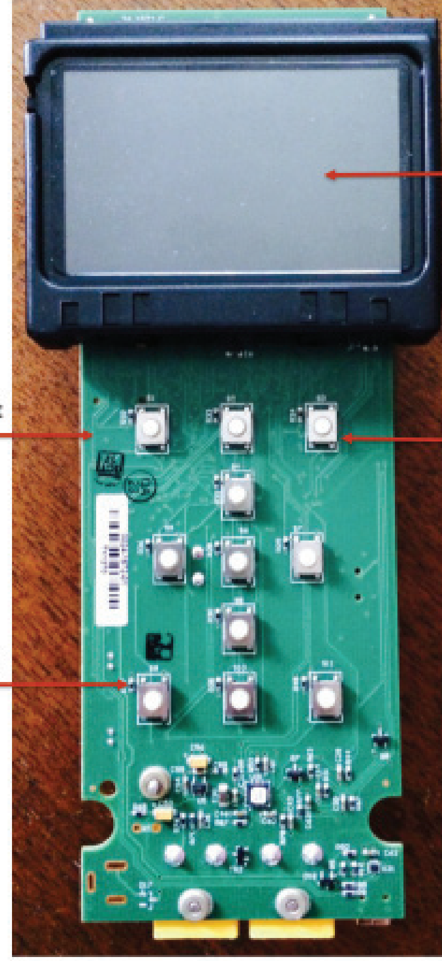
tools

Anatomy of an Analyzer



It's an odd relationship we have with technology. We regard each new invention with the awe it deserves, and then somewhere along the line we begin to regard the miracle as something normal, and we take it for granted. But every now and then, I like to stop and truly appreciate our amazing tools, and to consider what they do for us.

Take the common modern combustion analyzer. I'm old enough to have done my first combustion tests using reagent tubes, printed charts, a calculator, and some guess work. When I first got my hands on electronic combustion testing equipment, I was suitably wowed. But I soon forgot about the miracle taking place inside the case in my hands. I went about my work, though I did so with new speed and accuracy thanks to all the hard-working engineers who had designed and built my new instrument. I was working with a miracle in action, and the world was a better place for it.

Like any good technologist, I like to look inside gadgets to see how they work. So here I present the inside story of the Bacharach Fyrite Insight Plus, a full-fledged modern combustion analyzer. I asked Bill Spohn of TruTech Tools to give us a tour of this amazing instrument. Bill is a former development engineer for Bacharach, Inc., and one of the most talented scientists I know. These are his observations. -- Chris Dorsi

Front of Board

LCD Display

This Backlit color LCD display accepts signals from the display controller chip to deliver information in a variety of alphanumeric and graphic formats, streaming critical data into useful info. Costs on these displays have plummeted and quality and performance continues to rise as the consumer electronics market increase the volume and demands on display manufacturers. Your instruments benefit from consumer trends!

Micro Switches (11 count)

Here's where you communicate with the machine! The positive tactile and audio feedback (CLICK!) helps you to confirm that you made the right button choice. Robots in test labs actuate these switches for millions of cycles to be sure they'll work for years.

Surface Mount Components

This tiny black rectangle is one of dozens of surface mount resistors, capacitors, diodes, transistors and integrated circuits strategically placed around the PC board. While robotized machines with machine vision routinely pick and place these "surface mount" components on the Printed Circuit Board

(PCB) in the manufacturing process, a layer of silk-screen labeling is added for locating components for human testing, troubleshooting and service. The labeling is straightforward: R for resistor, S for switch, C for capacitor, D for diode, T for transistor, but U means integrated circuit (which is a combo of Ts and Ds). Surface mounting of components (vs. multiple "through holes" (for components with "leads" or legs to connect circuit traces)) further increases the available component density, making the products you use more compact and reliable.

Multilayer Printed Circuit Board

You are only seeing a small fraction of the interconnections on the two surfaces of a printed circuit board. These tiny and shiny copper traces carry the electric current from point to point, circuit to circuit and component to component making the instrument "sing" for you! Many circuit boards will have 12 or more layers of copper traces to route the electrons. Wherever you see a hole in the board, it's a location for an "interconnect" between layers. Some components require shielding from electromagnetic interference (radio waves). So one of the board layers in a typical 12-decker sandwich may be entirely copper to provide an "umbrella" of protection from interference.

Back of Board

IR Printer LED

This tiny LED (light emitting diode) operates in the Infrared Spectrum sending out prescribed pulses of IR light, which are received as a data stream by a wireless printer. This data stream is then converted into the information that is printed out on the printer. Starting in the late 1980's the original printers used by test instrument manufacturers were made by Hewlett-Packard (HP) and sold mainly for advanced calculators of that era. These printers used a communication protocol appropriately named "RedEye".

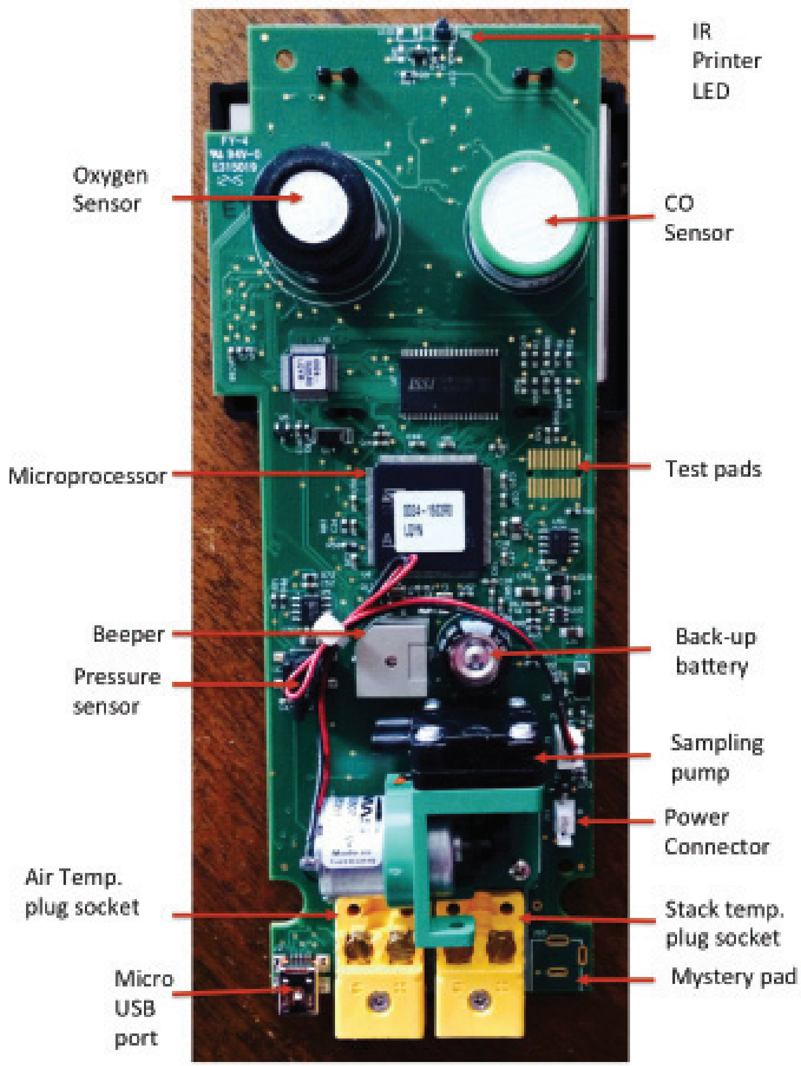
CO Sensor

The carbon monoxide (CO) sensor is a miniature lab test that is constantly primed (with a wet or gelled electrolyte) and ready to react with any CO gas molecules that permeate the hydrophobic (water-proof) membrane. Two of the electrodes (all of which connect to the outside world and PCB circuits via plug in pins) create the potential for the reaction to take place. One of these electrodes is made of expensive platinum, a catalytic metal to CO (it catalyzes the oxidation of CO to CO2). The third, or counter electrode actually intercepts electrons that are released when CO is converted to CO2. Through the connection pin to a circuit on the PCB, intercepted electrons are actually counted to determine concentration and read out as Parts per Million (PPM) on the instrument display.

Test Pads

Once the PC Boards are built, and at multiple times before they leave the factory, several series of tests are conducted on components and their function. These test pads allow one quick and convenient location to "hook up", apply power and see how the board tests out.

(con't page 38)



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Back-up Battery
A long life battery permanently connected to the PC Board provides enough juice to back up important product configuration and test data.

Sampling Pump
The tiny motor cranks away on this diaphragm pump pulling thousands of little gulps of air per minute to create a flow rate of 0.03 CFM, plenty of gas flow to get the sensors sensing!

Power Connector
Here's the hook-up where we bring power from the battery bay onto the board to light it up and bring your analyzer to life.

Stack Temperature Plug Socket
Here's where you plug in the two prongs of the K-Type Thermocouple whose tip is immersed in the hot stack gases. Two dissimilar metals (tightly controlled alloys of Chromel and Alumel) and welded together at the sensing tip of the thermocouple and create a voltage across the plug that has a known correlation to the actual temperature at the tip.

Mystery Pad
Lots of things happen in the product development cycle. Sometimes a seriously considered feature never makes it into production. Or an alternate model shares the same PC Board. Or a future feature will be rolled out. You just never know!

Micro-USB port
A two-way street for bringing data into and out of the analyzer. Many models allow for firmware updates through this port. Firmware is the operating software that the analyzer uses to do what it does so well. Firmware updates, added after you own the analyzer, breathe new life and functionality into your product, usually at a low or no cost!

Air Temperature Plug Socket
Same deal here as the Stack Temperature socket/probe, except this channel is normally used for ambient air temperature.

CONNECT

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Pressure Sensor
A tiny strain gauge (like a semi-conductor diaphragm) is pushed or pulled by the air or gas pressures from the connecting tubes to generate a change in resistance, which is measured by circuitry on the PC board, and translated into pressure in inches of water column (IWC), Pascals, or any other unit of measure programmed into the microprocessor. Originally the consumer automotive industry spurred the development of the digital pressure sensor to provide manifold air pressure (MAP) sensors for improving automotive mileage and emissions.

Beeper
A simple little sounder to alert you to instrument functions. One might think it could be smaller in today's age of miniaturization, but the physics of sound waves dictate how small the device can be and still produce adequate sound at a reasonable volume and cost.

Microprocessor
This is where all the magic happens! Signals from the sensors, buttons that are pushed, and associated components all feed into here. Data is deciphered and calculations are made, then data gets routed, massaged, stored, transmitted and pushed up to the display in alpha-numeric and graphical displays – all in a fraction of a second!

O2 Sensor
The Oxygen sensor operates like a fuel cell: a current is generated by the consumption of oxygen between two electrodes, so essentially it is a battery! (think of zinc-air hearing aid batteries.) That current is sensed across the pins coming from the sensor body. One of these electrodes is made of expensive gold or platinum. The other is usually made of lead! The voltage difference between the two pins is measured by a circuit on the board to determine concentration and read out on the instrument display as percent (%) of oxygen by volume.

TruTechTools