points are commonly accessed through the communication links to support programming screen attributes such as changing the color of a valve when it opens.

Communication Link Options

Communication link options include:

- An RS-232 port with Modbus Slave RTU or ASCII communications from the Main Processor Card. (Simplex: full capability. TMR: monitor data only – no commands)
- An RS-232 port with Modbus Master / Slave RTU protocol is available from the HMI.
- An RS-232/485 converter (half-duplex) can be supplied to convert the RS-232 link for a multi-drop network.
- Modbus protocol can be supplied on an Ethernet physical layer with TCP-IP for faster communication rates from the HMI.
- Ethernet TCP-IP can be supplied with a GSM application layer to support the transmission of the local high-resolution time tags in the control to a DCS from the HMI. This link offers spontaneous transmission of alarms and events, and common request messages that can be sent to the HMI including control commands and alarm queue commands. Typical commands include momentary logical commands and analog "setpoint target" commands. Alarm queue commands consist of silence (plant alarm horn) and reset commands as well as alarm dump requests that cause the entire alarm queue to be transmitted from the Mark VI to the DCS.
- Additional "master" communication drivers are available from the HMI.

Time Synchronization

Time synchronization is available to synchronize all controls and HMIs on the UDH to a Global Time Source (GTS). Typical GTSs are Global Positioning Satellite (GPS) receivers such as the StarTime GPS Clock or other time-processing hardware. The preferred time sources are Universal Time Coordinated (UTC) or GPS; however, the time synchronization option also supports a GTS using local time as its base time reference. The GTS supplies a time-link network to one or more HMIs with a time/frequency processor board. When the HMI receives the time signal, it is sent to the Mark VI(s) using Network Time Protocol (NTP) which synchronizes the units to within +/-1ms time coherence. Time sources that are supported include IRIG-A, IRIG-B, 2137, NASA-36, and local signals.

Diagnostics

Each circuit card in the Control Module contains system (software) limit checking, high/low (hardware) limit checking, and comprehensive diagnostics for abnormal hardware conditions. System limit checking consists of 2 limits for every analog input signal, which can be set in engineering units for high/high, high/low, or low/low with the I/O Configurator. In addition, each input limit can be set for latching/non-latching and enable/disable. Logic outputs from system limit checking are generated per frame and are available in the database (signal space) for use in control sequencing and alarm messages.

High/low (hardware) limit checking is provided on each analog input with typically 2 occurrences required before initiating an alarm. These limits are not configurable, and they are

selected to be outside the normal control requirements range but inside the linear hardware operational range (before the hardware reaches saturation). Diagnostic messages for hardware limit checks and all other hardware diagnostics for the card can be accessed with the software maintenance tools (Control System Toolbox). A composite logic output is provided in the data base for each card, and another logic output is provided to indicate a high/low (hardware) limit fault of any analog input or the associated communications for that signal.

The alarm management system collects and time stamps the diagnostic alarm messages at frame rate in the Control Module and displays the alarms on the HMI. Communication links to a plant DCS can contain both the software (system) diagnostics and composite hardware diagnostics with varying degrees of capability depending on the protocol's ability to transmit the local time tags. Separate manual reset commands are required for hardware and system (software) diagnostic alarms assuming that the alarms were originally designated as latching alarms, and no alarms will reset if the original cause of the alarm is still present.

Hardware diagnostic alarms are displayed on the yellow "status" LED on the card front. Each card front includes 3 LEDs and a reset at the top of the card along with serial and parallel ports. The LEDs include: RUN: Green; FAIL: Red; STATUS: Yellow.

Each circuit card and termination board in the system contains a serial number, board type, and hardware revision that can be displayed; 37 pin "D" type connector cables are used to interface between the Termination Boards and the J3 and J4 connectors on the bottom of the Control Module. Each connector comes with latching fasteners and a unique label identifying the correct termination point. One wire in each connector is dedicated to transmitting an identification message with a bar-code serial number, board type, hardware revision, and a connection location to the corresponding I/O card in the Control Module.

Power

In many applications, the control cabinet is powered from a 125Vdc battery system and short circuit protected external to the control. Both sides of the floating 125Vdc bus are continuously monitored with respect to ground, and a diagnostic alarm is initiated if a ground is detected on either side of the 125Vdc source.

When a 120/240vac source is used, a power converter isolates the source with an isolation transformer and rectifies it to 125Vdc. A diode high select circuit chooses the highest of the 125Vdc busses to distribute to the Power Distribution Module. A second 120/240vac source can be provided for redundancy. Diagnostics produce an under-voltage alarm if either of the AC sources drop below the under-voltage setting. For gas turbine applications, a separate 120/240vac source is required for the ignition transformers with short circuit protection of 20A or less.

The resultant "internal" 125Vdc is fuse-isolated in the Mark VI power distribution module and fed to the internal power supplies for the Control Modules, any expansion modules, and the termination boards for its field contact inputs and field solenoids. Additional 3.2A fuse protection is provided on the termination board TRLY for each solenoid. Separate 120Vac feeds are provided from the motor control center for any AC solenoids and ignition transformers on gas turbines. (*See Table 11.*)

Steady State Voltage	Freq.	Load	Comments
125Vdc (100 to 144Vdc)		10.0 A dc	Ripple <= 10V p-p Note 1
120vac (108 to 132vac)	47 - 63Hz	10.0 A rms	Harmonic distortion < 5% Note 2
240vac (200 to 264vac)	47 - 63 Hz	5.0 A rms	Harmonic distortion < 5 % Note 3

Table 11. Power requirements

Codes and Standards

ISO 9001 in accordance with Tick IT by Lloyd's Register Quality Assurance Limited. ISO 9000-3 Quality Management and Quality Assurance Standards, Part 3: Guidelines for the Application of ISO 9001 to Development Supply and Maintenance of Software.

Safety Standards

UL 508A Safety Standard Industrial Control Equip.

CSA 22.2 No. 14 Industrial Control Equipment

Printed Wire Board Assemblies

UL 796 Printed Circuit Boards

UL recognized PWB manufacturer,

UL file number E110691

ANSI IPC guidelines

ANSI IPC/EIA guidelines

CE - Electromagnetic Compatibility (EMC)

EN 50081-2
Generic Emissions Standards
EN 50082-2:1994
Generic Immunity Industrial Environment
EN 55011
Radiated and Conducted Emissions
IEC 61000-4-2:1995
Electrostatic Discharge Susceptibility
IEC 6100-4-3: 1997
Radiated RF Immunity
IEC 6100-4-4: 1995
Electrical Fast Transient Susceptibility
IEC 6100-4-5: 1995
Surge Immunity
IEC 61000-4-6: 1995
Conducted RF Immunity
IEC 61000-4-11: 1994
Voltage Variation, Dips, and Interruptions
ANSI/IEEE C37.90.1
Surge

CE - Low Voltage Directive

EN 61010-1
Electrical Equipment, Industrial Machines
IEC 529
Intrusion Protection Codes/NEMA 1/IP 20

Reference the Mark VI Systems Manual GEH-6421, Chapter 5 for additional codes and standards.

Environment

The control is designed for operation in an air-conditioned equipment room with convection cooling. Special cabinets can be provided for operation in other types of environments.

Temperature:

Operating	0° to +45°C	+32° to +113°F
Storage	-40° to +70°C	-40° to +158°F

The control can be operated at 50∞C during maintenance periods to repair air-conditioning systems. It is recommended that the electronics be operated in a controlled environment to maximize the mean-time-between-failure (MTBF) on the components.

Purchased commercial control room equipment such as PCs, monitors, and printers are typically capable of operating in a control room ambient of 0° to +40°C with convection cooling.

Humidity

5% to 95% non-condensing

Exceeds EN50178: 1994