

**CONTROL DATA**

**170**

**CARD PUNCH CONTROLLER**

VOLUME I  
DESCRIPTION, OPERATION  
AND PROGRAMMING

**CONTROL DATA**  
**170**  
**CARD PUNCH CONTROLLER**  
VOLUME 1  
DESCRIPTION, OPERATION,  
AND PROGRAMMING





## CONTENTS

### Chapter I - Description

### Chapter II - Operation and Programming

Punch and Controller Preparation	2-1
Formats	2-2
160 Output Format	2-3
1604 Output Format	2-3
Program Timing	2-4
Operation Codes	2-5
EF Select Codes	2-5
160 Status Responses	2-6
1604 EF Sense Codes	2-6

### Chapter III - Principles of Operation

Basic Principles	3-1
160 Operation	3-1
1604 Operation	3-2
Manual Select	3-3
Clearing	3-3
EF Code Translators	3-3
160 Operations	3-4
1604 Operations	3-5
Check Readiness	3-6
160 Status	3-6
1604 Sense	3-6
Punch Timing Control	3-7
Buffer Register	3-9
Output Gating Controls	3-10
160 Operation	3-10
1604 Operation	3-10
1604 Interrupt	3-11

## FIGURES

2-1	Switch Locations, 170	2-1
2-2	160 Output Format	2-2
2-3	1604 Output Format	2-3
2-4	Program Timing	2-4
2-5	Flow Chart, 160 Operation	2-7
2-6	Flow Chart, 1604 Operation	2-7
2-7	Flow Chart, 1604 Operation With Interrupt	2-8
3-1	Block Diagram, 160 Punch Operation	3-1
3-2	Block Diagram, 1604 Punch Operation	3-2
3-3	Manual Select	3-3
3-4	Clearing Control	3-3
3-5	160 EF Select Code Translator	3-4
3-6	1604 EF Code Translator	3-5
3-7	160 Status	3-6
3-8	1604 Sense	3-7
3-9	Punch Timing Control	3-8
3-10	Buffer Register	3-9
3-11	160 Output Gating	3-10
3-12	1604 Output Gating	3-11
3-13	1604 Interrupt	3-11

## TABLES

1-1	Physical Characteristics	1-1
1-2	EF Select Codes	1-2
1-3	160 Status Responses	1-2
1-4	1604 EF Sense Codes	1-2
2-1	EF Select Codes	2-5
2-2	160 Status Responses	2-6
2-3	1604 EF Sense Codes	2-6



CONTROL DATA 170

POWER  
POWER  
MEM

CHAPTER I  
DESCRIPTION

The CONTROL DATA\* 170 Card Punch Controller is a signal adapter used between the 160 and/or 1604 computers and the IBM 523 Card Punch. During a punch operation, the 170 assembles data from the computer into 80-column words and sets the punch magnets in the 523 prior to a punch stroke.

The controller logic cards are located on two chassis, one fixed and one movable. The power panel, power supply, and blower are beneath the logic chassis. Cables from the computer and card punch connect to jacks on the fixed chassis.

Three switches are on the front panel in the upper right corner: Power On, Power Off, and 160/1604 (the Manual Computer Select switch -- MS).

Components in the 170 are protected from overheating by a thermostat interlock. Four fuses protect against electrical overloads.

TABLE 1-1. PHYSICAL CHARACTERISTICS

170		523	
Dimensions	Height - 29 inches Width - 18 1/2 inches Depth - 30 1/2 inches	Processing Speed	100 cards/minute
Weight	240 pounds	Stacker Capacity	725 cards
Cooling Requirements	2750 btu/hour	Dimensions	Height - 51 inches Width - 40 inches Depth - 26 inches
Power Requirements	115 vac, 60~ , 1 $\phi$ , 7.0 amp	Weight	750 pounds
		Cooling Requirements	2375 btu/hour
		Power Requirements	115 vac, 60~ , 1 $\phi$ , 7.9 amp

\* Registered trademark of Control Data Corporation



TABLE 1-2. EF SELECT CODES

160	1604	Instruction
3002	740c4002*	Punch
--	740c4006	Punch with Interrupt
3040	--	Check Status
--	740c0000	Output Channel Clear

TABLE 1-3. 160 STATUS RESPONSES

Code	Translation
0000	MS switch in 160 position; 523 ready
0200	MS switch in 1604 position
2000	523 not ready

Multiple faults are indicated as the logical sum of individual faults.

TABLE 1-4. 1604 EF SENSE CODES

Code	Instruction
747c4004*	Exit on 1604 Selected and 523 Ready
747c4005	Exit on 1604 Not Selected or 523 Not Ready
747c4010	Exit on 1604 Selected
747c4011	Exit on 1604 Not Selected

Chapter 2, Operation and Programming, discusses in detail the use of the EF codes and explains the meaning of each status response.

---

\* c = output channel 4 or 6

CHAPTER II  
OPERATION AND PROGRAMMING

PUNCH AND CONTROLLER PREPARATION (figure 2-1)

- 1) Place cards in the hopper face down with row 9 facing in the direction of card feed.\*
- 2) Set MS switch on the 170 to desired position, 160 or 1604.
- 3) Turn 170 and 523 main power switches on.
- 4) Master clear from computer.
- 5) Push Start button on 523; Ready indicator should light.
- 6) 170 and 523 are now ready for control by the computer program.

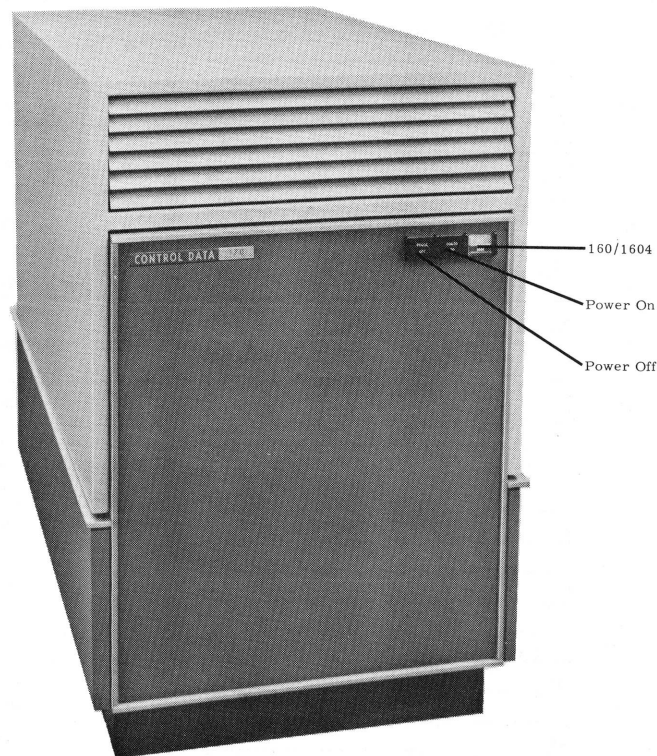


Figure 2-1. Switch Locations, 170

---

\* Row and column numbers will correspond to the accompanying timing chart and data formats.

## FORMATS

Bars on figures 2-2 and 2-3 represent consecutive storage addresses in a computer. Unshaded areas represent the relative locations in each address where information is stored before being transmitted to the 170 which assembles 12- or 48-bit computer words into the required 80-column card row format.

T1-T7 (for the 160) and T1-T2 (for the 1604) indicate the gating or timing order during the transfer of words from the computer to the 170. Numbering on the figures is correct only if cards are placed in the machine face down with row 9 facing in the direction of card feed.

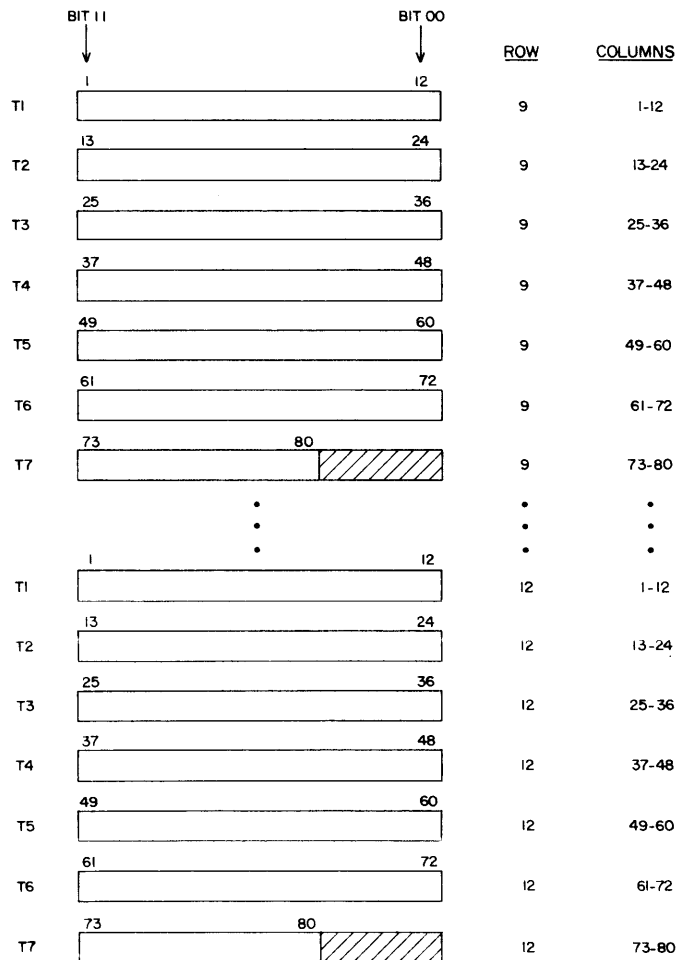


Figure 2-2. 160 Output Format

160 OUTPUT FORMAT

An 84-word block is normally established in the 160 to allow punching of one card. If the output block is less than 84 words, data is punched on the first sequential portion of the card.

1604 OUTPUT FORMAT

A 24-word buffer will normally be established in the 1604 to allow punching of a card. If the output buffer is less than 24 words, data is punched on the first sequential portion of the card.

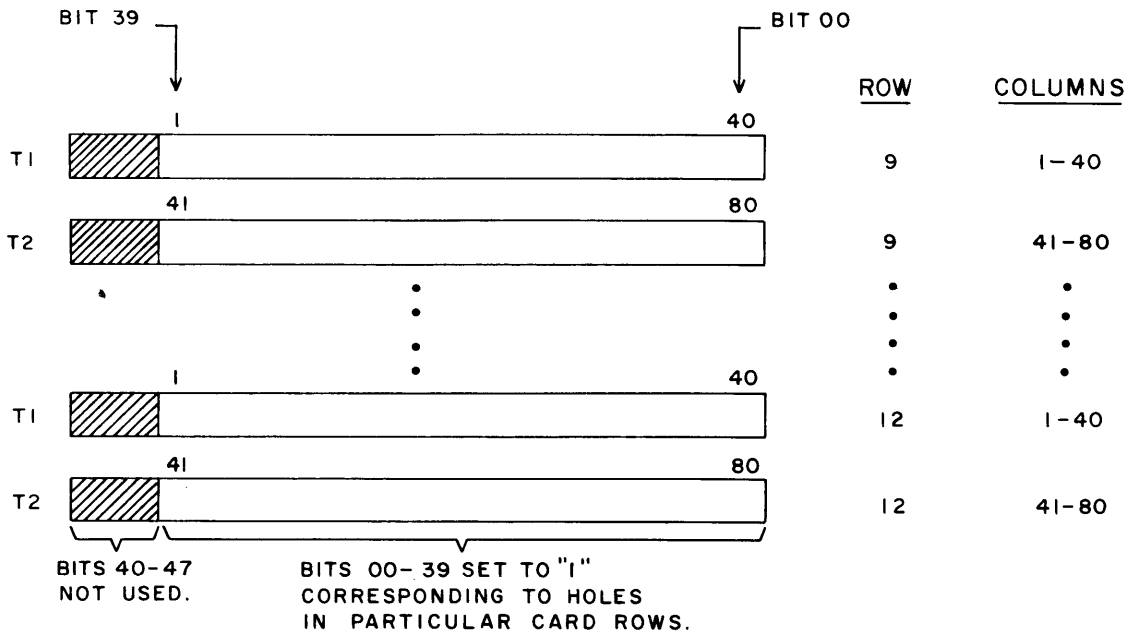
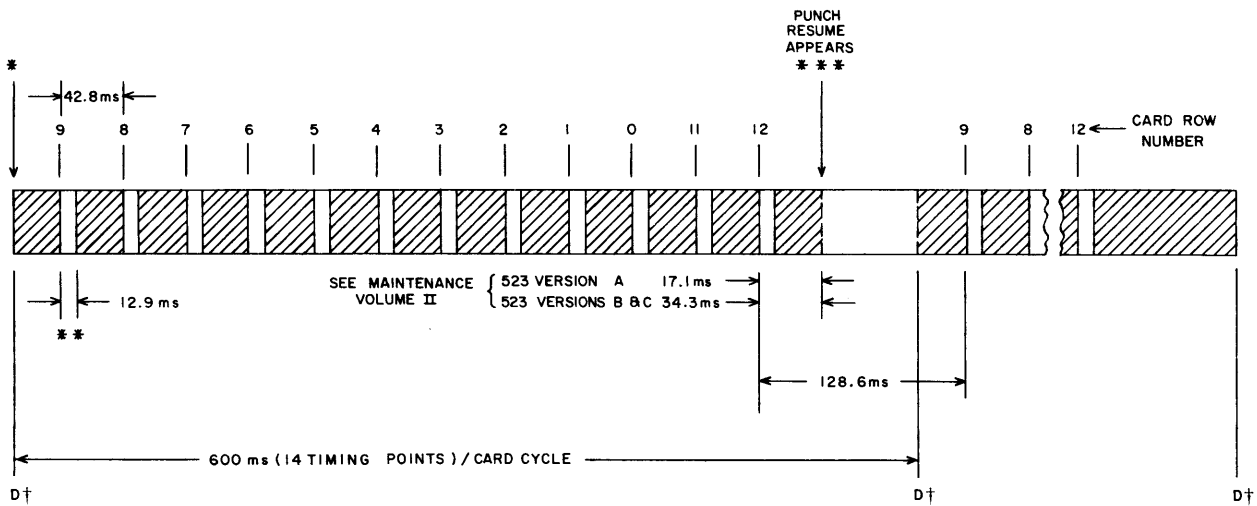


Figure 2-3. 1604 Output Format

## PROGRAM TIMING

Each card requires 600 ms to pass through the punch station. During a card cycle, the computer must send a select instruction as well as data to the 170. The program timing chart (figure 2-4) shows the correct spacing of outputs and position of the reselect for one card cycle. After leaving the hopper, cards pass through the punch station where a Geneva clutch mechanism momentarily stops the cards for punching as each row comes beneath the punch dies. The shaded areas represent time that is always available to the computer for computation during a card cycle. In addition to that time, all but approximately 300 usec of each row pulse interval and all time not used for sense (status) and reselect is also free for computation.



- \* Initial punch select starts mechanism at this time (Versions B & C, only).
- \*\* Output for one row must occur during interval that row pulse is up. Output takes a maximum of 300 usec. It is recommended that the first information ready should be present when a row pulse rises.
- \*\*\* For full speed operation, check status or sense conditions, then reselect punch as soon as possible after this point. A status response of 0000 will not be returned to the computer until the punch resume signal is present.
- † D represents clutch latch-up time for machines with 14-tooth clutch (Versions B & C, only).

Figure 2-4. Program Timing

## OPERATION CODES

### EF SELECT CODES

Output operations with the 170 are initiated by coded EF instructions from the computers. To assure full speed operation, a select code should be issued as soon as possible after the punch resume signal is received.

TABLE 2-1. EF SELECT CODES

160	1604	Description of Instruction
3002	*740c4002	<u>Punch</u> Connects 170 to computer output channel. Prepares 170 to accept and transform data from computer into an 80-column simulated card-row and send it to 523 punch station at punching time for each of the 12 rows on one card. Allows 170 to respond to: 160 information ready, or 1604 output ready. Card cycle started by: 160 select code, or 1604 output buffer active and select code. Punch selection is cleared after all 12 rows are processed (one complete card cycle).
----	740c4006	<u>Punch with Interrupt</u> Controller sends interrupt signal to computer when punch operation has been completed.
3040	----	<u>Check Status</u> Allows 160 to obtain a coded status response from 170 card punch controller. Normally followed by an input to A (INA) instruction.
----	740c0000	<u>Output Channel Clear</u> All external devices on output channel c are cleared.

\* c equals 1604 output channels 4 or 6.

160 STATUS RESPONSES

The following coded signals are returned to the 160 in reply to a status request (3040).

TABLE 2-2. 160 STATUS RESPONSES

Code	Response
0000	MS switch in 160 position; 523 ready
0200	MS switch in 1604 position
2000	523 not ready
2200	MS switch in 1604 position; 523 not ready

1604 EF SENSE CODES

A 740----- select instruction produces the same result when used in the upper or the lower position of an instruction word; however, a 747----- sense instruction causes a skip or a wait, depending on its position.

In the upper instruction position, a 747----- is a skip instruction. The lower instruction is skipped if the condition given by the EF code is present, but is executed if the condition is not present. In the first case, the 747----- exits to the next pair of instructions; in the second, it half exits to the lower instruction.

In the lower instruction position, a 747----- is a wait instruction. The sense is executed repeatedly until the condition given by the EF code occurs. An exit is then performed to the next pair of instructions. Until the condition given by the EF code is present, the instruction half exits to repeat itself.

TABLE 2-3. 1604 EF SENSE CODES

Code	Instruction
747c4004	Exit on 1604 Selected and 523 Ready. Sense response returned to computer if controller and 523 are ready.
747c4005	Exit on 1604 Not Selected or 523 Not Ready.
747c4010	Exit on 1604 Selected. Sense response returned to computer if MS switch is set to 1604 position.
747c4011	Exit on 1604 Not Selected.

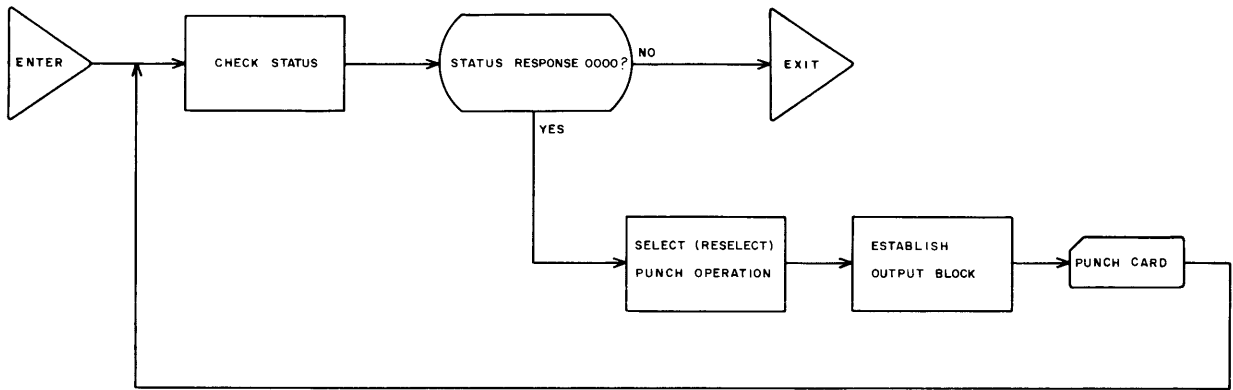


Figure 2-5. Flow Chart, 160 Operation

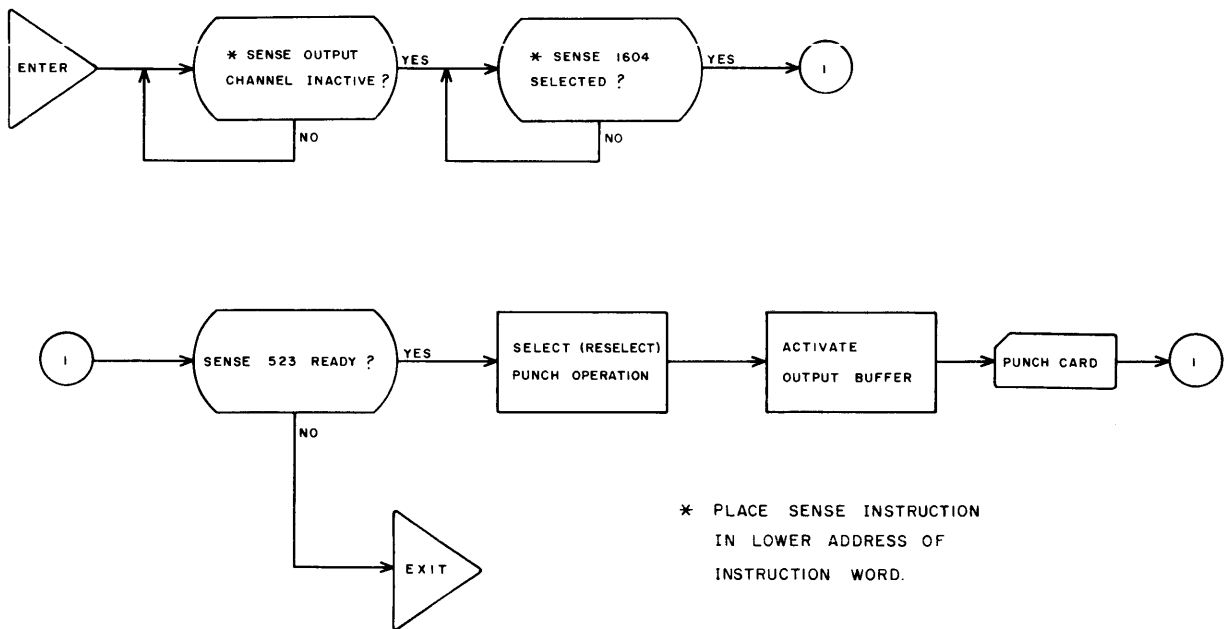
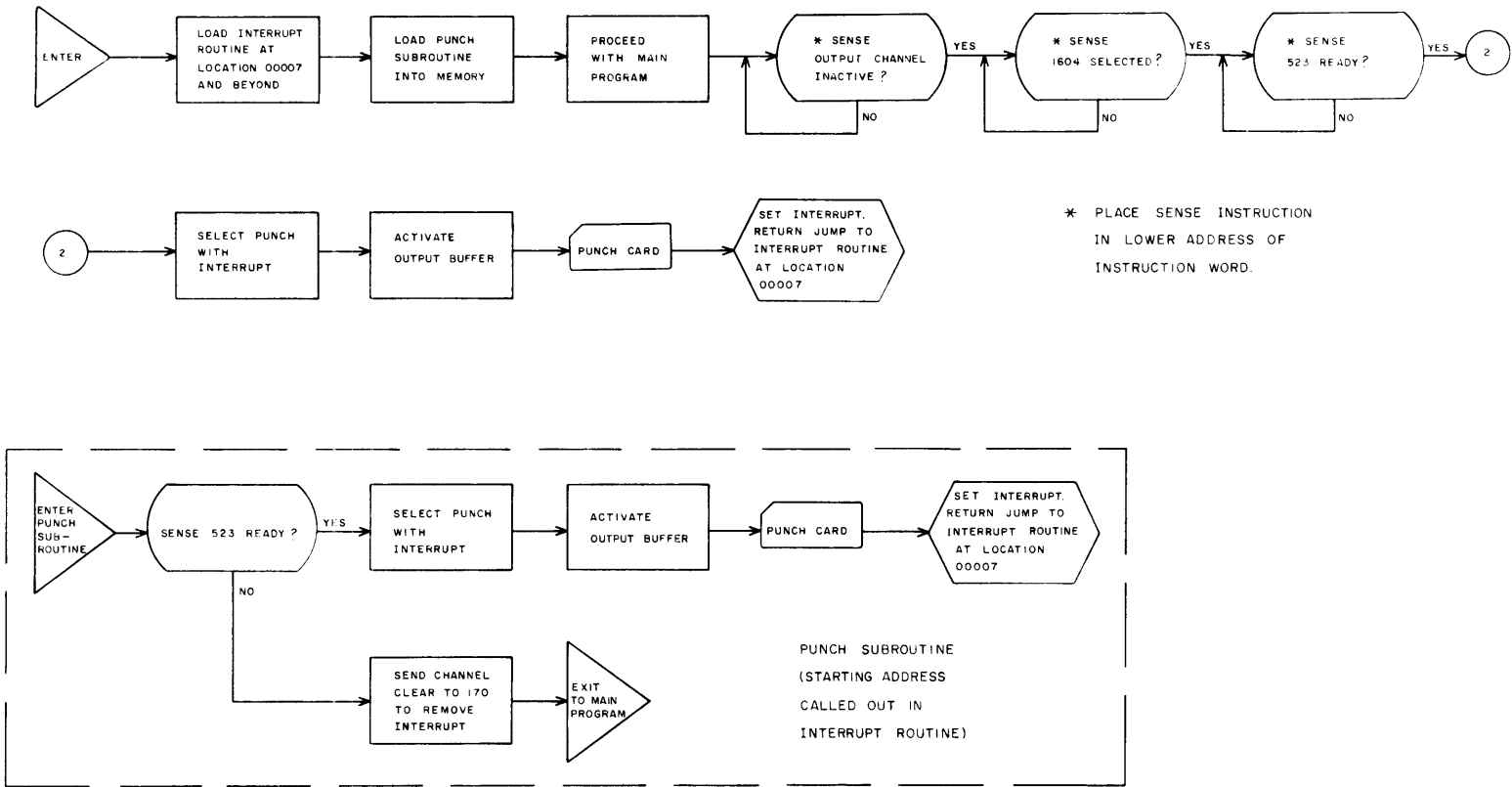


Figure 2-6. Flow Chart, 1604 Operation



Figure 2-7. Flow Chart, 1604 Operation With Interrupt



CHAPTER III  
PRINCIPLES OF OPERATION

BASIC PRINCIPLES

The 170 card punch controller is a signal adapter used between a CONTROL DATA 160 or 1604 Computer and the IBM 523 Card Punch.

160 OPERATION (figure 3-1)

The operator places the Manual Select switch in the 160 position and master clears the 170. Readiness is checked by selecting Status. An input request is sent from the computer to the 170. A coded status response accompanies the resulting input ready back to the computer.

During punching, the 170 starts the card punch, assembles seven computer words into an 80-column word, and sends one 80-column word to the card punch for each of the 12 card rows.

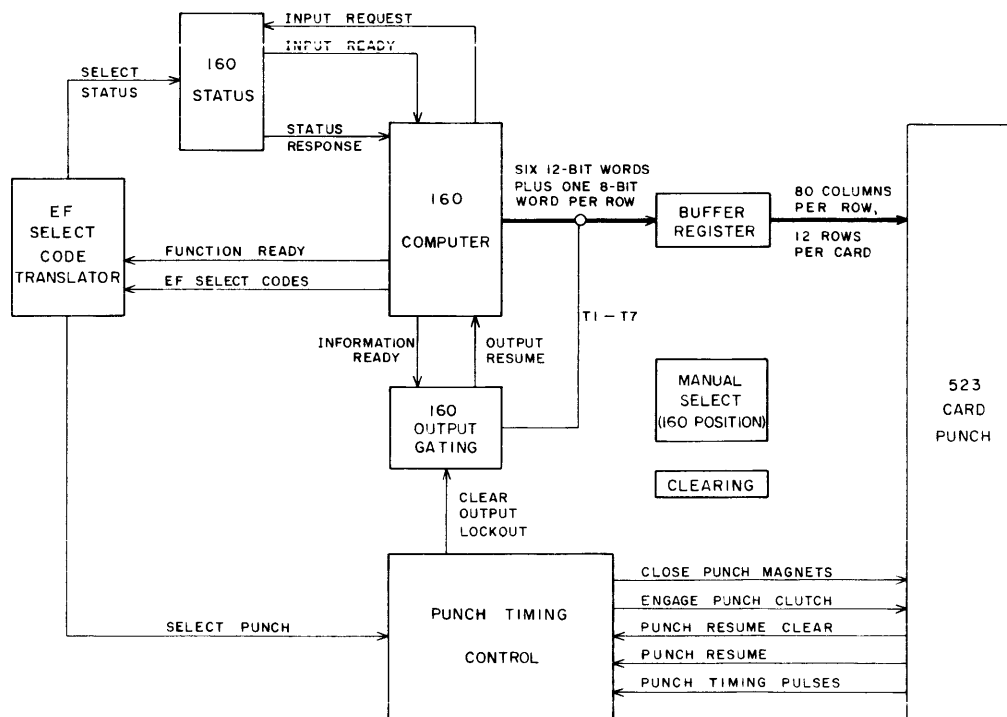


Figure 3-1. Block Diagram, 160 Punch Operation

1604 OPERATION (figure 3-2)

The operator places the Manual Select switch in the 1604 position and master clears the 170. Readiness is checked by sensing conditions in the 170 and the card punch.

During punching, the 170 starts the card punch, assembles two computer words into an 80-column word, and sends one 80-column word to the card punch for each of the 12 card rows. If the Interrupt function is selected, an interrupt is sent to the computer when the punch resume pulse rises near the end of a card cycle.

Pulses from the card punch notify the controller when data is needed (row pulses) for each row, and when the punch may be reselected (punch resume pulse).

This chapter emphasizes circuit logic rather than electrical operation. The logic network of the 170 is composed of circuit cards identical to those used in the 160 and 1604 computers. The diagrams in chapter 3 have been simplified. For more details on the 170, refer to the appendixes in volume 2.

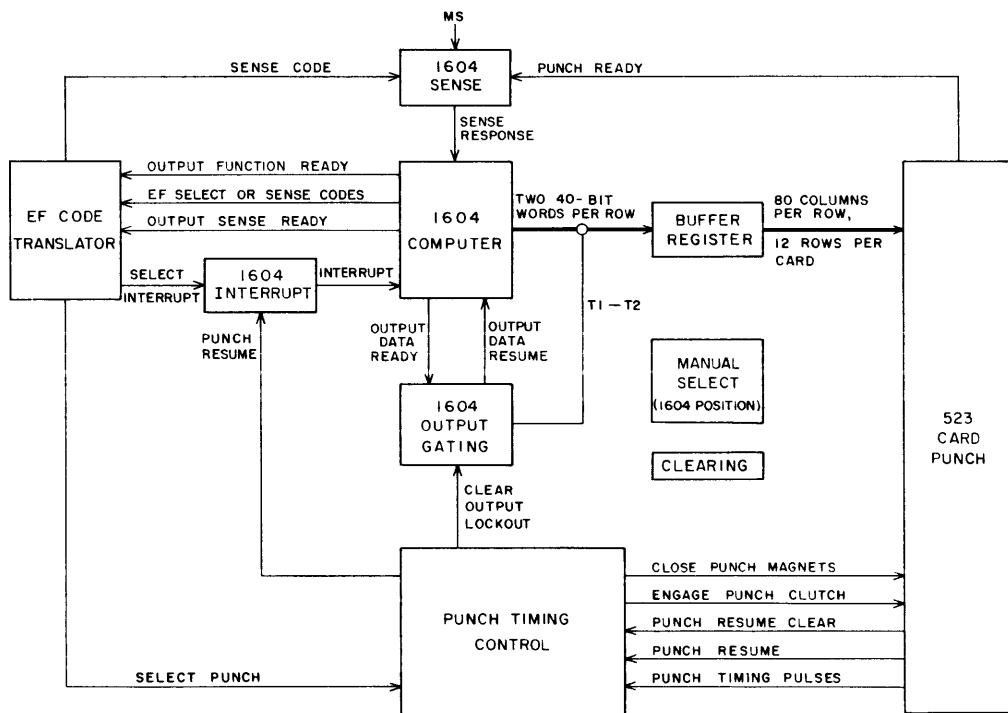


Figure 3-2. Block Diagram, 1604 Punch Operation

### MANUAL SELECT

The Manual Select (MS) switch (figure 3-3) on the controller permits selection of operation with either the 160 or the 1604 computer. The switch position determines the input to M514. Outputs of inverters F100-F102 control circuits not common to both computers, enabling those that are to be used and disabling those that are not to be used.

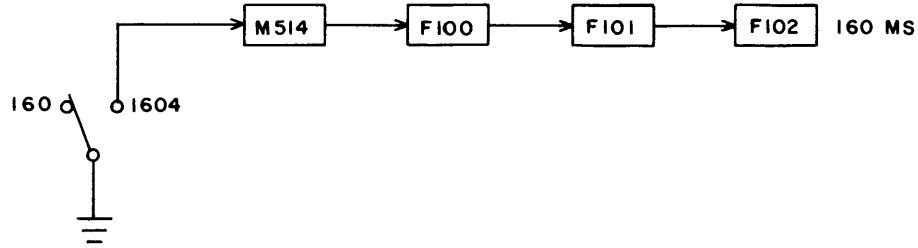


Figure 3-3. Manual Select

### CLEARING

Figure 3-4 shows how clearing signals are distributed to FFs in the 170.

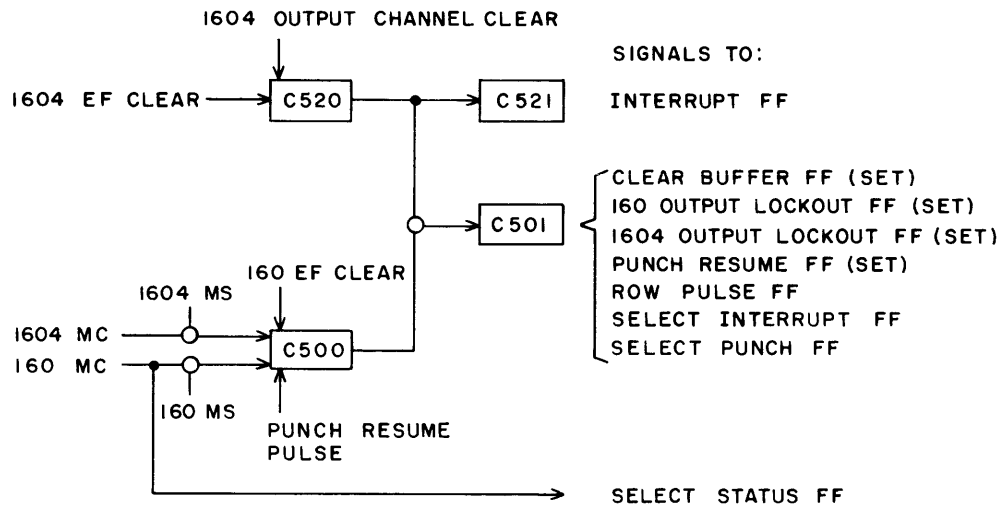


Figure 3-4. Clearing Control

### EF CODE TRANSLATORS

Many peripheral equipments may be connected to one computer. The EF code translators in the 170 recognize selection of the 170 and determine the functions it is to perform.

160 OPERATIONS (figure 3-5)

Select codes from the 160 are sent on its output lines. The accompanying function ready signal enables the 170 to translate the codes, distinguish them from data, and set the function select FFs. EF bits 06-11 (30XX) select the 170; bits 01 and 05 select the function. The Select Punch FF will be set only if:

- 160 MS is set,
- the Punch Resume FF is set, and
- the 170 is selected by bits 06-11.

The Status FF may be set even though 160 MS is not selected. A 0.8 usec pulse from A802 causes an internal master clear prior to an EF selection.

SELECT CODE	FUNCTION
3000	EF CLEAR
3002	PUNCH
3040	CHECK STATUS

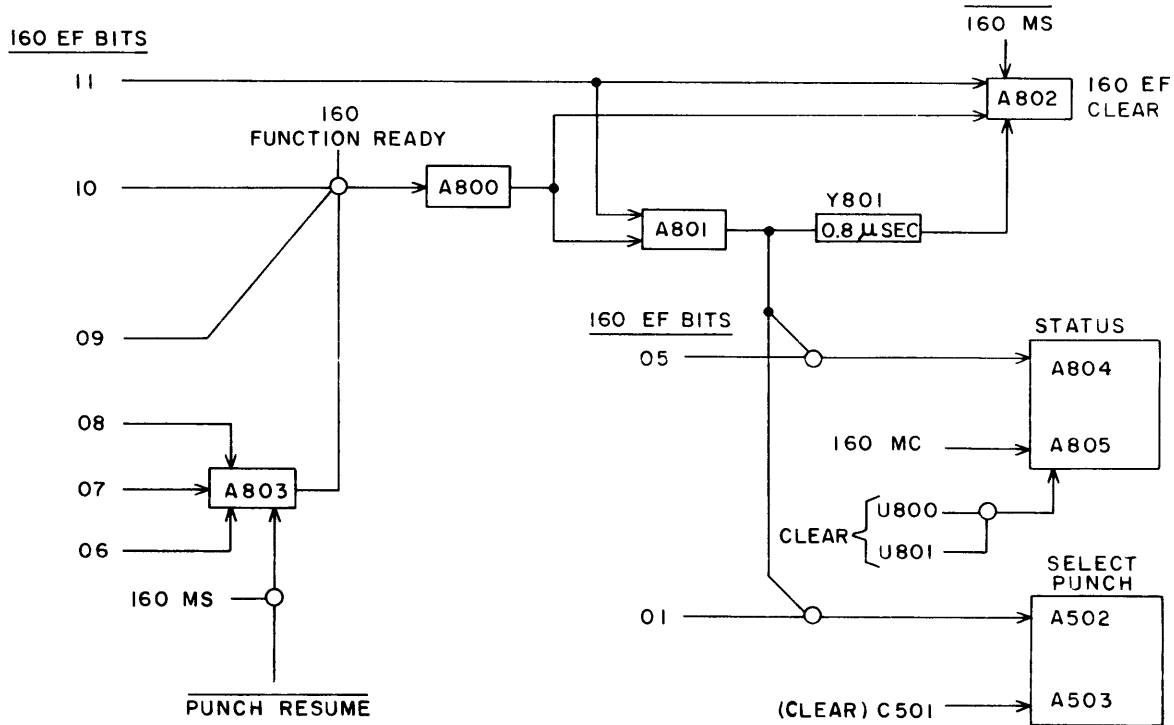


Figure 3-5. 160 EF Select Code Translator

1604 OPERATIONS (figure 3-6)

Select codes from the 1604 are transmitted over the 1604 EF lines. EF bits 09-11 (740c40XX) select the 170; bits 01 and 02 select the function. An output function ready signal accompanies the code. The function select FFs will be set only if:

- 1604 MS is set,
- an output function ready signal is present, and
- the 170 is selected by bits 09-11.

A 0.8 usec pulse from A906 causes an internal master clear prior to an EF selection.

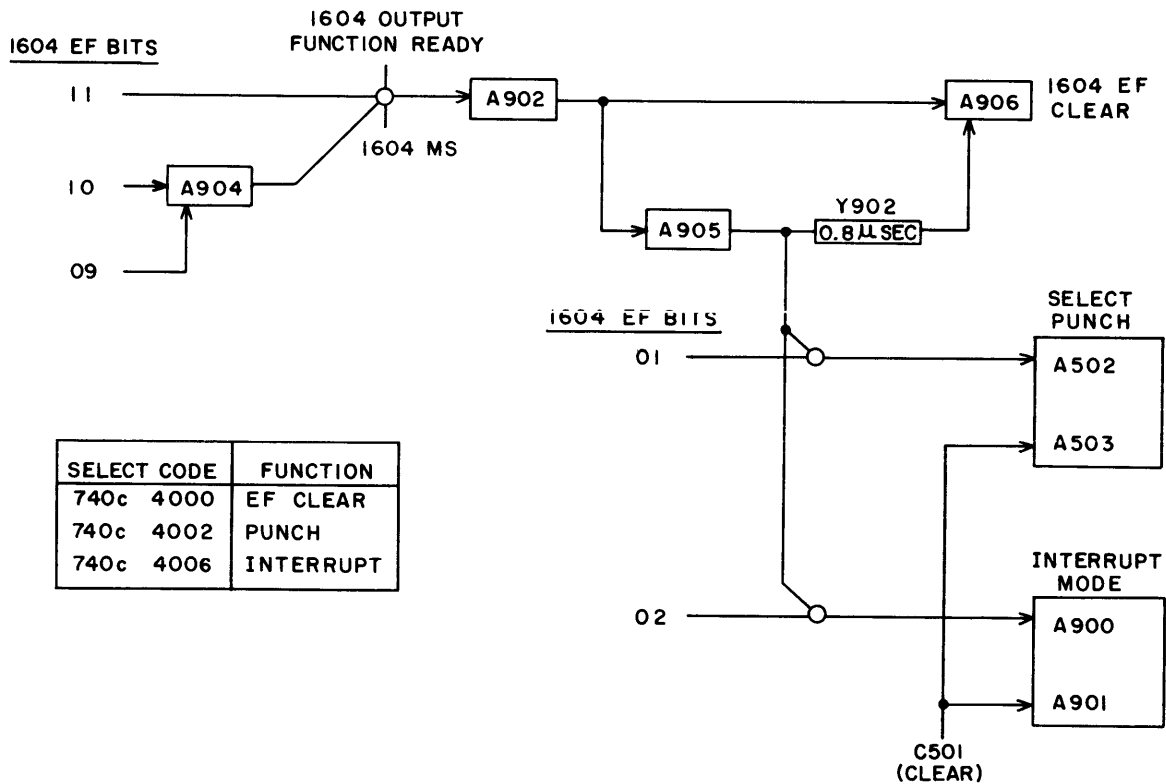


Figure 3-6. 1604 EF Code Translator

## CHECK READINESS

### 160 STATUS (figure 3-7)

Before selecting or reselecting a 170 punch operation, the 160 must check the MS switch position and the punch ready condition by executing a status request followed by an input to A (INA) instruction. Select code 3040, accompanied by a function ready signal, sets the Status FF. Anytime thereafter, an input request will gate coded status information and an input ready to the 160 on its input lines. In the 1604 MS position, the Status FF may be set at any time; in the 160 MS position, it may be set only when a punch resume signal is present.

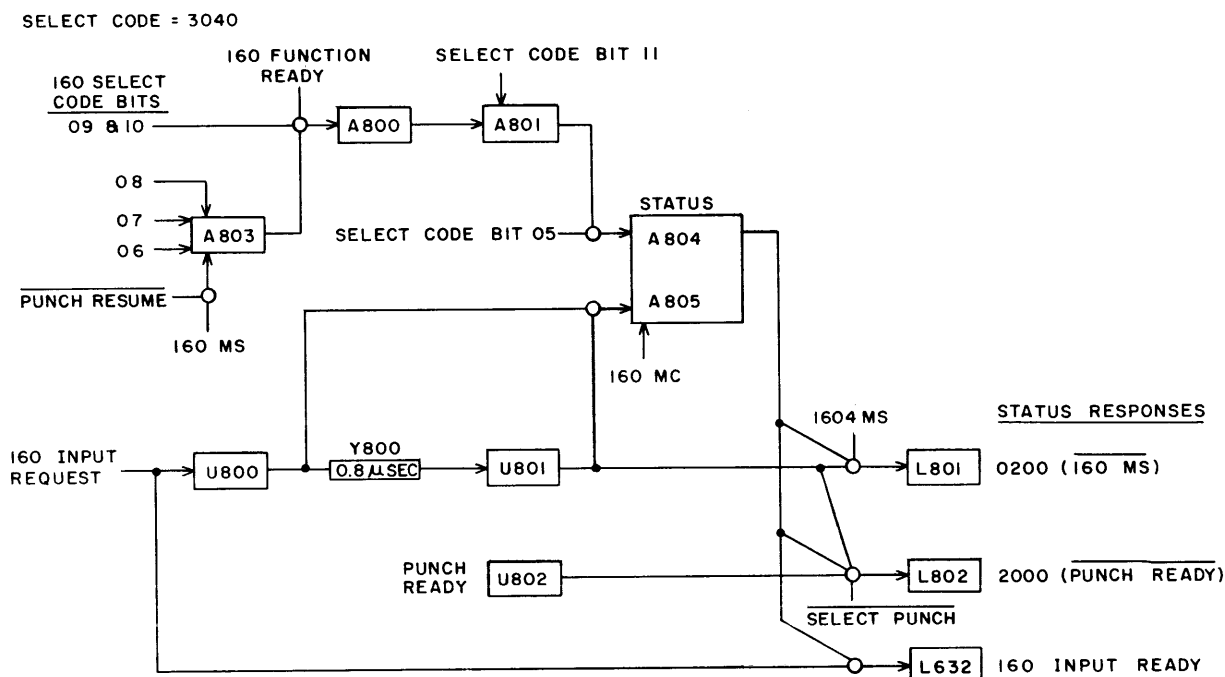
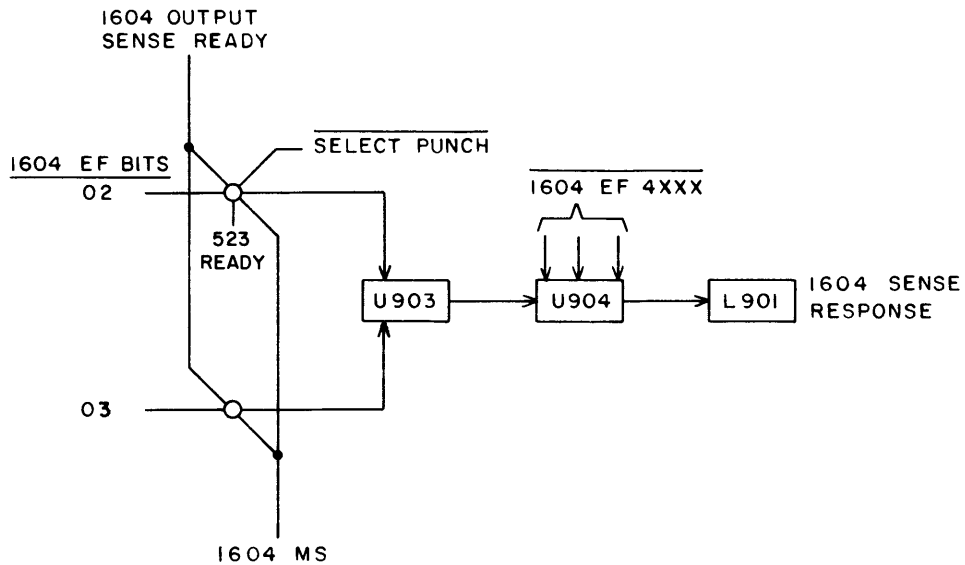


Figure 3-7. 160 Status

### 1604 SENSE (figure 3-8)

The 1604 checks punch unit readiness and the MS switch position by executing a sense instruction (747c40XX) accompanied by an output sense ready signal. The sense codes are sent to the 170 over the 1604 EF lines. Depending on the sense code used, either of two sets of conditions returns a sense response to the 1604.



SENSE CODE	FUNCTION
747C 4004	EXIT ON 1604 SELECTED & 523 READY
4005	EXIT ON 1604 NOT SELECTED OR 523 NOT READY
4010	EXIT ON 1604 SELECTED
4011	EXIT ON 1604 NOT SELECTED

Figure 3-8. 1604 Sense

### PUNCH TIMING CONTROL

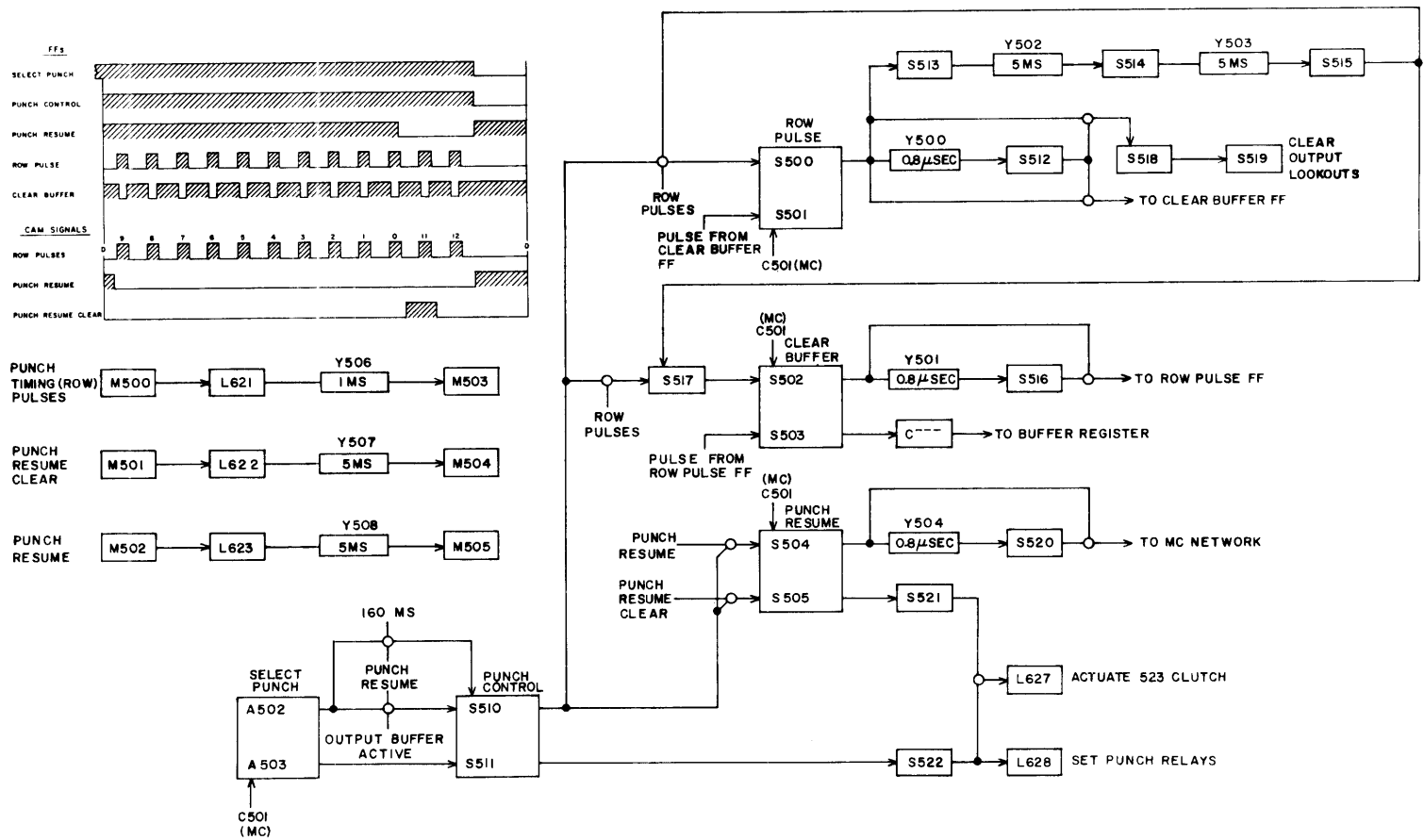
Three cam-generated signals originating in the 523 are sent to the 170. These signals are filtered, reshaped, and then used within the 170 for control purposes. The diagram and timing chart (figure 3-9) describe the sequence of operations in the punch timing controls.

Delays Y502 and Y503 insure that the Clear Buffer FF is not set during the first ten milliseconds of a row pulse. Delays Y506, 7, and 8 prevent spikes caused by cam contact bounce from accidentally setting a FF.

The Punch Control FF sets the punch relays immediately and then, with the Punch Resume FF, actuates the 523 clutch.



Figure 3-9. Punch Timing Control



## BUFFER REGISTER

The 523 performs its operations row by row. Its mechanism contains a punch magnet for each of the 80 card columns. The punch magnets do not do the actual punching, but instead, pull interposer levers into position so that all selected punches engage with the vertical thrust of the punch bail tongue during a punch stroke. The 170 must actuate all selected punch magnets before the punch stroke begins.

In the 170, a buffer register consisting of 80 sets of logic elements (figure 3-10) functions in a manner similar to a FF register. It does two things:

- 1) stores column punch selections as they are gated from the computer, and
- 2) actuates and holds selected punch magnets until the end of a punch stroke.

A "1" input from the computer to an inverter B--- drives the output of P--- to ground and completes the current path through a punch magnet coil. Since only one word can be sent at a time to the 170, some way to store or assemble a card row (80 columns) of data must be used. A feed-back signal from L--- via a diode at the input of P---, gated with a clear buffer signal from C5--, maintains a "1" input to B--- until the Clear Buffer FF sets at the end of a row pulse. This recirculating action simulates a FF set state.

A set of relay contacts is in series with each of the punch magnet coils in the 523. Their only purpose is to disable the punch coils during a printing operation in case the 523 should ever be connected to a 1610 with a 407 line printer.

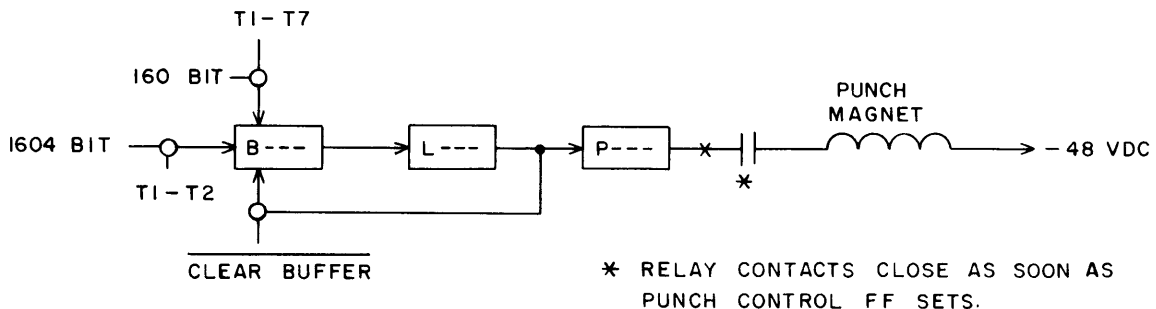


Figure 3-10. Buffer Register

## OUTPUT GATING CONTROLS

The output gating controls include counters that are used for loading computer words into the buffer register in the correct order. Each has an output lockout associated with it, so data will be accepted only when row pulses are present.

### 160 OPERATION (figure 3-11)

The counter emits seven pulses, T1-T7, during every row pulse. These pulses gate each of the seven computer words into its own portion of the 80-column buffer register. An information ready signal, which accompanies each of the words from the 160, advances the counter by one and causes an output resume to be sent back to the 160.

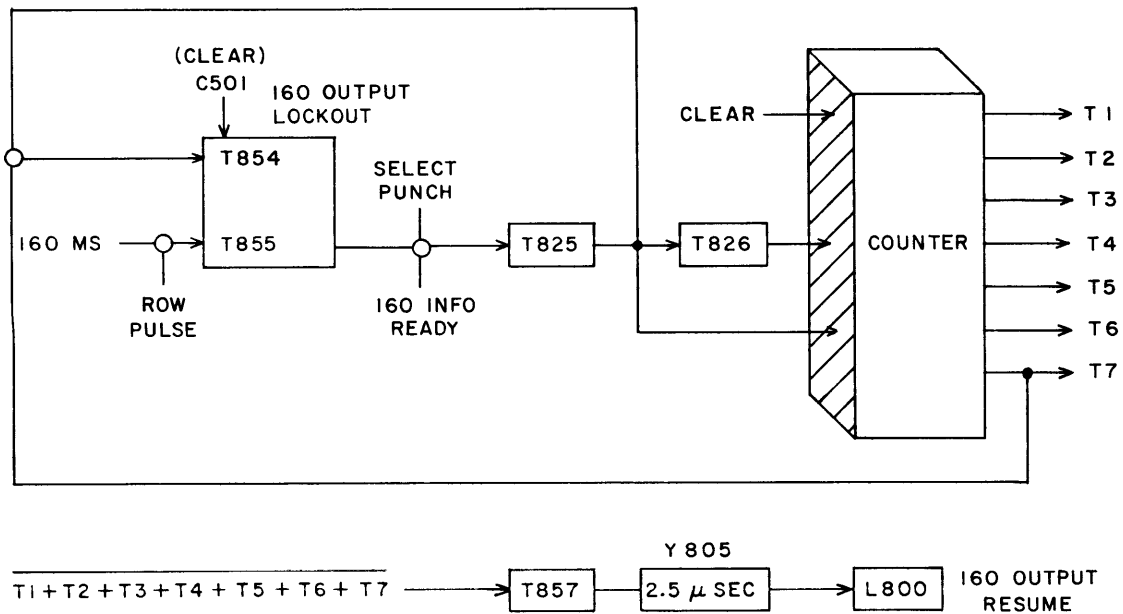


Figure 3-11. 160 Output Gating

### 1604 OPERATION (figure 3-12)

The counter emits two pulses, T1-T2, during every row pulse. These pulses gate each of the two computer words into its own portion of the 80-column buffer register. An output data ready signal, which accompanies each of the words from the 1604, advances the counter and causes an output data resume to be sent back to the 1604.

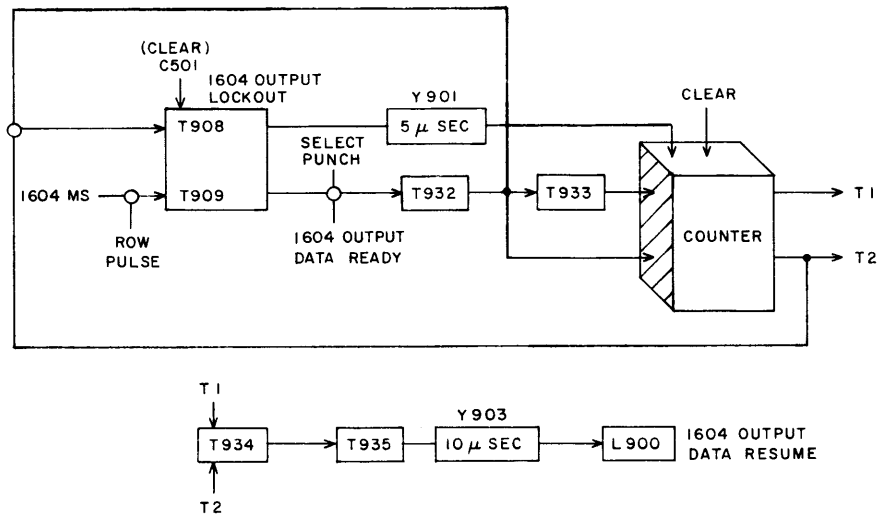


Figure 3-12. 1604 Output Gating

### 1604 INTERRUPT

An interrupt signal indicates that a punch cycle has been completed and that the 170 is ready for another EF instruction. The Select Interrupt FF (figure 3-13) is set by bit 02 of the select code. It remains set until all select FF's are master cleared by a punch resume. The interrupt signal sent to the 1604 remains on until the operator or program:

- master clears,
- issues a 1604 output channel clear, or
- issues another select code.

Delay Y900 permits the Interrupt FF to be set by the same punch resume pulse that clears the Select Interrupt FF because it prevents the output of inverter U902 from immediately dropping to a "0".

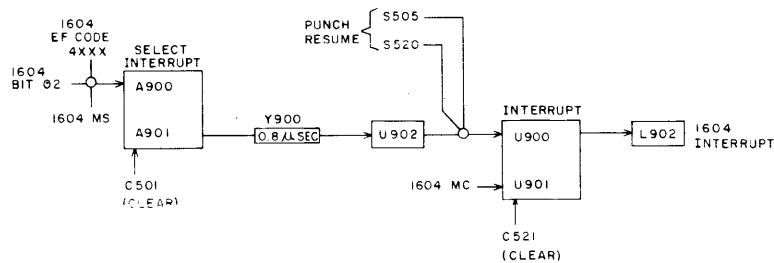


Figure 3-13. 1604 Interrupt

**CONTROL DATA**

CORPORATION

501 PARK AVENUE, MINNEAPOLIS 15, MINNESOTA • FEDERAL 9-0411