



GE Fanuc Automation

Programmable Control Products

***Genius[®] I/O
Distributed I/O System
Guide Form Specification***

GFT - 226

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1. GENERAL

1.1 SCOPE

This specification covers the technical requirements for an Input/Output system to be used for control or monitoring purposes in an industrial environment. The I/O system shall be designed to perform interface functions required or machine and machine line control, material handling and process control but shall not be limited to these functions.

2. MANUFACTURER'S QUALIFICATIONS

2.1 MANUFACTURER'S STANDARDS

The manufacturer shall have shown high commitment to product, manufacturing and design process quality. It shall have attained ISO9000 registration.

2.2 DESIGN AND MANUFACTURE

The I/O and Control System and all of the corresponding components within the family of controller products shall be manufactured by GE Fanuc Automation.

All products shall be designed, manufactured, and tested in accordance with recognized UL, C-UL, CE Mark, IEC and JIS industrial standards. The system shall be operational during and after testing.

- VIBRATION - Modules are to perform well where vibration is a factor. Designs are to be shock and vibration tested to meet the following specifications when panel mounted :
 - IEC68-2-6 :
 - 5 - 10 Hz 0.2in (5.08mm) displacement
 - 10 to 200 Hz at 1G
- SHOCK -
 - IEC68-2-27 :
 - Shock : 15G, 11milliseconds, half sine wave
- NOISE - Modules are to be resistant to noise levels found in most industrial applications when installed according to accepted practices, including proper separation of wiring by voltage and power levels, and mounting on a conductive (unpainted) DIN rail. The DIN rail is an integral part of the grounding system. Modules are to be tested to the following noise specification:

Emissions FCC part 15, section J, class A, Computing Devices
CISPR11 Class A

Susceptibility IEC801 - 2,3,4,6
ANSI/IEEE C37.90A (Relay and relay system associated
with Electrical Power Apparatus)

- TEMPERATURE -

Modules shall operate reliability in ambient air temperatures from 0°C
(+32°F) up to +60°C (+140°F).

Storage temperatures are to be -40°C (-40°F) to +100°C(+212°F).

- HUMIDITY -

5% to 95%, non-condensing.

The manufacturer shall have a fully operational quality assurance and quality control program in place.

Complete documentation describing the quality assurance and quality plan shall be available.

Complete product documentation describing installation and simple field maintenance shall be available.

The product shall be designed and manufactured in the USA.

2.3 SUPPORT

The manufacturer or its authorized representative shall provide complete technical support for all of the products. This shall include headquarters or local training, regional application centers, and local or headquarters technical assistance. A toll-free (800) number hot-line shall be available for emergency support.

An electronic Bulletin Board Service (BBS) shall be available to users for application support.

Product shall have a warranty period of at least 1 year from the date of purchase.

3. PRODUCT

3.1 HARDWARE

3.1.1 GENERAL

The I/O and Control Station shall consist of rugged components designed specifically for industrial environments. A complete station shall be modular in design. The modules shall, as much as possible, resemble terminal blocks commonly used in electrical panels. The small form-factor of the I/O Blocks (as they will be referred to in the remainder of this document) will include an electronic design that allows ease of installation and use in applications where a high degree of I/O distribution is desired. The I/O module shall be modular in design consisting of two components. The module components are electronic assembly and terminal assembly. The terminal assembly provides field wiring connection.

The electronics assembly shall include all active electronic components. The electronic assembly shall be removable. Indicators visible from the front side of the block shall be provided for the state of each individual I/O circuit (except on the I/O Block handling analog signals). Two additional indicators on each I/O Block shall provide general diagnostic information on the I/O Block as a whole and on the I/O circuits.

The terminal assembly shall be designed to be permanently mounted and to allow the electronics assembly to be plugged into/unplugged from it. All terminals shall accept a minimum of one #12 gauge or two #14 gauge wires, except the analog and 32 circuit discrete I/O Blocks which shall accept one #14 gauge wire. A built-in HHM connector shall be included. In addition to functioning as the user's field wiring connection point, the terminal assembly shall contain the memory that will store the I/O Block configuration and addressing. In the event of a failure that requires replacement of the electronics assembly, the new electronics assembly shall read the configuration information from the terminal assembly's memory to eliminate the need to manually reconfigure the I/O Block. The memory shall be the EEPROM type to eliminate the need for battery back-up.

3.1.2 PACKAGING

The I/O module shall be fully enclosed within a durable shroud. The I/O module design shall allow electronic assembly replacement without removing field wiring.

After the initial configuration is complete the electronic assembly shall be replaceable without requiring reconfiguration.

The electronic assembly shall be retained by metal screws on the upper and lower edges. Removing the electronic assembly shall require a screw driver.

All major assemblies and sub-assemblies shall be identified using permanent labels or markings each of which indicates the manufacturer's catalog number, product manufacturing date code,

CE, UL, and C-UL certification.

3.2 ENVIRONMENTAL CONDITIONS

STORAGE CONDITIONS : Temperatures -40°C (-40°F) to +100°C(+212°F).

OPERATING CONDITIONS : Temperature 0°C (+32°F) up to +60°C (+140°F).

HUMIDITY : 5 to 95% relative humidity, non-condensing

3.3 MONITORING and CONFIGURATION

All addressing, option configurations and monitoring of all types of I/O Blocks shall be accomplished through a Hand Held device (referred to as Hand Held Monitor or HHM in the remainder of this document). The Hand Held Monitor must be very portable and therefore shall be powered by rechargeable batteries. Each I/O Block shall have a connector to accommodate the HHM.

All addressing and option configurations for all I/O Block types shall be selected through the Hand Held Monitor and stored in software form in non-volatile memory residing in the terminal assembly.

The option of protecting the I/O Block's configuration data shall be available by setting a Configuration Protect mode that will prevent inadvertent changes to the configuration data. The I/O Block shall not allow any modification of the data until this Configuration Protect mode is disabled using the HHM mounted key switch.

3.4 COMMUNICATION

Communications between the controlling CPU and the I/O Blocks shall be via a proven reliable serial link with automatic CRC error checking and 2 out of 3 voting on each bit of information. The data communications baud rate shall be adjustable. A serial link is specified so that the physical connections between devices can be made with a single twisted pair cable or twin axial lead cable. The twisted pair cable shall be of the type commonly available from several different cable vendors and shall be connected using simple screw type terminals requiring no special connectors.

3.5 BLOCK POWER

The I/O Block power supplies shall be designed to operate with the same voltage as that being controlled by the I/O Block. This is required to eliminate the need for additional wires and for a second power source in the vicinity of the I/O Block.

3.6 DIAGNOSTICS

In combination with the capability for I/O distribution the I/O system must offer automatic diagnostic capabilities for the system as a whole, for individual I/O Blocks and for individual circuits. Diagnostic capabilities shall include the ability to monitor faults which are both internal and external.

All system, I/O Block and individual Circuit Faults detected by the automatic diagnostics shall be capable of being reported automatically to the controlling computer. Faults from individual I/O Circuits may be selected for reporting on a circuit by circuit basis. The selection to report or not report a fault shall be made through the HHM.

All I/O Blocks shall include a built-in self-test feature that 8 automatically occurs and results in any detected faults to be reported to the controlling computer.

3.7 GENERAL I/O SPECIFICATION

The I/O Blocks shall have the capability to interface to at least the following common control voltages.

Discrete :

- 115Vac
- 125Vdc (Sink or Source)
- 12/14/48Vdc (Sink or Source)
- 5Vdc Sink

Analog :

- 0 to 5Vdc
- 0 to 10Vdc
- ± 5Vdc
- ± 10Vdc
- 4 to 20ma
- RTD
- Thermocouple (J,K,T,E,B,R,S, and N Thermocouples supported)

In addition special functions blocks such as High Speed Counters and Power Monitoring shall be available.

4. I/O SPECIFICATION

4.1 DISCRETE I/O BLOCKS - COMMON SPECIFICATIONS

AC I/O Blocks shall have configurable input filter times of 10, 20, 30, 40, 50, 60, 70, 80, 90, or 100 milliseconds. 16 point DC I/O Blocks shall have an additional selection of 5 milliseconds. 32 point DC I/O Blocks shall have additional selections of 1, 2, 3, 4, or 5 milliseconds. Whatever filter time has been selected shall be common to all circuits on the block which have been selected to function as inputs. Filter times shall be selected by the HHM or host computer.

Discrete input circuits shall be available that offer an option of operating as a standard input (recognizing only the on and off states from the field input device) or as a tri-state input (recognizing on, off and open circuit states from the field input device). If a circuit is selected to function as a tri-state input, a detected Open Circuit Fault shall be reported automatically to the controlling computer and shall be made available to the HHM if it is on the communications bus.

All discrete output circuits shall offer the user one of three options that will determine what happens to that particular output circuit when, for whatever reason, the I/O Block stops receiving fresh output data from the controlling computer. The three options shall be selected by the HHM or host computer as:

1. Hold Last State
2. Default to the Off State
3. Default to the On State

Discrete output circuits shall be available that have a built-in diagnostic feature that checks for a minimum current to flow through the output circuit whenever the output is in the on state. If this minimum amount of current is not detected, a No Load Fault shall be automatically reported to the controlling computer and shall be made available to the HHM if it is on the communications bus. The ability to disable this check for minimum current shall be available through use of the HHM or host computer, to avoid the reporting of invalid faults from very light output loads.

No fuses shall be used in any of the output circuits. In lieu of destructive fuses, all discrete output circuits, except those which employ relays, shall have a built-in overload state. If this Overload current is detected, the output circuit shall turn itself off and an Overload Fault shall be reported automatically to the controlling computer. It should also be made available to the HHM if it is on the communications bus. Blocks shall be available that have the capability to disable this check for Overload current through use of the HHM to allow loads greater than two amps to be controlled.

All discrete output circuits, except those which employ relays, shall have a built-in diagnostic feature that checks for a maximum Short Circuit current through the output circuit whenever the output is in the on state. If this maximum amount of current is detected, the output circuit shall turn itself off and a Short Circuit Fault shall be reported automatically to the controlling

computer. It shall also be made available to the HHM if it is on the communications bus. The opportunity to disable this check for maximum Short Circuit current shall not be available.

Discrete circuits shall be available that have a built-in diagnostic feature that checks for a maximum temperature (100 degrees C.) at the I/O circuit switching device. This is required to prevent overheating in situations where the user may be driving very heavy loads and to prevent faulty operation in high ambient temperature environments. If this maximum temperature is detected, the output circuit shall turn itself off and an Over Temperature fault shall be made available to the HHM if it is on the communications bus. The option to disable this check of maximum temperature shall not be available.

Discrete outputs shall be available that provide the ACTUAL output state to the host computer and HHM. This feedback information shall be based on output current and voltage and be provided to the user in the form of an input that reflects the field side state of the output.

Capability to test discrete outputs without changing the state of the connected load shall be available. The tests shall be accomplished by quickly Pulsing the output to it's opposite state while checking for the correct current and voltage changes. If the correct change in current/voltage does not occur, the appropriate fault shall be reported automatically to the controlling computer. The pulses shall be of a short enough duration to not affect normal loads. The option for disabling this Pulse Test (through the HHM or host computer) on a Block by Block basis shall be available for outputs driving light loads which may respond to the short duration pulses.

4.2 115 VAC I/O BLOCK SPECIFICATIONS

A minimum of eight circuits shall reside on this type of I/O block. Circuits shall be available that are selectable as input or output circuits in any combination through the HHM or host computer.

The 115 VAC I/O Block shall operate with any voltage between 93 and 132 VAC at any frequency between 47 and 63 Hz.

Outputs shall be available that will drive up to a NEMA size four motor starter directly (30 amps in rush and 2 amps continuously).

The off state leakage current through any of the output circuits shall be less than 13 milliamps for standard I/O Blocks or 7 milliamps for low leakage I/O Blocks.

The output circuits shall be allowed to turn on or off only at the zero crossing point of the AC cycle.

There shall be a 115 VAC input-only block (16 points) that has programmable on/off thresholds, open wire detection thresholds, and shall be able to detect short circuits on the inputs. These

thresholds shall be programmable from 25% to 85% of the input voltage and be selectable at 5% increments. Diagnostics of open wire and short circuits shall be reported.

There shall be a block utilizing relay contacts as the switching device. The contacts shall be offered as normally open or normally closed. The contacts shall have a rating of 2 amperes maximum or 150 VA maximum (whichever is lower). The maximum switching frequency shall be 20 operations per minute into inductive loads. Output voltage range shall be from 5 to 250 VAC or 5 to 220 VDC. There shall be 16 points per block arranged as four groups of four contacts, each group having a shared common connection. The maximum switching power shall be 60 Watts or 125 VA, whichever is smaller. The minimum recommended load shall be 10 milliamps.

4.3 ISOLATED I/O BLOCK SPECIFICATIONS

A minimum of eight circuits shall reside on this type of I/O Block, selectable as input or output circuits in any combination through the HHM or host computer. The circuits shall be isolated from one another in at least groups of two. This isolation shall allow different pairs of I/O circuits to operate with different phases of a power source or different power sources altogether.

The isolated I/O Block shall operate with any AC voltage between 93 and 132 VAC at any frequency between 47 and 63 Hz and any DC voltage between 105 and 140 VDC with a ripple of up to 10%. outputs shall be available that will drive up to a NEMA size four motor starter directly (30 amps in rush and 2 amps continuously).

The off state leakage current through any of the output circuits shall be less than 13 milliamps at 115 VAC.

The output circuits operating with AC voltages shall be allowed to turn on or off only at the zero crossing point of the AC cycle.

The isolated I/O Block shall provide a "low voltage" diagnostic for the power source to each pair of circuits. If detected and requested, a Loss of Power fault shall be reported to the controlling computer and be made available to the HHM and host computer. This diagnostic shall be in addition to all other diagnostics previously discussed.

4.4 12/24/48 VDC I/O BLOCK SPECIFICATIONS

A minimum of 16 circuits shall reside on this type of I/O Block, selectable as input or output circuits in any combination through the HHM or host computer.

The DC I/O Blocks shall operate over the following supply voltages:

TTL operation	4.75 to 5.25 VDC
12 Volt Blocks	10 to 30 VDC

24 Volt Blocks	18 to 30 VDC
24/48 Volt Blocks	18 to 56 VDC

Allowable ripple shall be less than 10%.

Two classes of blocks shall be available. 32 circuit versions shall be capable of driving up to 0.5 amps per point continuously. 16 circuit versions shall be capable of driving up to 2 amps per point continuously.

The off state leakage current through any of the output circuits shall be less than 1 milliamp at any operating voltage.

Both current sinking and current sourcing versions shall be available.

4.5 ANALOG I/O BLOCK SPECIFICATIONS

Analog I/O Blocks shall be available which provide the following functionalities:

- a) four input channels and two output channels
- b) current source provided 4 input channels and 2 output channels
- c) current source provided 6 input channels
- d) current source provided 6 output channels

The high level voltage source input and output mixed blocks shall be individually-selectable to interface with any of the following voltage/current ranges:

1. 0 to 5 VDC
2. 0 to 10 VDC
3. -5 to +5 VDC
4. -10 to +10 VDC
5. 4 to 20 mAdc (1 to 5 VDC)

The Current Source Analog Blocks will provide internal power source to drive a 4-20ma transducer or actuator. Inputs will provide 1500 V isolation, outputs will be grouped.

The analog I/O Block shall provide at least 12 bits of resolution (0 to 4095 counts) for the unipolar ranges of 0 to 5V and 0 to 10V.

Within the Analog I/O Block shall be provided a means to scale the raw counts for any input or output channel to a 16 bit binary value giving an Engineering Units range of -32767 to +32767. This shall be the range of values presented to the controlling computer from the input channels and the range of values expected from the controlling computer for the output channels. This scaling to Engineering Units shall be linear.

Input channels shall utilize software filtering. Each channel is individually configurable in the

range of 4 to 1024 milliseconds.

The Analog input channels shall provide two Engineering units selections that will function as high and low alarm set-points. When these values are exceeded, the appropriate high or low alarm fault shall automatically be reported to the controlling computer and be made available to the HHM.

The analog input channels shall normally provide their data to the controlling computer in the scaled Engineering units form. The option shall also be available to select in place of the Engineering units a code that represents the alarm state (per the high and low alarm set-points) as follows:

- Value of 0 = No alarm condition
- Value of 1 = Low alarm condition
- Value of 2 = High alarm condition

All analog output channels shall offer the user one of two options that will determine what happens to that particular output channel when, for whatever reason, the I/O Block stops receiving fresh output data from the controlling computer. The two options shall be selected by the HHM or host computer and shall be:

1. Hold Last State
2. Default to a voltage that corresponds to a selected Engineering units value.

For analog input channels set to operate in the 4 to 20 milliamp range an Open Wire diagnostic shall be provided to detect open circuits in the input transducer or wiring. When detected, the Open Wire fault shall be reported automatically to the controlling computer and made available to the HHM.

All analog input and output channels shall provide Underrange and Overrange diagnostics that indicate that the limit of the hardware has been reached for the particular range that is being used. When detected, the Underrange or Overrange fault shall be reported automatically to the controlling computer and be made available to the HHM.

Absolute accuracy at 25 degrees C shall be +/-0.2% of full scale typical, and +/-0.5% of full scale maximum.

Thermal drift from 25 degree C shall be 10 ppm per degree C typical and 40 ppm per degree C maximum.

Common mode voltage channel-to-channel shall be 170 volts on all high level channels.

There shall be analog blocks that are compatible with Resistance Temperature Devices (RTDs). They shall have 6 channels. Each channel shall be independently configurable for copper, nickel or platinum RTDs. The input resolution shall be +/- 0.1 degrees centigrade. The inputs shall be filtered and shall have user configurable filter times of 400, 800, or 1600 milliseconds. When

configured for platinum or nickel RTDs, the typical absolute accuracy shall be +/- 0.5 degrees centigrade. For copper RTDs, the typical accuracy shall be +/- 5. degrees centigrade.

There shall be Analog Blocks that are compatible with thermocouple devices. They shall have 6 channels. Each channel shall be independently configurable for type J, K, T, E, B, R, S, or N (#14 Awg Nicrosil vs. Nisil) thermocouples. Each channel shall be capable of being configured using an internal, an external, or a user defined value for cold-junction compensation. Input measurements shall be capable of being adjusted through a range of +100 degrees C or +100 degrees F for greater accuracy. Circuits should measure the input millivolt signal to an accuracy of +10 uV (typical) or +20 uV (maximum).

5. COMMUNICATIONS LINK

The controlling computer and the I/O Blocks shall communicate via a reliable, high speed, peer to-peer serial link. A communications speed of up to 460.8 K Baud shall be available.

Cyclic Redundancy Check (CRC) type error checking shall be used for all data communicated on this link. Communications errors (Bus Errors) shall NOT prevent the I/O system from continuing its operation. If Bus Errors are encountered the incorrect data shall be rejected and the Bus Error reported to the controlling computer.

Isolation shall be provided between all devices connected to the communications bus. This isolation shall allow continued operation with up to 50 volts ground potential between devices. Also the communications bus shall be able to withstand 1500 volt transients between itself and the I/O circuits in each I/O Block.

There shall be NO active components in the serial cable path for the purpose of receiving, transmitting or amplifying the communications signal. This is required so that internal failures of any device on the communications bus do not affect communications with other devices on the same bus.

One individual communications bus shall be capable of handling at least 32 devices although it shall also operate with as few as two devices. The devices may be I/O Blocks, Hand Held Monitors or interfaces to the controlling computer.

The length of the communications bus shall be extendible up to 7500 feet. The physical configuration of the cables between devices shall be a daisy chain. Individual cable lengths between devices may be any length as long as the total for the complete cabling system does not exceed:

3500 feet @ 460 k baud

4500 feet @ 228 k baud

7500 feet @ 114 k baud

The communications bus shall be capable of being extended over a fiber optic cable through connection of a modem. The fiber network will offer greater distances in communications, greater immunity to electrical noise interference and full redundancy.

6. REDUNDANCY

The I/O system shall support at least two forms of redundancy: dual controlling CPUs and dual I/O communications uses. Using the Hand Held Monitor, blocks shall be configurable or either "hot standby", "duplex", or no redundancy.

A block configured for "hot standby" shall be able to determine which CPU shall control the output points on that block.

A discrete block shall be configurable for duplex redundancy. In this mode, the discrete block shall compare the output states commanded by two controlling CPUs attached to the bus. While the commanded states are the same, the physical corresponding output shall assume the commanded state. If the commanded states are different, the corresponding output shall assume a pre-configured default state. The default state shall be set by the HHM.

Dual communications buses shall be supported at the controlling CPUs by having one bus interface device per bus per CPU. Dual buses at the I/O Blocks shall be supported by utilizing a switching device that redirects the bus signals to the I/O.

7. HAND HELD MONITORING DEVICE SPECIFICATIONS

The HHM shall be a battery powered device with an LCD (Liquid Crystal Display) to extend the battery life. The batteries shall be rechargeable and in a modular form to allow easy replacement with a spare module when fully depleted. The batteries shall provide at least six hours of continuous HHM use. When depleted the user shall have the option of either recharging or replacing the batteries. Recharging to a minimum level that allows use of the HHM with a charger/AC adapter still plugged in shall take no more than one minute.

Circuitry shall be included to prevent overcharging the batteries while operating the HHM from the charger/AC adapter. The HHM shall be designed to allow permanent panel mounting.

A cable shall be provided with the HHM to connect to the communications link. The cable must be a minimum of five feet in length and must be easily replaceable.

The HHM shall include a key switch that prevents altering block configuration data. The

keyboard used on the HHM shall be a sealed membrane type to allow use in an industrial environment. The HHM shall be capable of communicating with an I/O Block from remote locations. It shall not be required to be physically plugged into the I/O Block it is communicating with. The capability to wire in a convenience connector at any point along the communications link shall be provided. The HHM shall include a self-test feature that occurs automatically at power up and informs the user of any detected failure of the HHM hardware. The HHM shall be a user friendly menu driven device capable of prompting the user on the LCD display in any one of the following four selectable languages.

1. English
2. French
3. German
4. Italian

HHM functions shall include, but not be limited to the following:

1. Monitoring I/O states
2. Forcing I/O states
3. Monitoring I/O faults (diagnostics)
4. Clearing I/O faults (to reset circuit operation)
5. Selection of display language
6. Manual execution of HHM self-test.
7. Selection of all configuration and diagnostic options
8. Execution of discrete I/O Block Pulse Testing
9. Addressing of all I/O Blocks
10. Monitoring of Communications bus status and parameters
11. Monitoring of points (registers or I/O) in the controlling CPU

The HHM shall have the ability to perform functions 1-9 as described above, with and without a host computer connected to the communications bus.

The HHM functionality shall be upgradeable via replacement of PROMs that store its executive software. The PROMs shall be placed in easy to access sockets so that upgrading can be accomplished in the field.

8. MISCELLANEOUS SPECIFICATIONS

The manufacturer shall provide a hardware and software interface to the I/O Blocks for the same manufacturer's Programmable Logic Controller. The interface shall properly interpret all diagnostic data (faults) provided by the I/O system described above. The diagnostic data shall be time tagged as received from the I/O system then stored in the PLC's memory. The manufacturer's standard programming terminal used with the PLC shall have the capability to access the faults stored in memory and display them in an easy to read English language format.

The fault information must be available, in an easy to use manner, for use within the PLC's logic program. This shall allow the PLC to take corrective action based upon fault information.

The PLC's programming terminal shall be able to Clear faults at the I/O Blocks via the PLC and its interface to the I/O system. A faulted I/O circuit will resume normal operation upon clearing the fault.

The manufacturer shall provide a means of displaying and printing a chronological log of faults reported from the I/O system as they occur, are acknowledged and cleared.

The PLC shall have the capability to read I/O Block configuration data from the It shall also be capable of writing this information back to the EEPROM of an I/O Block.

The I/O network shall be capable of connection to third party computing systems through either standard interface modules, i.e., PC, STD Bus, VME Bus or via custom OEM bus interface. To facilitate the custom interface capability, the I/O system vendor shall make available to the OEM an interface card with a simple to use shared RAM memory access. The vendor shall also have an established program in place for facilitation of custom interface on the part of the OEM.

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