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**Warning:**

*Extreme caution should be observed when using this product. Any work with energized meters can present the danger of electrical shock. Electric Utility specified procedures for setting and removing watthour meters should be followed and performed by qualified personnel. Safety precautions as described in the Handbook for Electricity Metering should be followed.*

*Radian Research, Inc. assumes no liability for the failure to comply with existing applicable safety precautions as well as those listed in this warning statement.*

### 1.0 Product Introduction

The RM-17-01 Portable Watthour Test System delivers the most effective method for field testing single-phase watthour billing meters. The RM-17-01 is in full compliance with ANSI C12 test criteria. The RM-17-01 is the only self-contained portable test system available that offers safe and simple operating procedures, complete data management and a true Radian reference standard. By incorporating a true Radian Research watthour reference standard within the RM-17-01 socket adapter, electric utility companies have the accuracy necessary for meeting today and tomorrow’s testing needs for both induction and Solid State meters. The RM-17-01 supports the following ANSI meter forms and meter classes:

#### Meter Forms

1S, 2S, 2SE, 12S and 12SE

#### Meter Classes

100, 200 and 320

The RM-17-01 Portable Watthour Test System is the only portable test system to include a complete calibration report. That calibration report certifies the RM-17-01 measurement accuracy across the entire operating range. Typical accuracy of the RM-17-01 is +/- 0.01% with a guaranteed accuracy of +/- 0.05%. The internal standard is NIST traceable through Radian’s metrology calibration laboratory. The internal watthour reference standard of the RM-17-01 provides the accuracy that the new single-phase, Solid State meters require.
The RM-17-01 combines data management and supervisory control resulting in a systematic approach to meter testing when used with the optional PCA-Link Meter Test Software. The PCA-Link supervisory control offers various downloading options to the RM-17-01 hand controller. One option is the downloading of 10 additional questions to the test setup. The additional questions allow the user to enter information regarding the meter test directly into the hand controller. When questions are downloaded, meter technicians are able to document, via the alphanumeric keypad, specific information relevant to that specific meter installation, test or trouble call. Downloading RM-17-01 configurations, allow the enabling and disabling of various menu options. This allows meter shop supervisors to simplify the RM-17-01 for non-metering personnel while maintaining a high degree of control.

While the RM-17-01 testing capabilities include the testing of both induction and Solid State single-phase meters. It also makes meter calibration in the field quick and easy with it’s automated current ranging. When the results are uploaded into PCA-Link, the software will sort through the results extracting the as found and as left data labeling the data respectively.

Meter results are stored in an Open Data Base Compliant (ODBC) format for easy uploading and processing by most commercial software packages such as Microsoft Excel and Microsoft Word.
1.1 Additional Features

The RM-17-01 provides optional kW demand testing and in service creep tests. With every meter tested, the weighted average is calculated, displayed and stored with the meter test results.

The RM-17-01’s audible test tone provides feedback to the operator when they are aligning the Radian Meter Disk pickups. The test tone will then be heard with each revolution (or, equivalent revolution), at the end of each test and whenever an error message is displayed. The test tone can be totally disabled in the preference menu under the user prompts option.

The RM-17-01 hand controller operates from a 9 volt battery in the absence of the socket adapter. This battery support allows for changing meter test setups and viewing meter test results anytime, anywhere. This also provides the power necessary for the uploading and downloading of data.

The RM-17-01 is as safe to use as it is simple. With all voltage and current connections contained within the socket adapter, personnel need only to remove the meter, insert the socket adapter and re-install the meter. This process completely eliminates manual voltage and current connections. The RM-17-01 socket adapter features an interlock sensing technology, which does not allow voltage to be present at the socket adapter jaws. For added safety, voltage is not present until the meter is set and the test initiated.

The RM-17-01 comes in a lightweight carrying case that accommodates all of the necessary testing accessories that any residential or light commercial billing meter would require.
The RM-17-01 uses nonvolatile memory to preserve both meter test results and meter test setups without regard to power.

The time clock in the RM-17-01 hand controller maintains an accuracy of 30 seconds per month. The clock also has its own lithium battery for a 10 year operation in the absence of power. The RM-17-01 functionality includes the ability to print in the field with the RM-RPP Remote 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. 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”).
2.0 Testing Methods

The RM-17-01 Portable Watthour Test System allows the operator to select the test method as either an automated or manual test. The RM-17-01 tests induction or Solid State meters automatically when used with the Radian line of sensor pickups. The Radian RR-DS and RR-1H’s accuracy make one revolution tests a reality. When these accessories are used with the RM-17-01 test time is decreased and the meter technician’s efficiency increased.

Induction meters use the RR-DS to sense disk rotations and convert the revolutions to pulses. These pulses are then recognized by the RM-17-01 hand controller and the accumulated watthours between each pulse is compared with reference to the internal watthour reference standard. For customer convenience Radian offers the RR-DS in different mounting options.

For Solid State meters the RR-1H optical pickup is used to read the infrared output pulse of the meter under test. That output pulse is then conditioned and acknowledged by the RM-17-01 hand controller. Watthours that are accumulated between each (equivalent) revolution are then calculated with reference to the internal reference standard.

For further testing flexibility, the RM-17-01 supports manual meter testing. Manual tests can be controlled directly from the RM-17-01 hand controller’s enter key. Alternatively, the RM-1S Remote Reset Switch can be used via the Input port on the RM-17-01 hand controller.

For added flexibility the RR-IRDS sensor can be used for both infrared and mechanical disk pickup.
3.0 Test Setups

Test setups can be created directly on the RM-17-01 hand controller. Up to ten meter test setups can be created and stored directly in the hand controller. Radian offers the most customized portable testing system available by supporting user defined test parameters. Those parameters are as follows:

[Blank Line] - Insert up to a 15 character test name.

**Form** - The meter form to be tested.

**Kh** - Pulse constant for the device to be tested.

**FL Amps** - Test amps to be used for the full load test.

**PF Amps** - Test amps to be used for the power factor test.

**LL Amps** - Test amps to be used for the light load test.

**Dm Amps** - Test amps to be used for the kW demand test.

**FL Revs** - Number of revolutions to use for the full load test.

**PF Revs** - Number of revolutions to be used for the power factor test.

**LL Revs** - Number of revolutions to be used for the light load test.

**Demand** - Number of minutes to be used for the kW demand test.

**Pulses per Rev** - Number of pulses (or equivalent pulses) per revolution of the meter under test.

**Creep Mins** - Number of minutes to be used for the Creep test.

The RM-17-01 matches the most common Kh values with the appropriate meter forms to further simplify the use of the test system. When a meter form is selected, the Kh field will display one Kh value of the meter type. To scroll through the entire list use the left and right arrow keys. See Figure 1 for the meter form and Kh value relationship. For flexibility, the operator can enter any value into the Kh field with the alphanumeric keypad.
### 3.1 Auto-advance feature

The auto-advance feature eliminates the long down-time in waiting for the meter to position the disk flag at a convenient position to start a test. After one test point, the RM-17-01 applies the user defined full load current to the meter to rotate the disk at a faster speed to position the disk flag just in front of the Radian sensor pickup.

### 3.2 Automatic Testing

The RM-17-01 runs all of the selected test points consecutively by ranging the current between test points automatically. All meter test results are automatically saved and stored with respect to the time and date of the meter under test. The hand controller can store up to 80 sets of meter test results. These results can be viewed directly from the RM-17-01 hand controller any time. The test results can be easily uploaded into any computer running PCA-Link Meter Test Software for total data management. This uploading feature eliminates manual data entry onto test cards, therefore eliminating manual calculations that can result in miscalculations.

---

**Figure 1: Meter Forms and Pre-Set Kh Values**

<table>
<thead>
<tr>
<th>1S</th>
<th>2S</th>
<th>2SE</th>
<th>12S</th>
<th>12SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.8</td>
<td>3.6</td>
<td>12</td>
<td>7.2</td>
<td>57.6</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>14.4</td>
<td>7.272727</td>
<td>115.2</td>
</tr>
<tr>
<td>3.030303</td>
<td>7.2</td>
<td>14.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.125</td>
<td>12</td>
<td>28.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 2: RM-17-01 BLOCK DIAGRAM
4.0 Theory of Operation

The RM-17-01 contains an actual internal reference standard that uses a Pulse Width Modulation (PWM) measurement approach. See Figure 2 for the block diagram. The input circuitry consists of a potential input, a current input circuit consisting of dual current amplifiers, a watt converter, a current to frequency converter, pulse comparator and display output.

4.1 Potential Input Circuit
The autoranging potential input circuit senses potential input voltages from the meter service. This input can be zero to 600 V AC. The circuit consists of a toroid wound potential transformer with electronic compensation. This compensation can eliminate over 99% of the error present. The transformer is so accurate that it is not a significant source of error regardless of the input level. The range selection is accomplished on the secondary side, with much greater accuracy and reliability that can be achieved with primary side switching. The potential input is taken from the service installation by setting the socket adapter into the meter installation socket. Voltage ranging is automatic and eliminates any possible operator error.

4.2 Current Input Circuit
The autoranging current input accepts a synthesized current in the range of 0.1 to 50 amperes. This circuitry isolates, ranges and scales the current to maintain an input current to the watt converter in the range of 1 to 5 milliamperes. The construction is of the toroidal type so there is not a problem with stray fields. Electronic compensation reduces errors to below measurement thresholds (0.0001%) at most operating currents, and to below 0.001% over the entire specified region.

4.3 Power Supply
The power supply voltage is derived from the service voltage and potential input. The power supply is able to operate efficiently in the range of 60 to 600 V AC. The power supply has an overall efficiency of 70% which changes very little with input voltage. This high efficiency results in a very low power consumption. This, coupled with a typical temperature coefficient below 0.0003% per degree C, results in negligible warm-up drift. VA consumption varies between 5 and 30 VA depending on the service voltage and test current.
4.4 Watt Converter
The Watt Converter is of the pulse width modulation type. A pulse width modulation multiplier forms a product by producing a pulse train the height of which is proportional to one input and the width of which (duty cycle) is proportional to a second input. A filter performs an integration, producing an average value proportional to the product of the two inputs.

An often overlooked aspect of using pulse width modulation for power conversion is that the current axis (load dependent) is much more likely to be distorted than the potential axis (line dependent). In pulse width modulation the axis which determines the pulse height (the multiplexor axis) is much less sensitive to distortion. In the RM-17-01 this is the axis which senses the current input to minimize distortion sensitivity.

The watt converter has a voltage and current input (units of watts) and has a current output. Since input / output is watt / current which is equivalent to volts, a voltage reference is required to reference the watt converter. No other component within the watt converter has a significant effect upon the calibration.

4.5 Current To Frequency Converter
The Current to Frequency Converter (watthour circuit) converts the current output of the Watt Converter into a pulse train with each pulse proportional to watthours of energy. It is referenced by a highly advanced charge balance integrator which can produce a much higher frequency (two megahertz or 7 billion pulses per hour) than older converters limited to pulse rates of only 400 hertz or 1.5 million pulses per hour. The circuit delivers this degree of resolution without compromise of the accuracy, which is typically 0.01%. The high resolution is an advantage in field testing because it permits autoranging on the current axis.

The current to frequency integrator works on the charge balance principle. This input current is proportional to watts. The input current over a period of time is proportional to watthours. The units of current multiplied by time is charge, so that the charge accumulated in a capacitor over a period of time is directly proportional to watthours. Quanta of charge are removed from the capacitor after they have accumulated for a fixed period of time. Each quanta of charge which is removed is directly proportional to ten microwatthours. The removal of charge is accomplished by injecting a current of known amplitude and duration. The amplitude of current is determined by the ratio of an extremely precise voltage reference to an extremely precise resistor. The duration of the pulse is determined by one clock cycle of a crystal.
4.6 Pulse Comparator and Display Output

The Pulse Comparator accepts the pulse train from the current to frequency converter and counts it. This pulse comparator circuit is also counting pulses from the meter under test. The counter is controlled by the input to the RM-17-01 Hand Controller. This input is made with a Radian Sensor, RM-1S or the enter key located on the hand controller. The first pulse present at the input starts the counter while a programmable number of pulses (revolutions) are counted with the last pulse stopping the counter. An additional pulse will start the process over again.

The RM-17-01 Hand Controller acts like a comparator by comparing the input pulses from the meter under test against the internal reference standard. The RM-17-01 will calculate the difference and display it on the hand controller LCD in % registration, % error or watthours.
5.0 Technical Specifications

5.1 Accuracy
At unity power factor: 0.01% typical, 0.05% maximum
At 0.5 lagging power factor: 0.01% typical, 0.05% maximum

All errors are in percent reading at any combination of the normal operating conditions. Note that stability is included within the maximum accuracy specification. *Power factor is referenced to Watthours and it is also assumed that voltage is the reference vector. Power factor accuracy specification is based upon a 60Hz line frequency.

Demand Time Accuracy: The crystal time base used for the demand time interval in the RM-17-01 has an accuracy of 0.005% over all operating conditions.

5.2 Normal Operating Conditions
Input voltage 60 - 600 VAC (Autoranging)
Input current 1-50 Amps
Power factor Unity and 0.5 lagging power factor
Relative humidity 0-95%
Frequency 57-63Hz
Orientation Any
Recalibration 365 days
Shock and vibration Any which is nondestructive
### 5.3 Physical Description

<table>
<thead>
<tr>
<th>Component</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand Controller</td>
<td>190 mm (7.5”) H</td>
</tr>
<tr>
<td></td>
<td>105 mm (4.0”) W</td>
</tr>
<tr>
<td></td>
<td>33 mm (1.25”) D approx.</td>
</tr>
<tr>
<td>Socket Adapter</td>
<td>178 mm (7.0”) W 178 mm (7.0”) D approx.</td>
</tr>
<tr>
<td>Influence Affecting Accuracy</td>
<td>None</td>
</tr>
<tr>
<td>Input Pickup Terminal</td>
<td>Lemo, 0.00001 pulse input for Radian RR-1H, RR-DS.</td>
</tr>
<tr>
<td>Input/Output Terminal</td>
<td>BNC, RM-1S Remote Reset Switch</td>
</tr>
<tr>
<td>Output Input/Output Terminal</td>
<td>BNC, 0.00001 pulse output value</td>
</tr>
</tbody>
</table>
6.0 RM-17-01 Hand Controller Conventions

1 - LCD: Allows the contrast of the LCD to be adjusted by pressing and holding down the LCD key and using the Up or Down Arrow keys for increasing or decreasing the contrast. Releasing the LCD key sets the RM-17-01’s new default contrast level.

2 - Alphanumeric Keypad: The numeric keypad is the default mode. Letter input is achieved by selecting the Shift key. Once in the TXT (Text) mode the keypad entry scrolls through the letters on the selected key with every press of that key. For additional letter entry, move the cursor to the left or right with the Left and Right Arrow keys. The keypad mode is displayed in the bottom right corner of the LCD.

3 - Cancel: When traversing menus on the RM-17-01 Hand Controller the Cancel key performs similar to the Escape key on most computers. Specifically, it backs the user out of the displayed menu leaving any parameters unchanged. The Cancel key is used to back out of sub-menus to reach the Main Menu. The Cancel key will also abort any test while in progress without saving the results.

4 - Enter: The Enter key serves as the primary selection key in the menu structure. It will also start and stop a manual test. The Enter key will also move the user up or into a menu saving any test parameter selected.

5 - Up and Down Arrow Keys: These keys control the 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.

6 - Left and Right Arrow Keys: These keys control the 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 icon will appear in the respective upper corner of the LCD. This indicates the direction that the user must move to view all of the results. These keys also provide simple yes-no respond capabilities.
Figure 3.0
7 - **Shift**: The RM-17-01 Hand Controller default input mode is NUM (Numbers). The Shift key puts the keypad in TXT (Text) mode activating the letters on the keypad as the active input. Pressing Shift again returns the keypad to the default mode.

For example, if the desired letter was “L” the user would:

1. Select Shift  (TXT would appear in the lower right corner of the LCD.)
2. Press the #5 key three times. (The three presses toggle through the 3 letters on that key.)

8 - **Spacing character**: The spacing characters are accessed in the text (TXT) mode using the number one key. These characters are ideal for serial numbers and other identification numbers.

9 - **On /Off Keys**: Turns the power to the RM-17-01 on and off. The RM-17-01 features a user defined time out interval. This allows the user to set the amount of time before the RM-17-01 will automatically shut off. This time out feature is not active when a test is in progress or when the RM-17-01 is in the RS-232 Mode.

10 - **LCD Display**: The RM-17-01 Hand Controller features a 16 character 4 line liquid crystal display.
7.0 Main Menu and Sub-Menu Structure

All menu items can 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 and down arrow keys to the desired selection and pressing the enter key. Four menu items are visible at one time on the LCD. A down arrow icon will be displayed in the lower right corner of the LCD as an indication that there are additional menu items. The unseen menu items can be viewed by using the down arrow key to scroll down through the menu items. When the user is at the last menu item an up arrow icon will appear in the upper right corner of the LCD. This indicates that the user must move back up through the menu items using the up arrow key.

The Main Menu consists of the following:

1  Run Test
2  Results
3  Test Setup
4  Preferences

When a main menu item is selected the various sub-menu or sub-menus will be displayed. The sub-menus are as follows:

7.1 Run Test
Displays all configured and stored test setups. The RM-17-01 leaves the factory with three default test setups. Those test setups are for a 1S, 2S and 12S meter. See Figure 4 for the factory set tests.
Sample Test Configurations

<table>
<thead>
<tr>
<th>RM-17-01 Test Parameters</th>
<th>1S</th>
<th>2S (Demand)</th>
<th>12S (Demand)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>1S</td>
<td>2S</td>
<td>12S</td>
</tr>
<tr>
<td>Kh</td>
<td>1.8</td>
<td>7.2</td>
<td>14.4</td>
</tr>
<tr>
<td>Full Load Amps</td>
<td>15</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Power Factor Amps</td>
<td>15</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Light Load Amps</td>
<td>1.5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Demand Amps</td>
<td>15</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Full Load Revolutions</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Power Factor Revolutions</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Light Load Revolutions</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Demand Time Interval</td>
<td>0</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Creep Test Time Interval</td>
<td>0</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Pulses per Revolution</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

*Note: For this example, the test parameters for the 1S meter exclude the demand and creep test. To exclude a test enter 0.*

**Figure: 4.0**

7.2 Results

1. **View** View the results directly from the Hand Controller

2. **Print** Print results from the Hand Controller with the RM-RPP Remote Portable Printer.

3. **Delete** Delete one set of meter test results from the Hand Controller at a time.

4. **Delete All** Delete all meter test results from the Hand Controller in one operation.
7.3 Test Setup
   1  Edit Edits an existing test setup.
   2  Create Creates a new test setup.
   3  Delete Deletes an existing test setup.

7.4 Preferences

7.4.1 RS-232 Mode
   Puts RM-17-01 Hand Controller into a remote operating mode which allows the PCA-Link software to take control.

7.4.2 Results Display
   Select the desired format for test results to be displayed and saved.
   1.  % Registration
   2.  % Error
   3.  Watthours

7.4.3 Results Digits
   Sets the displayed results resolution. One, two or three places to the right of the decimal point.
   1.  One Digit
   2.  Two Digits
   3.  Three Digits
7.4.4 Test Method
Selecting Sensor Test allows the use of the Radian pickup sensor. When Sensor is selected the RM-17-01 will run a Pick Up test. The Pick Up test will rotate the disk at the defined full load current so the operator may properly align the sensing accessory. The RM-17-01 LCD will show flashing LCD segments that coincide with the sensing accessories LED’s when proper alignment is achieved. Manual Test allows the RM-1S Remote Reset Switch or the RM-17-01’s enter key to start and stop the test.

1 Sensor Test
2 Manual Test

7.4.5 User Prompts
Questions that are answered prior to the test being ran. All of the following questions can be activated or de-activated by using the left and right arrow keys to respond “Yes” or “No”.

Tester ID # [Yes/No]
Manuf ID # [Yes/No]
Beep # [Yes/No]

7.4.6 Calibration
Puts the RM-17-01 into the calibration and accuracy cross check mode. Also, allows the operator to view and print the test points that were previously ran. The RM-17-01 can also be returned to the factory default calibration by selecting Original Cal, and confirming the adjustment.

1 View
2 Print
3 Setup
4 Run As Found
5 Adjust Cal.
6 Original Cal.
7.4.7 Print Banner

Use the alphanumeric keypad to enter a one to two line, 16 character per line, message to be displayed and stored in the results. This message may consist of alphanumeric characters and may be placed before, after, or before and after the test results. Use the left and right arrow keys to choose the placement of the message.

7.4.8 Time / Date Stamp

User may change the time and the date however, the time and date stamp cannot be deleted. All results are saved according to the time and date stamp.

Time:  HH:MM:SS
Date:  MM-DD-YY

7.4.9 Power Saver

Time allotted before the RM-17-01 automatically shuts off when in an idle mode. Time is user defined from 0 to 30 minutes. To disable the Power Saver enter a 0. Power saver does not shut the RM-17-01 down while in the RS-232 Mode or during an active test sequence.

7.4.10 About

Includes information specific to the RM-17-01. This information is loaded at the factory and is not accessible to the user for changes.

[Information Line]

S/N:  Of the RM-17-01
Rev:  Firmware and software
Cal:  Date
8.0 The RM-17-01 and PCA-Link Meter Test Software

When PCA-Link Meter Test Software is used with the RM-17-01 total supervisory control and data management is possible. The data management is achieved by four distinct transfer functions. Following are the transfer functions of PCA-Link Meter Test Software and the RM-17-01:

1. Creating and editing RM-17-01 configurations directly on the computer running PCA-Link.

2. Transferring the configurations from the computer running PCA-Link to one or multiple RM-17-01 hand controllers.

3. Saving configurations from a RM-17-01 hand controller to the computer running PCA-Link.

4. Transferring results from one or multiple RM-17-01 hand controllers to the computer running PCA-Link.

Configuring a RM-17-01 in PCA-Link allows the user to setup the RM-17-01 to meet their specific testing needs. The configuration can be edited directly on the device (RM-17-01) or in a file that can be downloaded at a later date. Configurations can be saved from the RM-17-01 to a PC by a simple “Save As..” command. The upload feature of the RM-17-01 and PCA-Link enhance record keeping of single phase meter testing allowing a seamless upload of the test results and user input regarding the meter under test. The following section is a break down of all the RM-17-01 parameters that can be configured using PCA-Link Meter Test Software.
8.1 Configuration - Test Setups
Up to 10 test setups can be downloaded and stored in the RM-17-01 hand controller. The parameters that can be configured in PCA-Link are the same as those parameters the user defines directly on the RM-17-01 hand controller. See section 3.0 for details. Customized weighted average formulas are available in PCA-Link only. The formula can then be downloaded to the RM-17-01 as part of the meter test setup.

8.2 Configuration - Menus
Lists the available menus on the RM-17-01 hand controller. Any of the below menu items may be disabled by selecting them with PCA-Link. For example, if you do not want the user to be able to delete test results, check the RESULT Delete and RESULT Delete All items.

RESULTS Delete - Enables the ability to delete results from the RM-17-01 Hand Controller.
TEST Edit - Enables the ability to edit test set ups on the RM-17-01 Hand Controller.
TEST Create - Will not allow for the test setups to be configured on the RM-17-01 Hand Controller.
TEST Delete - Will not allow for the test setups to be deleted from the RM-17-01 Hand Controller.
PREF RES Display - Disables the result’s display from being changed.
PREF RES Digits - Disables the result’s resolution from being changed.
PREF User Prompts - Will not allow User Prompts to be changed on the RM-17-01 Hand Controller.
PREF Cal Setup - The editing of calibration test point is disabled.
PREF Cal Run - RM-17-01 Calibration cannot be initiated from the RM-17-01 Hand Controller.
PREF Time/Date - Time and Date cannot be changed.
8.3 Configuration - Questions
LCD Line 1 - 3

If desired, up to 10 additional questions can downloaded to the RM-17-01 hand controller. These questions will appear prior to running the meter test. The user answers the questions with the alphanumeric keypad and the answers are saved with the test results.

8.4 Configuration - Preferences
The following preference menu items can be set directly from the RM-17-01 hand controller or through PCA-Link software.

Results Display: Select which calculation to perform on the test results. Possible options are % Registration, % Error or Watthours.

Results Digits: Sets the number of decimal places in which the test results are displayed. The available options are one, two or three places to the right of the decimal point.

Test Method: Set when running a test using the Radian sensor pickup or a manual test. With a sensor, the pulses are counted down. In the manual mode the start and stop pulse are all that is used.

Print Banner: Allows the supervisor (or RM-17 operator) to enter up to two lines of alphanumeric characters that is saved with the test results.

Tester ID # Prompt: Set to YES when the user should be prompted to enter in his identification number. For convenience, the Test ID # always defaults back to the last number entered. The number is then saved with the results.

Manuf ID # Prompt: Set to YES when the meter manufacturer identification number or manufacturer’s name must be entered. The Manuf ID # always defaults back to the last number entered. The number is then saved with the results.

Beep Prompt: Set to YES, the audible test tone is enabled. The default mode of this prompt is YES.

Power Saver Time (min.): User defines the number of minutes in which the RM-17-01 can set idle before automatically powering down. Setting 0 turns this feature off.
9.0 Calculations

9.1 Calculation for % Registration
The RM-17-01 performs two primary calculations. One calculation is used to support the % registration for Full Load, Power Factor and Light Load test points. The other calculation supports the % registration for kW Demand tests.

Formula for Full Load, Power Factor and Light Load:

\[
\text{% Registration} = \frac{K \times (\text{# of pulses}) \times (\text{# of standard inputs})}{(\text{display of standard}) \times (\text{# of meter elements})} \times 100
\]

where:

100 = used to convert to a percentage

K = constant, meter Kh

# of pulses = test duration in disk revolutions or pulses

# of standard inputs = this value is always 1 where the RM-17-01 is concerned

display of standard = Watthour reading from the RM-17-01 Socket Adapter (standard)

# of meter elements = the number of elements in the meter under test (The RM-17-01 knows how many elements when the form number is set in the Test Setup menu.)

9.2 Calculation for kW Demand
% Registration = \(\frac{A}{B}\) \times 100

where:

A = kW Demand of the standard

B = kW Demand of meter = \(\frac{\text{kW}}{\text{# of elements}}\)

100 = used to convert to a percentage
10.0 Creating a Test

1. Turn on the RM-17-01 Hand Controller. From the main menu select Test Setups then Create.

2. The first line of the LCD is blank. Fill in the test name using the alphanumeric keypad. Up to 16 characters may be used for the test name.

3. Move down the menu (using the down arrow key) and enter the meter under test’s form. Use the left and right arrow keys to scroll through the different meter forms (1S, 2S, 2SE, 12S and 12SE) that the RM-17-01 supports. Note that the Kh value located on the next line changes according to the meter form number.

4. Move down the menu and enter the meter under test Kh value. Use the left and right arrow keys to move through the different Kh values for the meter form selected. The user may enter any number for the Kh value by overwriting one of the preset values, using the keypad.

5. Enter the test current for the Full Load test.

6. Enter the test current for the 0.5 Lag Power Factor test.

7. Enter the test current for the Light Load test.

8. Enter the test current for the Demand test.

9. Enter the number of meter disk revolutions or output pulses for the Full Load test. To skip this test point enter 0.

10. Enter the number of meter disk revolutions or output pulses for the 0.5 Lag Power Factor test. To skip this test point enter 0.

11. Enter the number of meter disk revolutions or output pulses for the Light Load test. To skip this test point enter 0.

12. Enter the demand test time interval. The RM-17-01 will support a 1-99 minute time interval. To eliminate the demand test enter 0.

13. Enter the creep test time interval. The RM-17-01 supports a 1 - 99 minute interval. To eliminate the creep test enter 0.
14. Enter the number of pulses per revolution for the meter under test. For induction meters use 1 per revolution. For Solid State meters enter their pulses per equivalent revolutions. All pulse per revolution values are listed on the meter under test’s nameplate.

15. Press enter to save the test.
11.0 Editing a Test

1. From the main menu select Test Setups.

2. Select the test to be edited from the list of existing tests.

3. Open the test and make the modifications.

4. Once modifications are complete press Enter to save changes.
12.0 Test Results

Meter test results are automatically saved in the RM-17-01 Hand Controller. These results can be accessed at any time through the RM-17-01 Hand Controller. Result manipulation occurs through the view, print, delete and delete all options of the Result sub-menu on the RM-17-01 hand controller. When viewing results from the RM-17-01 use the up and down arrow keys to move in the respective direction through the test result data from one meter test. Use the left and right arrow keys to move between different meter test results. The meter test result that is visible in the LCD is the test result to be printed or deleted.

The RM-17-01 Hand Controller displays all results in the order as shown below. This order will vary slightly as tests are personalized by omitting test points and user prompts and downloading questions.

<table>
<thead>
<tr>
<th>LCD LINE</th>
<th>DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Print Banner</td>
<td>(One to two lines)</td>
</tr>
<tr>
<td>Date</td>
<td>mm/dd/yy</td>
</tr>
<tr>
<td>Time</td>
<td>hh:mm:ss</td>
</tr>
<tr>
<td>Meter ID</td>
<td>Up to 11 Alphanumeric Characters</td>
</tr>
<tr>
<td>Manuf. ID</td>
<td>Up to 15 Alphanumeric Characters</td>
</tr>
<tr>
<td>FL %</td>
<td>xxx.xxx</td>
</tr>
<tr>
<td>PF %</td>
<td>xxx.xxx</td>
</tr>
<tr>
<td>LL %</td>
<td>xxx.xxx</td>
</tr>
<tr>
<td>AVG %</td>
<td>xxx.xxx</td>
</tr>
<tr>
<td>Demand %</td>
<td>xxx.xxx</td>
</tr>
<tr>
<td>Creep Test</td>
<td>Pass / Fail</td>
</tr>
<tr>
<td>FL Wh</td>
<td>x.xxxxx</td>
</tr>
</tbody>
</table>
PF Wh  x.xxxxx
LL Wh  x.xxxxx
Demand kW  x.xxxxx
Test Name  Up to 16 Alphanumeric Characters
Tester ID  Up to 11 Alphanumeric Characters
Voltage  xxx.x
I: (FL TA, PF TA, LL TA)  xx.x, xx.x, xx.x
Demand TA  xx.x
Meter Form  xxxxx
Kh  xx.xx

Print Banner (One to two lines.)
1:  Answer to Question #1
2:  Answer to Question #2
3:  Answer to Question #3
4:  Answer to Question #4
5:  Answer to Question #5
6:  Answer to Question #6
7:  Answer to Question #7
8:  Answer to Question #8
9:  Answer to Question #9
10: Answer to Question #10
13.0 Demand Testing

The RM-17-01 supports the testing of kW demand meters. The user defines the demand time interval in the meter test setup. Prior to the demand test the RM-17-01 will prompt the operator to reset the demand register on the meter under test. Press the enter key on the RM-17-01 hand controller and start the demand time interval of the meter simultaneously. The demand time interval will appear to be counting down while the watthours are displayed as accumulating. When the demand time interval is complete, the RM-17-01 prompts the operator to manually enter the registration from the demand meter register. The RM-17-01 calculates, displays and stores the demand register test results as part of the meter test results.
14.0 In Service Test for Creep

The RM-17-01 supports an ANSI in-service test for creep. This test is required by ANSI if there is a 2% deviation between light load registration and full load registration. To accommodate various utility companies and meter testing services, the RM-17-01 allows the operator to set the amount of time in which the meter under test will the test voltage applied with no current load present. The time interval is set in the test setup menu of the RM-17-01. The in-service creep test can be disabled in the meter test setup by entering a 0 for the time interval. Disabling the creep test eliminates it from the meter test results.

Once the test conditions for the creep test have been met, the RM-17-01’s LCD will display the amount of time defined in the test setup and start counting down. For further convenience, the RM-17-01 allows the operator to set the creep time interval in the test setup, but then decline to run the test if the 2% deviation is not present. This is done by answering “No” when the prompt appears.

If the meter under test makes one complete disk revolution within the prescribed amount of time the meter has failed. Use the enter key to pass the meter or the cancel key to fail the meter. To stop the test use the enter key. When this is done the operator can still pass or fail the meter under test. Use the cancel key to abort the creep test. The test results will display either a pass or fail on the creep test.
15.0 Weighted Average

With every meter test result the weighted average is calculated, displayed and stored with the meter test results. The formula for the weighted average calculation is as follows:

\[
\frac{m(\text{Full Load Registration}) + n(\text{Light Load Registration})}{m + n}
\]

where:

\(m\) = The number defined for the full load revolutions

\(n\) = The number defined for the light load revolutions

Note: The actual revolutions ran at full load and light load have no impact on the weighted average calculation. The RM-17-01 uses only the number (defined for the revolutions) for the multipliers \(m\) and \(n\). Note that a custom formula for weighted average can be created in PCA-Link and then downloaded to the RM-17-01.
16.0 Running an Automated Meter Test

Equipment Needed:

- RM-17-01 Portable Watthour Test System
- RR-DS Disk Sensor with Field Mount or with Suction mount
- 2S Meter (240V, TA 30, Kh=7.2)

Optional Equipment:

- RR-1H Optical Pickup for Infrared LED (for use with Solid State meters)
- RM-RPP Remote Portable Printer

Preliminary Setup:

- Verify the Preference menu for the following:
  - Desired results format and resolution.
  - Test Method is Sensor Test for use with the RR-DS
  - Desired User Prompts are activated.
  - Print Banner is set appropriately.
  - Power Saver is set appropriately

Running the Test:

1. Note that before beginning a test, the RM-17-01 is intended for use by only properly trained personnel. Follow the Electric Utility Company guidelines and remove the meter to be tested from the meter socket. Reference the Handbook for Electricity Metering if necessary.

2. Insert the RM-17-01 Socket Adapter into the meter socket. Replace the socket cover or secure the RM-17-01 socket adapter clip to fit securely.

3. Insert the meter to be tested into the RM-17-01 Socket Adapter. Follow the appropriate Electric Utility Company guidelines for meter installation. If necessary, consult the Handbook for Electricity Metering.
4. Connect the RM-17-01 hand controller power cord into the RM-17-01 socket adapter. The power cord is hardwired directly into the hand controller in the port labeled “standard.” With the socket adapter installed in the socket, the connector is located at the seven o’clock position. When the test is finished disconnect the Lemo connector by pulling only the outer shell of the connector up gently until it stops. At this point pull the Lemo plug clear of the socket adapter connection.

5. Secure the RR-DS onto the meter cover and insert the Lemo plug of the RR-DS into the port of the hand controller labeled “pickup.” When the test is finished, disconnect the Lemo connector by pulling only the outer shell of the connector up gently until it stops. At this point pull the Lemo plug clear of the hand controller input port.

6. Turn the RM-17-01 hand controller on with the ON key located on the hand controller. From the main menu, select RUN TEST.

7. Using the up and down arrow keys, move through the test setups and select the appropriate test for a 240V, TA=30,Kh=7.2, Form 2S meter. When the desired test is highlighted, press enter.

Note: If the User Prompts were disabled in the Preference menu go to step 9.

8. Answer each of the User Prompt’s with the alphanumeric keypad. Press enter when finished with each response. Note that if the User Prompt is activated it must have an entry.

9. Enter the meter identification number. This is a mandatory entry.

10. The RM-17-01 will start the test by displaying the service voltage of the standard. Press enter to continue the test.

11. With Full Load current applied, align the RR-DS so that it is triggering from the edge of the disk. The target beam of the RR-DS should break the glass at an angle for the reflective circuitry to operate correctly. Note that there is one red and one green LED on the RM-DS. When both red and green flash simultaneously it signifies that the device is operating at its optimum level. Verify that the RM-17-01 LCD segments are flashing simultaneously with the red and green LEDs on the RR-DS during each revolution. Each disk revolution will change the direction of the arrows on the LCD. This is for reference purposes only. Press enter to continue.
The gain adjustment screw on the RR-DS can be used to adjust the signal strength. It is recommended that the supplied screw driver be used in order not to damage the adjustment screw. Note that in many cases once the gain adjustment has been set to optimum level, it may not be necessary to make further adjustments when testing each additional meter.

Instead of adjusting the gain setting, try changing the positioning of the sensor assembly.

**Note:** If testing a Solid State meter, the RR-1H Optical Pickup for infrared LED can be used with or without the RM-OA Optical Adapter. See section 18.0 for details on these items.

12. The RM-17-01 immediately ramps to the first test point.

13. When the first test point is finished the results are displayed briefly and the RM-17-01 ramps to the next test point. This process is repeated until the last test point is ran. At that time the RM-17-01 LCD display’s TEST COMPLETE. Press enter to continue.

14. The option to re-run the test will appear. To accept and re-run the test answer Yes. To decline and return to the main menu answer No.

15. The test results can be viewed, printed or deleted from the Results menu.
17.0 Running a Manual Meter Test using the Enter Key or RM-1S Remote Reset Switch

Equipment Needed:

- RM-17-01 Portable Watthour Test System
- 2S Meter (240V, TA 30, Kh=7.2)

Optional Equipment:

-RM-RPP Remote Portable Printer

Preliminary Setup:

-Verify the Preference menu for the following:
  -Desired results format and resolution.
  -Test Method is Manual Test.
  -Desired User Prompts are activated.
  -Print Banner is set appropriately.
  -Power Saver is set appropriately

Running the Test:

1. Note that before beginning a test, the RM-17-01 is intended for use by only properly trained personnel. Follow the Electric Utility Company guidelines and remove the meter to be tested from the meter socket. Reference the Handbook for Electricity Metering if necessary.

2. Insert the RM-17-01 Socket Adapter into the meter socket. Replace the socket cover or secure the RM-17-01 socket adapter clip to fit securely.

3. Insert the meter to be tested into the RM-17-01 Socket Adapter. Follow the appropriate Electric Utility Company guidelines for meter installation. If necessary, consult the Handbook for Electricity Metering.
4. Connect the RM-17-01 hand controller power cord into the RM-17-01 socket adapter. The power cord is hardwired directly into the hand controller in the port labeled “standard”.

5. If using the RM-1S Remote Reset Switch connect it to the “Input” port on the RM-17-01 Hand Controller. If using the enter key on the RM-17-01 Hand Controller continue on to step 6. Note that when in Manual Test mode the RM-17-01 will recognize pulses from both the input port (RM-1S) and the enter key.

6. Turn the RM-17-01 on and from the main menu, select RUN TEST.

7. Using the up and down arrow keys, move through the test setups and select the appropriate test for a 240V, TA=30,Kh=7.2, Form 2S meter. When the desired test is highlighted, press enter.

   **Note: If the User Prompts were disabled in the Preference menu go to step 9.**

8. Answer each of the User Prompt’s with the alphanumeric keypad. Press enter when finished with each response. Note that if the User Prompt is activated it must have an entry.

9. Enter the meter identification number. This is a mandatory entry.

10. The RM-17-01 will start the test by displaying the service voltage. Press enter to continue.

11. The RM-17-01 immediately ramps to the first test point. Establish a visual reference of the meter disk flag. This reference point is where the test is started and finished. After 2 to 3 seconds start the test by depressing the button on the RM-1S or RM-17-01 enter key.

12. After the desired number of revolutions have been completed depress the RM-1S button or the enter key on the hand controller to stop the test. The number of revolutions counted should be equivalent to the number of revolutions defined in the test setup.

13. When the first test point is finished, the results are displayed and the RM-17-01 ramps to the next test point. After waiting 2 to 3 seconds start the next test point. This process is repeated until the last test point is ran. At that time the RM-17-01 LCD displays TEST COMPLETE. Press enter to continue.
14. The option to re-run the test will appear. To accept and re-run the test answer Yes. To decline and return to the main menu answer No.

15. The test results can be viewed, printed, or deleted from the Results menu.
18.0 Accuracy Certification and Calibration

The RM-17-01 accuracy can easily be tested, adjusted, viewed and printed. This is done by externally connecting a RD-21 Primary Watthour Reference Standard to the pulse input of the RM-17-01. The RD-TJ Test Jack interfaces the two standards by seating into the socket adapter jaws. The RD-TJ has current leads protruding from the device that will “hard wire” directly into the current inputs of the RD-21. Connect the potential jumper on the RD-TJ to the RD-21 and the RD-21 output to the input port of the RM-17-01 hand controller. Once these connections are made, the RM-17-01 can run either as found or, actually adjust calibration. If the connection to the RD-21 is not correct, the RM-17-01 will display the following error message: No pulses, Enter to continue.

Set the test points to be ran by selecting the Setup option of the Calibration menu. Define the current, voltage and power factor for up to 40 test points. Once each test point is set, press enter to save. The RM-17-01 comes with 40 factory default test points.

Note: The RM-17-01 hand controller MUST have the 9 volt battery installed when running as found or adjusting calibration. This will prevent the powering down of the hand controller between voltage settings.

To run as found, select the Run As Found option from the Calibration menu. The RM-17-01 will automatically run through the test points prompting the user to change the voltage source when applicable. In this mode the RM-17-01 will produce as found results only. No adjustments are made. To view the as found results select View from the Calibration menu.

Adjusting the calibration of the RM-17-01 should be done after viewing the as found results. To adjust the calibration select Adjust Cal. from the Calibration menu. The calibration adjustment points are related to the test points defined in the Setup menu. For example, if only 240 volts is specified as the test voltage, then only 240 volts will be used during the calibration adjustment - all other ranges will continue to use the factory default calibration settings. Also, if the maximum test current specified under Setup is 30 amps, then the ranges above 30 amps will continue to use the factory calibration settings. Once the calibration adjustment is complete, the operator can run another as found and then view the change in calibration.

By selecting Original Cal. the RM-17-01 can be put back to the factory default calibration. This will undo any change in calibration that the customer has done. The printing option prints the last set of as found results.

Complete recertification an recalibration services are available from Radian’s NIST traceable metrology laboratory. Contact Radian Research or your local Radian Research Representative for details.
19.0 Test Accessories

19.1 RM-1S Remote Reset Switch
The RM-1S Remote Reset Switch is a normally closed push button switch. The RM-1S connects directly to the “Input” port on the RM-17-01 hand controller. The switch of the RM-1S is hermetically sealed to provide increased reliability during field use. The push-button has positive tactile feel to provide instantaneous feedback of the switch action.

![Figure 19.1 RM-1S Remote Reset Switch](image1)

19.2 RR-1H Optical Pickup for infrared LED
The RM-1H-17 is used to sense the infrared pulses from the calibration LED of Solid Statemeters. The pulses from the RM-1H are fed into the Pickup port of the RM-17-01 hand controller. When the RR-1H is used with the RM-17-01 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 RM-1H/v is available for Solid State meters with a visible calibration LED.

![Figure 19.2 RR-1H Optical Pickup for infrared LED](image2)
19.3 RM-OA Optical Adapter
The RM-OA Optical Adapter is used with Solid State meters whose infrared calibration pulse is emitted from the optical communications port. The RM-OA magnetically couples to the communication port of Solid State meters. The suction cup of the RR-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.

![Figure 19.3 RM-OA Optical Adapter](image)

19.4 RM-RPP Remote Portable Printer
The RM-RPP Remote Portable Printer is used for printing results from the RM-17-01 hand controller. 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 uses a re-chargeable battery for remote use. The RM-RPP is the ideal accessory for maintaining records and addressing billing complaints.

![Figure 19.4 RM-RPP Remote Portable Printer](image)
19.5 RM-TS Test Socket
The RM-TS Test Socket effectively interfaces the RM-17-01 to a potential source for testing purposes. The RM-TS connects voltage to the blades of the socket adapter portion of the RM-17-01. The RM-TS will generally be used in conjunction with the RM-TJ Test Jack.

![Figure 19.5 RM-TS Test Socket](image)

19.6 RD-TJ Test Jack
The RD-TJ is the Test Jack Interface Assembly that allows direct connection of the RM-17-01 Socket Adapter to an RD-21 Primary Watthour Reference Standard. When in the calibration mode the RM-17-01 hand controller works as a comparator counting pulses of both the RM-17-01 socket adapter and the RD-21 Primary standard. The RD-TJ is necessary for performing an accuracy cross check or for adjusting calibration.

![Figure 19.6 RD-TJ Test Jack](image)
19.7 RR-DS Meter Disk Sensor
The RR-DS is a reflective pickup assembly used to sense the disk rotation of an induction type meter. The pulses generated by the RR-DS are fed into the Pickup port on the RM-17-01 hand controller. With the RR-DS and the RM-17-01, induction meter testing is fully automated with a high degree of accuracy compared to using the conventional push button or snap switch method. The RR-DS is available in two different mounting options for increased flexibility.

Figure 19.7 RR-DS Meter Disk Sensor
20.0 Service and Routine Maintenance

The RM-17-01 Portable Watthour Test System is virtually a maintenance free test system. Internally, there are fewer circuit board to circuit board connections. This greatly reduces problems associated with wiring and ill-fitting connections. Radian Research recommends keeping the RM-17-01 Test System in the padded carrying case when not in use. Other than routine surface cleaning and yearly calibration, no routine maintenance is required.

20.1 Cleaning
Cleaning of the RM-17-01 may be performed with a clean, dry lint-free cloth dampened slightly with a mild window cleaner. The area around the current blades and meter jaws should be buffed dry with another cloth which is completely clean and totally dry.
21.0 Warranty and Calibration Service

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

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

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

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

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

Radian Research, Inc. maintains a complete state-of-the-art recalibration and repair facility in Lafayette, Indiana. Estimates for repairs are available by contacting our headquarters. All recalibrations, which are certified traceable to the National Institute of Standards and Technology are performed on the Radian RS-703A Automated Calibration System. The RS-703A Calibration System is referenced by three Radian RD-22 Primary Standards with a short-term repeatability of 0.001% or better.