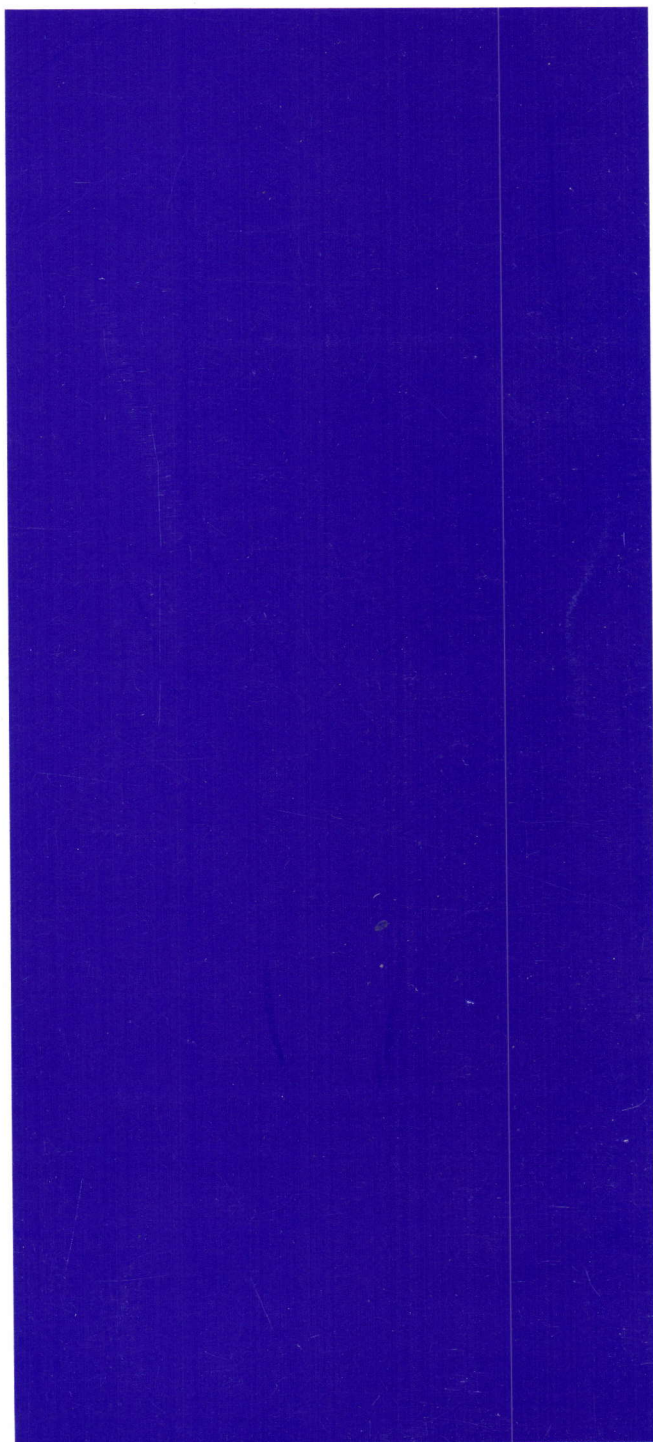


Honeywell

BASIC I/O DEVICES PROGRAMMING MANUAL

SYSTEM 700

HARDWARE



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Honeywell

BASIC I/O DEVICES PROGRAMMING MANUAL

SYSTEM 700

SUBJECT:

Normal and Compatible Operating Modes, Programming Techniques, and Programming Examples for Type 5307, 5310, and 5507 Teletypewriters, Type 5010 High-Speed Paper Tape Reader, and Type 5210 High-Speed Paper Tape Punch.

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PREFACE

This manual contains the information required to program Type 5307, 5310, and 5507 Teletypewriters, the Type 5010 High-Speed Paper Tape Reader, and the Type 5210 High-Speed Paper Tape Punch for operation with the Honeywell Type 716 Central Processor.

Section I describes the normal operating mode of the teletypewriters in full detail. The next two sections describe specific programming differences for the high-speed reader and punch, respectively, and reference Section I when the programming requirements are similar. Appendixes A, B, and C detail the compatible operating modes of the three devices.

It is recommended that all new coding for the devices reflect the normal operating mode rather than the compatible operating mode. In the normal mode, various features of the Type 716 Central Processor (e.g., a more powerful instruction set and interrupt structure) may be utilized in the programming. The hardware necessary for the compatible mode has been incorporated into the control units of the devices to allow operation with the existing 316/516 software. In the compatible mode, existing 316/516 programs can be run without modification. Each device may be operated in either mode, but under no circumstances should a device be operated in both modes simultaneously. Results are unspecified if this is attempted.

The reader is assumed to have a basic familiarity with System 700¹ assembly language programming and to have read the System 700 Programmers' Reference Manual (Document No. 70130072575, Order No. AC72).

¹ Trademark

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SECTION I

ASR/KSR-33 AND ASR-35 TELETYPEWRITERS IN NORMAL MODE

DESCRIPTION

The ASR (Automatic Send-Receive) and KSR (Keyboard Send-Receive) teletypewriters are used as primary input/output devices in many System 700 configurations. They may be used on-line to input data from the keyboard or tape reader (ASR only) and to output data to the printer or tape punch (ASR only). The ASR may also be used locally for low-speed punching and reading of paper tape. Two versions of the ASR option are available, the relatively inexpensive ASR-33 (Type 5307) and the more rugged ASR-35 (Type 5507). The lower cost KSR-33 (Type 5310) is also available for applications which do not require tape reader/punch capability. The three teletypewriters are illustrated in Figure 1-1.

The teletypewriter¹ is connected to the I/O bus of the Type 716 Central Processor via a teletypewriter control unit. Two 8-bit data registers in the control unit allow the teletypewriter keyboard and printer to operate in full duplex. A serial-to-parallel input register and a parallel-to-serial output register operate with a 110-baud clock to provide operating speeds up to 10 characters per second.

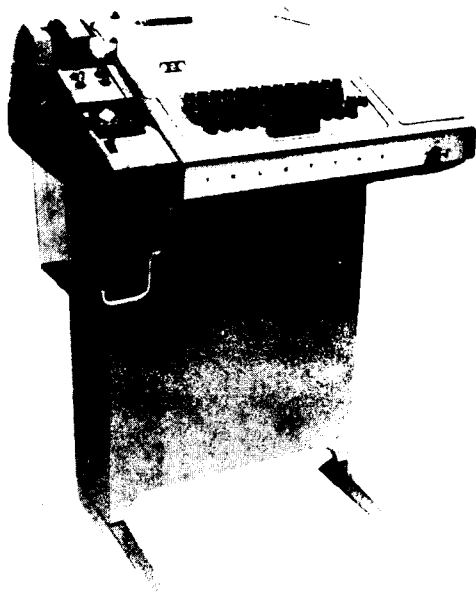
Teletypewriter functions are initiated by the receipt of certain codes. Some of these, such as carriage return and line feed, have their own keys. Other codes may be generated by simultaneously depressing the CTRL (control) key and one of the alphabetic keys.

The horizontal spacing is 10 characters per inch. Vertical spacing is six lines per inch with single spacing, and the line length is up to 72 characters. A local carriage return (generating no code) occurs after all 72 characters in the ASR/KSR-33 line have been printed and an attempt is made to print another character.

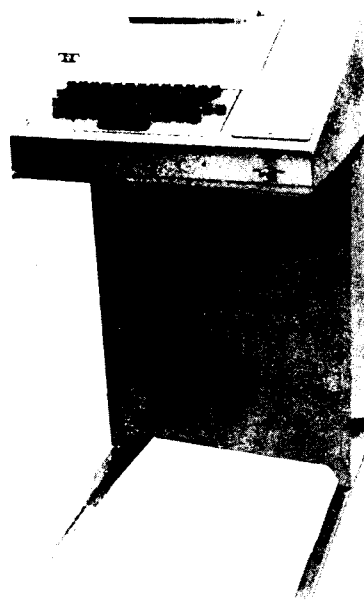
Operating Mode

The normal operating mode of the teletypewriter is described in this section. In this mode, the System 700 instruction set is used to enable the teletypewriter control unit and control the teletypewriter operation. When the control unit is operating in the normal mode,

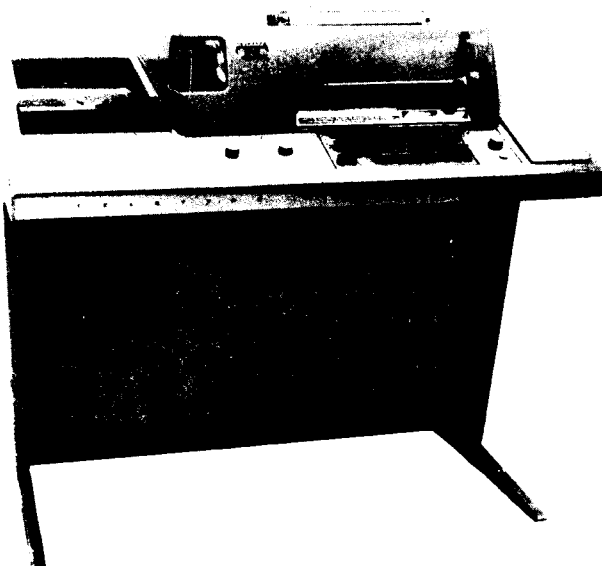
¹The terms teletypewriter, typewriter, ASR, and KSR will be used interchangeably in this section.



ASR-33
Type 5307



KSR-33
Type 5310



ASR-35
Type 5507

Figure 1-1. Teletypewriter Types

only the System 700 instruction set should be utilized. The results are unspecified if an attempt is made to utilize another instruction set, namely the 316/516 instruction set, while operating in the normal mode. The control unit is in the normal mode after the System 700 Central Processor is master-cleared. The control unit is not aware whether the teletypewriter is malfunctioning or even whether the teletypewriter is present at all. Therefore it is the operator's responsibility to see that the device is in operating condition.

ASR/KSR Common Controls

The control panels of the ASR-33 and ASR-35 are presented in Figure 1-2.

KEYBOARD

The keyboard is similar to a standard typewriter keyboard. The keys are interlocked so that only correct combinations may be depressed simultaneously. Some of the ASCII¹ keys are inscribed with words such as FORM and EOT for control functions. When a key is depressed, it generates a printable ASCII character (a nonparity 8-bit byte, with the eighth bit a ONE).

CTRL

The control key does not generate any code when depressed, but it allows some of the keys to generate a nonprintable function character (e.g., CTRL and A generate a '201,² or Start-of-Message (SOM), code). When CTRL is depressed, inappropriate keys (mostly those having upper case characters) are locked out.

SHIFT

This key does not generate any code, but it causes the ASCII keys to generate an upper case ASCII character (e.g., SHIFT and the 4 key generate a '244, or dollar sign (\$), code).

LINE FEED

This key generates the line feed control character '212. Receipt of this character causes the paper to advance vertically but does not cause the carriage to return to the left margin.

RETURN

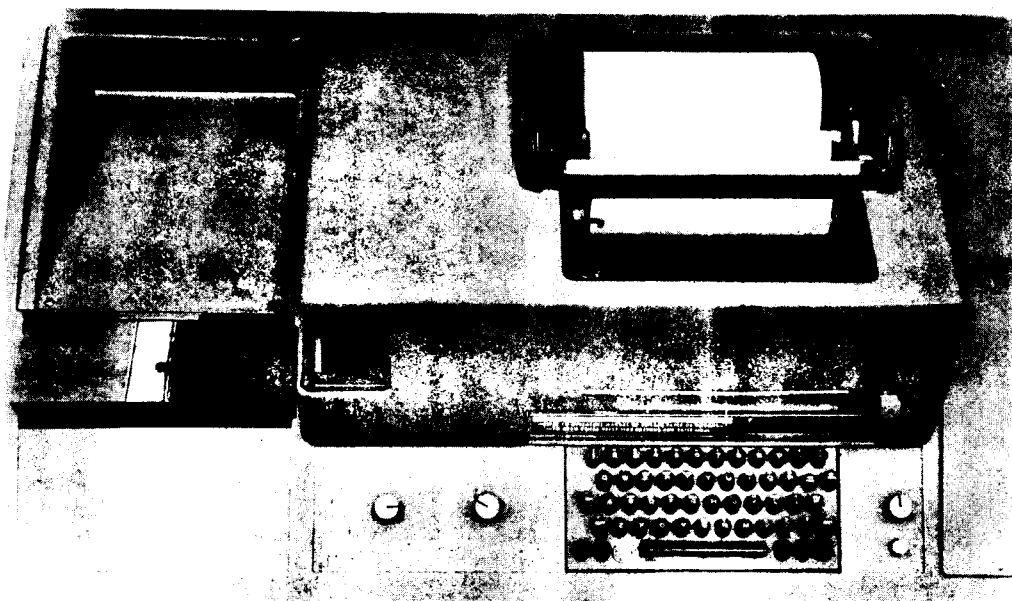
This key generates the carriage return control character '215. Receipt of this character causes the type carriage to return to the left margin but does not advance the paper vertically. A carriage return sometimes takes more than the 100 millisecond (ms) character time. To

¹American Standard Code for Information Interchange.

²The apostrophe indicates an octal number.



ASR-33 Controls



ASR-35 Controls

Figure 1-2. ASR-33/35 Controls

prevent a character from being printed before the carriage has fully returned to the left, the sequence RETURN, LINE FEED should be used. It gives the carriage 200 ms to return. Any null character may also be used, if printing on the same line is required.

RUB OUT

This key generates '377 (all bits marking), which is ignored by most input programs. Thus, by backspacing the tape and punching a RUB OUT over an error, the erroneous character is converted to '377 and ignored upon reading.

REPT

When this key is depressed simultaneously with any other, the action of the other key is repeated as long as the two keys are depressed. For instance, depressing REPT, CTRL and G simultaneously causes the bell to ring repeatedly.

BREAK

This key opens the control unit circuit, causing continuous zeros to be sent. It also causes zeros (leader) to be punched by the tape punch if it is turned on (ASR-35 only). The last character of a break is undefined. Consequently a backspace and rubout should be performed after the leader is generated in this way.

ASR/KSR-33 Controls

LINE/OFF/LOCAL

This control, located at the far right of the front panel, is the main power switch for the ASR/KSR-33. In the OFF position, the device is disabled. In the LINE position, the device is enabled to send to or receive from the central processor in the full duplex mode. In the LOCAL position, the ASR-33 is off-line in the half duplex mode and may be used to generate or reproduce paper tape. See ASR-33 Modes of Operation (p. 1-7) for a description of the LINE and LOCAL positions.

HERE IS

This key triggers the answer-back drum in the device used in communications installations for sending the station's identification. The ASR/KSR-33 used in System 700 has the answer-back drum coded to send twenty 000s. This is a useful method for punching blank leader. The drum does not respond to a WRU (ENQ) code.

ALT MODE

This key produces a '375 code. When depressed simultaneously with CTRL, it produces a '275 code. It performs no useful hardware function on devices supplied by Honeywell.

ASR-33 Only Controls

These controls are located on the tape reader/punch assembly at the left of the ASR-33.

ON

This pushbutton turns on the tape punch.

REL

This pushbutton releases the tape feed mechanism to facilitate tape changing.

BSP

This tape punch pushbutton spaces the tape back one space. It is used when it is necessary to rub out an erroneously punched character.

OFF

This tape punch pushbutton turns off the punch.

START/STOP/FREE

This lever is located on the tape reader. The momentary START and STOP positions control the reader if a tape is present. Once started, the tape is read until an X-OFF is read and echoed or the lever is depressed. An X-ON also starts the reader. Moving the lever to the FREE position stops the reader. In the FREE position the tape may be moved freely through the reader.

ASR-35 Only Controls

The following controls are unique to the ASR-35.

ON LINE/OFF/LOC

This control, located at the right of the keyboard, is the main power switch for the device. In the OFF position, the device is disabled. When ON LINE is selected, the device can send to and receive from the central processor in the full duplex mode. In the LOC position, the device, which is off-line in the half duplex mode, may be used to generate and reproduce paper tape. See ASR-35 Modes of Operation (p. 1-8) for additional information on the ON LINE and LOC positions.

MODE (K-KT-T-TTS-TTR)

This switch controls the information flow in the device. See ASR-35 Modes of Operation for additional details on the various modes.

BRK RLS

This key is inoperative.

LOC LF, LOC CR, AND LOC BSP

These three keys perform the line feed, carriage return, and backspace functions locally but do not send any code. The LOC BSP key backs the tape one character interval.

FREE/STOP/RUN

This lever, located on the paper tape reader at the left of the keyboard, is used in controlling tape reader operations. In the FREE position the tape may be moved freely. In the STOP position the tape may be read by receipt of the X-ON character ('221) if a tape is loaded. The paper tape reader is activated in the RUN position.

MANUAL READER CONTROL ON/OFF

If the reader is in the RUN position, a loaded tape is read when the switch is turned to ON. In the OFF position the reader is placed under remote control.

ASR-33 Modes of Operation

Figure 1-3 shows the interconnections of the various ASR components during local and line operation.

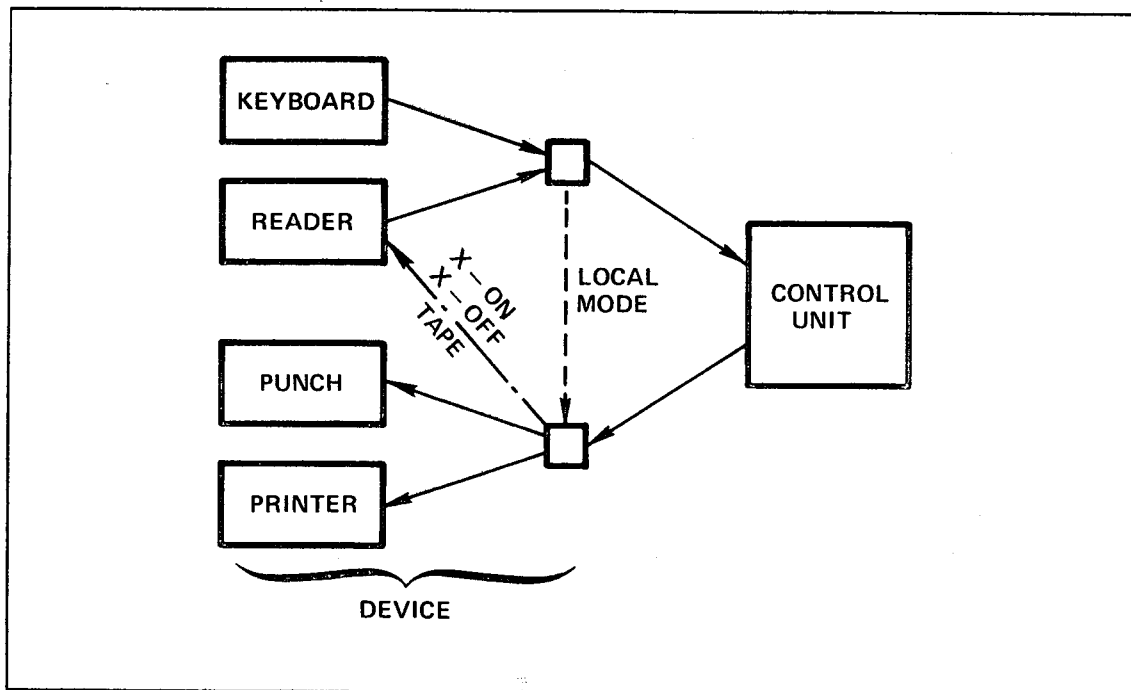


Figure 1-3. ASR-33 Interconnections in LOCAL and LINE Modes

PUNCH CONTROL

The paper tape punch on the ASR-33 is under manual control only.

READER CONTROL

The paper tape reader may be turned on either by moving the START/STOP/FREE lever to START or by receiving X-ON (CTRL, Q). Reading starts only if the tape is properly loaded.

The reader may be turned off by either moving the START/STOP/FREE lever to FREE or sending an X-OFF (CTRL,S). When an X-OFF is read, it must be echoed to turn the reader off. After the reader receives the echoed X-OFF from the central processor, it may read one or more character before stopping. Therefore, the tape normally stops two characters after an X-OFF, and it is conventional to follow all X-OFFs with two NULs (CTRL,SHIFT,P, which generates a '200).

ASR-35 Modes of Operation

The mode switch on the ASR-35 has five positions: K, KT, T, TTS, and TTR. Since only the first three modes are useful in this application, Figure 1-4 illustrates the interconnections of the various ASR-35 components in the K, KT, and T modes. When the power switch is in the ON LINE position, the ASR-35 is connected to the control unit as shown by the dashed line.

K MODE

In this mode, the keyboard and printer are on-line while the punch and reader are disabled. No external control of the punch or reader by code recognition is possible.

KT MODE

All units are available to the on-line circuit in this mode. When conditioned properly, the reader is capable of transmitting data and the punch is capable of receiving data. The printer copies all data originated at the central processor. Both the reader and the punch may be conditioned to be controlled by code recognition.

T MODE

When this mode is selected, the punch always receives data generated at the keyboard in a local circuit. The punch cannot be affected by any code detection. The printer and reader are available for on-line reception and transmission, respectively. In this mode the printer monitors the output of the reader and the reader can be controlled by code recognition.

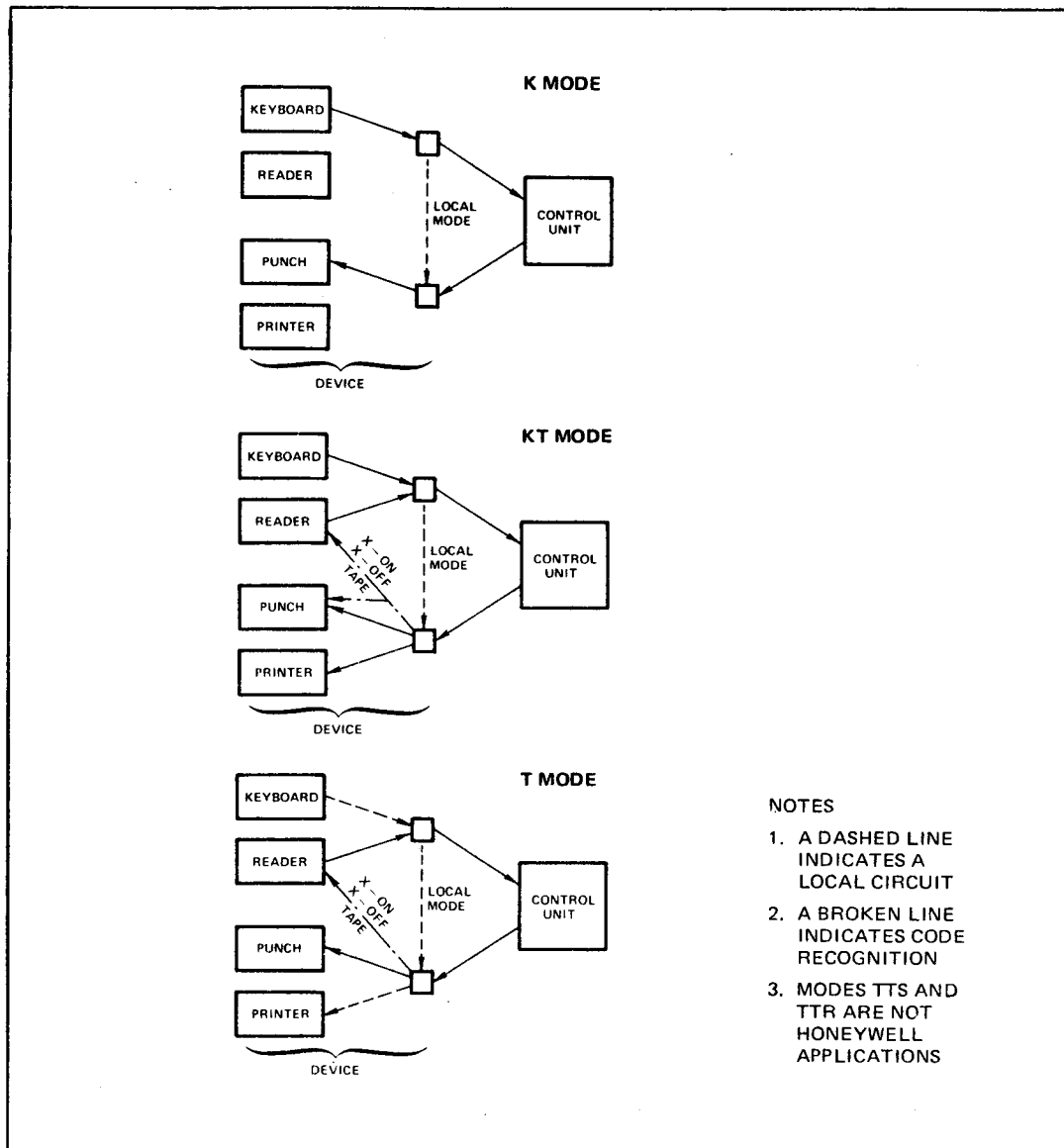


Figure 1-4. ASR-35 Connections in K, KT, and T Modes

PUNCH CONTROL

The punch can be controlled only in the modes in which it is operational (KT and T). It is turned on by the TAPE control character, '222 (CTRL,R). It is turned off by the X-OFF character, '223 (CTRL,S), from the central processor. The punch does not become operational until 200 ms (two character times) after the receipt of TAPE. In on-line operation this time is easily taken care of by sending one character (NUL ('200) is recommended) immediately after the TAPE. The punch does not become inoperational until 100 ms after the receipt of X-OFF. Thus a NUL sent immediately following X-OFF will be punched.

READER CONTROL

The paper tape reader may be turned on either by moving the FREE/STOP/RUN lever to RUN or by receiving an X-ON (CTRL,Q) from the CPU. The reader will not start unless a paper tape is properly loaded.

If the paper tape reader was turned on by the FREE/STOP/RUN switch, it can be turned off only by moving the lever to STOP. If it was turned on by an X-ON, it can be turned off only by an X-OFF (CTRL,S). When an X-OFF is read, it must be echoed to turn the reader off. After the reader receives the echoed X-OFF from the central processor, it may read one or more character before stopping. Therefore, the tape normally stops two characters after the X-OFF, and it is conventional to follow all X-OFFs with two NULs (CTRL,SHIFT,P, which generates a '200).

CAUTION

All tapes to be read on an ASR-35 which contain X-OFF characters must follow them immediately with two NULs ('200).

PROGRAMMING INFORMATION

Instruction Complement

Table 1-1 lists the normal mode instructions for the ASR/KSR-33 and ASR-35.

Table 1-1. Normal Mode Instructions for Teletypewriter

Instruction	Description
OCP '1204	Acknowledge
OCP '1504	Set Normal Mode Interrupt Mask
OCP '1604	Reset Normal Mode Interrupt Mask
OCP '1704	Initialize
INA 'X004 ^a	Input Data
INA '1104	Input Identification (ID) Code
INA '1204	Input Status Word
OTA '1004	Output Data
^a If X = 1, the A-register is cleared before transfer. If X = 0, the data on the data bus are ORed with the contents of the A-register.	

Device Address

The standard device address (the two least significant octal digits of the instruction) for the teletypewriter is '04. However, if more than one teletypewriter is to be used in the normal mode within the system, each additional device must be assigned a different address by modifying its associated control unit at the time of installation. This address is used when the device is programmed for the normal operating mode. Addresses '00, '20, and '24 must not be used for this purpose.

Device Interrupt Number

In the normal mode, the device interrupts through a location equal to '63 plus the device address. In the standard configuration, the teletypewriter interrupts through location '67.

Interrupt Operation

The device can interrupt whenever the input goes ready or whenever the output has gone ready after the first OTA '1004 has been issued and the controller has gone not busy. If it is desired to stop output interrupts, an OCP '1204 should be issued. This inhibits output interrupts until another OTA '1004 is issued and the controller has gone not busy.

Data Format

A full 8-bit character is transmitted between the least significant bits of the A-register and the teletypewriter, as shown in Figure 1-5. Two characters may be packed into the two bytes of each computer word.

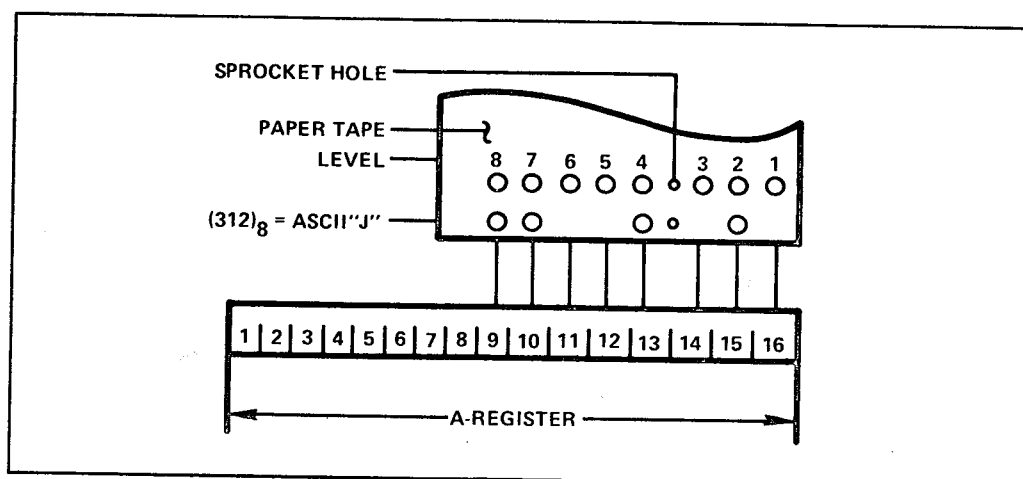


Figure 1-5. Teletypewriter Paper Tape Format

Description of Instructions

The following eight instructions control teletypewriter operations in the normal mode.

ACKNOWLEDGE (OCP '1204)

This instruction is executed after an input status word (INA '1204) instruction is encountered and the direction of transfer is determined. The instruction clears the interrupt indicators (bits 13 and 16) in the status word. If an output interrupt has occurred and an OCP '1204 has been issued, further output interrupts are inhibited until another OTA '1004 has been issued and the controller has gone not busy.

SET NORMAL MODE INTERRUPT MASK (OCP '1504)

This instruction enables the normal mode regardless of the previous mode. The normal mode interrupt mask is set, allowing an interrupt request to reach the central processor.

RESET NORMAL MODE INTERRUPT MASK (OCP '1604)

This instruction enables the normal mode and clears the normal mode interrupt mask. All interrupt requests (including any currently pending) are masked from the central processor until an OCP '1504 is executed.

INITIALIZE (OCP '1704)

When this instruction is executed, the control unit is set to the normal mode, all error conditions and interrupt requests are cleared, data transfers are terminated, the interrupt mask is reset, and the status word is cleared. This instruction has the same effect as a master clear, except that it is localized to the teletypewriter.

INPUT DATA (INA 'X004)

This instruction transmits the full 8-bit character from the teletypewriter to the central processor. If X = 1, the A-register is cleared prior to the transfer; if X = 0, the data are ORed with the contents of the A-register.

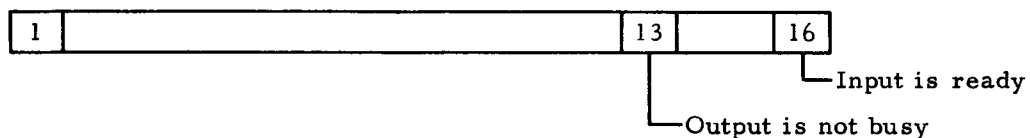
INPUT IDENTIFICATION (ID) CODE (INA '1104)

The A-register is cleared, the device ID code is transmitted to the central processor and the next instruction is skipped. The control unit should always be ready to input the ID code. Standard ID codes assigned to the various devices available with this option are as follows:

Type 5310 (KSR-33)	-	'00042
Type 5507 (ASR-35)	-	'00044
Type 5307 (ASR-33)	-	'00046

INPUT STATUS WORD (INA '1204)

The status word should be checked after detecting an interrupt request. The A-register is cleared and the status word is transmitted to the central processor. A ONE in the following bits indicates that the condition is true:



All unassigned bits will be ZEROs.

The status word is relevant only after an interrupt. After an interrupt, the status word can be cleared by acknowledging the interrupt with an OTA '1004, by executing an INA 'X004, or by issuing an OCP '1204.

OUTPUT DATA (OTA '1004)

This instruction transmits the full 8 bits from the central processor to the teletypewriter. The punch will punch all 8 bits if enabled. However, only the least significant 7 bits are used in the printer to determine the character to be printed or the control function to be performed.

Data Codes

The ASR-33/35 uses ASCII-7 data code. Tables 1-2 and 1-3 show respectively the code generated by the ASR and the ASR's action upon receipt of any possible code. Only those control characters which cause response on ASR-33/35s supplied by Honeywell are named. In the case of Table 1-3, codes '200 through '377 have been shown. However, the ASR is indifferent to the most significant bit and responds exactly the same to codes '000 through '177. Combinations shown blank in Table 1-2 are impossible; those shown blank in Table 1-3 are NULs, causing no ASR action except that they are punched if the punch is on.

PROGRAMMING EXAMPLES

A method of I/O handling utilizing the non-interrupt mode is illustrated in the programs presented below.

The program in Figure 1-6 outputs one character from the low-order eight bits of the A-register to the teletypewriter and returns to the calling program. The data transfer is performed without using interrupts. Before entering the subroutine, the character must be in the A-register.

ASR	DAC	**	ENTRY POINT
	OTA	'1004	OUTPUT ASCII CHARACTER
	JMP	*-1	DELAY UNTIL READY
	JMP*	ASR	RETURN

Figure 1-6. Sample Program to Output One Character to Teletypewriter

The program in Figure 1-7 is designed to read a record from paper tape on the ASR. Any record of 256 characters or less is read properly, with spaces filling the input buffer beyond the characters read. For this example the end of record is denoted by an X-OFF ('223) character.

Table 1-2. Code Transmitted by ASR-33/35

Key	Without Shift or Control	With Shift Only	With Control Only	With Control and Shift
A	301 A		201 SOM	
B	302 B		202	
C	303 C		203 ETX	
D	304 D		204 EOT	
E	305 E		205 ENQ	
F	306 F		206	
G	307 G		207 BELL	
H	310 H		210	
I	311 I		211	
J	312 J		212 LF ^a	
K	313 K	333 [	213	233
L	314 L	334 \	214	234 FS
M	315 M	335]	215 CR	235 GS
N	316 N	336 ↑	216	236 RS
O	317 O	337 ←	217	237
P	320 P	300 @	220 DLE	200 NUL
Q	321 Q		221 X-ON	
R	322 R		222 TAPE	
S	323 S		223 X-OFF (DC3)	
T	324 T		224 T-OFF (DC4)	
U	325 U		225	
V	326 V		226	
W	327 W		227	
X	330 X		230	
Y	331 Y		231	
Z	332 Z		232	
!1	261 1	241 !	261 1	241 !
"2	262 2	242 "	262 2	242 "
#3	263 3	243 #	263 3	243 #
\$4	264 4	244 \$	264 4	244 \$
%5	265 5	245 %	265 5	245 %
&6	266 6	246 &	266 6	246 &
'7	267 7	247 '	267 7	247 '
(8	270 8	250 (	270 8	250 (
)9	271 9	251)	271 9	251)
0	260 0		260 0	
*:	272 :	252 *	272 :	252 *
=-	255 -	275 =	255 -	275 =
+;	273 ;	253 +	273 ;	253 +
< ,	254 ,	274 <	254 ,	274 <
> .	256 .	276 >	256 .	276 >
? /	257 /	277 ?	257 /	277 ?
LINE FEED	212 LF			
RETURN	215 CR			
RUBOUT	377 DEL		277 ?	
Space bar	240 Space		240 Space	
BREAK	000 NUL			

^a ASR-33 only.**LEGEND**

BREAK	The last character of a break is undefined.	GS	File Delimiter.
CR	Carriage Return (Record Delimiter).	HERE IS	Causes a burst of 20 NULs. (ASR-33 only)
DC3	Turns off tape reader (and sometimes punch).	LF	Line Feed
DC4	May turn off punch.	RS	Record Delimiter.
DEL	Interrupt Process.	SOM	Start-of-Message (not a control function).
ENQ	May trigger answer-back drum	TAPE	Turns on tape punch.
EOT	May turn off ASR.	X-OFF	Turns off tape reader and punch.
ETX	End-Of-Text (not a control function).	X-ON	Turns on tape reader.
FS	File Set Delimiter.	←	Ignore Previous Character.
		@	Ignore This Record.
			Blank combinations are impossible.

Table 1-3. Translation of Codes by ASR-33/35^a

Code	ASR Action	Code	ASR Action	Code	ASR Action	Code	ASR Action
200 ^b		240	Space	300 ^b	@	340	@
201	SOM	241	!	301	A	341	A
202		242	"	302	B	342	B
203	ETX	243	#	303	C	343	C
204 ^b		244	\$	304	D	344	D
205 ^b	ENQ (WRU)	245	%	305	E	345	E
206		246	&	306	F	346	F
207	BELL	247	'	307	G	347	G
210		250	(	310	H	350	H
211		251	)	311	I	351	I
212 ^b	LF	252	*	312	J	352	J
213		253	=	313	K	353	K
214		254	,	314	L	354	L
215 ^b	CR	255	-	315	M	355	M
216		256	.	316	N	356	N
217		257	/	317	O	357	O
220 ^b	DLE	260	0	320	P	360	P
221	X-ON	261	1	321	Q	361	Q
222	TAPE	262	2	322	R	362	R
223 ^b	X-OFF (DC3)	263	3	323	S	363	S
224 ^b	T-OFF (DC4)	264	4	324	T	364	T
225		265	5	325	U	365	U
226		266	6	326	V	366	V
227		267	7	327	W	367	W
230		270	8	330	X	370	X
231		271	9	331	Y	371	Y
232		272	:	332	Z	372	Z
233		273	;	333	[	373	[
234 ^b	FS	274	<	334	\	374 ^b	Vert. Line
235 ^b	GS	275	=	335	]	375	
236 ^b	RS	276	>	336	↑	376	
237		277	?	337 ^b	←	377 ^b	DEL (RUB OUT)

^aAll codes are shown with bit 8 = 1. The same table is obtained with bit 8 = 0 (i.e., codes 000 to 177).

^bMust be escaped when punching binary.

LEGEND

CR	Carriage Return (Record Delimiter - Alternate).	
ENQ	May trigger answer-back drum.	
LF	Line Feed.	
SOM	Start-of-Message and End-of-Text. These cause no ASR action	
ETX	except to be punched. They are used as text delimiters.	
TAPE	Turns on tape punch (ASR-35 only).	
T-OFF (DC4)	May turn off tape punch.	
X-OFF (DC3)	Turns off tape reader (ASR-33 and -35) and tape punch (ASR-35).	
X-ON	Turns on tape reader.	
DLE	Interrupt Process	
FS	File Set Delimiter	These cause no ASR action except to be punched. They do have special meanings, as explained in the text, under Standard Device Driver.
GS	File Delimiter	
RS	Record Delimiter	
Vert. Line	Escape Character	
←	Ignore Previous Character	
@	Ignore This Record	

Blanks in the table are NUL, causing no ASR action except to be punched if the punch is on.

ASR	DAC	**	ENTRY POINT
	OCF	'1704	INITIALIZE
	LDA	= '221	X-ON CHARACTER
	OTA	'1004	OUTPUT X-ON TO TURN ON READER
	JMP	*-1	DELAY IF NOT READY
	LDX	=-128	MAXIMUM BUFFER SIZE
LOOP	CRA		CLEAR A-REGISTER
	STA	BUF+128,1	CLEAR BUFFER LOCATION
	INA	'0004	INPUT 1ST CHARACTER
	JMP	*-1	DELAY UNTIL READY
	JST	TEST	GO TO X-OFF TEST
	ICR		SHIFT TO PACK
	STA	BUF+128,1	STORE 1ST CHARACTER
	INA	'1004	INPUT 2ND CHARACTER
*			AFTER CLEARING A-REGISTER
	JMP	*-1	DELAY UNTIL READY
	JST	TEST	GO TO X-OFF TEST
	ADD	BUF+128,1	ADD 1ST CHARACTER
	STA	BUF+128,1	STORE WORD
	IRS	0	UPDATE INDEX
	JMP	LOOP	READ NEXT WORD
	JMP	EXIT	END OF BUFFER
TEST	DAC	**	SUBROUTINE ENTRY
	CAS	= '223	CHECK FOR X-OFF
	JMP*	TEST	NO, READ NEXT CHARACTER
	JMP	PAD	YES, DON'T INPUT
	JMP*	TEST	NO, READ NEXT CHARACTER
EXIT	LDA	= '223	X-OFF CHARACTER
	OTA	'1004	OUTPUT X-OFF
	JMP	*-1	DELAY UNTIL READY
	JMP*	ASR	RETURN
*			
PAD	OTA	'1004	OUTPUT X-OFF
	JMP	*-1	DELAY UNTIL READY
	LDA	BUF+128,1	LOAD LATEST WORD
	SZE		HAS ONE CHARACTER BEEN READ
	JMP	ONE	YES, ADD SPACE
	LDA	= '120240	NO, BLANK OUT BUFFER
L2	STA	BUF+128,1	STORE SPACES
	IRS	0	UPDATE INDEX
	JMP	L2	LOOP
	JMP*	ASR	RETURN
ONE	ADD	= '240	BLANK OUT 2ND CHARACTER
	STA	BUF+128,1	STORE IN BUFFER
	LDA	= '120240	TWO SPACES
	JMP	L2+1	
*			
BUF	BSZ	128	BUFFER

Figure 1-7. Sample Program to Read One Record from
Paper Tape via ASR

Before entering the program, the paper tape must be placed in the ASR tape reader. When the program is entered, an X-ON ('221) character is output, turning on the reader. The first character is input and checked for an X-OFF. If the character is not an X-OFF, it is shifted to the left side of the A-register and stored in its buffer location. The next character is read, checked for an X-OFF, and loaded into the right side of the same location.

Reading continues and characters are loaded two per location until an X-OFF character is detected. Then the X-OFF is echoed to the ASR, turning off the tape reader. The remaining locations in the input buffer are filled with spaces.

SECTION II

HIGH-SPEED PAPER TAPE READER IN NORMAL MODE

DESCRIPTION

The Type 5010 High-Speed Paper Tape Reader (Figure 2-1) reads punched tape at 300 frames (or characters) per second. Standard 8-level tape with coincident sprocket holes is read in the forward direction by a 9-channel read head that senses the presence or absence of tape perforations. One-inch-wide opaque tape of paper, oiled paper, paper-mylar, mylar, or metalized mylar may be utilized. Tape thickness may be between 0.0020 and 0.0050 inch. Butt or lapped splices may be used, but the thickness of the splice must be less than 0.010 inch.

The tape reader is started via a start instruction, and the sprocket holes are used to signal the presence of a frame. When a sprocket hole is detected, the frame is read and data are routed to the control unit. When the data transfer is complete, control signals are generated, energizing a stepper motor in the reader. A sprocket drive wheel, which is mechanically connected to the stepper motor, moves the tape to the next frame at a maximum rate of 300 frames per second (fps). If the central processor accepts the data at a rate slower than 300 fps, the tape reader adopts the same rate as the central processor. Reading continues one frame at a time in the manner described above until a stop instruction is executed, terminating tape motion and data transfers.

The normal operating mode of the high-speed paper tape reader is explained in this section. In this mode, the System 700 instruction set is used to enable the tape reader control unit and control the reading operations. When the control unit is operating in the normal mode, only the System 700 instruction set should be utilized. The results are unspecified if an attempt is made to utilize another instruction set, namely the 316/516 instruction set, while operating in the normal mode.

OPERATION

Operator Control

The ON/OFF switch on the front panel controls the primary power to the tape reader. The tape reader is in the active condition when the switch is on. If the power is off, the tape may be pulled freely through the reader in either direction. If the power is on, the tape position is locked.

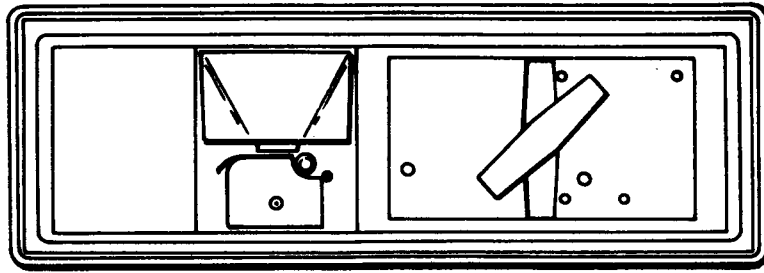


Figure 2-1. Type 5010 High-Speed Paper Tape Reader

Loading Tape

To load a tape, place the tape on the tape holder so that the sprocket holes (small holes) are the fourth channel from the front panel of the reader. Lift the upper tape guide and place the tape leader on the lower tape guide, making sure the sprocket holes engage the teeth of the sprocket drive wheel. Lower the upper tape guide and check the tape for proper alignment. The reader is now ready for operation, but the position of the tape guide does not control the device active/not active status.

PROGRAMMING INFORMATION

Instruction Complement

Table 2-1 lists the normal mode instructions for the Type 5010 High-Speed Paper Tape Reader.

Device Address

The standard device address (the two least significant octal digits of the instructions) for the high-speed paper tape reader is '01. However, if more than one Type 5101 reader is to be used in the normal mode within the same system, each additional device must be assigned a different address by modifying its associated control unit at time of installation. This address is used when the device is programmed for the normal operating mode. Addresses '00, '20, and '24 must not be used for this purpose.

Table 2-1. Normal Mode Instructions for Type 5010

Instruction	Description
OCP '1001	Start Reader
OCP '1101	Stop Reader
OCP '1201	Acknowledge
OCP '1501	Set Normal Mode Interrupt Mask
OCP '1601	Reset Normal Mode Interrupt Mask
OCP '1701	Initialize
INA 'X001 ^a	Input Data if Ready
INA '1101	Input ID (Identification) Code
INA '1201	Input Status Word
^a If X = 1, the A-register is cleared before transfer. If X = 0, the data on the data bus are ORed with the contents of the A-register.	

Device Interrupt Number

In the normal mode, the device interrupts through a location equal to '63 plus the device address. In a standard configuration, the high-speed paper tape reader interrupts through location '64.

Description of Instructions

The following nine instructions control tape reader operations in the normal mode.

START READER (OCP '1001)

This instruction initiates tape motion. The first character to move out of the read station is transferred to the data buffer.

STOP READER (OCP '1101)

This instruction terminates tape movement and data transfers. It also clears the ready indicator if it is set. If an OCP '1101 is issued after an OCP '1001 without an intervening INA 'X001, a character is lost. It is recommended that this instruction be executed only at the end of a record. If this instruction is not executed within 1 ms of ready, a character may be lost.

ACKNOWLEDGE (OCP '1201)

This instruction is used to acknowledge an interrupt request. It clears the going-not-active and/or going-active interrupt requests and clears their respective status word bits, bits 14 and 15.

SET NORMAL MODE INTERRUPT MASK (OCP '1501)

This instruction sets the normal mode interrupt mask, allowing interrupt requests to reach the central processor. Interrupt requests are generated when the ready indicator is set, the device goes active, or the device goes not active while reading.

RESET NORMAL MODE INTERRUPT MASK (OCP '1601)

The normal mode interrupt mask is cleared when this instruction is executed. All interrupt requests (including any currently pending) are masked from the central processor until an OCP '1501 is executed.

INITIALIZE (OCP '1701)

This instruction sets all functions in the tape reader control unit to their initial states. The tape reader is stopped, data transfers are terminated, the normal mode mask is cleared, and all status bits except bit 1 are cleared.

INPUT DATA IF READY (INA 'X001)

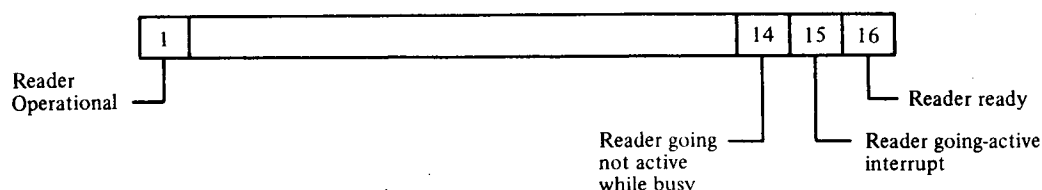
This instruction inputs data and skips the next instruction if the ready indicator was set. Otherwise, the data transfer is not completed and the next instruction is executed. The A-register is cleared prior to the transfer if $X = 1$; the contents of the data bus are ORed with the contents of the A-register if $X = 0$. The ready indicator is cleared at the completion of the INA.

INPUT ID (IDENTIFICATION) CODE (INA '1101)

The A-register is cleared, the device ID code is transferred to the central processor, and the next instruction is skipped. The control unit should always be ready to input the ID code. The assigned ID code for the high-speed paper tape reader is '000010.

INPUT STATUS WORD (INA '1201)

This instruction causes the tape reader status word to be transferred to the central processor. The A-register is cleared, the status word is transferred, and the next instruction is skipped. The control unit should always be ready to input the status word. A ONE in any of the following assigned status word bits indicates that the condition is true; unassigned bits should always be ZEROS.



The assigned bits are defined as follows:

- Bit 1: Power is applied to the reader.
- Bit 14: The reader went not active while the control unit was in the run state. The bit is cleared by an OCP '1201.
- Bit 15: The reader has gone active. The bit is cleared by an OCP '1201.
- Bit 16: The reader is ready to transfer the next character. The bit is cleared by an INA 'X001 or OCP '1101.

All bits in the status word, except bit 1, are cleared following an OCP '1701. Bit 1 assumes the appropriate condition, depending on whether the reader is operational or not operational.

PROGRAMMING EXAMPLE

A method of I/O handling utilizing the non-interrupt mode is illustrated in the program presented below.

Figure 2-2 shows a program to read two characters from the high-speed paper tape reader and pack them into one word. The control unit is initialized, the status word is input, and the operational status of the reader is determined by checking bit 1 of the status word. If power is applied (bit 1 is a ONE), the reader is started and the first frame is input to the right half of the A-register. The first frame is shifted to the left half of the A-register and the second frame is input to the right half of the A-register. The reader is stopped and the subroutine is exited, leaving the two frames in the A-register.

If the tape reader power was off when this subroutine was entered, bit 1 of the status word would be a ZERO. Under this condition, the program would jump to another subroutine (NTOPI), which could notify the operator (e. g., it could type "TURN ON READER POWER" on the ASR).

READ DAC	**	ENTRY POINT
OCP	'1701	INITIALIZE CONTROL UNIT
INA	'1201	INPUT STATUS
HLT		ERROR
SMI		IS READER OPERATIONAL?
JMP	NTOPI	NOTIFY OPERATOR
OCP	'1001	START TAPE READER
INA	'1001	CLEAR A AND INPUT 1ST FRAME
JMP	*-1	DELAY UNTIL READY
ICR		SHIFT TO PACK
INA	'0001	INPUT 2ND FRAME AND PACK
JMP	*-1	DELAY UNTIL READY
OCP	'1101	STOP TAPE READER
JMP*	READ	RETURN

Figure 2-2. Non-Interrupt Normal Mode Example for Tape Reader

SECTION III

HIGH-SPEED PAPER TAPE PUNCH IN NORMAL MODE

DESCRIPTION

The Type 5210 High-Speed Paper Tape Punch (Figure 3-1) punches a 1-inch paper tape at 110 frames (characters) per second. Tape frames should be punched in an 8-level format with coincident sprocket holes. Oiled black paper with a thickness between 0.0020 and 0.0050 inch is recommended for best punch life and compatibility with the Type 5010 High-Speed Paper Tape Reader.

The normal operating mode of the high-speed paper tape punch is explained in this section. In this mode, the System 700 instruction set is used to enable the tape punch control unit and control the punching operations. When the control unit is operating in the normal mode, only the System 700 instruction set should be utilized. The results are unspecified if an attempt is made to utilize another instruction set, namely the 316/516 instruction set, while operating in the normal mode.

OPERATION

Operator Controls

The following controls are located on the front panel of the tape punch, next to the tape chute.

POWER SWITCH

This toggle switch controls the application of power to the punching mechanism, power supply, and cooling fans. The punch is placed in the active condition and may be utilized when the switch is in the up position.

FEED SWITCH

This momentary-contact switch is pressed to punch blank leader or trailer. The power switch must be up to enable this function.

Tape Loading Procedure (see Figure 3-2)

To load tape into the high-speed punch, use the following procedure:

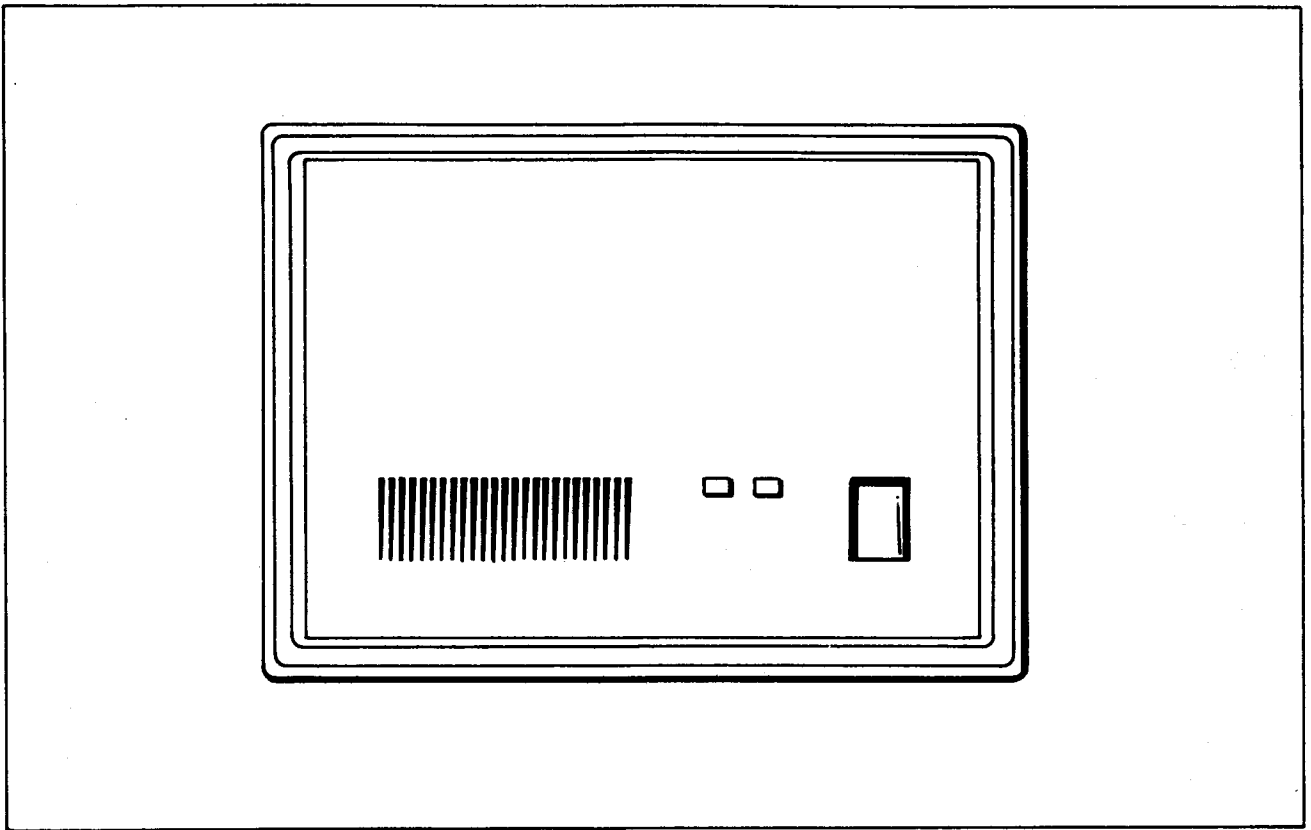


Figure 3-1. Type 5210 High-Speed Paper Tape Punch

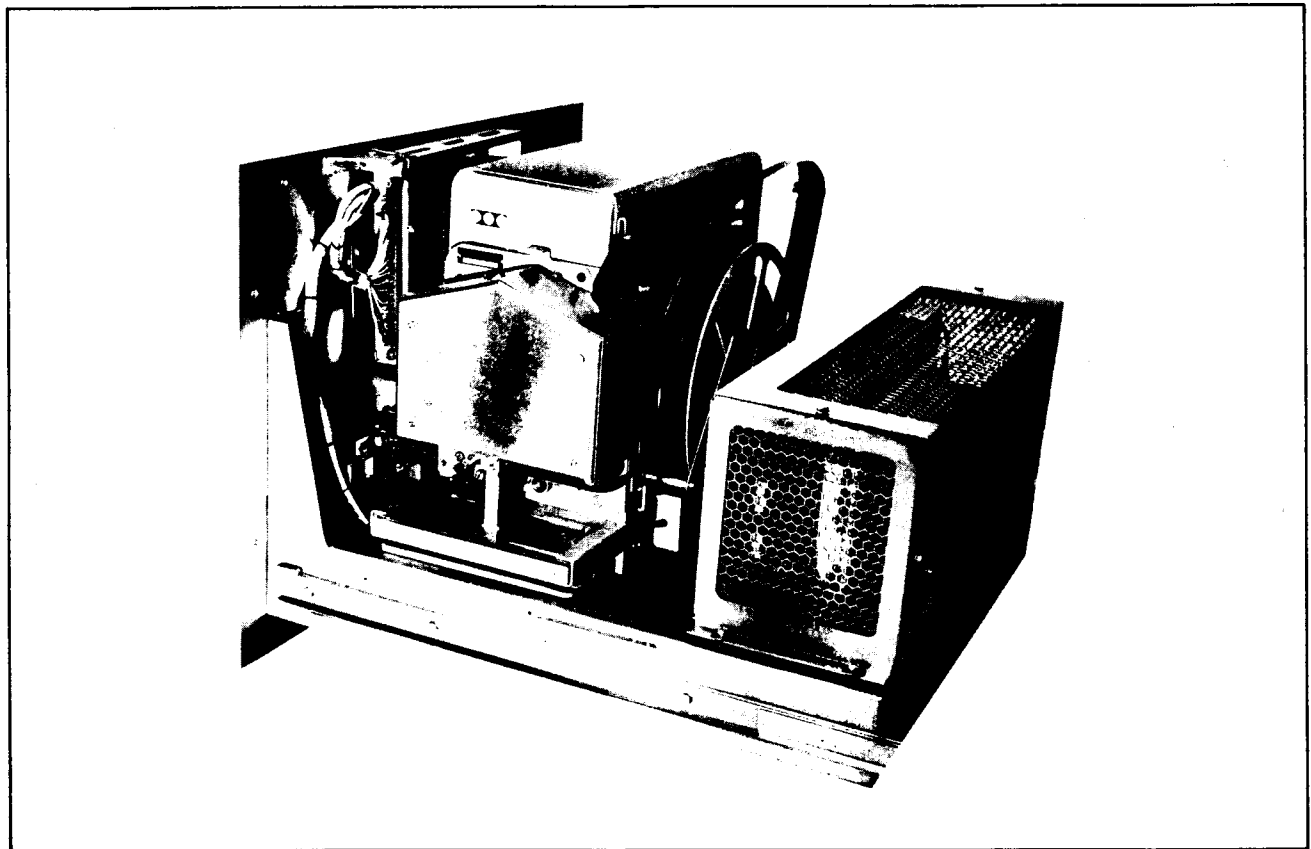


Figure 3-2. Type 5210 Paper Tape Loading

1. Turn off the punch power.
2. Loosen the tape punch drawer and pull it forward until the slide locks engage.
3. Remove the tape reel from the tape container and open it by unscrewing one side.
4. Remove the empty tape hub, place a new tape roll on the reel, and replace the side.
5. Hold the low tape lever open, place the reel in the tape container so that tape feeds from the bottom left, and release the lever.
6. Thread tape from the bottom left of the roll, up through the wire and roller guides, and then to the tape guide and punch block.
7. Lift the tape lid, place the tape between the lid and the feed wheel, and then push the tape through the tape chute in the front panel.
8. Remove, empty, and replace the chad box. (An interlock prevents the application of power if the chad box is not in place.)
9. Turn the power switch on, press and hold the feed switch, pull the tape forward until it begins to feed, and release the feed switch.
10. Close and secure the tape drawer.

PROGRAMMING INFORMATION

Instruction Complement

Table 3-1 lists the normal mode instructions for the Type 5210 High-Speed Paper Tape Punch.

Table 3-1. Normal Mode Instructions for Type 5210

Instruction	Description
OCP '1002	Start Punch
OCP '1102	Stop Punch
OCP '1202	Acknowledge
OCP '1502	Set Normal Mode Interrupt Mask
OCP '1602	Reset Normal Mode Interrupt Mask
OCP '1702	Initialize
OTA '1002	Output Data if Ready
INA '1102	Input ID (Identification) Code
INA '1202	Input Status Word

Device Address

The standard device address (the two least significant octal digits of the instruction) for the high-speed paper tape punch is '02. However, if more than one Type 5210 punch is to be used in the normal mode within a system, each additional punch must be assigned a different address by modifying its associated control unit at the time of installation. This address is

used when the device is programmed for the normal operating mode. Addresses '00, '20, and '24 must not be used for this purpose.

Device Interrupt Number

In the normal mode, the device interrupts through a location that is equal to '63 plus the device address. In a standard configuration, the high-speed paper tape punch interrupts through location '65.

Description of Instructions

The following nine instructions control the high-speed paper tape punch in the normal mode.

START PUNCH (OCP '1002)

This instruction turns on the punching mechanism power and initiates a 5-second delay which allows the punching motor to reach operating speed. The control unit is ready to accept the first character immediately, but punching is not performed until the delay has timed out.

STOP PUNCH (OCP '1102)

This instruction removes power from the punching mechanism and clears the ready indicator (bit 16 of the status word). The last character transferred to the data buffer is punched prior to the removal of power. Before executing this instruction, at least 12 inches of trailer should be punched to ensure that the last character punched has cleared the tape chute if the tape is to be torn off.

ACKNOWLEDGE (OCP '1202)

This instruction is used to acknowledge an interrupt request. It clears the device going-not-active (bit 14) and going-active (bit 15) indicators in the status word of the punch.

SET NORMAL MODE INTERRUPT MASK (OCP '1502)

This instruction sets the normal mode interrupt mask in the control unit, allowing interrupt requests to reach the central processor. An interrupt request is generated when the control unit is ready to receive data, the device goes active, or the device goes not active when busy.

RESET NORMAL MODE INTERRUPT MASK (OCP '1602)

The normal mode interrupt mask is cleared by this instruction. All interrupt requests (including any currently pending) are masked from the central processor until an OCP '1502 is executed.

INITIALIZE (OCP '1702)

This instruction sets all functions in the punch control unit to their initial states. The punch is stopped, the normal mode mask is cleared, and all bits in the status word except bit 1 are cleared.

OUTPUT DATA IF READY (OTA '1002)

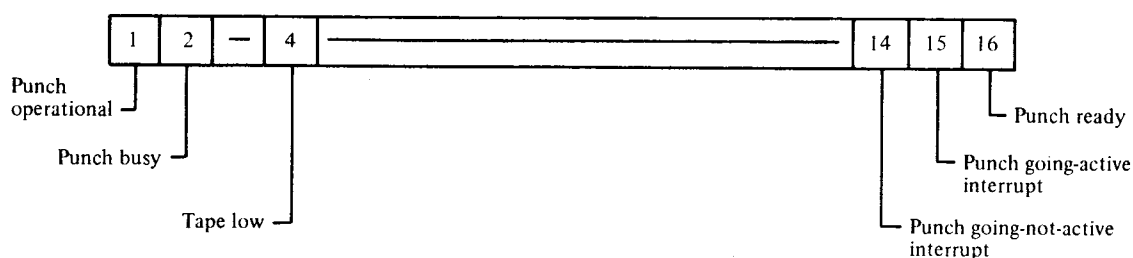
This instruction transfers 8 bits of data and causes the next instruction to be skipped if the control unit is in the ready condition. Otherwise, the data transfer is not completed and the next instruction is executed. Power is removed from the punch mechanism if more than 20 seconds elapses without a data output instruction. The effect is not visible to the programmer except for the increased time to punch the next character. Under this circumstance, the next OTA '1002 instruction turns on the punch mechanism power and initiates the normal 5-second delay.

INPUT ID (IDENTIFICATION) CODE (INA '1102)

The A-register is cleared, the device ID code is transferred to the central processor, and the next instruction is skipped. The control unit should always be ready to input the ID code. The assigned ID code for the high-speed paper tape punch is '000020.

INPUT STATUS WORD (INA '1202)

This instruction causes the tape punch status word to be transferred to the central processor. The A-register is cleared, the status word is transferred, and the next instruction is skipped. The control unit should always be ready to input the status word. A ONE in any of the following assigned status word bits indicates that the condition is true; unassigned bits should always be ZEROS.



The assigned bits are defined as follows:

- Bit 1: Power is applied to the punch and it is not busy.
- Bit 2: The punch has been enabled by an OCP '1002 and has not been disabled by an OCP '1102.
- Bit 4: The tape level on the spool is low.
- Bit 14: The punch went not active while the control unit was busy. The bit is cleared by an OCP '1202.

- Bit 15: The punch has gone active. The bit is cleared by an OCP '1202.
- Bit 16: The punch is ready to receive the next character. The bit is cleared by an OTA '1002 or OCP '1102.

All bits in the status word, except bit 1, are cleared following an OCP '1702. Bit 1 assumes the appropriate condition, depending on whether the punch is operational or not operational.

PROGRAMMING EXAMPLE

A method of I/O handling utilizing the non-interrupt mode is illustrated in the program presented below.

Figure 3-3 shows a program to output one 80-character record to the high-speed paper tape punch. The status word is input and bit 1 is checked. If the device is operational and not busy, a low tape level is detected by checking bit 4 of the status word.

The control unit is initialized and power to the punch is turned on. The index register is set up for a 40-word transfer, and the first word is transferred to the A-register. Characters are interchanged in the A-register and the first character is punched. A second interchange is performed and the second character is punched. The index register is decremented and the loop is repeated until all 80 characters have been punched. Then the punch is turned off and the program returns indirectly through location PNCH.

Upon entering this subroutine, program flow is different if bit 1 of the status word is a ZERO. In this case, a jump to location BUSY is performed and bit 2 of the status word is checked. Bit 2 is a ZERO if the punch power is off, and the program jumps to another subroutine (TRON), which may notify the operator (e.g., it may type "TURN ON PUNCH POWER" on the ASR). If bit 2 is a ONE, another program may be using the device, and an exit from the program should be performed.

The status word also monitors the tape level. When the tape reaches a preset level, bit 4 of the status word becomes set. When the bit is set, a subroutine is entered (NTOP) to notify the operator that the tape is low (e.g., it may type "LOW TAPE" on the ASR).

PNCH	DAC	**	ENTRY POINT
	INA	'1202	INPUT STATUS WORD
	HLT		ERROR
	SMI		CHECK BIT 1
	JMP	BUSY	GO TO CHECK BUSY
	LGL	3	MOVE TO BIT 4
	SPL		CHECK TAPE LOW
	JMP	NTOP	TAPE LOW NOTIFY OPERATOR
	OCF	'1702	INITIALIZE
	OCF	'1002	START PUNCH
	LDX	=-40	SET UP INDEX
LOOP	LDA	BUF+40,1	DATA WORD
	ICA		SET UP LEFT CHARACTER
	OTA	'1002	OUTPUT CHARACTER
	JMP	*-1	DELAY UNTIL READY
	ICA		SET UP RIGHT CHARACTER
	OTA	'1002	OUTPUT CHARACTER
	JMP	*-1	DELAY UNTIL READY
	IRS	0	UPDATE INDEX
	JMP	LOOP	CONTINUE IF NOT DONE
	OCF	'1102	TURN OFF PUNCH
	JMP*	PNCH	RETURN
BUSY	LGL	1	MOVE TO BIT 2
	SPL		CHECK BUSY BIT
	JMP	TRON	DEVICE NOT ACTIVE
*			NOTIFY OPERATOR
	JMP*	PNCH	RETURN DEVICE BUSY
BUF	BSS	40	DATA BUFFER

Figure 3-3. Sample Program to Output One Record

APPENDIX A
ASR/KSR-33 AND ASR-35 TELETYPEWRITERS IN
COMPATIBLE MODE

DESCRIPTION

The ASR and KSR teletypewriters are used as primary input/output devices in many System 700 configurations. They may be used on-line to input data via the keyboard or tape reader (ASR only) and to output data to the printer or tape punch (ASR only). The ASR may also be used off-line for low-speed punching and reading of paper tape. Types 5307, 5310, and 5507 are available for compatible mode applications.

The teletypewriter is connected to the I/O bus of the central processor via a teletypewriter control unit. Two 8-bit data registers in the control unit are used to transfer data. The serial-to-parallel input register and the parallel-to-serial output register operate with a 110-baud clock to provide operating speeds up to 10 characters per second.

Teletypewriter functions are initiated by the receipt of certain codes. Some of these, such as carriage return and line feed, have their own keys. Other codes may be generated by simultaneously depressing the CTRL (control) key and one of the alphabetic keys.

Horizontal spacing is 10 characters per inch. Vertical spacing is six lines per inch with single line spacing. A line may contain up to 72 characters. In the ASR/KSR-33, a local carriage return (generating no code) occurs after all 72 characters have been printed and an attempt is made to print another character.

The compatible operating mode of the teletypewriter is described in this section. In this mode, the Honeywell 316/516 instruction set is used to enable the teletypewriter control unit and control the teletypewriter in half-duplex operation. The control unit provides hardware echo-back of the input data. When the control unit is operating in the compatible mode, only the 316/516 instruction set should be utilized for ASR operations. The results are unspecified if an attempt is made to utilize the normal operating mode while the control unit is operating in the compatible mode.

The control unit is not aware whether the teletypewriter is malfunctioning or even whether the teletypewriter is present at all. Therefore it is the operator's responsibility to see that the device is in operating condition.

OPERATION

ASR/KSR Controls

The controls for the ASR-33, KSR-33, and ASR-35 are described in detail in Section I of this manual.

Modes of Operation

The operating modes of the ASR-33 and ASR-35 are detailed in Section I of this manual

PROGRAMMING INFORMATION

Instruction Complement

Table A-1 list the compatible mode instructions for the teletypewriter.

Table A-1. Compatible Mode Instructions for Teletypewriter

OCP '0004	Enable Input Mode
OCP '0104	Enable Output Mode
SKS '0004	Skip if ASR Ready
SKS '0104	Skip if ASR Not Busy
SKS '0404	Skip if ASR Not Requesting Interrupt
SKS '0504	Skip if X-OFF Was Not Received
INA 'X004 ^a	Input in ASCII Mode if Ready
INA 'X204 ^a	Input in Binary Mode if Ready
OTA '0004	Output in ASCII Mode if Ready
OTA '0204	Output in Binary Mode if Ready
SMK '0020	Set Compatible Mode Interrupt Mask
(Bit 11 Set)	

^aIf X = 1, the A-register is cleared before transfer. If X = 0, the data on the data bus are ORed with the contents of the A-register.

Device Address

In this mode, the standard device address (the two least significant octal digits of the instruction) used in the 316/516 software for the teletypewriter is '04.

Device Interrupt Number

The teletypewriter interrupts through location '63 when operating in the compatible mode.

Sense Instructions

The sense (SKS) instructions are used exclusively in the compatible mode. If the tested condition is true, the next instruction in the sequence is skipped. If the tested condition is false, the next instruction is executed.

Data Formats

ASCII FORMAT

In the ASCII format, a full 8-bit character is transmitted between the least significant bits of the A-register and the teletypewriter, as shown in Figure A-1. No modifications of the data are made. If the paper tape punch is on during a transfer in the ASCII mode, all eight bits are punched. The character to be printed or the control function to be performed is determined from the least significant seven bits.

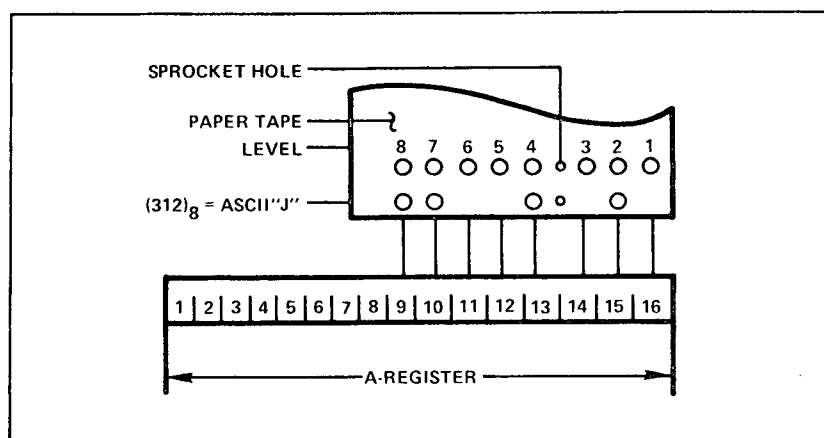


Figure A-1. Typewriter Paper Tape Format

BINARY FORMAT

Binary data are punched as 8-bit frames, and two frames are packed in the two bytes of each word.

Description of Instructions

The following 11 instructions control teletypewriter operations in the compatible mode.

ENABLE INPUT MODE (OCP '0004)

This instruction enables the control unit in the compatible mode and conditions the control unit for data transfers from the teletypewriter to the CPU. The control unit remains enabled until the enable output mode instruction (OCP '0104) is executed or the normal operating mode is selected. An OCP '0004 must not be issued while the control unit is busy. An OCP '1704 or a computer master clear disables the compatible mode. Therefore, an OCP '0004 or '0104

must be executed to enter the compatible mode after an OCP '1704 is executed or a computer master clear is performed.

ENABLE OUTPUT MODE (OCP '0104)

This instruction sets the control unit to the compatible mode and conditions the control unit for data transfers from the central processor to the teletypewriter. The control unit remains in the output mode until the enable input mode instruction (OCP '0004) is executed, the central processor is master cleared, or the normal mode is selected. An OCP '0104 must not be issued while the control unit is busy.

SKIP IF ASR READY (SKS '0004)

The control unit data ready indicator is set whenever it is ready to accept another character from the computer or present another character to it.

SKIP IF ASR NOT BUSY (SKS '0104)

The ASR busy indicator is set under the following conditions:

1. In the output mode the ASR is busy from the time a character is transmitted from the computer to the control unit until it has been serially shifted out to the ASR. This time is approximately 105 ms.
2. In the input mode the ASR is busy from the time it starts to transfer a character serially to the control unit until the transfer is complete and the ready indicator is set. This time is approximately 100 ms.

SKIP IF ASR NOT REQUESTING INTERRUPT (SKS '0404)

If the ASR mask bit is set and any of the following conditions occur, the control unit requests an interrupt and SKS '0404 does not skip:

1. The control unit is ready to receive a character following an enable output mode instruction (OCP '0104) or the completion of a previous output operation. This interrupt request is cleared by an OTA '0004 or '0204 or by the enable input mode instruction (OCP '0004).
2. The ASR control unit, in the input mode, has received a character. This interrupt request is cleared by INA 'X004 or 'X204.

SKIP IF X-OFF WAS NOT RECEIVED (SKS '0504)

This instruction skips unless the last character received was 023_8 or 223_8 (X-OFF). The X-OFF indicator is set from the time the character arrives in the control unit buffer until the next character arrives. The X-OFF character and one/two following characters (ASR 33/35) may be read before the tape stops.

INPUT IN ASCII MODE IF READY (INA 'X004)

Execution of an INA 'X004 inputs an 8-bit character in ASCII mode and skips the next instruction if the ready indicator was set. Otherwise, the instruction is not executed, no data is input, and the next instruction is executed. The A-register is cleared before the transfer if X = 1; if X = 0, data are ORed with the contents of the A-register. The ready indicator is cleared at the completion of the INA.

INPUT IN BINARY MODE IF READY (INA 'X204)

Execution of an INA '204 inputs the least significant 6 bits of an 8-bit character into the 6 least significant bits of the A-register.

OUTPUT IN ASCII MODE IF READY (OTA '0004)

This instruction outputs data to the ASR in ASCII mode and skips the next instruction if the ready indicator was set. Otherwise the instruction is not executed, no data is output, and the next instruction is executed.

OUTPUT IN BINARY MODE IF READY (OTA '0204)

This instruction outputs data to the ASR in binary mode and skips the next instruction if the ready indicator was set. Otherwise the instruction is not executed, data is not output, and the next instruction is not skipped.

SET COMPATIBLE MODE INTERRUPT MASK (SMK '0020, BIT 11 SET)

The compatible mode interrupt mask flip-flop is set if this instruction is executed and bit 11 of the A-register is a ONE. If bit 11 of the A-register is a ZERO, the compatible mode interrupt mask flip-flop is cleared when this instruction is executed. Teletypewriter interrupt requests are enabled if the compatible mode is selected and the mask flip-flop is set.

Data Code

The ASR-33/35 uses ASCII-7. In Section I of this manual, Tables 1-2 and 1-3 show, respectively, the code generated by the ASR and the ASR's action upon receipt of any possible code. Only those control characters which cause response on ASR-33/35s supplied by Honeywell are named. In the case of Table 1-3, codes 200 through 377 have been shown. However, the ASR is indifferent to the most significant bit and responds exactly the same to codes 000 through 177. Combinations shown blank in Table 1-2 are impossible; those shown blank in Table 1-3 are NULs, causing no ASR action except that they are punched if the punch is on.

In the compatible mode, binary information is punched at 8 bits per frame.

PROGRAMMING EXAMPLES

Basic I/O operations of the teletypewriter may be controlled by the 316/516 instruction set. Typical programs which utilize the non-interrupt operating mode are presented below.

The program in Figure A-2 outputs one character from the low-order eight bits of the A-register to the teletypewriter and returns to the calling program. The character must be in the A-register before entering the subroutine.

ASR	DAC	**	ENTRY POINT
	SKS	'0104	IS ASR BUSY?
	JMP	*-1	DELAY UNTIL NOT BUSY
	OCP	'0104	ENABLE ASR IN OUTPUT MODE
	OTA	'0004	OUTPUT ONE CHARACTER IN USASCII
	JMP	*-1	DELAY UNTIL READY
	JMP*	ASR	RETURN

Figure A-2. Sample Program to Output One Character to Teletypewriter

The program in Figure A-3 is designed to read a record from paper tape using the ASR paper tape reader. Any record of 256 characters or less is read properly, with blanks filling the input buffer beyond the characters read. The operation is uncertain for longer records.

ASR	DAC	**	ENTRY POINT
	SKS	'0104	TEST BUSY INDICATOR
	JMP	*-1	DELAY UNTIL NOT BUSY
	OCP	'0104	ENABLE IN OUTPUT MODE IN ORDER
*			TO TURN ON READER
	LDA	= '221	X-ON CHARACTER
	OTA	'0004	OUTPUT X-ON
	JMP	*-1	DELAY IF NOT READY
	LDX	= -128	MAXIMUM BUFFER SIZE
	SKS	'0104	WAIT UNTIL
	JMP	*-1	NOT BUSY
	OCP	'0004	ENABLE IN INPUT MODE
LOOP	CRA		CLEAR A REGISTER FIRST
	JST	TEST	READY DELAY WITH X-OFF TEST
	INA	'0004	INPUT DATA
	JMP	*-1	DELAY UNTIL READY
	ICR		SHIFT TO PACK
	JST	TEST	READY DELAY WITH X-OFF TEST
	INA	'0004	INPUT SECOND CHARACTER
	JMP	*-1	DELAY UNTIL READY
	STA	BUF+128,1	STORE IN INPUT BUFFER
	IRS	0	UPDATE INDEX
	JMP	LOOP	READ TWO MORE CHARACTERS IF THERE IS ROOM
	SKS	'0104	WAIT UNTIL
	JMP	*-1	NOT BUSY
	OCP	'0104	ENABLE IN OUTPUT MODE IN ORDER
*			TO TURN OFF READER
	LDA	= '223	X-OFF CHARACTER
	OTA	'0004	OUTPUT X-OFF CHARACTER
	JMP	*-1	DELAY UNTIL READY
	JMP*	ASR	RETURN
*			
TEST	DAC	**	SUBROUTINE ENTRY
	SKS	'0004	TEST READY INDICATOR
	JMP	*-1	WAIT FOR READY
	SKS	'0504	HAS X-OFF BEEN READ?
	JMP	EXIT	YES, DON'T INPUT IT
	JMP*	TEST	NO, READ THE CHARACTER
*			
EXIT	SZE		HAS ONE CHARACTER BEEN READ ALREADY?
	JMP	ONE	YES, ADD BLANK
	LDA	= '120240	NO, BLANK OUT BUFFER
L2	STA	BUF+128,1	STORE BLANKS
	IRS	0	UPDATE INDEX
	JMP	L2	LOOP
	JMP*	ASR	RETURN
*			
ONE	ADD	= '240	BLANK FOR SECOND CHARACTER
	STA	BUF+128,1	STORE IN BUFFER
	LDA	= '120240	TWO BLANKS
	JMP	L2+1	ENTER BLANKING LOOP
*			
BUF	BSS	128	

Figure A-3. Sample Program to Read One Record from
Paper Tape via ASR

APPENDIX B

HIGH-SPEED PAPER TAPE READER IN COMPATIBLE MODE

DESCRIPTION

The Type 5010 High-Speed Paper Tape Reader reads punched paper tape at 300 frames (or characters) per second. Refer to Section II for a description of this device.

The compatible operating mode of the high-speed paper tape reader is described in this section. In this mode, the Honeywell 316/516 instruction set is used to enable the tape reader control unit and control the reading operation. When the control unit is enabled for the compatible mode, only the 316/516 instruction set should be utilized for reader operation. Results are unspecified if an attempt is made to utilize the normal mode instructions while the control unit is enabled for the compatible mode.

OPERATION

Operator Control

The ON/OFF switch on the front panel controls the primary power to the tape reader. The switch must be on to use the tape reader.

Loading Tape

To load a tape, place the tape on the tape holder so that the sprocket holes (small holes) are the fourth channel from the front panel of the reader. Lift the upper tape guide and place the tape leader on the lower tape guide, making sure the sprocket holes engage the teeth of the sprocket drive wheel. Lower the upper tape guide and check the tape for proper alignment. The reader is now ready for operation.

PROGRAMMING INFORMATION

Instruction Complement

Table B-1 lists the compatible mode instructions for the Type 5010 High-Speed Paper Tape Reader.

Table B-1. Compatible Mode Instructions for Type 5010

<u>Instruction</u>	<u>Description</u>
OCP '0001	Start Reader
OCP '0101	Stop Reader
SKS '0001	Skip if Tape Reader Ready
SKS '0401	Skip if Tape Reader Not Requesting an Interrupt
INA 'X001 ^a	Input from Reader if Ready
SMK '0020 (Bit 9 Set)	Set Compatible Mode Interrupt Mask

^aIf X = 1, the A-register is cleared before transfer. If X = 0, the data on the data bus are ORed with the contents of the A-register.

Device Address

In this mode, the standard device address (the two least significant digits of the instruction) used in the 316/516 software for the high-speed paper tape reader is '01.

Device Interrupt Number

The high-speed paper tape reader interrupts through location '63 when operating in the compatible mode.

Sense Instructions

The sense (SKS) instructions are used exclusively in the compatible mode. If the tested condition is true, the next instruction in the sequence is skipped. If the tested condition is false, the next instruction is executed.

Description of Instructions

The following six instructions control the high-speed paper tape reader in the compatible mode.

START READER (OCP '0001)

This instruction initiates tape motion. The first character to move under the read station is transferred to a data buffer for transmission to the central processor.

STOP READER (OCP '0101)

This instruction terminates tape motion and data transfers. It also clears a ready condition if it is set.

SKIP IF TAPE READER READY (SKS '0001)

This instruction tests the condition of the ready logic to determine whether data is stored in the control unit data register. If the ready condition is true, the next instruction is skipped.

SKIP IF TAPE READER NOT REQUESTING AN INTERRUPT (SKS '0401)

If the compatible mode interrupt mask flip-flop is set, an interrupt request is caused each time the data buffer ready indicator is set. The interrupt request is reset by INA '0001 or '1001 or OCP '0101. If the tape reader is not requesting an interrupt, the next instruction is skipped.

INPUT FROM READER IF READY (INA 'X001)

This instruction inputs data and skips the next instruction if the ready indicator was set. Otherwise, the data transfer is not completed and the next instruction is executed. The A-register is cleared if X = 1; if X = 0, the contents of the data bus are ORed with the contents of the A-register. The ready indicator is cleared at the completion of the INA, and interrupt requests are removed.

SET COMPATIBLE MODE INTERRUPT MASK (SMK '0020, BIT 9 SET)

The compatible mode interrupt mask is set if this instruction is executed and bit 9 of the A-register (which must contain the entire mask word) is a ONE. This allows tape reader interrupts to reach the central processor. If bit 9 of the A-register is a ZERO when SMK '0020 is executed, the compatible mode interrupt mask is cleared, inhibiting tape reader interrupts. The compatible mode interrupt mask is also cleared by an OCP '1501, an OCP '1701, and a central processor master clear.

PROGRAMMING EXAMPLE

A typical program utilizing the non-interrupt operating mode is presented below.

Figure B-1 is a sample program to read two characters from paper tape and pack them into one word. The program starts the paper tape reader before reading and stops it after reading. The two characters input by the program are left in the A-register when it exits.

READ	DAC	**	ENTRY POINT
	OCP	'0001	START TAPE READER
	INA	'1001	CLEAR A AND INPUT FIRST FRAME
	JMP	*-1	DELAY UNTIL READY
	ICR		SHIFT TO PACK
	INA	'0001	INPUT SECOND FRAME
	JMP	*-1	DELAY UNTIL READY
	OCP	'0101	STOP READER
	JMP*	READ	RETURN

Figure B-1. Sample Program to Read Two Characters from Paper Tape

APPENDIX C

HIGH-SPEED PAPER TAPE PUNCH IN COMPATIBLE MODE

DESCRIPTION

The Type 5210 High-Speed Paper Tape Punch punches a 1-inch paper tape at 110 frames (characters) per second. Tape frames are punched in an 8-level format with coincident sprocket holes. Oiled black paper with a thickness between 0.0020 and 0.0050 inch is recommended for best punch life and compatibility with the Type 5010 High-Speed Paper Tape Reader.

The compatible operating mode of the high-speed paper tape punch is explained in this section. In this mode, the Honeywell 316/516 instruction set is used to enable the tape punch control unit and control the punching operation. When the control unit is enabled for the compatible mode, only the 316/516 instruction set should be utilized for punching operations. Results are unspecified if an attempt is made to utilize the normal mode instruction while the control unit is enabled for the compatible mode.

OPERATION

Operator Controls

The following controls are located on the front panel of the tape punch, next to the tape chute.

POWER SWITCH

This toggle switch controls the application of power to the punching mechanism, power supply, and cooling fans. The switch must be in the up position before the punch can be used.

FEED SWITCH

This momentary-contact switch is pressed to punch blank leader or trailer. The power switch must be up to enable this switch.

Tape Loading Procedure

The tape loading procedure is presented in Section III.

PROGRAMMING INFORMATION

Instruction Complement

Table C-1 lists the compatible mode instructions for the Type 5210 High-Speed Paper Tape Punch.

Table C-1. Compatible Mode Instructions for Type 5210

Instruction	Description
OCP '0002	Turn On Punch
OCP '0102	Turn Off Punch
SKS '0002	Skip if Punch Ready
SKS '0102	Skip if Punch Power On
SKS '0402	Skip if Punch Not Requesting an Interrupt
OTA '0002	Output to Punch if Ready
SMK '0020 (Bit 10 Set)	Set Compatible Mode Interrupt Mask

Device Address

In this mode, the standard device address (the two least significant octal digits of the instruction) used in the 316/516 software for the high-speed paper tape punch is '02.

Device Interrupt Number

The high-speed paper tape punch interrupts through location '63 when operating in the compatible mode.

Sense Instructions

The sense (SKS) instructions are used exclusively in the compatible mode. If the tested condition is true, the next instruction in the sequence is skipped. If the tested condition is false, the next instruction is executed.

Description of Instructions

The following seven instructions are used to control the high-speed paper tape punch in the compatible mode.

TURN ON PUNCH (OCP '0002)

This instruction applies power to the punching mechanism and initiates a 5-second delay which allows the punch motor to reach operating speed. The control unit is ready to accept the first character immediately, but punching is not performed until the delay has timed out.

TURN OFF PUNCH (OCP '0102)

This instruction removes power from the punching mechanism and clears the ready indicator. If the data buffer in the control unit has received a character to be punched prior to this instruction, the character is punched before power is removed. Before executing this instruction, at least 12 inches of trailer should be generated to ensure that the last character punched has cleared the tape chute if the tape is to be torn off.

SKIP IF PUNCH READY (SKS '0002)

This instruction tests the ready indicator, which is set whenever the data buffer is ready to accept a character. If the ready indicator is set, the next instruction is skipped.

SKIP IF PUNCH POWER ON (SKS '0102)

This instruction may precede an OCP '0002 instruction. If an OCP '0002 is executed when power is already enabled, the loss of a character does not occur and the instruction has no effect.

SKIP IF PUNCH NOT REQUESTING AN INTERRUPT (SKS '0402)

If the compatible mode interrupt mask is set, an interrupt request is generated each time the ready indicator is set. The interrupt request is reset by either OTA '0002 or OCP '0102.

OUTPUT TO PUNCH IF READY (OTA '0002)

This instruction causes the central processor to output an 8-bit frame (character) to the punch and skip the next instruction if the ready indicator is set. Then the transfer is performed, the interrupt requests are cleared. If the ready indicator is not set, the instruction is not executed, the data transfer is not performed, and the next instruction is executed. Power is removed from the punching mechanism if more than 20 seconds elapses between OTA '0002 instructions. Under this circumstance, the next OTA '0002 instruction turns on the punching mechanism and initiates the normal 5-second delay. This condition is visible to the programmer only through the increased time to punch the next character.

SET COMPATIBLE MODE INTERRUPT MASK (SMK '0020, BIT 10 SET)

The compatible mode interrupt mask is set if this instruction is executed and bit 10 of the A-register (which must contain the entire mask word) is a ONE. This allows interrupts from the high-speed paper tape punch to reach the central processor. If bit 10 of the A-register is a ZERO when SMK '0020 is executed, the compatible mode interrupt mask is cleared, inhibiting tape punch interrupts until the mask is again set. The mask is also cleared by an OCP '1502, an OCP '1702, and a central processor master clear.

PROGRAMMING EXAMPLE

Basic I/O operations of the high-speed paper tape punch may be controlled by the 316/516 instruction set. A typical program utilizing the non-interrupt operating mode is presented below.

Figure C-1 is a sample program to output one 80-character record to the high-speed punch. The punch is turned on at the beginning, if it is not on already, and it is turned off at the end. This program produces a record that has no mark to specify its beginning or ending. If it were desired to punch several records, the power-off routine should be separated, to avoid the 5-second startup delay for each record punched.

PNCH	DAC	**	ENTRY POINT
	SKS	'0102	IS POWER ALREADY ON?
	OCF	'0002	IF NOT, TURN IT ON
	LDX	=-40	SET COUNTER FOR 80-CHARACTER TRANSFER
LOOP	LDA	BUF+40,1	DATA WORD
	ICA		SET UP LEFT CHARACTER
	OTA	'0002	OUTPUT CHARACTER
	JMP	*-1	DELAY UNTIL READY
	ICA		SET UP RIGHT CHARACTER
	OTA	'0002	OUTPUT CHARACTER
	JMP	*-1	DELAY UNTIL READY
	IRS	0	UPDATE INDEX
	JMP	LOOP	CONTINUE IF NOT DONE
	SKS	'0002	DELAY UNTIL
	JMP	*-1	READY
	OCF	'0102	TURN PUNCH POWER OFF
	JMP*	PNCH	RETURN
*			
BUF	BSS	40	DATA BUFFER

Figure C-1. Sample Program to Punch One 80-Character Record on High-Speed Punch

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