

To be used for:
23 02 01 mechanical throttle and reverser

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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.

Installing the Engine Actuators and cables

Unpacking the Actuators

Install the actuator-cable support bracket as shown. Use a higher bracket position, when expecting to use an outer hole of the actuator crank.

Warning 1:



Stay clear from the actuator crank with hands and feet, whenever it is powered. The crank has the potential to cause severe injury. The installer is responsible to prevent anyone from coming close to a working actuator.

Warning 2:

Do not connect the actuators directly to power (for testing them). This would misalign their internal position sensor and possibly complicate the installation.

Warning 3:

Never connect the actuators directly to a higher than a 12 Volts source, this could damage the motors.

Warning 4:

During the whole installation process, keep the red disconnect nut open, to permit the crank to move freely.

Warning 5:

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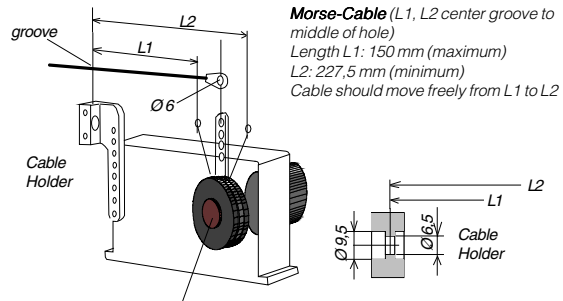
Mounting the Actuators

Although the actuators are sealed, it is imperative to have them at a dry location which will not be flooded or sprayed eventually.

A working temperature below 45 degrees Celsius (113 F) is recommended.

The FADEC-Box should be mounted as close as possible to the actuators, to minimize radio frequency emissions. Special attention should be paid to route the electrical cables at a safe distance from hot engine parts.

Actuator Crank Radius:		
Outer hole	56,7 mm	2.23 in.
2nd hole	49,7 mm	1.96 in.
3rd hole	42,7 mm	1.68 in.
Inner hole	35,7 mm	1.40 in.



Quick Disconnect: keep it open (counter clockwise) during the installation and initial setup, except for measuring the required cable length! Throttle and Reverser actuators are marked differently. They have different internal sensor wiring.

The Reverser actuator is shipped in NEUTRAL position. The throttle actuator comes in IDLE-power (retracted) position. These zero-positions can be adjusted later, if necessary.

Mounting a Reverser Actuator cable

Make sure the actuator is not connected electrically to the FADEC-Box, or at least the FADEC should not be powered.

Move the mechanically disconnected actuator crank to the upright position and engage the crank by tightening gently the red disconnect nut. Make sure the crank sits neatly in the groove of the actuator flange, when it stands up vertically.

The actuator flange has been marked with a black marker pen on the top side, when the flange was in NEUTRAL position. If the pen marking is found at a different angle, the actuator has been moved out from its NEUTRAL position. In this case disengage the cranks (open the red nut) of **both** actuators, connect **both** actuators electrically, put the throttle to NEUTRAL and press THR for one second. The actuator flanges should move to IDLE and NEUTRAL. If they don't, you will have to execute an alignment cycle by setting "Ac" = 01, as described later in this manual. Thereafter turn off power and continue mounting the cables.

Connect the reverser cable at the actuator crank. Use the outermost hole for now.

The outer hole of the actuator crank will move approximately 35 mm (1.5 in.) out of neutral, either to FORWARD or to REVERSE, with a setting of A5=15 (forward throw range), respectively A6=15 (reverse throw range).

Next connect the cable to the reverser crank, while the crank rests in NEUTRAL position. Adjust the fork length on either cable end as required and use an appropriate hole on the crank.

When the cable has been mounted on both ends, disengage the QUICK DISCONNECT at the actuator. Then move the actuator crank by hand to full FORWARD and REVERSE, and verify the reverser is moving properly, with no interference of the fork at either cable end.

Standard setting: selecting FWD thrust will pull on the reverser cable, selecting REVERSE will push (red actuator wire = terminal 7, black actuator wire = terminal 8; FADEC-Setup A1=00).

Non-Standard setting: selecting FWD thrust will push the shift cable, selecting REVERSE will pull on it (red actuator wire = terminal 8, black actuator wire = terminal 7; FADEC-Setup A1=01).

Throw adjustment: the FWD and REV actuator throw can be adjusted separately in the FADEC-Setup with A5 and A6 at a later stage:

A5, A6 (5...17)	throw [mm] outer hole	throw [inches] outer hole
5	23	0.9
10	28,5	1.12
15	35	1.38
17	38	1.5

Numbers above 17 are not recommended for A5 and A6, to limit bending of the cable end.

Mounting the Throttle Cable

Make sure the actuator is not connected electrically to the FADEC-Box, or at least the FADEC-Box should not be powered.

Move the mechanically disconnected actuator crank to a retracted cable position, which is about 30 degrees from upright towards the cable support bracket. Then engage the crank by gently tightening the red QUICK-DISCONNECT nut. Make sure the crank sits neatly in the groove of the actuator flange.

The actuator flange has been marked with a black marker pen on the top side, when the flange was in IDLE POWER position. If the pen marking is found at a different angle, you should move the flanges electrically to their IDLE and NEUTRAL position first, as described already for the Reverser Cable.

Now connect the throttle cable at the actuator crank. Use the innermost hole for now.

The inner hole of the throttle actuator crank will pull the cable approximately 43 mm (1.69 in.) out of IDLE, with a Setup of A7=64.

Next connect the cable to the governor crank, while the crank rests in the IDLE position. Adjust the fork length at either cable end as required. The engine **must accelerate immediately, when the actuator starts moving** out from idle position.

Use an appropriate hole on the governor crank, that will apply full power, when the cable moves by 68 mm (2.67 in.) approximately. After the cable has been mounted on both ends, disengage the QUICK DISCONNECT at the actuator. Move the actuator crank by hand to FULL power, and verify that the engine will accelerate properly, with no interference of the fork at either cable end.

Standard setting: advancing the throttle will pull on the cable (red actuator wire = terminal 3, black actuator wire = terminal 4; FADEC-Setup A0=01).

Non-Standard setting: advancing the throttle will push the cable (red actuator wire = terminal 4, black actuator wire = terminal 3; FADEC-Setup A0=00).

Governor Throw adjustment: the governor throw should normally not be reduced in the FADEC-Setup, to guarantee the highest throttle precision. Use a more inward hole on the throttle actuator, if a smaller throw is needed. It is not recommended to reduce the throttle throw electrically in the setup, by lowering A7 from its standard value of 64. The lowest number is 32, giving only half of the standard angular throw.

A7= (32...64)	throw inner hole		throw outer hole	
	mm	(in.)	mm	(in.)
64	43	(1.69)	68	(2.68)
32	23	(0.91)	37	(1.26)

New Cables First Operation

Open the QUICK DISCONNECT screw (red) of the **throttle and reverser** actuator. Make sure the motor wires and the sensor cables of both actuators are connected correctly to the FADEC-Box.

Disconnect all Autopilot-Boxes and an eventual second FADEC-Box from the CAN-Bus. Call up the AP ConFig-Mode on a Display-Unit and select "A5".

At the desired throttle station move the throttle levers to NEUTRAL and press THR to select the NORMAL Mode (**THR-LED steady**) and move the throttle lever to IDLE-FWD. Watch the reverser actuator flange turning into FWD-thrust position. Advancing the throttle lever further will move the throttle actuator accordingly. Then exercise the throttle through forward and reverse, from idle to full power.

Verify the actuator cranks could be connected with the red QUICK DISCONNECT (cranks in the groove), after moving the cranks manually to the corresponding position. Use a more inward crank hole or adjust A5, A6 and A7 if needed (see page 10). The cranks are now connected to the flanges and follow the movement of the throttle lever.

Adjusting engine RPM settings in SLOW Mode

When switching from *NORMAL Mode* to *SLOW Mode*, the engine(s) will accelerate automatically.

The SLOW Mode RPM-setting is determined by A8. Select an appropriate setting that has sufficient maneuvering thrust.

Adjusting Reverser NEUTRAL position

The adjustment is done with running engine in SLOW-Mode and the throttle in the forward or reverse idle detent.

The precise helm position can be modified by altering "A_₃₂" between 0 and 63. A higher setting will produce more forward thrust if A1=01 (less, if A1=00).

Setting the "zero" crank-position mechanically (not recommended)

Both the throttle and the reverser actuator's "zero"-position can be set mechanically, if the adjustment range in the setup or at the cable fork is not sufficient.

Remove the potentiometer lid of the actuator by unscrewing its three holding screws. A 2.5 mm Allen key (0.1 inches) is needed. Pay attention not to loose the O-ring seal of the lid. The adjustment screws of the potentiometer become visible under the lid.

Open the QUICK DISCONNECT on both actuators.

Operate the throttle and reverser actuator by using a throttle station.

The throttle idle position can now be adjusted by first moving the throttle lever to NEUTRAL and setting the throttle mode to normal (THR-diode steady, not flashing!).

Then loosen the three adjustment screws of the potentiometer-holder, just enough to rotate the potentiometer as desired. The throttle motor will instantly rotate the actuator flange by the same angle as the holder has been shifted.

When finished, tighten the three holder-screws and mount the sensor lid. Make sure the O-ring sits correctly under the lid.

WARNING: the "New Cables First Operation" procedure must be repeated, to ensure correct actuator throw, after setting a new idle point.

The reverser actuator can be adjusted in a similar way, after switching the throttle into SLOW-Mode (the throttle-diode is flashing) and also placing the throttle lever into forward idle.

Possible Problems

The actuator flanges are not moving as expected and seem to be locked, with their zero position mark near the bottom. Fail code 03 (throttle servo extreme) or 08 (reverser servo extreme) are displayed.

Reason: at least one of the actuators has reached an extreme position, possibly due to wrong wiring of the motor at the FADEC-Box or wrong setup data (A0 or A1).

Action: verify connections and setup data, then start an alignment cycle by setting "Ac" to 01. This should bring both servos to their zero position. If necessary, repeat that after cutting power to the FADEC-Box for 10 seconds.

Opposite way moving reverser actuator: (FWD instead REVERSE).

Reason: incorrect connection and setup of Reverser Actuator.

Action: Interchange Reverser Motor wires and switch setup parameter "A1" at the same time.

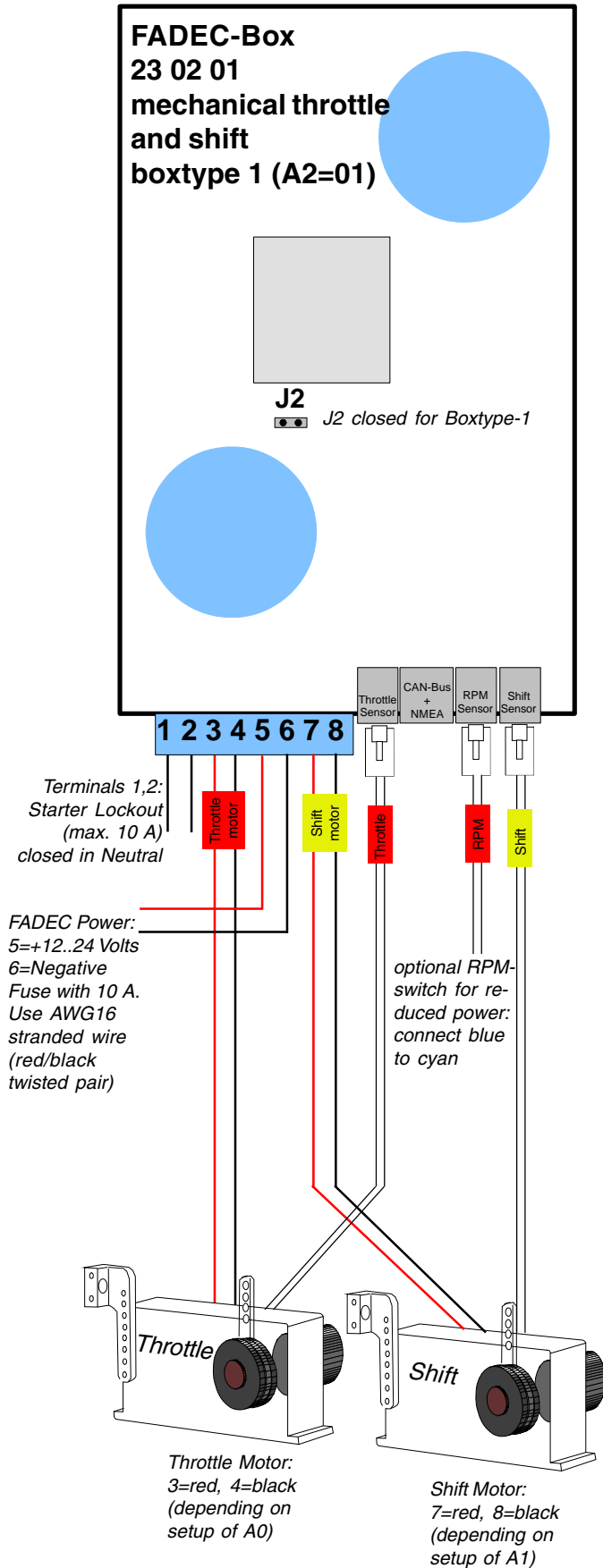
Reverser Actuator has incorrect throw:

Action: adjust FWD throw by altering "A5" in the setup, REVERSE throw by "A6". Avoid numbers above 17. Use different crank holes (at the actuator or at the reverser), if needed.

Throttle actuator has incorrect throw:

Action: use different crank holes at the actuator or at the governor. Only if still needed, lower "A7" in the setup. The standard value of A7=64 should be kept as close as possible to 64, to improve throttle accuracy.

Mechanical Throttle and Shift



FADEC-Box Setup

Initial Operation

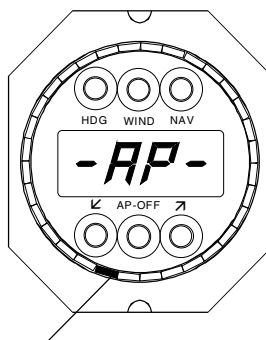
Operational aspects

The FADEC controls throttle and reverser buckets.

Shift delay: when switching from forward to reverse, there is a short break at Neutral. Shift cycle time in Docking Mode from FWD to REV, or REV to FWD is 0.75 seconds when A8=A9, or 1.1 seconds when A8 is different from A9.

In Normal Mode it is 1.0 seconds.

FADEC-Setup is done on any of the Autopilot-Displays in the System, and **only** after the Autopilot-Driveboxes and an eventual second FADEC-Box have been disconnected from the CAN-bus.



Throttle-Servo
Position LED

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

1. Select >Configuration Mode >"AP" 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.

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.

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

FADEC-Box Parameters

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

- A0:01** Rotational sense of the throttle actuator. A0=01 requires the red throttle-motor wire on terminal 3, black on 4. The throttle actuator will *pull* the cable, to increase power (however A0=00 and black=3, red=4 will push the cable).
- A1:00** (00 or 01) Rotation sense of the reverser actuator. A1=00 is the standard setting. It requires the red reverser-motor wire on terminal 7, black on 8. The actuator will *pull* the cable for FORWARD thrust. When reversing the wires, set also A1=01.
- A2:0?** Boxtype: 01 = mechanical throttle and reverser, 00 = mechanical reverser, electronic throttle signal
- A3:01** (01...02) Engine selection. Set A3=01 for the left (port) engine (engine #1) and A3=02 for the right (starboard) engine (engine #2). For a single engine boat set A3=01. A3=00 makes a Bow Thruster, A3=03 makes a Stern Thruster.
- A4:01** not used
- A5:17** (05 ...17) Reverser actuator FORWARD travel (up) limit.
- A6:17** (05 ...17) Reverser actuator REVERSE travel (down) limit.
- A7:64** (50...64) Throttle actuator travel. Keep A7 as high as possible, select more inward crank hole if possible, before reducing A7.
- A8:12** (0...31) engine idle RPM markup in SLOW Mode. Adjust with active throttle lever in NEUTRAL (zero thrust) while in SLOW Mode.
- A9:06?** -- A9 is a switch between selected parameter groups. A9=00 shows parameters A0* ... A8*. However A9 other than zero displays parameters A0 ... A8.
-- A9 is Thrust factor in Hover and Speed Mode, also lateral thrust factor in Hover or Joystick Mode.

AA:12 (0...32) Reverser travel limit in Docking-Mode. This is an additional limitation to A5 and A6.

A_:32 (0...63) Adjust the reverser zero thrust position with this number. Higher number is for more forward thrust. Throttle should be in SLOW Mode in the forward idle detent while adjusting, with engine running.

Ac:00 **Caution:** open the QUICK DISCONNECT on both actuators to permit a 360 degree rotation of the actuator shaft. Set Ac=01 to start an alignment cycle of the actuators. After completion, the actuator shaft should stop with the black marking on top. Press THR and verify movement and travel of both actuators, before reconnecting the QUICK DISCONNECTs. An alignment cycle may take a minute to complete. Repeat when not successful.



A-:00 NMEA output from the FADEC-box:
A- =00 .. Test data out (ASCII terminal)
A- =01 .. Set up data for HS8000
A- =02 .. HDM and VHW out (8 Hz)
A- =03 .. VHW out (8 Hz)
A- =04 .. Test heading instead fluxgate
A- =05 .. CAN-Bus separator active

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.

A0*:01 Must be 01 for Jet Drives.

A1*:00 Must be 00 for Jet Drives.

A2*:00 Must be 00 for Jet Drives.

A3*:01 Must be 01 for Jet Drives.

A4*:01 A4*=01..enables the SLOW-Mode

A5*:00 Must be 00 for Jet Drives.

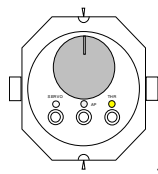
A6*:00 00..03 Amount of differential throttle by rudder, when the autopilot is controlling the engines (and only when commanded lateral thrust is zero).

A7*:00 Must be 00 for Jet Drives.

A8*:01 00..06 Joystick **longitudinal** Throttle Gain. Sets the maximum forward or reverse thrust by Joystick (before an eventual addition of asymmetric thrust by twisting the Joystick), corresponding to 20 .. 85% throttle lever angle. The range can be verified on the thrust display (En. 1) or (En. 2).

Throttle Lever Functions

Engaging the Throttle Station

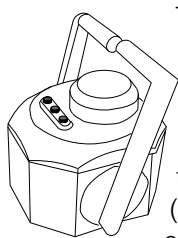


Press the THR-button briefly, to activate the throttle(s) of the unit. The engine(s) will immediately respond to the commanded lever position(s) and the THR-LED of the unit will be lit, to indicate the active throttle station.

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

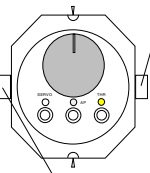
When moving to a different helm station, the existing throttle mode(s) at the previously active throttle station will be continued on the newly activated station. For example with the left engine in Neutral and the right engine in FWD gear, this will be copied to the newly activated station, when the THR button is pressed.

Twin Engine Throttle Station

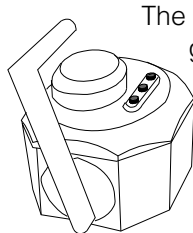


The status of the left engine (number 1) is indicated by the left (SERVO) LED, the status of the right engine (number 2) is indicated by the red (AP) LED.

engine #2 throttle

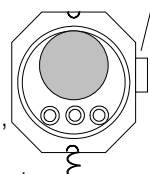


Single Engine Throttle Station



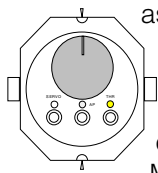
The status of the engine (number 1) is indicated by the left (SERVO) LED, no matter on which side the throttle lever is mounted.

engine #1 throttle



NEUTRAL, AHEAD and ASTERN

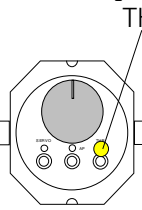
Throttle levers have a distinct detent at Neutral (zero thrust) and also at forward-idle and at astern-idle. If in NORMAL mode (as opposed to SLOW Mode), advancing the throttle further than the forward or astern idle detent will accelerate the engine.



Movement of the reverser helm is displayed by a flickering LED of the respective engine. When the reverser has reached the proper position, the flickering LED will stop with a short beep.

SLOW-Mode

Changing into and out of SLOW-Mode: The



THR-button may be used to select the SLOW-Mode. Switching into 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.

The autopilot will automatically switch between SLOW Mode and NORMAL Mode, when manual throttles are not active.

Throttle: In the lower thrust settings (first 25% of throttle range) the reverser buckets are moving proportional to the throttle lever, while the engine remains at constant rpm. Only thereafter will the engine accelerate.

In the FWD or AFT idle detent, a small amount of thrust is automatically applied, when manual throttles are used.

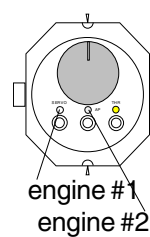
Steering: In SLOW Mode, the vessel can be steered with the Turn Knob at standstill.

Gearbox and Flushing

Controlling the gearbox has to be done independently from the FADEC system. A separate selector switch for forward and reverse gear, including starter lock out, should be installed.

Warm-Up Mode (Zero Thrust)

Put the throttle lever into NEUTRAL, then press and hold the THR-button. Now move the throttle lever to AHEAD idle (or more), and release the THR-button. Repeat that for the second engine, if desired. The WARM-UP Mode is indicated by a continuous double flash of the respective LED. The throttle lever can be used to control the engine governor as



engine #1
engine #2

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).

! **WARNING:** Forward and reverse thrust are cancelled out by the reverser bucket. However considerable side thrust may be developed in Warm-Up Mode, when the nozzle is not centered!

It is safer, to disconnect the engine from the jet pump by putting the gearbox into NEUTRAL, when an engine run up is performed.

FADEC fail codes

FADEC fail codes are produced by the FADEC-Box and sent to all display units, but only when no other Box is connected to the CAN-Bus. Therefore disconnect all autopilot and thruster boxes (and eventual second Fadec) from the bus temporarily when analyzing FADEC failures.

There are two ways to read the code:

A) select the FAIL code by reading it from a display unit (dF=F0 must be active).

B) select the "Config" mode on a display unit (any unit in the system) and press the right button to read out the last FAIL code of the box.

Note: when switching off bus power **and** FADEC power, any code stored inside the display units will be lost; a random number (e.g. 33) 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.

- 01 OFF due to over current
- 02 OFF due to box over temperature
- 03 OFF due throttle-servo extreme angle
- 04 OFF: CB on FADEC-BOX has dropped
- 05 INFO: Battery voltage low! (no disconnect)
- 06 OFF due to low internal Gate Voltage
- 08 OFF due to reverser extreme position
- 09 INFO: setup data loss. Insert setup data!**
- 10 INFO: sensed late dblvlt (> 18 V)
- 12 OFF reverser time-out (to either end posit.)
- 13 OFF due to > 65 A short circuit
- 14 OFF due to throttle or joystick fault
- 15 OFF due to 15A over current limit
- 17 OFF due to servo current > 30A
- 18 INFO: reverser time-out in SLOW Mode
- 19 INFO: reverser time-out (towards neutral)
- 21 INFO: throttle servo time-out
- 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

Failure treatment

Clear the fault and reconnect throttle station by pressing the THR-button.