

FADEC electronic
March 2021

Software Version
mth21.01

Covers engines with analog throttle signal (Boxtype_3) or PWM signal (Boxtype_4) and electrically controlled (hydraulically operated) gear boxes with or without trolling valve. Boxtype_5 is for "throttle" by proportional thruster valve.

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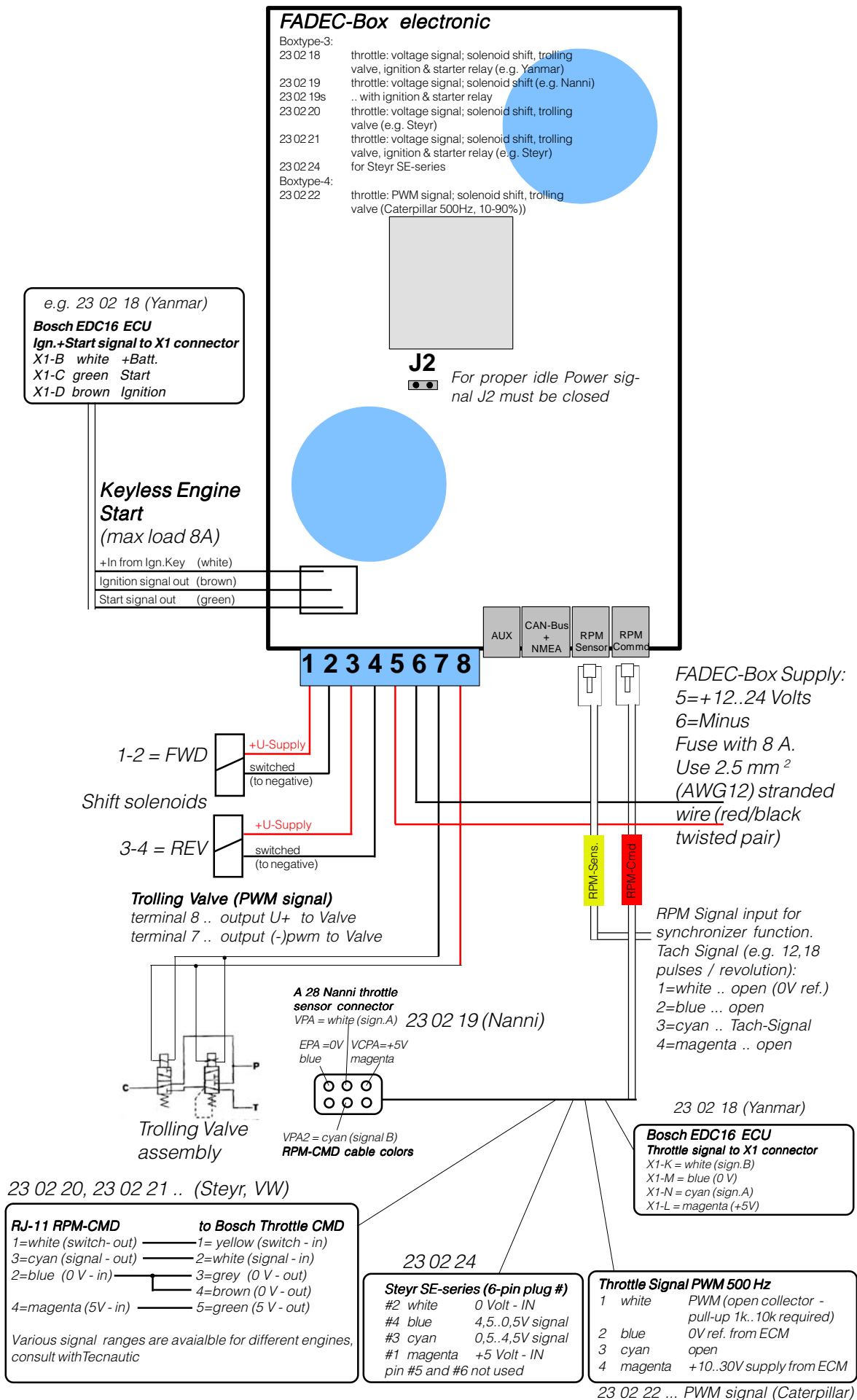
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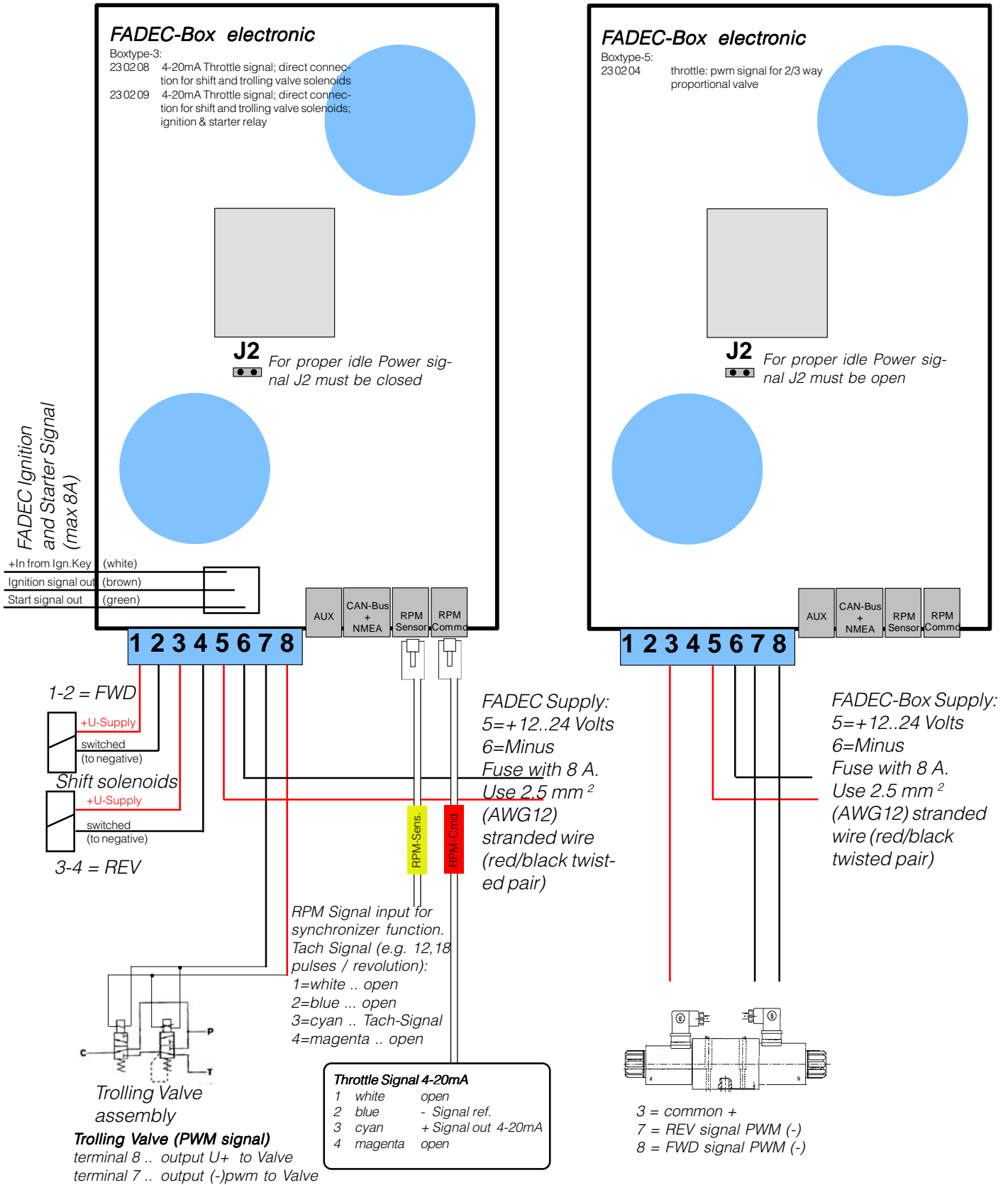
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Warning:

Only trained and qualified professionals should take responsibility to install the FADEC system on any kind of vessel. Only they know about the potential risks for life and property, involved with a potential failure of the system and loss of control of the vessel, as well as applicable laws.

Electrical Connection





A7 in the FADEC setup will determine the maximum Full-Throttle signal. A7=60 is for a 20mA signal at full throttle. Decrease A7 when a lower signal is desired.

Electrical Connection

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Wiring the ECU

Connect the ECU (engine control unit, supplied by the engine manufacturer) according the wiring diagram.

Throttle signal by Voltage:

Depending on the engine, there are different voltage signals available. Some versions provide a second signal, to permit verification of validity by the ECU.

Throttle by PWM signal:

Pin 1 = PWM signal (open collector, 1k..10k pull-up required)

Pin 2 = 0 Volt (supplied from ECU)

Pin 3 = open

Pin 4 = 10 to 30 V (supply from ECU)

Throttle signal by current 4-20mA:

Pin 1 = open

Pin 2 = - Signal

Pin 3 = + Signal 4-20mA

Pin 4 = open

Leave the Shift Valves initially unconnected, when testing the throttle response of the engine, or be sure to switch into WARM UP mode, before advancing the throttle.

Trolling Valve Wiring and Setup

Connect the Trolling Valve as shown. Only trolling valves with a combined connection for ON-OFF and pressure regulation can be connected (e.g. ZF-type). Adjust settings if needed (see also page 2 and 3):

1. On the Display unit: select the FADEC setup parameter "A6" (make sure only one Box is connected to the CAN-Bus during setup, no other FADEC-Box or Drivebox present).
2. With running engine select the low Mode and engage FORWARD IDLE. Adjust A6 for a slow shaft rotation (approx. 2 rev./sec). Verify switching between FWD and REV.

3. Select "A5" on the Display unit and switch from Trolling Mode to Normal Mode. Verify smoothness of clutch engagement when shifting quickly between FORWARD and REVERSE. Reduce A5 if clutch engagement is not gentle, but leave A5 as high as possible, for sufficient shaft braking during high speed shift reversal.

Wiring the Gear Box

Connect the shift valve solenoids as shown on the diagram.

Wiring Ignition and Starter

Enables engine start and stop from any installed Throttle Station.

Synchronizer

Engines are synchronized automatically on Twin Engine vessels.

Synchronizer function requires proper RPM signals (pulses) connected to each FADEC-Box. Such pulses are often provided by the ECU (ECM) for analog rpm gauges. For verification of proper RPM signal reception, display RPM readings on a Tecnautic Display unit (dF 92, select En.1 or En.2).

Synchronization takes place in NORMAL mode and with both throttles at same FORWARD position, when the throttle split is less than 150 rpm. Synchronization does not occur at low power settings or near full throttle.

Possible Problems

Engine stalls when shifting into gear

(Clutch is engaging normally. Throttle station shows no abnormal status)

Action: verify if engine responds to the throttle and can be accelerated in WARM-UP mode.

If "YES" assume: not enough spin up before shifting into gear: increase amount of spin up (by increasing A8 in the setup) or increase the shift delay (by increasing A0), or both. It may be helpful to disconnect the clutch wires temporarily, to monitor the spin up without actually engaging the gear, when selecting FWD or REV.

Operational aspects

The FADEC controls throttle, shift and clutch, similar like a driver would do in a manual car.

Driving styles can be very different, so can the FADEC either shift cautiously or as fast as possible. The setup permits you to set your personal limits or to let the FADEC decide, according the actual situation.

Variables

- **Shift delay** (when reversing gear): choose either a fixed delay or a variable automatic delay. The automatic shift delay is estimating actual engine rpm from the very recent throttle position. It does neither know nor estimate the actual propeller speed and direction. Shifting quickly into opposite gear from full throttle will produce an automatic delay of 3,5 seconds (from throttle movement to powering the shift solenoid), if so enabled in the setup. Depending on the clutch, it may take a little extra time until the clutch is filled and clutch pressure has risen.

If a Trolling Valve is installed, the hard onset of full clutch pressure will be smoothed over a period of 0.25 seconds. This smooth engagement often permits to forgo the shift delay. The 0.25 second rise time of the clutch pressure can be preceded by automatically slipping the clutch at a constant pressure (set by A5) over a desired period (set by A4), in order to slow down an eventually opposite spinning propeller.

- **Throttle delay** (after powering the clutch solenoid): the purpose is to avoid accelerating the engine significantly, before the clutch has engaged.

Depending on how fast the engine can accelerate and how slow the clutch will carry full torque, a fixed throttle delay can be set with A4. Note the dual function of A4 above. If there is no trolling valve installed, the throttle delay will replace the slip period above.

Manual or Autopilot Throttle ops

Manual throttle operation lets you choose the Driving Style, you are free to set fixed and long delays or choose an automatic shift delay, which optimally protects the drive train.

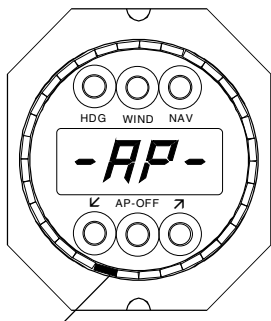
However automatic throttle modes, like the Hover mode, may require a very short shift cycle time, especially if a firm Hover Position is required in moderate sea conditions. This is like holding the boat off two feet from a rock in rough water.

Shortest shift cycle time with trolling valve is 0,7s and without trolling valve 1,0s (FWD to REV or REV to FWD).

FADEC-Box Setup

Initial Operation

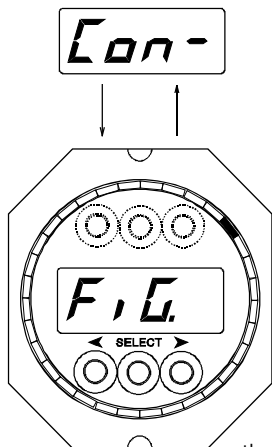
FADEC-Setup is done on an Autopilot-Display, but **only** after any Autopilot-Drivebox or Thruster-Box and eventual second FADEC-Box have been disconnected from the CAN-bus.



Throttle-Signal LED

The FADEC-BOX must be powered and connected to the bus to permit configuration.

ConFig menu:



1. Select the **AP-Configuration Mode** on an Autopilot Display (or set "di=01" on any other Tecnautic Display and select >ConFig>AP). Verify that an LED is lit in the lower half of the perimeter, as shown in the picture above. If none of the LEDs is lit, there is no communication with the FADEC-Box and the setup cannot start:

- 1) Press and hold the lower outer buttons
- 2) In addition press the lower middle button 4 times
- 3) Release all buttons (**Con-FiG** is shown)
- 4) Use the lower middle button to scroll forward until "-AP-" is displayed.

2. Press the lower left button once. The parameter **"A0:"** will be displayed (A0=00 or A0=01). Be careful not to alter A0 unintentionally by pressing (again) the left or right button.

3. Use the lower middle button to scroll forward to the next parameter **A1, A2** etc. Each parameter can be altered if needed, with the left or right lower button.

Setup Parameters

There are two groups of parameters. The proper selection is made with A9.

- A0:00** A0=01 is for Boxtype 3b only. A PWM signal for a proportional valve on the Hydro Motor of the main engine is provided on Terminal 1-2=FWD, 3-4=REV.
- A1:01** An automatic shift delay is created. Recommended when a Trolling Valve is **not** installed. No automatic shift delay when A1=00 (except in Hover, Joystick or Speed Mode, which has always an automatic shift delay)
- A2:0?** **Boxtype A2=03:** throttle signal is analog voltage (Nanni, Steyr, VW) or current 4-20mA (Volvo Penta, MAN); **A2=04:** signal is 500 Hz PWM (Caterpillar); **A2=05:** pwm-signal for hydraulic propulsion thruster by proportional valve.
- A3:01** Engine selection. A3=01 for the left engine (port engine, #1) or A3=02 for the right engine (starboard engine, #2). A3=00 makes a Bow Thruster, A3=03 makes a Stern Thruster with engine and gearbox.
- A4:05** a) Throttle delay from start of clutch engagement.
b) Trolling Valve *Break-Off time* [1 unit = 125 ms]. Time starts from beginning of clutch engagement. Smaller number permits faster shifting. Should be long enough, to ensure sufficient propeller braking in a high speed shift reversal. (01...31) Trolling Valve *Break-Off pressure*. Kicks off shaft rotation. Reduce setting when clutch engages hard, but keep it as high as possible, to allow for sufficient braking during high speed reversals from FULL AHEAD to FULL ASTERN.
- A5:16**
- A6:12** **Boxtype 3+4:** Sets minimum trolling valve pressure in Slow Mode, that keeps propeller spinning slowly in idle FWD or REV.
A6=00 will use the trolling valve for soft clutch engagement, but there will be no slip range on the throttle. This is valid in all modes (joystick, Speed, Hover or manual throttles).
Boxtype 5: Idle thrust setting.
- A7:64** (25...64) Throttle Gain. Reduce A7, to decrease *full throttle signal* such as to achieve full power only short of the throttle stop. Observe limits for specific versions (according page 2, 3).

A8:00 (0...31) Sets Engine RPM increase (Spin Up), before shifting into gear. Consider function of A1* and A2* below!
There is no Spin Up when switching into WARM-UP mode.

A9:10? -- A9 is a switch between selected parameter groups. A9=00 shows second group of parameters A0* ... A8*

On Twin Screw vessels with only a Bow Thruster: A9 sets the amount of fixed differential throttle, when sideways thrust is commanded in Joystick, Hover or SLIDE mode

On Twin Screw vessels with independent rudders (AA=02): A9 sets the amount of proportional differential throttle, when sideways thrust is commanded in Joystick, Hover or SLIDE mode,

AA:01 AA:01 = normal setting.
AA:02 = "split rudder", for independently steered stern or pod drives or ducted rudders.

A_:06 A_ is the longitudinal throttle gain setting in Hover, Speed and Anchor Mode.

Ac:00 Must be 00

A-:00 NMEA output from the FADEC-box:
A- =00 .. Test data out (ASCII terminal)
A- =01 .. a) Set up HS8000
b) without trolling valve: pulsing thrust enabled in Hover and Anchor Mode
A- =02 .. HDM and VHW out (8 Hz)
A- =03 .. VHW (8 Hz)
A- =04 .. simulated test heading
A- =05 .. CAN-Bus isolator active
A- =06 .. pulsing enabled
A- =07 .. CAN-Bus isol. active and pulsing thrust enabled

Note: for a non standard SLOW mode limit Speed, write the limit into ROM address 0007, e.g. 64h for SLOW mode up to 10 kn

Reversing without Trolling Valve installed

Shift+Throttle Delay

previous throttle angle %	shift delay	throttle delay A4=01	total thrust delay
idle InGear	1,0s	0,5s	1,5s
35%	2,2s	0,5s	2,7s
50%	3,5s	0,5s	4,0s
65-100%	4,0s	0,5s	4,5s

Second group of parameters A0* .. A8*:

The parameters A0* .. A8* are displayed whenever A9 has been set to zero previously. A0 .. A8 however will be displayed only when A9 is not zero.

Note that the asterisk (*) is not shown on the display unit. *Remember A9!*



A0*:00 not used

A1*:01 See table for Rev-Up on right side

A2*:01 With trolling valve installed set A2*=01
See also table for Rev-Up on right side.

A3*:00 Must be 00

A4*:01 A4*=01 enables the Slow Mode

A5*:00 Must be 00

A6*:02 00..03 Amount of differential throttle by rudder, in Speed, Joystick, Hover or Anchor Mode.

Independent rudders: only thrust increase, no reduction, when at the same time differential throttle is applied for lateral thrust with independent split rudders.

A7*:00 set A7*=01 for *Twin screw* tractor drive

A8*:02 00..06 Joystick longitudinal Throttle Gain. Sets the maximum forward or reverse thrust by Joystick, from 31% to 97%. The range can be verified on the thrust display.

Rev-Up options:

Engine spinup before clutch engagement. The parameters A8, A1* and A2* are used to set the desired Rev-Up:

A1*=01 and A2*=01
Rev-Up according A8, but only in Slow Mode

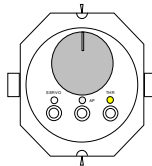
A1*=00 and A2*=01
Rev-Up according A8, in Slow Mode and Normal Mode

A1*=01 and A2*=00
Rev-Up according A8.

A1*=00 and A2*=00
Rev-Up according A8. The RPM spin-up will fade away after clutch engagement

Throttle Lever Functions

Engaging the Throttle Station



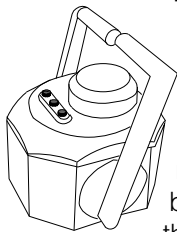
Press the THR-button briefly, to activate the throttle(s) of the unit (THR-Mode). The engine(s) will immediately respond to the commanded lever position(s) and the THR-LED of the unit will be lit, to indicate the active throttle station.



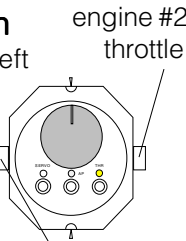
The throttle function is activated independently from the Turn Knob Function at each station.

The existing throttle mode(s) at the previously active throttle station will be continued on the newly activated station. For example with the left engine in WARM UP Mode and the right engine in FWD gear, this will be copied to the newly activated station, when the THR button is pressed.

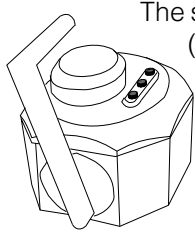
Twin Engine Throttle Station



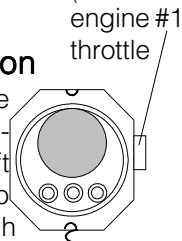
The status of the left engine (number 1) is indicated by the left (SERVO) LED, the status of the right engine (number 2) is indicated by the red (AP) LED.



Single Engine Throttle Station



The status of the engine (number 1) is indicated by the left (SERVO) LED, no matter on which side the throttle lever is mounted.



NEUTRAL, AHEAD and ASTERN

The throttle levers have a distinct detent at Neutral (zero thrust) and also at forward idle and at astern idle. If in NORMAL mode (as opposed to Slow Mode), advancing the throttle further than the forward or astern idle detent will accelerate the engine.

Shifting of the gear is displayed by a flickering LED and a short beep of the respective engine.

In Slow Mode and with a Trolling Valve installed, only clutch pressure is increasing during the first 25% of throttle range.

Warm-Up Mode (gear neutral)

Put the engine into NEUTRAL, then press and hold the THR-button. Move the respective throttle lever to FWD (idle or above), and release the THR-button. Repeat that for the second engine. The WARM-UP Mode is indicated by a continuous double flash of the left LED for engine # 1, or the middle LED for engine # 2. The throttle lever is controlling the governor position as needed.

WARM-UP Mode is cancelled by pulling the respective throttle lever back to NEUTRAL. It can be reentered anytime as above (with a running or stopped engine).

Engine Stop Mode

If an "Ignition Switch" is installed in the model of your FADEC-Box, it will be turned off when the STOP-Mode is selected from any throttle station.

When in NEUTRAL gear, press and hold down the THR-button, then pull back the respective throttle lever into REVERSE.

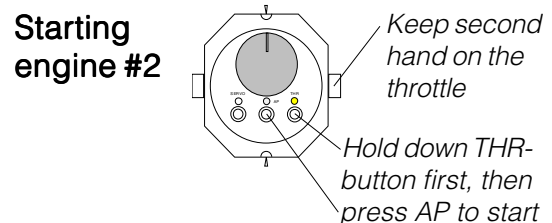
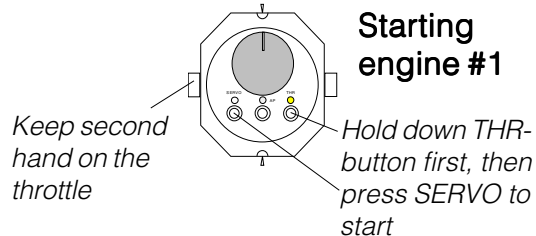
To cancel the STOP Mode, move the throttle to NEUTRAL on any active throttle station. The ignition switch remains off until entering the WARM-UP mode again.

Engine Start Mode

The FADEC-Box permits to duplicate the engine start button. The starter motor can therefore be activated from any throttle station. The throttle of the *respective engine* has to be in WARM-UP Mode. Then press and hold down the THR-button, and also press the SERVO-button to start engine #1, or the AP-button to start engine #2.

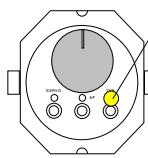
You will probably have one hand on the throttle lever and the other hand on those two buttons. When the engine fires, release the buttons and adjust the throttle as needed.

Engine Start from the Fly-By-Wire Station is only possible in WARM-UP Mode!



Slow Mode

Changing into and out of SLOW-Mode: The THR-button is used to select the Slow-Mode for engine control and for steering (if the autopilot is installed). Switching in and out of Slow-Mode requires the engines either in NEUTRAL or in WARM-UP Mode. Hold the THR-button for 2 seconds until it sends a short beep. The Slow-Mode is indicated by a blinking Throttle-LED.



FADEC in Slow-Mode: in the presence of a trolling valve or in case of Jet Drives or Voith-Schneider propellers, thrust will be adjusted continuously down to zero.

Autopilot in Slow-Mode: the vessel can be steered (turned) at standstill and also be shifted sideways. Bow and Stern Thrusters will be used automatically, if available. In the presence of two engines, these may be put into opposite gear and steered automatically to individual rudder angles.

The steering functions of the Slow-Mode will not become active, until boat speed has dropped below 50% of set max. Speed.

Failure treatment

Reconnect any throttle station by pressing the THR-button, which also clears the fault code. (FL:13 requires to cycle power for clearing the fault)

Continue with manual throttles. Remove failure cause if known.

FADEC fail codes

FADEC fail codes are produced by the FADEC-Box. This is very useful during installation.

Reading FAIL codes from the display unit is done with function "F0", which is shown after holding the OFF-button (for about 3 seconds). The lower right button is then used to select the desired Box:

P.1=Drivebox1, P.2=Drivebox2,
F.1=Fadebox1, F.2=Fadebox2.

For example F.2=08 points to a problem with the Shift Servo on the Starboard engine.

Note: when switching off bus power **and** FADEC power, any code stored inside the display units will be lost; a random number (e.g. 32) will be displayed after powering up the FADEC again, until a new fail code is transmitted by the box.

FADEC-Fail codes may be cleared with the THR-button.

"OFF" stands for automatic disconnect of the FADEC-Box:

Code	FADEC Failure Cause
01	OFF due to over current
02	OFF due to Fadec box over temperature
04	OFF: CB on Fadec box has dropped
05	INFO: Battery voltage low! (no throttle disconnect, only Info)
06	OFF due to low internal Gate Voltage
09	INFO: setup data loss. Insert setup data!
10	INFO: sensed late dblvt (> 18 V)
13	OFF due to > 65A short circuit. To reset the fault, cycle power to the box.
14	OFF due to throttle or joystick fault
15	OFF due to 4-sec 15A over current limit
17	OFF due to over current > 30 A
20	OFF due to Autopilot-Drivebox fault in Joystick or hover mode
22	hover OFF due to WP shifted >0,1 NM
23	hover OFF due to missing GPS, compass or gyro data
24	Speed mode OFF due to missing SPD data
25	hover or joystick mode OFF due to fault in the slave FADEC-Box
26	INFO: unlock code required for joystick or hover mode
27	INFO: Hover Mode not available due to missing GLL data (Lat/Lon)
28	hover OFF due to loss of master FADEC
29	INFO: insufficient heading control (by thrusters or engines) in Anchor or MOB Mode
31	INFO: FADEC-Box restarted during operation for unknown reason