ELE2EMI:
ELECTRONICS MEASUREMENTS & INSTRUMENTATION

16 General Purpose Interface Bus

References

- Carr, chapter 25, pages 571 to 578.
- Howard M. Berlin and Frank C. Getz, Principles of Electronic Instrumentation, Macmillan publishing company, 1988, chapter 16, pages 441 to 444.

Outline

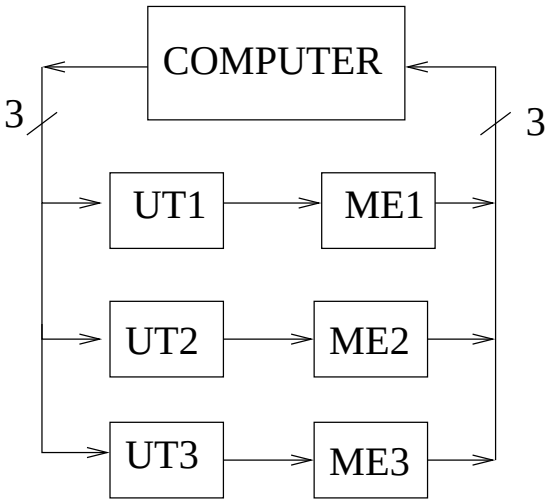
1. Automatic Test Equipment.
2. IEEE-488.
3. Examples.
4. Normal Data Transfer: Timing Diagram.
5. GPIB Bus.
6. Command and Addressing Codes.
7. Signal Lines.

16.1 Background to GPIB

Automatic Test Equipment (ATE) is used for testing other electronic equipment in:

1. Factory production.
2. Troubleshooting.

Figure 1: Automatic test equipment may utilise a computer as a controller. Here UT stands for the equipment Under Test, and ME for the Measuring Equipment.



Advantages of ATE over manual testing:

1. Multiple measurements simultaneously.
2. Repeatable results (because operator skill and fatique have less effect).
3. Automatic error correction.
4. Greater throughput (faster, so can test more circuits in a given time).
5. More complete testing (test more parameters, because faster).
6. Better test records (automatically stored, and easily retrieved for analysis).

History of GPIB:

1965: Hewlett-Packard Interface Bus (HPIB).

1975: First public specification of General Purpose Interface Bus (GPIB).

1987: IEEE Standard Digital Interface for Programmable Instrumentation (IEEE-488.1 and IEEE-488.2).

1990: Standard Commands for Programmable Instruments (SCPI), published by SCPI Consortium of instrument manufacturers.

1992: Renewal of IEEE-488.2.

2003: Renewal of IEEE-488.1.

2004: Reaffirmation of of IEEE-488.2.

16.2 The IEEE-488 and GPIB Standards for Computer-Instrument Interfaces

IEEE-488 specifies a standard interface between a computer and instruments:

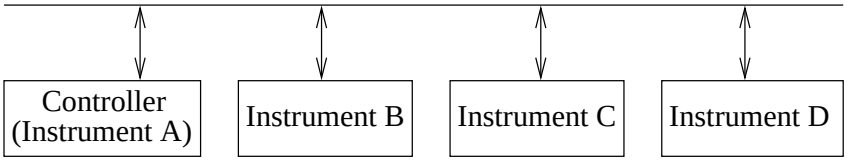
1. Bus (GPIB).
2. Instructions.

The **GPIB standard** specifies:

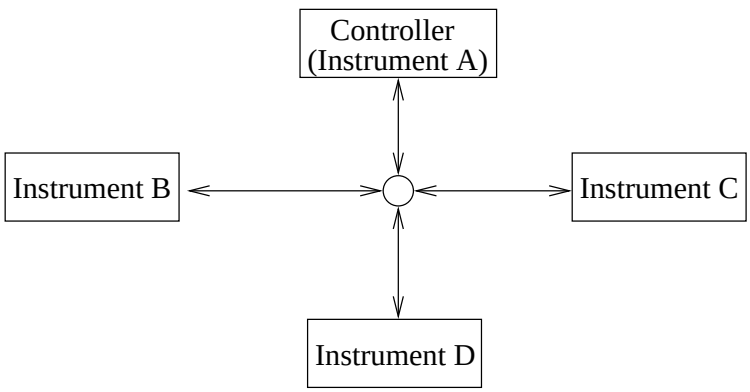
1. GPIB-Compatible test instruments have:
   (a) a GPIB input/output socket (or *port*) on their rear panel. This is a 24-pin female Amphenol blueline connector.
   (b) a 5-bit GPIB Address DIP switch, usually located near the GPIB port.
2. GPIB logic levels are the same as those for TTL device inputs:
   (a) Low ($\leq$ 0.800 V).
   (b) High ($\geq$ 2.0 V).
3. Cable connecting the instruments (and any computer):
   (a) Standard passive multiconductor cable.
   (b) Total length at most 20 metres.
   (c) Instrument loads every 2 m.
   (d) Up to 15 devices in parallel (including the computer, if present).
   (e) Any two devices can communicate with each other.
4. GPIB configurations (a.k.a. topologies):
   (a) Linear (= bus).
   (b) Star.

Figure 2: GPIB bus configurations.

Linear:



Star:



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5. GPIB data rate:

   (a) Unrestricted rate: up to 250 kB/s (kilobytes/second).

   (b) Restricted rate: over 250 kB/s.

6. Classes of device on GPIB:

   (a) Talker (transmits), e.g. signal generator.

   (b) Listener (receives), e.g. frequency counter.

   (c) Talker/Listener (transmits and receives), e.g. digital multimeter.

   (d) Controller (transmits and receives), e.g. a computer with a GPIB interface.

16.3 Examples of GPIB Systems

1. A minimal system consists of one talker and one listener, with no controller, e.g. an instrument sending data to a printer.

2. The controller, if present:

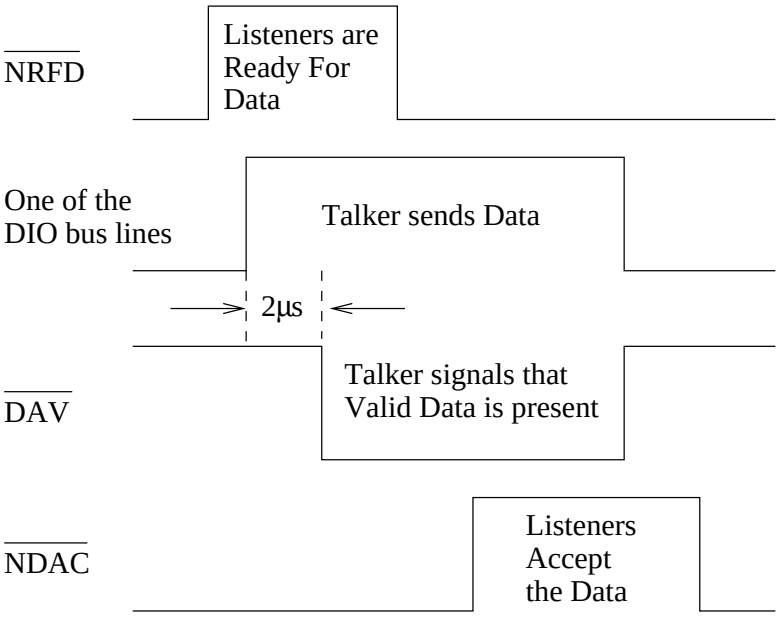
   (a) designates which devices send, and which devices receiver;

   (b) commands actions within devices;

   (c) is usually a computer, or possibly a programmable calculator.ELE2EMI:ELECTRONICS MEASUREMENTS& INSTRUMENTATION

16.4 GPIB Data Transfer

Figure 3: Timing diagram for normal data transfer in the GPIB.



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16.5 GPIB Bus

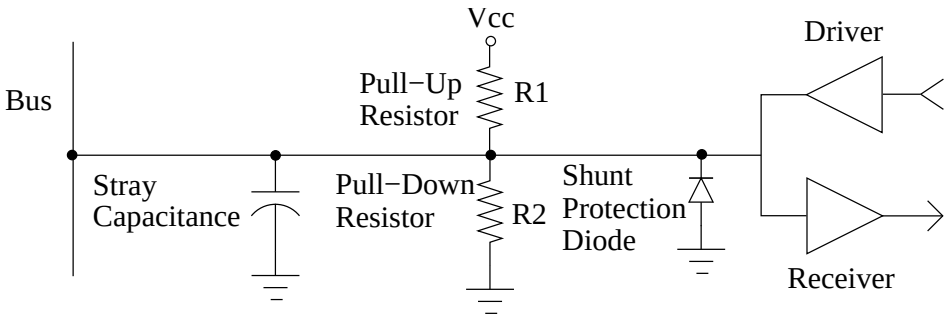
The GPIB bus consists of three constituent buses:

1. the 8-bit Data Input/Output (DIO) bus, which carries addresses , program data, measurement data, universal commands, and status bytes;
2. the 3-bit Data Byte Transfer (DBT) control bus;
3. the 5-bit General Interface Management (GIM) bus.

The three constituent buses in the gPIB have the same design of input/output circuit:

- Resistors R1 and R2 determine a standardised input impedance.
- The driver is tristate: when the driver is off, its output has a very high impedance so it won't affect the bus.
- The receiver is a non-inverting buffer with a high-impedance input.
- The driver and receiver have these properties to provide low current loading to the bus.

Figure 4: Design of each input/output circuit in the GPIB



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16.6 GPIB Command and Addressing Codes

Table 1: GPIB codes (in decimal). Unlisted codes are not used.

Type of Command	Code	Command Name or Address Number
Addressed Commands	1	GTL
	4	SDC
	5	PPC
	8	GET
	9	TCT
Universal Commands	17	LLO
	20	DCL
	21	PPU
	24	SPE
	25	SPD
Listen Addresses	32-62	0-30
	3	UNL
Talk Addresses	64-94	0-30
	95	UNT
Secondary Addresses or Commands	96-126	0-30

16.7 GPIB Signal Lines

Table 2: Signal lines on the GPIB.

Bus	Pins	Signal Lines	Name	Sent by	Note
DIO	1-4	DIO 1-4	DATA IN byte	Any device	
GIM	5	EOI	End or Identify	One talker or the controller	Talker's end of multibyte message; or controller's polling line (used with ATN signal).
DBT	6	DAV	Data Valid	One talker	E.g. measurement completed.
DBT	7	NRFD	Not Ready for Data	All listeners	Wired-AND to all listeners.
DBT	8	NDAC	Not Data Accepted	All listeners	Means data not yet received: wired-AND to all listeners.
GIM	9	IFC	Interface Clear	Controller	Makes devices on bus quiescent or standby, e.g. if an error occurs.
GIM	10	SRQ	Service Request	Any device	Data to send or receive.
GIM	11	ATN	Attention	Controller	ATN High $\Longrightarrow$ data is an address or command. ATN Low $\Longrightarrow$ data is for the addressed devices only.
None	12	Shield			
DIO	13-16	DIO 5-8	DATA IN byte	Any device	
GIM	17	REN	Remote Enable	Controller	Program a device via bus.
None	18-23	Ground			
None	24	Logic Ground			

END.