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## ENGINE INFORMATION SYSTEMS

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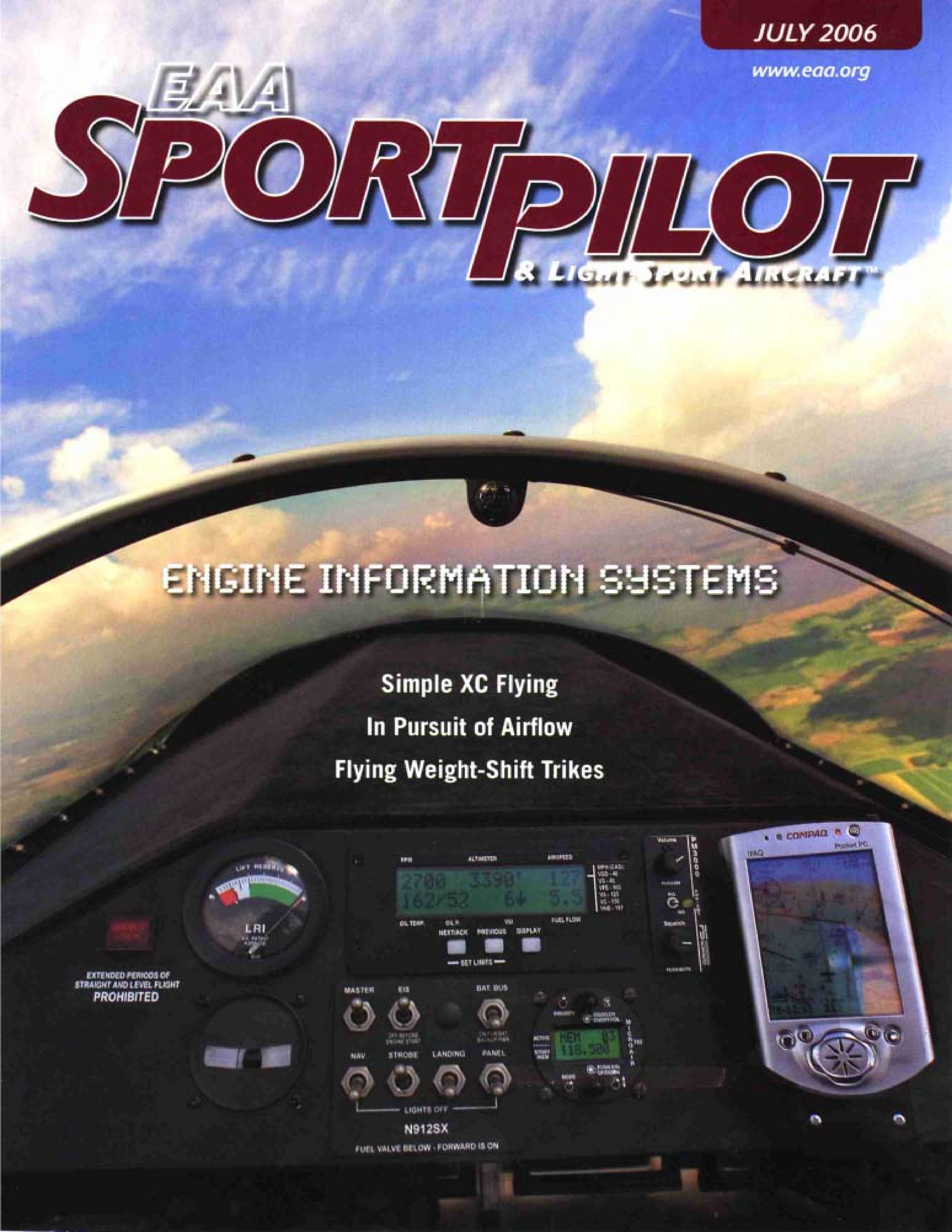
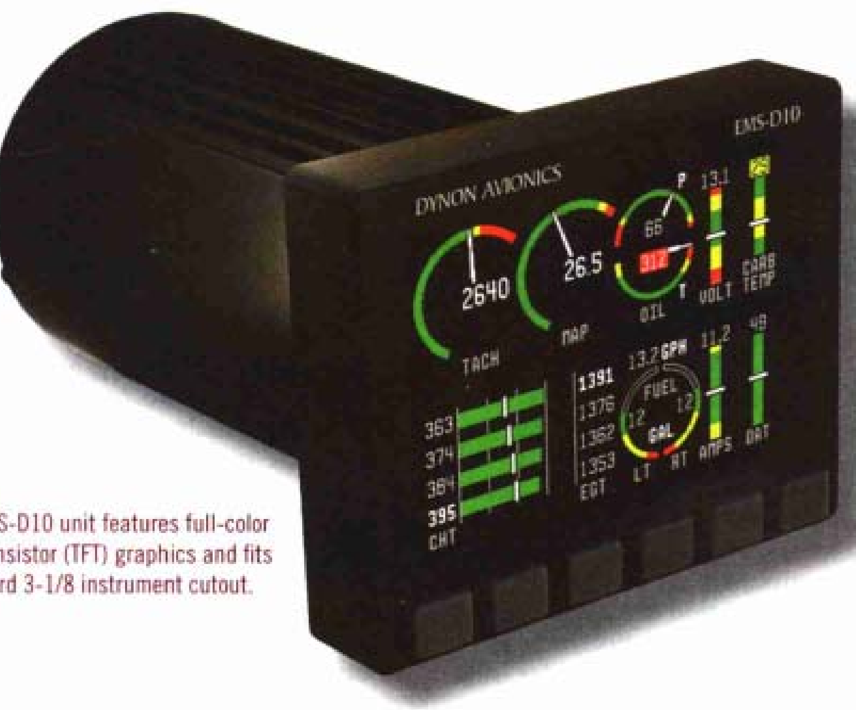


# ENGINE INFORMATION SYSTEMS FOR LIGHT-SPORT AIRCRAFT


## WHAT THEY DO AND HOW THEY DO IT

by Michael Huffman

The world of light-sport and amateur-built aircraft is a wonderful place to witness technological innovation. The word EXPERIMENTAL on our aircraft really means something; homebuilders and entrepreneurs are inveterate experimenters, and a great many of those experiments have resulted in true technological advances. Nowhere is that more evident than in the application of digital electronics in the cockpits of aircraft. One such application is the use of digital electronic devices to monitor engine operating parameters.




Dynon's EMS-D10 unit features full-color tin-film transistor (TFT) graphics and fits in a standard 3-1/8 instrument cutout.


A low-cost unit from IK Technologies, featuring high-brightness LED displays.

Unfettered by FAA regulatory oversight, these so-called *engine information systems* (EIS) have progressed technologically to their current state: robust, full-featured units that, in some cases, cost no more than the previously used steam gauges, provide much more usable information, weigh less, take up less space, and use less electrical power—all of which are especially important in light-sport aircraft.

Many of us aviation old-timers considered steam gauges to be marvelous technology in the 1960s when we were building aircraft from hastily scratched plans, lengths of 4130 chromoly tubing, and piles of aircraft spruce. Now some of us are behind the times and need to catch up. It is for that audience and new aviation enthusiasts that we take a look at the basics of EIS.

A plethora of EIS manufacturers have entered the marketplace in recent years, with products ranging from basic to advanced units. It is not our purpose to provide a manufacturer-by-manufacturer comparison. Instead, we will introduce the basic components of the systems, talk about features you are likely to find, and present considerations a prospective purchaser should consider in selecting an EIS.

A mild note of caution before we start: one of the things we lose in moving away from steam gauges is that with EIS we are dependent on the continuing functioning of the aircraft's electrical system and the EIS electronics. If the electrical system fails, we lose our readouts. Perhaps that is not a big deal with light-sport aircraft. First, most of us will be operating in VFR-day conditions. Second, if we lose the EIS, the engine will probably keep doing what it is supposed to at least until we can reduce power, richen the mixture, and make a precautionary landing (except that a lot of light-sport engine ignition systems also depend on battery power, but that is another story for another time). Third, EIS generally draw a small amount of electrical current.

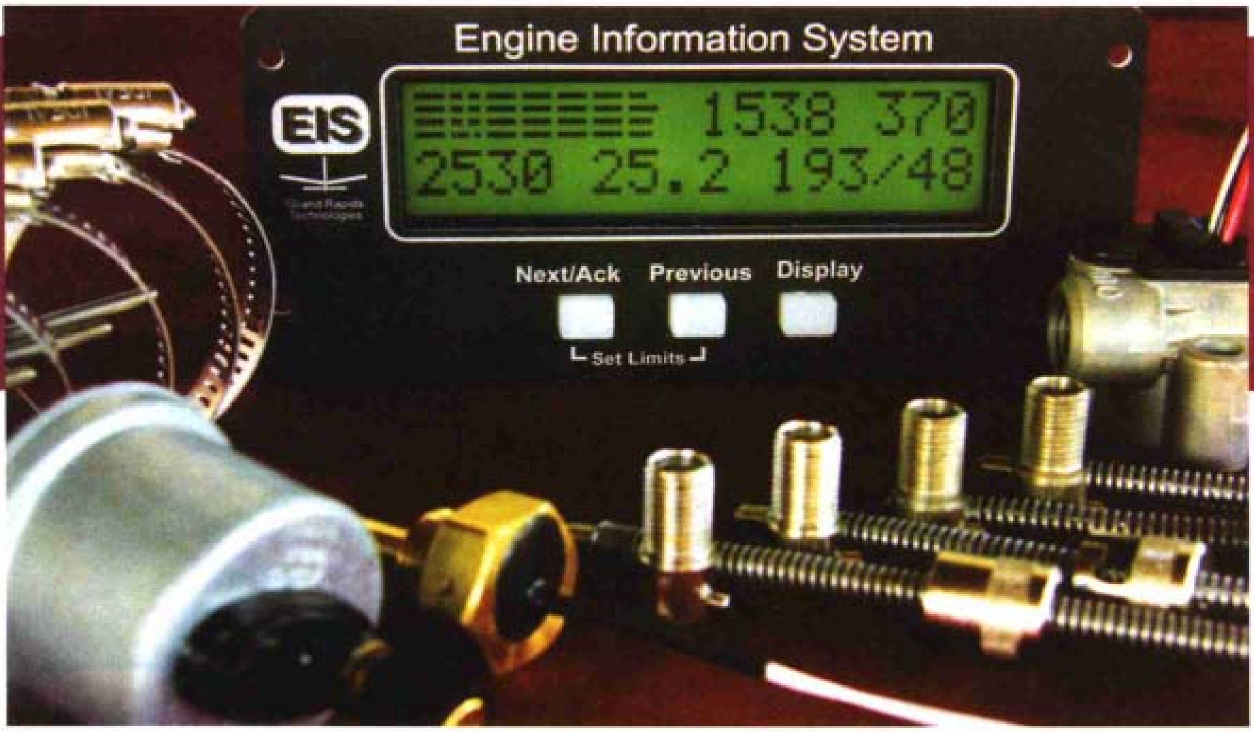
Let's dive in! Basically, an EIS consists of a set of *transducers* that feed engine data such as rpm, temperatures, and pressures to a *processing unit* that performs mathematical and logical manipulations of the data and then formats that information for presentation on the *display*. *Operator commands*, fed to the processing unit via front-panel buttons or knobs, change which information is displayed and how.

## TRANSDUCERS

Electrical transducers can be divided into two general groups, *digital* and *analog*. Like any true digital device, digital transducers put out discrete *bits* (1s and 0s) of information. Examples used in EIS include rpm sensors and fuel flow sensors, which basically create a train of pulses the frequency of which is proportional to the parameter being measured. The pulses in a given unit of time are simply counted by the processing unit and then divided by a calibration factor to obtain the true value of the parameter.

Analog transducers, on the other hand, put out a continuously variable signal (voltage, current, resistance, capacitance) as a measure of a parameter. Examples in EIS include pressure, temperature, and fuel level transducers. Analog transducers often produce a *non-linear* output, which means the output is not strictly proportional to the parameter being measured. In most cases, the processing unit must have the capability to "map" a non-linear output into a true proportional quantity.

Another aspect of EIS transducers deserves mention, namely their original intended use. For instance, manifold pressure (MAP) transducers origi-




A typical engine information system (EIS) and some of its transducers.

nated as part of the original equipment on a computerized automobile engine control. Others come from the automotive aftermarket. Others were designed, tested, and certificated to strict FAA technical standard orders or military requirements. Others were designed for use in general aviation aircraft but are not certificated to any specific standard. Still others are designed and built by the EIS manufacturers themselves.

Transducers for measuring oil, fuel, or coolant pressures are often resistive in nature—in response to pressure changes, a rubber diaphragm moves the wiper arm on a potentiometer (variable resistor). However, some more expensive certificated-aircraft pressure transducers use a stainless steel diaphragm that changes the output of a Wheatstone bridge strain gauge array.

Cylinder head temperature (CHT) and exhaust gas temperature (EGT) transducers are thermocouples, in which wires made of two different metals are welded together at the tip. A thermocouple produces a voltage proportional to the temperature of the tip, as compared to a reference junction temperature.

Electrical current transducers are most often of the Hall effect type, where a special semiconductor material produces an output voltage proportional to current flow.

Fuel level probes can be either resistive or capacitive in design.

Airspeed and altitude transducers are of a semiconductor strain-gauge design and often require testing of each individual unit, hand selection based on the test results, and custom calibration for the effects of temperature.

## THE PROCESSING UNIT

The processing unit electronics may be located in a separate box or in the same box as the display. The processing unit serves several functions, including:

- Providing electrical power for all components of the system, with some degree of robustness regarding temperature variations, voltage variations, spikes, lightning, static discharge, and electromagnetic fields.

- Providing *signal calibration,* which is the process of turning the raw transducer inputs into linear, meaningful real-world information.

- Accepting inputs from the operator controls and producing appropriate responses.

- Providing *logic* to analyze the transducer inputs, to summarize the information in useful ways, to allow the operator to set up the unit for specific engine and transducer types, and to allow limits to be set on parameters being measured.

- Providing outputs to the display, which often means "drawing the picture" on a bit-by-bit basis, while incorporating the parameter values and other display information in the stream of pictorial bits.

- Providing outputs to caution/warning lights or voice annunciators when programmed limits are exceeded.

- Providing the ability to store parameter values for later download.

## THE DISPLAY

Manufacturers employ a variety of different display technologies, each with its own characteristics. Here, you get what you pay for.

At the low end of the cost spectrum, some manufacturers use individual multi-colored *light-emitting diode* (LED) displays arranged in a bar-graph-type presentation, sometimes in conjunction with discrete LED lights and low-cost LED numeric or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Grand Rapids Technologies uses a 16-character, two-line trans-reflective backlit display that can also show limited bar graph information.

alphanumeric displays. Such displays are effective for simple presentations of data and, because the LEDs are bright, are readable in sunlight and at night. However, the legends for the displays are often screen-printed on the faceplate, thus if a given display is switched to show values of different variables, the user must momentarily ignore the printed legend.

At the next step upward, the pixel-type *liquid crystal displays* (LCDs) begin. The word pixel stands for "picture element," which describes the technology succinctly—a picture is formed by turning individual pixels on or off across the width and height of the display, in the same manner as your computer screen. The use of pixel displays increases flexibility and user-friendliness; the same display can be programmed to show different pages, each with different data and different legends.

Low-end LCDs are generally monochrome—either black-and-white or black-and-green—and have fairly coarse resolutions (pixels per inch of display width or height). That means they are useful in displaying alphanumeric text, but are too coarse to paint a picture.

High-end LCDs are generally full-color and have a fine enough resolution to paint a picture simulating, say, the faces of typical steam-gauge instruments. They also employ *thin film transistor* (TFT) technology—sometimes also referred to as *active matrix*—that results in high resolutions with bright pixels.

A word about readability in sunlight or at night is in order. Typical LCD displays come in three varieties: *reflective, transmissive,* and *trans-reflective.*

The displays on most laptop computers are transmissive; a fluorescent backlight behind the display illuminates the picture from behind. Transmissive TFT displays are great indoors and at night, but they tend to fade out in direct sunlight.

On the other hand, reflective displays actually show more contrast in direct sunlight. However, since the back of the display is opaque, night use requires front lighting, which is often not uniform across the face of the display.

But not to worry, the new kids on the block are trans-reflective, meaning they combine the best of both worlds. Trans-reflective displays are reflective in nature, but also have a backlight. As might be expected, they are also the most expensive.

## OTHER CONSIDERATIONS

This list is by no means exhaustive, but here are some other questions you might want to consider in selecting an EIS:

• What is the price of the system including all transducers you need? Low-end systems come in at $500 to $1,000, mid-level systems are $1,000 to $2,000, and high-end systems are above $2,000.

• How long has the company been in business producing EIS? How many systems has it delivered? What is its warranty/repair history?

• How good is the documentation? You will have to install the system,

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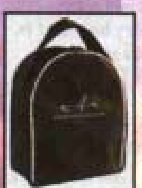

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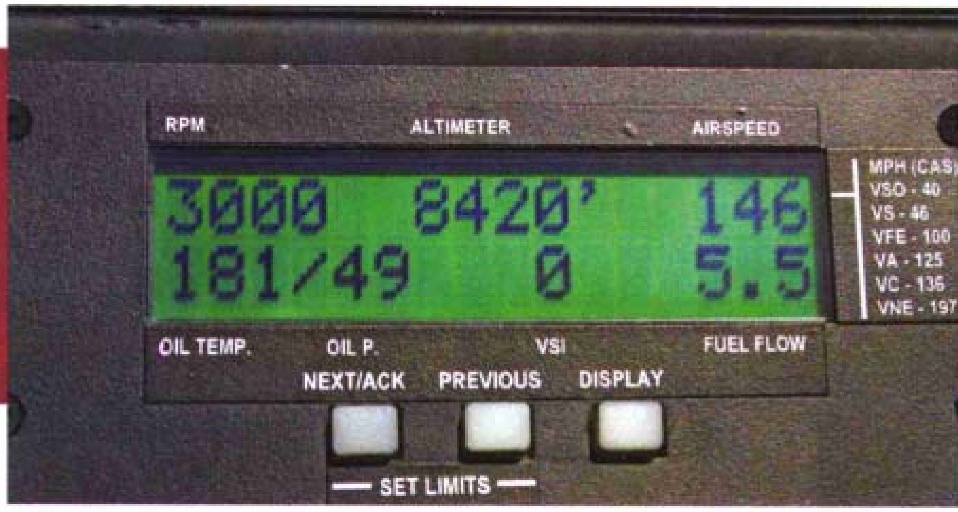


Kerry Forss personalized his Grand Rapids Technologies EIS, set the limits for his aircraft within the unit itself, and listed some of the aircraft's limits on the faceplate of the unit as well.

set it up, perform whatever calibration is required, and troubleshoot it if something goes wrong. Is the documentation user-friendly?

- How easy is the setup? Does it require connecting a computer? If not, are the on-screen setup commands easy to understand and use? Some high-end units allow you to simply select an engine model, which automatically sets up all your alarm limits for rpm, oil temp, and oil pressure, while others require manual input.

- How are software updates released and loaded into the unit?

- How robust is the hardware/software to shock, vibration, temperature, voltage spikes, lightning, and electromagnetic fields? I recently heard of a problem in which a certain Subaru electronic ignition system malfunctioned when the aircraft was flown in the vicinity of a large, high-powered radio station antenna.

- What fail-safe measures are in place to assure that an EIS failure will not cause an engine failure?

- Are pre-manufactured wiring harnesses provided, or must you build your own?


A typical resistive pressure transducer manufactured by Siemens VDO in Germany and sold with FAA-Parts Manufacturer Approval (PMA) by Mitchell Aircraft Products.

Cylinder head temperature transducer on a Rotax 912ULS, the non-certified version of its 100-hp engine.

• How intuitive are the controls and displays? Can you envision understanding what you are looking at and switching display pages during a busy time in the cockpit?

• What automatic real-time data analysis is provided? For instance, how does the system help you in leaning the mixture?

• Is the backlight or front lighting dimmable for use at night?

• Does the unit record engine data for later download and analysis? Does it have a USB port, or must you program a serial port connection? Is the downloaded data in comma-separated values (CSV) or other standard format that can be easily imported into a spreadsheet, or must you do custom programming or use a conversion program?

Engine information systems have become mainstream and are poised to largely supplant steam gauges. When you choose an EIS for your aircraft, consider your needs and your budget, then study the available units to find the one that is just right. We hope this introduction will allow you to begin that process with a little more knowledge under your belt.


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