

Programmable Control Products

Genius I/O
μGENI Board*

User's Manual

GFK0845A

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Customer Care Email	customercare.emea.ip@ge.com
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Technical Support Email	support.cn.ip@ge.com (China)
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	support.in.ip@ge.com (remaining Asia customers)
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	customercare.cn.ip@ge.com (China)

This book provides the information needed to integrate a Genius™ μ GENI Network Interface (μ 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. Introduction: gives board specifications, and describes μ GENI's capabilities.

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

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

Chapter 4. Setup: describes the area of Shared RAM where μ GENI stores its Genius bus setting and other setup data.

Chapter 5. Status: describes the portion of Shared RAM where μ 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 μ GENI to the host.

Chapter 7. Device Configuration: describes the table in Shared RAM where μ GENI stores information about devices on the bus. It also explains how μ 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. Commands: explains how the host can send and receive datagrams, and change μ GENI configuration.

Chapter 11. Global Data: describes how μ 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 μ GENI can direct or receive up to 128 bytes of data to/from any other bus controller.

Chapter 13. Memory Access Datagrams: explains how μ 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 μ 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.

We Welcome Your Comments and Suggestions

At GE Intelligent Platforms, we strive to produce quality technical documentation. After you have used this manual, please take a few moments to complete and return the Reader's Comment Card located on the next page.

Jeanne Grimsby
senior technical writer

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Board Specifications

<p>Electrical:</p> <p>Inrush at Powerup</p> <p>Power Requirements</p> <p>BusLoading</p> <p>BusDriveCapability</p> <p>Mechanical</p> <p>GENIBoardDimensions</p>	<p>420mA,300µS</p> <p>5 volts DC +/-10%, 470mA bus activity, 230mAidle</p> <p>1 LS TTL load per input line</p> <p>4 LS TTL loads per output line</p> <p>Height at tallest component: top, .465 inches (11.811 mm) bottom, .16 inches (4.064 mm)</p> <p>Width: 3.3 inches (83.82 mm)</p> <p>Depth: 4.5 inches (114.3 mm)</p> <p>Boardthickness: 0.063 inch (1.60 mm)</p>
<p>Environmental:</p> <p>Operating:</p> <p>AmbientTemperature at board</p> <p>Humidity</p> <p>Altitude</p> <p>Vibration</p> <p>Shock</p> <p>Non-operating:</p> <p>AmbientTemperature at board</p> <p>Humidity</p> <p>Altitude</p> <p>Vibration</p> <p>Shock</p>	<p>0C to +85 C, 32F to + 185F</p> <p>5% to 95% non-condensing</p> <p>10,000 feet</p> <p>0.2 inch displacement 5 to 10 Hz</p> <p>1 G 10 to 200 Hz</p> <p>15 G, 10mS duration per MIL-STD 810C, method 516.2</p> <p>-40C to +85 C, -40F to +185F</p> <p>5% to 95% non-condensing</p> <p>40,000 feet</p> <p>0.2 inch displacement 5 to 10 Hz</p> <p>1G 10 to 200 Hz</p> <p>Board packed in shipping container: 15 G, 10mS duration per MIL-STD 810C, method 516.2</p>

Ordering Information

Description	Catalog Number
µGENIBoard	IC660ELB912
32K x 8 EPROM	44A723394-000
HHMConnector	44A723293-001
<i>Genius I/O System User's Manuals</i>	GEK-90486

Board Components

Principal components of the μ GENI board are:

6303 microprocessor	The serial interface microprocessor. It writes messages to transmit buffers in the MIT chip.
MIT chip	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.
Transmit/receive circuit	A circuit that interfaces the MIT transmit and receive signal levels to bus signal levels.
Transformer	The transformer isolates the μ GENI board circuitry from the bus cable.
Dual port RAM	Dual port RAM is where the serial interface microprocessor (6303) and the μ 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 a GAL, which arbitrates memory requests on a byte-by-byte basis, allowing the 6303 and the 64180 equal access.
64180 Microprocessor	This microprocessor transfers data between μ 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.
Shared RAM	Shared RAM is the host's interface to μ 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 μ 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. The GAL 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.

Shared RAM Address Comparator The Shared RAM Address Comparator causes a 64180 micro-processor 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 64810'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.

This circuit is implemented in a single array logic device (GAL) which allows the address of the interrupt bytes to be reprogrammed during redevelopment, and provides the capability for latching and clearing the interrupt.

Motherboard Requirements

The motherboard must provide the following minimum support:

- +5V power connection with appropriate ground connections.
- Powerup Reset pulse to the μ GENI board.
- Male 50-pin connector for signal and power signals to μ GENI. Male 10-pin connector for additional power and ground. Recommended mating connectors are available from AMP, DuPont, Samtec, and Elco. 0.02" (0.508mm) square gold-plated pins should be used.
- Terminal block and optional D subminiature connector to the bus.
- HHM connector (D subminiature connector) with HHM Present signal.

Mounting

The μ 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.

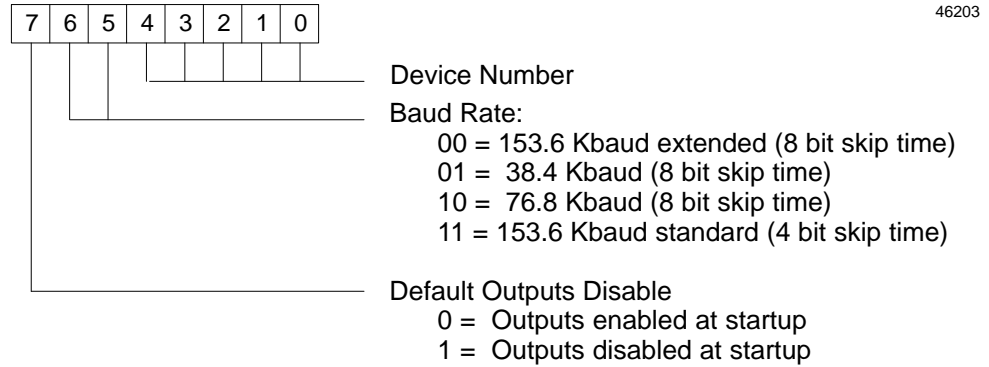
Power Supply Requirements

The μ 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).

Genius Setup Signals

The Genius Setup signals P6(0) to P6(7) must be driven prior to bringing the nGENI board out of reset on powerup. The eight signals determine: the baud rate, the status of the output disable bytes during initialization, and the Device Number of the μGENI board. The signals could be driven with DIP switches or latches, for example. Each signal has a 10K pullup to set the default values.

Genius Setup Signal 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 serial bus address. The default Device Number set with pullups on the setup signals on the μGENI 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 μGENI 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 μGENI bus controller is powered up. This prevents incorrect operation of the outputs at powerup. The default is for outputs to be disabled. To enable outputs, drive signal P6(7) to 0.

Changing the Genius Setup Signals

The nGENI reads these signals at powerup; if any signal is changed, it will be ignored until the next time μGENI is powered up.

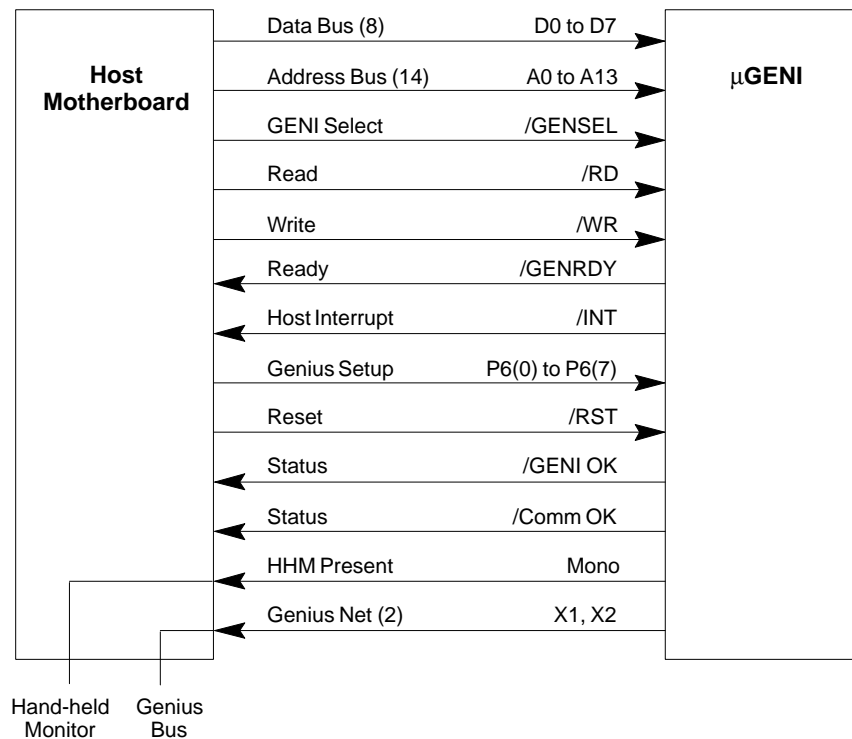
Chapter 2

Hardware Interface

Signal connection between μ GENI and the motherboard is provided via a 50-pin female connector and a 10-pin female connector.

The μ 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.

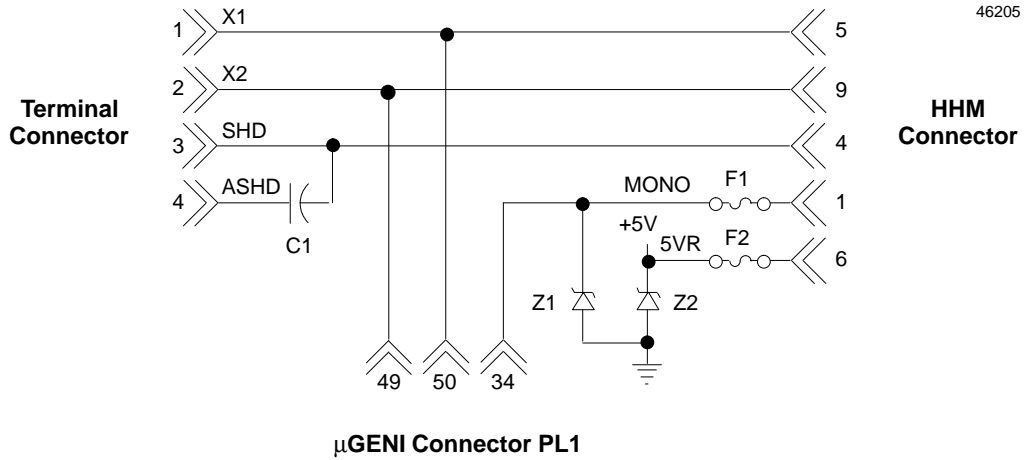
46204



Bus Loads/Drive Capability

All input lines to the μ GENI present no more than one standard LSTTL load to the host interface connector. All output lines from the μ GENI except the /INT and / μ 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 / μ GENI OK and /COMM OK lines are low-tr ue open-collector type outputs with built-in current-limiting to 5mA suitable for driving LEDs directly.

Motherboard Wiring Requirements



X1, X2, SHD, and ASHD 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.

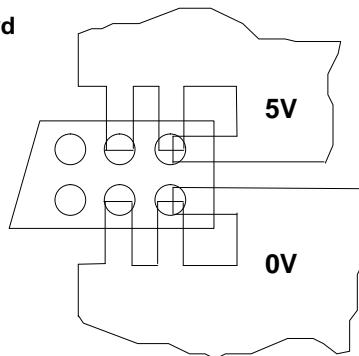
X1, X2, SHD, and ASHD must be connected to a terminal connector on the motherboard.

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

The μ GENI contains high-speed switching devices that require good 0V and 5V connection between the motherboard and the μ GENI to minimize ground bounce between the two boards, which could affect the quality of signals to/from the μ GENI. The μ GENI is a multilayer board with 1oz 5V and 1oz 0V power planes. It is designed to limit ground bounce on the board itself. Care must be taken in routing 0V and 5V to both the 50-pin connector and the 10-pin connector.

The following illustration shows routing for the 0V and 5V pins on the connector with a two-layer board.

Two-Layer Motherboard

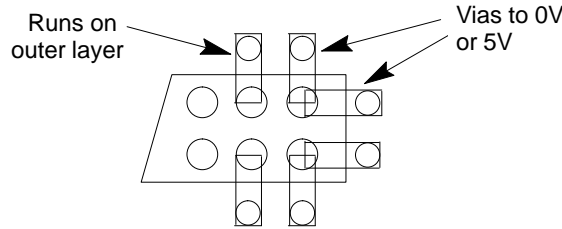


Due to the normal thermal relief patterns on power planes with 2mm center connector, additional 0V and 5V connections are required on the outer signal layers for all 0V and 5V pins.

The following illustration represents routing for the 0V and 5V pins on a multilayer motherboard with a 2mm connector.

46239

Multi-Layer Motherboard



The runs into the 2mm center connector pin pads should be the full width of the pad, typically .05" (1.27mm) to provide the lowest impedance path possible. Also, the length of the 0.02" square posts from the motherboard to the μ GENI should be as short as possible to provide the lowest inductance path.

The μ GENI utilizes ACT technology for driving the data lines and address lines shared with the motherboard to provide faster switching speeds and more load-driving capacity. Fanout and run length on the data lines and address lines must be limited to avoid transmission line effects with the ACT technology. The suggested number of buffering gates on the data lines is two (2) maximum. Pullup resistors should be avoided on the data lines and address lines to limit the current required by the μ GENI to drive these signals low. Any buffering devices should be located as close as possible to the respective μ GENI connector pins. The preferred run length to a buffering device for the data signals is 2", with a maximum of 4" from the PL1 pins 35–42.

The /GENRDY signal is open collector to accommodate a wider range of microprocessors; therefore, a pullup or pulldown resistor is required on the motherboard.

The electromagnetic compatibility of the μ GENI is determined by the grounding system of the motherboard. The Genius connector on the motherboard should provide a shield input (SHD) and a shield output (ASHD). The shield output must be connected directly to earth ground. Special care should be taken on the motherboard when routing the earth ground signal to minimize coupling with other signals and to provide the lowest impedance path possible (0.1" earth ground run is suggested).

When routing circuitry under a μ GENI daughterboard, care should be taken not to route noisy signals under the μ GENI. Some examples of noisy signals would be high speed clocks with fast edges, driving signals with inductive kickback, and power supply switchers.

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 ("C1" in the illustration above) is recommended to shunt any AC noise present on the bus shield. It should be a 0.1 μ farad ceramic 100 volt, 20% capacitor.

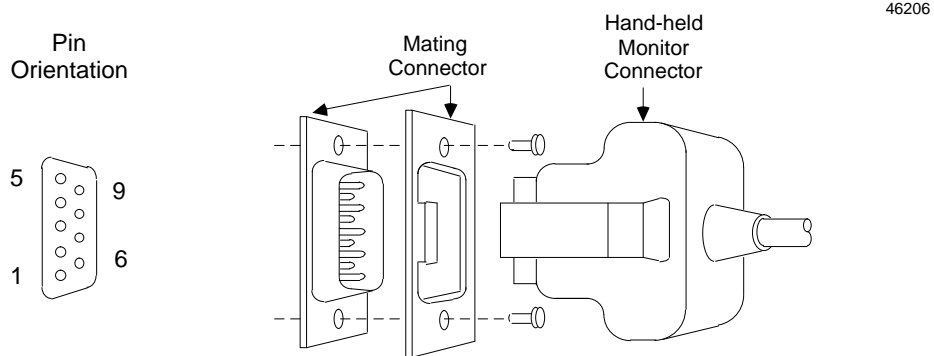
Faceplate Markings

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

X1	SERIAL1
X2	SERIAL2
SHD	SHIELDIN
ASGD	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. The HHM mounting kit (part number IC660MPH509) contains a D-connector, dress plates, and screw lock assembly. The dress plate is mounted on the front of the D connector and held in place by two locking screws. 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 50-pin connector provides the following Genius bus signals:

PIN	FUNCTION
50	X1
49	X2
48	NC
47	NC
46	NC
45	NC

X1 and X2 are differential signals that carry Genius bus data; they must be connected to a terminal connector on the host motherboard.

5 Volt Connector Signals

The 10-pin connector provides the following 0-volt and 5-volt signals:

PIN	FUNCTION	PIN	FUNCTION
1	5V	2	0V
3	5V	4	0V
5	5V	6	0V
7	5V	8	0V
9	5V	10	0V

The 50-pin connector provides the following 5-volt signals:

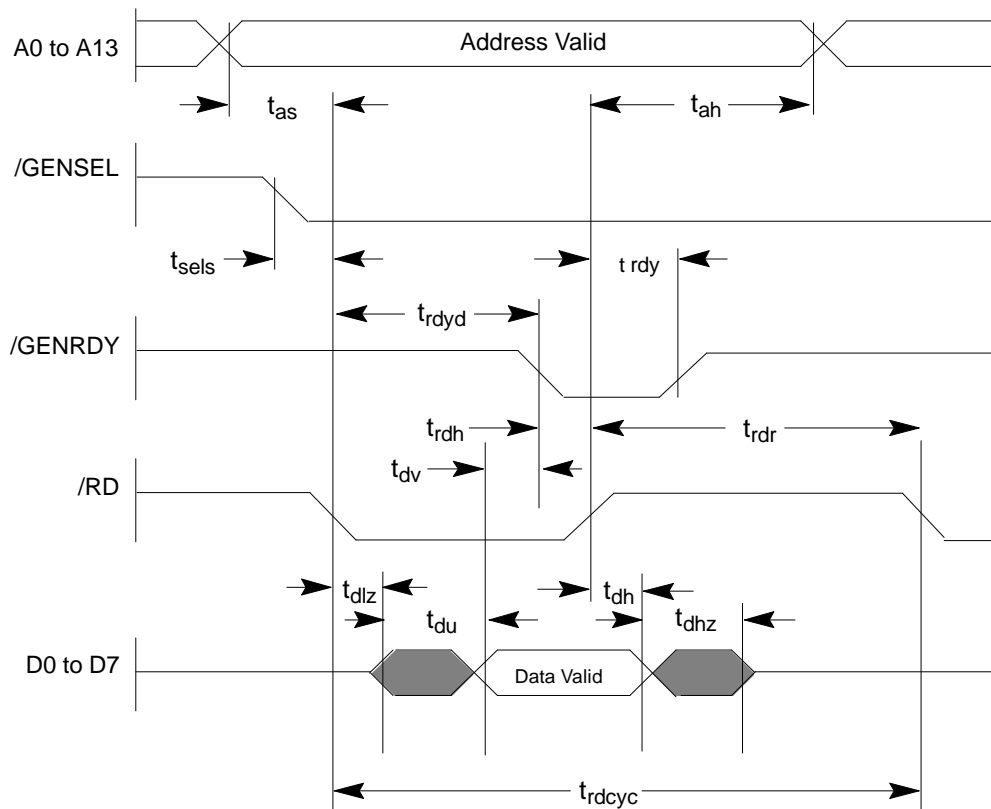
PIN	FUNCTION	PIN	FUNCTION
1	0V	23	P6(3)
2	+5V	24	P6(2)
3	0V	25	P6(1)
4	+5V	26	P6(0)
5	A0	27	NC
6	A1	28	/RST
7	A2	29	/INT
8	A3	30	/RD
9	A4	31	/WR
10	A5	32	/GENSEL
11	A6	33	/GENRDY
12	A7	34	MONO
13	A8	35	D0
14	A9	36	D1
15	A10	37	D2
16	A11	38	D3
17	A12	39	D4
18	A13	40	D5
19	P6(7)	41	D6
20	P6(6)	42	D7
21	P6(5)	43	/GENIOK
22	P6(4)	44	/COMMOK

Signals on the 50-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 μ GENI board's Shared RAM to/from an 8-bit microprocessor-type data bus. These lines enter the high-impedance state when $\overline{\text{RST}}$ is low or $\overline{\text{GENSEL}}$ 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	$\overline{\text{WR}}$	The Write strobe input to the μ GENI indicates that data on D0-D7 is valid and should be written from the host interface bus to Shared RAM.
	$\overline{\text{RD}}$	Read strobe line; The Read input to the μ GENI is used during a host CPU read cycle. It enables data transfer from Shared RAM to the host interface bus.
	$\overline{\text{RST}}$	ReSeT initializes the μ 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 μ GENI output signals are held inactive during reset.
	$\overline{\text{GENSEL}}$	GENi SElect is used by the host to request access to Shared RAM. All output signals from μ GENI are held inactive and data cannot be written into Shared RAM when this signal is high.
	$\overline{\text{GENRDY}}$	GENi ReaDY is an output from the μ 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 μ GENI Shared RAM access. $\overline{\text{GENRDY}}$ falls low until the low to high transition of $\overline{\text{RD}}$ or $\overline{\text{WR}}$. A high to low transition of $\overline{\text{GENRDY}}$ means that the host can stop inserting wait states (ending its read or write cycle).
Interrupt Signal	$\overline{\text{INT}}$	INT is an open-collector output that tells the host an event occurred whenever it goes low (it pulses low for 5.44 μ seconds). 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.
	μ GENI OK	Reflects the μ GENI OK LED output. Low when μ GENI is running normally. High when a hardware error has been detected. This line is internally current-limited to 5mA. It can directly drive an LED or be used as a logic signal.
	COMM OK	A low $\overline{\text{COMMOK}}$ output indicates no communication 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.
Bus Signals	X1 and X2	Differential signals that carry Genius bus data.
Genius Setup	P6(0) to P6(7)	Genius bus setup signals.

Timing for Shared RAM Read Cycle

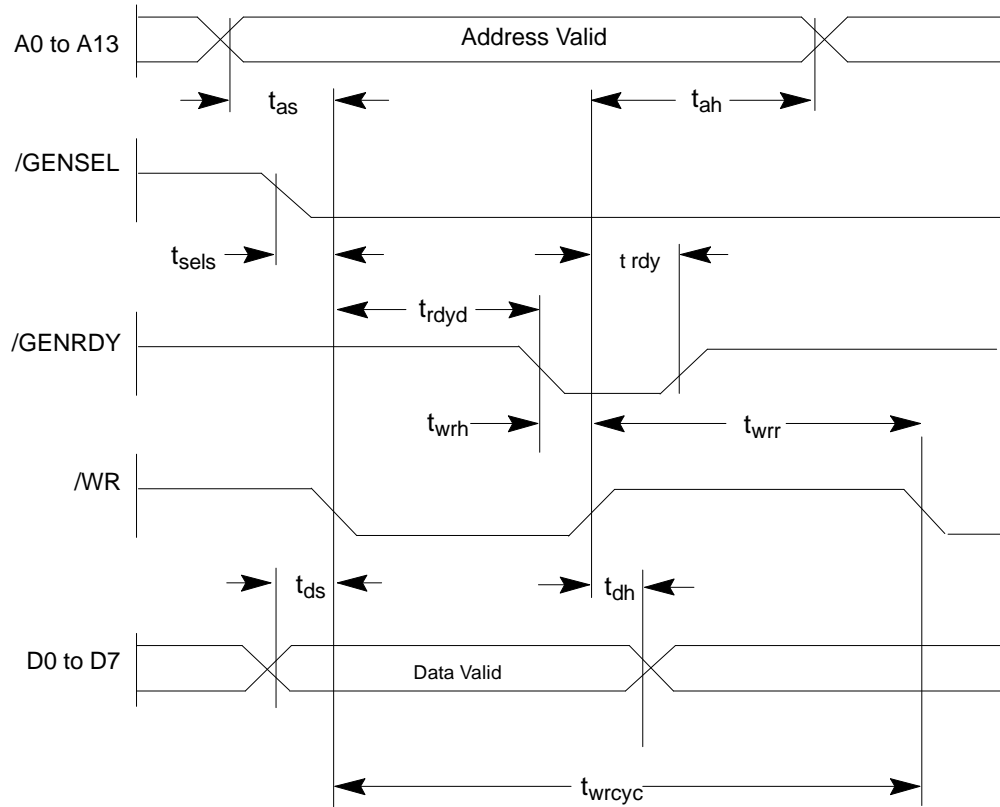
46207



Item	Minimum nS	Maximum nS
Read Cycle Time (t_{rdcyc})	500	-
Address Setup Time (t_{as})	0	-
Address Hold Time (t_{ah})	0	-
μ GENI Select Setup Time (t_{sels})	0	-
μ GENI Ready Delay (t_{rdyd})	319	848
Ready Hold After Read (t_{rdy})	5	31
Read Hold After Ready (t_{rdh})	0	-
Read Recovery Time (t_{rdr})	182	-
Data Time to Low Z (t_{dlz})	14	609
Data Undefined Time (t_{du})	-	84
Data Valid Before Ready (t_{dv})	134	-
Data Hold Time (t_{dh})	3	14
Data Time to High Z (t_{dhz})	2	38

Timing for Shared RAM Write Cycle

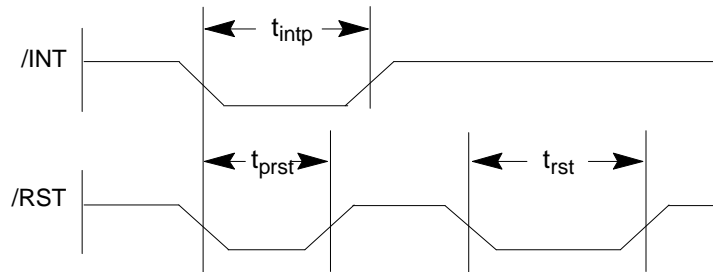
46208



Item	Minimum nS	Maximum nS
Write Cycle Time (twrcyc)	500	-
Address Setup Time (tas)	0	-
Address Hold Time (tah)	0	-
μGENI Select Setup Time (tsels)	0	-
μGENI Ready Delay (trdyd)	319	848
Ready Hold After Write (trdy)	5	31
Write Hold After Ready (twrh)	0	-
Write Recovery Time (twrr)	182	-
Data Setup Time (tds)	0	-
Data Hold Time (tdh)	0	-

Interrupt and Reset Timing

46209



Item	Minimum	Maximum
/INT Pulse Width (t_{intp})	5.44 μ S	-
Powerup /RST Pulse (t_{prst})	20mS	-
Operating /RST Pulse (t_{rst})	10 μ S	-

Reset Restrictions

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

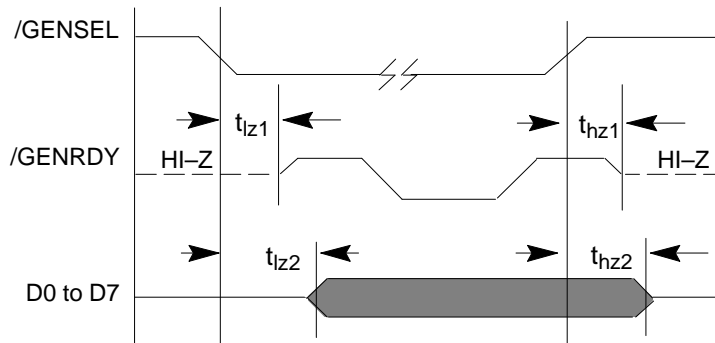
One false interrupt occurs within this time period. Reading or writing to Shared RAM during this time may cause the watchdog timer to time out.

Note

For version IC660ELB912G and later μ GENI boards, the watchdog timer can be reset using /RST. Version IC660ELB912F and earlier μ GENI boards must be power-cycled to clear the watchdog timer.

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

Board Ready/Data Select Timing



46210

Item	Minimum nS	Maximum nS
Select to Low Z /GENRDY (tlz1)	3	16
/Select to Low Z Data (tlz2)	14	609
/Deselect to High Z /GENRDY (thz1)	3	17
Deselect to High Z Data (thz2)	5	53

Chapter 3

Software Interface

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

Location		Content	Size in Bytes
dec.	hex.		
0000	0000	Request Queue	(2176)
2176	0880	Request Queue Head Pointer*	(1)
2177	0881	Request Queue Tail Pointer	(1)
2178	0882	μ GENI Setup Table	(16)
2194	0892	μ 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	Host Clear	(1)
2635	0A4B	Reserved	(64)
2699	0A8B	Auxiliary Request Queue	(48)
2747	0ABB	Heartbeat Enable	(2)
2749	0ABD	Heartbeat Timeout Multiplier	(1)
2751	0ABF	Reserved	(4930)
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 μ 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.

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

μ GENI Status Table: Diagnostics for μ GENI 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 μ 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 μ GENI lockout of I/O Tables.

I/O Table Lockout State: Actual lockout state.

Host Clear: Used by μ GENI to clear Interrupts from the host.

Reserved Area: The host should NOT read or write here.

Auxiliary Request Queue: Used in conjunction with Request Queue.

Heartbeat Enable: Used to enable host to μ GENI heartbeat monitoring.

Heartbeat Timeout Multiplier: Sets the heartbeat interval.

Reserved Area: The host should NOT read or write here.

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 μ 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        cmmd_block;
    unsigned char    outdata[240];
    unsigned char    indata[134];
    unsigned char    lockout;
    unsigned char    lockout_state;
    unsigned char    hostclr;
    unsigned AUX_Q    auxreq[16]
    unsigned int    heartbt-enable;
    unsigned char    heartbt-mult;
    unsigned char    spare[4930];
    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.

Interface Suggestions

μ GENI Setup

Use the μ GENI Setup Table to read or change:

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

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

See chapter 4 for information about the μ GENI Setup Table.

μ GENI Status

Use the μ GENI Status Table to monitor:

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

See chapter 5 for information about the μ 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. μ 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.

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 μ 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 μ GENI, after changing the μ GENI Setup Table. See chapters 4 and 10 for information.

Read or Write Datagrams

The μ GENI will send datagrams to other bus controllers, or receive datagrams from them, see chapter 10. It explains how to send commands to the μ 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. See 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.

Startup Self-test

When the μ GENI board Reset is released, it begins its startup procedure. During this time, μ 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, μ GENI reports it in the μ GENI Status Table. It then attempts to go into a controlled lockup state. The host does not receive the μ GENI OK status, and the μ GENI OK light does not go on. If no error is found during the diagnostic tests, μ GENI initializes the contents of Shared RAM to the following defaults.

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

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

Genius Setup signals on the μ GENI board are read after Reset is released. 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 Genius Setup signals.

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

μ 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, μ GENI is ready to begin transmitting on the bus.

Steady State Operation

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

μ GENI's activities during normal operation are summarized below.

Self-test	During steady-state operation, μ 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 μ GENI Status Table area of shared RAM. Outputs are then disabled, and the μ GENI bus controller attempts to halt.
Monitoring a Host Heartbeat	Optionally, the μ GENI can monitor a host "heartbeat" as described on page 30.
I/O Service	μ 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, μ GENI directs outputs from the host to those devices. It also maintains a queue of device addresses to which output data has been sent.
I/O Table Lockout	Upon request from the host, μ GENI will "lock out" the I/O table. During lockout, μ GENI will not access the Device I/O Tables, the Broadcast Control Output (Global Data) Table, or the Directed Control Input Table.
Host interrupts	Seven conditions which may require immediate host attention can be monitored, and may cause the μ GENI to send an interrupt the host. Before sending the interrupt, μ 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. 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, μ 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.
Datagram Service	μ GENI maintains a queue of datagrams from other devices. It will also transmit datagrams from the host to devices on the bus.
Maintain Bus Scan Time	μ GENI maintains a minimum bus scan time of 3mS. μ GENI monitors actual bus scan time, and stores the current scan time in Shared RAM, where it can be read by the host.

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, μ 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 μ 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, μ 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, μ 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 Status Change Interrupt or Interrupt Summary is NOT disabled, μ 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, μ GENI automatically directs an Assign Controller message to the device. This instructs the device to send fault reports and configuration change messages to the μ GENI. μ GENI then starts sending the data from that device’s area of the output table each bus scan.

Device Log-out

μ 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. μ 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 Device Status Change or Interrupt Summary is NOT disabled, μ GENI also sends an interrupt to the host.

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

Chapter 4

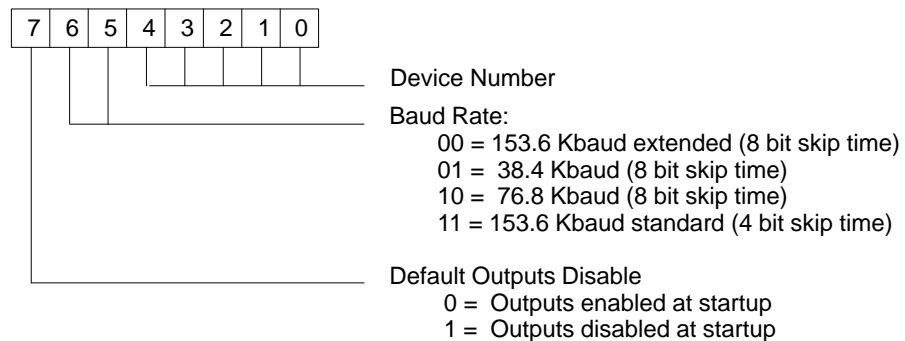
Setup

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

Byte No.	Description
byte 1	μ GENI board Genius Bus Setup Signals*
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.

Genius Bus Setup Signals the first byte of the Setup Table contains the levels of the Genius Bus Setup signals.



Broadcast Control Data Length specifies how much Global Data the μ GENI will broadcast each bus scan. The range is 0 to 128 bytes; the default is 0. μ 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 μ 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 μ GENI. The μ 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 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). μ 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 μ GENI.

```
typedef
struct {
    unsigned char    GenBus;        /* Genius bus setup 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_μGENI;
```

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 μ GENI OK flag should be on, indicating that the self-test has passed. The μ GENI will set this flag within 2 seconds of powerup. After the μ GENI OK flag is set, there is an additional 1.5 second delay. During this time, the host can change the μ GENI configuration. The 1.5 second delay is used to allow the host to change the configuration of the nGENI to the desired state before the nGENI gets on the bus.

The host can change any item in the μ GENI Setup Table except the Genius bus setup value by sending the μ GENI a Change Configuration Command.

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

To change any Genius bus setup value, it is necessary to change the Genius bus setup signals, then cycle power to the μ GENI board or reset then release the reset.

Read ID Requests

Another device on the bus may request setup information from μ GENI. It does that by sending μ GENI a Read ID datagram. μ GENI replies automatically, sending the contents of the μ 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.

Chapter 5

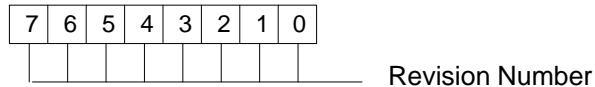
Status

To read diagnostic information about μ GENI and about the bus, use the μ GENI Status Table. The μ 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	μ GENI Revision Number
0893H	2	μ GENI OK Status
0894H	3	μ GENI Hardware Status
0895H	4	HHM Present
0896H	5	Serial Bus Error Count (lsb)
0897H	6	Serial Bus Error Count (msb)
0898H	7	Bus Scan Time in Milliseconds (lsb)
0899H	8	Bus Scan Time in Milliseconds (msb)
089A–089F	8 bytes reserved	

Software Revision Number

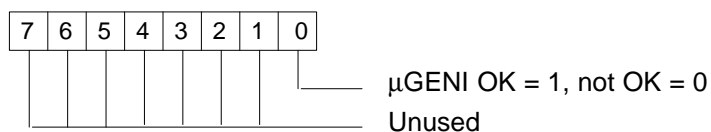
Shared RAM location 0892H contains the revision number of the μ GENI software.



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Board OK Status

Shared RAM location 0893H indicates the status of the μ GENI board. μ GENI automatically sets this byte to "1" to indicate that it is operational. The host can read this byte, then reset it. This byte can be used as a heartbeat indicator by both the host and the μ GENI. See page 30 for more information.

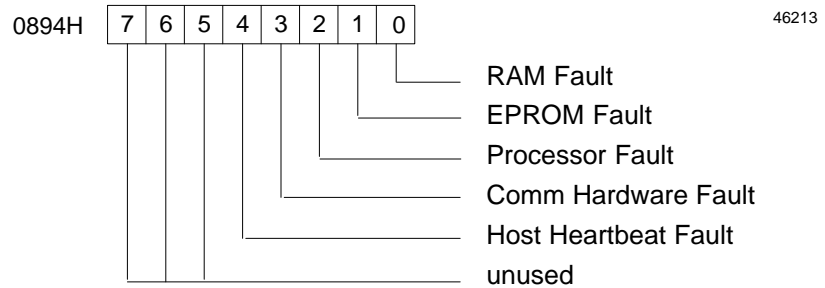


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The default is 0FFFF hex.

Board Hardware Status

Byte 0894H indicates the status of the μ GENI hardware. The μ GENI runs self-tests periodically as part of its normal operation. If an error occurs during one of these self-tests, the μ 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, the μ GENI OK bit (see “ μ GENI OK Status”, above) is cleared and the processor halts, which allows the watchdog timer to reset the board.



Note

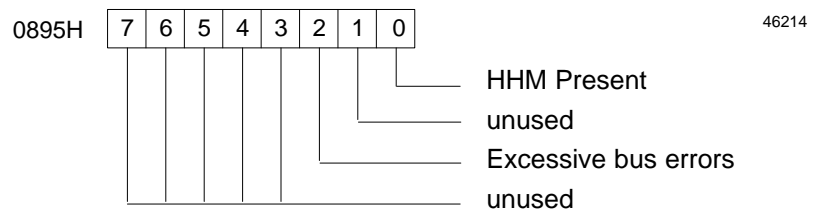
For version IC660ELB912G and later μ GENI boards, the watchdog timer can be reset using /RST. Version IC660ELB912F and earlier μ GENI boards must be power-cycled to clear the watchdog timer.

Hand-held Monitor Connected to μ 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

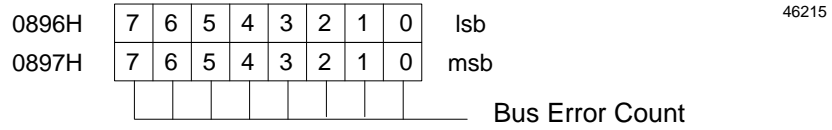
Bit 3 of byte 0895H flags excessive bus errors (10 or more in a 10-second interval). This is not a fatal condition; however, it indicates a bus problem and may cause an interrupt to the host. The total bus error count is contained in the next two status bytes.



Bus Error Count

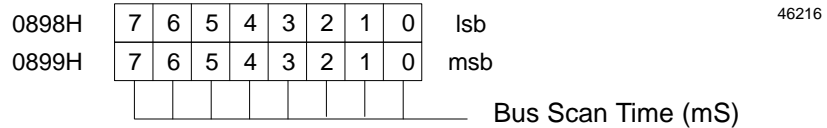
Bus Errors Bytes 0896 and 0897H form an integer count of the total bus errors. At powerup, this count is 0. If any bus errors occur, μ GENI increments this count. As errors

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 0898H 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 μ GENI's two previous turns on the bus. If μ GENI cannot access the bus, the value is set to 65535 (FFFFH). The host can monitor these locations to verify that μ GENI is communicating on the bus.



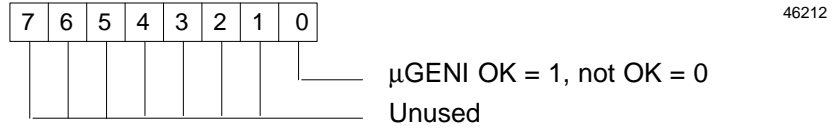
Example Variables

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

```
typedef
struct {
    unsigned char    Revision    /*  $\mu$ GENI revision number */
    unsigned char     $\mu$ 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 */
}  $\mu$ GENI_STATUS
```

Monitoring a Heartbeat

As mentioned previously, both the host and the μ GENI can use the mGENI OK byte in Shared RAM (location 0893H) as a heartbeat. This byte can be used as a heartbeat indicator by both the host and the μ GENI.

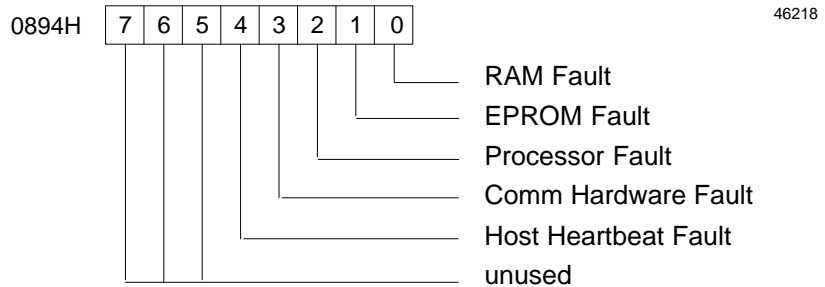


If the heartbeat feature is enabled, the mGENI checks the mGENI OK byte at the specified interval (for example, every 200mS). If the content of mGENI OK is a 0, the mGENI resets it to 1. The host can read this byte, then reset it to 0.

If the heartbeat feature is NOT enabled, the mGENI OK byte is normally set to 1 every 200mS. The mGENI sets the mGENI OK byte to 0 only if a fault occurs.

Monitoring the Host Heartbeat

If the heartbeat feature is enabled, and the nGENI encounters the value 1 on two successive checks, it assumes the host has stopped communicating, and sets bit 4 (Host Heartbeat Fault) of the nGENI Hardware Status byte (0894H).



As with other types of hardware faults (see page 28), if a heartbeat fault occurs the nGENI board resets in approximately 0.5 second.

Monitoring the nGENI Heartbeat

Similarly, the host can monitor the nGENI OK byte regularly. If the nGENI fails to reset the nGENI OK to 1, the host can assume that a problem has occurred, and take appropriate action.

Specifying the Heartbeat Interval

To use the host heartbeat feature, first the host must specify a time interval by writing a value from 4 to 20 into the Heartbeat Multiplier byte located at 2749D/0ABDH in Shared RAM. The time interval is equal to the multiplier times 50mS, as shown in the table below.

Multiplier Value	x 50mS = Heartbeat Interval	Multiplier Value	x 50mS = Heartbeat Interval
4	200mS	13	650mS
5	250mS	14	700mS
6	300mS	15	750mS
7	350mS	16	800mS
8	400mS	17	850mS
9	450mS	18	900mS
10	500mS	19	950mS
11	550mS	20	1 second
12	600mS		

If the value provided is not between 4 and 20, the nGENI changes it; any value less than 4 is changed to 4 and any value greater than 20 is changed to 20.

Changing the Heartbeat Interval During Operation

The host can change the Heartbeat interval while the system is operating by following these steps:

1. Clear nGENI OK.
2. Wait for nGENI OK to be set to 1 by the nGENI.
3. *Within the old Heartbeat interval*, change the multiplier and clear nGENI OK.
4. Wait for nGENI OK to be set (at old interval).
5. Start using the new Heartbeat interval.

Enabling the Heartbeat

After specifying the Heartbeat Interval, the host must enable the heartbeat by placing the value 4745H into the Heartbeat Enable bytes located at 2747D/0ABBH in Shared RAM. 47H must be placed in 0ABBH, and 45H must be placed in 0ABCH:

0ABB	47H	46219
0ABC	45H	

Chapter 6

Interrupts

μGENI automatically flags the occurrence of:

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

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

Three areas of Shared RAM are used for interrupts: the Interrupt Status Table, the Disable Interrupt Table, and the Host Clear byte.

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

Host Clear Byte

The Host Clear byte begins at Shared RAM location 2634D/0A4AH. It is used by the nGENI to clear interrupts sent to the host by the nGENI. The host should not access this byte.

Example Variables

The following interrupt variables might be defined for a C language interface to μGENI. 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 /* μGENI 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. μ 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 μ 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.

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 μ GENI has placed an incoming memory access Datagram in the Request Queue.
08A4H	μ GENI Status Change Flag	Set if μ GENI Status Table byte 0894 indicates a μ 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 μ 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 μ GENI has completed a task previously commanded by the host in the Command Block.
08A8H	Receive Queue Not Empty Flag	Set if μ 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	

Clearing the Interrupt Table

The host must clear the appropriate Interrupt Table flag after servicing an interrupt condition, *even if the host interrupt is disabled* as described at right.

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 μ GENI Status Change Interrupt	Set this bit to prevent sending an interrupt or setting the Interrupt Summary Status bit if the μ 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 μ 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 μ 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 μ 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	

Chapter 7

Device Configuration

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

- Model number
- Output Disable flag
- Devicepresent/absent
- Status Table or Reference Address
- Input data length
- Output data length
- BlockI/Otype

μGENI 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. μGENI 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, μGENI 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, μGENI automatically sends it a Read ID message. If the device sends back a Read ID Reply message, μGENI stores the configuration data it contains in the Device Configuration Table buffer that corresponds to the new device’s Device Number.

Next, μGENI sets the Device Present flag 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, μGENI also sends an interrupt to the host.

If μGENI powers up with device outputs disabled, the host must reset its Output Disable flag to enable sending outputs to a device. If μGENI powers up with device outputs enabled, this flag is reset when a new device logs in. When this flag is reset, μGENI automatically directs an Assign Controller message to the device. This instructs the device to send fault reports and configuration change messages to the μGENI. μGENI 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. μ GENI receives the datagram and places it in the Receive Queue. If the Receive Queue Not Empty interrupt is enabled, μ 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 μ GENI.

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

Therefore, if both interrupts are enabled, μ 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 μ 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 Genius Bus Setup signal P6(7) to the μ 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, μ 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 μ GENI.

Device Present μ 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 μ 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, μ 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. μ 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, μ 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.

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, μ GENI will mark the device 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 μ 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

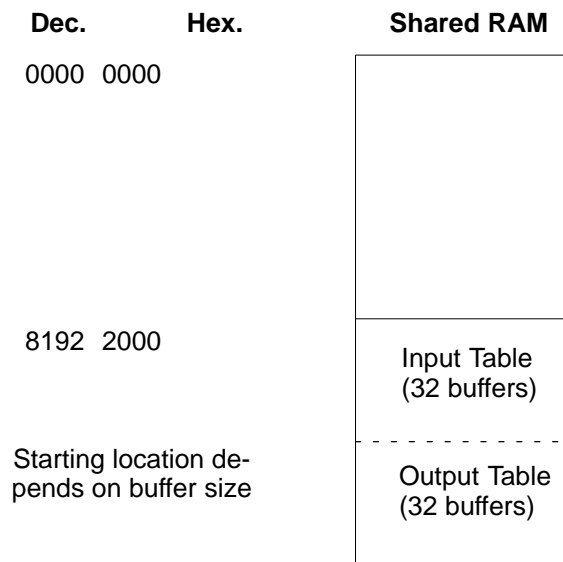
                                     7|6|5|4|3|2|1|0|
                                     |_|_|_|_|_|_|_|
                                     |_|_|_|_|_|_|_| block config
                                     |_|_|_|_|_|_|_| not used */
} DEV_CONFIG
```

Chapter 8

Device Inputs and Outputs

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.

46220



The Input Table contains inputs and incoming Global Data. μ 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. μ 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 μ GENI.

```
typedef
struct {
    unsigned char in_data[32][1-IO_BUFFER_LENGTH];
    unsigned char out_data[32][1-IO_BUFFER_LENGTH];
} IO_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 μ 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 μ GENI Setup Table, then sending μ GENI a Configuration Change command.

μ 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.

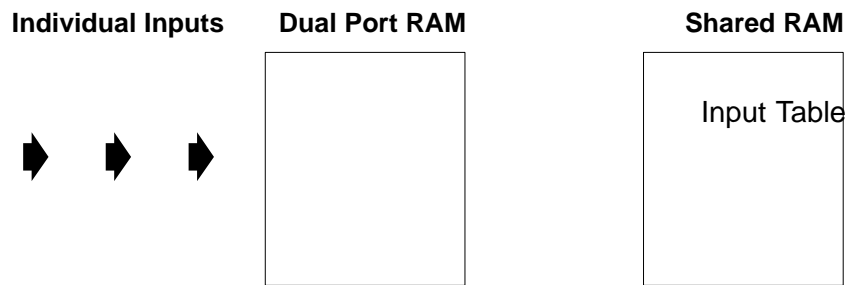
Device Type	Minimum Buffer Size (in bytes)
8-circuit Discrete I/O Block	1
16-circuit Discrete Block	2
32-circuit Discrete Block	4
4 Input/2 Output Analog Block	8
Analog Block with 6 Inputs (such as Thermocouple Block)	12
High-speed Counter Block	32
Power Monitor Module	38

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

Input Table

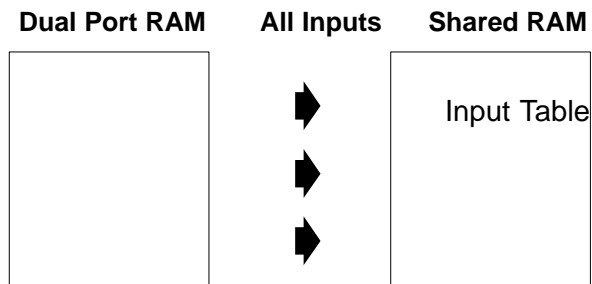
The Input Table is used for inputs from I/O blocks and incoming Global Data. During the bus scan, μ GENI receives inputs from devices on the bus and stores them in its Dual Port RAM.

46221



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

46222



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, μ GENI marks the device as Not Present. The input buffer is not cleared.

Location of a Device's Input Buffer

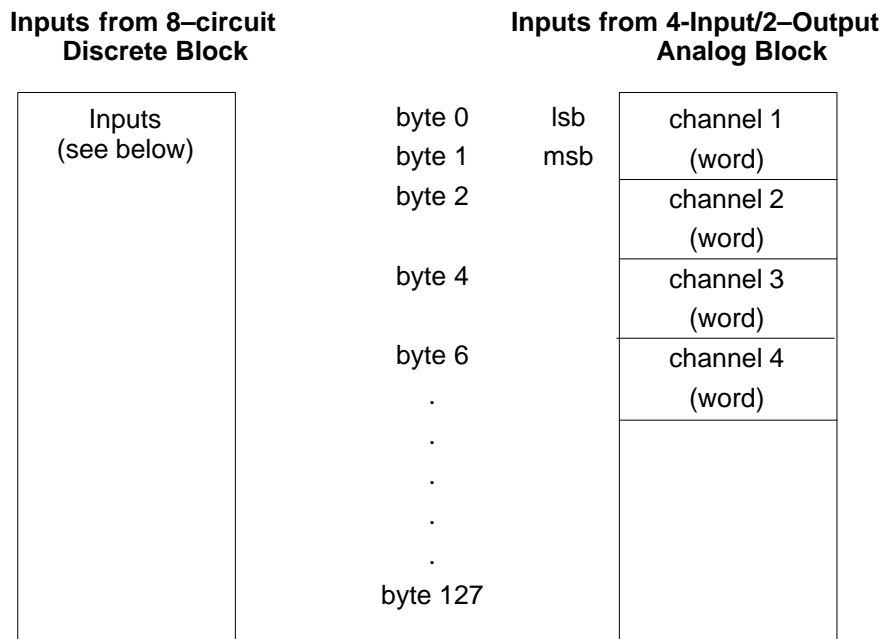
The Input Table location used by a device is equal to its Device Number multiplied by the selected I/O buffer length. For example, if the buffer length were 2, inputs from device 12 would begin at address 24 (2 x 12) of the input table. To find the start of the input data from each device, add this decimal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

Input Data Format

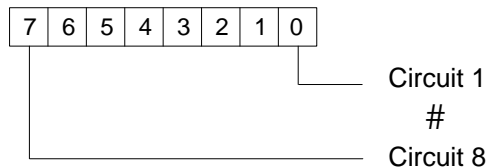
The format of the input data depends upon the type of device that sent the inputs. The host must interpret the data for each device properly. The host can determine device types from the Device Configuration Table. Inputs begin at the buffer starting address. If chosen buffer size is longer than the 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.

46223



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



46224

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.

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.

μGENI 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, μGENI 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 x 16).

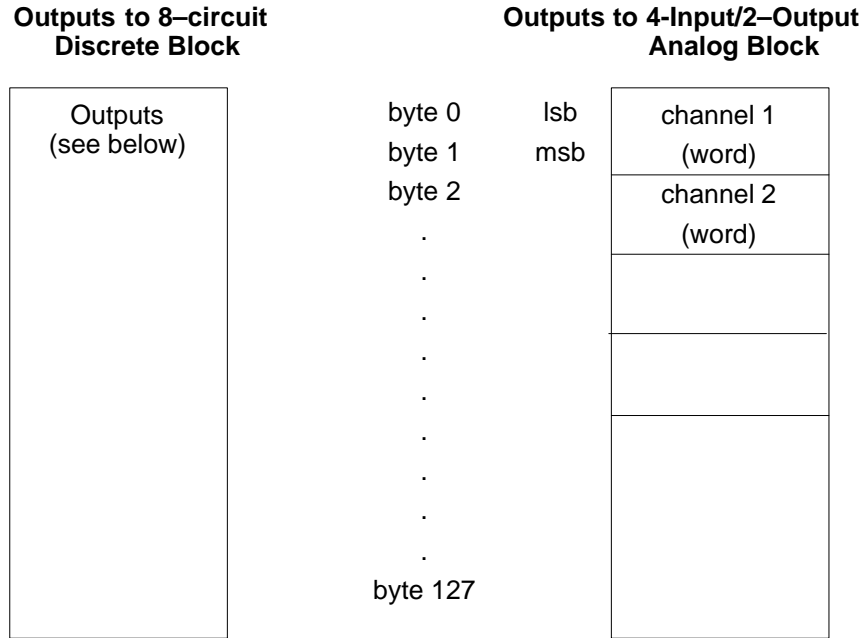
Location of a Device's Output Buffer

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 x 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.

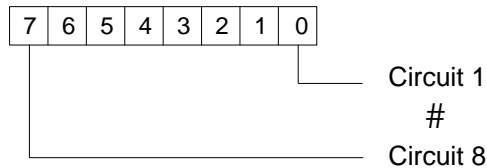
Output Data Format

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.

46225



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).



46224

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, µGENI will do nothing with the fresh output data.

Chapter 9

I/O Table Lockout

To prevent μ 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).

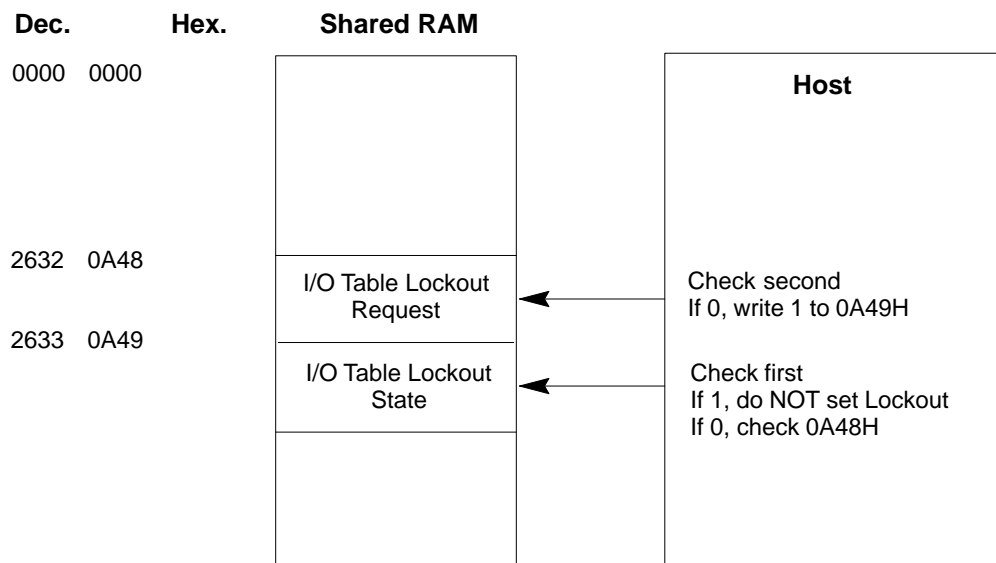
For a single-byte device such as an 8-circuit discrete I/O block, lockout may not be necessary. For devices with more than one byte of I/O data, lockout assures data coherency.

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).

46226



μ GENI automatically reads the state of the Lockout Request byte. μ 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, μ GENI will set or clear the Lockout State byte to match the content of the Lockout Request byte.

After setting the Lockout State byte, μ GENI sets the I/O Table Lockout Grant interrupt. If this interrupt is not disabled, μ 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. μ GENI monitors this byte; when it is reset, μ GENI clears the Lockout Status byte. μ 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 μ 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);

```

Chapter 10

Commands

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

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

Command Block

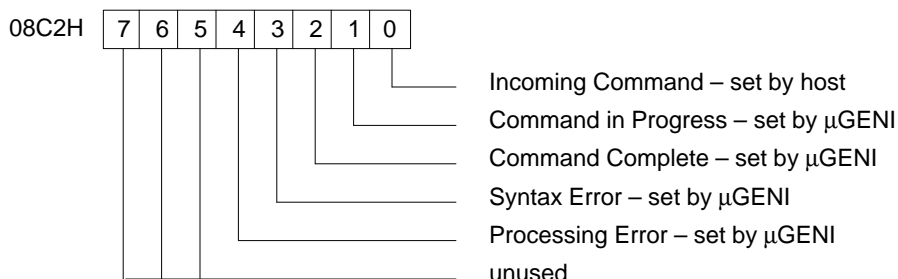
The Command Block begins at location 2242D/08C2H. Its format is shown below.

Location	Content	Description
08C2H	Status Byte	This byte indicates the status of the requested command. It may be: <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> 1 ReadDatagram (incoming). 2 Transmit Datagram (without reply). 3 Transmit Datagram with Reply 4 ConfigurationChange
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.

46227



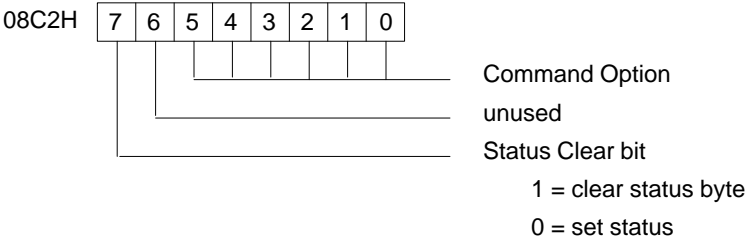
The content of the status byte may be:

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	μ 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	μ GENI sets the status to 4 after successfully completing a command.
08	Syntax Error	μ 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	μ 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.

Command Byte Format

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

46228



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 μ GENI acknowledges the command when it is received. If bit 8 is set to 0, μ 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, μ 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 μ 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 μ 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 μ 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  $\mu$ GENI Setup Table
        Send Command Block to  $\mu$ GENI
    Complete command /* see below */
```

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 */
      μGENI error /*Contact Technical Support.*/
  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 */
      μGENI error /*Contact Technical Support*/
  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 */

```

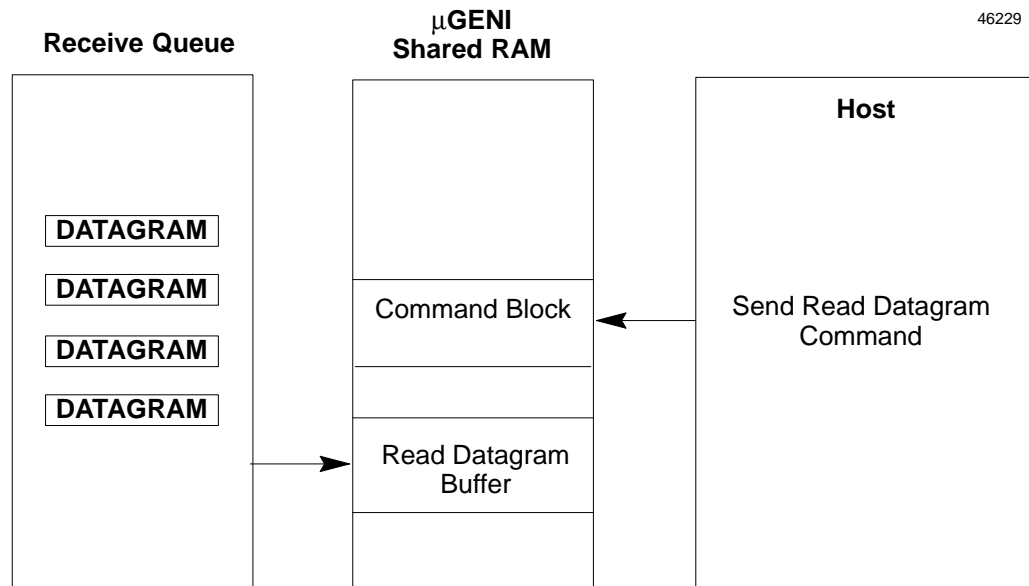
Read Datagram Command

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

When μ 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, μ 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 μ GENI a Read Datagram command. When μ 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 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, μ GENI would clear the status byte and not execute the command).
2. Set bit 1 of the Command Block status byte (08C2H) to 1 to indicate a command from the host.

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

Status Definitions

Status	Meaning	Description
02	In Progress	Processing not yet complete.
04	CommandComplete	Command completed properly; there is valid data in the Command Block and possibly in the Read Datagrambuffer.
08	SyntaxError	The Receive Queue is empty. No new data has been placed in the Command Block or the Read Datagrambuffer.
10	ProcessError	This status should not occur with a Read Datagramcommand.

Example Variables

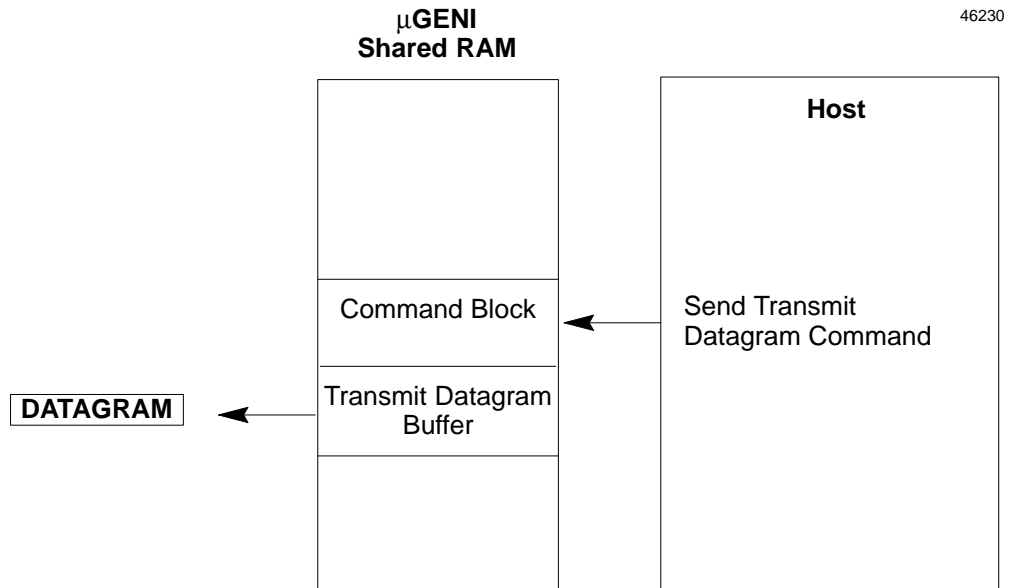
The following Read Datagram variables could be defined for a C language interface to μ GENI.

```
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 (0) */
    unsigned char Length;         /* length of message */
} READ_DATAGRAM
```

Transmit Datagram Command

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

When μ 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.

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 μ 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 μ 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	CommandType (02 = TransmitDatagram)
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 μ GENI.
4. If the message was broadcast, rather than directed, it will be received back by μ 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.

μ 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, μ 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), μ GENI sets the status to 4. It also sets the Command Complete interrupt (08A7H). If the interrupt is enabled, μ GENI sends an interrupt to the host.

Status Definitions Command Status

Status	Meaning	Description
02	In Progress	Processing not yet complete.
04	CommandComplete	Command completed properly.
08	SyntaxError	Something in the Command Block is not specified correctly.
		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.
10	ProcessError	the datagram was not properly acknowledged from the destination device. Occasionally this status indicates that μ 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 μ 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
```


Transmit Datagram with Reply Command

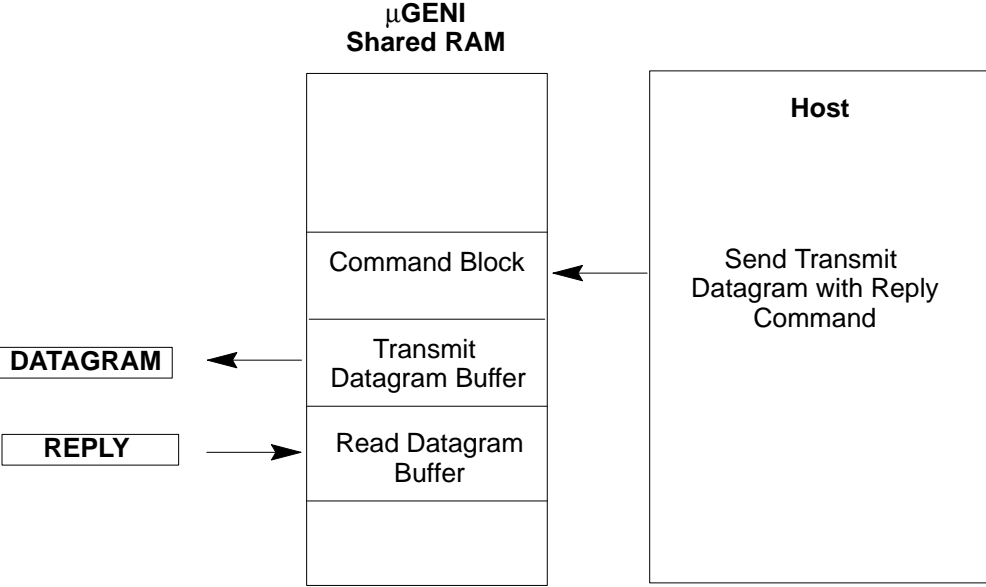
To instruct μ GENI to send a datagram which the host has placed in Shared RAM, and to receive a Reply datagram, use the Transmit Datagram with Reply command.

When μ 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, μ 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.

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

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

Status Definitions

Status	Meaning	Description
02	In Progress	Processing not yet complete.
04	Command Complete	μGENI 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 μGENI 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 μGENI.

```
typedef
struct {
    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 μ GENI to accept new configuration parameters the host has placed in the μ 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 μ 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 μ GENI bus controller. The μ 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 <i>Bus Controller User's Manual</i> 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 μ 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 μ GENI, the host should follow these steps:

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

Location	Description
0882H5	μ GENI board Genius Bus Setup 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

Complete the Command Block as follows:

Location	Description
08C2H	Status. This should be set to 1 to indicate a command from the host to μ 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, μ 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, μ GENI logs off the bus, but it does NOT stop its transmissions. During this type of change, μ 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	μ GENI has accepted the configuration changes in the μ 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, μ GENI places its current configuration data in the μ 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. μ GENI does not log out devices on the bus or drop off the bus.

Chapter 11

Global Data

Global Data is used to automatically broadcast up to 128 bytes of data from one host to all others on the bus. μ GENI sends Global Data from the Broadcast Control Data area of Shared RAM. If any other device on the bus sends Global Data, μ 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 μ GENI bus controller with Device Number 30 broadcasts 128 bytes of Global Data to μ GENI bus controllers with Device Numbers 29 and 31.

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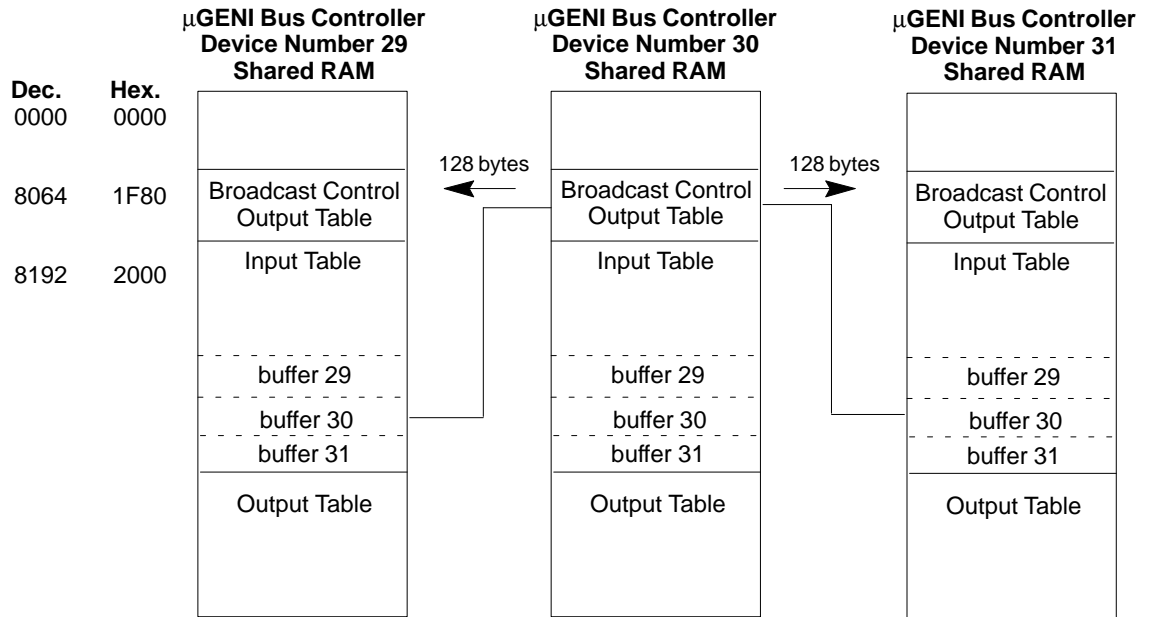


Table Lockout

μ 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, μ GENI will re-broadcast the previous scan's Global Data. When lockout is relinquished, new Global Data will be sent.

Sending Global Data

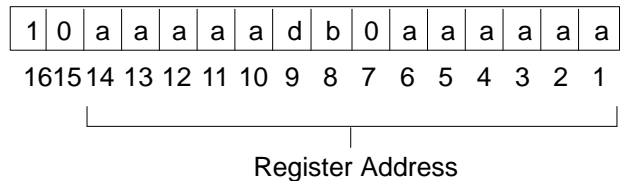
To broadcast Global Data, the host must regularly place that data in μ GENI's Broadcast Control Output Table, which occupies 128 bytes of Shared RAM beginning at location 8064D/1F80H. If the data should be sent to only one device, use Directed Control Data instead, as explained in the next chapter.

Specifying Global Data Length

Global Data length is specified by the μ GENI Setup Table selection for Broadcast Control Data (BCD) length. When the μ 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 μ GENI Setup Table. Then, the host sends μ GENI a Change Configuration command. When μ 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 μ 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 can also be specified in the μ GENI Setup Table. At initial powerup of the μ GENI, the Reference Address is set to 0FFFF (hex). 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.



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Receiving Global Data

Each bus scan, μ 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 10 μ S for each byte of Global Data transmitted on the bus. Bus scan time increases by approximately 72 μ S for each byte of Global Data transmitted.*

Chapter 12

Directed Control Data

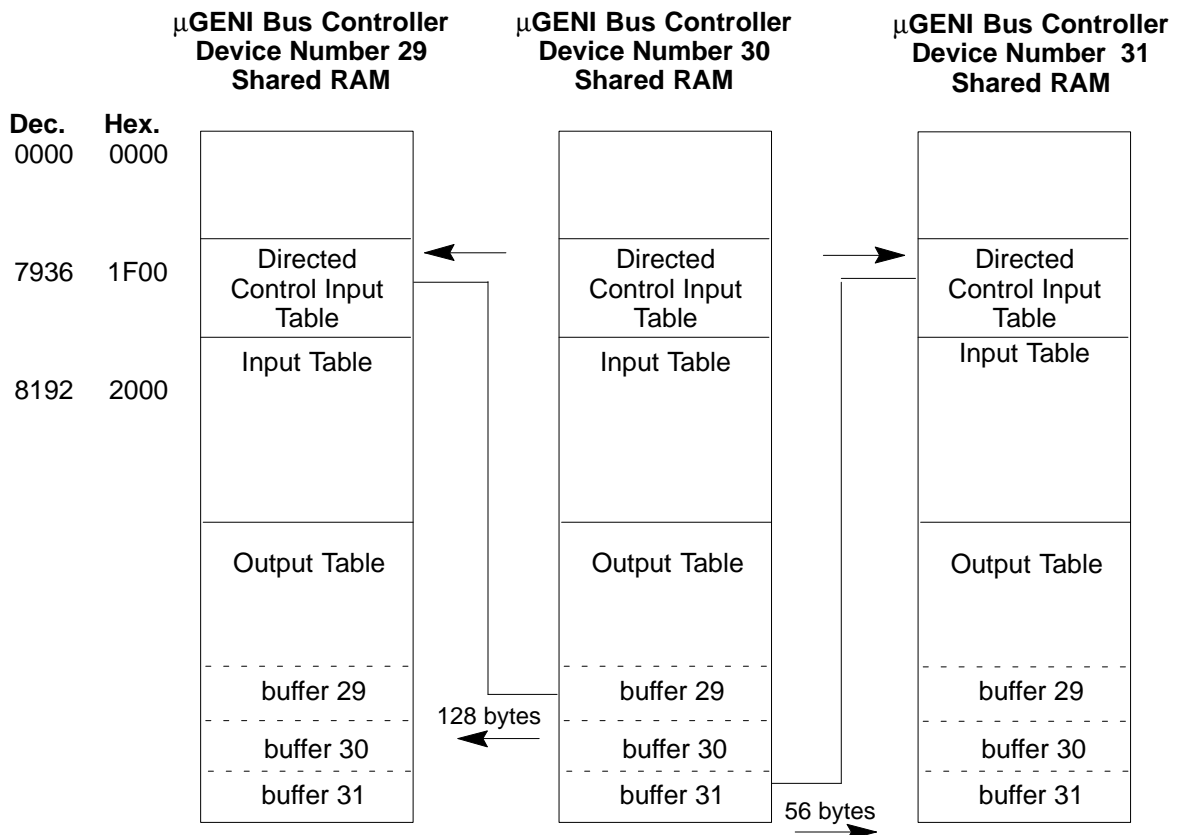
Receiving Directed Control Data is a unique feature of μ GENI and the larger GENI board. It is not available with other Genius I/O bus controllers. Like Global Data, Directed Control Data can be used to send up to 128 bytes to any device on the bus. Directed Control Data is automatically sent each bus 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.

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

Example:

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

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Sending Directed Control Data

The host can direct up to 128 bytes of data to another μ 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 μ GENI's Device Number.

The host must check the amount of data it can send to the other μ 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 μ GENI to which the data will be directed.

Receiving Directed Control Data

Each bus scan, μ 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 μ GENI Setup Table selection for DCD length. When μ 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 μ GENI reads this length, and sends it the amount of data specified.

At initial powerup of the μ 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 μ GENI Setup Table. Then, the host sends μ GENI a Change Configuration command, as explained in chapter 7.

When μ 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 μ 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

μGENI cannot receive Directed Control Inputs or direct outputs to another μGENI 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, μGENI will re-direct the previous scan's outputs. When lockout is relinquished, new data from the output table will be sent.

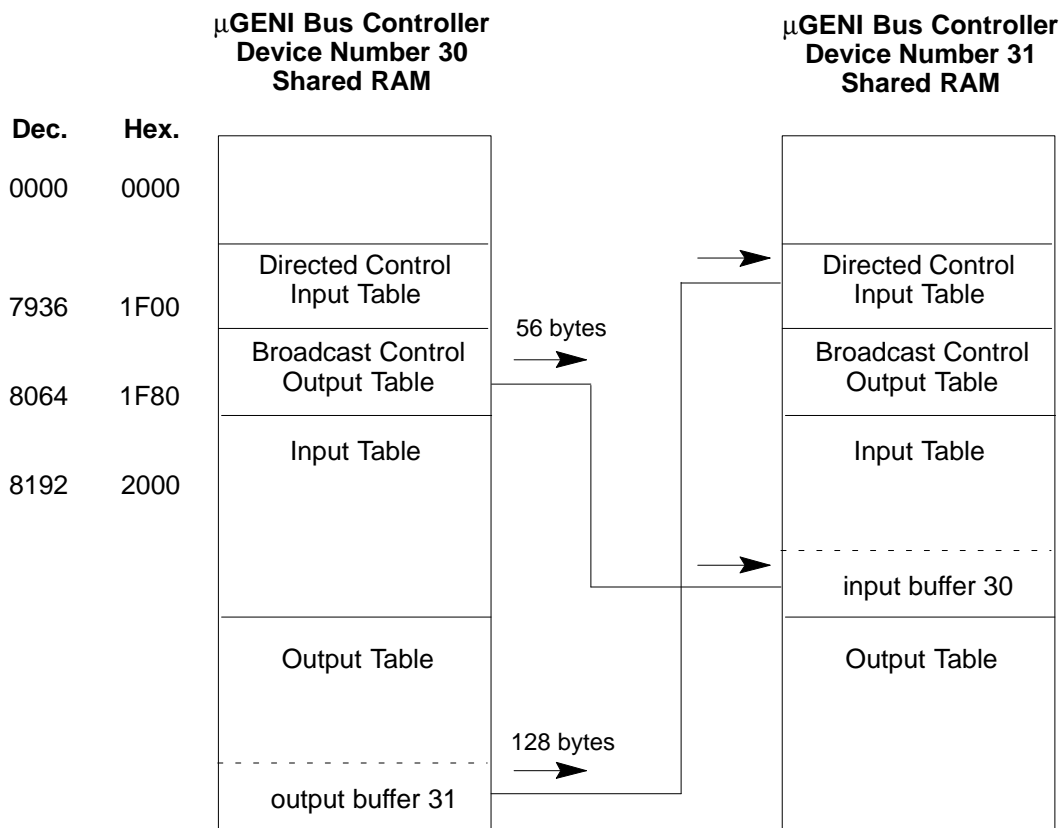
Using Global Data and Directed Control Data

Directed Control Data and Global Data are completely independent capabilities. μGENI can send up to 128 bytes of Directed Control Data to each μGENI 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 μGENI bus controller with Device Number 30 sends 128 bytes of Directed Control Data to the μGENI bus controller with Device Number 31, and broadcasts 56 bytes of Global Data to all devices on the bus.

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Chapter 13

Memory Access Datagrams

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

Read Device	The Read Device datagram is used to read up to 128 bytes of data from host memory.
Write Device	The Write Device datagram is used to write up to 128 bytes of data to a specified location in host memory.
Write Point	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 send a Transmit Datagram or Transmit Datagram with Reply command to μ GENI. Chapter 10 explains how to do that using the Command Block area of Shared RAM.

Receiving Memory Access Datagrams

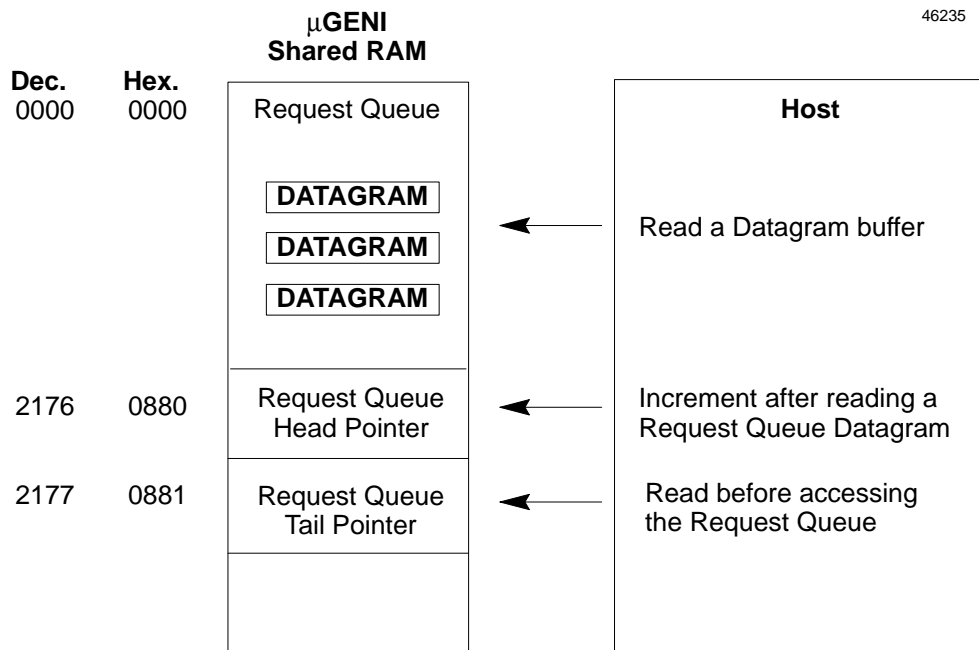
When μ GENI receives a memory-access datagram, it places the datagram into the Request Queue area of Shared RAM. The Request Queue can accommodate up to 15 datagrams at a time. The Request Queue can be directly accessed by the host. Other types of datagrams, which do not require access to host memory, are NOT placed in the Request Queue. Instead, they are placed in μ 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 54).

Request Queue	The Request Queue begins at location 0000D/0000H. It consists of 16 buffers containing header information and data.
Auxiliary Request Queue	The Auxiliary Request Queue begins at 2699D/0A8BH. It consists of 16 buffers that correspond to the buffers in the Request Queue, providing additional header information.
Request Queue Head Pointer	The Request Queue Head Pointer occupies byte 2176D/0880H. 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. This byte indicates 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

The Request Queue is divided into 16 fixed-length buffers (but can only accommodate 15 datagrams at one time). The buffers are numbered from 0 to 15. They are used in a circular fashion.

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

```

The host writes, and μ GENI reads, the head pointer. μ GENI writes, and the host reads, the tail pointer. When these two pointers are the same, the queue is empty. The μ 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 μ 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, μ GENI takes no action except to free up that buffer in the Request Queue.

If the host reports that it is currently busy, μ 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. μ 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.”

μ 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; μ 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 Buffers and Auxiliary Request Queue Buffers

The information for each datagram is contained in two buffers: a Request Queue buffer and a corresponding Auxiliary Request Queue buffer.

Request Queue Buffer Format

The Request Queue is divided into 16 fixed-length buffers numbered from 0 to 15. A typical Request Queue buffer may have the following format:

Command	byte + 0
Status	byte + 1
Reserved	byte + 2
Header byte 1	byte + 3
Header byte 2	byte + 4
Header byte 3	byte + 5
Header byte 4	byte + 6
Header byte 6	byte + 7
Data characters (128 bytes maximum)	byte + 8 to byte + 135

Auxiliary Request Queue Buffer Format

The Auxiliary Request Queue is also divided into 16 fixed-length buffers, numbered from 0 to 15, which directly correspond to the buffers in the Request Queue. Each provides the following information about the contents of the associated Request Queue buffer.

Data length	byte + 0
Header byte 5	byte + 1
Broadcast (0) or Directed (1)	byte + 2

Header Bytes and Data Length

The exact content of the Request Queue buffer and Auxiliary Request Queue buffer depends on the application. For example, header information for datagrams received from a Series 90-70 PLC is different from header information for datagrams received from a Series Six PLC. For information about Datagram formats, see the *Genius I/O System User's Manual* and the individual *Bus Controller User's Manual* for each PLC type.

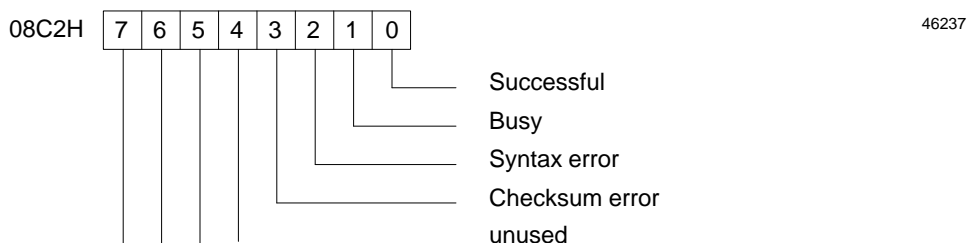
Normally, header bytes 1–6 (see the illustrations above) contain a memory address. Notice that header bytes 1–4 and 6 are located in the Request Queue buffer, while header byte 5 is located in the Auxiliary Request Queue.

Following the header bytes, each buffer accommodates up to 128 bytes of data.

If another device sends a datagram having more than 6 header bytes, the additional header information is still present, but is located in the area of the Request Queue buffer shown as “Data characters” above.

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 Variables for Request Queue Operations

The following Request Queue status variables might be defined for a C language interface to μ 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 */
```

The following Request Queue variables might be defined.

```
typedef
struct {
    unsigned char    command;
    unsigned char    status;
    unsigned char    reserved;
    unsigned char    map[5];
    unsigned char    data[128];
} REQUEST_Q
```

The following Auxiliary Request Queue variables might be defined.

```
typedef
struct {
    unsigned char    length; /* actual message data length */
    unsigned char    map; /* byte 4 of the source address */
    unsigned char    DB_indicator; /* flag for directed or broadcast */
} AUX_Q
```

Chapter 14

Troubleshooting

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 μ GENI board is such that few hardware failures will occur with μ 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 μ 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 μ 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. For version IC660ELB912G and later μ GENI boards, the watchdog timer can be reset using /RST. Version IC660ELB912F and earlier μ GENI boards must be power-cycled to clear the watchdog timer.
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 Genius Bus Setup signals are driven correctly. If incorrect, BOARD OK LED will not come on. If correct, assume a hardware failure; replace the μ 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 the serial bus is wired in a daisy-chain manner. Look for broken cable.
Both LEDs are off	Verify that the μ 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 μ 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 μ GENI up and running	Serial 1/Serial 2 are crossed.

The following macro definitions should be used for a C language interface to μ 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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