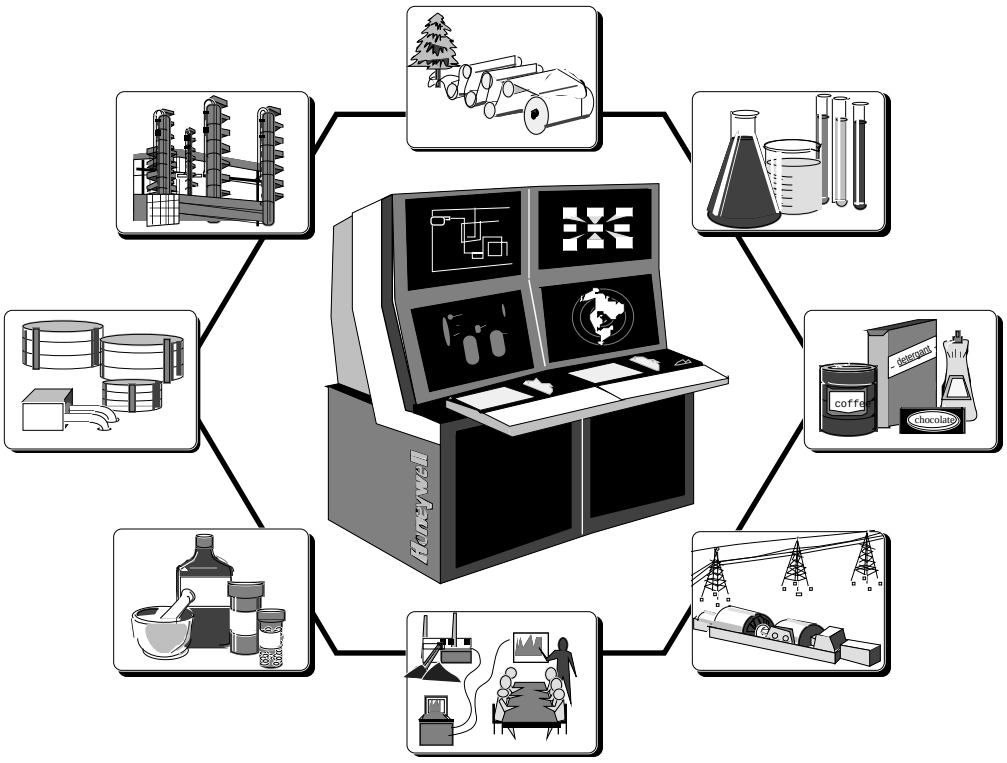
Honeywell

TDC 3000X Advanced Process Manager Specification and Technical Data

AP03-500
R500
2/96



Total Plant

TDC 3000X Advanced Process Manager

Specification and Technical Data

TABLE OF CONTENTS **Page**

Introduction **3**
Universal Control Network 3
Network Interface Module 4

Functional Description **4**
Functional Overview 4
Control Functions 5
Control Implementation 10
Alarm System Functions 11
Security 12

Physical Characteristics **12**
Power System 12
Card File Assemblies 13

Input/Output Functions **13**
Input/Output Processors 13
Field Termination Assemblies 14
Galvanically Isolated FTAs 14

Options **14**
APM Module Redundancy 14
Power System Redundancy 14
I/O Redundancy 14
Standby Manual 14
Battery Backup 14
I/O Simulation Option 14
Remote I/O 15
Corrosion Protection Option 15
Harsh Environment Option 15
European Community Compliance 16

Specifications **17**
APM Environmental Conditions 17
APM Certifications 17
CE-Mark Compliance 18
APMM Redundancy Option 18
I/O Link Extender (Remote I/O) 18
APM Standard Power Systems 19
APM AC-Only Power Systems 20

Model Numbers **21**

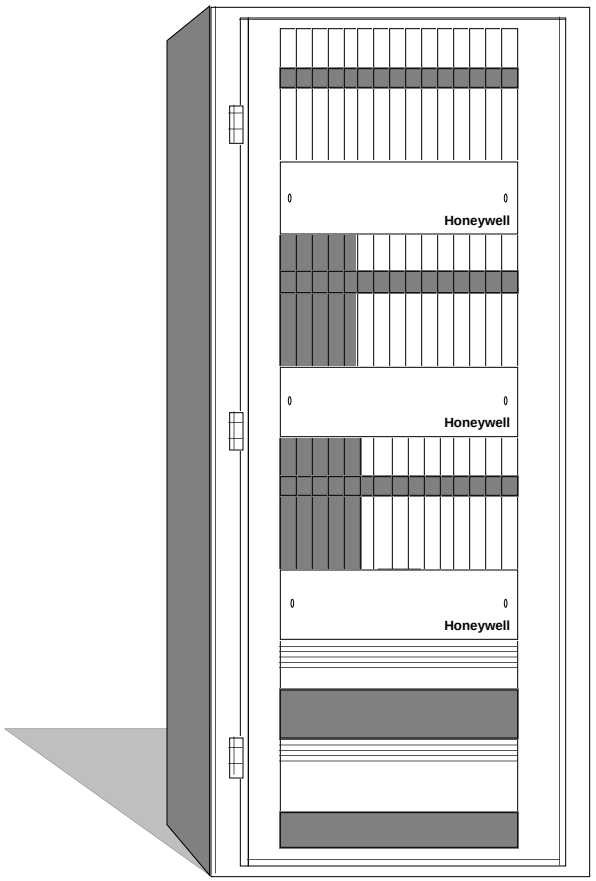


Figure 1 — Advanced Process Manager

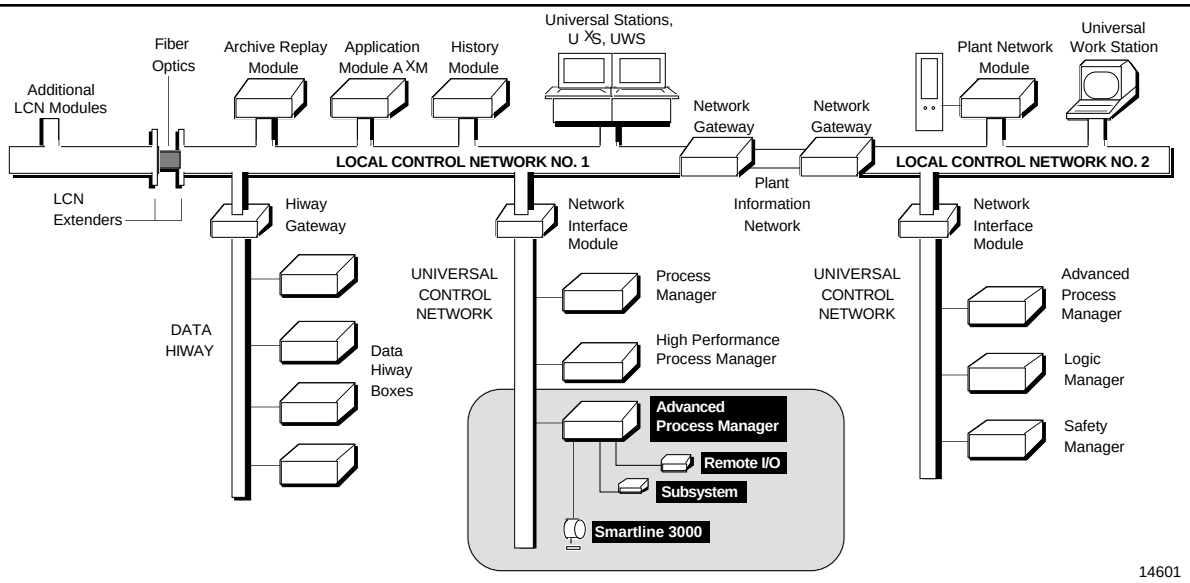


Figure 2 — TDC 3000X Architecture

Introduction

The Advanced Process Manager (APM) is Honeywell's most popular and well established TDC 3000 data acquisition and control device for industrial process applications.

Like the Process Manager™ (PM), its predecessor, and the High-Performance Process Manager (HPM), its successor, the APM offers a range of capabilities that meets today's and tomorrow's process requirements. The APM offers highly flexible I/O functions for both data monitoring and control. Powerful control functions, including regulatory, logic, and sequencing control are provided for continuous, batch, or hybrid applications.

An optimal toolbox of functions that can be configured and programmed meets the needs of data acquisition and advanced control requirements in a highly secure and performance-intensive manner. Of course, APM's capabilities include peer-to-peer communications and compatibility with industry-standard communications protocols.

As shown in Figure 2, the APM is a fully integrated member of the TDC 3000X family. Accordingly, it is capable of:

- Performing data acquisition and control functions, including regulatory, logic, and sequential control functions, as well as peer-to-peer communications with other Universal Control Network-resident devices.
- Providing bi-directional communications to Modbus™ and Allen-Bradley compatible subsystems through a serial interface.
- Fully communicating with operators and engineers at Universal Stations, UXSs, and Universal Work Stations. Procedures and displays are identical or similar to those used with other TDC 3000X controllers, as well as to HPM and PM point displays.
- Supporting higher level control strategies available on the Local Control Network through the Application Module and host computers.
- Using the same I/O and wiring as the PM and HPM, thus providing cost-effective upward migration from existing PMs as well as the capability to migrate to HPMs in the future.

Universal Control Network

The communications channel for the Advanced Process Manager is a local area network called the Universal Control Network (UCN). Introduced to TDC 3000X users in 1988, the UCN is the secure path for process I/O connections to the TDC 3000X.

The UCN features a 5 megabit per second, carrier band communication system with a token bus network. It is designed to be compatible with IEEE* and ISO** standards.

* Institute of Electrical and Electronics Engineers
** International Standards Organization

UCN communications are consistent with the growth and direction of evolving international standards, with appropriate Honeywell extensions for secure process control applications.

The UCN uses redundant coaxial cables and can support up to 32 redundant devices. The UCN supports peer-to-peer communication between devices on this network. This feature enables sharing information among HPMs, APMs, PMs, Safety Managers, and Logic Managers on the network, thus offering tremendous power and flexibility in implementing advanced, coordinated control strategies.

Network Interface Module

The Network Interface Module (NIM) provides the link between the Local Control Network and the Universal Control Network. Accordingly, it makes the transition from the transmission technique and protocol of the Local Control Network to the transmission technique and protocol of the Universal Control Network. The NIM provides LCN module access to data from UCN-resident devices. It supports program and database loads to the Advanced Process Manager and forwards alarms and messages from the network devices to the LCN. The NIM is also available in a redundant configuration to provide automatic, continued operation in the event of a primary failure.

LCN time and UCN time are synchronized by the NIM. The NIM broadcasts LCN time over the UCN. The APM (as well as the HPM) uses it for a number of time-driven functions, such as sequence of events reporting.

Functional Description

Functional Overview

Note: This Specification and Technical Data sheet covers the Advanced Process Manager only.

For information about APM Input/Output Processors, which are common to the PM/APM/HPM controller family, please refer to IO03-500, *Process Manager I/O Specification and Technical Data*.

The Advanced Process Manager is designed to provide flexible and powerful process scanning and control capabilities. To do this, it uses advanced multi-processor architecture with separate microprocessors dedicated to perform specific tasks. As depicted in Figure 3, the APM consists of the Advanced Process Manager Module (APMM) and the I/O Subsystem.

The Advanced Process Manager Module consists of an Advanced Communication Processor and modem, Advanced I/O Link Interface Processor, and Advanced Control Processor. A redundant APMM can be optionally provided.

The Advanced Communication Processor is optimized to provide high-performance network communications, handling such functions as network data access and peer-to-peer communications. It also supports high-accuracy time stamps.

The Advanced Control Processor is the APM resource dedicated to executing regulatory, logic, and sequence functions, including an excellent user programming facility. Because communication and I/O processing are performed by separate dedicated hardware, the full power of the Advanced Control Processor can be applied to control strategy implementation.

The Advanced I/O Link Interface Processor is the APMM interface to its I/O subsystem.

The I/O Subsystem consists of the redundant I/O Link and up to 40 redundant I/O Processors. These I/O Processors handle all field I/O for both data acquisition and control functions. For example, the I/O Processors provide such functions as engineering unit conversion and alarm limit checking independent of the Advanced Process Manager Module.

One IOP which illustrates the advanced capabilities of the APM I/O is the Smart Transmitter Interface. The Smart Transmitter Interface processor provides full bi-directional communication to Honeywell smart transmitters, supporting transmitter configuration and improved data accuracy. This includes the recently introduced Multivariable transmitter capability.

All control operations are performed within the Advanced Process Manager Module (optionally redundant), with all data acquisition and signal conditioning being performed in I/O Processors. For added control security, redundancy is available for several analog and digital I/O processing devices.

The remote I/O option allows I/O Processors to be remote-mounted up to 8 kilometers from the APM file. This option uses redundant fiber optic I/O Link extenders.

The process engineer has complete flexibility of choice in the assignment of point types and control strategies, within the maximum APMM design limits. These selections are implemented using the interactive tools provided by both the TDC 3000^X Universal Station and Universal Work Station.

Control Functions

The Advanced Process Manager Module (APMM) provides a variety of control tools that can be customized to address a wide range of process automation needs.

Functions, from I/O scanning through regulatory and logic control to more advanced control, can be easily implemented through the APM. Included are a sophisticated regulatory control package, fully integrated interlock logic functions, and an advanced process engineer-oriented Control Language (CL/APM).

CL/APM is an enhanced version of the Control Language implemented by Honeywell in the Process Manager. This language facility includes the sequence structures needed to handle batch or hybrid applications as well as the computational capability needed for some continuous control tasks. Key to the power of this control capability is the sharing of the data within the APM, and sharing of data from other devices on the Universal Control Network.

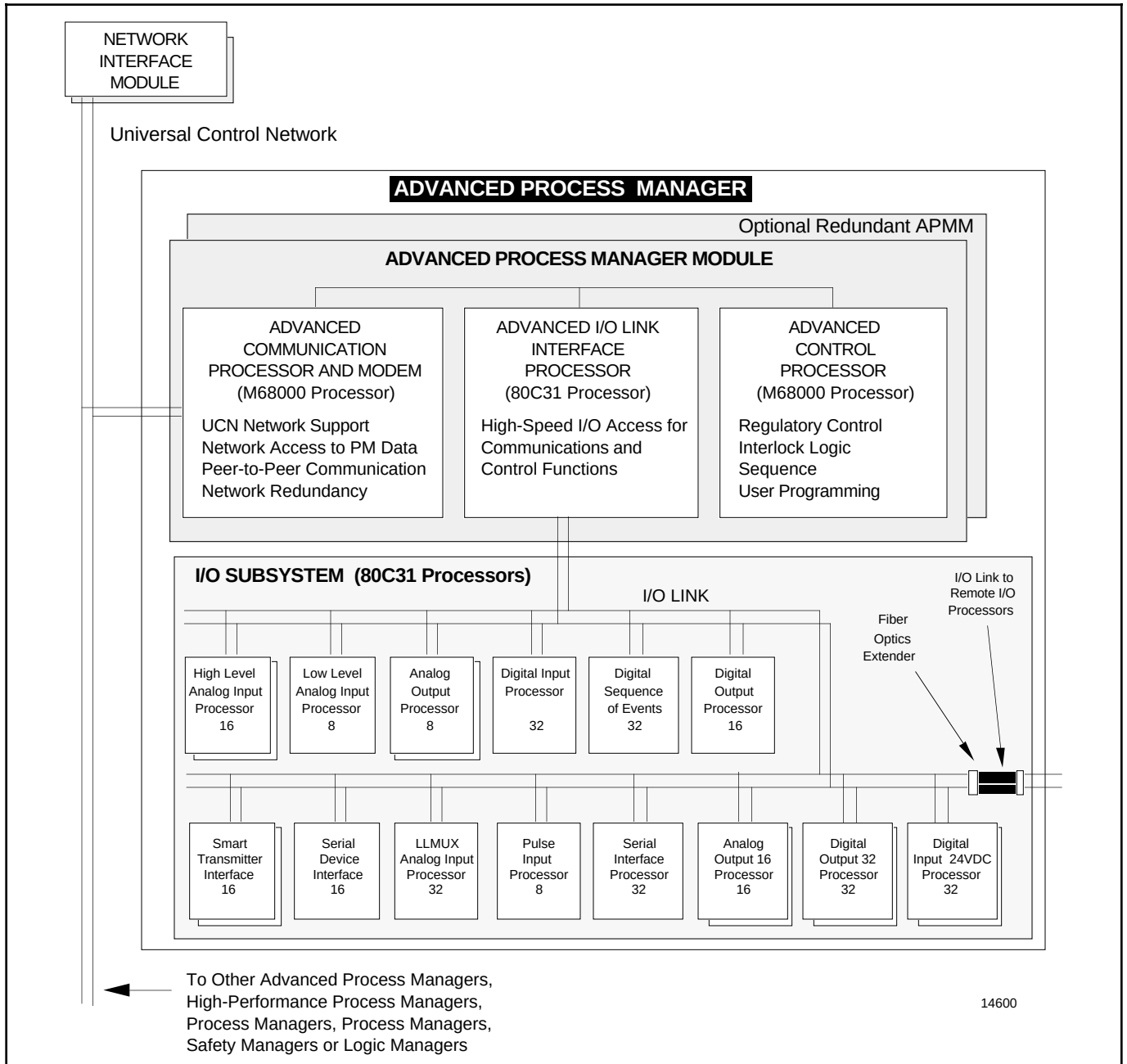


Figure 3 — APM Architecture

All I/O values are converted to engineering units by the I/O Processors and are made available for both communications and further control processing by the Advanced Process Manager Module (see Figure 4).

Conceptually, the APMM can be thought of as partitioned into "slots" of various types. These slots provide an allocated resource of processing power and memory that can be user-configured, including assignment of a tag name.

A tagged slot is referred to as a *data point* in a TDC 3000 System. This data point structure is supported by predefined group and detail displays as well as by custom graphics.

Any of the following types of data points can be configured into APMM slots:

- Regulatory PV
- Regulatory Control
- Digital Composite
- Logic
- Device Control
- Process Module
- Array
- Flag
- Numeric
- Timer
- String
- Time

Each of these data point types is discussed in the text that follows.

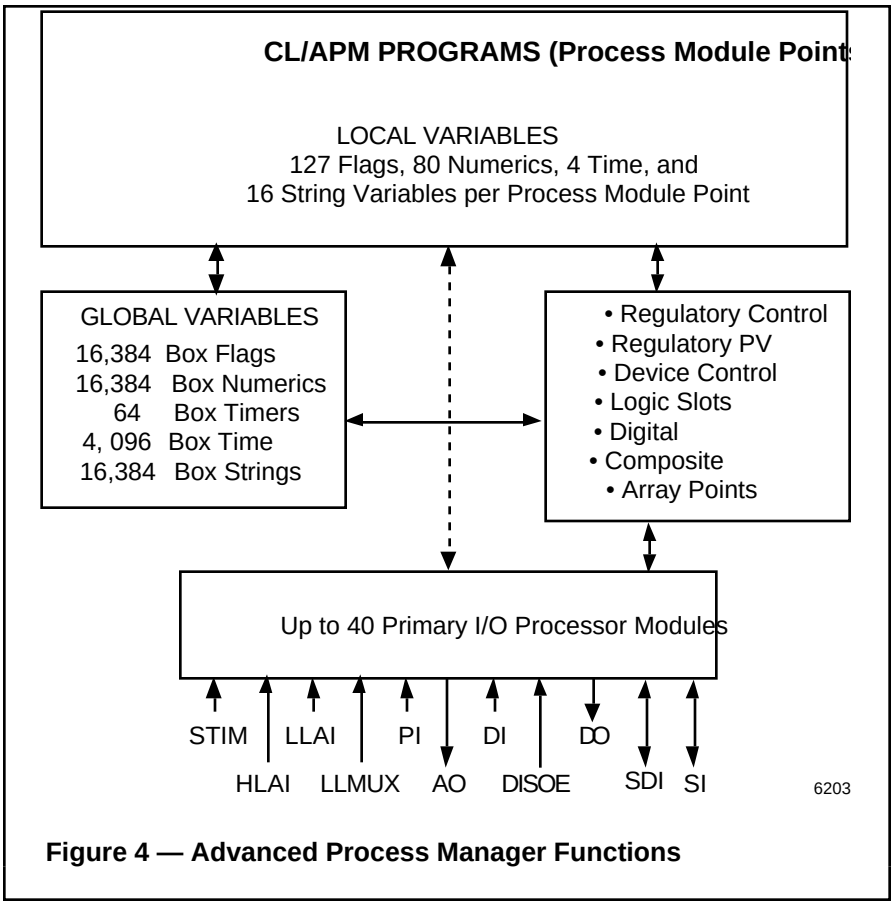


Figure 4 — Advanced Process Manager Functions

Regulatory PV Point

While standard I/O functions, such as engineering unit conversion and alarming, are handled directly by the I/O Processors, Regulatory PV points provide an easy-to-use configurable approach for implementing Process Variable (PV) calculation and compensation functions. PV processing provides a menu of selectable algorithms such as mass flow, totalization, and variable dead-time compensation. In addition, a full array of selectable functions, including extensive alarm checking and alarm suppression options, signal filtering, and algorithm equation options are provided. Available algorithms and other supported functions are listed in Table 1.

Regulatory Control Point

Configurable regulatory (or analog) control functions are performed using Regulatory Control points. Regulatory Control points are configured to execute one of the control algorithms listed in Table 2.

Table 1 — Regulatory PV Points

Available Algorithms	Supported Functions
Data Acquisition	PV Source (Auto, Manual, Substituted)
Flow Compensation	PV Clamping
Middle-of-3 Selector	EU Conversion & Extended PV Range
High/Low/Average Selector	PV Value Status and Propagation
Summer	PV Filter (Single Lag)
Totalizer	PV Alarming
Variable Dead Time with Lead/Lag	Bad PV
General Linearization	PV High/Low
Calculator	PV HiHi/LoLo
	PV Significant Change
	PV Rate-of-Change +/-
	Contact Cutout

Table 2 — Regulatory Control Data Points

Available Algorithms	Supported Functions
PID	Modes (Manual, Auto, Cascade, Backup Cascade)
PID with Feedforward	Mode Attribute (Operator, Program)
PID with External Reset Feedback	Normal Mode
PID with Position Proportional	Remote Cascade, Remote Request, and Remote Configurable Per Slot
Position Proportional	Initialization
Ratio Control w/Ramping Bias	Windup Protection
Ramp Soak	Output Fanning
Auto/Manual Station	Fixed or Auto Ratio and Bias
Incremental Summer	Override Propagation
Switch	External Mode Switching
Override Selector	Safety Shutdown
Summer	Target Value Processing (Setpoint Ramping)
	Alarms
	Limits (Output, Setpoint, Ratio, Bias)
	PV Source, PV Alarming
	Mode Shed on Bad PV

Each algorithm includes a wide range of configurable options to allow implementation of complex control strategies by a simple menu-selection process. In addition, some functions, such as initialization and windup protection, are inherently provided. Also, the capability to ramp setpoint (by operator entry of a target value and ramp time) is configurable. Standard and custom graphic displays are available to support these control strategies.

These built-in support functions (see Table 2) significantly simplify the implementation and use of sophisticated multiloop control strategies. This ease of APM configuration and operation allows implementation of advanced control strategies at the process-connected level.

At the same time, the slot structure for processing and memory resources is designed to ensure that proper control security is built into advanced control strategies. This means that high reliability and integrity are maintained over the entire range of control.

Digital Composite Point

Digital Composite points are multi-input/multi-output points that provide an interface to discrete devices, such as motors, pumps, and solenoid valves. (see Figure 5)

This point provides built-in structures for handling interlocks. It supports operator displays of interlock conditions in group, detail, and graphic displays.

Displays also contain information needed to trace interlock cause. In addition, provision is made for operation of hand/off/auto switches commonly used for local operation of motorized devices.

The major parameters associated with the Digital Composite point are represented pictorially in Figure 5. Runtime maintenance statistics for the Digital Composite point device are also supported.

Logic Point

A Logic point provides a configurable mix of logic capability. Together with a digital composite point, it provides the basis for integrated interlock logic functions. Conceptually, a Logic point can be thought of as the logic processing equivalent to one to two pages of relay ladder logic. A Logic point consists of logic blocks, flags, numerics, input connections, and output connections. Different mixes of inputs, outputs, and logic blocks can be selected. Maximums for each type are shown in Table 3.

In addition to the logic block functions listed in Table 4, the Logic point provides a general-purpose data transfer capability that can be used to read data from input connections and store this data to other database parameters defined by the output connections.

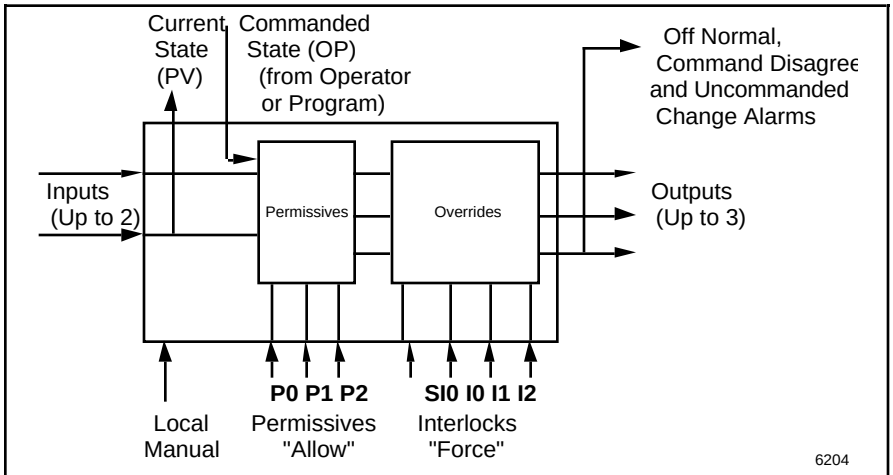


Figure 5 — Structure of Digital Composite Point

Table 3 — Maximum Number of Entries for a Logic Point

	Inputs	Logic Blocks	Outputs
Option 1	12	24	4
Option 2	12	16	8
Option 3	12	8	12
NOTE: Each logic point also provides six status flags and six user flags, plus eight numerics.			

Table 4 — Logic Block Algorithms

LOGIC (AND, OR, NOT, NAME, NOR, XOR, QUALIFIED- OR2, QUALIFIED-OR3)
COMPARE REAL (EQ, NE, GT, GE, LT, LE)
DELAY (ON DELAY, OFF DELAY, DELAY)
PULSE (FIXPULSE, MAXPULSE, MINPULSE)
WATCHDOG TIMER
FLIP-FLOP
CHECK for BAD
SWITCH
CHANGE DETECT
NOTE: AND, OR, NAME, and NOR Gates accept up to three inputs per block, where each input can be optionally inverted.

Table 5 — Device Control Point Algorithms

Gate	Algorithms	Function
Primary Input	Null	Pass Logic Input without change
	Invert	Invert Logic Input
	Arithmetic	Greater than, Greater than or equal
		Less than, Less than or equal, Equal to, Not Equal to
	In-Set	Compare a numeric with an array of 10 numerics
Secondary Input	Null	Pass Logic Input without change
	Delay	Delay, On delay, Off delay
	Pulse	Pulse, maximum pulse, minimum pulse (Time for delay and pulse < 8000 secs.)
Primary Gate	Logic	AND, OR, NAND, NOR, XOR
	Pulse	PAND, POR, PNAND, PNOR, PXOR ("P..." outputs are pulsed)
Secondary Gate	Logic	AND, OR, NAND, NOR, XOR
	Pulse	PAND, POR, PNAND, PNOR, PXOR ("P..." outputs are pulsed)

Device Control Point

The Device Control point provides maximum flexibility for controlling discrete devices. It combines the digital composite display and logic control function under a single tag name (see Table 5 and Figure 6). This provides an enhanced interface for pumps, motors, and motor-operated valves.

The Device Control point's single tag name enhances the operator interface for motor control points.

Operations are improved because the operator can see the cause of the interlock. Also, an analog feedback signal, such as motor control current, is displayed. Implementation effort is also reduced through the use of a simple configuration and standard graphics for troubleshooting.

User Programs — Process Module Point

Today's control strategies frequently need the flexibility of user programs that can be utilized for continuous, batch, or hybrid applications. A Process Module point is a resource for the execution of user-created programs written in Honeywell's Control Language (CL/APM).

The CL language provides an outstanding sequential control and computational tool. CL programs are self-documenting—an important feature when future modification of control strategies is anticipated.

The total statement capacity depends on configuration. Typically 10,000 to 20,000 CL/APM statements can be handled by a single APM.

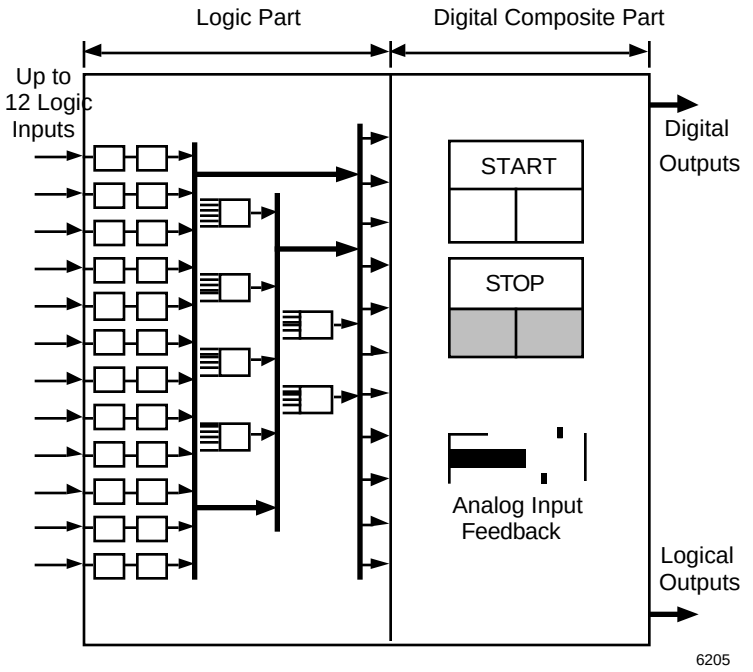


Figure 6 — Structure of Device Control Point

Using the Universal Station or Universal Work Station, individual programs can be easily modified and reloaded without affecting execution of regulatory control, logic blocks, and other user programs.

All process module programs can access the Advanced Process Manager database, thereby accessing analog inputs and outputs, digital inputs and outputs, array points, logic block states, alarm states, and failure states, numeric variables, and flags.

CL/APM programs can also manipulate ASCII values as well as time data. In addition, each process module program supports communication with the operator and can send or receive data from other controllers on the UCN.

Process module points provide a Phase/Step/Statement structure that is well suited for implementing batch process control functions. In addition, a multilevel abnormal handling capability allows user-specified conditions to automatically trigger pre-defined Hold, Shutdown, or Emergency Shutdown sequences.

Array Point

The Array point provides a more flexible, easy to access point structure for user-defined data. It is especially useful for advanced control or batch sequence programs. For example, an Array point can be used to store calculation variables or batch recipe data. This Array point data is available to the system for local data acquisition and control strategies as well as historization.

Up to 256 Array points can be configured per APM.

Each array point is a logical grouping of internal APM box global variables up to:

- 1023 Flags (boolean)
- 240 Numeric
- 240 Strings
- 240 Times

A subset of Array points can be used for Serial Interface (SI) communications. Up to 80 Serial Input Array points can be accessed at a 1 second rate per APM, 40 at a 1/2 second rate, or 20 at a 1/4 second rate.

A single Serial Interface Array point can handle:

- 512 Flags (Boolean) or
- 16 Numerics (Reals) or
- 32 Numerics (Integers) or
- 64 Characters of String Data.

Communication to any Serial Interface Array point is fully bidirectional (read and write). Data from any Serial Interface Array point can be accessed by other APM control and CL functions such as Device Control points. This allows subsystem data to be used for APM data acquisition and control strategies, as well as displayed at the Universal Station, $U^{X}S$ and UWS.

Flag Point

A Flag point is a two-state (On/Off) point that is used for storing a Boolean value. Flag points are not scheduled and are not processed. Their state is changed from another function, such as by operator input or a user-written program.

Provision is made for up to 16,384 Box Flag points, the first 128 of which can be configured for off-normal alarming.

Numeric Point

Numeric points are used for storage of real numbers.

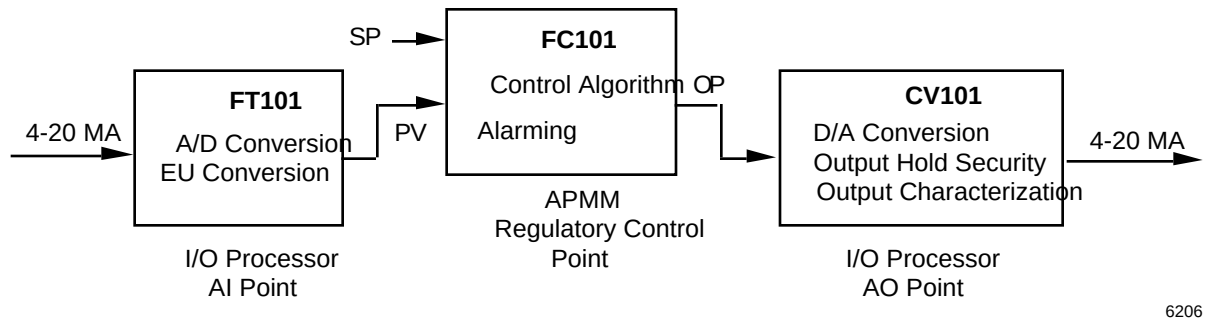


Figure 7 — Typical Regulatory Control Loop

They are used for batch/recipe operations, or as a scratch pad to store the intermediate results of calculations.
Like Flag points, they are not scheduled or processed, but are changed as the result of other system activity. There can be up to 16,384 Numeric points.

Timer Point

The Timer point allows for timing of process events by the operator or sequence program. After being started, it provides an indication when the elapsed time has reached a predefined limit. There are 64 timer slots—each is processed once per second.

String

The String variable adds increased flexibility to both continuous and batch oriented CL control programs. String variables of 8, 16, 32, or 64 characters can be compared and modified by the APM Control Language (CL). Using CL, you can manipulate and store unique messages that pertain to your process.
Also, with this Serial Interface, ASCII data from a subsystem can be imported and used as String variables, as well as written back to the subsystem.
Up to 16,384 eight character strings are supported.

Time

The Time variables allow CL programs access to both time and date information. CL programs can use elapsed or actual wall-clock time. Time-dates can be added or subtracted as needed.

Time allows you to schedule CL programs by time of day. You can also construct control schemes by allowing a logic slot access to time of day information. Up to 4,096 times are supported.

Control Implementation

A simple control loop can be implemented in an Advanced Process Manager, using an analog input point, a regulatory control point, and an analog output point as illustrated in Figure 7.

Although three data points are used, the primary operator interface is a single tag (FC101) for viewing, alarming, and manipulation in the customary manner through a Group, Detail, or Custom Graphic display.

Control Performance

The Advanced Process Manager is a high-performance device capable of an assured rate of 160 regulatory or discrete control loops per second. Users can customize their control configuration to meet the application requirements.

The parallel processing architecture of the Advanced Process Manager allows the control processing capability of the APM to be totally independent of other APM functions such as the number of I/O points built, data requests for APM data from the Network Interface Module and other UCN devices, and alarming functions. Only two factors must be considered when configuring the control processing—the **type** of control points (slots) desired and their **frequency** of execution, or scheduling interval. The processing power of the Advanced Control Processor is measured in terms of “Processing Units (PUs).” Each Advanced Control Processor has an assured rate of 160 PUs per second. Regulatory, logic, digital composite, and device control points can be configured at different execution frequencies (1/4, 1/2, or 1 second).

A subset of these points can be optionally configured for a 1/4-second rate, with the remainder at a slower rate. Since points use more processing power at faster frequencies, this feature allows the user to implement the greatest possible number of control loops while still assuring high-speed processing where required.

Table 6 — Control Configuration Examples

Point Type [1]	Example 1				Example 2			
	Frequency (Seconds)	Pt. Qty.	PU/Pt.	Total PUs	Frequency (Seconds)	Pt. Qty.	PU/Pt.	Total PUs
Regulatory Control	1	100	1	100	1	60	1	60
Regulatory PV	1	20	1	20	1	20	1	20
Logic	1	10	1	10	1/4	5	4	20
Digital Composite [2]	1	100	0.1	10	1/4	50	0.4	20
Device Control	–	–	–	–	1	20	1	20
Process Module	1	20	1	20	1	10/20	2/1 [3]	20
APM Total	–	250	–	160	–	180/190	–	160

1 Array, Flag, Numeric, and Timer points are not listed since they have a PU weight of 0.
2 Logic and DC points must run at execution frequencies equal to, or faster than, the normal scan rate for regulatory points.
3 1 PU for small or infrequently run programs; 2 PU for larger programs.

Still another option available for optimizing APM configuration is the selection between two program sizes for Process Module points. Users with sequence programs that process approximately 10 statements per second (or fewer) can implement twice as many such programs (160 instead of 80). This is possible because the smaller programs require less time to run and, therefore, are assigned only half as many Processing Units.

Typically, small programs are used for modular batch applications and large programs for continuous applications.

Any mixture of point types can be used, subject to the following individual maximums:

160	Regulatory Control
80	Regulatory PV
80	Logic
512	Digital Composite
160	Device Control
160	Process Module at 1 PU per APM program
	or
80	Process Module at 2 PUs per APM program

Table 6 shows two sample configurations.

Alarm System Functions

APM supports the extensive and flexible alarming capabilities of TDC 3000X. As process alarms occur, they are visually annunciated at the Universal Station through keyboard LEDs and numerous types of displays, such as custom graphic displays, group displays, alarm annunciator displays, and alarm summaries. They can also be externally announced through customer-supplied devices activated by contact closures at the Universal Station. Because alarms can be reported on an area or unit basis, operators receive alarm indications that relate to only their specific assignments.

For APM process variables, the following alarms can be configured:

- Hi
- HiHi
- Lo
- LoLo
- Bad PV
- Bad Output (RegCtl Point only)
- Rate of Change Hi
- Rage of Change Lo
- Significant Change
- Deviation Hi/Lo
- Advisory Deviation

All PV alarms can have a selectable deadband. Alarms can be assigned to both I/O Processors and APMM slots. In general, to provide a single tag for operator interface, when an I/O point is used by an APMM slot, the alarms are configured in the APMM slot.

The following digital alarm types are available:

- Uncommanded Change-of-State
- Off-normal alarms
- Command disagree alarms
- Logic input, flag, or gate output alarms
- Alarms forced by CL program
- Command Fail alarms
- User-defined alarms

Off-normal alarms feature a configurable time deadband. Command disagree, command fail, and uncommanded change-of-state are types of alarms that apply to digital composite points.

Alarm priority is individually configured for each alarm type used on a Advanced Process Manager point. There are seven selectable alarm priorities:

- Emergency
- High
- Low
- Journal

- Journal and Printer
- Printer Only
- No Action

Contact cutout is another configurable feature provided by the Advanced Process Manager. Contact cutout is used to automatically suppress alarm reporting on a point if certain external conditions occur.

Security

The APM has a number of security features to provide maximum process availability. A high-reliability fault-tolerant approach to both circuitry and overall system architecture has been used. CMOS technology, including highly heat-tolerant components, provides a high-density design with high reliability. Parallel power paths are employed so that control outputs can be maintained, even in the case of power regulator failure.

Redundancy for communications media, such as the I/O link and the UCN, is provided as a standard feature. Optional APMM redundancy is offered to provide one-on-one backup and auto-switchover for the common electronics. Optional I/O redundancy for HLAI, STI, AO, DI, and DO points can provide added security for critical control loops.

Since redundancy options are designed into the product, automatic switchover from primary to redundant electronics is fully supported. No special user programming is required. Ongoing diagnostics are provided to assure both primary and redundant electronics are functional. This one-on-one redundancy approach enhances coverage to maximize availability. It also simplifies system cabling and configuration.

Optional power redundancy and battery backup can be provided for assured power availability.

Extensive self-diagnostics are employed to diagnose APM operation and identify any failure. Failures are characterized as hard failure (HF) or soft failure (SF). The APM status is clearly indicated at the standard status displays at the Universal Station.

Repairs to the HPM can be made easily by replacing boards while power is on. Analog and Digital Standby Manual Units are available to maintain process outputs during board replacement of non-redundant boards. Overall, the APM provides outstanding control capabilities with excellent process control availability and security.

Physical Characteristics

The Advanced Process Manager consists of single or redundant Advanced Process Manager Modules, I/O Processors, associated card files, Field Termination Assemblies, and a single or redundant power assembly mounted in a cabinet. Either top or bottom field wire entry is available.

Because CMOS technology is used, power requirements and heat dissipation are extremely low. The Advanced Process Manager is also highly space efficient because of flexible I/O architecture, low power use, and high-density terminations.

The APM has been approved by Factory Mutual for mounting in, or interfacing to, devices in a Class 1, Division 2 area for the following signal types:

- Low Level Analog Input
- High Level Analog Input
- STI
- Analog Output
- Pulse Input
- 24 Vdc Digital Input

Power Systems

The Advanced Process Manager has significantly lower power requirements than traditional designs because it uses low-power CMOS technology. Two power systems are available to meet different system requirements.

The standard APM power system provides an integrated system battery backup option. The power system can also be easily upgraded to redundancy in the field.

The AC-only power system is intended for use with UPS systems and does not have provision for system battery backup. It can provide more cost effective power for a small, remote I/O installation where a UPS is available.

Both power systems provide 24 Vdc power to the Advanced Process Manager Module and I/O Subsystem, and 24 Vdc transmitter power is provided through standard FTA connections. Both power systems support single or redundant power supplies in a highly compact space.

Both power systems provide 50-hour memory backup; the standard system includes rechargeable batteries with a charger, while the AC-Only power system uses alkaline batteries.

Each power supply on both systems provide a relay with a Form-A contact output that de-energizes (contact opens) in the event of power loss.

A single LED on each power module of the AC-Only system annunciates power loss, while the standard system has separate LED indicators for:

- Loss of ac power
- Loss of dc power
- Improper charging of backup battery

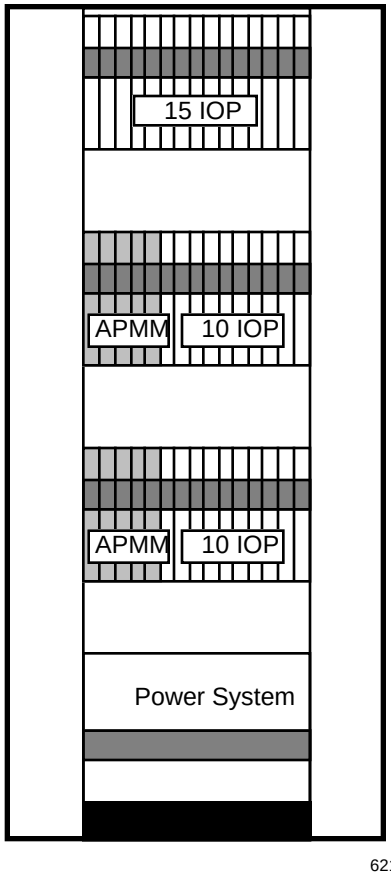


Figure 8 — Cabinet Layout with Redundant APMMs

- Failure or disconnection of battery
- High temperature

The standard APM power system delivers 20 amps. Two power supply sizes are available for the AC-Only power system—8 amp and 16 amp.

Card File Assemblies

A typical base APM configuration consists of up to 3 card files, as illustrated in Figure 8. When options such as I/O redundancy and/or remote I/O are used, configurations with up to 8 card files can be provided. One or two card files contain the Advanced Process Manager Module(s). All remaining card file slots can be filled with any combination of I/O Processors. A single cabinet holds up to 35 I/O Processors along with redundant Advanced Process Manager Modules. Alternatively, it holds up to 40 I/O Processors with a single Advanced Process Manager Module. Figure 8 shows the cabinet layout with redundant APMMs.

Input/Output Functions

Please refer to IO03-500, *Process Manager I/O Specification and Technical Data* for more details, model numbers, and specifications.

The following is an overview of HPM I/O functions and capabilities.

Input/Output Processors

Input/Output Processors (IOPs), along with Field Termination Assemblies (FTAs), perform input and output scanning and processing on all field I/O. A redundant I/O Link is standard for added security. Most IOPs are available in a redundant configuration. I/O processing is performed separately from control processing functions, so that I/O scan rates are completely independent of I/O quantity, controller loading, processing, and alarming. This partitioning of functions allows more efficient use of advanced control processor capabilities and provides for future I/O expansion.

A variety of I/O processors are available for the APM:

- Analog Input—High Level (16 points)
- Analog Input—Low Level (8 points)
- Analog Input—Low Level Multiplexer (32 points)
- Smart Transmitter Multivariable Interface (16 points total)
- Analog Output (8 points)
- Analog Output (16 points)
- Serial Device Interface (16 points—2 ports)
- Serial Interface (32 arrays, 2 ports)
- Pulse Input (8 points)
- Digital Input (32 points)
- Digital Input 24 Vdc (32 points)
- Digital Input SOE (32 points)
- Digital Output (16 points)
- Digital Output (32 points)

Any mix of the above I/O processors can be selected for an APM. This can be any combination of single and/or redundant (HLAI, STI, AO, DI, DISOE, and DO) pairs, up to a total of 40. Even with the maximum complement of 80

physical IOPs, there is no impact on control or communication performance. In a redundant configuration, I/O processing automatically transfers to the backup I/O processor when a board failure occurs.

Field Termination Assemblies

All connections to and from the process are made to Field Termination Assemblies (FTAs). Compression-type termination blocks (that can accept wire sizes as large as 14 AWG or 1.6 mm) are available for all FTAs. Screw-type terminations can also be provided for most FTAs. The FTAs are connected to the I/O processors by cables that can be up to 50 meters in length.

While a separate FTA of a given type is required to handle varying field wiring signal levels, identical I/O Processors can generally be used. This I/O approach simplifies system hardware selection and minimizes spare parts requirements. For example, one Digital Input Processor can handle 24 Vdc, 120 Vac, or 240 Vac, depending on the FTA selected.

Galvanically Isolated FTAs

These FTAs are available for connecting to field devices in NEC Class1 Division 1 Hazardous (classified) locations or Cenelec Zone 0 locations.

Wiring and installation are simplified because integral galvanically isolated intrinsic safety isolator modules are part of the FTA. **Please refer to GA03-100, *Galvanic Isolation/ Intrinsic Safety Specification and Technical Data* for further information.**

Options

Advanced Process Manager Module Redundancy

In addition to the UCN, the I/O Link, and dc power cabling, which are always redundant, the APMM is available with a one-on-one redundancy option. To minimize the impact of a single failure, the database and functions within the backup APMM are kept up-to-date with the primary. If failure of the primary is detected by diagnostics, the backup APMM automatically takes over from the primary and the operator is notified by a system alarm. The primary and secondary APMM can be located in separate card files to maximize control function availability.

Power System Redundancy

Both standard and AC-only power systems include the option for a redundant 24 Vdc power supply. In both cases, two different ac feeds can be used for the power system. With the standard power system, the second power supply may be added at a future date.

I/O Redundancy

A one-on-one I/O redundancy option is also available for critical high level analog inputs, smart transmitter interface connections, analog outputs, digital inputs, and digital outputs. This option offers significantly increased availability of automatic control by providing continuous operation through failure and replacement of I/O Processors, FTA cables, and backplanes. Up to 40 I/O Processors can be supported in a redundant or non-redundant Advanced Process Manager, and the user can selectively apply redundancy to some or all IOPs, for a maximum of 40 IOP pairs. The one-on-one design approach offers maximum coverage and fast switchover times. Integrity of the backup database and of the switching functions is provided through the extensive diagnostic coverage made possible by the processing capability of the smart I/O Processors.

Standby Manual

The 16-point digital output FTA and both analog output FTAs (8-point and 16-point) support connection to a standby manual unit. This option allows outputs to be maintained during I/O Processor replacement.

Battery Backup

An option to the standard APM power system is a backup battery capable of providing regulated 24 Vdc power in the event of the loss of ac input power. The battery is a compact set of gel cells that is mounted within the cabinet's power system enclosure. A fully charged battery provides a minimum of 20 minutes of backup for a fully loaded Advanced Process Manager.

Diagnostic and alarm capabilities inform the operator of the existing state of readiness of the battery and charger.

Because backup batteries provide input to the power supplies rather than powering the load directly, voltage regulation is equally as good when operating from either batteries or line power. If line power fails, load power is not interrupted during switchover. For the AC-only power system, line power backup is typically achieved by connecting a UPS to one of the two ac feeds.

I/O Simulation Option

The *optional* **APM I/O Simulator** package simulates the functions of the APM's Input/Output Processors (IOPs). It is a low cost, high fidelity tool for database building, control strategy checkout, and operator training support without the need for IOPs to be present. A unique feature of this optional package is

complete database transportability between the Simulation personality and the APM On-Process (normal operating) personality. This is especially useful for configuring the system before the physical I/O is available or connected. Features of the package include:

- 'Bumpless' pause/resume interruption/restart
- Physical IOPs, FTAs and field wiring not required
- Simulation status indicated and journaled
- Data base (checkpoint) transportable to target system
- Simulation rerun from saved data base using PV data
- Full peer-to-peer capability
- I/O functions simulated by Communications processor
- Any I/O configuration can be simulated
- Simulation load and status supported on system network
- Fault response testing & I/O redundancy simulation

The benefits of this package include:

- The ability to perform high fidelity simulation
- Control strategy checkout
- Operator training
- Project cost savings

Remote I/O

Two Remote I/O options are available. Both enable distribution of I/O Processors and FTAs at up to six remote sites. One option supports remote sites up to 1 kilometer from the main APM, while the second option provides for separation of up to 8 kilometers. FTAs at the remote locations can be located an additional 50 meters from the I/O processors, and LLAI MUX, Serial Device or Serial Interface FTAs can be placed an additional 300 meters away. Significant reduction of signal wire runs are possible with this option. Redundant fiber optic cables provide immunity to ground potential differences and EMI/RFI interference. Redundant links each require an I/O Link Extender Pair (IOLE) at both ends. The Remote I/O (1 km) option supports up to three remote sites for each IOLE at the APM end, while the Long Distance I/O (8 km) option requires one APM IOLE per site.

Corrosion Protection Option

As electronic boards have become more compact, sensitivity to corrosion has increased. In addition, a trend toward locating I/O closer to the process to save installation costs has generated a requirement for environmentally hardened products. To provide extra corrosion protection when APM equipment cannot be located in a mild (G1) environment, conformally-coated boards are available. These boards are completely covered with a thin plastic film resistant to the corrosive effects of humidity and certain gases, and are thus suitable for placement in a harsh (G3) atmosphere. Coating is optional for most APM components, such as IOPs, FTAs, power supplies, backplanes, and processor boards. Some components, however, are coated as a standard, such as the HLAI IOP, AO IOP, and 16 amp APM power supply.

All coated products are denoted by a “C” in the second character of their model number. Uncoated boards maintain the standard MU-xxxxxx style numbers. All products for which conformal coating is available have two model numbers. For example, the uncoated DI IOP model number is MU-PDIX02, and the coated version is MC-PDIX02. In order to easily identify coated IOPs in the field, they are labeled with a distinctive symbol located on their faceplate (see Figure 9). The “C” surrounded by a solid diamond (the universal symbol of hardness) represents the protection this conformal coating process provides.

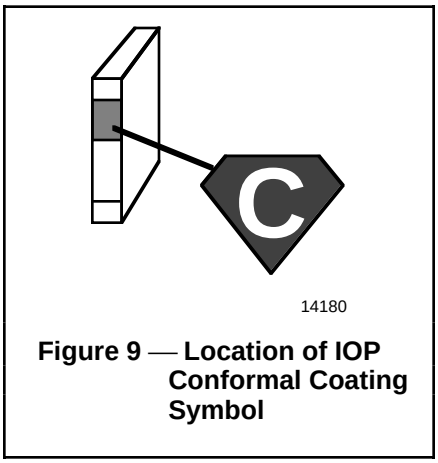


Figure 9 — Location of IOP Conformal Coating Symbol

Note: Boards installed and maintained in a G1 (mild) control room environment (defined by the ISA Environmental Severity Classification) do not need this added protection.

European Community (EC) Compliance

The APM is available in compliance with European Community (EC) directive requirements, denoted by the “CE mark” (Communaute Europeene). This compliance extends to the APMM, cardfiles, power supplies, IOPs and FTAs, as well as to Rittal cabinets. As of January 1, 1996, all goods imported into the European community or moving between member countries must be compliant with the new EC directives.

For APM, customers must choose whether or not CE compliance is needed. APMMs, IOPs, and power supplies are only available CE-compliant. For cardfiles and *some* FTAs, both compliant and non-compliant versions are available. Only Rittal cabinets are CE-compliant. Please refer to **IO03-500, Process Manager I/O Specification and Technical Data**, for IOP/FTA details.

Note that the following are some of the conditions required in order for CE compliance to be met:

- All FTAs must be connected to IOPs (no unconnected parts).
- Shielded FTA cables must be used if outside a cabinet.
- The system must be mounted into a Rittal cabinet per Honeywell specifications.
- All cabinet doors must be fully closed.
- Standard Honeywell/Rittal mounting plate and channels must be used.
- The system must be installed according to the Honeywell instructions.
- The system must be grounded per Honeywell instructions.

Harsh Environment Option

To help reduce wiring and installation costs, as well as free up valuable control room space, a Remote Hardened I/O (RHIO) NEMA4X sealed cabinet option is available for remotely mounting APM I/O. Backplanes and power supplies included with RHIO are conformally coated.

When populated with conformally coated IOPs, FTAs, and Fiber Optic Extenders, the RHIO option provides a GX 'Severe' environment product rating against corrosion due to humidity and corrosive gases in remote locations.

The IOP cabinet accommodates a 7-slot file and a redundant 8-amp power supply and is available as a standard product; the FTA cabinet must be custom ordered due to the many variations of FTA sizes and layouts.

Specifications

Specifications apply to the APM modules mounted in a standard APM cabinet.

Advanced Process Manager Environmental Conditions

Parameter	Reference Band	Normal Limits	Operative and Storage Limits	Transportation Band
Ambient Temperature(1,2) Range Rate of Change	 25 ± 1°C None	 0-50°C ≤0.25°C/min.	 0-50°C(2) ≤1°C/min.	 -40 to 80°C(3) ≤5°C/min.
Relative Humidity(4)	15-55%	15-70%	10-90% (No Condensation)	5-95%
Vibration (3 major axes) Frequency Acceleration Displacement	 None	 10-60 Hz 0.1 g maximum 0.03 inches	 10-60 Hz 0.5 g maximum 0.1 inches	 0-60 Hz 1 g maximum 0.1 inches
Mechanical Shock Acceleration Duration	 None	 1 g maximum 30 ms maximum	 5 g maximum 30 ms maximum	 20 g maximum 30 ms maximum
Barometric Pressure Altitude	 Sea Level	 +3000 m/-300 m	 +3000 m/-300 m	 any
Corrosives(1) **MU-MC-**	--	Class G1 (uncoated) Class G3 (coated)	Class G1 (uncoated) Class G3 (coated)	Class G1 (uncoated) Class G3 (coated)
Electromagnetic Interference(1)	--	15 V/M	15 V/M	--
Electrostatic Discharge	--	IEC 801-2 15 kV 20x once/5 seconds	IEC 801-2 15 kV 20x once/5 seconds	--
Surge	--	IEEE/ANSI C37.90.1-1989		

(1) External to standard APM cabinet with doors closed.

(2) APM boards are nominally rated for 0-70°C. This allows for a 15 °C temperature rise inside the cabinet when the external temperature is 0-50 °C, based on allowable hardware configurations inside a cabinet with the door(s) closed.

(3) Battery backup option must be transported and stored at temperatures -40 to +85°C.

(4) The maximum relative humidity specification applies up to 40°C. For 50°C, the RH specification is derated to 55% to maintain constant moisture content.

APM Certifications(1)

For:	Certifying Agency
General Purpose Area	FM, CSA
Class 1, Division 2 Mounting (1)	FM
Class 1, Division 2 Interfacing, without barriers (1, 2)	FM

(1) Received and Pending. For further details, see the APM Site Planning Manual, Section 13. Certification marking provided only if requested in sales order.

Specifications continued

European Community Compliance (CE-Mark)

CE Conformity (Europe)	This product is in conformity with the protection requirements of the following European Council Directives: 73/23/EEC, the Low Voltage Directive, and 89/336/EEC, the EMC Directive. Conformity of this product with any other "CE Mark" Directive(s) shall not be assumed. *Deviation from the prescribed procedures and conditions specified in the installation manuals may invalidate this product's conformity with the Low Voltage and EMC Directives.*
Product Classification	Class I: Permanently mounted, permanently connected Industrial Control Equipment with protective earthing (grounding). (EN 61010-1-1993)
Enclosure Rating	The APM is sold to users in a lockable cabinet which prevents OPERATOR access to live parts, thereby providing protection against shock hazard. If a user installs parts of a Process Manager outside of the standard cabinet, they must be in an equivalent enclosure.
Installation Category	Category II: Energy-consuming equipment supplied from the fixed installation. Local Level Appliances and Industrial Control Equipment . (EN 61010-1-1993)
Pollution Degree	Pollution Degree 2: Normally non-conductive pollution with occasional conductivity caused by condensation. (IEC 664-1-1992)
EMC Classification	Group 1, Class A, Industrial, Scientific and Medical (ISM) Equipment. (EN55011-1991; Emissions)
Method of Assessment	EMC: Technical Construction File (TCF) LVD: Technical File (TF)

APMM Redundancy Option*

Parameter	Specification
Control Hold Due to Swap or Failover Typical Maximum	 1.5 seconds 3.0 seconds
*Note: A redundant HPM requires a redundant power supply.	

I/O Link Extender (Remote I/O)

Parameter	Specification	
	Remote I/O Link Extender	**Long Distance I/O Link Extender**
Fiber Link Length	1.2 km	8 km
Fiber Size	62.5/125 µm	62.5/125 µm
Wave Length	820 nanometers	1300 nanometers
Fiber Power Budget Over-Temperature Range	5.5 db	10.0 db
Note: Fiber optic cables are supplied by outside vendors in accordance with Honeywell specifications. For additional information, see the *Advanced Process Manager Site Planning* Manual, Section 17.		

Specifications continued

Advanced Process Manager Standard Power Systems(1)

Electrical Specifications			
Parameter	**Reference**	**Normal Band**	**Operating Limits**
120/240 Vac Input(2)			
Voltage (Vac rms)	120 or 240 ± 1	100-264	100-264
Current (amps)			
- Maximum Inrush (Peak)	35	--	--
- Running (rms)	9	--	--
- Crest Factor	1.1 max.	--	--
Frequency	50/60 ± 0.1	47-63	47-63
Total Harmonic Distortion	0	0-8%	0-8%
DC Output			
Voltage (Vdc) powered from ac	25.5	25-26	25-26
Current (amps)	20	0-20	0-20
Voltage (Vdc) powered from batteries	24.5	24-25	24-25
Hold-Up Time (any supply voltage)	25 ms (Nominal line and full load — without batteries)		
Efficiency (any supply)	65% minimum		

System Battery Backup Specifications	
Parameter	**Specification**
Environment	See Environmental Conditions
Battery Type	48 Vdc (bulk), 12 amp-hours (sealed gel-cell)
Battery Life	5 years at 20°C ambient in an operating system
Switchover, Switchback Time	Instantaneous — diode switching

CMOS Memory Backup Specifications	
Parameter	**Specification**
Environment	See Environmental Conditions
Battery Type	Three 1.2 Vdc, size C nickel-cadmium cells
Battery Life	5 years
Switchover, Switchback Time	Instantaneous — diode switching

(1) A redundant APM requires a redundant power supply.

(2) The supply is intended to work on nominal voltages of 120 V (100-132) or 240 V (187-264). It is not necessary for the user to make any adjustments to do this.

Specifications continued

Advanced Process Manager AC-Only Power Systems

Electrical Specifications			
Parameter	**Reference**	**Normal Band**	**Operating Limits**
120 Vac Input(1)			
Voltage (Vac rms)	120	100-132	100-132
Current (amps)			
- Maximum Inrush (Peak)	30	--	--
- Running (rms) for 8 amp PS	3.5 max.	--	--
- Running (rms) for 16 amp PS	6.5 max.	--	--
- Crest Factor	2.8 max.	--	--
Frequency	50/60	47-63	47-63
Total Harmonic Distortion	0	0-8%	0-8%
240 Vac Input(1)			
Voltage (Vac rms)	240	200-264	200-264
Current (amps)			
- Maximum Inrush (Peak)	30	--	--
- Running (rms) for 8 amp PS	2.0 max.	--	--
- Running (rms) for 16 amp PS		--	--
- Crest Factor	2.8 max.	--	--
Frequency	50/60	47-63	47-63
Total Harmonic Distortion	0	0-8%	0-8%
DC Output			
Voltage (Vdc) powered from ac	25	24.5-25.5	24.5-25.5
Current (amps) for 8 amp PS (2)	8	0-8	0-8
Current (amps) for 16 amp PS (2)	16	0-16	0-16
Hold-Up Time (any supply voltage)	20 ms (Nominal line and full load)		
Efficiency (any supply)	75% minimum		

CMOS Memory Backup Specifications	
Parameter	**Specification**
Environment	See Environmental Conditions
Battery Type	Three size AA alkaline cells
Battery Recharge	Not rechargeable; replace after any use
Battery Life	One year if not used — 50 hours minimum when used
Switchover, Switchback Time	Instantaneous — diode switched

(1) Input voltage is factory set—cannot be changed in the field.

(2) Output current and redundancy are factory configured. They cannot be changed in the field.

(3) A redundant APM requires a redundant power supply.

Model Numbers -- Advanced Process Manager

Description	Uncoated Model Number	Coated Model Number
Advanced Process Manager Module Board Sets		
Advanced Process Manager Module Board Set — Redundant	MU-APMR01	MC-APMR01
Advanced Process Manager Module Board Set — Single	MU-APMS01	MC-APMS01
APMM Blank Filler Plates for 5 Slots	MU-APME01	--
APMM Redundancy Upgrade Kit (APMS01 to APMR01)	MU-ZAMR01	MC-ZAMR01
PM to APM Upgrade Kit (Single)	MU-ZAPS01	MC-ZAPS01
PM to APM Upgrade Kit (Redundant)	MU-ZAPR01	MC-ZAPR01
Card Files (Telephone Connector Version)		
APMM/PMM File (Empty, 10 I/O Slots), Non-CE	MU-PMFX02	MC-PMFX02
APMM/PMM File (Empty, 5 I/O Slots) Side-by-Side Red., Non-CE	MU-PMFR02	MC-PMFR02
I/O Processor File (Empty, 15 I/O Slots), Non-CE	MU-IOFX02	MC-IOFX02
CE-Mark APMM/PMM File (Empty, 10 I/O Slots)	MU-PMFX03	MC-PMFX03
CE-Mark APMM/PMM File (Empty, 5 I/O Slots) Side-by-Side Red.	MU-PMFR03	MC-PMFR03
CE-Mark I/O Processor File (Empty, 15 I/O Slots)	MU-IOFX03	MC-IOFX03
Advanced Process Manager Software Options		
APM/HPM I/O Simulator Software, R500	MU-SWSM22*	n/a

Note: *Software package includes I/O simulation personalities for both APM and HPM.

Model Numbers (continued)

Description	Model Number
Cabinets and Cabinet Components (Markhon Style) (not CE-compliant)	
Cabinet Dual Access (.8 W x .8 D x 2.1 H [meters])	MU-CBDM01
Cabinet Single Access (.8 W x 5.5 D x 2.1 H [meters])	MU-CBSM01
Cabinet Lifting Eyebolts (4)	MU-CLBM01
Cabinet (Dual Access) Forklift Base	MU-CFDM01
Cabinet (Single Access) Forklift Base	MU-CFSM01
Cabinet Trim File Filler Plate	MU-CTFP11
Vertical Trim Panel Set Full Height	MU-CTVF11
Vertical Trim Panel Set Half Height	MU-CTVH11
FTA Mounting Channel Narrow	MU-TMCN11
FTA Mounting Channel with Shield Ground Bar Narrow	MU-TMCN12
FTA Mounting Channel Wide	MU-TMCW11
FTA Mounting Channel with Shield Ground Bar Wide	MU-TMCW12
Cabinets and Cabinet Components (Rittal Style) (CE-compliant)	
Cabinet Dual Access (.8 W x .8 D x 2 H [meters])	MU-CBDX01
Cabinet Single Access (.8 W x .5 D x 2 H [meters])	MU-CBSX01
Cabinet Trim File Filler Plate	MU-CTFP01
Vertical Trim Panel Set Full Height	MU-CTVF01
Vertical Trim Panel Set Half Height	MU-CTVH01
FTA Mounting Channel Narrow	MU-TMCN01
FTA Mounting Channel with Shield Ground Bar Narrow	MU-TMCN02
FTA Mounting Channel Wide	MU-TMCW01
FTA Mounting Channel with Shield Ground Bar Wide	MU-TMCW02

Description	Uncoated Model Number	Coated Model Number
Cabinet Fan Assemblies (All Styles)		
Cabinet Fan Assembly (240 Vac-50/60 Hz)	MU-FAN501	n/a
Cabinet Fan Assembly with Alarm (240 Vac-50/60 Hz)	MU-FAN511	MC-FAN511
Cabinet Fan Assembly (120 Vac-50/60 Hz)	MU-FAN601	n/a
Cabinet Fan Assembly with Alarm (120 Vac-50/60 Hz)	MU-FAN611	MC-FAN611

Model Numbers (continued)

Description	Uncoated Model Number	Coated Model Number
Power Systems Including, or Upgradable to, System Battery Backup		
PM/APM/HPM Redundant Power System with Mounting (20 A)	MU-PSRX04	MC-PSRX04
PM/APM/HPM Single Power System with Mounting (20 A)	MU-PSSX04	MC-PSSX04
PM/APM/HPM Redundant Power System w/ Sys. Battery Backup Mounting (20 A)	MU-PSRB04	MC-PSRB04
AC-Only Power Systems		
AC-Only Redundant Power Supply 120 Vac (8 A)	MU-PAR111	MC-PAR111
AC-Only Redundant Power Supply 240 Vac (8 A)	MU-PAR211	MC-PAR211
AC-Only Single Power Supply 120 Vac (8 A)	MU-PAS111	MC-PAS111
AC-Only Single Power Supply 240 Vac (8 A)	MU-PAS211	MC-PAS211
AC-Only Redundant Power Supply 120 Vac (16 A)	MU-PAR121	MC-PAR121
AC-Only Redundant Power Supply 240 Vac (16 A)	MU-PAR221	MC-PAR221
AC-Only Single Power Supply 120 Vac (16 A)	MU-PAS121	MC-PAS121
AC-Only Single Power Supply 240 Vac (16 A)	MU-PAS221	MC-PAS221
AC-Only Power System Cover Plate	MU-PACP01	MC-PACP01
24 Vdc Power Distribution		
Power Distribution FTA (24 Vdc)	MU-TDPR02	MC-TDPR02

Model Numbers (continued)

Description	Model Number
UCN Cables (Indoor Use)	
UCN RG-6 Drop Cable Pair (In Cabinet)	MU-NKD000
UCN RG-6 Drop Cable Pair (2 m)	MU-NKD002
UCN RG-6 Drop Cable Pair (5 m)	MU-NKD005
UCN RG-6 Drop Cable Pair (10 m)	MU-NKD010
UCN RG-6 Drop Cable Pair (20 m)	MU-NKD020
UCN RG-6 Drop Cable Pair (30 m)	MU-NKD030
UCN RG-6 Drop Cable Pair (40 m)	MU-NKD040
UCN RG-6 Drop Cable Pair (50 m)	MU-NKD050
UCN RG-6 Drop Connectors Kit (24 Connectors)	MU-NKDK01
UCN RG-6 Trunk Cable Crimp Tool	MU-NKDT01
UCN RG-11 Trunk Cable Pair (2.5 m)	MU-NKT002
UCN RG-11 Trunk Cable Pair (5 m)	MU-NKT005
UCN RG-11 Trunk Cable Pair (10 m)	MU-NKT010
UCN RG-11 Trunk Cable Pair (20 m)	MU-NKT020
UCN RG-11 Trunk Cable Pair (30 m)	MU-NKT030
UCN RG-11 Trunk Cable Pair (50 m)	MU-NKT050
UCN RG-11 Trunk Cable Pair (100 m)	MU-NKT100
UCN RG-11 Trunk Cable Pair (200 m)	MU-NKT200
UCN RG-11 Trunk Cable Pair (400 m)	MU-NKT400
UCN RG-11 Trunk Cable Pair (600 m)	MU-NKT600
UCN RG-11 Trunk Connectors Kit (24 Connectors)	MU-NKTK01
UCN RG-11 Trunk Cable Crimp Tool	MU-NKTT01
UCN RG-11 Trunk Cable Splice Kit (10 in a Package)	MU-NCSK01
UCN RG-11 Raw Cable (152 m)	51190899-152
UCN RG-11 Raw Cable (305 m)	51190899-305
UCN RG-11 Raw Cable (762 m)	51190899-762
UCN Cables (Outdoor Use)	
UCN RG-11 Raw Cable (152 m)	51191607-152
UCN RG-11 Raw Cable (305 m)	51191607-305
UCN RG-11 Raw Cable (762 m)	51191607-762
UCN Taps	
UCN Tap Pair with 2 Drops per Tap (with Brackets)	MU-NTAP02
UCN Tap Pair with 4 Drops per Tap (with Brackets)	MU-NTAP04
UCN Tap Pair with 8 Drops per Tap (with Brackets)	MU-NTAP08
UCN Tap Torque Tool Kit	MU-NKTQ01

Copyright, Trademarks, and Notices