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NUFLO™

MC-I
Portable Rate Meter

User Manual

167018

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INTRINSICALLY SAFE
FOR HAZARDOUS LOCATIC
CLASS I, DIV. 1, GROUPS A,

Manual No. 9A-50165007, Rev. 01

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Introduction

NuFlo's MC-I Portable Rate Meter is a portable, easy-to-use readout instrument that accurately displays accumulated flow volume and flow rate of liquids and gases using alkaline battery power. The MC-I Portable Rate Meter's microprocessor circuitry counts the pulses generated by a flow meter, converts that data into volume and rate values in accordance with calibration settings, and displays the totalized data on two six-digit liquid crystal displays (LCDs). The top LCD indicates total flow volume; the bottom LCD indicates flow rate. The lightweight portable device is easily transported to field locations for verifying operation of turbine flow meters of any size.

The MC-I Portable Rate Meter automatically determines the flow rate decimal point position in accordance with flow conditions. As flow rates change, the flow rate decimal point shifts position to provide maximum resolution.

The MC-I Portable Rate Meter has no internal potentiometers, jumpers, or dip switches to adjust. The instrument automatically calculates the divisor for liquid flow measurement when you supply the calibration factor and standard engineering unit of the flow meter. The instrument can also be configured for measuring gas flow by entering a divisor.

With the simplistic MC-I Portable Rate Meter, you can save totals in nonvolatile memory or reset the total display to zero with the press of a button on the keypad.

The MC-I Portable Rate Meter is powered with an alkaline battery pack. Replacement battery packs are readily available from Cameron.

See Figures 1 and 2 for identification of components that make up the MC-I Portable Rate Meter.

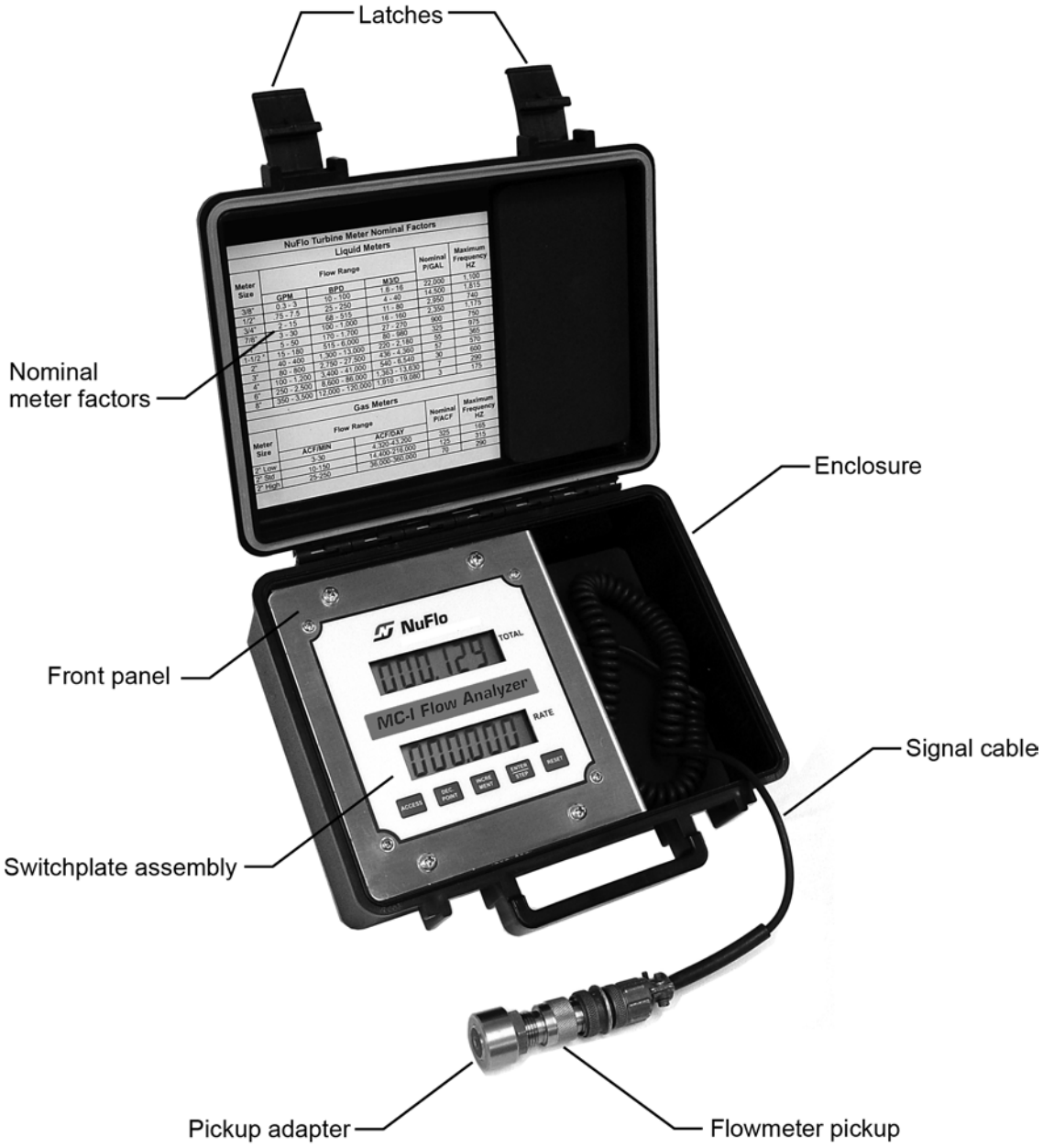


Figure 1—Nomenclature (exterior)

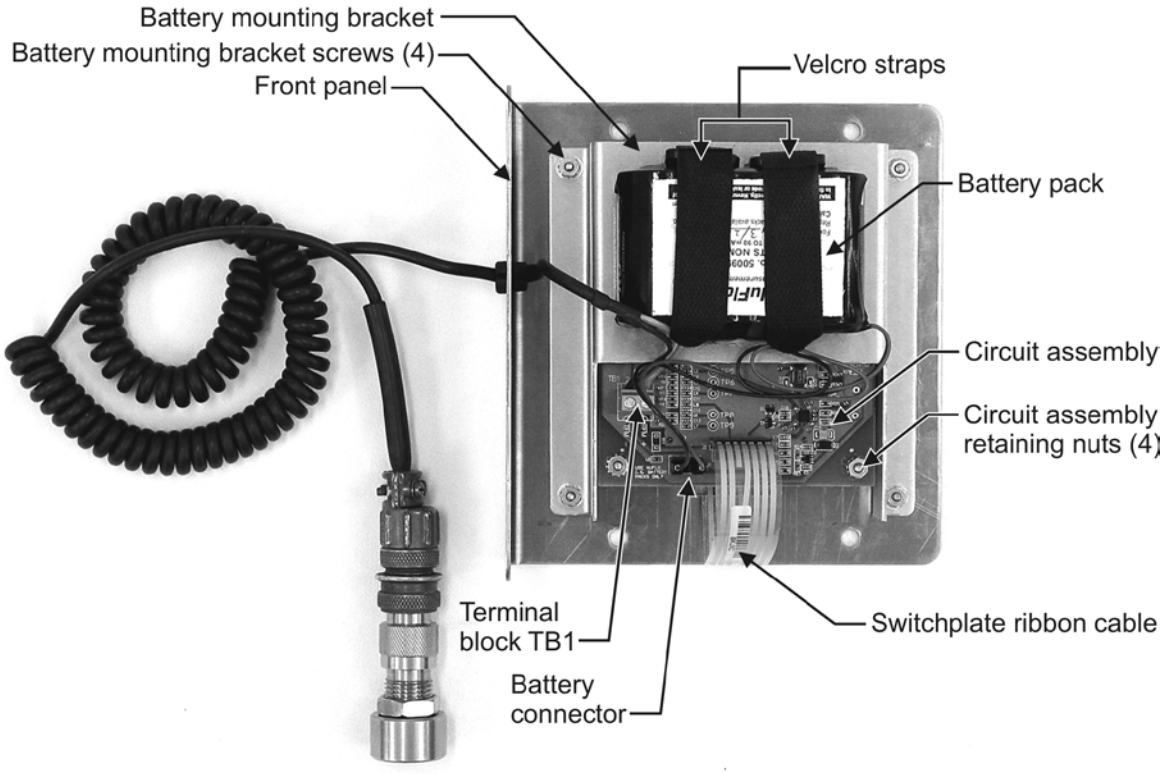


Figure 2—Nomenclature (interior)

Specifications

Enclosure:	Black ABS plastic, weatherproof design
Size:	8.78 in. wide x 3 7/16 in. high x 7 7/8 in. deep (including hinge and handle)
Weight:	3.2 lb (including batteries)
Shipping weight:	5 lb (including shipping container)
Power supply:	Alkaline battery pack (3 “C” batteries) supplied with instrument
Temperature range:	0 to +130°F (-18 to +55°C)
Totalizer:	Six digits, 0.5 in. character height Registers to three decimal places (thousandths of a unit) Default unit is barrels (bbl) unless other unit is specified at time of order. Calibration factor range: 0.001 to 999,999 pulses per gallon
Flow rate:	Six digits, 0.5 in. character height Default unit is barrels per day (bpd) unless other unit is specified at time of order. Updates once every 4 seconds
Accuracy:	±1 count (totalizer)
Input frequency:	0 to 2000 Hz
Input amplitude:	30 to 3000 mV peak to peak
Signal cable:	6-ft long coiled (retracts to 2 ft for storage)
Flow meter pickup:	Entity Parameters Voc = 4.95 V Isc = 2.28 mA Ca = 15 µF La = 6.84 H
Certification	Approved by CSA (US/Canada) for use in hazardous locations. Class I, Div. 1, Groups A, B, C, D

Operating the MC-I Portable Rate Meter

When fluid begins to pass through the flow meter, the MC-I Portable Rate Meter registers total accumulated flow volume in the top LCD and instantaneous flow rate in the bottom LCD. Decimal points will appear in their proper position in the displays when the unit is properly calibrated.

The MC-I Portable Rate Meter has two modes of operation: Run Mode and Calibrate Mode. The Run Mode is the standard operating mode during which the instrument displays flow rate and volume. The Calibrate Mode of the MC-I Portable Rate Meter allows entry of calibration data into the instrument using the five red keys aligned on the switchplate. Abbreviated menu names will appear in the upper display, and calibration data will be entered in the lower display. All five keys are used for calibrating the MC-I Portable Rate Meter. The **DEC. POINT, RESET and ENTER/STEP** keys are used in the Run mode.

See Table 1 below for a description of all keypad functions.

Due to the limitations of a 7-segment character, some of the letters in the menu names will be uppercase and some will be lowercase. All available unit abbreviations for volume totals and flow rate are listed on page 8.

Table 1—MC-I Keypad Functions

RUN MODE FUNCTIONS	
ENTER/STEP	Saves current volume total in nonvolatile memory.
RESET	Allows user to zero the volume. See Resetting Volume Totals, page 6.
DEC. POINT	Changes the position of the decimal point in the TOTAL (top) display.
CALIBRATE MODE FUNCTIONS	
ACCESS	Places the MC-I Rate Meter in the Calibrate Mode and permits you to perform the following tasks: Set units of measure for the TOTAL (top) display. Set the calibration factor. Set the units of measure for the RATE (bottom) display. SHORTCUT: Press ACCESS to accept an existing NUMERICAL calibration setting and advance to the next menu option. This shortcut is applicable to NUMERICAL data fields only.
DEC. POINT	Moves the position of the decimal point when entering numerical data such as a calibration factor.
INCREMENT	Scrolls/toggles through available settings for each menu option, and allows the user to change the flashing digit when inputting numerical settings. A single press advances digits/text entries to the next available setting. Depressing and holding the INCREMENT key scrolls through all digits.
ENTER/STEP	Accepts the calibration setting shown on the display and advances to the next data entry position (flashing digit field) or menu option.
RESET	Allows the user to re-enter a numerical value in the bottom display (if the value has not been accepted by pushing the ENTER/STEP button. The right-most digit will begin flashing, allowing the user to re-enter the value, right to left.

RUN Mode Keypad Functions

Saving/Storing Data

Loss of battery power can result in the loss of unsaved data. To store the total accumulated flow volume to nonvolatile memory, press **ENTER/STEP** each time you check the flow. The saved total accumulated volume value will be available when battery power is restored.

Total accumulated volumes are also automatically saved each time you exit the Calibrate menu.

Change Decimal Point Position

Volume readouts can be displayed in values as small as 0.001 of a unit by changing the decimal point position. In Run mode, press **DEC. POINT** until the desired decimal position is achieved. The decimal point position in flow rate readouts adjusts automatically and cannot be changed.

Resetting Volume Totals

At times, you may wish to reset the volume total to zero.

To reset the volume total, perform the following steps:

1. Verify that you are in Run mode.
2. Press **RESET** on the keypad. The prompt **RESET** will appear in the top display, and **no** (default setting) will appear in the lower display.
3. Press **INCREMENT** to toggle the bottom display from **no** to **YES**.
4. Press **ENTER/STEP** to reset the volume total.

   The prompt **SAVing** will appear in the lower display while the information is saved to nonvolatile memory. The MC-I Portable Rate Meter volume will then be reset to zero.

Timing Out

If the MC-I Portable Rate Meter is left in the Calibrate mode for longer than 1 minute, it will time-out and return to the Run mode. Data stored with the **ENTER/STEP** key will be saved. Data that was selected but not entered will be lost.

Overrun Error

If the calculated flow rate contains more than six digits, the MC-I Portable Rate Meter will generate an overrun error. A prompt, **oU run**, will appear in the lower LCD. To correct this error, enter the Calibrate Mode and change the flow rate unit.

Calibrating for Liquid Measurement Using Standard Units

The following information is needed to calibrate the MC-I Portable Rate Meter when measuring liquids:

- unit of measure for volume
- flow meter calibration factor (in pulses per gallon)
- unit of measure for flow rate

The calibration procedure is explained in detail below.

1. Press **ACCESS** to enter Calibrate mode and wait for the instrument to complete a diagnostic test. **Prog.no** will appear in the top display and the version number of the firmware will appear in the bottom display for 1 to 2 seconds.

   The **tot.Eng** menu will then appear in the top display. The factory default volume unit—bbL—will appear in the bottom display.

2. Press **INCREMENT** repeatedly to select a unit of measure for volume (bottom display). Unit options are bbl, gal, m^3, and liter. Press **ENTER/STEP** to accept the selection. The **Pu.P.gAL** menu will appear in the top display.

3. Locate the calibration factor (pulses per gallon) of the turbine flow meter. This factor is typically recorded on a plastic tag attached to the meter. If multiple NuFlo liquid turbine meters of the same size are being used, NuFlo recommends using the nominal calibration factor for that meter size. See Table 6, page 15 for NuFlo turbine meter nominal calibration factors. Enter the calibration factor into the MC-I Portable Rate Meter as follows:

   a. Note the position of the decimal point in your calibration factor, and press **DEC. POINT** repeatedly until the decimal point position in the display matches that of your calibration factor.

   b. Enter digits from right to left. The right-most digit will flash, indicating the digit being changed.

   c. Press **INCREMENT** repeatedly to advance the digits from 0 to 9, or press and hold **INCREMENT** to scroll through the digits to make the appropriate selection. Then, press **ENTER/STEP** to save it and advance to the next digit.

   d. Repeat Step c until all six digits have been entered. If your calibration factor is less than six digits in length, enter 0 for each of the unused digits at the left.

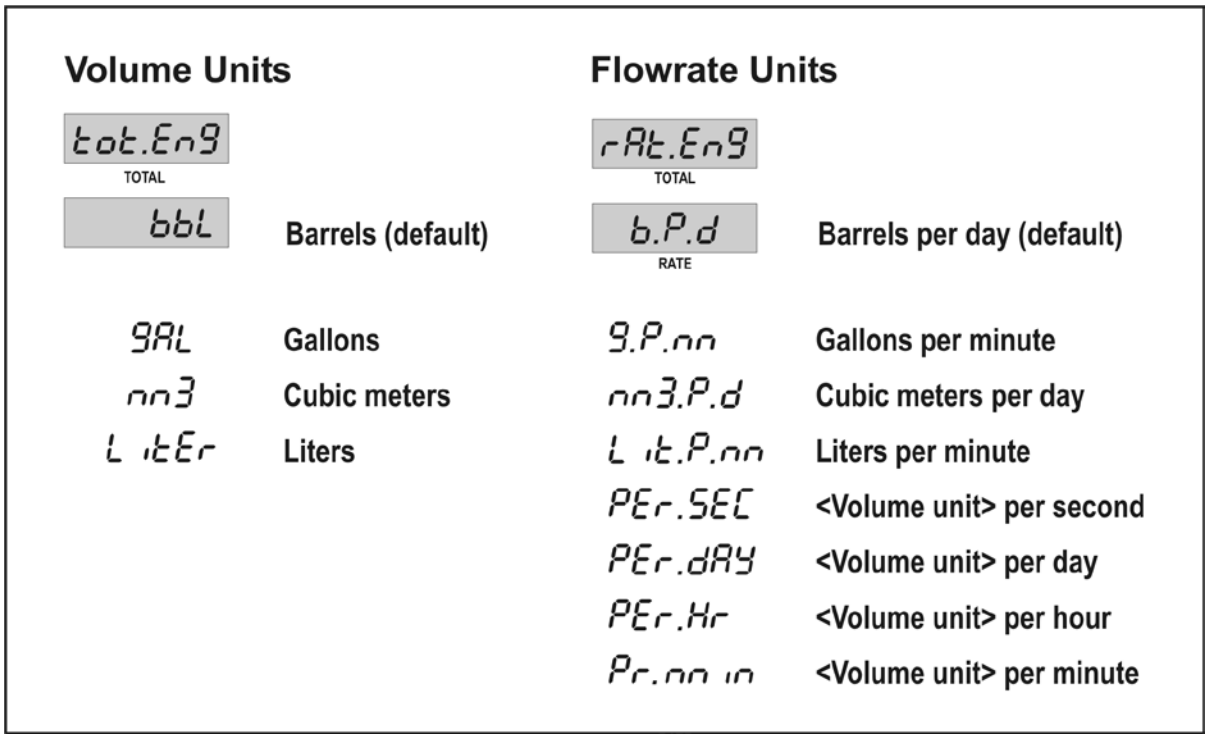
   e. Press **ENTER/STEP** to save the calibration factor in the MC-I Portable Rate Meter's memory. The **rAt.Eng** menu will appear in the top display.

4. At the **rAt.Eng** prompt, press **INCREMENT** repeatedly until the appropriate unit of measure appears in the bottom display. Unit options include:

   - barrels per day (b.P.d)
   - gallons per minute (g.P.nn)
   - cubic meters per day (nn3.P.d)
   - liters per minute (Lit.P.nn)
   - <preselected volume unit> per day (PEr.dAY)
   - <preselected volume unit> per hour (PEr.Hr)
   - <preselected volume unit> per minute (Prnn in)
   - <preselected volume unit> per second (PEr.SEC)

5. Press **ENTER/STEP** to accept the selection. The **SAVing** screen will appear momentarily, and the MC-I Portable Rate Meter will then automatically return to Run mode. The total volume and rate information will be displayed in the top and bottom displays, respectively.

Important: If the unit of measure selected for the flow rate results in a volume that contains too many digits to be displayed in the LCD window, the MC-I Portable Rate Meter will generate an overrun error. A prompt, oU run, will appear in the bottom display. To correct this error, press ACCESS to reenter the Calibrate mode and select a larger unit of measure for the flow rate.



Example Calibration

Calibration Information

- The MC-I Portable Rate Meter will be connected to a 1-in. NuFlo liquid turbine flow meter.
- The flow meter's calibration factor is 907.68 pulses per gallon.
- Flow volume will be measured in barrels and displayed in tenths of a barrel.
- The MC-I Portable Rate Meter is in the Run mode.

1. Press the **ACCESS** key to enter the Calibrate mode and wait for the MC-I Portable Rate Meter to complete a diagnostic test.
2. When the prompt **tot.Eng** appears in the upper display, press **INCREMENT** to scroll through the available volume units of measurement (bbl, gal, m^3, liter). Since the example calls for the volume to be measured in barrels, select "bbl" from the unit menu. Press **ENTER/STEP** to accept the selection.

3. When **Pu.P.gAL** appears in the upper display, enter the flow meter calibration factor in pulses per gallon according to the steps below. The lower display will show the previously entered flow meter calibration factor. The factory default is 900.00. The right-most digit—the hundredths position—will blink, indicating it is the digit currently selected for editing. All digits must be entered from right to left.

   a. Since 8 is the rightmost digit to be entered (in the hundredths position for the factor 907.68), press **INCREMENT** until 8 is displayed.

      Press **ENTER/STEP** to accept the selection of the digit 8. The digit to the left of the 8 (the tenths position) will begin blinking.

   b. Since 6 is to be entered in the tenths position (for the factor 907.68), press **INCREMENT** until 6 is displayed.

      Press **ENTER/STEP** to accept the selection of digit 6. The digit to the left of the 6 (the ones position) will begin blinking.

   c. Press **INCREMENT** until 7 is displayed. Press **ENTER/STEP** to accept the selection and proceed to the tens position.

   d. Press **INCREMENT** until 0 is displayed. Press **ENTER/STEP** to proceed to the hundreds position.

   e. Press **INCREMENT** until 9 is displayed. Press **ENTER/STEP** to accept the selection and proceed to the thousands position. Since the meter factor is now entered, the remaining digit to the left of the factor must be zero.

   f. Press **INCREMENT** until 0 is displayed. Press **ENTER/STEP** to accept the selection. You have now completed the entry of the calibration factor.

4. The upper display will show **rAt.Eng**, prompting you to enter the units of measure for the flow rate. Pressing **INCREMENT** allows you to scroll through the engineering flow rate units:

   - barrels per day (bpd) - factory default
   - gallons per minute (g.P.nn)
   - cubic meters per day (nn3.P.d)
   - liters per minute (Lit.P.nn)
   - <volume unit> per day (PEr.dAY)
   - <volume unit> per hour (PEr.Hr)
   - <volume unit> per minute (Pr.nn in)
   - <volume unit> per second (PEr.SEC)

   Press **INCREMENT** until **b.P.d** is shown on the bottom display. Press **ENTER/STEP.**

   The top display will be empty, and the bottom display will show **SAVing** momentarily while the MC-I Portable Rate Meter saves the calibration settings to nonvolatile memory. The MC-I Portable Rate Meter will automatically return to the Run mode.

5. In Run mode, press the **DEC. POINT** key to change the position of the decimal point. Since our example calls for volume to be displayed in tenths of a barrel, the decimal point in the top (volume) display should be positioned to show tenths (00000.0).

Calibrating for Liquid Measurement Using a Calculated Divisor

Calculating the divisor for liquids is necessary when registering the volume in units other than barrels, gallons, cubic meters, or liters.

Important: Since user-defined units are not available on the MC-I Portable Rate Meter, the GAL totals engineering unit must be used.

The divisor is calculated as follows:

Divisor =FC x CON

Where:

FC = Meter factor in pulses per actual cubic foot (PACF)

CON = Conversion factor for number of standard cubic feet (SCF) per unit volume of desired measure. (Table 4 contains the conversion factors for most commonly used units of measure.)

The calibration procedure is explained in detail below.

1. Press **ACCESS** to enter Calibrate mode and wait for the instrument to complete a diagnostic test. **Prog.no** will appear in the top display and the version number of the firmware will appear in the bottom display for 1 to 2 seconds.

   The **tot.Eng** menu will then appear in the top display. The factory default volume unit - bbL - will appear in the bottom display.

2. Press **INCREMENT** repeatedly to select **gAL** for the unit of measure for volume (bottom display). Unit options are bbl, gal, m^3, liter. Press **ENTER/STEP** to accept the selection. The **Pu.P.gAL** menu will appear in the top display.

3. Enter the calculated divisor into the MC-I Portable Rate Meter as follows:

   a. Note the position of the decimal point in your calibration factor, and press **DEC. POINT** repeatedly until the decimal point position in the display matches that of your calibration factor.

   b. Enter digits from right to left. The right-most digit will flash, indicating the digit being changed.

   c. Press **INCREMENT** repeatedly to advance the digits from 0 to 9, or press and hold **INCREMENT** to scroll through the digits to make the appropriate selection. Then, press **ENTER/STEP** to save it and advance to the next digit.

   d. Repeat Step C until all six digits have been entered. If your calibration factor is less than six digits in length, enter 0 for each of the unused digits at the left.

   e. Press **ENTER/STEP** to save the calibration factor in the MC-I Portable Rate Meter's memory. The **rAt.Eng** menu will appear in the top display.

4. At the **rAt.Eng** prompt, press **INCREMENT** repeatedly until the appropriate unit of measure appears in the bottom display. Unit options include:

   - barrels per day (b.P.d)
   - gallons per minute (g.P.nn)
   - cubic meters per day (nn3.P.d)
   - liters per minute (Lit.P.nn)
   - <preselected volume unit> per day (PEr.dAY)
   - <preselected volume unit> per hour (PEr.Hr)
   - <preselected volume unit> per minute (Prnn in)
   - <preselected volume unit> per second (PEr.SEC)

   Use only the PEr.dAY, PEr.Hr, Prnn in or PEr.SEC rate units of measure. Use of b.P.d, g.P.nn, nn3.P.d or Lit.P.nn will results in inaccurate rate readings.

5. Press **ENTER/STEP** to accept the selection. The **SAVing** screen will appear momentarily, and the MC-I Portable Rate Meter will then automatically return to Run mode. The total volume and rate information will be displayed in the top and bottom displays, respectively.

Important: If the unit of measure selected for the flow rate results in a volume that contains too many digits to be displayed in the LCD window, the MC-I Portable Rate Meter will generate an overrun error. A prompt, oU run, will appear in the bottom display. To correct this error, press ACCESS to reenter the Calibrate mode and select a larger unit of measure for the flow rate.

Example Calibration: Liquid Measurement Using a Calculated Divisor

A NuFlo ¾" liquid turbine meter will be measuring a liquid with a specifc gravity of 0.63 and the units of measure are to be in pounds and pounds per day. The meter factor of the ¾" meter is 2977.01.

SG= .63

FC= 2977.01 P/G

Referencing Table 4, the conversion formula for Gallons per Pound is:

Gallons per Pound = 1/(SG x 8.337) = CON

CON= 1/(.63 x 8.337) = .19039

DIV= P/G x CON

DIV= 2977.01 x .19039 = 566.79 P/lb

The divisor is entered in the same manner as the divisor was entered in the *Liquid Measurement* example.

1. Press the **ACCESS** key to enter the Calibrate mode and wait for the MC-I Portable Rate Meter to complete a diagnostic test.
2. When the prompt **tot.Eng** appears in the upper display, press **INCREMENT** to scroll through the available volume units of measurement (bbl, gal, m^3, liter). Select "gal" from the unit menu. Press **ENTER/STEP** to accept the selection.
3. When **Pu.P.gAL** appears in the upper display, enter the calculated divisor of 566.79 according to the steps below. The lower display will show the previously entered meter factor. The factory default is 900.00. The right-most digit, the hundredths position, will blink, indicating it is the digit currently selected for editing. All digits must be entered from right to left.
   a. Press DEC-POINT till the decimal point is in the hundreds position.
   b. Since 9 is the first digit to be entered (in the hundredths position for the factor 566.79), press **INCREMENT** until 9 is displayed.

      Press **ENTER/STEP** to accept the selection of the digit 9. The digit to the left of the 9 (the tenths position) will begin blinking.
   c. Since 7 is to be entered in the tenths position (for the factor 566.79), press **INCREMENT** until 7 is displayed.

      Press **ENTER/STEP** to accept the selection of digit 7. The digit to the left of the 7 (the ones position) will begin blinking.
   d. Press **INCREMENT** until 6 is displayed. Press **ENTER/STEP** to accept the selection and proceed to the tens position.
   e. Press **INCREMENT** until 6 is displayed. Press **ENTER/STEP** to proceed to the hundreds position.
   f. Press **INCREMENT** until 5 is displayed. Press **ENTER/STEP** to accept the selection.
   g. Press **INCREMENT** until 0 is displayed. Press **ENTER/STEP** to accept the selection.
4. The upper display will show **rAt.Eng**, prompting you to enter the units of measure for the flow rate. Pressing **INCREMENT** allows you to scroll through the engineering flow rate units:
   - barrels per day (bpd) - factory default
   - gallons per minute (g.P.nn)
   - cubic meters per day (nn3.P.d)
   - liters per minute (Lit.P.nn)
   - <volume unit> per day (PEr.dAY)
   - <volume unit> per hour (PEr.Hr)
   - <volume unit> per minute (Pr.nn in)
   - <volume unit> per second (PEr.SEC)
5. Press **INCREMENT** until PEr.dAY is shown on the bottom display. Press **ENTER/STEP.**

   The top display will be empty, and the bottom display will show **SAVing** momentarily while the MC-I Portable Rate Meter saves the calibration settings to nonvolatile memory. The MC-I Portable Rate Meter will automatically return to the Run mode.
6. In Run mode, press the **DEC. POINT** key to change the position of the decimal point. Select the decimal point for the resolution desired.

Calibrating for Gas Measurement Using a Calculated Divisor

To perform gas flow measurement with the MC-I Portable Rate Meter, the divisor must be calculated. Since gas units are not available on the MC-I Portable Rate Meter, the GAL totals engineering unit must be used.

The divisor is calculated as follows:

$$Divisor = \frac{FC \times Ps \times Tf \times CON}{(Pg + Pa) \times Ts \times (Fpv)^2}$$

Where:

FC = Meter factor in pulses per actual cubic foot (PACF)

Ps = Standard pressure in PSIA

Tf = Line (flowing) temperature in degrees Rankine (°R)
(Table 3 contains conversion factors for converting commonly used temperatures to Rankine)

CON = Conversion factor for number of standard cubic feet (SCF) per unit volume of desired measure. (Table 5 contains the conversion factors for most commonly used units of measure)

Pg = Line (flowing) pressure in PSIG

Pa = Atmospheric pressure in PSIA
(Table 2 contains factors for converting elevation to atmospheric pressure)

Ts = Standard temperature in degrees Rankine (°R)
(Table 3 contains conversion factors for converting commonly used temperatures to Rankine)

Fpv = Supercompressibility factor (enter a factor of 1 if supercompressibility factor is not to be entered)

Note:	If multiple NuFlo gas turbine meters of the same size are being used, NuFlo recommends using the nominal calibration factor for that meter size and range. See Table 6, page 15, for NuFlo gas turbine meter nominal calibration factors.

The calibration procedure is explained in detail below.

1. Press **ACCESS** to enter Calibrate mode and wait for the instrument to complete a diagnostic test. **Prog.no** will appear in the top display and the version number of the firmware will appear in the bottom display for 1 to 2 seconds.

   The **tot.Eng** menu will then appear in the top display. The factory default volume unit—bbL—will appear in the bottom display.

2. Press **INCREMENT** repeatedly to select **gAL** for the unit of measure for volume (bottom display). Unit options are bbl, gal, m^3, and liter. Press **ENTER/STEP** to accept the selection. The **Pu.P.gAL** menu will appear in the top display.

3. Enter the calculated divisor into the MC-I Portable Rate Meter as follows:

   a. Note the position of the decimal point in your calibration factor, and press **DEC. POINT** repeatedly until the decimal point position in the display matches that of your calibration factor.

   b. Enter digits from right to left. The right-most digit will flash, indicating the digit being changed.

   c. Press **INCREMENT** repeatedly to advance the digits from 0 to 9, or press and hold **INCREMENT** to scroll through the digits to make the appropriate selection. Then, press **ENTER/STEP** to save it and advance to the next digit.

   d. Repeat Step c until all six digits have been entered. If your calibration factor is less than six digits in length, enter 0 for each of the unused digits at the left.

   e. Press **ENTER/STEP** to save the calibration factor in the MC-I Portable Rate Meter's memory. The **rAt.Eng** menu will appear in the top display.

4. At the **rAt.Eng** prompt, press **INCREMENT** repeatedly until the appropriate unit of measure appears in the bottom display. Unit options include:

   - barrels per day (b.P.d)
   - gallons per minute (g.P.nn)
   - cubic meters per day (nn3.P.d)
   - liters per minute (Lit.P.nn)
   - <preselected volume unit> per day (PEr.dAY)
   - <preselected volume unit> per hour (PEr.Hr)
   - <preselected volume unit> per minute (Prnn in)
   - <preselected volume unit> per second (PEr.SEC)

   Use only the (PEr.dAY), (PEr.Hr), (Prnn in) or(PEr.SEC) rate units of measure. Use of (b.P.d), (g.P.nn), (nn3.P.d) or (Lit.P.nn) will results in inaccurate rate readings.

5. Press **ENTER/STEP** to accept the selection. The **SAVing** screen will appear momentarily, and the MC-I Portable Rate Meter will then automatically return to Run mode. The total volume and rate information will be displayed in the top and bottom displays, respectively.

Important: If the unit of measure selected for the flow rate results in a volume that contains too many digits to be displayed in the LCD window, the MC-I Portable Rate Meter will generate an overrun error. A prompt, oU run, will appear in the bottom display. To correct this error, press ACCESS to reenter the Calibrate mode and select a larger unit of measure for the flow rate.

Example Calibration: Gas Measurement Using a Calculated Divisor

A NuFlo 2-in. high-range gas turbine flow meter will be measuring gas flow with an average flowing pressure of 120 PSIG and an average flowing temperature of 50 degrees Fahrenheit (°F). The flow meter factor is 72.56 pulses per actual cubic foot (PACF). The unit of measure for volume is to be cubic meters and the unit of measure for the rate is to be cubic meters per day. The standard conditions to compensate to are 60°F and 14.73 PSIA. The atmospheric pressure is unknown but the elevation is 1000 ft above sea level.

The supercompressiblity factor from a reference table is determined to be 1.0102.

Therefore, *Fpv = 1.0102*

Referring to Table 2, it is determined that the average atmospheric pressure at 1000 ft above sea level is 14.21 PSIA.

Therefore, *Pa = 14.21 PSIA*

Referring to Table 3, it is determined that conversion from °F to °R is: °R = °F + 459.67.

Substituting:

Tf = 50°F + 459.67 = 509.67°R
Ts = 60°F + 459.67 = 519.67°R

Referring to Table 5, there are 35.31 cubic feet per cubic meter.

Therefore, *CON = 35.31*
Ps = 14.73 PSIA (Given); *Pg = 120 PSIG* (Given); *FC = 72.56 PACF* (Given)

Substituting in the formula:

$$Divisor = \frac{FC \times Ps \times Tf \times CON}{(Pg + Pa) \times Ts \times (Fpv)^2} = \frac{72.56 \times 14.73 \times 509.67 \times 35.31}{(120 + 14.21) \times 519.67 \times (1.0102)^2} = 270.2462 \approx \underline{270.246}$$

The divisor is rounded off to 270.246 since the MC-I Portable Rate Meter will take only the six most significant digits of the divisor.

The divisor is entered in the same manner as the divisor was entered in the *Liquid Measurement* example.

1. Press the **ACCESS** key to enter the Calibrate mode and wait for the MC-I Portable Rate Meter to complete a diagnostic test.
2. When the prompt **tot.Eng** appears in the upper display, press **INCREMENT** to scroll through the available volume units of measurement (bbl, gal, m³, liter). Select "gal" from the unit menu. Press **ENTER/STEP** to accept the selection.
3. When **Pu.P.gAL** appears in the upper display, enter the calculated divisor of 270.246 according to the steps below. The lower display will show the previously entered flow meter factor. The factory default is 900.00. The right-most digit—the hundredths position—will blink, indicating it is the digit currently selected for editing. All digits must be entered from right to left.

a. Press **DEC-POINT** till the decimal point is in the thousands position.

b. Since 6 is the rightmost digit to be entered (in the thousandths position for the factor 270.246), press **INCREMENT** until 8 is displayed.

c. Since 4 is the next digit to be entered (in the hundredths position for the factor 270.246), press **INCREMENT** until 4 is displayed.

   Press **ENTER/STEP** to accept the selection of the digit 4. The digit to the left of the 4 (the tenths position) will begin blinking.

d. Since 2 is to be entered in the tenths position (for the factor 240.246), press **INCREMENT** until 2 is displayed.

   Press **ENTER/STEP** to accept the selection of digit 2. The digit to the left of the 2 (the ones position) will begin blinking.

e. Press **INCREMENT** until 0 is displayed. Press **ENTER/STEP** to accept the selection and proceed to the tens position.

f. Press **INCREMENT** until 7 is displayed. Press **ENTER/STEP** to proceed to the hundreds position.

g. Press **INCREMENT** until 2 is displayed. Press **ENTER/STEP** to accept the selection. You have now completed the entry of the calibration factor

4. The upper display will show **rAt.Eng**, prompting you to enter the units of measure for the flow rate. Pressing **INCREMENT** allows you to scroll through the engineering flow rate units:

   - barrels per day (bpd) - factory default
   - gallons per minute (g.P.nn)
   - cubic meters per day (nn3.P.d)
   - liters per minute (Lit.P.nn)
   - <volume unit> per day (PEr.dAY)
   - <volume unit> per hour (PEr.Hr)
   - <volume unit> per minute (Pr.nn in)
   - <volume unit> per second (PEr.SEC)

5. Press **INCREMENT** until PEr.dAY is shown on the bottom display. Press **ENTER/STEP.**

   The top display will be empty, and the bottom display will show **SAVing** momentarily while the MC-I Portable Rate Meter saves the calibration settings to nonvolatile memory. The MC-I Portable Rate Meter will automatically return to the Run mode.

6. In Run mode, press the **DEC. POINT** key to change the position of the decimal point. Select the decimal point for the resolution desired.

Table 2—Determining Atmospheric Pressure from Elevation

Elevation (Feet Above Sea Level)	Atmospheric Pressure (Pounds per Square Inch)
0	14.73
500	14.47
1000	14.21
1500	13.95
2000	13.70
2500	13.45
3000	13.21
3500	12.97
4000	12.74
4500	12.51
5000	12.28
5500	12.06
6000	11.84
6500	11.63
7000	11.41
7500	11.20
8000	11.00
8500	10.80
9000	10.60
9500	10.40
10000	10.21

The above values were determined by the following formula:

PSIA = (55096-(Elevation-361))/(55096+(Elevation-361)x14.54

Where
Elevation is in feet above sea level.
PSIA is pounds per square inch absolute.

This formula is referenced in AGA Report No. 3-A, 1985, Page 18.

Table 3—Temperature Conversions

Deg F to Deg R = F + 459.67
Deg C to Deg F = (C x 1.8) + 32
Deg C to Deg R = (C + 273.15) x 1.8

Deg F = Degrees Fahrenheit
Deg C = Degrees Celsius (Centigrade)
Deg R = Degrees Rankine

Table 4—Liquid Volume Conversions

Gallons per Barrel = 42
Gallons per Cubic Meter = 264.17
Gallons per Liter = 0.26417
Gallons per Kiloliter = 264.17
Gallons per Pound = 1 / (SG x 8.337)

This table is based on the US liquid gallon and 42-gallon (API) barrel.
Specific gravity (SG) is based on the specific gravity of water (1).

Table 5—Gas Volume Conversions

Cubic Feet per Liter = 0.035316
Cubic Feet per Kiloliter = 35.316
Cubic Feet per Cubic Meter = 35.316

Table 6—NuFlo Turbine Flow Meter Nominal Calibration Factors

Liquid Meters

Meter Size	GPM	BPD	M3/D	Nominal Factor P/GAL	Maximum Frequency HZ
3/8"	0.3 - 3	10 - 100	1.6 -16	22,000	1,100
1/2"	.75 - 7.5	25 - 250	4 - 40	14,500	1,815
3/4"	2 - 15	68 - 515	11 - 80	2,950	740
7/8"	3 - 30	100 - 1,000	16 - 160	2,350	1175
1"	5 - 50	170 - 1,700	27 - 270	900	750
1 1/2"	15 - 180	515 - 6,000	80 - 980	325	975
2"	40 - 400	1,300 - 13,000	220 - 2,180	55	365
3"	80 - 800	2,750 - 27,500	436 - 4,360	57	570
4"	100 - 1,200	3,400 - 41,000	540 - 6,540	30	600
6"	200 - 2,500	6,800 - 86,000	1,090 - 13,630	7	290
8"	350 - 3,500	12,000 - 120,000	1,910 - 19,080	3	175

2-in. Gas Meters

Meter Size	ACF/MIN	ACF/DAY	Nominal Factor P/ACF	Maximum Frequency HZ
Low	7 - 30	10,080 - 43,200	325	165
Std	10 - 150	14,400 - 216,000	125	315
High	25 - 250	36,000 - 360,000	70	290

Maintenance

Battery Replacement

See Table 7, page 22, for recommended spare parts.

WARNING

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The standard alkaline battery life expectancy may be shortened by temperature extremes.

Important: Reduced contrast in the LCD may indicate that the batteries are reaching the end of their useful life and should be replaced. Extremely cold temperatures may also result in a reduced display contrast, however, even with fresh batteries.

To replace the battery, perform the following steps:

1. Open the two latches on the enclosure door and open the lid.
2. If the existing battery is still functional, press **ENTER/STEP** to store the current volume (if desired) in nonvolatile memory.
3. Loosen the four large Philips screws on the top and bottom edge of the front panel and remove the front panel. The battery should now be exposed for servicing (Figure 3).
3. Unfasten the Velcro straps holding the battery in place.
4. Disconnect the old alkaline battery pack from the circuit assembly and remove it from the battery mounting bracket.
5. Place the new alkaline battery pack on the battery mounting bracket, and connect it to the circuit assembly.
6. Re-fasten the Velcro straps over the battery pack snugly.
7. Place the front panel back in position in the enclosure and replace the screws removed in Step 3.
8. Close the enclosure lid and fasten the latches.

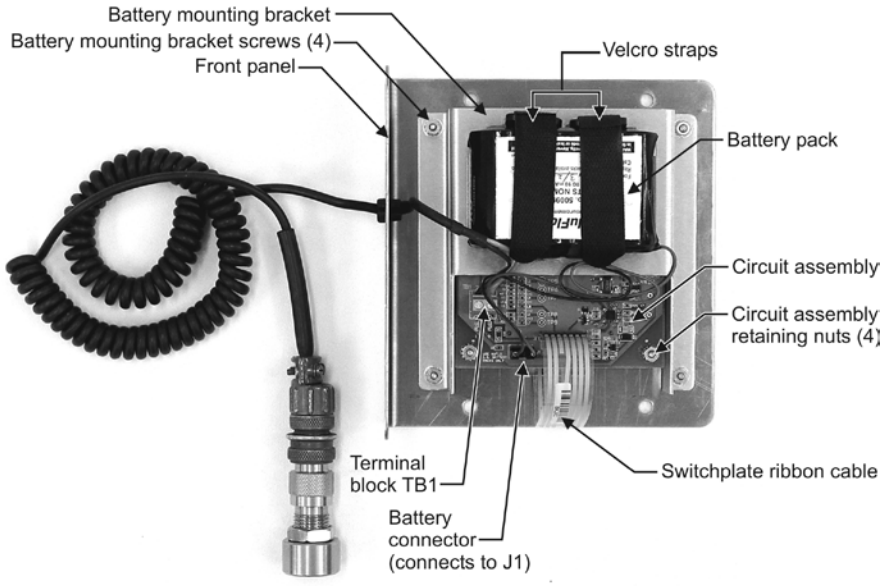

Figure 3—Alkaline battery pack replacement

Circuit Assembly Replacement

The circuit assembly contains all of the electronic components.

To replace the circuit card, perform the following steps:

1. Open the two latches on the enclosure and open the lid.
3. Loosen the four large Philips screws on the top and bottom edge of the front panel and remove the front panel.
4. Disconnect the alkaline battery pack from the circuit assembly.
5. Remove the four Philips screws holding the battery mounting bracket in place. Remove the battery mounting bracket (Figure 4).
6. Unplug the switchplate ribbon cable from the circuit assembly.
7. Disconnect the signal cable from terminal block TB1.
8. Remove the four nuts holding the circuit assembly in place. Remove the old circuit assembly.

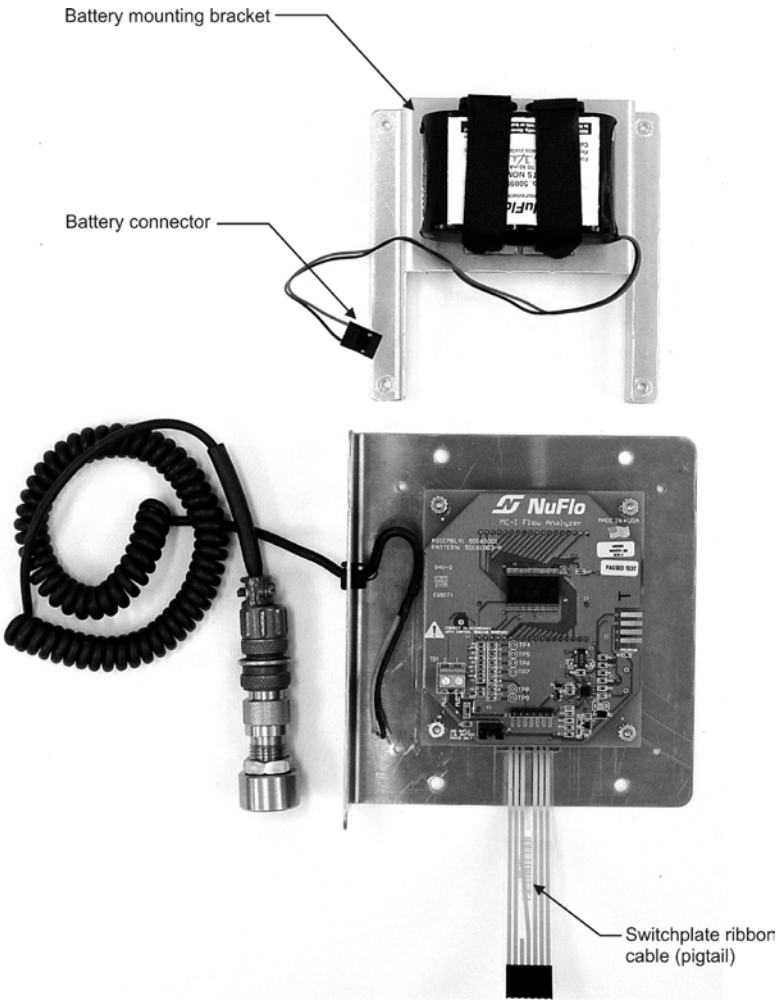

Figure 4—Circuit assembly replacement

9. Place the new circuit assembly over the 4-40 studs in the same position as the old circuit assembly that was removed.
10. Replace the four nuts removed in step 8.
11 Replace the battery mounting bracket removed in step 5.
12. Reconnect the switchplate ribbon cable.
13. Reconnect the signal cable to TB1.
14. Reconnect the battery connector to J1 (see Figure 3, page 16), observing proper polarity.
15. Place the front panel back in position in the enclosure and replace the screws removed in Step 3.
16. Close the enclosure lid and fasten the latches.

Switchplate Assembly Replacement

To replace the switchplate, perform the following steps:

1. Open the two latches on the enclosure and open the lid.
2. Press **ENTER/STEP** to store the current volume (if desired) in nonvolatile memory.
3. Loosen the four large Philips screws on the top and bottom edges of the front panel and remove the front panel.
4. Disconnect the alkaline battery pack from the circuit assembly (see Figure 3, page 16).
5. Unplug the switchplate ribbon cable from the circuit assembly.
6. Remove the switchplate from the front panel of the rate meter, taking care not to scratch the front panel.
7. Clean adhesive residue from the front panel using alcohol.

Caution: Do not use solvents other than alcohol, since they may damage the circuit assembly and plastic components on the rate meter. Allow the alcohol to dry.

8. Remove the paper backing from the replacement switchplate, and handle the switchplate with care to ensure that the adhesive backing does not touch any surface or the switchplate pigtail.
9. Slide the switchplate pigtail through the slot in the front panel. Align the switchplate with the display openings in the front panel and press the switchplate into place.
10. Connect the switchplate ribbon cable to the circuit assembly.
11. Reconnect the battery connector to J1 (see Figure 3, page 16), observing proper polarity.
12. Place the front panel back in its original position in the enclosure and replace the screws removed in Step 3.
13. Close the enclosure lid and fasten the latches.

Spare Parts

WARNING

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Table 7—Recommended Spare Parts

Quantity	Part Number	Description
1	2350596-01	Switchplate Assembly
1	9A-50160001	CPU-Display Circuit Assembly
1	9A-101227999	Signal Cable Assembly, 6 ft
1	9A-50099004	Alkaline Battery Pack, 3 “C” Batteries, Shrink-wrapped
1	2295367-01	Magnetic Pickup
1	9A-100003528	Magnetic Pickup Adapter
1	9A-50165007	User Manual

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