INTRODUCTION

The **Front Desk Bus** is a method and protocol for interconnecting computers with human input and other devices. This specification covers the **Physical, Datalink**, and **Network** layers of the **Front Desk Bus**. In this specification the computer is referred to as the host. Peripherals connected to the bus are referred to as devices.

The host is the undisputed bus master. It controls the flow of data by issuing **Commands** and it is the only device permitted to issue them. **Talk** is the command used for a data transaction from a device to the host. **Listen** is the command used for a data transaction from the host to a device.

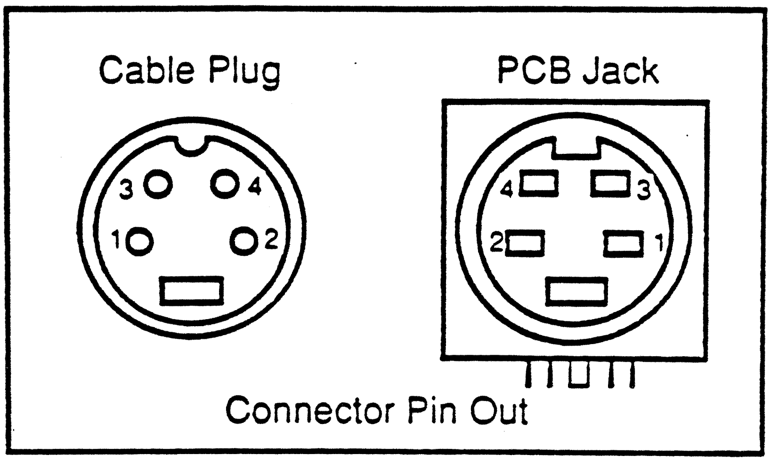
PHYSICAL LAYER

Interconnection:

All devices will communicate with the host via a four pin mini DIN jack, as specified in Apple Specification,T.B.D., with the following connector assignments;

1. Data
2. ~~No Connection~~ Reserved
3. Power(V+)
4. Return

They will be connected with three conductor cables, which do not exceed 100 pf per meter, terminated with four pin mini DIN plugs, as specified in Apple Specification, T.B.D.The maximum length of all cables shall be five meters.



Signal Levels:

Host:

Data:

The data line will be pulled up in the host with a 470 Ω ± 10% resistor and shall have the characteristics outlined in Table 1.

Power:

The Host will supply 5.0 Vdc ± 10% at .5 Amp minimum to the devices. The power line will be current limited by the host to prevent systems damage in the event of a Power to Power Return short. One **Front Desk Bus Load** (FDBL) is defined as a power consumption by a device of twenty five milliamps. Each system shall clearly state in it's documentation the number of **Front Desk Bus Loads** it can support.

FDB Host Electrical Characteristics					
Symbol	Parameter	Test Condition	Min.	Max.	Unit
V_{IL}	Low-Level Input Voltage		-0.2	0.8	V
V_{IH}	High-Level Input Voltage		2.4	V+	V
V_{OL}	Low-Level Output Voltage	I_{OL} = 12 mA	—	0.45	V
V_{OH}	High-Level Output Voltage	I_{OH} = -4.0 mA	2.4	—	V

Table 1

Devices:

Data:

The data line shall have the characteristics outlined in Table 2.

Power:

Each device shall be clearly marked on the device and in its documentation with the number of Front Desk Bus Loads it represents, which is equal to the devices maximun power consumption divided by twenty five milliamps.

FDB Device Electrical Characteristics					
Symbol	Parameter	Test Condition	Min.	Max.	Unit
V_{IL}	Low-Level Input Voltage		-0.2	0.8	V
V_{IH}	High-Level Input Voltage		2.4	V+	V
V_{OL}	Low-Level Output Voltage	I_{OL} = 12 mA	—	0.45	V
I_{OZ}	Off State Output Current	V_I = 0.4 V	—	-20	uA
C_{IN}	Input Capacitance		—	150	pF

Table 2

Modulation:

There are three forms of modulation on the bus; Normal modulation which transmits commands and data, High Speed modulation which transmits data, and Signals which broadcast global messages such as Service Request and Reset.

Normal Modulation:

An RZ code for modulation has been adopted for the Front Desk Bus. Each bit cell boundary is signified by a falling edge on the bus. The period of each bit cell is the time between two falling edges on the bus. The time for a normal modulation bit cell, T_{cyc}, is 100 usec ± 30%. All devices must support, initialize, and reset in normal modulation.

The data is encoded as the ratio of low to high time of each bit cell. Thus a "0" is encoded as a bit cell in which the low time is greater than the high time. Conversely, a "1" is encoded as a bit cell in which the low time is less than the high time. A Start is defined as a "1".A Stop is similar to a "0", in that it has a low time of T0 , but it does not have another negative edge to define the bit cell time. It is used to synchronize the stopping of a transaction.

High Speed Modulation:

High speed modulation is only used for data and not commands. A device will not send data with high speed modulation unless it has been enabledto do so by the host. The time for a high speed modulation bit cell is 50 usec ± 1%.

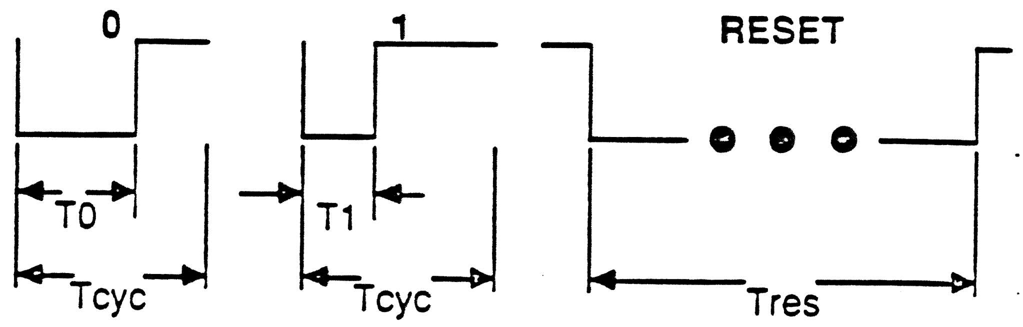


Fig. 1 FDB "0", "1" and RESET Time s

Signals:
Certain transactions fall under the category of neither commands nor data transactions. These are special transactions which globally broadcast status to devices on the bus. There are four special transactions in this group.

Attention and Sync:
To signal the start of a command, a long attention pulse is sent. This is followed by a synch pulse to give the initial bus timing. The falling edge of the synch pulse is used as a timing reference for the first bit of the command .

Reset:
Reset issues a break on the bus by holding the bus low for a minimum of T_{res}.

Service Request:
Service Request is a transaction that devices can use to signal the host that they require service, i.e. have data to send. Following any command transaction, a requesting device can signal by holding the bus low during the low portion of the stop bit of the Command transaction. The requesting device holds the bus low T_{int} beyond the bit cell boundary to signal.

Once a device has requested service by asserting a Service Request on the bus, it shall request service repeatedly until serviced. When the requesting device is addressed to Talk to any register, it will not assert Service Request. When the requesting device is addressed to Talk to the register which contains the data causing the Service Request condition, it will not assert Service Request , shall be considered serviced, and not request service again until it again needs to be serviced.

The ability for a device to assert a Service Request can be enabled and disabled by the host. All devices shall be initialized with the Service Request capability enabled.

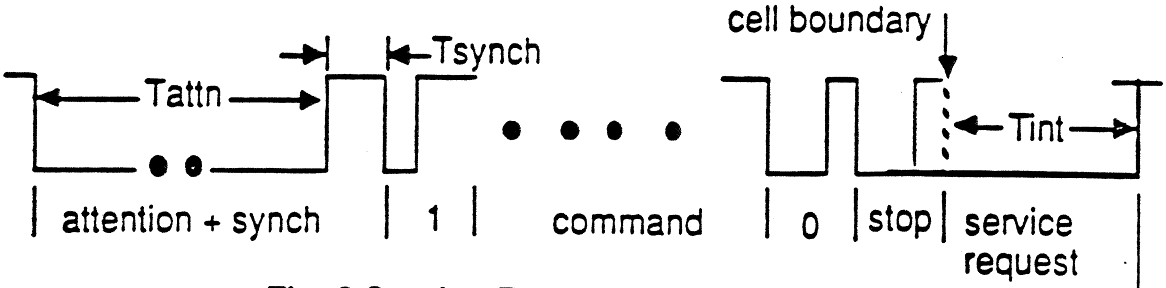


Fig. 2 Service Request Transaction

FDB Interface Characteristics						
Symbol	Parameter	Min.	Max.	Unit	Fig.	Definition
T0	"0" low time	60	70	% Tcyc	1	
T1	"1" low time	30	40	% Tcyc	1	
Tattn	ATTENTION signal	560	1040	usec	2	8 * Tcyc
Tcyc	FDB bit cell time	70	130	usec	1	
Tint	INTERRUPT signal	140	260	usec	2	2 * Tcyc
Tres	RESET signal	2.8	5.2	msec	1	40 * Tcyc
Tsynch	Synch pulse width	60	70	% Tcyc	2	
Tlt	Stop to start time	140	260	usec	3	2*Tcyc

Table 3

Transactions:

Commands:

The format of a command is an attention signal, followed by a sync signal, then by eight data bits,and to synchronize the stopping of the transaction, a stop bit. Following the imaginary bit cell boundary after the stop bit, the transaction is complete and the host releases its active drive of the bus.

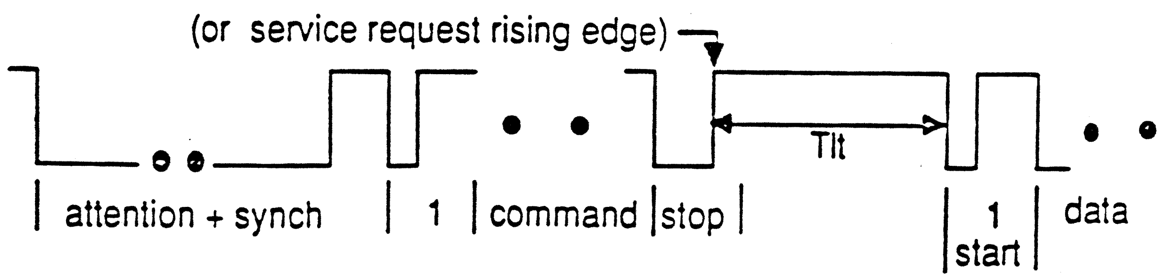


Fig. 3 Command Stop to Data Start

Data:

The format of a data transaction is a start bit ,followed by N times 8 bits of data with the most significant data bit sent first, where N may be from 2 to 32, followed by a stop bit. The specific length of the data transaction for a specific device is defined at a higher level of the protocal.

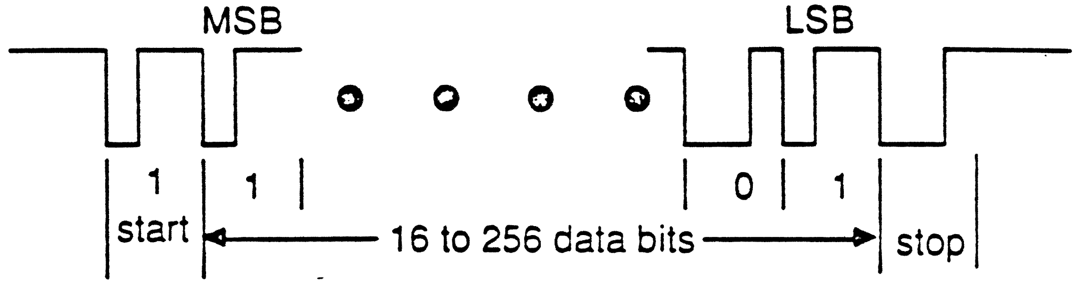


Fig. 4 Data Transaction Example

DATA LINK:

Each device on the bus has an address. There shall be only one active talker on the bus at any time, (see colision detection) this may be the host or an addressed device. A device addressed to talk, with data to send, "untalks" itself after it sends its data. If a device has no data to send, it "untalks" itself immediately and allows the bus to time-out.The host may also send data after a command.

Front Desk Bus Peripherals:

Addresses:

All devices have a four bit command address which is defined by device type assignment. A device will always respond to that address on either power on or after a reset signal. The Soft Address locations are places were devices may be moved to by the host. The Addresses are assigned as follows:

Device Table			
Address	**Device type**	**Addressing**	**Example**
0000 (0)	ADAPSO keys	extended	
0001 (1)	Appliances	extended	
0010 (2)	Encoded devices	movable	Keyboard
0011 (3)	Relative devices	movable	Mouse
0100 (4)	Absolute devices	movable	Tablet
0101 (5)	Reserved	-	
0110 (6)	Reserved	-	
0111 (7)	Reserved	-	
1000 (8)	Soft address	-	
. .	. .	. .	
1111 (15)	Soft address	-	

Table 3

Registers:

All devices have at most four locations to receive data, and at most four locations to send data. These locations are called registers and are referred to as R0 to R3. They depend on addressing mode supported and are defined as follows:

Register 0 Talk: Data Register, Device specific as to meaning.

Register 0 Listen: Data Register, Device specific as to meaning.

Register 1 Talk: Data Register, Device specific as to meaning.

Register 1 Listen: Data Register, Device specific as to meaning.

Register 2 Talk: Data Register,Device specific as to meaning.

Register 2 Listen: Movable Devices: Device specific as to meaning.
Extended Address Devices: Enabling Extended Address

Register 3 Talk: Status information, ie: device address, handler.

Register 3 Listen: Status information, ie: device address, handler.

Commands:

Commands may be sent only by the host. There are four commands; **Talk**, **Listen**, SendReset,and Flush. A command is an eight bit value with the following syntax. The most significant nibble is the address which ranges from 0 - 15 (A3-A0). The next two bits form the command.The last field is a two bit register address field (RB,RA). This field, which is optional, allows a specific register, R0 to R3, within an addressed device to be specified. An example of where this might be used is to differentiate a data register (in a keyboard, the specific keystroke) from a status or configuration register (in a keyboard, a response that signifies the model of the keyboard).

Command Syntax			
7654	32	10	Command
XXXX	00	00	SENDRESET *
A3 - A0	00	01	FLUSH
XXXX	00	10	RESERVED
XXXX	00	11	RESERVED
XXXX	01	XX	RESERVED
A3 - A0	10	RB RA	LISTEN
A3 - A0	11	RB RA	TALK
* forces RESET signal on FDB			

Table 4

To allow for future expansion of the command structure, a group of "place holder" Reserved instructions has been defined. These instructions shall be treated as no response and immediate bus release.

As a specific example, a Talk command to Register 0 of device 5 would be encoded as "01011100". The bus would be modulated with the following:

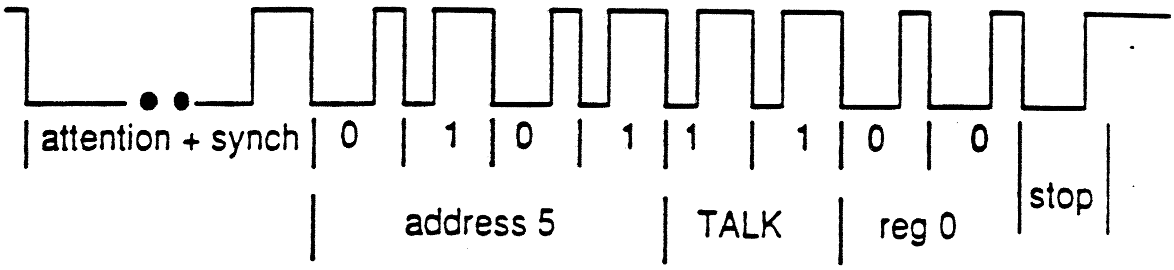


Fig. 5 TALK Command Example

Talk:

All devices on the bus must support Talk and Listen commands. When a device is addressed to Talk, it must respond before being timed out by the host. This timeout shall be T_{lt} max. after the rising edge of the stop bit of the Talk command.

The selected device, if it does not timeout, becomes active on the bus. It performs its data transaction no sooner then T_{lt} min after the rising edge of the stop bit of the Talk command then "untalks" itself and goes inactive on the bus.

Listen:

When a device is addressed to Listen, it is enabled to receive the data bits that are placed on the bus by the host. The host performs its data transaction within T_{lt} min to T_{lt} max, after the rising edge of the stop bit of the Listen command After the data bits are received, the transaction is complete and the device "unlistens" itself. If a device is addressed to Listen and it receives another command on the bus before it receives any data, then by definition the transaction is immediately complete and the device "unlistens" itself. Any "handshaking " will be handled at a higher level.

SendReset:

The SendReset commmand bit pattern does not go out on the bus. It causes a Reset signal to be put on the bus. The Reset has the effect of reseting all pending Service Requests; enabling the service request mode of all devices to enable; and in general puts the devices in a mode in which they will accept commands.

Flush:
The effect of the **Flush** command is defined by the device. It can be used for such functions as clearing a fifo and reseting all keys on a keyboard so that they will be sent again.

Collision Detection:

All devices will detect a collision of data. If a device is trying to output a one and the data line is or goes to a zero, it has lost a collision to another device. If another device sends data before the device is able to assert its start bit, it has lost a collision. The losing device should immediately "untalk" itself and preserve the data which was being sent for retransmission. The device will set an internal flag if it looses a collision .

In order to aid in collision detection, devices using internal clocks which operate within ± 1% should attempt to assert their start bit at a random time within the limits of the line turn around time, T_{lt}.

Error Conditions:

If the data line gets hung low for T_{res}, all devices will reset themselves and output a one. If a command transaction is incomplete by staying high beyond the maximum bit cell time, all devices will ignore the command and seek another attention signal.

NETWORK LAYER:

Front Desk Bus Peripheral Types:

Movable devices:
These devices will have the capability of being moved by the host to a Soft Address location. Movable device will optionally have a switch on them to indicate activity, which is called the **activator**. The activator can be a special key on a keyboard or a mouse button. In order to aid in collision detection they will also replace the address portion of the address field of **Register 3** with a random number in response to a **Talk R3** command.

Extended Address devices:

These devices all have the same command address as well as a unique 16 to 256 bit extended address which is stored in the device. Their command address may not be changed. On power up or after Reset they will only accept the Listen R2 command. They are enabled to talk and listen only after receiving a Listen R2 command in which the data matches their stored address. Once enabled they will respond to all commands addressed to them and have the capability to assert a Service Request. These devices become disabled after receiving a Listen R2 command in which the data does not match their stored address.

Register 3:

Register 3 contains the information which tells the device how to behave relative to the host.

Service Request and High Speed Enabling:

The Listen R3 command can be used to enable and disable Service Request and High Speed modulation. They are enabled by setting the appropriate bit in Register3 to a one and disabled by setting the appropriate bit to a zero.

Enabling the Service Request bit gives devices on the bus the ability to request service from the host. Setting the bit allows the device to signal a Service Request on the bus, or conversely, clearing the bit disables the signalling of a Service Request. This is useful in systems where the Service Request response time in a polled system is longer than desired. Or, when only specific devices are required for an application, the others could be disabled.

Enabling the High Speed bit causes the device to use High Speed modulation. Setting the bit causes the device to use High Speed modulation on the bus, or conversely, clearing the bit disables the use of High Speed modulation.

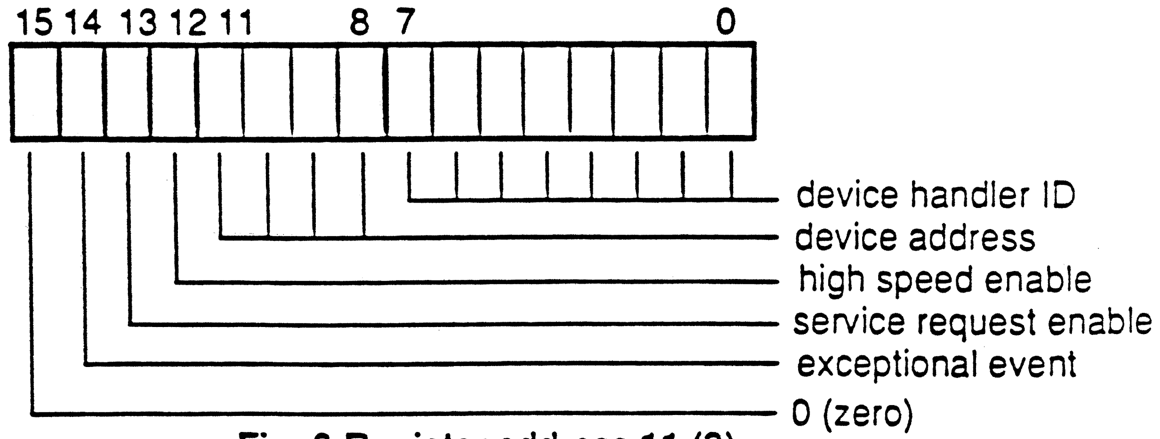


Fig. 6 Register address 11 (3)

Exceptional Event:

The Exceptional Event bit in Register 3 can be set and cleared by a device to indicate an exceptional input condition such as reset or a failure. The specific application is defined at a higher level.

Handlers:

Handlers define a set of capabilities in both the host and the device such as the meaning of the data in each of the registers, the length of data transactions, ect. The host is able to interact with devices to modify thier function with a Handler ID which is stored by the device in Register 3. The host is able to change the the way a device functions by sending it a new Handler ID with a Listen R3 command. If the receiving device is able to match the Handler ID to a function in the device, the new Handler ID will be stored and sent in response to a Talk R3 command.

Reserved Handler ID's

The Handler ID "FF" hex is reserved for the self test mode for all devices. The ID in Register 3 prior to command shall be perserved.

The Handler ID "00" hex, in response to a talk is reserved to indicate a failed self test.

The Handler ID "00" hex sent with a listen is reserved to indicate that the device is only to change unconditionally bits 8 to 13 of Register 3. The ID in Register 3 prior to command shall be perserved.

The Handler ID "FE" hex sent with a listen is reserved to indicate that the device is only to change the address portion of Register 3 if no collision has been detected. The ID in Register 3 prior to command shall be perserved. The Handler ID "FD" hex sent with a listen is reserved to indicate that the device is only to change the address portion of Register 3 if the devices switch is depresed. The ID in Register 3 prior to command shall be perserved.

Changing Addresses:

Systems Level:

At the systems level a host can change the address of Movable devices by forcing the collision of devices sharing the same address. By issuing a Talk R3 command and following it with a Listen R3 command, with a new address in bits 8 to 11 and Handler ID "FE" in bits 0 to 7 of the data, the device which did not detect a collision will be moved to the new address. This process can be repeated at the initialization address until the response to the Talk R3 command is a time out. This can be used to identify and relocate multiple devices of the same type after initialization of the system.

Applications Level:

At the applications level addresses can by changed by displaying a message requesting a user to use the devices activator. The host then issues a Listen R3 command with a Handler ID of "FD" to a new address and the device with the activator being used is moved. This can be used to identify and locate individual devices in multi-user applications.

