Stratomaster Ultra Horizon XL

This document is intended for the Ultra Horizon XL instrument panel as stand-alone or dual panel, with or without engine monitoring.

Owner's Manual

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Installation guide

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The Stratomaster Ultra Horizon XL

A typical setup including EMS (engine monitoring system)

The **Stratomaster Ultra Horizon XL** is a digital multifunction instrument designed for use in ultralight, microlight, experimental and homebuilt aircraft as well as any aircraft that permit use of such instrumentation under general or special operating permits.

The Ultra is designed around a transflective 5.7" monochrome display panel with a white LED backlight. Unlike current technology color displays, the monochrome panel is suited for operation in direct sunlight making it the only viable choice for many small aircraft applications. The panel does not need to be shaded and is capable of producing a clearly readable image even in very bright light conditions, with the light falling directly onto the panel.

The Ultra Horizon XL replaces the following previous product releases:
1) Stratomaster Ultra L
2) Stratomaster Ultra X
3) Stratomaster Ultra HL and HX
4) Stratomaster Ultra RL (Rotorcraft).

The Ultra Horizon XL is a fully user configurable panel that can be used as primary flight instrumentation display, engine monitor or both.
The Ultra provides two display pages, each page can be configured by the user, choosing from a selection of more than 50 instruments and display items.
Each item on the screen may be placed where the user wants it and most instruments provide several different display options. For example you can choose between analog altimeter and a tape based altimeter amongst other choices.

Panels may be designed on the Ultra itself or using a Microsoft Windows based panel design program available for free download from www.MGLAvionics.co.za.

Two Ultra panels may be connected to each other in a cockpit allowing Pilot/Co-Pilot displays providing redundancy in case of failure.

The Ultra Horizon XL can be connected to the following sensor sources:

RDAC A four channel thermocouple engine monitor
RDAC B twelve channel thermocouple engine monitor
RDAC C four channel thermocouple engine monitor with manifold pressure sensor
RDAC D twelve channel thermocouple engine monitor with manifold pressure sensor

SP-1 two-axis magnetic compass.
SP-2 three axis, tilt compensated magnetic compass.
SP-3h horizon / turn&bank sensor.
SP-3hc AHRS (attitude and heading reference system) , includes a three axis tilt compensated magnetic compass.

Details on either of the above can be found in the relevant manuals. Please browse the MGL Avionics website www.MGLAvionics.co.za for detailed information on these sensor packages. Most civil aviation authorities permit installation of the Ultra instrument as a secondary instrument on certified aircraft. Please ensure that you obtain the required permits or STCs before operating this instrument on a certified aircraft.

The Stratomaster Ultra has been designed with the following objectives in mind:

a) Provide a cost effective solution for a complete instrumentation system for small aircraft.
b) Provide instrumentation with uncompromising accuracy and range.
c) Provide a display unit with a shape and form factor suitable for installation into most small aircraft panels and pods.
d) Provide a display with the best possible viewing qualities over a wide temperature range, taking into account operation in bright sunlight as well as low light conditions.
e) Provide a system that offers long term stability and reliability with specific attention to low and medium frequency mechanical vibrations and shock loads such as when taxing a light aircraft on rough ground.
f) Provide a system that is easy to install and that maintains its usefulness should a different type of engine be installed in the aircraft.

The objectives have been achieved using the latest available embedded processing devices, which result in a drastic reduction of the amount of individual components required. This has a direct effect on improving reliability and reducing EMI (Electromagnetic interference), long a bane of digital systems.

Should you be using a RDAC X engine monitoring system, please refer to the manual that was included with your RDAC for specific installation instructions.

Typical installation options

Typical single panel setup
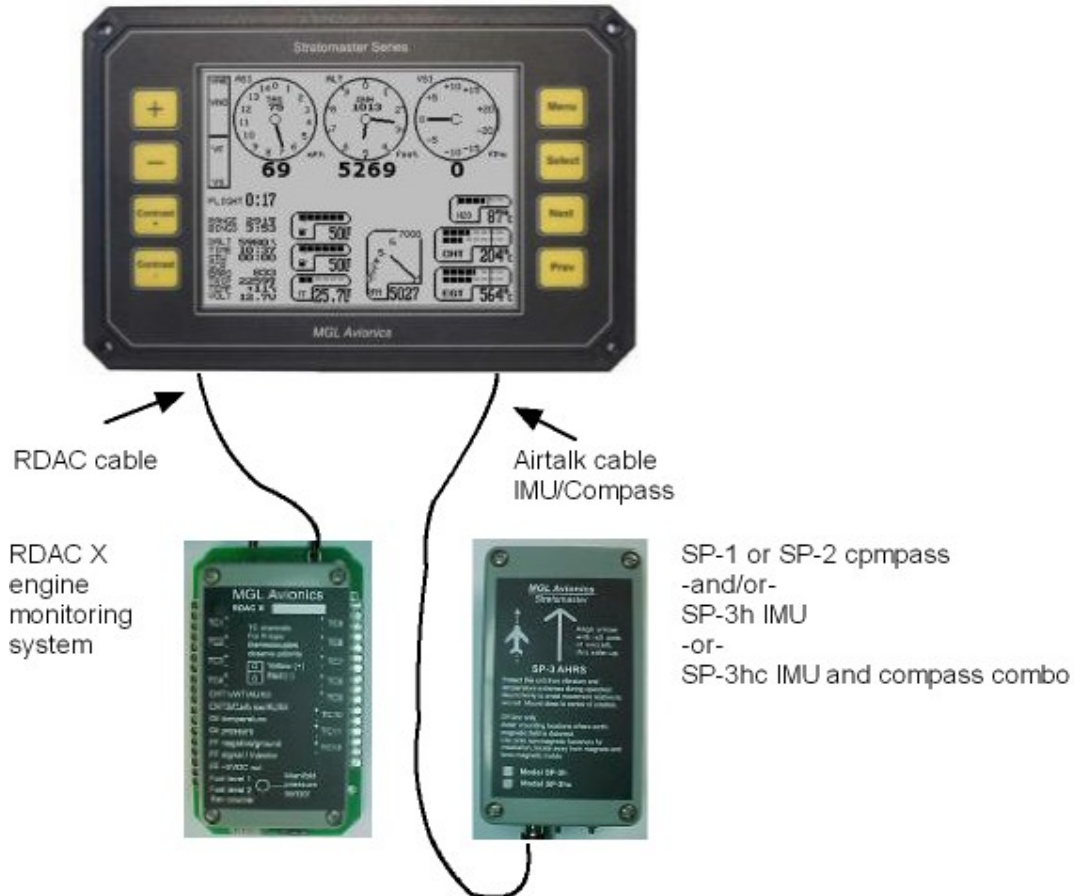
The above picture shows a typical single panel installation with an RDAC X engine monitor and SP-x compass or IMU sensor package.
Both RDAC and SP-x sensor package are optional components, although most installations make use of the RDAC engine monitoring system.

Typical dual panel setup with master and slave panel
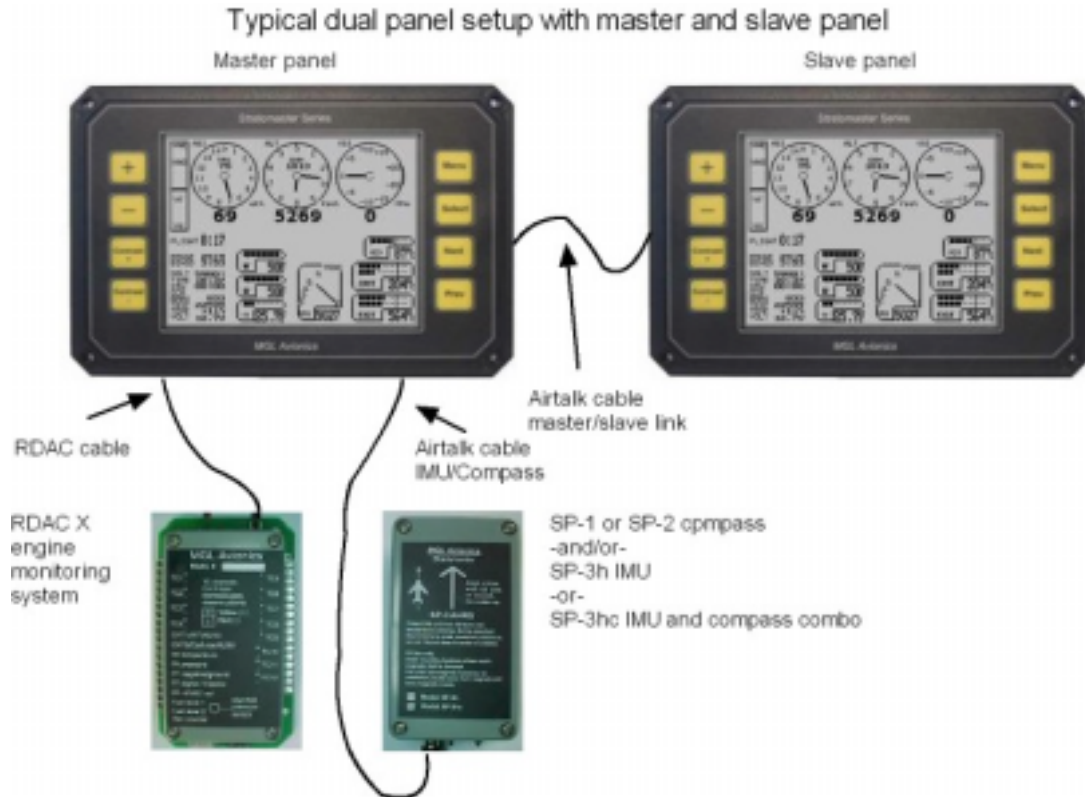
The above picture shows a dual panel setup. Two identical Ultra panels are used. The left panel is configured as master (setup in the mode menu) and the right panel is the slave.
The slave panel obtains all engine and other instrument data from the master panel via the airtalk link.
RDAC engine monitor and SP-x compass or IMU sensor packages are optional components. It is not strictly required that an Ultra system has an engine monitor, although most installations do.
For the above installation, the RDAC and tubing for airspeed and altimeter would normally be connected to both systems. This makes it possible to change the master/slave assignment should this be required.

For a dual panel layout, two distinctly different operating modes can be selected. The first is a mode where both panels operate autonomously but will share the same engine monitoring RDAC – the RDAC is wired to both panels. Also, the SP-3 is shared.
In this mode, the only interaction between the two panels is the adjustment of local pressure for the altimeter. You can change the pressure setting on any panel and the other will follow.

The second dual panel mode uses one panel as passive and the other as active panel. The active panel transmits all relevant data from altitude and airspeed to engine monitoring data to the passive panel. The passive panel does not acquire any data of its own but uses the data from the active panel instead.

Dual panel modes are setup in the Mode and Units setup menu.

SPECIFICATIONS:

General specifications

Ultra Display unit:

Size: 202x135 mm. Mounting depth 95mm (including connectors and wiring). Panel cutout 196x122 mm.

Weight: 980 grams. Excluding external senders, including RDAC unit.

Power supply requirements: 12V DC nominal. Range 6.5V DC to 28V DC. Internally protected to 33 V DC.

Current consumption: 80 mA with back light at 13.8V DC. Excludes current requirements of external sensor packages if any.

External temperature sensor input: Optimized for National Semiconductor LM335 temperature sender.

Alarm output: Active low pull down transistor output suitable for switching of lamps and LEDs with dropping resistors. Maximum current 0.5A DC.

Air-talk link: Two Air-talk links are provided. These are used to connect to other Air-Talk compatible devices. Standard audio RCA cable and connectors are used as medium. Air-talk is intended as a short distance, multi master communications link allowing Air-talk compatible devices to share information. The Stratomaster Ultra uses the Air-talk link to connect to another Stratomaster Ultra a PC, Flight data recorder (black box), and key download devices (for transfer of the log to a remote PC).
The airtalk link is also used to connect either SP-1, SP-2 or SP-3 attitude and heading sensor packages.

Rotor speed sensor input: This input is used for the split rotor speed and engine power instrument. Intended for rotor craft such as Gyro planes and helicopters.

Technical specifications Ultra display unit

Altimeter

Range 0-40 000 ft (12 195 m), 1ft (or 1 m) dynamic resolution, 7.5 ft (or 2 m) static resolution at sea level. Dynamic resolution applies with the aircraft in flight. Dynamic resolution is measured by mathematically evaluating the turbulence created around the aircraft.

Basic accuracy at 20 degrees C (68 degrees F) +/- 30 ft (9 m) based on calibration to mercury manometer at +/- 1 mb (0.0295 Inch of Hg).

Maximum theoretical error factor +/- 1.5% over temperature range 0-40 degrees C (104 degrees F). Typical error factor over temperature range 0-40 degrees C (104 degrees F) is less than 0.5%

Note: The altimeter can be operated to altitudes above 40 000 ft (12 195 m). Range and accuracy above the 40 000 ft (12 195 m) level are dependant on individual units. The achievable range is in the region of 45 000 ft (13 720 m) to 60 000 ft (18 293 m) depending on manufacturing tolerances of the pressure sensor.

Airspeed indicator

Range 0-250 mph (402 Kph or 217 Knots), 1 mph (1 Kph or 1 Knot) resolution. Theoretical accuracy 1% at 20 degrees C (68 degrees F), subject to installation of pitot tube and airflow pattern around aircraft.

VSI

Range +/- 9 990 ft. (3 045 m) Resolution truncated to 10 ft/minute (5cm per second). Internally 1 ft/minute. Accuracy +/-5 %, Please note: The VSI is compensated for altitude.

Minimum display resolution is as low as 10 ft/min (5cm per second) with a +/-2 000 ft (610 m) maximum reading.

Technical specifications RDAC

Rev counter

Range 0 to 9 999 revs. Resolution is dependant on rev counter setup in instrument. Accuracy: +/- 0.0005% + resolution.

Fuel flow sender input

Accuracy of measurement is +/-0.05% subject to accuracy of fuel flow sender used. Example sender is MGL Avionics dual range fuel flow sender: +/- 3% uncalibrated, typically less than 1% calibrated.

Fuel level sender inputs

Intended for use with resistive fuel level probes. Can be used with most capacitive type probes as well.
Input consists of a 1000 ohm pullup resistor to a 5VDC source.
Measurement accuracy of input: +/-2%. Overall measurement accuracy of fuel level is subject to quality and installation of chosen fuel level sender as well as complexity and form of tank shape.

Using the prescribed calibration procedure we find we can calibrate within 5% of actual level for most tank shapes.

Oil pressure sender input

1500 ohm pullup resistor to 5VDC source. For use with typical VDO and similar resistive oil pressure senders. Supports senders that increase resistance with pressure as well as senders that decrease resistance with pressure. Supports resistance ranges from 50 to 1000 ohms full range.

NTC temperature sender inputs

Measurement accuracy +/- 2% subject to accuracy of sender. Note: Senders are manufactured with a tolerance of up to +/- 20%.

Thermocouple temperature sender inputs

Measurement accuracy +/- 1%. The thermocouple amplifier system used is highly stable and long-term drift elimination is achieved by using a chopper stabilized system. The system

employed features full, accurate cold junction compensation and bow voltage correction. The system is further highly immune to received EMI from high powered radio transmitters.

Power supply

The Stratomaster Ultra unit is optimized and intended for operation on a 12V DC supply such as a motorcycle battery. However, it can be operated on any power supply down to about 6.5 volts as well as aircraft power supplies of 24 or 28V DC.

Current consumption may vary slightly between units but is typically in the region of 40 mA without display back light and 80 mA with display back light.
Current consumption reduces as supply voltage increases.

The unit is internally protected against temporary over voltage loads such as those that can be produced by a cranking starter motor.

It is advisable to power the unit via a fuse or circuit breaker. A fuse rating of 1A (slow blow) is recommended. Generally it is accepted to use circuit breakers that can be reset during flight should the need arise. Ordinary fuses are not recommended for aircraft use.

The Stratomaster Ultra Horizon XL features and functions

Basic system functions

- Altitude to 40 000 ft (12 195 m) calibrated, 1ft dynamic resolution
- Airspeed ASI analog and digital, TAS digital
- Stopwatch
- Glide and climb ratio to 1/99
- QNH 960 to 1 060 mb (28.3 - 31.3 Inch of Hg)
- QNE 1013 mb quick select (29.9 Inches of Hg)
- Time of day, Date for flight log entries
- Air time since take-off (or lesson time)
- Ambient temperature using external sensor
- Up to two Fuel level using flow sender or optional level sender
- Fuel flow using optional flow sender
- Current range estimate (range at current speed and fuel burn)
- Fuel bingo estimate (time until tank empty)
- Range calculator using manually entered ground speed
- Air distance made good
- Voltage. Supply to unit. Usually 12V battery.
- VSI +/- 9 990 ft/minute (50.7 meters per second) range
- Flight log storing up to 200 entries
- Hobbs meter, presetable to current engine time
- Density altimeter
- Barometer for ambient pressure
- Aircraft registration number display
- Maintenance timer
- Warnings for engine temperature, speed high, speed low, maximum altitude, low fuel level, etc
- Alarm output to switch a warning lamp
- Audio alarm output to drive a panel speaker or low level output for alarm tone injection into a suitably equipped headset or intercom system.
- Master and slave modes for dual instrument setup
- Measuring take-off run to 50 ft (15.24 m) above ground level
- Artificial horizon (requires SP-3h, SP-3hc)
- Slip indicator (requires SP-3h, SP-3hc)
- Rate of turn indicator (requires SP-3h, SP-3hc)
- Compass (requires SP-1, SP-2 or SP-3hc)
- Air talk link for connection to:
A) PC's and Laptops using optional cable
B) Stratomaster "Black Box" flight recorder
C) Stratomaster Ultra secondary instrument
D) Key ring flight log download device
E) Compass and AHRS sensor packages

RDAC EMS functions

- Four or twelve channel thermocouple amplifier, high resolution chopper stabilized system with full cold junction compensation and bow voltage correction to laboratory standards. The inputs can accept K-type or J-type thermocouples (selectable via provided menu functions)
- Oil and Water temperature NTC input compatible with most oil temperature senders and the MGL water temperature sender. Also accepts MGL precision semiconductor senders for water and oil temperature.

- Universal rev counter input. Can be used on a wide variety of engines using a variety of interface methods.
- Fuel flow sender input. Can be used with most commercial liquid flow senders. Calibration via provided menu functions.
- Oil pressure sender input. Accepts most commercial oil pressure senders including those from VDO.
- Fuel level sender input with extensive calibration functions provided to allow direct readout of fuel quantity corrected for tank shape and sender tolerances.
- LM335 sensor based temperature sender to indicate ice warning. The sender is normally fitted to the outside of a carburetor, in close proximity to the throttle slider or valve or in the intake airflow.

The EMS included with the Ultra "H" provides for a wide variety of engines and the display unit can be configured in many different ways as outlined under the "Device setup menu".

AHRS and compass functions

Available funcions in this category depend on the capabilities of the sensor package connected. The following list shows functions available with the SP-3hc package.

- Bank/Pitch attitude display. This display resembles the artificial horizon as found on typical IFR panels. The attitude display is not restricted to a range of bank or pitch and is thus fully aerobatics capable.
- Bank&Turn display. This consits of Rate 1 markers (2 minute standard rate turn at 20 degrees bank) and a traditional "ball slip" display.
- Compass or gyro compass heading. This depends on the abilities of the connected package.

Flight log

Perhaps one of the most useful features of the Stratomaster Ultra instrument is the ability to record a flight log.

You can setup your Stratomaster Ultra to record a log entry in one of the following ways:

1. Automatic flight log normal aircraft. This will automatically detect the start of a flight and end of a flight. The unit uses engine revs in combination with airspeed to detect a flight. This is the way most pilots prefer to operate the Stratomaster Ultra.
2. Automatic flight log rotor craft. This operates similar to above but air speed is not taken into account. Instead, rotor speed above 70% of the 100% setting is used to mark possible start of a flight. If you select the split rotor/engine RPM display this mode is automatically selected.
3. Manual flight log. In this case the pilot manually starts a flight and ends it. This mode is used mainly if no rev counter input to the instrument is available.

The Stratomaster Ultra will log all flights of longer than one minute. Any flights with less than one minute accumulated time are not stored in the log.

The Stratomaster Ultra will store the last 200 flights in the log.

At the end of a flight, the pilot number selected in the main menu will be written to the log entry for the flight. This can be used to log airtime of several pilots, for example with aircraft sharing schemes. The log can be viewed at any time. Please also note that the log may be downloaded to a PC using a direct cable connection or key-ring download device (optional extras).

The following information pertaining to a flight will be logged:

- Date (DD/MM) of take-off
- Take-off time.
- Flight time. Displayed in either hours and minutes or hours and fraction of hours depending on setup.
- Highest altitude reached (In ft or meters depending on setup)
- Maximum airspeed obtained. Displayed airspeed depends on whether ASI or TAS is selected. (Displayed in kilometers, miles or knots depending on setup).
- Hobbs meter reading at end of flight/lesson (Displayed in either hours and minutes or hours and fraction of hours depending on setup)
- Pilot number

The Ultra Horizon XL menus

Nearlt all of the Ultra Horizons functions are accessed via menus. The menus are easily navigated. Press Menu from any of the two main display pages to enter the "Main Menu". From here you have access to several functions and three sub menus.
Use the "Prev" and "Next" buttons to choose a menu item and press "Select" to enter the function or sub menu. Some functions accessible in the Main menu can be controlled directly with "Select", "+" or "-" as indicated in the item itself.

The following graphic shows the menu structure of the Ultra.
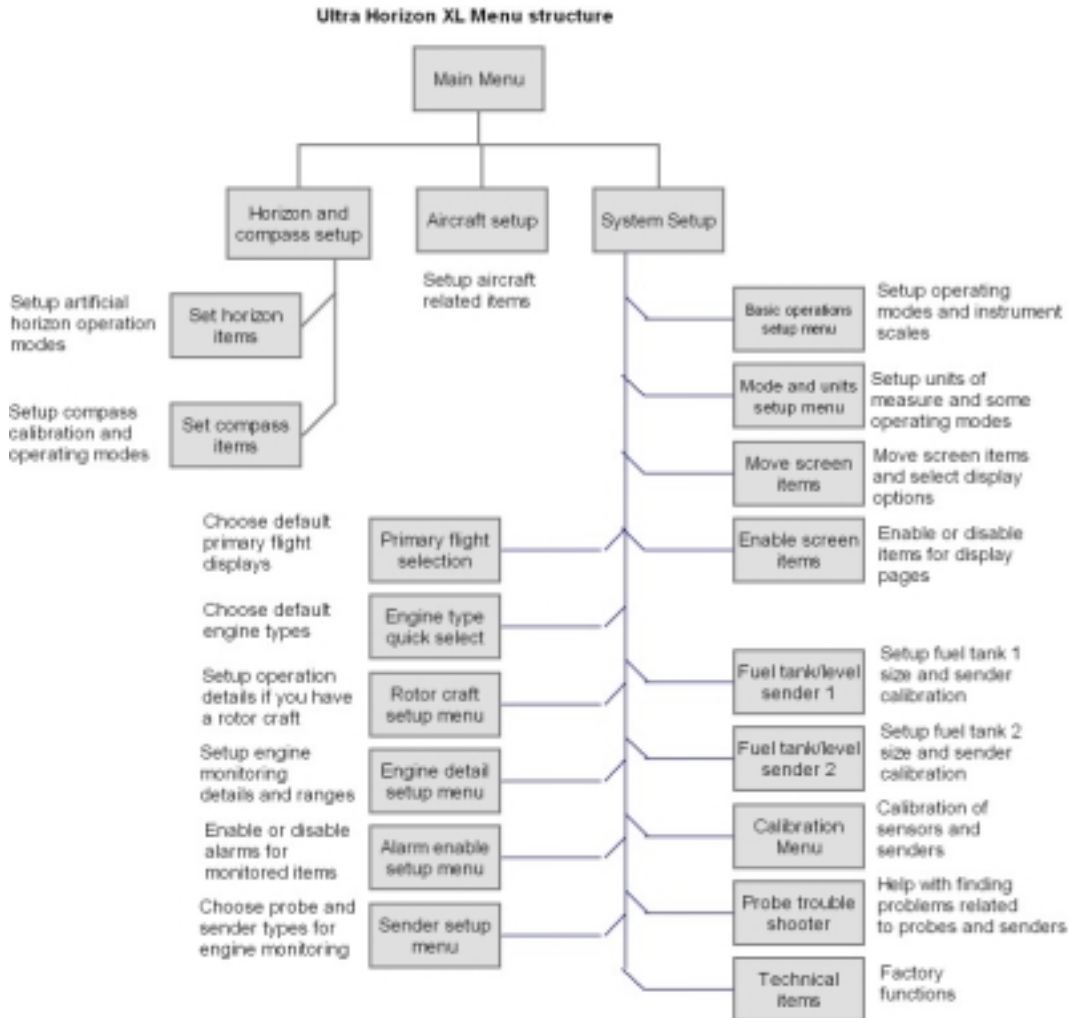
The main menu

The main menu is entered from the main instrument display by pressing the menu key.
The main menu is your route to accessing several additional functions as well as activating the many setup and configuration menus and functions.

```
                Main Menu

        Flight: Autodetect, in Flight
          Pilot for Flight log: 1
              View flight log
          Range at  84% is  179m
    FuelLevel Calc.:   59L +/- to change
     Fuel Accu: 19.8L Zero-press Select
   StopWatch Start-press +, Zero-press -
            Reset distance counter
    Takeoff distance measurement inactive
          Horizon & Compass setup
                Aircraft setup
                System setup
```
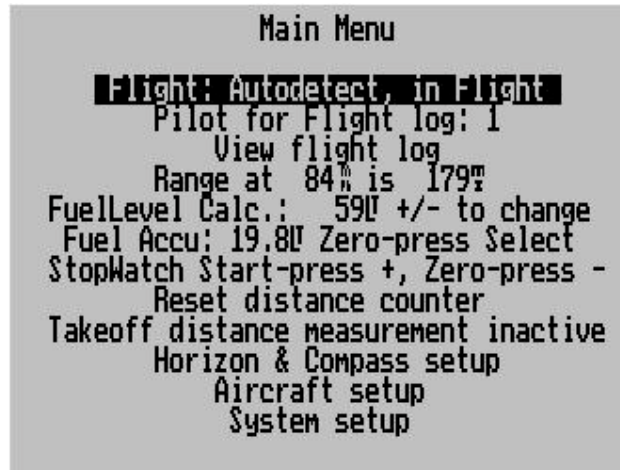
Flight…

This menu entry shows you your current flight detect status if you have automatic flight detect enabled. The above display would be shown if you are in flight.
If you are using manual flight start and stop, then this menu entry will allow you to start and stop flights. In this case automatic flight detect is disabled.
We recommend that you use automatic flight detect.
Flight detection is relevant for logging of flights for your built in flight log.

Pilot for flight log:

When a flight ends the flight information is written to the built in flight log. Each log entry contains a field containing the pilot number as selected in this field.
This can be used to keep track of flight times for several pilots when the aircraft is shared.

View Flight Log

This function allows you to view the logged flight details. The Ultra will maintain a log of the last 200 flights. The log can also be downloaded to a PC using the free flight log program from MGL Avionics (download from the website www.MGLAvionics.co.za). The log can be downloaded by direct cable connection using an airtalk to PC cable or you can use a MGL Avionics flight log download key device to transfer flight log data from your aircraft to your PC at home.

The range calculator

The Stratomaster Ultra includes a useful range calculator if you have at minimum a fuel flow sender.

`Range at 141ᴹ is  314ᵀ`

The range calculator defaults to your current TAS (true airspeed) as shown on the airspeed indicator face (bottom right corner). This agrees with the range calculation as shown if you have a range display enabled.

Move the menu highlight to the range calculator as shown above and you can now change the speed using the + and – keys. You might want to enter your current ground speed as shown on a GPS for example.

Range will be calculated using your current fuel flow reading as a base as well as the current fuel level.

As with all instrument readings, it is the pilot's responsibility to use these figures responsibly. Be certain that fuel level reflected is correct and that fuel flow as shown is calibrated and trustworthy.

The range calculator must never be used to stretch a marginal fuel range situation. It is the pilot's responsibility to work on actual fuel burn figures as well as loaded fuel quantities at all times. Good airmanship includes always planning a flight with sufficient fuel reserves.

Fuel level Calc.:…

This menu entry allows you to adjust your calculated fuel level. You can use a calculated fuel level if you have a fuel flow sender connected.
Set the calculated fuel level equal to your loaded fuel whenever you fuel or de-fuel your aircraft. You can set either of the two fuel level displays to show you the calculated fuel level instead of a physical fuel level obtained from a fuel level sender.

Fuel accu:…

This entry shows your accumulated fuel burn if you have a fuel flow sender connected. You can reset the accumulator by moving the highlight to this entry and then pressing "Select".

Stopwatch…

This function allows you to start, stop and reset the built in stopwatch. To view the stopwatch, you need to place the stopwatch display item onto one or both display pages.

Reset distance counter

This function resets the airspeed based trip counter to zero. Place the highlight on this item and then press "Select" to set the trip counter to zero.
Note: you can setup the system to clear this counter to zero every time you start a flight. This is done in the Mode and units setup menu.
To view the distance trip counter you need to place the trip display item onto one or two display pages.

Takeoff distance measurement

This interesting function will measure your takeoff distance based on the distance you have traveled through a body of air to the point where your altitude is 50 ft higher then at the point you started. This corresponds to standard 50 ft obstacle takeoff distance measurements.
The distance shown will be fairly independent on wind factors and corresponds closely to the zero windspeed takeoff distance when used on a tar runway.
For grass runways the distance will be influenced by the additional friction between your aircrafts wheels and the grass runway. This tends to make your takeoff run measured shorter if you takeoff into significant wind when compared to zero windspeed using the same runway. Please note, we are talking about distance traveled though a moving body of air, not actual distance traveled on the ground.

Using the takeoff distance measurement function:

Taxi to the start of your takeoff run and finish your pre-takeoff checks. When you are ready to roll, move the highlight to this entry and press select. The display changes to:

Start your takeoff run…

Start your takeoff run immediately. Once you have exceeded an airspeed of 16mph the display changes to:

Rolling…

Once you have exceeded 50 ft altitude gain the display changes again and will display your takeoff distance:

Takeoff distance is 135m (example distance in meters)

Please note:
Once you have started the takeoff distance measuring mode, you may change back to the main display screen.
Once you have reached a safe altitude, switch back to the menu to read your takeoff distance.

Horizon & Compass setup

This entry branches into the horizon and compass setup menu. You will only need these functions if you have a SP-1 or SP-2 compass or SP-3h or SP-4hc IMU system.
The Horizon and Compass menu is described later in this manual.

Aircraft setup

This function branches into a menu that allows you to set items such as date/time, hobbs meter etc.

System setup

This selection branches into the System setup menu. Here you will find all the items required to customize your Ultra to your needs.

Aircraft setup

The following items are setup under the Aircraft setup:

a) Date and time for the built in clock
b) Hobbs meter pre-set
c) Maintenance meter
a) Aircraft registration number

```
        Aircraft setup

Set date/time:|00/07/26 11:05
Set Hobbs meter: 0101.11
Maintenance hours:  26
Aircraft registration: ZS-WRG
```
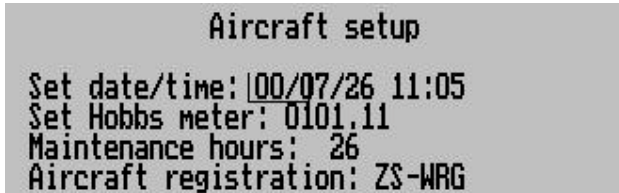
Date and time

Date and time is used for your flight log. Time of day is a display available both during flight and on the ground. Please note: The year is never stored in the log. The only reason for entering the year is to be able to correct for leap years. The internal real-time clock contains a year based counter that can count from 0 to 3 for leap year correction.

Use Next/Prev to select the item and then use +/- to change it.

(Nb: The Stratomaster Ultra uses a 24-hour clock)

Hobbs meter

The hobbs meter contained the the Stratomaster Ultra is pre-settable. You can set the meter to any time you like, usually this would be to your currently known engine time.

Use the Prev/Next keys to select the item and then use +/- to change it.

Maintenance meter

The maintenance meter can be viewed as a hobbs meter "in reverse". It counts engine running time down instead of up. This timer is used to control engine maintenance times, for example spark plug changes or MPI's. The maintenance timer is subject to the setting of the hobbs revs.

Use the Prev/Next keys to select the item and then use +/- to change it.

Aircraft registration

Enter your name or aircraft registration marks into this field to personalize your instrument.

You have 6 characters available.
Use the Prev/Next keys to select a character and then use +/- to change it.

Available characters:

Alphabet in capital letters
Alphabet in small letters
Numbers 0 - 9

Symbols:
! " # $ % & ' ( ) * + , . - . / : ; < = > ? @ [¥] ^ _ ` { | } ?

System setup

The system setup menu is the largest of the menu systems in the Stratomaster Ultra. Here all functions you require to customize and setup your Ultra are combined.

```
           System setup

     Mode and units setup menu
     Basic operaton setup menu
        Move screen items
        Enable screen items
     Primary flight selection
     Engine type quick select
       Rotor craft setup menu
     Engine detail setup menu
      Alarm enable setup menu
         Sender setup menu
     Fuel tank/level sender 1
     Fuel tank/level sender 2
         Calibration menu
       Probe trouble shooter
          Technical items
```
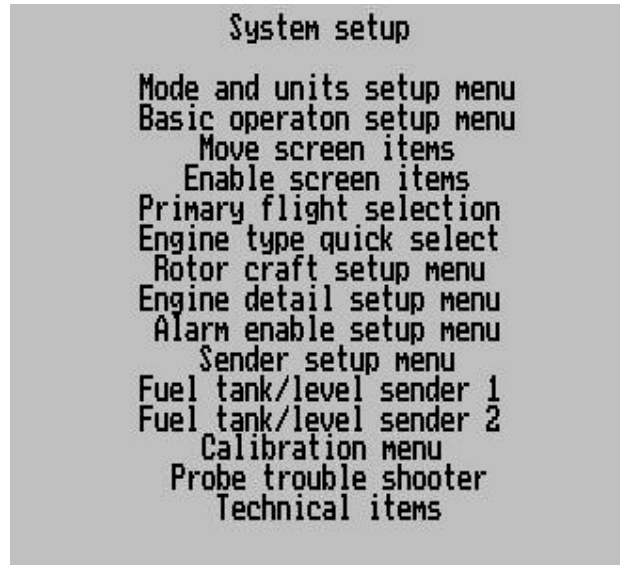
Mode and units setup
Select some operating modes and select units of measure.

Basic operation setup menu
Setup basic operating parameters, Vspeeds, scales etc

Move screen items
Enter the special display mode that allows you to move screen items and select display options for display items supporting more than one method of display.
You will move items in the display page that was active when you entered the main menu.

Enable screen items
Here you select which items will appear on which of the two display pages.

Primary flight selection
Select a standard VFR or IFR panel and program this into either display page one or two.

Engine type quick select
Select from standard engine types and program a standard layout for your selection. This is used as a starting point for your engine configuration, however, popular engines are directly supported.

Rotor craft setup menu
Here you will find setup items that are relevant for rotor craft such as helicopters and gyro planes.

Engine detail setup menu
Engine monitoring details, ranges, alarm levels etc.

Alarm enable setup menu
Enable or disable the various alarm sources in the Ultra.

Sender setup menu
Here you can select various types of senders for your engine monitoring and customize sender usage.

Fuel tank/level sender 1
Here you set the fuel tank size for tank 1. You also calibrate the fuel level sender for tank 1 here (if used).

Fuel tank/level sender 2
Here you set the fuel tank size for tank 2. You also calibrate the fuel level sender for tank 2 here (if used).

Calibration menu
The calibration menu contains functions to calibrate various sensors such as altimeter etc.

Probe trouble shooter
This function shows you a raw data display from the RDAC engine monitor. This can assist in finding problems with probes and senders.

Technical items
This function contains items normally only used during manufacture of your Ultra. In production versions this menu entry is hidden. It can be enabled by pressing both + and – at the same time when you switch on your Ultra.

Mode and units setup

```
          Mode setup menu

Altitude display units:   feet (ft)
Local pressure units:     millibar (mb)
Distance/Speed units:     miles
Fuel quantity units:      liters
Temperature units:        Deg C
Oil pressure units:       PSI
MAP pressure units:       Inch HG
Start of flight detect:   Automatic
Air distance reset:       Flight start
Hour fraction mode:       Decimals
Airtalk: This unit is     Master
```

Altitude display units
> Select whether you would like to display the altitude in meters or feet. This setting also influences the units used for the VSI. This will be selected to either feet/minute or meters/second.

Local pressure units
> Select your units of local pressure. Options are MilliBar (Hecto-Pascal) or Inches of Mercury.

> QNH is the local pressure setting of your airfield as given to you by your ATC. Be sure to use the correct QNH to ensure that your altitude is displayed correctly according to local conditions. This will keep your ATC happy as you will be flying your assigned altitude.

Distance/Speed units
> Select how you want to display your distance. You can choose between Nautical miles (Nm), Statute miles (m) and Kilometers (Km). This setting also influences your airspeed display, resulting in the display of Knots, mph, or kph.

> Distances are displayed by the distance traveled indication and range estimate.

Fuel quantity units

    Select if you want fuel quantity displayed in liters, imperial gallons, U.S. gallons, Kilograms or lbs. This setting also influences the fuel flow display.

Temperature units

    Select if you would like temperature displayed in degrees Fahrenheit or Celsius. This setting influences all temperature displays such as ambient, water or oil, EGT, CHT etc.

Oil Pressure units

    Select if you would like oil pressure displayed in Bar or PSI.

MAP Pressure units

    Select if you would like MAP pressure displayed in Bar, PSI or inches of Mercury.

Start of flight detect

    Select here if you want the instrument to detect the start of a flight automatically or if you want to manually start and stop a flight.

    This setting is relevant for the automatic logbook and the flight timer display. If you choose automatic flight detection, a flight starts if airspeed is above 30 mph (48 Kph or 26 Kn) and engine revs above the limit set in the take-off revs setting (basic setup menu).

    Flights are logged automatically if a flight duration of at least a minute has been detected. In the manual flight detect mode, you can start and stop flights for logging purposes yourself using the main menu. We recommend you use the automatic flight detect mode.

Air distance reset

    Select if you would like the air distance trip counter to reset to zero automatically when you start a flight. In any case you can reset this trip counter at any time manually from the main menu.

Hour fraction mode

    Select whether you want hour fractions to display in decimal fractions of an hour or in minutes. This applies for the display of hobbs meter and flight time. Time of day always displays minutes.

Airtalk This unit is

    If you have two Stratomaster units interconnected within your cockpit using the airtalk link, you must set one unit to be the slave while the other is the master. This is relevant for the QNH setting. If both instruments power up at the same time, the QNH from the master is transferred to the slave.

Basic operation setup menu

```
        Basic Device setup

Flight log RPM trigger:  5500
Hobbs meter trigger RPM: 2000
Rev counter scale:       7000
Fuel low alarm tank 1:     10lt
Fuel low alarm tank 2:     10lt
Backlight mode:          Auto
ALT scale:               200
ASI scale:               100
Tape resolution:         20
Fuel flow scale:         30
Stall speed VS:          Vs   30m
Flap speed VF:           VF   40m
Manouvering speed Vno:   Vno  70m
Never exceed speed Vne:  Vne  80m
Altitude alarm 12000ʒ
```

Flight log RPM Trigger (Take-off RPM)

This is the rev limit to use for automatic take-off detection. Take-off detection is relevant for the automatic logbook. The instrument uses a combination of take-off revs exceeded and airspeed above 30 mph (48 kph or 26 knots) to detect the start of the flight.

Note: Once a flight is started, revs are ignored. Only airspeed is relevant then.

Hobbs meter trigger RPM

This is the rev limit above which engine running time is added to the hobbs meter and maintenance meter. This setting allows you to choose whether or not to add engine idle speed time to the hobbs meter. Should you wish to have engine idle count towards the hobbs meter time, set the Hobbs revs value to less than your normal engine idle speed.

Rev counter scale

Select the maximum RPM for the analog RPM indicator here. You can choose from 3000,4000,5000,6000,7000,8000 or 9000 RPM.

For example, a typical Rotax two-stroke would need a setting of 7000 RPM. A Rotax four stroke would need a setting of 6000 while most other four stroke engines may need a setting of 4000 or 5000.

Fuel low alarm tank 1

Fuel low alarm tank 2

Set the minimum fuel level below which the unit will generate an alarm.

In order to use the fuel level alarm you must have either a fuel tank level sender installed or you must use a fuel flow sender (in which case the fuel level can be calculated from a starting value).

Please note that we recommend that you calibrate your system in such a way that you have reserve fuel at all times. It is not considered good airmanship to fly your tank empty!

Make allowance that any type of fuel flow or fuel level sensor may malfunction for whatever reason. Should you find unusual, unexpected fuel economy reported by your system, you most likely are getting incorrect readings. Always backup your fuel management with manual inspections and plan your flights using known fuel burn rates of your power plant.

Back light mode

The back light can be used in one of three ways. Permanently on. Permanently off or in "Auto mode". In auto mode the back light will switch on if the engine is running or if any key on the instrument is pressed. The back light will automatically switch off is there is the engine is not running or no keys have been pressed for a period of ten minutes.

ALT scale

This setting determines the altitude steps used with the tape based altimeter. Effectively this sets the resolution of the altimeter tape. This setting is not relevant for the analog altimeter.

ASI scale

Here you select what scale to use for your analog ASI (airspeed) indicator. You have a choice of 80, 100, 150, 200, 300 or 400 units of measure. Units of measure may be miles per hour, kilometers per hour or knots.

This setting is relevant for the analog ASI only.

Tape resolution

This setting determines the ASI tape resolution if a tape based ASI is used.

Fuel flow scale

Here you select what scale to use for your fuel flow indicator.

Stall speed Vs

The Stall speed or minimum speed setting for the VSpeed display. Also sets the limit for the low speed alarm.

Flap speed Vf

The maximum speed you may operate with flaps. Used for the speed arc.

Maneuvering speed Vno

Your maximum free maneuvering speed, often your maximum cruise speed. Used for the speed arc.

Never exceed speed Vne

Your maximum allowable speed. Used as limit for the high speed alarm. Also used for the VSpeed display.

Altitude alarm

Your altitude ceiling above which an alarm will be issued. Note that the alarm must be enabled separately.

Move display items

This functions enters a special mode allowing you to move screen display items. Select the display page that you want to modify before entering this function.
During the move function, the normal display will be shown with the currently selected item indicated by a frame and a cross as shown in the image below.
If you want to add a new item, enable it onto the screen first using the "Enable screen items" function, then enter the "Move display items".
Select the item to move using the "Prev" and "Next" buttons.
"+" moves the item right by 8 pixels.
"-" moves the item left by 8 pixels.
"Contrast –" moves the item up by 1 pixel.
"Contrast +" moves the item up by 1 pixel.
"Select" cycles through display options for the selected item.
"Menu" ends the move mode and resumes normal operation.
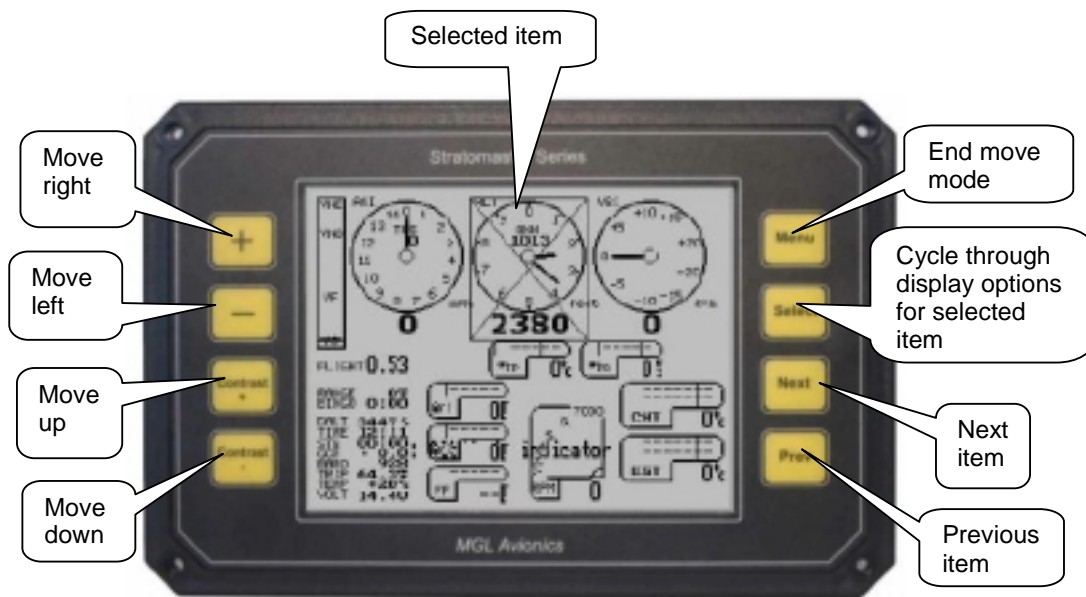
You can also use the Windows based Ultra Horizon XL panel design program to design your panels and download them to your Ultra using a PC to airtalk cable.
This program is a free download from the MGL Avionics website. Airtalk cables are a low cost option for your Ultra and are available with RS232 or USB interface.

Move mode should never be used in flight !

Enable screen items

This menu allows you to enable every individual screen display item onto one or both of the available display pages.
You would normally use this function to either remove or add an item, then you would use the "Move display items" function to move items to rearrange the display to suit your needs.

The following displays show the complete list of items using the default setup. There are a few entries marked "Unused entry". These are reserved for future expansion and have no current

function. Your list may vary slightly from the list presented here as we may add additional display items in future versions.

Screen items enable		VSI label	Page 1
		G-Force	Page 2
Altitude indicator	Page 1+2	ICE warn	No display
Air Speed indicator	Page 1+2	Unused entry	No display
Vertical speed indicator	Page 1+2	Unused entry	No display
EGT gauge	Page 1+2	Unused entry	No display
CHT gauge	Page 1+2	Unused entry	No display
RPM gauge	Page 1+2	Unused entry	No display
Fuel Flow gauge	Page 1+2	Unused entry	No display
Tank 1 level gauge	Page 1+2	Unused entry	No display
Tank 2 level gauge	Page 1+2	Unused entry	No display
Coolant temperature gauge	No display	Unused entry	No display
Oil temperature gauge	Page 1+2	Unused entry	No display
Oil pressure gauge	Page 1+2	Density alt label	Page 1
Manifold pressure gauge	No display	Air pressure label	Page 1
Fuel pressure gauge	No display	Time label	Page 1+2
VSpeed indicator	Page 1+2	Flight time label	Page 1+2
Attitude indicator	Page 2	G/C rate label	Page 1+2
Rate of turn indicator	Page 2	Ambient temp label	Page 1+2
Slip indicator	Page 2	Air distance label	Page 1
Compass/heading	Page 2	Voltage label	Page 1
Density altimeter	Page 1	Stopwatch label	Page 1+2
Ambient air pressure	Page 1	Maintenance label	Page 2
Current time	Page 1+2	Hobbs label	Page 2
Flight time	Page 1+2	Fuel range label	Page 1+2
Glide/climb ratio	Page 1+2	Fuel endurance label	Page 1+2
Ambient temperature	Page 1+2	Altimeter label	Page 1
Air distance	Page 1	ASI label	Page 1
Voltage	Page 1	TAS label	Page 1
Maintenance timer	Page 2	QNH label	Page 1+2
Hobbs meter	Page 2	VSI label	Page 1
Fuel range	Page 1+2	GForce label	Page 2
Fuel endurance	Page 1+2	ICE label	No display
Local pressure (QNH)	Page 1+2	Unused entry	No display
True airspeed (TAS)	Page 1	Unused entry	No display
Stopwatch	Page 1+2	Unused entry	No display
Altimeter label	Page 1		
ASI label	Page 1		

To change any item, move the highlight to the item using the "Next" and "Prev" buttons, then use "Select" to cycle through the options.

Primary flight selection

Primary flight selection

VFR panel
IFR panel

This function is included to allow you to reset your panel to the factory default. These two options will create either a VFR or IFR panel but they will not change any of your engine setup or engine display items placement on the screen.
Once you have selected VFR or IFR panel, you will be asked on which display page you would like to place the panel.
The factory default places the VFR panel on page 1 and the IFR panel on page 2.
Should you never require IFR, you can use this function to place a VFR panel on page 2 as well.

Engine type quick select

```
           Engine quick select

Rotax503 2xEGT 2xCHT
Rotax582 2xEGT WT
Rotax582 2xEGT 2xCHT WT
Rotax912 2xEGT 2xNCHT OP,OT
Rotax912 4xEGT 2xNCHT OP,OT
Four stroke 2xEGT 2xCHT OP OT
Four stroke 4xEGT 4xCHT OP OT
Four stroke 6xEGT 6xCHT OP OT
```
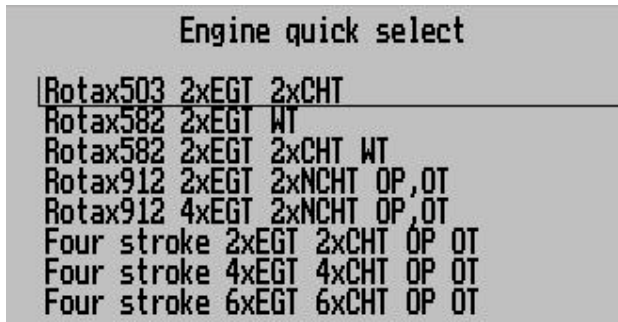
This function allows you to setup a basic engine monitoring system most suitable for your engine. Once you have made your selection, go into the engine detail setup menu to change any settings as required for your engine.

These functions assume that you are using default primary flight instruments in their standard locations (primary flight instruments at the top half of the display).

You will be asked if you would like to program your selection on page 1 or page 2. The engine layouts are slightly different for the two pages. The layout for page 2 is more compact as it is intended for the IFR screen which needs more space for the primary flight instruments.

It is advisable to program your engine choice into both pages one or two or else you could end up with a different engine type monitoring in each page.

The selected engine type is intended as a starting point from where you can customize the settings to suit your engine and screen layout best.

Rotor craft setup menu

Should you want to use the Ultra with a helicopter or autogyro aircraft, simply change the rev counter (RPM display) to rotor craft mode. You do this in the "Move screen items" function: Select the rev counter and use "Select" to cycle through the display options until you have the opposing needle rotor and engine RPM display.
This setup menu allows you to customize your display according to your aircrafts needs.

```
            Rotor craft setup

Rotor RPM low alarm:        85%
Rotor RPM high alarm:       110%
Engine 100% RPM:            5800
Rotor pules/10 revs:        10
Rotor 100% RPM:             500
Engine/Rotor RPM display Percent
```
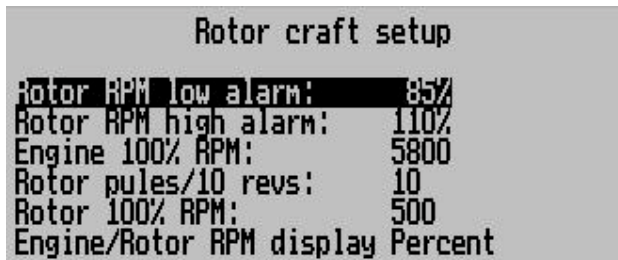
Rotor RPM low alarm:
Choose your low RPM limit for your rotor speed. This is entered as a percentage of your nominal 100% RPM (set below). Note: you still need to enable this alarm if you want to use it.
Rotor RPM high alarm:
Choose your maximum permissible rotor RPM as a percentage relative to your 100% setting. Please note that you still have to enable this alarm if you want to use it.
Engine 100% RPM:
Enter the RPM value that corresponds to a 100% power setting. This is used to calculate the correct 100% needle position for your engine RPM display.

Rotor pulses/10 revs:
Enter the number of pulses your rotor speed pickup sensor will create for 10 full revolutions. If your setup will create a single pulse per revolution, enter the value 10. Gyro aircraft will often use a geartooth sensor on the prerotation gear. In this case it is common to enter values of 10 times the number of gear teeth on the gear. A typical value would be around 400.

Rotor 100% RPM:
Enter the RPM value that corresponds to a 100% rotor speed (setting entered below). This is used to calculate the correct 100% needle position for your rotor RPM display.

Engine/Rotor RPM display…
Select if you would like the numeric readout of your rotor/engine RPM display to read in percent or in actual RPM.
We recommend that you choose RPM until you have your system setup correctly.
It is common for Gyro planes to use RPM as readout while helicopters tend to use percent.

Engine detail setup menu

The engine detail setup menu allows you to customize your engine monitoring parameters. These parameters will be set to factory defaults for the engine type you have selected if you have used the "Engine type quick select".

```
          Engine monitor setup

EGT Channels                 2
EGT alarm limit            650
CHT Channels                 2
CHT alarm limit            250
EGT/CHT bargraph mode    Highest
Oil pressure limit high    116"
Oil pressure limit low      29"
Oil temp. limit high       135
Oil temp. limit low         80
Coolant temp. limit High    95
Coolant temp. limit Low     60
MAP bargraph range        02.9
Fuel pressure low alarm     29"
```

EGT Channels…
Enter the number of EGT channels you would like to monitor. You can select up to 12 channels but the total number of EGT and CHT channels combined may not exceed 12.
The EGT display will change size as you add or remove channels. Should you require a large number of channels but do not have sufficient display size, you can choose a more compact scanning display using the "Move screen items" menu.
EGT channels start at RDAC input channel TC1.

EGT alarm limit…
Set the alarm limit (red line) as required for your engine. Most two stroke engine use a limit of 650 degrees Celsius. Many four strokes use 850 degrees Celsius. This value also sets the bargraph display range. Please note that the EGT bargraph starts displaying when a temperature of 50% of your alarm limit is reached. This ensures a good resolution of the bargraph in the temperature region that you would be interested in.
Verify the required EGT alarm limit for your engine by consulting the engine manufacturer or the documentation that came with your engine. Exceeding the recommended EGT temperature may seriously damage your engine.

CHT Channels…
Enter the number of CHT channels you would like to monitor. You can select up to 12 channels but the total number of EGT and CHT channels combined may not exceed 12.

The CHT display will change size as you add or remove channels. Should you require a large number of channels but do not have sufficient display size, you can choose a more compact scanning display using the "Move screen items" menu.
Rotax 912 and Rotax 914 engines have two built in CHT senders that are not thermocouples and they cannot be used with the normal CHT channels. These senders are ordinary NTC type oil temperature senders.
You can use these senders with the Ultra by selecting "Rotax 912" in the CHT channels setup (select the number of channels past 12). When you have done this, you can connect the two Rotax CHT senders to the RDAC inputs CHT1 and CHT2. In the "Sender setup" menu, ensure that the Rotax 912 CHT probe type is selected to "Standard NTC".

Verify the required CHT alarm limit for your engine by consulting the engine manufacturer or the documentation that came with your engine. Exceeding the recommended CHT temperature may seriously damage your engine.

CHT alarm limit…
Set the alarm limit (red line) as required for your engine. Many air cooled engines use a limit of 250 degrees Celsius while liquid cooled engines have limits around 135 degrees Celcius. Many air cooled four stroke engines have oil cooled heads with a CHT limit of around 135 degrees as well.
This value also sets the bargraph display range. Please note that the CHT bargraph starts displaying when a temperature of 50% of your alarm limit is reached. This ensures a good resolution of the bargraph in the temperature region that you would be interested in.

EGT/CHT bargraph mode
Select if you want the digital readout to show the highest temperature at all times or if you want the digital reading to scan though the channels.
Please note: This setting only affects the normal, large EGT or CHT display. Should you select the compact display, scanning is enabled automatically.

Oil Pressure limits
Enter the oil pressure limits as you require them. Note that you can enter both a low and a high limit and you can individually enable or disable these limits for alarm purposes in the "Alarm enable setup menu".
Most applications only monitor low pressure (oil pump failure or oil leak). You can also monitor for high pressure if you like. High oil pressure may indicate blocked oil passages or a blocked oil filter (depending where you measure the pressure).

Oil and Coolant temperature limits
Choose your cooling system temperature alarm limits. Note that you can also choose a "low temperature limit". Many water cooled engines require a minimum coolant temperature and this function allows you to have an alarm if the temperature drops below your required limit.
If you do not know what this limit is, select about 60 degrees C – this would be sufficient for most engines. High limits range from about 80 degrees C to about 95 degrees C. Consult your engine manufacturer's specifications.
Oil temperature high limits are usually in the region of 135 degrees Celcius.
You can individually enable or disable each of these alarms in the "Alarm enable setup menu".

MAP bargraph range
This setting determines the display range window for the manifold pressure indicator bargraph.
For eample, if you select a value of 100 millibars, the bargraph will indicate +/-100 millibars from the standard sea level pressure (1013.25 millibars).
Your selection would depend on the manifold pressure range that your engine produces and this also differs if you have a turbo charged engine or not.

Fuel pressure low alarm
Select the minimum pressure required for your fuel pressure below which an alarm will be activated. You still need to enable the alarm separately.

Alarm enable setup menu

This menu controls the individual alarms in the Ultra Horizon XL system You can enable or disable each alarm source as you require for your application.
A disabled alarm will never activate, regardless of condition.

Please note that the ICE warning alarm requires installation of a suitable temperature probe in your carburetor or airbox intake. This function is not normally used with fuel injected engines but it may be used if the construction of air intake passages can promote ice build-up.

```
           Alarm enable setup

EGT alarm                      Enabled
CHT alarm                      Enabled
Oil pressure high alarm        Enabled
Oil pressure low alarm         Enabled
Oil temp. high alarm           Enabled
Oil temp. low alarm            Enabled
Coolant temp. high alarm       Enabled
Coolant temp. Low alarm        Enabled
Fuel level 1 low alarm         Enabled
Fuel level 2 low alarm         Enabled
ASI below Vs alarm             Enabled
ASI above Vne alarm            Enabled
Altitude alarm                 Enabled
ICE warn alarm                 Enabled
Fuel pressure alarm            Enabled
Rotor speed alarm              Enabled
```

Sender setup menu

The sender setup selection menu is used to select the type of senders you have connected.

```
            Sender type selection

Flow sender type:           Turbine
Tank mode: Tank 1+2=level sender
Range calculation mode: Tank 1+2
CHT thermocouple        K type
Coolant temp. probe     MGL NTC
Oil temp. probe         Standard NTC
Oil pressure sender     Resistance 200
Oil pressure max        145"
Pressure resistance     INC with pressure
Fuel pressure range     116"
Fuel pressure port      CHT1/AUX3
912/914 CHT type        Standard NTC
Programmable probe:   20% - 1000
Programmable probe:   40% -  900
Programmable probe:   60% -  800
Programmable probe:   80% -  700
Programmable probe:  100% -  600
Programmable probe:  120% -  500
Programmable probe:  140% -  400
Programmable probe:  160% -  300
```

Flow sender type
Select if you have a turbine type flow sender connected or are using the fuel injection system monitor to obtain fuel flow information. The possible selections are:

Turbine: Impeller or turbine type with pulsed output signal.
Injector H: High side injector.
Injector L: Low side injector.

H and L refers to the type of signal used to switch the injector. Should you select the incorrect setting, fuel flow will decrease with engine power increasing. In this case simply select the other setting.
Please note that you should select the K-factor suitable for your flow sender or injector. This is done in the calibration menu. The correct K-factor is normally published for your flow sender. For fuel injection systems, the correct factor is found by experimentation.

Tank mode:…
Here you select how you would like to use your two tank level displays.
Options are:
a) Tank 1 and Tank 2 are each connected to a physical fuel tank level sender
b) Tank 1 is connected to a physical level sender and tank 2 uses a calculated fuel level
c) Tank 2 is connected to a physical level sender and tank 1 uses a calculated fuel level

Calculated fuel levels require that a fuel flow sender is installed.

Range calculation mode…
Select which tanks to take into account for your fuel range and endurance calculations.
Options are:
a) Tank 1
b) Tank 2

c) Tank 1+2

Range and endurance calculation requires a fuel flow sender.

CHT Thermocouple

CHT senders supplied by MGL Avionics are K-types. Some CHT senders from other manufacturers are J-types.
The characteristics of J and K types are different so it is important that you select the correct thermocouple type.
EGT thermocouples are K-types. It is very rare that other types are used here.

Coolant temperature probe

This entry selects which probe you have connected as water temperature probe.
You can select the M type probe (MGL supplied NTC probe) or the MGL precision temperature probe (see below).
You can also select Westach NTC water or oil temperature probes and the programmable probe.

Oil Temperature probe

This entry selects which probe you have connected as oil temperature probe.
You can select the Standard type probe or the MGL precision temperature probe (see below).
The Standard type oil temperature sender is a type used in many engines and most oil temperature probes will work with this setting. The oil temperature probe in a Rotax 912 is of this type.
You can also select Westach NTC water or oil temperature probes and the programmable probe.

Oil pressure sender

Oil pressure resistance refers to the resistance the oil pressure sender will exhibit at its maximum pressure. 200 ohms is the reading for the oil pressure sender fitted as standard to Rotax 912 and 914 engines at a pressure of 10 bar. You can adjust the setting over a wide range to allow use of the instrument with a large variety of oil pressure senders. Oil pressure senders supported must increase resistance fairly linearly with pressure. This is the case with most standard automotive senders.
Most available automotive senders will be in the range of 100 to 400 ohms. We recommend the oil pressure senders available from VDO.
Most oil pressure senders increase their resistance with pressure. There are a few types that work in reverse to this. These senders can also be used.

Oil pressure max

This setting is the pressure at maximum resistance (or minimum resistance if a reversed type of pressure sender is used).
For example, the oil pressure sender fitted to Rotax 912 engines is a 10 bar type. Some other senders are 5 bar types.

Pressure resistance…

Select if your oil pressure senders resistance increases or decreases with pressure. Most senders increase resistance with pressure.

Fuel pressure range

Select the pressure for your fuel pressure sender to deliver an output voltage of 5V.
The Ultra supports fuel pressure senders that can deliver a DC output voltage from 0V to 5V, linear with applied pressure.

Fuel pressure port

Select where you have connected the fuel pressure sender on the RDAC. Options are CHT1/AUX3 or Fuel level input 2.

912/914 CHT type

Select the built in CHT probe type used for 912/914 engines. This should be set to "Standard NTC" unless you are specifically using a different type of probe.

The programmable temperature probe

You can select a user programmable probe for either coolant temperature, oil temperature or Rotax 912 probes. Of course, if you would like to use the same type of probe for some or all of these then you can use the programmable probe for all of them.

In order to use the programmable probe, you need to tell the instrument how the probe behaves with temperature.
Luckily, this is quite easy to do.
You will need an accurate reference thermometer that is able to work over the desired range. If you do not have such a thermometer, simply use one of our K-type EGT or CHT senders together with your Ultra !

We recommend you use cooking oil in a pan. Immerse both the reference thermometer and the probe you want to use into the oil. Connect the probe to the oil temperature channel input of the RDAC.

Use the Ultras built in probe trouble shooter to get a reading from the probe.

Slowly heat the oil and monitor the oil temperature. Whenever the oil temperature reaches any of the temperature marks, take a note of the probe reading in the probe trouble shooter. Don't worry if you do not get quite to 160 degrees, estimate this one if necessary.

Once you have obtained all the readings, enter these into the above form in the sender setup menu. Now you are ready to use the programmable probe with your Ultra.

Please note that this is designed for NTC probes which have a falling resistance with temperature. Other probes cannot be used. NTC probes are the most common types.

The MGL precision temperature probe

MGL Avionics manufactures a precision temperature probe based on an accurate and well proven semiconductor chip. This sender is more expensive compared to the ordinary automotive senders used in standard applications but offers outstanding accuracy and as additional advantage is completely electrically isolated from the engine it is fitted to. This is an advantage in some installations as the temperature reading is not influenced by electrical currents flowing in the engine. This sender can be used to measure temperatures from zero degrees Celsius to about 180 degrees Celcius. The sender is suitable for water or oil temperature measurements to an accuracy of +/-2 degrees over the full temperature range.

Fuel tank/level sender setup 1 and 2

This function is used to setup and calibrate you fuel level sender(s). You would use this function partially even if you do not have a fuel level sender installed but are using a fuel flow sender. In this case the instrument can provide you with a tank level display as well as it will calculate the remaining fuel by subtracting fuel used (after you have given it a starting value). In this case all you have to do in this menu is to enter the capacity of your fuel tank so that the fuel level bargraph can show the correct level. You should also note that it is not possible to enter a fuel level greater than the tank capacity even if you only use the fuel flow sender and not a tank level sender.

```
Fuel tank 1 setup. Sender reads    59
Fuel tank 1 capacity|   50l'
Level sender reading at     0l' is    10
Level sender reading at    10l' is    20
Level sender reading at    20l' is    30
Level sender reading at    30l' is    40
Level sender reading at    40l' is    50
Level sender reading at    50l' is    60
Use +/- to change fuel tank capacity
```

This number is the value read from your fuel level sender. The actual value is not important, as long as it changes with fuel level.

These are the level sender readings at the various fuel levels. Use the "select" key to transfer the current reading to the relevant fuel level slot.

Regardless of your use of a fuel flow sender, you can install a fuel level sender into your fuel tank. These level senders are inexpensive and are available as after market replacement fittings from a car spares outlet. We recommend the senders available from VDO. **Be aware** that some makes of cheap level senders can prove troublesome, as the lever arms tend to be sticky. This prevents the floats from floating on the surface of the fuel at all times. As a consequence, this will lead to incorrect fuel level indication.

Once you have installed a fuel level sender into your tank, make sure the float can travel all the way from empty to full position without hindrance of any kind.

The calibration procedure should be carried out with your aircraft in flight attitude. This means you need to lift the tail if you have a tail-dragger or lift the nose wheel if you have a weightshift trike. You start the calibration procedure with an empty tank.

Your first determination should be how much reserve fuel you should carry. Reserve fuel would be fuel that is not taken into account by the fuel level sender. We recommend at least 10% of your fuel tank capacity as reserve fuel, preferably even more.

To illustrate the calibration procedure, let us assume we have a weightshift trike with a tank capacity of 50 liters without reserve.
We decide to use a five-liter reserve, leaving us with a usable fuel capacity of 45 liters.

Our first step is now to enter this capacity into the instrument. Use the "prev" and "next" keys to move the highlight to the "fuel tank capacity" item. Then use the + and – keys to set the entry to read 45 liters.

Our next step would be to raise the nose gear of the trike to flight position. An upturned bucket or similar item is normally all that is required.

We now start with the empty tank. Add five liters of fuel (our reserve quantity) using a suitable measure. Make sure the measure is suitably accurate.

This is now the "level sender reading at 0 Lt" position. Move the highlight to this position and wait until the sender reading has stabilized (You will see the sender reading at the top line). This could take up to a minute so have patience.

Should this number not react to changes of your level sender position, then you have a problem. Please check your wiring according to the installation section of this manual.

If you see the number changing then everything is well. Once it has stabilized and the highlight is on the 0 Lt position, press the "select" key to transfer the reading from the sender to the calibration point.

Now you are ready for the next step. Add the required amount of fuel to get to the next level (In our case 9 Lt – this is 20% tank capacity). Once done, wait for the reading to stabilize and press "select" again after you have moved the highlight to the "9 Lt" position.

Proceed in a similar manner until you have reached the last calibration position at 100% tank capacity.

You are done !

Press "Menu" to exit this function. This will write the new calibration to permanent memory in the instrument. You can repeat this calibration many times so do not worry if you do not get it right the first time.

The instrument uses the 6 calibration points to work out a correction curve that takes into account the tolerances of your fuel level sender and the shape of your fuel tank. This results in an incredibly accurate and usable fuel level display that far exceeds that available from ordinary dial type gauges.

Note:

The calibration positions may be edited by using the + and – keys. This allows you, in theory, to copy calibration settings from one instrument to another. We however recommend that you do go though the calibration procedure even if the two aircraft are identical in all respects. Tolerances do exist and the calibration cancels these out.
Accurate fuel level displays are a vital safety factor for an aircraft and a very useful feature for peace of mind during cross county flights.

Notes on Slope error

Sender value is a value determined by the Stratomaster Ultra. It is used to calculate e.g. fuel level, fuel bingo estimate and current range estimate. The fuel tank setup sender value can either increase in value as fuel is added on decrease in value if fuel is added. This is dependant on the type of fuel level sender used. However should the second reading be larger than the first reading all readings will have to be larger than the previous reading. Likewise should the second reading be smaller than the first reading all readings will have to be smaller than the previous reading. If this is not the case the wording "Slope error" will be displayed. This could happen when fuel was removed instead of added between steps, no fuel was added between steps or when the fuel level sender was moved in the wrong direction e.g. moving the fuel level sender manually when it is not inserted in to the fuel tank.

Should you get a slope error message determine the cause of the error. If you do not know the cause of your error it is best to start from scratch. It should be remembered that accuracy is the fuel tank calibration is very important to enable your Stratomaster Ultra to display the correct data.

Calibration Menu

The calibration menu contains functions to calibrate important sensors.

```
          Calibration Menu

Airspeed calibration:    100% (  0)
Altimeter calibration:   0 ( 2380)
VSI calibration:         100%
Reset ASI and VSI to zero
Rev counter, pulses per 10 revs: 60
Fuel flow K-factor:      7000
Ambient temperature:     0%
MAP calibration          0 (30,7)
```

Airspeed calibration

> This function is used to calibrate the airspeed reading. It works in % relative to a nominal value. Your calibration certificate will give you the setting required for correct reading if no external airflow factors are present. In many aircraft installations it may be required to correct the reading to cater for errors created by the airflow around your aircraft.
> You can use the + and – keys to change the calibration factor.

Altimeter calibration

> This calibration is done at the factory using very accurate references. It is not normally required to change this setting. You may do so if you feel that you would rather use another reference, like your local airfield's elevation according to survey maps.
>
> Be aware that generally survey maps and GPS readings may not give you the expected readings and are subject to small errors. For example, your GPS receiver may be using a different datum of reference to the survey maps.
>
> The value entered here is a correction factor that is entered during calibration of your instrument. This factor is shown on your calibration certificate.
>
> At sea-level, one unit corresponds to an air pressure difference as expected for a 7 ft (2,1 m) change in altitude. At 5 000 ft (1 524 m) MSL this corresponds to about 10 ft (3 m). A positive correction factor will decrease the altimeter reading and a negative factor will increase the reading.
>
> Please do not confuse this setting with the QNH (local pressure) setting available from the main display (+ and – keys).

VSI calibration

> This is a technical function that is used to calibrate your VSI to read exact rates of climb or decent. This function works as a percentage of initial reading. The default setting for this function is 100%. Increasing this value increases the VSI reading and decreasing the value decreases the reading.
>
> Suggested calibration method.
> After you have installed the instrument, perform a calibration flight. This should be done in very calm conditions. Turbulence and thermal activity will make accurate calibration impossible. Many areas have ideal conditions during early mornings or late afternoons.
>
> Place the instrument in "feet" units mode for ease of calibration.
> Take your aircraft to a few thousand feet above ground and start a glide with a low power setting. Take a stopwatch and when the glide is stable (stable VSI reading) start the stopwatch. Take note of your altimeter reading at the same time.

Continue the stable glide for one minute exactly. After the minute has finished, take another reading of your altimeter.

Example:
VSI reading during stable glide: -400 ft/min
Start altitude: 2500 ft.
End altitude: 2050 ft.

In the above example the VSI is under reading by about 12%. Set your VSI calibration to 112% to cancel out the error.

Reset ASI and VSI to zero

This function is used to calibrate the zero point readings of airspeed and vertical speed indicators (ASI and VSI). Use this function from time to time to zero the readings. This way your instrument will always perform at its best. Perform the zero calibration when your aircraft is on the ground and **not exposed to any airflow (for example when it is parked inside the hangar). (The engine should not be running)**.
Do take care to perform the calibration in conditions where no air pressure fluctuations are present. For example windy conditions can have an effect of air pressure inside your hanger that may lead to a false setting of the zero point for the VSI.

Use "select" to perform the calibration. The display will not change but may flicker for a moment. The calibration takes only a few fractions of a second. You may find that it is perfectly sufficient to perform this calibration once a year.

This function is the equivalent of the zero setting screw on traditional analog instruments.

Rev counter: Pulses per 10 revs

Use this function to calibrate your rev counter. A value of 60 is used for most two-stroke Rotax engines based on the Ducati DCDI system (6 pulses per rev). Rotax 912/914 engines produce 1 pulse per rev so the correct setting would be 10.

Select the value according to your engine's tach generator output for all other engines.

Should you have an engine without a tach generator such as a VW, we suggest that you try a pickup using a wire looped tightly about 20 times around one of the spark plug leads. (See installation manual for further details on this method). A spark is generated every second revolution per cylinder on a four stroke engine so you should enter a value of 5 in this case. You can also try pickups directly from the switched end of the ignition coil (points). This may give you a better signal. In this case the factor to be entered will depend on the number of cylinders. You should find two cylinders firing for every revolution in a typical four-cylinder four stroke engine so this would give you a factor of 20 to enter.

Fuel flow K-Factor

This setting is used to calibrate the fuel flow sender if you fit such a device. Increase the setting to lower the fuel flow reading and vice versa.

The value of 7000 corresponds to the recommended setting for the RS 256-225 liquid flow sender. Using this setting and a correctly installed sender you should expect an accuracy of about +/- 3% maximum error.

This factor will affect the instrument's range and fuel bingo time estimates so be careful should you choose to change this setting. Should you have difficulty in obtaining the correct fuel flow indication your problems are most likely due to vapor bubbles trapped in the fuel sender housing. Make sure you install the sender in such a way that it is not possible for bubbles to remain trapped in the sender housing.

The K-factor is the number of pulses the flow sender will generate for one liter of fuel flow. Most flow senders will be in the range of about 2000 to 15000 pulses per liter.

Ambient temperature

Use this function to correct errors of your ambient temperature probe. These probes may have small errors up to a few degrees in extreme cases. Add a positive or negative offset in degrees to correct for this error. Try and obtain an accurate reference thermometer to give you the correct temperature.

Please note: Your ambient temperature probe must not be exposed to engine heat or sunlight as this can cause it to report an incorrect ambient temperature. This could result in incorrect density altitude displays.

MAP calibration

If you have a RDAC X model B or D and want to use the built in manifold pressure sensor, use this function to calibrate the sensor.

This calibration must be performed every time you change the RDAC and also before using the RDAC for the first time.

To calibrate, ensure that the RDAC MAP sensor is not blocked and is open to the atmosphere.

Obtain a reading from the built in baraometer. You may need to place the barometer onto one of the displays if it is not there already (if you have a default panel, it is on page 1).

Take a note of the barometer reading.

Now go into the MAP calibration and adjust the calibration number so the value to the right in brackets of the calibration value reads the same as the barometer.

Probe trouble shooter

This useful function shows the raw data as obtained from the RDAC unit. This can be used to locate and interpret problems with probes and senders. Here is a typical display:

```
RDAC unit raw data display
RPM       = 3510
TC1       = 600        TC7        =   223
TC2       = 583        TC8        =   240
TC3       = 549        TC9        =    51
TC4       = 600        TC10       =    51
TC5       = 223        TC11       =    69
TC6       = 240        TC12       =    69

CHT1/H2O  = 2106  2.57V
CHT2/ICE  =  176  0.21V
OILT      =  117  0.14V
OILP      =  410  0.50V
FLEVEL1   =   59  0.07V
FLEVEL2   =   59  0.07V
FLOW      =   18
```

RPM refers to the time it takes between pulses as measured on the REV counter terminal. It is an internal unit of measure. The shorter the time, the smaller the number. A value of 31000 means: No pulses measured within a certain time frame.

TC channels show raw thermocouple channel data. This is the value in degrees C and will be for K-type probes. J-types are based on this number using a calculation.

The "Flow" item shows the number of pulses recorded in a certain time period. A value of zero means that no pulses have been counted.

All other values are from a "analog to digital converter" or ADC. These are numbers from 0 to 4095. "0" corresponds to "0" volts on the input and "4095" corresponds to "5" volts on the input. All of these inputs are internally "pulled up" to 5 volts using a resistor so if you have nothing connected to such an input you should get a reading of 4095.

Assume you have a probe connected and the probe is "pulling down" the voltage to 2.5V (half of 5V) then the number you see would be 2048.

What would typical values for various probes be ? The following provides a rough guide:

NTC temperature probes, standard oil or water temperature probes.
At ambient temperature: 1500 – 3000 depending on type.
At operating temperature: 50-150 depending on type.
Note that the number decreases with temperature.

MGL precision semiconductor probe:
At zero degrees C: approximately 2228. For every degree C above that, add 8.2.
The count increases with temperature.

Values of zero (or close to that) on any of the ADC inputs may indicate a connection that is shorted to ground while a very high number (>4000) could mean a bad connection or a faulty probe.
If you suspect a faulty RDAC input, always verify this with a multimeter. Compare the voltage you are measuring at the suspected terminal with the value you are getting from this menu function.

Ultra Horizon XL configurable displays

The Ultra horizon provides two independent display pages. Each display page can be freely configured to act as primary flight display, engine monitor or a combination of both.
Switching between the two display pages is done by pressing the "Select" button.
Configuration of either display is done by first selecting the required display page and then using the two system setup functions "Move display items" and "Enable display items".
These two functions are found in the System setup menu.

A choice of over 50 instruments and display items is offered. Each of these can be configured according to your needs.
Most display items offer several display options. These can be viewed and selected when you are in "Move Mode".
Instruments themselves offer many configurable options depending on the type of instrument. For example a EGT gauge requires setup of applicable channels and temperature ranges.
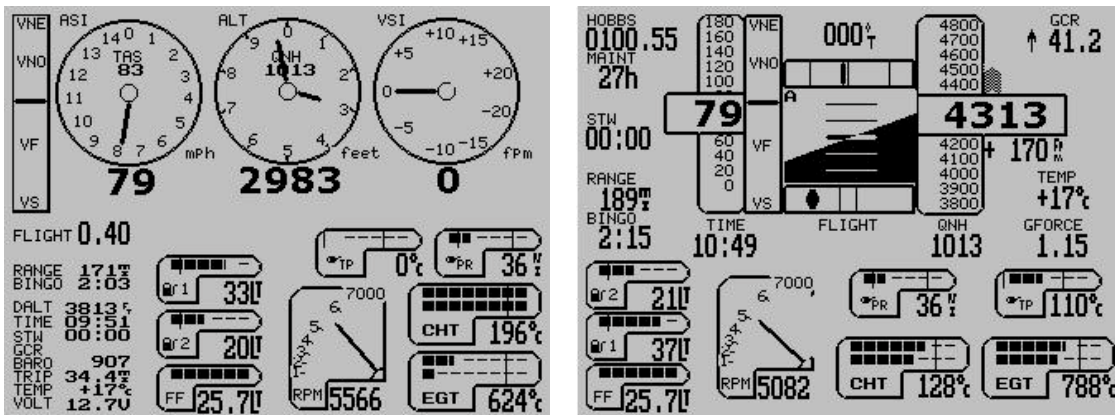
The two images above show two possible display pages built using the built in sample screens in only a few seconds. The left screen shows the standard VFR display with a two cylinder four stroke engine choice. The display on the right shows the standard IFR screen using the same engine choice.
The built in sample display setups are intended as a starting point for your customization. Add or remove items from the screens, move items to different locations or choose different display options for any item.
Both displays would require a RDAC X engine monitor and the display on the right would require a SP-3hc IMU/compass sensor package.

The Ultra Horizon XL allows you to create your own display layouts to suit your application and aircraft exactly.

The following pages offer detailed description of every available display item.
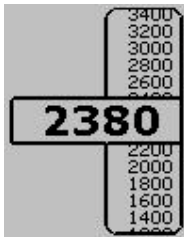
The Altimeter

The altimeter measures pressure altitude from -700 to over 40.000 ft. Altitude readout can be in feet or meters (select in mode and units setup).
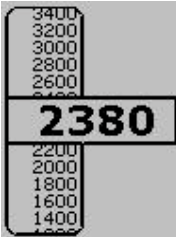
You can select between four different altimeter displays.
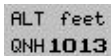
Traditional analog altimeter

Right biased tape altimeter. This form is normally used if an artificial horizon is used. You can select the steps used for the tape gradient to suit your expected operating altitude range.

Left based tape altimeter.

Compact, numeric only altimeter. Used to save space in busy panels.

Four related items can be used with the altimeter. The QNH label should be used with the QNH display (local pressure setting). QNH readout can be in millibar or inches of mercury.
Further to this you can use the ALT label and the altimeter units label. This label will show "feet" or "meter" depending on your setup.

Independent to the normal altimeter, you can enable a density altimeter. This consists of the label "DALT" and the density altitude readout. Density altitude takes the current ambient temperature into account. If no such temperature can be measured (no probe connected), you will see the readout "Temp ?"

The QNH label and QNH readout (local pressure) should be located close to the altimeter. In case of the analog altimeter, you can place the QNH items inside the altimeter.

QNH is adjusted in steps of 1 millibar (about 30 ft altitude) using the "+" and "-" buttons whenever one of the two main display pages is showing.

The altimeter may have an alarm enabled. Select the alarm limit (altitude ceiling) in the Basic operations setup menu. If you have exceeded the ceiling, the altitude display will flash.
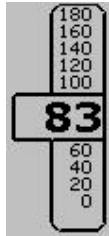
The Air speed indicator

The airspeed indicator (ASI) can indicate airspeed in mph (miles per hour), knots (nautical miles per hour) or km/h (kilometers per hour). This is selected in the mode and units setup menu. The Ultra ASI provides a range of 16mph to over 250mph.

You can choose from four different airspeed indicators.
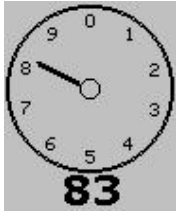
The traditional analog airspeed indicator. You can select a scale suitable for your application. Choose from a grading of 80, 100, 150, 200, 300, 400 units of measure.

Tape based airspeed indicator. This is normally used if an artificial horizon is displayed. You can select the steps between the tape gradients to suit your airspeed range.
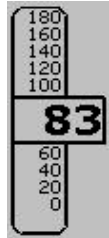
Tape based airspeed indicator with a left bias.

For busy panels a numeric airspeed indicator can be selected to save space.
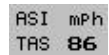
You can enable a "ASI" label and a airspeed units readout. Further to this you can enable a true airspeed readout and corresponding label. The true airspeed readout is based only on the altitude, assuming a standard gradient. This means that the true airspeed readout will work even if you do not have an ambient temperature sensor installed.

The ASI may have alarms enabled. If the alarm is enabled, the settings for Vs (stall speed) and Vne (never exceed speed) will be used as limits. When the alarm is active, the ASI readout will flash.

Note: If you have automatic flight detect enabled, the ASI readout will flash after you have landed for a short while until the flight has ended (logbook entry has been made).

You setup the V speeds in the Basic operations setup menu.

The VSI indicator

The VSI (vertical speed indicator) shows your rate of sink or climb.
Readout is in feet per minute or meters per second depending on your choice of altitude units.

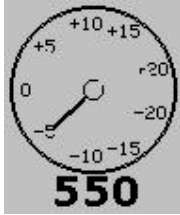You have four different display options for the VSI.

The traditional analog VSI. This provides you with an analog range of +/- 2000 ft per minute (or the equivalent in meters per second) plus a digital readout to +/-9999 ft/minute.

Two VSI options are provided, designed to be placed on top of the altimeter tapes. One version is provided for a left and one of a right bias tape altimeter display.

For applications needing to save display space, a compact numeric only VSI readout can be selected.

This image shows a tape based altimeter with correctly applied VSI readout.
Further to this the glide/climb ratio indicator is shown together with the matching "GCR" label.
Glide/climb ratio shows you the ratio between your forward airspeed (true airspeed) and your vertical speed.
This indication is a useful feature to optimize your aircrafts glide slope.

A "VSI" label is available as well as a VSI units readout that displays either "fpm" or "mps" depending on your chosen altimeter units.

The VSpeed indicator

The Ultra provides a VSpeed indicator. This instrument shows your airspeed (ASI) in relation to your defined VSpeeds. You can define the following VSpeeds in the Basic operation setup menu.

Vs – stall speed, minimum operating speed with full flaps deployed.
Vf – maximum flap speed.
VNo – maximum maneuvering speed.
VNe – maximum allowable straight and level airspeed.

Your airspeed in relation to the VSpeeds is indicated by the position of a horizontal bar.

The VSpeed indicator would normally be used with conventional three axis controlled aircraft.
This display is of lesser value in weight shift aircraft such as trikes and of little value in Rotor craft.

If you would like to use the VSpeed indicator, we recommend to place it next to the airspeed indicator.

The rev counter

The Stratomaster Ultra includes a very flexible rev counter that can be adapted to a very wide variety of engines. In the main this is done in the Device setup menu under "Basic operation setup menu" and "Calibration Menu". Here you enter the number of pulses the rev counter pickup (whatever it may be) will generate for every ten revolutions. The instrument will actually use this information to work out revs from the time it takes to complete ten revolutions of the engine. This way high resolution of the rev counter is guaranteed even if only one pulse is generated for a single revolution as would be the case for the 912 engine.

The rev counter is available in three variants, one of which is intended for rotor craft such as small helicopters and gyro planes.
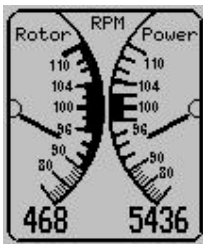The rotor craft option shows an opposing needle display for engine power (engine RPM) and rotor speed (or rotor RPM).
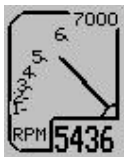
 Standard RPM rev counter. The scale (maximum RPM) can be selected in the Basic operation setup menu.

 This smaller version of the rev counter can be selected if you have a busy panel and want to save some space. You select the maximum RPM to display on the bargraph in the Basic operation setup menu.

 The Rotor craft opposing needle RPM and rotor speed display. Indications can be in RPM or as a percentage relative to a given RPM setting.
You setup most of these items in the "Rotor craft setup menu".

About rev counter pickups

Pickups vary from those provided by the engine manufacturers in the form of magneto coil tapings (Rotax / Ducati) to taping into the primary of a aircraft style magneto.
In fact, anything that is able to provide at least a 5 volt, reasonably stable signal at the rev counter input of the RDAC EMS system. Signals with a voltage as high as 100 volts can be used.

On unusual engines it is often a matter of experimenting with various pickup methods to find a satisfactory solution. Once a stable reading can be obtained, set the calibration of the rev counter so that correct revs are indicated.

The range of the rev counter is up to 9 999 revs. You should select the scale of the analog rev counter to just above the maximum RPM. For example for a VW engine you might select 4000 RPM.

Pickups for the Rotor speed sensor range from hall effect sensors, gear tooth sensors to simple magnetic switches that are closed by a small magnet once per revolution of the Rotor.

You setup the number of pulses generated by 10 revolutions of the rotor in the Rotor craft setup menu.

Selecting between RPM and percentage for the rotor craft display is also done in the Rotor craft setup menu.

The Rotor speed display may have alarms enabled for rotor low and rotor high RPM. You setup the desired RPM limits in the Rotor craft setup menu. If the alarm is active, the rotor speed display will be flashing.

EGT and CHT thermocouple display

The RDAC X engine monitoring system makes twelve thermocouple channels available.
These inputs can be used for EGT probes (exhaust gas temperature) or cylinder head probes (typically the spark plug washer types).
You determine how and if these channels are used in the "engine detail setup menu".

Each EGT or CHT display panel can operate in one of three modes:

   a) Full panel, numeric readout shows highest temperature
   b) Full panel, numeric readout shows one channel at a time (scanning mode)
   c) Small panel, scanning mode with highest temperature always shown. This option is normally used if you have a busy panel, lots of channels to monitor and need to save panel space for other instruments.
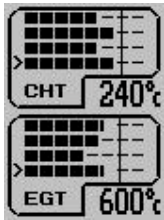
Example four channel EGT and four channel CHT display using the full panel in scanning mode. The ">" symbol is used to indicate the currently showing channel.

You select number of channels, temperature ranges and scanning mode in the Engine detail setup menu.
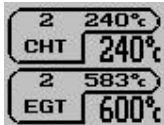
Example of a small EGT and CHT panel. This display can be used if you need to save display space for other instruments. In this case the display shows you one channel at a time (channel number followed by the temperature) plus a larger readout of the maximum temperature of all channels.

You can assign your RDAC X TC channels to EGT and CHT probes, up to a total of 12 channels. EGT probes always start at channel TC1. CHT channels start at the next available channel.
For example, assume you need four EGT channels and four CHT channels. In this case TC1 to TC4 will be EGT, TC5 to TC8 will be CHT.

The only exception to this is if you have selected Rotax 912 CHT mode (select this in the Engine detail setup menu – change the number of CHT channels until you see "Rotax 912").

In this case, all TC channels are available for EGT while the RDAC inputs CHT1 and CHT2 are used to measure the standard, built in Rotax 912 and Rotax 914 CHT probes. These probes are not thermocouples but are in fact standard oil temperature senders, used to measure the cylinder head temperature.

If you have EGT and/or CHT alarms enabled, the alarm will be activated whenever one or more of the channels exceeds the temperature you have specified in the Engine detail setup menu. Alarm channels will be shown with a flashing bargraph (large displays) as well as a flashing temperature readout.

Coolant temperature indicator

This instrument is used to display coolant temperature for water cooled engines

Water temperature measurements requires the sender available from MGL Avionics. This is a standard automotive sender with the following characteristics:
900 Ohms at 20 degrees C and 93 ohms at 85 degrees C.
You can also use the precision semiconductor temperature sender available from MGL Avionics. We recommend the use of this sender for applications were you need to know the exact water temperature.

You can also select one of the alternative temperature senders in the Sender setup menu.

When procuring oil or water temperature senders, be aware that these senders are based on NTC resistors and typically have a fairly large tolerance. They tend to be more accurate at higher temperatures but can have large errors at low temperatures.
We suggest that you use a multimeter in combination with the ambient temperature probe of the Stratomaster Ultra to verify that you have the correct sender.
Using the Stratomaster connected to a 12V battery or similar power supply, use the included ambient temperature probe to measure the temperature of a jug filled with boiling water.
Insert the temperature probe in question connected to the resistance measurement setting of your multimeter. Ensure that the top terminal of the sender remains dry to avoid measurement errors.
Wait until the temperature drops to 85 degrees and then take a reading of the resistance. A tolerance of up to 5% is acceptable.

Please note that you can also use the programmable probe in cases where you need to use an existing temperature sender.

Oil temperature and Oil pressure indicator

Two related instruments are oil pressure and oil temperature. These instruments are often used together but they are two independent instruments and you can enable and place them individually.

Pressure is shown either in BAR or PSI as selected in the "mode and units setup menu". Temperature units are selected in the same menu and can be either degrees F or degrees C.

The oil pressure indicator

Please setup the required oil pressure sender parameters in the "Sender setup menu".

You should setup the following items:

a)   The maximum resistance of the sender (200 ohms in case of most VDO senders)
b)   The pressure required for maximum/minimum resistance (often 5 or 10 bars)
c)   The direction of the resistance versus the pressure. Most senders increase resistance with pressure but there are a few that work the other way around.

You can enable either a minimum pressure level or maximum pressure level or both for alarm monitoring.

Please note: Should you switch on alarms for the oil pressure reading, the alarm will be activated if oil pressure falls below the set level. This implies that the alarm will be activated should you switch your engine off.

Set the required alarm level in the Engine detail setup menu (page **Error! Bookmark not defined.**). Most requirements would use a minimum pressure of 1.5 to 2.0 Bars (20 – 30 PSI).

The oil temperature indicator

The RDAC EMS can interface to standard VDI oil temperature sender (these are used in Rotax 912/914 engines as well).

These senders exhibits a resistance of 100 ohms at 85 degrees C and 1000 ohms at 20 degrees C.
It is also possible to use the MGL precision semiconductor sender instead of a standard automotive sender. This sender, although more expensive, is very accurate and does not suffer from the wide tolerances of standard automotive components. You need to select the type of sender used for the oil pressure in the "sender setup menu". The default sender selected is the standard automotive type.
The Ultra HXL also allows you to use Westach NTC senders as well as a user programmable probe (here you can set the Ultra to recognize the characteristics of just about any NTC type sender).

You can enable minimum and maximum temperature alarms for oil temperature. Should any alarm be active the temperature readout will flash.

Manifold pressure indicator

Manifold pressure is used in aircraft with variable pitch propellers to monitor and set engine power. In turbo boosted engines it can also be used to monitor the amount of boost pressure delivered by the turbo charger.

The MAP indicator can be setup to give a readout in millibars, inches of mercury or psi. Select the required units in the Mode and units setup menu.
Manifold pressure is displayed relative to sea level atmospheric pressure on a standard day (1013.25 millibars). You can select the width of the window you would like the display to use. For example, if you select a 100 millibar range, the bargraph will show from 913 to 1113 millibars.
You select the display range in the Engine detail setup menu.

Please note: before you can use the MAP indicator for the first time, you must perform the MAP sensor calibration as explained in the Calibration menu section of this manual.

The fuel flow and fuel level indicators
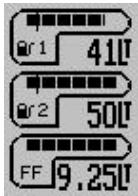
The Ultra Horizon XL provides you with options to connect up to two physical fuel tank level senders plus a fuel flow sender.
You can choose to display a single or a dual tank system, any tank level can be based on a calculated fuel level if you have a fuel flow sender.

The fuel flow indicator

If you have a fuel flow sender installed this instrument will show you your current fuel flow per hour. The indication will be in liters per hour, imperial or U.S. gallons per hour. Select this in the mode and units setup menu.

Fuel flow rate is an important and useful indicator showing you the health status of your engine and fuel system. We recommend from actual past experience that you include the fuel flow rate in your pre-flight checks at engine run up time. You will soon know what fuel

flow rates to expect from your engine at various power settings. At run-up time, run the engine for at least 30 seconds to a minute at full take-off power and watch the fuel flow rate. Should your fuel pump and related system not be capable of supplying enough fuel the fuel flow rate indication will tell you that you have a problem before you take to the air. If the fuel flow rate is not where you remember it should be, it is not because your engine is very economical today but because you have a potentially dangerous problem!

The Ultra HXL is able to provide fuel flow information from an inline turbine sender or directly from information obtained by monitoring your fuel injectors (fuel injected engines only). Select the required source in the "Sender setup menu".

Please note:
You have a fuel accumulator available in the main menu. This shows you a total of fuel used since you last reset the accumulator.

Fuel flow senders require correct installation and calibration in order to give you accurate readings. Please see the relevant section in this manual.

The fuel tank level indicators

You have two physical fuel tank level sender inputs on the RDAX X engine monitor. Each of these can provide a measurement of fuel level in one tank for display by the two available fuel level displays.
Each sender needs to be calibrated before you can use it. This is done in the Fuel tank/level sender 1 and Fuel tank/level sender 2 menu functions.
You setup tank size and sender calibration using these functions. Please also see the separate section on tank level sender calibration in this manual.

Alternatively, it is possible to display a calculated fuel level. In this case you need a fuel flow sender connected. You enter a starting fuel quantity (for example after you have filled your tank) and any fuel used is subtracted from the remaining fuel quantity.

You enter the calculated fuel level in the main menu.

Fuel levels are also used for range calculation. You select which tanks to use for range calculation in the sender setup menu.
You select whether to use physical level senders, calculated fuel level or both in the same menu.

Both tank level indicators can have alarm levels set and enabled. You set the fuel low levels in the Basic operations setup menu.

Fuel pressure indicator

The fuel pressure indicator can show fuel or any other liquid pressure based on the measurement output of a suitable pressure sender.
The Ultra Horizon XL is optimized for any pressure sender that can produce a low impedance 0-5V DC output, linear with applied pressure. A typical, very good quality pressure sender is the type A-105 with a 200psi pressure range from Honeywell Sensotec. We recommend that you use sensors like this or similar to this as they are based on sealed stainless steel diaphragms that will not be attacked by fuels and other aggressive liquids.

You can setup the senders maximum pressure reading at an output of 5VDC. In the case of the suggested sender, this is 200psi.
You also need to select where you are going to connect the sender on the RDAC X engine monitor. You can choose between CHT1/AUX3 or Fuel level sender input 2.

The above two items are selected in the Sender setup menu.

You can enable an alarm, activated below a minimum pressure level. You can select the required minimum pressure level. This is selected in the Engine detail setup menu.

Example Honeywell Sensotec A-105 pressure sender suitable for aggressive liquids.

Model A-105

Numeric information displays

The Ultra Horizon XL provides you with a number of numeric information items that you can place onto the display.

Each numeric item has an associated label that is also an independent item. This allows you to place the identifier for the numeric item at your convenience.

Each numeric item can be shown in either a small font or a large font. In the sample display on the left you can see the flight time using a large font and the remainder of the items uses a small font.

The following documentation lists every available item in this category.

DALT (DENSITY ALTITUDE)

Density altitude is pressure altitude corrected for air density. This relates to altitude and temperature. To use this function you must install the included ambient temperature probe so the instrument can measure the correct ambient temperature.

Density altitude is an useful indicator for your aircraft's performance at altitude. The altitude given is the equivalent altitude that you should consider your aircraft to be at currently, regardless of the actual altitude. This in turn will enable you to correctly assess required take-off and landing distances as well as load carrying abilities. Consult your aircraft's handbook on relevant de-rating curves.

BARO (BAROMETER)

The barometer shows your current ambient pressure. It is the basis of your altimeter.
Why include a barometer in an aircraft – this is a question we get asked often. Here is why:

Firstly and perhaps most obviously, it has uses when predicting frontal systems and general weather forecasting. Sailors use it with great effect and much the same reasons apply for many of us aviators.

The second reason however I value as the most important: To convince you that flying too high in an unpressurised aircraft without added oxygen is not a good idea.
At an altitude of 12.000 ft (3 658 m), considered by many as limit for unaided ascent, the barometer reading will be as little as 640 mb (18,9 Inch of Hg) even less depending on local conditions at the time. Further considering that at sea-level you will be at around 1000-1025 mb (29,5 – 30,3 Inch of Hg) most of the time, you should easily see that you're going to deprive your lungs of badly needed oxygen. Many accidents have happened as a result.

TIME

The current time of day. This is set in the "Aircraft setup" menu. Should you often fly in controlled airspace you may want to set the time to read UTC rather than local time. Date and time of day are relevant for flight information stored in the logbook. The date and time originates from a built in crystal controlled watch with low drift characteristics. You may need to correct the time for small drift every few months. This is done in the "user setup menu".

FLIGHT

The duration from take-off of the current flight or the duration of the last flight if no flight is currently active.

Note: We recommend that you set the instrument to "automatic flight detect" in the mode menu. Should you prefer manual flight start and stop then the FLIGHT timer will show the time from the manual start of a flight to its manual stop.

Manual flights are started and stopped in the relevant menu item in the main menu.

GCR

Glide or climb ratio indicator. This useful item divides your forward distance made good by your vertical speed. The ratio is shown as a number from 0.00 to 99.9. It should be interpreted as follows:

Example: GCR 8.5. This means for every 1 ft (or meter) of vertical sink or climb you are traveling 8.5 ft (or meters).

The arrow in front of the number indicates climb or sink rate. This function is useful to optimize glide ratio or judge the effects of changes to your airframe or power plant.

TEMP

The ambient temperature. You need to install the included ambient temperature probe in such a fashion that it is exposed to the outside air. Do not install the probe inside your cockpit or instrument pod. Install the probe in such a fashion that it will not be heated by engine exhaust or sunlight. Ambient temperature is required to calculate density altitude.

TRIP

A flight distance trip counter similar to a trip counter in a car's speedometer. The trip counter is reset using the relevant menu entry in the main menu. You can also set the instrument to reset the trip counter automatically at the start of a flight (mode setup menu). The trip counter shows the actual distance traveled through the air and does not take wind speed or direction into account. The distance is based on TAS (true airspeed) regardless of the setting of the air speed indicator.
The trip counter is useful during navigation competitions when GPS may be banned.

VOLT

The supply voltage level to the unit. This would normally be the voltage of your battery. This indication serves as a battery charge indicator. Should you be using a lead-acid battery (sealed unit or open, motor cycle battery), your maximum voltage should not exceed 13.8 volts if you have a 12 volt battery or else overcharging and damage to your battery will result. Many regulators are of poor quality and will overcharge your battery.

A voltage level of under 11 volts indicates a discharged battery. Do not discharge your battery below this level as you will damage it.

A charged, healthy battery will have voltage levels between 12V and 12.6V when not charged.

RANGE

Should you have a fuel flow sender installed and calibrated correctly, this field will show you your current range given your current fuel flow, remaining fuel level and airspeed. This function is among the most important items for the seasoned cross-country flyer. It allows you to optimize your aircraft's range by choosing the best power setting.
The RANGE estimate is dependant on the quality of calibration and installation of your fuel flow sender, as well as the correctness of reported fuel levels in your tank. The RANGE estimate applies for still air (no winds) using your current power setting.

Remaining fuel level can be a calculated item if you do not have a fuel level sender installed. In this case you enter a starting fuel level in the main menu and the unit calculates remaining fuel level by subtracting fuel used as reported by the fuel flow sender.

We recommend, should this be possible in your aircraft, to fit a fuel level sender.

BINGO

The fuel bingo estimate is related to the RANGE estimate. The fuel bingo estimate is the time in minutes it will take at your current power setting to reach a fuel level of zero. We do recommend that you setup your system so the zero fuel level corresponds to your fuel reserve level. Should you not do this, BINGO will mean "engine out", usually a condition for heightened heart beat rate for the Pilot. Land **before** you reach BINGO time, even if that means putting down in a less desirable place.

STW

The stopwatch. Use the relevant main menu item to start, stop and reset the stopwatch. The stopwatch is independent of any flight operation and can be used for various tasks. Often, it can be a useful aid as leg timer during navigation competitions. The range is to 60 minutes with a one second resolution and thereafter to 99 hours with a one minute resolution.

The stopwatch can be used as follows:

Activating the stopwatch

Step one: Press Menu, then press Next until cursor is on the Stopwatch menu item.

`StopWatch Start-press +, Zero-press -`

Step two: Press + to start the stopwatch

Step three: Press - to Zero the stopwatch if required

Step four: Press Menu to exit

Deactivating the stopwatch

Step one: Press Menu and then use Next to select the stopwatch item

`StopWatch Stop-press +, Zero-press -`

Step two: Press + to stop

Step three: Press Menu to exit

Resetting the stopwatch to zero and starting/stopping are two different operations. This allows you to stop the watch and restart at a later stage without clearing the reading if required.

HOBBS METER

The hobbs meter shows your engine running time. The hobbs meter is presetable to your current engine time (User setup menu). Engine running time accumulates when the engine revs is above the "hobbs revs" as defined in the "Basic setup menu". This setting allows you to ignore idle time if you so wish.

MAINTENANCE METER

The maintenance meter is a "hobbs meter in reverse". You set the meter to your desired engine maintenance interval (for example 50 hours) in the "user setup menu". When the meter has counted down to 0 hours, your maintenance is due.

GCR (Glide or climb ratio)

Briefly mentioned in the VSI description, the glide or climb ratio shows your current ratio between true airspeed and vertical speed. This reading can be used to optimize your aircrafts glide or climb ratio.

Operating the Ultra Horizon

This describes how to use the buttons in flight whenever you see the mail screen as shown below

Increase or decrease the display contrast to adjust the display quality to best possible setting. If operated at temperature extremes, this should be done whenever the temperature changes by a large amount.

Increase or decrease local pressure setting as directed by air traffic control or to get the correct altitude at you local airfield.

Enter the main menu as required.

If the checklist is not active, pressing and holding Select for 5 seconds will simulate a total instrument failure for training purposes.

Pressing "Next" will send a command to the SP-3h or SP-3hc sensor to instantly level the horizon. This can be used if the horizon is showing incorrectly after extended manouvering and you do not want to wait for internal error correction to do its work. You need to fly straight and level to use this function properly.

Pressing "Prev" will add an offset to the current pitch angle displayed so that the pitch angle will read zero degrees. This is used to show level flight at different power settings which may result in different pitch angles. The AHRS mode display will have a "P" added in this case to remind you. Pressing "Prev" again will cancel the offset.

IFR displays using the AHRS components

AHRS mode indicator

Compass or Gyro compass heading

Compass mode indicator

Artificial horizon (attitude indicator)

036

Turn indicator
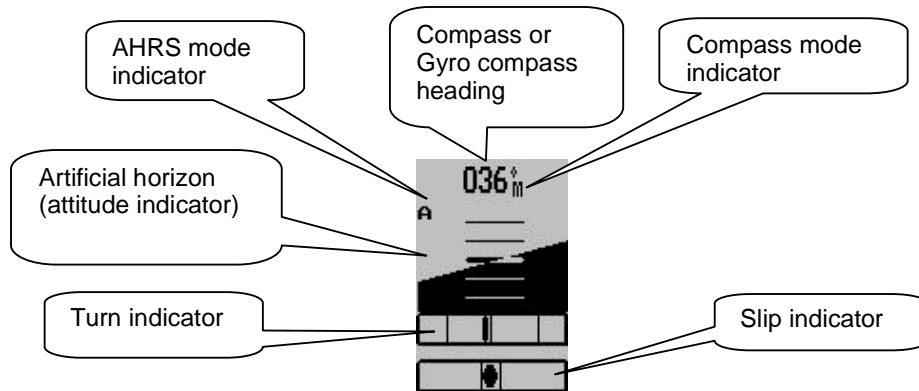
Slip indicator

The Ultra Horizon offers you the following IFR related components:

a) Artificial horizon (attitude indicator) – requires SP-3h or SP-3hc or SP-4
b) Rate of turn indicator – requires SP-3h or SP-3hc or SP-4
c) Slip indicator – requires SP-3h or SP-3hc or SP-4
d) Compass – requires SP-1, SP-2 or SP-3hc

AHRS mode indicator

The first character can be:
1) A – the AHRS is operating in accelerometer mode.
2) G – the AHRS is operating in gyro mode.

The optional second character is a "P". This is shown if you have pressed the "Prev" button to set the pitch angle on the display to zero. This is to remind you that you are not seeing the actual pitch angle as measured by the IMU but have told the instrument to add an additional angle so the display is shown with zero pitch. Pressing the "Prev" button again will cancel this mode.

Slip indicator

This resembles a traditional slip indicator. It is based on the X axis accelerometer.

Turn indicator

This gives you a marker that shows you a rate one turn (20 degrees). If the marker is aligned with either of the two outer vertical lines then you are flying a rate one turn.

The horizon display

This shows you a view on the estimated horizon. Take note that the horizon shown is a result of thousands of calculations per second, measuring your aircrafts movement through the air. The horizon is called estimated as it is subject to errors that may have been introduced by various factors. Keep in mind that a IMU cannot know where the earth surface is in relation to your aircraft, it can only estimate it.
You will find more detail on this and how to install and setup the IMU for best performance in the manuals for the IMU.

Compass and Horizon setup

Horizon and Compass setup

Set Horizon items
Set Compass items
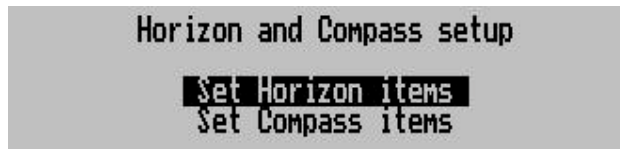
This menu is accessible from the main menu.
Here you will find various functions to setup and calibrate your SP-1, SP-2 or SP-3 sensor package.
This documentation should be read in conjunction with the documents for the various sensor units.

Horizon Setup

Horizon setup

Set Bump factor
Set Slew factor
Attitude mode: IMU
Set inclination

Set Bump factor

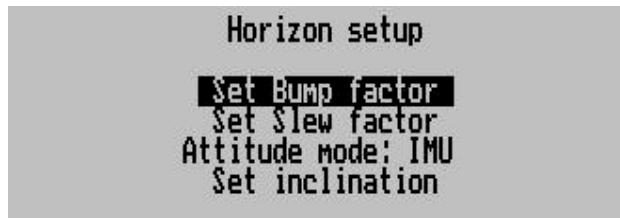This function presents you with a small menu. You can send one of five settings to your SP-3. This function will only work if you have a SP-3 connected. The setting is stored in the SP-3, the highlighted entry that is shown is NOT the setting in the SP-3, only the setting that you want to send to the SP-3. The SP-3 stores the setting in permanent memory, the setting is not lost if you remove power from the unit.

Bump lowest
Bump low
Bump medium
Bump high
Bump highest

This filter has five settings: Lowest, Low, Medium, High, Highest.
This filter sets the threshold that determines un-accelerated flight. It can be viewed as a limit on the acceleration force acting on the aircraft below which the gyro derived attitude will be corrected by the attitude as derived from the accelerometers.
Typical settings are Low or Medium. Other settings may be useful in some environments.

Effect of too low setting:
System will never or only very seldom have the opportunity to correct errors. Continuous turbulent flight will require a higher setting.
This setting is normally chosen on the mass of your aircraft and how it behaves with turbulence. The more stable your aircraft, the lower a setting you can choose.

Effect of too high setting:
System remains in "accelerometer" mode too long. The most noticeable effect this has is during very slow entries to banks – the displayed horizon may show horizontal even though you have banked or the bank angle is shown too shallow. As the horizon is now wrong, the error will grow quickly as gyro rate information will be misinterpreted.

Set Slew factor

This function presents you with a small menu. You can send one of five settings to your SP-3. This function will only work if you have a SP-3 connected. The setting is stored in the SP-3, the

highlighted entry that is shown is NOT the setting in the SP-3, only the setting that you want to send to the SP-3. The SP-3 stores the setting in permanent memory, the setting is not lost if you remove power from the unit.

Slew lowest
Slew low
Slew medium
Slew high
Slew highest

Like the "Bump" filter, the "Slew" filter also has five settings:
Lowest, Low, Medium, High, Highest.

This filter setting affects the speed at which error corrections take place.
Good settings are usually Low, medium or high.

This filter setting interacts somewhat with the Bump setting. Should you find your installation tends to accumulate errors quickly (for example you may have unavoidable vibration affecting the sensors), set the error correction speed higher.
Do not set the error correction speed unnecessarily high as this may degrade your systems ability to correctly detect very slow entries to banks.

Finding the right filter values

Once good filter values are found, they are rarely if ever changed.
Good filter value selection will result in the system remaining in accelerometer mode (indicated on your screen) for most of the time during straight and level flight.
Slow entries into banks are the most critical factor, so try these in calm conditions. Bump factor too high or Slew factor too high (or both too high) may result in bad detection of this maneuver.
Select the Slew factor such that any errors that have accumulated during a full 360 turn at 30 degrees of bank are corrected quickly after you roll out straight and level.

Attitude mode

Here you can select the type of attitude calculations you want to use.
The choice is between "IMU" and "Mattitude". The display shown indicates the current mode of operation if you have the SP-3 connected.
Please read the documentation on the SP-3 for detail of which mode you should choose.
"Mattitude" is an experimental system at this point in time, "IMU" is the normal way a strapdown artificial horizon works.
"Mattitude" will not work correctly if your aircraft has a significant effect on the direction and strength of the measured Earth magnetic field.
Please note that before you can use this mode, you have to set the magnetic inclination at your location (described below).

Attitude determination modes

The SP-3hc unit provides the user with a choice of two different modes to obtain aircraft attitude (bank and pitch).

IMU attitude determination

This mode is the traditional IMU consisting of three gyros and three accelerometers. Gyros provide rate of turn information while the accelerometers are used to vector gravity in order to compensate for gyro drift and also to set the initial orientation of the quaternion.

Magnetometer based attitude determination

This method uses the magnetic vector direction in three dimensions to obtain a relative attitude that can be used as bases for determining attitude relative to the earth surface.
The SP-3hc will automatically obtain the magnetic inclination (dip angle) regardless of its own tilt relative to the earths surface. This measurement needs to be done very accurately. The SP-3 will perform this measurement about once every 10 seconds provided the aircraft is providing a stable enough platform. (benign flight conditions).

The magnetic inclination does not change by a large amount over a large distance, however small local variations of the inclination angle do occur in some locations and it is these variations that the SP-3hc will attempt to track.

The SP-3hc provides a function that allows the user to set the default magnetic inclination. This functions needs to be used at least once and may have to be repeated should the SP-3hc be operated in an area with a different magnetic inclination.

No knowledge of the inclination angle is required by the user during this process as the SP-3hc is capable of measuring this angle.

Set inclination

Use this function to set the magnetic inclination at your location. The aircraft has to be steady and stationary. Ensure that you have moved away from metallic structures such as aircraft hangers or reinforced concrete aprons.

Selecting this function will return the angle of inclination (zero degrees is straight up/down, as you would get at the magnetic poles). The SP-3hc needs to be connected for this.

The inclination is only needed if you want to use the "Mattitude" mode. Should you move to an area with a different angle of inclination, you should repeat the procedure.

Note: Set the inclination only after you have performed the deviation compensation.

Compare the angle derived with what it should be, should you not get an acceptable result, you may have to relocate the SP-3 as it is measuring a magnetic field with significant deviation, probably due to metal effect of your aircraft.
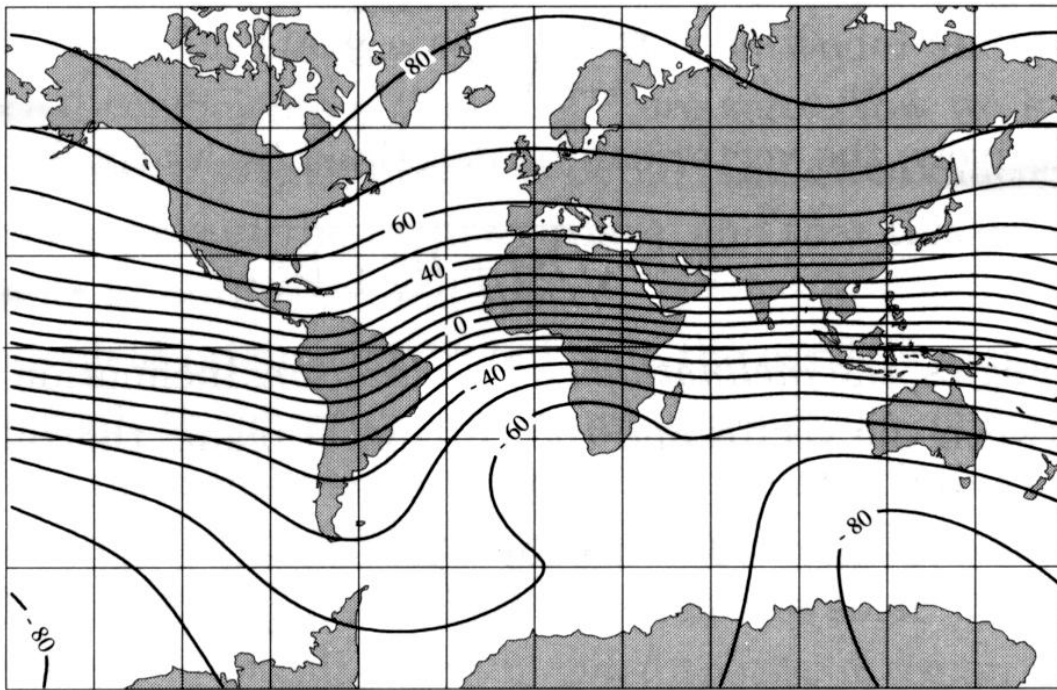
Map of the Earth showing isobar lines of magnetic inclination.

Compass Setup

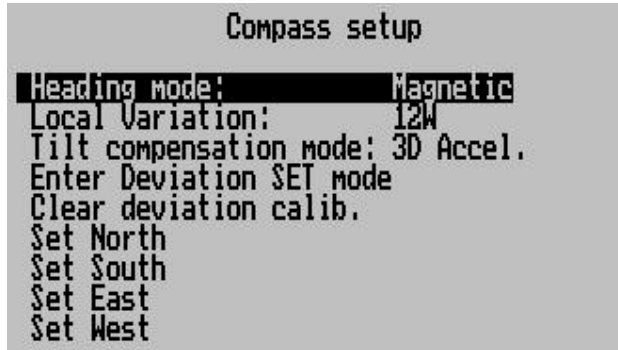In this section of the Ultra menu system you will find the compass setup functions and items you need for deviation compensation and calibration.

```
              Compass setup

Heading mode:        Magnetic
Local Variation:     12W
Tilt compensation mode: 3D Accel.
Enter Deviation SET mode
Clear deviation calib.
Set North
Set South
Set East
Set West
```

Heading mode Magnetic / True

Select if you would like the instrument to display magnetic or true heading.
If you select true heading, you need to enter the correct magnetic variation for your location. You can find your local variation on aeronautical or maritime charts.
The heading displays will be augmented with °M or °T depending on the mode you have selected.

Local variation

Enter the magnetic variation of your location. This is only used if you would like the instrument to display true heading. True heading is the heading relative to the geographic north pole. Magnetic heading is the heading relative to the magnetic north pole.
Variation is expressed in degrees east or west.
Please note that should you move a long distance, you may have to update the variation setting.
This setting may be ignored if you only use the magnetic heading display option.

Tilt compensation mode

Select the mode you would like your compass to operate under.

2D – this mode selects a two axis compass system. This has no tilt compensation.
3D A – this mode selects a three axis compass system. Tilt compensation by means of gravity vectoring via accelerometers.
3D G – this mode selects a three axis compass system. Tilt compensation by means of information supplied by an artificial horizon.

SP-3hc can be used with any of the above modes.
SP-2 can be used in modes 2D or 3D A. 3D G is available if an external artificial horizon is connected.
SP-1 can only be used in 2D mode.

Each mode has advantages and disadvantages over other modes. Briefly, these are outlined in the table below:

Mode	Advantage	Disadvantage
2D	Most accurate as long as compass remains level. Not affected by turns or acceleration provided compass remains	Large heading errors when compass is tilted. The magnitude of these errors is dependent on the heading, type of tilt (pitch and/or

	level during turns.	bank) as well as location on Earth.
3D-A	Self-contained tilt compensated compass. Will compensate for most tilt errors up to 60 degrees of tilt.	Cannot correctly compensate for tilt during any form of turn due to centrifugal forces acting on the accelerometers.
3D-G	Can provide for accurate heading even during turns as tilt compensation is based on gyro derived horizon.	Can show very large errors should the horizon information be invalid which could have a number of causes such as exceeding operational limitations of the horizon system.

Enter Deviation SET mode

Enters the deviation acquisition mode. Please read the text on the procedure to use.

Clear Deviation calib.

Clears any previous deviation compensation and returns the instrument to factory calibration.

Set North, South, East, West

Once you have completed the deviation compensation, you may want to remove remaining errors from the four main headings.
Point your aircraft exactly North, East, West or South and select the corresponding button. The compass system will store a correction value that will be used when you fly these headings. For other headings the correction factor is interpolated based on your settings.
This function should be handled with care and only after you have performed deviation compensation as outlined below.

Using the deviation compensation feature

When you install your compass sensor package, it may be surrounded by several items or materials that in some way change the strength and direction of the earth magnetic field that your sensors are measuring. If left unattended, this may contribute to considerable errors in the heading as indicated by your instrument.
Due to the magnetic sensor not being based on a magnetic item (such as a magnetic needle) as in a normal compass, the effect of deviation is lessened a little. This is because the needle in a magnetic compass will be attracted by iron, even if the offending iron has no effect on the magnetic field (i.e. does not change the field direction or strength in a hypothetical case).

Deviation needs to be corrected if you intend using the compass for navigational purposes. The procedure for this is traditionally called a "compass swing". Often, two small magnets are placed close to the compass in an effort to correct some of the larger errors. Smaller, remaining errors are then noted on a "deviation chart" and this is placed next to the compass for future reference.

With the SP-1,2 and 3, a very simple method can be used to correct for most of the deviation that may be present in your aircraft or vehicle.
However, before you start, ensure that the sensor package is installed as far away as possible from any of the following:

    a) Ferro magnetic materials such as Iron, many steels and soft magnetic materials such as ferrites. Any magnets must by located as far away as possible from the sensor package. This includes electromagnets as used in solenoids, electrical motors and relays.
    b) Cables containing large electrical currents. DC currents will cause magnetic fields around the cables which will lead to deviation. AC currents cause fluctuating magnetic fields that may reduce your compass resolution.
    c) Be aware that some lower grades of stainless steel may be ferro magnetic.

If in any doubt, use a small magnet to test any metals surrounding the sensor package.

We recommend to mount the sensor package using glued on strips of velcro material. This allows for easy alignment of the sensor package horizontal to the earth magnetic field.

Never perform the deviation compensation procedure or a compass swing if your aircraft is placed on a reinforced concrete apron or tarmac. The steel that may have been used to reinforce may have a very significant effect on the strength and direction of the magnetic field at your location.

To start the deviation compensation procedure, enter the menu and select "Deviation SET". You will see the following display:

Place your aircraft in flight attitude. For example, if you own a tail-dragger, raise the tail. Some tricycle gear aircraft may need to raise the nose gear slightly. The object is to place the sensor package as close to horizontal attitude relative to the earth's surface as you can.
Press the "+" key or have an assistant do this for you if you are busy holding up your aircraft's tail.

```
Proceed with deviation compensation ?
Press "+" to start or
any other key to cancel...
```

Press "+" to start the deviation compensation procedure.

You will now be presented with the following display. Please note that you have to have a SP-1, SP-2 or SP-3hc connected or else the display will not show and you will be directed back to the menu.

```
Turn compass through 360
degrees twice.

Press "+" when done.

EW:        342
NS:       -124          Current
Z:        -397          magnetometer
EW Max:    420          sensor readings
EW Min:   -320
NS Max:    525
NS Min:   -432
Z Min:   -417
Z Max:      0
```

Current magnetometer sensor readings

Maximum readings in each direction – these values will be used for the deviation compensation.

Place your aircraft in flight attitude. For example, if you own a tail-dragger, raise the tail. Some tricycle gear aircraft may need to raise the nose gear slightly. The object is to place the sensor package as close to horizontal attitude relative to the earth's surface as you can.
Press the "+" key or have an assistant do this for you if you are busy holding up your aircraft's tail.

Proceed as instructed and turn the aircraft through a full 360 degrees at least once. Allow this procedure to take some time, perhaps a minute. You can proceed to turn your aircraft though two or even more turns but you need to fully complete at least one turn.
You will see the instrument tracking minimum and maximum values for each sensor and you can see the current values.
Once you have completed your turn(s), press "+" again to inform the instrument that you have finished.
Your instrument will at this point calculate a best possible fit of the sensor data to a 360 degree arc taking the relative strengths and offsets of the magnetic field into account.
This procedure can result in remarkably good overall performance of your compass.

Please note: After this procedure has been completed, you may have to verify the compass performance by performing a normal compass swing. Should any deviation remain, you need to note this on a deviation card and place this card next to the compass.
This may be a legally required procedure in your country for your aircraft class. Please check your relevant regulations.

Deviation compensation and compass swing may need to be repeated from time to time as the magnetic properties of metals in your aircraft may change over time.

CARING FOR THE STRATOMASTER ULTRA

Pitot tube

Dust etc. can cause a blockage in the pitot tube. Such blockage will effect the operation of the pitot tube which will in turn affect the accuracy of the ASI/TAS readings. We recommend that the pitot tube be covered when the aircraft is not in operation.

Cleaning

The Stratomaster Ultra can be cleaned by wiping it with a damp cloth. A mild soap may be used if necessary.

Take care not to wet the instrument excessively.

Do not use chemicals e.g. petrol, spirits, turpentine when cleaning the instrument.

Never clean the non-reflective display lens with abrasive cleaners or cleaners containing solvents as this will destroy the lens coating.

Calibration

The Stratomaster Ultra instrument does not require re-calibration if it is used in normal operation.

Stratomaster Instruments used as references to calibrate other instruments may be sent in for periodic calibration to MGL Avionics. For this application we recommend a two year calibration interval. Please contact MGL Avionics for details.

Altimetry

This section is intended to clarify how an altimeter works and what determines its accuracy in simple terms.

As you know an altimeter is a simple absolute pressure gauge. This means it measures the pressure of the surrounding air relative to absolute vacuum as you would find in outer space.

Ordinary, well made altimeters are intricate mechanical devices that can achieve very good performance. However, these are subject to a whole host of influences that introduce errors in the readings. Vibrations tend to wear out the tiny gears, temperature has an effect on the elasticity of the materials used and therefore has a direct influence on the reading. The quality of the vacuum has a direct bearing on errors and the maximum altitude the instrument can indicate with a reasonable error.

The Stratomaster Ultra is based on a silicon pressure sensor. In principle, these sensors are subject to many of the problems that affect ordinary mechanical instruments and many digital altimeters have poor accuracy and resolution.

What is different in the Stratomaster Ultra?

The Stratomaster Ultra employs the most accurate absolute pressure sensor available. This sensor is not cheap or simple. It starts with a tiny cavity in a silicon chip. This cavity is about ¼ mm^3 in size and contains a near perfect vacuum. It is sealed with a very thin membrane that is only a few thousand atoms thick. The air pressure on the one side of this membrane bends the membrane towards the vacuum cavity. This introduces tiny changes in the

electrical properties of the membrane. These changes are measured. Temperature effects on the membrane are taken into account by measuring the temperature on the membrane and compensating for known effects. During manufacture of this sensor, the membrane is exposed to a focused electron beam that, atom by atom removes material from the membrane until the sensor reads exactly the correct value. The Stratomaster Ultra then converts this reading into digital form. But the results are not taken for granted. The Stratomaster Ultra attempts to measure the signal to levels below those created by thermal noise. This electrical noise is caused by the vibration of atoms. The Stratomaster Ultra knows the characteristics of this unwanted signal and eliminates errors caused by this signal. In addition, the Stratomaster Ultra measures the temperature surrounding the sensor and compensates for any remaining temperature induced error. This compensation is different from sensor to sensor as it depends on tiny, remaining manufacturing tolerances of the sensors. But your instrument knows the behavior of its sensor and can correct for errors.

Once the pressure of the surrounding air has been accurately determined, how does one calculate the altitude? Is atmospheric pressure not supposed to change with the local weather as well?

Well, there you have it: All this accuracy and then a storm comes in and all is lost.

Back in the beginning of flight, (sometime after the Wright Brothers did the silly thing of inventing powered flight), it was thought that it would be a good idea to have some indication as to how high one was flying. Early, primitive altimeters where based on principles much like we use today but were very crude and what was more disturbing, they depended on each manufacturers interpretation as to how pressure changes with altitude.

We all know that pressure gets less as we increase our altitude. But by how much? The American National Standards Institute and other standards bodies came up with the idea of simply dictating how the atmosphere behaves. So ANSI created the "standard atmosphere" which was valid on a "standard day". The "standard day" was decreed to be a day at mean sea level with a temperature of 15 degrees Celsius (59 degrees Fahrenheit). Further to this it was decided that the temperature would decrease at a certain rate as we increased our altitude. All of this and a portion of maths would now determine how our altimeter should work. Of course, suitable "fudge factors" were used to make the maths agree with what could be implemented using a bunch of mechanical gears.

So, the formula to use became:

$$P=P\_0*(1-6.8755856*10^6*H)^{5.2558797}$$

Where:

P= pressure
P_0= pressure at sea level (1013.25 mb on the "standard day")
H= height in feet above mean sea level

This formula is used to a level of 36.000 ft (10 975 m) . Above that a different formula is used.

Now what does all of this mean to you?

It means you have an exceedingly accurate altimeter that implements the ANSI standard in detail. It does not mean that your altitude is correct as indicated !

Your local pressure is determined by many factors, temperature and weather are only a few. All of these influence your altitude reading. Place your Stratomaster Ultra on the ground and run it for a whole day. Notice slight changes in the altitude (perhaps up to 60 ft (18 m) or even more?). These are caused by local changes of atmospheric pressure.

These are some of the reasons the altimeter has a QNH setting. This is simply a correction factor that is entered into your altimeter to correct for current local atmospheric conditions. As long as all altimeters use the same QNH they should all read the same altitude. This is all that aviation requires.

Should you be interested in your actual altitude, we recommend using a GPS. It is probably the most accurate method available today. However, it is not suitable for use on an aircraft due to the inability to display altitude according to ANSI standards and local QNH settings. It is important that all aircraft fly to a common altitude reference, **even if is not correct**.

True airspeed (TAS)

The Stratomaster Ultra instrument can indicate true airspeed. TAS is used for most internal calculations where air distance is of importance.

What is TAS and how is it calculated?

TAS is indicated airspeed (ASI) compensated for altitude and temperature. Often pilots ignore the effect of temperature and only take altitude into account when converting ASI to TAS. For practical purposes this is quite accurate and gives a good reflection on your true airspeed. Keeping in mind that ASI measurement is subject to errors caused by airflow around your aircraft, there seems little point in taking this calculation to absolute resolution.

Again, we have decided to use a formula often used by pilots. This way the instrument reading will agree with what pilots are used to.

Based on Worthingtons 13th edition page 349:

Add 1.75% of IAS per 1 000 ft (304.9 m) increase in altitude above sea level.

We assume here that IAS = RAS (rectified air speed).

The Stratomaster Ultra applies the above rule but works it at a finer resolution of 100 ft (30.5m).

WARRANTY

The Stratomaster Ultra is guaranteed against faulty workmanship on the part of MGL Avionics for a period of 12 months from date of purchase. MGL Avionics may at their discretion decide to either repair or replace the instrument. MGL Avionics will provide free labor and parts. Courier costs or postage costs will be for the account of the purchaser.

Please note: Certain parts are subject to breakage by misuse or external influences that cannot be covered by any warranty.

In particular the following possible damages are excluded:

- LCD display – glass cracked due to mechanical damage or freezing of the liquid crystal. The LCD must not be exposed to temperatures below –20 degrees Celsius (-4 degrees Fahrenheit) or above +80 degrees Celsius (176 degrees Fahrenheit).
- Any damage due to unusual events e.g. aircraft crashes, hard landings, dropping the instrument, excessive G forces, excessive vibration.
- Exposing the instrument to incorrect power supply voltages, such as connecting the instrument to mains power supply, any voltage in excess of 30 volts DC, and any AC voltage.
- Connection of unqualified or incorrect devices. Please contact us before you connect anything unusual to this instrument.
- Destruction of the air-talk link due to connecting the unit to PC's with unconnected earth leads or leaky power supplies.
- Damage due to excessive static discharge.
- Damage due to lightning strike.
- Damage due to overpressure of any sensors, in particular ruptured silicon diaphragms due to overpressure or mechanical action.

Any signs of opening the instrument or tampering with any of the internal parts will invalidate the warranty.

MGL Avionics endeavors to repair any faulty unit whether inside or outside of the warranty period speedily and at the lowest possible cost. Your first stop in case of a malfunction should be the dealer were you bought the instrument. It may be possible to repair your instrument without it having to be shipped to us.

DISCLAIMER

MGL Avionics cannot be held responsible for incidents or damage by whatsoever nature caused by incorrect fuel level indication. Installation and operation of the instrument and its related parts is outside our sphere of influence and control. We do not manufacture either the fuel level sender or the fuel flow sender and are not appointed agents of either.

MGL Avionics cannot be held responsible for incidents or damage by whatsoever nature caused by incorrect readings, displays, installation or operation of the instrument.

Operation of the Stratomaster Ultra instrument is the responsibility of the pilot in command of the aircraft. The pilot in command has to make himself/herself familiar with the operation and limitations of the Stratomaster Ultra instrument before commencing ground or flight operations as well as all other aspects of operation.

The Stratomaster Ultra intended for operation by a licensed pilot who is the holder of a MPL (Micro light pilot license) or PPL (Private Pilot license) or the equivalent thereof. The pilot should further be rated on the aircraft type on which the Stratomaster Ultra is being operated.

The Stratomaster Ultra has not been submitted to the CAA or FAA or any of its agencies for any form of certification. Operation and installation of this instrument is subject to the relevant rules and regulations of your country and flight authority.

If any of the above is not acceptable to the pilot in command he/she must refrain from operating the aircraft or remove the Stratomaster Ultra from the aircraft before commencing aircraft operations.

Installation manual for the Stratomaster Ultra "H"

Introduction

Before you commence any attempt at installing this instrument it is your duty to familiarize yourself with the relevant aircraft equipment installation requirements and regulations of your country. Proceed only if you are certain that you are permitted to install this instrument or seek approval from the required authorities. Also note that in some countries only approved persons may perform the installation of this instrument.

This instrument has not been submitted to CAA or FAA approval of any kind. Although this instrument surpasses all known specifications, it has not been the manufacturers intention to submit this instrument for approval due to the large costs involved. In addition, the instrument is targeted for aircraft classifications that do not require or warrant such approval.

In particular the instrument is intended for use with:

- Home built or amateur built aircraft
- Experimental aircraft
- Microlight and Ultralight aircraft
- Aircraft not falling in any of the above categories that may use non-certified instruments
- Aircraft having obtained special flight permits specifying the use of this instrument

Please note:

You should perform the following settings after installation:

1. ASI/VSI zero procedure.
2. Set the date and time.
3. Change any other settings as required.
4. Verify that Altimeter correction and ASI gain are set to the values given in the calibration certificate of this instrument

All mode setups are permanent and do not rely on a battery.
Values that may be affected by a low battery are:

- Date and time (real time clock)
- Current fuel level if you use the calculated fuel level using the fuel flow sender
- Hobbs and maintenance timer
- Current flight details if the flight was not yet logged due to a power failure in flight

This unit is fitted with a Lithium battery. The expected lifetime of this battery is 10 years. A suitably qualified electronics technician should do replacement of this battery.
The above image is the rear panel of the Stratomaster Ultra. At a minimum, you need to connect a 8V to 18V DC power supply, usually a 12V battery fitted to your aircraft.
In addition you should fit the included ambient temperature sender and connect an optional alarm indicator lamp. Suitable lamps are available as "pilot lights" or "panel lights" from electronics or automotive supplies.

The following pages show the recommended connections one item at a time. Proceed with your installation according to your requirements.

The Ultra Horizon XL rear panel
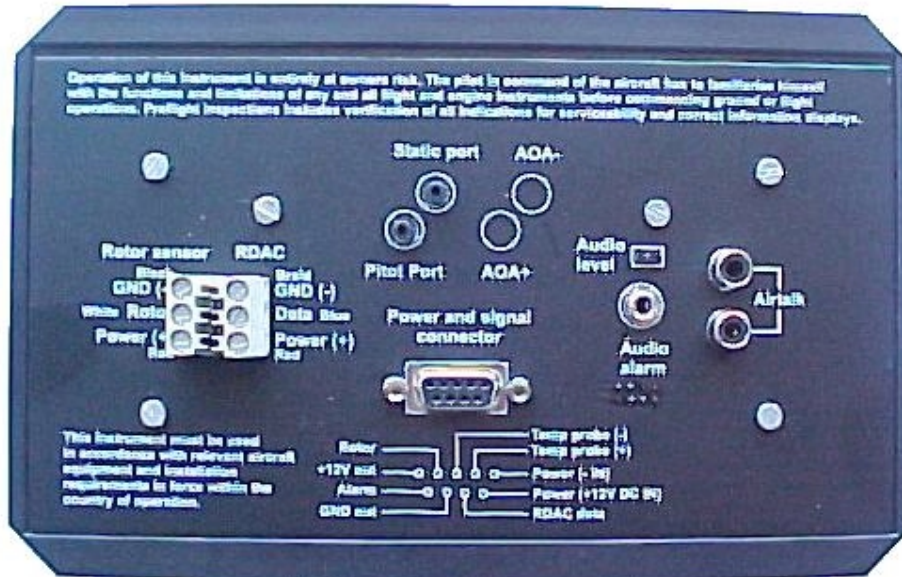
Rear panel connections and items:

Cannon D-9 connector. This connector is used for power and ambient temperature probe. Although other signals are available on this connector, they are not normally used.

Audio alarm output. Suitable for connection of a speaker or feed to an intercom system.

Audio level link. Close the link to reduce audio output level by a factor of 20.

Two airtalk local area network connectors. Connection for SP-x sensor packages, airtalk to PC cables, flight log download devices, interconnect between panels etc.
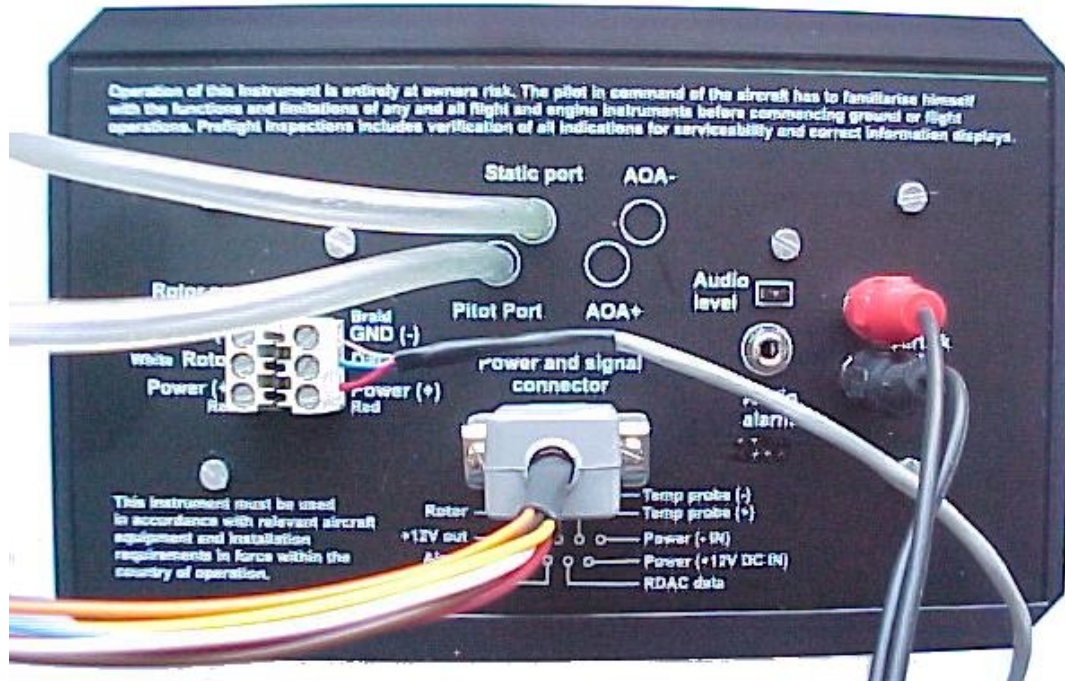
Terminal block for RDAC connection (engine monitor).

Terminal block for rotor speed sensor connection (rotor craft only).

Static port for altimeter and vertical speed indicator.

Pressure port for airspeed indicator (pitot tube port).

Connections to the Ultra

Power to the Ultra

The Stratomaster Ultra requires between about 7.0V to 28V of DC power supply. Current consumption is very low at about 40 mA without display backlighting and in the region of 80 mA with backlight. These figures are for a supply voltage of 13.8V DC.

Generally it is not required to fit any form of power supply filters or surge suppressors as the Stratomaster Ultra includes the required protection devices. External power line filters or surge protectors should only be considered in very unusual conditions.

Important note: Please provide the Stratomaster with its own ground (earth) return wire to the battery. Do not share this wire with any other equipment like lamps, radios or any other items. Spurious currents caused by other equipment can cause the Stratomaster to receive an invalid ground reference.

Please note: If you set the display backlight mode to "auto", the display backlight will be switched off automatically after four minutes of no activity to conserve power. The display backlight will remain switched on if engine revs are detected.
You can select backlight modes in the Device Setup Menu under Basic operation Setup.

If you are using the standard connector supplied with your Ultra, power needs to be connected to the Red and Black wires. Red is positive +12VDC and black should be connected to the battery minus. Do NOT reverse these connections.

If you are using your own connector, please connect as indicated on the rear panel.

Ambient temperature sender

The Stratomaster Flight includes a precision semiconductor temperature probe. It is recommended that you install it as shown above. The **RED** wire connects to the "Temp probe +" terminal. The remaining wire is **GREEN**. This wire connects to the "Temp probe –" terminal.
If you are using the supplied cable connection, wire the RED wire of the probe to the Orange wire of the connector. The green wire from the probe connects to the green wire of the connector.

The probe head itself should be mounted using suitable means outside of the instrument pod or aircraft if a closed cockpit aircraft is used. The probe should be placed in the shadow of the pod or aircraft or in a place were sunlight cannot heat the probe. Also ensure that engine heat or exhaust gases cannot heat the probe at any time. Remember – the probe is intended to show the temperature **__outside__** of your aircraft – not inside.

The twisted cable can be extended should this be required. In this case please use a similar cable type and continue the twist for the length of the cable.

The probe is required for the display of ambient temperature and density altitude.

We recommend that you install the external temperature probe.

Should you require a suitable replacement probe, it can be obtained from MGL Avionics at reasonable cost or you can make up your own probe. In this case please obtain a National Semiconductor Temperature Sensor type LM335 in a TO92 package.

External, visual alarm indicator

If you are using the supplied connector, the alarm output is on the white wire.
The alarm output is a open collector transistor switching to ground (battery minus) in case of an active alarm.
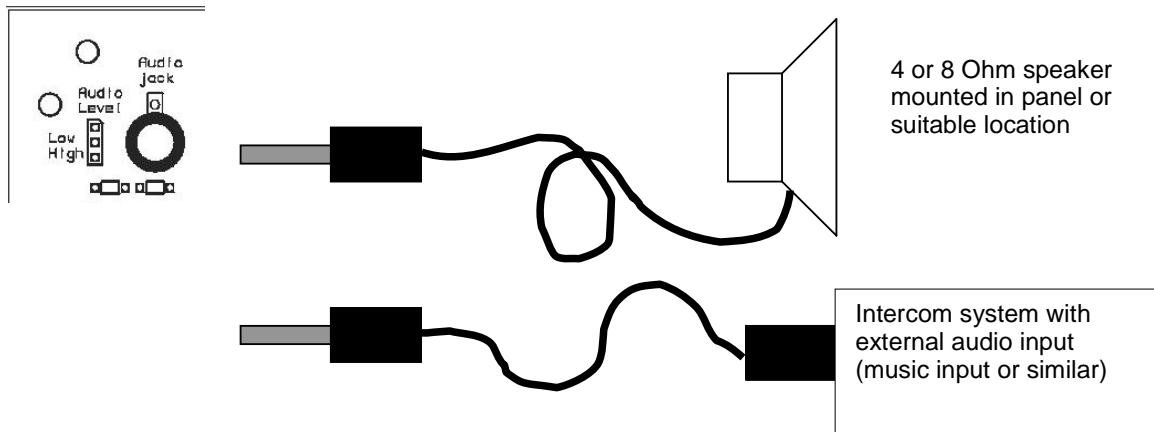
You can use this to switch a alarm lamp or LED. In case of a LED you need to wire a series resistor in line with the LED to provide current limiting. Consult your LED data sheet for required values.

The white wire should be connected to one pole of the lamp or the cathode of the LED. The remaining pole of the lamp should be connected to +12VDC.
The anode of the LED should be wired to the dropping resistor. The remaining connection of the dropping resistor should be wired to +12VDC.
Typical values for the dropping resistor are 100 to 500 ohms depending on the amount of current the LED can handle.

In case of a lamp, do not use a lamp with a greater power rating than 6W at 12 volts.

Maximum current for the alarm line is specified at 0.5A.

External, audible alarm

4 or 8 Ohm speaker mounted in panel or suitable location

Intercom system with external audio input (music input or similar)

In addition to the alarm output contact described in the previous section, you can connect either a speaker or an intercom system to the Stratomaster Ultra. In this case an alarm tone will sound once a second for half a second whenever an alarm is active.
In case you connect a speaker, the audio level link should be left open.
Should you want to connect to an intercom system that has an external audio input, close the audio level link.

Note: Please ensure that your intercom system will mute any external audio should radio transmissions be received. It may be illegal in your country to use any other system.

Pitot tube and static port

Pitot tubes are found in a large variety in at your aircraft parts shop, in mail order catalogs or you can make your own.
Contrary to popular belief, Pitot tubes are not carefully designed and calibrated but are simple orifices or tubes that get pointed in the direction that you are flying. The forward movement of the aircraft causes air to dam inside the pitot tube. This increases the pressure inside the tube. The Stratomaster Flight contains a sensitive silicon diaphragm sensor that measures the pressure difference between the pitot pressure port and the static port. This measurement is used to calculate the airspeed.
In addition, the static port is connected to the altimeter sensor.
Most small aircraft such as ultralights or microlights do not require a connection to a static port. In these cases, simply leave the static port open. Ensure however that the static port does not receive pressurized air due to the forward movement of the aircraft.
Static ports are usually mounted at a strategic position on the rear side of the aircraft fuselage for faster, pressurized aircraft.

Suitable pitot tubes can be made from a short piece of hollow aluminium or copper piping. Length and diameter are not important. Ensure that the front of the pitot tube has a suitable chamfer if you use thick walled tubing or you may introduce a speed reading error if you have a faster aircraft.
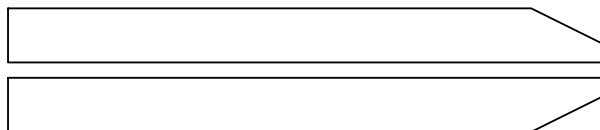
Example cross-section of thick walled pitot tube.

Pitot and static port (Continued from last page)

Suitable connection hose for both pitot tube and static port can be obtained from a hardware store or even a pet shop. Good quality tubing is often used for fish tanks and it has just the right diameter.

Please note that this kind of tubing is not advised for pressurized aircraft. In this case you would need to obtain aircraft grade tubing of suitable diameter. You would also have to use hose clamps to fasten the hose onto the Stratomaster pitot and static ports.

The Stratomaster Ultra instrument allows you to calibrate the airspeed reading. This is done in the "Device setup Menu" "ASI Gain". The main reason for this is to be able to remove errors introduced due to the airflow around your aircraft which may have an effect of your pitot tube pressure build up.

If you have a GPS receiver with a ground speed function you can use this as reference after allowing for any winds (Choose a wind still, absolutely calm day if possible).
You should also compensate for density altitude before you correct the ASI reading. It is quite normal to under-read on the ASI if your are flying at higher than sea level in moderate or high temperatures. You can set the Stratomaster Ultra instrument to display "True airspeed" or TAS. In this case a correction factor depending on your current altitude is applied.

Zeroing the air-speed sensor.

It may be required from time to time to zero the airspeed and VSI readings. This will be true if you are reading a small VSI or ASI when the aircraft is standing still on the ground.
Ensure that the readings are not caused by winds or other factors before performing the zero calibration. Also, ensure that no wind is blowing into the pitot tube.
The zero calibration is outlined in the owners manual. It is quick and easy and will ensure that your Stratomaster Ultra will perform at its best at all times.

Getting started with the Ultra

So, you have installed your Stratomaster Ultra. What now ?
Here is a short list of things you should do to make the instrument work the way you want it.

1) Verify that the RDAC is connected and working. The red LED on the RDAC should be flashing. You should see EGT and CHT readings giving approximate ambient temperatures (if the engine has not been running).
2) Altitude OK ? Good. Adjust the QNH using the + and – keys so you get your fields correct elevation.
3) Pilot tube connected and pointing the direction you think your aircraft is going to fly ? Blow lightly into the pitot tube and verify that you get an airspeed reading. Get somebody to do it for you if required.
4) Now go to the "Mode and units setup menu" (You'll find it in the "Device setup menu"). Select your required units of measure. Also, at this time select three important items listed here:
   How do you want to log flights ? Set to automatic or manual detect of flight start and end.
5) Have you got your fuel level sender(s) installed and connected ? Perhaps now is the time to calibrate your sender(s) as detailed in the relevant chapter in this manual.
6) Start the engine. Do you get correct RPM indication and is the RPM stable over the full range ? Adjust Rev counter calibration if required.
7) Select your engine type using the "Engine quick type select", perhaps select an engine closest to what you have and then modify the entries in the "Engine detail setup" so you have the temperature ranges and alarm levels the way your need them.
8) Select from the choices available how you want to use the twelve TC channels. You do this in the "Engine detail setup menu".
9) Connect your SP-1, SP-2 or SP-3 sensor package. Verify that your AHRS indicator is functional. You will have to perform compass swing (deviation compensation) and setup various factors for your horizon to perform as expected. Please view the documentation that comes with your sensor package for the required procedures.

Finally, verify that all your connected probes and senders operate the way they should. Are all the readings correct and as expected ?
Is all wiring secure ? No loose cables ? Have you made sure that the RDAC unit has a nice and **SHORT** electrical connection between the ground terminal and the engine block ? This connection must not break due to engine vibrations.

Everything done and working ?

Congratulations – you have one of the finest instruments on Earth in your aircraft.

Best wishes from the team at MGL Avionics.