

Radian Research, Inc.

RM-111

Automated Comparator

Operations Manual

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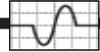
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1.0 Product Introduction

The RM-111 Automated Comparator is a compact, easy to use, hand-held instrument that allows for digitally comparing a primary reference standard (usually one, two or three Radian RM or RD primary standards) to any standard, test board, or solid state or induction meter. The RM-111 uses precise digital counters to count and compare calibration pulses from either reference standards or billing meters. The RM-111, after programmed with specific test parameters, automatically calculates and displays results in a user defined display of either percent registration or percent error.

For field use, the RM-111 provides the user with an efficient means of testing both solid state and induction meters. The RM-111 tests true three phase and series single phase and provides calculations for full load, power factor, light load and demand. With capabilities to store results for up to 100 meter tests and 28 standard tests, the RM-111 is a cost efficient alternative to carrying expensive notebook computers in the field. For further test enhancement, the RM-111 can be used with various Radian software applications for data collection and device/test configuration. In addition to saving and uploading test results, the RM-111 can print results using the RM-RPP Portable Printer.

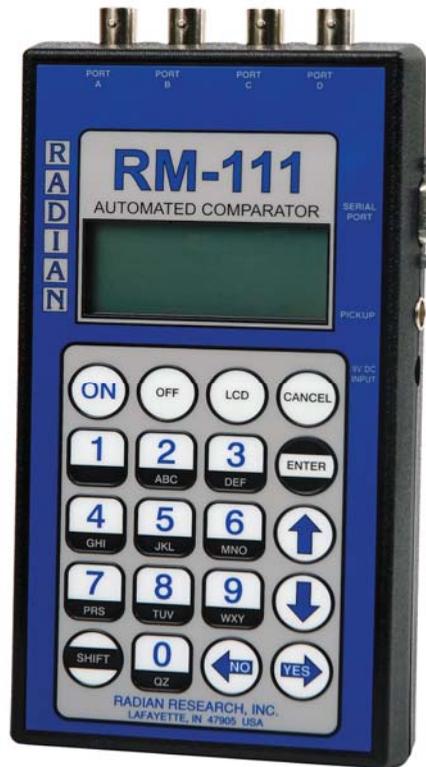
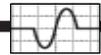
Note: If you have a RM-RPP printer serial number 100017 or larger you will need to configure the printer for 1200 baud and use a null adapter (supplied with printer). The printer will not function correctly without the setup procedure being performed. For detailed instruction consult the instruction CD supplied with the printer (see section 6 “Function Setting”).

In the meter shop, the RM-111 automates testing of any electronic or electromechanical watt-hour reference standard. Up to three reference standards can be averaged together to provide a more precise and repeatable references. The RM-111 can also sum up to three reference standards for the testing of both polyphase standards and meters. In the laboratory, test automation is achieved by using existing voltage and current sources with the RM-111 and Radian software. This combination provides result calculation, data management and uploading options.



1.1 Features

- Tests any electronic or mechanical standard
- Tests any test board
- Tests any solid state or induction meter
- Operates as a pulse divider for interfacing with other products
- Ability to average or sum up to three reference standards
- Performs single phase or polyphase testing
- Environment resistant
- Powered from a 9 volt battery or AC adapter
- Optional on-site printing capabilities
- Optional potential gating capabilities
- Optional Radian software applications available for data collection and device/test configuration
- Stores up to 80 meter and 12 standard test setup
- Stores results for up to 150 meter and 28 standard tests
- Utilizes pulse counting as the preferred testing method
- Low battery indication





2.0 Specifications

2.1 Physical

Length:	190mm (7.5")
Width:	105mm (4.0")
Height:	33mm (1.25") approx.
Weight:	.85 lbs approx.
Case Construction:	Flame resistant ABS plastic with polycarbonate label / keypad. Keypad good for 1 million cycles

2.2 Electrical

Power:	9 volt battery or 9-12 volt AC adapter
Power Consumption:	171 mW typical, 1.150 W maximum

2.3 Environmental

Temperature:	-20° to 70° C (-4° to 158° F) normal operating conditions
Relative Humidity:	0 - 95%
Shock and Vibration:	Any which is nondestructive
Water Resistance:	Unit is splash proof, but it is not air tight
Orientation:	Any, unless using the RM-1R electronic/mechanical relay accessory. When using the electronic option, the arrow in the relay box must remain in the upward position with respect to the horizon.



2.4 Accuracy

Digital Gating

Total % Error: Open collector less than: .0001

Potential Gating

Total % Error: Electronic output less than:
 $(.0005 \text{ sec} / T) + (I_{\text{pot}} * .02 \text{ ohms} / V_{\text{pot}}) * 100$

Potential Gating

Total % Error: Mechanical Output less than:
 $(.002 \text{ sec} / T) + (I_{\text{pot}} * .004 \text{ ohms} / V_{\text{pot}}) * 100$
 (T: length of test in seconds)
 (Ipot: current draw of potential)
 (Vpot: potential test voltage)

2.5 Inputs (Ports A, B, C and D)

Pull-Up Port A:	150 ohm	
Pull-Up (Ports B, C, D):	150 ohm / 1000 ohm, user defined,	
Maximum Input voltage (Ports A and B):	5 volts - 500mW zener clamp at 6.2 volts (85mA maximum zener current)	
Maximum Input Voltage (Ports C and D):	25 volts - 500 mW zener clamp at 33 volts (14.4mA maximum zener current)	
Maximum Frequency (Ports A - D):	2.1 MHz per port	
Minimum Input Pulse Width (Ports A - D):	200nS	
Schmitt Trigger Levels:	Ports A and B	Ports C and D
Positive going threshold Max.:	1.90V	2.10V
Positive going threshold Typ.:	1.39V	1.65V
Negative going threshold Typ.:	0.67V	0.93V
Negative going threshold Min.:	0.23V	0.53V
Minimum hysteresis:	0.40V	0.40V
Maximum hysteresis:	1.40V	1.40V



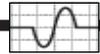
2.6 Outputs (Port D Only)

Type:	Open collector with 1000 Ohm pull-up to 5V.
Maximum input current:	100 mA (If using RM-10-01 with serial number below 501000 the maximum number of standards the RM-111 will support is 6. The RM-111 will support more of the newer generation standards).
Vmax Pull Up:	25 volts - 500mW zener clamp at 33 volts (14.4mA maximum current)
Typical State:	Open

2.7 Output Accessories (Port D Only)

RM-1R Electronic/Mechanical Potential Relay Mechanical Relay Specifications

Type:	Coin silver dry contact relay
Resistance:	.004 ohms typical, .005 ohms maximum
Imax:	5 amps AC RMS
Vmax:	630 volts AC RMS (relay clamped at 680V)
VA max Switch:	125 VA inductive
Operate Time:	8 mS maximum
Release Time:	8 mS maximum
Offset Time:	2 mS maximum
Dielectric Withstand:	2.5kV to any other part of the unit



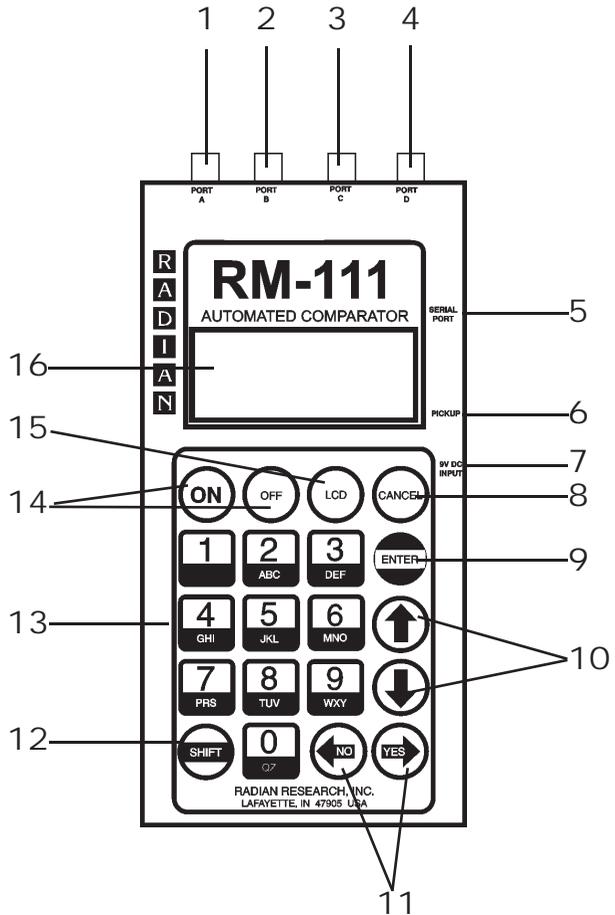
Electronic Relay Specification

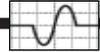
Type:	Mercury wetted reed relay
Resistance:	.020 ohms typical, .050 ohms maximum
I _{max} :	1 amp AC RMS
V _{max} :	630 volts AC RMS (relay clamped at 680V)
VA-max Switch:	10 VA inductive
Operate Time:	2 mS maximum
Release Time:	2 mS maximum
Offset Time:	0.5 mS maximum
Dielectric Withstand:	2.5 kV to any other part of the unit



3.0 RM-111 Keypad Conventions

1. PORT A Input
2. PORT B Input
3. PORT C Input
4. PORT D Input/Output
5. Serial Port
6. Pickup
7. 9-12V DC Input Jack
8. Cancel
9. Enter
10. Up/Down Arrow Keys
11. Left/Right, Yes/No Arrows keys
12. Shift
13. Alphanumeric Keypad
14. On/Off
15. LCD Intensity
16. 4 Line 16 Character per Line LCD





- 1 **Port A:** Input
- 2 **Port B:** Input
- 3 **Port C:** Input
- 4 **Port D:** Input/Output
- 5 **Serial Port:** Interface for communications with PC or RM-RPP printer
- 6 **Pickup:** Interface for either the RR-1H Optical Pickup for infrared LED, the RR-DS Meter Disk Sensor, or the RR-KYZ Pulse Input Adapter
- 7 **9V DC Input:** 9-12V DC adapter
- 8 **Cancel:** When traversing menus on the RM-111 the CANCEL key performs similar functionality to the ESCAPE key on most software applications. Specifically, it should back the user out of the displayed menu leaving any parameters unchanged.
- 9 **Enter:** This key serves as the primary selection key in the menu structure and as the start/stop test key for running a test. It serves the same function as the START button on the RM-109, but it can also stop the test at anytime and get a result calculated from the comparison of the pulse count between a standard and a device under test when running a manual length test. The ENTER key moves the user into or down the menu structure while the CANCEL key moves the user out of or up the menu structure.
- 10 **Up/Down Arrow Keys:** These keys control vertical cursor movement for scrolling through menu items and results. If there are more than four menu items or four lines of result data an up or down movement is required for viewing purposes. An up or down arrow icon will appear in the upper right or lower right corner of the LCD. These icons direct the user to scroll in the appropriate direction.
- 11 **Left/Right Arrow and Yes/No Keys:** These keys control horizontal cursor movement within a keypad entry field and enables the user to scroll through multiple test result files. When viewing results, either a left or right arrow will be present on their respective upper corners of the LCD indicating the direction the user needs to move to see all of the results. Test parameters of the RM-111 can often be answered/set with the YES/NO keys. Direct keypad entry of the YES/NO key will also satisfy those parameters.



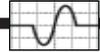
12. **Shift:** The SHIFT key puts the keypad in TXT mode activating the letters on the keypad as the user input mode. Pressing SHIFT again returns the keypad to the default mode (normal operating mode) of NUM where the normal input is once again numerical.

13. **Alphanumeric Keypad:** Numeric keypad entry is direct when the RM-111 is in the NUM input mode. Character input is achieved via the keypad when the SHIFT key is pressed as described above. Once in the TXT input mode, keypad entry scrolls through the letters on the selected key with every press of that key. For example, there are either two or three letters assigned to every number key. Moving among characters on the LCD is done with the LEFT/RIGHT ARROW keys. Moving between lines is done with the UP/DOWN ARROW keys.

14. **The ON key** turns the RM-111 power on. The OFF key turns the RM-111 power off. Note that the RM-111 boasts a user configurable time out feature and will shut itself off after a pre-set time. However, it will not time out during a test or while in RM-111 Link Mode.

15. **LCD:** Allows the contrast to be adjusted by pressing and holding down the LCD key and using the UP/DOWN ARROWS for increasing and decreasing contrast level, respectively. Releasing the LCD key returns the RM-111 to normal operating mode.

16. **LCD Display:** 16 character 4 line liquid crystal display.



4.0 Menu Structure

All menu items should be selected by one of two methods. First, by direct keypad entry of the number to the left of the desired menu option. Second, by moving the cursor using the UP/DOWN ARROW keys to the desired selection and pressing ENTER. A maximum of 8 menu items are allowed. Four menu items are visible on the LCD at one time. A DOWN ARROW icon is placed in the lower right corner of the display for menus containing additional menu items. The unseen menu items can be viewed by using the RM-111's DOWN ARROW key to move down the menu. When the user is at the bottom of the menu an UP ARROW icon will appear in the upper right corner of the display. This indicates that the user must move up the menu structure for previous items. The UP ARROW key is used to move back up the menu structure.

4.1 Main Menu

- 1 RUN TESTS**
- 2 RESULTS**
- 3 TEST SETUPS**
- 4 PREFERENCES**

Main Menu and Sub-Menus

1 RUN TESTS

- 1 Test Standard
- 2 Test Meter
- 3 Test Board
- 4 Pulse Divider



2 RESULTS

1 STANDARD TEST

- 1 View Result
- 2 Print Result
- 3 Delete Result
- 4 Delete All

2 METER TEST

- 1 View Result
- 2 Print Result
- 3 Delete Result
- 4 Delete All

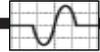
3 TEST SETUPS

1 STANDARD TEST

- 1 Edit
- 2 Create
- 3 Delete

2 METER TEST

- 1 Edit
- 2 Create
- 3 Delete



4 PREFERENCES

1 RS-111 Link Mode

2 Result Display

1 % Registration

2 % Error

3 Result Digits

1 One digit

2 Two Digit

3 Three Digit

4 Kh Format

1 Wh/Pulse

2 Pulses/Wh

5 User Prompts

Enter Voltage

Enter Test Amps

Enter Meter Form

Enter Tester ID#

Enter Manufacturer ID#

Enter Beep



6 Time/Date

Time: HH:MM:SS

Date: MM-DD-YY

7 Power Saver

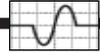
Time in minutes (0-30)

8 About

RM-111

S/N: XXXXXX

Rev: Vxx.xx.xx



4.2 Detailed Description of Menu Items

Run Test

Test Standard - Mode used for testing all standards.

Test Meter - Mode used for testing all meters and testing mechanical standards by pulse counting.

Test Board - Mode used for testing the accuracy of test boards.

Pulse Divider - Mode used for interfacing solid state meters with test boards. It also provides basic pulse dividing.

Results

View Results - Allows user to view test results. Up to 100 meter and 28 standard test results can be stored and viewed from the RM-111. The LEFT/RIGHT ARROW keys move among the different sets of results. The UP/DOWN ARROW keys move within a single result field to allow all of the result data to be seen.

Print Results - When used in conjunction with the optional RM-RPP Portable Thermal Printer, the RM-111 can print results on site

Delete Results - Allows for deleting the test results one set at a time. Use the arrow keys to select the results to be deleted.

Delete All Results - Allows for deleting all test results in one step.

Test Setups

Standard Test

Edit – Allows user to edit all applicable parameters of an existing standard test setup.

Create – Allows user to create a new standard test setup.

Delete – Allows user to delete a standard test setup.

METER TEST

Edit – Allows user to edit all applicable parameters of an existing meter test setup.



Create – Allows user to create a new meter test setup.

Delete – Allows user to delete a meter test setup.

Preferences

RM-111 Link Mode – Puts the RM-111 in a communication mode, allowing Radian data collection and configuration software applications to completely take control of the RM-111. The RM-111 must be in this mode to either upload or download test information and results.

Results Display – Selects either percent registration or percent error.

Result Digits – Selects results resolution-either one, two, or three places to the right of the decimal point.

Kh Format – Allows the user to select the Kh format in the test setups screen – Pulses/Wh or Wh/pulse.

User Prompts – Specific meter and tester information is entered to enhance the test results. These entries will also be stored with the results. All user prompts can be enabled or disabled directly from the RM-111 YES/NO keys.

Enter Test Voltage – The service voltage of the meter under test.

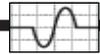
Enter Test Amps – The test amps of the meter under test.

Enter Meter Form – The form number of the meter under test.

Enter Tester ID# - The tester's identification number, if applicable.

Enter Manufacturer ID# - The manufacturer's identification number, if applicable.

Enter Beep – Enables or disables the RM-111's audible response.



Time/Date – View and set the time and date. The time and date are stamped on all results.

Power Saver – User can adjust the amount of time before the RM-111 turns off due to inactivity.

About – This provides a screen of information specific to the RM-111, which includes the device's serial number and firmware revision.



5.0 Inputs

5.1 Reference Standards (Open Collector)

Port A, B, C and D may be configured as inputs for the reference standards that serve as the reference for the test. The RM-111 knows how many reference standards due to the number defined in the TEST SETUPS menu. The reference standard may be autoranging or a device with taps. The RM-111 will prompt the user to make the appropriate connections based on that number. For example, if there are three reference standards listed in the TEST SETUPS menu the RM-111 prompts the user to connect the reference standards to port A/B/C. If there is only one reference standard defined then the user would be prompted to connect the reference standard to port A.

When using multiple reference standards the RM-111 determines the appropriate calculation based the single-phase (1-Phase Avg.) or polyphase (Poly-PH Sum) selection made in the TEST SETUPS menu. If single-phase is selected, the inputs (reference standards output) will be averaged. If polyphase is selected the inputs will be summed. Selecting polyphase is necessary for testing both polyphase standards and meters.

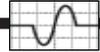
5.2 Device Under Test (DUT)

For testing solid state meters, induction meters or standards the input ports and PICKUP port on the RM-111 are defined as DUT inputs. These inputs can be the output of the standard, or in the case of meter testing, any Radian accessory emitting some form of calibration pulse such as the RM-1H, RM-1H/v, RR-1H, RR-DS, RM-DS, or RM-KYZ. The RR-1H, RR-DS, and RR-KYZ are connected to the PICKUP PORT. Input pulses are acceptable from other open collector style pulse output interfaces, such as *SC-10's and *SC-60's.

5.3 RM-1S

The RM-1S Remote Reset Switch, when connected to port A, replaces the ENTER and CANCEL keys. This allows for the start, stop and reset cycling of any Radian standard connected to the RM-111 output port. The cycling sequence continues until the user presses the CANCEL key to stop the test cycle. This input option should only be used when the user wants to manually control the testing process by counting disk revolutions.

* See page 96



6.0 Output (Port D Only)

6.1 RM-1P

With the RM-111's output defined as the RM-1P Electronic Light Valve, applications such as interfacing with a test board and testing a test board are possible. In this mode the RM-111 produces a continuous pulse train that mimics the hole in the rotating disk of a meter and, therefore, trips the photo pickup. The RM-1P interfaces with the output of the RM-111, or to the optics of the calibration test board.

6.2 Open Collector

When the Open Collector option is selected as the Pulse Output Type, (Run Tests/Pulse Divider) the RM-111 will output pulses every time a set number of pulses or wathhours are counted by the RM-111's internal counter. This pulse output stream will continue until the ENTER key is pressed on the RM-111. This output is desired for testing test boards using their open collector inputs.

6.3 RM-1R, Electronic/Mechanical Potential Relay

The RM-1R is an external adapter housing both a high current dry contact relay and a mercury wetted relay. Physical connection to the RM-111 determines which relay is used. The Mechanical relay's output has been optimized for potential gating mechanical standards. The Electronic relay's output potential gates electronic standards. Due to the mercury wetted relay, orientation of the RM-1R when using the Electronic relay option is critical. The RM-111 prompts the operator when to connect the RM-1R to port D.



7.0 Testing a Standard using the Average of One to Three Reference Watthour Standards. (Counting Pulses)

Equipment Needed:

- RM-111 Automated Comparator
- One, two or three Radian RM or RD Primary Reference Watthour Standards
- One, two or three Standards to be tested (Device Under Test, D.U.T's)

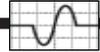
Important:

The *J-44 and *IB-10 can not be tested using pulse counting unless the standards are tested under the Test Meter option of the RM-111 RUN TESTS menu. This is due to the pulses per equivalent revolution of the induction standards. A test of 1000 revolutions would be necessary for one pulse per equivalent revolution if the Test Standard option was used. When the J-44 and IB-10 are tested under the Test Meter option, test times are greatly decreased while the accuracy is maintained. Test duration is determined by the user defined number of revolutions. The RM-111 then compares and calculates the results. Please note that the J-44 and IB-10 can be tested using any of the test standard gating options.

Test Steps:

1. Make the appropriate connections so that the standard(s) under test (DUT) and the RM or RD Primary Reference Standard(s) are powered from the same voltage and current source.
 2. Apply test voltage, current and auxiliary power. At the point, the RM or RD Reference Standard(s) should be counting.
- Connect all standard pulse outputs to the RM-111.

* See page 96



- The RM or RD Primary Reference Watt-hour Standard will output pulses continuously once auxiliary power, voltage and current have been applied.

3. Turn on the RM-111 and select the TEST SETUPS menu option. From the TEST SETUPS menu, select STANDARD TEST. To create a new test setup, select Create. To edit an existing test setup, select Edit. To delete a test, select Delete. The Test Setup screen contains all the necessary parameters to run a standards test. The arrow keys are used to move the cursor throughout this screen. Enter the appropriate value for each parameter:

Name - Enter a test setup name on the first line by typing over the current text (16 characters maximum).

PriKh – Enter the primary reference standard(s) Kh value.

Kh – Enter the DUT Kh value.

#Pulse – Enter the number of pulses for the reference standard(s) to output before stopping the test.

Time* – Not applicable for this test.

Test by* – Select **PULSE**

Type – Select Cnt Pulse for the gating method.

#Standards – Enter the number of reference standards that will be used.

Mode – If more than one reference standard is used, the user must choose between single-phase or polyphase modes of operation.

Ref Type – This defines the reference standard output pull-up value. Select **Radian** (150 ohm). **Other** is 1000 ohm.

Input A** – Select either DUT or REF.

SER#1 – Enter a serial number for standard 1, if applicable.

SER#2 – Enter a serial number for standard 2, if applicable.



SER#3 – Enter a serial number for standard 3, if applicable.

*The “**Test By:**” parameter input allows the user to select the type of test – TIME, PULSE, MANUAL, or ENERGY. If ENERGY is selected, the “**Time:**” parameter input dynamically changes to “**Energy:**”. This allows a test to be stopped after a pre-set amount of energy has been accumulated by the DUT. standard.

When testing a standard by counting output pulses, the RM-111 will count the output pulses of both the reference standard (REF) and the standard under test (DUT), until the selected number of pulses are achieved. The “Input A:**” parameter input allows the user to select either “**REF**” or “**DUT**”. If “**REF**” is selected, the test will stop after the RM-111 counts the specified number of pulses from the reference standard. If “**DUT**” is selected, the test will stop after the RM-111 counts the specified number of pulses from the standard under test. To reduce errors associated with testing standards with different pulse output constants, the “**Input A:**” parameter should be set to “**DUT**” whenever the DUT has a lower pulse resolution than the reference standard. If “**DUT**” is selected, the DUT must be connected to PORT A. Follow the prompts on the RM-111 for connection details.

4. Press **ENTER** to exit the **Test Setup** screen.

5. From the **Main Menu** select **RUN TESTS**.

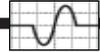
6. Select **Test Standard**.

7. Select the previously configured test setup.

8. If not already completed, follow the prompts on the RM-111 to make the appropriate connections. If using three inputs, see Figure 3.0 “Testing a Radian Standard Using the Average of Three Inputs (Counting Pulses)” or see Figure 4.0 “Testing a Radian Standard (Counting Pulses)” for testing with only one reference standard. The number of reference standards defined in the test setup determine how the ports are configured. If three reference standards are used, then ports A, B, and C will be configured and their results averaged. This configuration will allow only one standard under test, which will connect to port D. For one reference standard, only port A will be configured. This option will allow for up to three standards to be tested.

9. Once connections are complete press **ENTER** to start the test.

10. The RM-111 counts the number of pulses from both the reference standard(s) and the standard(s) under test. The watt-hour count will be displayed when the specified number of pulses have been counted. The RM-111 averages the multiple reference standards internally then calculates the



averaged value in the results.

11. The test is now complete. To process the results press **ENTER**.

12. To re-run the test select **Re-Run Test**. The pulses will be counted again and the new count will be displayed on the RM-111. Press **ENTER** to continue.

13. To display the calculated results select **Show Results**. The end count is displayed along with a down arrow icon in the lower right corner. This icon references the **DOWN ARROW** key on the RM-111 hand controller. By pressing the **DOWN ARROW** key the RM-111 displays the calculated results. Using the **UP/DOWN ARROW** keys the user can move between the watt-hour count and the calculated results.

14. To print the results connect the RM-RPP Remote Portable Printer to the **SERIAL PORT** on the RM-111. Turn the RM-RPP to the ON 1 position. Select **Print Results**. This will start the printing process. The printout is time/date stamped and includes both the watt-hour count and the calculated % Registration or % Error.

15. To save the results select **Save Results**. The RM-111 will prompt the user for the enabled parameters in the **User Prompts** menu and save the test results.

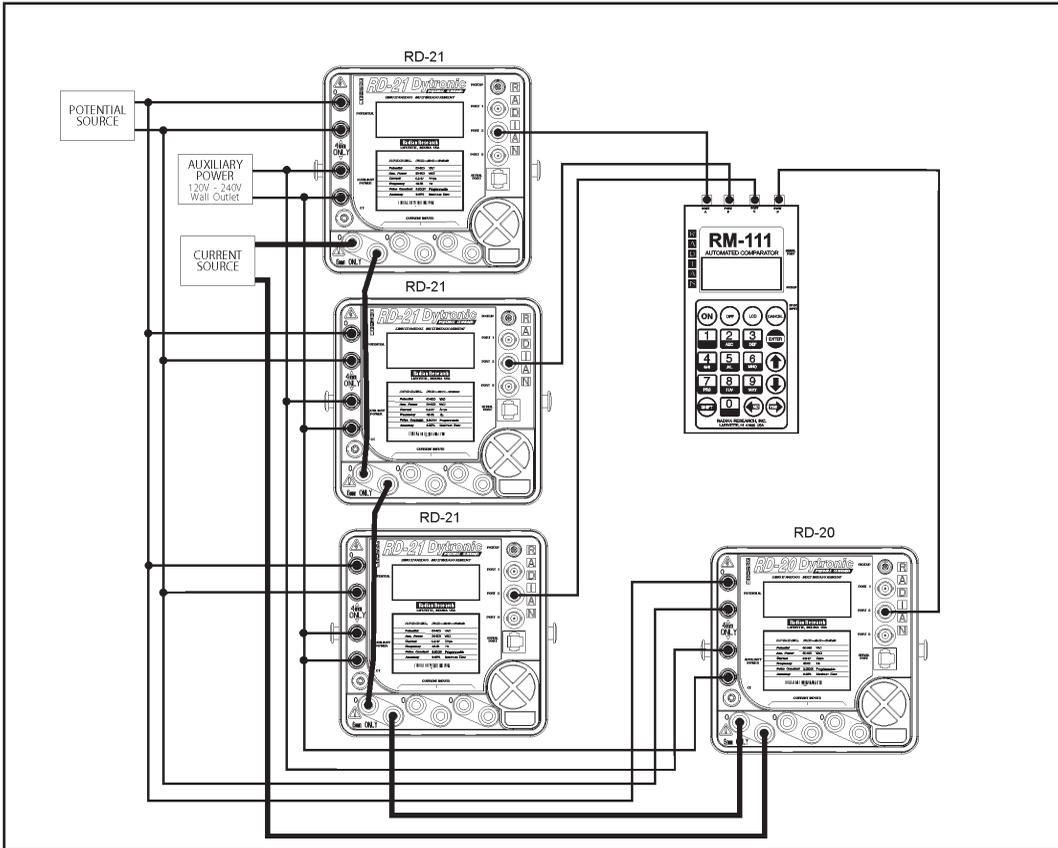
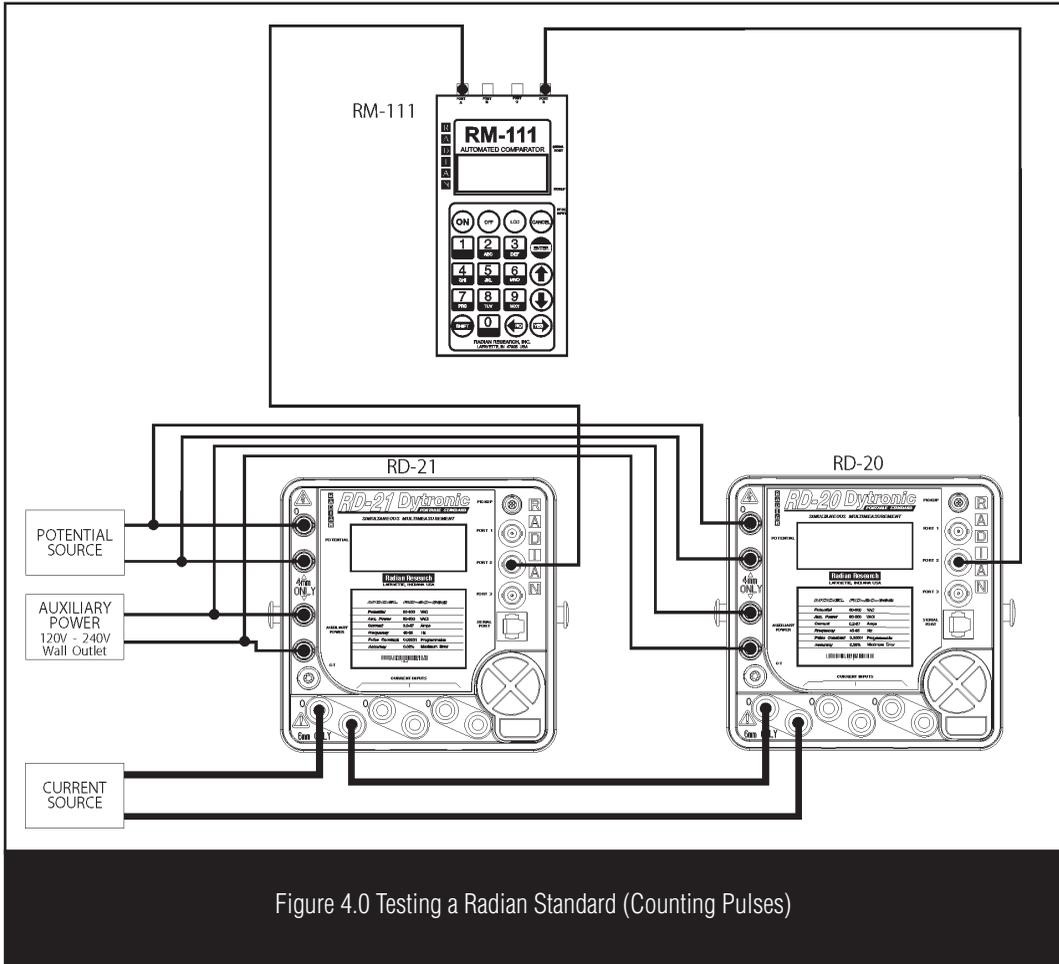
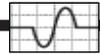


Figure 3.0 Testing a Radian Standard Using the Average of Three Inputs (Counting Pulses)





8.0 True Three Phase Standard Testing

Equipment Needed:

- RM-111 Automated Comparator
- Three reference watt-hour standards (RM or RD's)
- One polyphase standard to be Tested (Device Under Test, DUT)

Test Steps:

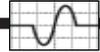
1. Connect the DUT as follows:

- Each phase input in series with the current input of each reference standard.
- All potential neutrals connected to the neutral input of each reference standard.
- Each positive (+) voltage source (A, B, C) connected to the corresponding potential input of the D.U.T.

2. Apply test voltage, current, and auxiliary power. At the point, the RM or RD reference standard(s) should be counting. Reset the standard under test.

- Connect all standard pulse outputs to the RM-111.
- The RM or RD Primary Reference Watthour Standard will output pulses continuously once auxiliary power, voltage and current have been applied.
- Auxiliary power can be paralleled on all three of the reference standards.

3. Turn on the RM-111 and select the TEST SETUPS menu option. From the TEST SETUPS menu, select STANDARD TEST. To create a new test setup, select Create. To edit an existing test setup, select Edit. To delete a test, select Delete. The Test Setup screen contains all the necessary parameters to run a standards test. The arrow keys are used to move the cursor throughout this screen. Enter the appropriate value for each parameter:



Name - Enter a test setup name on the first line by typing over the current text (16 characters maximum).

PriKh – Enter the primary reference standard(s) Kh value.

Kh – Enter the D.U.T. Kh value.

#Pulse – Enter the number of pulses for the reference standard(s) to output before stopping the test.

Time* – not applicable for this test

Test by* – Select PULSE

Type – Select Cnt Pulse for the gating method

#Standards – Enter the number of reference standards that will be used. For this application enter three.

Mode – If more than one reference standard is used, the user must choose between single-phase or polyphase modes of operation. For this application select polyphase.

Ref Type – This defines the reference standard output pull-up value. Select Radian (150 ohm). Other is 1000 ohm.

Input A** – Select either DUT or REF

SER#1 – Enter a serial number for standard 1, if applicable.

SER#2 – Enter a serial number for standard 2, if applicable.

SER#3 – Enter a serial number for standard 3, if applicable.

* The “**Test By:**” parameter input allows the user to select the type of test – TIME, PULSE, MANUAL, or ENERGY. If ENERGY is selected, the “**Time:**” parameter input dynamically changed to “**Energy:**”. This allows a test to be stopped after a pre-set amount of energy has been accumulated by the D.U.T.



When testing a standard by counting output pulses, the RM-111 will count the output pulses of both the reference standard (REF) and the standard under test (DUT), until the selected number of pulses are achieved. The “Input A:**” parameter input allows the user to select either “**REF**” or “**DUT**”. If “**REF**” is selected, the test will stop after the RM-111 counts the specified number of pulses from the reference standard. If “**DUT**” is selected, the test will stop after the RM-111 counts the specified number of pulses from the standard under test. To reduce errors associated with testing standards with different pulse output constants, the “**Input A:**” parameter should be set to “**DUT**” whenever the DUT has a lower pulse resolution than the reference standard. If “**DUT**” is selected, the DUT must be connected to PORT A. Follow the prompts on the RM-111 for connection details.

4. Press **ENTER** to exit the **Test Setup** screen.

5. From the Main Menu select **RUN TESTS**.

6. Select **Test Standard**.

7. Select the previously configured test setup.

8. If not already completed, follow the prompts on the RM-111 to make the appropriate connections. See Figure 5.0 “Testing a Polyphase Standard True Three Phase”. The number of reference standards defined in the test setup determine how the ports are configured. In this application, three reference standards, powered from independent voltage and current sources, are used. Therefore, ports A, B, and C will be configured and their results averaged. This configuration will allow only one polyphase standard under test, which will connect to port D.

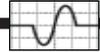
9. Once connections are complete, press **ENTER** to start the test.

10. The RM-111 counts the number of pulses from both the reference standard(s) and the standard under test. The watt-hour count will be displayed when the specified number of pulses have been counted. The RM-111 averages the multiple reference standards internally then calculates the averaged value in the results.

11. The test is now complete. To process the results press **ENTER**.

12. To re-run the test select **Re-Run Test**. The pulses will be counted again and the new count will be displayed on the RM-111. Press **ENTER** to continue.

13. To display the calculated results select Show Results. The end count is displayed along with a down arrow icon in the lower right corner. This icon references the **DOWN ARROW** key on



the RM-111 hand controller. By pressing the **DOWN ARROW** key, the RM-111 displays the calculated results. Using the **UP/DOWN ARROW** keys, the user can move between the watt-hour count and the calculated results.

14. To print the results connect, the RM-RPP Remote Portable Printer to the **SERIAL PORT** on the RM-111. Turn the RM-RPP to the ON 1 position. Select **Print Results**. This will start the printing process. The printout is time/date stamped and includes both the watt-hour count and the calculated % Registration or % Error.

15. To save the results, select **Save Results**. The RM-111 will prompt the user for the enabled parameters from the User Prompts menu and save the test results.

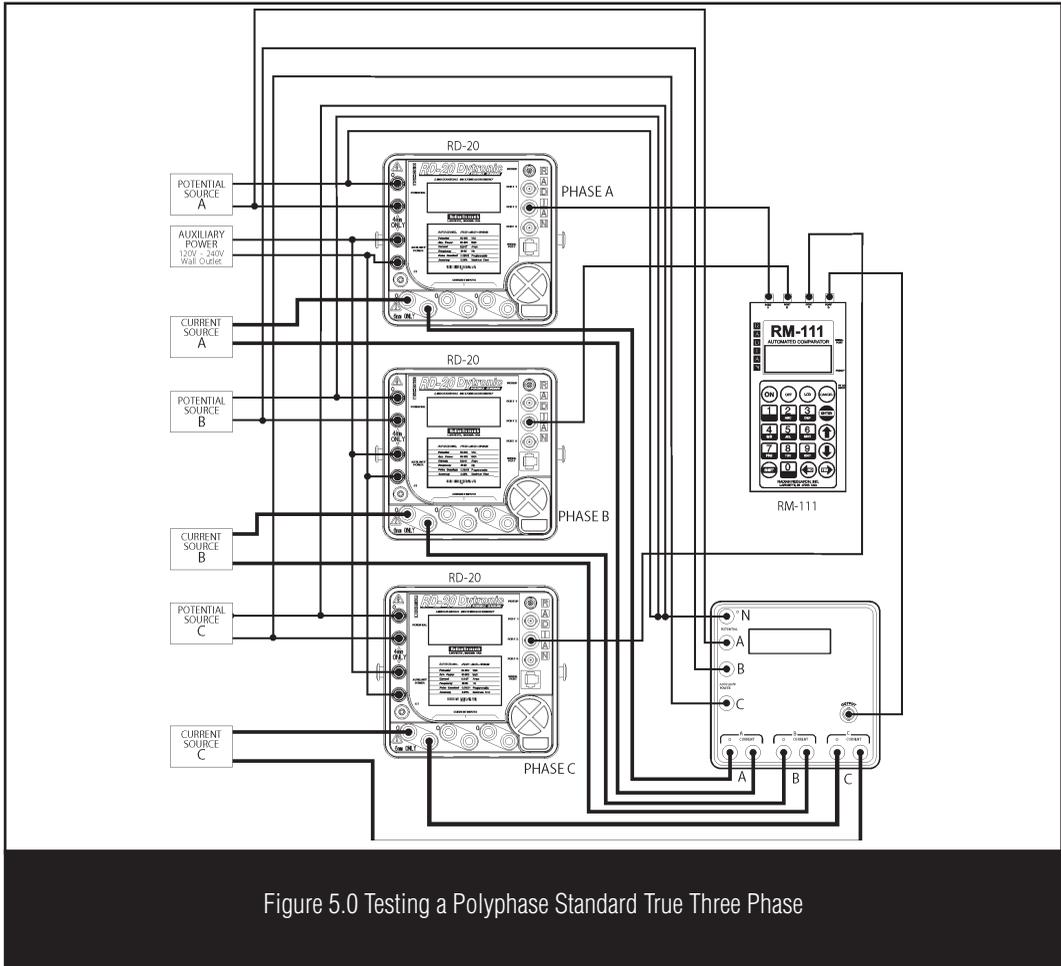
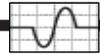


Figure 5.0 Testing a Polyphase Standard True Three Phase



9.0 Testing a Radian Standard (Display Gating)

Equipment Needed:

- RM-111 Automated Comparator
- One, two or three Radian RM or RD Primary Reference Watthour Standards
- One, two or three radian standards to be tested (Device Under Test, DUT)

Test Steps:

1. Make the appropriate connections so that the standard(s) under test (D.U.T.'s) and the RM or RD Primary Reference Standard(s) are powered from the same voltage and current source.

2. Apply test voltage, current and auxiliary power. At this point, the RM or RD reference standard(s) should be counting. Reset the standard(s) under test's display. If correctly reset, there should be zeros across the entire display.

- Connect all standard pulse outputs to the RM-111.
- The RM or RD Primary Reference Watthour Standard(s) will output pulses continuously once auxiliary power, voltage, and current have been applied.

3. Turn on the RM-111 and select the TEST SETUPS menu option. From the TEST SETUPS menu, select STANDARD TEST. To create a new test setup, select Create. To edit an existing test setup, select Edit. To delete a test, select Delete. The Test Setup screen contains all the necessary parameters to run a standards test. The arrow keys are used to move the cursor throughout this screen. Enter the appropriate value for each parameter:

Name - Enter a test setup name on the first line by typing over the current text (16 characters maximum).

PriKh – Enter the primary reference standard(s) Kh value.

Kh – Enter the DUT Kh value.

#Pulse – Enter the number of pulses for the reference standard(s) to output before stopping the test.



Time* – not applicable for this test

Test by* - Select PULSE

Type – Select D. Gating (display gating) for the gating method

#Standards – Enter the number of reference standards that will be used

Mode – If more than one reference standard is used, the user must choose between single-phase or polyphase modes of operation.

Ref Type – This defines the reference standard output pull-up value. Select Radian (150 ohm). Other is 1000 ohm.

Input A** – Select either DUT or REF

SER#1 – Enter a serial number for standard 1, if applicable.

SER#2 – Enter a serial number for standard 2, if applicable.

SER#3 – Enter a serial number for standard 3, if applicable.

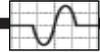
* The “**Test By:**” parameter input allows the user to select the type of test – TIME, PULSE, MANUAL, or ENERGY. If ENERGY is selected, the “**Time:**” parameter input dynamically changed to “**Energy:**”. This allows a test to be stopped after a pre-set amount of energy has been accumulated by the D.U.T.

When testing a standard by counting output pulses, the RM-111 will count the output pulses of both the reference standard (REF) and the standard under test (DUT), until the selected number of pulses are achieved. The “Input A:**” parameter input allows the user to select either “**REF**” or “**DUT**”. If “**REF**” is selected, the test will stop after the RM-111 counts the specified number of pulses from the reference standard. If “**DUT**” is selected, the test will stop after the RM-111 counts the specified number of pulses from the standard under test. To reduce errors associated with testing standards with different pulse output constants, the “**Input A:**” parameter should be set to “**DUT**” whenever the DUT has a lower pulse resolution than the reference standard. If “**DUT**” is selected, the DUT must be connected to PORT A. Follow the prompts on the RM-111 for connection details.

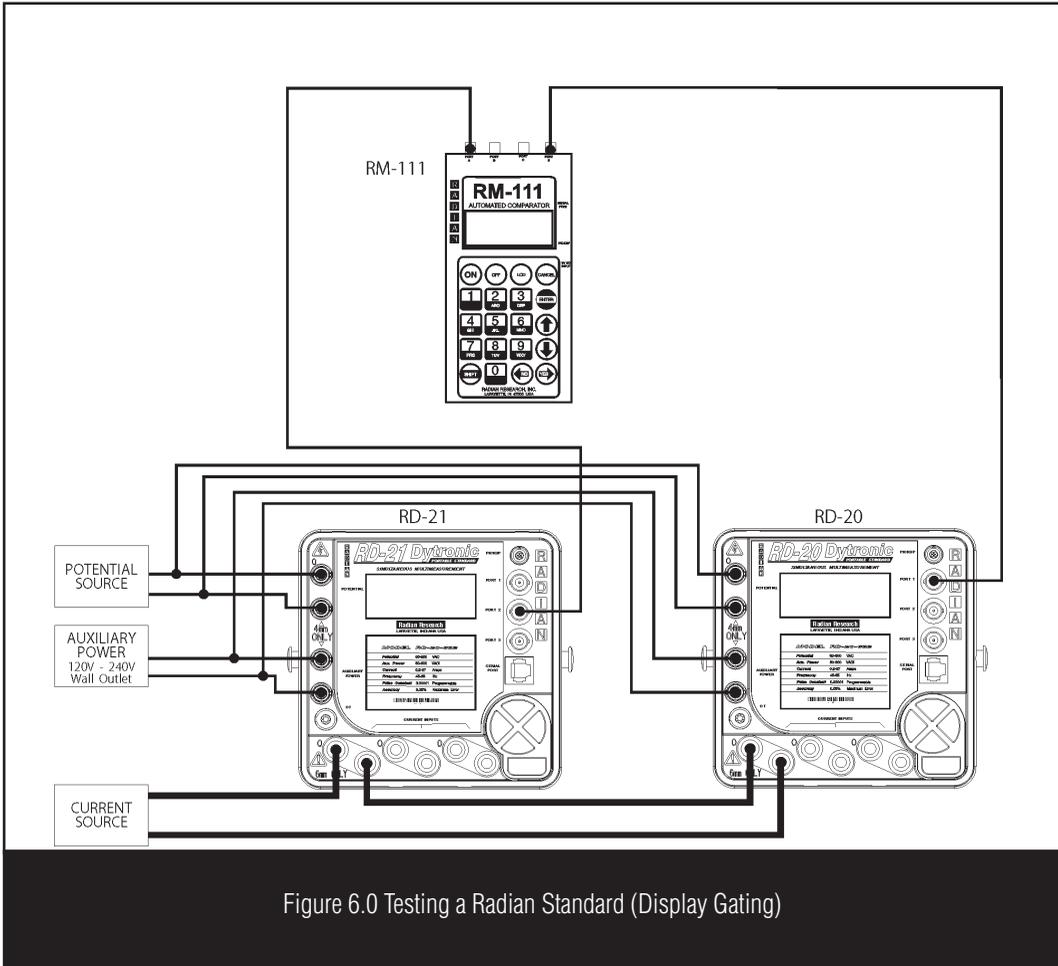
4. Press ENTER to exit the Test Setup screen.

5. From the Main Menu select RUN TESTS.

6. Select Test Standard.



7. Select the previously configured test setup.
8. If not already completed, follow the prompts on the RM-111 to make the appropriate connections. If using three inputs, see Figure 7.0 “Testing a Radian Standard Using the Average of Three Inputs (Display Gating)”. See Figure 6.0 “Testing a Radian Standard (Display Gating)” for testing with only one reference standard. The number of reference standards defined in the test setup determine how the ports are configured. If three reference standards are used, then ports A, B, and C will be configured and their results averaged. This configuration will allow only one standard under test, which will connect to port D. For one reference standard, only port A will be configured. This option will allow for up to three standards to be tested.
9. Once connections are complete, press ENTER to start the test.
10. The RM-111 will prompt the user to reset the standard(s) displays.
11. In this mode, the RM-111 counts the number of pulses from the reference standard(s). The wathour count will be displayed when the specified number of pulses have been counted. The RM-111 averages the multiple reference standards internally then calculates the averaged value in the results.
12. The test is now complete. To process the results press ENTER.
13. Showing the results will display the result screen with a down arrow icon in the lower right corner. This icon references the DOWN ARROW key on the RM-111. Pressing the DOWN ARROW key prompts the user to enter the DUTs display reading. Enter that value directly into the keypad and press ENTER. The calculated % Registration or % Error will appear at the bottom of the screen. For multiple DUTs enter their respective display reading directly over the previous display reading. Press ENTER for the calculated result. Use the LEFT and RIGHT ARROW keys to move the cursor through the display’s digits. The DUT number increases numerically as multiple entries are made. Repeat this process for all additional DUTs. Press CANCEL when finished to return to the Main Menu.
14. To re-run the test select Re-Run Test. The pulses will be counted again and the new count will be displayed on the RM-111. Press ENTER to continue.
15. To print the results connect the RM-RPP Remote Portable Printer to the SERIAL PORT on the RM-111. Turn the RM-RPP to the ON 1 position. Select Print Results. This will start the printing process. The printout is time/date stamped and includes both the wathour count and the calculated % Registration or % Error.
16. To save the results select Save Results. The RM-111 will prompt the user for the enabled parameters in the User Prompts menu and save the test results.



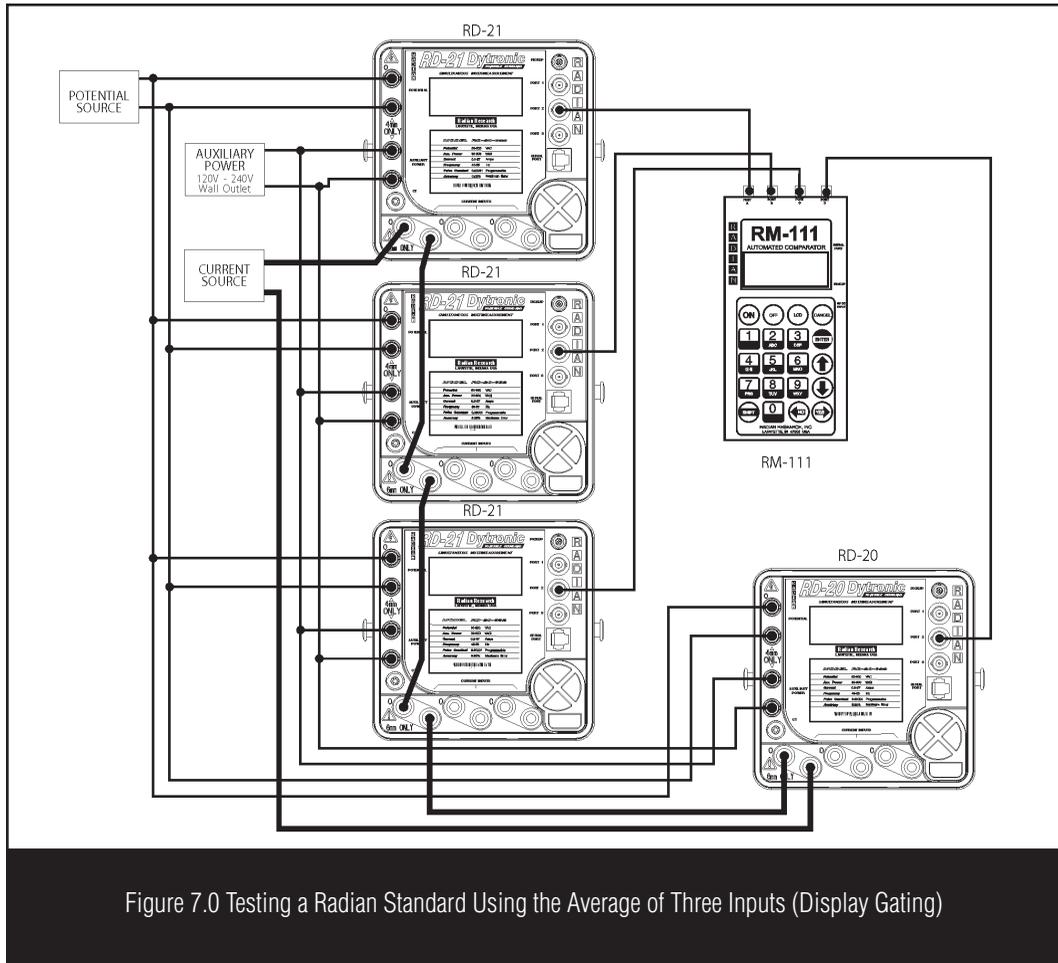
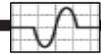


Figure 7.0 Testing a Radian Standard Using the Average of Three Inputs (Display Gating)



10.0 Testing an Electromechanical Standard (Potential Gating)

Equipment Needed:

- RM-111 Automated Comparator
- RM or RD Primary Reference Watthour Standard
- RM-1R Electronic/Mechanical Potential Relay

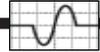
Test Steps:

1. Make the appropriate connections so that the standard(s) under test (D.U.T.'s) and the RM or RD Primary Reference Standard(s) are powered from the same voltage and current source.

2. Apply test voltage, current, and auxiliary power. At this point, the RM or RD reference standard(s) should be counting, but the electromechanical standard will not be rotating. Reset the electromechanical standard using its reset lever on the instrument face.

- Connect all standard pulse outputs to the RM-111.
- The RM or RD Primary Reference Watthour Standard will output pulses continuously once auxiliary power, voltage and current have been applied.
- Older generation induction and electronic standards display “equivalent revolutions” instead of “watthours.” The Kh of these older standards is usually 0.6 watthours per equivalent revolution when tested at 120 volts, 5.0 amps at 1.0 power factor. To determine the proper number of output pulses from the reference standard, use the following as a guide. If the reference standard for this test is a Radian standard that outputs 100,000 pulses per watthour, multiply 100,000 times the Kh of 0.6, which results in 60,000. Enter this value as the “number of reference standard pulses to count” for a one revolution test of the D.U.T. To select the number of pulses to count for the 1.0; 12.5; 15.0 and 50.0 amp taps, refer to section 20 of this manual for the Kh at each of these taps and multiply that figure by 100,000. Example: for the 12.5 amp tap: $100,000 \times 1.5 = 150,000$.

3. Turn on the RM-111 and select the TEST SETUPS menu option. From the TEST SETUPS menu, select STANDARD TEST. To create a new test setup, select Create. To edit an existing test



setup, select Edit. To delete a test, select Delete. The Test Setup screen contains all the necessary parameters to run a standards test. The arrow keys are used to move the cursor throughout this screen. Enter the appropriate value for each parameter:

Name - Enter a test setup name on the first line by typing over the current text (16 characters maximum).

PriKh – Enter the primary reference standard(s) Kh value.

Kh – Enter the DUT Kh value.

#Pulse – Enter the number of pulses for the reference standard(s) to output before stopping the test.

Time* – not applicable for this test

Test by* - Select PULSE

Type – Select M. Gating (mechanical gating) for the gating method

#Standards – Enter the number of reference standards that will be used. In this application, select one.

Mode – If more than one reference standard is used, the user must choose between single-phase or polyphase modes of operation.

Ref Type – This defines the reference standard output pull-up value. Select Radian (150 ohm). Other is 1000 ohm.

Input A** – Select either DUT or REF

SER#1 – Enter a serial number for standard 1, if applicable.

SER#2 – Enter a serial number for standard 2, if applicable.

SER#3 – Enter a serial number for standard 3, if applicable.

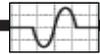
* The “**Test By:**” parameter input allows the user to select the type of test – TIME, PULSE, MANUAL, or ENERGY. If ENERGY is selected, the “**Time:**” parameter input dynamically changed to “**Energy:**”. This allows a test to be stopped after a preset amount of energy has been



accumulated by the D.U.T

When testing a standard by counting output pulses, the RM-111 will count the output pulses of both the reference standard (REF) and the standard under test (DUT), until the selected number of pulses are achieved. The “Input A:**” parameter input allows the user to select either “**REF**” or “**DUT**”. If “**REF**” is selected, the test will stop after the RM-111 counts the specified number of pulses from the reference standard. If “**DUT**” is selected, the test will stop after the RM-111 counts the specified number of pulses from the standard under test. To reduce errors associated with testing standards with different pulse output constants, the “**Input A:**” parameter should be set to “**DUT**” whenever the DUT has a lower pulse resolution than the reference standard. If “**DUT**” is selected, the DUT must be connected to PORT A. Follow the prompts on the RM-111 for connection details.

4. Press ENTER to exit the Test Setup screen.
5. From the Main Menu select RUN TESTS.
6. Select Test Standard.
7. Select the previously configured test setup.
8. If not already completed, follow the prompts on the RM-111 to make the appropriate connections. See Figure 8.0 “Testing an Electromechanical Standard (Potential Gating)” for the applicable wiring diagram. The number of reference standards defined in the test setup determine how the ports are configured. In this application, there is one RM or RD Primary Reference Watthour Standard that is connected to Port A. The RM-1R Mechanical Relay will connect to Port D.
9. Once connections are complete press ENTER to start the test.
10. The RM-111 will prompt the user to reset the standard displays. Reset the standard’s display and press ENTER.
11. In this mode, the RM-111 counts the number of pulses from the reference standard(s). The watthour count will be displayed when the specified number of pulses have been counted.
12. The test is now complete. To process the results press ENTER.
13. Showing the results will display the result screen with a down arrow icon in the lower right corner. This icon references the DOWN ARROW key on the RM-111 keypad. Pressing the DOWN ARROW key prompts the user to enter the DUTs display reading. Enter that value



directly into the keypad and press ENTER. The calculated % registration or % error will appear at the bottom of the screen. For multiple DUTs enter their respective display reading directly over the previous display reading. Press ENTER for the calculated result. Use the LEFT and RIGHT ARROW keys to move the cursor through the display's digits. The DUT number increases numerically as multiple entries are made. Repeat this process for all additional DUTs. Press CANCEL when finished to return to the Main Menu.

14. To re-run the test select Re-Run Test. The pulses will be counted again and the new count will be displayed on the RM-111. Press ENTER to continue.

15. To print the results connect the RM-RPP Remote Portable Printer to the SERIAL PORT on the RM-111. Turn the RM-RPP to the ON 1 position. Select Print Results. This will start the printing process. The printout is time/date stamped and includes both the watt-hour count and the calculated % Registration or % Error.

16. To save the results select Save Results. The RM-111 will prompt the user for the enabled parameters in the User Prompts menu and save the test results.

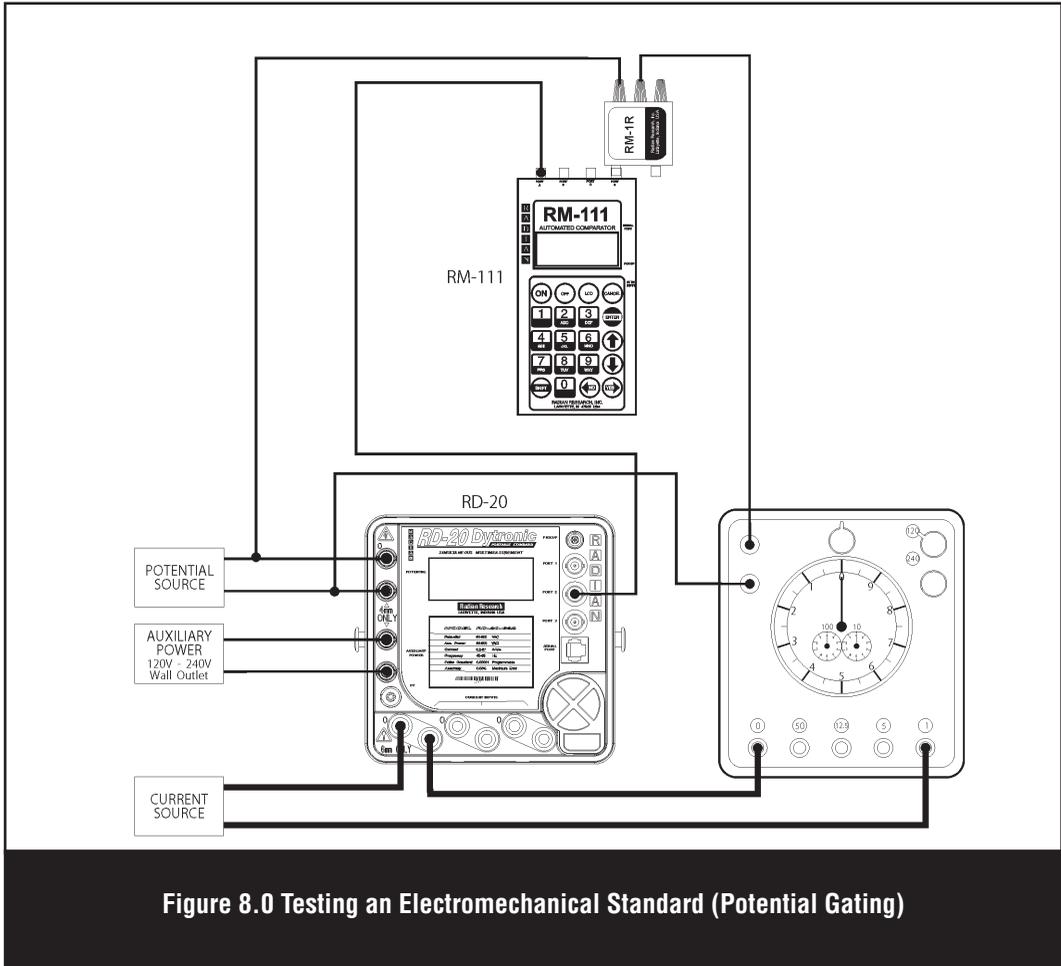
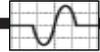


Figure 8.0 Testing an Electromechanical Standard (Potential Gating)



11.0 Testing an Electronic Standard with Taps (Potential Gating)

Equipment Needed:

- RM-111 Automated Comparator
- RM or RD Primary Reference Watthour Standard
- Electronic standard to be tested
- RM-1R Electronic/Mechanical Potential Relay

Test Steps:

1. Make the appropriate connections so that the standard(s) under test (DUTs) and the RM or RD Primary Reference Standard(s) are powered from the same voltage and current source.
2. Apply test voltage, current and auxiliary power. At this point, the RM or RD Reference standard(s) should be counting.
 - Connect all standard pulse outputs to the RM-111.
 - The RM or RD Primary Reference Watthour Standard will output pulses continuously once auxiliary power, voltage, and current have been applied.
 - Older generation induction and electronic standards display “equivalent revolutions” instead of “watthours.” The Kh of these older standards is usually 0.6 watthours per equivalent revolution when tested at 120 volts, 5.0 amps at 1.0 power factor. To determine the proper number of output pulses from the reference standard, use the following as a guide. If the reference standard for this test is a Radian standard that outputs 100,000 pulses per watthour, multiply 100,000 times the Kh of 0.6 which results in 60,000. Enter this value as the “number of reference standard pulses to count” for a one revolution test of the D.U.T. To select the number of pulses to count for the 1.0; 12.5; 15.0 and 50.0 amp taps, refer to section 20 of this manual for the Kh at each of these taps and multiply that figure by 100,000. Example: for the 12.5 amp tap: $100,000 \times 1.5 = 150,000$.
3. Turn on the RM-111 and select the TEST SETUP menu option. From the TEST SETUP menu, select STANDARD TEST. To create a new test setup, select Create. To edit an existing test setup, select Edit. To delete a test, select Delete. The Test Setup screen contains all the necessary



parameters to run a standards test. The arrow keys are used to move the cursor throughout this screen. Enter the appropriate value for each parameter:

Name - Enter a test setup name on the first line by typing over the current text (16 characters maximum).

PriKh – Enter the primary reference standard(s) Kh value.

Kh – Enter the DUT Kh value.

#Pulse – Enter the number of pulses for the reference standard(s) to output before stopping the test.

Time* – not applicable for this test

Test by* - Select PULSE

Type – Select M. Gating (mechanical gating) for the gating method

#Standards – Enter the number of reference standards that will be used. In this application, select one.

Mode – If more than one reference standard is used, the user must choose between single-phase or polyphase modes of operation.

Ref Type – This defines the reference standard output pull-up value. Select Radian (150 ohm). Other is 1000 ohm.

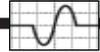
Input A** – Select either DUT or REF

SER#1 – Enter a serial number for standard 1, if applicable.

SER#2 – Enter a serial number for standard 2, if applicable.

SER#3 – Enter a serial number for standard 2, if applicable.

* The “**Test By:**” parameter input allows the user to select the type of test – TIME, PULSE, MANUAL, or ENERGY. If ENERGY is selected, the “**Time:**” parameter input dynamically changed to “**Energy:**”. This allows a test to be stopped after a pre-set amount of energy has been accumulated by the DUT



When testing a standard by counting output pulses, the RM-111 will count the output pulses of both the reference standard (REF) and the standard under test (DUT), until the selected number of pulses are achieved. The “Input A:**” parameter input allows the user to select either “**REF**” or “**DUT**”. If “**REF**” is selected, the test will stop after the RM-111 counts the specified number of pulses from the reference standard. If “**DUT**” is selected, the test will stop after the RM-111 counts the specified number of pulses from the standard under test. To reduce errors associated with testing standards with different pulse output constants, the “**Input A:**” parameter should be set to “**DUT**” whenever the DUT has a lower pulse resolution than the reference standard. If “**DUT**” is selected, the DUT must be connected to PORT A. Follow the prompts on the RM-111 for connection details.

4. Press ENTER to exit the Test Setup screen.
5. From the Main Menu select RUN TESTS.
6. Select Test Standard.
7. Select the previously configured test setup.
8. If not already completed, follow the prompts on the RM-111 to make the appropriate connections. See Figure 9.0 “Testing an Electronic Standard (Potential Gating)” for the applicable wiring diagram. The number of reference standards defined in the test setup determine how the ports are configured. In this application, there is one RM or RD Primary Reference Watthour Standard that is connected to Port A. The RM-1R Mechanical Relay will connect to Port D.
9. Once connections are complete press ENTER to start the test.
10. The RM-111 will prompt the user to reset the standard displays. Reset the electronic standard using it’s reset button on the instrument face and press ENTER.
11. In this mode, the RM-111 counts the number of pulses from the reference standard(s). The watthour count will be displayed when the specified number of pulses have been counted.
12. The test is now complete. To process the results press ENTER.
13. Showing the results will display the result screen with a down arrow icon in the lower right corner. This icon references the DOWN ARROW key on the RM-111 keypad. Pressing the DOWN ARROW key prompts the user to enter the D.U.T.’s display reading. Enter that value directly into the keypad and press ENTER. The calculated % registration or % error will appear at the bottom of the screen. For multiple D.U.T.’s enter their respective display reading directly



over the previous display reading. Press ENTER for the calculated result. Use the LEFT and RIGHT ARROW keys to move the cursor through the display's digits. The DUT number increases numerically as multiple entries are made. Repeat this process for all additional DUTs. Press CANCEL when finished to return to the Main Menu.

14. To re-run the test select Re-Run Test. The pulses will be counted again and the new count will be displayed on the RM-111. Press ENTER to continue.

15. To print the results connect the RM-RPP Remote Portable Printer to the SERIAL PORT on the RM-111. Turn the RM-RPP to the ON 1 position. Select Print Results. This will start the printing process. The printout is time/date stamped and includes both the watt-hour count and the calculated % Registration or % Error.

16. To save the results select Save Results. The RM-111 will prompt the user for the enabled parameters in the User Prompts menu and save the test results.

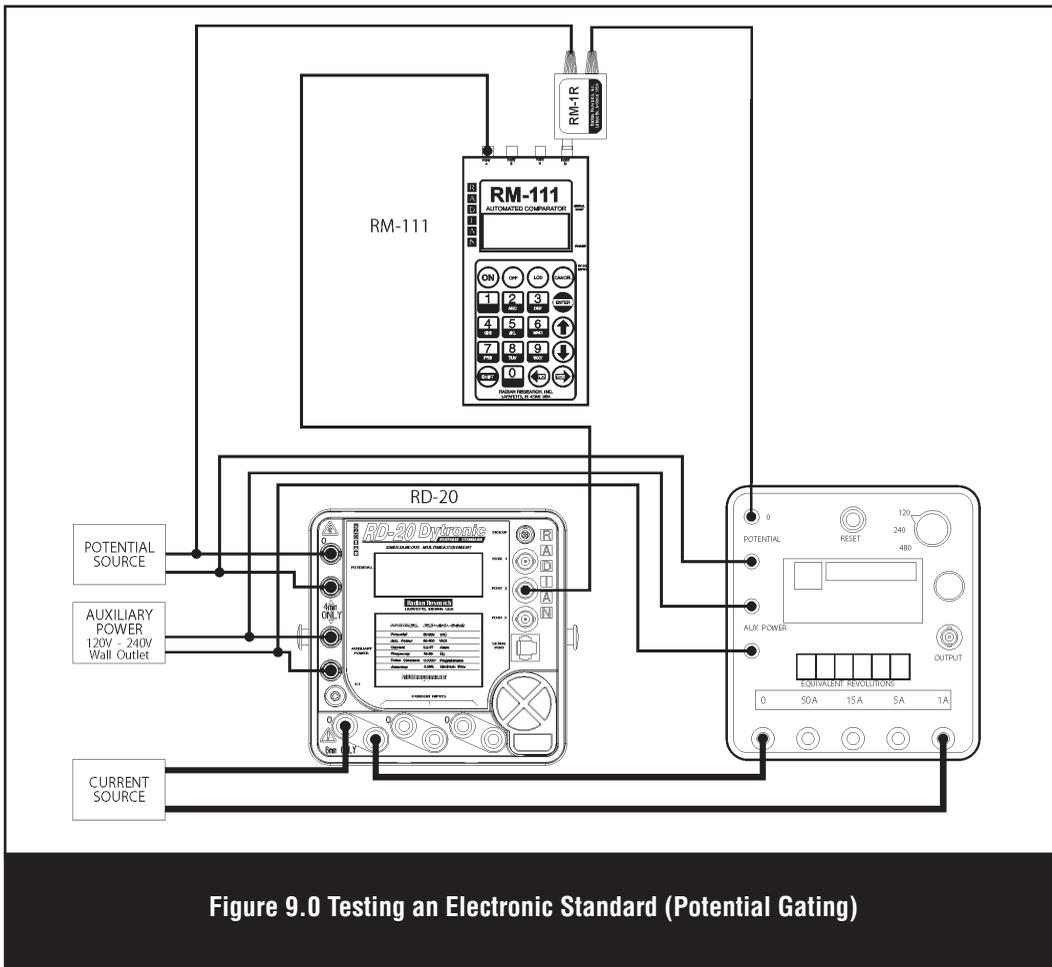


Figure 9.0 Testing an Electronic Standard (Potential Gating)



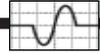
12.0 Testing an Electronic Standard (Electronic Gating)

Equipment Needed:

- RM-111 Automated Comparator
- RM or RD Primary Reference Watthour Standard
- Electronic standard with a gate input
- RM-1R Electronic/Mechanical Potential Relay

Test Steps:

1. Make the appropriate connections so that the standard(s) under test (DUTs) and the RM or RD Primary Reference Standard(s) are powered from the same voltage and current source.
2. Apply test voltage, current and auxiliary power. At this point, the RM or RD Reference standard(s) should be counting.
 - Connect all standard pulse outputs to the RM-111.
 - The RM or RD Primary Reference Watthour Standard will output pulses continuously once auxiliary power, voltage and current have been applied.
 - There are several Electronic Standards that can be tested by electronically gating the display. For testing a SC-10V, A-7 or SC-30, follow the guide for each below, when using a Radian RM or RD series standard as the reference standard.
 - SC-10 and A-7: The number of standard pulses for the reference standard to count when testing the D.U.T. at 120 volts and 5 amps at 1.0 power factor on the 5 amp tap = 60,000.
 - Older generation induction and electronic standards display “equivalent revolutions” instead of “watthours.” The Kh of these older standards is usually 0.6 watthours per equivalent revolution when tested at 120 volts, 5.0 amps at 1.0 power factor. To determine the proper number of output pulses from the reference standard, use the following as a guide. If the reference standard for this test is a Radian standard that outputs 100,000 pulses per watthour, multiply 100,000 times the Kh of 0.6 which results in 60,000. Enter this value as the “number of reference standard pulses to count” for a one revolution test of the DUT To select the number of pulses to count for the 1.0; 12.5;15.0 and 50.0 amp taps, refer to section 20 of



this manual for the Kh at each of these taps and multiply that figure by 100,000. Example: for the 12.5 amp tap: $100,000 \times 1.5 = 150,000$.

- SC-30: The number of standard pulses for the reference standard to count will be 100,000 for all currents and voltages.
- To properly electronic gate any of the above standards with the RM-1R, a coax cable (RG-58U or similar) about 36" long with a BNC connector on one end and the cable shield and center conductor on the other end to each be terminated with either a spade lug of proper size to fit the connectors on the RM-1R or banana plugs.
- Maintain the relationship of the RM-1R Electronic relay indicator arrow to the horizon. With the RM-111 laying flat, the arrow should point up. This is a wetted relay and must stay within 30° of the horizon.

3. Turn on the RM-111 and select the TEST SETUPS menu option. From the TEST SETUPS menu, select STANDARD TEST. To create a new test setup, select Create. To edit an existing test setup, select Edit. To delete a test, select Delete. The Test Setup screen contains all the necessary parameters to run a standards test. The arrow keys are used to move the cursor throughout this screen. Enter the appropriate value for each parameter:

Name - Enter a test setup name on the first line by typing over the current text (16 characters maximum).

PriKh – Enter the primary reference standard(s) Kh value.

Kh – Enter the DUT Kh value. See chart on page XX for commonly used Kh pulse constants.

#Pulse – Enter the number of pulses for the reference standard(s) to output before stopping the test.

Time* – not applicable for this test

Test by* - Select PULSE

Type – Select E. Gating (electronic gating) for the gating method

#Standards – Enter the number of reference standards that will be used. In this application, select one.



Mode – If more than one reference standard is used, the user must choose between single-phase or polyphase modes of operation.

Ref Type – This defines the reference standard output pull-up value. Select Radian (150 ohm). Other is 1000 ohm.

Input A** – Select either DUT or REF

SER#1 – Enter a serial number for standard 1, if applicable.

SER#2 – Enter a serial number for standard 2, if applicable.

SER#3 – Enter a serial number for standard 2, if applicable.

* The “**Test By:**” parameter input allows the user to select the type of test – TIME, PULSE, MANUAL, or ENERGY. If ENERGY is selected, the “**Time:**” parameter input dynamically changed to “**Energy:**”. This allows a test to be stopped after a pre-set amount of energy has been accumulated by the DUT

When testing a standard by counting output pulses, the RM-111 will count the output pulses of both the reference standard (REF) and the standard under test (DUT), until the selected number of pulses are achieved. The “Input A:**” parameter input allows the user to select either “**REF**” or “**DUT**”. If “**REF**” is selected, the test will stop after the RM-111 counts the specified number of pulses from the reference standard. If “**DUT**” is selected, the test will stop after the RM-111 counts the specified number of pulses from the standard under test. To reduce errors associated with testing standards with different pulse output constants, the “**Input A:**” parameter should be set to “**DUT**” whenever the DUT has a lower pulse resolution than the reference standard. If “**DUT**” is selected, the DUT must be connected to PORT A. Follow the prompts on the RM-111 for connection details.

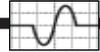
4. Press ENTER to exit the Test Setup screen.

5. From the Main Menu select RUN TESTS.

6. Select Test Standard.

7. Select the previously configured test setup.

8. If not already completed, follow the prompts on the RM-111 to make the appropriate connections. See Figure 10.0 “Testing an Electronic Standard (Electronic Gating)” for the applicable wiring diagram. The number of reference standards defined in the test setup determine



how the ports are configured. In this application, there is one RM or RD Primary Reference Wathour Standard that is connected to Port A. The RM-1R Mechanical Relay will connect to Port D.

9. Once connections are complete press ENTER to start the test.

10. The RM-111 will prompt the user to reset the standard displays. Reset the electronic standard using its reset button on the instrument face and press ENTER.

11. In this mode, the RM-111 counts the number of pulses from the reference standard(s). The wathour count will be displayed when the specified number of pulses have been counted.

12. The test is now complete. To process the results press ENTER.

13. Showing the results will display the result screen with a down arrow icon in the lower right corner. This icon references the DOWN ARROW key on the RM-111 keypad. Pressing the DOWN ARROW key prompts the user to enter the DUTs display reading. Enter that value directly into the keypad and press ENTER. The calculated % registration or % error will appear at the bottom of the screen. For multiple DUTs enter their respective display reading directly over the previous display reading. Press ENTER for the calculated result. Use the LEFT and RIGHT ARROW keys to move the cursor through the display's digits. The DUT number increases numerically as multiple entries are made. Repeat this process for all additional DUTs. Press CANCEL when finished to return to the Main Menu.

14. To re-run the test select Re-Run Test. The pulses will be counted again and the new count will be displayed on the RM-111. Press ENTER to continue.

15. To print the results connect the RM-RPP Remote Portable Printer to the SERIAL PORT on the RM-111. Turn the RM-RPP to the ON 1 position. Select Print Results. This will start the printing process. The printout is time/date stamped and includes both the wathour count and the calculated % Registration or % Error.

16. To save the results select Save Results. The RM-111 will prompt the user for the enabled parameters in the User Prompts menu and save the test results.

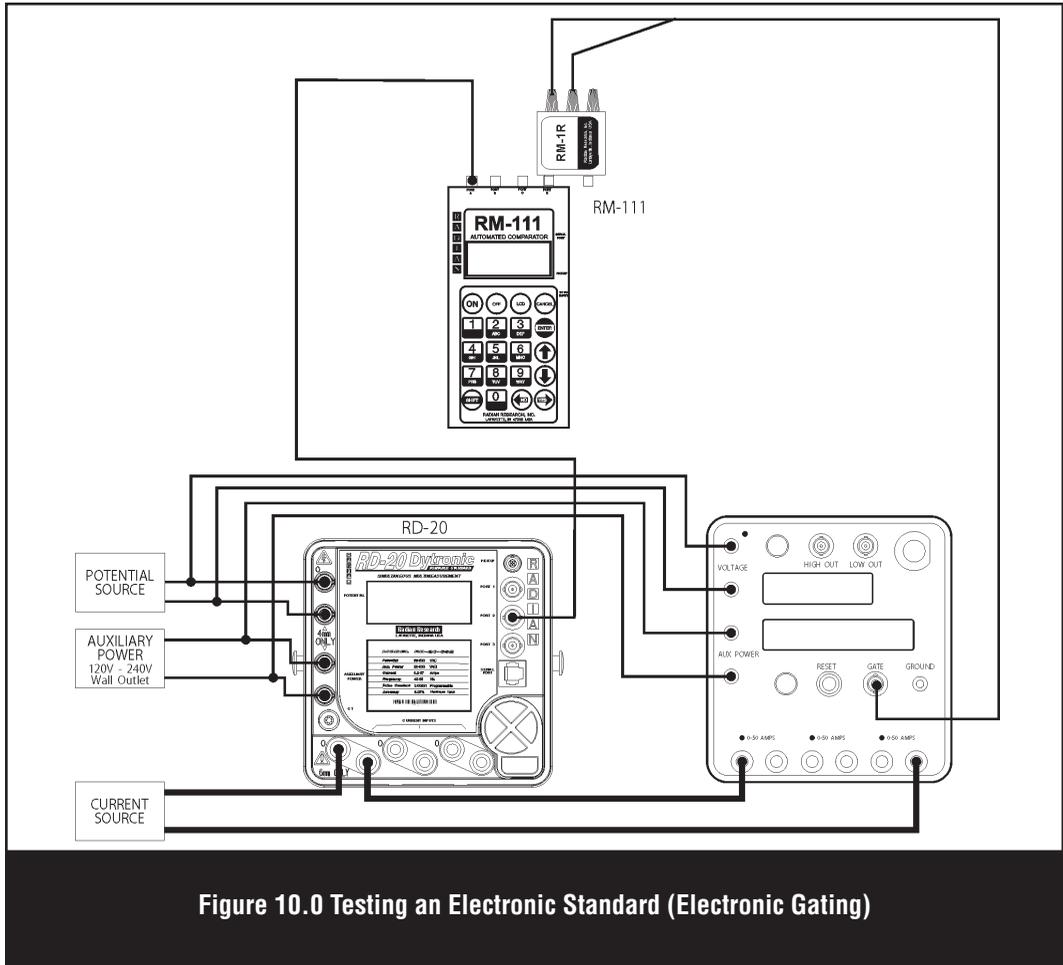
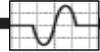


Figure 10.0 Testing an Electronic Standard (Electronic Gating)



13.0 Testing an Induction or Solid State Meter via KYZ

Equipment Needed:

- RM-111 Automated Comparator
- RM or RD Portable Watthour Standard
- Induction or solid state meter with KYZ and a known Mp ratio (revs per pulse)
- RM-KYZ or RR-KYZ Pulse Input Adapter
- Universal test jack and a source of voltage and a current such as a watthour test board

Test Steps:

1. Make the appropriate connections so that the meter(s) under test (DUTs) and the RM or RD Primary Reference Standard(s) are powered from the same voltage and current source.
2. Apply test voltage, current and auxiliary power. At this point, both the DUT and the RM or RD reference standard(s) should be running.

- Connect all standard pulse outputs to the RM-111.
- The RM or RD Primary Reference Watthour Standard will output pulses continuously once auxiliary power, voltage, and current have been applied.
- The Ke factor of any meter can be calculated by manipulating the following constants:

Ke = The watthour pulse constant of each pulse from the pulse initiator (KYZ). The value of the Ke depends upon the meter Kh and the type of test conducted.



M_p = Number of revolutions per pulse.

Examples:

For a **mechanical** meter:

$$K_e = (K_h) (M_p) = \frac{K_h = 7.2 \text{ Wh}}{1 \text{ Rev}} * \frac{M_p = 2 \text{ Revs}}{1 \text{ Pulse}} = \frac{K_e = 14.4 \text{ Wh}}{1 \text{ Pulse}} \quad K_e = 14.4 \text{ Wh}$$

where:

$M_p = 2/1 = 2$ revolutions per 1 pulse

$K_h = 7.2$ wathours per 1 revolution

For a **solid state** meter:

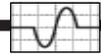
$$K_e = (K_h) (M_p) = K_h = \frac{1.8 \text{ Wh}}{1 \text{ Rev}} * M_p = \frac{1 \text{ Rev}}{12 \text{ Pulses}} = K_e = \frac{1.8 \text{ Wh}}{12 \text{ Pulses}} \quad K_e = 0.15 \text{ Wh}$$

where:

$M_p = 1/12 = 1$ revolution per 12 pulses

$K_h = 1.8 =$ wathours per 1 revolution

- The formula that the RM-111 uses to calculate percent registration is as follows:



$$\% \text{ Registration} = \frac{K_e * (\# \text{ KYZ pulses}) * (\# \text{ of standard current inputs})}{\text{Display of Ref. Standard} * \# \text{ of Meter Elements}} * 100$$

Where:

100 = used to convert to a percentage

K = pulse constant from meter

of KYZ pulses = calibration pulses per equivalent Kh

number of standard inputs = how many current inputs are being used on the reference standard.

display of standard = the reading of the reference standard display

of meter elements = the number of elements used on the meter under test

3. Turn on the RM-111 and select the TEST SETUPS menu option. From the TEST SETUPS menu, select METER TEST. To create a new test setup, select Create. To edit an existing test setup, select Edit. To delete a test, select Delete. The Test Setup screen contains all the necessary parameters to run a meter test. The arrow keys are used to move the cursor throughout this screen. Enter the appropriate value for each parameter:

Name - Enter a test setup name on the first line by typing over the current text (16 characters maximum).

Form: Enter the meter form.



KH - Enter the DUT Kh value.

PriKh – Enter the primary reference standard(s) Kh value.

Test by* – Select either Revs or Energy.

#Standards – Enter the number of reference standards that will be used.

Mode – If more than one reference standard is used, the user must choose between single-phase or polyphase modes of operation.

Ref Type – This defines the reference standard output pull-up value. Select Radian (150 ohm). Other is 1000 ohm.

#Inputs – Enter the number of current inputs used for the reference standard(s).

SER#1 – Enter a serial number for standard 1, if applicable.

SER#2 – Enter a serial number for standard 2, if applicable.

SER#3 – Enter a serial number for standard 3, if applicable.

Element – Enter the number of meter elements.

FL Revs – Enter the desired number of revolutions for the full load test (FL).

PF Revs – Enter the desired number of revolutions for the power factor test (PF).

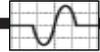
LL Revs – Enter the desired number of revolutions for the light load test (LL).

FL WAVG – Enter the desired weight of the measured FL value in the weighted average calculation.

PF WAVG – Enter the desired weight of the measured PF value in the weighted average calculation.

LL WAVG – Enter the desired weight of the measured LL value in the weighted average calculation.

Demand – Enter the desired number of minutes for the demand test. To omit the demand test, enter zero.



Pulses/Rev – Enter the number of pulses (or equivalent pulses) per revolution of the meter under test. Use the calculations above and enter one pulse per Ke value.

Creep Mins – Enter the desired number of minutes to be used for the Creep test.

* The “**Test By:**” parameter input allows the user to select the type of test – **Revs** or **Energy**. If **Energy** is selected, the “**FL Revs:**”, “**PF Revs:**”, and “**LL Revs:**” parameter inputs dynamically change to “**FL Wh:**”, “**PF Wh:**”, and “**LL Wh:**”. This allows a test to be stopped after a pre-set amount of energy has been accumulated by the D.U.T.

4. Press ENTER to exit the Test Setup screen.
5. From the Main Menu select RUN TESTS.
6. Select Test Meter.
7. Select the previously configured test setup.
8. The RM-111 will prompt the user to select either a Manual (RM-1S or RR-1S) test or a Pulse Sensor (RM-KYZ or RR-KYZ) test. Select Pulse Sensor. Select BNC if using an RM-KYZ, or select Lemo if using an RR-KYZ.
9. If not already completed, follow the prompts on the RM-111 to make the appropriate connections. See Figure 11.0 “Testing an Induction or Solid State Meter via KYZ Output” for the applicable wiring diagram. The number of reference standards defined in the test setup determine how the ports are configured. If using the RM-KYZ, connect it to port A. If using the RR-KYZ, connect it to the PICKUP input. Connect the standards to ports B, C, and D.
10. Once connections are complete press ENTER to start the test.
11. The RM-111 starts the ALIGN PULSE SENSOR TEST to allow for the pulse sensor to be checked. During this time, the disk rotates at full load current. When the KYZ sensor is properly connected, the LCD will show flashing segments that are synchronous with the KYZ output. Press ENTER when alignment is achieved.
12. In this mode, the RM-111 counts the number of pulses from both the reference standard(s) and the KYZ signal from the meter under test. While the test is in progress, the RM-111 display shows the meter registration as it accrues and also shows the standards counting. When using a pulse sensor, the test automatically stops when the pulse sensor senses the last pulse.
13. The test is now complete. To process the results press ENTER.



14. To re-run the test select Re-Run Test. The pulses will be counted again and the new count will be displayed on the RM-111. Press ENTER to continue.

15. To display the calculated results select Show Results. The end count is displayed along with a down arrow icon in the lower right corner. This icon references the DOWN ARROW key on the RM-111 hand controller. By pressing the DOWN ARROW key the RM-111 displays the calculated results. Using the UP/DOWN ARROW keys the user can move between the watt-hour count and the calculated results.

16. To print the results connect the RM-RPP Remote Portable Printer to the SERIAL PORT on the RM-111. Turn the RM-RPP to the ON 1 position. Select Print Results. This will start the printing process. The printout is time/date stamped and includes both the watt-hour count and the calculated % Registration or % Error.

17. To save the results select Save Results. The RM-111 will prompt the user for the enabled parameters in the User Prompts menu and save the test results.

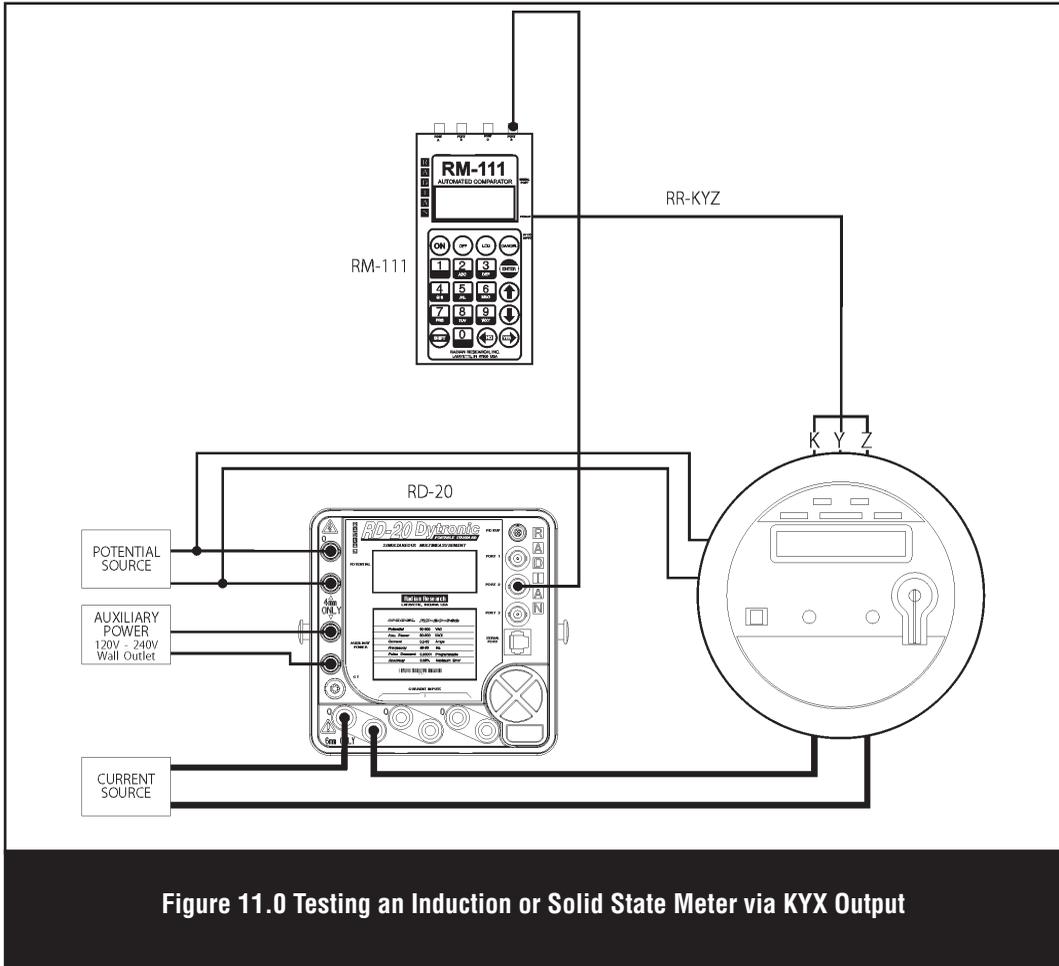
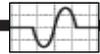


Figure 11.0 Testing an Induction or Solid State Meter via KYX Output



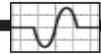
14.0 Testing a Solid State Meter Using Calibration LED Output or Induction Meter Using an Edge Test

Equipment Needed:

- RM-111 Automated Comparator
- RM or RD Portable Watthour Standard
- Solid state meter programmed with a known number of infrared calibration pulses per Kh, or induction meter
- RM-DS or RR-DS Disk Sensor or the RM-1H or RR-1H Optical Pickup
- Universal test jack

Test Steps:

1. Make the appropriate connections so that the meter(s) under test (DUT's) and the RM or RD Primary Reference Standard(s) are powered from the same voltage and current source.
2. Apply test voltage, current, and auxiliary power.
 - Connect all standard pulse outputs to the RM-111.
 - The RM or RD Primary Reference Watthour Standard will output pulses continuously once auxiliary power, voltage and current have been applied.
 - To implement a demand and/or creep test to any meter test, set the desired time duration (minutes) in the Test Setup screen. Setting these parameters to zero will omit the test from the sequence.
 - The formula that the RM-111 uses to calculate percent registration is as follows:



$$\% \text{ Registration} = \frac{K_e * (\# \text{ KYZ pulses}) * (\# \text{ of standard current inputs})}{\text{Display of Ref. Standard} * \# \text{ of Meter Elements}} * 100$$

Where:

100 = used to convert to a percentage

K = pulse constant from meter

of KYZ pulses = calibration pulses per equivalent Kh

number of standard inputs = how many current inputs are being used on the reference standard.

display of standard = the reading of the reference standard display

of meter elements = the number of elements used on the meter under test

3. Turn on the RM-111 and select the **TEST SETUPS** menu option. From the **TEST SETUPS** menu, select **METER TEST**. To create a new test setup, select **Create**. To edit an existing test setup, select **Edit**. To delete a test, select **Delete**. The Test Setup screen contains all the necessary parameters to run a meter test. The arrow keys are used to move the cursor throughout this screen. Enter the appropriate value for each parameter:



Name - Enter a test setup name on the first line by typing over the current text (16 characters maximum).

Form: Enter the meter form.

KH - Enter the DUT Kh value.

Test by* – Select either Revs or Energy.

PriKh – Enter the primary reference standard(s) Kh value.

#Standards – Enter the number of reference standards that will be used.

Mode – If more than one reference standard is used, the user must choose between single-phase or polyphase modes of operation.

Ref Type – This defines the reference standard output pull-up value. Select Radian (150 ohm). Other is 1000 ohm.

#Inputs – Enter the number of current inputs used for the reference standard(s).

SER#1 – Enter a serial number for standard 1, if applicable.

SER#2 – Enter a serial number for standard 2, if applicable.

SER#3 – Enter a serial number for standard 3, if applicable.

Element – Enter the number of meter elements.

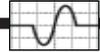
FL Revs – Enter the desired number of revolutions for the full load test (FL).

PF Revs – Enter the desired number of revolutions for the power factor test (PF).

LL Revs – Enter the desired number of revolutions for the light load test (LL).

FL WAVG – Enter the desired weight of the measured FL value in the weighted average calculation.

PF WAVG – Enter the desired weight of the measured PF value in the weighted average calculation.



LL WAVG – Enter the desired weight of the measured LL value in the weighted average calculation.

Demand – Enter the desired number of minutes for the demand test. To omit the demand test, enter zero.

Pulses/Rev – Enter the number of pulses (or equivalent pulses) per revolution of the meter under test. Use the calculations above and enter one pulse per Ke value.

Creep Mins – Enter the desired number of minutes to be used for the Creep test.

* The “**Test By:**” parameter input allows the user to select the type of tests – **Revs** or **Energy**. If **Energy** is selected, the “**FL Revs:**,” “**PF Revs:**,” and “**LL Revs:**” parameter inputs dynamically change to “**FL Wh:**,” “**PF Wh:**,” and “**LL Wh:**.” This allows a test to be stopped after a pre-set amount of energy has been accumulated by the DUT.

4. Press ENTER to exit the Test Setup screen.

5. From the Main Menu select RUN TESTS.

6. Select Test Meter.

7. Select the previously configured test setup.

8. The RM-111 will prompt the user to select either a Manual (RM-1S or RR-1S) test or a Pulse Sensor (RM-DS, RR-DS, RM-1H, or RR-1H) test. Select Pulse Sensor. Select BNC if using an RM-1H or RM-DS, or select Lemo if using an RR-1H or RR-DS.

9. If not already completed, follow the prompts on the RM-111 to make the appropriate connections. If using an RM-1H or RR-1H, see Figure 12.0 “Testing a Solid State Meter Using Calibration LED Output.” If using an RM-DS or RR-DS, see Figure 13.0 “Testing an Induction Meter Using an Edge Test.” The number of reference standards defined in the test setup determine how the ports are configured. If using the RM-1H or RM-DS, connect it to port A. If using the RR-1H or RR-DS, connect it to the PICKUP input. Connect the standards to ports B, C, and D.

10. Once connections are complete, press ENTER to start the test.

11. The RM-111 starts the ALIGN PULSE SENSOR TEST to allow for the pulse sensor to be checked. During this time, the disk rotates at full load current. When the 1H or DS sensor is



properly connected, the LCD will show flashing segments that are synchronous with the sensor output. Press ENTER when alignment is achieved.

12. In this mode, the RM-111 counts the number of pulses from both the reference standard(s) and the sensor signal from the meter under test. While the test is in progress, the RM-111 display shows the meter registration as it accrues and also shows the standards counting. When using a pulse sensor, the test automatically stops when the pulse sensor senses the last pulse.

13. The test is now complete. To process the results press ENTER.

14. To re-run the test select Re-Run Test. The pulses will be counted again and the new count will be displayed on the RM-111. Press ENTER to continue.

15. To display the calculated results select Show Results. The end count is displayed along with a down arrow icon in the lower right corner. This icon references the DOWN ARROW key on the RM-111 hand controller. By pressing the DOWN ARROW key the RM-111 displays the calculated results. Using the UP/DOWN ARROW keys the user can move between the watt-hour count and the calculated results.

16. To print the results connect the RM-RPP Remote Portable Printer to the SERIAL PORT on the RM-111. Turn the RM-RPP to the ON 1 position. Select Print Results. This will start the printing process. The printout is time/date stamped and includes both the watt-hour count and the calculated % Registration or % Error.

17. To save the results select Save Results. The RM-111 will prompt the user for the enabled parameters in the User Prompts menu and save the test results. The saved results also include the time and date stamp, and both the calculated results and the accumulated watt-hours during the test.

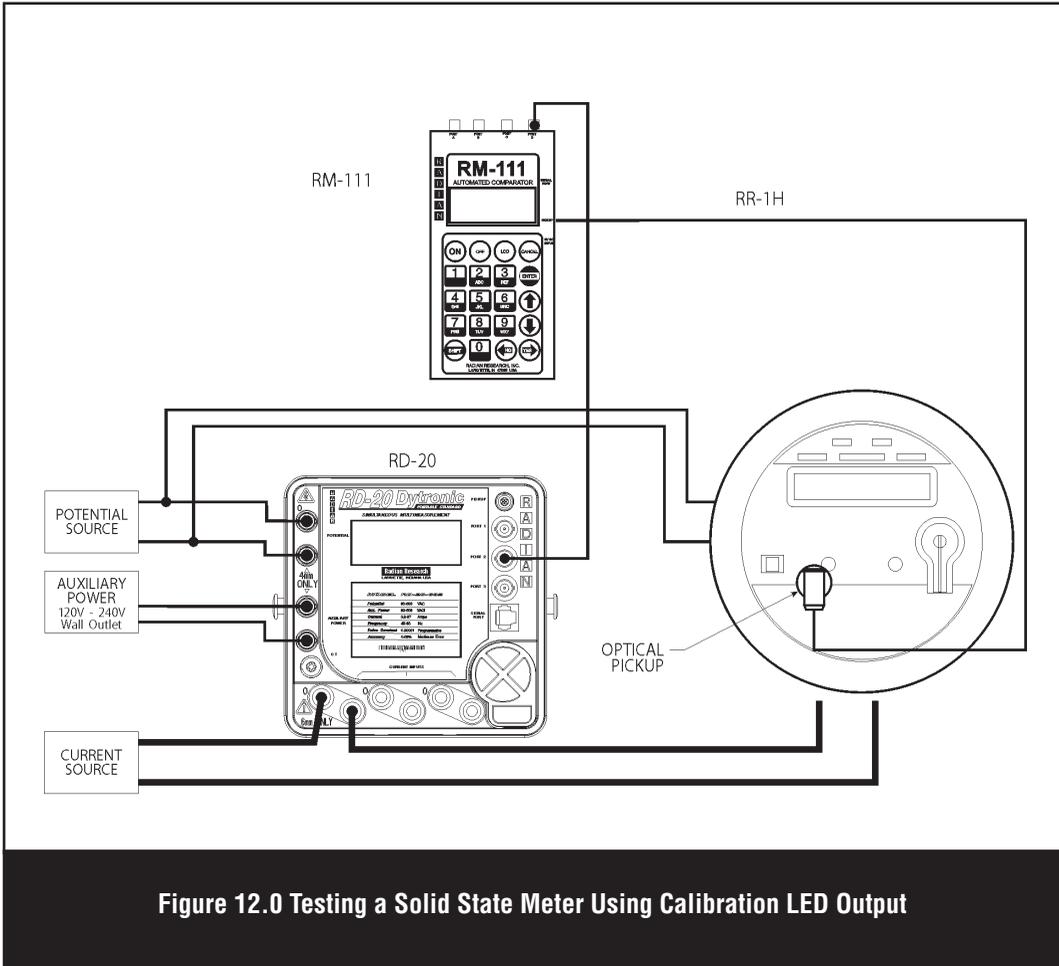
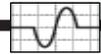


Figure 12.0 Testing a Solid State Meter Using Calibration LED Output

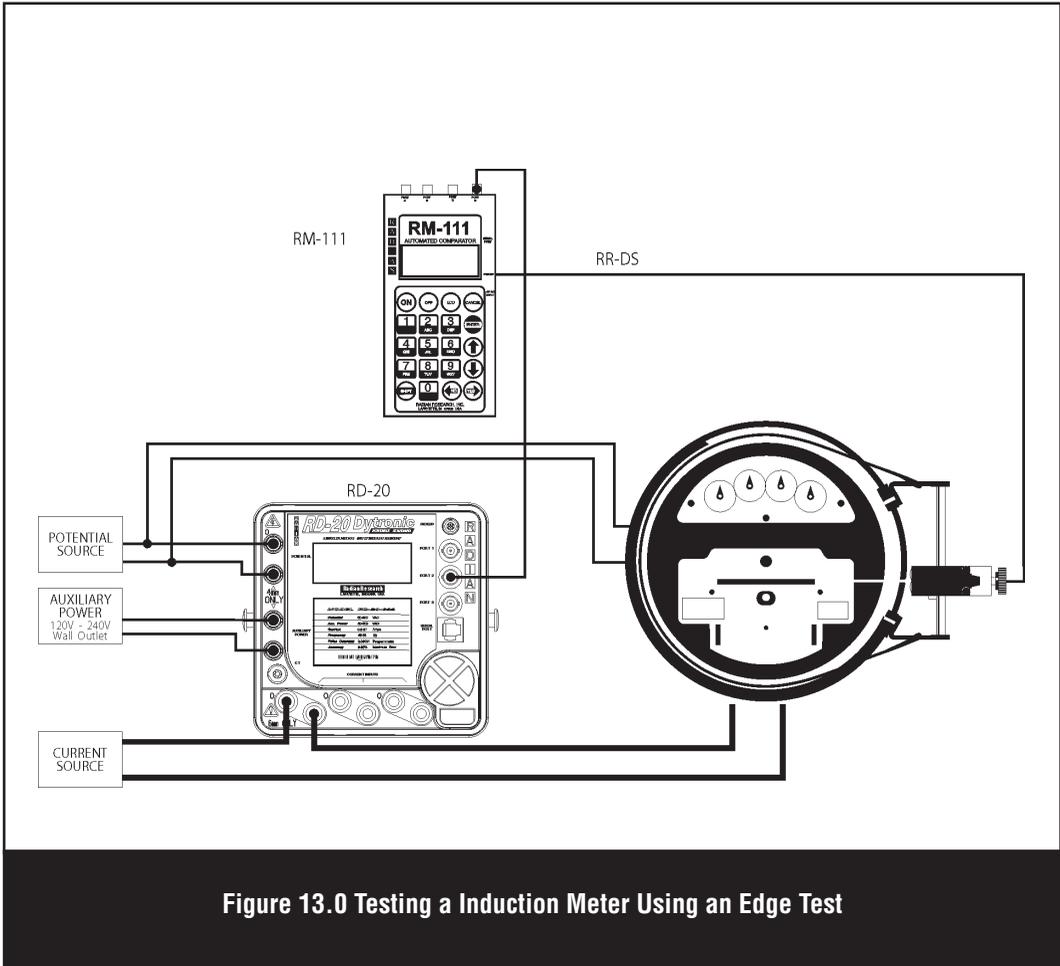
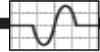


Figure 13.0 Testing a Induction Meter Using an Edge Test



15.0 True Three Phase Meter Testing Using Customer Load

Equipment Needed:

- RM-111 Automated Comparator
- Three RM or RD Reference Standards
- Polyphase solid state or induction meter
- RM-1H or RR-1H Optical Pickup or RM-DS or RR-DS Disk Sensor
- Universal test jack or test switch connection

Test Steps:

1. Make the appropriate connections either with a universal socket adaptor or connections made from the meter test switch at the installation so that each reference standard is powered from one of the voltage and current sources in each phase. Refer to Figure 14. Auxilliary power for each standard can be wired in parallel and sourced from any convenient 120/240 volt single phase supply.

2. Apply test voltage, current, and auxiliary power.

- To implement a demand and/or creep test to any meter test, set the desired time duration (minutes) in the Test Setup screen. Setting these parameters to zero will omit the test from the sequence.

3. Turn on the RM-111 and select the TEST SETUPS menu option. From the TEST SETUPS menu, select METER TEST. To create a new test setup, select Create. To edit an existing test setup, select Edit. To delete a test, select Delete. The Test Setup screen contains all the necessary parameters to run a meter test. The arrow keys are used to move the cursor throughout this screen. Enter the appropriate value for each parameter:

Name - Enter a test setup name on the first line by typing over the current text (16 characters maximum).



Form: Enter the meter form.

KH - Enter the DUT Kh value.

PriKh – Enter the primary reference standard(s) Kh value.

Test by* – Select either Revs or Energy.

#Standards – Enter the number of reference standards that will be used. For this application, enter three.

Mode – If more than one reference standard is used, the user must choose between single-phase or polyphase modes of operation. For this application, enter polyphase.

Ref Type – This defines the reference standard output pull-up value. Select Radian (150 ohm). Other is 1000 ohm.

#Inputs – Enter the number of current inputs used for the reference standard(s).

SER#1 – Enter a serial number for standard 1, if applicable.

SER#2 – Enter a serial number for standard 2, if applicable.

SER#3 – Enter a serial number for standard 3, if applicable.

Element – Enter the number of meter elements.

FL Revs – Enter the desired number of revolutions for the full load test (FL).

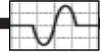
PF Revs – Enter the desired number of revolutions for the power factor test (PF).

LL Revs – Enter the desired number of revolutions for the light load test (LL).

FL WAVG – Enter the desired weight of the measured FL value in the weighted average calculation.

PF WAVG – Enter the desired weight of the measured PF value in the weighted average calculation.

LL WAVG – Enter the desired weight of the measured LL value in the weighted average calculation.



Demand – Enter the desired number of minutes for the demand test. To omit the demand test, enter zero.

Pulses/Rev – Enter the number of pulses (or equivalent pulses) per revolution of the meter under test. Use the calculations above and enter one pulse per Ke value.

Creep Mins – Enter the desired number of minutes to be used for the Creep test.

* The “**Test By:**” parameter input allows the user to select the type of tests – **Revs** or **Energy**. If **Energy** is selected, the “**FL Revs:**”, “**PF Revs:**”, and “**LL Revs:**” parameter inputs dynamically change to “**FL Wh:**”, “**PF Wh:**”, and “**LL Wh:**”. This allows a test to be stopped after a pre-set amount of energy has been accumulated by the DUT

4. Press ENTER to exit the Test Setup screen.
5. From the Main Menu select RUN TESTS.
6. Select Test Meter.
7. Select the previously configured test setup.
8. The RM-111 will prompt the user to select either a Manual (RM-1S or RR-1S) test or a Pulse Sensor (RM-DS, RR-DS, RM-1H, or RR-1H) test. Select Pulse Sensor. Select BNC if using an RM-1H or RM-DS, or select Lemo if using an RR-1H or RR-DS.
9. If not already completed, follow the prompts on the RM-111 to make the appropriate connections. See Figure 14.0 “True Three Phase Meter Testing (Using Customer Load)” for the applicable wiring diagram. The number of reference standards defined in the test setup determine how the ports are configured. In this application, three standards are used. If using the RM-1H or RM-DS, connect it to port A. If using the RR-1H or RR-DS, connect it to the PICKUP input. Connect the standards to ports B, C, and D.
10. Once connections are complete, press ENTER to start the test.
11. The RM-111 starts the ALIGN PULSE SENSOR TEST to allow for the pulse sensor to be checked. During this time, the disk rotates at full load current. When the 1H or DS sensor is properly connected, the LCD will show flashing segments that are synchronous with the sensor output. Press ENTER when alignment is achieved.



12. In this mode, the RM-111 counts the number of pulses from both the reference standard(s) and the sensor signal from the meter under test. While the test is in progress, the RM-111 display shows the meter registration as it accrues and also shows the standards counting. When using a pulse sensor, the test automatically stops when the pulse sensor senses the last pulse.

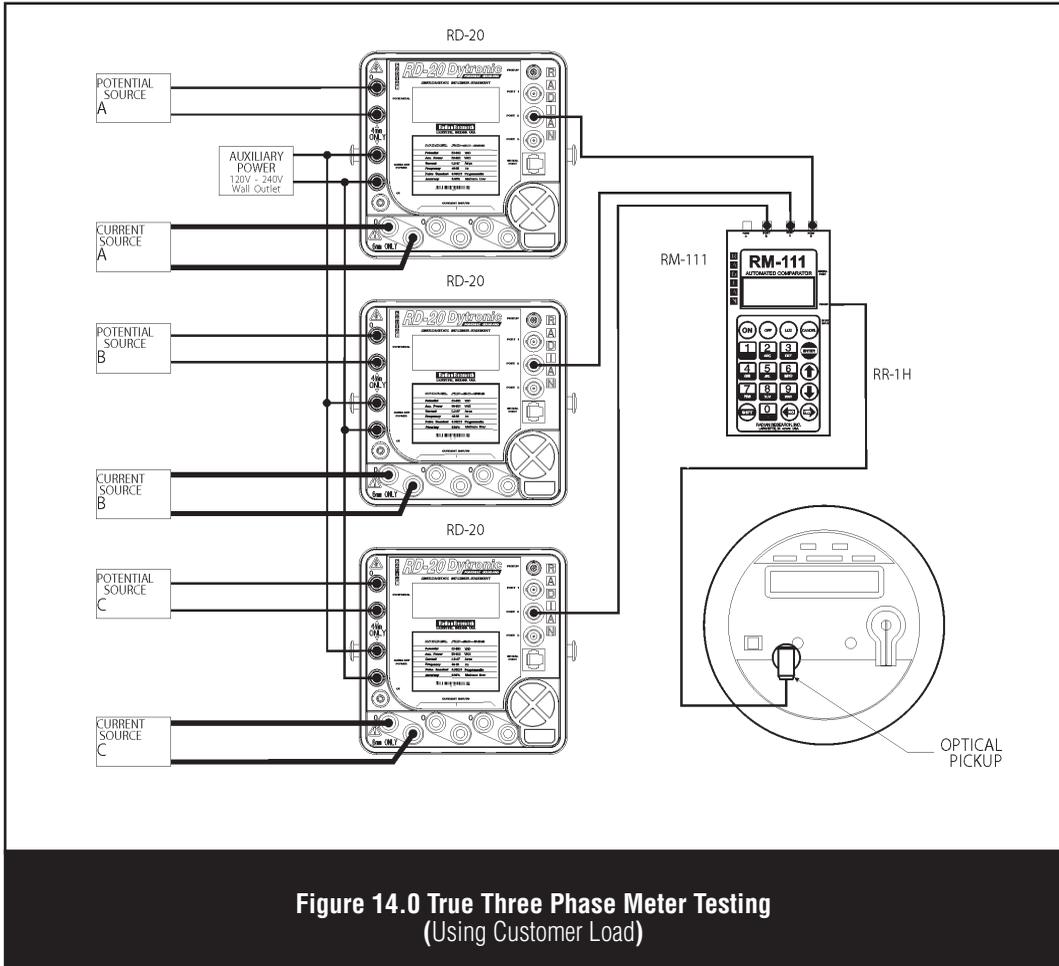
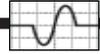
13. The test is now complete. To process the results press ENTER.

14. To re-run the test select Re-Run Test. The pulses will be counted again and the new count will be displayed on the RM-111. Press ENTER to continue.

15. To display the calculated results select Show Results. The end count is displayed along with a down arrow icon in the lower right corner. This icon references the DOWN ARROW key on the RM-111 hand controller. By pressing the DOWN ARROW key the RM-111 displays the calculated results. Using the UP/DOWN ARROW keys the user can move between the watthour count and the calculated results.

16. To print the results connect the RM-RPP Remote Portable Printer to the SERIAL PORT on the RM-111. Turn the RM-RPP to the ON 1 position. Select Print Results. This will start the printing process. The printout is time/date stamped and includes both the watthour count and the calculated % Registration or % Error.

17. To save the results select Save Results. The RM-111 will prompt the user for the enabled parameters in the User Prompts menu and save the test results. The saved results also include the time and date stamp, and both the calculated results and the accumulated watthours during the test.





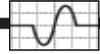
16.0 Testing The Accuracy of a Test Board (RM-1P Electronic Light Valve Option)

Equipment Needed:

- RM-111 Automated Comparator
- RM or RD Primary Reference Watthour Standard
- RM-1P Electronic Light Valve

Test Steps:

1. Make connections between the test board and the RM or RD standard(s) as per Figure 16.0. The standard must get both current and potential from the test board.
2. Position the RM-1P between the test board's light emitter and the light detector.
 - The RM-1P will function with both visible light or infrared light.
3. Turn on the RM-111 and select RUN TEST.
4. Select Test Board.
5. Enter the Kh.
 - The Kh value will appear truncated in the LCD. However, all six places to the right of the decimal point are used in the calculation.
 - There is no need to put a meter on the test board. The RM-1P will simulate a meter for testing purposes.
6. Select the Pulse Output Type. For this application, select RM-1P.
7. Make the proper connections to the RM-111. Connect the standards to ports A,B, and/or C. Connect the RM-1P to port D. Refer to Figure 16.0 "Testing the Accuracy of a Test Board (RM-1P Electronic Light Valve Option)" for connection details. Press ENTER to start the test.



8. Set up the test board as if testing a meter. For this example, the variables will be set for a Form 1S meter: $K_h=1.8$, 120V, 10Amps, and one revolution.
9. Start the test on the test board. The standard must be on, and the test board's light detector should now be waiting for the first pulse to start the test.
10. After the test board's counter has counted the specified number of pulses or disk revolutions it stops the test.
11. The RM-111's display shows the K_h value entered in the test and the end count of the standard(s). The test board itself shows the percent error, which is the percent error of the test board.

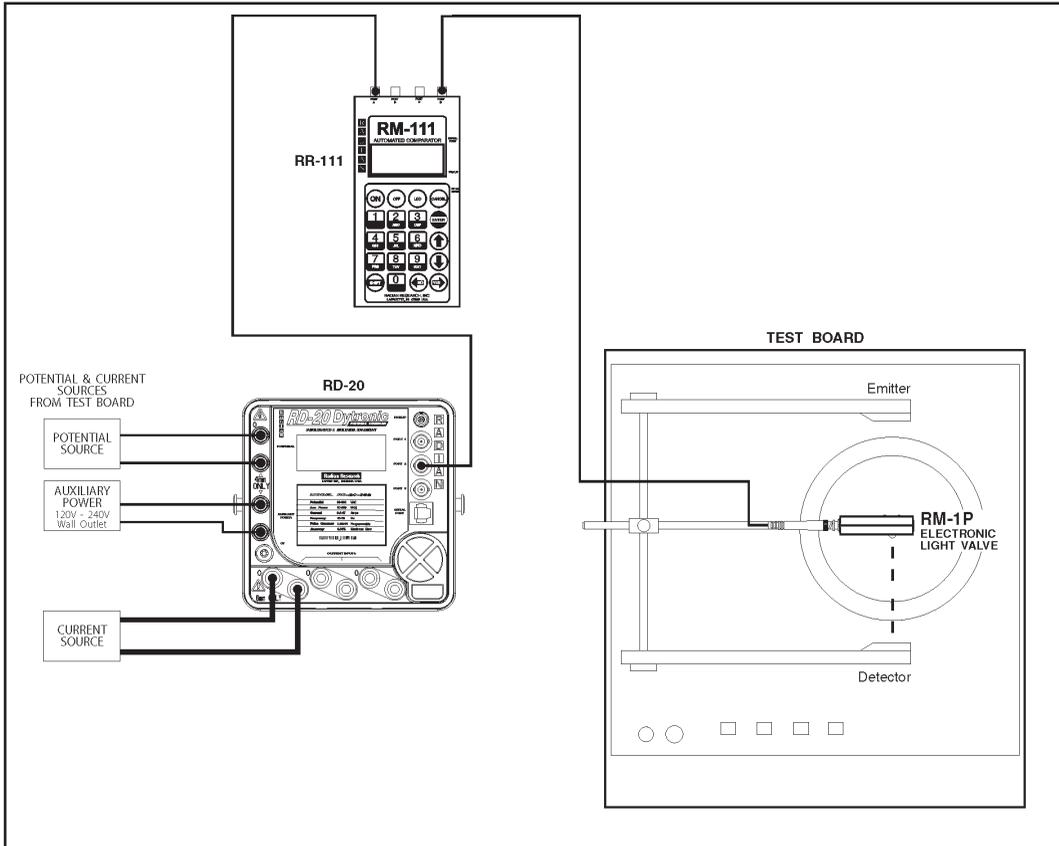
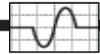


Figure 15.0 Testing the Accuracy of a Test Board (RM-1P Light Valve Option)



17.0 Testing the Accuracy of a Test Board (Open Collector Option)

Equipment Needed:

- RM-111 Automated Comparator
- RM or RD Primary Reference Watthour Standard
- Meter test board with open collector input
- Commercial adapter or a modified meter baseplate with the proper leads to bring voltage and current from the test board to the reference standard

Test Steps:

1. Make connections between the test board and the RM or RD standard(s) as per Figure 17.0. The standard must get both current and potential from the test board.
2. Turn on the RM-111 and select RUN TESTS.
3. Select Test Board.
4. Enter the Kh.
5. Select the Pulse Output Type. For this application, select Open Collector.
 - The Kh value will appear truncated in the LCD. However, all six places to the right of the decimal point are used in the calculation.
6. Make the proper connections to the RM-111. Connect the standard(s) to ports A,B, and/or C. Connect the test board to port D. Refer to Figure 17.0 “Testing the Accuracy of a Test Board (Open Collector Option)” for connection details. Press ENTER to start the test.
7. Set up the test board as if testing a meter. For this example, the variables will be set for a Form 1S meter: Kh=1.8, 120V, 10Amps, and one revolution.



8. Start the test on the test board. The standard is running on and the test board starts receiving pulses from the RM-111. After the RM-111 sends the specified number of pulses (based on the Kh value) to the test board the test will stop.
9. The RM-111's display shows the Kh value entered earlier in the test and the end count of the standard(s). The test board itself shows the percent error, which is the percent error of the test board.

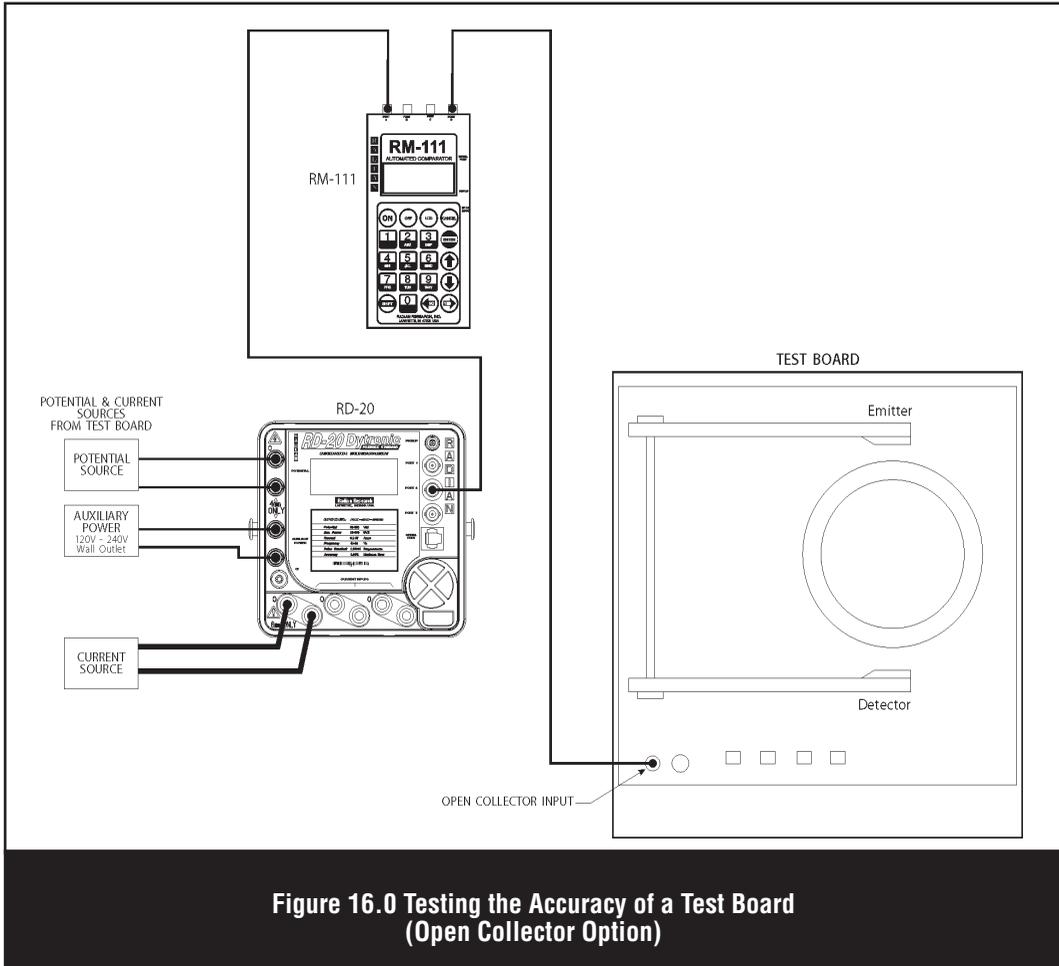
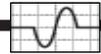


Figure 16.0 Testing the Accuracy of a Test Board (Open Collector Option)



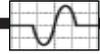
18.0 Interfacing a Solid State Meter to a Test Board (Open Collector Option)

Equipment Needed:

- RM-111 Automated Comparator
- Meter test board with open collector input
- Solid state meter programmed with a known number of infrared LED calibration pulses per Kh
- RM-1H or RR -1H Optical Pickup

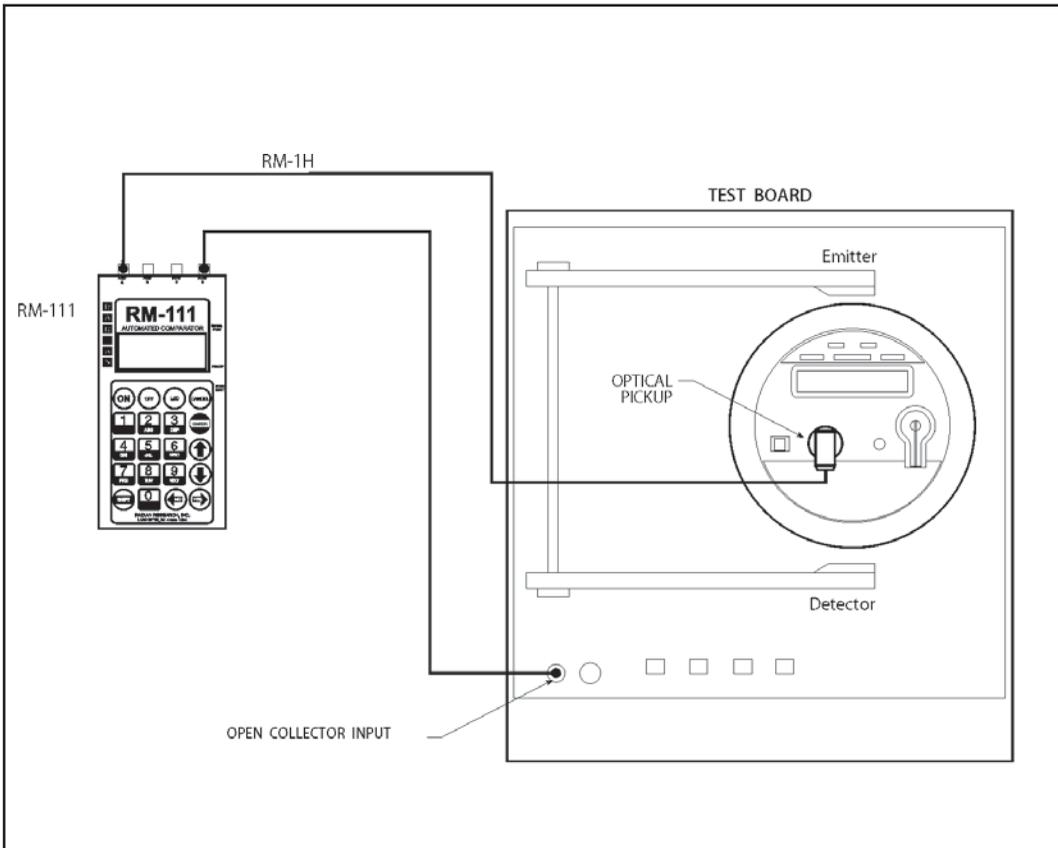
Test Steps:

1. Install the meter to be tested into the test board socket fixture.
2. Turn on the RM-111 and select RUN TESTS.
3. Select Pulse Divider.
4. Enter the number of pulses in for one pulse out.
5. Enter the number of pulse input ports (1-3).
6. Select the pulse output type. For this application, choose Open Collector.
7. Make proper connections to the RM-111, see figure 18.0. Connect Pulse IN(s) to port(s) A, B, and/or D and Pulse OUT to port D.
8. Set up the test board to test the solid state meter. Include all variables such as: form number, volts, current, and number of pulses per revolution.
9. Start the test on the test board. The RM-111 starts receiving pulses. After the specified number of pulses has been counted the RM-111 outputs one pulse. This continues until the RM-111's

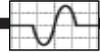


CANCEL key is pressed.

10. The RM-111's display shows the pulses IN per the pulses OUT for as long as the test is ran. For this application, there are no results and therefore no save option.



**Figure 17.0 Interfacing a Solid State Meter to a Test Board
(Open Collector Option)**



19.0 Interfacing a Solid State Meter to a Test Board (RM-1P Electronic Light Valve Option)

Equipment Needed:

- RM-111 Automated Comparator
- Meter test board with open collector input
- Solid state meter programmed with a known number of infrared LED calibration pulses per Kh
- RM-1P Electronic Light valve
- RM-1H or RR -1H Optical Pickup

Test Steps:

1. Install the meter to be tested into the test board socket fixture.
2. Position the RM-1P between the test board's light emitter and detector.
 - The RM-1P will function with both visible and infrared light.
3. Turn on the RM-111.
4. Select RUN TESTS.
5. Select Pulse Divider.
6. Enter the number of pulses in for one pulse out.
7. Enter the number of pulse input ports (1-3).
8. Select the pulse output type. For this application, choose RM-1P.



9. Make proper connections to the RM-111, see figure 19.0. Connect Pulse IN(s) to port(s) A, B, and/or D and Pulse OUT to port D.
10. Set up the test board to test the solid state meter. Include all variables such as: form number, volts, current, and number of pulses per revolution. If necessary, specify that a through-hole test will be conducted.
11. Start the test on the test board. The RM-111 starts receiving pulses. After the specified number of pulses has been counted the RM-111 outputs one pulse. This continues until the RM-111's CANCEL key is pressed.
12. The RM-111's display shows the pulses IN per the pulses OUT for as long as the test is ran. For this application there are no results and therefore no save option.

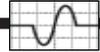


20.0 Pulse Constants and Kh values for the RM-111

(*SC-10, *SC-10v, *SC-30, *A-7, *IB-10 and the RM-16)

Note: When using an RM-16 the position of the Pulse Constant switch located on the front panel, will be the multiplier for the following pulse constants and Kh values. The chart below is applicable for the 1,000 switch setting.

AUTORANGING STANDARDS		
DEVICE & TAPS	PULSE CONSTANTS	Kh VALUE
RM 150A	0.00001	1.0
RM 200A	0.00002	2.0
SC-30 HI	0.00001	1.0
SC-30LO	0.0001	1.0
NON-AUTORANGING STANDARDS		
DEVICE & TAPS	PULSE CONSTANTS (SC-10, RM-16)	Kh VALUE
1A 120V	0.00012	0.12
5A 120V	0.0006	0.60
12.5A 120V	0.0015	1.50
15A 120V	0.0018	1.80
50A 120V	0.006	6.00
1A 240V	0.00024	0.24
5A 240V	0.0012	1.20
12.5 240V	0.003	3.00
15A 240V	0.0036	3.60
50A 240V	0.012	12.00
1A 480V	0.00048	0.48
5A 480V	0.0024	2.40
12.5A 480V	0.006	6.00
15A 480V	0.0072	7.20
50A 480V	0.024	24.00



21.0 CALCULATIONS

The following are calculations used for percent registration by the RM-111. For percent error, just take the percent registration minus 100%. For example, if percent registration is 99%, then percent error is $99\% - 100\% = -1.0\%$. Note that the negative percent error indicates that the meter is running slow.

TESTING STANDARDS: COUNTING PULSES

$$\% \text{ Registration} = 100\% * \frac{\text{DUT pulses} * \text{DUT pulse constant}}{\text{Reference Standard Pulses} * \text{Reference Standard Pulse Constant}}$$

TESTING STANDARDS: POTENTIAL GATING THE STANDARD UNDER TEST

$$\% \text{ Registration} = 100\% * \frac{\text{DUT display} * \text{DUT Display Kh}}{\text{Reference Standard Pulses} * \text{Reference Standard Pulse Constant}}$$

For the above applications the RM-111 divides the reference standard pulse constants by the number of reference standards used if averaging is specified.

NOTE #1:

If more than one current input is used, and the inputs are in series on the reference standards, then, the user must enter the pulse constant multiplied by the number of current inputs in series.

For example, in the reference pulse constant is 0.00001 and 3 inputs are in series then the reference standard's pulse constant = $3 * 0.00001 = 0.0003$.



SERIES SINGLE-PHASE METER TESTING

$$\% \text{ Registration} = \frac{100\% * \text{Meter Kh} * \text{Pulses per Rev.} * \#\text{Revs.} * \#\text{REF Current Inputs}}{\text{Reference pulses B} * \text{Reference Standard Pulse} * \# \text{ of Elements}}$$

NOTE #2:

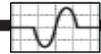
Number of elements corresponds to the number of meter elements in series.

TRUE THREE PHASE METER TESTING (USING CUSTOMER LOAD)

$$\% \text{ Registration} = \frac{100\% * \text{Meter Kh} * \text{Pulses per Rev.} * \#\text{Revs.}}{\text{Reference Standard pulses B+C+D} * \text{Reference Standard Pulse Constant}}$$

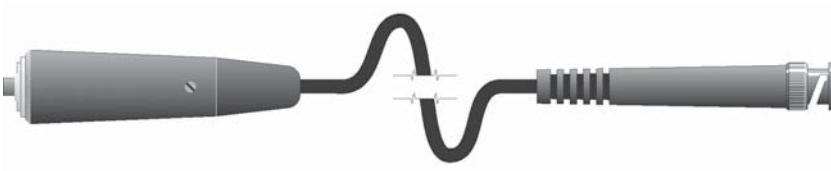
NOTE #3:

If testing 3-phase, then 3 reference standards must be connected into ports B, C and D. If testing 2-phase, then 2 reference standards must be connected to ports B and C, B and D or C and D. If two or three current inputs on the reference standards are connected in series, then the reference pulse constant must be adjusted by the number of current inputs in series. See NOTE#1 for standard testing.

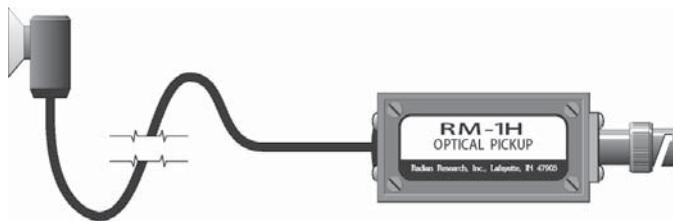


22.0 Test Accessories

The **RM-1S Remote Reset Switch** is a normally closed push button switch. The RM-1S connects directly to port A of the RM-111 Automated Comparator. 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.



The **RM-1H Infrared Optical Pickup** is used to sense the infrared pulses from the calibration LED of solid state meters. The pulses from the RM-1H are fed into the input of the RM-111 into port A. When the RM-1H is used with the RM-111 Automated Comparator the testing of solid state meters is done automatically. The wide angular displacement of this sensor allows for fast, non-critical alignment. Also, automatic gain control circuitry of the RM-1H assures operation in all ambient sunlight conditions. The RM-1H/v is also available for those solid state meters that have a visible calibration LED.



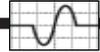


The **RR-1H Infrared Optical Pickup** is used to sense the infrared pulses from the calibration LED of solid state meters. The pulses from the RR-1H are fed into the input of the RM-111 into the Pickup port. When the RR-1H is used with the RM-111 Automated Comparator the testing of solid state meters is done automatically. The wide angular displacement of this sensor allows for fast, non-critical alignment. Also, automatic gain control circuitry of the RR-1H assures operation in all ambient sunlight conditions. The RR-1H/v is also available for those solid state meters that have a visible calibration LED.



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





The **RM-KYZ Pulse Input Adapter** is used to sense the KYZ output pulses of an induction type or solid state meters. The pulses received from the meter's KYZ output are conditioned and fed into input port A of the RM-111 Automated Comparator. With the RM-KYZ and the RM-111 the testing of KYZ equipped meters is done automatically.

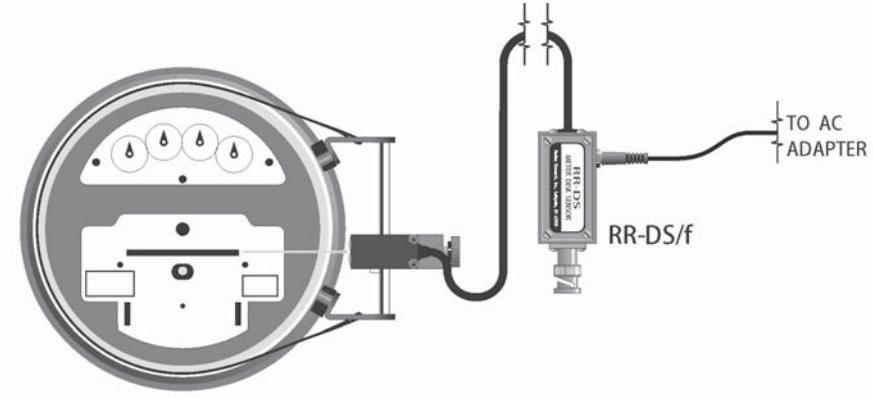


The **RR-KYZ Pulse Input Adapter** is used to sense the KYZ output pulses of an induction type or solid state meters. The pulses received from the meter's KYZ output are conditioned and fed into the PICKUP port of the RM-111 Automated Comparator. With the RR-KYZ and the RM-111 the testing of KYZ equipped meters is done automatically.

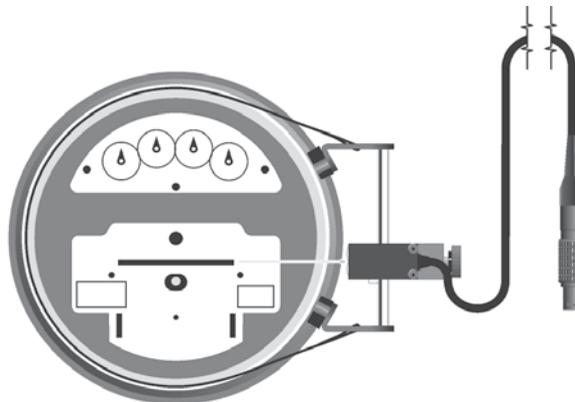


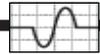


The **RM-DS Meter Disk Sensor** is a reflective pickup assembly used to sense the disk rotation of an induction type meter. The pulses generated by the RM-DS are fed into input port A of the RM-111 Automated Comparator. With the RM-DS and the RM-111 testing of induction type meters is done automatically and with a high degree of accuracy compared to using a conventional push button or snap switch.

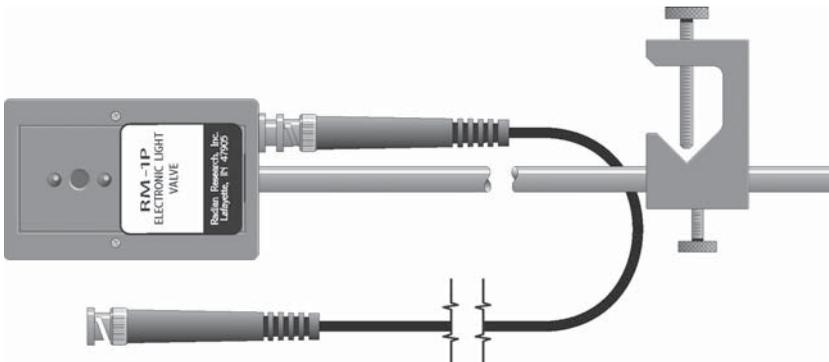


The **RR-DS Meter Disk Sensor** is a reflective pickup assembly used to sense the disk rotation of an induction meter. The pulses generated by the RR-DS are fed into the PICKUP port of the RM-111 Automated Comparator. With the RR-DS and the RM-111 testing of induction type meters is done automatically and with a high degree of accuracy compared to using a conventional push button or snap switch.





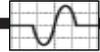
The **RM-1P Electronic Light Valve** is used to interface the output of the RM-111 Automated Comparator with the optics of a calibration test board. The RM-1P operates with both incandescent and infrared optic assemblies. To trigger incandescent source optics, the RM-1P uses a super luminous LED. This red visible LED must be aligned with the sensing assembly of the test board's optics. To trigger infrared (modulated or non-modulated) source optics, the RM-1P uses an infrared sensor and emitter combination. Using the RM-1P with the RM-111, solid state meters can effectively be interfaced to older test board designs. The RM-1P connects to port D on the RM-111.



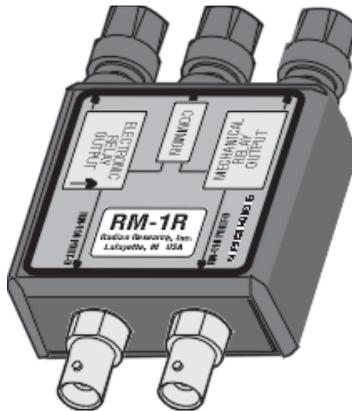


The **RM-RPP Remote Portable Printer** is used for printing results from the RM-111 Automated Comparator. The RM-RPP has an abundance of beneficial features in one of the smallest, lightest printer packages available. Offering features such as bi-directional printing, logic-seeking print and a variety of character formats including condensed and enhanced print fonts. The RM-RPP has full battery operation or the included AC adapter. The RM-RPP is the ideal tool in the field for maintaining records and addressing billing complaints.





The **RM-1R Electronic/Mechanical Potential Relay** houses two independent relays necessary for the electronic and mechanical Potential gating options supported by the RM-111. The relay used is determined by the RM-1R BNC connection used. The electronic relay is a mercury wetted reed relay used for testing *SC-10's, *SC-10/r's and *A-7's.. The mechanical relay is a coin silver dry contact relay used on induction standards like the *1B-10 and *J-44.



* See page 96



23.0 Warranty 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 of product from Radian to the customer.

If warranty service is required, write or call your local Radian Research representative or contact our headquarters in Lafayette, Indiana and ask for an RMA (Return Materials Authorization) number. You will be given prompt assistance and shipping instructions.

This warranty is voided by disassembly of the unit.

Our mailing address is:

RADIAN RESEARCH

3852 Fortune Drive

Lafayette, IN 47905 USA

Attn: RM-111 Service

The RM-111 is 100% digital and will remain within 0.0001% transfer error for life. It never needs to be calibrated.

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IB-10 is a trademark of the General Electric Company.

A7, J44 are trademarks of the Sangamo Company.