INTRODUCTION TO IEEE-488

Hewlett-Packard originally developed the interfacing technique for computer controlled measurement systems in 1960's. It was called HP-IB (Hewlett-Packard interface bus).

HP-IB quicly became very popular, thus IEEE (Institute of Electrical and Electronics Engineers) made a standard of it and renamed it GP-IB (General Purpose Interface Bus).
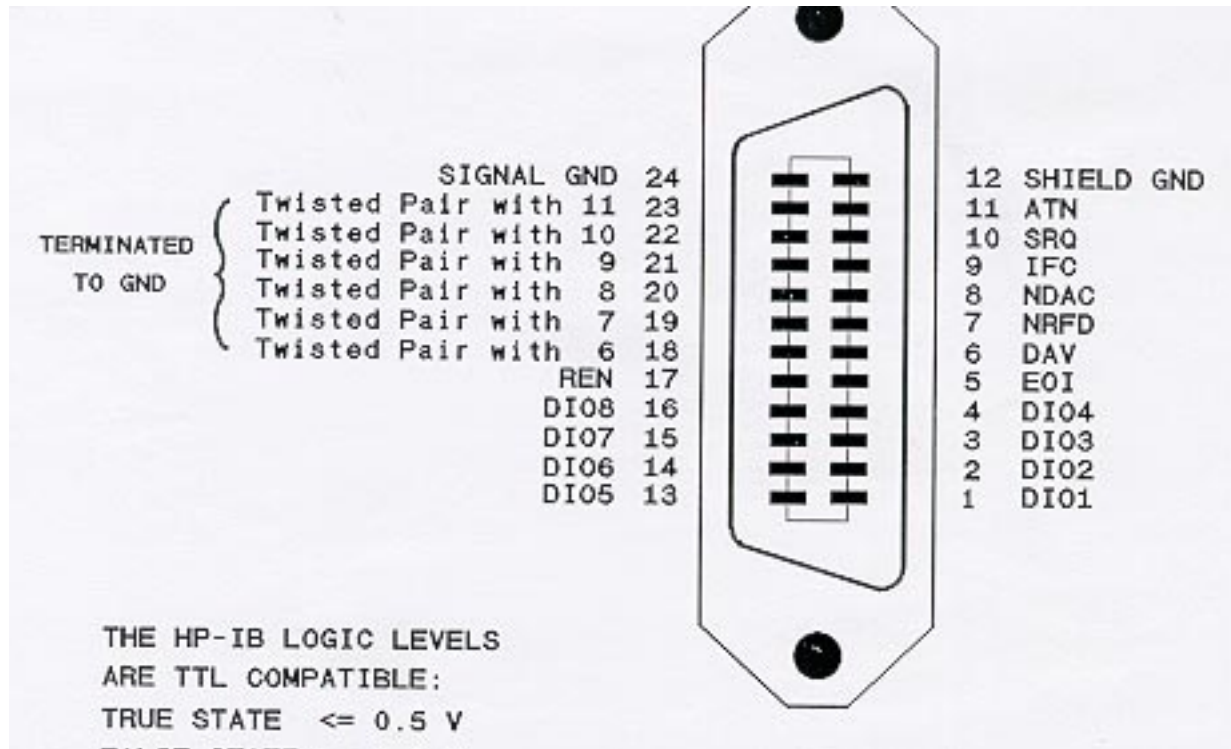
IEEE-488 was first established in 1978. Later on, during 1980, a new layer was added to IEEE-488 standard and the old standard was renamed IEEE-488.1 and the new one IEEE-488.2. In modern professional measurement devices equipped with the IEEE-488.2 interface.

IEEE-488.2 provides minimum set requirements for controller and device capabilities (talker, listener, controller). Also, data coding and format, message and communication protocol structures between controller and device are defined more specifically compared to IEEE-488.1.

Properties of IEEE-488:
- 1 Mbyte/sec maximum data transfer rate
- up to 15 devices parallel can be connected to one bus
- total bus length 20 m max. (distance between devices up to 2 m max.)
- messages are sent one byte (8 bits) at time
- message transactions are hardware handshaked

IEEE-488 CONNECTOR

```
                    SIGNAL GND  24          12  SHIELD GND
           Twisted Pair with 11 23          11  ATN
           Twisted Pair with 10 22          10  SRQ
TERMINATED Twisted Pair with  9 21           9  IFC
  TO GND   Twisted Pair with  8 20           8  NDAC
           Twisted Pair with  7 19           7  NRFD
           Twisted Pair with  6 18           6  DAV
                         REN  17             5  EOI
                        DIO8  16             4  DIO4
                        DIO7  15             3  DIO3
                        DIO6  14             2  DIO2
                        DIO5  13             1  DIO1


THE HP-IB LOGIC LEVELS
ARE TTL COMPATIBLE:
TRUE STATE  <= 0.5 V
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The 24 bus lines are divided to four categories:
- data and commands lines (DIO1-DIO8)
- handshake lines (DAV, NDAC, NRFD)
- bus management lines (ATN, IFC, REN, SQR, EOI)
- ground lines used for shielding and signal returns (See, figure)

GP - IB cable
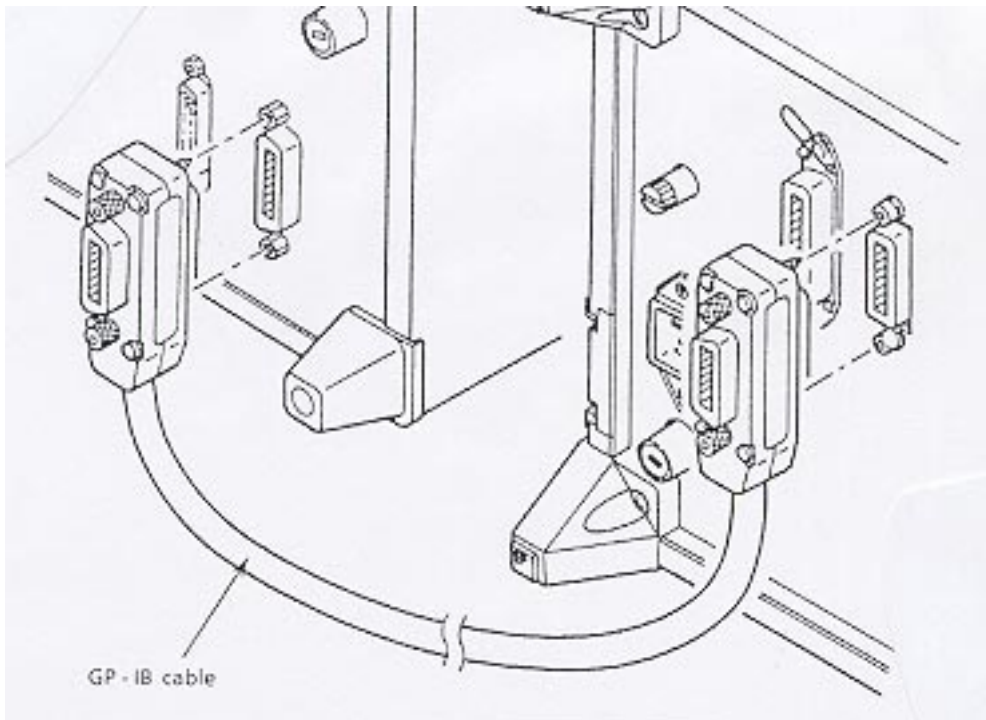
Devices can be connected in a star or consecutively to each other. In practice, ONLY THREE CONNECTORS CAN BE CONNECTED ON THE TOP OF ANOTHER.


female

male
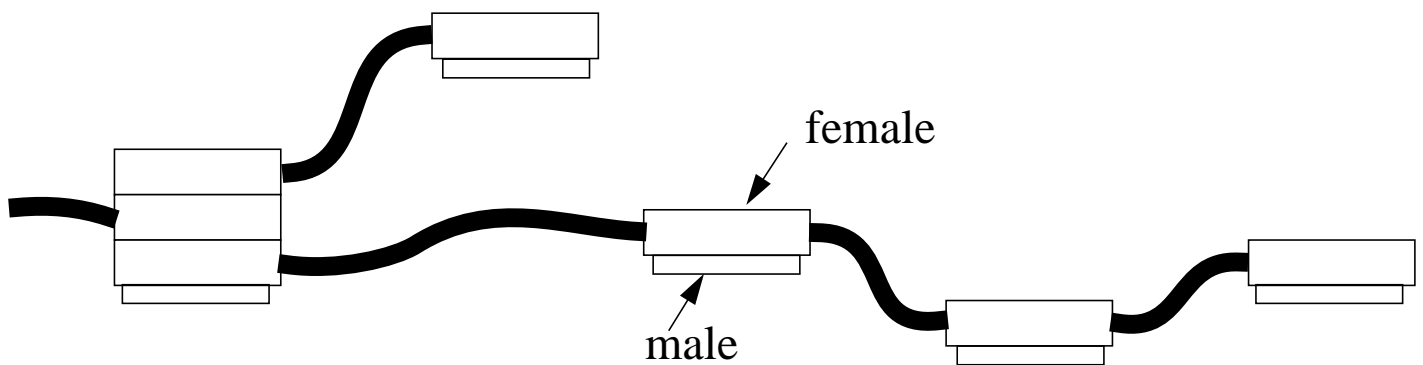
In a star   Consecutively connected

The max. transfer rate 1 Mbyte/sec can be reached only when the total length of the bus cable is no more than 15 m with the average interdevice cable 1 m or less! The maximum data transfer rate, of course, depends on the used controller/controller card, too.

Peripheral devices have female connectors and the connecting bus cable has, usually, male and female connectors wired in parallel in the both ends.

OVERVIEW OF MEASUREMENT SYSTEM

A conventional computer controlled measurement system consists of different kind of measurement devices (peripherals) equiped with IEEE-488 interface and PC or workstation (controller) equiped with a controller card.
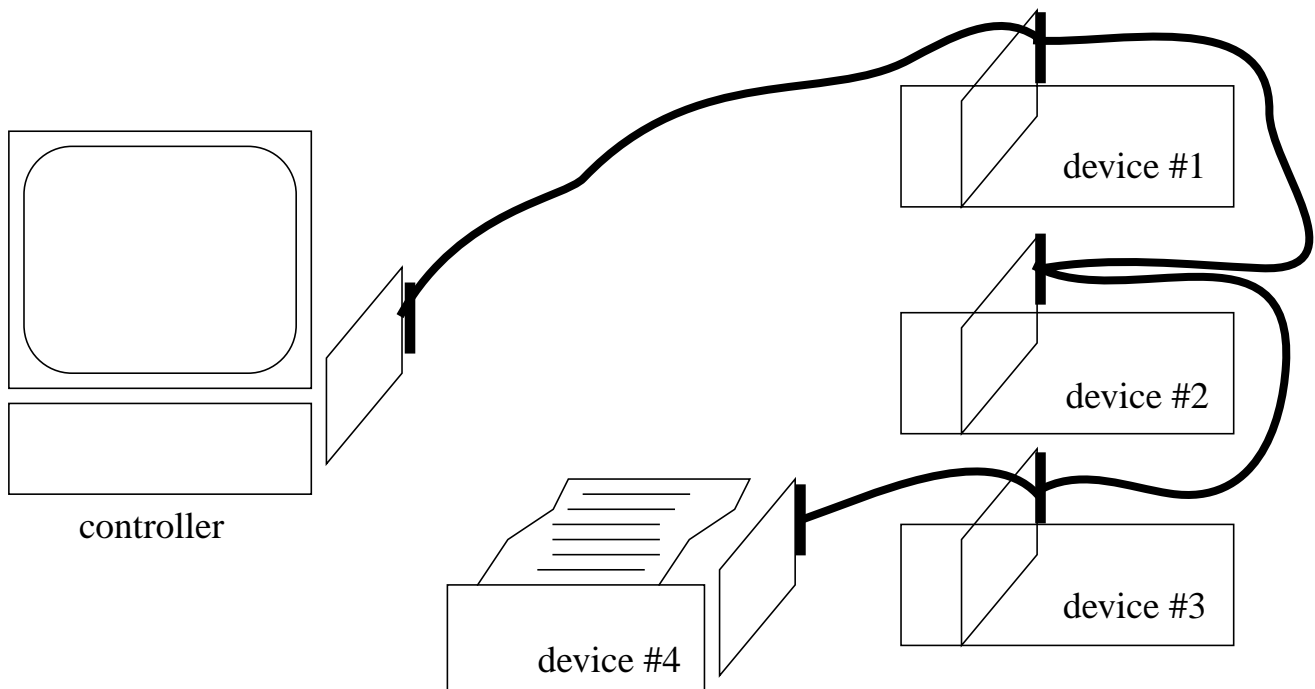
Usually, PC or workstation acts as a system controller with a IEEE-488 controller card installed in.

IEEE-488 controller card are available for IBM compatible PC's and UNIX-workstations, as well as for PS/2 and Macintosh machines. Also, IEEE-488 controllers supports SCSI-interface. So called protocol converters can be used in connection with SCSI (portable PC's).

It is possible to install several controller cards into one PC. Of course, then each card must have own I/O address (I/O mapped cards) or own select code (memory mapped I/O cards).

Up to 14 peripherals + system controller can be interconnected parallel on a communication link to a single IEEE-488 interface

Addressing
Each peripheral must has its own IEEE-488 interface with an unique address.

The address can be any value between 0 ... 30. However, when using a HP-IB interface, the address 30 has been reserved for the HP-IB Command Library.

A address for each device can be set by using a dip-switchs or using configuring menu of the device.

In addition to address range 0 ... 30, extended addressing can be used. The extended addressing (secondary addresses) are needed when it is desired to address subinstruments embended inside complex measurement equipment (for instance, VXI system with multiple I/O cards).

730

70210

702

controller

device with multiple cards
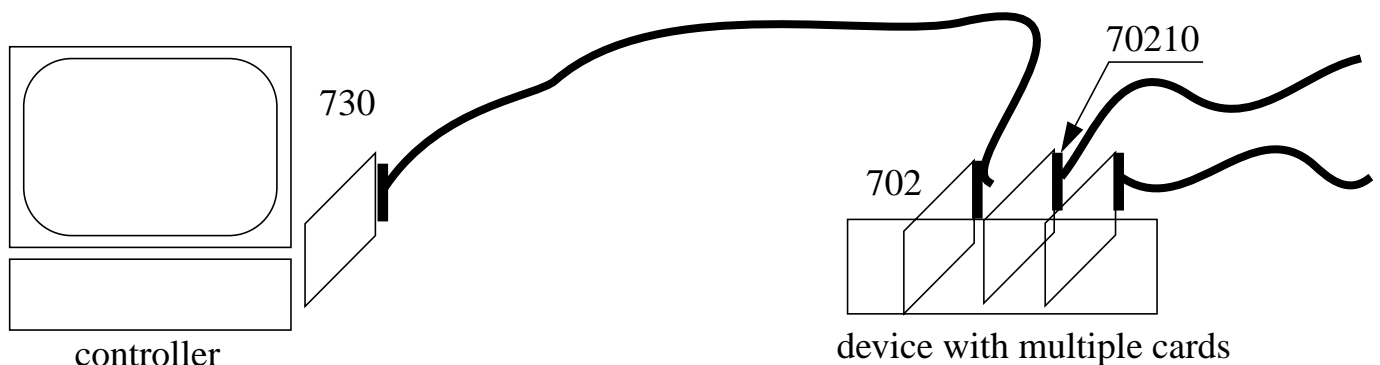
CONTROLLERS - TALKERS - LISTENERS

CONTROLLER
* System controller
* Active controller

System controller is capable of taking control of the interface at any time (IFC = interface clear, REN = remote enable). Only one device can be the system controller.

One or more devices can act as an active controller, but only one may be active controller at any given time. The active controller has the ability to perform tasks such as <u>establishing listeners and talkers, sending bus commands, and performing serial polls.</u>

The system controller always has ultimate control of the bus. Altought, it passes control to another device (this device is now the active controller), it still has exclusive control over IFC and REN. The system controller can take controll of the bus when ever it desires.

TALKER
Only one talker at any given time. A device becomes addressed as talker by the active controller.
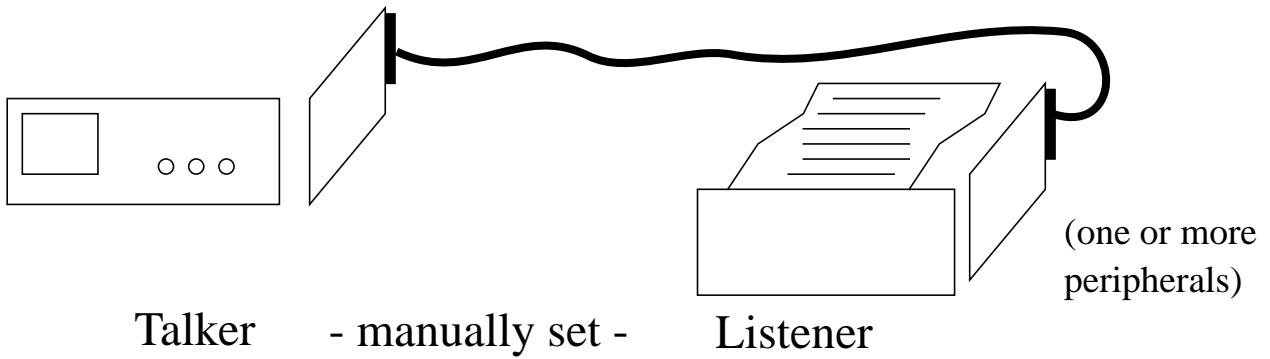
LISTENER
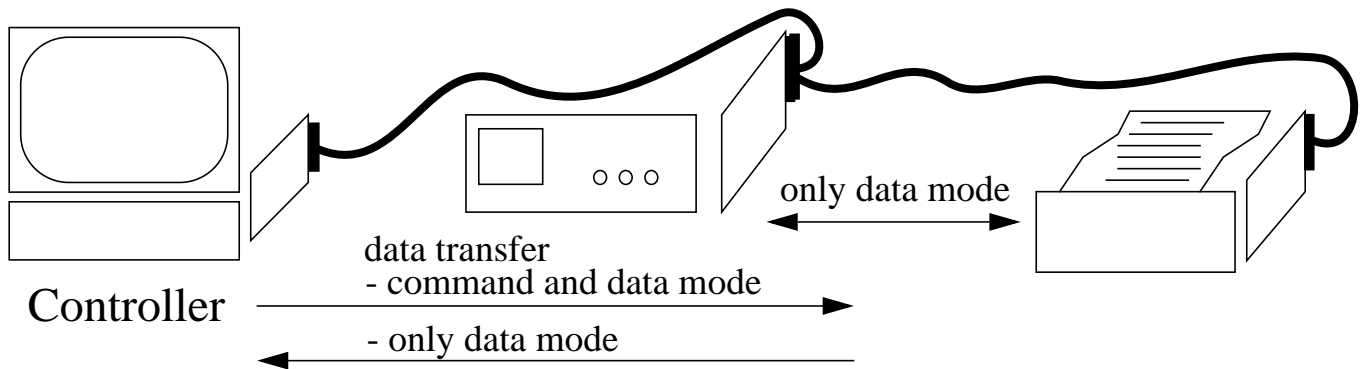Multiple devices can be addressed to listen at any time, and data bytes will be received by all listeners in parallel.

OBS! Most devices can not be addressed to both talk and listen at the same time.

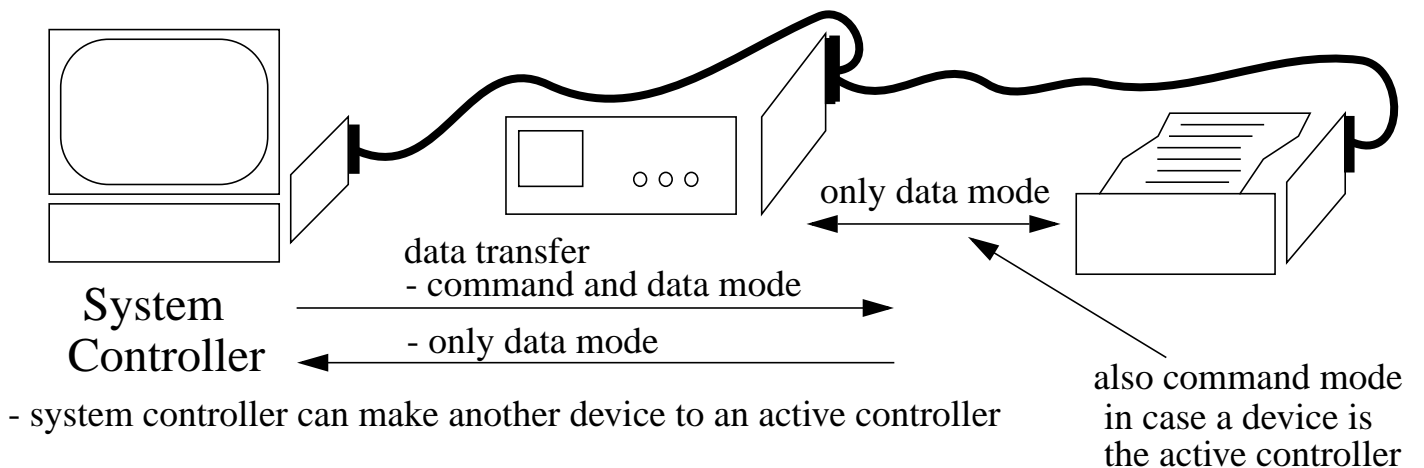# GP-IB system can be configured in one of three ways:

1) *No controller*

Talker   - manually set -   Listener

(one or more
peripherals)

2) *Single controller*

only data mode

Controller

data transfer
- command and data mode

- only data mode

3) *Multiple controllers*

only data mode

System
Controller

data transfer
- command and data mode

- only data mode

- system controller can make another device to an active controller

also command mode
in case a device is
the active controller

DEVICE SPECIFIC LANGUAGE

In addition to HP-VEE (or other same kind of software), device specific commands are needed to control the instruments needed in the measurement. Each instrument has its own and unique command set. These commans are transferred to a certain instrument, e.g., by using HP-VEE.

In HP-VEE, device spesific commands are transferred to a instrument by using *Direct I/O, Component Driver, or Instrument Panel Driver.*

Device specific command sets can be found from operating/programmer's manual of an instrument.

Usually, device specific language is hierarchical, i.e., higher level commands are written first and separated from lower level commands with, e.g., a colon or semicolon. For instance, a syntax to command HP 5600-Series Oscilloscope to set a trigger to NORMAL MODE and its level to -0.4:

":TRIGGER:MODE NORMAL"
":TRIGGER:LEVEL -.4"

Here, TRIGGER is higher level command which must be executed first and MODEL NORMAL is lower level command which can be executed only after the TRIGGER command.