

# Power Data

AMS-9000

Advanced Metering System

Manual

March 14,

2006

## REVISION HISTORY

<b>VERSION</b>	<b>DESCRIPTION</b>	<b>DATE</b>
1.0	Preliminary Release	February 16, 2006
1.1	Added RF Exposure Information	March 14, 2006

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## CHAPTER 1

# System Overview

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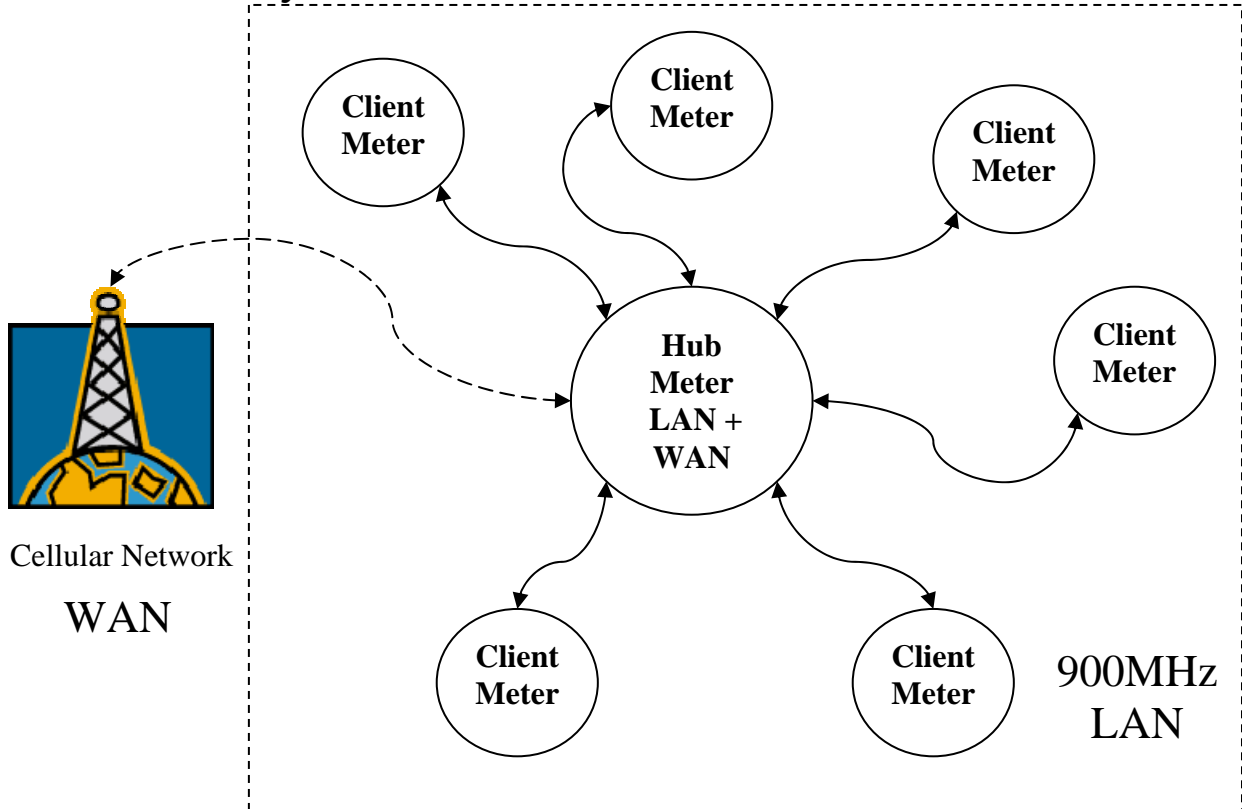
### 1.1 Introduction

- 1.1.1.** The AMS-9000, Advanced Metering System, is an under-glass, two-way, battery-free electricity metering system that employs wireless communications technologies to provide utilities with a cost-effective AMI alternative that is feature rich and extremely simple to install and maintain.
- 1.1.2.** AMS-9000 Communications are organized in a star topology. Hub meters act as an interface between large volumes of less expensive Client meters and the Host system, and are fitted with cellular modems (GSM/GPRS) and 900MHz ISM band radios. The more plentiful Client meters contain the 900MHz ISM band radio. Multiple Client meters automatically associate themselves with a Hub meter into groups known as “clusters”.
- 1.1.3.** The system is further comprised of a remote database server (AMS-DB) running Microsoft SQL Server connected to the Internet (or to the Utility and the cellular phone provider) via secure connections. During standard (daily) uploads, and on specific events, the cluster calls into the database server to report consumption readings and any recordable events. The database will send any new information and commands applicable back to the meters. Typical commands would include, but not be limited to, synchronization of system time, and reset of one or more Demand registers within a meter. The configuration of the meters is controlled by the AMS-DB. Any new information can be sent to change rate plans or to switch the available Whole House Disconnect Relay as necessary.
- 1.1.4.** Each electricity meter in the AMS-9000 system is a full function kWh/Demand/TOU billing quality meter. Interruptions to meter network communication have no effect on individual meters’ ability to accurately perform their metering billing functions. All meters have real time clocks whose power supplies are maintained during power outages using super-capacitors. No batteries are required to operate the system.
- 1.1.5.** The meters are capable of recording kWh only in a flat rate plan or can be configured to operate as Time-Of-Use meters. The configuration is kept within the meter in non-volatile memory (FRAM - Ferroelectric Random Access Memory) and new rate plans can be downloaded from the database server.
- 1.1.6.** Every meter is capable of storing interval data (down to 15 minute intervals) and internally maintains data for the last 35 days. In addition, each day at

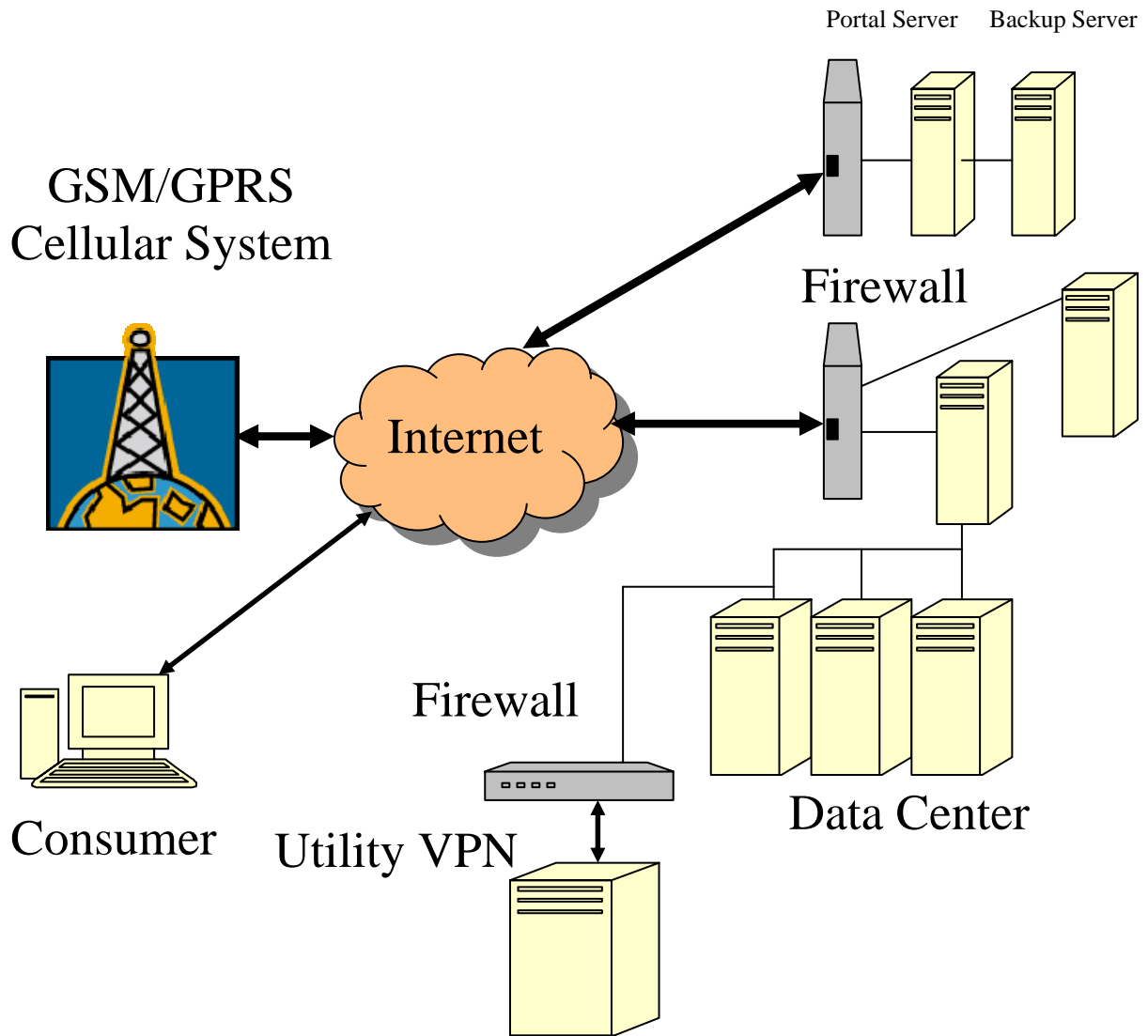
midnight, the meter takes a snapshot of the active register values (i.e. Total kWh, On Peak kWh, On Peak kW) and stores this information, along with a time/date stamp in non-volatile memory.

- 1.1.7.** At installation the Hub meters will be deployed first (typical ratio of one per 30 Client meters) and then the Client meters will be installed afterwards. When the Hub is placed in the field it will power up and send a message to the database indicating its condition and synchronize its real time clock with the server. Subsequently, when Client meters are installed they search for all Hubs in range over the 900MHz radio. Algorithms determine the Hub with the best signal and once located the Client “joins” that cluster. When a Hub is found the Client will immediately synchronize its real time clock with the Hub (note that the Hub had previously synchronized its time with the database server). Once the Client has joined the cluster its sends a Power Up Message to the Hub over the 900MHz link, which it in turn relays to the Database server via the cellular interface. If the Database has any new information for the Client meter it will be sent back via the cellular modem to the Hub and then on the 900MHz link to the Client meter.
- 1.1.8.** Every meter has its own unique serial number individually identifying it to the database. It is this serial number that is used as the primary key to the database. During the manufacturing process, when the PowerOneData circuit board assembly is installed into the meter (solid state or electromechanical), the meter serial number and the silicon serial number are recorded and entered into the AMS-9000 database. When the meter is set in the field at a customer premise the meter number is recorded against the premise number or physical address. This information is then added to the database making the specific relationship between silicon serial number, meter serial number and premise number (address).

### 1.2. AMS-9000 System Architecture



1.3. Database System Architecture





## **1.4. Configuring the Meters**

- 1.4.1** The AMS-9000 system is designed such that minimal configuration is required before the meters are set in the field. There is a default rate plan programmed into the meters that can be changed at time of order. If the rate plan needs to be changed once the meter has been installed in the field then this can be done by instructing the database server that a particular meter/premise requires new information. The database stores this information in a file on the database server by silicon serial number. The next time that a communication is received from that meter, the database will determine that new data is available for that specific meter and send it over the communications link. The new rate plan information is sent with an effective date. Just past midnight on that day the rate plan will become active and the meter will change its accumulation processes to follow the new rate plan. When the rate plan goes into effect the meter makes an entry into its Event Log. The Event log is uploaded to the database server each night during the standard upload process.

## 1.5. Hardware Overview

**1.5.1** The AMS-9000 system board is essentially the same for the Hub and Client meters. The foundation of the system is a 16-bit microcontroller running at 15MHz with up to 256kB of FLASH memory and up to 20kB of RAM. In addition there is 16kB of EEPROM that is used for system configuration information, consumption registers and up to 35 days of interval data. A real time clock running from a 32kHz crystal synchronized to the database server is backed up during power outages through the use of a super-capacitor. Time will be maintained for up to 4 days during the absence of mains power (resynchronization occurs at power up).

A liquid crystal display provides customer consumption and time/date information on 0.6" high characters as well as diagnostics information during communications operations by way of 3 small status digits. The contrast of the display is maintained through changes in ambient temperature by the use of a thermostat based temperature compensation circuit on the voltage bias of the LCD.

The incoming 240VAC power is conditioned by the on-board power supply, which smoothes and regulates the DC rail. The DC rail charges 2 super-capacitors that provide power in the event of loss of line voltage. Adequate energy is stored for up to 45 seconds of operation allowing a power fail message to be sent to the database server.

Three serial communication interfaces are provided: the Cellular Modem (WAN), the 900MHz (LAN) and a diagnostics/factory programming port. The processor is capable of duplex communications in real time on the two main communications ports.

Client meters only have the 900 MHz radio installed and are firmware programmed as Clients. The Hub meters have, in addition to the 900 MHz radio, a GSM/GPRS cellular modem and are firmware programmed as Hub meters.

In the system that uses the Itron CENTRON metrology, the AMS-9000 board simply snaps into the meter base clips (replacing any previously installed Itron Register) and interfaces to the metrology board via the AMP edge connector. No other connections are required.

### Metrology Interface Signals

LINE 1, LINE 2	- AC Line Power (240V or 120V)
+2.5V, -2.5V	- DC Power
CAL	- Pulse for every 1WH of measured consumption
SIGN	- Low for positive consumption, High for negative
SYNC	- 60Hz reference signal

LINE 1 and LINE 2 are the 240VAC connections. -2.5V is interfaced to the AMS-9000 system low voltage 0V. The SIGN signal indicates if the meter has been installed upside down, that is, energy is not flowing in the expected direction.

The CAL signal pulses once (10ms) for each 1 Wh of electricity consumption. These pulses are accumulated by the AMS-9000 system to produce the register values and the interval data.

Monitoring circuits are provided on the board such that the system can determine if there has been a loss of line voltage. Also monitored is the 5V rail so that the system does not attempt to operate with incorrect system voltages.

The microcontroller incorporates a hardware watchdog circuit that once activated must be retriggered (by software) every 100ms or sooner or it will cause the system to go through a full system reset. The feature has the effect of continually monitoring operation of the embedded firmware. Should the program get “stuck” at any point then the watchdog will time out, forcing the system to restart. **Note that the software is set up such that every 15 minutes all critical data is stored to EEPROM and it is from here that system operations will be restored after the reset condition.**

## CHAPTER 2

### **Cellular Modem Description**

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The GSM/GPRS Modem is capable of establishing a TCP/IP connection to a remote computer. Once this connection is established data can pass freely between the AMS-9000 Hub and the remote Host computer. No external configuration is required for the modem.

## CHAPTER 3

### Hub Installation

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Hub meters can be installed in any suitable socket and there are no special requirements beyond requiring that cellular GSM/GPRS signal is present at that location. Each hub is capable of supporting up to maximum of 100 Client meters. However it is recommended that average cluster sizes be of 30-40 meters and Hub meters be installed in sufficient numbers so that each Client can “hear” at least two Hubs. The 900MHz radios have an average urban range of 600-700ft. In areas such as apartment complexes, higher numbers of Clients can be operated on each Hub due to the closer proximity of the meters to each other. In some cases a Hub meter may have few or no Clients if the premise density is very low.

#### **IMPORTANT**

**\*\*\*As with any AMR system it is extremely import to note the meter serial number that is placed on any given residence or premise. The PowerOneData AMS-DB database already has the relationship between meter serial number and silicon serial number but has no idea where the meter is installed. After the field installation order is completed, the premise to meter number relationship must be fed back to AMS-DB in order to bill the correct electrical consumption to the corresponding customer.**

## CHAPTER 4

# Client Configuration

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Client meters require no configuration before installation in the field.

## CHAPTER 5

### **Cluster Configuration**

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There are no settings that need to be made before meters are set in the field. Field deployment is planned such that there is one Hub for every 30-40 meters. It is recommended that Hubs be placed in accessible locations that are not unduly screened by porches or canopies if possible, as this will give the system a longer range. Ideally the 600-700' range will allow each Client to be in range of at least two Hubs. With this arrangement, if a Client should lose communications with its initial Hub, it will be able to find a new Hub during the daily Roll Call at 09:30pm. Once a Client misses daily Roll Call, the Client meter will search for and join a second Hub that is in range. The Client will remain part of this cluster until such times (if ever) that it misses roll call again and seeks out a new Hub once more.

Each time a Client joins a cluster, information is sent to the AMS-DB updating the Client meter record with its new associated Hub number.

## CHAPTER 6

## Programmable Parameters

Command	Parameter	Note
1	New interval value with Effective Date (H, C)	Interval/D/M/Y
2	Time to call to Start Standard Upload (H)	
4	Host IP 1 address, Port Number (H)	Add – 4 Port - 2
5	Host IP 2 address, & Port Number (H)	Add – 4 Port - 2
6	Generate new random Time to Call (H)	
7	TOU Rates and Season Dates	
8	TOU Schedule Effective Date	D/M/Y/PlanID
9	Holiday Dates	
10	Effective Date	D/M/Y
11	Reset Configuration	
14	Rate Configuration Flag	See Note 1 Below
15	Billing Date	D/M
16	Event Notification Flag	
17	Demand Config/Demand Duration	See Note 2 Below
18	DST (Effective month/date & enable / Disable)	
19	GPRS Access Point Name	
20	Demand Reset	
21	Remote Disconnect	See Note 3 Below
22	Cluster Channel	
23	Cluster ID	System ID, Cluster ID
24	Cluster Redistribution	Enable/Hour/Minute
25	Public Link Parameters	See Note 4 Below
26	Private Link Parameters	See Note 4 Below
27	Roll Call Time	Hour/Minute
28	Schedule Label	
29	Custom LCD Message Table	
30	Display Message Structures	See Note 6 Below
31	Custom Display Message 1	Raw LCD Data
32	Custom Display Message 2	Raw LCD Data
33	Clear Registers Command	See Note 7 Below
34	Trigger Standard Upload	(Hub Only)
35	Premise ID	Raw Format
36	Interval Data Upload Enable	0xff == Enable 0x00 == Disable
37	Meter ID (from faceplate)	Raw Format

- \* - **Time is in the format as sec:min:hour:date:month:year:day of week**
- \*\* - **8 Seasons are possible. Each Season can have 4 rate schedules per day. Each rate Schedule may have 50 bytes maximum, 48 bytes for data, one byte for season & rate schedule info and another byte is for end of schedule info. For details refer to the following protocol...**
- \*\*\* - **Holiday Dates indicates how many holidays per year & the date of each holiday**



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## CHAPTER 7

### Notes

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#### **Note 1: Rate Config: Byte Definition**

1 = Rate is used in the year  
 0 = Rate is not used in the year

Bit 0 = ON Peak	(YEAR1)
Bit 1 = OFF Peak	(YEAR1)
Bit 2 = SH1 Peak	(YEAR1)
Bit 3 = SH2 Peak	(YEAR1)
Bit 4 = ON Peak	(YEAR2)
Bit 5 = OFF Peak	(YEAR2)
Bit 6 = SH1 Peak	(YEAR2)
Bit 7 = SH2 Peak	(YEAR2)

#### **Note 2: Demand Config: Byte Definition**

Bit 0 = B  
 Bit 1 = M  
 Bit 2 = D  
 Bit 3 = X  
 Bit 4 = X  
 Bit 5 = X  
 Bit 6 = X  
 Bit 7 = X

D,M,B as defined previously

#### **Note 3: Remote Disconnect/Connect Command Values**

SCHEDULED_DISCONNECT_POWER	1
SCHEDULED_CONNECT_POWER	2
IMMEDIATE_DISCONNECT_POWER	3
IMMEDIATE_CONNECT_POWER	4
SCHEDULED_AUTO_CONNECT_POWER	5
IMMEDIATE_AUTO_CONNECT_POWER	6

**Note 4: Link Definition Table Format**

Offset	Definition
0	scenario retry interval (minutes between scenarios)
1	scenario retry range (possible deviation from interval)
2	socket retry limit (while connecting)
3	socket retry limit (after connection)
4	socket retry delay (seconds before retransmit)
5	socket auto ack delay (seconds from receive to auto-ack)
6	socket ack resend delay (seconds from receive to re-ack)

**Note 5: Custom LCD Message Table Format**

Message	Number	Type
00	Blank	
01	Total	

**Message Number Type**

02	On Peak
03	Off Peak
04	SH1
05	SH2
06	Total Demand
07	On Peak Demand
08	Off Peak Demand
09	SH1 Demand
10	SH2 Demand
11	Date
12	Time
13	Total Demand Time
14	On Peak Demand Time
15	Off Peak Demand Time
16	SH1 Demand Time
17	SH2 Demand Time
18	Schedule Label
19	All Segments On
20	Custom Display 1
21	Custom Display 2

---

**Note 6: Display Message Structures Format**

20 Structures of 4 bytes each, with the following structure format:

Byte 1: Unit

00 = None  
01 = kW  
02 = kWh  
03 = H

Byte 2: Parameter

00 = None  
01 = Total  
02 = On Peak  
03 = Off Peak  
04 = SH1  
05 = SH2

Byte 3: Status MSB

Raw LCD data, most significant digit of two-digit display

Byte 4: Status LSB

Raw LCD data, least significant digit of two-digit display

**Note 7: Clear Registers Command**

<b>Command</b>	<b>Value</b>
Clear all registers	0x10
Clear all registers except total	0x20
Do not clear registers	0x30

CHAPTER 8

TOU Data Structure

8.1. Rate Schedules

8.1.1. Data >>>>> N Bytes
Max of 200 bytes per season, if there are 4 day schedules possible per season and each day schedule has 4 rate schedules in it. If this is the case, then the following data bytes including End Of Schedule byte, will be given for each day schedule. And for the next season, a new packet should be sent from HOST / PALM.

Data 1:

> Season & schedule info >>>>> 1 Byte

This Byte will have the information regarding which day schedule it is and for which season. The bit format is as

Table with 8 columns: D7, D6, D5, D4, D3, D2, D1, D0. Row 1: 0, 0, Y, S, S, S, R, R.

Y \_\_\_\_ 0 - Current Year
1 - Next Year

SSS \_\_\_\_ 000 \_ For Season1
001 \_ For Season2
|
111 \_ For Season8

RR \_\_\_\_ 00 \_ Weekday Schedule
01 \_ Saturday Schedule
10 \_ Sunday Schedule
11 \_ Holiday Schedule



**Data 2:**➤ **Rate Schedules**>>>>> **M Bytes**

**Four** Time Frames are possible for each Rate Schedule and there are **Four** rate schedules such as **ON**, **OFF**, **SH1** and **SH2**. Each Time Frame consists of a Start Time and the Rate Code. Each of these time consumes **2 Bytes** ( hh : mm ). The first time starts with 00:00, followed by the Rate Code. This consumes 3 bytes and if there is 'n' number of Rate schedules, then the total number of bytes in the packet, will be  $n*3$ . After the final Rate schedule is entered, end the message packet with the **EOS**. For example, if there is 4 Time frames for a Rate Schedule, then the total number of bytes in the packet will be  $( 3*4*4 )$  **48 bytes**.

**8.1.2. Rate Schedule Codes:****01 – ON** time**02 – OFF** time**03 – SH1** time**04 – SH2** time

The time should be entered in an increasing fashion. For example, (the first time entry is always 00:00),

00:00 04, 09:00 01, 12:00 03, 17:00 02, 19:00 01 21:00 02

could be a possible entry. This implies that,

00:00 hours – 09:00 hours – **SH2** Rate Schedule  
 09:00 hours – 12:00 hours – **ON** Rate Schedule  
 12:00 hours – 17:00 hours – **SH1** Rate Schedule  
 17:00 hours – 19:00 hours – **OFF** Rate Schedule  
 19:00 hours – 21:00 hours – **ON** Rate Schedule  
 21:00 hours – 00:00 hours – **OFF** Rate Schedule

The start time of the next Rate Schedule is the end time of the previous one.

- |   |                        |       |                |
|---|------------------------|-------|----------------|
| ➤ | <b>End Of Schedule</b> | >>>>> | <b>1 Byte</b>  |
|   | May be 0xFF            |       |                |
| ➤ | <b>Checksum</b>        | >>>>> | <b>2 Bytes</b> |
|   | CRC checksum.          |       |                |

## 8.2. Calendar Schedules: Total Bytes is 203(max)

**8.2.1** There can be a maximum of Eight - season information. Season info will contain information regarding the season starting dates. The start of one season specifies the end of previous one.

**8.2.2.** Maximum of 22 Holidays are possible. The date, month and year of holidays are given. Season & Holiday information for 2 years is given in a single communication.

**8.2.3.** The Byte format is as,

- **Date of Start of a Particular Season** >>>>> **N Bytes**

The Date, at which a particular season begins, should be given. All the Seasons begin at 00:00 Hrs of the specified date. A date code consists of 3 Bytes as **Year : Month : Date** followed by the Season Code. For 8 Seasons ( max ), the total bytes are **32**. Since there is 2 year's info( Current year followed by the next year ) it occupies **67 bytes ( max )**. Last 3 bytes have the end date of the last season.

- **End of Season ( EOS )** >>>>> **1 Byte**

After all the entries for that year, are over, the Season information should be terminated by this byte.

----- May be 0xFF -----

- **Holiday Dates** >>>>> **M Bytes**

The absolute date of a holiday is given. Max of 22 Holidays are possible per year. Since a date code consumes 3 bytes ( **year : month : date** ), for 22 days, and for 2 years it is **132 bytes**.

➤ **End of Holiday ( EOH )** >>>>> **1 Byte**

After all the entries are over, the Holiday information should be terminated by this byte.  
 ----- May be 0xFF -----

➤ **Checksum** >>>>> **2 Bytes**  
 CRC checksum.

The following example explains how the season info and holiday info are sent... Consider, there are 8 seasons (4 seasons per year) and there are 4 holidays per year.

1. For 2001 & 2002

01:03:08 **01** 01:06:20 **02** 01:09:15 **03** 01:11:05 **04** 02:03:18 **01** 02:06:01 **02** 02:09:20 **03**  
 02:11:10 **04** 03:03:05 **FF** 01:01:01 01:07:04 01:11:24 01:12:25 02:01:01 02:07:04 02:11:22  
 02:12:25 **FF** CRC

And for 2002 & 2003, part of 2001 & 2002 season info is seen with the new dates for 2003. This is to make easy the comparison for dates in the S/W. The Numbers in BOLD, are the Season Codes and the EOS / EOH.

### 8.3. TOU\_EVENT\_CONFIG & DEMAND DURATION

**8.3.1.** The demand info contains the type of demand, whether a straight demand or a rolling demand. Demand is nothing but the highest count in a particular time frame. The maximum value in the ON TOU time is considered as ON PEAK Demand, the maximum value in the OFF TOU time, is considered as OFF PEAK Demand and so on. The maximum value, irrespective of time frame and day schedules, in any day, is considered as TOTAL PEAK Demand.

**8.3.2.** All these values are stored in separate memory locations. This storage of values is mainly used for Tariff calculations. This demand duration should be in multiple of that corresponding TOU time frame. For Example, the time frame of ON time of a particular day is 3.5 hours; the demand duration of ON peak demand should not be greater than 3.5 hours and not in multiple of 1 hour. It should be 15 minutes or 30 minutes so that it will cover the entire 3.5 hours slot. And it should not be less than the interval time.

**8.4. Byte Format**

➤ **TOU\_EVENT\_CONFIG FLAG** >>>>> **1 Byte**

<b>D7</b>	<b>D6</b>	<b>D5</b>	<b>D4</b>	<b>D3</b>	<b>D2</b>	<b>D1</b>	<b>D0</b>
<b>E</b>	<b>D</b>	<b>M</b>	<b>B</b>	<b>R</b>	<b>R</b>	<b>R</b>	<b>R</b>

**EDMBRRRR** – **E** -

**D** – If 0, Demand Calc OFF  
If 1, Demand Calc ON

**M** - If 1, Demand is Moving (Rolling) Demand

**B** - If 1, Demand is Block Demand

**RRRR** – Indicates ON peak TOU Calc (LSB), OFF peak TOU Calc, SH1 TOU Calc & SH2 TOU Calc (MSB). If 1, indicates the presence.

➤ **Demand Duration** >>>>> **1 Byte**

**Gives the demand duration in minutes**

➤ **Checksum** >>>>> **2 Bytes**

CRC checksum.



## CHAPTER 9

# Basic Operation

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### 9.1. Hub Field Installation and Power Up

#### 9.1.1. Configuration

Hub meters are labeled HUB on the front panel.

Hub meters are shipped with a default TOU program (9-9 On Peak, M-F. Off Peak Weekends) with 1hr block demand for On Peak periods. The meter self-selects its 900MHz Channel set and cluster ID. Similarly, there is no configuration required for the GSM/GPRS WAN interface.

#### 9.1.2. Installation

Remove existing meter from socket. Install AMS-9000 Hub meter. Unit will power up going through the following sequence:

All segments on.

Display of Silicon ID – first 6 characters

Display of Silicon ID – final 6 characters

The unit will then start its normal message scroll on the main display:

Time – 11:15:43

Date - 072604

Rate Plan Indicator – ETC-1R

Total kWh – 000023kWh

Peak kWh – 000006kWh

Peak kW – 02.7kW

#### 9.1.3. Hub Power Up Message To Host

Once the Hub meter has gone through its power-on reset process, it initiates a Power Up Message scenario with the Host. A public link data connection is established using the GSM/GPRS modem to the Host. In order for the Hub to open up a communication socket on the Host AMRUDP program it must authenticate itself to the Host. This security measure ensures that only valid connections can be established with the Host computer. Once authenticated, the Hub sends its power up message that contains the silicon ID of the Hub along with the time and date of the event. Also included in this message is the 900 MHz RF channel information and cluster identifier byte. Once this message has been accepted by the Host then the current time is returned to the Hub meter. If there are no pending power up messages from Clients in the cluster managed by the Hub then the public link connection is closed, else the Client power up messages are passed onto the Host. This power up window remains open for 20 seconds. After the power up window closes AMRUDP looks to see if there is any new information pending for download for any member of the cluster. If there is, then this is now done and once acknowledged, the public link connection is closed.

#### 9.1.4. 3 Digit Display

The 3 digit display in the lower left corner of the LCD has 2 modes:

Normal Mode – left 2 digits indicate the Register Number currently displayed. The 3 digit will display a “walking segment” that moves each time a consumption pulse is received from the metrology board. Note that the display is only updated every 250ms.

STATUS Mode – when the Status indicator is lit then the 3 digit display indicated the progress state of the communications link. Chapter 9 shows the meaning of the Status digits.

Once a successful public link communications scenario has been completed the display will read **6P≡** if the connection was successful or **6F≡** if a failure occurred. During a successful communications setting with the Host the Hub meter will receive the updated time from the Hosts clock.

## 9.2. Client Field Installation and Power Up

### 9.2.1 Configuration

Client meters are labeled CLIENT on the front panel. Client meters are shipped with a default TOU program (9-9 On Peak, M-F. Off Peak Weekends with 1hr block demand for On Peak periods). No other communications settings or configuration is required.

### 9.2.2. First Time Field Power Up

When the Client meter powers up it will cycle through the same displays as the Hub (see above). Almost immediately the Client meter will go into Hub Search Mode. In this mode the Client meter will broadcast a “Seeking Hub” message over the 900MHz RF link. If a Hub meter hears this message then it will respond and the Client will join the Cluster managed by the Hub. During this exchange the Hub will send the current time to the Client meter.

Once the Client has found a Hub it will then send a Power Up Message to the Hub. When the Hub receives this message it will open up a Public connection (through the GSM/GPRS modem) to the Host. Once the link is opened, the Power Up message will be passed through to the Host. The successful receipt of the message will be acknowledged by the Host to the Hub which will then pass the acknowledgement on to the Client.

The Hub waits for any other power up messages to be received for a period of 30 seconds and passes on any that are received.

Once the 30 second window closes the Host downloads the current time to the Hub which acknowledges receipt of the message. Then the Hub asks the Host application if it has any new information for any members of the cluster (meter configuration, demand reset etc.). If there is “New Info” available then this is downloaded and passed on to the appropriate Client meter.

Once this process is complete the connection with the Host is terminated and the Status display will show **9P≡** if the transactions were successful.

### **9.2.3. After First Time Field Power Up**

After the initial field power up and Cluster configuration the Client meters expect to be able to find the same Hub that they previously contacted. In this case the Client will attempt to immediately send its Power Up Message to its last known Hub. The Communications protocol at the low level will attempt to open up a socket with the Hub. If the Hub is not busy it will acknowledge the communication with a message that includes an ACK and the current time. The Hub will then open up a connection to the Host on the public link and relay the Power Up message to the Host.

If the Hub is busy communicating with another meter it will acknowledge the transaction with a Not Ready message and will send back the current time. In this case the Client will wait for 1 minute and then try again.

Should the Client meter be unable to contact its previous Hub after 6 tries then it will enter Hub search mode as described in First Time Power Up Section 9.2.2.

## **9.3. Power Fail**

**9.3.1.** The power fail scenario on a Hub can be initiated from its local power sense or it could be initiated from a Client that has detected its own power failure. On the Hub, the first step is to cancel any currently active communications scenario. On the Client, if power fail is sensed, a short delay is started. If the Hub is also failing, it will send out a broadcast to synchronize the Client responses. Each Client is assigned a period to delay after receiving the request, and before transmitting its response. However, if the Client does not receive a broadcast from the Hub, it sends a broadcast to get the Hub to start a power fail scenario. The Client will still respond to the Hub's broadcast later.

After the Hub collects power fail statistics from the Clients, the information is passed on to the Host system on the public link. Once the message is completed the Hub will close the public link and wait either for power to be restored or until power from the super-capacitors is exhausted, at which point the display is blank and the processor is put into a reset state.

## **9.4. Roll Call**

**9.4.1.** At 9:30pm each day the Hub will carry out a Roll call, attempting to connect to each of the Clients that had previously registered with that Hub. The Hub sends an "are you there" message to each Client in turn. If a response is received, the Hub then moves on to the next Client in its Clients table. If no response is received then the Hub will retry 5 more times at 6 second intervals. After the 6 tries that Client is removed from the Clients table. This process continues until communications have been attempted with all Clients in the table.

All Clients expect to receive a Roll Call message by 9:45pm. If they do not receive the message by this time then they will enter Hub Search Mode looking for a replacement Hub. Once they find a Hub they will join that cluster. Clients remain in Hub Search mode until a Hub is found.

## **9.5. Standard Upload**

- 9.5.1.** The standard upload process will be performed daily and this is controlled by the Hub such that data is collected and uploaded to the Host in an orderly manner. When the Hub reaches its scheduled 'Time To Call' it establishes a public link connection with the Host. Once the link is established it sends any of its pending packets to the Host. Normally there would be only one packet for the prior day. However, if communications had failed in recent days there may be up to a months worth of packets (31 days). The packet contains a sequence to notify the Host how many more packets to expect from this meter. There is also a flag, added by the Hub, which indicates if this is the last known meter in the cluster. Once the packets for the Hub have been sent, the Hub establishes a private link connection with the first Client in its membership table. The Hub forwards the packets from the Client to the Host. When the Client packets have been sent, the private connection is closed and the Hub starts processing the next Client. After packets for all meters have been sent, the Host may have download packets (new info) that are destined for the Hub and/or Clients. For each new info packet that is destined to a Client, the private link is opened with that Client. The packet is delivered, and the connection is closed. When no more packets are available from the Host, a terminate packet is sent from the Host.

## **9.6. General Meter Status Messages**

- 9.6.1.** If an exceptional event occurs during the day on a meter, (Back Rotate, Hardware Error), the Host is notified. When the Client needs to send a message to the Host, it opens a private connection with the Hub. The Hub in turn opens a public link connection with the Host and the packet is routed from the Client through the Hub to the Host. If the packet is successfully received an ACK is sent back to the Client through the Hub and the connection is closed. If the Host does not successfully acknowledge the packet the Hub will try up to 5 more times to send the message to the Host. If it is still unsuccessful it will close the Public link and send a status message NACK to the Client. These status messages are also considered as events and will be entered into the event log and sent to the Host as part of the daily standard upload.

The recorded events are:

**9.6.1.1 Time Change**

- Old Time/Date, New Time/Date, Update Type (PU, STD Upload, Host Query)

**9.6.1.2 Demand Reset**

- Time/Date, Demand Value prior to reset

**9.6.1.3 Reverse Rotate**

- Time/Date

**9.6.1.4 New Schedule Implemented**

- Records the Time and Date at which the new schedule went into effect and also saves active Register Values as of midnight on the day prior to activation.

**9.6.1.5 Remote Disconnect**

- Time/Date action occurred, Action type: On, Off or customer confirmation for button press

**9.6.1.6 Hardware Error**

- Time/Date, Type code for problem

## CHAPTER 10

**LCD AMS-9000 Maintenance Display Status Codes**

	HUB METER		CLIENT METER
<b>0</b>	<b>STANDRAD UPLOAD</b>	<b>0</b>	<b>STANDARD UPLOAD</b>
<b>000</b>	START_UP	<b>010</b>	START_UP
<b>010</b>	OPEN_PUBLIC	<b>020</b>	OPEN_PUBLIC
<b>020</b>	OPEN_PRIVATE	<b>030</b>	OPEN_PRIVATE
<b>030</b>	SEND_STD_HUB	<b>040</b>	SEND_STD_CLIENT
<b>040</b>	SEND_STD_CLIENT	<b>050</b>	SEND_NACK
<b>050</b>	SEND_CLIENT_REQUEST		
<b>060</b>	SEND_CLIENT_DECREMENT		
<b>070</b>	SEND_CLIENT_ALERT		
<b>080</b>	CLOSE_PRIVATE	<b>080</b>	CLOSE_PRIVATE
<b>090</b>	SHUT_DOWN	<b>090</b>	SHUT_DOWN
<b>1</b>	<b>POWER UP</b>	<b>1</b>	<b>POWER UP</b>
<b>101</b>	START_UP	<b>101</b>	START_UP
<b>111</b>	HUB_OPEN_PUBLIC	<b>111</b>	HUB_OPEN_PUBLIC
<b>121</b>	CLIENT_OPEN_PUBLIC	<b>121</b>	CLIENT_OPEN_PUBLIC
<b>131</b>	OPEN_PRIVATE	<b>131</b>	OPEN_PRIVATE
<b>141</b>	SEND_HUB	<b>141</b>	SEND_HUB
<b>151</b>	SEND_CLIENT	<b>151</b>	SEND_CLIENT
<b>161</b>	SEND_CLIENT_ACK	<b>161</b>	SEND_CLIENT_ACK
<b>171</b>	CLOSE_PRIVATE	<b>171</b>	CLOSE_PRIVATE
<b>181</b>	SEND_COMPLETE	<b>181</b>	SEND_COMPLETE
<b>191</b>	SHUT_DOWN	<b>191</b>	SHUT_DOWN
<b>2</b>	<b>BACK ROTATE</b>	<b>2</b>	<b>2</b> <b>BACK ROTATE</b>
<b>3</b>	<b>WATCHDOG</b>	<b>3</b>	<b>3</b> <b>WATCHDOG</b>
<b>4</b>	<b>SYSTEM ERROR</b>	<b>4</b>	<b>4</b> <b>SYSTEM ERROR</b>
<b>5</b>	<b>RELAY STATUS</b>	<b>5</b>	<b>RELAY STATUS</b>
<b>50</b>	START_UP	<b>50</b>	START_UP
<b>51</b>	OPEN_PUBLIC	<b>51</b>	OPEN_PRIVATE
<b>52</b>	SEND_HOST	<b>52</b>	SEND_HOST
<b>53</b>	SEND_CLIENT	<b>53</b>	SEND_CLIENT
<b>54</b>	SEND_CLIENT_ACK	<b>54</b>	SEND_CLIENT_ACK
<b>55</b>	SHUT_DOWN	<b>55</b>	SHUT_DOWN

	<b>HUB METER</b>		<b>CLIENT METER</b>
<b>6</b>	<b>NEW INFORMATION MANAGER</b>	<b>6</b>	<b>NEW INFORMATION MANAGER</b>
<b>60</b>	OPEN_PRIVATE	<b>60</b>	STARTUP
<b>61</b>	RCVD_HOST	<b>61</b>	RCVD_HOST
<b>62</b>	SEND_HOST_ACK		
<b>63</b>	SEND_HOST_NACK		
<b>64</b>	SEND_CLIENT_MESSAGE		
<b>65</b>	SEND_CLIENT_ALERT		
<b>66</b>	SEND_CLIENT_RESPONSE		
<b>67</b>	SEND_DATA_RESPONSE	<b>67</b>	SEND_DATA_RESPONSE
<b>68</b>	CLOSE_PRIVATE	<b>68</b>	CLOSE_PRIVATE
<b>69</b>	SHUT_DOWN	<b>69</b>	SHUT_DOWN
<b>7</b>	<b>POWER FAIL</b>	<b>7</b>	<b>POWER FAIL</b>
<b>70</b>	START_UP	<b>70</b>	START_UP
<b>71</b>	OPEN_PUBLIC	<b>71</b>	OPEN_PUBLIC
<b>72</b>	OPEN_PRIVATE	<b>72</b>	OPEN_PRIVATE
<b>73</b>	SEND_CLIENT_BROADCAST	<b>73</b>	SEND_CLIENT_BROADCAST
<b>74</b>	CLOSE_PRIVATE	<b>74</b>	CLOSE_PRIVATE
<b>75</b>	SEND_HOST_POWER_FAIL	<b>75</b>	SEND_HOST_POWER_FAIL
<b>76</b>	SEND_CLIENT_MESSAGE	<b>76</b>	SEND_CLIENT_MESSAGE
<b>77</b>	SHUT_DOWN	<b>77</b>	SHUT_DOWN
<b>8</b>	<b>ROLL CALL</b>	<b>8</b>	<b>ROLL CALL</b>
<b>9</b>	<b>CLUSTER MANAGER</b>	<b>9</b>	<b>CLUSTER MANAGER</b>
<b>90</b>	START_UP	<b>90</b>	START_UP
<b>91</b>	PRIVATE_REQUEST	<b>91</b>	* BROADCAST_CHANNEL
<b>92</b>	PUBLIC_OPEN	<b>92</b>	* BROADCAST_OPEN
<b>93</b>	PUBLIC_REQUEST	<b>93</b>	* BROADCAST_SEARCH
<b>94</b>	PUBLIC_RESPONSE	<b>94</b>	* BROADCAST_CLOSE
<b>95</b>	PRIVATE_RESPONSE	<b>95</b>	PRIVATE_OPEN
<b>96</b>	PRIVATE_CLOSE	<b>96</b>	PRIVATE_REQUEST
<b>97</b>	PUBLIC_NEWINFO	<b>97</b>	PRIVATE_RESPONSE
<b>99</b>	SHUT_DOWN	<b>98</b>	PRIVATE_CLOSE
		<b>99</b>	SHUT_DOWN
<b>0</b>	<b>HOST_QUERY_SCENARIO_ID</b>		

**10.1. Link Status Display Codes (3<sup>rd</sup> digit)**

-- 0	LLCOMM_DISPLAY_STATUS_CLEAR
-- 1	LLCOMM_DISPLAY_STATUS_INIT_MODEM
-- 2	LLCOMM_DISPLAY_STATUS_GPRS_REGISTER
-- 3	LLCOMM_DISPLAY_STATUS_GPRS_CONNECT
-- 4	LLCOMM_DISPLAY_STATUS_PPP_ESTABLISH
-- 5	LLCOMM_DISPLAY_STATUS_UDP_ESTABLISH
-- 6	LLCOMM_DISPLAY_STATUS_AUTHENTICATE
-- 7	LLCOMM_DISPLAY_STATUS_LINK_UP
-- 8	LLCOMM_DISPLAY_STATUS_LINK_SHUT_DOWN

On a Hub meter, the link status codes relate to the public link connection.

On a Client meter, the link status codes refer to the private link connection

\* During Client Configuration on the Client meter in the broadcast phase (codes 91 – 94), the third digit of the status code represents the 900MHz hopping sequence (channel number).



## CHAPTER 11

### **Replacing a Meter**

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#### ***11.1. Replacing a Hub Meter***

**11.1.1** If a Hub meter needs to be replaced it can simply be removed from its socket and replaced with another Hub. The replacement Hub can be installed and will send a Power Up message to the host as described in Section 3 of System Overview. When the Roll Call process is initiated at 9:30pm, no meters will be in the Hub's Clients table. At 9:45pm the Clients attached to the previous Hub will realize that they have not heard from their Hub and enter Hub Search Mode as described in Section 9.2.2 of Basic Operation.

#### ***11.2. Replacing a Client Meter***

**11.2.1.** When a Client meter is replaced in the field the old meter is removed causing it to send a Power Fail message to the Host. The new Client meter is installed and it performs a Power Up sequence as described in Section 9.2.2 of Basic Operation.

## CHAPTER 12

### **Calibration**

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The Itron CENTRON metrology has no means to adjust the calibration.

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## CHAPTER 13

### Zeroing the Meter

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**CAUTION: HAZARDOUS VOLTAGES ARE PRESENT ON THE CIRCUIT BOARD. EXTREME CARE SHOULD BE EXERCISED WHEN CARRYING OUT THIS PROCEDURE.**

The AMS-9000 meter (Hub or Client) can be zeroed by briefly jumping J3, which is located on the top left hand side above the LCD, with the meter powered up and operating.

**AN INSULATED JUMPER MUST BE USED.**

When the jumper is removed the system will reset and perform the initial startup display sequence.

The meter will zero all active registers (TOTAL, ON PEAK, OFF PEAK, SH1, SH2 and all associated Demand values).

## APPENDIX

### Regulatory Information

**IMPORTANT:**

The AMS-9000 Advanced Metering System complies with Part 15 of the FCC Rules. Changes or modifications not expressly approved by PowerOneData could void the user's authority to operate the equipment.

**FCC ID: TRCAMS-9000****IC: 6190A-AMS-9000**

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) 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 into 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.

**CAUTION:**

The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 25 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter except as documented in the FCC application. This device has been approved for simultaneous transmission of the collocated WLAN and Cellular/PCS transmitters. Users and installers must be provided with antenna installation instructions and transmitter operating conditions for satisfying RF exposure compliance.