Radian Research, Inc.

RM-10, RM-12, RM-15

Portable Metronic Standard

Operations Manual

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RADIAN

Revision 007-12/98
944000

Contents

1.0 Product Introduction

The RM-10, RM-12 and RM-15 make up the Radian family of autoranging portable watthour standards. Each model provides full autoranging capability for the Potential Input, Auxiliary Power Input and Current Input. Totally autoranging inputs, a feature pioneered by Radian, make it impossible to damage the unit by applying a signal to the wrong input. Each model provides extreme linearity coupled with extreme stability. In addition, high resolution and repeatability permits rapid and accurate single revolution testing both in the field and in the lab with the appropriate optical pickup.

The RM-10, RM-12 and RM-15 provide a true watthour display with a Kh of 1 for their entire operating range. This feature, introduced by Radian, allows for a much simpler percent registration calculation. Models with VARhour, Qhour and VAhour capabilities are available for testing the newer multifunction solid state meters.

The RM-10, RM-12 and RM-15 can be used to upgrade older test boards and load boxes to provide the accuracy required for testing solid state meters. A full line of test accessories to use with these standards are also available from Radian. These accessories can be used for field and shop testing of solid state and induction meters.

The RM-1N is a solid state counter which automatically starts and then stops the test after it has counted the desired number of pulses from the meter. To further enhance testing automation, a communications I/O port is available for computer access to the standard's display. Application of PCA-*Link*™ Meter Test Software coupled with the RM-PCA Computer Interface Adapter will eliminate the need for manual record keeping.

Throughout this manual information that pertains to all three models will be labeled as RM-10/12/15. If information only pertains to a specific model(s) then it will be specified in the text (i.e. RM-15).

1.1 RM-10 Portable Watthour Standard

The RM-10 Metronic Portable Watthour Standard is a highly advanced electronic standard for use wherever high to extreme accuracy and stability are desirable or required.

In addition to its autoranging capabilities, the RM-10 features three summing current inputs which can be used to perform closed link testing. A test current of 150 amps maximum can be used by applying 50 amps to each of the inputs. A 200 amp version is available where a maximum of 66.6 amps can be applied to each input.

The RM-10 is also available in a Watthour/VARhour configuration or in a Watthour/VARhour/Qhour configuration. The multifunction capability is needed to appropriately test multifunction billing parameters on solid state meters.

1.2 RM-12 Portable Watthour Standard

The RM-12 provides high accuracy coupled with a high current input for use wherever test currents will exceed 50 amps. The RM-12 features one current input which is rated at 0.2 to 100 amps.

1.3 RM-15 Portable Multifunction Standard

The RM-15 is the most versatile portable standard available providing as many as 16 different measurement functions. The RM-15 is well-suited for test applications that require multiple measurements with high accuracy and stability.

In addition to its autoranging capabilities, the RM-15 features three summing current inputs which can be used to perform closed link testing. A test current of 150 amps maximum can be used by applying 50 amps to each of the inputs.

2.0 Configurations Available (RM-10, RM-12, RM-15)

2.1 RM-10 Models

RM-10-01 Portable Watthour Standard
RM-10-02 Portable Watthour 200 Amp Standard
RM-10-03 Portable Watthour Standard with I/O Communications Port
RM-10-06 Portable Watthour/VARhour Standard
RM-10-07 Portable Watthour/VARhour/Qhour Standard
RM-10-08 Portable Watthour/VARhour 200 Amp Standard
RM-10-09 Portable Watthour/VARhour/Qhour 200 Amp Standard

*The RM-10-02, -03, -06, -07, -08 and -09 Models are provided with an I/O Communications Port

Figure 2.1 RM-10 Metronic Portable Watthour Standard

2.2 RM-12 Models

RM-12-01 Portable Watthour Standard
RM-12-03 Portable Watthour Standard with I/O Communications Port

Figure 2.2 RM-12 Metronic Portable Watthour Standard

2.3 RM-15 Models

RM-15-02 Portable Wh/kW, VAh/kVA (RMS responding) Standard
RM-15-04 Portable Wh/kW, VAh/kVA, VARh/kVAR, mVh/V, mAh/A (RMS responding) Standard
RM-15-12 Portable Wh/kW, VAh/kVA, RMS/AVG Responding Standard
RM-15-13 Portable Wh/kW, VAh/kVA, VARh/kVAR, RMS/AVG Responding Standard
RM-15-14 Portable Wh/kW, VAh/kVA, VARh/kVAR, mVh/V, mAh/A, RMS/AVG Responding Standard

*All RM-15 Models are provided with an I/O Communications Port

Figure 2.3 RM-15 Metronic Portable Multifunction Standard

3.0 Specifications

Unless otherwise noted, specifications apply to the RM-10, RM-12 and RM-15 standard models and their respective configurations.

3.1 Accuracy

RM-10

All errors are in percent of reading at any combination of the normal operating conditions. Note that stability is included within the maximum accuracy specifications for Watthours, VARhours and Qhours. *Power factor is referenced to Watthours and it is also assumed that voltage is the reference vector.

	Watthour
At Unity Power Factor* (0°):	*±0.01% typical, ±0.05% maximum*
At 0.5 Lag Power Factor* (-60°):	*±0.02% typical, ±0.05% maximum*
At Power Factor* P< 0.5	
(F between -60° and -90°):	*±0.05%/P maximum*

	VARhour
At 0.0 Lag Power Factor* (-90°):	*±0.025% typical, ±0.1% maximum*
At 0.866 Lag Power Factor* (-30°):	*±0.035% typical, ±0.1% maximum*

	Qhour
At Unity Power Factor* (0°):	*±0.035% typical, ±0.1% maximum*
At 0.5 Lag Power Factor* (-60°):	*±0.025% typical, ±0.1% maximum*

RM-12

All errors are in percent of reading at any combination of the normal operating conditions. Note that stability is included within the maximum accuracy specifications for Watthours. *Power factor is referenced to Watthours and it is also assumed that voltage is the reference vector.

	Watthour
At Unity Power Factor* (0°):	*±0.025% typical, ±0.1% maximum*
At 0.5 Lag Power Factor* (-60°):	*±0.03% typical, ±0.1% maximum*
At Power Factor* P< 0.5	
(F between -60° and -90°):	*±0.1%/P maximum*

RM-15

All errors are in percent of reading at any combination of the normal operating conditions. Note that stability is included within the maximum accuracy specifications for all measurement functions. All other measurement functions other than Watthours and VARhours have an accuracy of ± 0.1% maximum. *Power factor is referenced to Watthours and it is also assumed that voltage is the reference vector.

	Watthour
At Unity Power Factor* (0°):	*±0.01% typical, ±0.05% maximum*
At 0.5 Lag Power Factor* (-60°):	*±0.02% typical, ±0.05% maximum*
At Power Factor* P< 0.5	
(F between -60° and -90°):	*±0.05%/P maximum*

	VARhour
At 0.0 Lag Power Factor* (-90°):	*±0.025% typical, ±0.1% maximum*
At 0.866 Lag Power Factor* (-30°):	*±0.035% typical, ±0.1% maximum*

3.2 Input

Input Terminal: *BNC, digital display gate*

3.3 Output

Output Terminal: *BNC*

RM-10

Pulse Values:	*Watthour/VARhour/Qhour*	*0.00001*
	Watthour/VARhour/Qhour	*0.00002 (200 Amp Ver.)*

RM-12

Pulse Value:	*Watthour*	*0.00001*

RM-15

Pulse Values:	*Watthour*	*Wh*	*0.00001*
	Kilowatt (1 sec. scan)	*kW*	*0.00001 (outputs in Wh's)*
	VARhour	*VARh*	*0.00001*
	KiloVAR	*kVAR*	*0.00001 (outputs in VARh's)*
	VAhour (Avg/Rms)	*VAh*	*0.00001*
	KiloVA(Avg/RMS)	*kVA*	*0.00001 (outputs in VAh's)*
	MilliVOLT hour (Avg/Rms)	*mVh*	*0.0001*
	MilliAMP hour (Avg/Rms)	*mAh*	*0.0001*
	Volts (Avg/Rms)	*V*	*0.0000001 (outputs in mVh's)*
	Amps (Avg/Rms)	*A*	*0.0000001 (outputs in mAh's)*

NOTES:
- Volts (RMS/Avg) displays in Volts but pulse outputs are in millivolt hours.
- Amps and mAh's act in the same manner as Volts and mVh's.
- mVh (RMS/Avg) displays in millivolt hours and outputs in mVh's.
- Kilowatts displays in kW but outputs in watthours. The same applies to VARhours/kVAR; and VAhours/kVA.

Please note that the standard's display for millivolt hour (mVh) or milliamp hour (mAh) will be off by a factor of 10. This can be compensated for by multiplying the display's readout by 10. The number of output pulses are correct.

The percent of nominal VARhour and Qhour output can be calculated by using the following formulas:

$$\%\ \text{OUTPUT}_{\text{VARhour}} = \sqrt{1 - \text{pf}^2} \times 100$$

$$\%\ \text{OUTPUT}_{\text{Qhour}} = .5(\text{pf} + \sqrt{3} \times \sqrt{1 - \text{pf}^2}) \times 100^{*}$$

*(pf of 1.0 to 0.0 lag)

3.4 Normal Operating Conditions

Input Potential:	*60 to 600 VAC (Autoranging) at 60 Hertz*
	60 to 500 VAC (Autoranging) at 50 Hertz
Input Current:	*0.2 to 50.0 Amperes (Autoranging) RM-10 and RM-15*
	0.2 to 100.0 Amperes (Autoranging) RM-12
Power Factor:	*Any (see accuracy definition)*
Ambient Temperature:	*20° to 30° C (68° to 86° F)*
Relative Humidity:	*0 to 95%*
Auxiliary Power Voltage:	*80 to 600 VAC (Autoranging)*
Frequency:	*48 to 62 Hz (Watthours)*
	50 or 60 Hz (VARhour/Qhour only)
	For Varhour and Qhour correction at other frequencies refer to page 38.
Orientation:	*Any*
Recalibration Interval:	*365 days*
Warm-up:	*30 seconds*
Shock and Vibration:	*Any which is nondestructive*

3.5 Influences Affecting Accuracy

Temperature: *±0.001%/°C typical, ±0.003%/°C maximum (Watthours)*
-20° to 70° C (-4° to 158° F)

±0.003%/°C typical, ±0.001%/°C maximum (VARhour/Qhour only)
-20° to 70° C (-4° to 158° F)

3.6 Protection

Isolation: *Complete: Inputs/Output/Power/Case/Control*
Dielectric Withstand: *2.3 kVrms, 60 Hz, 60 seconds*
Surge Withstand: *IEEE 472 and ANSI 37.90*
Fuses: *Schurter #0342516 or Radian #3001000*

3.7 Burden Values

Potential Input:	**Impedance**	**Input Voltage**	**Burden (V^2/R)**
	1 M W	*120 V*	*0.014 VA*
		240 V	*0.06 VA*
		480 V	*0.23 VA*
		600 V	*0.36 VA*

Current Input:	**Impedance**	**Input Current**	**Burden(I^2R)** single input	**Burden($I^2R/3$)** 3 inputs in parallel
	0.001W	*0.2 A*	*0.00004 VA*	*0.000013 VA*
		0.5 A	*0.00025 VA*	*0.00008 VA*
		5 A	*0.025 VA*	*0.008 VA*
		50 A	*2.5 VA*	*0.8 VA*
		150 A	***DO NOT USE***	*7.5 VA*

Auxiliary Power: *3.5 W for RM-10-01 and RM-12-01*
4.0 W for multifunction RM-10 and RM-15
<10 VA for all units

3.8 Physical Description

Size: *190.5 mm (7.5") **(**216 mm,8.5" for RM-15**) High***
*139.7 mm (5.5") **Wide***
*139.7 mm (5.5") **Deep** excluding latches and strap*

Weight:	*2.5 kg (5.5 lbs); 3.6 kg (8 lbs) shipping weight*
	2.9 kg (6.4 lbs); 4.1 kg (9 lbs) shipping weight for RM-15
Shipping Dimensions:	*305 mm (12") **High***
	*248 mm (9.75") **Wide***
	*248 mm (9.75") **Deep***
Display:	*12.7 mm (0.5") LCD, 6 digits*
	Readout in Watthours, VARhours, Qhours (RM-10)
	Readout in Watthours (RM-12)
	Readout for all measurement functions (RM-15)

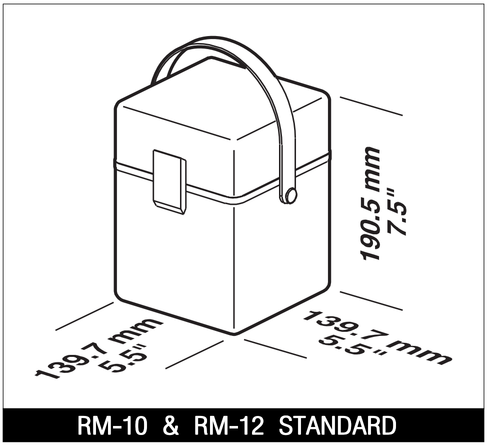


Figure 3.8a RM-10 & RM-12 Physical Dimensions

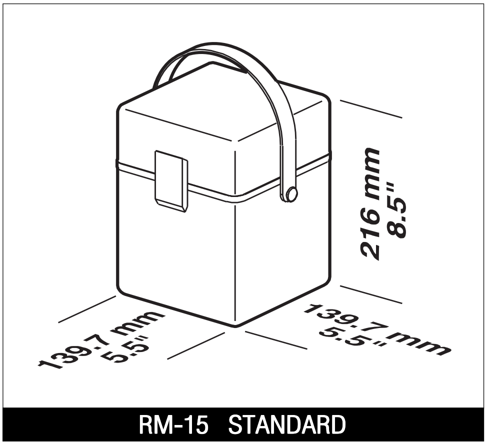


Figure 3.8b RM-15 Physical Dimensions

4.0 Operations Overview

4.1 Auxiliary Power

Auxiliary power is required to power the electronic watt converter, current to frequency converter, display and transformers. It may be derived from the same signal as the potential input providing that there is sufficient volt-amperes available. Auxiliary power may also be supplied independent from the potential input source. The voltage can range from 80 to 600 VAC at any frequency from 48 to 500 Hz. If the auxiliary power is derived from the same potential source as the potential input, no fuses should be between the terminals of the unit under test and the RM-10/12/15. The auxiliary power and power to any load source must be fused independently of the potential input.

The power supply for the RM-10/12/15 is a very advanced switching power supply which is inherently capable of converting the available input power to regulated power over the entire operating range. The converter is so effective at this that the input may be changed freely between the ranges of 80 and 600 volts during operation without a measurable effect upon operation. There are no moving components or relay contacts so reliability is dramatically improved over older designs with rotary switches or autoranging relays.

Because of an absence of ranges to be selected, either manually or automatically, it is very unlikely that a fuse will ever be blown. Fuse replacement may be required if the display fails to indicate. Press the panel reset once if the display is not lit, then verify the AC power is on the auxiliary power terminals with a voltmeter. If power is present, consult Section 5.1 “Fuse Replacement” for fuse replacement instructions. The fuses are mounted underneath the connection terminals and are accessible externally.

For self-powered applications, such as field testing with a load box, best accuracy is obtained if the power wiring to the auxiliary power and to the load box is routed independent of the signal wiring to the potential input. Both should be routed separately to the meter under test then to service power. This avoids the voltage drop induced in the wire to the auxiliary power from being sensed by the potential input. This performance improvement applies to all types of standards.

The potential input must be fused independently if fusing is present. Many commercial load boxes do not fuse potential and auxiliary power independently. Significant improvements in accuracy (as much as 0.25%) can be obtained by correcting such a deficiency. This problem is less for the RM-10/12/15 than for other standards because of the low burden, but should be investigated.

For laboratory and Original Equipment Manufacturer (OEM) use (incorporated within test panels), the RM-10/12/15 auxiliary power is best connected to any convenient AC source which is independent of the potential signal. The source used may be any voltage between 80 and 600 VAC. For optimum performance use a twisted pair cable and do not group in the same bundle as the current leads. For retrofit into older test boards it is advisable to power the RM-10/12/15 from an external 120 volt source as the test board may generate severe transients.

4.2 Current Input

The RM-10 and RM-15 have three separate and isolated current inputs. All are identical and interchangeable, and may be paralleled for lower burden (rarely necessary) or put in series to increase sensitivity. This configuration facilitates easy and accurate closed link testing (Section 11.1) when used with test boards and load boxes with multiple floating current outputs. For most existing load boxes connect the current leads to any one of the current inputs and ignore the other two current inputs. Leave the unused current inputs floating (open). NEVER short an unused current input on any type of watthour standard.

The current input of the RM-10 and RM-15 is autoranging and covers the entire range from 0.2 amperes to 50 amperes in five ranges on only a single input and to 150 amperes with the three inputs in parallel. The five ranges keep the watt converter of the RM-10 and RM-15 close enough to full scale so that full rated accuracy is obtained over this 750:1 range.

The RM-12 has one autoranging current input and covers the entire range of 0.2 amperes to 100 amperes in five ranges. The five ranges keep the watt converter close enough to full scale so that full rated accuracy is obtained over this 500:1 range.

The display is also ranged such that the display always registers in watthours. Hysteresis is provided at the ranging threshold points. The unit is designed for the input current to be set prior to the start of a test to preclude ranging during the course of a test. Tests performed with load boxes or in test panels are performed in this way. Small additional errors will occur on unstable loads, but this additional error is typically less than 0.002% for each range change within a 30 second test. Following are the ranging points for the current axis:

	CURRENT AUTORANGING				
	Range 1	Range 2	Range 3	Range 4	Range 5
Increasing Current	0 - 0.432A	0.433 - 1.731A	1.732 - 6.925A	6.926 - 27.7A	27.71 - 50A
Decreasing	0.356 -	1.425 -		22.80 -	

Table 4.2 Current Autoranging Points

4.3 Potential Input

The potential input of the RM-10/12/15 is entirely autoranging from a range of 60 to 600 VAC. Following are the ranging points for the potential axis:

	POTENTIAL AUTORANGING		
	Range 1	Range 2	Range 3
Increasing Voltage	0 - 152V	153 - 263V	264 - 600V
Decreasing Voltage	129 - 0V	248 - 130V	600 - 249V

Table 4.3 Potential Autoranging Points

For retrofit and replacement of mechanical standards it is customary to parallel, with jumpers, the potential input and auxiliary power input of the RM-10/12/15. Phasing of these jumpers is unimportant. Slightly better performance will be achieved if the auxiliary power and load box power leads are run separately from the potential input leads back to the meter under test. The voltage drop in the lines created by the auxiliary power burden will therefore not be sensed by the potential input leads. If paralleling the two inputs at the RM-10/12/15, a heavier wire, such as 14 gauge, is recommended.

When retrofitting the RM-10/12/15 into a load box, eliminate the potential gating switch and use the Radian Research RM-1S Remote Reset Switch. In the design of the RM-10/12/15 the control means selected to start and stop the indication of energy is by far the more accurate method of controlling the register. Potential gating has an inherent random error which is a maximum of 1/120 of a second or about .02% on a 36 second test and about .2% on a 3.6 second test.

The potential input is totally autoranging so there is no need to select a voltage range. Since both the potential and auxiliary power do not require an operator selection of range, the usual fuse replacement and reliability problems associated with this function are eliminated. Both of these inputs are fused with the fuses being underneath the input terminals. Refer to Section 5.1 for replacement.

Phasing must be observed when connecting the potential. If the phasing is wrong, reverse power flow will not be indicated and the instrument will not register. If no energy is registering, check the phasing and also verify with a voltmeter and a clamp-on type ammeter that the signals are actually present.

4.4 Remote Reset Switch Input

The "Input" connector on the RM-10/12/15 is for connection of a control input to gate the display on and off and to reset it. This input connection replaces both the reset switch and the click switch or photocounter control which gates the potential input. Gating the register rather than the potential input is definitely more accurate on any standard since the measurement circuitry then gets a flying start on the measurement. Potential gating has only been done historically because of a lack of alternatives.

The most common input is the Radian RM-1S Remote Reset Switch. It connects directly to the "Input" connection of the RM-10/12/15 by means of a BNC shielded connector. A momentary push of the button starts the counter. A second push stops it after the test duration (frequently 10 revolutions), freezing the last reading for as long as desired, and a third push will reset the counters to zero for the next test.

Removal of the switch will, within fifteen seconds, permit the unit to enter the continuous run mode, where it may be gated by the potential input. In this mode the unit will behave identical to older electronic and mechanical standards. This would normally be done in retrofit applications where changing an existing photocounter or test board to display gating might not be a justifiable expense. Radian recommends the RM-1A Photo Counter Interface for retrofit applications. This adapter will permit older test boards to do single or two revolution testing in many applications.

The "Input" will also accept a normally closed contact or normally on transistor open collector from any source. The common of the "Input" is fully isolated from the internal common of the standard to eliminate noise or hipot problems. A momentary pulse (open) lasting between .05 and one second will trigger the input. The display circuit will sense the leading edge of the contact open. The "Input" control has no effect on the pulse output. Gating of the potential input does, of course, effect both the display and the output.

4.5 Percent Registration Calculation

The LCD output of the RM-10/12/15 is used to calculate the percent registration of the meter under test. The formula by which this is accomplished is much simpler than the conventional calculation. The output of the RM-10/12/15 reads out in watthours, with a Kh of 1.00 on all ranges. The RM-10/12/15 is also accurate enough and linear enough that correction factors for the standard are not necessary. Hence, the simple calculation of percent registration. The formula to be used is:

$$\%REG = 100 \text{ x } Kh \text{ x } \frac{REV}{(DISPLAY \text{ x } EL)}$$

where “%REG” is the percent registration, “Kh” is the watthour constant of the meter under test, “REV” is the number of revolutions of the test, “DISPLAY” is the displayed value in watthours and “EL” is the number of elements energized with the same current on the meter under test.

For two and one half element meters (two elements, three current leads for four wire circuits), use the value of four for the “EL” in the above calculations.

For one and one half element meters (residential Form 2S meters) a factor of one is used for a standard test and 0.5 elements for a closed link (two current elements on the RM-10 or RM-15) test.

4.6 Pulse Output

The pulse output is available on the RM-10/12/15 display panel as a BNC shielded connector labeled “Output.” The extreme resolution of the RM-10/12/15 yields an output with a calibration of 10 microwatthours per pulse (0.00001 watthours per pulse or 100,000 pulses per watthour). This calibration is the same on all voltage and current ranges.

Table 4.6 Pulse Frequency Table lists the frequencies which are obtained at typical operating voltages and currents. All the values are reduced by 50% at 0.5 power factor. All values are multiplied by the number of current inputs used (EL).

The output frequency may be calculated at any voltage, current and power factor by the following formula:

$$FREQ = EL \text{ x } VOLTS \text{ x } AMPS \text{ x } \frac{PF}{(3600 \text{ x } 0.00001)}$$

where 3600 is the number of seconds in an hour and 0.00001 is the number of watthours per pulse.

To reach the maximum frequency out when designing an interface to a commercial counter or systems interface to the RM-10/12/15, a pull-up resistor of 1000 ohms or less is recommended so that the capacitance of the connecting cables can be overcome without losing counts. If a cable run of more than six feet is necessary, lower the pull-up resistor valueaccordingly. The RM-10/12/15 can sink a maximum of 50 milliamperes, permitting a pull-up resistor limitation of 100 ohms minimum at five volts. If the available power supply cannot supply the current for low resistor values, consider using low capacitance cable for long runs. For test board interface development work, there is no substitute for a close inspection of the output waveform at maximum frequencies with an oscilloscope to verify that there are absolutely no problems with pulses being missed.

The frequencies which are obtained, ranging from 666.7 to 666.667 Kilohertz in Table 4.6, are beyond the input capabilities of some calibration equipment. A variable divide down device makes interface with the older calibration equipment straightforward. The RM-1D Frequency Divider available from Radian Research can solve this problem.

@1.0 pf	120v	240v	480v
0.20A	666.7	1333.3	2666.7
0.25A	833.3	1666.7	3333.3
0.50A	1666.7	3333.3	6666.7
1.00A	3333.3	6666.7	13333.3
2.00A	6666.7	13333.3	26666.7
2.50A	8333.3	16666.7	33333.3
5.00A	16666.7	33333.3	66666.7
10.00A	33333.3	66666.7	133333.3
15.00A	50000.0	100000.0	200000.0
20.00A	66666.7	133333.3	266666.7
25.00A	83333.3	166666.7	333333.3
45.00A	150000.0	300000.0	600000.0
50.00A	166666.7	333333.3	666666.7

Table 4.6 Pulse Frequency Table (pulses per second)

5.0 Service & Routine Maintenance

The RM-10/12/15 Metronic Portable Watthour Standards are virtually maintenance free. The use of a highly advanced all hermetic referencing system reduces drift an order of magnitude and therefore permits yearly recalibrations with no degradation in performance. The elimination of all contacts, switches and tap selections on the primary side of the input transformers significantly improves reliability by eliminating both service components and the opportunity for operator error. Other than cleaning of the outside surface and the yearly recalibration, no routine maintenance is required. Yearly recalibration may be deleted if 0.1% accuracy is specified.

5.1 Fuse Replacement

Fuse replacement is not very likely because of the elimination of primary side switching. However, fuses are included and are accessible without disassembly. There are four fuses: two potential input and two auxiliary power. Fuse replacement is performed as follows:

1. Test for blown fuses. Approximately 14 to 17 Kohms of impedance on the potential input circuit is normal; approximately .08 amperes of cur rent draw is normal at 120 VAC of the auxiliary power.
2. Replace both fuses on a circuit if one is bad.
3. Remove the terminal knobs of the circuit with bad fuses.
4. Remove the stainless steel set screws underneath each of the two terminals with a 1/8 inch Allen (hex key) wrench.
5. Remove the fuses underneath by turning the RM-10/12/15 upside down and shaking the fuses out.
6. Replace the fuses with 5 x 20 mm 1 ampere medium blow fuses. Schurter #0342516 or Radian #3001000 are recommended. If the unit blows the fuses again, the unit needs to be serviced.

5.2 Cleaning

Cleaning of the RM-10/12/15 may be performed with a clean, dry lint-free cloth dampened slightly with a mild window cleaner. The areas around the top terminals should be buffed dry with another cloth which is completely clean and totally dry. This is to maintain dielectric with complete assurance for voltages of 480 volts and higher.

5.3 Repair

Repair is recommended to be performed by Radian Research. We have excellent automated testers with which every internal module can be tested quickly to original factory specifications. A final calibration and quality control inspection to original factory specifications is performed quickly and thoroughly.

5.4 Case Removal

Removal of the case is required to obtain access to the digital decade switches to set calibration. Since the unit is readily subject to damage when out of the case, it is recommended that the change in calibration be determined prior to case removal. For instance, suppose that it is determined that the unit is running 0.007% slow and that the records show that the present setting of the calibration is +0.034%. The new number must be 0.007% higher to correct for the slow output. The RM-10/12/15 can therefore be removed from the case and the switches changed to +0.041.

To remove the case first ease the leather strap off of the strap retainers. Secondly, remove the retainers by inserting a 3/64″ Allen (hex key) wrench through the hole and carefully remove the strap retainer so as not to damage the paint. The RM-10/12/15 can then be slid carefully out of the case by pulling on the lip of the black thermoplastic top panel (DO NOT use a screwdriver to pry the RM-10/12/15 from the case). After recalibration reassemble in the reverse order being careful to replace the internal insulating paper. The internal insulating paper is best wrapped around the RM-10/12/15 and then slid into the case with it. The internal paint can withstand the rated hipot voltage but the insulating paper provides insurance against a breakdown due to scratches.

5.5 Recalibration

Recalibration is recommended yearly. If 0.1% accuracy is acceptable the unit need never be recalibrated. A periodic cross check against another RM-10/12/15 is recommended to preclude the possibility of a failure in either.

6.0 Recalibration

Recalibration is recommended at yearly net intervals. We highly recommend the use of Radian's recalibration service as a very cost effective alternative to manual recalibration by the utility. Our RM-703 Automated Test System has a repeatability of better than 0.001% and an accuracy limited by available calibration from the National Institute of Standards and Technology. Our RM-703 Automated Test System collects a data point on an Radian standard every thirty seconds on up to sixteen standards simultaneously, collecting literally thousands of data points on an overnight run. When using this service, and economics permit, prudence would dictate having a dedicated RM-10 or an RM-11 primary standard which is checked by NIST or NRC (National Research Council in Canada). With this instrument it is feasible to sample test units at various points as a "backup" test.

Historically, watthour standards have had to run at each power setting for considerable periods of time to be calibrated. This has been due to two interacting effects within the input transformers. The high burden of first generation electronic watthour standards causes heating in the input transformers. The accuracy of the transformers and stability of the electronics renders a sensitivity to this heating which must stabilize out for data to be taken. The RM-10/12/15 has such low input burden that this heating is very small. The electronically compensated transformers and advanced references of the RM-10/12/15 are highly immune to heating even if it were not small. Our extremely accurate and cost effective automated recalibration system permits highly accurate data points to be taken within a few seconds of each other (See Figure 6.0a).

CALIBRATION REPORT

RM-11-06 METRONIC PRIMARY WATTHOUR STANDARD

MODE........................... WATTHOURS

DATE............................ 27-Oct-94

SERIAL NUMBER......... **6272**

THE FOLLOWING DATA WAS COLLECTED BY AN RM-703 COMPUTER CONTROLLED CALIBRATION SYSTEM. THE RM-703 CALIBRATION SYSTEM INCORPORATES AN RM-11 PRIMARY REFERENCE STANDARD CALIBRATED BY THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY TO AN UNCERTAINTY OF 0.005% AT UNITY POWER FACTOR AND 0.010% AT 0.5 POWER FACTOR. THE TEST PARAMETERS WERE 23 DEGREES CENTIGRADE WITH A TEST TIME OF 45 SECONDS PER POINT. THE TIMING WAS DONE BY GATING THE PULSE OUTPUT. FOR LAGGING POWER FACTORS, THE CURRENT LAGGED THE VOLTAGE.

VOLTAGE & PHASE ANGLE

AMPS	120 UNITY	120 60' LAG	240 UNITY	240 60' LAG	480 UNITY	480 60' LAG	600 UNITY	600 60' LAG
0.5	0.002	0.000	0.000	0.003	0.001	0.003	0.001	0.006
1.0	0.000	0.001	-0.002	0.003	-0.002	0.004	-0.001	0.006
2.0	-0.002	-0.002	-0.003	0.000	-0.003	0.002	-0.002	0.004
2.5	-0.001	-0.002	-0.004	0.001	-0.004	0.002	-0.002	0.005
3.0	-0.003	-0.002	-0.003	0.000	-0.004	0.002	-0.002	0.005
5.0	0.000	0.000	-0.001	0.001	-0.002	0.004	0.001	0.006
6.0	0.000	0.000	-0.002	0.002	-0.002	0.004	-0.001	0.006
10.0	-0.001	-0.003	-0.001	0.002	-0.001	0.002	-0.001	0.005
12.0	0.000	-0.001	-0.001	0.001	-0.001	0.004	0.000	0.006
15.0	0.000	0.001	-0.002	0.002	-0.002	0.003	0.001	0.006
20.0	0.001	0.001	-0.001	0.002	-0.002	0.005	0.000	0.007
25.0	0.000	-0.001	-0.001	0.003	-0.001	0.005	0.001	0.006
30.0	0.000	0.000	-0.001	0.002	-0.001	0.005	0.000	0.006
40.0	0.001	0.001	-0.001	0.002	-0.002	0.005	0.000	0.007
45.0	0.001	0.001	-0.001	0.004	-0.002	0.005	0.001	0.007
50.0	0.001	0.001	-0.002	0.002	-0.002	0.005	0.000	0.007
AVERAGE	**0.000**	**0.000**	**-0.002**	**0.002**	**-0.002**	**0.004**	**0.000**	**0.006**
MAXIMUM	0.002	0.001	0.000	0.004	0.001	0.005	0.001	0.007
MINIMUM	-0.003	-0.003	-0.004	0.000	-0.004	0.002	-0.002	0.004

OVERALL

	UNITY	60' LAG
AVERAGE	-0.001	0.003
MAXIMUM	0.002	0.007
MINIMUM	-0.004	-0.003

Figure 6.0a Typical Radian Calibration Report

The watthour calibration of the RM-10/12/15 is changed by the setting of two ten-position digital switches located on the bottom printed circuit board of the standard. The switches have 199 possible settings between +0.099 and -0.099%. As referenced to Figure 6.0b, Switch 1 changes the second calibration digit to the right of the decimal point and Switch 2 changes the third calibration digit to the right of the decimal point. Switch 3 changes the registration from negative (left position) to positive (right position). To adjust to 100.000% registration, mathematically subtract the percent error of the standard from the number derived by reading the three switches. To illustrate the process of recalibrating a Radian standard using the digital switches, the following four examples are given:

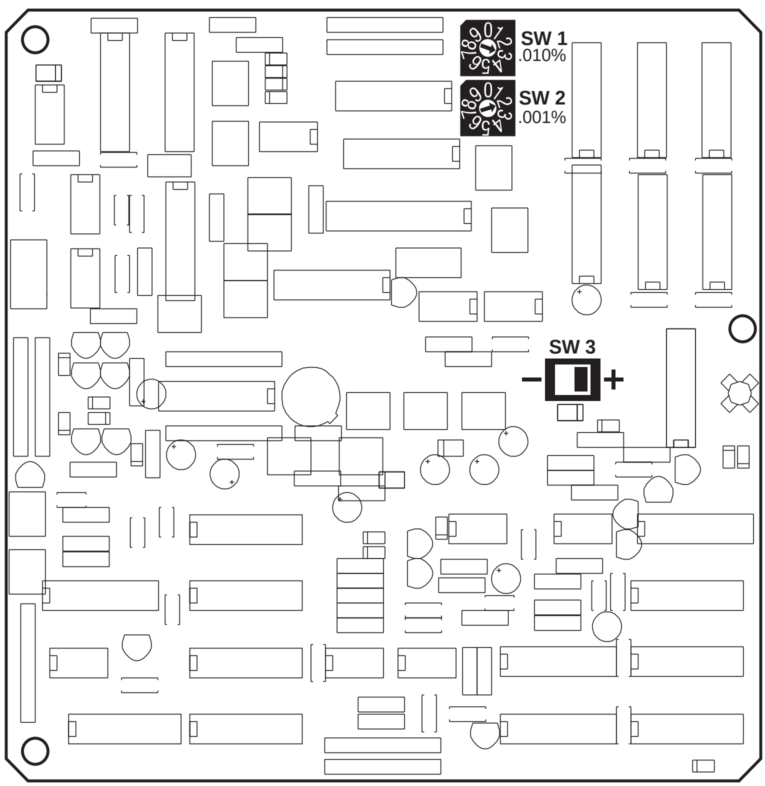


Figure 6.0b Digital Switch Location

1. Initial switch settings are SW1=3, SW2=2 and SW3=right (+0.032) and the percent error of the standard is –0.005%. Therefore, the standard is running at 99.995% registration or 0.005% slow. To adjust to 100.000% registration the new switch settings would be SW1=3, SW2=7 and SW3=right (+0.037). [+0.032 – (–0.005) = +0.037]

2. Initial switch settings are SW1=3, SW2=2 and SW3=right (+0.032) and the percent error of the standard is +0.005%. Therefore, the standard is running at 100.005% registration or 0.005% fast. To adjust to 100.000% registration the new switch settings would be SW1=2, SW2=7 and SW3=right (+0.027). [+0.032 – (+0.005) = +0.027]

3. Initial switch settings are SW1=1, SW2=8 and SW3=left (–0.018%) and the percent error of the standard is –0.007%. Therefore, the standard is running at 99.993% registration or 0.007% slow. To adjust to 100.000% registration the new switch settings would be SW1=1, SW2=1 and SW3=left (+0.011). [–0.018 – (–0.007) = –0.011]

4. Initial switch settings are SW1=0, SW2=1 and SW3=right (+0.001%) and the percent error of the standard is +0.004%. Therefore, the standard is running at 100.004% registration or 0.004% fast. To adjust to 100.000% registration the new switch settings would be SW1=0, SW2=3 and SW3=left (–0.003). [+0.001 – (+0.004) = –0.003]

Historically, calibration factors have been used instead of adjusting standards. The primary intent was to maintain a calibration history. Units with substantial drift could be detected by virtue of a continuously changing calibration factor with time. The problem with readjustment was that potentiometers and other screw adjustments became more unstable mechanically after adjustment than before. The digital decade switches of the RM-10/12/15 cannot be bumped or jarred from their setting in transportation or handling and the switches themselves provide the calibration history. The switch settings should definitely be recorded with the date at the time of each recalibration. A typical sheet may look as follows:

Date	Setting	Notes
3/06/94	+.032	NEW UNIT, AS RECEIVED
6/06/94	+.037	THREE MONTH CHECK OF NEW UNIT
3/06/95	+.039	ROUTINE YEARLY RECALIBRATION
3/09/96	+.039	ROUTINE YEARLY RECALIBRATION
3/06/97	+.039	ROUTINE YEARLY RECALIBRATION

Table 6.0 Typical Recalibration Sheet

A recalibration is normally performed at 120 VAC, 5 amperes and unity power factor. A reason for checking for power factor error and for error on each range is to check against the very remote possibility of a failure which may have occurred which is not apparent at the reference point.

To verify full accuracy on every internal range it is sufficient to check the RM-10/12/15 approximately every factor of two on current and voltage: 0.1, 0.2, 0.5, 1, 2, 5, 10, 20 and 50 ampere checks as well as 80, 120, 240 and 480 volt checks will assure that all ranges are properly functioning. The RM-10/12/15 should be within 0.025% at all unity power factor points and within 0.05% at all 0.5 power factor points.

Gang testing is the most economical method of calibration verification on RM-10/12/15 Standards. A number of standards are powered with auxiliary power in parallel, potential inputs in parallel and currents in series (unused currents inputs are open of course). The "Input" connections on the RM-10/12/15 registers are paralleled using one RM-1G cable per RM-10/12/15 so that one RM-1S Remote Switch controls all RM-10/12/15 Standards. Optionally, an RM-109 Digital Watthour Comparator may be used in place of the RM-1S. If testing other types of standards along with RM-10/12/15 Standards then the RM-109 Comparator is necessary.

7.0 Test Board Retrofit

The retrofit of an RM-10/12/15 Metronic Portable Watthour Standard to an existing test board is an economical way of achieving dramatic improvements in performance. The basic accuracy of a test board, properly retrofitted so as to eliminate any existing instrument transformers, is limited only by the accuracy of the RM-10/12/15 itself. Radian test accessories, such as the RM-1N, RM-1H, RM-DS and RM-1S can be added to successfully test solid state and induction meters. Note that with these Radian test accessories, it is not necessary to use the test board's counter or optics.

If you are not thoroughly familiar with the internal operation of your test board send us a copy of the schematic of the test board before attempting installation. Send it to:

Test Board File
Radian Research, Inc.
3852 Fortune Drive
Lafayette, IN 47905
USA

When retrofitting an RM-10/12/15 into an existing test board there are four factors to consider: current inputs, potential input, auxiliary power input and watthour display. Each item is explained in the following sections.

7.1 Current Inputs

The current inputs are to be connected directly in series with the meter under test. This frequently means that there are four or five different current leads to be rendered common to a single current input on the RM-10/12/15. Jumpering of the unused lower current outputs to the 50 ampere output at the output of the test board is the most convenient way to accomplish this. For an initial installation you may use your old standard to sum the four currents to one by seriesing the RM-10/12/15 with the common of the old standard.

7.2 Potential Input

The potential input is to be connected directly across the meter under test. For test tables equipped with four potential outputs for dual coil standards usually the desired voltage exists across two of these. Significant gains in accuracy will be obtained by bypassing any internal potential transformers. The potential input transformer of the RM-10/12/15 is far more accurate than any potential transformer used in commercial test tables.

7.3 Auxiliary Power Input

The auxiliary power input is to be connected to any available fixed power source. The auxiliary power input cannot be connected to the potential signal since potential gating would turn the RM-10/12/15 off after every test. If the RM-10/12/15 registers counts on changing ranges of the test board, power the RM-10/12/15 from a source not connected to the test board.

7.4 Display

The display reads out in watthours which is more convenient but different than “revolution” readouts. The readout in watthours is simpler to use and to learn than the revolution readouts, particularly where there are a variety of types of meters to be tested.

The following installation procedure will significantly reduce the possibility of improper connection or misapplication in retrofitting an RM-10/12/15:

1. Power the RM-10/12/15 by connecting a continuous source of 120 or 240 VAC power to the auxiliary power terminals. Run a test or two with the old standard and observe that the display of the RM-10/12/15 remains on continuously.
2. Connect one RM-10/12/15 current circuit in series with the common of the current circuit of the old standard. Run a test or two with the old standard and observe that the test board performs normally.

3. Connect the RM-10/12/15 potential in parallel with the potential of the old standard. The accuracy of the RM-10/12/15 may be degraded with a mechanical standard in parallel on potential gating due to inductive kickback, but functionality should be observed. Run a test or two with the old standard and observe normal operation.
4. The RM-10/12/15 should be operating. If it is not, try reversing the potential or current. If the RM-10/12/15 is still not registering power, check for nominal voltage and current at its terminals. Make sure that there is nothing connected to the INPUT connector of the RM-10/12/15 if you are using potential gating.
5. Remove the old standard and run one or two tests. Try all voltages used on your test board and verify that the potential voltage on the RM-10/12/15 is identical to the test voltage.

Further assistance is available from the factory. When consulting the factory, sending a copy of the schematic of the particular test board is very helpful.

The RM-1A Photo Counter Interface is available from Radian Research to eliminate the inherent errors of potential gating and thereby achieve the inherent ability of the RM-10/12/15 to perform single revolution testing. Note that the RM-1A is necessary only if the test board's counter is still being used. The RM-1A is not needed if the test board's counter has been replaced with the RM-1N Solid State Meter Interface.

8.0 VARhour / Qhour Models

8.1 Potential Gating

Potential gating, a time honored approach which today should be avoided because of more accurate approaches, is fundamentally incompatible with the VARhour or Qhour function. All Radian standards are designed for gating of the register rather than the potential, thus making a VARhour or Qhour standard practical. The Radian RM-1A Photocounter Interface is recommended to eliminate the need for potential gating for applications where the hardware or procedures already exist; such as with older test board designs.

8.2 Stability

The stability of the VARhour and Qhour function of the RM-10 and RM-15 is significantly improved over that of older VARhour circuits. The stability is improved by eliminating electrolytic capacitors from the signal path and by using all hermetically sealed reference components. The capacitors used are the most stable type film capacitors known. 90 day recalibration and avoidance of temperature excursions beyond 10 to 40 degrees Celsius are recommended to attain the highest possible stability. Recalibration should be performed at 120 Volts, 5 Amperes and 100% output. The phase error of the VARhour or Qhour circuit is small enough that it never needs to be calibrated.

Stability of the VARhour or Qhour function is enhanced considerably by avoiding temperature extremes. There is a hysteresis of about 0.02% by going from temperature extremes for long periods (greater than 12 hours) and then returning to room temperature. The hysteresis set can be eliminated by temperature cycling (-20, +70, -10, +60, +0, +50, +10, +40, +20 °C).

8.3 Function Select

To change from one measurement parameter (ie: Watthours, VARhours or Qhours) to another, simply press the "Select" pushbutton on the RM-10 or RM-15 top panel (Figure 2.1 & 2.3). Annunciators on the custom liquid crystal display indicate the measurement mode of the standard.

8.4 I/O Control / Communications Port

On all multifunction RM-10 and RM-15 Standards an Input/Output port is located in the upper right corner of the top panel. The I/O port can function as a direct control port or as an intelligent communication port.

In the direct control mode the I/O port can be used to: (1) select the measurement mode and (2) cycle the display from one mode to another (ie: free run, stop or reset). Detailed technical information on the direct control mode of the I/O port is presented on the following two pages.

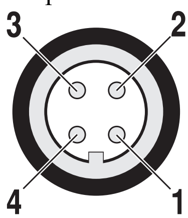
In addition to the direct control mode, the I/O port can be used as an intelligent computer communication interface. In this mode any PC-compatible computer can be used to do the following:

1. Select the measurement mode
2. Cycle the display from one mode to another
3. Read the display value
4. Input and read the serial number of the standard
5. Input and read the last calibration date of the standard
6. Input and read other record keeping data

The Radian Research RM-PCA Computer Interface Adapter connects to the I/O port and to the serial port of a computer. The RM-PCA provides access to the standard's display through the PCA-*Link*™ Meter Test Software.

Contact our headquarters for more detailed technical information.

Pin Description:



Pin 1 (black)	:	Common
Pin 2 (green)	:	Display Control
Pin 3 (red)	:	VARhour Control
Pin 4 (white)	:	Qhour Control

Figure 8.4a I / O Port Pin Description

Drive Options:

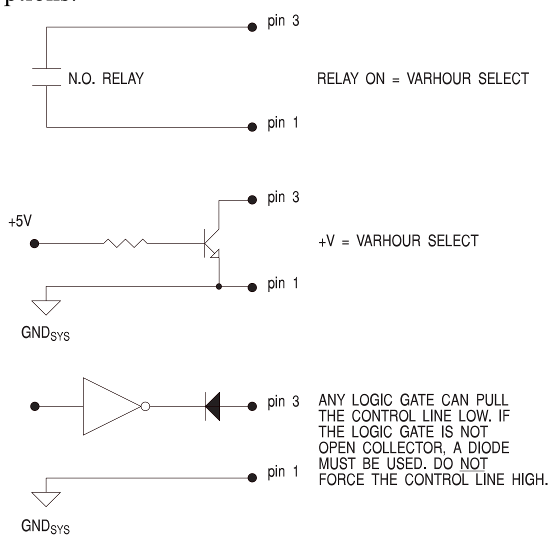


Figure 8.4b Drive Options

Mode Select Options:

To select a mode, the control line must be pulled to common (need to sink 3 mA at no more than 0.7V).

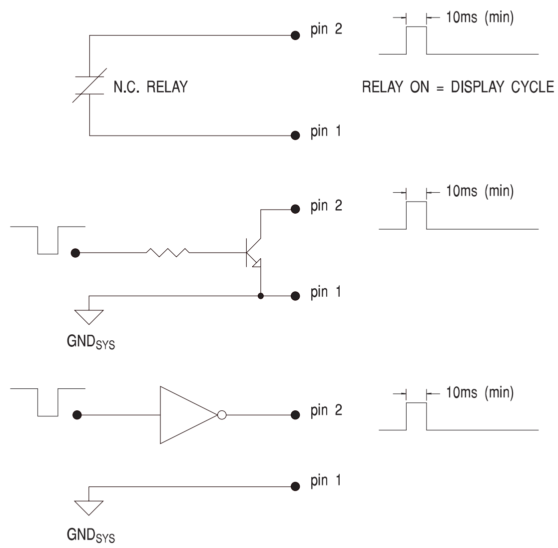


Figure 8.4c Mode Select Options

Display Control Options:

The display control is accomplished by making a connection between pins 1 and 2. This connection signals the display to enter the display gate mode. The connection can be accomplished with a normally-closed relay, an open collector output or a driven output. To cycle the display this circuit must be opened for at least 10ms. The rising edge is the timing marker.

Low (closed) = 1mA at less than 0.7 volts

High (open) = 4.5 volts (pulled up internally)

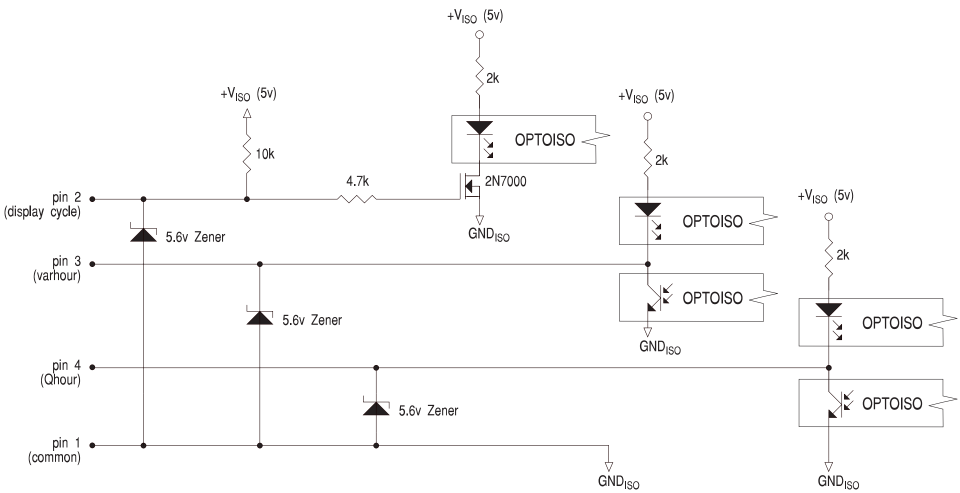


Figure 8.4d Display Control Options

- Varhour correction formula for RM standard calibated at 60 Hertz but used at a different frequency:

$$\text{Varhour Actual} = \text{Varhour}_{RM} \times \frac{\text{Actual Frequency}}{60}$$

- Varhour correction formula for RM standard calibrated at 50 Hertz but used at a different frequency:

$$\text{Varhour Actual} = \text{Varhour}_{RM} \times \frac{\text{Actual Frequency}}{50}$$

- Qhour correction formula for RM standard calibrated at 60 Hertz but used at a different frequency:

$$\text{Qhour Actual} = \text{Qhour}_{RM} \times \left(\frac{\sqrt{1 + 3\left(\frac{f}{60}\right)^2}}{2} \right) \left(\frac{\cos(\theta + 60^\circ)}{\cos\left[\theta + \tan^{-1}\left(\sqrt{3}\,\frac{f}{60}\right)\right]} \right)$$

- Qhour correction formula for RM standard calibrated at 50 Hertz but used at a different frequency:

$$\text{Qhour Actual} = \text{Qhour}_{RM} \times \left(\frac{\sqrt{1 + 3\left(\frac{f}{50}\right)^2}}{2} \right) \left(\frac{\cos(\theta + 50^\circ)}{\cos\left[\theta + \tan^{-1}\left(\sqrt{3}\,\frac{f}{50}\right)\right]} \right)$$

Where:

Varhour Actual = the corrected Varhour accumulation
Qhour Actual = the corrected Qhour accumulation
f = frequency
Varhour RM = the RM standard's Varhour accumulation
Qhour RM = the RM standard's Qhour accumulation
o = phase angle difference between voltage and current

9.0 200 Amp Models

The RM-10/15 Standard has a 50 ampere per input current specification (150 amperes total). The RM-10/15 is also available in a 200 ampere configuration. To achieve the 150 or 200 ampere current input capacity the three current inputs must be paralleled (Figure 9.0).

Use #4 or larger cable making sure that the total length of the three current paths are equal. Tightly bundle the leads and route as indicated in Figure 9.0. The routing is important as at high current inputs the magnetic field created can affect the accuracy of the unit. Also, make sure the current input knobs are securely tightened.

The specifications of all 200 Ampere models are identical to the standard 150 Ampere models with the following exception:

OUTPUT PULSE VALUE = 0.00002 watthours per pulse

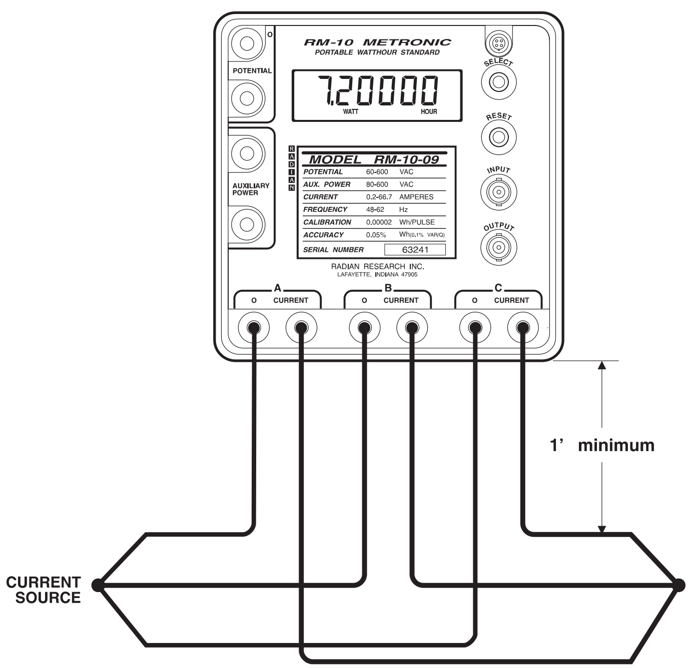


Figure 9.0 Paralleling the Three Current Inputs

10.0 Test Accessories

10.1 RM-1S Remote Reset Switch

The RM-1S Remote Reset Switch is a normally closed push button switch. The RM-1S will connect directly to the "Input" BNC of a Radian standard or to the RM-1S Input of the RM-1N Solid State Meter Interface. The switch of the RM-1S is hermetically sealed to provide increased reliability during field use. The push-button has tactile feel to provide instantaneous feedback of switch actuation.

Specifications

Application:	*Used to reset the display of a Radian standard and re-arm the RM-1N*
Switch:	*Normally closed contact; momentary open*
Size:	*Handle; 19 mm (.75") dia. x 79 mm (3.1")*
	RM-1S Cable; 1727 mm (68") Length
	RM-2S Cable; 2743 mm (108") Length
Weight:	*RM-1S, .12 kg (.26 lbs)*
	RM-2S, .15 kg (.33 lbs)

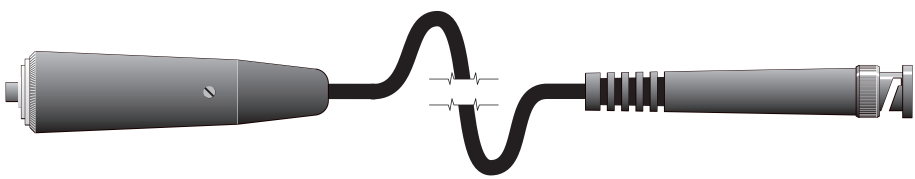


Figure 10.1 RM-1S Remote Reset Switch

10.2 RM-1N Solid State Meter Interface

The RM-1N is a lightweight, compact electronic counter designed to meet numerous field and shop testing applications. In the field, the RM-1N will provide for totally automated testing of both solid state and induction meters. The RM-1N controls the test by automatically starting the display of the Radian standard and then stopping the display after it has counted a specified number of pulses. In the shop, the RM-1N will interface any solid state meter with existing calibration equipment.

In field testing applications the output of the RM-1N is used to gate the display of any Radian standard. The rate of output to input pulses can be set by selecting the appropriate input pulse divisor. The RM-1S Remote Reset Switch is used to reset the Radian Standard's display and re-arm the RM-1N's counter. The RM-1N can operate either on battery or AC power. These plus other features allow for convenient and cost effective field testing of solid state and induction meters.

When testing solid state meters, the input pulses to the RM-1N are received via the RM-1H Infrared Optical Pickup. The RM-1H senses pulses from the infrared calibration LED found on most solid state meter designs. These infrared pulses are then sent to the pulse input of the RM-1N to be counted.

When testing induction meters, the RM-DS Meter Disk Sensor is used to reflectively sense disk rotations. The RM-DS will sense disk rotation and send pulses to be counted to the input of the RM-1N electronic counter.

Both solid state and induction meters can be tested from the KYZ output with the RM-KYZ Pulse Input Adapter. The RM-KYZ will sense the meter's KYZ pulses and send pulses to be counted to the pulse input of the RM-1N.

The RM-1N is used to interface a solid state meter to existing shop calibration equipment. The input pulses are received via the RM-1H Optical Pickup. The output pulses of the RM-1N are fed into the optics assembly of a calibration test board. This interface to the test table's optics is done via the RM-1P Electronic Light Valve. The output of the RM-1N can also be interfaced directly to a test table's open collector input (if available).

Specifications

Inputs:	*Pulse Input; for RM-1H, RM-KYZ or RM-DS*
	RM-1S Input; to reset RM-1N and Radian standard
Max. Input Freq.:	*60 pulses per second*
Outputs:	*Open Collector Output; for interface to Radian standard or open collector input of test board*
	RM-1P Output; for connection to RM-1P Electronic Light Valve
Accuracy:	*.0001% transfer error for life*
Input Power:	*Internal 9V battery or 120V AC adapter (provided with unit)*
Size:	*112 mm (4.4") **H** x 83 mm (3.25") **W** x 45 mm (1.75") **D** (excluding BNCs)*
Weight:	*.26 kg (.57 lbs); .9 kg (2 lbs) shipping weight*
Counter:	*4 digit (pushwheel type)*
Battery Type:	*9V alkaline*
	Use Radian #800001, Duracell MN16004B2 or Eveready 522BP-2
Battery Life:	*Approximately 400-500 hours of operation*

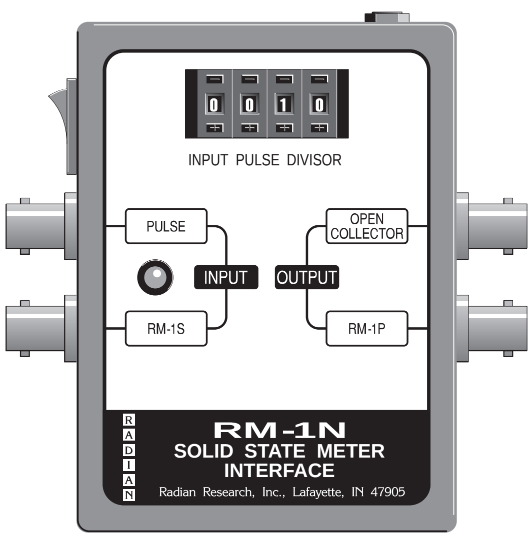


Figure 10.2 RM-1N Solid State Meter Interface

10.3 RM-1H Optical Pickup for Infrared LED

The RM-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 RM-1H are fed into the input section of the RM-1N Solid State Meter Interface or RM-109 Digital Watthour Comparator. With the RM-1H and the RM-1N or RM-109, testing of solid state watthour meters is done automatically. The wide angular displacement of this sensor allows for fast, noncritical alignment. Also, automatic gain control circuitry of the RM-1H assures operation in all ambient sunlight conditions. The RM-1Hv is available for those solid state meters that provide a visible calibration LED.

Specifications

RM-1H Application:	*Senses pulses from infrared calibration LED; input pulses to RM-1N or RM-109*
Peak Sensitivity Wavelength:	*980nm*
Size:	*Case; 30 mm (1.2") **H** x 57 mm (2.25") **W** x 23 mm (.9") **D*** *Cable; 1803 mm (71") Length*
Weight:	*.09 kg (.19 lbs)*

Specifications

RM-1Hv Application:	*Senses pulses from visible calibration LED; input pulses to RM-1N or RM-109*
Peak Sensitivity Wavelength:	*680nm*
Size:	*Case; 30 mm (1.2") **H** x 57 mm (2.25") **W** x 23 mm (.9") **D*** *Cable; 1803 mm (71") Length*
Weight:	*.09 kg (.19 lbs)*

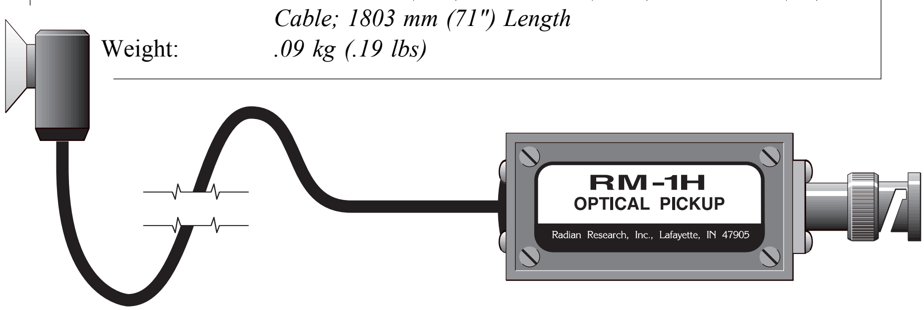


Figure 10.3 RM-1H Infrared Optical Pickup

10.4 RM-DS Meter Disk Sensor

The RM-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 RM-DS are fed into the input section of the RM-1N Solid State Meter Interface or the RM-109 Digital Watthour Comparator. With the RM-DS and the RM-1N or RM-109, testing of induction type meters is done automatically and with a high degree of accuracy as compared to using a conventional push-button or snap switch.

Specifications

Application:	*Senses disk rotation of an induction meter. The signal is conditioned and sent to the RM-1N or RM-109*
Supply Voltage:	*9 volts DC to 24 volts DC*
Current Consumption:	*30mA*
Max. Detection Distance:	*100 mm (4")*
Size:	*Case; 30 mm (1.2")* ***H*** *x 57 mm (2.25")* ***W*** *x 23 mm (.9")* *Cable; 2032 mm (80") Length*
Weight:	*.13 kg (.29 lbs) RM-DS only*
Field Mount Version:	*Pickup Assembly; 95 mm (3.75")* ***H*** *x 71 mm (2.8")* ***W*** *x 44 mm (1.75")* ***D****, .1 kg (.22 lbs)*
Shop Mount Version:	*Base; 51 mm (2.0") dia. x 9.7 mm (.38"), .17 kg (.38 lbs) with Flexible Arm* *Flexible Arm; 8 mm (.32") dia. x 465 mm (18.3")*Shop
Suction Mount Version:	*Pickup assembly; 57.7 mm (2.27")* ***H*** *x 44 mm (1.73")* ***W*** *x 44 mm (1.73")* ***D****, .05 kg (.12 lbs.)*

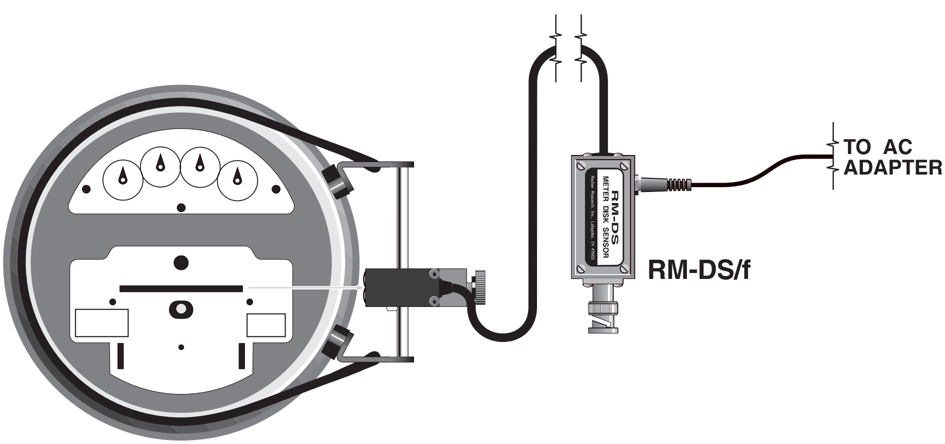


Figure 10.4a RM-DS/f Meter Disk Sensor (field mount version)

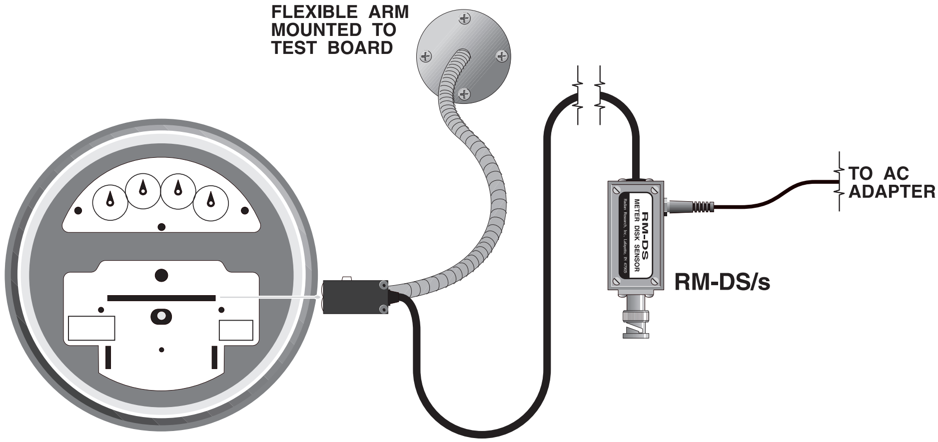


Figure 10.4b RM-DS/s Meter Disk Sensor (shop mount version)

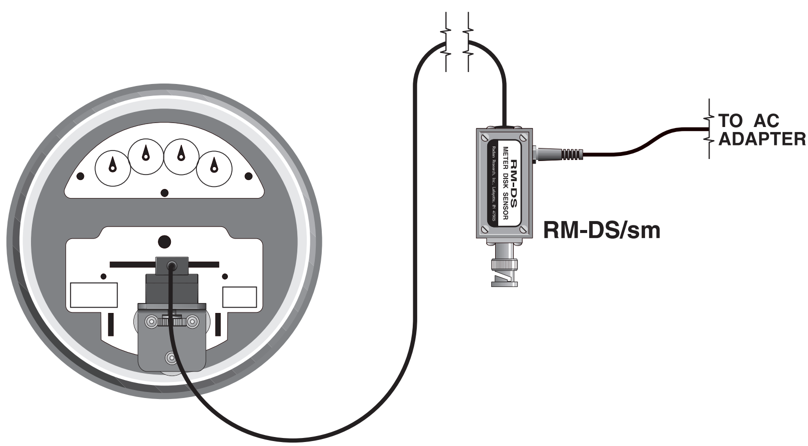


Figure 10.4c RM-DS/sm Meter Disk Sensor (suction mount version)

10.5 RM-KYZ Pulse Input Adapter

The RM-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 input section of the RM-1N Solid State Meter Interface or the RM-109 Digital Watthour Comparator. With the RM-KYZ and the RM-1N or RM-109, testing of KYZ equipped meters is done automatically.

Specifications

Application:	*Senses pulses from the KYZ output of a meter. The signal is conditioned and sent to the RM-1N or RM-109. For proper operation, meter output must be a true 3 wire Form C output.*
Max. Pulse Input Frequency:	*60 pulses per second*
Size:	*Case; 30 mm (1.2") **H** x 57 mm (2.25") **W** x 23 mm (.9") **D*** *Cable; 1905 mm (75") Length*
Weight:	*.13 kg (.29 lbs)*

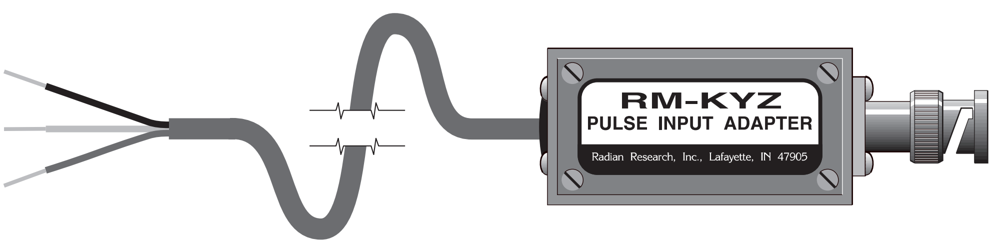


Figure 10.5 RM-KYZ Pulse Input Adapter

10.6 RM-1P Electronic Light Valve

The RM-1P Electronic Light Valve is used to interface the output of the RM-1N Solid State Meter Interface or the RM-109 Digital Watthour Comparator with the optics of a calibration test board. The RM-1P will operate with both incandescent and infrared optic assemblies. To trigger incandescent source optics, the RM-1P uses a super luminous LED. This red visible light LED must be aligned with the sensing assembly of the test table's optics. To trigger infrared (modulated or non-modulated) source optics, the RM-1P uses an infrared sensor and emitter combination. With the use of the RM-1P with the RM-1N and RM-1H, solid state meters can effectively be interfaced to older test board designs.

Specifications

Application:	*Interface with optics of calibration test board*
Emitter for Incandescent Optics:	*Superluminous LED with 5000mcd luminous intensity and peak emission wavelength of 660nm*
Sensor/Emitter for Infrared Optics:	*Infrared sensor with peak sensitivity wavelength of 960nm. Two sets of infrared emitter LED's with peak emission wavelength of 950nm.*
Size:	*Case; 61 mm (2.4") H x 97 mm (3.8") W x 23 mm (.9") D* *Rod; 356 mm (14") Length* *Clamp Assembly; 89 mm (3.5") H x 38mm (1.5") W x 19 mm (.75") D* *Cable; 1219 mm (48") Length*
Weight:	*.25 kg (.55 lbs)*

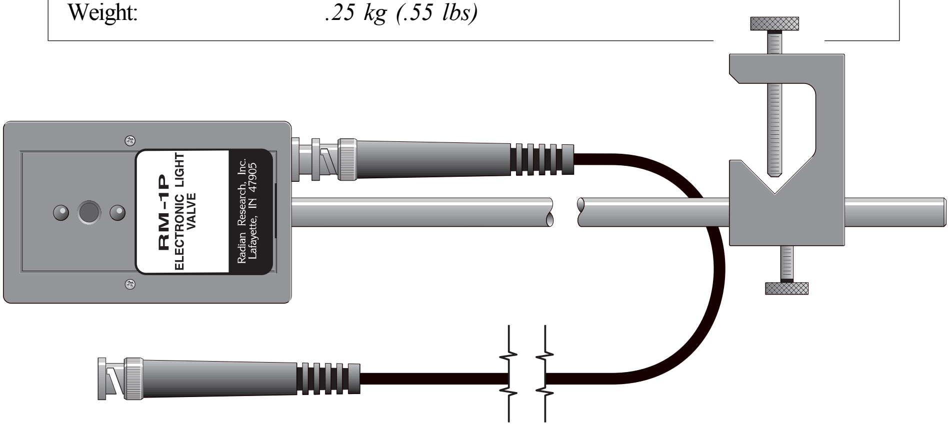


Figure 10.6 RM-1P Electronic Light Valve

10.7 RM-PCA Computer Adapter and PCA-*Link*™ Meter Test Software

PCA-*Link*™ Meter Test Software automates field testing and eliminates the need for manual record keeping by metering personnel. All meter test variables are entered with minimal key strokes from a single screen. Multiple test configurations may be created and saved to memory. Each configuration contains user-definable fields to record any additional test information. Examples may include: customer account number, service connection code, voltage checks, current checks, etc. This flexible format allows for customized test configurations as well as increased efficiency.

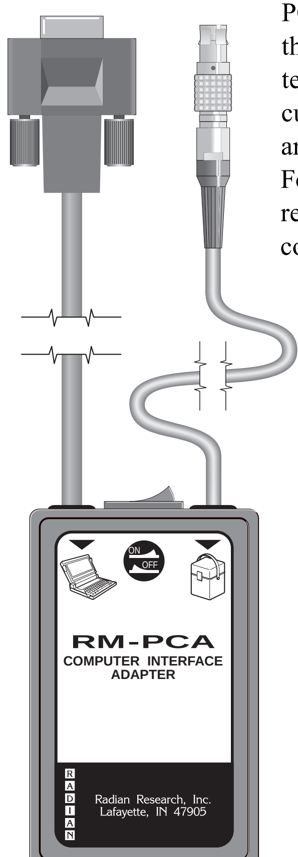


Figure 10.7a RM-PCA Computer Interface Adapter

PCA-*Link*™ will display the standard's reading on the computer screen at the conclusion of each test. The percent registration is automatically calculated for Light Load, Full Load, Power Factor and kW Demand. Test results may be saved for "As Found," "As Left" and "Individual Elements." Test results are saved on the computer's hard disk according to the meter serial numbers. Data is in ASCII file format so that it can be uploaded into and processed by commercial software packages such as Lotus® 1-2-3, Microsoft® Excel or Word.

PCA-*Link*™ operates with the RM-PCA Computer Interface Adapter. The RM-PCA is an intelligent cable assembly which interfaces the serial port of a computer to the I/O port of a Radian standard. Popular Radian test accessories, such as the RM-1N, RM-1H, RM-KYZ, RM-DS and RM-1S, can be effectively used with the RM-PCA and PCA-*Link*™ Software. PCA-*Link*™ Software, RM-10 Standard and Radian test accessories can be used to upgrade older test boards and load boxes. This upgrade will not only automate testing but will also provide the accuracy required for testing solid state meters.

PCA-*Link*™ comes complete with a simple install program and a fully illustrated operations manual. The manual provides step-by-step procedures for conducting a complete test using PCA-*Link*™ with Radian test accessories.

Specifications

Application:	*Interface a Radian standard to a personal computer*
Size:	*97 mm (3.8") **H** x 61 mm (2.4") **W** x 23 mm (.9") **D***
Weight:	*.18 kg (.39 lbs)*
Cable:	*9 Pin Serial Port; 203 mm (8"), 4 Pin Lemo; 1829 mm (72")*
Battery Type:	*9 Volt alkaline* *Use Radian #800001, Duracell MN16004B2 or Eveready 522BP-2*
Battery Life:	*Approximately 1700-1800 hours of operation*

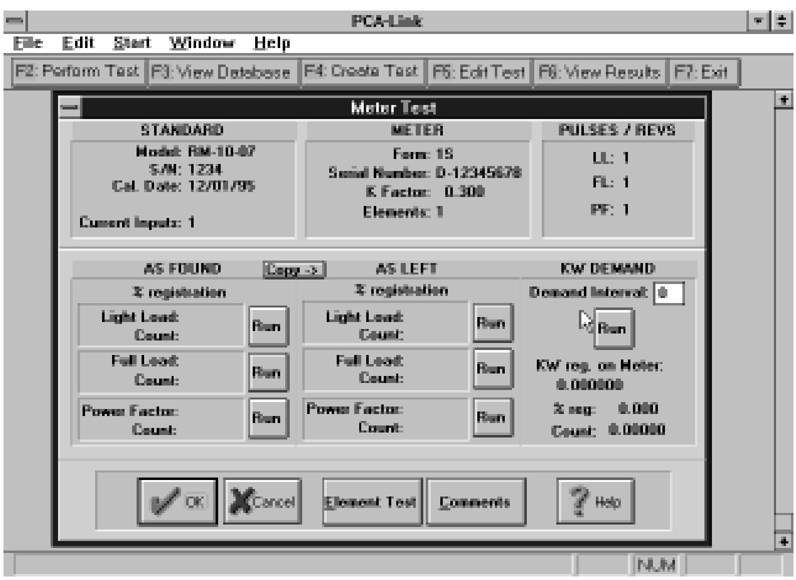


Figure 7.6b PCA-*Link*™ Meter Test Software
Main Menu and Test Screen

10.8 RM-1D Frequency Divider

The RM-1D Frequency Divider is designed primarily to reduce the output frequency of the RM-10/12/15 to interface to older equipment. The RM-1D can also be used for other scaling operations by creating an output with no diode drops for compatibility with all logic types.

The output pulse rate of the RM-10/12/15 standard is 10 microwatthours per pulse (0.00001 watthours per pulse) which is high enough resolution for the most demanding single revolution or high accuracy testing requirements. The calibration factor goes up proportionally to the divide ratio selected:

Ratio	Kp in Watthours/Pulse
2	0.00002
10	0.00010
20	0.00020
100	0.00100
200	0.00200
1000	0.01000
2000	0.02000
10000	0.10000

The Output of the RM-1D is an open collector. It will interface to all commercial test equipment designed to accept an open collector input. It will not drive a commercial counter such as those from Fluke, Hewlett-Packard or Phillips because they have no internal pull-up. A one Kohm pull-up resistor and a 1.5 to 5 volt D.C. source will work to provide the signal to commercial counters. We recommend that the counter input be set on D.C. with a slight positive threshold shift. Using the counter on A.C. works fine for high frequency outputs but may cause errors on very low frequency outputs or on the start of a test.

Accuracy is not directly affected by using the RM-1D. Indirectly, accuracy (resolution) is degraded to some degree any time a frequency divider is used. However, this degradation is unavoidable if the instrument being used is incapable of accepting a high frequency.

SPECIFICATIONS

Application:	*Divides the pulse output frequency of Radian standard*
Size:	*112 mm (4.4") **H** x 83 mm (3.25") **W** x 45 mm (1.75") **D***
	(excluding BNCs and knob)
Weight:	*.18 kg (.39 lbs)*
Cable:	*Female BNC to Female BNC; 610 mm (24"), .05 kg (.11 lbs)*
Battery Type:	*3 Volt lithium*
	Use Radian #800000, Duracell 123A or Panasonic Br-$^{2}/_{3}$A 3V
Battery Life:	*Approximately 600-800 hours of operation*

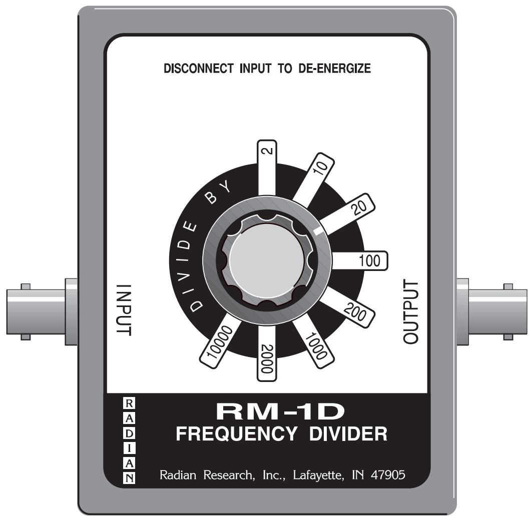


Figure 10.8 RM-1D Frequency Divider

10.9 RM-1A Photo Counter Interface

The RM-1A Photo Counter Interface permits direct control of the register of one or more RM-10 Metronic Watthour Standards. This permits use of equipment which had been previously designed for potential gating to use the superior register gating input of the RM-10. By using the RM-1A higher accuracy, single revolution testing, multiple RM-10 testing and ease of retrofit can be had in a variety of applications.

The "Input" of the RM-1A is connected directly to a floating normally open contact by means of the included cable. If this same contact has previously been used to potential gate another standard then remove the two potential wires from the contact and permanently connect them to each other. No other wires should be connected to theses contacts. The RM-1A senses the closure of the contact attached to the "Input" and initiates a pulse at its output. It also senses the opening of this contact and initiates another pulse to stop the register.

The "Input" contact is generally derived from an older photocounter. The signal necessary to sense the contact closure is supplied by the RM-1A with no external source being required.

The "Output" of the RM-1A is connected to the RM-10 "Input" with the included BNC cable. The RM-10 register is then directly controlled by the contact connected to the "Input."

The operation of the RM-1A is dependent on the three cycle Input of the RM-10. To initiate a test, press the "Reset" button of the RM-10 and begin the test. The RM-10 register will start when the contact connected to the "Input" of the RM-1A is closed and will stop when it is opened. Press the "Reset" button again to initialize the RM-10 for another test.

Specifications

Application:	*Converts relay contact signal (open/close) to a display gating signal for a Radian standard.*
Size:	*112 mm (4.4")* ***H*** *x 83 mm (3.25")* ***W*** *x 45 mm (1.75")* ***D*** *(excluding BNCs and pushbutton)*
Weight:	*.57 kg (1.26 lbs)*
Cables:	*Female BNC to Female BNC; 1219 mm (48"), .08 kg (.17 lbs)*
	Female BNC to 2 Spade Lugs; 1981 mm (78"), .08 kg (.17 lbs)
Battery Type:	*3 Volt lithium*
	Use Radian #800000, Duracell 123A or Panasonic Br-$^{2}/_{3}$A 3V
Battery Life:	*Approximately 2000 hours of operation*

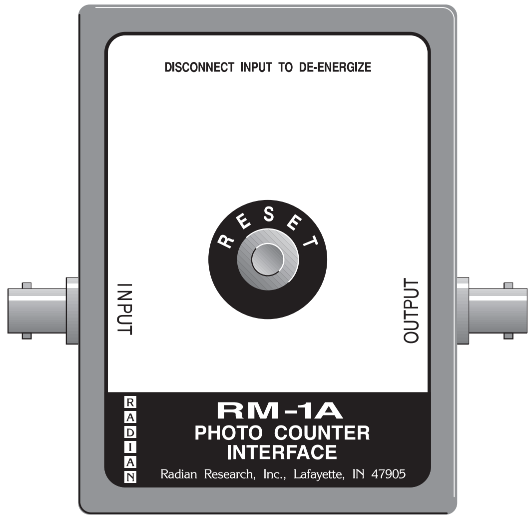


Figure 10.9 RM-1A Photo Counter Interface

10.10 RM-OA Optical Adapter

The RM-OA Optical Adapter is used with solid state meters whose infra-red calibration pulse is emitted from the optical communications port. The RM-OA magnetically couples to the communication port of solid state meters. The suction cup of the RM-1H is attached to the clear poly-carbonate cover of the RM-OA. The RM-OA incorporates a rare earth permanent magnet for exceptional holding power over the life of the product.

Specifications

Application:	*Magnetically couples to solid state meters' optical communication port for the RM-1H suction cup*
Magnet:	*Rare earth*
Lens:	*Scratch resistant polycarbonate*
Size:	*35 mm (1.38") dia. x 23 mm (.9")*
Weight:	*.05 kg (.1 lbs)*

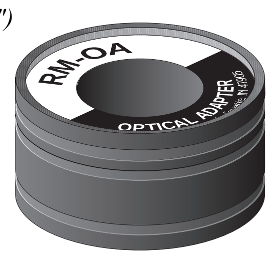


Figure 10.10 RM-OA Optical Adapter

10.11 RM-TC Transit Container

The RM-TC Transit Container is an excellent packaging solution for safe shipment of Radian standards. Applications may include internal company shipments of Radian standards as well as for shipments back to Radian Research for recertification services. The RM-TC provides absolute protection of your Radian standard in the most extreme environmental, shipping and handling conditions. The RM-TC's composition consists of a structural foam resin making it resilient to denting, cracking or corrosion. To further ensure the integrity of your Radian standard during shipment, the RM-TC is also watertight, airtight, dust-proof and rustproof. Internally, the RM-TC uses industrial grade photographic cushions for maximum shock protection of your Radian standard.

Specifications

Application:	*Transit container for shipment of Radian Standard.*
Exterior Dimensions:	*273 mm (10.75") **L** x 248 mm (9.75") **W** x 178 cm (7") **D***
Interior Dimensions:	*241 mm (9.5") **L** x 191mm (7.5") **W** x 165 mm (6.5") **D***
Weight:	*1.8 kg (4 lbs); 2.25 kg (5 lbs) shipping weight*
Color:	*Charcoal Black*
Foam:	*Industrial grade photographic foam*
Watertight:	*To 30' (27 m) O-ring is easily replaced if damaged*

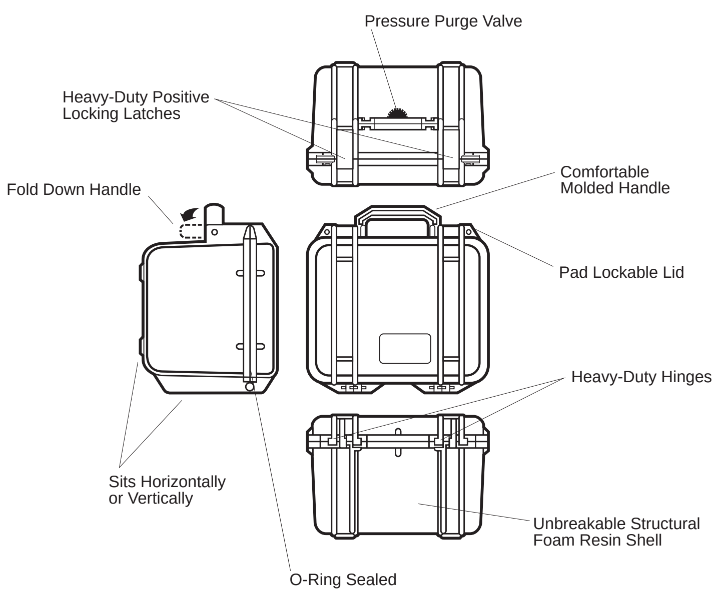


Figure 10.11 RM-TC Transit Container Features

11.0 Testing Applications

11.1 Closed Link Testing (RM-10 and RM-15 only)

Three sets of input terminals are provided for the purpose of closed link testing. Figure 11.1 illustrates the principle behind the method. The input transformers of the RM-10 and RM-15 have three identical input windings, arbitrarily labeled A, B and C. Each of these is put in series with a separate floating current source. Because the current sources and the separate inputs of the RM-10 and RM-15 are isolated from each other, there is no need to open the potential link or make a connection to the opened link. The advantages to this extend beyond the necessity of using meters without links to discourage power diversion.

The current sources cannot be wound on a common core because the loads being driven are not nearly identical enough. Two or three separate cores are necessary to create the high impedance current sources to make this technique work.

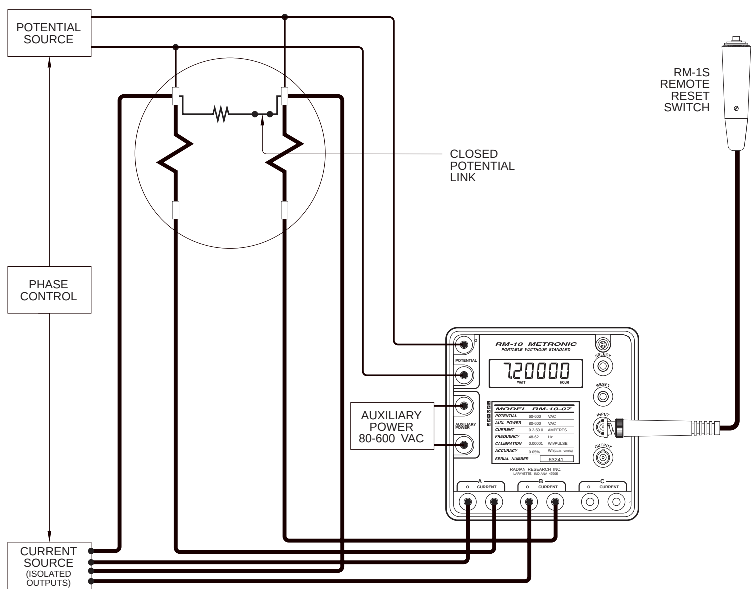


Figure 11.1 Fundamental Closed Link Meter Test Circuit using the RM-10 or RM-15

11.2 Open Link Testing (RM-10, RM-12, and RM-15)

As illustrated in Figure 11.2, the RM-10, RM-12 and RM-15 can also be used to conduct an open link test. For the RM-10 and RM-15, it is necessary to only use one of the three sets of current inputs. When using only one input it does not matter whether input A, B or C is used. However, for increased sensitivity all three current inputs could be connected in series. Note that if all three inputs are connected in series then the RM-10 or RM-15 will run three times as fast compared to using only one input.

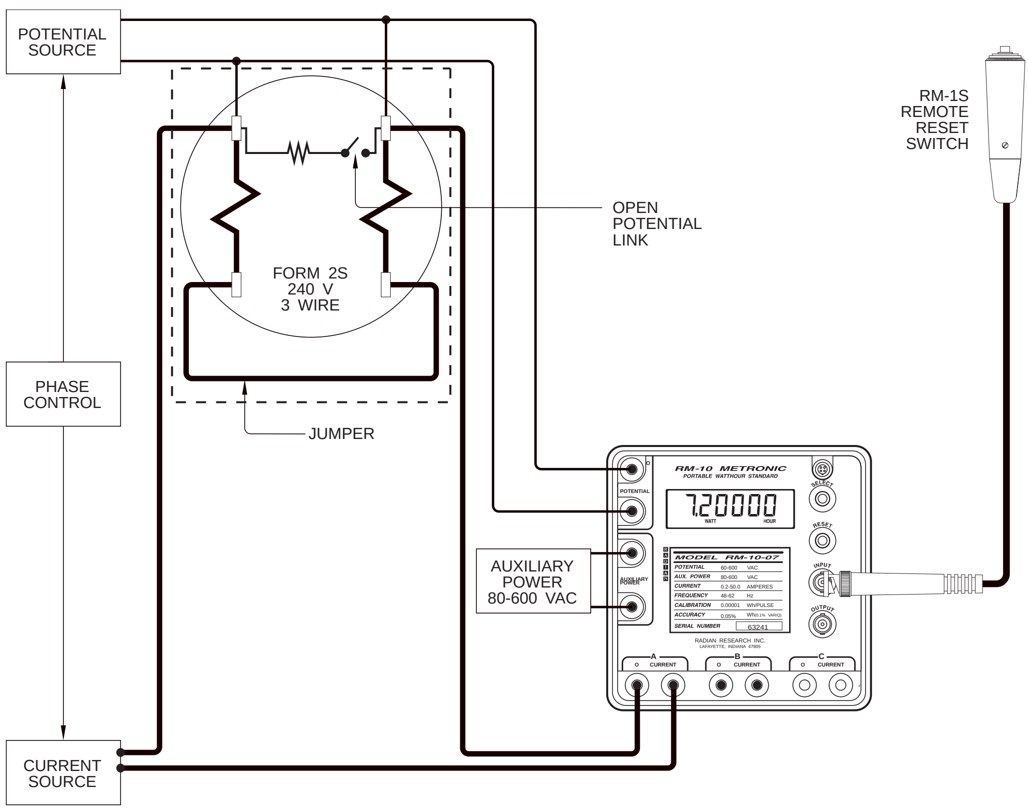


Figure 11.2 Fundamental Open Link Meter Test Circuit using the RM-10, RM-12 or RM-15

11.3 Testing Applications Using Radian Products

Following are simplified diagrams showing Radian products used in various test applications.

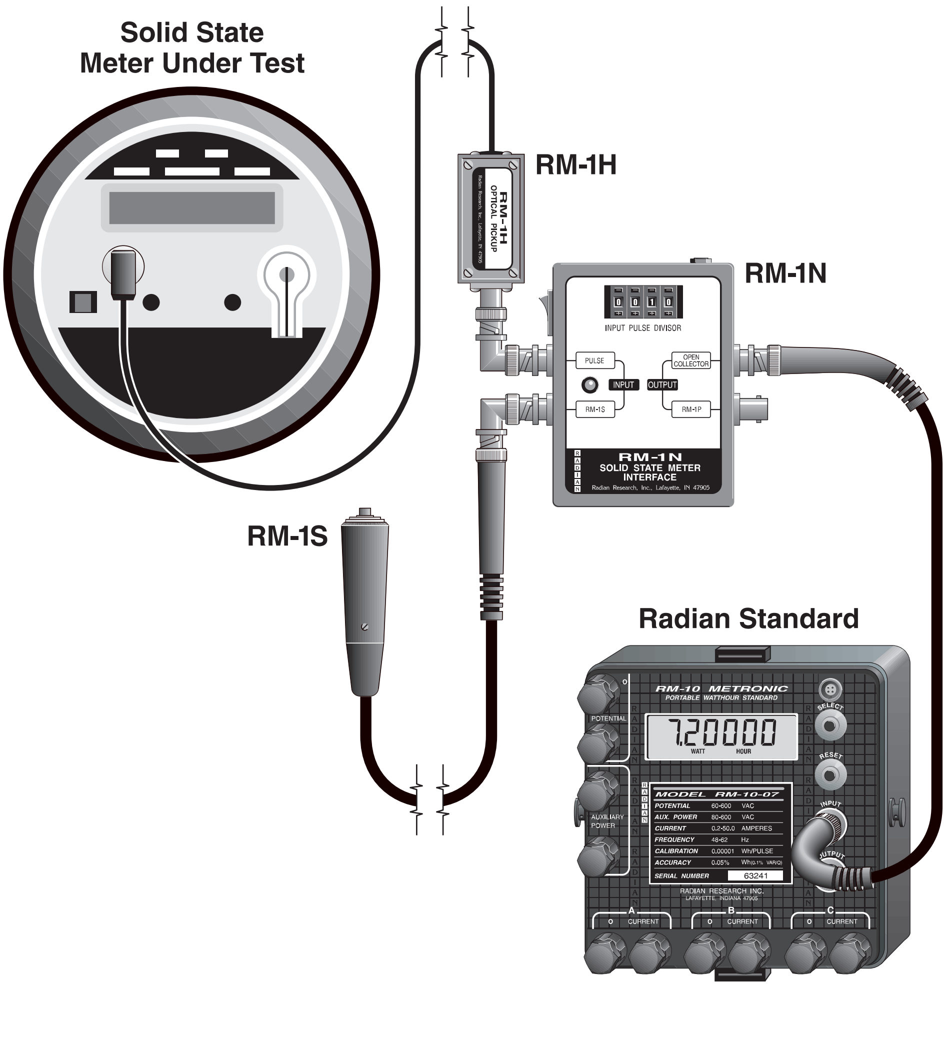


Figure 11.3a Field Testing a Solid State Meter

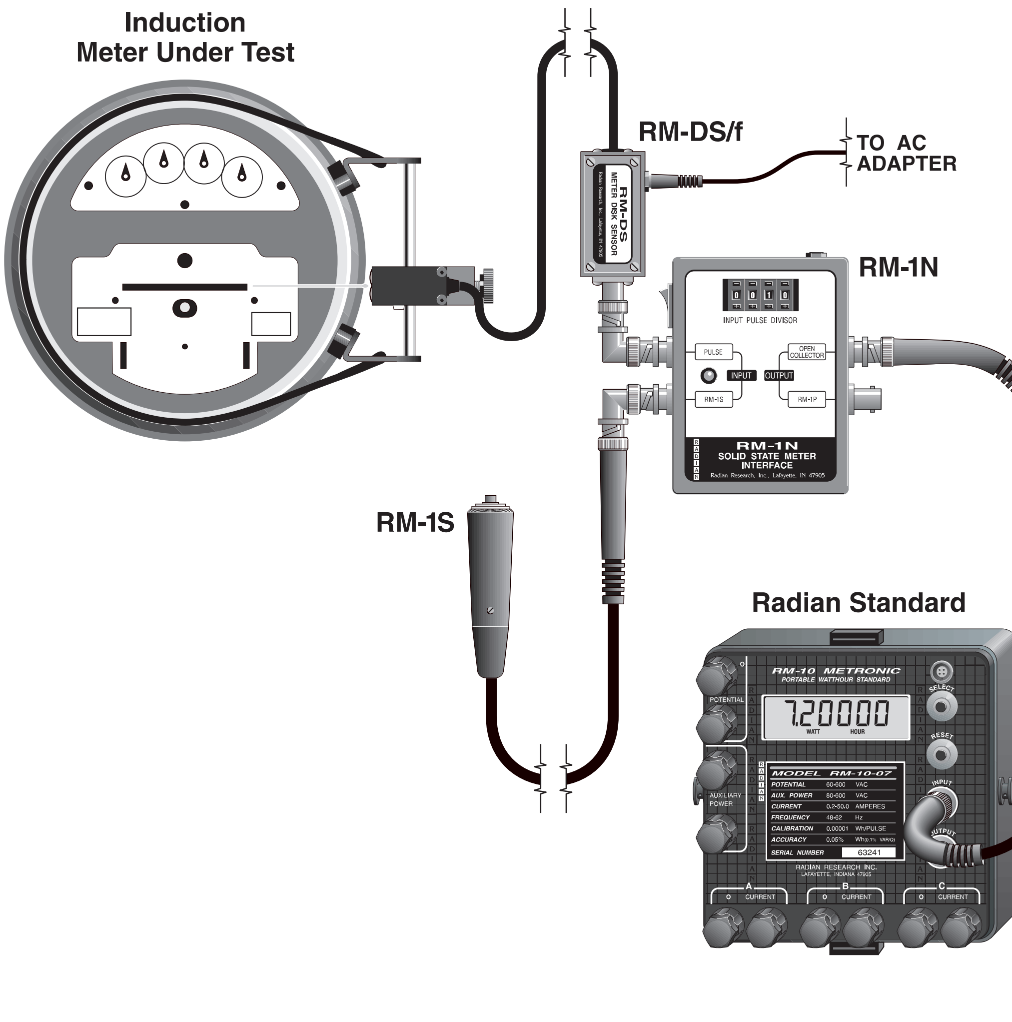


Figure 11.3b Field Testing an Induction Meter

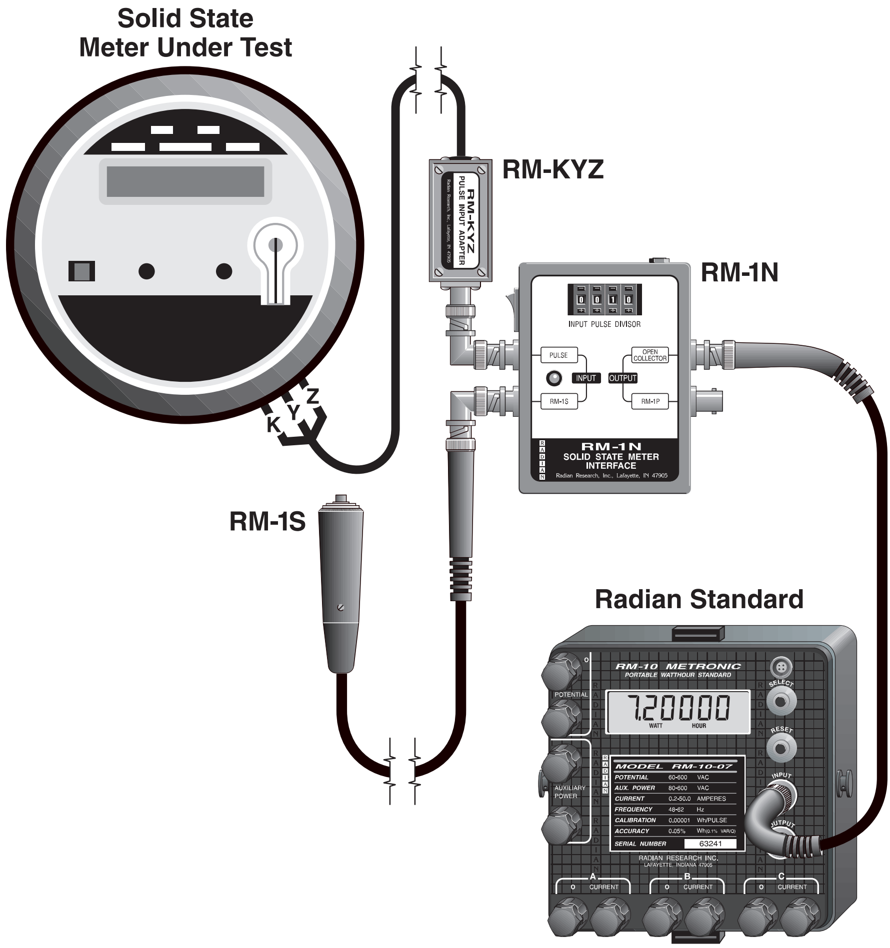


Figure 11.3c Testing a Meter via KYZ Output

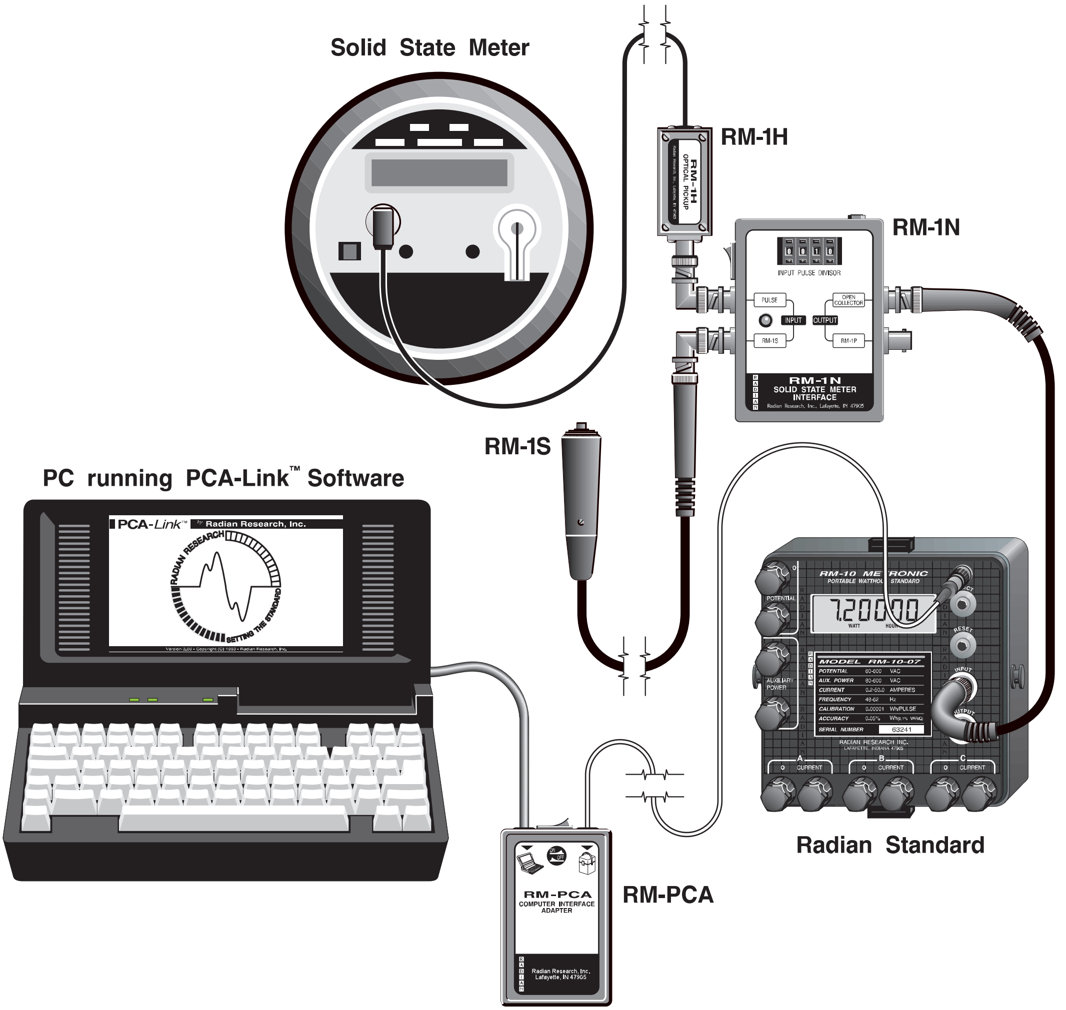


Figure 11.3d PCA-Link™ Software and the RM-PCA

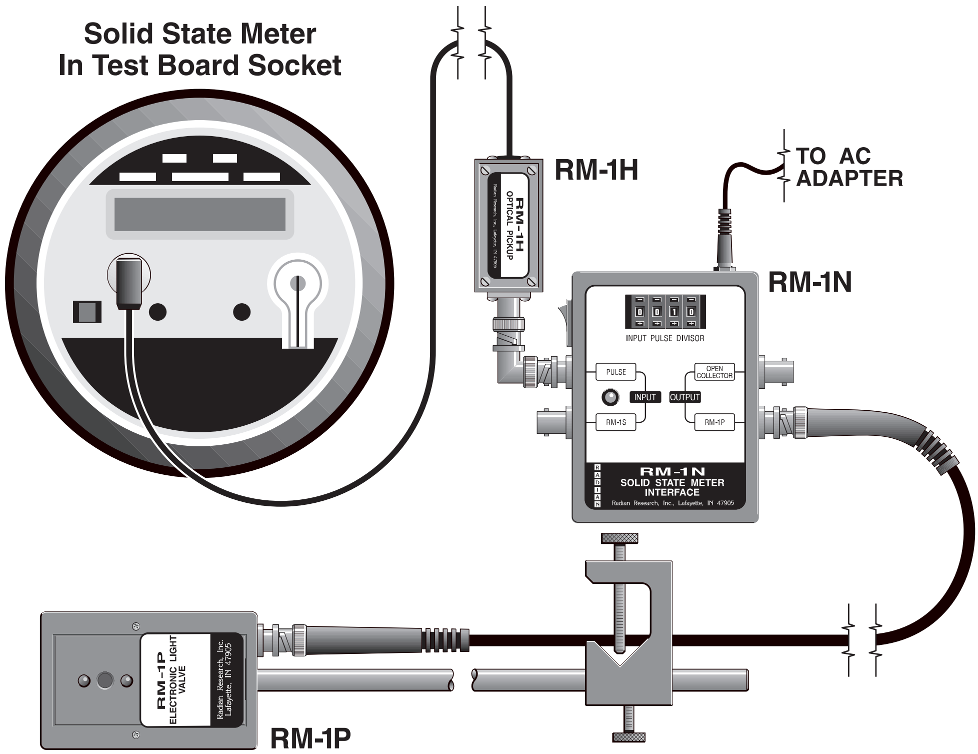


Figure 11.3e Interfacing a Solid State Meter to the Optics of a Test Board

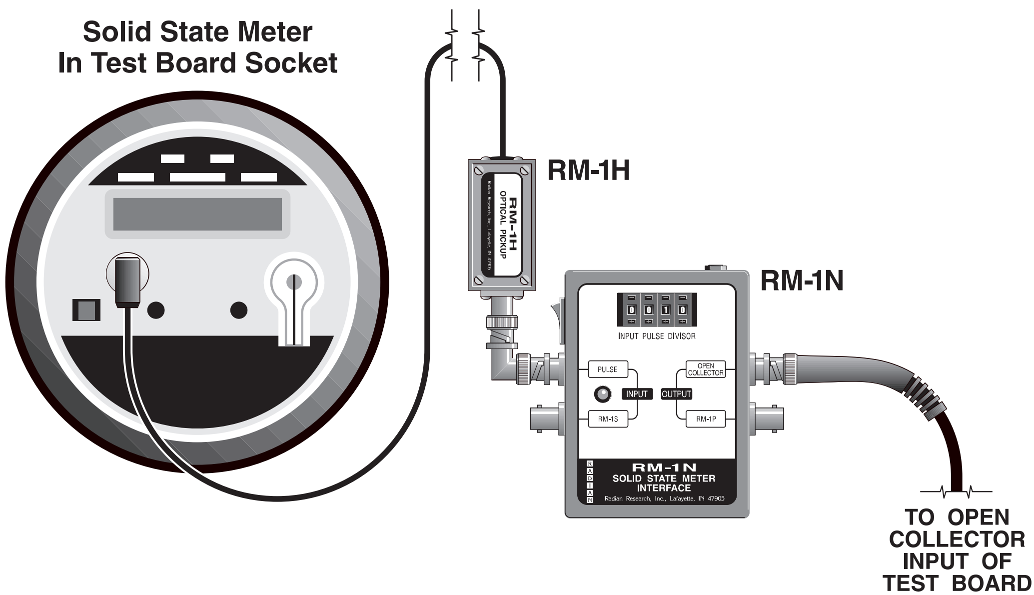


Figure 11.3f Interfacing a Solid State Meter to an Open Collector Input

12.0 Warranty & Calibration Service

Radian Research warrants each of our products to be free from defects in material and workmanship. Our obligation under this warranty is to repair or replace any instrument or component therein which, within two years after shipment, proves to be defective upon examination. Radian will pay local domestic surface freight costs for return shipment of the product back to the customer.

In addition, all Radian Metronic Watthour Standards are warranted to be substantially stable in calibration over time. If within one year after factory calibration the standard does not meet its specifications, we will repair and recalibrate the unit at our cost. Our calibration records retain the value of each of the three reference elements to six decimal positions.

For a period of ten years, we warrant any fully autoranging reference standard from catastrophic failure caused by failure to range properly. This warranty is voided by disassembly of the unit beyond removal of the case for recalibration.

If warranty service is required, write or call your local Radian Research representative or contact our headquarters in Lafayette, Indiana. You will be given prompt assistance and shipping instructions.

An optional five year extended warranty and calibration service is available on all Radian standards. Contact your local Radian representative or our headquarters for details.

Radian Research, Inc. maintains a complete state-of-the-art recalibration and repair facility in Lafayette, Indiana. Estimates for repairs are available by contacting our headquarters. All recalibrations, which are certified traceable to the National Institute of Standards and Technology are performed on the Radian RM-703 Automated Calibration System. The RM-703 Calibration System is referenced by Radian RM-11 Primary Standards with a short-term repeatability of 0.001% or better.

R A D I A N

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