MAXIFLEX P3e-R CPU

M1267C (P3e-R) Redundant Controller

DATASHEET

FEATURES

- **Designed for High Availability Applications**
- **Support for up to three Remote I/O Bases using Conet**
- **Support for up to seven Remote I/O Bases using Ethernet**
- **Support for 1ms input time-stamping (with 32SOE Input Card)**
- **Synchronises Program Data with Standby Controller**
- **No programming required for remote I/O applications.**
- **Integrated 10/100 Ethernet Network Port**
- **Automatic I/O module identification and scanning.**
- **Programmable in five IEC61131 Programming Languages**

The MAXIFLEX P3e-R CPU is designed specifically for redundant remote I/O and control applications, where high availability is required in hot standby configurations.

A high availability system is constructed by combining two identical P3e-R CPU's, each with their own Power Supply and Base, to create independent Primary and Secondary Master Controllers. These two Master Controllers are connected to up to either three common Remote I/O Bases through a M1593A Conet Remote I/O Network Interface Module on each of the Controllers to a M1249A Remote I/O Scanner on each of the Remote I/O Bases using Conet OR up to seven common Remote I/O Bases though Ethernet using a M1594A Redundant I/O Link Ethernet Network Interface Module on each of the Controllers to a M1262F CPU as a Remote I/O Scanner using Ethernet, and to the SCADA system to create a hot standby controller configuration with common I/O.

The Primary and Secondary Controllers in a hot standby system are synchronised every program scan, so that should the primary Controller fail, the secondary Controller can automatically continue program operation from the last Primary Controller scan.

All local data is accessible from a SCADA system through up to 65,500 Data Interchange Registers in a single "Data Interchange Table" for ease of communications.

All system configuration data and dynamic data can be read and written through this convenient table interface.

The P3e-R can be programmed in one or more of the standard IEC61131-3 programming languages using the Omniflex ISaGraf Programmer's Workbench, although conventional remote I/O systems can be implemented without the need for any programming.

The P3e-R CPU automatically identifies the presence of I/O modules and performs I/O scanning of these modules, making this data available in the Data Interchange Table without needing to write a line of code.

Following the ISO OSI 7-layer model, this CPU includes a powerful inter-network routing capability for retrieving data from the corners of the factory in very large, geographically spread-out installations. This capability allows many dissimilar network types to be linked to create a seamless factory intranet, quite often without the need to lay special network cabling.

Many other features such as a built-in real-time clock, battery backup for temporary dynamic data.

APPLICATIONS

- **High Availability Solutions for PLC and analogue control applications (including auto-tuning PID) where unexpected system failures can be costly.**
- **Remote I/O for SCADA software packages using Ethernet. Use with CONET networking to retrieve data over distances up to 10km.**
- **Integrate third party devices into MAXIFLEX using network interfaces to achieve maximum plant visibility.**
- **Distributed Event Handling Systems with Time-stamping to 1ms at source using 32SOE input card (M176X).**

General Description

High Availability System operation

A high availability system is constructed by combining two identical P3e-R CPU's, each with their own Power Supply and Base, to create Primary and Secondary Master Controllers. These two Master Controllers are connected to common Remote I/O Bases, and optionally to a supervisory system.

Both Controllers consume the common input data from the remote I/O Bases, but only the active Controller controls the outputs, and communicates with the supervisory computer.

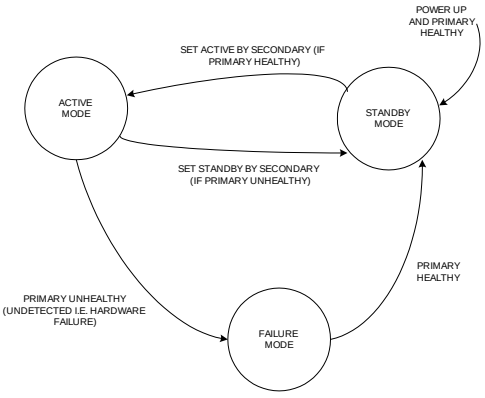
The Secondary Controller continuously monitors the health of the Master Controller, and if a failure is detected, then the Secondary Controller takes over control.

The Primary and Secondary Controllers stay synchronised through a separate communications link between the two Controllers.

The monitoring, and switch-over between Primary and Secondary Controllers occurs completely transparently to the SCADA computer.

The Secondary controller can either run a program identical to the Primary Controller, or it can run an independent program designed to bring the process to a safe state.

The following state diagram illustrates the redundant hot standby operation:



LED Indicators

A comprehensive set of LED indicators are used for status indication on the front of the CPU. These identify:

- **CPU Healthy**
- **I/O Module Status**
- **RUN Application program started**
- **Battery Status**
- **Serial Port Communications Activity**
- **Network Communications Activity**

DIT Service

The Data Interchange Table (DIT) in the CPU is the focal point for data storage in the CPU. Any exchange of data between functions in the CPU and with the outside world takes place through the DIT.

The DIT is an array of 16 bit registers accessible from any function or communications port in the system for interchanging data.

The P3e-R CPU has a "dynamic" DIT area comprising of 30,000 data registers used for temporary storage of normal dynamic data, and a non-volatile "static" DIT area of 5500 registers used to store configuration data for the system.

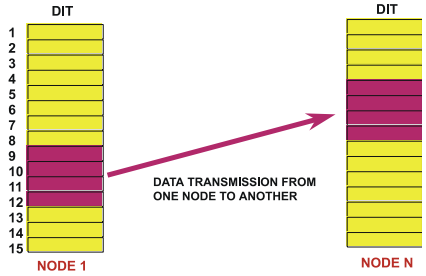
The total addressable range of 65,500 registers allows the Data Interchange Tables in any module in the system, including Network Interface Modules, to also be directly addressable through any of the CPU ports.

Subscription Service

Central to many applications involving communications across networks is the need to replicate data between nodes on the network. The subscription service provides an easy to use but extremely powerful data replication ability between DIT's in the system, whether they are local or remote.

This service provides change-of-state detection and error reporting for optimum performance and reliability.

Examples include SCADA systems acquiring data from remote telemetry units in the field to a central point; or a point-to-point telemetry application, where inputs are transmitted from one location to outputs at another location.



In all these cases, the traditional method is for a controlling master node to poll the slave nodes regularly for data in case something has changed. This crude method is an inefficient use of the limited network bandwidth, and is inherently slow in typical update times. The MAXIFLEX P3e-R CPU provides a superior mechanism to accomplish this commonly used function, through its Subscription Service.

The receiving node is configured to request the data from the source node, by setting up a subscription, very much like you would subscribe to a magazine through your

newsagent. A subscription can be a single register or a block of up to 120 registers which you wish to receive on any change of state and/or at a regular time interval.

Each P3e-R CPU can be configured to subscribe to 64 data blocks as receiver, and be requested for up to 16 data blocks as transmitter.

AutoScan

The P3e-R CPU is equipped with "Autoscan", a feature that automatically identifies all the I/O Modules and intelligently scans all. Using "Autoscan", the CPU scans all conventional I/O modules installed on the MAXIFLEX bases, sorts the data into convenient tables according to type of I/O (Analogue or Digital; Input or Output) and copies this data to/from the CPU's Data Interchange Table (DIT) for easy access from any of the network ports. SCADA, DCS or other devices can read/write the Data Interchange table in efficient blocks without PLC programming required.

I/O Module Configuration Management

I/O Module Configuration Management is included in all of the P3e-R CPU's. This function is responsible for continuously monitoring all slots of the MAXIFLEX I/O base. A copy of all intelligent I/O module setup data is kept in the CPU. If any I/O modules is changed, the CPU will automatically update the new module with its configuration. This allows I/O modules to be changed without the need to reconfigure them. (e.g. a TC module with different TC types and set points selected.)

(Network Interface Modules installed on the MAXIFLEX base are equipped with their own configuration storage and are not updated from the CPU when replaced.)

I/O Module List Feature

This function is responsible for continuously monitoring all slots of the MAXIFLEX I/O base, keeping track of the currently installed module types. This list is compared against the required list (the I/O Module List) configured by the user. Any change in module positions will be detected. This I/O status is displayed on the front of the CPU, and is available as an alarm status register in the Data Interchange Table. This status can also be read through any of the network ports.

CONET Technology

The P3e-R CPU is equipped with the field proven CONET industrial intranet technology.

CONET is a peer-to-peer internetworking technology designed from the ground up for noisy industrial plant environments.

CONET can run on a number of physical media including existing plant cabling, conventional copper twisted pair, over radio links, over fibre-optic links, over virtual serial links, and over Ethernet.

CONET is available for the following media:

- ***Conet/c*** is used over copper bus systems including twisted pair and industrial instrumentation cabling. This is a full-function token-passing peer-to-peer network technology that runs on conventional twisted pairs. Conet/c can be used with the P3e-R using an M1589 Conet/c Network Interface Module
- ***Conet/s*** is used over point-to-point virtual full-duplex serial links, including fibre-optic links or through modems for wide area applications.
  This full duplex protocol provides full peer-to-peer communications capability to allow multiple local networks systems to be interconnected over a wide area into a single intranet. This efficient protocol retains the full capability of the CONET inter-networking technology including remote programming, event message handling and the ability to run data subscriptions in both directions simultaneously. Any virtual serial link supporting full duplex communications can be used as a full peer-to-peer link in the CONET intranet.
  The serial port on all P3e-R CPU's can be set for the Conet/s protocol.
- ***Conet/e*** is used over TCP/IP Ethernet networks. This protocol encapsulates all of the standard CONET message types in packets for transmission over Ethernet.
  The P3e-R CPU is equipped with an Ethernet Port.

The CONET message protocol allows for remote programming, time-stamped at source event messaging, data replication using the subscription service, as well as the more conventional data polling access methods.

CONET Inter-Network Routing

Many systems are constructed of multiple networks to overcome the difficulties of topology or communication protocol conversion. The CONET Network Routing service provides a means to seamlessly interconnect these networks into an integrated "intranet" so that any node in the system may be globally addressed from any other without regard for its physical location or network segment.

This feature also allows redundant network paths to be implemented.

CONET Router Wizard

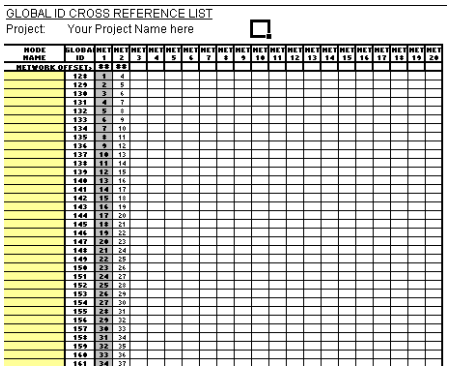
The CONET Router Wizard is a user-friendly spreadsheet based software utility, used to calculate the router table register entries for all router Nodes in a MAXIFLEX intranet system.

A router node exists wherever two CONET equipped Networks are connected to the same CPU/IO system. Simply make a sketch of the Intranet, numbering each network. Identify the communications port on the MAXIFLEX CPUs and Network Interface Modules (NIM's) connected to each network.

The CONET Router Wizard then calculates the Network Routing Table register entries for each CPU in the system acting as a network router.

Enter these values into the CPU DIT to invoke the Network Routing Capability.

Global Addressing can then be used on the MAXIFLEX Intranet.


GLOBAL ID CROSS REFERENCE LIST

Project: Your Project Name here

NODE NAME	GLOBAL ID	NET 2	NET 3	NET 4	NET 5	NET 6	NET 7	NET 8	NET 9	NET 10	NET 11	NET 12	NET 13	NET 14	NET 15	NET 16	NET 17	NET 18	NET 19	NET 20
NETWORK OFFSET:		55	59																	
	128	1	4																	
	129	2	5																	
	130	3	6																	
	131	4	7																	
	132	5	8																	
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	158	31	34																	
	159	32	35																	
	160	33	36																	
	161	34	37																	

Router Wizard System Interconnection Table

NETWORK ROUTER TABLE CONFIGURATION DATA Project: Your Project Name here

[Enter these values into the Data Interchange Tables of each Router Node]

DIT No.	ROUTER 1	ROUTER 2	ROUTER 3	ROUTER 4	ROUTER 5	ROUTER 6	ROUTER 7	ROUTER 8
64101	64512							
64102	33281							
64103	0							
64104	0							
64105	0							
64106	0							
64107	0							
64108	0							
64109	0							
64110	0							
64111	0							
64112	0							
64113	0							
64114	0							
64115	0							
64116	0							
64117	0							
64118	0							
64119	0							
64120	0							

Calculated Router Table Register Entries

Serial Port Protocol Selection

The included serial port on the P3e-R CPU comes equipped with four protocol options as standard:

- ***Modbus Master*** can be selected for easy interconnection of the P3e-R CPU to third party systems equipped with a Modbus Slave interface.
- ***Modbus Slave*** can be selected for easy interconnection of MAXIFLEX I/O to third party equipment such as HMI's, Distributed Control System's, SCADA software, or Master Programmable Logic Controllers.
- ***Conet/s protocol*** can be selected to interconnect MAXIFLEX systems over wide areas using the RS232 port. This full duplex protocol provides full peer-to-peer communications capability to allow multiple local networks systems to be interconnected over a wide area into a single intranet. This efficient protocol retains the full capability of the CONET inter-networking technology.
- ***Custom Port Protocol Definition.***
  The P3e-R CPU supports custom protocols on the serial port. In order to use this advanced feature of the P3e-R CPU, download the custom protocol driver to P3e-R CPU and select the "User" Protocol type. Consult the factory for available protocols.

Ethernet Port Protocol Selection

The Ethernet port included on the P3e-R CPU comes equipped with two protocol options as standard:

- ***Modbus/TCP Master*** can be selected for easy interconnection of MAXIFLEX systems over Ethernet to third party systems that support Modbus/TCP Slave protocol. This protocol option conforms to Class 0 of the Modbus/TCP conformance classification. 32 Modbus Master Queries are supported.
- ***Modbus/TCP Slave*** can be selected to interconnect MAXIFLEX systems over Ethernet to SCADA software equipped with Modbus/TCP drivers. This protocol option conforms to Class 0 of the Modbus/TCP conformance classification.
- ***Conet/e.*** can be used to communicate between devices supporting the Conet/e protocol, providing all the facilities of the CONET network.
  Remote Programming Service

Every CPU is equipped with a dedicated programming port that is equipped with the Conet/s protocol. Using the network routing function and convenient table configuration, it is possible to configure/program every node in a MAXIFLEX intranet remotely from a single programming port. This function significantly reduces system downtime and improves maintenance efficiency and therefore life-cycle costs. Engineering access to the Network is simple and can be made at any point on the network enabling nodes to be reprogrammed remotely via any of the P3e-R CPU ports.

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IEC61131 Programming Support

Full Windows based graphical programming support is available for the P3 CPU's using the available "Application Workbench".

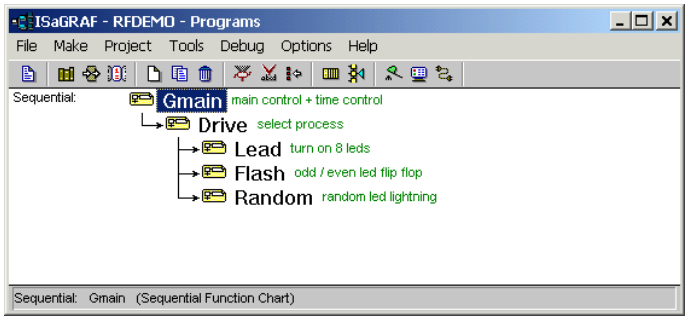
The Application Workbench is a complete programming environment used to develop complex control algorithms. It fully supports six automation languages: the five IEC 1131-3 languages plus Flow Chart. This flexibility

enables developers to choose the language that best suits their knowledge, style and application. The Workbench provides tools for editing, debugging, code generation, documentation, library management, archiving, on-line monitoring, off-line simulation and on-line changes.

The Application Workbench uses the IEC61131 industrial standard PLC programming methodology for designing powerful applications without requiring the programmer to know complex, high-level computer languages. Designed to make it easier and faster to write applications, the Workbench imposes a simple but structured methodology and catches syntactic errors at during program writing. The result is a much more robust application code in the shortest possible development time.

The programming languages supported by the P3 CPU's are:

- SFC – Sequential Function Charts
- FC – Flow Charting
- FBD –Function Blocks
- LD – Graphical Ladder Diagram
- ST – Structured Text
- IL – Instruction List



Program Structure on the Application Workbench

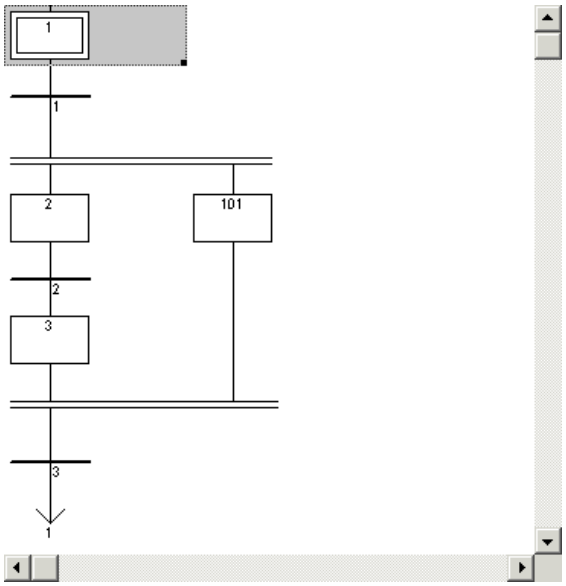
Program Debugging

Using the Workbench Debugger, it is possible to lock I/O while the debugger is connected, and to force an I/O point to a known state. Variable locking is a dynamic operation, and is not memorised when the application restarts. The lock operation applies to only one variable (one I/O channel) at a time.

Defining an I/O module as "virtual" disconnects the processing of the physical I/O channels. In this mode, inputs/outputs are not updated, and it is possible to use the Debugger to modify the input values. The virtual attribute is a static feature, and is stored when the application is stopped and restarted.

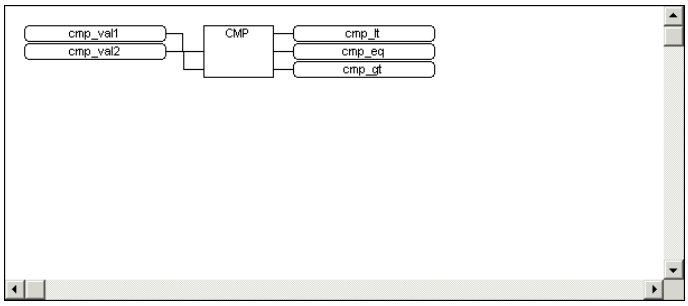
While any I/O is under debugger control, the I/O LED flashes to indicate this condition.

SEQUENCE FUNCTION CHART (SFC)



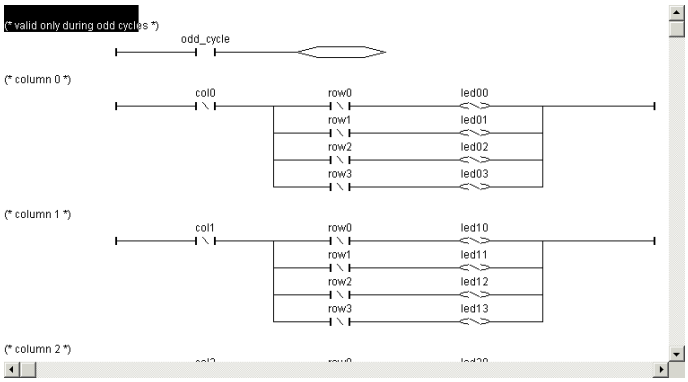
Sequential Function Chart (SFC), the core language of the IEC 61131-3 standard, divides the process cycle into a number of well-defined steps, separated by transitions. The other languages are used to describe the actions performed within the steps and the logical conditions for the transitions. Parallel processes can easily be described using SFC

FUNCTION BLOCK DIAGRAM (FB)



Function Block Diagram (FBD) is a graphical language that allows the user to build complex procedures by taking existing function blocks from the library, and wiring them together on screen.

LADDER DIAGRAM



The Ladder Diagram (LD) is one of the most familiar methods of representing logical equations and simple actions, particularly in the United States. Contacts represent input arguments and coils represent output results. The Workbench's Quick LD editor provides the best compromise between high-level graphic capabilities and easy-to-use keyboard driven programming. LD and FBD programming can be mixed in the same chart.

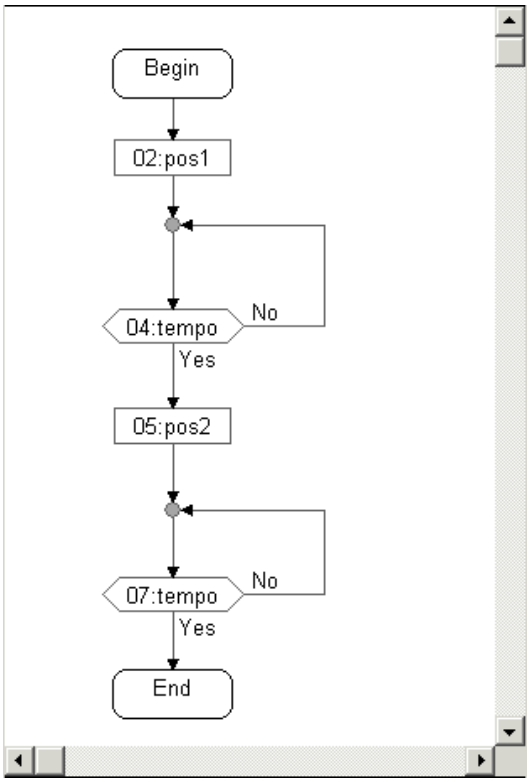
STRUCTURED TEXT

Structured Text (ST) is a high level structured language with a syntax similar to Pascal but more intuitive to the automation engineer. This language is primarily used to implement complex procedures that cannot be easily expressed with graphical languages (e.g. IF / THEN / ELSE, FOR, WHILE...). The ST editor guides the user to the correct syntax and punctuation. To further facilitate and speed development, highly useful validation and programmer assistance facilities are included.

INSTRUCTION LIST

The Application Workbench also includes Instruction List (IL), a low-level Boolean language similar to the simple textual PLC languages that are programmed at the register level.

FLOW CHART



Recognising that virtually every engineer graduating from college today has programmed in Flow Chart, the Workbench fully supports graphical Flow Chart programming. The Flow Chart is an easy to read decision diagram where actions are organised in a graphic flow. Binary decisions are used to control the flow. The Flow Chart Editor has full support for connectors and sub-programs. Actions and tests can be programmed in LD, ST or IL. The graphical editor allows each symbol to be re-sized independently, and automatically arranges the chart during development. The Level 2 code is displayed in a resizable editor window.

FUNCTION BLOCKS

In addition to the IEC 61131-3 languages and Flow Chart, the ISaGRAF Application Workbench includes a library with more than 60 ready-to-use blocks. Users can enlarge this library by writing functions and function blocks in LD/FBD/ST/IL languages or "C". The enhanced Library Manager is completed with import/export commands between the library and applications, so that new developed functions can easily be stored in library, and are directly ready for future applications.

Specifications

Communications Ports

Programming Port

Type	Asynchronous RS232 serial port
Protocols	Supports Conet/s allowing remote programming and full system data access through this port.
Standard Baud Rate	Preset at 19,200 baud
Maximum cable length	5 meters
Connection	RJ11 jack. Use with Model M1831 programming cable for connection to PC serial port (9 pin).

Serial Port

Type	Asynchronous serial port
Protocols	Supports Conet/s and Modbus ASCII and RTU (Master and Slave).
Maximum cable length	15 meters (50ft) in RS232 mode 1200m (4000ft) in RS485 mode
Connection	9 pin sub-miniature DB9 (male).

CONET/e Ethernet Port

Type	10/100 Interface (UTP via RJ45)
Network Protocol Support	TCP/IP
Protocols	Modbus/TCP Class 0 Conet/e for remote programming support and Network Routing
IP Address	Single IP Address for access to the Redundant Controller pair. Upon change-over, the secondary controller assumes the same IP address as the primary controller.

Sync Port

Type	100Mb/s Ethernet (UTP via RJ45)
Protocol	Dedicated high speed link protocol for synchronising redundant CPU's

Processor

Processor size	32 bit processor
Clock speed	50Mhz

Program Execution Times

Small (<64 I/O)	5 to 100ms typical
Medium (64 to 256 I/O)	100 to 500ms typical
Large or Complex	>500ms

Memory

Total memory	8Mbit FLASH; 8Mbit RAM; 128kbit EEPROM
Software Kernel Program	Stored in FLASH memory
Software Kernel Upgrades	Installed through the programming port without hardware change.
User Program	256kbyte Program Space in FLASH
User Variables	64kbyte Battery Backed RAM
Data Interchange Table	65,500 16 bit Registers on CPU Up to 4000 Registers in each I/O Module.

Front Panel Indicators

CPU OK (Green)	On = CPU Healthy Flashing or Off = CPU faulty
I/O OK (Green)	On = I/O OK Flashing = I/O does not match configuration or is under Debug Control. Off = I/O configuration not set.
RUN (Green)	On = Application Program Running Off = No application program or application program not running
BATT (Red)	Off = Lithium Battery healthy On = Lithium Battery required replacing. (Battery used for real-time clock and User Data retention.)
Serial Tx (Red)	On = data is waiting to be sent out serial port. Off = no data waiting to be sent.
Serial Rx (Amber)	On = Data is being received on serial port. Off = No data being received.
Link (Green)	On = Ethernet network link is good Flashing = Data is being transmitted/received on Ethernet port.
100 (Amber)	On = 100 Mbps connection

Real Time Clock

Resolution	10 milliseconds
Accuracy	1 minute per month
Battery Life	Greater than 1 year with power off. Greater than 5 years with power on.
Battery Type	3.6V Lithium wafer Cell Model TL-5186

Environmental

Operating Temperature	-25°C to +60°C (-13°F to +140°F)
Storage Temperature	-40°C to +70°C (-40°F to +158°F)
Humidity	95% max. at 40°C (104°F) non-condensing.
Protection	Electronics conformal coated

Logic Power Consumption

From Logic Power Supply	650mA from 5Vdc max.

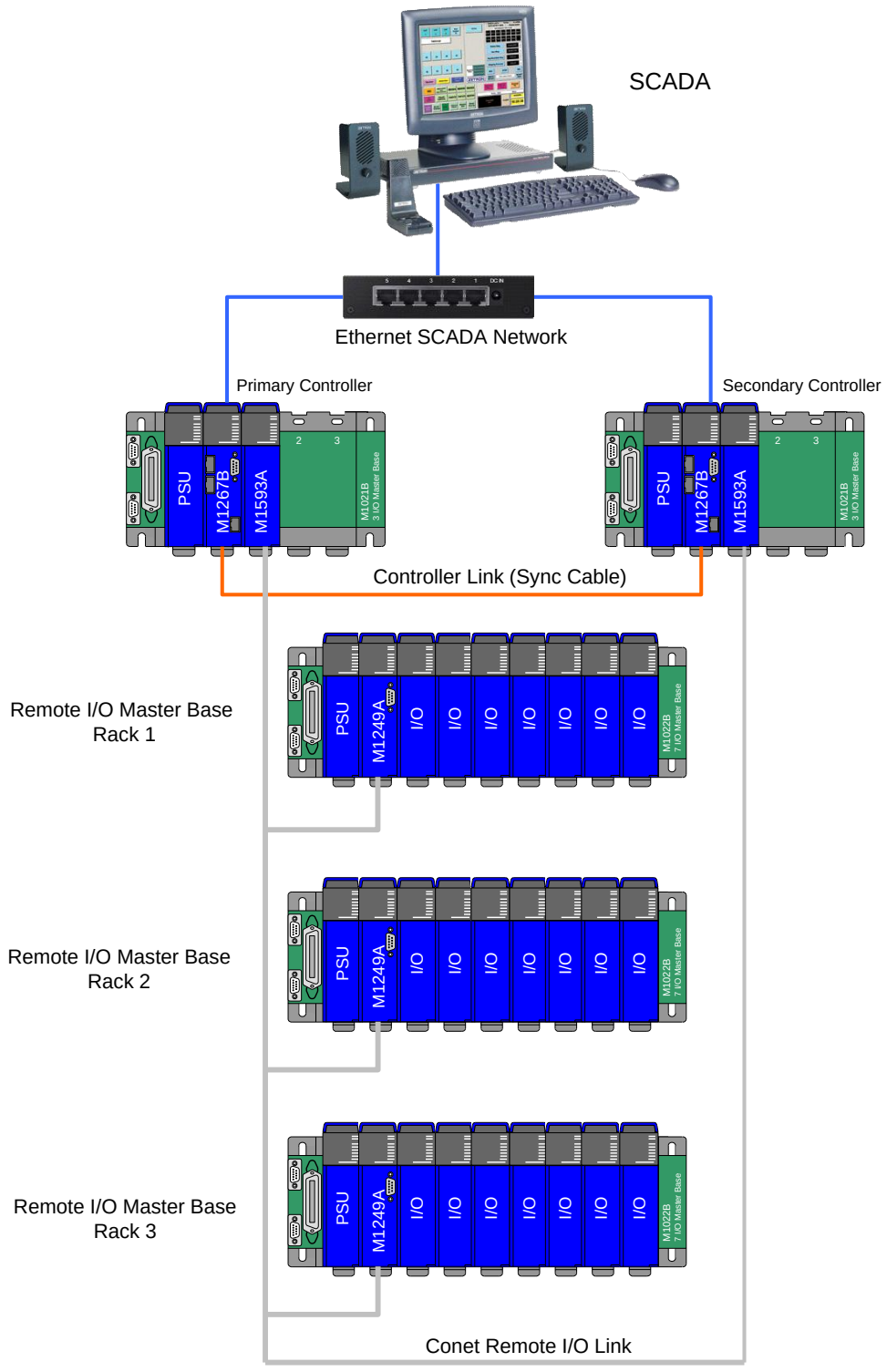
Mass

Excluding Packaging	390g (13.8oz)
Including Packaging	480g (16.9oz)

Ordering Information

Model	Order Code
P3e-R CPU (with Conet/e Ethernet network Port)	M1267C
Associated Products and Accessories	
Synchronisation Link Cable	M1834A
Maxiflex Programming Cable	M1831A
Maxiflex (RIOc) Remote I/O Link Module Conet	M1593A
Maxiflex (RIOe) Redundant I/O Link Module, Ethernet	M1594A
Maxiflex Remote I/O Scanner Module - Conet	M1249A
Maxiflex P3 CPU Module as Remote I/O Scanner (R3e) – Ethernet	M1262G

Typical Redundant System Configuration using Conet



Typical Redundant System Configuration using Ethernet