# MGL Avionics
# iBOX V1 Installation manual

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# Description of the connector signals

Harness wire colors given here refer to the standard MGL Avionics iBOX harness kit. Should your wire harness be obtained from a third party, wire colors may differ.

The MGL iBOX harness kit is an optional item. The iBOX ships as standard with 4 x DB-25 male and 2 x DB-9 male solder bucket connectors with connector shells.

Each wire is 1 meter (3 feet) in length and should be cut to size or extended as needed.

## *Power connector*


This is a DB-9 female connector. It contains connections related to the supply of power to the iBOX.

VA Power supply input 1
VB Power supply input 2
VS Power supply output
KA Keep alive. Power input to maintain backup power
TMP Ambient temperature sensor input
G Power supply ground

**MGL standard harness colors:**

| | | |
|---|---|---|
| 1 | VA | Red |
| 2 | VB | White/Red |
| 3 | VS | Grey/Red |
| 4 | G | Black |
| 5 | KA | Pink |
| 9 | TMP | Green |

The iBOX contains two independent power supply inputs – VA and VB. At least one of these inputs must be supplied with Power (8V-28V, 300mA) sourced from the avionics bus.
The two inputs are decoupled using two 3A shottky diodes and the resultant power is made available at connection VS for use by other low current users. In particular this output is intended to supply compass, AHRS and engine monitoring systems like MGL's SP-6, SP-7 and RDAC XF.

The second supply input (VB) is intended for usage with an independent power backup system. Should your aircraft not be fitted with such a system or if the backup power switchover is done separately, please use input VA only and leave VB unconnected.
The EFIS contains voltage measurement displays for each input.

The ground terminal should be connected to your avionics ground bus.

The Keep alive power input should have a permanent, uninterrupted connection to the aircraft's positive battery terminal (typically 12V or 24V). This supply requires only a few micro ampere of current and is of no consequence to the aircraft battery charge life. This current is

used to maintain the time and date of the internal real time clock as well as certain non-volatile data such as engine hobbs or virtual tank fuel levels. The iBOX contains an internal, user replaceable battery to maintain these functions, however if the “keep alive” wire is connected the internal battery will not be used resulting in a very long life time of this battery (estimated 10 years or more).
In addition, backup power from the keep alive wire is also routed to all EFIS panels via the LAN connector which means that EFIS systems do not have to use their own backup batteries either.

The ambient temperature sender input is used for a MGL Avionics OAT sensor. You may also use any LM335 based sensor from another source. The sensor is connected between the temperature sensor input and the ground connection of the iBOX. Do not use any other ground connection as this will introduce measurement errors.
Note: The LM335 sensor is a polarized device. Reverse polarity may damage the sensor.

## *CAN connector*


This is a DB-9 female connector. It contains the signal lines for two independent CAN bus interfaces. The CAN bus is used to connect MGL servos, RDAC XF devices, SP6 compass, SP7 compass etc.

You may connect any MGL compatible CAN device to either of the two CAN bus interfaces.

Note: Never connect the two CAN bus interfaces together – they must remain independent.

You may partition your devices onto the two interfaces anyway you like. For example you may connect autopilot servos and RDAC XF to one interface and SP-6 and SP-7 to the other interface. If you have multiple SP-7 devices you may also connect these to different CAN bus interfaces.

1L CAN bus 1, low
1H CAN bus 1, high

2L CAN bus 2, low
2H CAN bus 2, high

G Ground (use only for shielded cable)

**MGL standard harness colors:**

| | | |
|---|---|---|
| 1 | 1H | White/Red |
| 2 | 1L | White/Black |
| 3 | 2H | Grey/Red |
| 4 | 2L | Grey/Black |
| 6 | G | Black |
| 7 | G | Black |

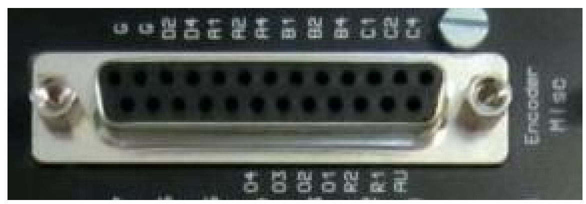
Please follow the wiring guidelines for CAN interfaces given in this manual. Every CAN bus requires at least one termination resistor if short wire runs are used or two terminating

resistors at each end of the bus if longer wire runs are used.
If a single resistor is used, connect this close to the CAN connector across the two signal wires. Typical values that can be used range from 60 ohms to 120 ohms.
If you require two resistors due to longer cable runs, one resistor should be placed on each end of the cable run. The value of each resistor must be at least 120 ohms and can go to 240 ohms. Devices should be connected to the cable run using short stubs (not longer than 60 cm or about 2 ft).

Single resistor termination may be used if the total length of the cable is not more than 3 meters (10 ft). For longer runs, please use two resistors. The maximum cable run distance may not exceed 20 meters (60 ft).

Two core twisted pair wire must be used for the CAN bus. Single, untwisted wire may only be used for short runs. Shielded, twisted pair cable may be used for EMI sensitive applications. The shield may be connected to any ground terminal on the CAN connector. Please do not connect the shield to any other ground point in your aircraft as this may potentially cause serious damage to the system should you have a ground fault. Ground faults can inject large electrical currents into sensitive EFIS equipment.

## *Encoder/MISC connector*




This is a DB-25 female connector. It contains the signals of the internal alticoder for use with a transponder. Note: Some newer type of transponders may no longer use these signals.
Further we find the audio output, two pulse counter inputs typically used for rotor speed measurements on rotor craft as well as 4 switched digital outputs.

C4,C2,C2, B4,B2,B1,A4,A2,A1,D4,D2 Connect these lines to the equivalent, identically labeled encoder inputs of your transponder. Should your transponder have a strobe input, in most cases this needs to be tied to ground (check the transponder installation manual for this). Any lines your transponder does not support can be left unconnected as these are used for high altitude only. The alticoder outputs are always active if the iBOX is supplied with power and are not dependent on a connected EFIS panel.
Note: EFIS panels diagnostics will temporarily switch the Alticoder outputs one by one for debugging purposes as long as you are viewing the active iBOX status display. For this reason please do not leave your transponder in mode-c as incorrect altitudes will be transmitted during diagnostics.

O1,O2,O3,O4 These four outputs are open collector darlington transistors capable of sinking 500mA of current each. The function of these outputs is determined by the EFIS panel. For MGL EFIS panels you can create a “script file” that will switch these outputs depending on defined conditions. A typical use is to activate an output if the EFIS detects “ground mode” for use with a modern mode-s transponder. Note: The MGL/Garrecht mode-s transponder does not require this as the relevant information is transmitted by the CAN bus to the transponder.

R1,R2 Two digital rotor RPM inputs are available here for use with rotor craft. Normally, only R1 is used for a single rotor helicopter or gyro copter. The input requires a switched signal that ranges from ground (0V) to at least 6V. Voltages up to 28V are acceptable. Note: Some sensors require a pull-up resistor to the power rail in order to create a positive output voltage. These sensors are basically a switch to ground that opens and closes.

AU The iBOX audio output. This output can drive a 8 ohm speaker to about 0.5W. It is intended to be connected to the aircraft's intercom system and allows the EFIS to create verbal voice messages or audible signals to the pilot.

G Signal ground

**MGL standard harness colors:**

| | | |
|---|---|---|
| 1 | C4 | Brown |
| 2 | C2 | Red |
| 3 | C1 | Orange |
| 4 | B4 | Yellow |
| 5 | B2 | Green |
| 6 | B1 | Blue |
| 7 | A4 | Violet |
| 8 | A2 | Grey |
| 9 | A1 | Pink |
| 10 | D4 | White/Black |
| 11 | D2 | White/Red |
| 12 | G | Black |
| 13 | G | Black |
| 14 | AU | White/Green |
| 15 | R1 | Grey/Black |
| 16 | R2 | Grey/Red |
| 17 | O1 | Grey/Yellow |
| 18 | O2 | Grey/Blue |
| 19 | O3 | Red/Yellow |
| 20 | O4 | Red/White |

## *Analog/Digital inputs connector*


This is a DB-25 female connector. This connector contains inputs and the alarm output.

A1,A2,A3,A4,A5,A6,A7,A8 Analog and digital inputs. These eight inputs can be used as analog inputs with a measurement range from 0V to about 16V and a resolution of 4 millivolt (4096 quantization levels). They can be used as digital inputs based on a fixed threshold. Usage of these inputs is determined by the EFIS setup. Typical uses are flap and trim position measurement, gear status indication, etc.

D1,D2 Currently unused system control inputs.
D3 Used to identify a standby iBOX if tied to ground, left open for the master iBOX.

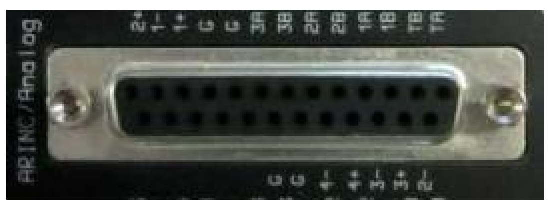
O5 Output 5. Used as “Alarm” output. This output is a open collector darlington transistor output that is switched to ground whenever an alarm is active and not acknowledged by the pilot. This line is typically used to switch a red alarm lamp that is in visual range of the pilot during normal flight. This output can sink up to 500mA. Should a normal incandescent light bulb be used, please use a maximum rating of 1W for a 12V bulb or up to 2W for a 24V bulb. Higher wattage may damage the output as the bulbs draw a high current just as they are switched on (and the filament is still cold). MGL recommends the use of LED lamps.

G Signal ground

**MGL standard harness colors:**

| | | |
|---|---|---|
| 1 | A1 | Brown |
| 2 | G | Black |
| 3 | A2 | Red |
| 5 | A3 | Orange |
| 7 | A4 | Yellow |
| 9 | A5 | Green |
| 11 | A6 | Blue |
| 13 | A7 | Violet |
| 15 | A8 | Grey |
| 16 | G | Black |
| 17 | D1 | Grey/Black |
| 19 | D2 | Grey/Red |
| 21 | D3 | Grey/Yellow |
| 23 | O5 | Grey/Blue (Alarm output) |
| 25 | G | Black |

## *Arinc/Analog connector*



This is a DB-25 female connector. This connector contains the ARINC communications interface as well as balanced analog inputs used with older navigation equipment.

| | |
|---|---|
| TA,TB | The ARINC transmitter output. |
| 1A,1B | ARINC receiver 1 |
| 2A,2B | ARINC receiver 2 |
| 3A,3B | ARINC receiver 3 |
| 1+,1- | Balanced analog input 1. Used as HSI input. |
| 2+,2- | Balanced analog input 2. Used as GSI input. |
| 3+,3- | Balanced analog input 3. Used to validate the HSI input. |
| 4+,4- | Balanced analog input 4. Used to validate the GSI input. |

G Signal ground

**MGL standard harness colors:**

| | | |
|---|---|---|
| 1 | TA | Brown |
| 2 | TB | Red |
| 3 | 1B | Orange |

| | | |
|---|---|---|
| 4 | 1A | Yellow |
| 5 | 2B | Green |
| 6 | 2A | Blue |
| 7 | 3B | Violet |
| 8 | 3A | Grey |
| 9 | G | Black |
| 10 | G | Black |
| 11 | 1+ | White/Red |
| 12 | 1- | Red/Yellow |
| 13 | 2+ | Red/White |
| 14 | 2- | White/Green |
| 15 | 3+ | Grey/Black |
| 16 | 3- | Grey/Red |
| 17 | 4+ | Grey/Yellow |
| 18 | 4- | Grey/Blue |
| 19 | G | Black |
| 20 | G | Black |

The ARINC transmitter is typically used at “normal” ARINC speed. All ARINC receivers are autobauding and can accept normal as well as high speed ARINC signals without further setup required.
ARINC receiver 2 is used for TIS or TCAS traffic.
Receivers 1 and 3 are free for use and are used as composite device (both receivers used) for a Garmin 430W or compatible system. See seperate Garmin installation document on MGL Avionics website for installation and configuration information.

Balanced analog inputs accept standard +/-150mV signals as created by older navigation systems.

### *RS232 connector*


This is a DB-25 female connector. This connector contains 6 RS232 compatible serial ports for use with various types of equipment such as COM radios.

T1,T2,T3,T4,T5,T6 RS232 level compatible transmitters. These are connected to the receivers (RX) of the connected equipment.
R1,R2,R3,R4,R5,R6 RS232 level compatible receivers. These are connected to the transmitters (TX) of the connected equipment.

G Signal ground

**MGL standard harness colors:**

| | | |
|---|---|---|
| 1 | T1 | Brown |

| | | |
|---|---|---|
| 2 | R1 | Red |
| 3 | G | Black |
| 4 | T2 | Orange |
| 5 | R2 | Yellow |
| 6 | G | Black |
| 7 | T3 | Green |
| 8 | R3 | Blue |
| 9 | G | Black |
| 10 | T4 | Violet |
| 11 | R4 | Grey |
| 12 | G | Black |
| 13 | T5 | Pink |
| 14 | R5 | White/Black |
| 15 | G | Black |
| 16 | T6 | White/Red |
| 17 | R6 | Blue/Green |
| 18 | G | Black |

RS232 channels 1 and 2 are reserved for high speed applications but can also be used for normal speeds. Channels 3,4,5 and 6 are normal RS232 speeds only.

The only dedicated channel is channel 6. This channel is the GPS NMEA port. It can be used both for receiving NMEA sentences from other GPS receivers (for example from FAA certified receivers required for approaches) and it is used to transmit a range of standard NMEA messages from the built in GPS receiver. This port can be used to connect to a stand alone, NMEA based autopilot. Please enable the NMEA autopilot functionality in the EFIS should you wish to use this functionality. The NMEA baudrate is fixed to the standard of 4800 baud.

RS232 channel usage is selected in the EFIS setup.

### Recommendation:

**All panels and iBOX are supplied via MGL AvioGuard isolated power supply**

RS232 ground must be connected to all connected RS232 devices (black wire).

**MGL AvioGuard isolated power supply is not used, no galvanic power isolation**

RS232 ground should not be connected or only connected to a wire shield on one side (so the shield does not act as ground conductor). This prevents ground loops and possible damage to iBOX and/or EFIS equipment due to ground faults. RS232 tends to be tolerant to missing ground connection provided equipment is powered from the same supply. This is the case in typical aircraft installations.

## Master and Standby

If you have two iBOX devices in your system, one will be the “master” unit, one will be the “standby” unit. Only one of the two units will be “active”.

The “active” IBOX will be responsible for all IBOX functionality. The iBOX that is not “active” will be switched on but remain passive. It forms a “hot standby” in case of a system failure of the “active” iBOX unit.

The “master” unit will normally be the “active” unit when both iBOX devices are on line.

The “standby” unit is normally dormant and intended to take over as temporary master unit should the “master” unit fail or alternatively the pilot selects the “standby” system to operate as “active” iBOX.

Mandatory hardware installation requirements for a “master/standby” dual iBOX system
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- During installation the “standby” unit needs to be identified. This is done by means of connecting signal line “D3” permanently to ground. The “master” iBOX leaves “D3” unconnected. “D3” is on the “Analog/Digital inputs” connector.
- The “standby” iBOX LAN must be connected to all of the panels “secondary LAN”. The “master” iBOX must be connected to all of the panels “primary LAN”.
  Do not mix LAN networks on the panels – this will prevent the master/standby system from operating properly. Primary and secondary LANs must never be connected together.
- The two iBOX units must be able to exchange data during operation. This is done via the CAN interface. For this reason, at least one of the CAN interfaces must be connected to both iBOX units. In a normal installation, both CAN interfaces will be connected between the two IBOX units so this criteria is met automatically.
- Each iBOX must be powered via a private, pilot accessible circuit breaker. Should both main and standby power supply inputs be used, both power supply circuits need to be switched by the breaker. The breaker can be an ordinary single or dual circuit switch of a minimum 1A DC rating. You need a dual circuit switch in case the iBOX is operated using power main and standby power supplies.

Note: should one of the EFIS nodes only have a single LAN connection (for example the wireless node) then connect this node to the “primary” LAN. Single network nodes will not operate in case of a “master” iBOX failure.

Note: It is theoretically possible that an iBOX could fail leaving its output drivers energized. For this reason it is mandatory that the pilot has the ability to disconnect power to the affected iBOX. Removing power will disconnect the iBOX regardless of its state.

Note: No electrical damage will result should both iBOX units power their shared outputs, however connected devices may not receive data from affected iBOX outputs.

### *Wiring equipment to both iBOX devices*

A typical install will wire all equipment such as radios and navigation systems in parallel to both iBOX units. The non-active iBOX unit (normally the Standby) will disconnect all outputs so there is no electrical conflict. All inputs remain active so the standby iBOX can follow any data transmission from a connected device.

Note: The audio outputs should be connected via two 10 ohm decoupling resistors, do not tie the two audio outputs directly together.

Inputs tend to have a certain impedance (or resistance) to ground. This may affect signal levels of connected devices slightly depending if one or two iBOX devices are used in the system. There is no effect related to an iBOX being active or not or even powered up. Please consult the technical data for information on input impedance. You may assume that if two inputs are used in parallel (such as is the case for a dual iBOX system) – the input impedance will halve. For example if the input impedance for a single input is 5000 ohms, it will be 2500 ohms if two inputs are connected together.

# Pressure sensors

## *Altimeter*

The iBOX contains a silicon resistor film based absolute pressure sensor that measures pressure with respect to vacuum (zero pressure). The sensor can measure altitudes in excess of 40.000ft with a resolution of less than 1ft at sea level.

The altimeter sensor is connected to the static port. The static port is shared with the low speed airspeed sensor.

## *Airspeed (low)*


The iBOX contains a silicon piezo resistance based pressure sensor to measure airspeed using a pitot and static port. The static port is shared with the altimeter.

The low speed sensor is fitted as standard and provides a usable measurement range from 16mph to 250mph.

## *Airspeed (high) - optional*


Optionally the iBOX can be supplied with a high speed sensor fitted. This sensor is based on a piezo resistance pressure sensor and is able to measure air speeds up to 600mph at sea level pressure.

Note: The high speed sensor is fitted in addition to the slow speed sensor so accuracy in the low speed region is not affected.

The high speed sensor is fitted with its own static port to enable installations to provide two independent static port installations based on suitability at the various speed ranges. Should it be so desired, a single static port may be used for both air speed sensors. In this case, simply provide an external T-splitter in the static line and feed both sensors with the same static pressure.

## *Angle of attack (AOA)*


The iBOX provides a angle of attack differential pressure sensor. This sensor can be used either with single ended AOA ports or a fully differential pressure system may be used.

For single ended applications, the “V” port must be connected to static pressure. For differential applications, the “P” port is connected to the pressure that increases with angle of attack while the “V” port is connected to the pressure that decreases with angle of attack.

Please note that either system must be selected in the EFIS and that a calibration flight is required. Please also note that airspeed indication must be fully operational as airspeed forms an input to the AOA calculations.

## IBOX status LED


IBOX is master iBOX, iBOX is not active (standby iBOX is selected as active)

Single flash, three second interval.

IBOX is master iBOX, iBOX is active (standby iBOX not connected via CAN)

Double flash, three second interval.

IBOX is standby iBOX, iBOX is not active (master iBOX active and connected via LAN)

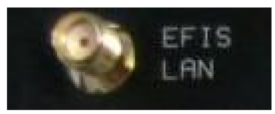
Single inverted flash, three second interval.

IBOX is standby iBOX, iBOX is active (master iBOX not active, connected or not connected)

Double inverted flash, three second interval.

Inverted Flash means LED is on and switches off to flash.

## IBOX LAN




The iBOX LAN is based on a propriety communications protocol optimized for the required task. The LAN distributes information between iBOX and panels as well as between panels. The iBOX LAN is a deterministic network using a token passing protocol. The iBOX is responsible of managing the protocol. Without an iBOX connected, panels cannot communicate amongst themselves. You can view the iBOX as being the conductor in a symphonic orchestra.

Apart from data, the iBOX distributes a small amount of backup electrical current to each EFIS panel if the iBOX power connector has been connected via the “keep alive” connection to the aircraft's battery. This power can be used by the panels to maintain internal information during the time that the systems are powered down without them needing to draw power from their own backup batteries. This saves batteries and extends maintenance intervals.

The iBOX LAN uses 50 ohm RG174 cable and SMA connectors. MGL EFIS panels provide two SMA connections for every LAN making it simple to connect multiple panels to the network.

Standard SMA to SMA cables included with every MGL EFIS have a three foot length (1 meter).

TBD: Maximum length of the iBOX network cable.

# IBOX GPS


The iBOX contains a high specification 50 channel GPS receiver with SBAS/WAAS support.

Sensitivity:

| | |
|---|---|
| Tracking and navigation: | -162dbm |
| Reaquisition: | -160dbm |
| Cold start: | -148dbm |
| Hot start: | -157dbm |

Achievable horizontal positioning accuracy is specified as 2.5m and 2.0m with SBAS support.

Time to first fix is 26 seconds for a cold start and under 1 second for a hot start. The GPS remains powered if the “keep alive” wire is connected so all starts are normally hot starts.

Navigation rate is 5Hz however, NMEA output on RS232 port 6 is limited to 1 navigation solution per second as the standard NMEA baudrate of 4800 does not permit more data to be sent in the given time.

Positional dynamics are assumed to not exceed 4G for temporary interpolation during brief outages due to antenna blanking (GPS aircraft mode). Maximum altitude is 50.000 meters (about 150.000 feet) while maximum velocity is 500 meters/second or about 1500 ft/second.

The GPS receiver supports RAIM (receiver autonomous integrity monitoring) which will lock out satellites from the navigation solution if the satellite signal is deemed to worsen the solution. This can be as a result of a faulty satellite or unsuitable atmospheric conditions. The RAIM information is typically displayed on the EFIS in the form of number of satellites considered and number actually used. If this number is different, satellites have been excluded by RAIM. The position can be relied upon as having a high degree of accuracy if at least 4 satellites remain active after RAIM processing. The GPS requires at least 5 visible satellites to be able to perform RAIM processing.

**The implementation of this GPS receiver complies with standard RTCA/DO-229C, class beta-1. All time outs are chosen for the en-route case.**

The GPS receiver will use non-U.S. SBAS satellites if these are in view and is able to simultaneously view WAAS, EGNOS and MSAS satellites. However, it will only choose one at any given time based on its estimated accuracy.

## *Antenna*

The iBOX ships with a flat “patch” antenna which is active, i.e. Contains an amplifier to cancel out cable losses. For this reason, please do not shorten or lengthen the cable as this will affect the reliability of GPS reception.
The antenna is supplied with 3.3V via the antenna cable. Should the cable be shorted to ground, an internal PTC fuse will disconnect the antenna supply. The fuse is self healing and will reconnect after some time if the short is removed.

## Backup battery


Underneath the removable cover is a Lithium cell of type CR2032. This battery is easily obtainable in hardware stores and electronic goods supply stores.

This battery is used to maintain the internal real time clock and non-volatile memory which contains items like hobbs meters, virtual fuel tank levels etc.

This battery is only used if there is no other power source available. You should connect the “keep alive” wire on the Power connector to the aircraft battery positive at all times. Only very little current will be drawn from the battery, far less than the batteries own self discharge rate so the battery life time is not affected.

If you have power available at the “keep alive” wire, no current will be drawn from the iBOX's own internal battery.

The battery is expected to last around 3-5 years if no “keep alive” supply is connected. With “keep alive” the battery is expected to last around 10 years and will only suffer from self discharge at a low rate.

To replace the battery, remove the cover and use a pair of insulated tweezers to assist with removing and replacing the battery which is located in a holder under the cover (you can insulate a pair of metal tweezers with some electrical tape).

## Input impedance

Analog/Digital inputs: 12 K to ground.
D1,D2,D3: 10K pullup to 3.3V, 20K to ground.
Balanced analog: 10K to ground.
ARINC RX: 10K to ground.
R1, R2: 5.6K to ground, 2.7K to 5V limiter.

## Outputs

Alticoder outputs are weakly pulled up to VS level by 10K resistors. Darlington outputs. Low level is 0.6V.

## Power supply iBOX

8V to 28V DC. 300 mA at 12V, 180mA at 24V.

Internally protected against reverse polarity and power supply spikes to a maximum of 100V/50mS. Meets all DO-160 power supply requirements for 12V and 24V systems.

Maximum permitted total ground current on any pin and any pin combination: 1A continuous.

## Mechanical dimensions