



# ***GE Fanuc Automation***

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***Programmable Control Products***

***Genius™ I/O  
GENI Board***

***User's Manual***

***GFK-0073***

***May 1990***

## *Warnings, Cautions, and Notes as Used in this Publication*

### **Warning**

**Warning notices are used in this publication to emphasize that hazardous voltages, currents, temperatures, or other conditions that could cause personal injury exist in this equipment or may be associated with its use.**

**In situations where inattention could cause either personal injury or damage to equipment, a Warning notice is used.**

### **Caution**

**Caution notices are used where equipment might be damaged if care is not taken.**

### **Note**

**Notes merely call attention to information that is especially significant to understanding and operating the equipment.**

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This book provides the information needed to integrate a Genius™ Network Interface (GENI) board in a user-developed microprocessor system. The reader should be familiar with microprocessor system design and implementation, and with the Genius I/O system.

## Contents of this Manual

This book contains the following chapters:

**Chapter 1. The GENI Board:** gives board specifications, and describes GENI's capabilities.

**Chapter 2. Hardware Interface:** contains information about GENI board hardware, motherboard requirements, signals, and timing.

**Chapter 3. Software Interface:** describes the GENI's Shared RAM memory, which handles all data transfer between GENI and the host. Chapter 3 also summarizes GENI's activities during startup, steady state operation, and device login.

**Chapter 4. GENI Setup:** describes the area of Shared RAM where GENI stores its DIP switch setting and other setup data.

**Chapter 5. GENI Status:** describes the portion of Shared RAM where GENI stores its status data.

**Chapter 6. Interrupts:** describes Interrupt conditions. Chapter 6 also explains how to monitor Interrupt status, and how to enable or disable Interrupts from GENI to the host.

**Chapter 7. Device Configuration:** describes the table in Shared RAM where GENI stores information about devices on the bus. It also explains how GENI obtains this data.

**Chapter 8. Device Inputs and Outputs:** describes the area of Shared RAM which is used for input and output data.

**Chapter 9. I/O Table Lockout:** explains how the host can request or relinquish lockout of the I/O Tables in Shared RAM.

**Chapter 10. GENI Commands:** explains how the host can send and receive datagrams, and change GENI configuration.

**Chapter 11. Global Data:** describes how GENI can automatically exchange up to 128 bytes of Global Data with all other devices on the bus.

**Chapter 12. Directed Control Data:** explains how GENI can direct or receive up to 128 bytes of data to/from any other bus controller.

**Chapter 13. Memory Access Datagrams:** explains how GENI handles requests by other devices to read or write host memory.

**Chapter 14. Troubleshooting:** suggests troubleshooting steps based on observation of LEDs and the occurrence of bus errors.

**Appendix A. General Macro Definitions:** suggests simple macro definitions that might be used for a C language interface to GENI.

## For More Information

Refer to the *Genius I/O System User's Manual* (GEK-90486) for detailed information about Genius I/O blocks, system communications, types of systems, and system planning.

Jeanne Grimsby  
Technical Writer

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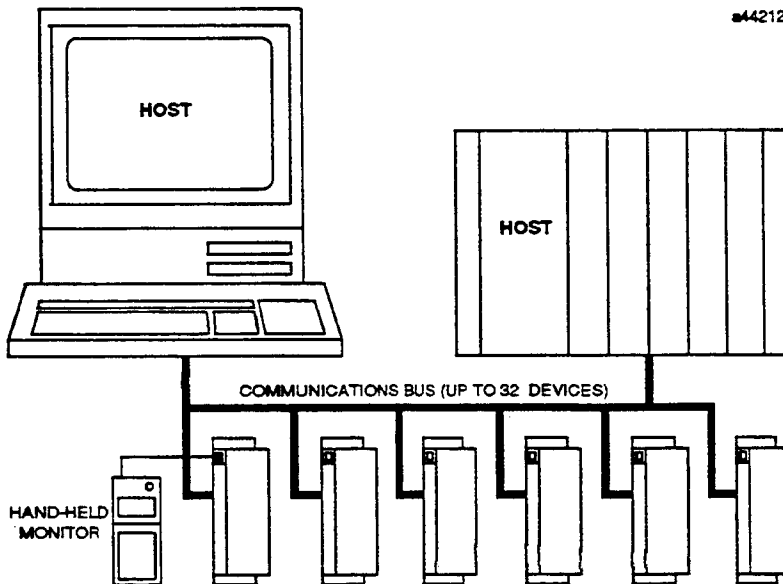
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The GENI (Genius™ Network Interface) Board (IC660ELB905) is a single printed circuit board designed to be a daughterboard in a user's microprocessor system. This manual explains motherboard requirements and operational and programming information needed to interface the GENI and motherboard to a host CPU. The host can be any CPU-type device which is capable of reading and writing to GENI's general-purpose Shared RAM. The interface to this RAM is optimized for the IBM personal-computer bus, but can be adapted to work with many other types of CPU.

GENI handles all data transfer between the host and a Genius I/O bus, allowing the host to control remote I/O utilizing the extensive diagnostics, high reliability, and noise immunity of Genius I/O. In addition, the host can communicate with other hosts using the communications capabilities of the Genius LAN.

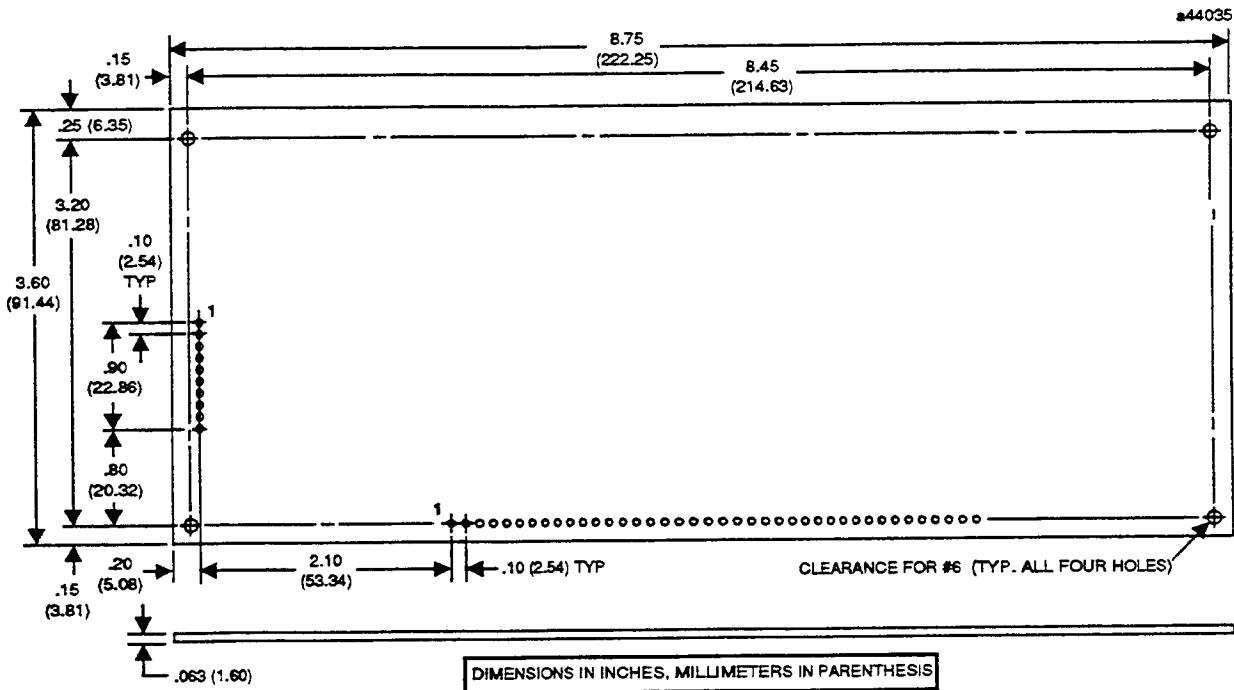
GENI operates as a general-purpose controller, performing the housekeeping tasks of initialization and fault management for up to 31 other bus devices. It keeps up-to-date images of the I/O controlled by each device, and can communicate with other controllers using datagrams, Global Data, and Directed Control Data messages. GENI handles all protocol, and provides a non-time critical method of tapping into the Genius bus.

The bus may serve any mix of I/O blocks and bus controllers; its primary purpose may be I/O control, or communications between hosts, or any combination of the two. The *Genius I/O System User's Manual* describes many types of systems that can be set up. In addition to Genius I/O blocks and bus controllers, a bus may serve one or more Genius Hand-held Monitors. The Hand-held Monitor is a versatile, portable operator interface device.



## GENI Board Description

The GENI board is a rectangular, 4-layer board (3.6" by 8.75"). Components extend no more than .75" above the board surface. No components are mounted on the foil side of the board.



Connections to the motherboard are made by pins through the GENI board into a 10-pin connector and a 40-pin connector. The transformer and hybrid are located near the 10-pin connector to keep on-board electrical noise to a minimum.

### Board LEDs

Two LEDs on the GENI board show the status of the board itself, and of its communications with the Genius bus. During proper operation, both the BOARD OK and COMM OK LEDs will be on.

### DIP Switches

DIP switches on the board are used to select Baud Rate, to specify a bus Device Number, and to enable or disable outputs from the host to the devices on the bus.

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**GENI Board Specifications**

<p><b>Electrical:</b>  <b>Power Requirements</b>  <b>Bus Loading</b>  <b>Bus Drive Capability</b></p> <p><b>Mechanical</b>  <b>GENI Board Dimensions</b></p> <p><b>Environmental:</b>  <b>Operating:</b>  <b>Ambient Temperature at board</b>  <b>Humidity</b>  <b>Altitude</b>  <b>Vibration</b></p> <p><b>Shock</b></p> <p><b>Non-operating:</b>  <b>Ambient Temperature at board</b>  <b>Humidity</b>  <b>Altitude</b>  <b>Vibration</b></p> <p><b>Shock</b></p>	<p>5 volts DC +/-10%, 400mA (maximum)                      1 LS TTL load per input line                      10 LS TTL loads per output line</p> <p>Height at tallest component: 0.75 inches (19.05mm)                      Width: 3.6 inches (91.44mm)                      Depth: 8.4 inches (213.36mm)                      Board thickness: 0.063 inch (1.60mm)</p> <p>-25°C to +85 °C, °F to + °F                      5% to 95% non-condensing                      10,000 feet                      0.2 inch displacement 5 to 10 Hz                      1 G 10 to 200 Hz                      5 G. 10mS duration per MIL-STD 810C, method 516.2</p> <p>-40°C to +125 °C, °F to + °F                      5% to 95% non-condensing                      40,000 feet                      0.2 inch displacement 5 to 10 Hz                      1G 10 to 200 Hz                      Board packed in shipping container:                      5 G, 10mS duration per MIL-STD 810C, method 516.2</p>
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**Ordering Information**

Description	Catalog Number
GENI Board	IC660ELB905
8K x 8 EPROM	44A723355-000
HHM Connector	44A723293-001
<i>Genius I/O System User's Manual</i>	GEK-90486

## GENI Board Components

Principal components of the GENI board are:

<b>6303 microprocessor</b>	The serial interface microprocessor. It writes messages to transmit buffers in the MIT chip.
<b>MIT chip</b>	The MIT chip handles the hardware interface to the bus. It also provides many support functions such as CRC generation, error checking, a watchdog timer function, chip select, LED drivers, and processor clock signals.
<b>Transmit/receive hybrid circuit</b>	A hybrid circuit interfaces the MIT transmit and receive signal levels to bus signal levels.
<b>Transformer</b>	The transformer isolates the GENI board circuitry from the bus cable.
<b>Dual port RAM</b>	Dual port RAM is where the serial interface microprocessor (6303) and the GENI manager microprocessor (64180) exchange data. Dual port RAM removes timing skews between the two processors, which are running two separate, asynchronous systems. Dual Port RAM is controlled by an EPLD, which arbitrates memory requests on a byte-by-byte basis, allowing the 6303 and the 64180 equal access.
<b>64180 Microprocessor</b>	This microprocessor transfers data between GENI's Shared RAM and the serial interface microprocessor (6303), through dual port RAM. The 64180 microprocessor has 8K bytes of RAM for its exclusive use.
<b>Shared RAM</b>	Shared RAM is the host's interface to GENI. It provides 16K bytes of storage space for I/O tables, configuration data, diagnostic data, and background message queues. Shared RAM can be accessed by either GENI or the host without loss of data. There is no need for software arbitration. Shared RAM looks like a pure RAM device to both systems.
<b>Shared RAM Address Comparator</b>	<p>The Shared RAM Address Comparator causes a 64180 microprocessor interrupt when the host's Write line is true and the current Shared RAM address matches a specific interrupt (command) byte address. The interrupt is latched until the 64180's Read line is true and the current Shared RAM address matches the specific interrupt (Command) byte address. Thus, an interrupt occurs when the host writes to the command byte and is cleared when the 64180 reads the command byte.</p> <p>This circuit is implemented in a single array logic device (EPLD) which allows the address of the interrupt bytes to be reprogrammed during redevelopment, and provides the capability for latching and clearing the interrupt. The EPLD arbitrates Shared RAM memory requests on a byte-by-byte basis and allows the host and bus controller equal access to any byte of Shared RAM without loss of data.</p>

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## Motherboard Requirements

The motherboard must provide the following minimum support:

- +5V power connection with appropriate ground connections.
- Powerup Reset pulse to the GENI board.
- Female 10-pin and 40-pin connectors for signal and power signals to GENI. Recommended mating connectors are available from AMP, Berg, Cannon, and Augat.
- Terminal block and optional D subminiature connector to the bus.
- HHM connector (D subminiature connector) with HHM Present signal.

## Mounting the GENI Board

The GENI board is designed to be mounted to the motherboard, using spacers, via its four corner holes. These holes accept plastic PCB supports (Richo Plastics or equivalent), or screws or standoffs.

DO NOT

- Mount the board where airflow across the board is obstructed.
- Mount the board nearer than 1/8" (.125") to any other boards or rack components.
- Use adhesives or conformal coatings on any part of the board.

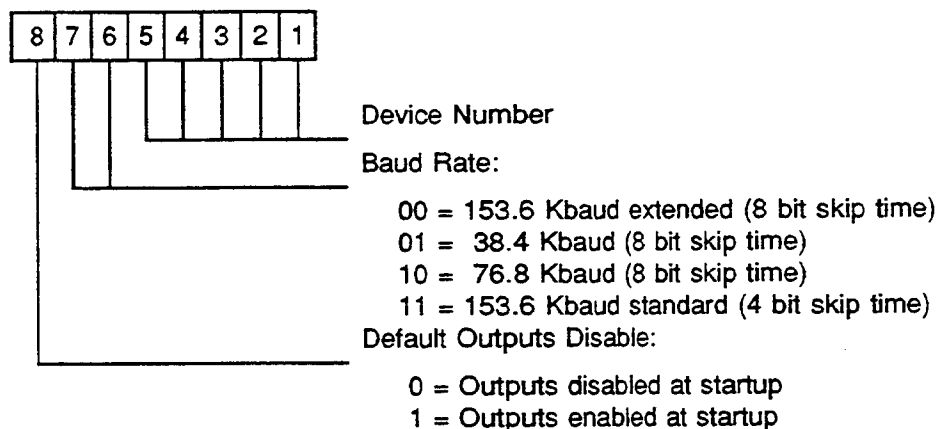
## Power Supply Requirements

The GENI board requires a 5 volt DC source for logic power. Supply voltage should not vary more than 10% above or below nominal (below 4.5 VDC or above 5.5 VDC).

## GENI DIP Switches

The GENI board's DIP switches must be set before installing the GENI bus controller into the host device. The switch settings determine: the baud rate, the status of the outputs disable bytes during initialization, and the Device Number of the GENI board.

### DIP Switch Assignments



#### Baud Rate

All devices on a bus must use the same baud rate: 153.6 Kbaud standard, 153.6 Kbaud extended, 76.8 Kbaud, or 38.4 Kbaud. The default is 153.6 Kbaud standard. Baud rate must be selected on the basis of cable type, and other factors determined by the application.

#### Device Number

Each device connected to the Genius bus must have a unique Device Number assigned. This number represents the module's "bus address". The default Device Number set with the DIP switches on the GENI module is 31.

Each Genius communications bus can serve up to 32 devices, which are identified by Device Numbers from 0 to 31. A module's Device Number represents its place in the communications sequence on the bus.

By convention, certain numbers are associated with particular types of devices. For example, Device Number 0 is normally used for a Genius Hand-held Monitor. The Series 90-70 PLC and the Series Six PLC use Device Numbers 30 and 31 for bus controllers in a backup (redundancy) type of system. Be sure that the Device Number assigned to the GENI bus controller is both unique and appropriate for the system.

#### Outputs Enabled/Disabled

Disabling Outputs means preventing the transmission of outputs to all devices on the bus when the GENI bus controller is powered up. This prevents incorrect operation of the outputs at powerup. The default setting is for outputs to be enabled (DIP switch 8 is set to 1). To disable outputs, set switch 8 to 0.

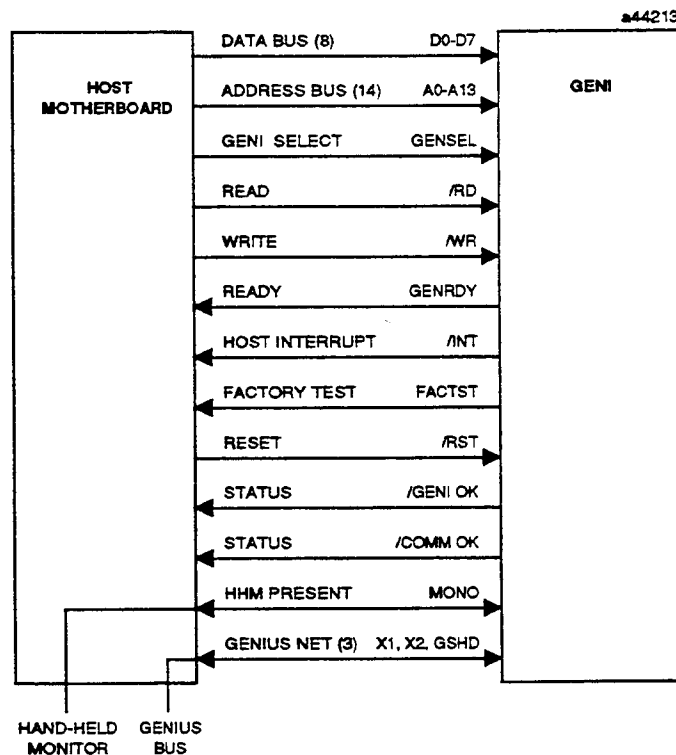
### Changing the DIP Switch Settings

GENI reads these switch settings at powerup; if any switch setting is changed, it will be ignored until the next time GENI is powered up. An exception to this is that the Device Number may be changed if there is a Device Number conflict.

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Signal connection between GENI and the motherboard is provided by via a 40-pin male connector for logic signals and a 10-pin male connector for Genius bus signals.

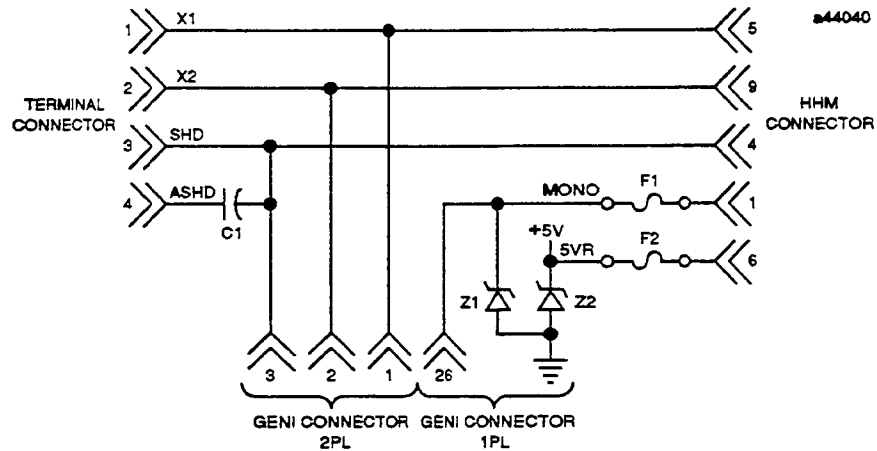
The GENI board's interface signals are directly compatible with those of the IBM PC backplane. Hosts with significant variances from the IBM PC backplane may require motherboard translation circuitry.



### Bus Loads/Drive Capability

All input lines to the GENI present no more than one standard LSTTL load to the host interface connector. All output lines from the GENI are capable of driving 10 standard LSTTL loads. These lines, with the exception of the /INT and /GENI OK lines are tri-state outputs. The /INT line is an open-collector output that can be wired-ORed to a single interrupt input. The /GENI OK and /COMM OK lines are low-true open-collector type outputs with built-in current-limiting to 10mA suitable for driving LEDs directly.

## Motherboard Wiring Requirements



X1, X2, SHD, and AUXSHD must be 1/16 inch from all other signals on the motherboard. MONO and 5VR must be 1/16 inch from all other signals on the motherboard up to the high voltage suppressors, at which point, they may be grouped with the other motherboard 5 volt signals.

X1, X2, and GSHD must be connected to a terminal connector on the motherboard.

The GSHD input, which connects to the bus shield, should be connected to earth ground on the motherboard.

Five volt power and logic grounds should be brought into the GENI board on both sides of the 40-pin connector. These grounds must be at the same potential at both ends of the connector so ground loop currents will not flow in the GENI board.

### Signal Conditioning

The MONO line should be protected from the accidental application of 120 VAC by adding over-voltage protection devices on the motherboard. These devices should shunt to ground any excess currents developed from high voltage devices applied to either pin 1 or pin 6 of the HHM connector. Recommended devices are transient suppressors with a breakdown voltage of 7.5 volts.

1. 1N6268A - Motorola and other vendors
2. TZV7.5A - Semicon

The capacitor ("c" in the illustration above) is recommended to shunt any AC noise present on the bus shield. It should be a 0.1 microfarad ceramic 100 volt, 20% capacitor.



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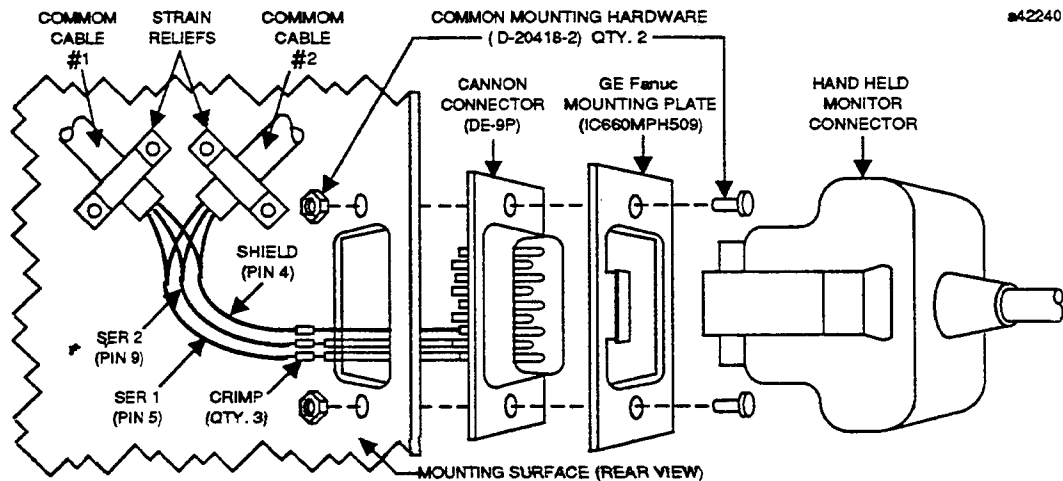
## Faceplate Markings

If a faceplate is used for the combined motherboard/daughterboard (referred to in this book as the GENI bus controller), it should provide the following names for the signals on the external bus connector:

<b>X1</b>	SERIAL 1
<b>X2</b>	SERIAL 2
<b>SHD</b>	SHIELD IN
<b>AUXSGD</b>	SHIELD OUT

## Hand-held Monitor Connector

The Hand-held Monitor connector should be a DE-9P subminiature male connector capable of accepting two 4-40 threaded screws. Since the DE-9P connector does not provide a mechanical locking mechanism to secure the clip at the end of the HHM's cable, a mounting plate (order part number IC660MPH509) should be used to prevent the HHM cable from falling out of the connector. This dress plate has a metal catch that allows the HHM connector clip to hook onto the D connector. The dress plate is mounted on the front of the D connector and held in place by two locking screws (Cannon D20418-2). The unused pins on the D connector should remain unconnected in order to maintain isolation between the X1, X2, SHD lines, and the MONO and 5VR lines.



## Bus Cable Selection

The type of bus cable used will depend upon the application requirements. The *Genius I/O System User's Manual* gives guidelines for bus cable selection.

## 10 Volt Connector Signals

The 10-pin connector provides the following Genius bus signals:

PIN	FUNCTION
1	X1
2	X2
3	GSHD
4	NC
5	NC
6	NC
7	NC
8	NC
9	NC
10	NC

X1, X2, and GSHD are the serial bus connections; they must be connected to a terminal connector on the host motherboard.

X1 - X2 are differential signals that carry Genius bus data.

GSHD is connected to the serial bus shield. This signal should be connected to earth ground on the motherboard.

## 5 Volt Connector Signals

The 40-pin connector provides the following 5-volt signals:

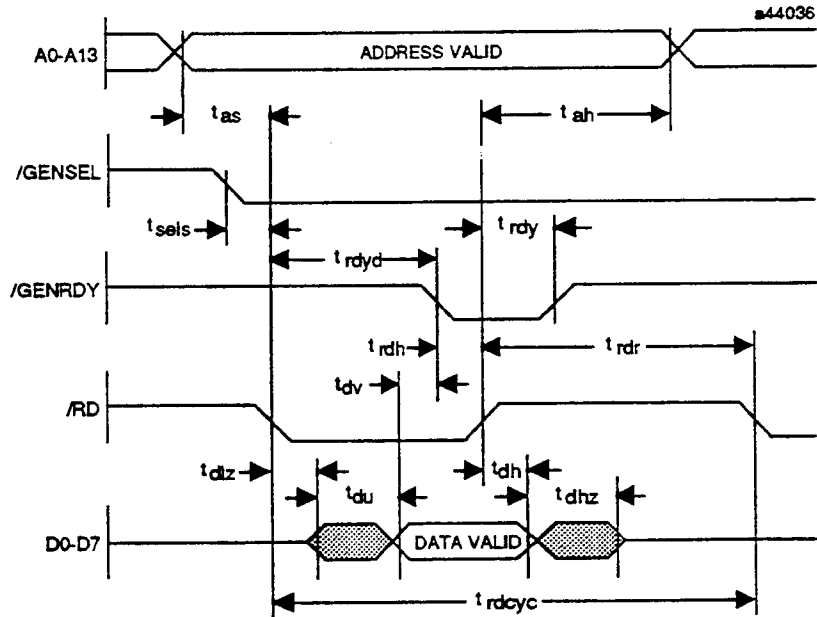
PIN	FUNCTION	PIN	FUNCTION
1	GND	21	A13
2	+5V	22	+5V
3	NC	23	/RD
4	/GENIOK	24	/WR
5	/INT	25	/GENSEL
6	/RST	26	MONO
7	FACTST	27	/GENRDY
8	A0	28	/COMM OK
9	A1	29	NC
10	A2	30	GND (0V)
11	A3	31	D3
12	A4	32	D2
13	A5	33	D4
14	A6	34	D1
15	A7	35	D5
16	A8	36	D0
17	A9	37	D6
18	A10	38	D7
19	A11	39	+5V
20	A12	40	GND

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Signals on the 40-pin connector are described in the following table.

Signal Type	Signal Name	Description
Data Signals	D0-D7	The eight data lines are bi-directional. They are used to transfer data in the GENI board's Shared RAM to/from an 8-bit microprocessor-type data bus. These lines enter the high-impedance state when /RST is low or /GENSEL is high. Tristate output.
Address Signals	A0-A13	Fourteen consecutive address lines which designate an address in Shared RAM to be written or read.
Control Signals	/WR	The Write strobe input to the GENI indicates that data on D0-D7 is valid and should be written from the host interface bus to Shared RAM.
	/RD	Read strobe line; The Read input to the GENI is used during a host CPU read cycle. It enables data transfer from Shared RAM to the host interface bus.
	/RST	ReSeT initializes the GENI board when held low. It must be held low during powerup and for a minimum of 20 milliseconds after all power supplies are in tolerance. All GENI output signals are held inactive during reset.
	/GENSEL	GENi SElect is use by the host to request access to Shared RAM. All output signals from GENI are held inactive and data cannot be written into Shared RAM when this signal is high.
	/GENRDY	GENi ReaDY is an output from the GENI to the host motherboard, which tells the host to complete its memory access cycle. It is functionally identical to a 'WAIT' signal from a slow memory device. The host system should use this signal to introduce WAIT states if necessary during a GENI Shared RAM access. /GENRDY falls low until the low to high transition of /RD or /WR. A high to low transition of /GENRDY means that the host can stop inserting wait states (ending its read or write cycle).
Interrupt Signal	/INT	INT is an open-collector output that tells the host an event occurred whenever it goes low (it pulses low for 5.44 microseconds). Provision must be made for the host to remember that this pulse occurred. Conditions that may cause an interrupt can be selected and monitored through the Shared RAM interface.
Status Signals	MONO	When the HHM MONitOr (MONO) signal is high, a Hand-held Monitor is attached to the HHM connector on the motherboard.
	/GENI OK	Reflects the GENI OK LED output. Low when GENI is running normally. High when a hardware error has been detected. This line is internally current-limited to 10mA. It can directly drive an LED or be used as a logic signal.
	COMM OK	A low /COMM OK output indicates no communications errors on the bus. COMM OK is current limited and can directly drive an LED or can be used as a logic signal.
5 Volt		5 volt +/-10% power supply input.
0 volt		Logic ground input.

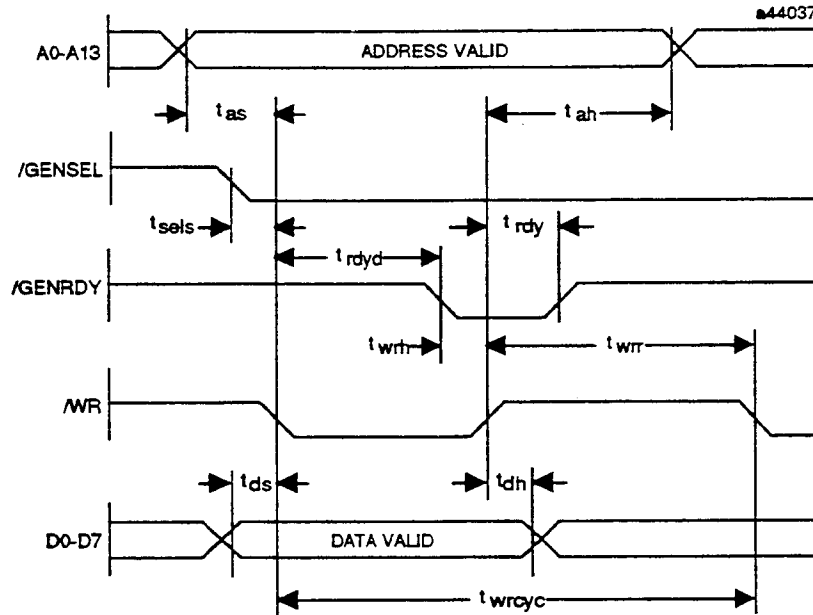
### Timing for Shared RAM Read Cycle



Item	Minimum nS	Maximum nS
Read Cycle Time ( $t_{rdcyc}$ )	615	-
Address Setup Time ( $t_{as}$ )	0	-
Address Hold Time ( $t_{ah}$ )	0	-
GENI Select Setup Time ( $t_{sels}$ )	0	-
GENI Ready Delay ( $t_{rdyd}$ )	479	937
Ready Hold After Read ( $t_{rdy}$ )	16	31
Read Hold After Ready ( $t_{rdh}$ )	0	-
Read Recovery Time ( $t_{rdr}$ )	136	-
Data Time to Low Z ( $t_{dz}$ )	2	668
Data Undefined Time ( $t_{du}$ )	-	178
Data Valid Before Ready ( $t_{dv}$ )	96	-
Data Hold Time ( $t_{dh}$ )	2	28
Data Time to High Z ( $t_{dhz}$ )	2	28

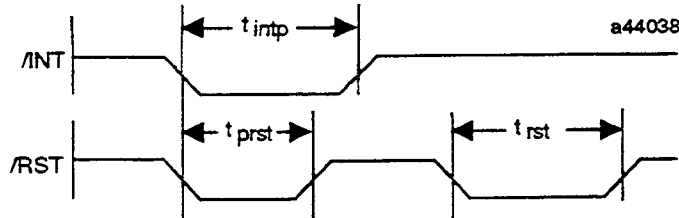
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### Timing for Shared RAM Write Cycle



Item Name	Minimum nS	Maximum nS
Write Cycle Time ( $t_{wrcyc}$ )	615	-
Address Setup Time ( $t_{as}$ )	0	-
Address Hold Time ( $t_{ah}$ )	0	-
GENI Select Setup Time ( $t_{sels}$ )	0	-
GENI Ready Delay ( $t_{rdyd}$ )	479	937
Ready Hold After Write ( $t_{rdy}$ )	16	31
Write Hold After Ready ( $t_{wrh}$ )	0	-
Write Recovery Time ( $t_{wrr}$ )	136	-
Data Setup Time ( $t_{ds}$ )	0	-
Data Hold Time ( $t_{dh}$ )	0	-

## Interrupt and Reset Timing



Item	Minimum	Maximum
/INT Pulse Width ( $t_{intp}$ )	5.44 $\mu$ S	-
Powerup /RST Pulse ( $t_{prst}$ )	2000mS	-
Operating /RST Pulse ( $t_{rst}$ )	10 $\mu$ S	-

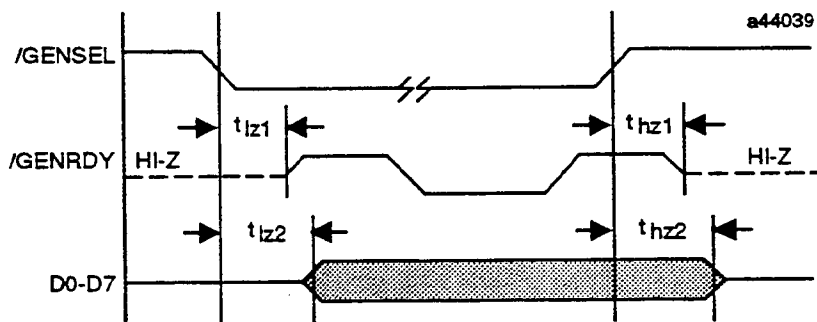
### Reset Restrictions

After the rising edge of /RST, do not enable interrupts or read/write to Shared RAM for 500 microseconds. This time is required for hardware and software initialization on the GENI board.

One false interrupt occurs within this time period. Reading or writing to Shared RAM during this time may cause the watchdog timer to time out.

The GENI OK flag is invalid during this period. In addition, the /GENRDY line may remain high indefinitely after /GENSEL goes low.

## GENI Ready/Data Select Timing



Item	Minimum nS	Maximum nS
Select to Low Z /GENRDY ( $t_{lz1}$ )	2	30
/Select to Low Z Data ( $t_{lz2}$ )	2	668
/Deselect to High Z /GENRDY ( $t_{hz1}$ )	2	31
Deselect to High Z Data ( $t_{hz2}$ )	4	32

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GENI's Shared RAM memory handles all data transfer between GENI and the host. A memory map is shown below.

Location dec. hex.	Content	Size in Bytes
0000 0000	Request Queue	(2176)
2176 0880	Request Queue Head Pointer*	(1)
2177 0881	Request Queue Tail Pointer	(1)
2178 0882	GENI Setup Table	(16)
2194 0892	GENI Status Table	(16)
2210 08A2	Interrupt Status Table	(16)
2226 08B2	Interrupt Disable Table	(16)
2242 08C2	Command Block*	(16)
2258 08D2	Transmit Datagram Buffer	(240)
2498 09C2	Read Datagram Buffer	(134)
2632 0A48	I/O Table Lockout Request *	(1)
2633 0A49	I/O Table Lockout State	(1)
2634 0A4A	Reserved	(5045)
7680 1E00	Device Configuration Table	(256)
7936 1F00	Directed Control Input Table	(128)
8064 1F80	Broadcast Control Output Table	(128)
8192 2000	Device I/O Table	(8192)
16383 3FFF		

\* Host write causes interrupt to GENI

**Request Queue:** Queue for incoming Read Device, Write Device, and Write Point datagrams to the host.

**Request Queue Head Pointer:** Number of the Request Queue buffer currently being read.

**Request Queue Tail Pointer:** Indicates the most recent entry in the Request Queue.

**GENI Setup Table:** Characteristics of GENI and the bus.

**GENI Status Table:** Diagnostics for GENI bus controller and the bus.

**Interrupt Status Table:** Current status of interrupts to host.

**Interrupt Disable Table:** Used to enable/disable host interrupts.

**Command Block:** Used by host to send Read Datagram, Transmit Datagram, Transmit Datagram with Reply, and Configuration Change commands to GENI.

**Transmit Datagram Buffer:** Temporary location for sending datagrams.

**Read Datagram Buffer:** Location where host may read incoming datagrams.

**I/O Table Lockout Request/Relinquish:** Used to set or release GENI lockout of I/O Tables.

**I/O Table Lockout State:** Actual lockout state.

**Reserved Area:** *The host should NOT read or write in this area.*

**Device Configuration Table:** Location of device ID, status, and setup information.

**Directed Control Input Table:** Location for receiving Directed Control Data.

**Broadcast Control Output Table:** Buffer for sending Global Data.

**Device I/O Table:** Contains all device inputs and outputs, and incoming Global Data.

## Shared RAM Structure Variables

The host can access various elements of Shared RAM by assigning them variable names. For example, the Shared RAM variables listed below might be defined for a C language interface to GENI. The chapters that follow list additional example variable names for use with specific areas of Shared RAM.

```
typedef
struct {
    REQUEST_Q          request_q[16];
    unsigned char      head_idx;
    unsigned char      tail_idx;
    SETUP_GENI         setup;
    GENI_STATUS        status;
    unsigned char      int_status[16];
    unsigned char      int_disable[16];
    COMMAND            cmd_block;
    unsigned char      outdata[240];
    unsigned char      indata[134];
    unsigned char      lockout;
    unsigned char      lockout_state;
    unsigned char      host_clr;
    unsigned char      spare[5045];
    DEV_CONFIG         devices[32];
    unsigned char      geni_dcd[128];
    unsigned char      geni_bcd[128];
    unsigned char      iotables[8192];
}SRI;
```

This example defines one variable for the device I/O tables. Separate variables could be defined for the Input Table and the Output Table. The size of the Input Table and Output Table depends on the I/O buffer length that has been selected for the application.



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## Interface Suggestions

### GENI Setup

Use the GENI Setup Table to read or change:

- A. Global Data length (for Global Data sent by GENI).
- B. Directed Control Data length (for Directed Control Data received by GENI).
- C. Reference Address
- D. I/O buffer length

To change the GENI Setup Table, place the new data in the Setup Table, then send GENI a Configuration Change command in the Command Block.

See chapter 4 for information about the GENI Setup Table.

### GENI Status

Use the GENI Status Table to monitor:

- A. GENI Revision Number
- B. GENI OK status
- C. GENI hardware status
- D. HHM Present status
- E. total bus error count
- F. I/O scan time

See chapter 5 for information about the GENI Status Table.

### Interrupts

Use the Interrupt Status Table to monitor the Interrupt Summary byte, as well as individual interrupt status bytes:

- A. Request Queue entry
- B. GENI status change
- C. Device status change
- D. Outputs sent
- E. Command complete
- F. Receive Queue not empty
- G. I/O Table Lockout grant

Use the Interrupt Disable Table to enable or disable one or more interrupts.

See chapter 6 for information about the Interrupt Tables.

### Device Configuration

Use the Device Configuration Table to read information about each device on the bus:

- A. its model number
- B. whether outputs from the host are enabled
- C. whether the device is present on the bus
- D. the device's Status Table or Reference Address
- E. its I/O data length
- F. its block I/O type

The host can change the outputs enable/disable flag for each device.

See chapter 7 for information about the Device Configuration Table.

To read additional device configuration data, the host can use a Transmit Datagram with Reply command to send a Read Configuration datagram to the device. See chapter 10 for details.

To change device configuration data, the host can use a Transmit Datagram command to send a Write Configuration datagram to the device. See chapter 10.

### Device Inputs and Outputs

Use the Device I/O Table to read device inputs, or to send outputs. See chapter 8 for instructions.

To assure integrity of I/O data, Global Data, and Directed Control Inputs, set I/O Table Lockout. This will lock GENI out of the I/O tables while the host completes its access. See chapter 9 for information.

To change the length of the I/O Table buffers, use a Command Block to send a Configuration Change command to GENI, after changing the GENI Setup Table. See chapters 4 and 10 for information.

### Read or Write Datagrams

If GENI will send datagrams to other bus controllers, or receive datagrams from them, see chapter 10. It explains how to send commands to the GENI through the Command Block area of Shared RAM.

There are two exceptions to this:

1. Datagrams that require no host interaction: Read ID and Configuration Change datagrams from devices on the bus.
2. Datagrams that require direct access to host memory. These are explained in chapter 13.

### Automatic Data Transfer Between Hosts

- A. Use Global Data to automatically send up to 128 bytes of data to all other bus controllers on the bus. See chapter 11 for instructions.
- B. Use Directed Control Data to automatically send up to 128 bytes of data to one specific device on the bus. See chapter 12 for instructions.
- C. Monitor the Input Table to read Global Data or input data received from another device. See chapter 11.
- D. Monitor the Directed Control Inputs Table to read Directed Control Data received from another device. See chapter 12.

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## Startup

When the GENI board Reset is released, it begins its startup procedure. During this time, GENI automatically performs the following diagnostic hardware tests:

1. EPROM checksum test
2. microprocessor test
3. MIT bus test
4. RAM test

If any error is found, GENI reports it in the GENI Status Table. It then attempts to go into a controlled lockup state. The host does not receive the GENI OK status, and the GENI OK light does not go on. If no error is found during the diagnostic tests, GENI initializes the contents of Shared RAM to the following defaults.

<b>Device Present Flag</b>	0
<b>Outputs Enable</b>	setting based on DIP switch
<b>Device Number</b>	setting based on DIP switch
<b>Baud Rate</b>	setting based on DIP switch
<b>I/O Table Lockout State</b>	0
<b>Broadcast Control Data(inputs) length</b>	0
<b>Directed Control Data(outputs) length</b>	0
<b>I/O Table Buffer Length</b>	128 (80 hex)
<b>Reference Address</b>	0FFFF (hex)
<b>All Interrupt Status</b>	0
<b>All Interrupt Disable</b>	0
<b>All GENI Status</b>	0
<b>Receive Queue</b>	empty
<b>Transmit Datagram Buffer</b>	empty
<b>Request Queue</b>	empty
<b>Command Status byte</b>	Command Complete

It also initializes the dual port RAM, the MIT, and other hardware or software related variables needed to begin steady-state operation.

DIP switch settings on the GENI board are read at powerup. This information is ignored at all other times. When the MIT is initialized, it is set with the Device Number and baud rate selected with the DIP switches.

During the powerup sequence, the host must not read or write to the Shared RAM for 1.7 seconds. After that time, the GENI OK flag should be on, indicating that the self-test has passed. The GENI will set this flag within 2 seconds of powerup. After the GENI OK flag is set, there is an additional 1.5 second delay. During this time, the host can change the GENI configuration.

GENI will not accept inputs from devices on the bus or send outputs until powerup has been completed successfully. When the board's MIT microprocessor is initialized, GENI is ready to begin transmitting on the bus.

## Steady State Operation

After successful startup, GENI starts transmitting the bus token, and begins normal operation. GENI will immediately begin collecting input data from devices on the bus. It sends outputs from Shared RAM immediately unless the Outputs Disable DIP switch is set to Disable. If the switch is set to Disable, the host must enable outputs before GENI will send outputs from Shared RAM.

GENI's activities during normal operation are summarized below.

- |                               |   |
|-------------------------------|---|
| <b>Self-test</b>              | During steady-state operation, GENI continually executes self-tests. This testing includes non-destructive private RAM test, EPROM checksum, and maintenance of an internal heartbeat. If any fault occurs, it is reported through the GENI Status Table area of shared RAM. Outputs are then disabled, and the GENI bus controller attempts to halt.   |
| <b>I/O Service</b>            | GENI maintains a table of inputs received from the other devices on the bus. It also maintains an information queue containing the Device Numbers of the devices that sent input data. Each bus scan, GENI directs outputs from the host to those devices. It also maintains a queue of device addresses to which output data has been sent.  |
| <b>I/O Table Lockout</b>      | Upon request from the host, GENI will "lock out" the I/O table. During lockout, GENI will not access the Device I/O Tables, the Broadcast Control Output (Global Data) Table, or the Directed Control Input Table.  |
| <b>Host interrupts</b>        | <p>Seven conditions which may require immediate host attention can be monitored, and may cause the GENI to send an interrupt the host. Before sending the interrupt, GENI sets a byte corresponding to the detected condition in the Interrupt Status Table in Shared RAM. The host must clear the byte after servicing the interrupt.</p> <p>The host can disable any of the seven interrupt conditions by setting bytes in the Interrupt Disable Table area of Shared RAM. If one of the interrupt conditions occurs, GENI sets the appropriate byte in the Interrupt Status Table. If the corresponding disable flag is set, no interrupt to the host is generated. The host is still responsible for clearing the Interrupt Status Table bytes.</p> |
| <b>Datagram Service</b>       | GENI maintains a queue of datagrams from other devices. It will also transmit datagrams from the host to devices on the bus.  |
| <b>Maintain Bus Scan Time</b> | GENI maintains a minimum bus scan time of 3mS. GENI monitors actual bus scan time, and stores the current scan time in Shared RAM, where it can be read by the host.  |

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## Device Login and Log-out

Device login and log-out are two activities that occur automatically while the bus is in operation.

### Device Login

During normal operation, login activity occurs when a new device on the bus starts broadcasting input data. Whenever inputs are received from a device, GENI checks to determine that the device is "logged in" to the Configuration Table area of Shared RAM. If it is, the input data is accepted and placed in the Input Table. If the device is not logged in, the bus controller automatically goes through the login steps described below.

In a redundant system, heavy login activity occurs following a bus or controller switch.

The host should check the login status of a device before reading inputs from its buffer in the Input Table, to assure that the data is valid inputs.

During operation of the bus, if GENI receives input data from a previously unrecognized device, it automatically sends a Read ID message to the new device. If the device sends back a Read ID Reply message, GENI stores the configuration data contained in that message in the Device Configuration Table area of Shared RAM, in the buffer that corresponds to the new device's Device Number.

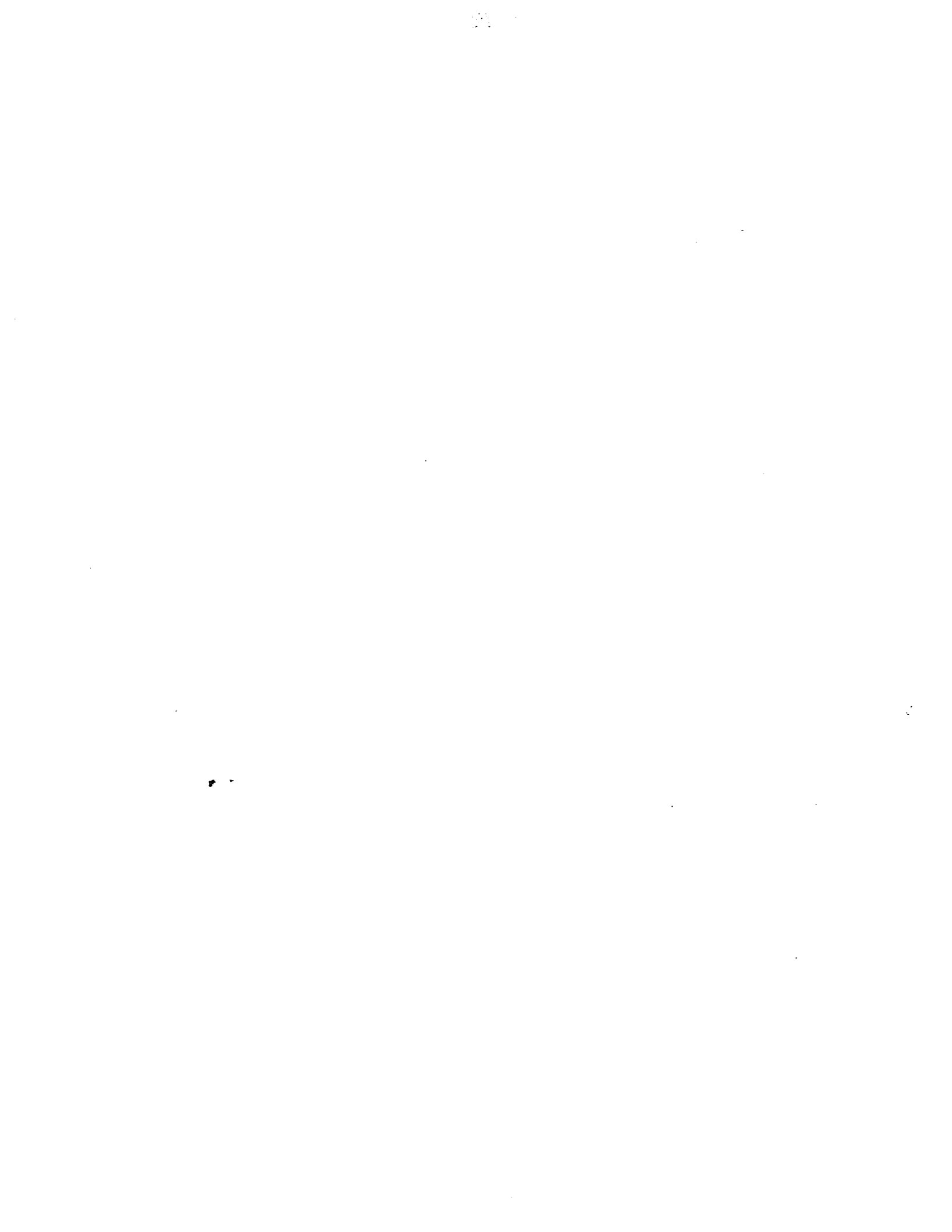
Next, GENI sets the Device Present flag for that device in the Device Configuration Table. It also sets the Device Status Change byte in the Interrupt Status Table. If the Device Change Interrupt or Interrupt Summary is NOT disabled, GENI also sends an interrupt to the host.

To enable sending outputs to the new device, the host must reset the Output Disable flag in the Device Configuration Table. When this is done, GENI automatically directs an Assign Controller message to the device. This instructs the device to send fault reports and configuration change messages to the GENI. GENI then starts sending the data from that device's area of the output table each bus scan.

### Device Log-out

GENI automatically logs out any device that was previously logged in, if it does not send new inputs for at least three consecutive bus scans. GENI stops sending outputs to the device. It also marks the device as "not present" and sets the Device Status Change byte in the Interrupt Status Table. If the Loss of Device or Interrupt Summary is NOT disabled, GENI also sends an interrupt to the host.

The device remains logged off until it begins broadcasting inputs again. At that time, GENI will execute the login steps described above.



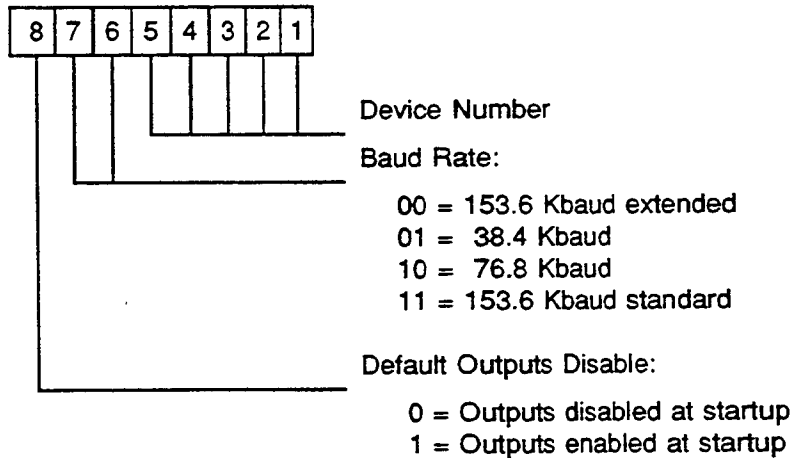
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To read or change the GENI's configuration, use the GENI Setup Table, which begins at Shared RAM location 2178D/0882H. It contains the following information:

Byte No.	Description
byte 1	GENI board DIP Switch Value*
byte 2	Reference Address (lsb)
byte 3	Reference Address (msb)
byte 4	Broadcast control data length
byte 5	Directed control data Length
byte 6	I/O Table Buffer Length
bytes 7-16	Reserved

\* Only byte the host may NOT change directly.

**DIP Switch Value** the first byte of the Setup Table contains the settings of the GENI board DIP switches.



**Broadcast Control Data Length** specifies how much Global Data the GENI will broadcast each bus scan. The range is 0 to 128 bytes; the default is 0. GENI will automatically provide this value, and the Directed Control Data Length, to any device that sends it a Read ID Datagram.

**Directed Control Data Length** specifies how much data GENI will accept in the Directed Control Input Table each bus scan. The range is 0 to 128 bytes; the default is 0.

**Reference Address** this can be set by the host to desired value. Usually, it represents a logical reference that may correspond to the host memory location where the host stores I/O data from GENI. The GENI doesn't use the Reference Address itself. Rather, it passes the information to any device that requests it. The address should be set to a byte boundary. The default is 0FFF hex. For values compatible with the Series Six PLC, see the *PLC Bus Controller User's Manual*.

**I/O Buffer Length** the length of each buffer in the device I/O Tables. The default buffer length is 128 bytes. Shortening the buffer length (all buffers are the same length), shortens the entire I/O Table. The buffer length may be 1 to 128 bytes. The length selected must be long enough to accommodate any device's inputs and outputs (including Global Data and Directed Control Inputs data). GENI will not log in any device that sends or receives more data than will fit into its I/O Table buffer.

### Example Variables

The following Status Table variables might be defined for a C language interface to GENI.

```
typedef
struct {
    unsigned char    DipSwitch;        /* GENI board DIP switch value */
    unsigned int     ST_addr;          /* Reference Address */
    unsigned char    BCD_length;       /* broadcast control data length */
    unsigned char    DCD_length;       /* directed control data length */
    unsigned char    IOTable;          /* length of each I/O table buffer */
    unsigned char    Reserved[10];     /* currently undefined */
} SETUP_GENI;
```

## Changing the Setup Table

During the powerup sequence, the host must not read or write to the Shared RAM for 1.7 seconds. After that time, the GENI OK flag should be on, indicating that the self-test has passed. The GENI will set this flag within 2 seconds of powerup. After the GENI OK flag is set, there is an additional 1.5 second delay. During this time, the host can change the GENI configuration.

The host can change any item in the GENI Setup Table except the DIP switch value by sending the GENI a Change Configuration Command.

First, the host must first change the intended item(s) in the GENI Setup Table. Then, the host must send GENI a Configuration Change command, in the Command Block area of Shared RAM. See the chapter "GENI Commands" for more information.

To change any DIP switch value, it is necessary to reset the DIP switch, then cycle power to the GENI board or reset then release the reset. In the case of a Device Number conflict, the Device Number can be changed without cycling power or resetting the board.

## Read ID Requests to GENI

Another device on the bus may request setup information from GENI. It does that by sending GENI a Read ID datagram. GENI replies automatically, sending the contents of the GENI Setup Table in form of a Read ID Reply datagram. The reply is sent with high priority. This occurs automatically; it requires no host interaction.



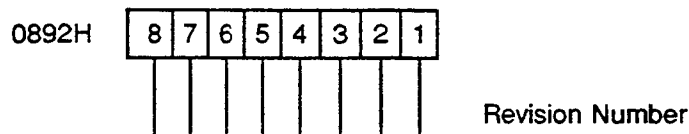
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To read diagnostic information about GENI and about the bus, use the GENI Status Table. The GENI Status Table occupies 16 bytes of Shared RAM, starting at location 2194D/0892H. It contains the following information:

Location	Byte No.	Description
0892H	1	GENI Revision Number
0893H	2	GENI OK Status
0894H	3	GENI Hardware Status
0895H	4	HHM Present
0896H	5	Serial Bus Error Count (lsb)
0897H	6	Serial Bus Error Count (msb)
0898H	7	I/O Scan Time in Milliseconds (lsb)
0899H	8	I/O Scan Time in Milliseconds (msb)
089A-089F	8 bytes reserved	

### GENI Software Revision Number

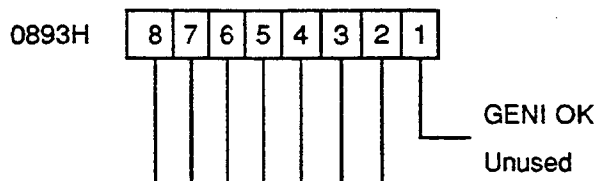
Shared RAM location 0892H contains the revision number of the GENI software.



The default is 0FFFF hex.

### GENI OK Status

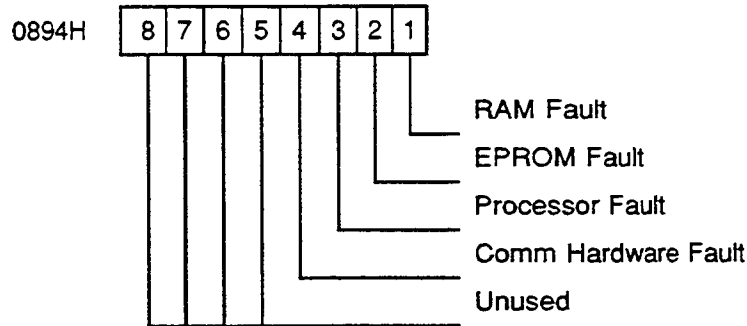
Shared RAM location 0893H indicates the status of the GENI board. GENI automatically sets this byte to "1" every 200 mS. The host can read this byte, then reset it. This would act as a continuous check (a 'heartbeat') on the normal operation of the GENI.



The default is 0FFFF hex.

## GENI Hardware Status

Byte 0894H indicates the status of the GENI hardware. The GENI runs self-tests periodically as part of its normal operation. If an error occurs during one of these self-tests, the GENI immediately stops all processing. Individual bits in this byte indicate the type of error that has occurred. If any of these bits is set and the host has the Status Change Interrupt enabled, the GENI OK bit (see "GENI OK Status", above) is cleared and an interrupt may be generated.

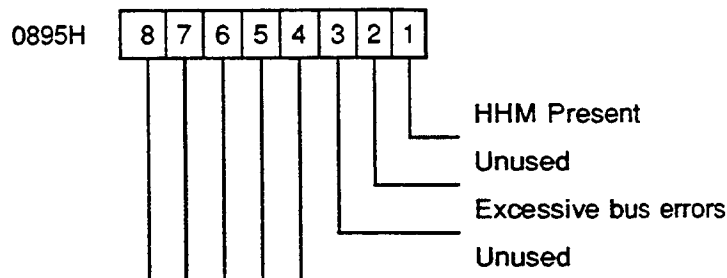


## Hand-held Monitor Connected to GENI Bus Controller

Bit 1 of byte 0895H (illustrated below) indicates that a Hand-held Monitor has been directly attached to the HHM connector on the motherboard.

## Excessive Bus Errors

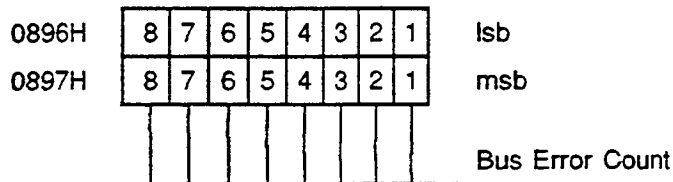
Bit 3 of byte 0895H flags excessive bus errors (10 or more in a 10-second interval). This is not a fatal condition; however, it indicates a bus problem and may cause an interrupt to the host. The total bus error count is contained in the next two status bytes.



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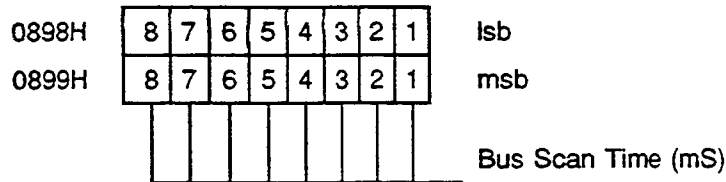
### Bus Error Count

Bytes 0896 and 0897H form an integer count of the total bus errors. At powerup, this count is 0. If any bus errors occur, GENI increments this count. As errors occur over multiple bus scans, the total count increases to a maximum of 65535. If this total is reached, the count wraps back to 0.



### Bus Scan Time

Bytes 0898 and 0899H of Shared RAM form an integer count of the bus scan time. This milliseconds value is updated each bus scan. It represents the amount of time between GENI's two previous turns on the bus. If GENI cannot access the bus, the value is set to 65535 (FFFFH). The host can monitor these locations to verify that GENI is communicating on the bus.



### Example Variables

The following Status Table variables might be defined for a C language interface to GENI.

```
typedef struct
{
    unsigned char    Revision        /* GENI revision number */
    unsigned char    GENI_OK;        /* every 200mS, set to one */
    unsigned char    Fault;          /* overall fault byte */
    unsigned char    Active;         /* HHM Present...excessive l.o.*/
    unsigned int     Sberr;          /* bus error count */
    unsigned int     Scan;           /* I/O scan time (mS) */
    unsigned char    Reserved[8];    /* currently undefined */
} GENI_STATUS
```



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GENI automatically flags the occurrence of:

- a new datagram in the Request Queue
- a new datagram in the Receive Queue
- a change in GENI status
- a change in bus device status
- GENI passing the bus token
- a host request for I/O Table Lockout

In addition to maintaining a status table containing these flags, GENI will send an interrupt to the host for any interrupt condition, if enabled.

Two adjacent areas of Shared RAM are used to enable/disable interrupts from GENI to the host, and to monitor the current status of the interrupt flags.

### Interrupt Status Table

The Interrupt Status Table begins at Shared RAM location 2210D/08A2H. It contains the current status of each interrupt flag.

### Disable Interrupt Table

The Disable Interrupt Table begins at Shared RAM location 2226D/08B2H. It is used to enable or disable sending interrupts to the host for these conditions

### Example Variables

The following interrupt variables might be defined for a C language interface to GENI. The same variable names can be used for the Interrupt Status Table and the Disable Interrupt Table.

```
typedef unsigned char INTERRUPT[16];    /* not used */

#define I_SUMMARY      0    /* summary byte for Interrupt Table */
#define I_REQUEST_Q    1    /* Request Queue entry */
#define I_GENI_STAT    2    /* GENI status change */
#define I_DEV_STAT     3    /* device status change */
#define I_OUT_SENT     4    /* outputs sent */
#define I_CCOMPLETE    5    /* command from host complete */
#define I_RECEIVE_Q    6    /* Receive Queue not empty */
#define I_LOCKOGRANT   7    /* lockout request received */
```

## Interrupt Table

The least significant bits of bytes 08A2H through 08A9H contain the interrupt status flags. GENI sets these flags to indicate the status of interrupt conditions. The corresponding Interrupt Disable table (see next page) determines which of them will also cause GENI to send an interrupt to the host.

The host can monitor the Interrupt Status Table for changes in the interrupt status flags. The first byte of the table is a summary byte, which indicates whether any other interrupt flag is currently set.

*The host must clear the interrupt flag after servicing an interrupt condition, even if the host interrupt is disabled.*

Location	Interrupt Flag	Description
08A2H	Interrupt Summary	The host can monitor the lsb of the Interrupt Summary byte to determine when an interrupt condition has occurred. If this bit is 1, looking at the rest of the interrupt flags will identify the specific interrupt condition. The host must then clear the summary bit (lsb of 08A2) and the individual interrupt bit that was set.
08A3H	Request Queue Entry Flag	Set if GENI has placed an incoming memory access Datagram in the Request Queue.
08A4H	GENI Status Change Flag	Set if GENI Status Table byte 0894 indicates a GENI status change, or if byte 0895H, bit 3, indicates excessive bus errors.
08A5H	Device Status Change Flag	Set if a device on the bus logs in, logs out, or changes its configuration data.
08A6H	Outputs Sent Flag	Set each time the GENI bus controller passes the implicit bus token to the next device. This indicates that host outputs have been sent by the bus controller to the devices on the bus. If needed, this interrupt status indication can be used to synchronize the bus scan.
08A7H	Command Complete Flag	Set when GENI has completed a task previously commanded by the host in the Command Block.
08A8H	Receive Queue Not Empty Flag	Set if GENI has placed an incoming datagram in its Receive Queue. The host can read it using a Read Datagram command.
08A9H	I/O Table Lockout Grant Flag	Set if the host requests an I/O Table Lockout. The lockout is not enforced until this byte is returned to the host.
08AA-08AF	8 bytes reserved	

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## Disable Interrupt Table

The Disable Interrupt Table begins at location 2226D/08B2H. Its 16 bytes correspond to those in the Interrupt Status Table. Each can be used to disable or enable sending an interrupt to the host. The first byte of this table is also a summary byte, which can be used to disable all host interrupts and the use of the summary byte in the Interrupt Status Table.

To disable all interrupt conditions, set the lsb of location 08A2 to 1. To disable one interrupt condition, set the lsb of the appropriate byte to 1.

Location	Disable Interrupt	Description
08B2H	Disable Interrupt Summary	The host can set the lsb of this is not used.
08B3H	Disable Request Queue Entry Interrupt	Set the lsb to prevent sending an interrupt or setting the Interrupt Summary Status bit after receiving a memory access datagram.
08B4H	Disable GENI Status Change Interrupt	Set this bit to prevent sending an interrupt or setting the Interrupt Summary Status bit if the GENI status or Excessive Bus Errors status changes.
08B5H	Disable Device Status Change Interrupt	Set this bit to prevent sending an interrupt or setting the Interrupt Summary Status bit if a device on the bus logs in, logs out, or changes its configuration data.
08B6H	Disable Outputs Sent Interrupt	Set this bit to prevent sending an interrupt or setting the Interrupt Summary Status bit each time the GENI bus controller passes the implicit bus token to the next device.
08B7H	Disable Command Complete Interrupt	Set this bit to prevent sending an interrupt or setting the Interrupt Summary Status bit when the GENI has completed a task commanded by the host.
08B8H	Disable Receive Queue Not Empty Interrupt	Set this bit to prevent sending an interrupt or setting the Interrupt Summary Status bit if GENI has placed an incoming datagram in its Receive Queue.
08B9H	Disable I/O Table Lockout Grant Interrupt	Set this bit to prevent sending an interrupt or setting the Interrupt Summary Status bit if the host requests an I/O Table Lockout.
08BA-08BF	8 bytes reserved	





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Use the Device Configuration Table in Shared RAM to read the following information about EACH DEVICE on the bus:

- Model number
- Output Disable flag
- Device present/absent
- Status Table or Reference Address
- Input data length
- Output data length
- Block I/O type

GENI places data in this table automatically; the host may read it at any time. The only item in this table the host can change directly is the Output Disable flag. GENI obtains the rest of the data from Read ID Reply messages it receives when devices log onto the bus.

When inputs are received from a device, GENI checks whether the device is “logged in” to the Configuration Table. If it is, the input data is accepted and placed in the Input Table. If the device is not logged in, GENI automatically sends it a Read ID message. If the device sends back a Read ID Reply message, GENI stores the configuration data it contains in the Device Configuration Table buffer that corresponds to the new device’s Device Number.

Next, GENI sets the Device Present flag (byte 1E02H) for that device. It also sets the Device Status Change byte in the Interrupt Status Table. If the Device Change Interrupt or Interrupt Summary is NOT disabled, GENI also sends an interrupt to the host.

If GENI powers up with device outputs disabled, the host must reset its Output Disable flag in byte 1E01H to enable sending outputs to a device. If GENI powers up with device outputs enabled, this flag is reset when a new device logs in. When this flag is reset, GENI automatically directs an Assign Controller message to the device. This instructs the device to send fault reports and configuration change messages to the GENI. GENI then starts sending the data from that device’s area of the Output Table each bus scan.

## Device Configuration Changes

If a device is reconfigured while the system is in operation, the device will automatically send a Configuration Change datagram to the host. GENI receives the datagram and places it in the Receive Queue. If the Receive Queue Not Empty interrupt is enabled, GENI will send an interrupt to the host. The host can read this datagram by moving it into Shared RAM with a Read Datagram Command to GENI.

In addition, if the message indicates that the device’s input data length, output data length, or I/O Type has changed, GENI will send an interrupt to the host if the Device Configuration Change interrupt is enabled.

Therefore, if both interrupts are enabled, GENI will send TWO interrupts to the host after receiving a Configuration Change datagram.

## Device Configuration Table

The Device Configuration Table begins at location 7680D/1E00 of Shared RAM. It is divided into 32 buffers, one for each possible Device Number (0 to 31) on the bus. The buffer that corresponds to the GENI bus controller's own Device Number is not used.

Each buffer in the Device Configuration Table is eight bytes in length, and has the following format:

Byte #	Description
1	Model Number
2	Outputs Enable (bit 0)*
3	Device Present (bit 0)
4	Reference Address (lsb)
5	Reference Address (msb)
6	Broadcast Control Data (or Global Data) length
7	Directed Control Data length
8	Block Configuration

\* Only byte the host may change.

- Model Number** Identifies the device. For example, Model Number 64 (decimal) is used for a 115 VAC 4 Input/2 Output Analog I/O block. Refer to the *Genius I/O System User's Manual* for a complete list of model numbers.
- Outputs Enable** At powerup, the content of this byte is determined by the setting of DIP switch 8 on the GENI board. The host can set this byte to "1" to disable outputs to a device. When the host resets this byte to "0", if the device is logged in, GENI will send it an Assign Controller message and begin sending it outputs. Outputs can be disabled, then selectively enabled as devices log in at powerup. Or, outputs to specific devices may be enabled as the devices log onto the GENI.
- Device Present \*** GENI sets this byte to 1 if the associated device is present on the bus and has been logged in. A device is considered to be present if it has sent inputs at least once, and it responds to a Read ID message sent to it by the GENI. After logging in, if the device stops sending inputs for three consecutive bus scans it is considered not present. Whenever a device is lost or added, GENI sets the Device Status Change interrupt.
- Reference Address** Bytes 4 and 5 contain the device's Reference Address. This is a logical reference that may correspond to where the device's I/O data is stored in host memory. GENI passes this information to the host (it does not use the information itself). The host may assign any meaning to the Status Table Address. If there is any PLC on the bus, that PLC may have special requirements for assigning a device's Reference Address. These requirements are detailed in the Bus Controller User's Manual for each PLC type.
- Broadcast Control Data Length** This byte specifies the amount of control data (inputs) or Global Data the device will broadcast on the bus. This length must not be more than the buffer size set up in the I/O Buffer. If it is, GENI will mark the device as Not Present in the configuration table. To change this status, the device must log off the bus, then log back on with a data length less than the I/O buffer buffer length. Alternatively, the host can increase the buffer size in the I/O table, as explained previously.

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**Directed Control Data Length** This byte specifies the amount of control data the device expects to receive. This length must also not be more than the buffer size set up in the I/O Buffer. If it is, GENI will mark the device as Not Present in the configuration table. To change this status, the device must log off the bus, then log back on with a data length less than the I/O buffer length. Alternatively, the host can increase the buffer size in the I/O table, as explained previously.

**Block Configuration** The last byte of the configuration table describes whether the device is an inputs only, outputs only, or combination I/O device. Values are:

Bits	Description
0 0	Not Used
0 1	All Inputs
1 0	All Outputs
1 1	Combination

### Example Variables

The following Device Configuration Table variables could be defined for a C language interface to GENI.

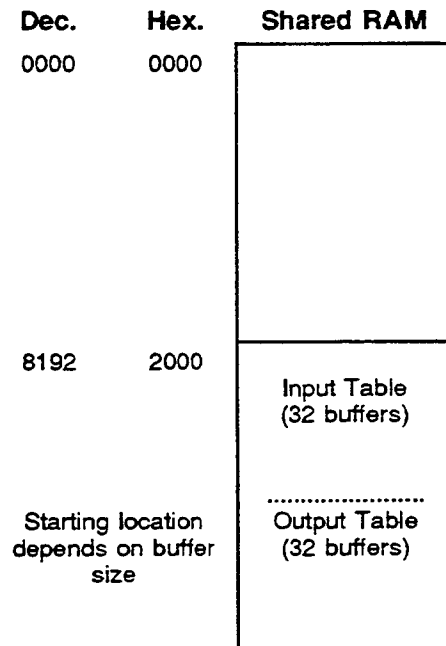
```
typedef
struct {
    unsigned char    Model;           /* model number of device */
    unsigned char    Outputs;        /* outputs disable flag */
    unsigned char    Present;        /* device present flag */
    unsigned int     ST_addr;        /* Reference Address */
    unsigned char    BCD_length;     /* broadcast control data length */
    unsigned char    DCD_length;     /* directed control data length */
    unsigned char    Block_cfg;      /* Block configuration

    | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
    |__|__|__|__|__|__|__|__|
    |__|__|__|__|__|__|__|__| block config
    |__|__|__|__|__|__|__|__| not used */
} DEV_CONFIG
```



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To read inputs received from the devices on the bus, and to send output data from the host, use the Device I/O Tables, which occupy the last half (8K bytes) of Shared RAM. This area is divided into two tables--an Input Table and an Output Table.



The Input Table contains inputs and incoming Global Data. GENI automatically updates the Input Table with new inputs every bus scan unless I/O Lockout is enabled.

The Output Table contains outputs and outgoing Directed Control Data. The host places output table in this table. GENI automatically sends this data is sent to each logged-in device each bus scan, unless I/O Lockout is enabled.

### Example Variable

The following I/O Table variable could be defined for a C language interface to GENI.

```
typedef
struct {
    unsigned char    data[128];

} SRI_TABLE;
```

## I/O Table Structure

Both the Input Table and the Output Table are organized into 32 equal buffers which correspond to the total number of potential devices on the bus.

### Length of I/O Buffers

At powerup, each I/O buffer is set to a length of 128 bytes. This length will accommodate the longest amount of I/O data, Global Data, or Directed Control Data that might be placed in the I/O Table. If it is desirable to speed up the I/O read/write cycle between GENI and the host, this buffer length can be shortened as described below.

### Shortening the I/O Buffer Length

Because each buffer will be the same size, shortening the I/O buffer length shortens the length of the entire I/O table. For example, if the I/O buffer length is set to 1, the length of the device I/O table is 64 bytes--32 Input Table bytes and 32 Output Table bytes.

This feature can be used to speed the host's data transfer to and from Shared RAM. For example, if the bus has only 8-circuit discrete blocks, then the I/O buffer length could be set to 1 (byte). The host can then transfer all 64 bytes into its local memory, make changes, then transfer 32 bytes of output data back to the Output Table. If the buffer length is longer than needed, there will be gaps of unused memory that must be skipped over during transfer.

The host changes buffer length by writing the desired new length to the GENI Setup Table, then sending GENI a Configuration Change command.

GENI will not log in devices whose input or output data exceeds the configured buffer length. Therefore, the buffer size must be large enough to accommodate each type of device that may be used on the bus.

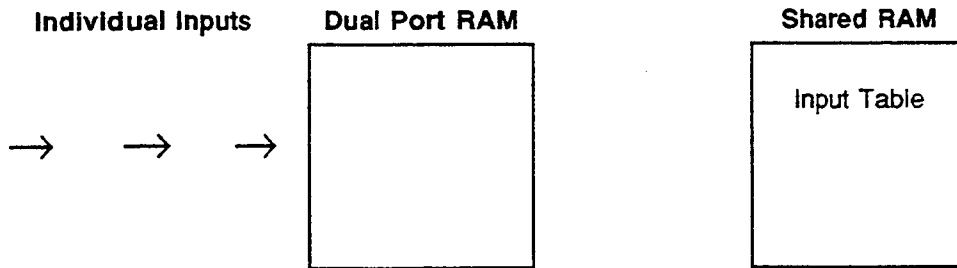
Device Type	Minimum Buffer Size (in bytes)
8-circuit Discrete I/O Block	1
16-circuit Discrete Block	2
32-circuit Discrete Block	4
4 Input/2 Output Analog Block	8
Analog Block with 6 Inputs (such as Thermocouple Block)	12
High-speed Counter Block	32
Power Monitor Module	38

For example, if the buffer length were set to 1, GENI would not log in any devices with more than 8 bits of I/O data (such as 16-circuit blocks).

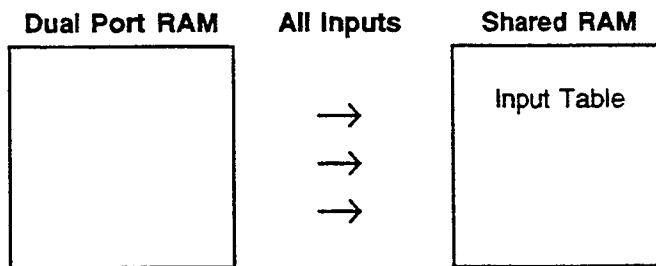
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## Input Table

The Input Table is used for inputs from I/O blocks and incoming Global Data. During the bus scan, GENI receives inputs from devices on the bus and stores them in its Dual Port RAM.



Unless I/O Lockout is enabled, GENI moves all the inputs in Dual Port RAM to the Shared RAM Input Table once per bus scan.



Input data is placed into the Input Table buffer associated with each device. That is, inputs from the device with Device Number 12 are placed in buffer 12.

The host must check the Device Configuration Table to see if a device is present before determining that input data is valid. If a device logs out, GENI marks the device as Not Present. The input buffer is not cleared.

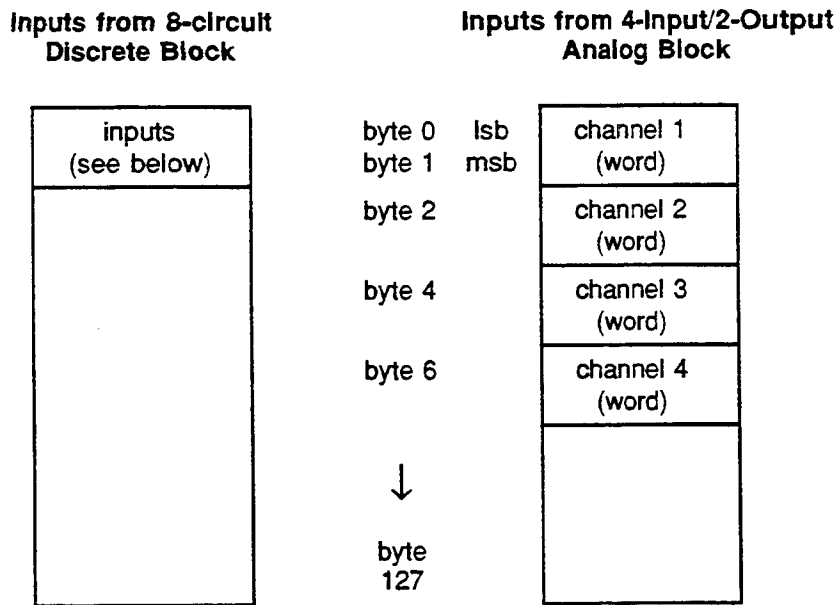
### Location of a Device's Input Buffer

The Input Table location used by a device is equal to its Device Number multiplied by the selected I/O buffer length. For example, if the buffer length were 2, inputs from device 12 would begin at address 24 (2 x 12) of the input table. To find the start of the input data from each device, add this decimal number or its hex equivalent to the beginning location of the Input Table (8192D or 2000H).

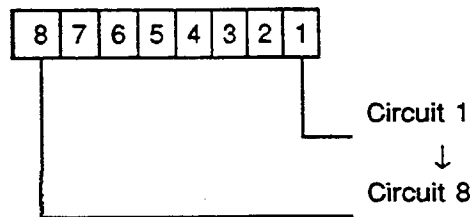
**Input Data Format**

The format of the input data depends upon the type of device that sent the inputs. The host must interpret the data for each device properly. The host can determine device types from the Device Configuration Table. Inputs begin at the buffer starting address. If chosen buffer size is longer than the amount of input data received from a device, extra bytes at the end of the buffer are not used.

The following illustration represents inputs from an 8-circuit discrete block (regardless of the block's actual I/O usage), and a 4 Input/2 Output analog block, where the buffer length has not been changed from the original 128 bytes.



**Discrete inputs** are stored as individual bits, so inputs from an 8-circuit discrete block are stored in 1 byte of the Input Table.



**Analog inputs** are word (16-bit) values; each input is stored in 2 adjacent bytes of the Input Table. Therefore, inputs from a 4 Input/2 Output analog block are stored in 8 bytes of the Input Table.



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## Output Table

The Output Table is used for outputs from the host to the devices on the bus, and for outgoing Directed Control Data. The host writes new output data to this table.

GENI automatically accesses the Output Table, and sends all output data to the devices on the bus each bus scan.

If I/O Lockout is in effect for more than one bus scan, GENI retransmits the same output data.

### Location of the Output Table

Unlike the Input Table, which always starts at the same location in Shared RAM (8192D/2000H), the starting location of the Output Table depends on the buffer length that has been selected (input and output buffers are the same length).

If the default length of 128 bytes is not changed, the Output Table begins at 12288D (3000H) and ends at 16383D (3FFFH). If the buffer length is shortened, the entire I/O Table is shorter, so the Output Table portion begins at a different location. This location is equal to 8192D (2000H) plus the product of 32 (the number of buffer occupied by the Input Table), times the I/O buffer length.

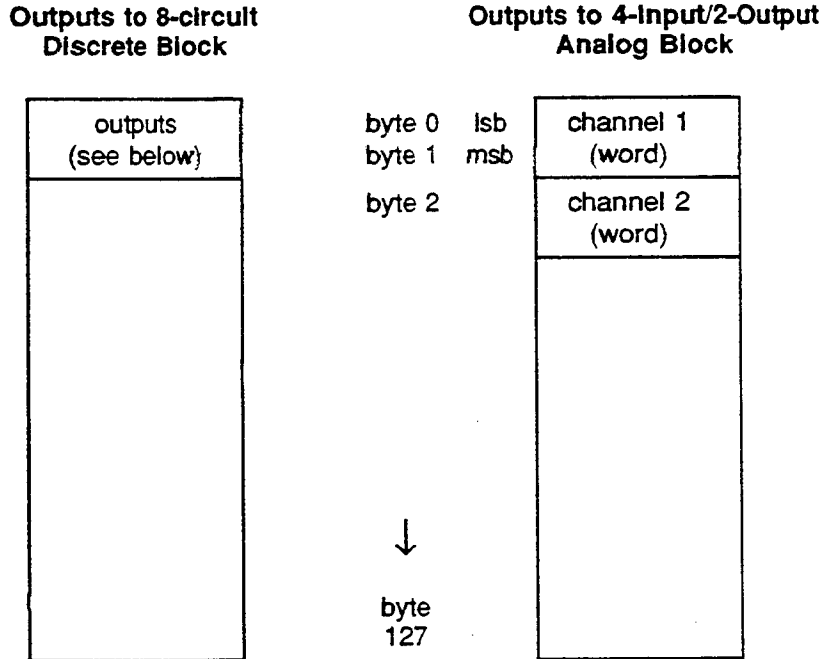
For example, if the buffer length were shortened to 16, the beginning location of the Output Table would be equal to  $8992D + (32 \times 16)$ .

### Location of a Device's Output Buffer

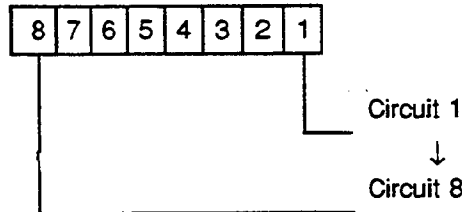
The relative Output Table location of the outputs for a device is equal to its Device Number multiplied by the selected I/O buffer length. For example, if the buffer length were 2, outputs from device 12 would begin at address 24 ( $2 \times 12$ ) of the Output Table. To find the absolute location of the start of the output data from each device, add this decimal number or its hex equivalent to the beginning location of the Output Table.

### Output Data Format

As with the Input Table, the format of each Output Table buffer is based on the specific device associated with that buffer. Outputs begin at the buffer's starting address. If the buffer is longer than the amount of output data received from the host, extra bytes at the end of the buffer are not used. The following illustration represents outputs from an 8-circuit discrete block (regardless of the block's actual I/O usage), and a 4 Input/2 Output analog block. The length for both is 128 bytes.



**Discrete outputs** are stored as individual bits, so outputs from an 8-circuit discrete block are stored in 1 byte of the Output Table (regardless of the block's actual I/O usage).



**Analog outputs** are word (16-bit) values; each output is stored in 2 adjacent bytes of the Output Table. Therefore, outputs from a 4 Input/2 Output analog block are stored in 4 bytes of the Output Table.

The host must check the Device Configuration Table to see if a device is present before writing to the Output Table. If a device is not present, GENI will do nothing with the fresh output data.

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To prevent GENI from attempting to access the I/O Table, the Broadcast Control Output Table or the Directed Control Input Table at the same time as the host, use I/O Table Lockout.

Two adjacent bytes of Shared RAM are used for I/O Table lockout.

I/O Table Request/Relinquish (byte 0A48H).

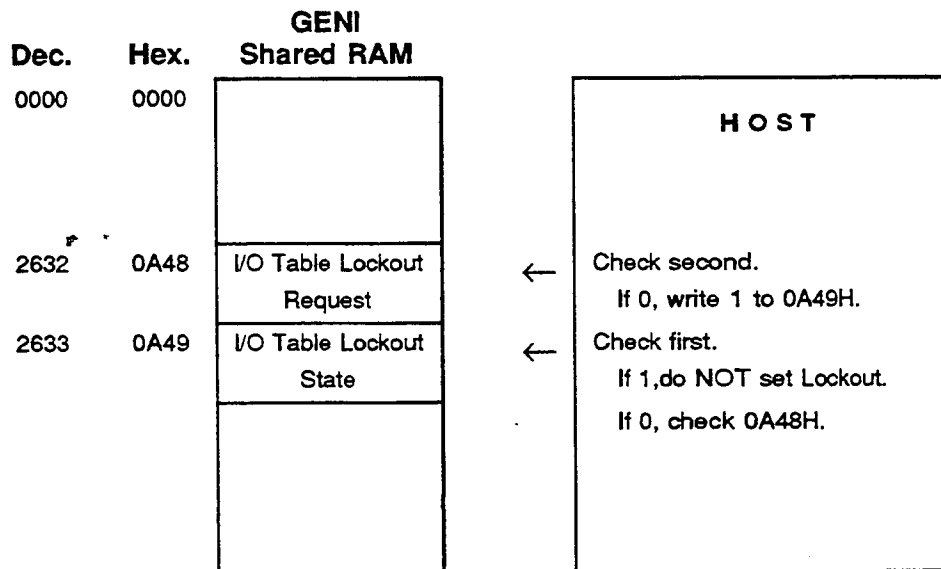
I/O Table Lockout State (byte 0A49H).

For a single-byte device such as an 8-circuit discrete I/O block, lockout may not be necessary. For devices with more than one byte of I/O data, lockout assures data coherency.

### Lockout Procedure

The host sets and clears I/O Table lockout. First, the host must check the lockout state stored in byte 0A49H. If this is a 0, the host should check byte 0A48H to determine whether a previous request has been made. If byte 0A48H is also 0, the host may write a 1 to the I/O Lockout Request byte (0A48H).

*NOTE: If either byte 0A48H or byte 0A49H is already set to 1, the host should NOT set the lockout request. The host should never write to byte 0A49H (I/O Lockout State).*



GENI automatically reads the state of the Lockout Request byte. GENI will not permit lockout while it is in the process of writing inputs or reading outputs in the I/O Table. After completing any I/O Table access currently in progress, GENI will set or clear the Lockout State byte to match the content of the Lockout Request byte.

After setting the Lockout State byte, GENI sets the I/O Table Lockout Grant interrupt. If this interrupt is not disabled, GENI also sends an interrupt to the host.

If lockout is in effect, after accessing the I/O Table the host must reset (to 0) the Lockout Request byte. GENI monitors this byte; when it is reset, GENI clears the Lockout Status byte. GENI then resumes its normal I/O table access.

If the Lockout Request byte is on too long or is not set off, the host will miss data from one or more bus scans, or will repeat old data to an output device.

*NOTE: If the Lockout State byte and the Lockout Request bytes are not BOTH set, the host must NOT clear the Lockout Request byte.*

The rule to follow is: the host may write to the Lockout Request byte and read only the Lockout State byte, while GENI may write to the Lockout State byte and read only the Lockout Request byte.

### Example Algorithm

```

Lockout Request

If (lockout state == 0 && lockout request == 0)
|
lockout request = 1;
  while (lockout state == 0)
    ; /*do nothing because
      lockout is not yet granted.
|
Else
  /* lockout cannot be granted */
  return (error);
return (success);

Lockout Release

If (lockout state == 1 && lockout request == 1)
|
  lockout request = 0;
  while (lockout state == 1)
    ; /*do nothing because
      lockout is not released.*/
|
Else
  /* lockout cannot be released */
  return (error);
return (success);

```

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Use the Command Block area of Shared RAM to send the following commands to the GENI:

- Read Datagram**      instructs GENI to move a datagram from its internal Receive Queue to Shared RAM.
- Transmit Datagram**    instructs GENI to send a datagram which the host has placed in Shared RAM.
- Transmit Datagram with Reply**    instructs GENI to send a datagram which the host has placed in Shared RAM, and to receive a Reply.
- Configuration Change**      instructs GENI to accept new configuration data which the host has placed in the GENI Status Table.

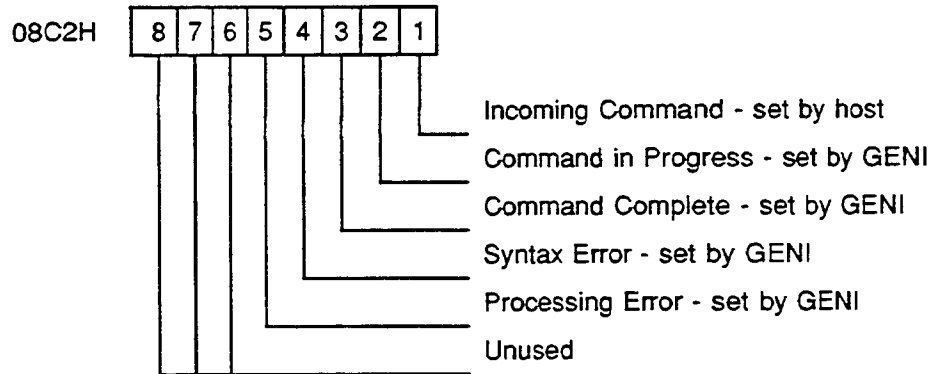
### Command Block

The Command Block begins at location 2262D/08C2H. Its format is shown below.

Location	Content	Description
08C2H	Status Byte	This byte indicates the status of the requested command. It may be: 0 if the Command Block is free. 1 for an incoming command. 2 if a command is currently in progress. 4 for Command Complete. 8 if a syntax error has occurred. 10 if a processing error has occurred.
08C3H	Command Byte	This byte specifies the command to be performed: 1 Read Datagram (incoming). 2 Transmit Datagram (without reply). 3 Transmit Datagram with Reply 4 Configuration Change
08C4H-08D1H	Options	The content of the command itself. The Configuration Change command has no associated options; any values in these bytes are ignored if the value in the Command Byte is 4.
08AA-08AF	8 bytes reserved	

### Status Byte

The first byte of the Command Block indicates the status of the requested command.



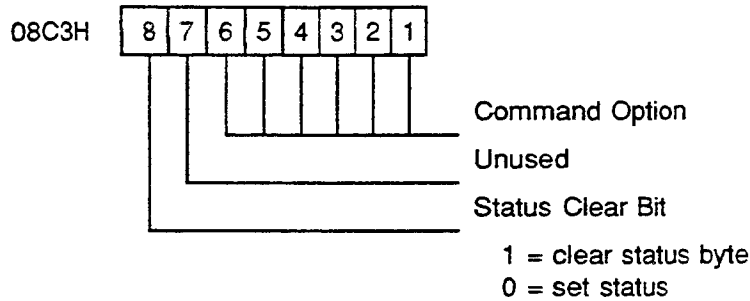
The content of the status byte may be:

Content	Status	Description
01	Incoming Command	The host sets the first byte of the Command Block to 1 to indicate that a command request is being made.
02	In Progress	GENI sets the status to 2 to indicate it is processing the command from the host, and no new command will be accepted until the current command is in finished.
04	Command Complete	GENI sets the status to 4 after successfully completing a command.
08	Syntax Error	GENI sets the status to 8 if the information given with the command is incorrect, and the command could not be completed. If there are no data options (such as the Read Datagram command), the command is not completed.
10	Process Error	GENI sets the status to 10 if an error (usually a bus error) occurred during execution of the command. Failure to receive an acknowledgement to a Transmit Datagram command is one type of processing error.

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### Command Byte Format

The Command Byte (located at 2243D/08C3H), specifies the command to be performed, and determines how GENI will acknowledge the command when it is received.



### Command Types

Bits 1 through 6 specify the command. It may be:

- 1 = Read Datagram
- 2 = Transmit Datagram
- 3 = Transmit Datagram with Reply
- 4 = Change Configuration

These commands are described later in this section.

### Clear Status Bit

Bit 8 determines how GENI acknowledges the command when it is received. If bit 8 is set to 0, GENI sets the status byte to some non-zero completion value. It also sets the Command Complete byte in the Interrupt Status Table, and generate a host interrupt (if the interrupt is enabled).

If bit 8 is set to 1, GENI sets the status byte to 0 as soon as it has removed the data from the command block. This enables the host to immediately send another command in the command block. However, it also means that there will be no indication of command completion, either successful or not. The interrupt status byte will not be set, and no interrupt will be sent to the host. Bit 8 can only be set to 1 for the Transmit Datagram command, For any other command type, entering 1 in bit 8 causes GENI to clear the status, and prevents completion of the command.

## Example Variables

The following Command Block example variables could be defined for a C language interface to GENI.

```
typedef
struct {
    unsigned char    Status;    /* status of operation */
    /* If this byte is 0, the entire command is free. */

    unsigned char    Command;    /* command to process */

    /* unsigned char    Options[14];    /* Options for command */
} COMMAND;
```

## Example Macros

The following Command Block macros could be defined for a C language interface to GENI.

```
#define CMDMASK            0x3F
#define FLGMASK            0x80    /* use only Status Clear bit */

#define FREEBLK            0        /* Command Block is free */
#define INCOMECMD          0x1    /* Incoming command */
#define INPROGRESS         0x2    /* Command in progress */
#define CCOMPLETE         0x4    /* Command complete */
#define SYNTAXERR          0x8    /* Syntax error */
#define PROCERR            0x10   /* Processing error */
```

## Example Algorithms

Basic algorithm for starting a command:

```
Check GENI OK status
  If GENI OK status not 1, return failure message
  If GENI OK = 1, check Command Block status
    If not free, return busy message
    If Command Block free, begin
      For Read Datagram:
        Send Command Block
        Start timeout. If time expires before command
          completes, return "no message".
        Read Read Datagram buffer. Return "success".
      For Transmit Datagram/Transmit Datagram with Reply:
        Place datagram in Transmit buffer
        Send Command Block
        If Reply is returned, read Read Datagram buffer
      For Configuration Change:
        Make changes to GENI Setup Table
        Send Command Block to GENI
    Complete command /* see below */
```



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Algorithm 1 for completing the command:

```

Do until timeout /* typical timeout = 5 x bus scan time */
  If (Status Byte greater than/equal to 4 /*command complete*/
    Break Do Loop
End Do

If (not time out)
  Case Status Byte
    Case 4: /*command complete*/
      process resulting data
    Case 8: /*usually syntax error*/
      process syntax error
    Case 10(hex): /*usually process error */
      process process error
    Case default /*unknown */
      GENI error /*report to GE Fanuc */
  End Case
End If

```

Algorithm 2 for completing the command:

```

Do until timeout /* typical timeout = 5 x bus scan time */
  If (interrupt status table [command complete])
    Break Do Loop
End Do

If (not time out)
  Case Status Byte
    Case 4: /*command complete*/
      process resulting data
    Case 8: /*usually syntax error*/
      process syntax error
    Case 10(hex): /*usually process error */
      process process error
    * -Case default /*unknown */
      GENI error /*report to GE Fanuc */
  End Case
End If

```

Algorithm 3 for completing the command:

```

Wait until Command Complete interrupt
-or-
Do other tasks until Command Complete Interrupt

Case Status Byte of Command Block
/* see algorithms 1 and 2 */

```

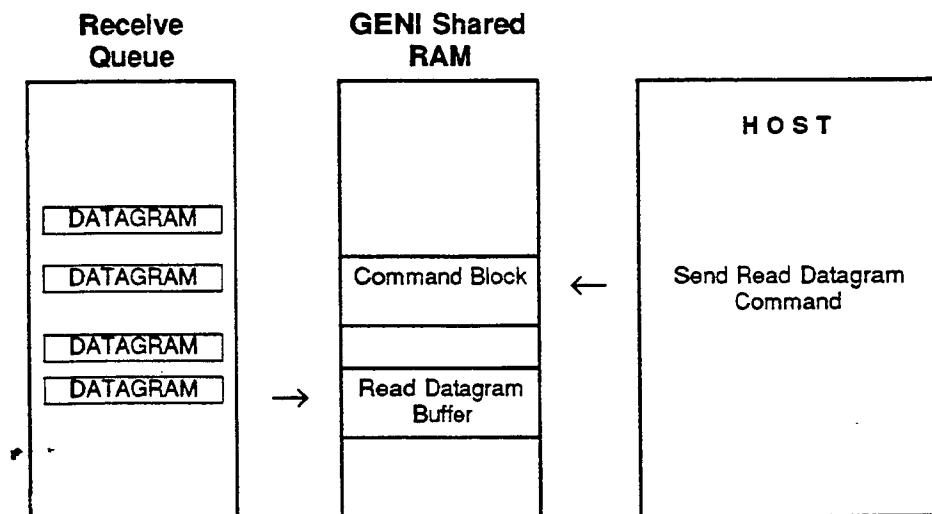
## Read Datagram Command

To instruct GENI to move a datagram into Shared RAM where it may be read by the host, use the Read Datagram command.

When GENI receives a datagram from another device, it checks to see what type of datagram it is. All incoming datagrams which are not Reply datagrams (see Transmit Datagram with Reply) or memory-access Datagrams (see chapter 13) are placed in the Receive Queue, which is NOT part of Shared RAM. The Receive Queue can contain up to 15 datagrams.

After placing a datagram in the Receive Queue, GENI sets the Receive Queue Not Empty flag. In addition, it sends an interrupt to the host unless the interrupt is disabled.

The host cannot access the Receive Queue directly; it must send GENI a Read Datagram command. When GENI receives a Read Datagram command, it moves the oldest datagram currently in the Receive Queue to the Read Datagram buffer (this is the same Shared RAM buffer from which the host reads replies to Transmit Datagram with Reply commands). Once the datagram is in this buffer, it can be read by the host.



### Procedure

To send a Read Datagram command, the host should:

1. Set bit 1 of the Command Block status byte (08C2H) to 1 to indicate a command from the host.
2. Set bit 0 of byte 08C3H (the command byte) to 1 (Read Datagram). Simultaneously, set bit 8 of the command byte to 0, since a reply is expected (if bit 8 were set to 1 with this command, GENI would clear the status byte and not execute the command).

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Upon receiving the command, GENI sets the status to 2 (command in progress). It then returns the oldest datagram in the Receive Queue to the Read Datagram buffer. It also places information about the datagram in the Command Block:

Location	Description
08C2H	Status (02 = In Progress)
08C3H	Command Type (01 = Read Datagram) set by host
08C4H	Device Number of device that sent the datagram
08C5H	Function Code of the datagram
08C6H	Subfunction Code (identifies the datagram type)
08C7H	Directed (1) or Broadcast (0) indication
08C8H	Length (up to 134 bytes)

When the command is complete, GENI sets the status to 4. It also sets the Command Complete interrupt status byte (08A7H). If the Command Complete interrupt is enabled, GENI then sends an interrupt to the host.

### Status Definitions

Status	Meaning	Description
02	In Progress	Processing not yet complete.
04	Command Complete	Command completed properly; there is valid data in the Command Block and possibly in the Read Datagram buffer.
08	Syntax Error	The Receive Queue is empty. No new data has been placed in the Command Block or the Read Datagram buffer.
10	Process Error	This status should not occur with a Read Datagram command.

### Example Variables

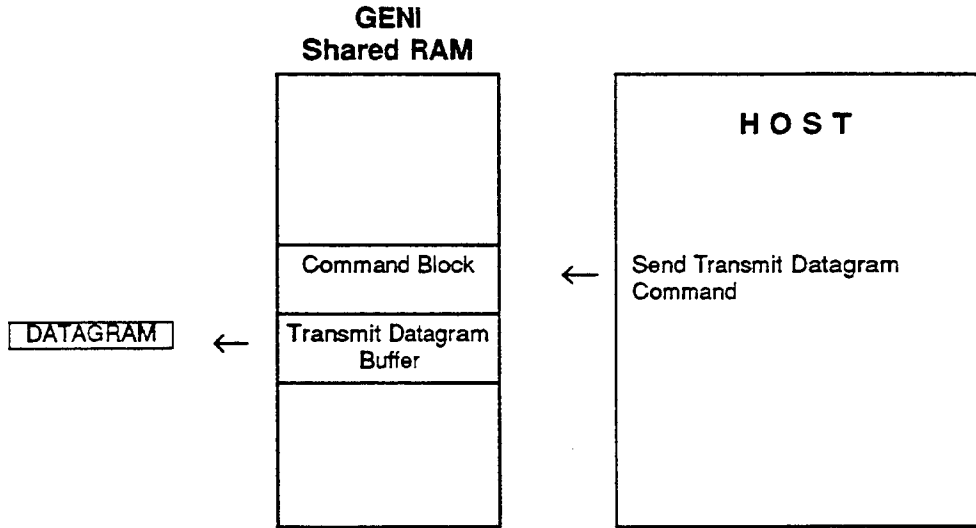
The following Read Datagram variables could be defined for a C language interface to GENI.

```
typedef
struct {
    unsigned char    Source;        /* source address of bus device */
    unsigned char    Function;     /* function code */
    unsigned char    Subfunction;  /* subfunction code */
    unsigned char    DB_Indicator; /* flag for directed (1)
                                   or broadcast (2) */
    unsigned char    Length;      /* length of message */
} READ_DATAGRAM
```

## Transmit Datagram Command

To instruct GENI to send a datagram which the host has placed in Shared RAM, use the Transmit Datagram command.

When GENI receives this command, it sends the current content of its Transmit Datagram Buffer to the device or devices specified in the Command Block.



The datagram can be broadcast to all devices on the bus, or directed to a specific device.

The content of the buffer must be one of the Genius I/O datagrams defined in the *Genius I/O System User's Manual*. It should be a datagram that does not cause the receiving device to send back another datagram in reply. Examples of datagrams that would be sent using the Transmit Datagram command are:

- Write Configuration
- Assign Monitor
- Write Point
- Pulse Test
- Clear Circuit Fault
- Clear All Circuit Faults
- Write Device

To send a datagram that **DOES** generate a Reply datagram, use the Transmit Datagram with Reply command (#3) instead.

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### Priority

The datagram can be sent with either normal priority or high priority. Normal priority should be used for most applications. Normal priority means that GENI will send the datagram only if no other datagram or similar “background” message has been sent during the current bus scan. High priority means that the datagram will be sent when GENI has its turn on the bus regardless of the number of background messages that have already been sent during the current bus scan. Sending datagrams with high priority may adversely affect bus scan time. Refer to the *Genius I/O System User’s Manual* for more information before assigning high priority to a datagram.

### Maximum Datagram Length

Maximum datagram length (not including the header information) is 128 bytes. However, the maximum length for a datagram to an I/O block is 16 bytes, plus the length of the header. Longer messages must be sent as multiple datagrams.

### Procedure

To send a datagram, the host should follow these steps:

1. Complete the Command Block as follows:

Location	Description
08C2H	Status
08C3H	Command Type (02 = Transmit Datagram)
08C4H	Device Number of device to which the datagram is being sent. To broadcast it to all devices on the bus, use the number 255 (decimal, or FF hex). Broadcast messages go to all bus devices; use them carefully.
08C5H	Function Code of the datagram
08C6H	Subfunction Code (identifies the datagram type).
08C7H	Priority (1 = high, 0 = normal).
08C8H	Length (up to 134 bytes).

2. Place the datagram in the Transmit Datagram buffer of Shared RAM. This area begins at location 08D2 hex. Correct formats are shown in the *Genius I/O System User’s Manual*.
3. Set bit 1 of the Command Block status byte (08C2H) to 1 to indicate a command from the host to the GENI.
4. If the message was broadcast, rather than directed, it will be received back by GENI itself, and placed in its Receive Datagram queue. The host should use a Read Datagram command to clear this unwanted message from the Receive Queue.
5. If the host requires an acknowledgement from the receiving device, be sure bit 8 of the command byte is set to 0.

GENI will clear the status byte, the Command Block, and the Transmit Datagram buffer as soon as it finishes transmitting the message on the bus.

Upon receiving the command, GENI sets the status byte to 2 (command in progress). It then begins to execute the command.

When the command is complete (that is, acknowledged by the receiving device if bit 8 = 0 or sent on the bus if bit 8 = 1), GENI sets the status back to 0. It also sets the Command Complete interrupt (08A7H). If the interrupt is enabled, GENI sends an interrupt to the host.

## Status Definitions

Status	Meaning	Description
02	In Progress	Processing not yet complete.
04	Command Complete	Command completed properly.
08	Syntax Error	Something in the Command Block is not specified correctly.
10	Process Error	This error occurs if the Device Number is greater than 31 and less than 255, or if the Function Code is greater than 112. The message is not transmitted.  the datagram was not properly acknowledged from the destination device. Occasionally, this status indicates that GENI temporarily did not have memory available for the Datagram. Try to send it again. If command bit 8 has been set to 1, process errors are NOT reported to the host.

## Example Variables

The following Transmit Datagram variables might be defined for a C language interface to GENI.

```
typedef
struct {
    unsigned char    Destination;    /* Device Number of destination */
    unsigned char    Function;       /* function code */
    unsigned char    Subfunction;    /* subfunction code */
    unsigned char    Priority;       /* priority 0 (lowest) thru 2 */
    unsigned char    Length;        /* data buffer length */
} XMIT_DATAGRAM
```

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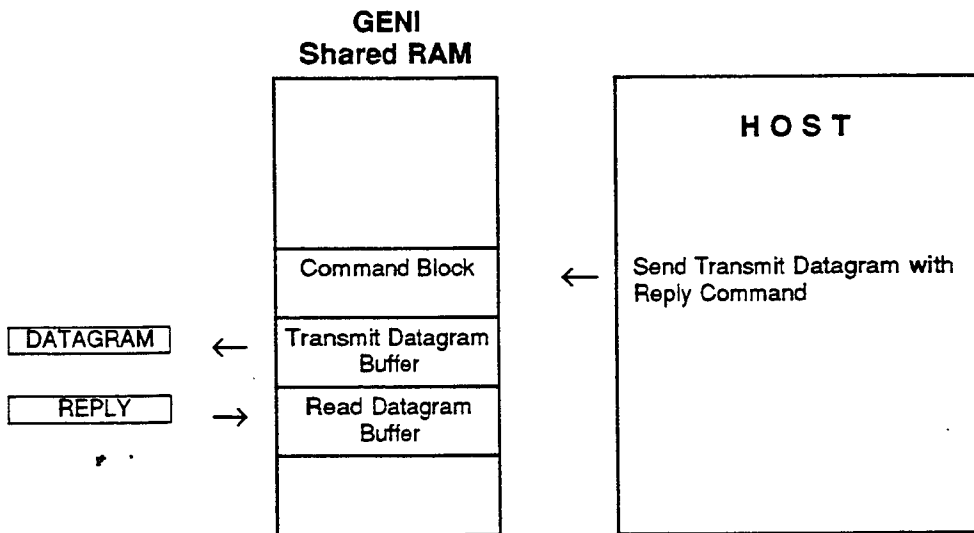
## Transmit Datagram with Reply Command

To instruct GENI to send a datagram which the host has placed in Shared RAM, and to receive a Reply datagram, use the Transmit Datagram with Reply command.

When GENI receives a Transmit Datagram command, it sends the current content of its Transmit Datagram Buffer to a device specified in the Command Block. The content of the buffer should be a Genius I/O datagram that has a corresponding reply-type datagram:

- Read Configuration (other device returns a Read Configuration Reply)
- Read Diagnostics (other device returns a Read Diagnostics Reply)
- Read Device (other device returns a Read Device Reply)

When the other device sends the Reply datagram, GENI places it directly into the Read Datagram buffer (Reply datagrams are NOT placed in the Receive Queue). The host does not have to use a Read Datagram command to read a Reply datagram.



A datagram that generates a reply cannot be broadcast; it must be directed to a specific device on the bus. It can be sent with either normal priority or high priority. See "Transmit Datagram" for information about datagram priority.

## Procedure

To send a Transmit Datagram with Reply command, the host should follow these steps:

1. Complete the Command Block:

Location	Description
08C2H	Status (set by GENI).
08C3H	Command Type (03 = Transmit Datagram with Reply).
08C4H	Device Number of device to which the datagram is being sent.
08C5H	Function Code of the datagram.
08C6H	Subfunction Code (transmitted datagram).
08C7H	Subfunction Code (reply datagram).
08C8H	Priority (1 = high, 0 = normal). Normal priority should be used for most applications. Sending datagrams with high priority may adversely affect bus scan time. Refer to the <i>Genius I/O System User's Manual</i> for more information before assigning high priority to a datagram.
08C9H	Transmit Data Buffer Length (up to 134 bytes).
08CAH	Reply Data Buffer Length (up to 134 bytes). This value is set by the GENI, if the expected reply is received within 10 seconds.

2. Place the datagram in the Transmit Datagram buffer. This area begins at location 08D2 hex. Message formats are shown in the *Genius I/O System User's Manual*.
3. Set the status to 1 to indicate a command from the host.
4. This message requires an acknowledgement from the receiving device; be sure bit 8 of the command byte is set to 0. (If bit 8 were set to 1, the command would not execute.)

Upon receiving this command, GENI sets the status to 2 (command in progress), then begins to execute the command.

If the Command Complete interrupt is enabled, GENI sends an interrupt to the host when the command is complete.



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## Status Definitions

Status	Meaning	Description
02	In Progress	Processing not yet complete.
04	Command Complete	GENI has sent the datagram, received the reply, and updated the Command Block. It may also have placed the reply in the Read Datagram Buffer.
08	Syntax Error	Something in the Command Block is not specified correctly. This error occurs if the Device Number is greater than 31 or if the Function Code is greater than 112. The message is not transmitted.
10	Process Error	This error usually indicates that the reply has not been received within 10 seconds. Occasionally, it means GENI temporarily did not have memory available for the datagram. Try to send it again.

## Example Variables

The following Transmit Datagram with Reply variables might be defined for a C language interface to GENI.

```
typedef
struct {
    unsigned char Destination: /* Device Number of destination */
    unsigned char Function; /* function code */
    unsigned char T_Subfunction: /* subfunction code (transmitted) */
    unsigned char R_Subfunction: /* subfunction code (expected reply) */
    unsigned char Priority; /* priority 0 (lowest) or 1 */
    unsigned char T_Length: /* transmit data buffer length */
    unsigned char R_Length; /* reply data buffer length */
} XMIT_R_DATAGRAM
```

## Configuration Change Command

To instruct GENI to accept new configuration parameters the host has placed in the GENI Status Table, use the Configuration Change command.

- Broadcast Control Data Length** Specifies how much Global Data to broadcast from the Broadcast Control Output Table. The range is 0-128; default is 0.
- Directed Control Data Length** Specifies how much Directed Control Data GENI will accept and move to the Directed Control Input Table. The range is 0-128; default is 0.
- Reference Address** This is set by the host to any meaning the host defines. Usually, it represents a logical reference that may correspond to the host memory location where the host stores I/O data from the GENI bus controller. The GENI doesn't use the Reference Address itself. Rather, it passes the information to any device that requests it. The address should be set to a byte boundary. The default is 0FFFF hex. For the Series Six PLC, see the *Bus Controller User's Manual* for information about Reference Addresses.
- I/O Buffer Length** The length of each buffer in the Device I/O Tables. The default buffer length is 128 bytes. By shortening the buffer length (all buffers will be the same length), the overall table length is shortened. The buffer length chosen must be long enough to accommodate any device's inputs and outputs. The GENI will not log in any device that sends or receives more data than will fit into its I/O Table buffer. The range is 1-128; default is 128.

### Procedure

To send a Configuration Change command to the GENI, the host should follow these steps:

1. Make the desired changes to the GENI Setup Table area of Shared RAM.

Location	Description
0882H	GENI board Dip Switch value (Read Only item)
0883H	Reference Address (lsb)
0884H	Reference Address (msb)
0885H	Broadcast control data length
0886H	Directed control data length
0887H	I/O Table buffer length
0888H-0892H	These bytes are not used

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2. Complete the Command Block as follows:

Location	Description
08C2H	Status. This should be set to 1 to indicate a command from the host to GENI.
08C3H	Command Type (4 = Configuration Change). This must be done first.
08C4H-08D1H	These bytes have no meaning for the Configuration Change command. Configuration parameters are changed directly in the Setup Table (see above).

When configuration changes for the Reference Address, Broadcast Control Data Length, or Directed Control Data Length, GENI stops all transmissions for 1.5 seconds and logs out all the devices on the bus. When the devices log in again, the new configuration parameters are in effect.

If the I/O Table Length is changed, GENI logs off the bus, but it does NOT stop its transmissions. During this type of change, GENI is off the bus for 1.5 seconds and all devices are logged out.

### Status Definitions

Status	Meaning	Description
02	In Progress	Processing not yet complete.
04	Command Complete	GENI has accepted the configuration changes in the GENI Setup Table, and has dropped off the bus for 1.5 seconds.
08	Invalid Configuration Data	Something in the Command Block is not specified correctly; for example, data lengths entered are greater than 128 bytes, or the I/O Table length has been set to 0. If this error occurs, GENI places its current configuration data in the GENI Setup Table. It does not drop off the bus.
10	No Changes Found	The configuration data sent in the command matched the current configuration data. GENI does not log out devices on the bus or drop off the bus.

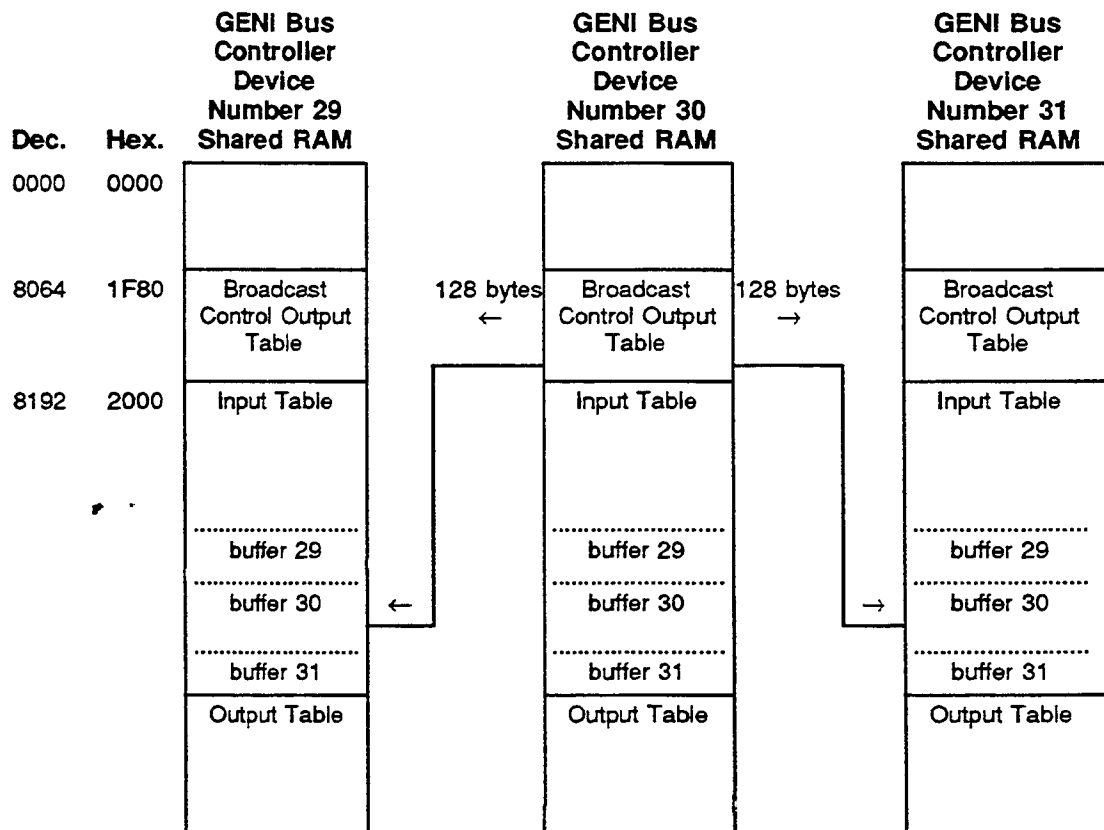


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Global Data is used to automatically broadcast up to 128 bytes of data from one host to all others on the bus. GENI sends Global Data from the Broadcast Control Data area of Shared RAM. If any other device on the bus sends Global Data, GENI will receive it in the Input Table buffer assigned to that device. (Other types of bus controller use different schemes for handling Global Data. These are explained in the bus controller documentation.)

Example:

In a three-host system, the GENI bus controller with Device Number 30 broadcasts 128 bytes of Global Data to GENI bus controllers with Device Numbers 29 and 31.



### Table Lockout

GENI cannot broadcast or receive new Global Data while I/O Lockout is in effect. Both the Broadcast Control Output Table, used to send Global Data, and the Input Table, used to receive Global Data, are affected by the current I/O Table Lockout state.

If lockout is in effect more than one bus scan, GENI will re-broadcast the previous scan's Global Data. When lockout is relinquished, new Global Data will be sent.

## Sending Global Data

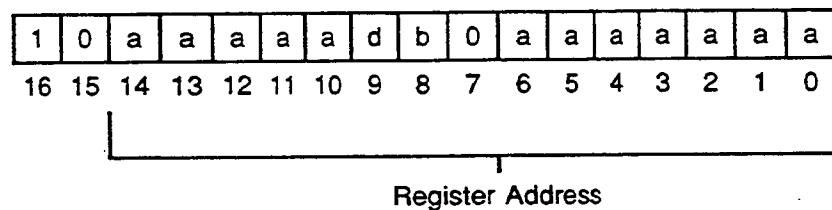
To broadcast Global Data, the host must regularly place that data in GENI's Broadcast Control Output Table, which occupies 128 bytes of Shared RAM beginning at location 8064D/1F80H. If the data should be sent to only one device, use Directed Control Data instead, as explained in the next chapter.

### Specifying Global Data Length

Global Data length is specified by the GENI Setup Table selection for Broadcast Control Data (BCD) length. When the GENI logs on the bus, it supplies its current BCD length to any bus controller that sends it a Read ID message. At powerup, the default BCD length is set to 0. It can be changed to any length up to 128 bytes. The host does this by entering the desired BCD length the GENI Setup Table. Then, the host sends GENI a Change Configuration command. When GENI changes its configuration, it drops off the bus for 1.5 seconds. After logging on again, it sends the new BCD length to any host that sends it a Read ID message. The GENI then begins broadcasting the specified amount of Global Data from the Broadcast Control Output Table.

### Specifying the Global Data Address

The location where the receiving host will place the Global Data is also specified in the GENI Setup Table. At initial powerup of the GENI, the Reference Address is set to 0FFFF (hex). The host should enter an address controller, the 16 bit register address must have the two upper bits set as shown below. The Series Six PLC will only use the bottom 14 bits.



## Receiving Global Data

Each bus scan, GENI may receive up to 128 bytes of data from any other bus controller. This Global Data is automatically placed in the input buffer of the I/O Table that corresponds to the Device Number of the sending device. The host must read the appropriate Input Table buffers regularly to capture Global Data. If the data is only sent occasionally, the program must employ some means of detecting it. The host can choose to ignore any Global Data that has been received.

## Timing Considerations

If the program sweep time is longer than the bus scan time, new Global Data may not be available each bus scan; in that case, the same data may be sent more than once. If the program sweep time is much shorter than the bus scan time, it is possible that Global Data might change more quickly than the bus controller can send it. If that happens, some data could be lost. The host must accommodate these timing issues to assure data integrity. *Logic execution time increases approximately 10µS for each byte of Global Data transmitted on the bus. Bus scan time increases by approximately 72µS for each byte of Global Data transmitted.*

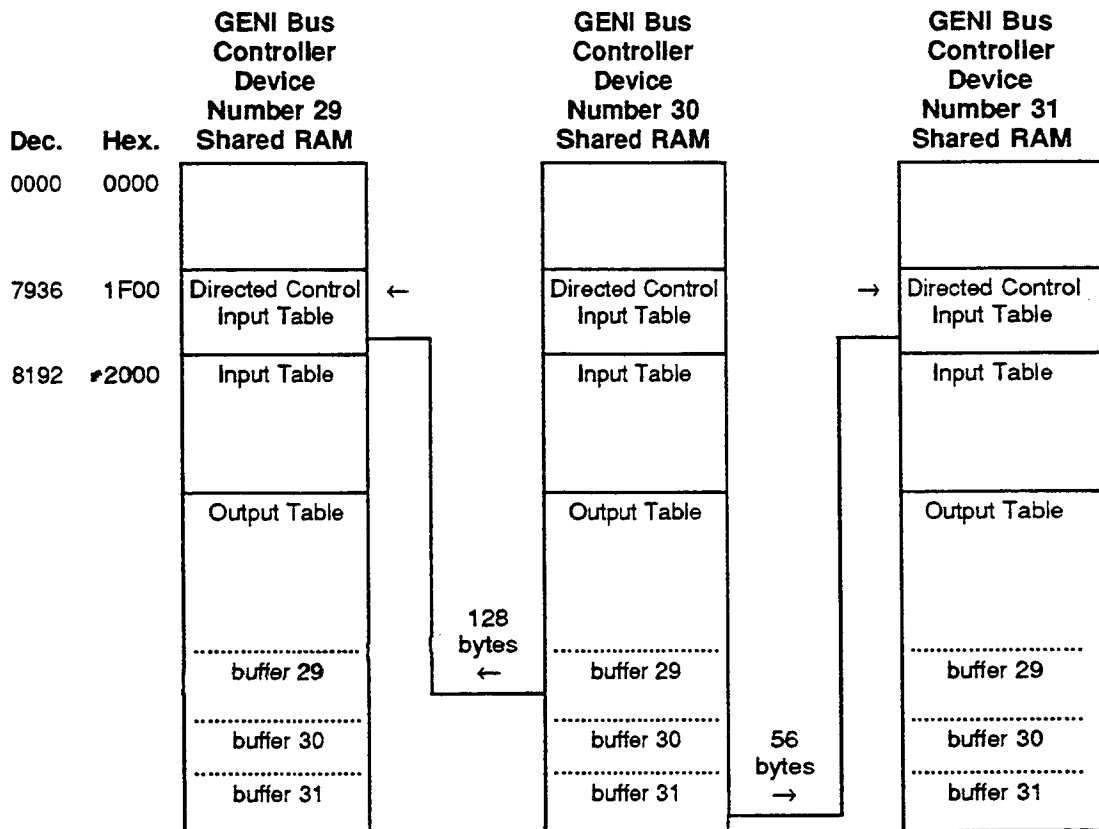
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Directed Control Data is a unique feature of GENI, not available with other Genius I/O bus controllers. Like Global Data, Directed Control Data can be used to send up to 128 bytes to any device on the bus. Directed Control Data is automatically sent each bus scan, with the same priority as device inputs. But unlike Global Data, which is broadcast to all other devices on the bus, Directed Control Data is sent to just one device.

GENI sends Directed Control Data from the I/O Table output buffer that corresponds to the Device Number of the receiving device. The GENI bus controller that receives the data places it in its Directed Control Input Table.

Example:

In a three-host system, the GENI bus controller with Device Number 30 sends 128 bytes of Directed Control Data to the GENI bus controller with Device Number 29 and 56 bytes of Directed Control Data to the GENI bus controller with Device Number 31.



## Sending Directed Control Data

The host can direct up to 128 bytes of data to another GENI on the bus by sending it as output data (just like outputs to an I/O block). The host should place the data into the I/O Table output buffer that corresponds to the receiving GENI's Device Number.

The host must check the amount of data it can send to the other GENI. It does this by reading the Directed Control Data (DCD) Length the device specified in the Read ID Reply message it sent when it logged onto the bus. This information is located in the Device Configuration Table. The host should look at byte 7 of the Configuration Table buffer corresponding to the Device Number of the GENI to which the data will be directed.

## Receiving Directed Control Data

Each bus scan, GENI may receive up to 128 bytes of data from one other bus controller and automatically place it in the Directed Control Input Table. This table occupies 128 bytes of Shared RAM, starting at location 7636D/1F00H.

The host must read this area regularly to capture data it contains. If the data is only sent occasionally, the program must employ some means of detecting it.

### Specifying the Directed Control Data Length

The amount of data received in the Directed Control Input Table is determined by the GENI Setup Table selection for DCD length. When GENI logs on the bus, it supplies its current DCD length to any bus controller that sends it a Read ID message. The device that will be sending Directed Control Inputs to GENI reads this length, and sends it the amount of data specified.

At initial powerup of the GENI, the DCD length is set to 0. It can be changed to any length up to 128 bytes. The host does this by entering the desired DCD length in the GENI Setup Table. Then, the host sends GENI a Change Configuration command, as explained in chapter 7.

When GENI changes its configuration, it drops off the bus for 1.5 seconds. It then logs on again, sending the new DCD length to any host that sends it a Read ID message. The other device can then begin sending GENI the specified amount of data each bus scan.

## Timing Considerations

If the program sweep time is longer than the bus scan time, new outputs may not be available each bus scan; in that case, the same outputs may be sent more than once. If the program sweep time is much shorter than the bus scan time, it is possible that output data might change more quickly than the bus controller can send it. *If that happens, some output data could be lost.* The application program must accommodate these timing issues to assure data integrity.

## Table Lockout

GENI cannot receive Directed Control Inputs or direct outputs to another GENI while I/O Table Lockout is in effect. Both the Directed Control Input Table, used to send Directed Control Data, and the Output Table, used to receive Directed Control Data, are affected by the current I/O Lockout state.

If lockout lasts longer than one bus scan, GENI will re-direct the previous scan's outputs. When lockout is relinquished, new data from the output table will be sent.



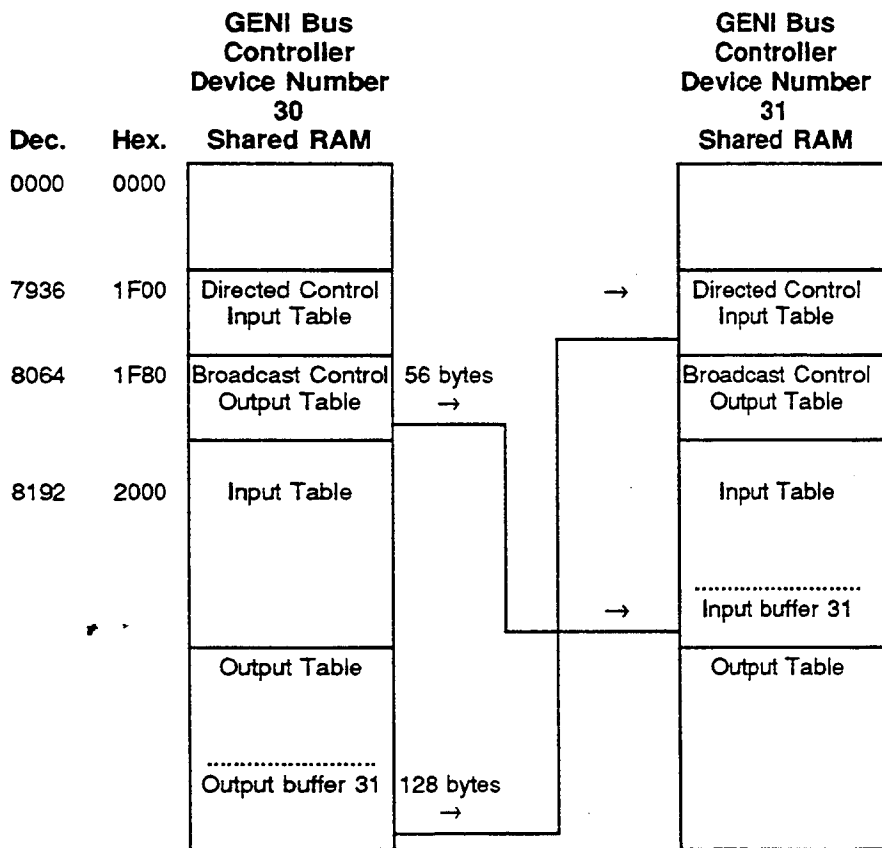
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## Using Global Data and Directed Control Data

Directed Control Data and Global Data are completely independent capabilities. GENI can send up to 128 bytes of Directed Control Data to each GENI on the bus, AND up to 128 bytes of Global Data in the same bus scan. A device receiving the Directed Control Data would also receive the Global Data, since that is sent to all devices on the bus.

Example:

In a system with several hosts, the GENI bus controller with Device Number 30 sends 128 bytes of Directed Control Data to the GENI bus controller with Device Number 31, and broadcasts 56 bytes of Global Data to all devices on the bus.





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GENI can send or receive memory-access datagrams. These datagrams directly read or write host memory.

<b>Read Device</b>	The Read Device datagram is used to read up to 128 bytes of data from host memory.
<b>Write Device</b>	The Write Device datagram is used to write up to 128 bytes of data to a specified location in host memory.
<b>Write Point</b>	The Write Point datagram is used to set or reset up to 18 individual bits of data in host memory.

## **Sending Memory Access Datagrams**

To send one of these datagrams, the host must use send a Transmit Datagram or Transmit Datagram with Reply command to GENI. Chapter 10 explains how to do that using the Command Block area of Shared RAM.

## **Receiving Memory Access Datagrams**

When GENI receives a memory-access datagram, it places the datagram into the Request Queue area of Shared RAM. The Request Queue can be directly accessed by the host, as described below. Other types of datagrams, which do not require access to host memory, are NOT placed in the Request Queue. Instead, they are placed in GENI's Receive Queue; the host must transfer them to Shared RAM individually. This is described in chapter 10 (see "Read Datagram Command" on page 10-6).

### **Request Queue**

The Request Queue begins at location 0000D/0000H. Queue:

### **Request Queue Head Pointer**

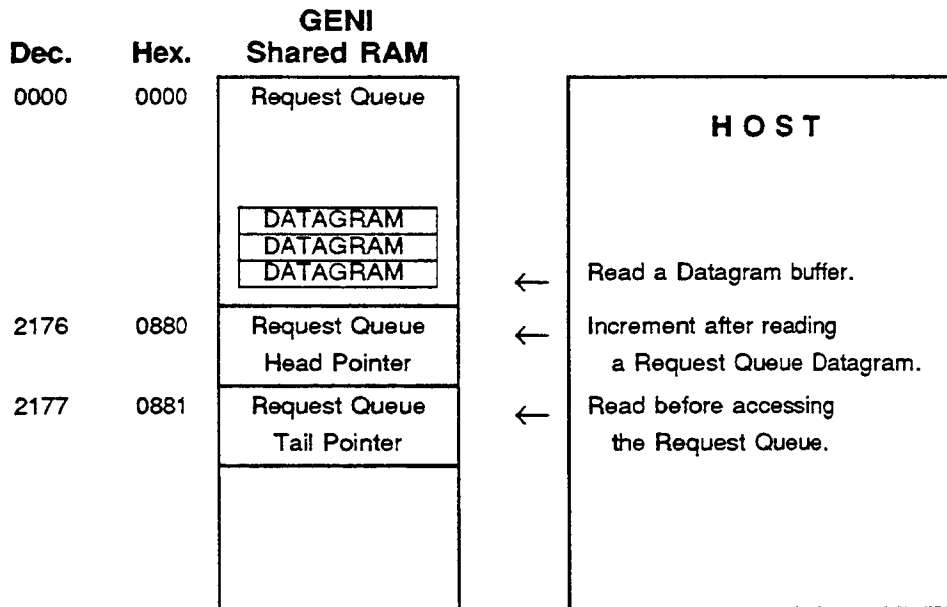
The Request Queue Head Pointer occupies byte 2176D/0880H of Shared RAM. It indicates which of the 16 Request Queue Datagram buffers the host is currently reading. The host should increment this pointer after reading a Datagram from the Request Queue.

### **Request Queue Tail Pointer**

The Request Queue Tail Pointer occupies byte 2177D/0881H of Shared RAM. GENI uses this byte to indicate which Request Queue buffer contains the most recent memory access Datagram. When the Tail Pointer is equal to the Head Pointer, the Request Queue is empty.

## Handling the Request Queue

If the host chooses to honor memory access Datagrams, it should monitor the Request Queue Tail Pointer. As new Datagrams enter the Request Queue, the host should read them out. This should keep pace with the rate at which new memory access Datagrams are queued, to prevent the queue backing up. If the queue were to become full, additional Datagrams would be lost with no indication to the host or to the device that sent the request.



The host should service the request, set the status byte, then increment the Request Queue Head Pointer by one.

### Example Logic for the Request Queue Pointers

The host should set a variable equal to the head pointer and use it as an index into the queue. After obtaining the datagram, the host should increment the index. If the index is 16, it should roll over to 0. Then the host should set the head pointer to the value of the index.

```

if (head_ptr <> tail_ptr)
  then
    index = head_ptr
    get message using [index]
    index = (index + 1)

    index = index AND 0fhex
    head_ptr = index
  end if

```

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The host writes, and GENI reads, the head pointer. GENI writes, and the host reads, the tail pointer. When these two pointers are the same, the queue is empty. The GENI will not advance the tail pointer to be equal to the head pointer. The host should not advance the tail pointer.

Any write to the head pointer causes an interrupt to the GENI. Therefore, the example logic above increments and rolls over the variable index, which is a local copy of the head pointer, instead of the head pointer itself. This prevents having to write to the head pointer twice.

#### NOTE

At no time should the host write to the tail pointer. This will cause the bus controller to hang in the request queue.

If the host reports (in the header) any error state, GENI takes no action except to free up that buffer in the Request Queue.

If the host reports that it is currently busy, GENI requeues the request that caused the "busy" status, and frees up that buffer. The message moves to the next available buffer in the Request Queue as if it were a new message. The host must try again to read the message.

## Host Responses to Memory Access Datagrams

1. If the Request Queue datagram is a Write Device or Bit Write datagram, the host must read the contents of the data area of the buffer. GENI will free up the Request queue buffer. No further action is needed to complete these requests.
2. For a Read Device datagram, the host must place the contents of the requested memory location into the data area of the same Request Queue buffer. The host should then set the status byte to "completed."

GENI will send the entire buffer contents to the requesting device as a Read Device Reply datagram.

The host does not need to clear the status byte; GENI does this automatically.

General algorithm for Processing Request Queue:

```

Case Request Queue Command
  Case Read Device:
    Place requested data into data area of Request Queue
  Case Write Device:
    Take data from data area of Request Queue
  Case Point Write:
    Take data from data area of Request Queue
End Case

```

Complete status byte in Request Queue

Head pointer = (head pointer +1) mod 16

## Request Queue Buffer Format

The Request Queue is divided into 16 fixed-length buffers, numbered from 0 to 15. These are used in a circular fashion. A typical buffer may have the following format:

<b>Header</b>	Command	byte + 0
.	Status	byte + 1
.	Data length	byte + 2
.	Host memory map address, lsb	byte + 3
.	Host memory map address	byte + 4
.	Host memory map address, msb	byte + 5
.	Source device number	byte + 6
<b>End of Header</b>	Auxiliary source address	byte + 7
<b>Data</b>	Data characters (128 bytes maximum)	byte + 8 to byte + 137

### Example Request Queue Variables

The following Request Queue variables might be defined for a C language interface to GENI.

```
typedef
struct {
    unsigned char    command;
    unsigned char    status;
    unsigned char    length;
    unsigned char    map[3];
    unsigned char    source;
    unsigned char    aux_src;
    unsigned char    data[128];
} REQUEST_Q
```

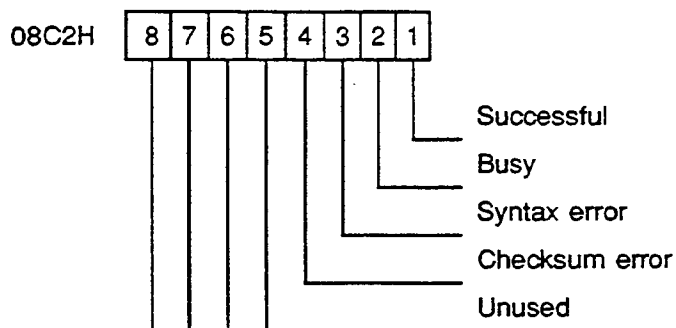
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## Header Byte

The first 8 bytes of each buffer are used for the Datagram header. This header specifies the request parameters, including the actual length of data characters. Following the header, each buffer accommodates up to 128 byte of data. For information about Datagram formats, see the *Genius I/O System User's Manual*.

## Status Byte

The second byte of a Request Queue buffer is used as a status byte. Bits in the status byte have the following definitions:



## Example Status Variables for Request Queue Operations

The following Request Queue status variables might be defined for a C language interface to GENI.

```
#define RQ_COMPLETE 1 /* successful completion */
#define RQ_BUSY 2 /* host busy status */
#define RQ_SYNTAX 4 /* host syntax error */
#define RQ_CKSUM 8 /* host checksum error */
```





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Troubleshooting involves thinking logically of the function of each part of the system, and understanding how these functions interrelate. When problems occur, the total system must be considered. All the devices on the bus must be connected and operating properly.

The technology used in the design of the GENI board is such that few hardware failures will occur with GENI itself under normal operating conditions. If a failure does occur, it can be quickly isolated and the defective component replaced with minimum downtime.

### Board LEDs

A malfunction causing improper operation of a GENI board can usually be isolated by checking the board LEDs. These indicate the status of the board itself, and of its communications with the Genius bus. During proper operation, both the BOARD OK and COMM OK LEDs will be on.

Indicator	Status	Definition
BOARD OK	ON	The GENI board is receiving adequate power, and has passed its diagnostic self-test.
	OFF	The watchdog timer has expired. This indicates an improper Device Number selected for the board, or the /RST line is low, or the board has failed.
COMM OK	ON	Power is available, and the board receives the bus token every three bus scans.
	OFF (or flashing)	An error has been detected in the communications hardware, or access to the Genius bus.

## Troubleshooting Steps

The module should be plugged in and powered up; /RST should be high:

Indication	Troubleshooting Steps
BOARD OK is off COMM OK is on	Check that DIP switches are set correctly. If set incorrectly, BOARD OK LED will not come on. If set correctly, assume a hardware failure; replace the GENI board.
BOARD OK is on COMM OK is off	Check for correct cable type and length.  Be sure correct terminating resistors are installed at both ends of the bus.  Be sure GENI jumper J2 is set for the type of terminating resistor used.  Be sure the serial bus is wired in a daisy-chain manner.  Look for broken cable.
Both LEDs are off	Verify that the GENI is plugged in, seated properly, and receiving power.  Check voltage receiving level of /RST. It must remain at 2.4 volts or higher (TTL logic 1).
Both LEDs are flashing in unison	Two devices on the bus have been assigned the same Device Number. This can be checked with a Hand-held Monitor.
Repeated bus errors occur	Be sure cable shielding is properly installed and grounded.  Unplug bus communications cable from the GENI. Refer to the Device Number assignments made when configuring the system. Use a Hand-held Monitor to read configuration, compare Device Numbers, and I/O reference numbers, if used.
Bus errors--can't get the GENI up and running	Serial 1/Serial 2 are crossed.

---

---

## Appendix A General Macro Definitions

The following macro definitions should be used for a C language interface to GENI. Additional variable definitions are suggested in the text.

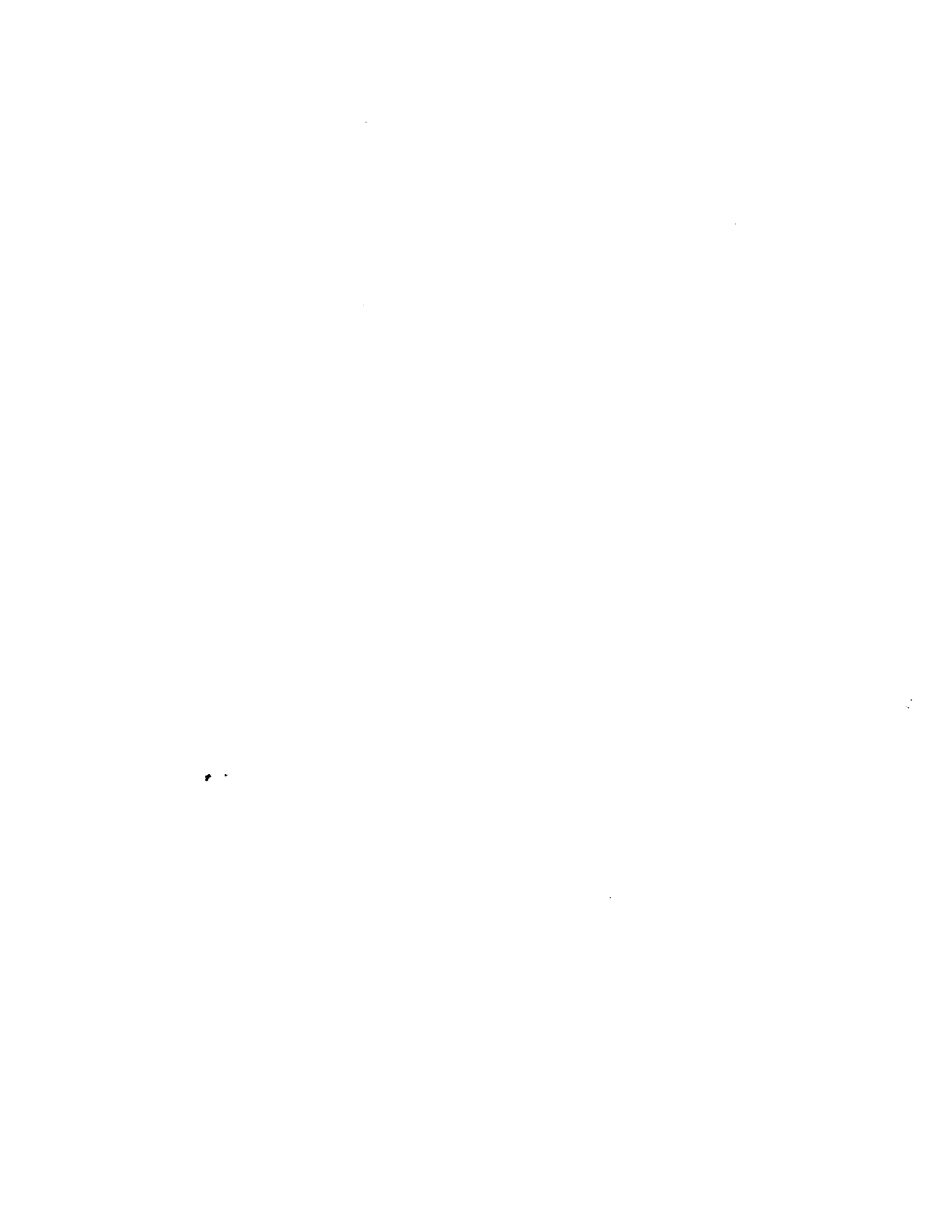
```
#define MAXDEVICE      32      /* maximum number of bus devices */

/* the following macros will implement a MOD(ulo) 16 */

#define BUMP10(X)      ((X) & 0xF)      /* will add 1 to index mod 16 */
#define DEC10(X)      ((X) & 0xF)      /* will sub 1 from index mod 16 */
#define TBUMP10(X)    (((X) + 1) & 0xF) /* will add 1 to index but not change
                                         index */

/* the following macros will implement a MOD(ulo) 32 */

#define BUMP20(X)      ((X) & 0x1F)     /* will add 1 to index mod 32 */
#define DEC20(X)      ((X) & 0x1F)     /* will sub 1 from index mod 32 */
#define TBUMP20(X)    (((X) + 1) & 0x1F) /* will add 1 to index but not change
                                         index */
```



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## ***GE Fanuc Automation***

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