GA33-1516-0

Systems

IBM System/370 Model 115 Channel Characteristics

First Edition (March 1974)

Changes are periodically made to the information herein; before using this publication in connection with the operation of IBM systems, refer to the latest *IBM System/360 and System/370 Bibliography,* GA22-6822, and associated Technical Newsletters, for the editions that are applicable and current.

Requests for copies of IBM publications should be made to your IBM representative or to the IBM branch office serving your locality.

A form for readers' comments is provided at the back of this publication. If the form has been removed, comments may be addressed to IBM Laboratories, Product Publications, Dept. 3179, 703 Boeblingen Wuertt, P.O. Box 210, Germany. Comments become the property of IBM.

IBM Technical Newsletter

This Newsletter No.	GN33-1681
Date	23 April 1976
Base Publication No.	GA33-1516-0
File No.	S370-01
Previous Newsletters	GN33-1615 GN33-1627 GN33-1675

IBM System/370 Model 115
Channel Characteristics
(for Systems with IBM 3115-0
Processing Unit)

This Technical Newsletter provides replacement pages for the subject publication. Pages to be inserted and/or removed are:

1, 2
33, 34

A change to the text or to an illustration is indicated by a vertical line to the left of the change.

Summary of Amendments

Information has been added about a faster magnetic tape subsystem (comprising a 3803 Tape Control, Model 3, and 3420 Magnetic Tape Units, Models 3 or 5) which can now be attached to the Model 115's magnetic tape adapter.

Note: *Please file this cover letter at the back of the manual to provide a record of changes.*

IBM Laboratories, Product Publications, Dept. 3179, 703 Boeblingen/Wuertt, P.O. Box 210, Germany

Printed in U.S.A.

Preface

This manual describes how the effects of imposing loads on the channels of the IBM System/370 Model 115 can be checked. The book is intended for physical planning engineers and systems analysts who wish to check that a proposed configuration of input/output (I/O) devices will work satisfactorily in the System/370 Model 115.

The first section of the book describes the types of channels to which I/O devices can be connected, the theoretical data rates of the channels, and the possible effects of imposing heavy I/O loads on those channels. The effects considered are: data overrun, loss of device performance, channel interference with the machine instruction processor (MIP), program overrun, and excessive channel utilization.

The second section gives the procedures for testing data overrun on the byte-multiplexer channel. This section also includes a description of how to assign priorities to devices on the byte-multiplexer channel.

The third section deals with interference with the MIP that is caused by activities on the channels, and describes how the interference can be assessed. The same section also shows how to check for the possibility of program overrun.

The fourth section describes the concept of channel utilization.

Before using this manual, the reader should have a thorough understanding of input/output operations for the Model 115 as described in:

IBM System/370 Model 115 Functional Characteristics, GA33-1510.

IBM System/370 Principles of Operation, GA22-7000.

Detailed information on the standard I/O interface is given in *IBM System/360 and System/370 I/O Interface Channel to Control Unit, Original Equipment Manufacturer's Information,* GA22-6974.

When calculating for data overrun on the byte-multiplexer channel, a special worksheet is required: *IBM System/370 Model 115 Byte-Multiplexer Channel: Load Sum Worksheet* GX33-6007, available in pads of 50.

Contents

Illustrations

I/O Devices on IBM System/370 Model 115

Input/output (I/O) devices are connected to the IBM 3115-0 Processing Unit via the following facilities:

1. Byte-multiplexer channel with standard interface.

2. Integrated card I/O and printer attachment for connecting several types of card I/O machines and line printers.

3. Integrated communications adapter (ICA) for connecting up to four binary synchronous and eight asynchronous communication lines.

4. Direct disk attachment (DDA) for connecting the IBM 3340 disk storage subsystem (which allows up to four disk drives to be connected).

5. Magnetic tape adapter for connecting either an IBM 3410/3411 magnetic tape subsystem, Model 1, 2, or 3 (with up to four or six tape drives), or an IBM 3803-3/3420 magnetic tape subsystem (with up to eight tape drives).

6. Service processor (SVP) native attachments for connecting the video display, keyboard, and console matrix printer.

	Channel Address	Device Address
Video Display, Keyboard, and Console Printer	0	X'1F' or X'1E'
Integrated Card I/O and Printer Attachment	0	X'00' to X'0E'
Integrated Communications Adapter	0	X'20' to '2F'/'30' to '36'
Byte Multiplexer Channel	0	X'40' to 'FF'
Direct Disk Attachment	1	'60' to '63'
Magnetic Tape Adapter	2	'80' to '85'

Figure 1. Use of I/O Addresses by MPX Channel and Integrated Attachments

I/O devices can be connected directly to the Model 115's integrated attachments and adapters instead of via the usual channel and control unit combination. However, the devices appear to the programmer as if they were connected to normal channels (Figure 1).

SUBCHANNELS

The byte-multiplexer channel contains 32 subchannels. Each control unit attached to the channel requires a subchannel to hold information for controlling the current operation at the device. A subchannel may be shared by more than one device or it may be nonshared. A shared subchannel is used for a control unit that can have several devices attached, only one of which requires the subchannel at any one time. A nonshared subchannel is used for a control unit which controls only one device.

As shown in Figure 1, some natively attached I/O devices are addressed as if they were on channel 0. For the byte-multiplexer channel only the device address range X'40' to X'FF' is available.

Subchannel Addressing

In I/O instructions associated with the byte-multiplexer channel, the most significant bit of the device address byte defines whether a subchannel is nonshared (bit 0=0) or shared (bit 0=1).

Because the byte-multiplexer channel contains 32 subchannels, a nonshared subchannel is addressed by the "address folding" method, which permits a greater choice of device addresses to be available with a limited number of subchannels. A shared subchannel has the address of the corresponding control unit.

When allocating device addresses, the programmer must observe the conditions given in the following paragraphs.

Nonshared Subchannels

For nonshared subchannels (hexadecimal addresses 40 through 7F), the most significant three bits of the device

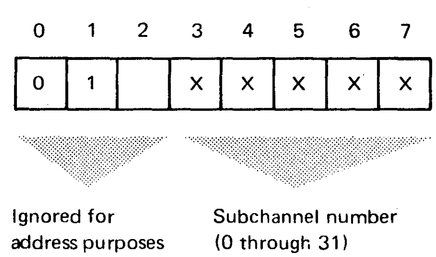


Figure 2. Device Address Byte for Non-shared Byte-Multiplexer Subchannel

address byte are ignored for address purposes (Figure 2). Thus the addresses '4F' and '6F' (for example) would both address the same subchannel – subchannel '0F' (hex), 15 (dec). Therefore, device addresses for nonshared subchannels must be chosen so that the least significant five bits of the device address are never repeated.

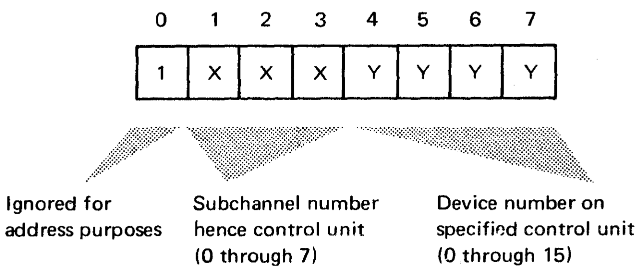


Figure 3. Device Address Byte for Shared Byte-Multiplexer Subchannel

Shared Subchannels

For shared subchannels (hexadecimal addresses '80' through 'FF'), the most significant bit of the device address byte is ignored (Figure 3) and the least significant four bits have no function in the identification of the subchannel.

Bits 1, 2, and 3 specify one of eight shared subchannel numbers (0 through 7) and, hence, one of up to eight control units. Each control unit that is associated with a shared subchannel may have up to 16 devices attached. A control unit which is capable of handling 32 devices would occupy two shared subchannels*. The devices are identified by the four least significant bits of the device-address byte. Thus, the device addresses '90' through '9F' (for example) would all address (and share) subchannel 1.

Device addresses for shared subchannels must be chosen so that they do not address subchannel numbers in use for nonshared subchannels.

INTERFERENCE ON MODEL 115

On a Model 115 the byte-multiplexer channel and the integrated I/O attachments, except the direct disk attachment (DDA), each have their own processing capability. The DDA has only limited processing capability of its own and has to make use of the MIP for certain operations. Because they do not share microprogram control, all attachments (except the DDA), the multiplexer channel, and the MIP may run independently of each other. This means the load on an integrated I/O attachment has no impact on the multiplexer channel, and the multiplexer channel does not interfere with instruction processing in the MIP.

The only common resource for all I/O devices and the MIP is main storage. Access to main storage is controlled by the main storage controller (MSC) which has a data handling capacity of 2.08 megabytes per second. If the Model 115 includes natively attached disk or tape subsystems, and thus has a high transfer rate of I/O data, MSC usage will still be below 50%. Therefore, the time that the I/O devices and the MIP wait for MSC service is small in comparison to the time they require for processing and data handling. MSC time is therefore ignored in the calculations described in this manual.

However, some interference occurs during the processing of I/O instructions, such as "start I/O" (SIO) "test I/O"(TIO) and during interrupt handling. For these activities the MIP and the integrated attachments or byte-multiplexer channel have to communicate with each other, and occasionally they may have to wait. Interference will obviously occur when the DDA requires the processing capabilities of the MIP.

The DDA only uses the MIP to initiate instructions and commands, and for certain supervisory processing tasks. Once the MIP begins data transfer, the DDA takes over and continues control of the transfer between the disk I/O device and main storage.

Using the MIP to begin data transfer via the DDA can have two effects. Firstly, when an I/O device other than a disk is waiting for the next "start I/O" instruction it may have to wait until the MIP is released for further processing. Secondly, when an I/O device other than a disk sends an interrupt it may have to wait for the interrupt to be accepted. Both these effects can lead to a program overrun.

Program overrun occurs when the next instruction is issued too late; either before a timeout, or too late for proper document routing. Program overrun will rarely occur because most of the data transfer is handled by the DDA without participation by the MIP.

To understand the interference by the DDA, it is necessary to break down the two processing tasks of the MIP that are involved. The two tasks are:

- command handling for the disk
- search supervision (index, gaps, and count fields).

Command handling is negligible. Supervisory tasks of search criteria, however, can take the MIP some time. Because supervisory tasks are time-dependent and therefore cannot be interrupted, the effect is significant. Supervisory tasks are also job-dependent and therefore the structure of the program (record length, number of records per second, and so on) determines the amount of interference.

Appendix C contains a graph showing the percentage of interference with the MIP plotted against the number of records per second and various record sizes. The graph assumes that every access to main storage by the MIP coincides with an access for data transfer (worst case); something that does not happen. Assuming even the worst

* For details of the number of subchannels required by a specific control unit, consult the control unit reference manual.

Channel Activity	Time in Microseconds	
	Time Overlapped	Processing Time Per Byte
REQ-IN up to rising of HOLD-OUT and SEL-OUT		2.25
SEL-OUT up to test for OP-IN up*		2.70
OP-IN found up to test for ADR-IN up*		0.45
ADR-IN found up to rising of COMD-OUT		2.25
COMD-OUT up to dropping of SEL-OUT and HOLD-OUT	0	
COMD-OUT up to test for SERV-IN up*		9.00
SERV-IN found up to rising of SERV-OUT (read or write)		15.30
SERV-OUT up to test for SERV-IN down**	0.1	
SERV-IN found down to dropping of SERV-OUT**	0.1	
SERV-OUT up to test for OP-IN down*		14.40
OP-IN found down to test for next REQ-IN up		5.85
Total time		52.20 μs

* These tests are carried out by microprogram and repeated each 3.5 microseconds. When the referenced TAG line does not switch in time, the transfer time is increased in increments of 3.5 microseconds until the I/O device responds.

** Controlled by hardware.

Note: Further information about the signals shown in the table is available in *IBM System/360 and System/370 I/O Interface Channel to Control Unit, Original Equipment Manufacturers' Information,* GA22-6974.

Figure 4. Processing Time of System/370 Model 115 Byte-Multiplexer Channel for Data Transfer in Byte Mode, Started by Polling

Channel Activity	Time in Microseconds	
	Time Overlapped	Processing Time per Byte
1. Initial Selection to First SERV-IN Test		
ADR-OUT, HOLD-OUT, SEL-OUT up to test for OP-IN up*		3.1
OP-IN found up to dropping of ADR-OUT		0.9
ADR-OUT down to test for ADR-IN up*		1.3
ADR-IN found up to dropping HOLD-OUT, SEL-OUT and rising of COMD-OUT		2.7
COMD-OUT up to test for STAT-IN up*		0
STAT-IN found up to rising of SERV-OUT (unit status = 0)		4.5
SERV-OUT up to test for STAT-IN down**	0	
STAT-IN found down to dropping of SERV-OUT**	0.1	
SERV-OUT up to test for SERV-IN up* (or for OP-IN down)		4.9
Total Time		17.4 μs
2. Data Transfer in Burst Mode		
SERV-IN found up to rising of SERV-OUT		8.5
SERV-OUT up to test for SERV-IN down	0	
SERV-IN found down to dropping of SERV-OUT	0.1	
SERV-OUT up to test for next SERV-IN up*		26.0
Total Time to Transfer One Byte		34.5 μs

* These tests are carried out by microprogram and repeated each 3.5 microseconds. When the referenced TAG line does not switch in time, the transfer time is increased in increments of 3.5 microseconds until the I/O responds.

** Controlled by hardware.

Note: Further information about the signals shown in the table is available in *IBM System/360 and System/370 I/O Interface Channel to Control Unit, Original Equipment Manufacturers' Information,* GA22-6974.

Figure 5. Processing Time of System/370 Model 115 Byte-Multiplexer Channel for Data Transfer in Burst Mode, Started by Channel Initiated Selection

Channel Activity	Time in Microseconds
1. Data chaining will increase the basic time to transfer one byte in byte mode by:	42.7
in burst mode by:	34.6
and, Additional for transfer-in-channel (TIC) command:	20.2
Additional for I/O relocation (IDA flag)	22.0
Additional for program controlled interruption (PCI) set-up:	1.3
2. Command chaining* REQ-IN up to test for STAT-IN (I/O initiated selection)	17.1
From STAT-IN presentation of channel end and device end to COMD-OUT with next command *best case* (count zero, data transfer complete)	79.6
worst case (outstanding data transfer from buffer – only for read-type operation)	90.0
as before, but STAT-IN presenting device end alone	72.1
COMD-OUT up to test for OP-IN down	8.1
OP-IN found down to test for next REQ-IN up	7.2
and, Additional for Status Modifier	6.7
Additional for TIC Command	20.2
Additional for I/O relocation (IDA)	22.0
Additional for PCI set-up	1.3

* Command chaining contains deselection and channel initiated I/O reselection. These times may be increased depending on response times of I/O device. For details see Figures 4 and 5.

Figure 6. Processing Time of System/370 Model 115 Byte-Multiplexer Channel for Chaining Data, and Chaining Commands

case, the graph shows that there is little interference by the DDA for most common record sizes and job streams. For additional information about interference and program overrun see 'Channel Interference with the MIP' and 'Program Overrun'.

Interference on the common service processor (SVP) interface is not considered, because the I/O adapters and the byte-multiplexer channel use this interface only under exceptional conditions (checks, logging).

DATA RATES AND TIMINGS OF BYTE-MULTIPLEXER CHANNEL

The maximum theoretical data rates of the System/370 Model 115 byte-multiplexer channel are:

- Byte mode: 19 kilobytes per second
- Burst mode: 29 kilobytes per second

These theoretical data rates are calculated as the inverse of the time (including address fetching for indirect data addressing – IDA – but without chaining) which the channel microprogram requires to transfer one byte. The data transfer time includes waiting times for I/O response. I/O devices which exceed this response time slow down the data transfer.

Data chaining will slow down data transfer, because of the longer processing time required by the channel microprogram.

To evaluate the load caused by different tasks on the channel, e.g., priority load, and device load factors of an I/O device, the timing characteristics of the channel and the I/O device, or its control unit, must be known.

Figures 4, 5, and 6 give timings for the most common operations on the byte-multiplexer channel on the System/370 Model 115.

EFFECTS OF CHANNEL LOADING

If the byte-multiplexer channel is too heavily loaded, that is, if the CPU attempts to communicate simultaneously with too many high data-rate devices on this channel, the following effects can occur:

1. Unbuffered I/O devices may lose data, this is called data overrun. Data overrun occurs when a channel does not accept or transfer data within the required time limits. This data loss may occur if the total channel activity that is started by the program exceeds the channel capabilities. The possibility of data overrun can be checked as described in "Byte-Multiplexer Channel Data Overrun".

2. Performance of buffered I/O devices may be reduced. When channel service is not provided within the required time limits, the buffered device – being immune from data overrun – merely waits for channel service. Loss of performance on buffered

devices is unlikely to be significant unless the percentage channel utilization is high.

3. Certain real-time devices may not receive service from the program fast enough to prevent incorrect device operation. This effect is called program overrun and is described under "Program Overrun" in "Channel Interference with MIP"

4. Queues may develop for tasks that require channel service, thus leading to loss of throughput (see "Channel Utilization").

Because of these effects it is desirable that the loading of a particular configuration of I/O devices be checked – using the procedures in this manual – during the physical planning phase of a system installation. These procedures will determine – in most cases – whether system operation will be satisfactory. More detailed investigation may be necessary for configurations that appear to exceed the byte-multiplexer channel's input/output capabilities.

The test procedures in this manual assume worst case situations, in which the most demanding devices in the configuration all make their heaviest demands on the byte-multiplexer channel simultaneously. Such situations may not occur frequently. The procedures are not suitable for calculating the incidence of worst cases, however. In actual operation, a device may perform satisfactorily even though the test procedures showed that it was liable to overrun. This is because the worst case situation may never occur in the lifetime of the device.

Byte-Multiplexer Channel Data Overrun

This section describes how to test for possible data overrun on the byte-multiplexer channel.

The validity of the test procedures depends on normal channel programming without unusual "tricks" such as chains of immediate commands, 'transfer-in-channel' (TIC) command loops, successive 'no-op' commands, 'no-op' TIC chains, etc. The calculations are based on normal command chains.

WAIT TIME AND INTERFERENCE

Each I/O device on the byte-multiplexer channel has a wait time. The wait time is the maximum period that the device can wait for completion of channel service (see "Glossary") before data overrun occurs (that is, the device loses data) or before its performance is impaired. In this manual, a device that is waiting for the completion of channel service is called a waiting device, and any channel activity that causes a device to wait for channel service is called interference.

The following three types of interference can cause a device to wait for completion of channel service:

- Previous load
- Priority load
- Device load

If the combined effect of these three types of interference causes the completion of channel service for a waiting device to be delayed beyond its wait time, the device may lose data (data overrun) or may suffer loss of performance as shown in Figure 7. The test procedure for byte-multiplexer channel data overrun (given later in this section) assumes the worst case, namely that all these factors cause interference with the waiting device.

Previous Load

A device on the byte-multiplexer channel may be forced to wait for channel service if another device with lower priority is in operation at the moment when the waiting device requests channel service. The lower priority device must be allowed to finish its operation before channel service can be given to the waiting device. Interference of this type is called a previous load and is assumed to last for approximately 0.10 millisecond (ms). The appendixes to this manual contain tables of channel evaluation factors in which the previous-load factor for each waiting device is expressed as a percentage of the wait time for that device.

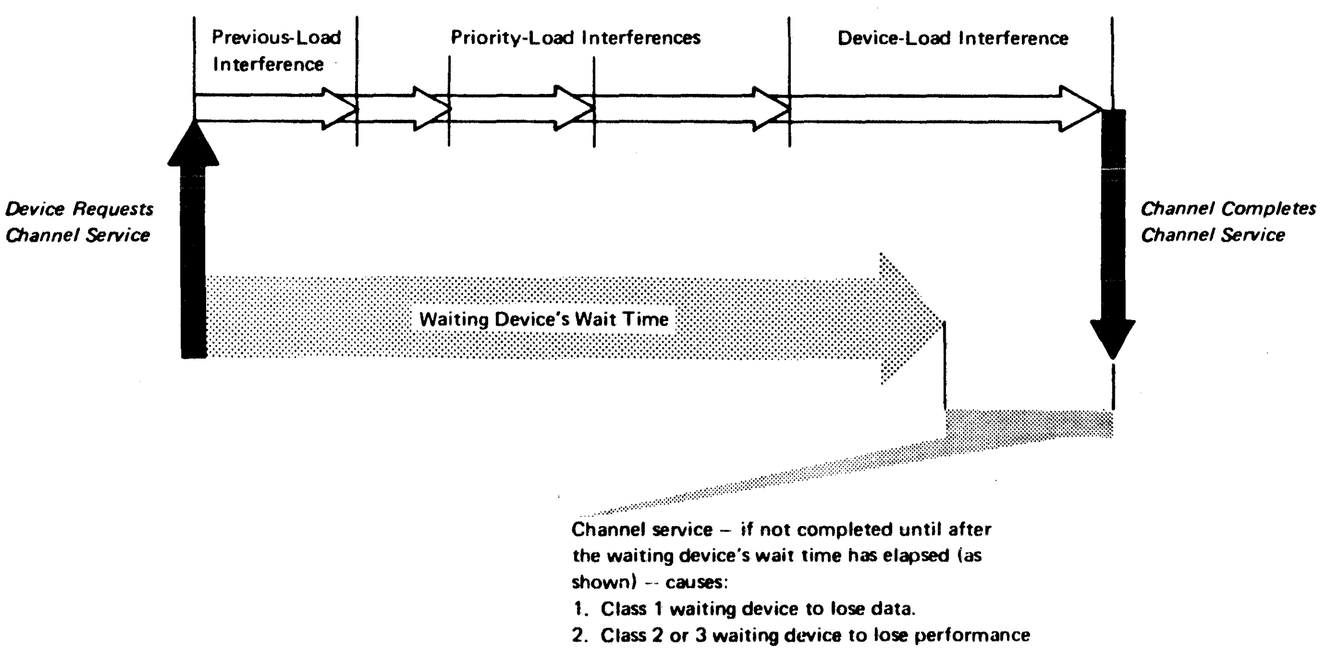


Figure 7. Three Kinds of Interference can Cause Channel Service to be Delayed Beyond a Waiting Device's Wait Time

Impact of MIP Service on I/O Service

The channel has to service I/O devices and the MIP. The MIP is serviced when no I/O requests are pending. To minimize the impact of MIP handling on I/O service, handling of I/O instructions or interrupts by the MIP may be interrupted by I/O requests each 30 to 40 microseconds. The longest continuous microprogram routine is shorter than a data transfer of one byte from an I/O device. For channel load evaluations (testing for data or program overrun) this interference is included in the previous load.

Priority Load

The byte-multiplexer channel services all attached devices in the order of their priority. A waiting device on the byte-multiplexer channel may be forced to wait for channel service while channel service is being given to higher-priority devices on the byte-multiplexer channel. In this manual, a higher-priority device that can cause a waiting device to wait for channel service is called a priority device. The interference from a priority device is called a priority load.

Because of the way in which data overrun is tested, the priority load of each priority device is expressed as a percentage of the waiting device's wait time. Therefore a priority device does not necessarily have the same priority-load factor for all waiting devices. In the calculation of priority load, the interference is considered to have two distinct components: the A factor and the B factor.

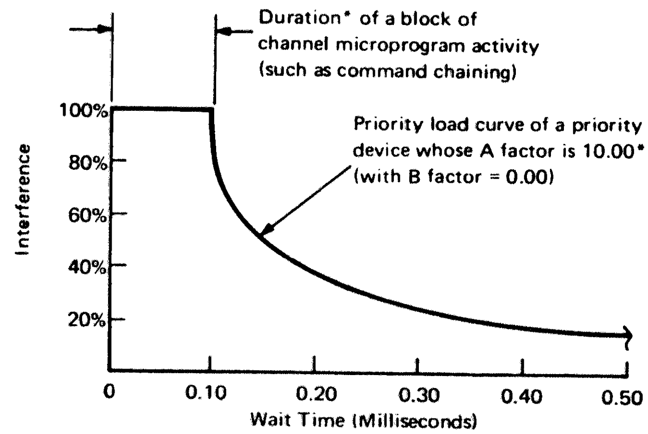
A-Factor Interference

A-factor interference is caused by channel microprogram activity, such as command chaining, for the priority device. The duration of this type of interference is significant compared with typical wait times. Therefore, the priority load, being expressed as a percentage of wait time, depends on the wait time of the waiting device. For example, if a waiting device's wait time is 0.20 millisecond and the microprogram activity associated with the priority device lasts for 0.10 millisecond, then the priority load is 50 per cent. (In the channel evaluation factor tables in Appendixes A and B, the A factors are expressed in milliseconds multiplied by 100. In the example above, the A factor associated with a microprogram activity lasting 0.10 millisecond is, therefore, 0.10 x 100 = 10.00.)

Figure 8 shows how A-factor interference varies with the wait time of the waiting device.

B-Factor Interference

B-factor interference is caused typically by data transfers to and from the priority device. As shown by the example in



* The A factor given in the channel evaluation factor tables (see Appendixes A and B) is the duration of interference in milliseconds multiplied by 100. If the duration of interference is 0.10 millisecond (as shown in the illustration), the A factor is 0.10 X 100 = 10.00. Thus, for a waiting device having a wait time of 0.2 millisecond, the interference is obtained directly as a percentage thus:

$$\frac{\text{A factor}}{\text{Wait time}} = \frac{10.00}{0.2} = 50\%$$

Figure 8. Example of Priority Load Curve of a Priority Device Causing Interference by Command Chaining (A Factor Interference)

Figure 9, the duration of each data transfer is short compared with typical wait times. The data transfers occur frequently enough, however, to have a total effect that can be expressed as a percentage interference – namely, the B factor – that is constant for all wait times.

A and B Factors Combined

In actual I/O operations, the pattern of interference tends to be more complex than has been suggested by the example priority load curves in Figures 8 and 9. Usually, the A and B factors are both nonzero and the total priority load of a priority device is given by:

$$\text{Priority load} = \frac{\text{A}}{\text{Wait time}} + \text{B}\%$$

where the wait time is that of the waiting device.

Multiple A and B Factors

Some devices have only one set of A and B factors but others have more than one set (see Figures 22,23,and 24 in the appendixes). In these tables (as shown in Figure 10), the A and B factors have priority time factors associated with them that show the ranges of wait times (of waiting devices) for which the A and B factors are valid. Figure 10 also shows how to choose the appropriate A and B factors according to the wait time of a waiting device.

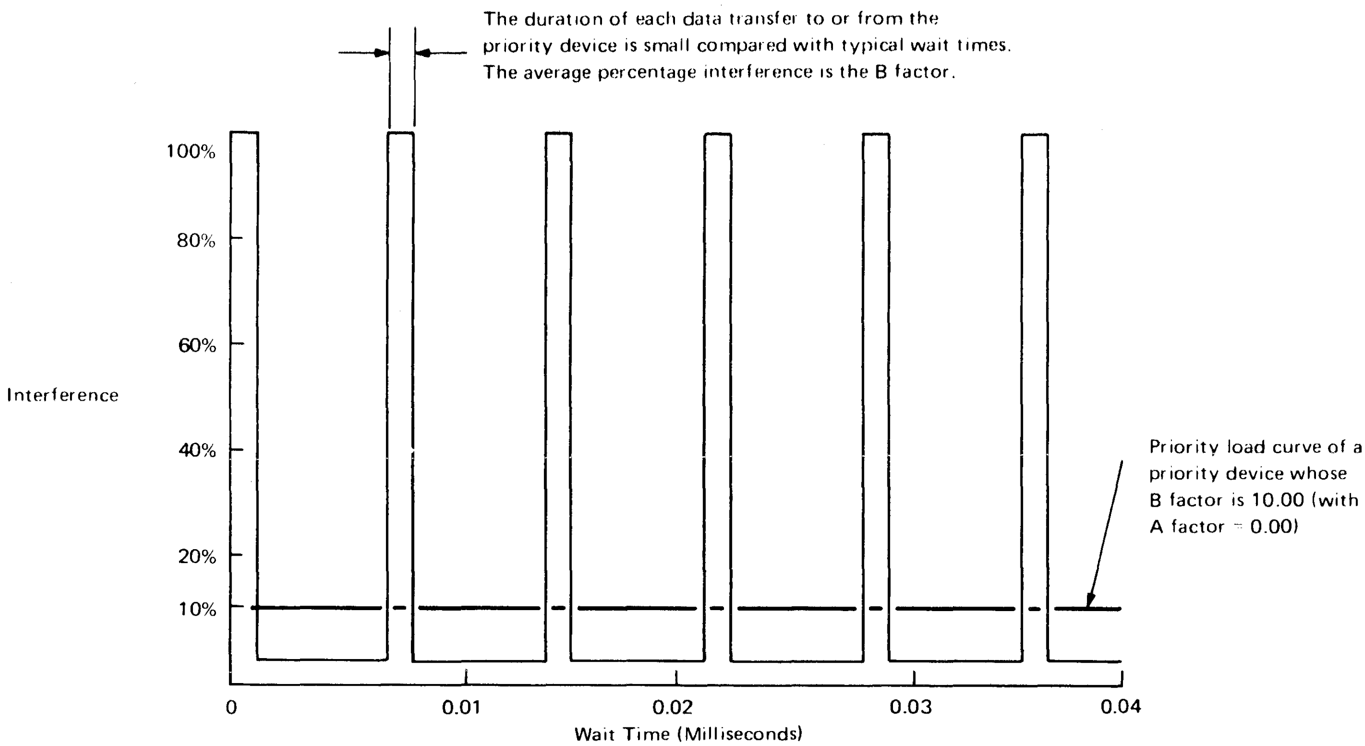


Figure 9. Example of Priority Load Curve of a Priority Device Causing Interference by Transferring Data (B Factor Interference)

Device Load

When channel service to priority devices has finished (see Figure 7), channel service to the waiting device then starts and continues until the data byte has been transferred to, or from, the waiting device. The delay caused by providing this channel service to the waiting device is called the device load and is expressed in the channel evaluation factor tables as a percentage of the device's own wait time.

Priority device

These priority time factors .... indicate that the corresponding A and B factors are valid for these wait-time ranges

Input/output device	Priority load: Time	Priority load: A	Priority load: B	
1442 Card Read Punch Model N1				
Read EBCDIC	0.16	16.2	0	0.16 ms to 0.46 ms
	0.46	3.44	27	0.46 ms to 32 ms
	32	703	5.9	32 ms and longer

Example 1

When considering the priority load of an IBM 1442 Card Read Punch Model N1, (that is reading EBCDIC), upon a waiting device that has a wait time of 0.41 ms, use the following priority load factors:

A = 16.2 and B = 0.00 (because 0.41 ms is in the range 0.16 ms to 0.46 ms)

Example 2

Similarly, for a waiting device that has a wait time of 10.00 ms, use the following priority load factors:

A = 3.44 and B = 27 (because 10.00 ms is in the range 0.46 ms to 32 ms)

Figure 10. Examples Showing how to Choose Priority Load Factors

Priority assignments for devices that are to be connected to the byte-multiplexer channel should be established during the physical planning phase of an installation so that cables for the I/O devices can be properly specified. The channel performance is affected by the priority sequence in which the I/O devices are attached to the channel.

The underlying principle in assigning priorities to devices on the byte-multiplexer channel is that the highest priority is given to:

1. Those devices that would overrun (that is, lose data) if channel service were delayed beyond the wait time.

2. Those devices that are least able to tolerate interference (that is, have the shortest wait times).

CLASSES

In the assignment of priorities, byte-multiplexer channel devices are considered in three classes:

Class 1 Devices that are liable to overrun, such as the IBM 2501 Card Reader.

Class 2 Devices that need channel service to be synchronized with their mechanical operations. For example, the IBM 2540 Card Read Punch has a constant mechanical cycle. A delay in channel service for such a device usually causes an additional delay because data cannot be transferred until the next operational point is reached in the device cycle.

Class 3 Devices that do not need synchronized channel service, such as an IBM 2260 Display Station with an IBM 2848 Display Control. Similarly, the IBM 1443 Printer is a class 3 device. It can begin printing as soon as its buffer is full and line spacing is completed; any loss of device performance is due solely to delay in providing channel service.

PRIORITIES

Assign priorities in class order, with class 1 devices having the highest priority and class 3 devices having the lowest. (Class 2 and class 3 devices may operate with reduced performance on an overloaded channel but are not liable to data overrun). Within each class, assign decreasing priority to devices in order of their increasing wait times, that is, the devices with the shortest wait times should have the highest priorities.

Example: Assume that an IBM 2501 Card Reader, an IBM 1442 Reader Punch, an IBM 3270 Information Display Terminal, and an IBM 1419 Magnetic Character Reader/Sorter are to be connected to the Model 115 multiplexer channel. After these devices have been sorted by classes, the following priorities will be found:

- First Priority: 1419 Magnetic Character Reader/Sorter (class 1)
- Second Priority: 2501 Card Reader (class 1, wait time greater than 1419)
- Third Priority: 1442 Reader Punch (class 1 with inseparable class 2 component)

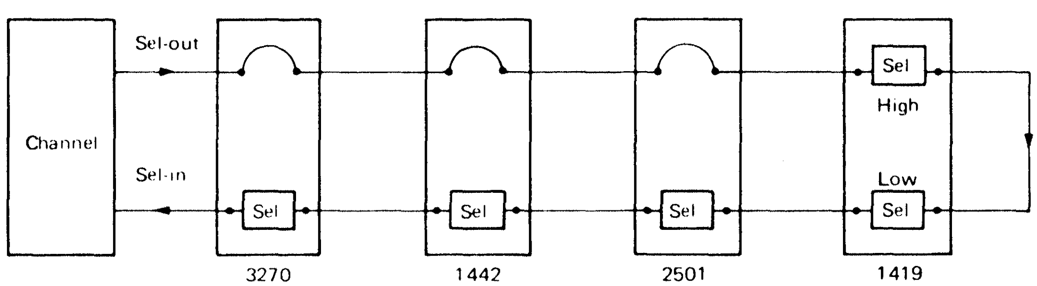


Figure 11. Example for Assigning Priority on the MPX-Channel

- Fourth Priority: 3270 Information Display Terminal (class 3).

The priorities thus found are put into effect by appropriate wiring of the select-out signal which the channel uses to poll its connected devices. The device that first receives the select-out signal can seize it and block further propagation. For our example, the select-out signal must be wired as shown in Figure 11, where the 1419 receives this signal first.

The configuration shown in Figure 11 was obtained from two criteria, that is, class and device wait time. The same is true for any other configuration, class and wait time determine select-out routing.

Figure 22 in Appendix A gives the wait times for devices that can be connected to the byte-multiplexer channel and are *liable to data overrun*. The following devices are class 2 or class 3 devices and no information is given in Figure 23 as these devices do not overrun:

IBM 1017 Paper Tape Reader
IBM 1018 Paper Tape Punch
IBM 1403 Printer
IBM 1443 Printer
IBM 2250 Display Unit
IBM 2260 Display Station
IBM 2495 Tape Cartridge Reader
IBM 2540 Card Read Punch
IBM 2715 Transmission Control Unit
IBM 3270 Information Display System
IBM 3505 Card Reader
IBM 3525 Card Punch.

SPECIAL CASES

IBM 1419 Magnetic Character Reader/Sorter

See Appendix B for details of assigning priorities to this device.

Devices having Class 1 and Class 2 Components

Class 1 devices that have an inseparable class 2 component should be assigned a priority according to the class 1 wait time. For example, the IBM 1442 Card Read Punch Model 1 incorporates a class 1 reading component and a class 2 punching component. The priority that is assigned to this 1442 Card Read Punch should be in the sequence of the wait time for the reading (class 1) component.

Burst-Mode Devices

A burst-mode device monopolizes the channel for the duration of an operation — a period of time which is long relative to the wait times of typical byte-mode devices. Therefore, any class 1 device that has not finished transferring all the bytes of a byte-mode operation when the burst-mode operation begins, is very likely to overrun. Similarly, class 2 or class 3 devices are likely to lose performance. Burst-mode devices should, therefore, have the lowest priority on the channel.

IBM 2701 Data Adapter Unit, IBM 2702 Transmission Control, IBM 2703 Transmission Control

These teleprocessing devices operate in byte multiplex mode but are relatively insensitive to overrun because all teleprocessing access methods provide the means to recover lost data. These devices should be given the lowest priorities *among the class 1 devices* on the channel.

How to Test for Byte-Multiplexer Channel Data Overrun

The test for data overrun on the byte-multiplexer channel involves the calculation of a load sum (see "Glossary") for each waiting device. These calculations are given as a step-by-step procedure in the following paragraphs (and Figures 12 through 19). Before starting the step-by-step procedure:

1. Obtain *IBM System/370 Model 115 Byte-Multiplexer Channel: Load Sum Worksheet*, GX33-6007, available in pads of 50 (Figure 12).

2. Check that the devices to be connected to the byte-multiplexer channel have been assigned their priorities as described under "How to Assign Priorities of Byte-Multiplexer Channel Devices".

Now calculate the load sum as described in the example which begins on the following page.

STEP A

List the devices by name in the priority sequence previously determined. The worksheet has device boxes numbered 1 to 9 for that purpose (Figure 12). We use the example given in Figure 11.

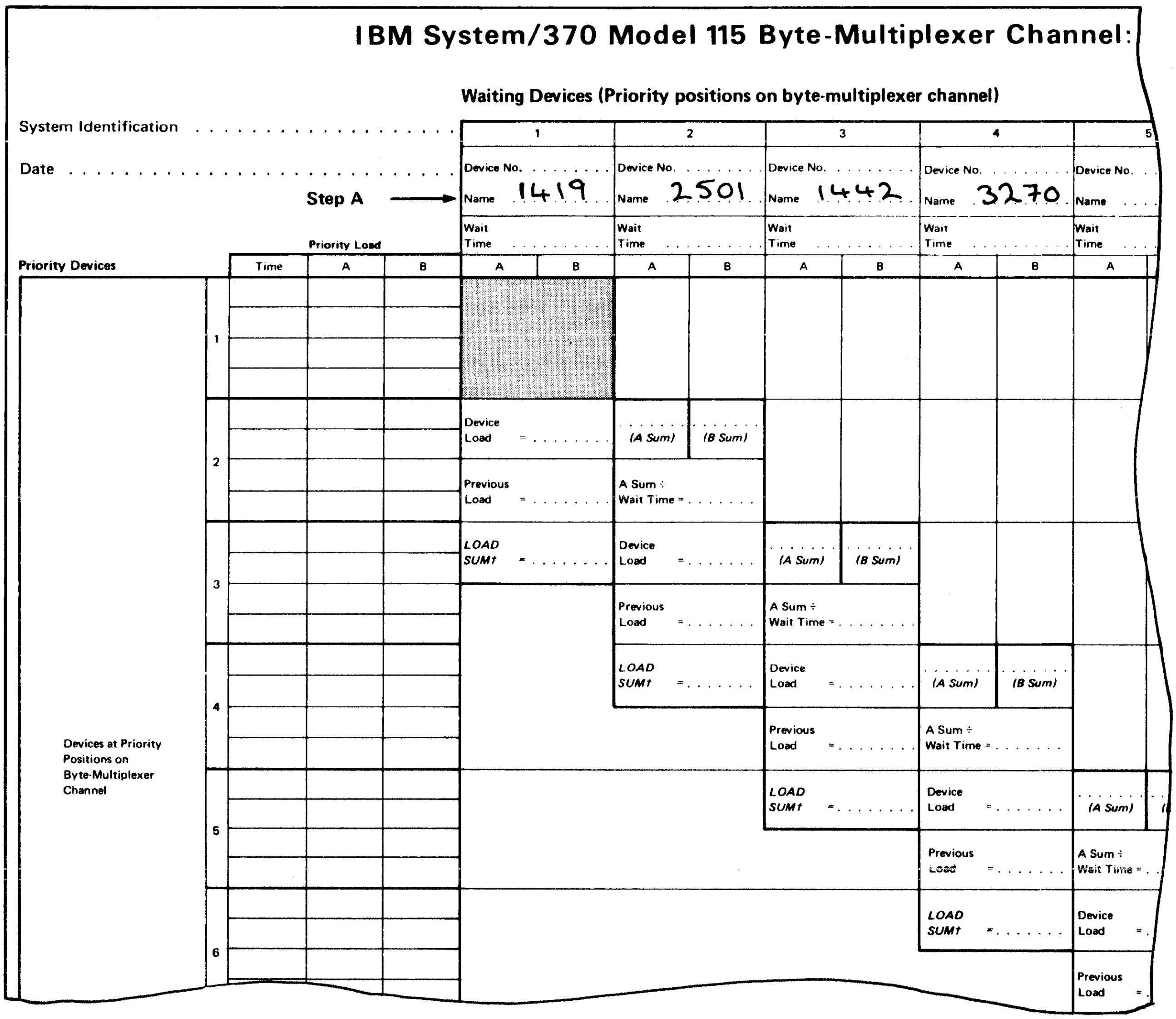


Figure 12. Load Sum Worksheet with Devices Listed in Priority Sequence

STEP B

From Figures 22 and 23 obtain the wait times of each device and insert these times on the worksheet (Figure 13). Notice that no times are required for the 3270 because this device is overrun-free. After entering the devices' wait times, proceed to step C.

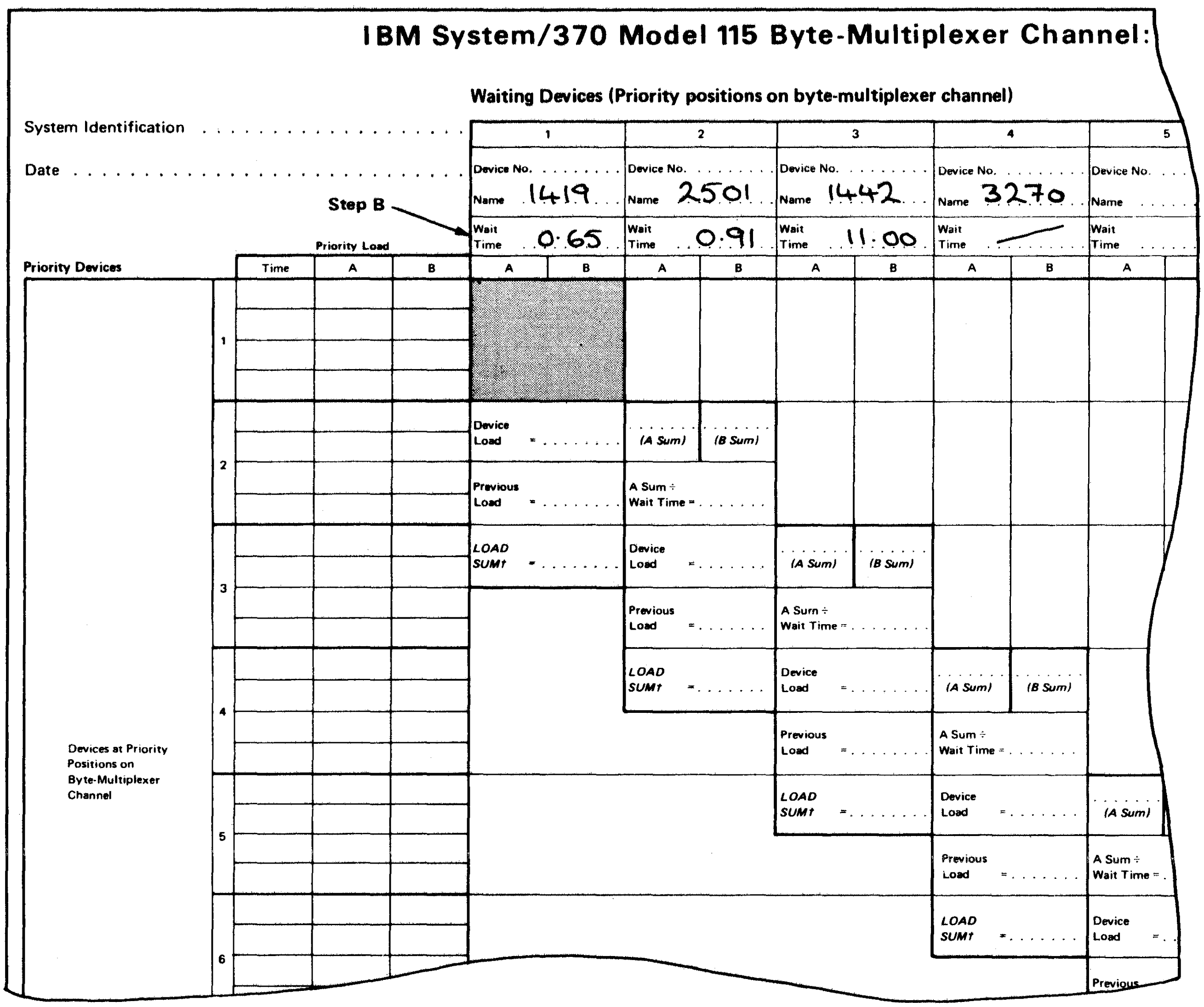
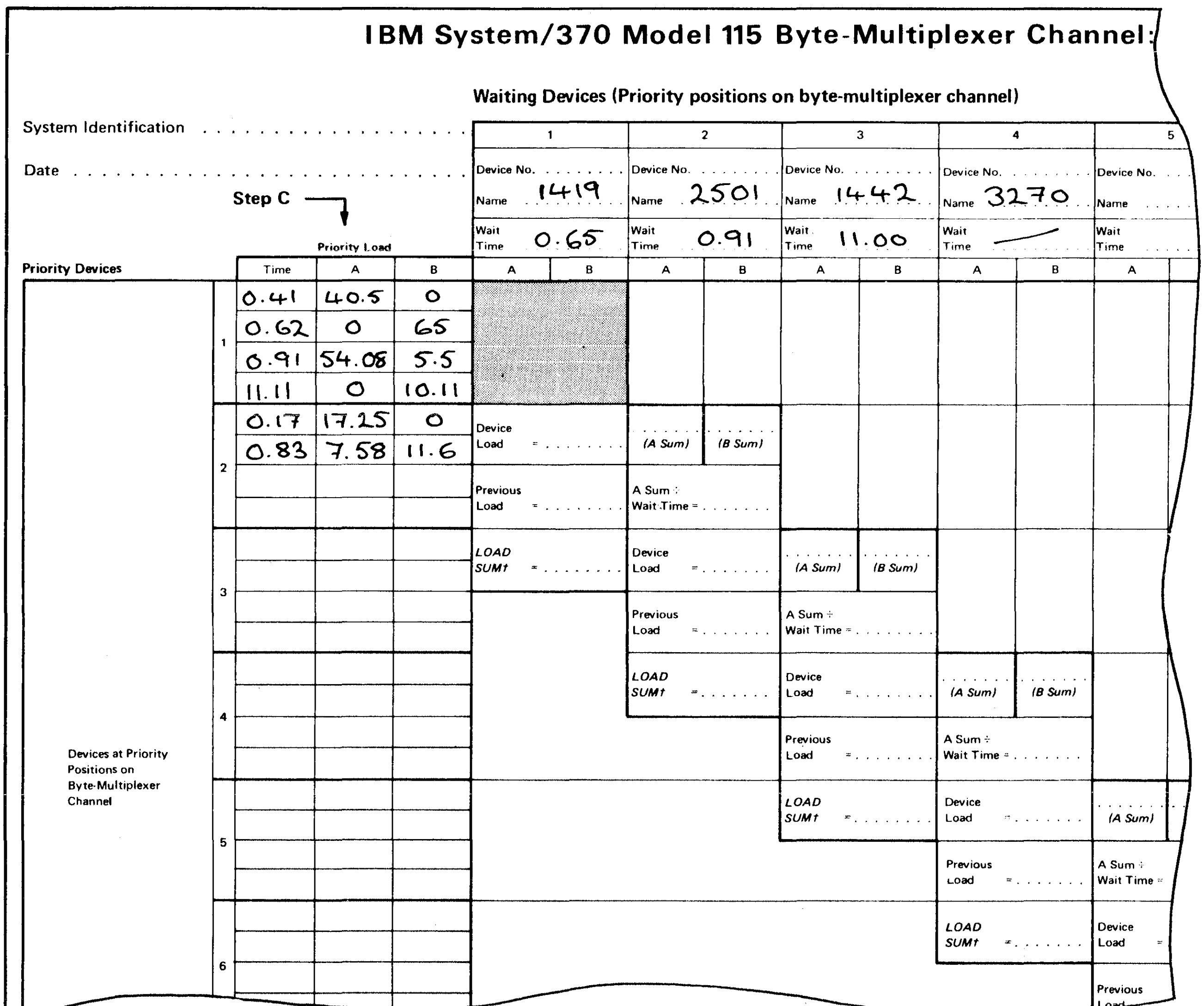


Figure 13. Device Wait Times Listed

STEP C

Notice the priority load column at the left-hand side of the sheet. Obtain the priority load (time, A, B) from the appendixes for the first and second devices on the channel. The third device (the 1442 in our example) need not be listed because the 1442 creates a priority load only for the 3270 which is overrun-free, hence, independent of any priority load. After writing in the priority loads, the worksheet will appear as shown in Figure 14.

Notice that you must list *all* times that a device may have, e.g., if there are two or three different priority loads, all of them must be listed. This is necessary because, in the next steps, you must select the appropriate priority load upon the waiting device as discussed under "Multiple A and B Factors" (see Figure 10).



IBM System/370 Model 115 Byte-Multiplexer Channel

System Identification . . . .

Date . . . .

Step C

Waiting Devices (Priority positions on byte-multiplexer channel)

	1	2	3	4	5
Device No.					
Name	1419	2501	1442	3270	
Wait Time	0.65	0.91	11.00	—	

Priority Devices — Priority Load

Priority position	Time	A	B
1	0.41	40.5	0
	0.62	0	65
	0.91	54.08	5.5
	11.11	0	10.11
2	0.17	17.25	0
	0.83	7.58	11.6
3			
4			
5			
6			

Devices at Priority Positions on Byte-Multiplexer Channel

Device Load = ... (A Sum) (B Sum)

Previous Load = ... A Sum ÷ Wait Time = ...

LOAD SUM† = ...

Figure 14. Priority Loads Listed

STEP D

Select the priority load which the first priority device (the 1419) imposes on the second device (the 2501 in our example). Since the priority load column shows four A and B factors for the first device, look for the A and B factors that represent a range into which the wait time of the 2501 fits.

- the wait time of the 2501 is 0.91
- the priority load times of the 1419 are 0.41, 0.62, 0.91 and 11.11. Because 0.91 is the same as the wait time of the next device, use the A and B factors associated with the "time" 0.91 and copy these factors as priority loads into the A and B columns of the second device (Figure 15).

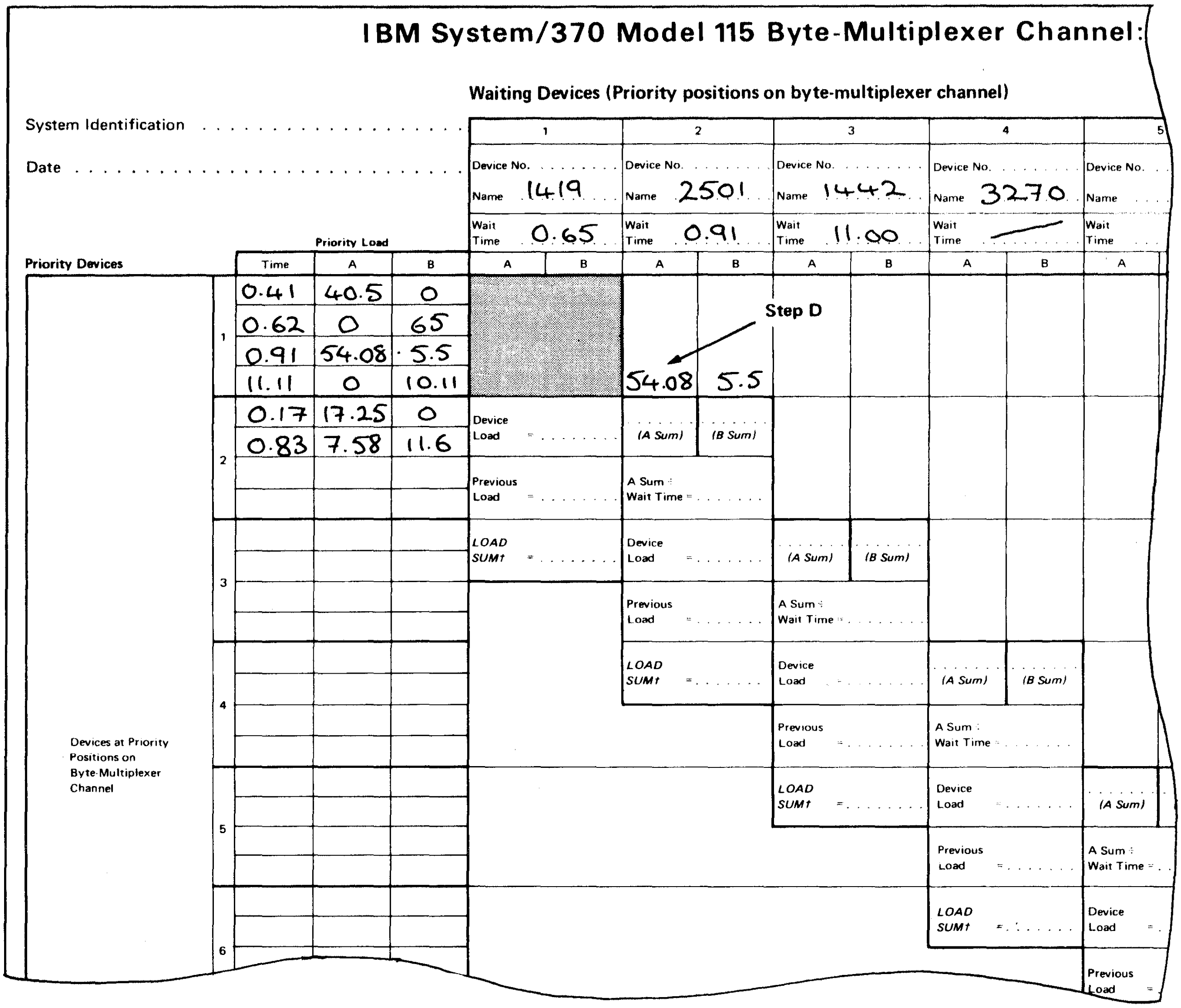


Figure 15. Priority Loads Inserted for Second Device

STEP E

You can now calculate whether the 2501 will overrun or not by proceeding as follows:

1. Add the priority loads to obtain an A sum and a B sum. Since there is only one priority load each, the A factor is already the A sum and so is the B factor the B sum.

2. Divide the A sum by the wait time (i.e., 54.08 by 0.91) and write the result into the appropriate box.

3. Get the device load (of the 2501) and the previous load (of the 2501) from Appendix A and enter these values into the appropriate boxes (Figure 16).

4. Add (from bottom to top) previous load, device load, quotient of A sum by wait time, and B sum. In our example, the result is 91.8, and, since this does not exceed 100.0, the 2501 will definitely not overrun.

The next step will now be a similar calculation for the 1442.

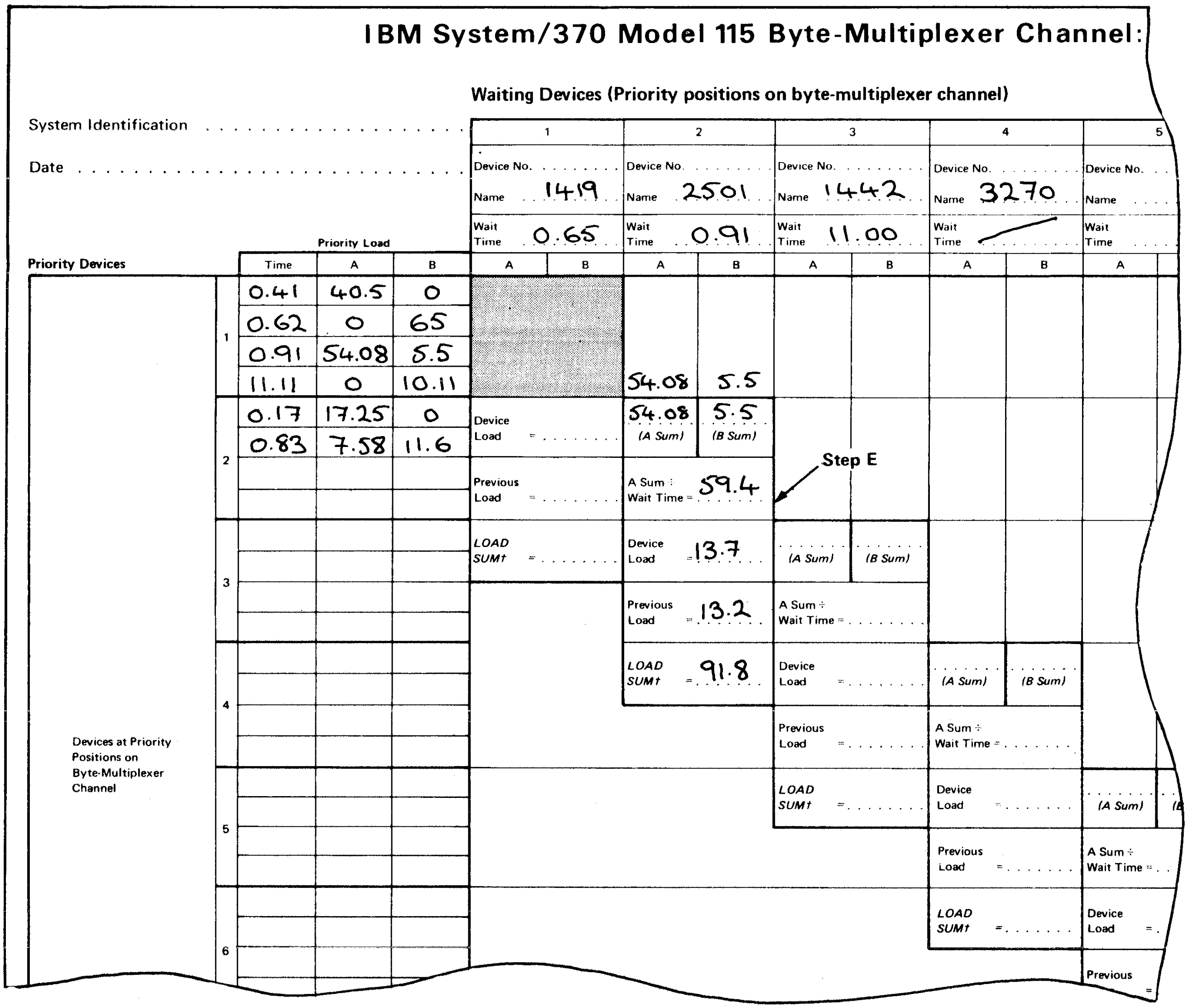


Figure 16. All Factors Added to Obtain Load Sum for 2501

STEP F

To calculate the overrun situation for the third device, select the 1419 priority load range that falls into the wait time of the 1442, then select the priority load which the second device (the 2501) imposes on the 1442 (Figure 17).

Notice that the wait time is 11.00 which falls into the range '0.91 to 11.11' for the 1419. Therefore, the A and B factors are 54.08 and 5.5.

IBM System/370 Model 115 Byte-Multiplexer Channel:

Waiting Devices (Priority positions on byte-multiplexer channel)

System Identification . . . .

Date . . . .

	1	2	3	4	5
Device No.					
Name	1419	2501	1442	3270	
Wait Time	0.65	0.91	11.00	—	

Priority Devices

Devices at Priority Positions on Byte-Multiplexer Channel	Time	Priority Load A	Priority Load B
1	0.41	40.5	0
	0.62	0	0.65
	0.91	54.08	5.5
	11.11	0	10.11
2	0.17	17.25	0
	0.83	7.58	11.6
3			
4			
5			
6			

Waiting device 1:

Device Load = ...

Previous Load = ...

LOAD SUM† = ...

Waiting device 2:

A	B
54.08	5.5
54.08 (A Sum)	5.5 (B Sum)

Device Load =

A Sum ÷ Wait Time = 59.4

Device Load = 13.7

Previous Load = 13.2

LOAD SUM† = 91.8

Waiting device 3:

A	B
54.08	5.5
7.58	11.6
(A Sum)	(B Sum)

Step F

A Sum ÷ Wait Time = ...

Device Load = ...

Previous Load = ...

LOAD SUM† = ...

Waiting device 4:

(A Sum) (B Sum)

A Sum ÷ Wait Time = ...

Device Load = ...

Previous Load = ...

LOAD SUM† = ...

Waiting device 5:

(A Sum)

A Sum ÷ Wait Time =

Device Load =

Previous Load =

Figure 17. Priority Load of all Previous Devices Copied

STEP G

In step G, add the priority loads to obtain an A sum and a B sum (Figure 18).

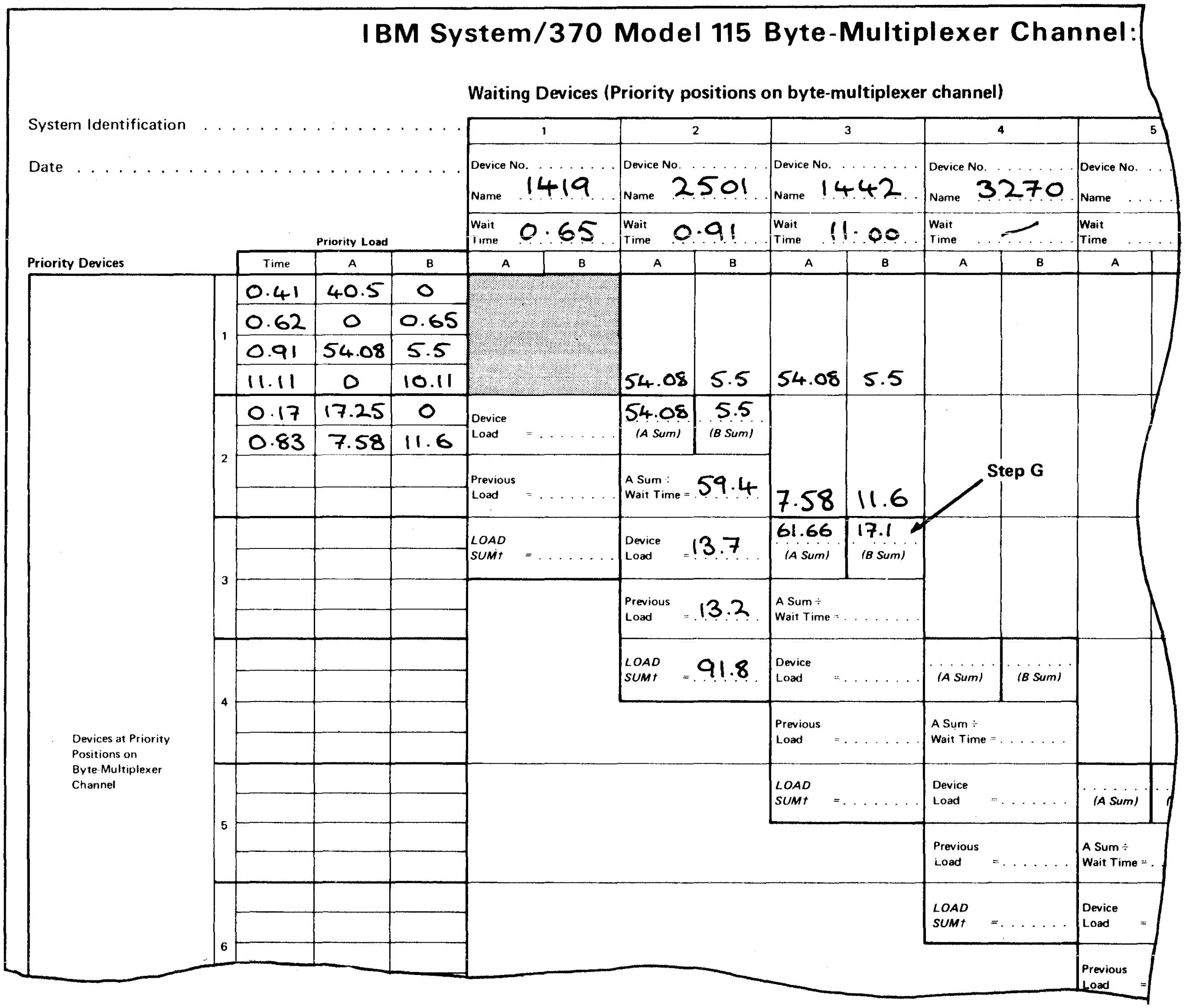


Figure 18. Priority Loads Added to Get A-sum and B-sum

STEP H

The principle of the calculation should now be clear. The more devices there are, the greater the A and B sums will be. The remainder of the operation consists of dividing the A sum by the wait time (in our example 61.66 by 11.0), then introducing the device load, the previous load, and adding all the results including the B sum. The load sum thus obtained will show whether the 1442 will overrun or not (Figure 19).

The result shows that the 1442 cannot overrun. To sum up the example: the configuration of 1419, 2501, 1442, and 3270 would run on the Model 115 without ever incurring an overrun. To be certain, you may calculate the 1419 itself although there is rarely a need for calculating the top-priority device. In Figure 19 you see the device load and the previous load for the 1419 added (there is no priority load) and this also does not exceed 100. This is proof of a sound configuration.

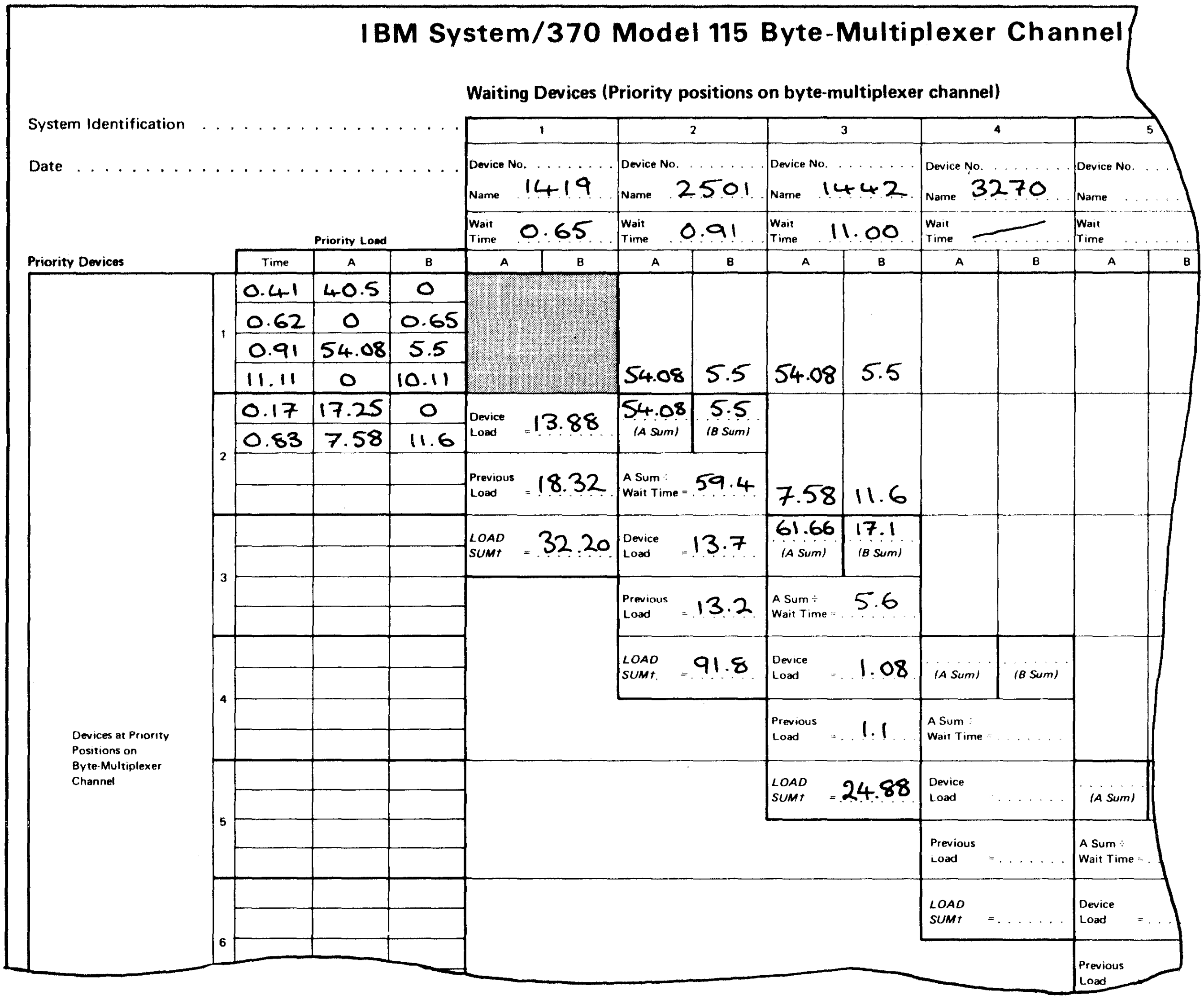


Figure 19. Load Sum for 1442 Completed

OVERRUN CONFIGURATION

The next example shows an overrun-configuration. It is assumed that a 1419, a 2501 with column binary read feature, and a 1442 (read EBCDIC) are to be connected (Figure 20).

The results in Figure 20 demonstrate that the 2501 and the 1442 would both have an overrun hazard. The 2501 with column binary feature transfers two bytes per card column, hence imposes a greater load. The load sums, being absolute worst case figures, do not show how often the overrun would occur in practice. The decision to connect devices with a potential overrun hazard must be made by considering the actual application. This is because the foregoing procedure for testing data overrun on the byte-multiplexer channel assumes that:

1. Each waiting device makes its request for channel service at the worst possible time – that is, when all the priority devices combine to cause maximum interference during the waiting device's wait time. However, the greater the number of priority devices that contribute to a load sum for a particular waiting device, the less likelihood there is of all worst-case conditions occurring simultaneously.

2. Devices all work at their maximum possible data rates, or at their tolerance limits, whichever is the worst case.

3. Data field lengths and command sequences can cause the worst interference that can be reasonably expected in practice.

4. Channel programming conventions have been followed, see "Channel Programming Conventions".

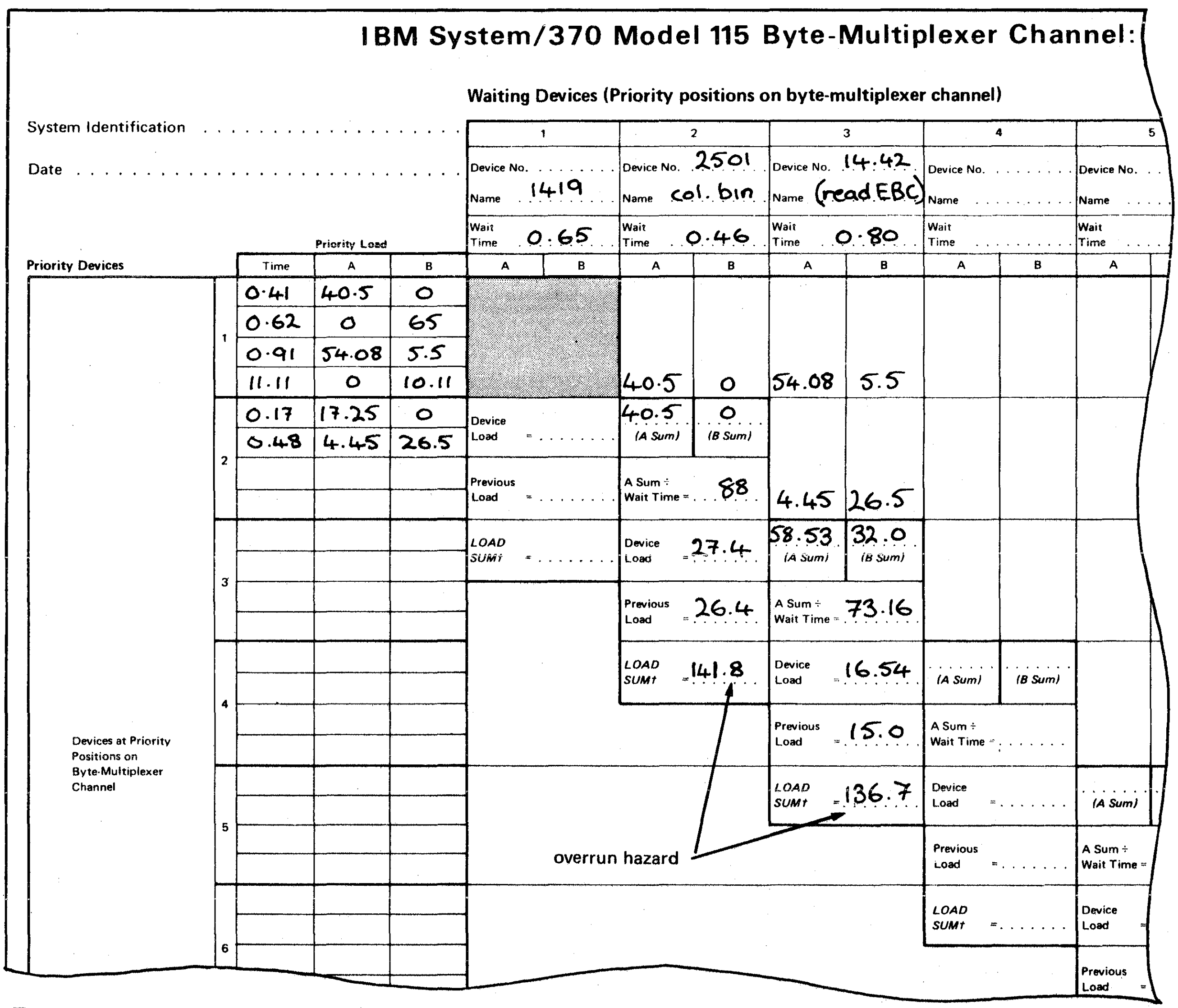


Figure 20. Example of an Overrun Configuration

I/O operations on the byte-multiplexer channel (such as data transfer and command chain handling) do not interfere with the MIP's instruction processing, because the MIP and the channel do not share microprogram control. Nor do the integrated attachments (except for DDA) interfere with the MIP. However, I/O instructions which require MIP service and channel service simultaneously – SIO, TIO, 'halt I/O' (HIO) and 'halt device' (HDV) instructions – and the associated interrupt handling *do interfere* with the MIP. (The 'store channel identifier' (STIDC) and 'test channel' (TCH) instructions for channel 0 are handled by the MIP only.)

MIP-channel interference may be calculated as:

1. Waiting time for channel service.

2. Communication time from the channel accepting selection (from MIP) to storing channel status and/or offering condition code (to MIP).

MIP WAITING TIME FOR CHANNEL SERVICE

The byte-multiplexer channel's main task is to service I/O devices. I/O requests are handled with priority over MIP requests. (I/O service may be interrupted only by an HIO instruction or an HDV instruction addressed to the device being serviced – and only in burst mode.) When all I/O requests have been serviced, the multiplexer channel tests for a request from the MIP at 60-microsecond intervals.

With normal channel utilization, the MIP does not wait longer than a few hundred microseconds for channel service. (Excessive loads on the byte-multiplexer channel can be avoided by testing for data overrun, as already described, before installation.) If an I/O device forces data transfer in burst mode, the channel automatically answers a MIP request for channel service with the 'channel busy' response (condition code 2). If a buffered I/O device is transferring data in byte mode (requesting channel service for each successive byte before the channel has returned to its idle loop), a MIP request for channel service must wait until the device has transferred an entire record.

COMMUNICATION TIME BETWEEN MIP AND BYTE-MULTIPLEXER CHANNEL

After accepting a MIP request, the byte-multiplexer channel fetches and decodes the instruction identifier. For an SIO instruction it fetches the channel address word (CAW) and handles the first CCW, selects the I/O device, tests the received initial status, stores the CSW, if applicable, and offers the condition code to the MIP. For a TIO instruction or an I/O interruption the channel stores the CSW. If the interruption is a device end (secondary) interruption, the device is selected and the status is fetched for storing in the CSW. For a TIO instruction, a condition code is also stored.

The time used by the channel microprogram for the different tasks is given in Figure 21. When an I/O selection is necessary, the elapsed time depends also on the response time of the addressed I/O device. This I/O device response time (non-overlapping channel activity) must be added to find the complete MIP interference.

Channel Activity	Interference microseconds
The time (in microseconds) is the period from "IPU-Select" on to "Response" off	
Execution of SIO for CC = 0 without IDA and PCI in CCW	97*
Additional for IDA	25
Additional for PCI	1.5
Execution of TIO for clearing:	
1. Interrupt condition in subchannel (channel status not zero or unit status with channel end, CC = 1)	58
2. Interrupt condition in I/O device (unit status not zero, without channel end, CC = 1)	62*
3. No interrupt condition (CC = 0)	41*
4. No interrupt condition, subchannel busy (CC = 2)	None
Interrupt handling for clearing:	
1. PCI interrupt	50 to 118**
2. Interrupt condition in subchannel (channel status not zero or unit status with channel end)	124 to 193**
3. Interrupt condition in I/O device (unit status not zero, without channel end)	201**

* Includes time for selecting device (time varies depending on type of device). For further information see channel's I/O selection timing (Figure 5) and the appropriate System Library manual for the I/O device.

** Contains interrupt priority handling, timing depends on subchannel address.

Figure 21. Interference with MIP during I/O instructions, Caused by Channel Service to Devices Connected to Byte-Multiplexer Standard I/O Interface

Program Overrun

A particular effect of channel interference with MIP processing (see previous section) is program overrun. Program overrun results from a program being slowed down to such an extent that the program is late in providing real-time service to a device and, therefore, causes incorrect operation of that device.

The possibility of program overrun must always be considered for those I/O operations that involve high-speed document-handling devices such as the 1419 Magnetic Character Reader. In program-sort mode, the 1419 reads data into the main storage while the document is passing the read station. Then, before the document reaches the stacker-select station, the program must calculate the stacker required and issue the correct stacker-select command. If the stacker-select command arrives too late (because of program overrun), the document is not stacked correctly and the channel program stops.

Interference with MIP processing by the DDA can result in program overrun. See "Interference on Model 115" and Appendix C.

HOW TO ASSESS PROGRAM OVERRUN

To investigate the possibility of program overrun, proceed as follows:

1. Establish the available program time, that is, the time during which the program must perform its calculations and issue the command. Call this "A" (available time).

2. Establish the time that the program takes between reading data and issuing the command. (This time can be established by totaling the execution times of the component instructions – see "Appendix B. Instruction Timings" in *IBM System/370 Model 115 Functional Characteristics*, GA33-1510). When establishing this time, take all program activity into account including, for example, the handling of the interruption after the data is read, and the SIO for the selection of the I/O device, and any possible supervisor program activity. Call this time "P" (processing time).

3. Subtract the processing time "P" from the available time "A" and you will get the maximum waiting time for channel service.

4. Test for program overrun in the same manner as explained in the foregoing section for data overrun. Regard the MIP as the device with the lowest priority on channel. Calculate the priority load of all connected I/O devices which may run concurrently.

$$\frac{\text{Device load}}{\%} = \frac{\text{Device time of waiting device}}{\text{Waiting time for MIP service}} \times 100$$

$$\frac{\text{Previous load}}{\%} = \frac{0.1 \text{ ms}}{\text{Waiting time for MIP service}} \times 100$$

If the load sum exceeds 100 per cent, program overrun may occur.

Channel Utilization

The percentage of time for which a channel is busy and is therefore not available for use by other devices is called the channel utilization. Excessive channel utilization (greater than 70%) can cause queues to form for tasks or devices that need to use the channel. This excessive channel utilization can occur only in large configurations however, and is unlikely to be the limiting factor in system performance.

Because excessive loading of the byte-multiplexer channel can be investigated adequately by checking for data overrun and by checking the interference with the MIP, it is unnecessary to evaluate channel utilization for the byte-multiplexer channel.

Appendix A. Channel Evaluation Factors for Devices on Byte-Multiplexer Channel

Input/output device	Class	Nominal data rate	Cycle time	Wait time	Device load	Previous load	Priority load: Time	Priority load: A	Priority load: B
		kilobytes/s	ms	ms	%	%	ms	% ms	%
1287 Optical Reader									
1428 and ASCS OCR font	1M*	2.50	Var	0.40	16.55	30.0	0.46 0.95	45.75 32.97	0 16.6
1428 and ASCS OCR font with blank detection	1M*	2.50	Var	0.13	50.92	92.0	0.46 0.96 13.33	45.75 14.32 110.67	0 32.5 25.2
1428 and ASCS OCR font with imprinting	1M*	0.50	Var	2.00	3.31	6.0	0.46 1.39 1.54	45.75 0 44.17	0 33 4.3
7B1/Gothic font	1M*	0.40	Var	2.50	2.65	4.8	0.46 1.40 1.52	45.75 0 44.80	0 32.8 3.5
Numeric handwritten characters	1M*	0.33	Var	3.00	2.21	4.0	0.46 1.39 1.54	45.75 0 46.31	0 33 2.9
Handwritten with blank detection	1M*	0.33	Var	1.50	4.41	8.0	0.46 1.41 1.54	45.75 0 41.85	0 32.6 5.4
Mark read 10 positions	1M*	0.50	Var	2.00	3.31	6.0	0.46 0.93 1.03	45.75 0 45.85	0 49 4.3
Mark read 12 positions	1M*	0.86	Var	2.30	2.88	5.22	0.46 0.93 1.03	45.75 0 46.37	0 49 3.8
Roll form	1M*	2.50	Var	0.40	16.55	30.0	0.16 0.44	16.47 8.33	0 14
Roll form with separate mark line command	1M*	2.50	Var	0.40	16.55	30.0	0.29 0.63	28.73 20.68	0 13.5
Roll form with blank detection	1M*	2.50	Var	0.13	50.92	92.0	–	–	–
Roll form with blank detection and separate mark line command	1M*	2.50	Var	0.13	50.92	92.0	–	–	–

M = Byte mode on byte-multiplexer channel
Var = Variable

* The 1287 is classified as '1' because it is capable of overrun. Recovery from overrun is completed under program control (no manual intervention is needed) and there is only a slight degradation of performance.

** The 1288 is not currently offered for attachment to the System/370 Model 115. All the 1288 figures are provided for information purposes only.

Figure 22. (1 of 3) Byte-Multiplexer Channel Devices – Channel Evaluation Factors

Input/output device	Class	Nominal data rate	Cycle time	Wait time	Device load	Previous load	Priority load		
							Time	A	B
		kilobytes/s	ms	ms	%	%	ms	% ms	%
1288 Optical Page Reader**									
Formatted alphameric	1M	1.00	Var	1.00	5.58	12.0	0.40	36.65	7.4
Unformatted alphameric	1M	1.00	Var	1.00	5.58	12.0	0.40	36.72	7.2
Handwritten/Gothic font	1M	0.33	Var	2.50	2.23	4.80	0.40	38.37	3.1
Mark read 1 position	1M	1.00	Var	1.00	5.58	12.0	0.40	36.66	7.4
Mark read 2 positions	1M	0.56	Var	1.77	3.15	6.78	0.40	37.92	4.2
Mark read 3 positions	1M	0.39	Var	2.54	2.20	4.73	0.40	38.42	2.9
Mark read 4 positions	1M	0.30	Var	3.31	1.69	3.62	0.40	39.68	0
Mark read 5 positions	1M	0.49	Var	4.08	1.37	2.94	0.40	39.68	0
Mark read 6 positions	1M	0.41	Var	4.85	1.15	2.47	0.40	39.68	0
Mark read 7 positions	1M	0.36	Var	5.62	0.99	2.14	0.40	39.68	0
Mark read 8 positions	1M	0.31	Var	6.39	0.87	1.87	0.40	39.68	0
Mark read 9 positions	1M	0.28	Var	7.16	0.78	1.68	0.40	39.68	0
Mark read 10 positions	1M	0.25	Var	7.93	0.70	1.51	0.40	39.68	0
Mark read 11 positions	1M	0.23	Var	9.70	0.64	1.38	0.40	39.68	0
Mark read 12 positions	1M	0.21	Var	9.47	0.59	1.27	0.40	39.68	0
1419 Magnetic Character Reader	1M	See Appendix B							
1442 Card Read Punch Model N1									
Punch-only EBCDIC	2M	0.12	656	11.00	1.08	1.1	0.16	16.4	0
Punch-only card image	2M	0.24	656	5.5	2.16	2.2	0.16 5.26	16.4 7.77	0 1.6
Read EBCDIC	1M	0.53	150	0.80	16.54	15	0.16 0.70 2.5	16.4 5.8 30	0 19 7
Read card image	1M	1.07	150	0.40	33.08	30	0.16 0.35 2.5	16.4 4.74 50	0 34 14
2501 Card Reader Model B2									
EBCDIC	1M	1.33	60	0.91	13.70	13.2	0.17 0.83	17.25 7.58	0 11.6
Column binary	1M	2.67	60	0.46	27.41	26.4	0.17 0.48	17.25 4.45	0 26.5

M = Byte mode on byte-multiplexer channel
Var= Variable

Figure 22. (2 of 3) Byte-Multiplexer Channel Devices – Channel Evaluation Factors

Input/output device	Class	Nominal data rate kilobytes/s	Cycle time ms	Wait time ms	Device load %	Previous load %	Priority load: Time ms	Priority load: A % ms	Priority load: B %
2520 Card Read Punch Model B1									
Read/punch EBCDIC	1/2M	1.33	120	1.02	12.33	11.8	4.4 31.75	438 151	0 9
Read/punch card image	1/2M	2.67	120	1.02	18.75	11.8	8.42 40	842 280	0 15
2520 Card Read Punch Model B1 and 2520 Card Punch Model B2									
Punch-only EBCDIC	2M	0.67	120	9.0	46.92	1.33	4.28 59.5	428 119	0 5
Punch-only card image	2M	1.33	120	9.0	91.92	1.33	8.33 63.2	833 266	0 9
2520 Card Punch Model B3									
Punch-only EBCDIC	2M	0.40	200	15.00	28.15	0.8	4.28 95.2	428 225	0 2.14
Punch-only card image	2M	0.80	200	15.00	55.15	0.8	8.33 87	833 472	0 4.2

M = Byte mode on byte-multiplexer channel
Var = Variable

Figure 22. (3 of 3) Byte-Multiplexer Channel Devices – Channel Evaluation Factors

Appendix B. IBM 1419 Magnetic Character Reader: Priority Assignment and Channel Evaluation Factors

This appendix describes:

1. How to assign the priority of a 1419 Magnetic Character Reader in relation to other devices (including other 1419s) on the byte-multiplexer channel.

2. How to enter 1419 channel evaluation factors on the byte-multiplexer channel load sum worksheet. This information is required for steps A to F in "How to Test for Byte-Multiplexer Channel Overrun" for calculating the load sum of the 1419.

HOW TO ASSIGN PRIORITY POSITION OF A 1419

Treat the 1419 as a class 1 device; that is, assign it a priority according to its wait time as described under "Priorities" in "How to Assign Priorities of Byte-Multiplexer Channel Devices". Figure 23 gives the wait times.

When the priority of the 1419 is being assigned, the 1419(s) should be the last unit(s) on the physical interface.

HOW TO ENTER 1419 CHANNEL EVALUATION FACTORS ON LOAD SUM WORKSHEET

Obtain the wait time, device load, previous load, and priority-load factors from Figure 23 and enter them on the load sum worksheet as described in Figures 13, 14, and 15.

1419 Magnetic Character Reader with feature:	Class	Nominal data rate	Cycle time	Wait time	Device load	Previous load	Priority load		
							Time	A	B
		kilobytes/s	ms	ms	%	%	ms	% ms	%
S/360 Adapter – Single Address	1M	1.25	32.3	0.65	13.88	18.32	0.287 1.04	28.7 13.75	0 14.51
S/360 Adapter – Single Address, and Batch Numbering	1M	1.25	32.3	0.65	13.88	18.32	0.55 1.35	55.3 33.99	0 15.75
S/360 Adapter – Dual Address, as supported by DOS	1M	1.25	32.3	0.65	13.88	18.32	0.41 0.62 0.91 11.11	40.5 0 54.08 0	0 65 5.5 10.11

Figure 23. 1419 Channel Evaluation Factors

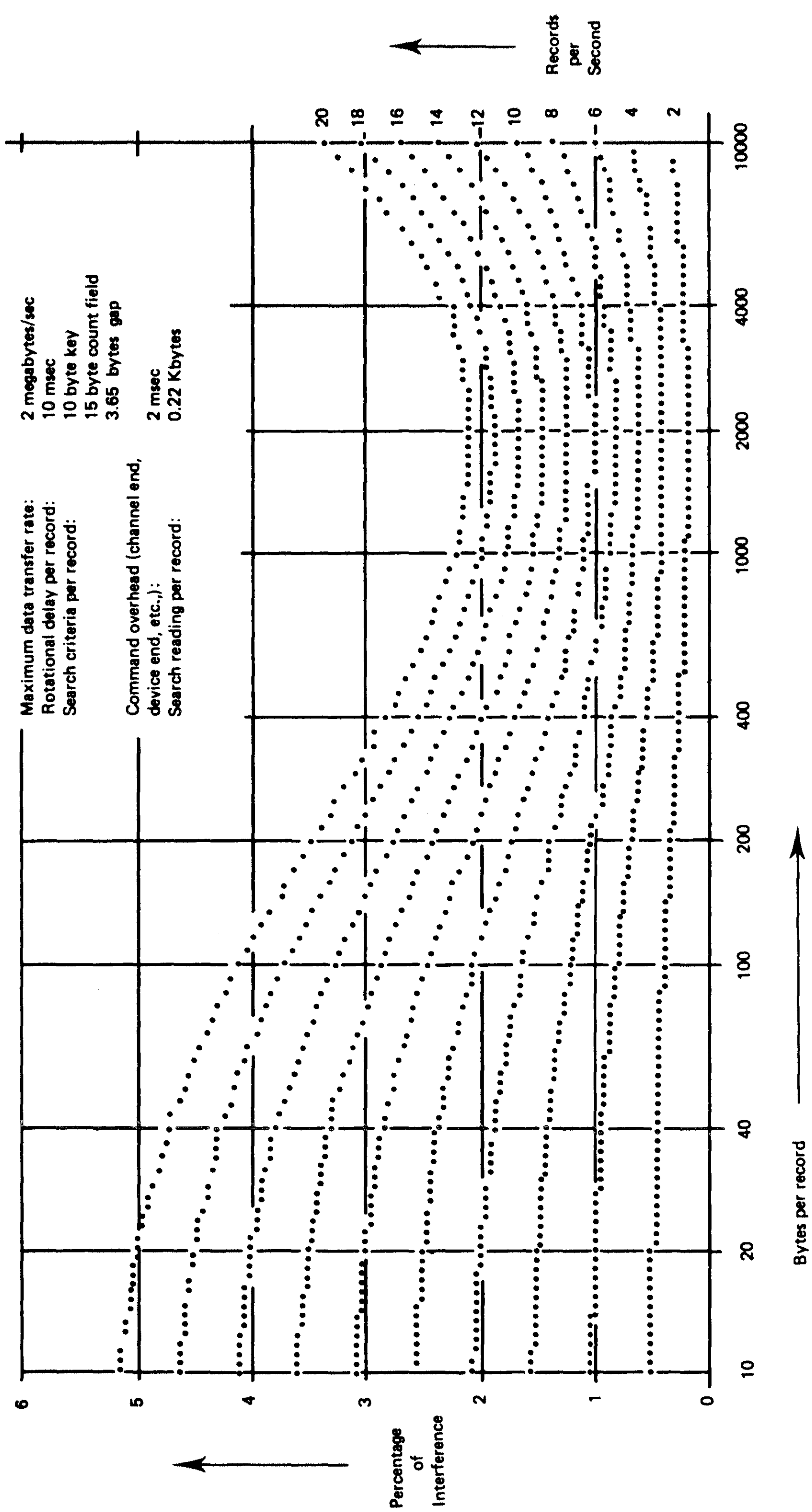


Figure 24. Percentage of DDA Interference with MIP Processing, assuming Each Access by MIP to Main Storage Coincides with an Access for Data Transfer (worst case)

Appendix D. Abbreviations

ABBREVIATIONS

avail	available
bps	bits per second
CAW	channel address word
CCW	channel command word
CSW	channel status word
cmnd	command
cps	characters/second
CPU	central processing unit
DDA	direct disk attachment
EBCDIC	extended binary-coded-decimal interchange code
HDV	halt device
HIO	halt I/O
ICA	integrated communications adapter
IDA	indirect data addressing
I/O	input/output
MIP	machine instruction processor
ms	millisecond
MSC	main storage controller
No.	number
PCI	program-controlled interruption
s	second (of time)
SIO	start I/O
STIDC	store channel identifier
SVP	service processor
TCH	test channel
TIC	transfer in channel (channel command)
TIO	test I/O
μs	microsecond
var	variable
WT	wait time

Channel Service: The channel activity that is needed to select a particular device and to completely transfer a byte.

Channel Utilization: For a given rate of record transfer (records per second), channel utilization is the percentage of time that a channel is busy and unavailable to other devices.

Data Overrun: The failure of the channel to provide input or output service fast enough to prevent the loss of data. Data overrun can occur only on I/O devices or control units that have no data buffer (class 1 devices).

Device-Load Factor: The percentage of the device's wait time that is required for the channel to provide the device with channel service.

Immediate Operation: An operation is called *immediate* when the I/O device signals the channel end condition immediately on receipt of the command code. (Further information is given in *IBM System/370 Principles of Operation*, GA22-7000).

Interference: Any activity that causes a device to wait for the completion of channel service.

Kilobyte (per second): One thousand bytes (per second).

Load Sum: The percentage of a waiting device's wait time that is required to allow for all possible I/O interference. The load sum is made up of priority-load factors, a previous-load factor, and the device-load factor.

Previous-Load Factor: The percentage of a device's wait time that is required to allow a lower-priority device to finish using channel service. (The previous-load figures given in the channel evaluation factor tables assume that interference of this kind lasts for approximately 0.1 millisecond.)

Priority Device: A device that can cause a lower-priority device to wait for the completion of channel service.

Priority-Load Factors: These yield the percentage of a device's wait time that is required to provide channel service to a higher-priority device.

Program Overrun: The failure of the program to provide an I/O device with *program* service fast enough to prevent incorrect operation.

Waiting Device: A device that is caused to wait for the completion of channel service.

Index

O

P

R

S

T

U

W

Numeric

IBM System/370 Model 115
Channel Characteristics

Order No. GA33-1516-0

READER'S COMMENT FORM

Your views about this publication may help improve its usefulness; this form will be sent to the author's department for appropriate action. Using this form to request system assistance or additional publications will delay response, however. *For more direct handling of such requests, please contact your IBM representative or the IBM Branch Office serving your locality.*

Possible topics for comment are:

Clarity Accuracy Completeness Organization Index Figures Examples Legibility

Cut or Fold Along Line

What is your occupation? ________________________________

Number of latest Technical Newsletter (if any) concerning this publication: ____________

Please indicate in the space below if you wish a reply.

Thank you for your cooperation. No postage stamp necessary if mailed in the U.S.A. (Elsewhere, an IBM office or representative will be happy to forward your comments.)

GA33-1516-0

Your comments, please . . .

This manual is part of a library that serves as a reference source for systems analysts, programmers, and operators of IBM systems. Your comments on the other side of this form will be carefully reviewed by the persons responsible for writing and publishing this material. All comments and suggestions become the property of IBM.

Cut or Fold Along Line

Fold Fold

First Class
Permit 40
Armonk
New York

Business Reply Mail
No postage stamp necessary if mailed in the U.S.A.

Postage will be paid by:

International Business Machines Corporation
Department 813B
1133 Westchester Avenue
White Plains, New York 10604

Fold Fold

System/370 Model 115 Channel Characteristics Printed in U.S.A. GA33-1516-0

IBM

International Business Machines Corporation
Data Processing Division
1133 Westchester Avenue, White Plains, New York 10604
(U.S.A. only)

IBM World Trade Corporation
821 United Nations Plaza, New York, New York 10017
(International)

GA33-1516-0

System/370 Model 115 Channel Characteristics Printed in U.S.A. GA33-1516-0

IBM

International Business Machines Corporation
Data Processing Division
1133 Westchester Avenue, White Plains, New York 10604
(U.S.A. only)

IBM World Trade Corporation
821 United Nations Plaza, New York, New York 10017
(International)

370/115

_____ Check optional features -- if they are incorrect, you may have to order a new microcode disk.

_____ Has enough control storage been ordered?

_____ 2311 and 1052 compatibility - should be considered interim for conversion only.

_____ Check platen width and ribbon part number on 5213. 13-7/8" is IBM size. OEM size is 13-1/8".

_____ Contact Region on any non-standard RPQs, (e.g.- 3411 on the MPX channel.)

_____ Customer should maintain checkpoints as loss of power means loss of memory.

_____ Tape &/or MPX channel &/or ICA require CHAN support. If you want concurrent maintenance, you will require OLTEP. CHAN is a DOS/VS SYSGEN option.

_____ Software conversion plans. Back Release DOS 21 - 26 should be considered as an interim step only.

_____ File conversion plans, what are they & where will they be done.

_____ Space, power and air conditioning for parallel operation of hardware systems.

_____ RPQ is required if 1400 and 360/20 compatibility are both installed.

_____ 5213 cannot be used as a system printer.

_____ Speed 1.0 - 2.1 x Mod 25; 1.4 - 3.2 x Mod 22.

_____ 2311 - 2314 compat on 3340s require special addressing. Refer to the attached.

_____ Floating point is a NO CHARGE (N/C) feature. and may be required at a later date if it is not ordered. Recommend ordering it if time allows.

_____ If Integrated Communications Adapter is on order compare the ICA features against the terminals ordered to insure feature compatibility.

_____ Limited addresses available on the Multiplex channel. Consult the 3115 Channel Characteristics manual GA33-1516, also the 3115 Functional Characteristics manual GA33-1510.

370/115

INTEGRATED ADAPTERS

TYPE OF ADAPTER	CHAN	STD ADDR	OTHER ADDR AVAILABLE?
TAPE 3411/10	2	28x	RPQ
DISK 3340	1	16x	RPQ
UR (the 5425 or 2560 use only one address - x,'00D', not two normally associated with RD/PCH.)	Ø	ØØC, ØØD (THE UR IOP RESERVES ØØØ-Ø1B)	RPQ
INTEGRATED PRINTER	Ø	ØØE	RPQ
CONSOLE (CRT, 5213 & KB)	Ø	Ø1F (THE SVP RESERVES Ø1C - Ø1F)	RPQ
ICA	Ø	Ø2Ø to Ø2F, Ø3Ø-Ø34 (ACTUAL ADDRESS VARIES DEPENDING ON-LINE TYPE)	RPQ
MULTIPLEXER	Ø	Ø4Ø - ØFF	RPQ

° THE ABOVE ADDRESSES ARE ASSIGNED TO IOP'S (IO PROCESSOR), AND EXIST WHETHER OR NOT THE FEATURE IS INSTALLED AND ARE NOT AVAILABLE TO OTHER DEVICES.

° MULTIPLEXER CHANNEL HAS STANDARD 32 SUB-CHANNELS. RPQ TO EXPAND TO 64.

8 SHARED

24 UNSHARED

° IOP PRIORITY LOW TO HIGH; MIP, SVC/PROC, UR/IOP, MTA/IOP (TAPE), DDA/IOP (IFA), ICA/IOP, MPX/IOP.

- IFA -

3330·3340 intermix not available,
3340 only. RPS optional !

- 2314 FILES ON 3340

3340-addr.=	160 161 162 163
3348 Cylinders	- - - 2314 addresses - -
001-339	190 19B 1A6 1B1
340-678 (m70 only)	191 19C 1A7 1B2

- 2311 FILES ON 3340

3340-addr. =	160 161 162 163
3348 Cylinders	- - - 2311 addresses - -
1-85	190 19B 1A6 1B1
86-170	191 ' ' '
171-255	192 ' ' '
256-340	193 ' ' '
341-425 (M70 only)	194 ' ' '
426-510 "	195 ' ' '
511-595 "	196 ' ' '
596-680 "	197 1A2 1AD 1B8

- IPA

° 5203 M3 ATTACHMENT REQUIRES THE FOLLOWING FEATURES FOR CPU AND 5203:

CPU - FC: 4653 & 4690 (9848 IF UCS ON 5203)

5203 - FC 9223 (8639 IF UCS IS DESIRED)

° 3203 COMES STANDARD WITH UCS.
REQUIRES FC4653 PRE-REQ ON 3115. (MODEL DESIGNATION MANDATORY)

- MPX CHAN -

° THE 3211 IS TOO FAST FOR 115 MPX CHANNEL AND REQUIRES AN RPQ TO BE ORDERED FOR THE 3115. (RPQ SU0058)

° CONTACT REGION IF 1419 MICR WILL BE USED ON MPX CHANNEL.
RPQ SU0044 IS REQUIRED ON THE 3115. CHANNEL ADDRESSES LIMITED - X'050-05F' OR X'070-07F' RESERVED FOR 1419 ONLY!
EXTERNAL SIGNALS FC3898 REQUIRED ON 3115.

- ICA -

° ADDRESS ASSIGNMENTS

20 - 2F ARE SS LINES

30 - 34 ARE BI SYNC MEDIUM SPEED (MAX. 7200 BPS)

34 IS BI SYNC HI SPEED (MAX 50 KBS) LINE IF HI SPEED LINE IS PRESENT.

° MAX. CONFIGURATION - 5 BSC OR 8 SS LINES.

° ICAE FC# 4641 REQUIRED FOR ALL COMBINATIONS OF SS AND BSC. MAX. CONFIGURATION WITH FC4641 IS 4 BSC AND 8 SS. (DEPENDS ON LINE SPEED)

° THE USE OF AUTOCALL IN ANY LINE GROUP PRECLUDES THE LAST TWO LINES/LINE PAIRS OF THAT GROUP.

° MAX. OF ONE SYNC LINE HIGH SPEED, FC# 7121. LIMITATION: THIS LINE MAY NOT OPERATE CONCURRENTLY WITH ANY OTHER LINE ON THE ICA.

INTERFERENCE BY MULTIPLEXER CHANNEL

- THE LOAD OF INTEGRATED ATTACHMENTS HAS NO IMPACT ON MULTIPLEXER CHANNEL AND THE MULTIPLEXER CHANNEL DOES NOT INTERFERE WITH INSTRUCTION PROCESSING IN THE IPU EXCEPT DURING SIO, TIO AND INTERRUPT HANDLING.

IPU/MPX CHANNEL INTERFERENCE

° MAXIMUM FOR SIO	123.5 µSEC
° MAXIMUM FOR TIO	62 µSEC
° MAXIMUM FOR INTERRUPT HANDLING	201 µSEC

MPX CHANNEL DATA RATE

BURST	29KB
BYTE	19 KB