

### 'Weather Watch'- Performance tuning weather station and analyser



Less oxygen = lower potential power, we can't prevent this; however we can reduce the impact.

Maximum engine performance needs the correct air to fuel ratio, we all know this!

Temperature, pressure and humidity determine the amount of oxygen available in the air, therefore the amount of fuel needed to maintain our target mixture.

'Weather Watch' is a track side analyser for monitoring weather conditions to allow tuning to the current RAD (Relative Air Density).

Inbuilt LCD display shows barometric pressure, temperature, humidity, RAD, change of RAD from a saved reference and even power loss or gain due to atmospheric conditions!

Data can be optionally transmitted to either 'DYNertia3' dynamometer software or to the included 'Weather Watch' monitoring program if data logging is required.

#### Key Features -

- No PC required- USB powered, can run off any USB power source such as USB outlets, chargers, phones, PC's, power packs etc. \*
- Displays barometric pressure, temperature, relative humidity, RAD (Relative Air Density)
- Tracks changes in RAD from a saved reference, indicates richer or leaner jetting required.
- Displays the potential percentage of power lost or gained due to the current weather conditions.
- Configurable pressure units (mBar, Pa, kPa, "Hg, hPa), temperature units (°C, °F), power correction standards (SAEJ607, SAEJ1349, DIN70020), RAD precision (1 or 2 decimal places) and even the screen displayed at start-up can be selected.
- LCD backlit display for track side visibility.
- Data logging to a PC for optional record keeping, 'WeatherWatch' software is included.
- Direct interface to DYNertia3 dyno software to allow correcting of data for atmospheric conditions.
- Compact dimensions 114 x 64 x 30mm, rugged metal case with mounting tabs.

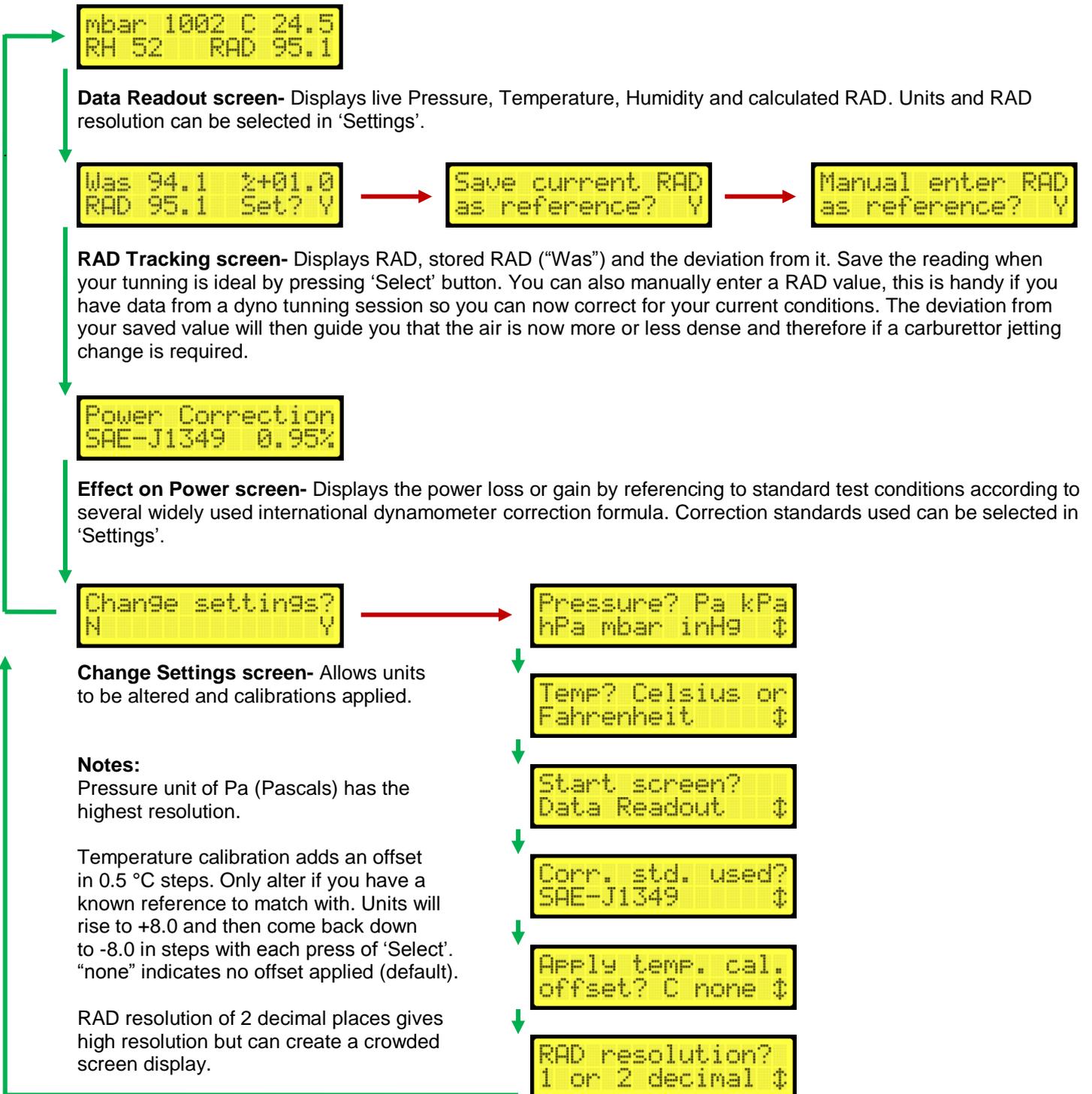
\* Note: Ensure USB supply is active with low power demand (WeatherWatch draws approximately 30mA of current).



## Menu structure -

The menu structure is intuitive. The 'Screen' button progresses you to the next screen and the 'Select' button is used to make a selection.

When in any settings screen, just press the 'Screen' button to progress through to the next screen. If you have made a change with the 'Select' button it will now be saved to memory, if not, it just progresses to the next screen unaltered.



**NOTE:** When viewing data on PC software there will be slight (insignificant) differences from the LCD display. The hardware transmits in mBar and 0.5°C temperature steps only; this will create 'rounding' differences that can be seen on the software display.



## Why air density should concern a tuner:

For maximum engine performance you need the correct air to fuel ratio, we all know this! Unfortunately it is often overlooked the effect that temperature, pressure and humidity have in determining the amount of oxygen available in the air, therefore the amount of fuel needed to maintain our target mixture.

Most have us have noticed the change in performance with a cold morning race or experienced the negative effects of high altitude on our engines.

These influences are well understood for dyno testing and most quality software packages (like DTec's 'DYNertia3') allow for atmospheric correction of their power readings to compensate for changes in power output. Less oxygen = lower potential power, we can't prevent this; however, we can reduce the impact.

Races are not run on a dyno! We must consider that the change in available oxygen will require us to change our fuel quantity if we are to prevent the mixture from being too lean or rich. The following article will discuss the effect of changing weather conditions and offer a guide as to what we need to do to correct our engine tune.

## Effects of weather on air density:

Air density is the mass of air in a given volume. It is dependent on temperature, pressure and humidity. Lower density means less oxygen available for combustion.

### Temperature-

Higher temperatures reduce air density and the amount of available oxygen. Hotter days require smaller jetting.

### Pressure-

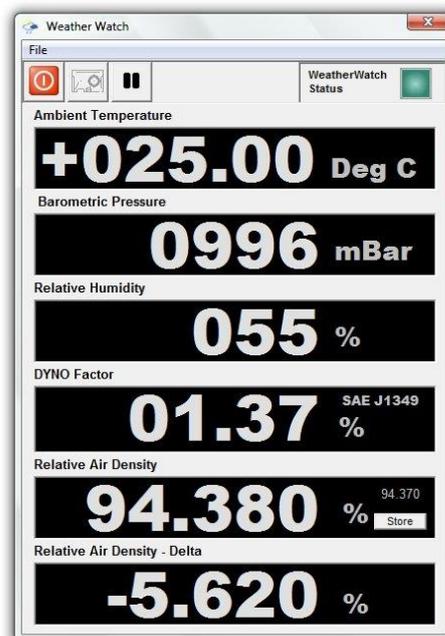
Lower air pressure (such as at higher altitudes) reduces air density and available oxygen. Altitude is a major contributor and every 1000ft you ascend there is a drop of close to 4% in density. Weather systems also have an effect and pressure can change very quickly during the day, particularly as a storm front approaches. Lower pressure requires smaller jetting.

### Humidity-

Moist air is actually less dense (just trust me on this one). A certain volume of air will contain a certain number of molecules (based on the 'ideal gas law') and it just happens that water molecules are relatively light compared to Nitrogen and Oxygen (H<sub>2</sub>O vs O<sub>2</sub> and N<sub>2</sub>), therefore the more moisture the lower the density! Higher humidity requires smaller jetting.

Any of these variables can have a big effect (particularly temperature and pressure) but it's when you combine the influences that knowing air density becomes a truly significant factor in extracting maximum engine performance.

This is a screen shot from the included PC software. The only advantage of this is that you can also log the data, the drawback is a PC is needed, not just a USB power supply.





## Calculating air density:

Don't do it! It's a lot easier to use a commercial air density meter or a more sophisticated device such as DTec's 'Weather Watch' to work with density or better still Relative Air Density (RAD).

If you choose to calculate densities based on individual atmospheric measurements (from precision wet/dry bulb thermometers, barometers or altitude data) then prepare to use lots of maths and psychrometric 'look up' tables. You will be dealing with terms such as vapour pressure, saturation vapour pressure, dry air pressure, dewpoint etc. If you truly wish to punish yourself then please feel free.

## Utilising Relative Air Density (RAD):

To allow us to get easy tuning information from air density data it is better to compare our value to a standard set of conditions, this is based on the international standard of 0 meters altitude, 15°C, 1013.25mb pressure and 0% relative humidity.

So what we end up with is a simple comparison relative to a standard. If RAD goes up 3% it means 3% more density, if it goes down 3% it's 3% less dense (and therefore 3% less fuel required).

When you have our engine tuned correctly you simply note down the RAD reading (or save it with the press of a button with 'Weather Watch'). When racing under different conditions you note the new RAD reading, the difference in percentage is the difference in fuelling required i.e. if RAD is now 5% higher we need to set a 5% increase in fuel. Weather Watch displays this difference for you!

## Jetting carburettors based on RAD:

A change in RAD requires a proportionate change in jetting. The only catch here is the way jets are sized- with RAD it's easy now to know if we need larger or smaller jets and by what percentage we need to alter the fuel flow, but how does a percentage in flow relate to jet sizes?

Unfortunately there is no standard method of numbering carburettor jets; different manufacturers have their own ideas.

Generally jet numbers can signify-

- Diameter e.g. 120 (1.20mm) also could represent thousands of an inch or be in wire gauge drill sizes.
- Area of the orifice.
- Flow in certain units at a particular test pressure.
- Just an arbitrary number the manufacturer assigns.

If jets are sized in flow then it's particularly easy e.g. if you needed an increase of 6% fuel and you had 200 jets then 6% larger would be 212 as the choice (200 x 1.06).



If jets are sized by diameter then we need to calculate the orifice area and use this to approximate the practical flow change. The following formula is simplified from the fact that Area=3.142 x radius<sup>2</sup>.

New jet diameter =  $\sqrt{\text{Old jet diameter}^2 \times \text{required flow factor}}$ . Flow factor is e.g. 4%=1.04, -7%=0.93 etc.

This jet 'area' tuning concept has been used for decades successfully. In reality however, there are many things that affect the flow through a jet, such as pressure differential, fuel viscosity, orifice diameter, entry shape, exit shape (coefficient of discharge), wall finish and length. The fuel discharge curve through a jet is easily upset by drilling or deposit build up.

If your estimated jetting change falls between available sizes then always err on the rich side and if a trend can be seen when observing the RAD over time then it may pay to anticipate the changing conditions.

Some re-testing after jetting with RAD will soon allow you to fine tune the approach for your fuel system. There is no substitute for using a wide-band air fuel ratio meter (such as DTec's 'WB2' unit) to confirm or trim the new settings if appropriate. This can sometimes indicate the need to reduce the jet size slightly from that calculated.

Observation of individual data is also useful for tuning. For example air temperature can play a big part in the tendency for detonation and could be useful for 'tweaking' the ignition timing.

### Tools for measuring, calculating and tracking RAD changes:

Many air density tools don't account for humidity; this is due to the difficulty in measuring and calculating its effect on density.

Although humidity usually lies in a fairly narrow range, and has less effect on density than temperature and pressure, we wouldn't be trying to optimally tune if we ignored it. 'Weather Watch' calculates what is sometimes known as 'corrected RAD', this accounts for humidity to achieve the highest accuracy.

Weather Watch addresses all of the following points in equipment selection and requirements-

- Accurate and able to account for humidity.
- Simple and fast to use so you instantly see RAD without looking up tables and calculating.
- Portable, rugged and value for money.
- Allow trends to be observed so you can track and anticipate changes.
- Display the weather data and not just the RAD value.
- Record to file so you can save with your race notes for future reference. You could graph this in 'Excel' to see how all the weather data changed throughout the day.
- It's also nice to see the power correction factor displayed, this gives an idea of the engines power potential under current conditions if the tuning can be optimised.



An understanding of air density and its effects allows us to optimise our engine to maximise our performance. It's all very simple as long as we choose the appropriate equipment; we want to win races, not be in the pits playing weather man and physicist.

**Foot note:** density plays a big part in aerodynamics (just ask pilots) so the effects on your aero package and drag vs. down force might be worth tracking



## 'Weather Watch'- optional PC software installation



### PC System requirements:

Windows XP has proven a very stable platform and is still extremely widely used. Windows Vista's continual security paranoia means security settings must be set correctly. Windows 7 operates well when UAC (User Account Control) etc. is appropriately adjusted. Windows 10 is the most common platform used by customers.

### Software Installation:

There are basically two parts to the install, the actual 'WeatherWatch' software and also a USB 'driver' needed for the USB connection to your WeatherWatch hardware.

**Step 1:** DO NOT plug in your hardware, DO close all windows programs. Ensure you are setup as an 'administrator' on your PC (this gives you permission to install software) and turn your security settings to a minimum to allow trouble free installation.

**Step 2:** Insert the provided software USB stick and execute the program "WeatherWatch Installer.exe" and follow the prompts.

After the main installation above is completed you will need to restart your PC. There will be a desktop icon created for you and WeatherWatch will appear in your PC's program list.



**Note-** Step 3, USB driver installation, is sometimes not required as the drivers are often included in later Windows versions. Testing first now is a good idea.

**Step 3:** From the USB stick open the "USB driver" folder and execute the program "SETUP.EXE" (or "DRVSETUP64" for a later more common 64 bit Windows PC), follow the prompts.

**Step 4:** **After a restart-** Plug the WeatherWatch hardware into your PC.



Run the software, open the menu choice 'File/Setup' and press the 'Link' button. This will allow WeatherWatch to find the USB port and begin communication.

### General installation issues:

Most Issues are due to the PC security software blocking full installation. You may need to disable your antivirus software or within its settings list WeatherWatch as an approved piece of software so it install.

If you are experiencing particular issues then we suggest you try on another PC to confirm the operation.

**If you have any problems or questions then please contact us for assistance!**