UNIVAC®

9200/9300 SYSTEMS

9200/9300 TO 9200/9300 COMMUNICATIONS

PROGRAMMERS REFERENCE

UP-7611

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CONTENTS

CONTENTS	1 to 2
1. INTRODUCTION	1-1 to 1-2
1.1. SCOPE	1-1
1.2. GENERAL DESCRIPTION	1-1
2. PROGRAM REQUIREMENTS	2-1 to 2-10
2.1. GENERAL	2-1
2.2. RESPONSE TABLE	2-1
2.2.1. Use Key	2-3
2.2.2. Table Identification	2-3
2.2.3. Request Key	2-3
2.2.4. Wraparound Indicator	2-3
2.2.5. Deactivate Key	2-4
2.2.6. Input Interrupt Entry	2-4
2.2.7. Output Interrupt Entry	2-4
2.2.8. Clock Interrupt Entry	2-5
2.2.9. Communications Buffer Area Address	2-5
2.2.10. Receiving Channel Number	2-5
2.2.11. Logical Unit Number (Device Address)	2-5
2.2.12. Transmitting Channel Number	2-5
2.2.13. Error Indicator	2-5
2.2.14. Clock Counter	2-5
2.2.15. Input BCW Address	2-6
2.2.16. Output BCW Address	2-6
2.2.17. Status	2-6
2.2.18. Toggle	2-6
2.2.19. Current Packet Address	2-6
2.2.20. Sentinel Key	2-6
2.3. REQUEST PACKETS	2-6
2.3.1. Packet Identification	2-6
2.3.2. Error Count	2-6
2.3.3. Availability Field	2-8
2.3.4. Indicator Code Routine Address	2-8
2.3.5. Work Area Address	2-8
2.3.6. Function Field	2-8
2.3.7. Error Code	2-9
2.3.8. Interlock Field	2-9
2.3.9. Message Size	2-9
2.4. LINKING	2-9
2.5. MASTER ROUTINE DISPLAYS	2-10

3. PROGRAM PROCEDURES 3-1 to 3-2

3.1. SCOPE 3-1

3.2. OPEN 3-1

3.3. SEND AND RECEIVE 3-1

3.4. CLOSE 3-2

4. PROGRAMMING CONSIDERATIONS 4-1 to 4-2

4.1. SCOPE 4-1

4.2. PROGRAM COORDINATION 4-1

4.3. RESPONSE TABLE AVAILABILITY 4-1
4.3.1. Master Response Table 4-1
4.3.2. Slave Response Table 4-1
4.3.3. Request Packet 4-2

5. OPERATIONAL CONSIDERATIONS 5-1 to 5-5

5.1. SCOPE 5-1

5.2. DATA TRANSFERS 5-1
5.2.1. Control Blocks 5-1
5.2.2. Data Block 5-2

5.3. CODE GENERATION 5-3

5.4. INTERRUPT PROCESSING 5-4

5.5. OPERATION OF COMMUNICATIONS MACRO ROUTINES 5-5
5.5.1. C9MR Macro Routines 5-5
5.5.2. C9SR Macro Routines 5-5

FIGURES

2-1. Master Response Table Format 2-2

2-2. Slave Response Table Format 2-2

2-3. Master Request Packet Format 2-7

2-4. Slave Request Packet Format 2-7

5-1. Transfer of Control for an Interrupt 5-4

1. INTRODUCTION

1.1. SCOPE

This manual describes the Communications routines required to implement the interchanges of data between two or more UNIVAC 9200/9300 computers. Use of this manual assumes a knowledge of the "UNIVAC 9300 System Operating System Programmers Reference," UP-7531 (current version), "UNIVAC 9200/9300 Systems Central Processor and Peripherals Programmers Reference," UP-7546 (current version), and "UNIVAC 9200/9300 Systems Card Assembler Programmers Reference," UP-4092 (current version), and "UNIVAC 9200/9300 Systems Programming Utility Programmers Reference," UP-4120 (current version).

1.2. GENERAL DESCRIPTION

Communication between two or more UNIVAC 9200/9300 computers is made possible with Communications routines used in conjunction with the UNIVAC Data Communications System (DCS) equipment.

The 9200/9300 to 9200/9300 Communications routines provide an interface between problem programs and the Operating System. There are two routines: a master routine (C9MR) which is linked with a problem program, and a slave routine (C9SR) linked with another closely integrated problem program. Both routines are capable of sending and receiving messages; however, only the master routine may initiate the transmission of data. There may be more than one slave program, each incorporating a slave routine, operating with a single master program.

The master and slave routines are supplied in relocatable form in the UNIVAC 9200/9300 Systems software library.

The connecting link between the master problem program and the master routine is the Response Table. This table must be defined by the programmer and contains a unique set of characteristics which describe a file. The master routine uses the table to maintain the current status of an interchange. There must be a Response Table for each slave program with which the master program communicates.

Each slave program likewise requires a Response Table as a link with its slave routine. There may be only one Response Table for each slave program.

Data is exchanged between the two computers by executing block transfers of data from one computer memory to the other.

The following sections give a detailed description of the Response Table and how it serves as a link between the problem programs and the Communications routines; the procedures for initiating data transfer; certain programming considerations regarding the interaction of a problem program with its associated Communications routine; and supplemental background information concerning the operation of the 9200/9300 to 9200/9300 Communications routines.

The Communications routines are designed to operate with a Data Communications Subsystem having the following options:

Input LT:	F1005-05
Output LT:	F1005-04
LRC:	F1008-99
Overrun:	Input and Output

No automatic search for Synch bytes

No idle character generation or automatic look for Synch bytes

2. PROGRAM REQUIREMENTS

2.1. GENERAL

The problem programs must be so designed that the requests issued by the master computer can be properly interpreted and accepted by the slave computers. This is accomplished not only by the overall design of the two programs, master and slave, but specifically in the information contained in the Response Table. The type of information in the Response Table includes addresses, indicators, and request packets required to establish an interchange between master and slave computers. The request packets within a Response Table are associated with a specific request for data; one packet for each type of request.

This section describes the format and the contents of both the Response Table and the request packets.

2.2. RESPONSE TABLE

The Response Table describes a communications file for the problem program and the Communications routine. If more than one slave computer is communicating with the master computer, one Response Table for each must be defined within the master program.

The formats for a master and a slave Response Table are shown in Figures 2–1 and 2–2. A description of the contents and use of the bytes follow the table formats.

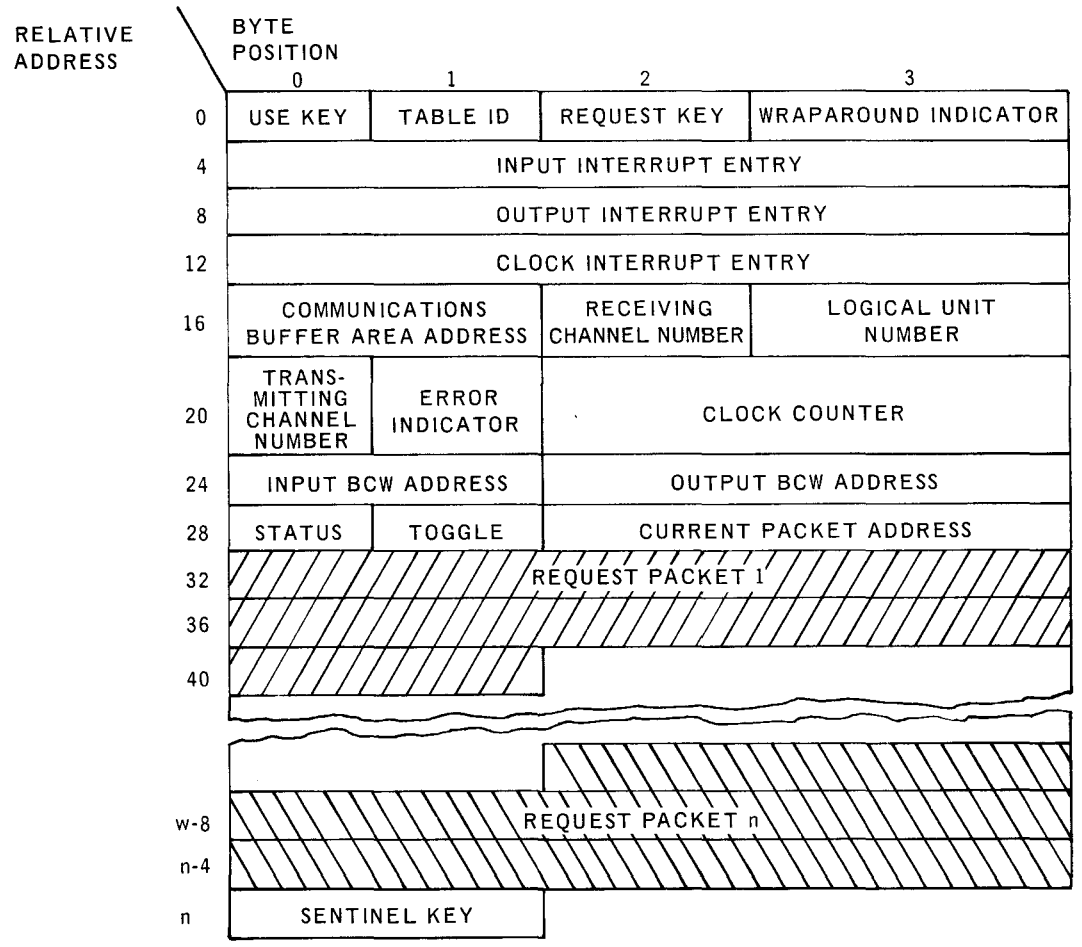


Figure 2–1. Master Response Table Format

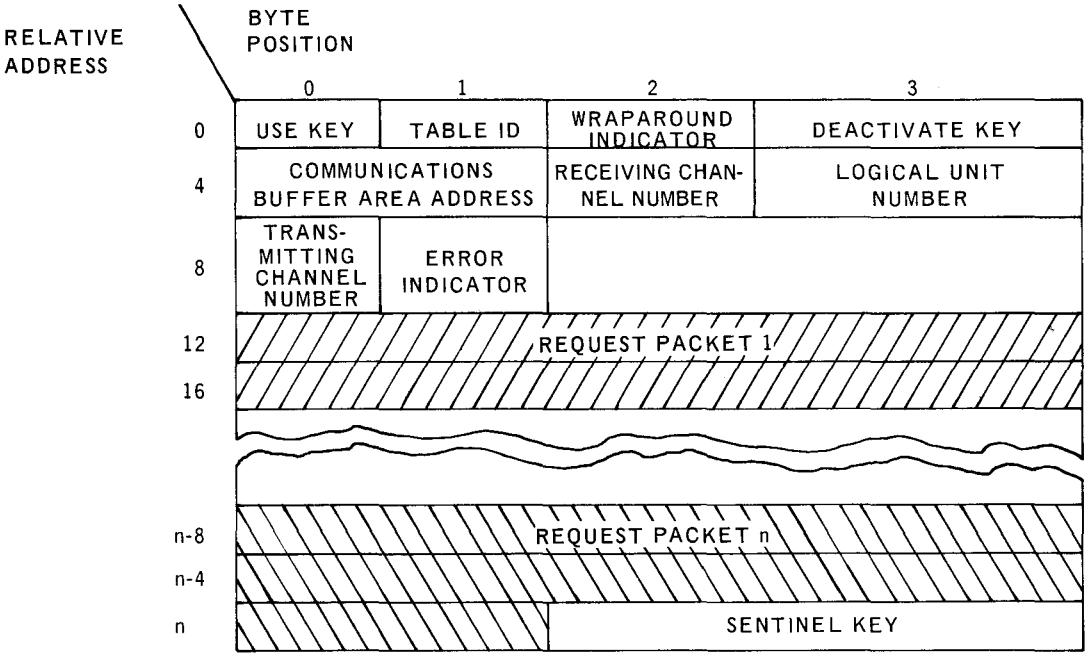


Figure 2–2. Slave Response Table Format

2.2.1. Use Key

This byte must be set initially to 00_{16}. Both master and slave routines set the byte to FF_{16} when an interchange is taking place. When this byte is set to FF_{16}, the table must not be modified by either the master or slave problem program. The slave program also checks this byte for the end-of-transmission setting 01_{16} (see 3.4).

2.2.2. Table Identification

This byte contains the identification assigned by the problem program to a particular Response Table. The identification must be identical within a pairing of master and slave Response Tables. The identification may be any combination of two hexadecimal digits, 00 through FF.

2.2.3. Request Key

This byte indicates the status of the request and is set by the master routine. The slave Response Table does not contain a request key. The master program can determine the status of a request by checking this byte. The request key may have the following hexadecimal values.

Hexadecimal Value	Meaning
00	Request pending
02	Error
03	Time out
04	Program not in
05	Program not ready
12	Incorrect packet
FF	Request successfully completed

A value of 02 (error) indicates an error in transmission. The request should be resubmitted.

A time out (03) occurs when the clock counter is reset during an interchange. The request should be resubmitted. The master program is notified of a time out by means of a display.

When a value of 12 (incorrect packet) occurs, a CANCL macro instruction must be executed.

2.2.4. Wraparound Indicator

Initially, this byte is set to 00_{16} by the problem programs. Thereafter it is used by the master and slave routines to indicate whether the upper or lower half of the communications buffer is being filled.

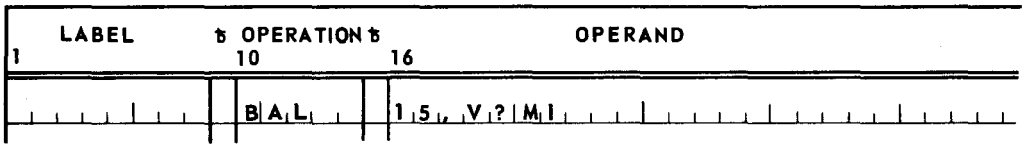
2.2.5. Deactivate Key

The deactivate key indicates the availability of the Response Table to either the slave program or the slave routine. If the key is set to FF_{16}, the slave Response Table is not available to the slave routine and may be altered by the slave program at this time. When the key is set to 00_{16}, the Response Table is available to the slave routine exclusively.

The master Response Table does not contain a deactivate key.

2.2.6. Input Interrupt Entry

At assembly time these bytes must contain the Branch And Link instruction



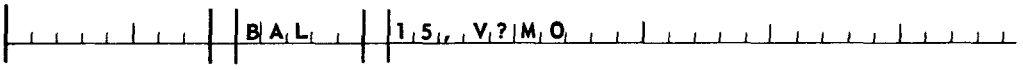
Where: V?MI is the label of the entry to the routine processing the input interrupts.

The problem program must define V?MI in an EXTRN card. V?MI is also defined in an ENTRY card in C9MR.

This entry is not required in the slave Response Table because the slave routine maintains the information within its own environment.

2.2.7. Output Interrupt Entry

At assembly time these bytes must contain the Branch And Link instruction



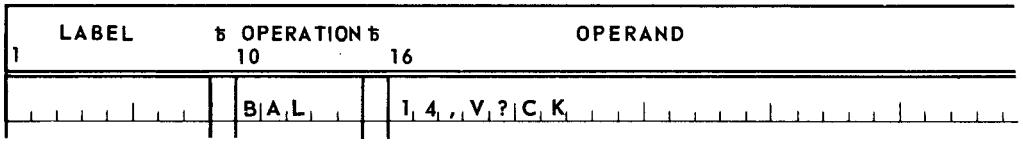
where: V?MO is the label of the entry to the routine processing output interrupts.

The problem program must define V?MO in an EXTRN card. V?MO is also defined in an ENTRY card in C9MR.

This entry is not required in the slave Response Table.

2.2.8. Clock Interrupt Entry

At assembly time these bytes must contain the Branch And Link instruction



where: V?CK is the label of the entry to the routine processing clock interrupts.

The problem program must define V?CK in an EXTRN card. V?CK is also defined in an ENTRY card in C9MR.

This entry is not required in the slave Response Table.

2.2.9. Communications Buffer Area Address

This is the address, defined by the problem program, of a dynamic buffer area in memory into which data is read during an LT Summary Interrupt. Data is automatically transferred from the buffer area to the work area.

The buffer area must be defined as a 128-byte area and is filled at a rate of 64 bytes at a time. While the lower half is being filled, the upper half is being transferred to the work area. The upper half is filled while the lower half is being transferred. The buffer *must* be assigned a modulo 128 address.

2.2.10. Receiving Channel Number

This is an 8-bit binary number denoting the physical unit number of the receiving channel. The number may be an odd number from 17 to 31. The physical unit number does not have to be the same for master and slave.

2.2.11. Logical Unit Number (Device Address)

The logical unit number is an 8-bit binary number which corresponds to the logical unit number assigned to the paired line terminals in the Logical Unit Table.

2.2.12. Transmitting Channel Number

This is an 8-bit binary number denoting the physical unit number of the transmitting channel. The number may be an even number from 16 to 30. The number does not have to be the same for the master and slave computers.

2.2.13. Error Indicator

When the prefix of the data block (see 5.2.2) is not equal to 0001_{16} for data received, the error indicator is set to FF_{16}.

2.2 14. Clock Counter

A clock counter is maintained by the master routine for timing data transfers requested by the problem program. In the slave routine, the clock counter is maintained internally.

2.2.15. Input BCW Address

The address of the input Buffer Control Word is stored in these bytes by the master routine.

2.2.16. Output BCW Address

The address of the output Buffer Control Word is stored in these bytes by the master routine.

2.2.17. Status

This byte is used only by the master routine to maintain the internal status of a particular request.

2.2.18. Toggle

This byte is used only by the master routine.

2.2.19. Current Packet Address

The master program places the address of the current request packet into register 13 when it issues a request. When the master routine receives control as a result of the interrupt, it stores the address in register 13 into these bytes in the Response Table.

2.2.20. Sentinel Key

The last two bytes in the table must contain $FFFF_{16}$ to indicate the end of the table. The relative location of the sentinel key will vary, depending on the number of request packets in the table. The request packets immediately precede the sentinel key and are ten bytes in length.

2.3. REQUEST PACKETS

The request packets are an integral part of any Response Table. The number of packets within a table may vary, and they may be deleted or inserted during the execution of a problem program. While a request is being processed, the problem programs should not delete packets from the Response Table or make an active request packet inactive.

The formats for a master and a slave request packet are shown in Figures 2–3 and 2–4.

2.3.1. Packet Identification

The packet identification is assigned by the problem program and is used by both master and slave routines to specify a particular type of interchange. The identification of the request packet in the master routine must match a corresponding request packet identification in the slave routine and must be unique. It may be any combination of binary 0's and 1's, but must not be all 1's.

2.3.2. Error Count

The master program must set this byte to 00_{16} initially. For each packet, the master routine maintains a count of any hardware errors which occur during the processing of a packet.

0	1	2	3
PACKET ID	ERROR COUNT	INDICATOR CODE ADDRESS	

4	5	6	7
WORK AREA ADDRESS		FUNCTION FIELD	ERROR CODE

8	9
MESSAGE SIZE	

Figure 2–3. Master Request Packet Format

0	1	2	3
PACKET ID	AVAILABILITY FIELD	INDICATOR CODE ADDRESS	

4	5	6	7
WORK AREA ADDRESS		ERROR CODE	INTERLOCK FIELD

8	9
MESSAGE SIZE	

Figure 2–4. Slave Request Packet Format

2.3.3. Availability Field

This byte is used by the slave program to communicate the availability of a packet to the slave routine. When the slave program sets this byte to FF_{16}, making a packet inactive, no interchange requesting that packet can take place. To make the packet active and available to the slave routine again, the slave program must set this byte to 00_{16}.

2.3.4. Indicator Code Routine Address

These two bytes contain the address of a routine in the problem program (master or slave, or both) that is to be executed at the completion of an interchange. The indicator code routine is executed in I/O program state; therefore, execution time should be minimized. GET or PUT macro instructions must not be issued by an indicator code routine. The exit from an indicator code routine should be the instruction

```
LABEL      OPERATION      OPERAND
1          10             16
           BC             15,0(,14)
```

The saving and restoring of any special registers is the responsibility of the problem programs. If these bytes are set to 0000_{16}, no indicator code routine is executed.

2.3.5. Work Area Address

The problem program must define its work area and store the address in bytes 4 and 5 of the request packet. The first two bytes of the work area are used by the Communications routines; therefore, the work area must be at least two bytes greater than the size of the message. If data is being sent, the Communications routine places 0001_{16} in these two bytes. If data is being received, the Communications routine places the address of the last byte of the message being received into these two bytes before branching to any indicator code routine. This facilitates processing variable-length messages.

If a message exceeds the work area, the excess is stored in the next higher memory locations contiguous to the work area. Therefore, the work area should be equal to or greater than the longest data message to avoid unpredictable results.

2.3.6. Function Field

This byte specifies whether the function of the request packet in a master Response Table is to send data to or receive data from the slave routine.

Hexadecimal Value	Function
00	Receive (GET)
01	Send (PUT)

2.3.7. Error Code

The various bits in this byte are used by both the master and slave routines to indicate the type of hardware error. This byte must be set initially to 00_{16} by the problem programs.

2.3.8. Interlock Field

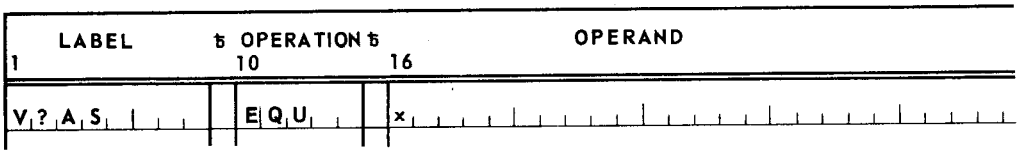
The slave routine sets this byte to FF_{16} at the successful completion of an interchange. This indicates to the slave program that the requested data is available for processing in the work area. The slave routine cannot use this packet again until the slave program sets the interlock field to 00_{16}. This byte is not used by the master program or master routine.

2.3.9. Message Size

In request packets containing a Send function, this byte must contain the number of bytes in the message, in binary. This number must be two greater than the actual number of data bytes to be transmitted, since the first two bytes of the message are used by the Communications routine for control purposes.

2.4. LINKING

When linking the relocatable element of C9MR to the master problem program and of C9SR to the slave problem program, the following EQU card must be submitted to the Linker.



where: x has the following value, depending on the type of data sets used by the system:

DATA SET*	BAUDS	VALUE OF X
201A3	2,000	1
201B1 or 202D	2,400	1
205B1	4,800	1
301B or 303C	50,000	10

Bell Telephone Company Data Set model numbers.

2.5. MASTER ROUTINE DISPLAYS

The format of the displays generated by the master routine (C9MR) is:

7xyy

where: 7 indicates that this display is generated by the master routine.

x is the error message.

yy is the device address.

Hexadecimal Display	Reason and Action
71yy	Parity error (includes BUS OUT, data check, overrun, and carrier off). Press the START switch to re-try five times, or key a nonzero into location 4 to cancel.
72yy	File not opened. Press the START switch to cancel.
73yy	Response Table error (for example, the communications buffer area is not mod 128). Press the START switch to cancel.
78yy	Offline. Place the DCS online and press the START switch to re-try.
79yy	Invalid function (command reject). Press the START switch to re-try, or key a nonzero into location 4 to cancel.
7Ayy	Time out; clock is reset during an interchange. Press the START switch to resubmit the request.
7Byy	Physical unit already allocated. Press the START switch to cancel.

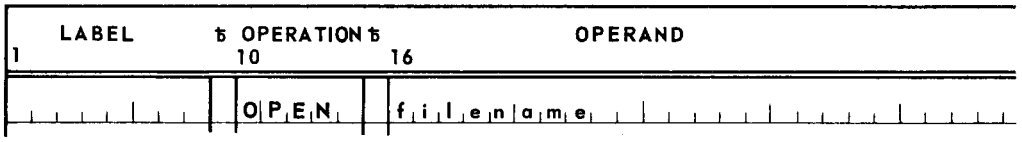
3. PROGRAM PROCEDURES

3.1. SCOPE

This section describes the procedures for opening a file, for sending and receiving data, and for closing a file.

3.2. OPEN

The master program must open the master routine and all associated Response Tables; the slave program must open the slave routine and its Response Table. The following macro instruction is used to open a routine.

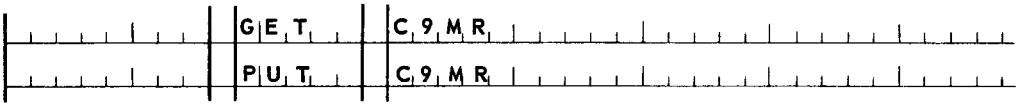


where: filename is C9MR for the master routine or C9SR for the slave routine.

Register 15 must be loaded with the address of the table before the OPEN macro instruction is issued. If there is more than one master Response Table, the master program must load register 15 with the address of the table and issue an OPEN macro instruction for each Response Table required.

3.3. SEND AND RECEIVE

The master program initiates all requests, whether data is to be sent or received. To initiate a request, the master program must load register 15 with the address of the appropriate Response Table, load register 13 with the address of the applicable request packet in the Response Table, and then issue either of the following macro instructions.



The GET macro instruction is used to receive data from the slave program. The PUT macro instruction is used to send data to the slave program. The direction of the interchange is also specified in the function field of the request packet in the master Response Table.

The GET or PUT macro instruction executes a Branch And Link to the master routine (C9MR). If the master routine determines that the Response Table is currently unavailable because another request is in process, it returns control to the byte following the GET or PUT macro instruction in the master program. The master program should resubmit the request if the request is to be processed.

If the master routine determines that the Response Table is available, it accepts the request and returns control to the fifth byte following the GET or PUT macro instruction in the master program. The master program can then determine the status of the request from the value stored in the request key in the Response Table.

When a request is accepted, the master routine sets the request key to 00_{16}. Acceptance of the request does not imply that it has been completed.

To determine when a request has been completed, the master program can check the request key for a value of FF_{16}. If the request was a GET macro instruction, the requested data is in the work area available for processing.

Both the master and slave programs can use indicator code to determine when an interchange is completed. The Communications routines do not process an indicator code routine until the interchange is completed.

The slave program does not use the request key; it checks the interlock field to determine when an interchange is completed. The slave routine sets the interlock field to FF_{16} upon the successful completion of a request. Until the slave program resets this byte to 00_{16}, no further interchanges requiring this particular packet are permitted by the slave routine. The master program and routine do not use the interlock field.

3.4. CLOSE

The master program must close the master routine and all associated Response Tables; the slave program must close the slave routine and its Response Table. The following macro instruction is used to close a routine.

LABEL (1)	OPERATION (10)	OPERAND (16)
	CLOSE	filename

where: filename is C9MR for the master or C9SR for the slave routine.

Register 15 must be loaded with the address of the Response Table before issuing the CLOSE macro instruction.

When the master program issues a CLOSE macro instruction to end communications with a particular slave program, the master routine sends an End-of-Transmission (EOT) message to the slave routine. The slave routine sets the use key in its Response Table to 01_{16} to indicate that communications are being terminated. The slave program can then close its Response Table and slave routine.

4. PROGRAMMING CONSIDERATIONS

4.1. SCOPE

This section discusses the aspects of the coordination and interaction of the problem programs and the Communications routines that must be considered when designing a pair of master and slave programs.

4.2. PROGRAM COORDINATION

The design of a pair of problem programs, master and slave, must be so coordinated that a data message transmitted by one can be interpreted and processed by the other. When a request packet is issued by the master, there must be a corresponding request packet in the slave with a matching identity. The identification of a pair of Response Tables, master and slave, must also match.

4.3. RESPONSE TABLE AVAILABILITY

Although a problem program may check the status while a request is in process, it should not alter the Response Table until the table is available. The methods by which the problem programs may have access to the Response Table are explained in the following paragraphs.

4.3.1. Master Response Table

The master program initiates all requests; the master routine controls the processing of all requests. The master routine sets the use key to FF_{16} when a request is accepted for processing. When processing is completed, the master routine resets the use key to 00_{16} and sets the status of the request into the request key. Therefore, the availability of the master Response Table depends on whether the request is being initiated or processed.

4.3.2. Slave Response Table

The slave program can determine the availability of the slave Response Table by checking the following bytes:

	Available	Not Available
Use Key	00_{16}	FF_{16}
Deactivate Key	FF_{16}	00_{16}

The slave program can make the table unavailable to the slave routine and thus prevent an interchange from taking place by the following procedure:

(1) Set the deactivate key to FF_{16}.

(2) Wait until the use key becomes 00_{16}.

(3) Modify the table.

(4) Reset the deactivate key to 00_{16}.

The slave routine can now proceed with an interchange.

4.3.3. Request Packet

The slave program can determine the availability or activity of a particular request packet by checking the following bytes:

	Available/ Inactive	Not Available/ Active
Availability Field	FF_{16}	00_{16}
Interlock Field	FF_{16}	00_{16}

The slave program may arbitrarily return an inactive packet to an active status by setting either or both the availability and interlock fields to 00_{16}. A packet is inactive when the slave program sets the availability field to FF_{16}, at which time the slave program may alter the packet. When it has completed the change, the slave program sets the field to 00_{16}. A packet is also inactive when the slave routine sets the interlock field to FF_{16} at the successful completion of an interchange. The packet remains inactive until the slave program sets the field to 00_{16}.

5. OPERATIONAL CONSIDERATIONS

5.1. SCOPE

This section discusses operational considerations of the Communications routines and the interaction of the routines with their respective problem programs. Those functions of the routines which may be pertinent to a 9200/9300 to 9200/9300 communications system are mentioned here. These functions are not a function of the problem programs.

5.2. DATA TRANSFERS

An interchange of data between two 9200/9300 computers is accomplished by executing block transfers of data from one computer's memory to the other. Two types of blocks are transferred: control blocks and data blocks.

5.2.1. Control Blocks

When the master routine receives control following a GET or PUT macro instruction issued by the master program, it stores the following information in the control block: the prefix code, the table identification, and the request packet identification. A control block has the following format:

BYTE	0	1	2	3	4	5	6	7	8
	SYNCH	SYNCH	SYNCH	PREFIX		TABLE ID	PACKET ID	EOM	LRC

The three Synchronization bytes, the End-of-Message (EOM), and the Longitudinal Redundancy Check (LRC) characters are automatically generated by a hardware function.

The prefix code in bytes 3 and 4 of the control block may have the following values, depending on whether it is set by the master or slave routine.

	Hexadecimal Value	Meaning
Master	010x	Send (PUT)
	020x	Receive (GET)
	030x	EOT
	040x	Wait
Slave	0000	Acknowledge
	0002	Error
	0003	Proceed
	0004	Program not in
	0005	Program not ready

The setting for the I/O toggle is indicated by the x in the four least significant bits of the prefix code for the master control block. The master routine sets the I/O toggle.

The table identification in byte 0 of the Response Table is loaded into byte 5 of the control block. The packet identification in byte 0 of the request packet is loaded into byte 6 of the control block. Transmission of the control block is then initiated.

5.2.2. Data Block

The length and contents of the data block are determined by the problem program. The data is in no way restricted, edited, or interpreted by the Communications routines. The data block has the following format.

BYTE	0	1	2	3	4	5 . . . n	n+1	n+2
	SYNCH	SYNCH	SYNCH	PREFIX		DATA	EOM	LRC

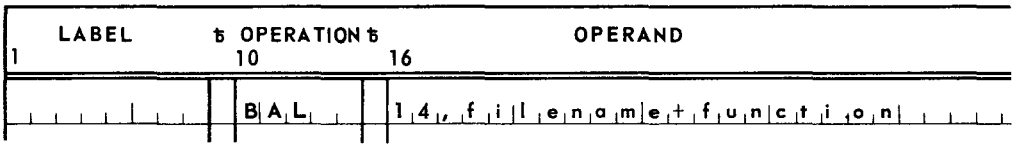
The three Synchronization bytes, the End-of-Message (EOM), and Longitudinal Redundancy Check (LRC) characters are automatically generated by a hardware function.

The prefix is set to a value of 0001_{16} when either the master or the slave is sending data. When the data is received and the request is completed, the address of the last character received is stored in these bytes by the Communications routine. This information is transferred to the first two bytes of the work area.

5.3. CODE GENERATION

When the problem program issues an imperative macro (OPEN, GET, PUT or CLOSE), the Assembler produces a BAL instruction whose operand addresses one in a series of BC instructions in the Communications routine. The BC instruction points to the macro label within the routine.

The imperative macro instructions produce the following source code:



where: filename is C9MR for the master routine, or C9SR for the slave routine.

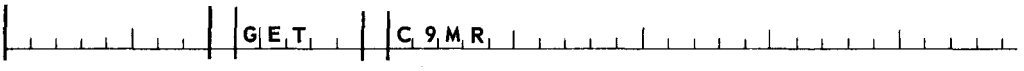
function has one of the following values:

Function	Value
OPEN	0
CLOSE	4
GET	8
PUT	16

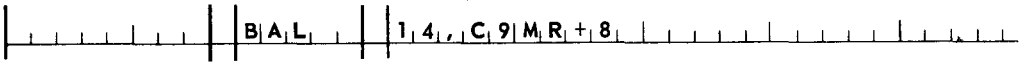
Before issuing the macro instruction, the problem program must load register 15 with the address of the Response Table and register 13 with the address of the request packet.

The following is an example of code generation:

If the master program issues the following macro instruction



the source code produced by the Assembler or the Preassembly Macro Pass is



This instruction gives control to the master routine at byte 8, which contains an unconditional branch to the entry point for the GET subroutine.

The series of unconditional branch instructions at the beginning of the master routine which point to the various macro subroutines are:

Relative Address	Instruction		Function
C9MR	BC	15,V?OP	Open
+4	BC	15,V?CL	Close
+8	BC	15,V?GT	Get
+12			
+16	BC	15,V?PT	Put

The slave routine does not execute a GET or a PUT macro instruction.

5.4. INTERRUPT PROCESSING

As discussed previously, the Response Table is the link between the master program and the master routine. The operands of the three BAL instructions stored in the table by the master program contain the addresses of the input, output, and clocking interrupt routines. The OPEN subroutine in C9MR stores the Response Table address of each of these BAL instructions into the Interrupt Table, the Scan Table, and the Clocking Table.

When an interrupt occurs because the input Buffer Control Word associated with a particular Response Table is found to be active, the Supervisor transfers control to the address of the input interrupt routine paired with the input BCW. This is the address of the entry in the master Response Table containing the BAL instruction directing control to the input interrupt routine in C9MR.

Figure 5–1 illustrates the transfer of control from the address of the interrupt routine in the Scan Table to the linking instruction in the master Response Table to the input interrupt routine in C9MR, the master routine. As a result, register 15 contains the address of the Response Table when the input interrupt routine begins execution.

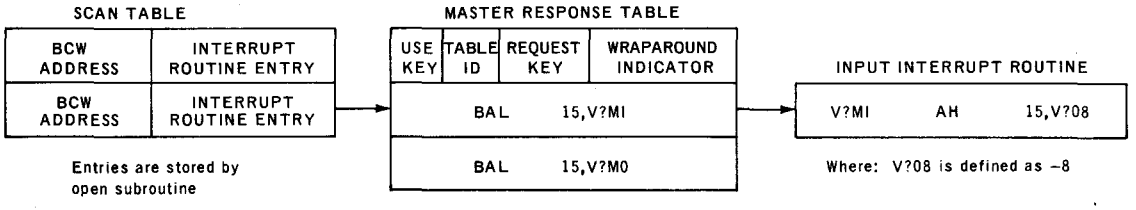


Figure 5–1. Transfer of Control for an Interrupt

5.5. OPERATION OF COMMUNICATIONS MACRO ROUTINES

A brief description of the functions performed by the Communications routines when an imperative macro instruction is issued by the problem programs is given for purposes of general information.

5.5.1. C9MR Macro Routines

- OPEN – From the starting address of the Response Table stored in register 15, calculates the Response Table address of the BAL instructions for the input, output, and clocking interrupt routines. Stores these addresses into the Interrupt Table, the Scan Table, and the Clocking Table within the Supervisor.

  Calculates the BCW addresses associated with the receiving and transmitting channels. Stores the addresses into the Response Table and into the Scan Table. Checks the physical unit entries associated with the logical unit numbers to ensure that they are properly allocated and that they contain the proper channel and unit number as specified in the receiving and transmitting channel numbers. This routine then indicates that the Response Table is open.

- GET/PUT – Ensures that the Response Table is open and initiates the control sequence to transfer the data message to or from the work area specified in the request packet.

- CLOSE – Sends an EOT control block to the slave computer; ensures that all transmissions are completed, and marks the Response Table as closed.

5.5.2. C9SR Macro Routines

- OPEN – From the address of the Response Table stored in register 15, calculates the addresses of the interrupt entries for the transmitting and receiving channels and stores into these locations and into the Scan Table the addresses of the interrupt subroutines. Calculates the BCW addresses from the channel addresses and stores them in the Scan Table. Stores the address of the clock interrupt subroutine into the Clocking Table. Ensures that the logical units given in the Response Table are properly allocated.

- CLOSE – Ensures that all transmissions are completed and marks the Response Table as closed.

UP-7611