NEPTUNE
TECHNOLOGY GROUP

MACH 10® Ultrasonic Meter
Installation and Maintenance Guide

MACH 10® Ultrasonic Meter

Installation and Maintenance Guide

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FCC Notice

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference.
- This device must accept any interference received, including interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy, and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures.

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment to an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio / TV technician for help.

> Changes or modifications not expressly approved by the party responsible for compliance could void the users' authority to operate the equipment.

Professional Installation

In accordance with section 15.203 of the FCC rules and regulations, the MIU must be professionally installed by trained meter installers. Changes or modifications not expressly approved by the party responsible for compliance void the user's authority to operate the equipment.

Industry Canada

This Class B digital apparatus meets all requirements of the Canadian Interference Causing Equipment Regulations. Operation is subject to the following two conditions.

- This device may not cause harmful interference.
- This device must accept any interference received, including interference that may cause undesired operation.

Cet appareillage numérique de la classe B répond à toutes les exigences de l'interférence canadienne causant des règlements d'équipement. L'opération est sujette aux deux conditions suivantes: (1) ce dispositif peut ne pas causer l'interférence nocive, et (2) ce dispositif doit accepter n'importe quelle interférence reçue, y compris l'interférence qui peut causer l'opération peu désirée.

Contents

Contents

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Figures

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Tables

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This chapter provides a general description of the Neptune® MACH 10® Ultrasonic Meter (MACH 10).

Introduction

The MACH 10 solid state meter uses ultrasonic transit-time technology and solid state electronics. The meter is contained in a compact, totally encapsulated, weatherproof, and ultraviolet (UV) resistant housing for residential and light commercial applications. Ultrasonic technology features the following:

- Contains no moving parts
- Provides long-term accuracy
- Reduces measurement errors due to sand, suspended particles, and pressure fluctuations

The MACH 10 provides a Neptune E-CoderPLUS output signal to Neptune R900® and other Automatic Meter Reading (AMR) / Advanced Metering Infrastructure (AMI) endpoints. The MACH 10®)R900*i*™ contains a MACH 10 meter and an integrated R900 radio for transmitting meter reading data. Consumption reflected is up to nine digits.

The meter electronics and battery are fully potted to eliminate the intrusion of moisture, dirt, or other contaminants. It is suitable for installation in all environments including meter pits subject to continuous flooding.

Figure 1 – MACH 10® Residential Ultrasonic Meter

Figure 2 – MACH 10® Intermediate Ultrasonic Meter

Understanding Ultrasonic Technology

An ultrasonic water meter uses high-frequency sound waves to measure the velocity of an acoustically-conductive fluid moving through it. The velocity of the fluid is then converted to volume throughput using sophisticated algorithms and electronics.

Transit-Time Technology

The MACH 10 utilizes *transit-time* ultrasonic technology. This technology takes advantage of the principle that an acoustic signal travels faster with the flow than against the flow of the fluid. These meters have a pair of transducers that are essentially transceivers, sending and receiving the acoustic signals.
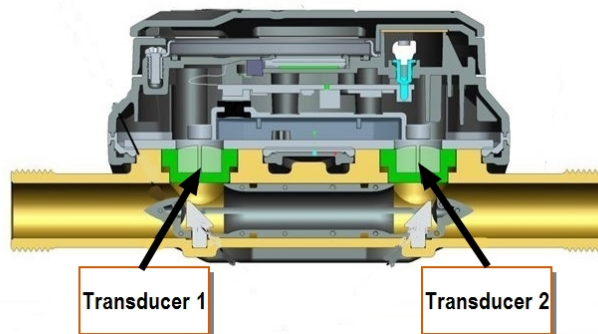
Figure 3 – Transducers

The difference between the downstream and upstream transit time—the time it takes for the signal to travel from one transducer to the other—is proportional to the flow rate.

The calculated velocity of the water is then converted to volume based on the area of the measurement section and by the algorithms and electronics in the register.

$$u = k\ \left(\frac{t_2 - t_1}{t_1 t_2}\right)$$
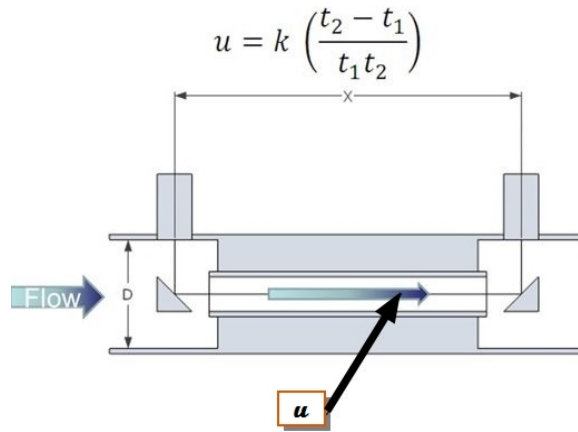
Figure 4 – Transducer - Calculated Velocity

Summary

The MACH 10 meter is a transit-time ultrasonic flow meter with wetted transducers. Designed as an alternative for mechanical meters, the MACH 10 meter utilizes traditional utility pipe connectors and lay lengths. It is totally self-contained. The battery, processor circuit, and electronic display are fully potted and permanently sealed as an integral unit. The MACH 10 meter provides an E-CoderPLUS output signal to Neptune R900 and other AMR / AMI endpoints. The MACH 10)R900*i* contains a MACH 10 meter and an integrated R900 radio for transmitting meter reading data. See "MACH 10®)R900*i*™" on page 27.

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This chapter provides the specifications for the MACH 10® Ultrasonic Meter.

Environmental and Performance Specifications

This table defines environmental specifications that apply to both the Residential and Intermediate MACH 10 meters.

Table 1 – Environmental Specifications

Specification	Description
Operating temperature	14° to 149° F (-10° to 65° C)
Storage temperature	–40° to 158° F (–40° to 70° C)
Water temperature	33° to 122° F (0.5° to 50° C)
Operating humidity	0 to 100% condensing

This table defines performance specifications that apply to both the Residential and Intermediate MACH 10 meters.

Table 2 – Performance Specifications

Meter Size	Normal Operating Range @ 100% Accuracy (± 1.5%)	AWWA C715 Standard Type 1	Extended Low Flow @ 100% Accuracy (± 3%)
Residential			
5/8"	0.10 to 25 U.S. gpm	0.2 to 20 U.S. gpm	0.05 U.S. gpm
3/4"	0.10 to 35 U.S. gpm	0.5 to 30 U.S. gpm	0.05 U.S. gpm
1"	0.40 to 55 U.S. gpm	0.75 to 50 U.S. gpm	0.25 U.S. gpm
Intermediate			
1-1/2"	0.80 to 125 U.S. gpm	2.0 to 100 U.S gpm	0.30 U.S. gpm
2"	1.50 to 160 U.S. gpm	2.5 to 160 U.S. gpm	0.50 U.S. gpm

Weight and Dimension Specifications

The following tables define the weight and dimension specifications for the Residential and Intermediate MACH 10 meters.

Table 3 – MACH 10® Meter Weight Specifications

Meter Size	Weight
Residential	
5/8"	2.8 lbs
3/4"	2.9 lbs
1"	3.6 lbs
Intermediate	
2" x 17"	15.6 lbs
1 1/2" x 13"	13.9 lbs
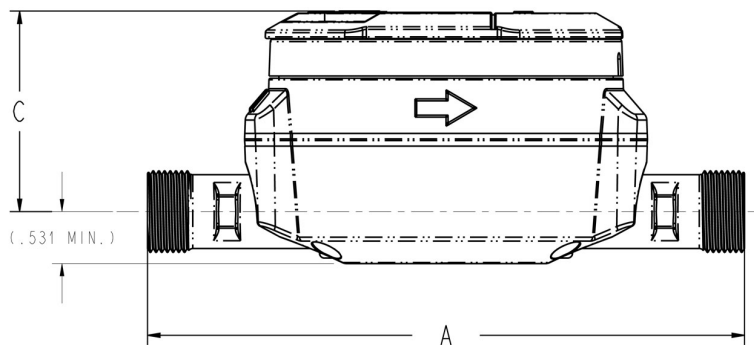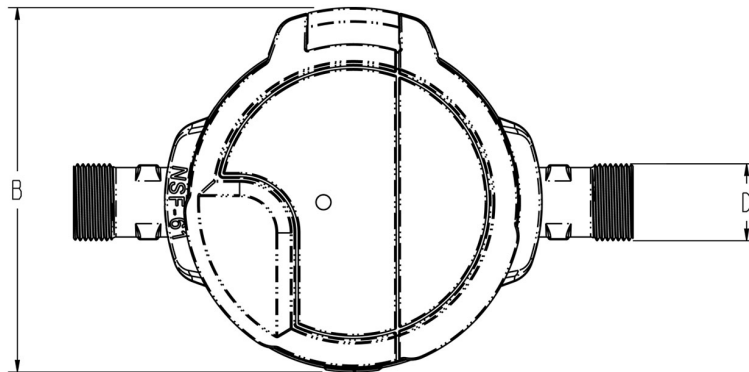
The following tables define the meter dimensions as shown in the previous illustrations .

Table 4 – Residential MACH 10® Dimensions

Meter Size	A	B	C	D NPSM
5/8"	7-1/2"	4-7/8"	2-1/2"	3/4" – 14
5/8" x 3/4"	7-1/2"	4-7/8"	2-1/2"	1" – 11-1/2
3/4"	9"	4-7/8"	2-9/16"	1" – 11-1/2
3/4" SL	7-1/2"	4-7/8"	2-9/16"	1" – 11-1/2
3/4" x 1"	9"	4-7/8"	2-9/16"	1-1/4" – 11-1/2
1"	10-3/4"	4-7/8"	2-11/16"	1-1/4" – 11-1/2
1" x 1-1/4"	10-3/4"	4-7/8"	2-11/16"	1-1/2" – 11-1/2

Table 5 – Intermediate MACH 10® Dimensions

Meter Size	Length	Height	Flanges
1-1/2"	10"	6-1/4"	Oval
	13"	6-1/4"	Oval
	12-5/8"	6-1/4"	Internal thread
	12-5/8"	6-1/4"	External thread
2"	10"	6-1/2"	Oval
	15-1/4"	6-1/2"	Oval
	17"	6-1/2"	Oval
	15-1/4"	6-1/2"	Internal thread
	15-1/4"	6-1/2"	External thread

Additional Specifications

The following specifications are for the 5/8-inch through 2-inch Residential and Intermediate meters.

Table 6 – Additional Specifications

Specification	Description
Maximum operating pressure of meter housing	175 psi (12 bar)
Register type	Straight reading, permanently sealed electronic Liquid Crystal Display (LCD); digits are 0.28" (7 mm) high
Register display	• Consumption (up to nine digits) • Rate of flow • Alarms • Unit of measure factory programmed for gallons, cubic feet, or cubic meters
Battery	3.6 volt lithium thionyl-chloride; battery is fully encapsulated within the register housing and is not replaceable

Fluid Compatibility

The MACH 10 meter is designed and calibrated for potable, combination potable and fire service, and reclaimed water across the defined temperature and velocity range.

Maincase

The meter maincase is manufactured using lead free bronze, and contains the wetted elements of the meter: two transducers, pressed in reflections, and the flow conditioner.

Transducers

The piezoelectric transducer is the heart of the system. Although these transducers are very small, they have very high measurement dynamics.

The signal path of the transducer utilizes two stainless steel reflectors. The transducers are permanently installed and the path length and angles are fixed. Each meter is uniquely calibrated at the factory and the calibration data is permanently stored in the meter.

Battery Requirement

Solid state metering technologies require a battery to power the transducers and electronics, just like a radio Meter Interface Unit (MIU) requires a battery to perform its functions. With the continued improvements made in battery technology, electronic metering utilizing internal batteries is practical today. The MACH 10 uses lithium thionyl-chloride battery technology.

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This chapter describes tools, materials, and general installation information for the MACH 10®.

Tools and Materials

Table 7 and Table 8 show the recommended tools and materials you need to successfully install the MACH 10.

Table 7 and Table 8 are not complete lists of tools and materials.

Table 7 – Recommended Tools

Item	Description / Recommendation	Use
Tool Kit	Contains standard tools including: • Screwdrivers • Pliers	Performing various installation procedures
Flashlight	N/A	Activating the LCD
Magnet	• 6 lb force • Part No: 12287-0001	Activating the MIU

Table 8 – Recommended Materials

Item	Description / Recommendation	Use
Moisture Protection Compound	Novaguard® sealant Part No: 96018-072	Connecting the pit antenna to the MIU
Site Work Order	Documentation provided by your utility	Receiving and recording information about the work site

Safety and Preliminary Checks

Observe the following safety and preliminary checks before and during each installation.

- Verify that you are at the location specified on the site work order.
- Verify that the site is safe for you and your equipment.
- Notify the customer of your presence, and tell the customer that you need access to the water meter.
- Write the ID numbers of the MACH 10 meters you are about to install on the site work order. If the site work order already has a MACH 10 ID number, verify that it matches the ID numbers on the MACH 10 you are about to install.

Installation and Application Considerations

This section provides information to consider before installing the MACH 10.

Water Temperature

The temperature range of the water is a factor in the selection of an ultrasonic meter, since the meter is calibrated to operate within a specified range. The MACH 10 meter is calibrated for water temperature (between 33° F and 122° F or 0.5° C and 50° C) measuring applications.

Meter Installation

The MACH 10 meter can be installed using horizontal or vertical piping applications. The meter features standard laying lengths for ease of retrofit of mechanical meters. A flow direction arrow is visible on the top of the meter to aid in installation in the proper direction.

Water Flow

The MACH 10 meter is unable to measure flow when an empty pipe condition is detected. An empty pipe is defined as a condition when the ultrasonic sensors are not fully wetted. In this situation, the meter displays an alarm and no measurement occurs.

Meter Sizing and Selection

Traditional meter sizing methods apply to both electronic meters and mechanical meters. That is, the maximum flow and maximum continuous flow rate requirements should be considered when selecting a meter. Mechanical meters allow a temporary flow at a rate higher than the maximum continuous flow. However, since electronic meters have no moving parts, these two specifications are identical; the maximum flow rate is also the maximum continuous flow rate.

All MACH 10® ultrasonic meters are delivered activated and ready to be installed. When the meter lid is opened, the meter shows the empty pipe icon and the latest volume on the LCD. The empty pipe icon clears immediately after the condition is corrected and the pipe is full.

Installation Instructions for MACH 10® Meters

This section defines the step-by step instructions for installing the MACH 10 meter.

> **ℹ** In outdoor settings, the meter and service line should be located deep enough in the ground to prevent freezing.

New Meter Installation

The following are steps for installation of the MACH 10 meter.

1. Flush the service line prior to meter installation in order to remove debris in the line.
2. Place an electrical grounding strap on the service line, connecting the inlet and outlet service lines on either side of the meter setting.

> **ℹ** Install suitable inlet and outlet meter valves and couplings / setters if they are not already present. Allow appropriate space in the line for the meter laying length and two coupling gaskets. Align the pipe ends sufficiently so that the coupling and meter threads can engage without binding or cross-threading.

3. Remove the thread protectors (if installed) before installing the meter.

> **⚠** Use caution; the meter threads are sharp.

4. Be sure that no debris enters the meter during installation.
5. Place the coupling gaskets, and set the meter in the line.
6. Start turning the coupling or flange nuts by hand, then using a wrench tighten sufficiently to prevent leakage.

> **⚠** Be careful not to cross-thread the connections.

7. Open the upstream inlet valve.

8. Open the meter outlet valve slowly.
9. Open a downstream faucet, and run enough water to dissipate entrained air and flush the line.

> ⚠️ The Intermediate MACH 10 may take longer to completely remove air from the meter, particularly when flow rates are less than 25% of the maximum flow rate of the meter.

10. Check to see if the meter is operating correctly, while the faucet is open.
11. Turn OFF the faucet, and check the meter installation for leaks.

Wiring the MACH 10®

The following table defines the steps to wire the MACH 10 meter while you are in the field.

> ℹ️ If the meter is not a MACH 10 prewired and potted to an MIU, complete the following steps to wire the MACH 10.

1. Hold the Scotchlok™ between the index finger and thumb with the red cap facing down.
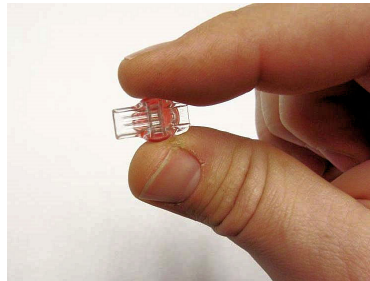

Figure 5 – Scotchlok™ Connector

2. Take one non-stripped black wire from the pigtail and one from the receptacle / MIU.
3. Insert the wires into the Scotchlok connector.
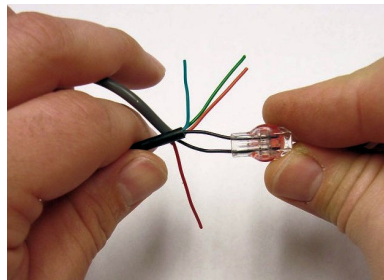4. Insert the insulated color wires directly into the Scotchlok connector until fully seated.

Figure 6 – Seat the Connector Wires

> Do not strip the colored insulation from the wires, or strip and twist the bare wires before inserting them into the connector. Insert the insulated colored wires directly into the Scotchlok connector.

5. Place the connector red cap side down between the jaws of the UR crimping tool.
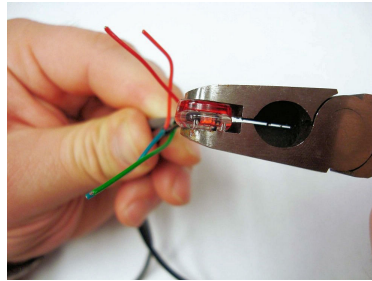
Figure 7 – UR Crimping Tool

6. Check to ensure the wires are still fully seated in the connector before crimping the connector.
7. Squeeze the connector firmly with the proper crimping tool until you hear a pop and the gel leaks out the end of the connector.
8. Repeat steps 1 through 5 for each color wire.
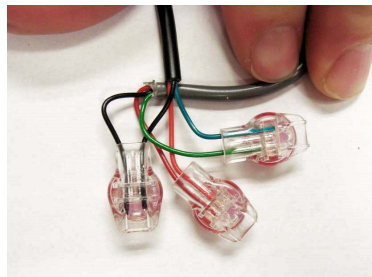
Figure 8 – Improper Connections

Table 9 – Color Codes for Wires

MIU Wire Color / MACH 10 Wire Color	MIU Type
Black/B Green/G Red/R	R900
Black/G Green/R Red/B	Sensus
Black/B White/G Red/R	Itron

Table 9 – Color Codes for Wires (continued)

MIU Wire Color / MACH 10 Wire Color	MIU Type
Black/G White/R Red/B	Aclara
Black/G Green/B Red/R	Elster
Black/G Green/R Red/B	Badger

Completing the Wiring

The following table outlines the steps to wire the MACH 10.

1. After you connect all three color wires, read the encoder register to ensure proper connections and the receptacle / MIU is functioning properly.

Figure 9 – Three Colored Wires Connected

2. Take all three connected Scotchloks and push them into the splice tube until fully enclosed by the silicone grease.

Figure 10 – Splice Tube

3. Separate each gray wire and place them into the slots on each side.

Figure 11 – Gray Wires in Slot

4. Snap the cover closed to finish the installation.
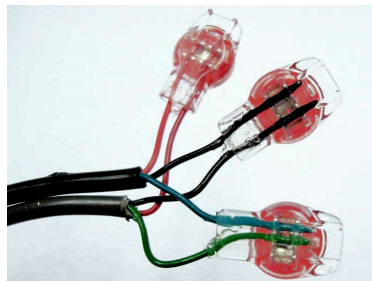

Figure 12 – Cover in Place

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This chapter explains the operations of the MACH 10® ultrasonic meter.

Activating the LCD Meter Display

The light sensor is located in the center of the faceplate of the MACH 10, and it supplies the power for the Liquid Crystal Display (LCD) panel.

Figure 13 – MACH 10® Faceplate

Timeout Period

Typically, the display is OFF. The meter includes a light sensor used to activate the LCD when you open the meter. A timed out LCD can not be reactivated just by shining a light on the light sensor. In order to reset the meter, close and re-open the lid.

Meter Display

The Neptune MACH 10 ultrasonic meters use a nine-digit LCD to show consumption, flow rate, and alarm information.

LCD Panel

Following is an example of the MACH 10 LCD panel. The table on the following page provides a description of each icon.
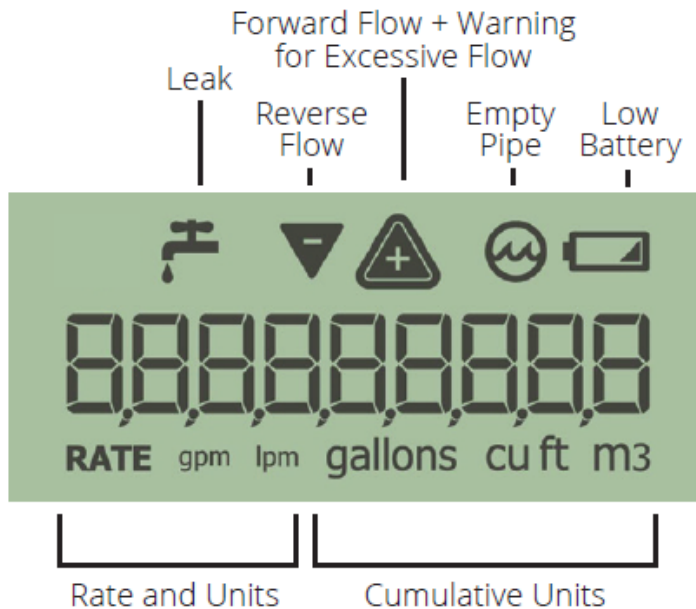
Figure 14 – MACH 10® LCD Panel

The LCD can display commas or decimals, depending on the configuration of each register, to show digits in the tens position, ones position, tenths position, and so forth. For example, some registers display 1,234,567.89. Others display 123,456.789, 12,345,678.9, or 1,234,567,89 depending on the need of the meter/register combination.

How to Read the Meter

It is important to become familiar with the information available from the meter. The icons and displays provide helpful information.

Alarms

Indicators and alarms appear in the displays as symbols that illuminate when the condition is active, and disappear when the alarm condition is eliminated.

LCD Icons

The following table defines the MACH 10 LCD icons and the status they indicate.

Table 10 – MACH 10® Icons and Displays

Icon	Description	Status	Explanation
Leak	Icon used to indicate a leak. Leak status is determined by keeping track of the number of 15-minute intervals where the volume consumption exceeds Vmin in the previous 24-hour period. Vmin is factory programmed depending on meter size. It is defined as a change of the ninth digit on the LCD.	OFF	Number of 15-minute intervals < 50.
		Flashing	50 ≤ Number of 15-minute intervals < 95.
		Continuous ON	Number of 15-minute intervals ≥ 95.
Forward and reverse flow	Icons used to indicate the forward and reverse direction of flow.	OFF	No flow is detected.
		Continuous ON	The meter has detected flow.
High flow warning	Icon used to indicate excessive flow which can be a burst pipe.	OFF	Rate of flow < Maximum defined by normal flow range specifications.
		ON	Rate of flow exceeds normal operating flow limits.
Empty pipe	Icon used to indicate if the pipe is empty or there is excessive air in the line. If this occurs, there is no receive signal in the expected time window.	OFF	Typically OFF. Meter is operating normally.
		ON	Turned ON if no receive signal is seen for 1 minute.
Battery status	Icon used to indicate time and voltage of remaining battery life.	OFF	> One year of battery life remaining. Time since first power ON < 19 years.
		Continuous ON	< One year of battery life remaining or time since first power ON > 19.5 years.
		Continuous FLASHING	Low battery or time since first power ON > 20 years.

Consumption and Unit of Measure

The consumption display contains all nine digits, including leading zeros and a decimal point. The value displayed is the sum of the forward flow minus the reverse flow.

The unit of measure and resolution are factory programmed and options include gallons, cubic feet, and cubic meters.

Table 11 – Consumption and Units of Measure

Capacity				Display Resolution		
Size	Gallons	Cubic Feet	Cubic Meter	Gallons	Cubic Feet	Cubic Meter
Residential						
5/8"	10,000,000	1,000,000	100,000	0.01	0.001	0.0001
3/4"	10,000,000	1,000,000	100,000	0.01	0.001	0.0001
1"	10,000,000	1,000,000	100,000	0.01	0.001	0.0001
Intermediate						
1"	100,000,000	10,000,000	1,000,000	0.1	0.01	0.001
2"	100,000,000	10,000,000	1,000,000	0.1	0.01	0.001

Rate of Flow

The rate of flow is factory programmed for either gallons per minute or liters per minute. The LCD displays both the unit of measure and rate of flow. The rate of flow display also serves as the flow finder indicator. The rate of flow display is shown without leading zeros. When rate of flow is displayed, it is updated every two seconds.

Flow Direction

An arrow on the electronic register housing shows the direction of flow. Current flow direction can be viewed on the LCD panel.

The direction of flow arrows on the LCD are activated when the meter detects any amount of flow. If the volume of the flow is below a predetermined measurement threshold in a given time period, the meter does not accumulate flow.

AMR / AMI Output

The Neptune MACH 10 ultrasonic meter is a compact design where the electronic register is fully potted and permanently sealed to the meter maincase. The meter provides high resolution E-CoderPLUS protocol. It communicates status indicators to Neptune R900 RF endpoints as part of the extended encoder / meter reading message. The meter also provides ProRead™ protocol for third-party endpoints that are not capable of reading E-CODER® eight digit or E-CoderPLUS protocol.

Endpoint Reading Resolution

The reading resolution sent to the reading software is dependent on the endpoint to which the encoder is connected. Readings reported from the endpoints are the left-most significant digits for the encoding reading.

Refer to "Wiring the MACH 10®" on page 14 for wiring considerations.

Bench Testing the Meter

Unlike other solid state meters introduced to the market, the Neptune MACH 10 ultrasonic meter is designed to be bench tested as a traditional mechanical meter.

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This chapter provides information for maintaining and troubleshooting the MACH 10® meter.

Maintenance

Mechanical meters are subject to wear and are often rebuilt to extend their life. On the other hand, the electronic MACH 10 meter does not have moving parts and requires no maintenance. The meter enclosure, which contains electronics, transducers, battery, and display is completely potted eliminating any maintenance. At the end of the meter's life, the meter is simply replaced.

Replacement Parts

There are no replacement parts for the MACH 10 ultrasonic meter. If the plastic meter lid becomes damaged or broken, it can be replaced.

Troubleshooting

Some conditions such as the following can occur.

- Battery is at low power.
- Meter starts sending colons.
- Communication stops.

Checklist

Before leaving the installation site, be sure to do the following.

☑   **Record the MIU ID for each register.**

☑   **Verify that you have followed all requirements of this Installation and Maintenance Guide.**

☑   **Verify that you have recorded all required information.**

☑   **Clean up any installation debris.**

☑   **Verify that the requirements of the Site Work Order have been completed.**

☑   **Inform the customer that you have completed your work. If you were unable to finish, inform the customer when you are returning to complete the project.**

Contact Information

Within North America, Neptune Customer Support is available Monday through Friday, 7:00 A.M. to 5:00 P.M. Central Standard Time, by telephone, email, or fax.

By Phone

To contact Neptune Customer Support by phone, complete the following steps.

1. Call **(800) 647-4832**.
2. Select one of the following options:

   - **1** if you have a Technical Support Personal Identification Number (PIN)
   - **2** if you do not have a Technical Support PIN

3. Enter the six-digit PIN and press #.
4. Select one of the following options.

   - **2** for Technical Support
   - **3** for maintenance contracts or renewals
   - **4** for Return Material Authorization (RMA) for Canadian Accounts

You are directed to the appropriate team of Customer Support Specialists. The specialists are dedicated to you until the issue is resolved to your satisfaction. When you call, be prepared to give the following information:

- Your name and utility or company name
- A description of what occurred and what you were doing at the time
- A description of any actions taken to correct the issue

By Fax

To contact Neptune Customer Support by fax, send a description of your problem to (334) 283-7497. Please include on the fax cover sheet the best time of day for a customer support specialist to contact you.

By Email

To contact Neptune Support by email send your message to support@neptunetg.com.

This appendix provides a general description of the MACH 10®)R900*i*™.

Product Description

The MACH 10®)R900*i*™ is manufactured by Neptune and is an integrated register that contains both the MACH 10 meter and the R900® technologies in one register that collects reading data. It then transmits the data for collection by the meter reader. A Neptune walk-by, mobile, or R900® Gateway fixed network data collection system receives the data and stores it to be downloaded into the utility billing system for processing.

The MACH 10 is easily installed and operates within a Radio Frequency (RF) band, which does not require an operating license. The MACH 10®)R900*i*™ meets FCC regulations part 15.247 allowing higher output power and greater range. The MACH 10 uses frequency-hopping spread spectrum (FHSS) technology to avoid RF interference and enhance security.

The transmitted data is updated at 15-minute intervals. It transmits a mobile message that includes the meter reading data and the unique 10-digit MACH 10 ID every 14 to 20 seconds. This allows the meter to be read by a hand held unit (HHU) or mobile data collection unit. The MACH 10 also transmits a high power fixed network message every seven and one-half minutes on an interleaved basis to an R900 Gateway.

The MACH 10 is designed to offer advantages to utility organizations of all sizes.

- Increases meter reading accuracy
- Eliminates hard-to-read meters
- Protects utility liability by increasing meter reader safety
- Requires no external wiring or programming
- Provides enhanced eight-digit AMR meter reading
- Provides proactive customer service benefits (leak, tamper, and backflow detection)

MACH 10®)R900*i*™ Programming

The MACH 10 is not field-programmable. Each MIU is given a unique 10-digit serial number / identification number.

RF Protocol Error Detection

The RF protocol is comprised of a header, data packet, and an error detection mechanism that reduces the erroneous data.

MACH 10®)R900*i*™ Specifications

This section provides you with the specifications for the MACH 10®)R900*i*™.

Electrical Specification

Power is provided by a lithium thionyl-chloride battery.

Transmitter Specifications

The following table defines the specifications for the MACH 10 transmitter.

Table 12 – Transmitter Specifications

Specification	Description
Transmit Period	• Every 14 to 20 seconds – standard mobile message • Every 7-1/2 minutes – standards, high power, fixed network message
Transmitter Channels	50
Channel Frequency	910 to 920 MHz
Output Power	Meeting FCC Part 15.247
FCC Verification	Part 15.247

Environmental Conditions

The following table defines the optimal environmental conditions for the MACH 10.

Table 13 – Environmental Conditions

Condition	Description
Operating temperature	14° to 149°F (–10° to +65°C)
Storage temperature	–40° to 158°F (–40° to 70°C)
Operating humidity	0 to 100% condensing

Functional Specifications

The following table defines the functional specifications for the MACH 10.

Table 14 – Functional Specifications

Specification	Description
Register Reading	• Eight digits (AMR) • Nine digits (Visual)
MIU ID	10 digits

Dimensions

The dimensions of the MACH 10 are shown in the following images and on page 30.
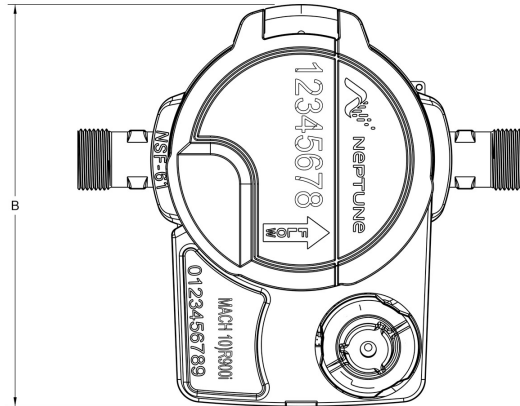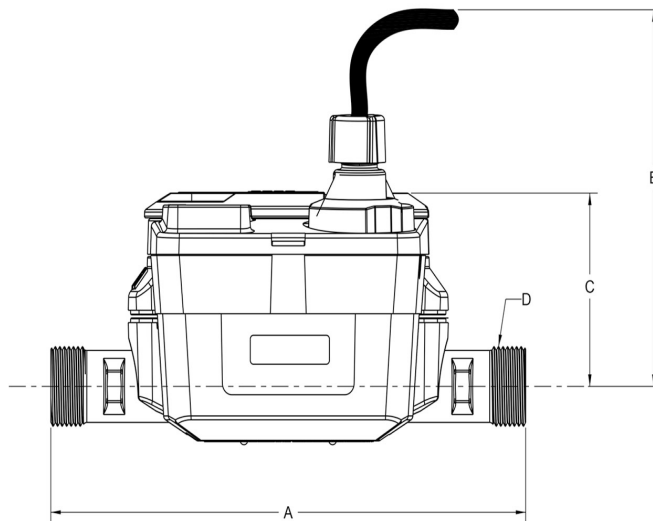

Figure 15 – MACH 10®)R900*i*™ Top View

Figure 16 – MACH 10®)R900*i*™ Side View

The following tables define the dimensions of the Residential MACH 10 meters.

Table 15 – MACH 10®)R900*i*™ Dimensions

Meter	A	B	C	D NSPM	E (external antenna)
5/8"	7-1/2"	6-3/4"	2-1/2"	3/4" - 14	5-7/8"
5/8" x 3/4"	7-1/2"	6-3/4"	2-1/2"	1" - 11-1/2	5-7/8"
3/4"	9"	6-3/4"	2-9/16"	1" - 11-1/2	5-7/8"
3/4" SL	7-1/2"	6-3/4"	2-9/16"	1" - 11-1/2	5-7/8"
3/4" x 1"	9"	6-3/4"	2-9/16"	1-1/4" - 11-1/2	5-7/8"
1"	10-3/4"	6-3/4"	2-11/16"	1-1/4" - 11-1/2	5-7/8"
1" x 1-1/4"	10-3/4"	6-3/4"	2-11/16"	1-1/2" - 11-1/2	5-7/8"

The three tables in this appendix describe the volume represented by the eighth digit by meter size (Residential and Intermediate), and the flags used by the MACH 10®)R900*i* (digits) and MACH 10®)R900*i* (minutes).

Table 16 – Eighth Digit Resolution by Meter Size

Register Size	Eighth Digit Resolution - Least Significant Digit
Residential (5/8" - 1")	1/10 U.S Gallons or 1/100 Cubic feet
Intermediate (Light Commercial and Industrial) (1-1/2" and 2"; 1-1/2" - 4" HPT)	1 U.S. Gallon or 1/10 Cubic feet

Table 17 – MACH 10®)R900*i*™ Flags (digits)

Backflow Flag (Resets After 35 Days)	
Based on reverse movement of the eighth digit; eighth digit is variable based on the meter size.	
No backflow event	Eighth digit reversed less than one digit
Minor backflow	Eighth digit reversed more than one digit up to 100 times the eighth digit
Major backflow event	Eighth digit reversed greater than 100 times the eighth digit

Table 18 – MACH 10®)R900*i*™ Flags (minutes)

Leak Status Flag (Resets After 35 Days)	
Based on total amount of 15-minute periods recorded in the previous 24-hour period.	
Leak icon off	Eighth digit incremented less than 50 of the 96 15-minute intervals
Flashing leak icon	Eighth digit incremented in 50-95 of the 96 15-minute intervals
Solid leak icon	Eighth digit incremented in all of the 96 15-minute intervals
Consecutive Days with Zero Consumption Flag (Resets After 35 Days)	
Number of days the leak status was at a minimum value	

A

AMI

Advanced Metering Infrastructure. A system that captures, stores, and provides to the utility at frequent intervals detailed consumption and other information, such as, usage, leak, and flow status, to support advanced applications.

AMR

Automated or Automatic Meter Reading.

E

empty pipe

Condition whenever the measurement section of the meter is not completely filled with water.

L

LCD

Liquid Crystal Display.

light sensor

Component located under the recess that is used to activate the Liquid Crystal Display (LCD).

M

MIU

Meter Interface Unit.

S

serial number

Unique identification number given to each meter at the factory. The default value is the last programmed plus one. Custom serial numbers are not available.

T

transceiver

Device that transmits and receives communications, in particular a combined radio transmitter and receiver.

transducer

Device that converts one form of energy to another form of energy.

transit-time

Technology that takes advantage of the principle that an acoustic signal travels faster with the flow than against the flow.

U

ultrasonic flow

Use of ultransonic technology to measure the velocity of an acoustically conductive liquid or gas moving through it. The velocity of the water is then converted to volume throughput using sophisticated algorithms and electronics.

ultrasonic meter

Electronic meter using ultrasonic technology and solid state electronics contained in a compact, totally encapsulated, weatherproof, and ultraviolet (UV) resistant housing for residential and light commercial applications.

V

Vmin

Change the ninth digit of the LCD. This is factory programmed depending on meter size.

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