

Radian Research, Inc.

***The RD-3x Dytronic Energy
Reference Standard...
The Most Versatile
Reference Instrument Ever!***

**R
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N**



RD-3X Lab Standard



RD-3X Portable Field Standard



RD-3X Analyzing Standard



Radian Research...Setting the *Energy* Standard



Radian Research world headquarters Indiana



Radian Research WECO facility Mississippi

Radian Research Company Overview

Radian Research, Inc. is a recognized world leader of Energy Reference Standards, Energy Meter Testing Systems, Current Transformer Testers, DC to AC Transfer Standards, and Automated Laboratory Energy Reference Systems. Radian provides both portable and primary energy reference standards that are absolutely unequaled in accuracy, stability and reliability. Radian customers typically consist of electric utility companies, energy meter manufacturers, energy meter test system manufacturers and national metrology institutes located throughout the world.

Radian is a company founded upon innovation, technology breakthrough and outstanding customer service. Radian is a privately held corporation founded by Glenn A. Mayfield in 1982. As an electrical measurement physicist, Mr. Mayfield realized that watt-hour reference standards would require a technological advancement to be accurate and stable enough to test new emerging electronic watt-hour revenue billing meters. Therefore, he established the Company's focus as the research, development and production of advanced power and energy measurement instruments for the worldwide electric utility industry.

In 2011, Radian Research acquired Watthour Engineering (WECO) this new combination forms a world powerhouse in power and energy meter testing equipment. The alliance will strengthen each company's abilities, product offerings and will provide outstanding value to our customers.

WECO a Radian Research company

Watthour Engineering Co., Inc. (WECO) was incorporated in the State of Mississippi in March of 1980. Initially, it provided custom electric meter test equipment to utilities primarily in the South and Southeast United States. Watthour Engineering is a leading manufacturer and supplier of products and services for use in testing, repair, maintenance, and tracking of electric meters and associated equipment. Its products are used by utility companies and meter manufacturers throughout the United States and the world.

In addition to manufacturing quality electric meter test equipment, Watthour Engineering has extensive software capabilities that complement its hardware. The WATT-Net™ and WATT-Net Central™ software products provide data collection, reporting, and tracking information, which allow the utility to save money, increase data integrity, and have vital decision-making information readily available.

At Radian and WECO, we hold long traditions of innovative products with ultimate accuracy, usability and quality. Our customer value centered approach is now combined and will provide outstanding customer value well into the future.



Radian Research...Setting the *Energy* Standard

RD-3x Versatility, Accuracy & Portability

The Radian RD-3x series of Polyphase Electricity Energy Reference Standards are designed to meet the demanding needs of today's Electrical Power & Energy applications. The RD-3x extends beyond traditional Power & Energy measurement with optional Power Quality & CT analysis making the RD-3x a truly versatile instrument.

The RD-3x incorporates Radian's patented Dytronic measurement technology consisting of a Radian designed Integrating Analog to Digital Signal Converter. Unlike off-the-shelf A/D converters used in similar instruments, Radian's A/D Converter is specifically designed and optimized for power and energy measurement. This unique design makes the RD-3x absolutely unsurpassed in their ability to accurately measure "real world" waveforms.

The RD-3x A/D Converter is combined with Radian's patented electronically compensated voltage and current input transformers along with hermetically sealed & matched reference resistors that provide the highest degree of accuracy, stability, and versatility offered in a portable three-phase standard. This transformer technology replaces the need for less reliable range changing relays found in traditional measurement instruments.

- 1 mA to 120 Amp (200 Amp optional)
- 30 V to 630 V
- Phase 0.003° - P.F. Range: Any
- 45 Hz to 65 Hz (Fundamental)
- Harmonics to the 64th
- Programmable Wh/pulse

Versatility

The RD-3x series is versatile enough to be used for a broad range of laboratory and field-test applications. Functionality is maintained throughout a -20°C to +70°C temperature range over which the RD-3x has an unparalleled accuracy making it an ideal solution for field meter as well as CT test applications using the optional RD-BR1 burden and ratio analysis module.

The RD-3x supports a broad range of functionality, including measurement of voltage, current, phase, harmonics and an ample selection of time based energy measurement functions.

Accuracy

Energy Measurement		
Accuracy		
GOOD:	RD-30	0.04%
BETTER:	RD-31	0.02%
BEST:	RD-33	0.01%

The Radian RD-33 Three-phase Electricity Reference Standard achieves a level of accuracy and performance unsurpassed for portable standards. The RD-3x is a four quadrant three-phase measuring instrument that registers both forward and reverse energy flow and provides per phase voltage, current, power and energy (Active, Reactive, Apparent) information.

RD products are thoroughly evaluated during manufacturing across a wide temperature range to help remove premature failures. Measurement performance is certified using Radian's RS-Syntron calibration systems, which are traceable to National & International Institutes.

Portability

The rugged, light weight RD-3X extends its capability to on-site Meter & CT test applications. The optional built in computer and Power analysis capability further reduces the need for additional computing hardware.

Traceability and Precision

National Measurement Institutes: Energy measurement is an important component of legal metrology as it directly impacts the cost to transact electricity. The importance of traceability and precise energy measurement of sine and non-sinusoidal signals should not be underestimated. The Radian RD-33 is used by most National labs' as a solution for Real Power (W), Apparent Power (VA) and Reactive Power (VAR) measurements. Furthermore the RD-3x is portable enough to be used in an electrical Energy Measurement Assurance Program (MAP) where routine inter lab comparisons are undertaken to determine each labs relative measurement capabilities.

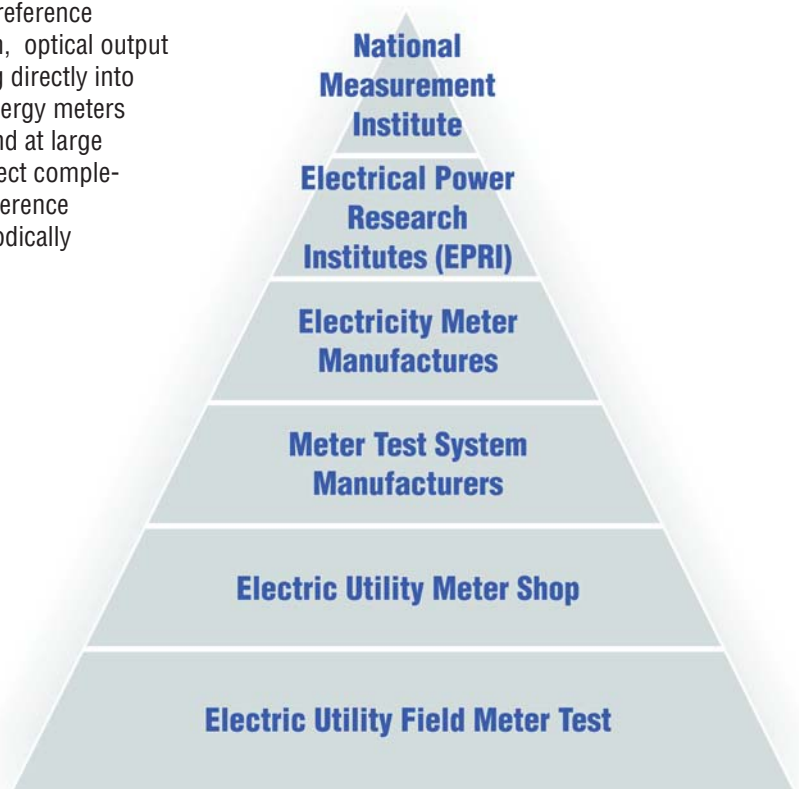
Electrical Power Research Institutes: The demand for SMART as well as Automated (AMR) metering has significantly increased research institute testing requirements. The RD-33's stability and accuracy is an ideal solution to determine meter type test performance against the IEC 61036 & IEC 62053 and ANSI C12 specifications.

Electricity Meter Manufactures: The RD-3x is used to validate the design, test and manufacture of a wide range of electricity meters. Many leading meter manufacturers use Radian's measurement standards in part or in all of these processes. Furthermore, semiconductor manufacturers including (Prolific, Analog Devices and Texas Instruments) supplying the meter manufactures use Radian standards to validate and improve the accuracy of their components.

Meter Test System Manufactures: Test board manufactures including Watthour Engineering* and Metertest* benefit from the accuracy of an embedded Radian RD standard. Embedded standards help improve system uptime as the RD standard can be removed or exchanged and returned for routine calibration.

Electric Utility Meter Shop: The RD-3x is used with a controlled current source to test revenue meters and reference standards. Pulse sensors to detect meter disk rotation, optical output pulses of infrared or visible light, and KYZ pulses plug directly into the RD-3x. The RD-3x is ideal for testing high-end energy meters found in power plants, substations, inter-tie points, and at large utility customer accounts. The RD-3x is also the perfect complement to relay test sets where it serves as an active reference standard when testing meters or may be used to periodically certify the accuracy of the test set itself.

Electric Utility Field Meter Test: The Radian RD Three-phase Portable Field Standards provide the ultimate "Measurement Engine" for true three-phase, portable and stationary energy meter test systems. In field applications, the RD-3x performs a true three-phase meter accuracy tests using existing service load.

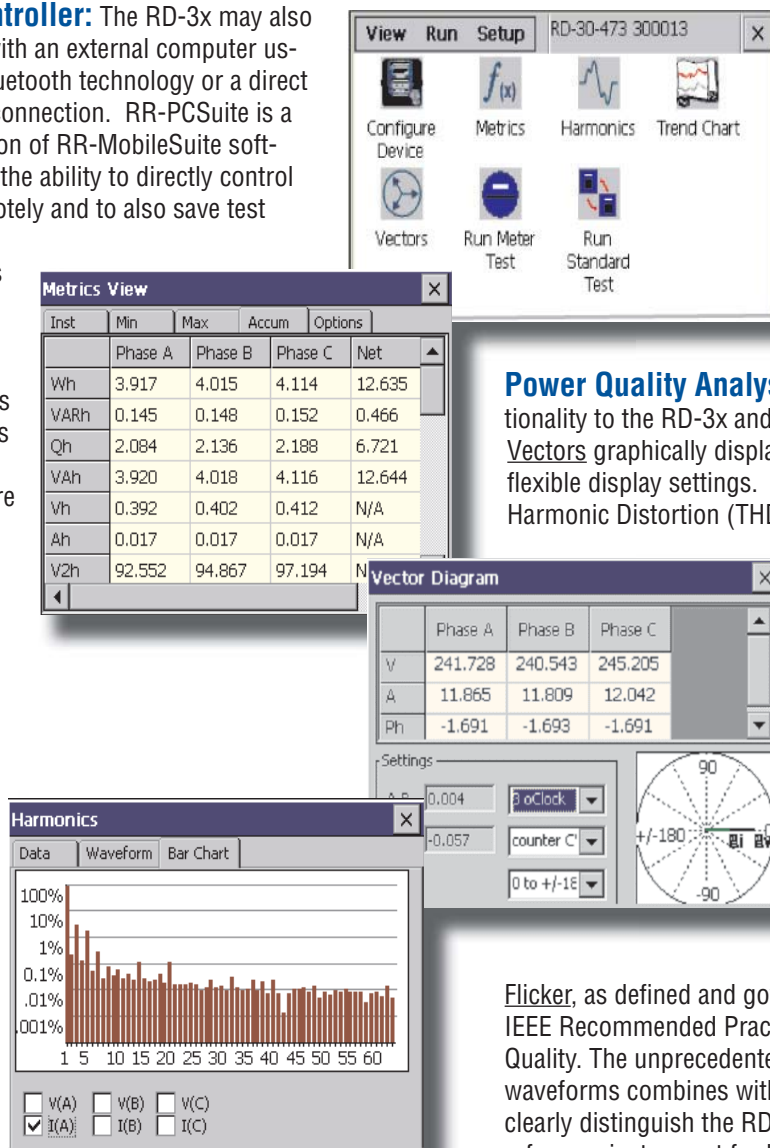


RD-3x Software Automation

Embedded Controller: The RD-3x has an optional built-in computer with Windows CE and a color touch screen display. Radian developed software powers the testing and analysis functions of the RD-3x. RR-MobileSuite comprise a set of simple, yet extremely powerful, software tools. Metrics enables the user to view all measurements including: Instantaneous, MIN/MAX, and Accumulating functions.

Results for Meter and Standard testing are calculated, displayed, and then saved for future reference. The use of PCMCIA memory card insures unlimited data expansion and storage. Data management features allow users to easily query, view and transfer saved test results to a PC. Customizable export files can be created using a flexible Comma Separated Variable (CSV) format that is easily imported into other PC applications.

External Controller: The RD-3x may also be controlled with an external computer using wireless Bluetooth technology or a direct RS-232 serial connection. RR-PCSuite is a PC based version of RR-MobileSuite software that adds the ability to directly control the RD-3x remotely and to also save test results directly to a computer's hard disk. RR-Kit software is a set of commands, routines and instructions for developing custom software applications.



Power Quality Analysis: This option adds valuable functionality to the RD-3x and RR-MobileSuite.

Vectors graphically display three-phase vector diagrams with flexible display settings. Harmonics option provides Total Harmonic Distortion (THD) for all three-phases of voltage and current waveforms, displays amplitude and relative phase angle data up to the 200th harmonic, and provides graphical representations of all harmonics information.

Trend Charts enable the user to generate a trend data for any of the instantaneous metrics. Power Quality allows for the set-up and testing for Sags, Swells, Transients, Frequency, Total Harmonic Distortion (THD), Imbalance, Noise and

Flicker, as defined and governed by IEEE Standard 1159-1995 IEEE Recommended Practice for Monitoring Electric Power Quality. The unprecedented accuracy of measuring distorted waveforms combines with this power analysis capability to clearly distinguish the RD-3x as the definitive portable energy reference instrument for both testing and power quality applications.

Precision Energy Standard

- Maintain Polyphase AC Energy Traceability to National Metrology Institutes
- Harmonic Analysis
- Certify Accuracy of Meter Shop Test Boards
- Certify Secondary and Working Standards
- Certify AC voltage, current and power sources
- Test High End Revenue Billing Meters
- Small, lightweight, easy to transport



RD-33

+/- 0.01% Guaranteed Accuracy

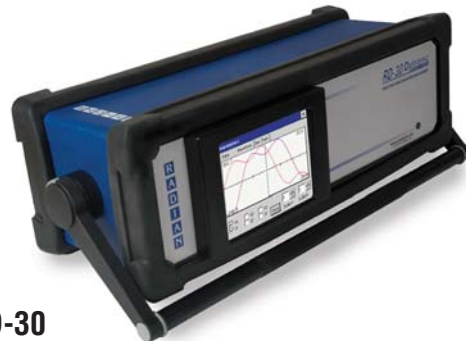
The Radian RD-33 Three-phase Reference Standard is one of the most accurate and versatile measurement instruments ever designed. The RD-33 provides a guaranteed accuracy of 0.01% for all measurement functions fully traceable to national and international measurement institutes. The RD-33's portability makes it ideally suited as a transfer standard that can be easily shipped and transported to locations around the world. The RD-33 can also be used as an ultra-accurate standard for testing of high end revenue billing meters such as those found in sub-station and power plant installations.



The RD3x with built-in computer provides a user friendly interface utilizing color touch screen technology

Portable Field Standards

- Test Revenue Billing Meters
- Two Accuracy Classes Available
- Small, Compact Package
- Independent Phase Measurement
- Programmable Pulse Outputs



RD-30

+/- 0.04% Guaranteed Accuracy



RD-31

+/- 0.02% Guaranteed Accuracy

The Radian RD-30 and RD-31 Three-phase Portable Field Standards provide the ultimate "Measurement Engine" for true three-phase, portable and stationary energy meter test systems. They are available with flexible features and options to meet a diverse set of testing applications. Rack mount versions are also available for stationary test systems.

Analyzing Standards

- Analyze Entire Metering Installation
- Selectable accuracy classes
- Powerful Testing and Analysis software
- Convenient Wireless Interface
- CT Burden & Ratio Testing

**Choice of
RD-30/31/33**



"Site Analyzer" Package
Available in Plus, Premium or Pro Bundles

The Radian Research Three-phase Analyzing Standard is the ultimate instrument for on-site accuracy testing of electricity meters, performing power quality analysis, testing CTs, and site wiring confirmation. Built upon the robust and world renowned performance of the Radian Research RD-3X family of reference standards, these Analyzing Standards provide for unsurpassed accuracy, functionality, and ease of operation. Radian Research Analyzing Standards are designed to work with customer load or with a stand-alone current source.

Radian Research...Setting the Energy Standard

R A D I A N

Wide Range Voltage - input allows for powering RD in any application

GUARD - used to connect the common of a Wye source to reduce noise through improved common mode rejection

KEYBOARD - external keyboard speeds data entry

RS-232 SERIAL PORT - for remote communication, full automation and remote firmware upgrade

PULSE INPUTS - three pulse input ports used simultaneously or individually for use with Radian pick-up sensors

PULSE OUTPUTS - three programmable per phase or total energy pulse output ports

PICKUP - suitable for lemo terminated pulse sensors

ANALOG SENSE - optional analog sense input used for DC or AC 20mA transducer test applications



CURRENT INPUT - 6mm safety interlock current inputs are designed to prevent inadvertent disconnection

SAFETY FUSE - user accessible in-line fuse

CT INPUT - current probe input, improves CT accuracy using programmable RD calibration memory and integrated serial communication

PCMCIA - memory card for data storage and PC transfer

RD-3x Options & Accessories



Pictured: RD-BR1 Burden & Ratio Analysis Module

Current Transformer & Burden Test Accessories

The Radian RD-BR1 Burden & Ratio Analysis Module is an innovative advancement in CT testing. This accessory provides several benefits over alternative testing methods. The RD-BR1

allows testing without interruption to the customer's service and the design features single cycle burden insertion with simultaneous CT ratio and phase error. The module's unique design allows all ANSI values of 0.1, 0.5, 1.0, 2.0, 4.0 and 8.0 Ohms to be inserted with virtually no magnetizing effect on the CT. When testing with the RD-BR1 the user need not be concerned with overheating. An onboard temperature controlled fan keeps the module running cool and trouble free.

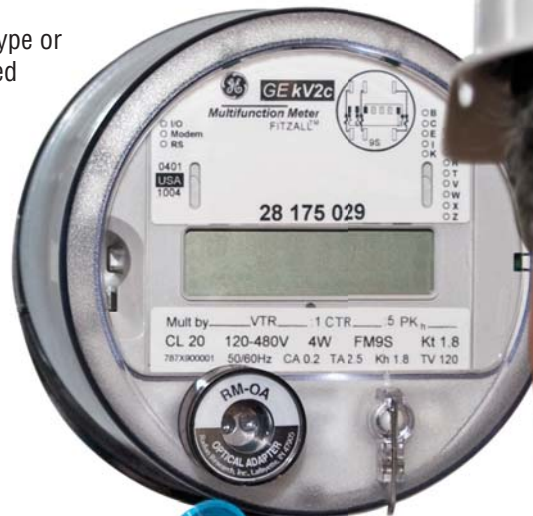
Optical Sensors

Accurately test all types of meters with our complete line of optical sensors. With a wide variety of reflective and infrared (IR) heads to choose from, lab and field testing has never been easier - or more accurate. All of our sensors are small and made with very flexible but durable wire. Magnetic base or meter globe mounting hardware is available for field testing.

RR-DS Meter Disk Sensor is a reflective pickup assembly used to sense the disk rotation of an induction type meter. The pulses generated by the RR-DS are fed into the sensor input of a Radian comparator or reference standard.

RR-1H Infrared Optical Pickup is used to sense the infrared pulses from the calibration LED found on most solid state meters. The pulses from the RR-1H are fed into the sensor input of a Radian comparator or reference standard.

RR-KYZ Pulse Input Adapter is used to sense the KYZ output pulses of induction type or solid state meters. The pulses received from the meter's KYZ output are conditioned and fed into the sensor input of a Radian comparator or reference standard.



Pictured: RR-1H Optical Pickup and RM-OA Optical Adapter

Probes and Leads

A range of current probes are available to operate with the RD-3x. Each probe is engineered for optimum performance with any RD-3x Standard.



RC-HV2000A - High Voltage Current Probe is a high voltage AC current probe comprised of a high voltage current sensor, with a fiber optic link to an electronic readout module, and Radian Research's RC-CTA1, voltage to current converter. The high voltage sensor is traditionally mounted on a hotstick (optional) and allows for measurements on conductors where standard clamp-on probes may not be used. The RC-CTA1 must be used to insure the proper input to Radian Research RD reference standards. Radian Research has terminated the RC-CTA1 with a seven-pin Redel connector to allow for direct connection to RD reference standards. The RC-HV2000A with RC-CTA1 provides for true RMS measurement capabilities when used in conjunction with a Radian Research RD reference standard with RMS measurement capability. The RC-CTA1's contribution to the overall accuracy specification of the RC-HV2000A is negligible.



RC-FLEX3000A - 36" Flex Probes is a 36" flexible AC current probe comprised of a flexible sensor, an electronic module, and Radian Research's RC-CTA1, voltage to current converter. The flexible sensor permits measurements on conductors where standard clamp-on probes may not be used. The RC-FLEX3000A presents virtually no load to the circuit under test, has a low phase shift, excellent frequency response, and can not be damaged by current overloads. The RC-CTA1 must be used to insure the proper input to Radian Research RD reference standards.



RC-SR704 - 0.2 A to 800 A AC Current Probe is a robust current probe designed for AC current measurements up to 800 Amps. The unique ergonomic design of the RC-SR704 makes it an ideal current probe to easily clamp onto cables or small bus bars. The RC-SR704, with its excellent transformation, low phase shift, and broad frequency response characteristics provides for accurate measurements of current for power and power quality testing applications. The RC-SR704 works as a traditional current transformer with a transformation ratio of 1000:1. Radian Research has terminated the RC-SR704 with a seven-pin Redel connector to provide for direct connection to Radian Research RD reference standards.



RC-MN106 - 0.2 A to 150 A AC Current Probe is a small, compact, and rugged current probe designed for AC current measurements up to 150 Amps. The "clothes-pin" shape makes the RC-MN106 ideal for working in extremely tight environments. The RC-MN106 works as a traditional current transformer with a transformation ratio of 1000:1. Radian Research has terminated the RC-MN106 with a sevenpin Redel connector to allow for direct connection to a Radian Research RD reference standard.

Care Plans for Radian Standards

Whether you are an existing customer, or receiving a new Radian standard you will become a member of an exclusive club. Radian Care Plans provide the ultimate in service.

With the purchase of any Radian energy reference standard you automatically become a member in our Blue Service Plan. The care plan covers the new Radian product under a limited two year warranty and provides access to on-site training and our periodic training seminars. At any time, you may upgrade your membership to either our Silver, Gold, or Platinum Care Plans. These plans provide additional coverage and protection, training and comprehensive calibration packages.

PLATINUM

Five Year Warranty Coverage
Five Years Recalibration and Recertification
On-site Product Training
“First on Bench” Priority Status for Recalibration and Repair

GOLD

Four Year Warranty Coverage
Four Years Recalibration and Recertification
On-site Product Training

SILVER

Three Year Warranty Coverage
Three Years Recalibration and Recertification

BLUE

Standard Two Year Warranty



RD-3x Product Configuration Guide

Accuracy: RD-30 0.04%, RD-31 0.02%, RD-33 0.01%

Specifying the first of the last three digits: RD-3x-Xxx

Model	Measurement Function
RD-3x-2xx	Whrs, VARhrs, Volts, Amps, VAhrs, Qhrs, Watts, VARs, VA, Phase Angle, PF, Frequency
RD-3x-3xx	Whrs, VARhrs, VAhrs, Qhrs, Volts, Amps, Watts, VARs, VA, Vhr, Ahr, V2hr, A2hr, Phase Angle, PF, Frequency Min & Max measurements: All indicating functions Current Clamp-on Input
RD-3x-4xx	Whrs, Volts, Amps, VARhrs, Qhrs, VAhrs, Watts, VARs, VA, Vhr, Ahr, V2hr, A2hr, Phase Angle, PF, Frequency Min & Max: All indicating functions AVG response: VAhrs, VA, Volts, Vhrs, Amps, Ahrs Current Clamp-on Input

Specifying the second of the last three digits: RD-3x-xXx

-x0x	No computer, No power analysis, No analog sense input
-x1x	Built-in computer (with color touch screen display and MobileSuite software)
-x2x	Power analysis (Harmonics, Trending and Vector Analysis and Power Quality Analysis)
-x3x	Built-in computer and Power analysis
-x4x	Analog Sense Input (for Volts, Amps, Watts, VARs, VA) (20mA DC max)
-x5x	Built-in computer and analog sense input
-x6x	Power analysis and analog sense input
-x7x	Built-in computer, power analysis and analog sense input

Specifying the third of the last three digits: RD-3x-xxX

-xx1	120 Amp (6mm insert) current inputs, Rack Mount
-xx2	200 Amp (bolt on) current inputs, Rack Mount
-xx3	120 Amp (6mm insert) current inputs, Portable
-xx4	200 Amp (bolt on) current inputs, Portable

Accessories

RD-BR1	CT Ratio and Burden Testing
RR-PCSuite	Testing and Analysis PC software for RD Standards
RR-Kit	Software for Custom Application Development
RR-1H	Optical Pickup for Infrared LED, 4-Pin plug
RR-DS/sm	Meter Disk Sensor with 4-Pin plug, suction mount
RR-DS/f	Meter Disk Sensor with 4-Pin plug, field mount



RD-3x Specifications

General		
Operating Range:		
Current	0.001 to 120 Amp, (200 Amp optional)	
Voltage	30 to 630 Vac (60Hz), 30 to 525 Vac (50Hz)	
Aux Power	60 to 630 V (autoranging)	
Frequency	45 Hz to 65 Hz	
Harmonic Analysis	< 64 th (bandwidth 10000 Hz)	
Input Impedance:	Current Input	< 1 mOhm
	Voltage Input	~ 1 MOhm
Dimensions:	5"(127 mm), 17.5" (444.5 mm), 6.25" (158.7 mm)	
Weight:	16 lbs (7.2 kg), Shipping weight 28 lbs (12.6 kg)	
Environment:		
Operating & Storage Temp.	-20°C to +70°C	
Humidity	0 % to 95 % non condensing	
Vibration	All non destructive	
Safety:		
Hi-Pot	2.3 kVrms, 60 Hz for 60 seconds	
Surge	IEEE 472 and ANSI 37.90	
Fused	Potential and Auxiliary Input	
Warm-up:	30 seconds	

Interface	
Display:	Touch screen, color back lit LCD
Communications:	
Serial Port	RS -232
Sensor Port	Lemo type
CT Port	3 CT Inputs (optional Clamps from Radian)
Inputs 1,2 & 3:	
BNC Display gate	150 Ohm pull up to 5 V, clamped at 5.7 V
BNC Gate rate	200 nS pulse width minimum, maximum 20 Hz repetition rate.
Outputs 1, 2 & 3: (default = 0.00001 Wh/pulse)	Programmable KH value Open collector, clamped at 27 V Max 2.1 MHz (200nS pulse width minimum) Selectable Watt Hours, VAR Hours, VA Hours
Current Inputs	6 mm (<120 Amp), 8 mm (<200 Amp option)
Aux & Potential Inputs	4 mm

Unless stated specifications apply to the Radian Model RD-30, RD-31 and RD-33. All accuracy specifications are guaranteed and include traceable accuracy to calibration standards used, 95% confidence level. Specifications are for 365 day calibration interval.

Specifications									
Function	Reading	Accuracy (ppm) ³ TCAL ¹ ± 5°C			Stability (ppm √ Month)			Cal Unc. (ppm)	Temperature Coefficient ⁶ (ppm/°C)
		RD-30	RD-31	RD-33	RD-30	RD-31	RD-33		
Voltage	30 V to 630V ⁵	200	100	50	8	4	2	30	2.5
Current	1 mA ... 20 mA ²	280	140	70	12	6	3	50	2.5
	20 mA ... 200 A								
Power / Energy ^{3,4}	1 mA ... 20 mA ²	400	200	100	16	8	4	80	5
	20 mA ... 200 A								
Power Factor	≥ 0.5	0.04 %	0.02 %	0.01 %					
	< 0.5	0.04%/2PF	0.02%/2PF	0.01%/2PF					
Phase angle	0° ... 360°	0.012°	0.006°	0.003°					

RD-BR1 Burden & Ratio Analysis Specifications		
Input Power	RD Standard connection (Allows 60-600V at Site)	
Measurement Inputs	Primary CT Current:	0.1 – 3000 Amperes, 50 or 60 Hz (using probes)
	Secondary CT Current:	0.01 – 20 Amperes, 50 or 60 Hz
	CT Primary Probe Input Voltage:	3V RMS Max (using RR-CTA1)
	Probe Scales:	10mV/A
	Accuracy	Dependent on RD standard & clamp-on selected
CT Burden Testing	CT Burden Value:	0.1, 0.2, 0.5, 1.0, 4.0, 8.0 Ohms
	Resistive Element Tolerance:	+/- 1%
	Insertion Burden:	+/- 0.04 Ohms

Notes:

1 TCAL = 23°C

2 20mA/Reading x Accuracy Specification (ppm)

3 Includes variables of Stability, Power Factor, and Traceability Uncertainty

4 (30 V ... 630 V) For ≥ 1 second Test

5 Maximum 525 V at 50 Hz

6 Maximum -20°C ... +70°C

$$\text{Repeatability} = \frac{1 \text{ ppm}}{\sqrt{\text{Seconds}}}$$



RM-17 Portable Watthour Test System

The RM-17 Portable Watthour Test System is the most accurate self-contained residential meter tester available. Unlike other residential meter testers, the RM-17 is not simply an electronic meter or a resistive load used as a verifier. Instead, the RM-17 incorporates a true field proven Radian Research watthour standard as its reference. The RM-17 has a guaranteed accuracy of $\pm 0.05\%$ which is traceable to NIST.



WE-20 Portable Tester/Analyzer

WE-20 Portable Tester/Analyzer delivers three-phase field-testing using a Radian Research RD-30 internal standard complimented by a sophisticated, lightweight package. The WE-20 allows you to execute a multitude of tests at the customer's site. Test the meter with the customer's load, perform CT burden and ratio tests, and verify system wiring to give you the peace of mind that the entire metering installation is correct. Harmonic Analysis, CT Testing, Vectors, and Trends can all be tested without pulling the meter from its socket.



RD-20, 21 & 23 Single phase Reference Standards

The Radian RD-20 and RD-21 Single-phase Portable Field Standards provide the ultimate "Measurement Engine" for portable and stationary energy meter test systems. They are available with flexible features and options to meet a diverse set of testing applications.



RS-933A 200 Amp Automated Energy Calibration System

The RS-933 is a totally automated laboratory calibration system that provides automated testing of field and primary standards as well as qualification testing of new solid state meter designs. The RS-933 will calibrate these devices with a typical accuracy of 0.005% (50 PPM). The RS-933 will replace existing standards, references and loading devices so as to provide all the functions of a complete AC metrology laboratory with unequaled accuracy.

Radian Research, Inc.
3852 Fortune Drive
Lafayette, Indiana 47905 USA

Phone: 765-449-5500
Fax: 765-448-4614
Web Site: www.radianresearch.com