Model 520C User's Guide

Revision 1.0, 13 September, 2004

Sensus Metering Systems-North America Inc.

REVISION SUMMARY

Date	Author	Change Description
12 August, 2004	GM/CP/AN	Baseline
13 September, 2004	GM	Removed references to Register wiring. Cleanup.

TABLE OF CONTENTS

1. Introduction

This document describes how to install, activate, operate and deactivate the CellNet Meter Transponder Unit (MTU).

1.1 Reference Documents

The following documents are referenced by this document:

[1] *RF LAN1 Air Interface Specification (95-1501Rev. A),* CellNet, 5 May 2004

[2] *Preliminary – Protocol Data Unit Specification, PID 0x02, 0x03, 0x04 – Electric, Gas and Water Meter Packets Rev. C*, CellNet, 5 May 2004

1.2 Open Issues

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1.3 Glossary

BPSK	Binary Phase Shift Keying
CRC	Cyclic Redundancy Check
ECR	Electronically Controlled Register
FCC	Federal Communications Commission
JEA	Jacksonville Electric Authority
kHz	Kilohertz
LAN	Local Area Network
LED	Light Emitting Diode
MHz	Megahertz
MTU	Meter Transmitter Unit
OOK	On-Off Keying
RAD-40	CellNet proprietary compression scheme
RF	Radio Frequency
TRPL	Touch Read Pit-Lid
TX	Transmit

2. CellNet Water MTU Overview

The sections which follow provide a high-level functional description of the CellNet Water MTU.

2.1 Features

The CellNet Water MTU provides the following features:

2.1.1 Field Configurable

The CellNet Water MTU can be configured via the programming interface using the Touch Gun. Configurable parameters are as specified in [ref 2]. Note that configuration is limited to parameter settings that are consistent with the Marketing Specification – particularly with respect to battery life.

Field re-configurability is not supported for this release, but will be supported in subsequent releases of this product.

2.1.2 Magnetic Switch Controlled Activation/Deactivation

The CellNet Water MTU can be "activated" and "deactivated" by passing a magnet over a magnetic switch present on the endpoint.

2.1.3 Magnetic Switch Forced Transmission

Once the CellNet Water MTU has been activated, it can be forced to transmit meter readings by passing a magnet over the magnetic switch.

2.1.4 Touch Coupled Register Interface

The CellNet Water MTU communicates with the register via an inductive interface, making the endpoint/register connection easier to install and less prone to water damage due to incorrect installation.

2.1.5 Battery Life

The CellNet Water MTU, when deployed as configured at the factory, will operate for **[TBD]** years.

2.1.6 FCC

The CellNet Water MTU is FCC Approved. The CellNet Water MTU transmits using frequencies in the 900MHz ISM band and as such deployment of the CellNet Water MTU does not require an FCC license.

Changes or modifications not expressly approved by Sensus Metering Systems could void the user's authority to operate the equipment.

To meet FCC RF exposure requirements a distance of at least 20 cm (8 inches) must be maintained between the transmit antenna and all persons.

2.2 Functional Description

2.2.1 Overview

This section provides a high-level description of how to operate an endpoint from activation through deactivation of the endpoint.

2.2.2 Description

CellNet Water MTUs ship with their batteries connected as part of one package. In order to make certain that the endpoints do not transmit while on the shelf, or while in transit to the deployment site, the endpoint must be activated after being connected to the meter. The endpoint will not transmit until is has been activated.

2.2.2.1 Installing the Endpoint

The endpoint is installed as shown in the following sequence. The pit lid found at JEA customer sites is shown below:

Table 2-1 JEA Customer Site Pit Lid

The antenna enclosure (mushroom) is inserted through the pit lid as shown in the following pictures:

Table 2-2 Mushroom Inserted Through Pit Lid (Top View)

Table 2-3 Mushroom Inserted Through Pit Lid (Bottom View)

The mushroom is then secured to the pit lid:

Table 2-4 Securing the Mushroom to the Pit Lid

The endpoint is then inserted into the mushroom:

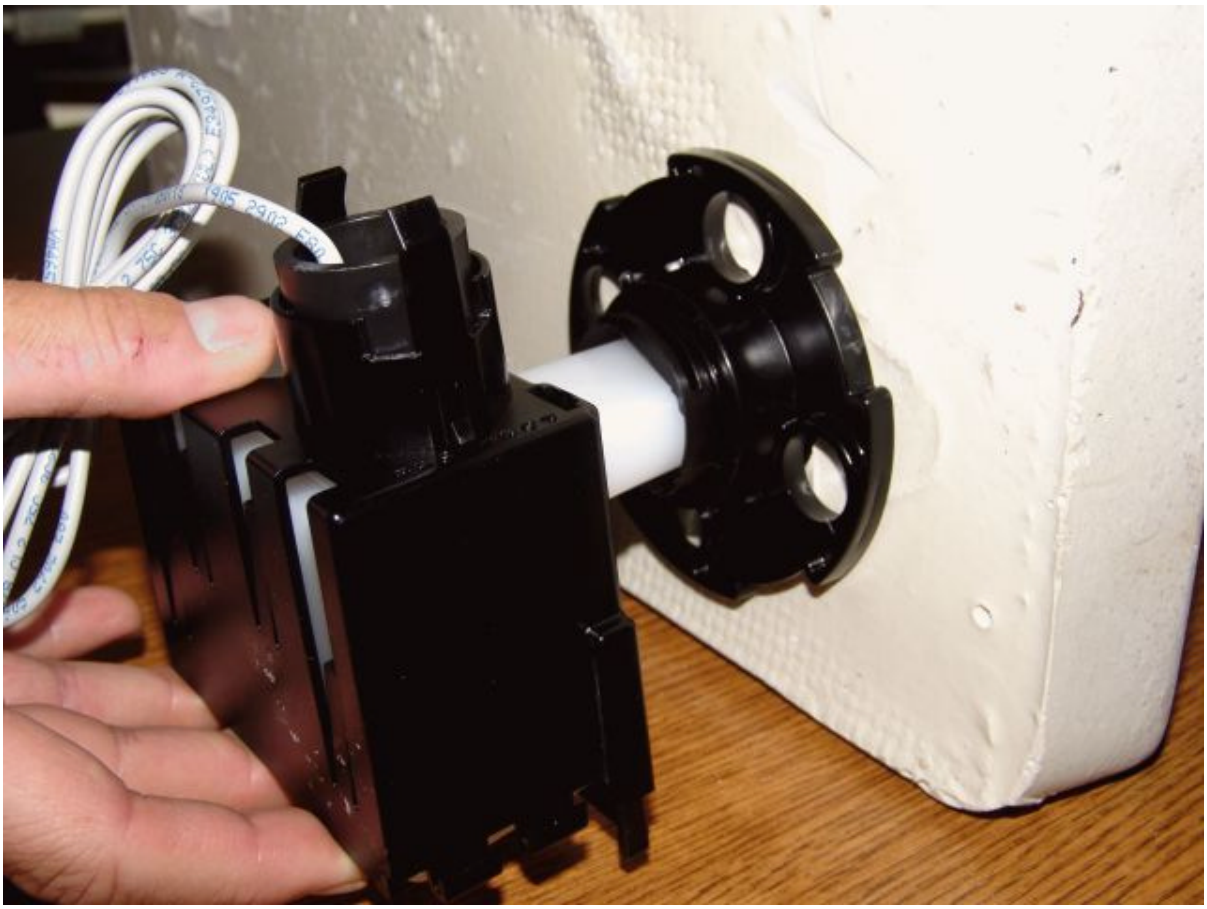

Table 2-5 Insertion of the Endpoint Into the Mushroom

Finally, the endpoint is secured to the mushroom:

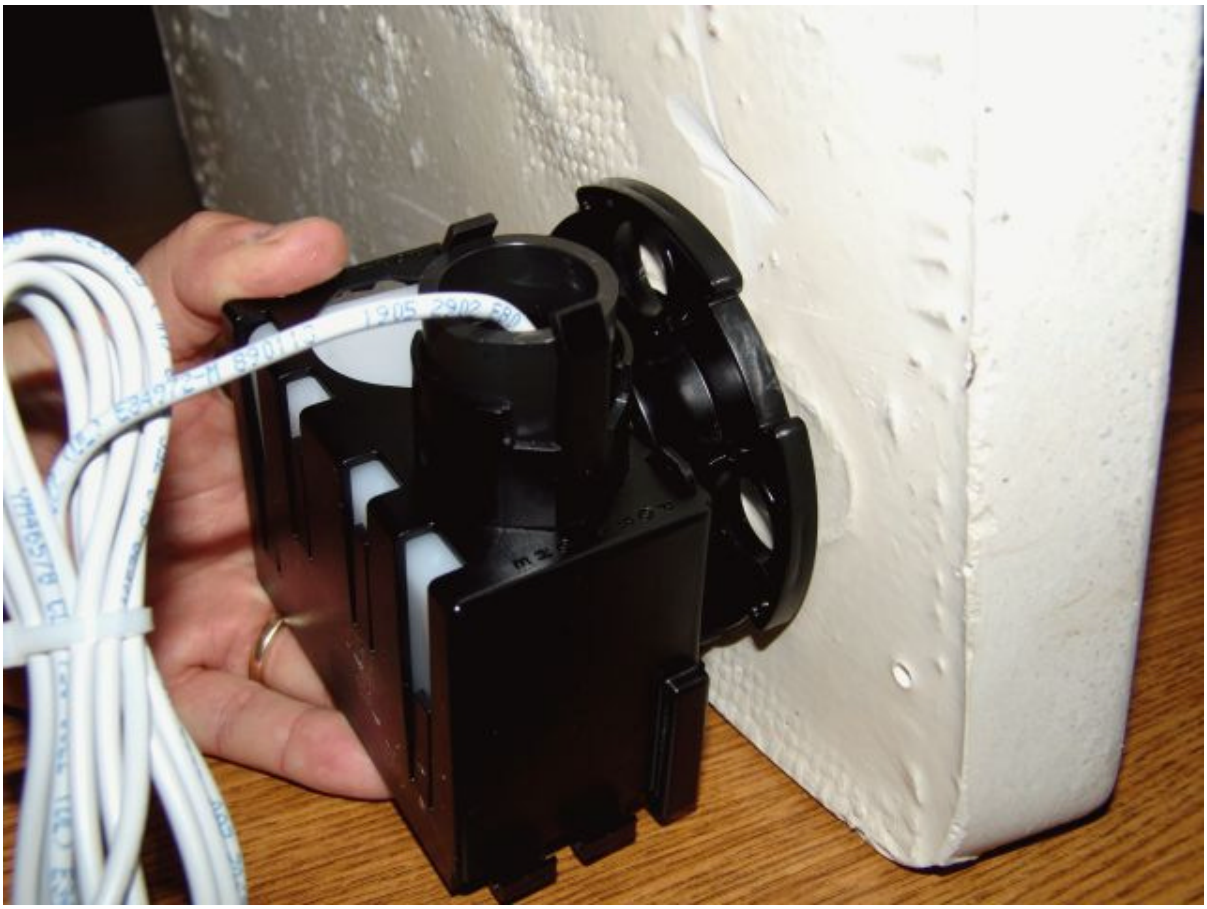

Table 2-6 Securing the Endpoint to the Mushroom

Notice that the Touch Read PaneL (TRPL) is connected to the ECR port labeled `Port One` (Port One is the only port that has a mounting bracket provided).

2.2.2.2 Activation

Activation of the endpoint requires a tool known as the "RF Buster". The "Buster" is used to close a reed switch on the endpoint via a magnetic field. A Buster is shown in Table 2-7:

Table 2-7 RF Buster

The RF Buster consists of:

- A relatively strong magnet (using the orientation as shown in Table 2-7, the magnet is on the lower right corner of the RF Buster)
- An LED/Speaker
- A short range RF Receiver, tuned (roughly) to the range of 911.58MHz through 917.58MHz
- A button that enables the RF Receiver while it is pressed and held in the down position.

When the button is pressed and the Buster detects RF in the above range, it blinks the LED and generates a short audible "beep" for each RF transmission detected.

The operation of "busting" an endpoint consists of performing the following:

- Press and hold the button
- Pass the magnet over the endpoint's reed switch
- Continue to press and hold the button while the Buster blinks/beeps.
- Once the Buster stops blinking/beeping, release the button.

When the endpoint is busted (as shown in Table 2-8), the reed switch closes causing the endpoint to immediately attempt to read the meter.

Table 2-8 "Busting" the Endpoint

If the register has been correctly connected to the endpoint, the meter will be read successfully, and the meter reading will be transmitted to the network 10 times. Thus, following a successful installation of the endpoint, busting the endpoint will result in 10 blinks of the LED where each blink is associated by an audible beep. The unit is now activated.

NOTE: In the busting sequence described above, the meter is read just once prior to transmission of the first RF packet. The same meter reading is transmitted 10 times.

If the register has not been correctly connected to the endpoint, the meter will not be read successfully upon being busted. In this case, the endpoint will not activate upon closure of the reed switch, and thus will not transmit. Therefore, until the RF Buster indicates that the unit has been activated, the technician must assume that the endpoint has not been correctly installed.

2.2.2.3 Operation

Once the unit has been activated, it will read the meter and transmit Consumption data using the timing configured at the factory. Packets transmitted by each endpoint are uniquely identified by a 10 digit LAN Address. The 10 digit LAN Address of each endpoint can be found on the label applied to the endpoint enclosure, and can be queried through the programming interface.

The default timing of RF transmissions from the CellNet Water MTUs, and the type of data transmitted, is as follows:

- **Consumption Data:** Consumption data consists of the current cumulative meter reading. Consumption data is transmitted once every 15 minutes (15 minute intervals)
- **Administration Data:** Administration data consists of the current cumulative meter reading, as well as the current configuration of the endpoint. Administration data is transmitted once every 60 minutes (1 hour intervals).

In order to guarantee that all meters are able to be read over the course of a few hours, the meter read/RF transmissions are scheduled for a random time during each interval. Thus, the time between two consecutive Consumption data read/transmissions could be as short as a couple of seconds, or as long as 30 minutes.

Consumption data contains only the current cumulative meter reading. The CellNet Network requires additional data to ensure the integrity of the network over time. Thus, in addition to the Consumption data that is transmitted 4 times per hour, Administrative data is transmitted once per hour.

Administrative data provides the network with the configuration of the endpoint, in addition to a cumulative reading of the meter. Thus, the packets used to convey this data over the air are much larger than those used to convey Consumption data – and are transmitted less often.

The meter read/RF transmission required to convey Administrative data over the network is randomized to occur at an arbitrary time within the hour. Thus, the time between two consecutive Administrative data read/transmissions could be as short as a couple of seconds, or as long as 2 hours.

NOTE: The interval timing of the endpoint is configurable as per [ref 2]. Most endpoint parameters can be programmed via the Programming interface.

For the remainder of this document, the reader may assume that any behavior mentioned can be configured via the programming interface unless otherwise indicated.

NOTE: The re-programming of endpoint parameters should only be performed by knowledgeable technicians, as it can

adversely affect the battery life of the endpoint.

2.2.2.4 Diagnostics

[Ref 2] describes the diagnostics that are available via the CellNet RFLAN1 Protocol. For details on diagnostics, please refer to [ref 2].

When an endpoint detects an error condition, these conditions are reported via diagnostic bits in the RF LAN1 Frames transmitted by the endpoint. While the error condition exists, the endpoint will transmit packets with the corresponding diagnostic bit set. If the error condition clears, the bit will be set for the next 14 transmitted packets following the clearing of the condition. Thus, diagnostic bits will be set based on an error condition for a minimum of 15 packet transmissions.

There are 4 diagnostic bits provided:

Bit	Description
S	**Sensor Bit:** This bit is set if an error occurs when reading the register.
R	**Low Battery:** This bit will be set when the endpoint has approximately 7 days of battery life left.
W	**Watchdog Reset:** This bit will be set at any time the unit resets. This will almost always be due to a watchdog reset, however might occur due to events such as a direct lightening strike.
C	**Memory Corruption:** This bit will be set if at any time the endpoint's non-volatile storage becomes corrupted. Note that endpoints are built to recover gracefully from this situation, however may not be able to recover if a memory device is damaged (say as the result of a lightening strike), or if the product has reached the end of its useful life-cycle.

Table 2-9 Description of Diagnostic Bits

2.2.2.5 Forcing a Meter Read

Since a technician might have to wait up to 30 minutes to receive a reading of the meter based on the timing described above, the RF Buster can be used to force a read of the meter. An endpoint (that has been activated, and is properly connected to a register) will always respond to a magnet event in the manner previously described.

2.2.2.6 Deactivation

Units that are to be removed from the field must be deactivated. In order to swap out a meter, the unit must have the meter removed, be deactivated, have the new meter connected, and then be activated.

In order to deactivate a unit, the following steps must be taken:

- The endpoint must be disconnected from the meter
- The endpoint must then be busted

Busting an endpoint forces a read of the meter. When an endpoint unsuccessfully attempts to read a meter due to a magnet event, it will transmit 3 Magnet Packets (where the cumulative reading field is set to `0x00AAAAAA`) and deactivate. In order to activate this unit in the future, the activation procedure described previously must be repeated. The unit will not transmit again until it has been activated. This can be verified by busting the unit again. The Buster will not beep/blink in response to being busted once it has been deactivated as long as there is no register connected to the device.

NOTE: It is critical that the technician properly deactivate the unit prior to taking it out of service. Failure to properly deactivate the unit will result in the transmission of data (with the previously described timing) until the unit's battery life has been exceeded. This can have detrimental effects on the CellNet Network, particularly if the device transmits when in a moving vehicle from different locations.

It is important to understand that once an endpoint is activated, there may be times when a given read of the meter is unsuccessful. This will *not* result in the deactivation of the endpoint. Only an unsuccessful meter read in response to a magnet event will deactivate the device.

2.2.3 Summary

The following table summarizes the behavior described in the previous sections:

State When Magnet Event Occurs	State of Connection to Register	Response to Magnet Event	State Following Magnet Event
De-activated	Not Connected (or improperly Connected)	No Reponse	De-activated (unchanged)
De-activated	Connected	Buster Blinks/Beeps 10 times	Activated
Activated	Disconnected	Buster Blinks/Beeps 3 times	De-activated
Activated	Connected	Buster Blinks/Beeps 10 times	Activated (unchanged)

Table 2-10 Endpoint Activation/Deactivation State Summary

2.3 Configuration

This section will describe how the board is configured as shipped, as well as how it is configured in the field.

2.3.1 Configuration as Shipped

The following table describes the configuration of the endpoint as shipped:

Configuration Parameter	Default Configuration
Operating Mode	Consumption Only
Interval Period	15 minutes
Administrative Interval Period	1 hour
Alarm Count	15
Hardware Revision	1
Firmware Revision	0.37 (may change prior to shipping)
Scaling Constant	1
Max Pulse Rate	NA
Super Tx	1
# Digits	8
Manufacturer ID	0
Product ID	???
Cumulative Meter Reading Data Format	4 bytes, Binary Coded Decimal (first two bytes are always 0). Digits encoded as 0xE indicate digit could not be read.
Device ID Field	RAD-40 encoding of the ASCII-Decimal version of the LAN Address, padded to 10 digits with zeroes to the left, padded to 18 characters with spaces on the right.
Transmit Frequency	917.58MHz +/-10kHz
Default PN Code	x^6+x^1+1 (CellNet RFLAN1 Spread Spectrum Channel #1)

Table 2-11 Summary of Configurable Parameters

2.3.2 Supported Encoders

This release of the CellNet Water MTU product supports 2-wire Sensus Registers only.

2.3.3 Re-Configuring In the Field

Sensus Metering Systems builds endpoints to support re-configuration in the field. However, this release of the CellNet Water MTU product does not support re-configuration. The programming port is currently only available to Sensus Engineers for obtaining engineering telemetry.

Subsequent releases of this product shall support this feature.