
5.10.1 Specifications

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.

5.10.2 Odometer Display Properties



Note:

Odometer Reset is a Factory operation only.

Odometer Units follow depth selection:

Feet => MI

METERS => KM

5.11 Trip Odometer

An operator resetable 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.

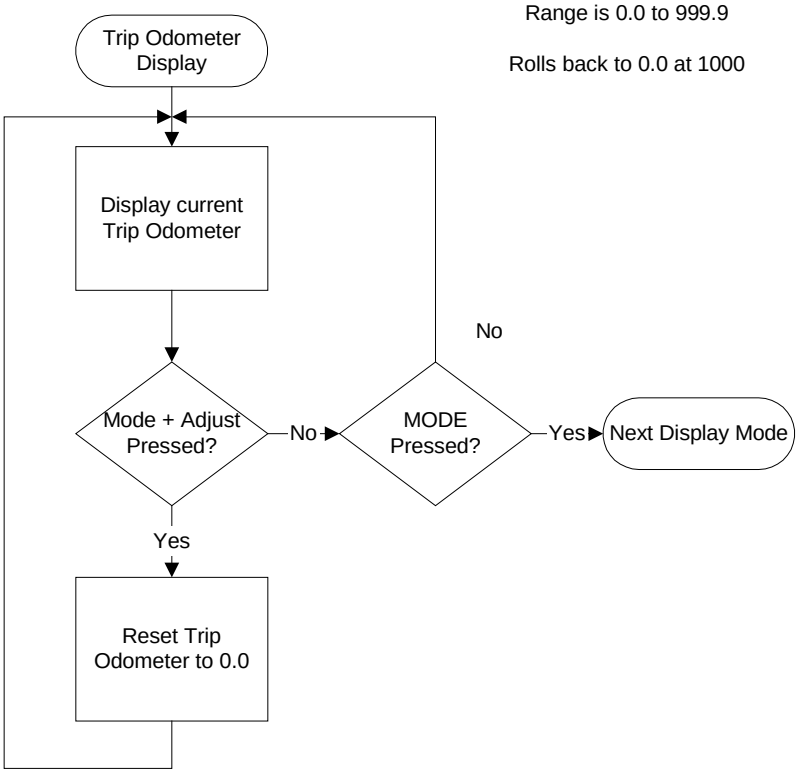
5.11.1 Specifications

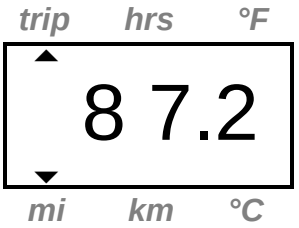
Range:	1000 miles or 1000 km.
	Rolls back to 0.0 miles or km. every 1000 miles or km.
Sensor:	See section 5.1 for speed sensor characteristics
Display Properties:	0.0 to 999.9 mi or km.
Display Resolution:	0.1 miles or 0.1 kilometers
Display Units:	MI or KM, operator selectable w/EEPROM default at battery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

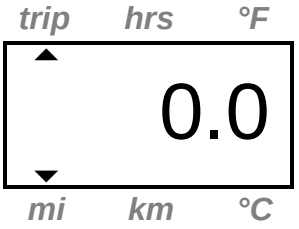
NOTE:

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

5.11.2 Trip Odometer Display Properties







Trip Odometer Units follow depth selection:

Feet => MI

METERS => KM

5.12 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.

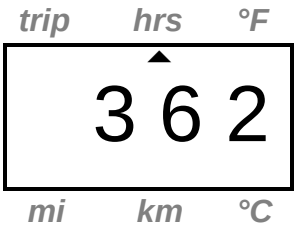
5.12.1 Specifications

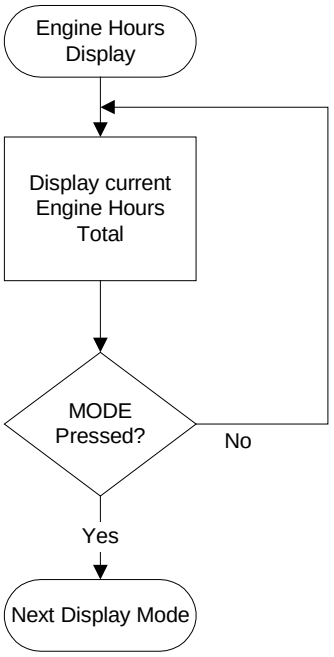
Range:	9999 hours
	Total freezes at 9999 hours.
Minimum Speed:	Time below 325 rpm not counted..
Sensor:	See section 4.2 for tachometer sensor characteristics
Display Properties:	0 to 9999 hours
Display Resolution:	1 hour
Display Units:	hours
EEPROM updated:	Every 15 minutes of engine running time.
EEPROM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

5.12.2 Engine Hours Display Properties





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

Note:

Total Hours only updated when Engine Running.

5.13 Trip Engine Hours

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

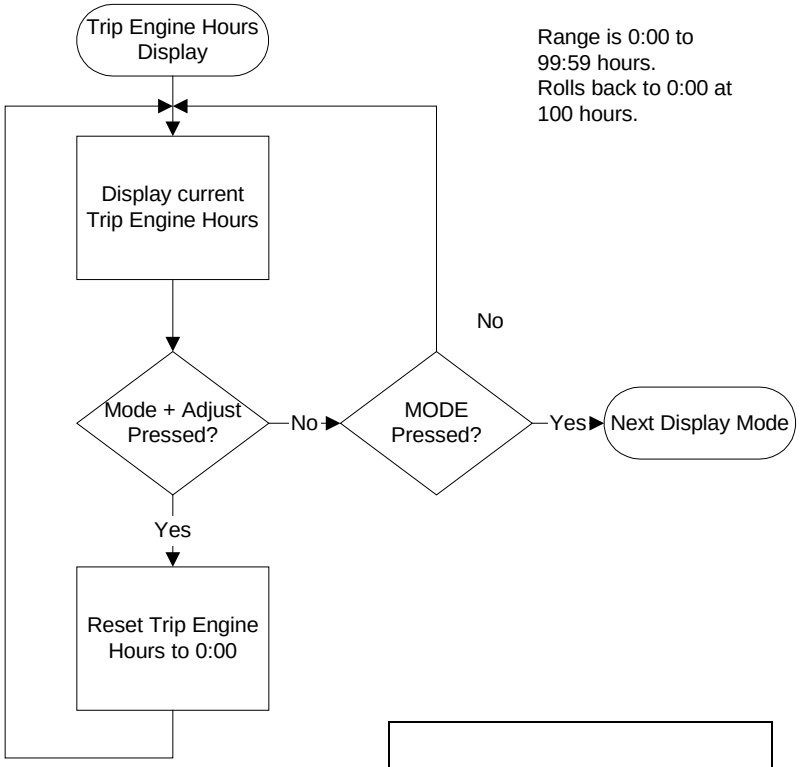
5.13.1 Specifications

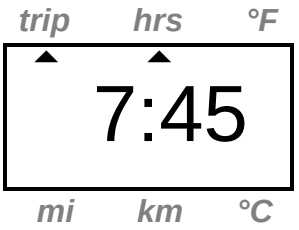
Range:	100 hours
Minimum Speed:	Time below 325 rpm not counted.
Sensor:	See section 4.2 for tachometer sensor characteristics
Display Properties:	0:00 to 99:59
Display Resolution:	1 minute
Display Units:	hours and minutes

NOTE:

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

5.13.2 Trip Engine Hours Display Properties





Note:

Trip Hours only updated when Engine Running.

5.14 Seawater Temperature

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

5.14.1 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

5.14.2 Characteristics

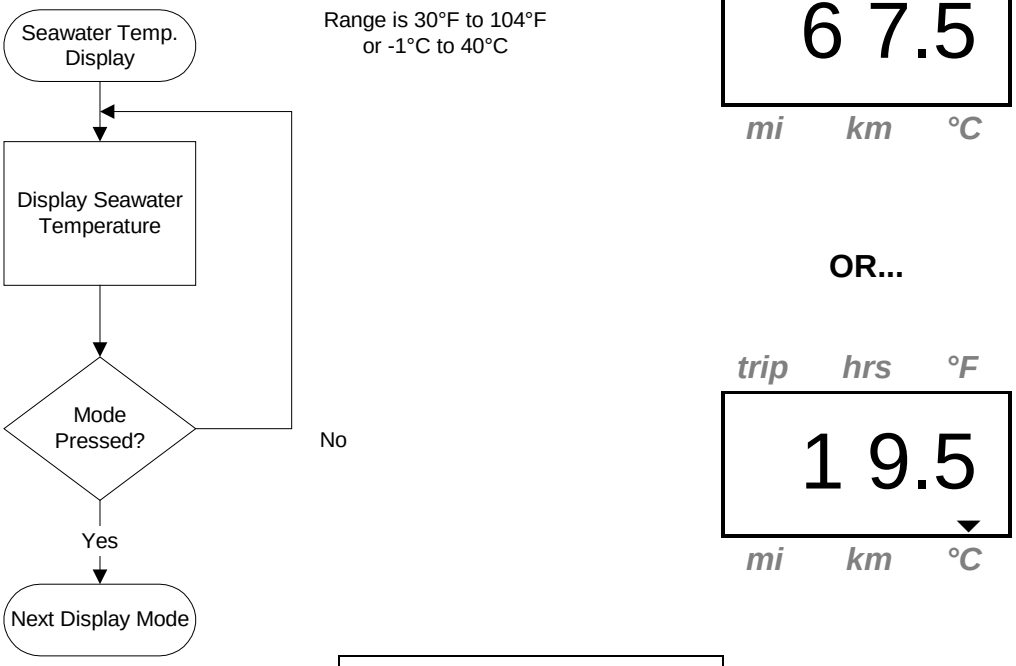
Displayed Temperature		Display Tolerance		Resistance [Ω] ±100
°C	°F	°C	°F	
-1.0	30.0	+1.0 / -0	+2.0 / -0	34400
13.0	55.0	±1.0	±2.0	16800
22.0	71.5	±1.0	±2.0	11200
33.0	91.0	±1.0	±2.0	6900
40.0	104.0	+0 / -1.0	+0 / -2.0	5300

5.14.3 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.

5.14.4 Seawater Temperature Display Properties



Temperature Units follow depth selection:

Feet => °F

METERS => °C

6 Front Panel Programming

This section defines built-in Front Panel Programming for the Bayliner Marine Instrument Cluster 2001.

6.1 Overview

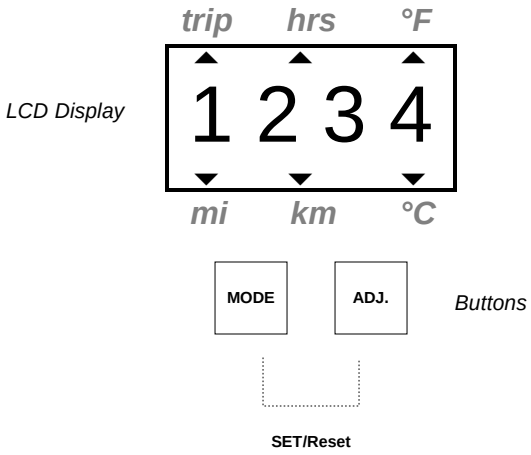
A limited range of field adjustments can be made to the cluster. The process is carried out by special button press sequences. Access to the front panel re-programming features is only possible upon ignition on and requires the operator to simultaneously hold down both the MODE and ADJ buttons for 5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

Setup/Programming Features:

- Tachometer Pulses per Engine Revolution, from 1 to 12
- 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:

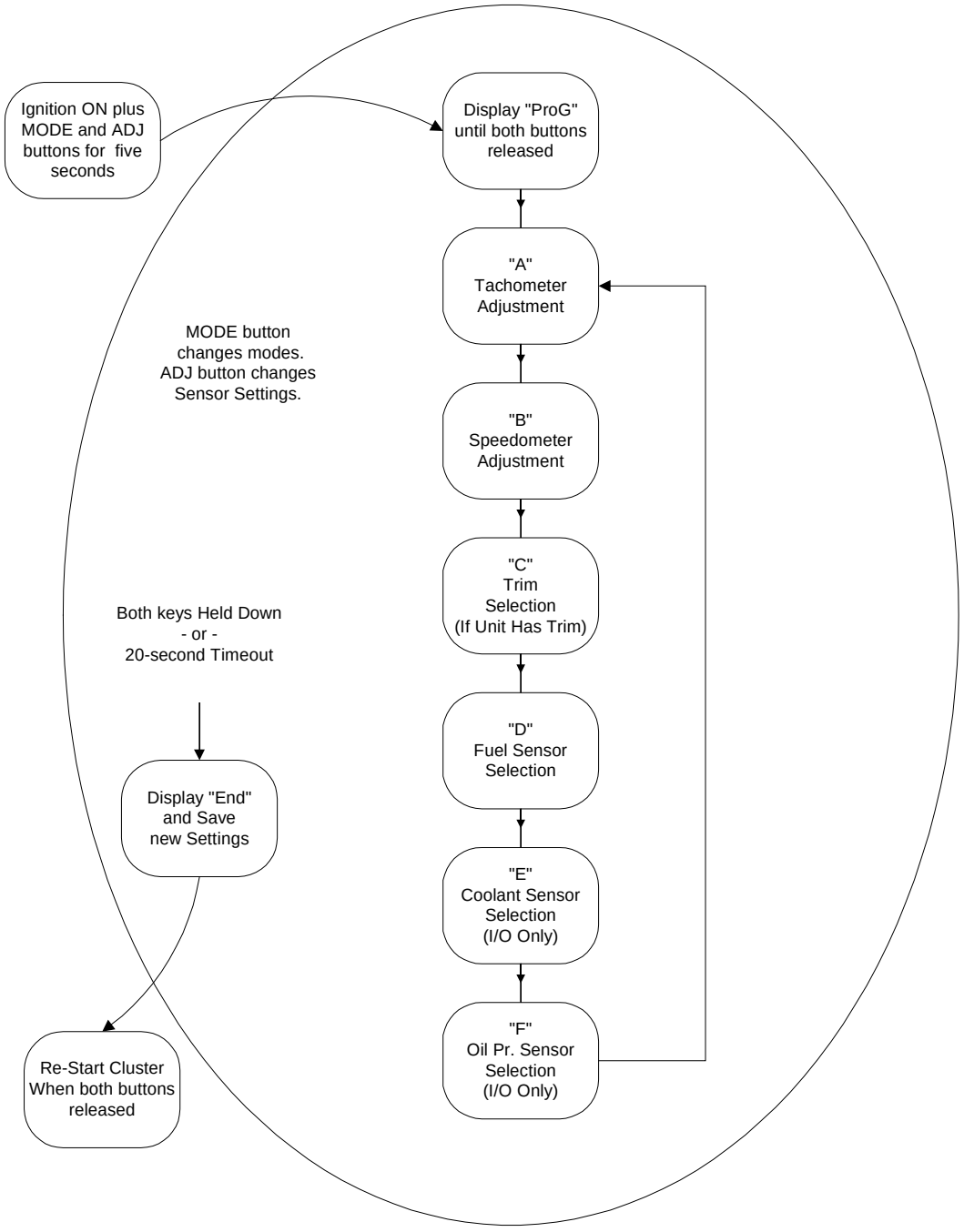
- **Pressed**: Button pushed down for 0.15 to 1.175 seconds and then released.
  Advances to the next programming option: A -> B -> C…

- **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.

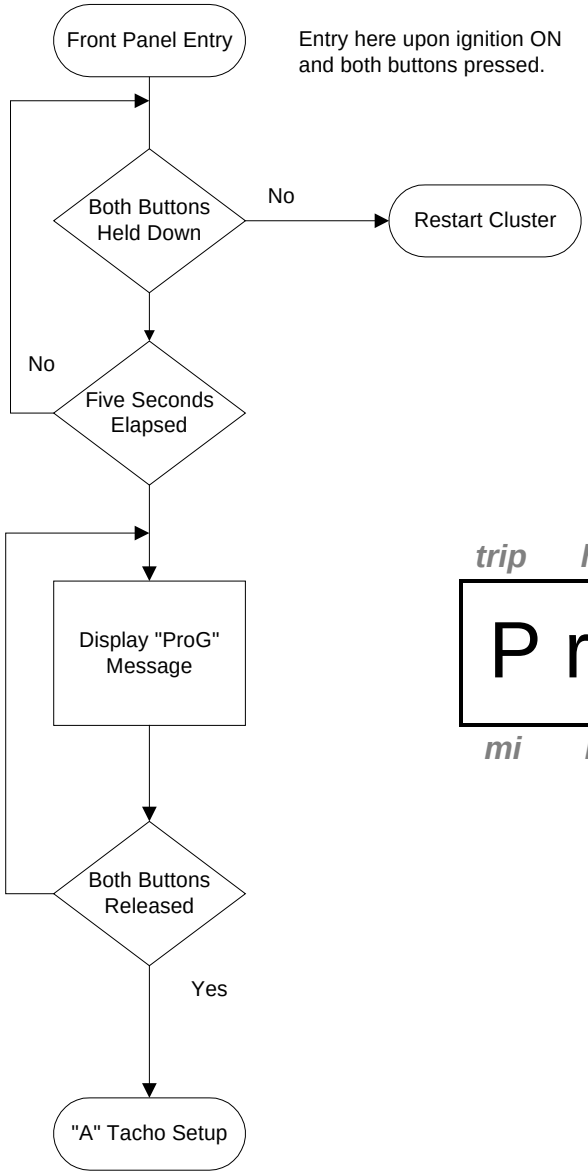
Combined Button States:

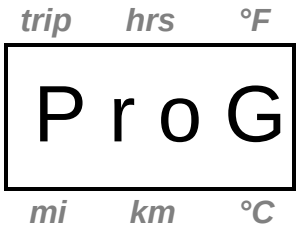
- **Held**: Both buttons held down for 1.2 seconds or more.
  Ends the Front Panel Programming process and saves any changed settings.

6.3 Programming Modes Overview

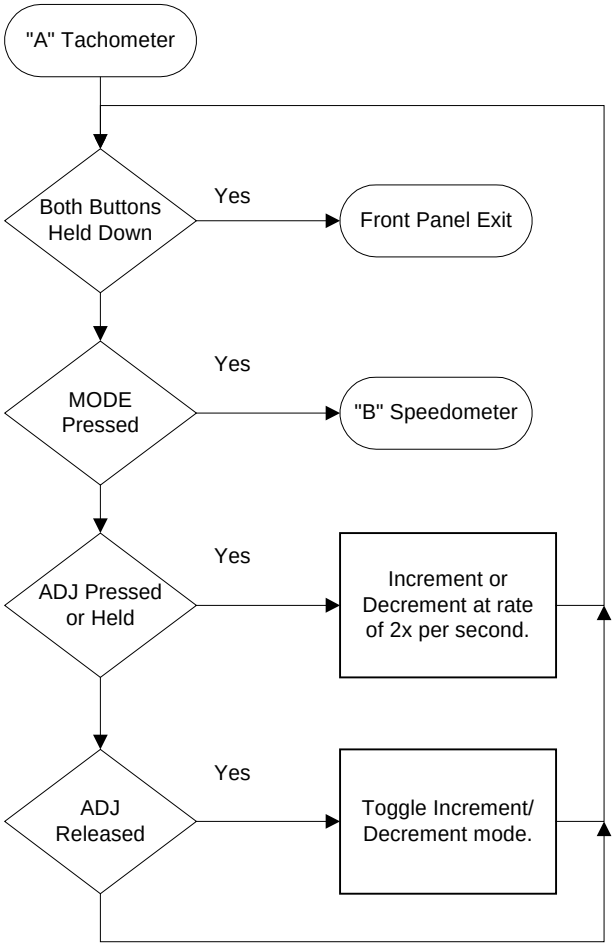


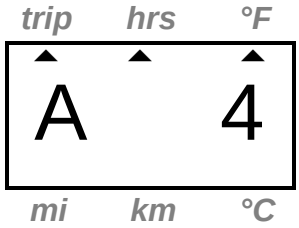
6.3.1 Entry To Front Panel Programming



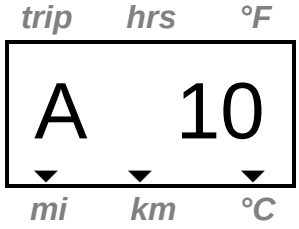


6.3.2 “A” Tachometer Adjustment





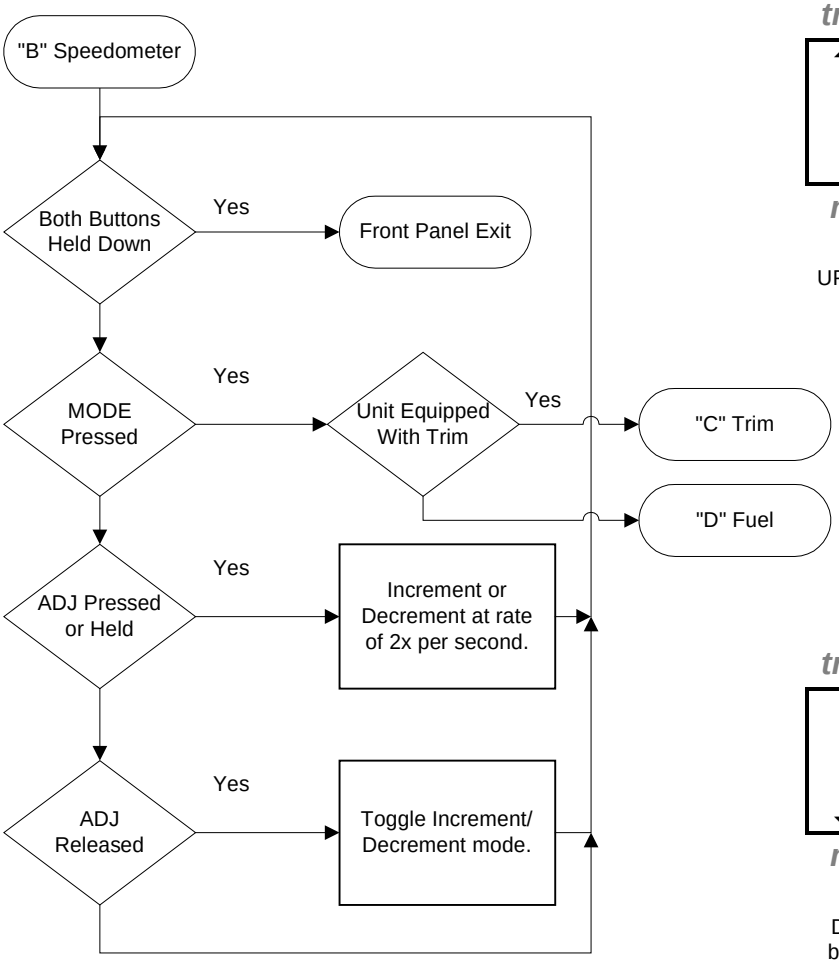
UP arrows indicate ADJ button increments the value to maximum 12 pulses per rev.

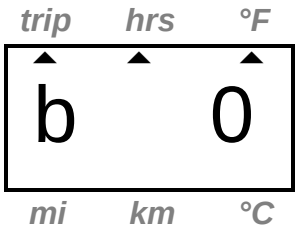


DOWN arrows indicate ADJ button decrements the value to minimum of 1 pulse per rev.

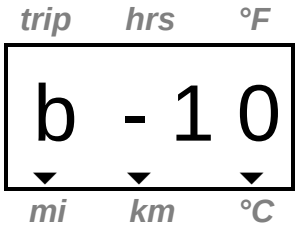
Pulses Per Engine Rev.
Minimum: 1
Maximum: 12

6.3.3 “B” Speedometer Adjustment





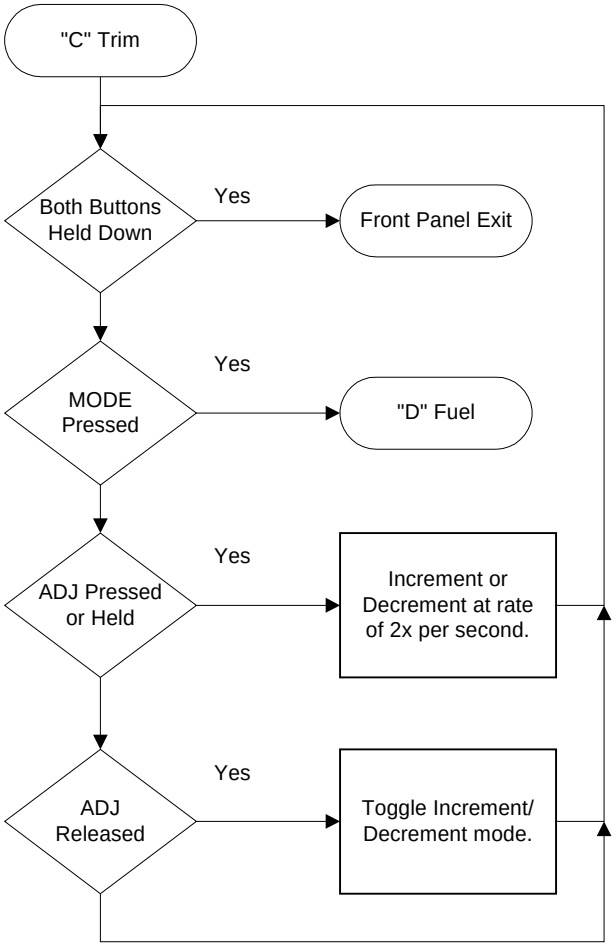
UP arrows indicate ADJ button increments the value to maximum of 50%.

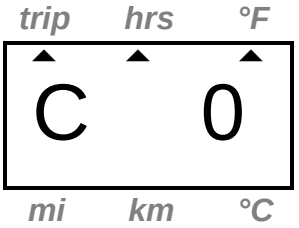


DOWN arrows indicate ADJ button decrements the value to minimum of - 50%.

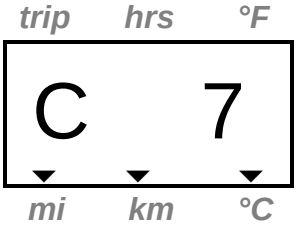
Speed Adjustment Range
- 50% to + 50%
of Original Setting

6.3.4 “C” Trim Sensor Selection





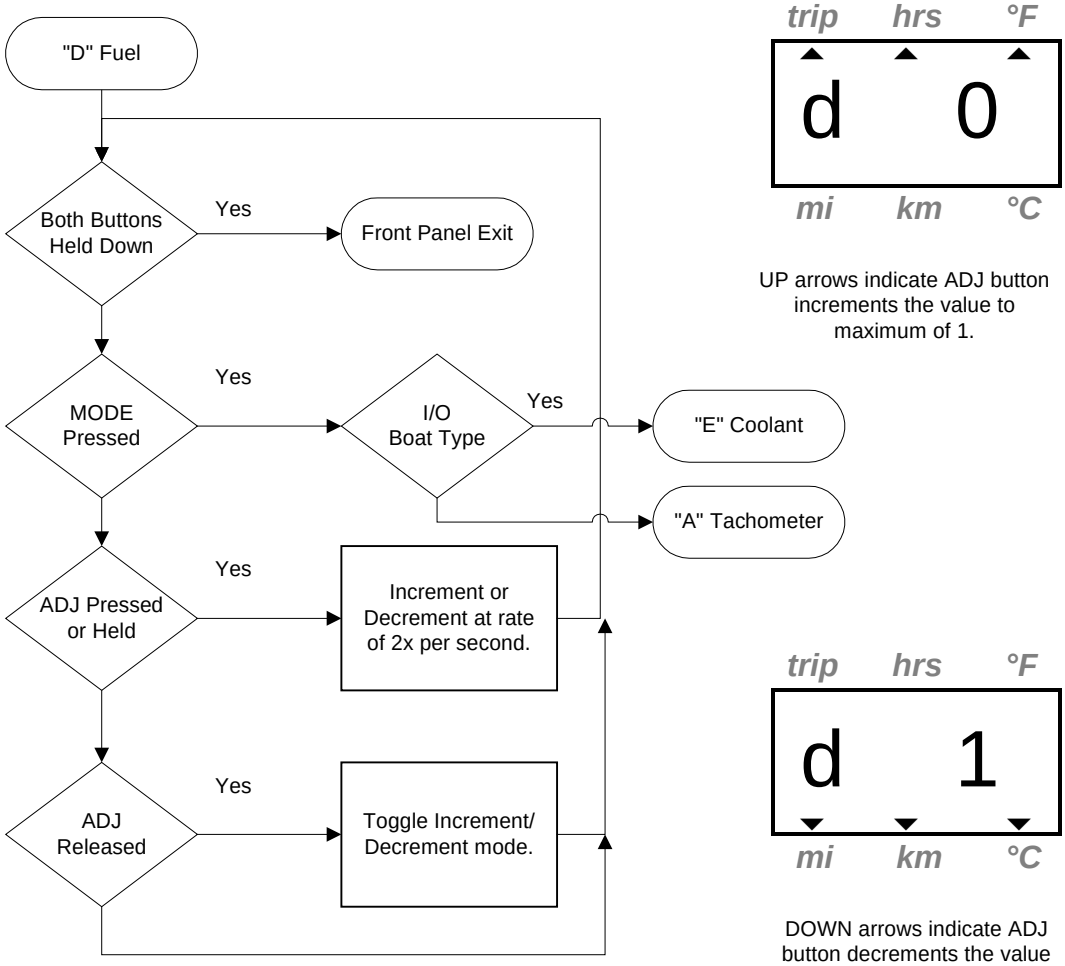
UP arrows indicate ADJ button increments the value to maximum of 8.



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

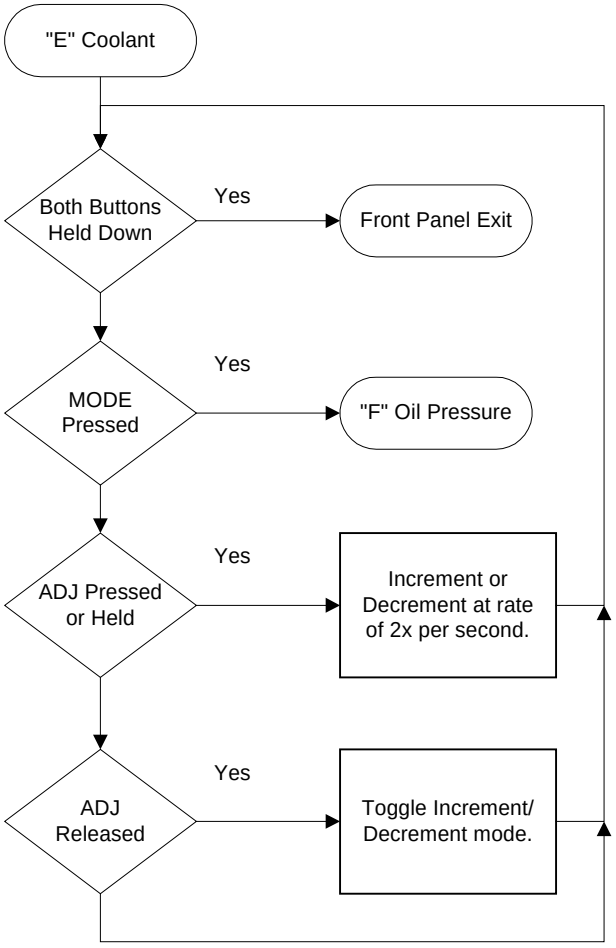
No.	Description
0	Mercury I/O
1	Mercury O/B
2	OMC Cobra I/O
3	Volvo DP/SX I/O
4	OMC O/B
5	Evinrude O/B
6	Johnson O/B
7	Honda O/B
8	Yamaha O/B

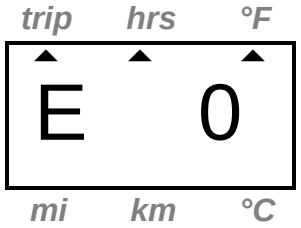
6.3.5 “D” Fuel Sensor Selection



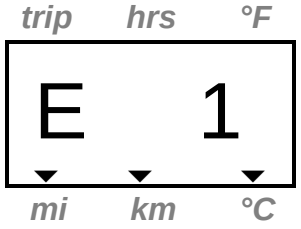
No.	Description
0	VDO
1	US

6.3.6 “E” Coolant Sensor Selection





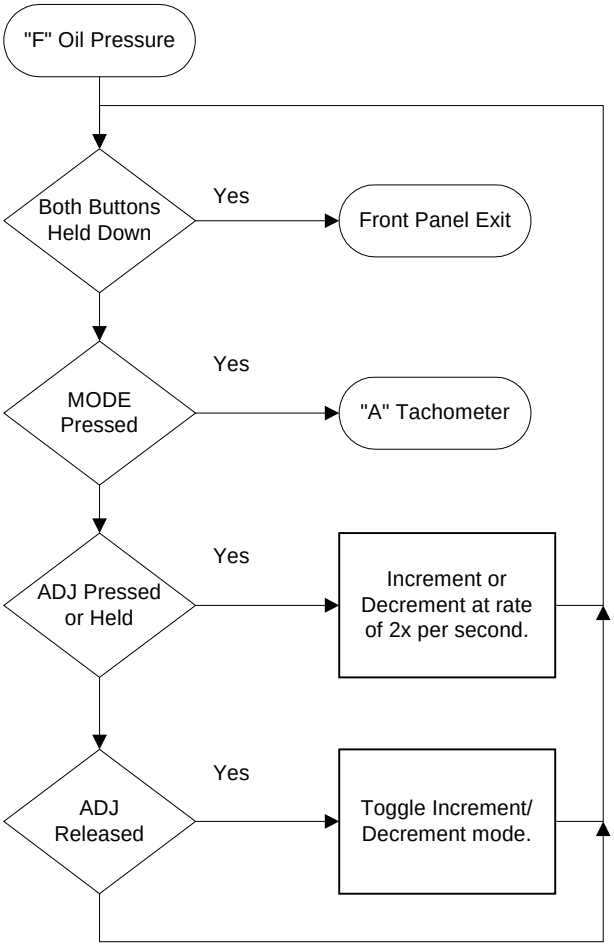
UP arrows indicate ADJ button increments the value to maximum of 1.

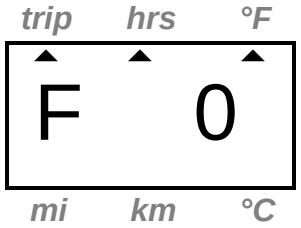


DOWN arrows indicate ADJ button decrements the value to minimum of 0.

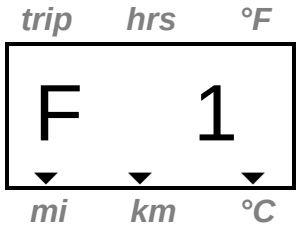
No.	Description
0	VDO
1	US

6.3.7 “F” Oil Pressure Sensor Selection





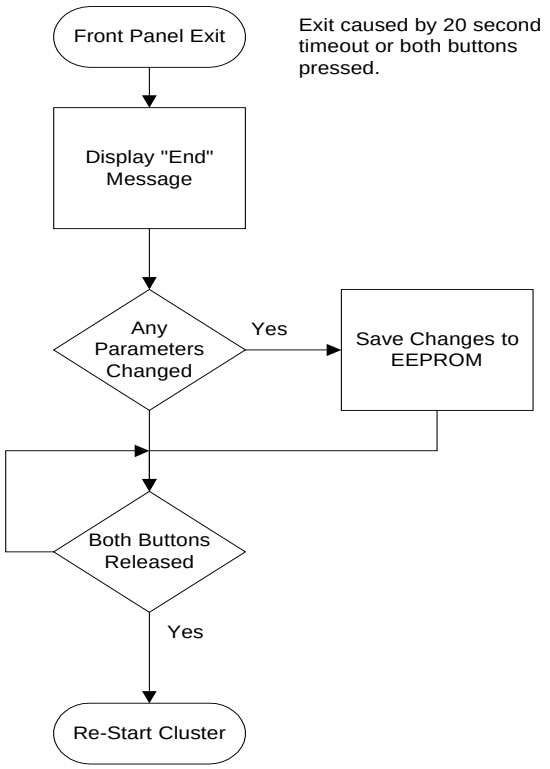
UP arrows indicate ADJ button increments the value to maximum of 1.

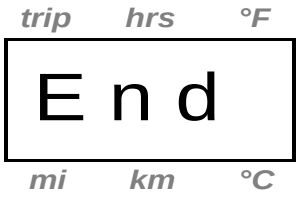


DOWN arrows indicate ADJ button decrements the value to minimum of 0.

No.	Description
0	VDO
1	US

6.3.8 Exit Front Panel Programming





7 Electrical Interconnection

7.1 Main Connector

The cluster connector is an Amp Mate-N-Lok. The mating connector is AMP part # 770587-1

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 Main Connector 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	Spare (Make no connection)
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	22	Ignition (B+)
11	Engine Coolant Temp. Input	23	Battery
12	Tach Input	24	Speed Input

7.2 Pitot Sensor Connector

Mating connector is AMP part number 770579-1, VDO sensor part number is 1 521 004 184A.

4	3	2	1
8	7	6	5

Front view of connector

7.2.1 Pitot Sensor Connector Pinout

Factory Programming and Pitot Feature Connector .

Pin No.	Signal	Description	Notes
1	Analog Sensor Power Out	+5 Volt Power for Special VDO Sensor	Maximum 20mA
2	Analog Sensor Signal Input	0.5 to 4.5 Analog Signal from Sensor	Voltage Proportional to Speed
3	Analog Signal Ground	Ground (Return) for Analog Sensor Only	Isolated Sensor Ground
4	Insitu Programming Data	Make no connection	Factory use only
5	Insitu Programming Clock	Make no connection	Factory use
6	Ground 1	Make no connection	Factory use / LED Cathode
7	Insitu MCLR/Vpp	Make no connection	Factory use only
8	Insitu test output	Null/Status LED Anode	Test use only

7.3 Input Signals

7.3.1 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
11	Engine Temperature	Resistance **(I/O)**	GND	Ignition		external sensor	Temperature Sender
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
18	Oil Level	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

7.3.2 Analog Inputs

7.3.2.1 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.

7.3.2.2 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.

7.3.2.3 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.

7.3.2.4 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.

7.3.2.5 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.

7.3.2.6 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.

7.3.3 Digital Inputs

7.3.3.1 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.

7.3.3.2 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.

7.3.4 Frequency Inputs

7.3.4.1 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	
Hertz per mph (nominal)	3.00
pulses per statute mile (nominal)	10,800 pulses
Input duty cycle	10 – 90 %
max. indicated speed	60 mph
max. frequency (nominal +50%)	270 Hz
min. speed	0 mph
min. frequency	0 Hz

7.3.4.2 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)

7.3.4.3 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	6000 rpm
max. frequency	1000 Hz (10ppr @ 6000 rpm)
min. indicated engine speed	325 rpm
min. frequency	10.8 Hz (2ppr @ 325rpm)

7.3.5 Depth Sounder Receive

The depth sounder signal and operation is discussed in detail in section 5.8.

7.4 Output Signals

7.4.1 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

7.4.2 Speed Sensor Power Supply

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

7.4.3 Depth Sounder Transmit

The depth sounder signal and operation is discussed in detail in section 5.8.