

MGL Avionics

EFIS

Integrated Autopilot

User and installation manual

Preliminary manual dated 9 March 2009

General

This manual describes the integrated autopilot functionality built into MGL Avionics EFIS systems.

This functionality is available in MGL Avionics Enigma, Odyssey, Voyager and Explorer EFIS systems.

Autopilot functionality

The autopilot system is based on a characterizable application core that takes advantage of the highly modular software structure of the EFIS systems.

The autopilot system forms the bridge between various available navigation sources, both horizontal and vertical guidance and servos that are linked to the aircrafts controls.

Characterizations are user selectable depending on the type of autopilot functionality required.

Characterizations fall into two categories: Flight stabilization with course and altitude capture and track and full authority systems.

The first release of the MGL Avionics integrated autopilot provides a traditional two axis system intended to control ailerons or rudder and elevator or elevator trim tabs..

Autopilot navigation sources

Available navigation sources are dependent on the type of EFIS and its installation.

Horizontal navigation sources

Horizontal navigation sources include the following:

- Magnetic compass (heading)
- Magnetic or true track derived from a GPS
- Track to a waypoint using GPS
- Track derived from route waypoints and followed by means of a GPS
- VOR radial
- GVOR radial (VOR simulated by a GPS)
- ILS Localizer
- GLS (GPS based localizer)
- Other sources as may be connected to the EFIS

Vertical navigation sources include the following:

- Altimeter (altitude hold)
- Altimeter (following vertical profile as part of route)
- Glideslope

- GLS (GPS based glide slope)
- Other sources as may be connected to the EFIS

Autopilot requirements

In order for the autopilot to function, the following items are required:

Either Enigma, Explorer, Voyager or Odyssey EFIS panel operated as master in case of a dual panel system.

SP-2 compass. This is required if magnetic compass heading needs to be followed and no GPS fix is available. In case of a valid GPS fix, magnetic heading is calculated from GPS track for use by the autopilot as this provides a more stable heading signal.

SP-4 or SP-5 AHRS. The AHRS supplies turn rates, bank and pitch angles for use by the autopilot. The autopilot will not work without an AHRS.

For PWM and Trio Avionics servos: MGL Avionics COM extender module. Using this module up to 4 Trio digital servos and 4 PWM servos can be connected. This module can also be used for other purposes requiring RS232 serial ports.

Implementation differences between Enigma and Odyssey based systems.

Odyssey and related systems such as Voyager and Explorer provide external autopilot control via ARINC steering messages. Due to this the autopilot interface can be switched between internal and external ARINC based autopilot. In case the external ARINC autopilot has been selected, some of the internal autopilot adjustments remain available and these will be used to control the external autopilot. Example: The bank setup “Heading change magnitude” will remain accessible and can be used to change the external autopilots response to required heading/course intercept commands.

For Enigma systems the internal autopilot can be either switched on or off.

Please note: The provided NMEA autopilot interface via RS232 port remains completely independent from anything mentioned in this manual, it is a separate system.

Autopilot characters

MGL Avionics refers to the different types of autopilots that can be implemented as “autopilot characters”. One of the available characters can be selected in the autopilot setup menu, selecting a character will enable the autopilot.

2 axis capture and track

This is the most basic character supported and usually the type most often used. This requires two servos, one connected to either rudder or aileron and the other to the elevator. This character is able to capture a track or heading from any available horizontal navigation

source, hold altitude or capture a new altitude within the limitations given by aircraft characteristics.

This character is suitable for most aircraft that are able to enter and exit a reasonably balanced rate 1 turn (3 degrees per second) without rudder assistance in case of aileron control or without aileron assistance in case of rudder control.

Most applications use aileron and elevator control.

It may be possible to use control of elevator trim tabs rather than controlling the elevator directly for certain aircraft. This is typically only possible if trim tabs have sufficient authority and speed of adjustment to allow rapid enough control over the pitch attitude.

3 axis capture and track and yaw damper

This character requires three servos. One servo is connected to the ailerons. A second servo is connected to the elevator while the third servo is connected to the rudder.

The third servo controls the rudder so as to keep the aircraft controls balanced in a turn.

Typically, the system can be setup to engage the autopilot with only the yaw servo active should this be desired.

This character should be chosen for aircraft that require rudder input to enter or exit a turn or require rudder input to correctly fly a turn without slipping or skidding excessively.

This character has not been released at time of writing this manual.

Further characters in development

The autopilot system used in the MGL Avionics EFIS's lends itself to further characteristics. The following are planned or in development:

- 2 axis capture and track with power control. This character lends itself better to applications that require well managed ascent and descent functionality or may be required for aircraft fitted with power plants that suffer excessively from power output changes due to propeller load changes (mainly two stroke engines with torque curves that are not flat).
- 3 axis capture and track with yaw damper and power control. This character is perhaps the most complete of the basic "capture and track" systems.
- 4 and 5 axis Rotor craft control. These characters control stick, rudder, collective and optional power and are able to fly a rotor craft in both horizontal as well as vertical domain.
- Full authority control fixed wing and full authority control rotor craft. These types of characters tend to use fast, full range servos and can be augmented with additional functionality such as autoland systems. These characters can be used for fully autonomous flight control.

Servos

In keeping with the MGL Avionics flexible autopilot implementation, different types of servos are supported and these can be mixed if required.

PWM servo

This types of servo uses a PWM signal (Pulse width modulation). The servo responds to a repetitive pulse (usually 50 or 100 pulses per second) and the pulse with of the servo (1 to 2 milliseconds) determines the servo position.

This type of servo is generally not recommended but can still be used with the MGL Avionics system (up to 4 PWM servos can be controlled).

PWM servos are not able to report their position to the host system so need to be engaged in a specific position. The servo setup contains setups for these positions if a PWM servo has been chosen for a particular function.

Further limitations of PWM servos are that no reporting of faults, slippage etc can be reported to the host system.

If a PWM servo has been selected for a particular function, a further setup entry will be available for that function to allow selection of the desired position at servo engage. This position can be adjusted in flight.

Bank neutral position trim

Example servo setup function applicable only for a PWM servo.

Trio Avionics Digital servo

This is the recommended servo for most capture and track applications.

This servo is based on a geared DC motor with a solenoid engage mechanism and a mechanical clutch on the output shaft. This servo has modest power electrical power needs and zero system drag if not engaged. Control speed is modest and control angle is limited. Most applications will install the servo such that it is able to control approximately 50% of the available control movement.

The digital servo provides feedback to the host system and the host is able to engage the servo at its current position. The servo provides feedback on clutch slippage, control limits and internal faults.

MGL Avionics Digital servo

This servo is currently in development. This servo is based on a powerful stepper motor and provides high control speed and full range of control movement including capstan control. This servo is intended mainly for full authority control systems. With medium power consumption it provides electronically variable torque and relatively low system drag when not engaged.

The MGL servo provides position information and operational status back to the host system and can be engaged in any position.

Other servo systems

MGL provides the “MGL Avionics universal servo protocol” document to interested parties

allowing special application servos to be constructed or existing servos to be modified to be able to be used with the MGL Avionics autopilot system.

In addition to this, other autopilot manufacturers servos may be able to be used if there is demand for such and the manufacturer is willing to allow use of his servos in MGL systems and will provide the required interfacing information.

Engaging and disengaging the autopilot

The autopilot can be engaged and disengaged in several ways:

- Via the EFIS keypad
- Via autopilot engage/disengage switch (this requires fitting of an I/O extender).
- Via optional autopilot control panel (Planned item)

The autopilot will refuse to engage if:

- The servos are interface using a MGL Avionics COM extender and no communications to this unit can be established.
- A digital servo is used and it reports a position beyond its control limits
- A digital servo is used and it reports a fault
- A digital servo is used and no information is received (RX fault)
- Selected navigation source does not have valid solution
- No AHRS is connected

The autopilot will disengage if:

- The disengage function on the EFIS keypad is activated (button push)
- Engage/disengage switch is pressed (switch connected to I/O Extender)
- Disengage button is pressed on optional autopilot control panel
- A digital servo reports that it has reached its control limit
- A digital servo reports a slipping clutch or torque overdrive for 1 second
- Active navigation source has been lost
- G-force acting on aircraft exceeds 2G (not applicable for full authority systems)
- Power is removed from a digital servo (causes RX fault)
- Connection to MGL COM Extender is lost (if this unit is required to control servos)

Preflight check of the autopilot installation

Menu level 2 provides a preflight check function.

Each servo (excluding power control) will be moved to its extreme control limits and when

complete left it its neutral position. At the same time, the display will show the action taken so servo direction can be verified.

Note: This function will not be available if an active flight has been detected. Airspeed must read below 30mph. In addition, a confirmation will need to be acknowledged before this function will commence. Under no circumstances should this function be activated in flight. The function can be exited by pressing any key on the EFIS which will also disengage the servos.

During the servo preflight check, verify the correct directional operation of each servo. The controls must not bind and the servos must not slip in any position. With the servos disengaged, verify that full manual control is present.

Installation

Installation of the autopilot system consists of four steps:

- Obtain information from suitable sources as to best or recommended location and means for servo installation – if this is not possible, perform a test flight as outlined in the next chapter to determine suitability of the aircraft for installation of an autopilot.
- Physical installation of the servos, electrical and mechanical connections
- Ground based configuration of the autopilot system
- Test flight based calibration of the autopilot system

Physical installation of the servos

This phase starts with the identification of a suitable location for each servo. In many cases the aircraft manufacturer may have predetermined a suitable location and control linkage. Installation of the servo should be carried out by a suitably qualified aircraft technician.

- The servo needs to be installed on a rigid platform. It must not move under any expected mechanical load.
- Control linkages must be installed such that there is no play between servo bell crank and controls. Any play introduced here can seriously affect the autopilot's ability to fly the aircraft properly.
- Electrical wiring should be installed to aircraft standards using suitably dimensioned cable. Please consult with the servo manufacturer for recommended wire types and core dimensions.
- Servo power must be routed via a circuit breaker or switch easily accessible to the pilot. Servos will disengage if power to them is removed.

Post installation checks:

DO NOT FLY THE AIRCRAFT UNTIL THE FOLLOWING POST INSTALLATION CHECKS HAVE BEEN CARRIED OUT AND FULL AND CORRECT FUNCTIONS HAVE BEEN OBSERVED:

- Verify that no controls are binding during any position of the flight controls
- Verify that the servos when not engaged will not restrict movement of any flight

controls including maximum limits of the flight controls

- Verify that the servos, once engaged, have as close to zero tolerance as possible when moving the control surfaces. **VERIFY THIS.** With the autopilot engaged, move the control surfaces by hand and ensure that there is no significant play. If any play is found, recheck your control linkages and install better or more suitable parts if required. Control linkage play may seriously limit the autopilot's ability to control your aircraft, in particular where pitch control is concerned.

Pre-installation test flight

Unless a suitable, known good servo installation is used (for example a series built aircraft with existing autopilot installations), it is recommended to test fly the aircraft before installation as follows here. Please note that this is a guide only and may need modification to suit the particular aircraft.

The main aim is to fly the aircraft manually in exactly the same fashion that the autopilot would. If you are installing a two-axis system and want to use aileron and elevator controls without pilot assisted rudder and power input, ensure that your aircraft can actually be flown that way. If you cannot, the autopilot will not be able to do so either !

Using the above example, fly the aircraft to a stable, straight and level condition, then move your feet off the rudder pedals and refrain from adjusting power. Attempt to keep the aircraft on your current heading or ground track and exactly on your current altitude using aileron and elevator control only. Important: Use only small control corrections and feed these in gently, emulating a servo as best you can. If you find you can control your aircraft this way in moderate turbulence while keeping the speed relatively constant proceed to the next step:

Intercept a new heading 90 degrees from your current heading using only aileron and elevator, use a turn rate that you feel comfortable with – we suggest around 2 to 3 seconds per degree (approximately rate one turn). If you find you can perform this maneuver fine with gentle control inputs proceed to the next step:

From a straight and level position, attempt a climb to a new altitude (perhaps 500 feet above where you are now). Take note of your climb rate (feet per minute) and airspeed. Decide on a climb rate that results in best climb and a good speed without you needing to adjust power.

Note down your result as you will be entering this in the autopilot pitch setup.

Now repeat the same for a descent. Again, take note of your speed and descent rate and choose a combination that is most suitable for your aircraft without power adjustment.

Remember these values for the pitch setup.

Possible issues and suggested solutions:

If your aircraft does not turn well without rudder input, try turning it with rudder only – will the ailerons self-center due to aerodynamic forces ? If you find you can turn your aircraft well without active aileron input you may be able to connect the bank servo to the rudder rather than the ailerons.

Difficulty holding altitude due to engine power effects. This can be a bothersome issue and may be related to the amount of power your engine produces at various propeller loads coupled with an uneven torque curve of the engine. Here is a typical scenario based on a

particular aircraft we used during the autopilot development:

You start off with a low power setting (economy cruise) and you are holding altitude. The aircraft ascends a bit and you correct by a slight nose down attitude change. The engine now has a slightly lower load and RPM increases, the engine produces more power and instead of descending back to your target altitude your speed and lift increases so you ascend even more. More nose down worsens the effect. Eventually you find some equilibrium where you can hold altitude but only at a much higher speed where drag starts to help you from increasing speed.

The reverse is also true – pitch up the nose and you slow down, more engine load – slower RPM, less engine power and you might find you start descending in a nose high attitude at slow speed rather than gaining altitude, the effect you had hoped for.

The above scenario is often related to two stroke engines but can also affect four stroke engines that are “lugged” by a propeller with a too high pitch.

If your aircraft behaves as above, it may not be possible for a two axis autopilot to even hold altitude properly, never mind climb and descend. In this case you may need to control power manually to assist the autopilot – a control you may find you need to do even when flying without autopilot to remain within target speed and altitude.

As an alternative, you need to install an automatic power/RPM control (governor) or select a autopilot characteristic that includes throttle control.

Issues related to aircraft stability:

Traditional capture and track autopilots can only be used with any measure of success on aircraft that are neutrally stable. If your aircraft is subject to a yawing moment when proceeding through the yaw-neutral position or a pitch moment when proceeding through pitch-neutral or significant stick force reversal based on angle-of-attack or speed changes, it is unlikely that you will be able to use this type of autopilot with any satisfaction.

Aircraft like this can still be flown using an autopilot but tend to need full authority systems using fast servos that can instantly and proportionally correct any attitude deviation. Often, autopilots for these types of aircraft are purpose-build and designed for a particular aircraft. Example: B2 Stealth bomber.

Ground based configuration of the autopilot system

During this phase you select the autopilot character and individual servo configurations.

The autopilot setup menu is accessible via the setup menu. Please note that some functions in this menu cannot be selected if a flight is active or airspeed shows above 30 mph.



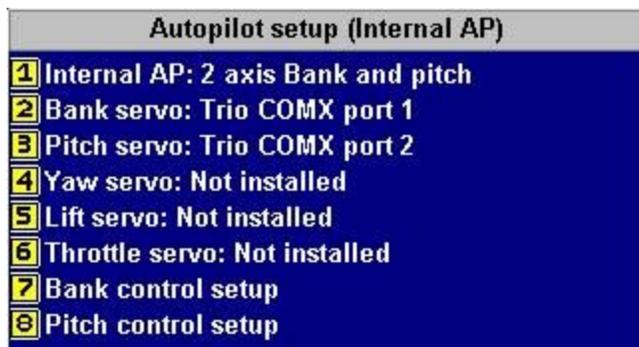
For each servo select the servo type and electrical connection source.

Trio Avionics digital servos are controlled using RS232 serial data connections. The MGL Avionics COM Extender provides four suitable serial ports. RS232 ports available on the EFIS cannot be used. Only COM Extender serial ports may be used.

Each RS232 port provides a bidirectional communications link. The TX connection sends position and other data to the servo while the RX connection receives position and status data from the servo.

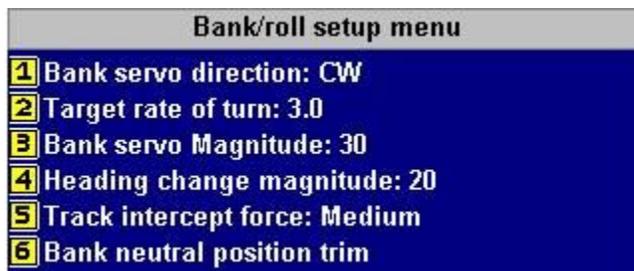
PWM servos can be connected to the MGL Avionics COM Extender. Up to four PWM servos can be controlled. PWM servos can be considered as roll, yaw, power or lift servos. PWM servos should not be considered for pitch servos as these need to be engaged at a known position and this is only possible with digital servos.

MGL Avionics servos may be connected to either RS232 ports on the COM Extender or they may be connected to the EFIS's AeroCAN interface if the EFIS supports this type of interface.



Once the servo type and connection location has been selected, a corresponding configuration menu becomes available for that servo. For example, once you have allocated a bank servo, you will be presented with the Bank control setup menu.

Configuring the roll (bank) servo



Bank servo direction

Here you select the servo rotation direction. This depends on your installation. The direction is identified as CW (clockwise) or CCW (counter clockwise) as specified by the servo manufacturer to achieve a right bank.

The servo direction is usually selected after performing the servo preflight test and noting the control movement vs. the intended movement. If the preflight screen is showing a left bank and your controls are moving for a right bank, change this setting.

Target rate of turn

Select your desired target rate of turn when capturing a new heading.

Typical turn rates range from 2.0 to 3.0 degrees per second. A rate of 3.0 degrees per second corresponds to a rate one turn (360 degrees in two minutes).

This value is used for large heading errors, for smaller errors this value is suitably scaled down to ensure smooth track intercept and hold.

Bank servo torque

This entry will only show if you have the MGL Avionics servo selected. Here you select the maximum torque the servo will be able to hold before slipping. 100% is the maximum possible torque. Lower this number if you need the servo to slip at a lower torque setting. You should select a setting that allows an easy override of the servo by the pilot but it should remain high enough so it will not slip during higher control force loads that may be experienced during moderate turbulence.

Bank servo Magnitude

This setting selects the amount of servo movement for a given bank angle error (the error between desired bank angle and actual bank angle). This value is selected during a test flight (next chapter). Set this value to "10" before the first flight. A higher value produces more servo movement. The aim is to find a value that results in rapid correction of an error without over-correction. Typical values are from 10 to 30.

Heading change magnitude

This entry is also available if the external ARINC autopilot has been selected (Odyssey, Voyager or Explorer).

Using this setting you select the amount of bank angle to apply to correct a given track error. This allows you to select a "gentle" or "forceful" intercept. If the value is set too low, the autopilot may have difficulty holding a track exactly (it may allow a drift of a few degrees before correction takes place). If the setting is too high, over correction will take place. In this case it may not be possible for the autopilot to hold your track as it will overshoot every time it intercepts the track. Values between 10-20 seem good for most aircraft.

Track intercept force:...

This setting has three options: Low, medium and high.

Select a suitable setting for your aircraft to hold a track that is NOT heading, for example a GPS track. Here the track error is made up from the actual track error as well as the amount of course deviation (i.e. distance from the desired track).

The MGL Autopilot will intercept a track at an initial 15 degree angle if you are relatively far from the track but as you get closer to the track this setting takes over. It determines how well you would like the autopilot to stay on track. Often it is desirable to allow a small deviation to avoid continuous corrections. Select a value that best satisfies your requirements.

Bank neutral position trim

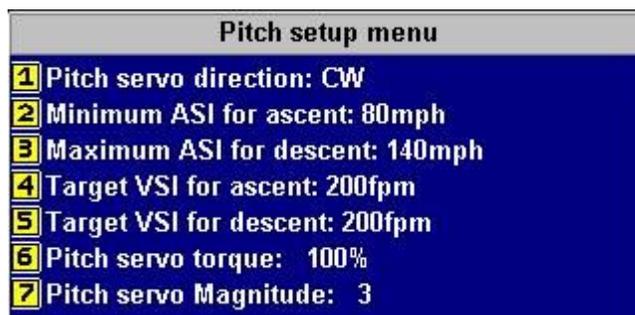
This entry will only be available if you are using a PWM servo. Here you select the servo position to be used when engaging the autopilot. This position is normally selected during a test flight, trimming out any unwanted turn.

To use this function in flight, the autopilot must not be engaged (this function will not operate if the autopilot is engaged). If you activate this function the bank servo will engage at the current servo neutral position – note that other servos will not engage.

Adjust the neutral position until any tendency to turn has been tuned out. This should best be done during calm flight conditions as turbulence may mask the neutral position.

The bak servo will disengage as you deselect this function or exit the menu.

Configuring the pitch servo



Pitch servo direction

Here you select the servo rotation direction. This depends on your installation. The direction is identified as CW (clockwise) or CCW (counter clockwise) as specified by the servo manufacturer to achieve a pitch up.

The servo direction is usually selected after performing the servo preflight test and noting the control movement vs. the intended movement. If the preflight screen is showing a pitch up and your controls are moving for a pitch down, change this setting.

Minimum ASI for ascent

Select the minimum allowable airspeed during a climb. The autopilot system will control the pitch gyro during a climb such that when this airspeed limit is reached, a pitch down command will be issued to regain airspeed above this value.

Airspeed has priority over ascent or descent rate.

Maximum ASI for descent

Select the maximum allowable airspeed during a descent. The autopilot system will control the pitch gyro during descent such that when this airspeed limit is reached, a pitch up command will be issued to retain airspeed below this value.

Airspeed has priority over ascent or descent rate.

Target VSI for ascent

Select the desired vertical rate of climb for ascent to a new flight altitude. This rate will be used as target if the new altitude is relatively far away.

If your autopilot character does not include power control, select a target rate of climb that is achievable using elevator control only, taking into account minimum airspeed as selected for the ascent.

If your autopilot character includes power control, select a climb rate that can be sustained using acceptable power setting.

Avoid the temptation to select a climb rate that is higher than what your aircraft can sustain

given the selected autopilot character.

Target VSI for descent

Select the desired vertical rate of descent to a new flight altitude. This rate will be used as target if the new altitude is relatively far away.

If your autopilot character does not include power control, select a target rate of descent that is achievable using elevator control only, taking into account maximum airspeed as selected for the descent.

If your autopilot character includes power control, select a descent rate that can be sustained using acceptable power setting without undue cooling of the power plant.

Pitch servo torque

This entry will only show if you have the MGL Avionics servo selected. Here you select the maximum torque the servo will be able to hold before slipping. 100% is the maximum possible torque. Lower this number if you need the servo to slip at a lower torque setting. You should select a setting that allows an easy override of the servo by the pilot but it should remain high enough so it will not slip during higher control force loads that may be experienced during moderate turbulence.

Pitch servo Magnitude

This setting selects the amount of servo movement to achieve a given change in vertical speed rate. This value is selected during a test flight (next chapter). Set this value to "1" before the first flight.

Ground based testing of the autopilot system

If this is your first installation using the COM extender, first ensure that the COM extender is operational. Ensure that it is connected to any one of the two USB host connectors on the back of the EFIS. Switch the EFIS on.

As you switch the EFIS on, the RED LED on the COM Extender should light and stay on for about 5 seconds. It should then start flashing once per second. If the LED does not light at all, does not start flashing or if it flashes very fast then there is a problem. Do not proceed until you have resolved the issue.

With the servos connected and the COM Extender LED flashing once per second, apply power to the servos. The servos should not engage at this stage.

Perform the autopilot preflight check. This is an automated procedure accessible from the main menu level 2.

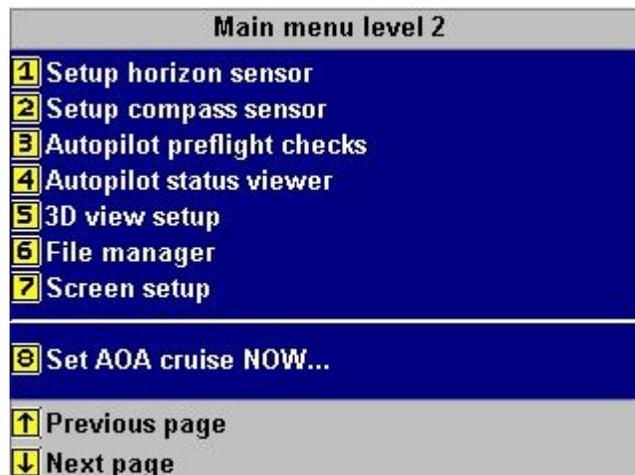
The bank and pitch servos will be activated in turn and each will move to its maximum limits and then center. During this time, the EFIS will inform you of the action it is taking, for example "Bank left". Ensure that the control surfaces of your aircraft are moving in the correct direction. If they are not, correct this by setting the corresponding servo direction setting in the autopilot setup menu.

Use the autopilot preflight check repeatedly to verify that all mechanical linkages are performing correctly and are not binding or have excessive play.

While the preflight check is operating, physically move the control surfaces by hand against the servo force to locate any play. If you find significant play, please fix the cause before attempting a test flight. The autopilot cannot perform correctly if there is excessive play in the controls.

This may also be the correct time to adjust the servo torque. Please refer to the manual of the servo manufacturer on how to adjust the torque. Correct torque is achieved if you can override the servo with fair ease using the control stick but it is firm enough not to cause the servo to slip in turbulent flight.

The autopilot is designed to disengage if it detects a servo slipping for more than one second. This can be used as a convenient method to disengage the autopilot and it is the recommended method as this results in your hand on the control as the autopilot disengages.



If you have PWM servos connected, use the neutral positioning functions provided in the autopilot setup menus to set an approximate position. You will fine tune this position during flight. Please note: MGL Avionics does not recommend the use of PWM servos for pitch applications and recommends the use of digital servos for all functions.

If your autopilot preflight tests have been completed satisfactory, you can consider a first test flight as outlined in the next chapter.

Test flight based calibration of the autopilot system

During this phase you calibrate each servos response characteristic to match your aircrafts flight dynamics and the servo control linkage to its corresponding control.

While there may be more than one way to go about this, we recommend the following procedure:

Adjusting the bank setups

Using the autopilot setup, disable the pitch servo and only enable the bank servo (ensure type and location of servo are selected correctly).

Set the bank control setup as follows:

Target rate of turn: 2.0
Bank servo magnitude: 10
Heading change magnitude: 1
Track intercept force: high

If you are using a PWM servo, you will first perform the bank neutral position trim. This is the servo position that will be used as you engage the autopilot. If you are using a digital servo, skip this step.

Engage the autopilot and only use pitch control to keep the aircraft level. Use the bank neutral position trim to trim the aircraft for straight flight. This is best done in calm conditions.

Position the aircraft in a stable, straight and level attitude, power the servos and engage the autopilot.

Keep the aircraft level using the pitch, the autopilot should now control the bank. It will not attempt to intercept any particular heading as we have set the heading change magnitude very low. We now want to adjust the PID controller for holding the bank angle. Slowly increase the Bank servo magnitude number until a slight upset of the bank angle will start a relatively fast oscillation, then reduce the number until the oscillation stops, then reduce the number by another 10%.

Now increase the heading change magnitude to a value between 10 and 30. You will likely adjust this value in future as you gain experience as to how your aircraft reacts to heading changes. If you find the autopilot correcting heading to forceful (which can result in a slow oscillation), reduce the number. If you find the autopilot struggles to hold a heading in turbulence, increase the number.

Track intercept force is a setting that is used if you are following a GPS track and are not quite on track. You will adjust this value at a later stage when you fly your first GPS track. Effectively this settings allows the autopilot some error when following a track so not to cause the servos from working overtime trying to keep to the track with unnecessary precision.

Adjusting the pitch setups.

Once your bank setup is known to be stable and your aircraft is holding a given bank angle well, it is time to adjust the pitch.

Enable the pitch servo in the setup and ensure that the type and location is selected correctly.

We recommend you start with the following settings:

Pitch control magnitude: 1

Pitch servo magnitude: 1

Pitch servo retard: 4

Target VSI for ascent and decent: adjust for a relatively low level to prevent power changes from being needed.

Low and high ASI: set correct values for the minimum and maximum speeds the autopilot must note. These should be higher than your stall speed and lower than your maximum speed.

If you have a PWM servo connected, use the pitch servo neutral adjustment to find a suitable

position for servo engagement. Be aware that large pitch changes may occur if the servo position at point of engagement is incorrect. Be alert and remove power to the servos instantly if pitch change is too large. We at MGL do not recommend the use of PWM servos for pitch as it is not possible to engage them at their current position.

Place the aircraft in a stable, straight and level attitude and engage the autopilot. Your task is now to slowly increase the pitch servo magnitude. Increase the number by a single count and wait for a few seconds – if the pitch remains stable, increase the number by another count. Repeat this until the aircraft starts to oscillate around the pitch axis, then reduce the number until the oscillation stops – then reduce by one. You will most likely end with a number in the range of 2-4.

Once this is done, increase the Pitch servo magnitude to 10. Observe how well your aircraft maintains its current altitude (the altitude it is trying to hold is on your altitude bug). If you prefer, adjust the altitude bug or disengage and then reengage the autopilot so it follows the current altitude you are at.

Increase the Pitch control magnitude if you find that the autopilot is not able to hold altitude well or takes a long time to correct deviations.

Should you find that your aircraft porpoises around the target altitude too much, increase the pitch servo retard.

The pitch servo retard effectively introduces a delay when you are close to target altitude. A value of “4” means the autopilot will check the result of a pitch control adjustment after one second, a value of “8” would be two seconds.

Once your aircraft is holding altitude well, it is time to try some climbing and descending.

Adjust your altitude bug for altitudes 1000 ft higher and then 1000 ft lower than your current altitude.

Ensure that you have set achievable values in the target VSI fields as these are the values the autopilot will try to obtain when changing flight altitude. These values will not be used if you are very close to your altitude.

Ensure that the autopilot can fly to a new level without you needing to adjust engine power (unless you would like to fly that way) and that minimum and maximum speed limits will not be exceeded.

Once your autopilot is matched to your aircraft

When you are satisfied with your autopilot setups, please take some time to note down your various autopilot setups for future reference.

We at MGL would be very interested in your setup values and the type of aircraft you fly and would like to share your experience with pilots of similar aircraft that may ask us for suitable starting values. Please contact us at info@mglavionics.co.za.

Trouble shooting and known issues

Menu level 2 contains a autopilot status viewer which gives a lot of information on what the autopilot is trying to do and current aircraft attitude measurement results.

This is the list of currently know issues we are aware of:

Aircraft stability

This autopilot is a “capture and track type”. It requires that your aircraft is stable on all axis. Unstable aircraft include many high performance types. If you have an aircraft that needs unusual control input at times to maintain attitude, you need a full-authority autopilot that is matched to the characteristics of your aircraft. Owing to the adjustments this autopilot allows, it may still be possible to use the autopilot in a limited way.

Engine torque effects

Some engines may react with large power output changes related to pitch and speed changes. This may oppose the autopilots attempts at altitude correction to a large degree. The only solution is pilot control of engine power or an autopilot that has control over the engine throttle.

PWM servos

PWM servos cannot be monitored by the autopilot. This means they need to be engaged at a predefined position. This position can be adjusted via the setup menus. It is not possible to monitor servo slip. Generally, PWM servos are not suited for pitch control applications.

Prerequisites

The following prerequisites and parts are required to allow the autopilot to function correctly:

SP-4 or SP-5 AHRS in correctly installed and operating environment

SP-2 compass (only used if GPS not operational).

MGL Avionics COM Extender. (Acts as servo interface and provides additional Rs232 ports that can be used for other functions).

Enigma, Voyager or Odyssey EFIS with latest software installed (check on www.MGLAvionics.co.za for updates and current version numbers).

Servos

Compatible servos:

Trio Avionics Gold standard digital servo

Navaid PWM servo and any other PWM servo that can accept a 100Hz PWM signal of 1-2mS pulse width at TTL levels (positive pulse).

Please contact the manufacturer of a given servo for installation hardware, mounting brackets and advice for specific aircraft.

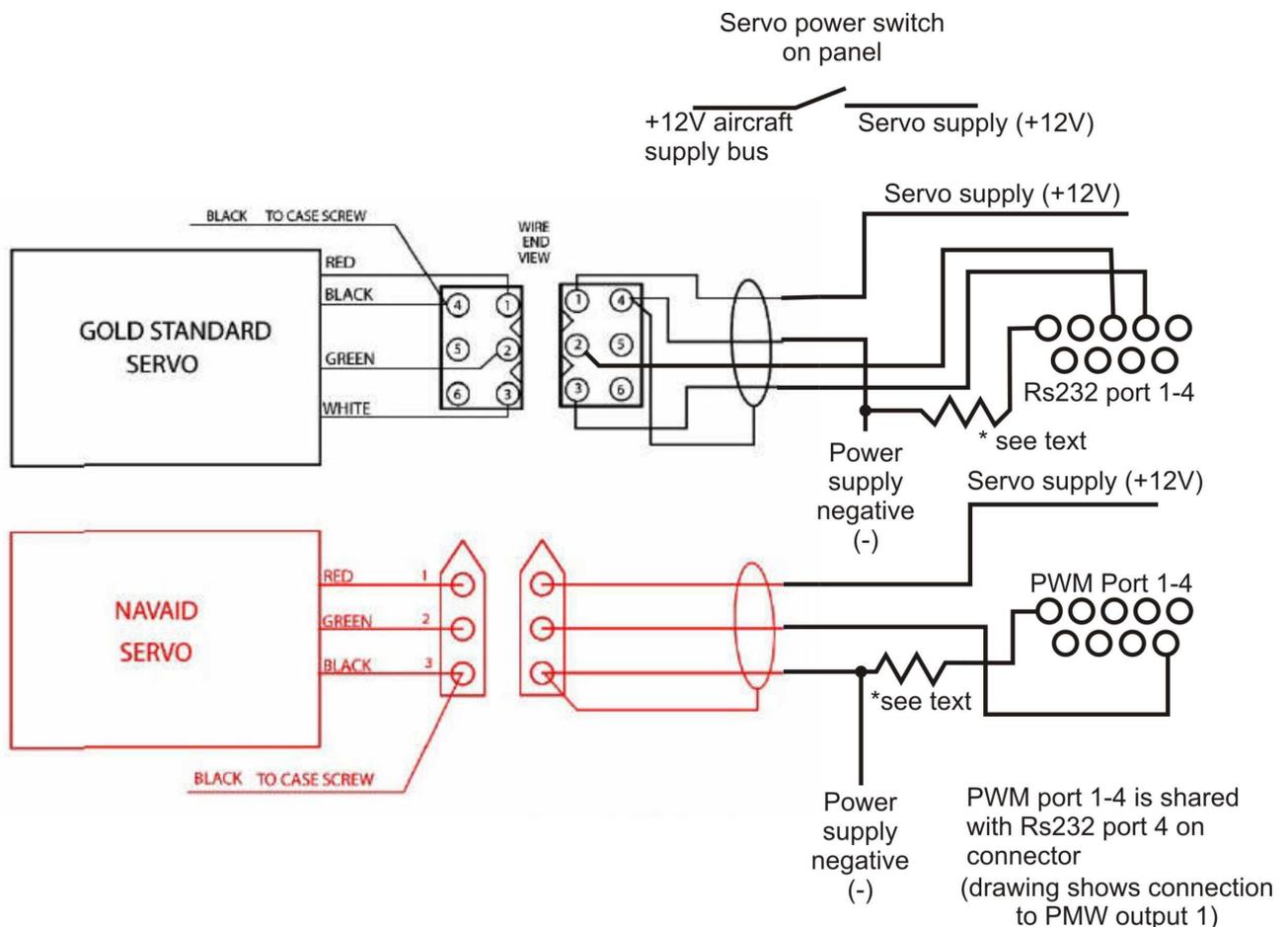
Electrical installation of servos

Servos are powered by the aircrafts power supply bus. Typically this bus supplies either 12V or 24V DC. Ensure that your servos are compatible with the DC supply available.

Ensure that your aircrafts power supply is sufficient to supply your servos peak power demand. Use power cables of sufficient diameter to supply the required current without causing undue voltage loss.

DANGER: Ensure that your servos supply ground is secure at all times. Loss of ground (ground fault) may cause extensive damage to connected systems. Please read notes on preventative measures related to ground faults.

Servo positive power supply should be routed via a latching switch that is easily accessible by the pilot and clearly marked "Autopilot servo power: On/Off".



The above drawing shows the installation for a Trio Gold standard digital servo and a PWM servo (in this case a Navaid servo).

The communications link for the Gold standard servo is bi-directional, similar to RS232 but without negative voltage signals. In order for this to operate securely, it must be ensured that the ground of the COM-extender (available on pins 5 of each Rs232 connector) is at the same electrical potential as the servos own ground. Please ensure that you are using a sufficiently

thick ground wire for the servos so the voltage potential at the servo will not be raised while the motor is operating.

The autopilot is designed to disengage if it is not able to receive data from the servo.

In case of PWM servos, there is no feedback from the servo back to the autopilot and the autopilot will not disengage in case of a servo fault as it is not able to detect this.

It is highly recommended that 33 ohm resistors of 1/2W rating are inserted into the ground connections from each servo to the COM Extender ground as indicated in the drawing. These resistors will prevent excessive ground current from flowing from the servo through the COM extender and EFIS which could cause damage.

These ground currents will occur if for some reason the servo loses its own supply ground while connected to +12V.

Note: Servo communications cables must not be routed close to or alongside audio cables from an intercom system as the signals traveling in these cables may cause interference. It is advised to use shielded cable with the shield itself connected at one location only. The shield must not carry any current as this will result in the shield radiating possible interfering signals.



MGL Avionics USB COM Extender and autopilot servo interface