Electronics News

Products and tips for electronics professionals

Volume 1, Number 1

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Products and tips for electronics professionals

Volume 1, Number 1

Feature

- 3 World's telecommunications network relies on razor-accurate test tools
- 4 Find hidden ac problems with true-rms
- 6 So you need a DMM? Which one do you pick?
- 8 Non-contact temperature measurements using of **IR** thermometers
- **10** Test tool accuracy more than critical to Fike



Products

- 2 ScopeMeter[®] 190C Series
- **4** Smart meters for the most demanding users
- 6 Fluke digital multimeters
- 8 Industrial thermometers
- 10 Fluke accessories

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The best view of problem-solving in the field

ScopeMeter[®] **190C** Series

The best view of problem-solving in the field

The new ScopeMeter® 190C Series with large, high-resolution, color screen and new Digital Persistence mode gives you an even better view of complex waveforms in the most demanding troubleshooting applications in the field. In addition to the impressive capabilities of the 190 Series, the new color models offer:

- Color for easy identification of individual waveforms
- Full-size, high-resolution screen for revealing more signal detail Digital Persistence for analyzing complex dynamic waveforms like on an analog scope
- Fast display update rate for seeing dynamic behavior instantaneously
- Stop-on-Trigger in ScopeRecord[™] mode for storing and analyzing pre-trigger waveform data
- Waveform reference for visual comparisons Vpwm function for motor drive and frequency
- inverter applications And all the high performance scope specifications
- of the Fluke 190 Series ScopeMeter apply: Up to 200 MHz bandwidth
- Up to 2.5 GS/s real time sampling
- Isolated inputs (1000 V CAT II/600 V CAT III)
- · 4 hours battery operation

Test drive this product before you buy at www.fluke.com/electronic



Automatic capture and replay of 100 screens

Connect-

captures

even the

complex

most

signal

See

dynamic signal

behavior

instantaneously

Deep memory for highresolution Scope-Record



FlukeView[®] software adds PC power to your Fluke 190C, 190, 123 or 90 B Series **Industrial ScopeMeter**

FlukeView software helps you get more out of your ScopeMeter by:

DOCUMENTING: Transfer screens, waveforms, and measurement data from the ScopeMeter to your PC for printing, or importing data to other programs.

ARCHIVING: Store and retrieve waveforms with text annotations and create your own library for easy reference and comparison

ANALYSIS: Gather valuable measurement data and enable cursor measurements to reveal relationships and conditions. Extended recording of up to four user-selected measurements help you monitor and analyze slow moving signals and related events. Upload waveforms to the PC and use cursors for detailed measurements. Perform waveform analysis, including analyzing harmonics.









aking sure the world's telecommunications networks operate at peak efficiency is no small task, with almost a billion telephone lines stretched across the globe from Alaska to Zanzibar. Today's phone lines carry more information than they were ever intended to hold, as data streams now sandwich between voice communications to take advantage of every drop of bandwidth available. Yet the demand for more – more lines, more services, more capacity – continues to explode. Enter Teradyne Corporation.

World's telecommunications network relies on razor-accurate test tools

Teradyne's Broadband Test Division qualifies and tests broadband services, working with telecommunications service providers to maintain installed telephone networks, perform routine maintenance and diagnostics, and pre-qualify lines for additional levels of broadband service.

In addition, Teradyne can locate the source of a line problem. "Our system can tell whether the fault is on the customer's premises, somewhere between the central office and the customer's premises, or in the central office itself."

In the "noisy" environment of a central office, even the best equipment can pick up spikes and electrical noise. "You've got hubs, you've got routers, you've got providers that co-locate their equipment in the central office," Weadick said. "There is the huge bank of batteries that the central office uses to provide electricity to the phone lines, in a massive battery room. There's a generator that kicks on periodically. There are all kinds of noise, spikes and signals that can be coupled into our equipment or anyone else's."

When Weadick encountered a noise problem during product development in just such an environment, he turned detective. He set about to chart and monitor the effect of the electrical spikes on the new product's performance. Using a ScopeMeter test tool from Fluke Corporation, a test tool that essentially combines a highpowered digital multimeter and oscilloscope in one handheld instrument, Weadick was able to automatically capture and record the duration and frequency of waveforms in the field and then download them to his PC for comparison and analysis.

"I didn't know if the situation I was seeing was tied to something related to the central office or if it was related to the specific hardware we were developing," Weadick said. "We use electromechanical switching relays in our equipment to enable various measurements. We generate signals and send them down the line under test. We also receive those signals back, perform signal analysis and then characterize the line condition. My analysis ended up identifying the effect of ambient noise on our product.

"Using the ScopeMeter test tool and my PC, I could bring multiple waveforms into one window on my PC and save that group as one individual file," he said. "Then I could go capture another group of waveforms in another window and save that to reflect whatever category I had changed."

To Weadick, the handheld ScopeMeter test tool's portability offered a particular advantage.

"I was working between two locations," Weadick said. "Portability was important, as was battery power. If I didn't have a laptop handy, I could just disconnect the meter, have it working on battery power, return to my desk and unload everything into my PC."

Weadick's persistence paid off. He tracked down the subtle noise source and solved the problem.

In a world run by the communications that course through the world's telephone lines, the determination it takes to solve such a complex noise problem is a bottom line benefit difficult to overemphasize. "It means better products introduced to market and greater efficiency on the job," Weadick said. "And that cascades right down to the bank."

For the entire article, visit our web site at www.fluke.com/electronic

Find more articles on the *Fluke Electronics News* web site.

"Taming the variable speed drive" www.fluke.com/electronic

"Pulse width triggering with the ScopeMeter 190C" www.fluke.com/electronic

Smart meters for the most demanding users



Find hidden ac problems with **true-rms**

easuring ac signals accurately is a fundamental, but increasingly difficult job in today's offices and industrial plants. Personal computers, electronic lighting, and adjustable speed drives controlling the air handling equipment in large office buildings are just a few examples of types of non-linear loads; loads that draw current in abrupt pulses rather than in a smooth, sinusoidal manner. These pulses cause distorted current wave shapes that in turn cause harmonic currents to flow back into other parts of the power system.

Symptoms of harmonics usually show up in the power distribution equipment that supports the nonlinear loads, whether single-phase or three-phase. Single-phase non-linear loads are prevalent in offices, while three-phase loads are widespread in industrial plants. The details of the effect of harmonics on different types of electrical systems vary, but common problems include transformers that overheat, even when supplying normal loads; circuit breakers that trip for no apparent reason; or neutral conductors in balanced circuits that overheat from excessive loads. Yet when measured, standard troubleshooting procedures show everything to be normal.

What's happening?

The reality is, harmonics and other types of distorted waveforms cause the readings of conventional electrical measurement tools - the majority of those on the market today - to be significantly inaccurate. When confronted with these more complicated conditions, average-responding meters can give incorrect readings that may be off by as much as 50 percent. That's because averageresponding meters are designed to provide correct readings for pure sine waves only. They typically will read low when confronted with a distorted current waveform.

Enter true-rms.

Today's more complicated signal measurements require the right tools. That's why Fluke Corporation designed its 170 Series Digital Multimeters (DMMs) with true-rms (root mean square) capabilities. True-rms meters give correct readings for any wave shape within the instrument's crest factor and bandwidth specifications.

True-rms meters eliminate the risk of these incorrect measurements. A true-rms meter uses an electronic measurement technique to provide the user with the correct effective value of an ac current, whether the signal's waveform is a perfect sine wave or the short-pulse distorted waveforms frequently encountered on the job today.

Electrical and electronic equipment will only get more complicated. To track down the hidden problems that plague such systems, technicians must first make an accurate measurement by reaching for the correct tool for each measurement task. In more and more cases today, that task requires true-rms capabilities.

True-rms is available on Fluke Corporation's 110, 170 and 180 Series Digital Multimeters and their 335, 336 and 337 Clamp Meters.

For the entire article, visit our web site at www.fluke.com/electronic



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Electronics

"Power quality at the

www.fluke.com/electronic

"ABCs of DMM safety,

Cat IV can really mess

up your DMM. Worse

www.fluke.com/electronic

yet, it can kill you."

web site.

service panel"

News

Fluke 189 Digital Multimeter – Smart meters for the most demanding users.

Check out the features and you'll see we've enhanced the performance beyond any other handheld meter on the planet. Like faster readings. Extended ranges. Lower dc volts. Dual displays. Broader capacitance range. The ability to download data to your PC. And a lot more. No wonder more people prefer Fluke meters over any other brand. Anywhere. So make a smart move. Discover the world's smartest meter — the Fluke 180 Series.

- 50,000-count resolution with instant readings for detailed analyses (0.001 mV, 0.01 mA, 0.01 Ω)
- Multiple reading display with bargraph and two-level backlight
- 0.025 % basic dc accuracy
- True-rms ac, ac and dc
- 100 kHz ac bandwidth for troubleshooting modern electronics
- Two separate internal memories. One for logging up to 995 readings automatically at user selectable intervals and one for 100 manually saved measurements.

CATIV 600 V, CAT III 1000 V

Test drive this product before you buy at www.fluke.com/electronic





FlukeView[®] Forms documentation and analysis software

FlukeView[®] Forms Documenting Software is the easy way to document, store and analyze measurements from your Fluke Digital Multimeter. Use it with:



- Fluke 180 Series Digital Multimeters (Model FVF-SC2)
- Fluke 87-IV & 89-IV Digital Multimeters (Model FVF-SC1)
- Fluke 53-II & 54-II Thermometers (Model FVF-SCI)
- Fluke 45 Bench Meter (Model FVF-SC3)

Now you can get the professional looking documents you need and data analysis that is much more in-depth than from a meter alone. FlukeView Forms records, charts and graphs data to help you perform in-depth analysis.

FlukeView Forms comes with both standard and customizable forms. You can use them immediately or customize the format to fit your specific applications. Once your form is customized, it can be easily used by less experienced staff.

Fluke digital multimeters -Rugged. Reliable. Accurate.

ABCs of DMMs multimeter basics explained



ultimeters. They've been described as the tape measure of the new millen-

nium as electrical and electronic circuitry seems to permeate our world. With its ability to measure electricity, the digital multimeter (DMM) has become indispensable. And while they all measure volts, ohms, and amperes, there are dramatic differences in their capabilities which affect how they should be used. Below is a brief description of the basic specifications you need to understand to use a DMM effectively and safely.

Resolution, digits and counts

Resolution refers to how fine a measurement a meter can make. By knowing the resolution of a meter, you can determine if it is possible to see a small change in the measured signal. For example, if the DMM has a resolution of 1 mV on the 4 V range, it is possible to see a change of 1 mV (1/1000 of a volt) while reading 1 V.

The terms digits and counts are used to describe a meter's resolution. DMMs are grouped by the number of counts or digits they display. A 3 1/2-digit meter can display three full digits ranging from 0 to 9, (continued on next page)

1000

Fluke 179 **Digital Multimeter**

Tough meters for industrial professionals

Designed tough to withstand the harshest work environments, and are accurate enough to rival most bench meters.

- 6000 count display provides better resolution 0.09 % basic dc accuracy zeros in on tight readings
- True-rms ac voltage and current measurement for accurate readings on all waveforms
- Frequency, capacitance and resistance
- Auto and manual hold
- Min/max/average records irregular activity
- CAT IV 600 V, CAT III 1000 V

Test drive this product before you buy at www.fluke.com/electronic

Fluke 112 **Digital Multimeter**

Compact meters for easy use.

Compact digital multimeter with a wide range of functions for general purpose measurements

- · 6000-count display provides improved resolution
- 0.7 % basic dc accuracy
- · True-rms ac voltage and current measurement for accurate
- readings on all waveforms · Frequency, capacitance and resistance capabilities
- Min/max/Average captures irregular activity
- · Backlight illuminates the display in dark workspaces CAT III 600 V

Test drive this product before you buy at www.fluke.com/electronic

Fluke 80 Series III Analog/Digital Multimeters

High-performance meters for demanding electronic and industrial applications

Fluke's 80 Series III DMMs provide 11 functions for electronic and industrial applications including high-performance dc/ac voltage and current measurement, frequency, duty cycle, resistance, conductance, continuity, diode test and capacitance measurement.



- 4-1/2 digit mode, 20,000-count display (Fluke 87, 87/E only)
- 0.05 % basic dc accuracy
- True-rms measurements (Fluke 85, 87 and 87/E only)

CAT III 1000 V



bench meters you can count on.

- The Fluke 45 is a feature rich meter for your bench or test system. 5 digit, 10,000 count
- 0.025 % basic dc accuracy
- 16 different measurement capabilities





(continued from previous page)

until you exceed 320 volts.

and one "half" digit which displays only a 1 or is left blank. A 3 1/2-digit meter will display up to 1,999 counts of resolution. A 4 1/2-digit meter can display up to 19,999 counts of resolution.

It is more precise to describe a meter by counts of resolution than by digits. Today's 3 1/2-digit meters may have enhanced resolution of up to 3,200, 4,000, or 6,000 counts.

For certain measurements, 3,200-count meters offer better resolution. For example, a 1,999count meter won't be able to measure down to a tenth of a volt if you are measuring 200 volts or more. However, a 3,200count meter will display a tenth of a volt up to 320 volts. This is the same resolution as a more expensive 20,000-count meter

Accuracy

Accuracy is the largest allowable error that will occur under specific operating conditions. In other words, it is an indication of how close the DMM's displayed measurement is to the actual value of the signal being measured.

Accuracy for a DMM is usually expressed as a percent of reading. An accuracy of one percent of reading means that for a displayed reading of 100 volts, the actual value of the voltage could be anywhere between 99 volts and 101 volts.

Specifications may also include a range of digits added to the basic accuracy specification. This indicates how many counts the digit to the extreme right of the display may vary. So the preceding accuracy example might be stated as \pm (1 % + 2). Therefore, for a display reading of 100 volts, the actual voltage would be between 98.8 volts and 101.2 volts.

Analog meter specifications are determined by the error at full scale, not at the displayed reading. Typical accuracy for an analog meter is ± 2 % or ± 3 % of full scale. At one-tenth of full scale, these become 20 percent or 30 percent of reading. Typical basic accuracy for a DMM is between \pm (0.7 % + 1) and \pm (0.1 % + 1) of reading, or better.

Ohm's Law

Voltage, current, and resistance in any electrical circuit can be calculated by using Ohm's Law, which states that voltage equals current times resistance. Thus, if any two values in the formula are known, the third can be determined. A DMM makes use of Ohm's Law to directly measure and display ohms, amps, or volts.

Digital and analog displays

For high accuracy and resolution, the digital display excels, displaying three or more digits for each measurement. The analog needle display is less accurate and has lower effective resolution because you have to estimate values between the lines. A bar graph shows changes and trends in a signal just like an analog needle, but is more durable and less prone to damage.

For the entire article, visit our web site at www.fluke.com/electronic



Non-contact temperature measurements **using IR thermometers**

nfrared (IR) thermometers allow non-contact measurement of surface temperatures by analyzing the invisible, infrared spectrum emitted from an object. IR devices, like the Fluke 61 and 65 thermometers, make it safe to take surface temperature measurements of items like rotating, hard-to-reach, electrically live, or dangerously hot targets. For preventative maintenance tasks, they cut measurement time to almost zero with the ability to take a surface temperature reading in less than one second.

IR thermometers can be used to conduct thousands of different temperature measurements, including:

- Electrical
- Preventive maintenance
- HVAC
- Steam
- Food processing
- Fast test of multiple targets

Proper use of IR technology

Although IR temperature measurement will never be quite as accurate as a calibrated contact temperature device, a typical reading will be within 2 °F of the actual temperature when the instrument is properly applied. For scanning applications like those mentioned above that do not require precise measurement, this level of accuracy is more than adequate.

Putting IR technology to use is easy, but there are two critical



parameters that must be understood to ensure proper and consistent temperature measurements with infrared type devices:

- Optical resolution
- Emissivity

Optical resolution

Optical resolution refers to the sample area the IR meter is measuring at a given distance. Optical resolution is also referred to as the "distance-to-spot-size ratio" or "field-of-view."

Know your application! A device with a 4:1 optical resolution cannot effectively be used to measure the temperature of an object 15 feet away – even if the laser beam sight projects that far.

Try to determine how you are going to apply the IR thermometer before purchasing, and then buy a tool that provides the appropriate optical resolution for the application. Many erroneous readings are taken because the technician unknowingly samples a larger area than the object he is trying to measure.

Emissivity

Emissivity indicates the ability of an object to emit infrared energy. Emissivity is determined by the material from which the object is constructed and its surface finish. Values can range from less than 0.1 for a highly reflective body like polished metal to 1.0 for an ideal black body.

In simple terms, emissivity can be likened to the reflectivity - or shininess - of an object. Items such as soft-drawn copper are very smooth and shiny even under a microscope, while other objects such as lacquer paint appear quite porous under the microscope. The porous object will have a relatively high emissivity (typically 0.7 to 0.98), while new soft-drawn copper (shiny, not oxidized) will have a low emissivity (typically below 0.2). Shiny objects reflect IR energy from objects surrounding them, which dilutes the IR energy from the measured object. A porous body tends to absorb surrounding IR energy, thus emitting its IR energy without dilution (like a black body).

Low-cost IR measurement instruments (under \$400) are typically fixed at 0.95 emissivity (the Fluke 61 and 65 are set to measure 0.95 emissivity). To get an effective absolute temperature (continued on next page)



Temperature solutions



(continued from previous page)

reading, the surface being measured must have an emissivity close to 0.95. In other words, measuring a surface that is not highly reflective will provide an accurate reading. For shiny surfaces, use a coat of black paint, electrical tape, or magic marker to reduce reflection! If a 0.95 fixed emissivity IR instrument is used to measure an object that is not close to 0.95, the reading will be incorrect as follows:

• If the measured object is warmer than ambient temperature, the reading will be erroneously lower than the actual temperature

• If the measured object is colder than ambient temperature, then the reading will be erroneously higher than the actual temperature.

For the entire article, visit our web site at www.fluke.com/electronic

Fluke 61 IR Thermometer

Easy to use

- Quick non-contact temperature measurements from -18 to 275 °C (0 to 525 °F)
- 0.2 °C or 0.5 °F resolution

Best IR accuracy

•

is greater

from -40 to 500 °C (-40 to 932 °F)

• Laser-sighted; 8:1 optical resolution

Repeatability of $\pm 1^{\circ}$ or ± 1 %, whichever

- Backlight illuminates the display in the dark
- · Laser-sighted; 8:1 optical resolution



Fluke 50 Series II **Digital Thermometers**

- Large backlit dual display
- Min, max and avg with time references captures major events
- · Supports a wide range of thermocouple types
- Powerful data logging capabilities on the Fluke 53 and 54 allow the user to log up to 500 points of data.

VR101S Voltage Event Recorder System

- Records up to 4000 sags, swells, transients, outages and frequency variations on line voltage at receptacles
- Includes a compact VR101 event recorder, an optical interface cable, and EventView[™] software that turns your PC into a power quality reporting tool.

CAT III 300 V





10

965



o Rick Reade, of Fike Corporation, an eternity is measured in milliseconds. Fike, of Blue Springs, Missouri, designs and manufactures systems that protect against fires and explosions in business and industry worldwide. From fire protection for telecommunications facilities,

Get more with Fluke accessories

enough electricity to fire the circuit." Continual testing is an integral part of any suppression system once it's installed, as well. Regulations require that certified technicians completely test a protection system every 90 days.

Reade's job is to provide training to those who will operate and maintain these suppression systems once they're on the job. Because of its specialized nature - and the lifeor-death responsibility that rides on its accuracy - Fike provides each certified technician with a Fike toolkit.

Test tool accuracy more than critical to explosion suppression company

hotels, convention centers and electronic switching stations to explosion protection for chemical and petrochemical, food and pharmaceutical manufacturing plants, textile and paper mills, Fike's critical life-safety systems require the highest degree of reliability.

Dust, gas and assorted components found in manufacturing environments can create a potentially hazardous environment before you realize it. Fike's Explosion Protection Group specializes in combustion testing and designing on-site systems that detect and eliminate fires and explosions, even as they're developing. Even though they may appear instantaneous, explosions actually take varying times to develop to damaging proportions - time measured in milliseconds (.001 sec.) and microseconds (.000,001 sec.).

With electronics that make a hair trigger seem downright slow, a Fike system at work can respond 800 times in the time it takes a human to blink once, shutting down a fire or explosion before it gains enough heat or explosive capacity to do much damage.

Fike systems are tested all along the manufacturing route, from order to installation and beyond. "We test every aspect of the system," Reade says. "Wiring resistance, output circuits, how long it takes to put out Typically technicians who go through the training have varying backgrounds, requiring Reade to develop training manuals and tool kits that are both thorough and easy to understand. Fike's curriculum, while stringent, is specifically designed to allow someone with no scientific or little mechanical training to use the full capability of each tool in ways that provide the exactness required by the sophisticated electronics.

An integral part of the Fike operations and its training tool kit is a Fluke ScopeMeter test tool. The ScopeMeter test tool combines a powerful oscilloscope, a digital multimeter and a paperless recorder in one compact, handheld test tool, and its new 190C Series adds a full-color display and even faster waveform update rates. The ScopeMeter 190 and 190C provide the hair-trigger measurements Fike production systems demand with a portability and ease of use that Reade's on-the-job technicians require.

Since Fike tests each of its systems throughout production, before giving final sign-off, after installation and routinely after that, the ScopeMeter test tool gets a good workout. "We use the ScopeMeter for many tests," Reade said. "In one, we use the ScopeMeter as a stopwatch. We hook

ToolPak

The meter hanging solution

- Kit includes, universal hanger clips (2), hook & loop straps (2 lengths), adapter
- and strong magnet Combine components to
- meet most hanging needs
 - Attaches to back of many Fluke meters, including 110, 170, 180 Series, 80 Series IV DMMs, 725 Process Calibrator, 70 Series III DMMs and 50 Series II Digital Thermometers.

LockPak

The meter locking solution

- Kit includes a locking accessory
- Attaches to back of a 80 Series IV and 180 Series meters or a Fluke 725 Process Calibrator to help deter theft
- Accepts most common locks (not included)



it to the input side of our main electronics controller and trigger the system. We check to see how long it takes the control panel to receive the signal to set off the pressure relief devices."

Calibrating a protection system that must respond in fractions of a second requires the next generation of test tools and a way of constructing a training system that leaves no room for error. By pre-packaging the curriculum and test tool kit, Fike ensures everyone who goes through Reade's program is ready to join him in an environment where the blink of an eye is way too slow.

For the entire article, visit our web site at www.fluke.com/electronic



H900 Test Lead Holder

- · Heavy duty construction with mounting holes
- 10 slots for wires up to 0.320" dia • Overall dimensions:
- 11" L x 3.5" W x 1.25" H



TL940 Multistacking Banana Plug to Mini-Hook

- Mini-Hooks attach to component
- leads up to 0.060" dia. • 36" PVC insulated leads
- 30 V rms, 60 V dc, 5 A



BP980 Double Banana Plug Kit

- 5 pair (red/black) double banana plugs
- Brass plug/jack, beryllium copper spring, nickel plated finish
- 30 V rms, 60 V dc, 15 A



TL935 Patch Cord Kit (3 pair)

- 24", 36" and 48" multi-stacking banana plug patch cords
- Banana plugs have nickel-plated finish
 - 30 V rms, 60 V dc, 15 A



TL970 Hook and Pincer Kit

· Handy all-in-one kit Includes TL940, TL950, TL960



TL932 36" Patch Cords (1 pair)

- 36" multi-stacking banana
- plug patch cords • Banana plugs have
- nickel-plated finish
- 30 V rms, 60 V dc, 15 A



TL960 Multistacking Banana Plug to Micro-Hook

leads up to 0.040" dia

• 36" PVC insulated leads

• 30 V rms, 60 V dc, 3 A

· Micro-Hooks attach to component



- **TL930 24" Patch Cords** (1 pair)
- 24" multi-stacking banana plug patch cords
- Banana plugs have nickel-plated finish
- 30 V rms, 60 V dc, 15 A



TL950 Multistacking Banana **Plug Mini-Pincer**

- Mini-Pincers open to 0.090"
- 36" PVC insulated leads
- 30 V rms, 60 V dc, 5 A



TP920 Test Probe Adapter Kit

- IC Test Tip Adapters, Extended Tips, Medium Alligator Clips fit over TL71 and TL75 test lead sets
- IC Test Tip Adapter, 3 A
- Extended Probe Tip, 3 A
- Med. Alligator Clip, 5 A
- CAT II, 300 V





Harley[®] contest winner!

Palmer Thornton, of Sawdy Electric in Palmetto, Florida is the winner of the Fluke's "Take a Test Drive Sweepstakes." Palmer has been an electrician since 1981. Sawdy Electric is a two person firm specializing in residential and light commercial electrical work. Palmer entered the sweepstakes at Rexel Consolidated in Bradenton, Florida. His Rexel salesperson was John Fox.



See more, fix more with ScopeMeter® test tools

ScopeMeter[®] 199C See more, fix more – with color!

THE NEW SCOPEMETER 190C SERIES with large, high-resolution color screep and new Digital Persistence mode

high-resolution, color screen and new Digital Persistence mode gives you an even better view of complex waveforms in the most demanding troubleshooting applications in the field.

- Up to 200 MHz bandwidth
- Up to 2.5 GS/s real-time sampling rate
- Connect-and-View[™] triggering for an instant stable waveform
- Automatic capture and replay of last 100 screens
- Isolated Inputs (1,000 V CAT II/ 600 V CAT III)
- 4-hour battery operation



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ENTER TO WIN a Casio handheld 2.5" color television



See details on business reply card inside or sign up at www.fluke.com/subscribe Fluke Corporation PO Box 9090 Everett, WA 98206-9090 USA



ScopeMeter 123

- Dual input 20 MHz digital oscilloscope
- Two 5,000 count true-rms digital multimeters
- Dual input TrendPlot[™] recorder
- Connect-and-View trigger simplicity for hands-off operation



