Abstract: UMP System for Utilities and Resource Management.

This design concerns use of various communication technologies in an integrated, modular, Non-Hardware/Platform dependent system for use by utilities and other resource management organizations (henceforth referred to as "utility" or "utilities"). This system is available for use by the end-user of the utility/resource (henceforth referred to as "consumer") for utilization in dwelling, multi-dwelling and commercial energy/resource management systems. This design is a result of the need for a total Utility Management Processing (UMP) system . Unlike current Automatic Meter Reading (AMR) systems, it requires little more than the current billing system at the utility, coupled with the technologies presented in this paper and associated system implementations.

Declaration

(It is assumed that the person or examiner reading this document has a current working knowledge of this and other technologies presented.)

The system involves the use of many data communication and remote telemetry technologies in a holistic approach to management of the resources. The block illustrations show an increasing level of modularity and detail, starting with Figure 1. In Figure 1, the overall system's bi-directional capabilities are apparent. This system allows the entity that is supplying the resource total control over the distribution and complete monitoring of the resource usage, and allows Remote Real Time Consumption (RRTC) monitoring in many of the situations and implementations, especially when used with a dedicated Remote Meter Processor (RMP).
With the UMP system, communication of consumer usage is not dependent on any one technology. It is possible for the utility to utilize any of the communication technologies (CIM or Consumer Interconnection Medium) declared within this document, and other technologies as they become available. This includes fixed and mobile RF (regardless of the actual modulation technique and spectral content), Cellular services, Plain-old telephone services (POTS), broadband land links (fiber, CATV, ISDN-1, ISDN-2, T1-3,), point-to-point wireless links (sub-microwave, microwave) and satellite up/down links. A sample of this technology is shown in Figure 2.

Communication of telemetry data to the consumer site from the utility is also non- dependent on the medium used. There is inherent limitations to control of the utility consumption as directed by the implementation of the system by the utility. In other words, if the utility does not install solenoid shut-off valves or contactors, it cannot remotely terminate service. But this will not limit the data acquisition capabilities of the system.

In Figure 3, it is shown that the ability to acquire the consumer's usage information is not dependent on the metering technology employed. All meters, whether machine readable (proprietary or public domain technologies) or older, non-machine readable metering are able to be utilized (by use of the SBA assembly). Machine readable technologies include:
Pulse-type (Hall effect) - existing meter technology in which pulses generated by a magnet coupled to the meter vane are used to increment a mechanical counter or other device located elsewhere on the consumer premises.
Encoders - used by meters that are capable of being read by a gun that generates the proper clock/power signals and accessed from outside the premises (usually on an outside wall). There are various protocols and formats used today, with some being utilized in internal RF meterheads and other, previous AMR systems.
RF - RF meters are actually some sort of pulse, encoder or electronic buffer technology with a small transmitter built into the meterhead itself. The reason this type of technology should be addressed is that in order to be compliant with the existing installed base of meters (used primarily by electric companies), the UMP system must gather it's data from the RF signal due to the encoder/pulse/buffer being sealed in the existing meter.

Visual-only (no obvious machine readable format available) meters are also able to be read by using a CCD imaging device (such as the Scan Boot Assembly or SBA, Figure 4) coupled to the consumer's utility management system. The scan file is converted to a machine readable format for use by the RMP.

As explained throughout this document, the concept of a Universal Meter Processing (UMP) system is to autonomously store and manipulate data in a common format, with all data (regardless of source type or communication technology) being channeled to a common site selected for use by the utility. Utilizing a PUMI (Programmable Universal Meter Interface, explained later) programmed for the correct meter acquisition/control functions, any protocol, SBA adapter, and ancillary device (solenoid valves, contactors, leak detectors, etc...) or combination thereof can be accessed by the corresponding utility. Access to the respective utility functions is password-protected and secure from other utilities or outside parties. In POTS and Cellular CIM implementations, protection is inherent due to pre-programmed, valid CND (Calling Number Delivery) being the only way to connect to the RMP modem on a demand (also called Outbound) read originating at the utility billing office. Inbound (see next section) destinations (the SFS-see next section) are password/ID protected from unauthorized uploads and can only upload or download data to a valid Caller ID terminal (either billing office or system maintenance office origination).

In Figure 3, the addition of the RC100 Collar (explained later in this document and shown in Figure 5) allows the RMP to have unlimited access to power, even with the consumer's power disconnected. Coupled with the CLTX01 option (Cellular module, explained in the RFDEX1 block diagram description) uninterrupted access to a CIM technology occurs, regardless of the status of the consumers telecommunication state (disconnected or not available). With shared RMP and CIM, each utility would have undeniable access to their respective UMP hardware.

CIM Concept - MFUME

The goal of the data acquisition and manipulation system is to allow utility billing software autonomous and automatic updates of consumer usage and control. This is accomplished by gathering of the consumer data (as stated, regardless of meter hardware, utility management system or consumer site communication technology) to one Store Forward Site (SFS). This includes data such as termination status files and other instructions from the utility to the device at the consumer site. As shown in Figure 6, many consumer sites are tied to a wide-bandwidth data link via any available CIM. Since the SFS is the common point, access is available to the utility computer, in order to retrieve data sent autonomously by the RMP's at each site (in the AMR industry this is known as an Inbound function), and also can put data and programs in the SFS for download to the RMP sites during their next inbound call. The latter function is the basis for the Maintenance Free Utility Management Engineering (MFUME) concept.

Again, the SFS site hardware and software is non-dependent on any one technology, as long as the predetermined and future-required functions are satisfied. For example, the consumer sites could be a mix and match of dedicated and non-dedicated hardware such as dedicated Remote Meter Processors (RMP), existing consumer computers (non-platform dependent) acting as RMP units, RMP's installed by others (electric sell back to gas or water), any AMR device able to be connected to the SFS, etc... The SFS is also non-platform/software dependent, and can receive data over a myriad of communication
mediums and under most Operating Systems (OS). All that is required is that these systems have the ability to freely exchange, store and manipulate data as set forth in this document. This will then create a system that can function in a self-supporting integration of inquiry, logging, documentation, billing, termination of service, and other bidirectional functions. Limitations of current AMR technology are then eliminated.

Block diagram descriptions

The first block diagram labeled UMPNET2 (Figure 7) , gives an overview of the system, in an effort to show the basic requirement for the system architecture. The five main areas are:

(A) the consumer site
(B) the communication networks between the SFS-Link and the consumer site (CIM) and the networks between the SFS-Link and the utility billing office. It also is the communications network or system between the utility billing office and the consumer site
(C) PSDN or other wideband communication network
(D) the Store Forward Site (SFS)
(E) the utility billing office.

Since it is impossible to illustrate all possible configurations, this block shows only the major implementations currently available in a practical means. By nesting these blocks together, it is possible to show levels of increasing detail, down to the component level.

Communication mediums are shown as Landline, Fixed RF, Mobile RF, Cellular, CATV and ISDN. In addition to these technologies, other broad/wide-band systems could be used. The only requirement of the medium used at the consumer site is the ability to recover (either through demodulation or decoding) data originating at the RMP and the ability to forward this data to the SFS. If the utility is not interested in demand reads (explained further in this document), or the ability to send data to the consumer site, then modulation or encoding at the utility is not a requirement of the medium. Unlike other systems until UMP, only a section of the service area might be unidirectional with no loss of data collection or autonomous capability. This uni/bi-directional connection to the consumer site is known as the CIM (Consumer Interconnection Medium).

Shown on the UMPNET2 block are the various communication mediums (CIM)available. These mediums cover the entire gambit of current and planned telecommunication interconnections. As set forth by this specification, all mediums are eventually cross-coupled to a PSDN/WAN. The reader is cautioned to not limit this to what is widely known as the Internet/Information Superhighway. Unlike these primitive wide-band technologies, UMPNET is not dependent on conformance to TCP/IP or other protocols, FSK or other interconnect techniques. Although this network will definitely be utilized, any type of PSDN/SFS-to-CIM link can be used. But for sake of clarification, we will explain only those CIM technologies that have applicable hardware manufactured or to be manufactured.

In the UMPNET2 drawing, section A, blocks representative of a fraction of the consumer site configurations are presented. R1, R2, R3, RFD01, APT01, and ISDN represent detailed drawings that follow this discussion of the UMPNET2 drawing. In each, the three major utilities are represented, with the options and hardware/software available at each example.

Front End Examples

In this and other consumer site (known as the Front End) examples, the initial installation may have been by either of the three utilities. It is feasible (due to inter-utility conflicts; i.e. utilities that are unwilling to share RMP hardware) that each utility could have installed totally separate RMP/UMP systems (with the possibility of different CIM technology) but for the sake of simplicity, we will assume that the utilities at this consumer site are willing to share RMP units and utilize a common CIM. The three meters (labeled E, G and W) are shown with the interface possibilities. As indicated, either technology could be utilized in order to perform the actual data acquisition. In multi-utility installations like Figure 8, various technologies connected to the same RMP can co-exist. This is a function of the PUMI design, which can be programmed or re-programmed to see different types of data acquisition technology on its respective channels (see the PUMI description later in this document).

In Figure 8 (see following illustration), the CIM shown is typical of the current two-wire switched network installed by the regional phone companies. This particular implementation of RMP hardware and other typical RMP consumer site installations will follow.

In the following sections, implementation of the meter to the RMP connection is to be in accordance with any of the subsystems discussed in the Equipment Disclosure which follows the Block Diagram Descriptions. As stated before, these connections are interfaced through the Programmable Universal Meter Interface which is a sub-part of the RMP hardware. Regardless of the interface technology employed, the RMP will react and function to the extent of implementation. Since the PUMI is a programmable device (with 96 bidirectional patch points), it can accommodate any configuration deemed necessary (tamper functions, leak detect, zone or device temperatures, etc...) And since the PUMIC96 can be cascaded to the RMP PUMI module, thousands of PUMI connection points are possible.

Front End Block Diagrams

(Note: A full discussion and explanation of equivalent schematics/software will be presented in the following Equipment Disclosures.)

The first implementation we will discuss is the typical two-wire TELCO CIM. It is understood that the system presented here is in conformance to standards of telephony as laid out by the respective organizations. This includes previous and current Bell specifications and entails the use of communication mediums that are prevalent at the time this specification was written. Other protocols and communication methods are equally applicable, but since standards exist for terminal-to-terminal (DTE-DCE) connection methods, this description will confine itself to these standards.

In Figure 8, the TELCO connection provides the CIM technology for this site. As shown, the RMP is connected to the TELCO lines via a standard RJ-11 connector. It could be connected directly across the consumer's telephone connection at the downlead junction box. This device could also seize the lines though the preferred method for TELCO connection is in parallel with the existing consumer equipment. Power for charging the supply is acquired at a rate of 5-10 mA from the 50 VDC that's carried on the TELCO pair.

Communication through this type of CIM is typically via standard modem-style data transmission techniques with virtual connection to a PSDN or other wide-band, high volume conduit. Call origination from the RMP to the SFS, Emergency monitor, or other site (known as the Autonomous Update Mode or AUM) is either initiated by the Real Time Clock (RTC) settings, a tamper detect, an invalid checksum/error flag from any software that would require a MFUME update from the SFS, a previous flag set by either the utility or RMP maintenance personnel, a leak or excessive consumption detection, or any other internal request by the RMP hardware for remote interaction.

In order to perform a demand read (a call originating either at the utility or a maintenance office), a valid Caller Identification V.23/Bell 202 FSK format signal must be passed to the CND detect circuitry. Valid numbers are those that were either programmed at install, any subsequent install, or during a previous AUM/Demand session. It is this mechanism that initiates the RMP for connection during a demand read. TELCO implementation of CND is between the first two standard ring signals (an analog 95 volt sine wave), the consumer's telephones may ring. once, possibly twice. But by informing the consumer of this, they can be made aware of this fact and react accordingly.

In figure 9, an existing RF system is used as the CIM and, as shown, could be either a fixed or mobile RF system. This system could be remnants of a previous AMR system or could be part of another special services one/two-way wireless system. Data acquisition and control options are the same as all other systems, with the only difference being the output from the RMP being sent to a RFTX01 module. This module could receive drive and power either directly from the RMP, or else from the RC100 collar. When fed by the RC100 collar, the RF pre-drive is actual sent back to the RC100 from the RMP (via the RC100-to-RMP cable assy.) Since this unit is not connected to TELCO, implementation can constitute power being derived from the RC100 collar (if used) or via wall wart (AC adapter).

Figure 10 shows the same consumer site options, this time tied to a bi-directional CATV channel that's usually available as a subcarrier. Again , since power is not normally carried on the CATV cable, for charging must be derived from the RC100 collar or from a wall wart. During an AUM session, the RMP CA01 module (see equipment disclosure) is used to access a subcarrier assigned by the CATV company for use by the utility(ies). The CA01 module requests attention of the CATVHE controller (located at the CATV head end) and then performs basically the same function as it would if it were connected directly to the SFS. As shown in the UMPNET2 drawing, the CATVHE (see figure 11) node performs a sub-server function, gathering data and sending data, programs, commands and timing information to the RMP. The CATV head end shown is typical of many CATV system installations, simplified for this block diagram. Note that interface for MUX and DEMUX to the CATV subcarrier is provided by the CATV company (CATVCO). This device normally complies with standard data transmission techniques and varies from CATVCO to CATVCO. But since the protocols available are already standardized, it makes little sense to develop a proprietary WAN implementation.

Recovered data from the CATV system (i.e. - data from the RMP's connected to the CATV network during the AUM mode) is demodulated then sent to the PC or other standalone computer terminal, located as shown in Figure 11, which acts as a 24 hour data buffer and controller. This is accomplished by utilization of standard server software of the utilities choosing. Any LAN software supported by the hardware may be used. At the end of the 24 hour period, or during and emergency condition, the CATVHE terminal will then invoke a call to the SFS or in the case of an emergency, the utility emergency terminal (if installed). The reverse is true for instructions and updates sent from the utility to all/individual RMP's. In summary, the CATVHE terminal acts as temporary daily server for RMP's connected to the CATV system.

In figure 12, a typical office or apartment building/complex is able to be ultimately controlled by a single RMP. In this figure, concentration of the individual meters is accomplished by the PUMIC96 concentrator. The PUMIC96 is basically an extension of the RMP PC104 bus via typical serial communications. In large complexes this can be converted to 10baseT or thinwire, again using off the shelf data components configured to work with the PC104 standard. The PUMIC96 will be explored further in the Equipment Disclosure following these block diagram descriptions.

The block diagram in Figure 12 also introduces the 3P01 module, which is used to acquire data from and control a typical three-phase installation. If the building was a single or multiple single-phase installation, the RC100 collar could be implemented for each service. Further still, as with all of these front end installations, the electric utility RMP hardware is not required for functionality of the system with regards to the other utilities present (i.e. - gas, water, steam, etc...).

The CIM technology used in Figure 12 is shown as a standard two-wire TELCO connection which is either a management office line or a dedicated pair installed/billed to the utility. But any valid CIM described previously could be employed with the same net effect of acquisition and control.

The next block (Figure 13) shows the implementation of ISDN technology to the MFUME concept. This will probably become the second favorite CIM for utilities due to the fact that the current specification for ISDN provides a dedicated channel specifically for utility management. But since wide-spread implementation of ISDN sites is limited, and since final spec's for ISDN are still on the drawing board, particulars are not possible. But certain universal principles apply. One is the ISDN bidirectional, High Speed data channel; another is the matrix involved in carrying point-to-point data from location to location.

The system in Figure 13, again non-dependence on any particular meter technology is shown. The only difference is the CIM and related RMP module(in this case an ISDN01 module would be employed). Since ISDN service does not provide DC power, other means (either wall wart or RC100, if installed) is necessary.

The CIM technology in Figure 14 is shown as cellular. This system could possibly be the most impervious of all CIM technology available; especially when coupled with the RC100 collar. Since the cellular connection is maintained by the utility(ies), unlimited access is provided. This system is shown in a rural setting, but any location with cellular service can utilize cellular CIM implementation.

The cellular option comprises of an interface adapter, cellular-capable modem, and the CLTX01. If combined with the RC100 collar, power supply and signal drive are provided to the CLTX01 module via the RC100 circuitry. Since the RC100 collar includes a serial communication device for connection to the RMP (via the PUMI or other interface), this data link is also used for data traveling between the RMP/PUMI and the CLTX01 module. This arrangement is also available for the RFTX01 CIM.

TELCO and Other CIM Considerations

As stated previously, many of the existing technologies that comprise the current telecommunications industry have proven themselves, over and over again, as reliable methods for moving data between sites. Each system presents it's inherent limitations. But by choosing the proper RMP hardware and modules, the utility is able to address these situations with a modular system that allows for proper MFUME designs. It is important for the utility to study the available CIM technology in the geographic area of concern. If participation of the CIM carrier can be obtained, great strides in cost effectiveness and reliability result. Unlike previous AMR systems, many of the CIM's discussed do not require carrier participation or premium services/special carrier-provided equipment.

Existing RF technologies are usually proprietary and are particular to the system installed. The main reason that RF CIM technology is addressed is two-fold. One, if the utility has previous installations of fixed-base or mobile RF systems or requires access to sealed meters; and two, the seemingly poor use of private radio operators such as paging and mobile radio systems for this purpose. In many of the urban and residential area's small business-band repeater sites that could offer a perfect low-cost CIM-link are not being employed. We find it disturbing that many of the previous and current systems utilize addition RF bandwidth by employing exclusive channel space in an ever-crowded spectrum. Still, this document would not be accurate if it ignored the need to address this technology.

The goal of the CIM is to provide a bidirectional connection for AUM to the SFS medium (usually the PSDN or a private high speed data network) and also to provide a bidirectional data link between the RMP and the utility. Again, standards exist for data transmission across these mediums; since these standards are preferred and in many instances required for compliance with the carrier, adherence will be a priority. Part of the strength of this system is the proven track record of these standards. Applicable are those for Caller Identification compliance, RS-232 sync and async standards, CCITT V.xx bis standards, Bell 212A/103, MNP-10 cellular data (as laid forth by cellular carriers), etc...

SFS Site Requirements

The Store Forward Site (SFS) requirements are easily accommodated by any of the +2000 sites currently available via the PSDN. Any LAN/WAN or high volume data network that is generally accessed via switched common carrier. This includes what has been currently known as the Information Super-Highway or Internet. Recall the previous mention not to limit the scope of this to current technology.

Functions performed at the SFS include those shown on the Equipment Disclosure. One of the primary intentions of the MFUME concept is to off-load date storage tasks to a third-party site, separate from the utility office. This is due to the fact that high-volume services already exist for data storage and retrieval. CompuServe and America on-line are a few examples of fancy, consumer data sites. Another prime example is that of the TRANSACT Network utilized by the credit issuing organizations. In fact, the RMP has the capability (see later in the Equipment Disclosure Section) to interface with a third-party provided card swipe system.

Equipment Disclosure

Due to the modular nature of the UMP system, we feel that a simple embodiment is too limiting to the usefulness of the system (patent). Therefor we will discuss each module and device, with the respective block and schematics included. This will be considered the preferred embodiment, because in order to satisfy the claim of a holistic process, each particular implementation is valid and preferred. Overall, the major advantage to a UMP system is modularity; the ability to manage utility data and control via the MFUME concept, regardless of the CIM employed.

Due to the utilization of third party communication services, it is assumed that the reader has an understanding of the basic principles of which these mediums operate. Detail will be provided as to such utilization by the CIM modules, with it employed as to the service provided.

RMP Hardware

The RMP Hardware consists of modules that, depending on the meter technology, I/O and auxiliary functions and CIM implementation desired, are interconnected for use with the site technologies present. In Figure 15, the various blocks that comprise of the typical RMP are shown. Blocks delineated with dashed lines are options for that particular RMP function.

PC-104 Buss

The primary internal interconnection means for RMP hardware is the PC-104 bus. This bus is a standard developed for use by embedded devices requiring an EISA (Extended Interconnection System Architecture - 16 IBM PC) interface in a compact size. The typical edge-cards used in standard EISA are replaced by a 40 and 64 pin header. (Figure's 16 & 17). This style of connector facilitates employment of standard AT-compatible open architecture. Due to the availability of of-the-shelf interface chipsets, third-party development will occur, with optional energy management systems that utilize PC-compatible software.

System interface to the PC-104 bus is accomplished via standard interface control techniques. This is true for all modules that are connected to internal RMP hardware. Since the PC-104 specification requires feed-through connectors on both the component and solder side, a theoretical unlimited number of PCB assemblies can be interconnected; though the practical limit is 16 for hardware driven interrupt modules. Using software interrupts, approximately 64,000 devices can be addressed. Initial I/O device design will incorporate hardware modules, but this does not preclude the future addition of memory-mapped I/O.

The schematic symbol for the PC-104 bus is shown in Figure 16, the actual PCB outline is shown in Figure 17.

MB01 - Main Board Assembly

In Figure's 18, 19, 20 and 21 are the schematic representation of the MB01 main board assembly. U2 is the main processor, here shown as a I386_P. In Figure 18, U2 incorporates an internal pin mux system used to select on-chip options. A no boot selection is available via JP1. IC's U4, U13, and U7, provide I/O and memory management support. U1 and U5 provide data buffering. Osc's 1, 3, and 4 provide clocks for the COM control, main and I/O timing respectively.

In Figure 19, U's 10, 11, and 12 provide management and interface of U54, which can be selected to support 1, 4, or 16 Mb of DRAM or DRAM-emulated system memory. U53 consists of the Boot Block Flash, a static device used for system files and a command interpreter. This is also used for system-specific files and execution code used in operation of the RMP. In addition, options and utility-specific code can reside between system areas, in order to preserve configuration information when powered down. System state is loaded into U51 during System Management Mode. U3, Q1, and Q2(A & B) provide 12V necessary for programming U53.
U6, U8, and U9 (Figure 20) provide COM support and interface to the MB01. P1 is configured for DCE, P2 is configured for DTE operation. J1 and J2 are PC-104 connections with JP3 and JP5 selecting DMA channels that will appear on the MB01 PC-104 connector. OSC2 provides the bus clock. JP6 provides selection of higher order IRQ settings.

JP3 in Figure 21 is used to provide power to the MB01. This connector supplies the MB01 with GND, 5, 12 and -12 VDC. Please note: these voltages are referenced to the PC-104 bus voltages. On-board bypass, filtering and decoupling are accomplished via the network of capacitors. Polarized 22 µfd capacitors and non-polarized .1µfd capacitors are employed. CR1 indicates the presence of the 5V VCC supply. S1 provides field reset, S2 and S3 provide in-the-field system management and non-maskable hardware interrupts. JP7 provides field access to CPU options and test signals. This is used during troubleshooting and factory testing. Spare IC components are shown tied to GND to prevent substrate damage due to static from open IC connections.

Flow diagrams of the internal operating system of the MB-01 are shown in Figure's 22, 23, and 24. A block representation of MB-01 is shown in Figure 25.

RTC01/ BB01

In Figure U1 is a DP8578 Real Time Clock IC configured for AT-bus (PC-104) interconnection to the RMP system. JP1 & JP2 are PC-104 connections. In Figure 25, the power for clock memory is provided (VBB) in order to maintain configuration and setting. U2 is a data latch/buffer; U3 provides chip-select via higher order addresses. Osc Y1 provides clock with C1 providing trim adjust. R8 provides adjustment of VBB set point.

The remainder of Figure 26 is for RMP power management. This circuitry utilizes the Truegauge power management system. The MTA11200 (U7) is driven by comparators (U4A..D) which monitor cell conditions (connected to JP6 - 48V) and controls current flow to the cell. U5/Q2 regulates switched SMI power to the local circuitry. U8 provides timing control for the MTA11200‘s internal idle mode. Y2 is a 4 Mhz clock required for MTA 11200 timing. SW1 allows field reset of CHG#, used during installation and service of the RMP. Serial data is provided by the MTA11200 and is routed via the level shifter (U12 and support components) to the MB01. Charge current which originates at JP7 (connected to either the 48V from TELCO, photo-cell or wall-wart) is passed through Q4, a pass regulator under the control of the MTA11200. Current is monitored by the MTA11200 and statistical data is communicated to the MB01 via the COM port described above. J1 is a stackable connector that supplies voltages to auxiliary connections (usually site hardware). U17 and 18 provide regulation of the voltages connected to J1 and those that reside on the bus. Q9, 10, 11, 12 provide switching for supplies feeding SMI-cycled devices.

PUMI96

Figure 27 and Figure 28 are respective schematic and block diagrams for the PUMI96. Central to the design is the Flex8000 8452 device (PLD2), a register-based PLD. This device is programmed by the MB01 (via PC-104) for functions specific to the input being polled. This configuration is controlled by the support chip, PLD1. PLD1 is a FLEX7032 used to configure PLD2 from address and data presented on the PC-104 bus (JP1 & JP2). J1 through J6 are the PUMI96 connections to the Site Hardware, providing signal and power. Connectors J1-J6 are used to connect to any type of machine-readable meter or can connect to the SBA01 assembly. Power for connections to these devices is provided on these connectors to allow devices such as the SBA01 to be connected via any cable up to 24 conductors. Since PLD2 can be configured within 100mS, it’s internal logic can be customized by the utility for any configuration required with the Altera MAX+Plus 2 software. Register-rich devices such as the Altera FlexXXXX family can be re-programmed using industry-standard VHDL-compiled code generated by many of the major PLD-device software packages (ViewLogic, Cadence, Mentor and others)

PUMIC96

The PUMIC96 (Figure 29) is equivalent to a paired down RMP. A MB01 assembly is coupled to a PUMI96 whose PLD2 is configured via the host RMP. The MB01 DTE connection is used to transmit data to the host RMP via RS-232 protocol. Provision is made to connect external systems, such as leak detection and tamper systems from manufacturer’s such as Honeywell, White-Rogers and others. Power and input connection is identical to the PUMI96.

RC100

The RC100 provides the an electric utility with remote disconnect capability (re-connection usually requires on-site visits to insure consumer load reduction) and connection to unlimited power for the RMP, even after disconnection of electricity to the consumer site. If installed by a utility other than electric (with permission), the disconnect feature can be disabled with no loss of functionality with regards to power provision to the RMP.

By design, NEMA meter enclosures for single-phase residential installations provide the typical electric meter with two input and two output connections. The electric meter utilizes a shunt that is inductively coupled to the metering mechanism. With the RC100 installed, a low current tap is coupled to a transformer that can supply both the RMP and an auxiliary device with power.

In figure 30, a schematic is presented of the internal RC100 circuitry. J5 and J6 are shunt-connected to J7 and J8 in order to pass connection through to the electric meter. After passing through the electric meter, connection is then recaptured via J3 and J4. A 200 amp solid-state or mechanical relay (K1) is then placed in series with connection to the consumer service via J1and J2. R1,R2, C1 and C2 provide relay contact protection during operation with nominal loads. Picofuses F5, F6, F11, F12 and F13 provide connection to the RMP and internal RC100 power provision circuitry. K2 provides a safety interlock function for initial connection of the RC100 to the consumer’s meter enclosure. T1 is a 240VAC to dual 48VAC transformer that provides both D1 and the auxiliary connector J10 with supply voltage via Picofuses F1-F4 which are rated in accordance to the load required. U1A provides 2-bit disconnect decoding from the PUMI96 via connector J9. U1A then feeds opto-isolator/TRIAC driver U2 with drive for operation of K1. In addition, J9 also passes through data lines from the PUMI96 to the auxiliary connector J10. U3 provides local RC100 DC voltage regulation with C4 and C3 providing filtering of DC supplies.

Figure 31, 32 and 33 are front, side and typical installation mechanical drawings respectively.

SBA01

In Figure 33, the scan assembly SBA01 is shown attached to the existing meter. By utilizing CCD/CID technologies interface to the PUMI96 is realized via RS-232 protocols. In Figure 34 a schematic embodiment is presented utilizing a CID Technology, Inc. CID2250 (U2). Necessary clock and sync signals for horizontal and vertical drive are provided by a mask-programmed FLEX8282 (PLD1) configured for the CID2250. Interface of these signals to the CID is provided by exclusive OR gates U4A-D, and by the TSC427 buffers (U5-8, U10 and U12). U3 provides 10VDC for use by the TSC427's. Transformers T1 and T2 set the input level of the internal horizontal sync circuits of the CID2250. U11 provides output conditioning of the CID2250 outputs which are basically inversions of each other. These two signals are then connected to the multiplexer inputs of PLD1 via transistors Q3 and Q4. The mux'ed signal is then returned to the PUMI96 via U1, an Intel 8250. Clocks for the PUMI96 are provided by U9 and U13 which are used to drive internal logic in the PLD1 IC. power and signals are routed through P1 a 25 pin LIMA connector. Since the SBA01 is located remotely from the RMP, filtering for DC supplies are provided by C19-C30. Inductor L1 insures that horizontal switching noise is removed from the 10VDC supply.

A mechanical representation of the SBA01 rubber boot assembly is presented in Figure 35. The lens assembly is embedded in the rear of the assembly. The PCB assembly is attached as shown in Figure 33.

MD01/CE01/RF01

The above modules are virtually identical except for interface signals required by each CIM technology DAA/hardware.

In Figure 36; which is the MD01 embodiment, PC104 connection is provided by JP1 and JP2. U1 is a PLA configured for address decoding of chip select for IC2 a Rockwell microcontroller C40. Host address, data and hardware handshaking to the PC-104 bus is shown with HA prefix. External system bus connection for address, control and data is shown with standard industry prefix. IC1 is the Rockwell MDP RC144DPi data pump. Configuration of the data pump and microprocessor is performed by IC4, an Intel 27C010 EPROM and IC3 an Intel 51256 SRAM device. As recommended by Rockwell, DAA interface is provided by a MIDCOM 671-8005 transformer in a barrier circuit for compliance to FCC Part 68 specifications. See Bell and UL specifications for USA standards and interface techniques. Caller ID detection is provided by passing the RIN signal via the MDP to the MCU. Registers in the MCU are compared to the incoming CND signal.

By selecting cellular operation (Figure 37), the MCU/MDP are configured to pass cellular phone control signals CNLT0, CNTL1, CLCLK, CELDATA, CELBSY and #CLBSY to cell hardware (CLTX01) provided by the cellular service. These signals are described in the RC144ACi/ACL/DPL/DPi manuals.

With Figure 38, the modem is configured for use with a cable television network or ISDN D/B-channel adapters using single-ended RXA and TXA signals. Such devices as the Motorola ISDN series MC145490EVK or any of the T1/E1 devices from Silicon Systems; devices such as the MHW10000 series from Motorola RF Products (RFTX01) catalog can also be interfaced to the MCU/MDP chipset. The interface device selected should provide control signals for network navigation of read, write and collision detect, depending on the CATV system used. RF systems also can utilize this configuration with keying of transmission achieved by utilizing either CNTL bit or a combination for 2-Bit addressing of the RF interface equipment. Typical RF transmission or newer spread spectrum systems can be interfaced.

When using either the CATV or RF system, head-end interface can be accomplished with matching interface hardware connected to any PC or mainframe terminal using modems/network cards compatible with those selected for use at the RMP modem.

Miscellaneous Drawings

In Figure 39, a typical residential basement installation is presented. In Figure 40, suggested Store-Forward functions are presented in a flowchart format.