



Solar Measurement Webinar

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TEquipment.NET

- Aerospace / Aviation
- Commercial
- Contractors
- Educational
- Electrical / Electronic
- Government
- HVAC
- Industrial
- Manufacturing
- Military
- Petrochemical
- Pharmaceutical
- Power / Utility
- R & D
- Semiconductor
- University

And much more...

- Audio
- Battery
- Boroscopes
- Calibrators
- Combustion Analyzers
- Current
- Data Loggers
- Environmental Meters
- Energy
- Fiber Optic Testing and Certification
- Function Generators
- Gas Analyzers
- Ground Resistance
- Hart Communicators
- Hi Pot Testers / Insulation Testers
- Humidity
- Light
- Multimeters, Analog, Digital, Clamp-On
- Network Testing and Certification
- Oscilloscopes
- Power / Power Quality
- Power Supplies
- Pressure
- Programmers
- Refrigeration
- RF Generators
- Signal Generators
- Solar Analyzers
- Soldering
- Sound Level
- Spectrophotometry
- Spectrum Analyzers
- Tachometers / Stroboscopes
- Thermal Imaging Cameras
- Temperature
- Vibration
- Voltage

Next Generation Websites

- First for Test & Measurement retail websites. Q4 2013

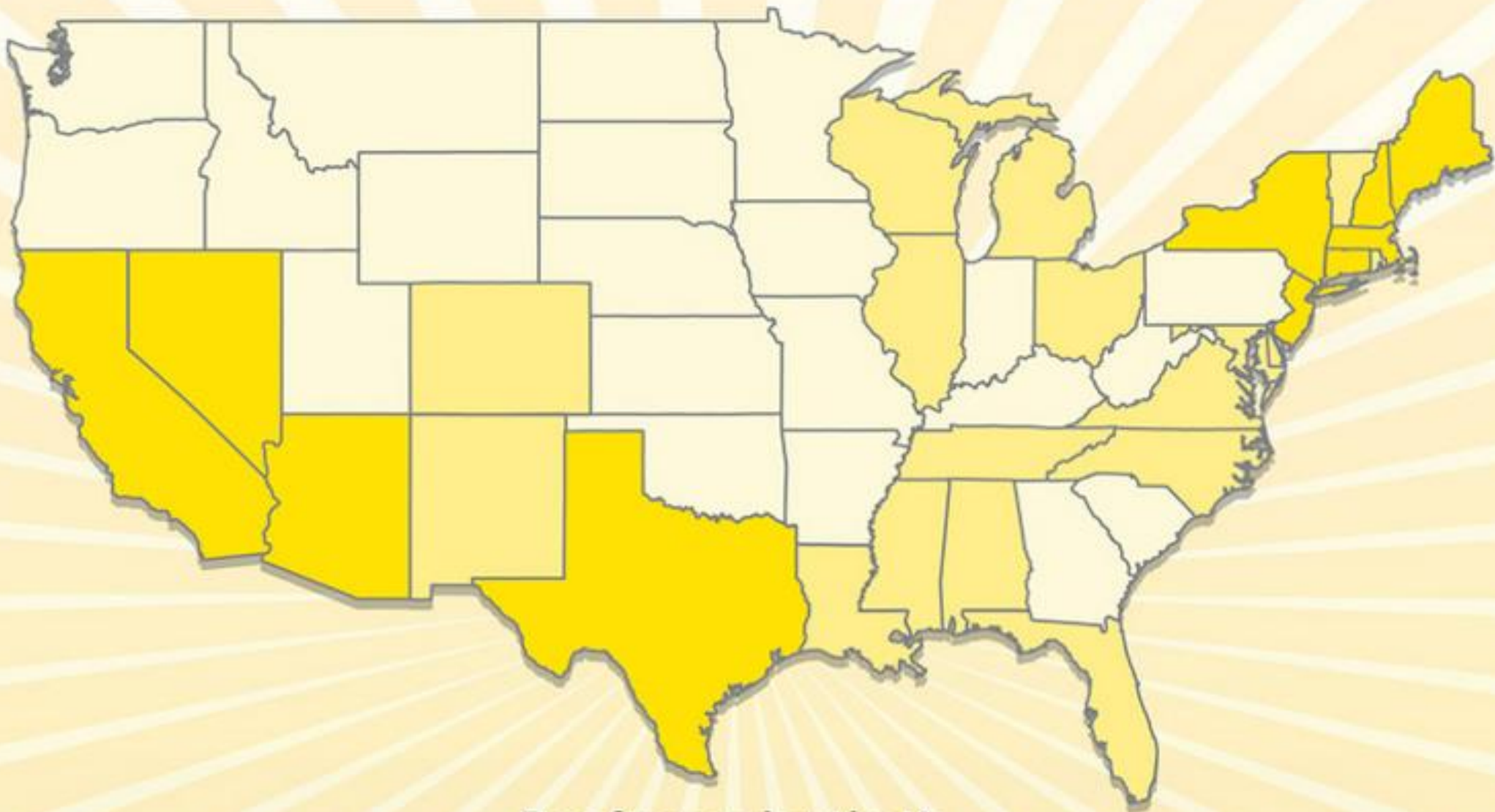
The screenshot shows the HT Instruments website interface. At the top, there are navigation tabs for PRODUCTS, BRANDS, DEALS, and RESOURCES, along with a search bar. Below this, a breadcrumb trail reads: Home > HT Instruments > Solar Analyzers > Solar Field Analyzers. A sidebar on the left titled 'Narrow Your Search Results' includes sections for 'You've Selected' (Solar Analyzers, Solar Field Analyzers), 'Search within these results', 'Price Range' (Less than \$500 (2), \$500 - \$1000 (1), \$1000 and up (6)), 'I-V Curve Test' (No (1), Yes (3)), and 'Auto Scan for Power Pmax' (Yes (3)). The main content area features a promotional banner for 'HT INSTRUMENTS SOLAR ANALYZER' with the text 'Solar's so Bright, you're gonna need shades! Combining the best of Italian Design for you!' and an image of three solar analyzers. Below the banner, there's a 'Sort By' dropdown set to 'Most Popular', a 'View' dropdown set to '12', and a 'COMPARE' button. A product card for 'HT Instruments HT204' is displayed, showing a portable digital sun irradiation meter with a sale price of \$295.00, an 'ADD TO CART' button, and a 'Low Price Guarantee' badge.

- ❑ Advanced search and filtering
- ❑ Side by side comparisons
- ❑ Customer portal for special pricing and preferences
- ❑ Customer community product reviews

- Internal Order Portal

- Customized for our needs
- Linked to accounting
- Vendors to update status
- Faster & more accurate

The screenshot shows an internal order portal interface. At the top, there are navigation tabs for Home, Sales Orders, Purchase Orders, Items, PIM, IML Portal, and Settings. Below this, there's a search bar and a table of sales orders. The table has columns for SO#, Date, Status, Proc, Web, Est Ship, Customer, Quote #, St, Entry, and Ship Via. The table contains 20 rows of data, with some cells redacted with black boxes. On the left side of the table, there are several filter sections: 'Search Text' with a search box and checkboxes for Order#, Item, Track#, Cust PO#, Invc #, Invc Amt, Customer, Email, Zip, Quote #, and Sliperson; 'Order Status' with checkboxes for Open, On Hold, Closed, and Deleted; 'Inv Allocation Status' with checkboxes for Not Fully Allocated, Flagged For Review, and Flagged For Re-Order; and 'Order Date' with 'From' and 'To' date pickers and a 'Search' button.



Rooftop solar that's
as cheap as the grid:



NOW



NEAR TERM

1-3 years



LATER

4+ years

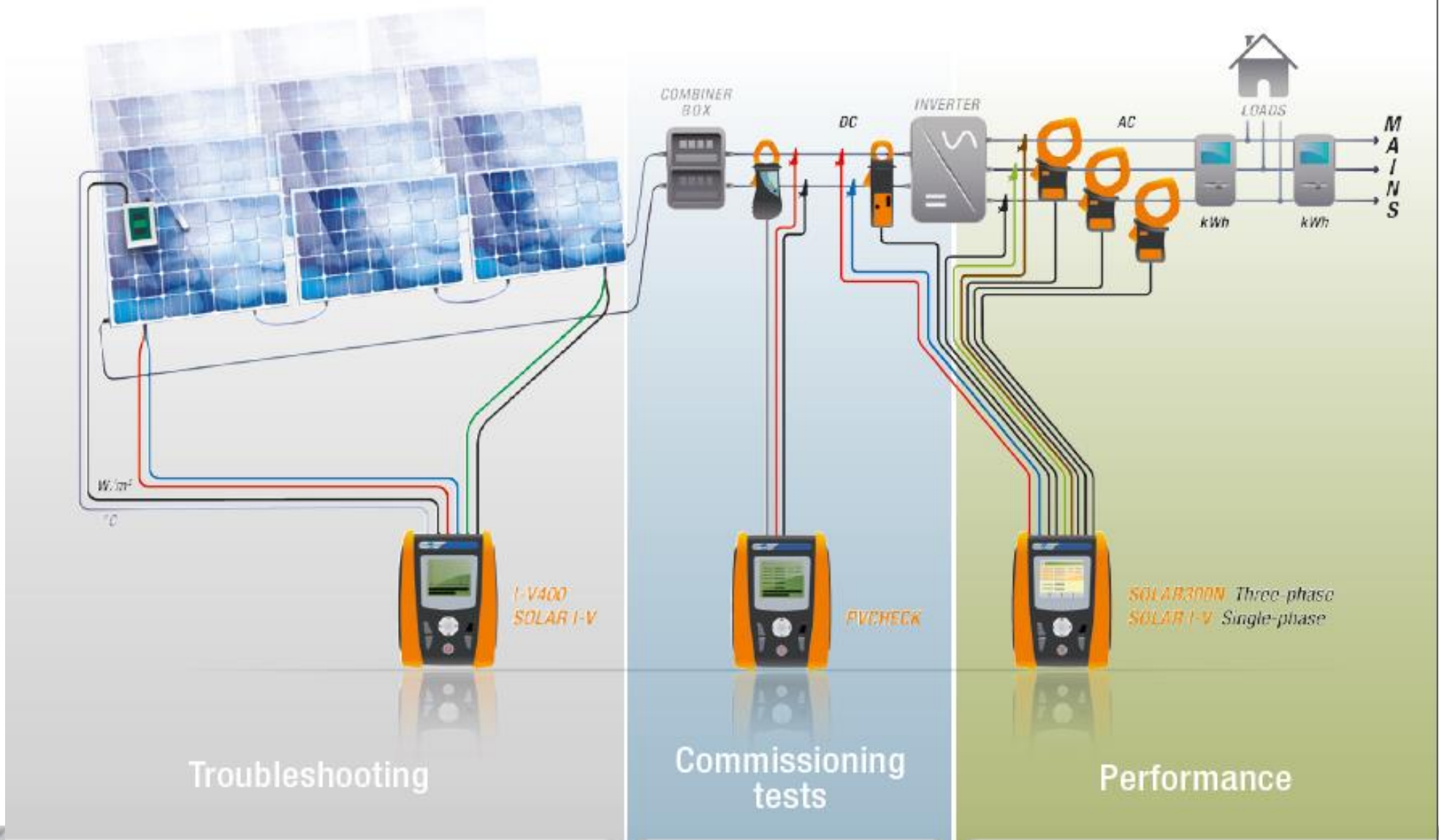
PV Market 20,000 ft.

- PV installations growing at >30% CAGR
- Two distinct markets –
 - Commercial – Large with \$ to test up to 100 MW
 - Residential – Fast and Cheap. Testing is only beginning in general
- N.E. Hybrid models– Tax benefits
- Farms are largely in the SW (CA, AZ, NV)

Measurements for Solar PV

- Drivers for PV Measurements
 - O&M needs
 - Acceptance Testing – Making sure the system is delivering to specification – There are no manufacturing final tests in most companies. Too expensive
 - Periodic Checks on Safety and performance often part of service agreement.
 - Troubleshooting
 - Differentiation – Many Installers and O&M companies are wanting to show quality and value by testing their work.
- Solar PV Measurement overview:
 - Insulation and Conductivity – Safety and Basic Performance
 - IV Curves – Performance, troubleshooting and ensuring panels are in Spec.
 - Efficiency from sun to DC power to AC power

H T S (☀) L A R



Are Solar Measurements Different?

- Some measurements are the same as traditional electrical measurements.
 - DC Power, AC Power, Continuity
- Different
 - IV Curves, I short circuit, V open circuit
- Mixed
 - Insulation resistance has challenges on Panels, strings and fields.
 - Example is doing the standard Insulation testing (Megger)

OPC and STC

- Terms
 - Standard Test Conditions (STC)
 - 1000 W/mm, 25 degrees C, Atmospheric density of 1.5
 - Operating Conditions (OPC)
 - Physical Test Results
- Need – Determine if panel or string is meeting the specifications.
 - Translate OPC measurements to equivalent STC to evaluate.
 - Requires to understand the Irradiance at the time of test.

Installation Testing

- Standard for Grid Connected systems outlines 4 tests.
 - These are pretty good for making sure the field is running and is safe.
 - Isc, Voc, Insulation of active cables and Continuity of Grounding cables.
 - Standard does not call out checking Isc and Voc to STC.
 - Many professionals are using Reference cells in combination with Testing to determine

Why can't a megger Work?

- Quick answer is that the PV Panel or string presents a great deal of noise into the system.
 - While you place a megger onto the PV conductor it is presenting you with up to 1000V DV right back at you, and it varies with sun etc.
 - This creates an uncertain measurements environment and will guarantee a bad reading on Insulation.
- What the answer?
 - Specialized tools Short out the + and – sides of the panels then measure Insulation. It is not recommended that you try this method by yourself in shorting the lines.
 - HT Method of Field tests the entire field by measuring at the combiner box in one test!

Installation and Troubleshooting

- I-V Curves are the Core Measurements to ensure the Panel is performing to specifications.
- Key Measurements
 - I Short Circuit – Current when output is shorted Today up to ~ 10
 - V Open Circuit – Voltage output with no Load
 - MPP (Max Power Point)= $I_{mpp} \times V_{mpp}$
 - I Max Power Point (MPP) – Current at the high power point.
 - V_{mpp} Voltage @ MPP
- Other issues:
 - Curve should be smooth as shown.
 - I is fairly linear to the suns output
 - Voltage is fairly stable to the sun

