I/O Functions

I/O Processors, along with Field Termination Assemblies (FTAs), perform input and output scanning and processing on all field I/O (Figure 8). A redundant I/O Link is standard for added security. Optionally High Level Analog Input, Smart Transmitter Interface, and Analog Output processors can be redundant. 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 capability 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 Interface (16 points) (Multivariable)
- Analog Output (8 points)
- Serial Device Interface (16 points—2 ports)
- Serial Interface (32 arrays, 2 ports)
- Pulse Input (8 points)
- Digital Input (32 points)
- Digital Input SOE (32 points)
- Digital Output (16 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, and AO) 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, control automatically transfers to the backup I/O processor during board replacement.

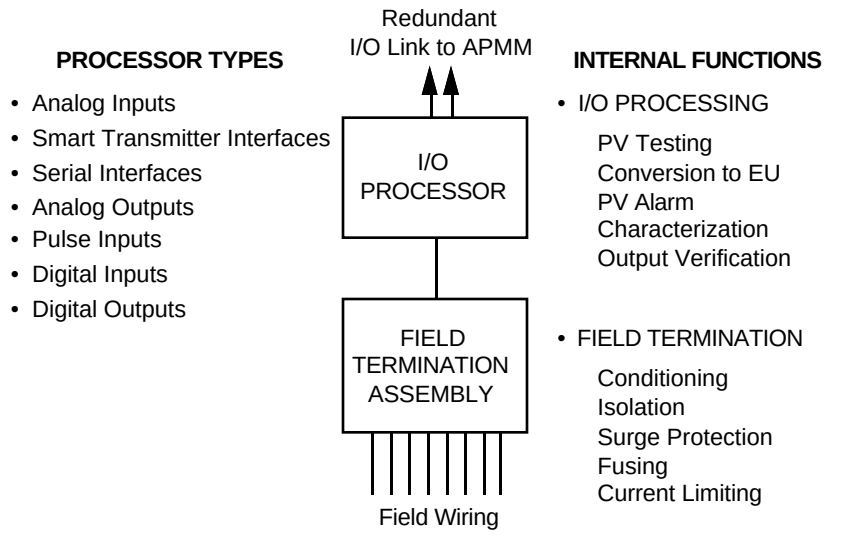

Figure 8 — APM I/O Functions

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

Analog Input

Both the high and low level analog input processors perform signal conversion and conditioning functions:

- PV Source (Auto, Manual, Substituted)
- PV Clamping
- EU Conversion
- PV Value Status
- PV Alarming
  - Bad PV
  - PV Hi/Lo
  - PV HiHi/LoLo
  - PV Rate-of-Change +/-
- Software Calibration

They perform engineering unit conversion, including fifth-order polynomial temperature input characterization, with the high level processor receiving these inputs from mV/I converters.

Through use of a dual processor design and custom integrated circuits, the low level analog input processor supports software configuration per channel for different thermocouples or RTD types with excellent resolution and accuracy. Open thermocouple detection is performed once per scan so that no bad data is propagated for control processing.

The low level multiplexer processor provides an even more economical way to bring in a large number of data acquisition signals. Each processor can handle 32 points, using two 16-point FTAs. Each point is scanned once per second with a 1 second scan delay for processing. Open thermocouple detection is performed on a regular basis for all points. Options for either local or remote cold junction reference are available.

Smart Transmitter Multivariable Interface

The Smart Transmitter Multivariable (STI-MV) processor is the APM's digital interface to Honeywell's advanced series of smart transmitters.

Each STI-MV processor can communicate bidirectionally with up to 16 smart transmitters, including

- ST3000
- STT3000
- Smart MagneW™ 3000

These transmitters are used for pressure, temperature, and flow measurement. Multivariable transmitters provide the high accuracy of a digital interface, while reducing wiring costs, because multiple PVs are available over a single pair of wires.

Each STI-MV processor also has the ability to accept up to four PVs each from the following multivariable transmitters:

- SCM 3000 Coriolis flowmeter
- Drexelbrook LT level transmitter

Each IOP can accommodate DE inputs to a maximum of

- 16 single PV inputs from Smartline transmitters
- Four multivariable field devices with up to four PVs each, or
- A mix of single and multivariable field devices that equals up to 16 inputs per IOP (some restrictions apply).

The STI-MV Interface supports the functions for PV processing, EU conversions, and alarming supported by the other analog input processors (see above). It also provides Bad PV and Bad Database protection for added security.

All communications from the STI-MV processor to the Smart Transmitter are bit-serial, bidirectional, using the Honeywell DE (digital enhanced) protocol.

An individual at a Universal Station can perform any of the following functions:

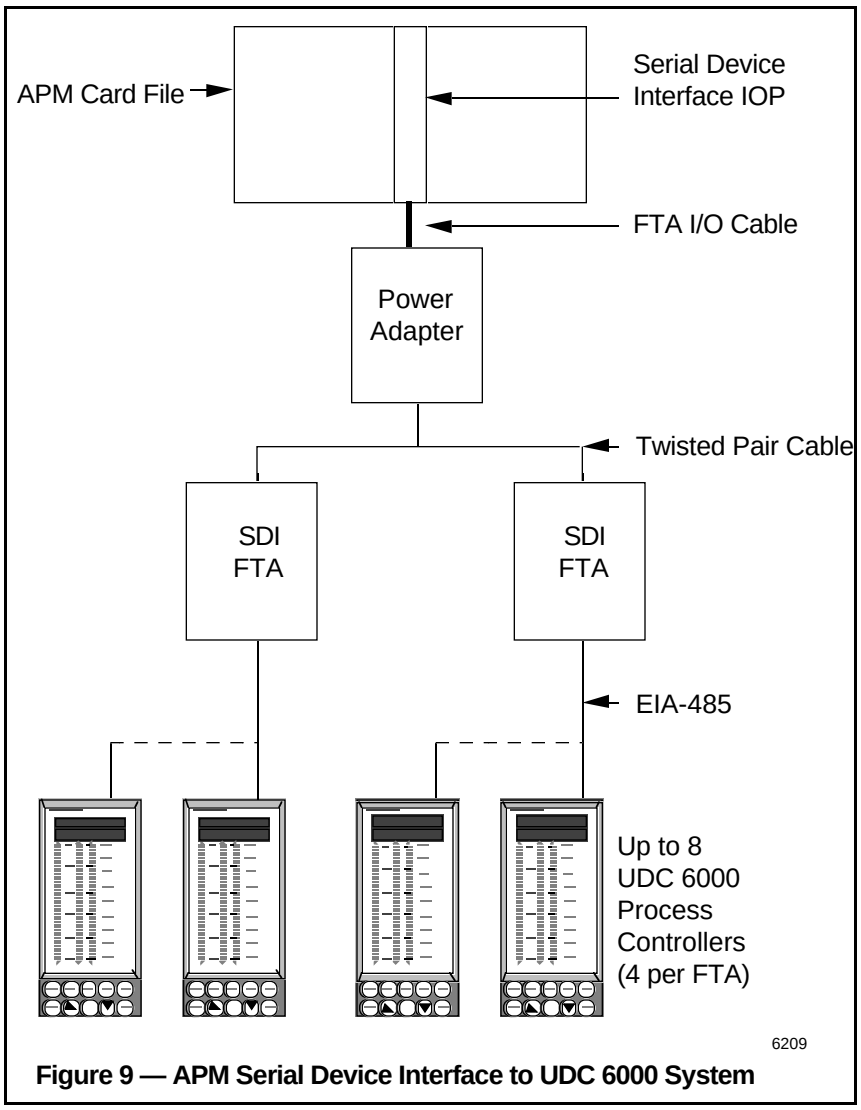

Figure 9 — APM Serial Device Interface to UDC 6000 System

- Display primary and secondary Process Variables
- Display/Modify/Configure the transmitter database
- Re-range the transmitter
- Save/Restore the database
- Support calibration commands
- Display detailed transmitter status information
- Display the transmitter scratch pad, serial number, and revision level.

Enhanced digital accuracy is provided for all signals, resulting in accuracy that typically is three times better than that of analog.

Serial Device Interface

The Serial Device Interface (SDI) processor provides a cost-effective method to connect to field devices that use serial communications (EIA-232* or EIA-485*). Inputs from these devices are mapped into the I/O database and can be used directly for calculations and control by the Advanced Process Manager. The data is available for Universal Station display, advanced control applications, analysis, and reports. Since communication is bidirectional, information such as target value or damping factors can be written to or read from the field device.

™ MagneW is a trademark of Honeywell Inc.

* Electronic Industries Association (formerly RS-232 and RS-485)

Specific serial devices are supported by custom programmable modules.

One such device is the UDC 6000 Process Controller (Figure 9), which provides single-loop remote display and control capability.

Operating as a subsystem of the APM controller, the UDC 6000 displays PV, SP, and OP on front panel bar graphs. When digitally integrated with the APM, the UDC Controller can be configured for the following modes:

- Manual/Auto (M/A) Station where all control resides in the APM.
- M/A Station with emergency backup control.
- Stand-alone control with the APM as supervisor.
- Stand-alone control with remote SP from the APM.

An interface to Toledo Weigh Cell (T8142), providing weight, setpoint control of feed (fast cutoff) and rate of change alarming, is also supported.

Serial Interface IOP

The serial interface IOP provides a communications interface to Modbus or Allen-Bradley compatible subsystems (see Figure 10). Each serial interface IOP supports up to two FTAs. Each FTA supports one port and up to 16 array points.

The Modbus SI FTA supports Modbus RTU protocol and uses either EIA-232 or EIA-422/485 communications. The Allen-Bradley FTA supports DF-1 protocol and uses only EIA-232 communication.

The serial interface supports direct digital communications to any qualified subsystems. Using this scheme, serial data is then made available for all APM data acquisition and control strategies. Using the 16 available array points, an SI FTA can access up to

- 8192 Flags (boolean) or
- 256 Reals or
- 512 Integers or
- 1024 Characters.

The array point values can be displayed at the Universal Station or used as part of advanced control strategies. These values can be configured into APM control strategies using Digital Composites, Device Points, and Regulatory Points as well as CL programs. Both reads and writes of subsystem data are supported. To assure smooth field integration of a variety of subsystems, subsystem devices with the serial interface are qualified as part of Honeywell's Multi-Vendor Interface Program.

Pulse Input

Precise control using high-accuracy pulsing-type sensing devices is possible with the Pulse Input processor. The result is improved product quality and reduced material waste. Pulse rates up to 20 kHz can be handled. Conversion to engineering units is performed, along with alarm checking, filtering, and data validity checking. Pulse input provides 24 Vdc transmitter power.

Analog Output

The Analog Output Processor provides the following functions:

- Readback check of actual output current
- Output characterization (5-segment)
- Output default action on failure (hold or unpowered)
- Modes and associated functions to support Manual loader and DDC control
- Software calibration

The analog output processor provides separate D/A converters and power regulator per channel for maximum output security.

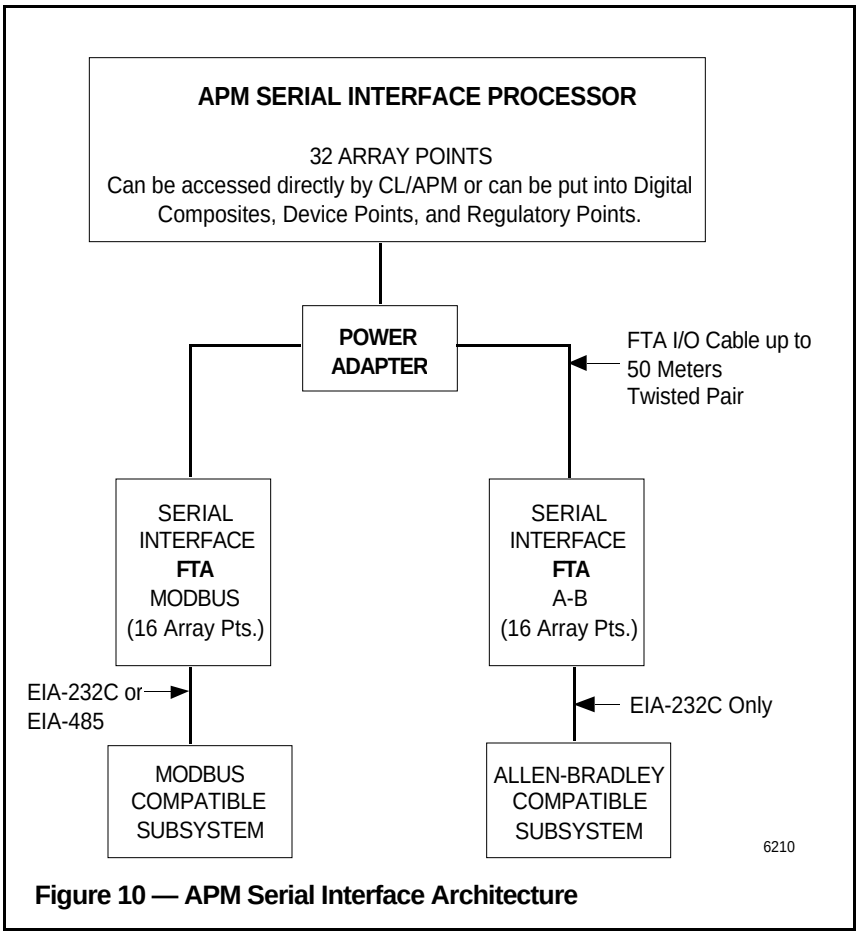

Figure 10 — APM Serial Interface Architecture

As an option, one-on-one Analog Output processor redundancy provides even higher control strategy integrity.

Digital Input

The Digital Input Processor provides the following functions:

- Event counting (accumulation) (maximum pulse rate = 15 Hz)
- Pushbutton and status type inputs (minimum on-time = 40 ms)
- Time deadband on alarms for status inputs
- Input direct/reverse
- PV source selection
- State alarming for status inputs
- Sequence of events resolution within 20 ms

Digital Input—Sequence of Events

This specialized digital input processor (DISOE) provides all the functions of the conventional Digital Input except accumulation. Inputs from the board can be used for control strategies just like any other digital input.

In addition, this DISOE processor provides high-resolution sequence of events monitoring. Using the DISOE processor, time stamp resolution within 1 ms SOE is assured.

The DISOE processor provides optimum resolution when used with the standard 24 Vdc Digital Input FTA.

Digital Output

The Digital Output Processor provides the following functions:

- Output types (configurable per output)
  - Latched
  - Pulsed
  - Pulse-width modulated
- Output default action on failure (hold or unpowered)
- Output readback checking

For added output security, separate output latches with redundant power regulators are provided for default values.

I/O Simulation Option

An optional I/O Simulator package is available which simulates the functions of the IOPs for the APM. It is a low cost, high fidelity simulation approach for control strategy checkout or for operator training support. 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

- Physical IOPs, FTAs and field wiring not required
- Database (checkpoint) transportable to target system
- Simulation rerun from saved database using PV data
- Full peer-to-peer capability
- I/O functions simulated by Communications processor
- Any I/O configuration can be simulated

The benefits of this package include

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

Alarm System Functions

APM supports the extensive and flexible alarming capabilities of TDC 3000^X. 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, alarm summaries, and so on. 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	• Rate of Change Hi
• HiHi	• Rate of Change Lo
• Lo	• Significant Change
• LoLo	• 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.

For digital alarms, these are the types of alarm:

- Uncommanded Change-of-State
- Off-normal alarms
- Command disagree alarms
- Logic input, flag, or gate output alarms
- Alarms forced by CL program
- Command Fail alarm
- 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 and each Hi or Low trip point for each Advanced Process Manager point. There are five selectable alarm priorities:

- Emergency
- High
- Low
- Journal
- 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 Advanced Process Manager has a number of security features to provide maximum process availability. Throughout the APM's design, a high-reliability, fault-tolerant approach to both circuitry and overall system architecture has been used. For example, an overall reduction in the number of components increases overall reliability and availability. CMOS technology, including highly heat-tolerant components, provides a high-density design with high reliability. Individual circuitry is used for critical functions, such as D/A converters on the output circuitry. 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, and AO 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.

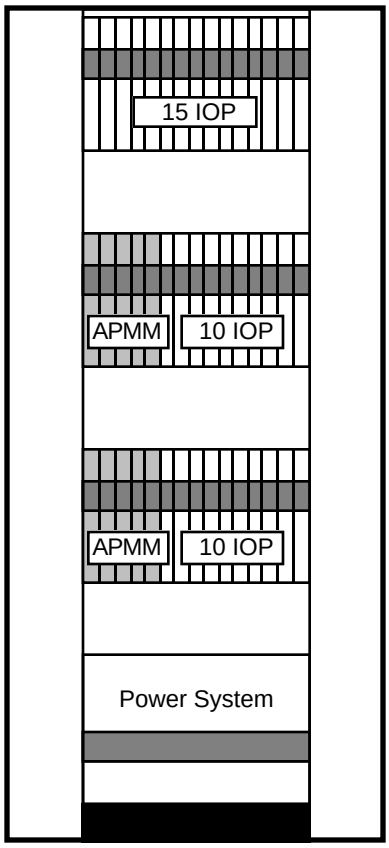

Figure 11 – Cabinet Layout with Redundant APMMs

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). APM status is indicated both locally through LEDs and at the standard status displays at the Universal Station.

Repairs to the APM 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. Overall, the APM provides superb 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, and 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
- 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.

Table 7 — FTA Sizes

FTA Type	Compr'n Terminals	Screw Terminals	Circuits	Size(1)
High Level Analog Input/STI	√		16	A
High Level Analog Input/STI		√	16	B
HL Analog Input/STI (Redundant)	√	√	16	B
Low Level Analog Input	√		8	B
Low Level Analog Input Multiplexer (2)	√		16	B
Serial Device Interface (2)			1	A
Serial Interface (2)			1	A
Power Adapter				A
Analog Output	√		8	A
Analog Output		√	8	B
Analog Output (Redundant)	√	√	8	B
Digital Input—24 Vdc	√	√	32	C
Digital Input—120 Vac	√	√	32	C
Digital Input—240 Vac	√	√	32	C
Power Distribution FTA	√		12	A
Pulse Input	√	√	8	B
Digital Output—24 Vdc, Nonisolated Solid State	√	√	16	B
Digital Output—3-30 Vdc Solid State	√	√	16	B
Digital Output—31-200 Vdc Solid State	√	√	16	B
Digital Output—120/240 Vac Solid State	√	√	16	B
Digital Output—120 Vac/125 Vdc Relay	√	√	16	B
Digital Output—240 Vac/125 Vdc Relay	√	√	16	B
I.S. Galvanic Isolation—HLAI/STI FTA	√		16	B
I.S. Galvanic Isolation—AO FTA	√		16	B
I.S. Galvanic Isolation—DI FTA	√		16	B
I.S. Galvanic Isolation—DOFTA	√		16	B
I.S. Galvanic Isolation—Marshalling Panel		√	16	B

(1) Length: A = 15.24 cm/6.0 in.
B = 30.73 cm/12.1 in.
C = 46.228 cm/18.2 in.

(1) Width: (all FTAs except I.S. Galvanic Isolation) = 12.065 cm/4.75 in.
(all I.S. Galvanic Isolation FTAs) = 12.446 cm/4.90 in.

(2) Requires Power Adapter FTA (see Figures 9 and 10).

Card File Assemblies

A typical base APM configuration consists of up to three card files, as illustrated in Figure 11. When options such as I/O redundancy and/or remote I/O are used, configurations with up to eight 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 11

shows the cabinet layout with redundant APMMs.

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) are available for all FTAs. Screw-type terminations can also be provided for most FTAs as shown in Table 7.

The FTAs are connected to the I/O processors by cables that can be up to 50 meters in length. Three sizes of FTAs are used (Table 7). FTAs can be mounted in cabinets, or remotely, using Termination Mounting Channels. Digital input sense and 24 Vdc transmitter power are provided through standard FTA connections.

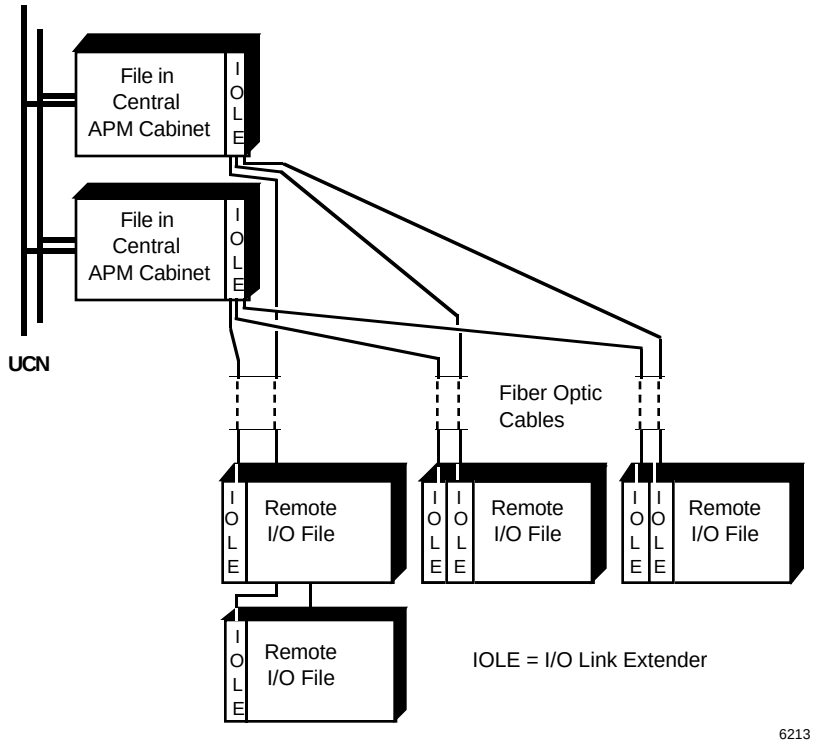

Figure 12 — Fiber Optic Remote I/O—1 Kilometer

Options

Advanced Process Manager Module Redundancy

In addition to the Universal Control Network, the I/O Link, and dc power cabling, which are always redundant, the Advanced Process Manager Module has a one-on-one redundancy option. In order 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 that are continually being executed, 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.

I/O Redundancy

A one-on-one I/O redundancy option is also available for critical high level analog inputs, smart transmitter interface connections, and analog outputs. This option offers significantly increased availability of automatic control by providing continuous operation through failure and replacement of I/O Processors, FTA cables, backplanes, and AO switching hardware. Up to 40 I/O Processors can be supported in a 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.

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. No rearrangement of devices within a cabinet is necessary and, with the standard power system, the second power supply may be added at a future date.

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 the backup batteries provide input to the power supplies, rather than powering