INPUT/OUTPUT SPECIFICATIONS FOR

CONTROL DATA

8092 TeleProgrammer

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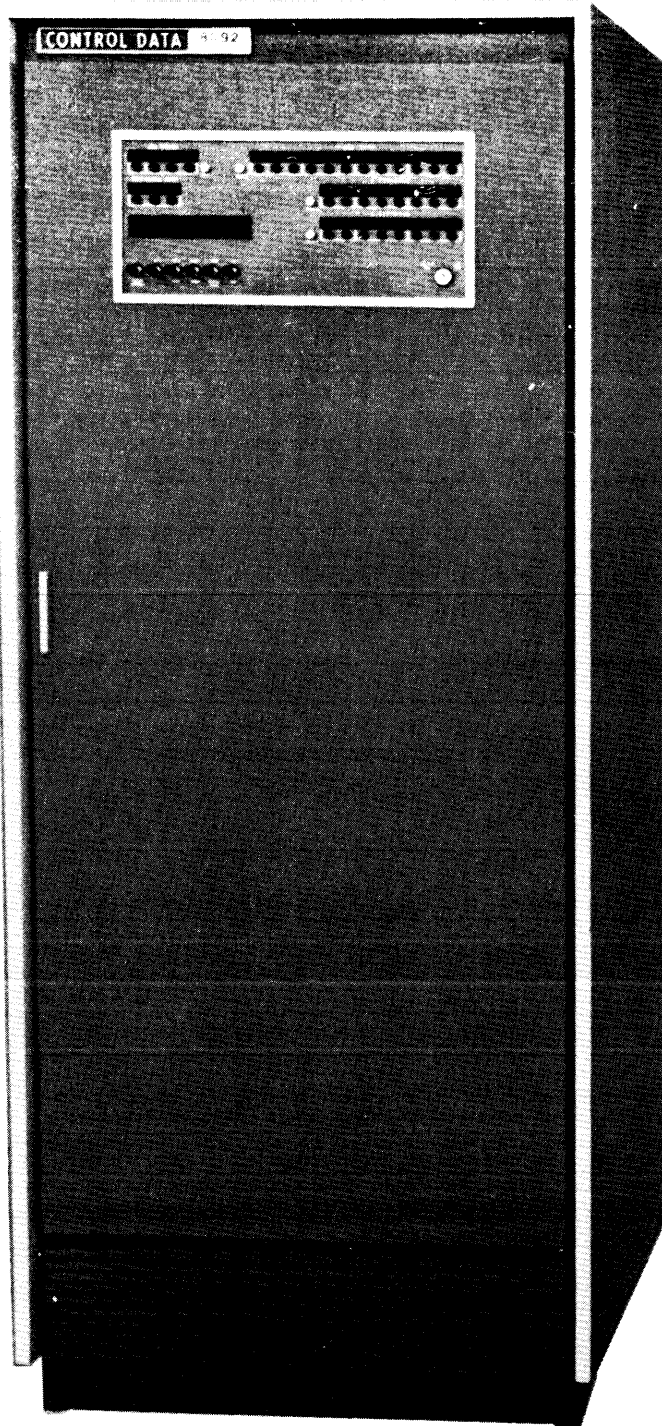| RECORD OF CHANGE NOTICES				
C. N. NO.	DATE ORIGINATED	DATE ENTERED	INITIALS	REMARKS

C O N T E N T S

FIGURES

TABLES

Figure 1 - 8092 TeleProgrammer

The input/output (I/O) specifications for the CONTROL DATA*
8092 TeleProgrammer apply to all devices which connect with
the TeleProgrammer. This specification is written to allow a
minimum data exchange time consistent with accepted engineering
practices and moderate hardware requirements.

The 8092 has a four-level interrupt and a buffered I/O. The
latter permits the TeleProgrammer to continue high-speed compu-
tation while communicating with external equipment. The minimum
system may be expanded to include the following external equipment:

- Additional magnetic tape stations
- I/O typewriters
- Punched card readers, punches, and low speed
  line printers
- High speed printers - 1000 lines/minute
- Plotting and digital display equipment
- Analog to digital and digital to analog equipment
- Two or more CONTROL DATA TeleProgrammers
  operating in a satellite system

All information is measured as binary "1" and "0" voltage levels,
nominal ground level (-0.5v) constituting a "1", and -16v a "0".**
Voltage is measured at the output terminals of the TeleProgrammer
and the external equipment.

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*   Registered Trademark of Control Data Corporation
** See page 18 for tolerances on these voltage levels.

1

INTERRUPT

Certain internal and external conditions arise which make it
desirable for the main program to be notified of their presence.
An interrupt is the program signal which transfers computer con-
trol to some fixed location in memory without losing the information
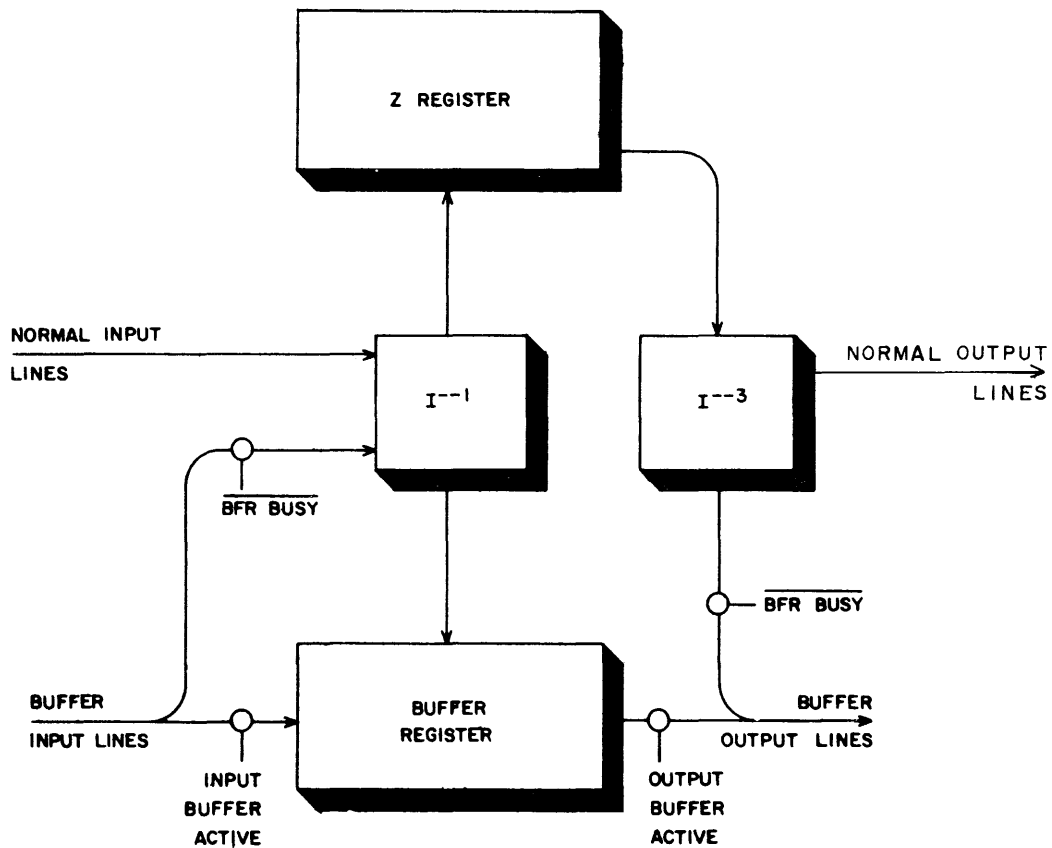needed to return to the main program.

Figure 2   8092 Input/Output System

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The 8092 has four interrupt lines: two internal, 10 and 20, and two external, 30 and 40. When an external equipment generates an interrupt the TeleProgrammer may enter the interrupt routine if the interrupt lockout is not on. The TeleProgrammer program may send a status request to all equipment which might have generated the interrupt to determine which interrupted. This status request is a signal to the external equipment to turn off the interrupt, or the signal in the external device may be turned off by a function response.

SELECT CODES

The TeleProgrammer selects the external equipment for I/O operation by the use of select codes. The I/O operation is initiated by a 75 instruction which selects a 12-bit code and places it on the output lines with a function ready signal. The upper 6 master bits (unit designator) select the external equipment, and the lower 6 bits (function designator) designate the function.

Master bits for select codes must be unique for each 8092 I/O equipment. Master bits given below are in octal and quartic (base 4) notation, and represent devices currently available. It is recommended that the 8092 Engineering Department of Control Data Corporation be consulted before assigning master bits for select codes on new equipment. This will minimize the chance of select code duplication through future expansion of an existing system.

3

SELECT CODE ASSIGNMENTS

Octal Code	Equipment
07	166-2 Printer (with 8294 adaptor)
11 12 13	162 Mag. Tape Systems (6-bit transfer)
10 11 12 13	8293 Mag. Tape Synchronizer
30	170 Card Punch Control Unit
35	8295 Records Transmission Control Panel
36	8061, 8062, 8064, 8065 DCT
41	Reader and Punch
42 43	161 Typewriter or Model 33 Page Printer
45	167-2 and 177 Card Readers
53	Exchange Unit (with 8294 adaptor)
63	8294 Peripheral Equipment Adaptor
01XX 02XX	8155 Multiplexer

TABLE 1. COMMUNICATION LINES
Output Cable

TELEPROGRAMMER TO EXTERNAL EQUIPMENT	
External Master Clear (Pin U)	Static "1" signal appears on the line whenever Load/Clear switch at 8092 console is set to Clear. Signal is available to clear external equipment attached to the TeleProgrammer.
Function Ready (Pin T)	Static "1" signal is produced on the line when external function code is present on output data lines for examination and translation by external equipment. Signal is removed by output resume signal from external equipment.
Information Ready (Pin R)	Static "1" signal accompanies each word of output information. Signal is turned off by output resume signal from external equipment.
EXTERNAL EQUIPMENT TO TELEPROGRAMMER	
Output Resume (Pin S)	Static "1" indicates external equipment has accepted word of information or external function code. Signal turns off information ready or function ready signal at TeleProgrammer. Output resume drops when function ready or information ready drops.
Interrupt 30, 40 (Pins, Y,Z)	Static "1" signal notifies 8092 that interrupt is generated. 8092 enters interrupt routine and sends status request code which signifies that the interrupt should be turned off.
OUTPUT DATA AND EXTERNAL FUNCTION LINES	
(Pins A,B,C,D,E,F,H,J,K,L,M, and N)	The 8 lines which carry output data information when accompanied by information ready signal, output word from 8092. External equipment samples these lines to ready the output word.
	The 12 lines which carry external function information when accompanied by function ready signal, hold EF code which selects operational mode within external equipment.

TABLE 2. COMMUNICATION LINES
Input Cable

TeleProgrammer to External Equipment
   Input Request
      (Pin S)
	Static "1" signal is produced when TeleProgrammer is ready to receive an input word. Signal drops on receipt of input ready signal.

External Equipment to TeleProgrammer
   Input Ready
      (Pin R)
	Static "1" signal produced when information, in a state which Teleprogrammer may sample, is present in input register of external equipment. Signal is dropped when TeleProgrammer drops input request signal.

Disconnect (Pin V)	Static "1" signal is produced when input device has transmitted final word of input data and the Tele-Programmer transmits an additional Input Request. Upon receipt of signal, TeleProgrammer drops Input Request and resumes main program with no further delay. Signal is dropped when TeleProgrammer drops input request signal. (Generally, input instruction establishes a storage field of greater capacity than the anticipated input data block.)

Input Data and Status Lines
   (Pins A,B,C,D,E,F,H,
   J)
	The 8 lines which carry input data and status information perform as follows:
	1) Following a normal input mode selection, lines hold content of external equipment input register which TeleProgrammer samples. Data is removed from lines when input request is dropped from TeleProgrammer.
	2) Following request for status from TeleProgrammer, lines contain external equipment response. (Input instruction is programmed to ascertain status response.)

TABLE 3. CABLE DESIGNATIONS
8092 INPUT/OUTPUT EQUIPMENT

Use	Cable Number
Input Cable	J01
	J03
Output Cable	J02
	J04
Buffer Input Cable	J05
	J07
Buffer Output Cable	J06
	J08

COMMUNICATION LINES

Of the four communication cables between the TeleProgrammer and all external equipment, two carry normal I/O signals and two carry buffer I/O signals. Each input cable contains 8 data lines plus various control lines, and each has two connectors. Each output cable contains 12 data lines (i.e. 12 for EF and 8 for data) and various control lines and each has two connectors. Cables from external equipment enter the TeleProgrammer through the rectangular opening in the bottom. The front door of the TeleProgrammer permits access to jack locations found on the lower portion of the main chassis. (Jack numbers for I/O lines are given in table 3.)

Every external unit must be connected to the output cable because the external function code (carried on data lines of output cable) must be available to both input and output devices.

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The total number of devices attached to one line is limited by maximum cable length and power capacities of the transistors on the amplifier cards. Five pieces of equipment may be attached to the normal channel and five to the buffer channel.

Equipment attached to the buffer lines may be addressed directly if no buffer operation is in progress. Consequently any one of up to ten external pieces of equipment may be addressed by normal I/O if the buffer is not busy.

TABLE 4. PIN ASSIGNMENTS, INPUT/OUTPUT CABLES

Normal Input and Buffer Input Cable	Pin	Normal Output and Buffer Output Cable
Bit 0 input status and information	A	Bit 0 output function and information
1	B	1
2	C	2
3	D	3
4	E	4 } Data
5	F	5
6	H	6 } External
7	J	7 Function
	K	8
	L	9
	M	10
	N	11
	P	
Input Ready	R	Information Ready
Input Request	S	Output Resume
	T	Function Ready
	U	Master Clear
Disconnect	V	
	W	
	X	
I/O Sequence } Used by Paper Tape	Y	Interrupt 30
Load Mode } Reader Only	Z	Interrupt 40
	a	
Ground	b	Ground

NORMAL INPUT/OUTPUT

Sequence of Events in Normal Input (Refer to figure 3)

1. The TeleProgrammer executes a 75 instruction and sends out an external function code (EF), together with a function ready signal to select external equipment. The time required for initiating the EF code is 12 usec.

2. The external equipment receives the EF code at its own rate, and sends back an output resume, turning off the function ready signal. (Termination of the function ready signal in the Tele-programmer must turn off the output resume in the external equipment within 4 usec.)

3. The TeleProgrammer takes 12 usec. to set up the input instruction (72), after which an input request signal is issued.

4. The external equipment accepts the input request signal, places a word on the data lines, and returns an input ready signal which turns off the input request in the TeleProgrammer. The external equipment delivers the word to the TeleProgrammer at its own rate. (Termination of the input request signal must turn off the input ready signal in the external device within 4 usec.)

   When the TeleProgrammer receives an input ready signal, it initiates a store sequence and issues another input request if more information is desired. Steps 3 and 4 repeat until the last word is received in the TeleProgrammer. Termination

of data input may originate in the TeleProgrammer through failure to issue an input request or in the external equipment through an input disconnect.

Sequence of Events in Normal Output (Refer to figure 4)

1. Same as normal input.

2. Same as normal input.

3. In 16 usec, the TeleProgrammer sets up the output instruction and delivers the first word to the data lines along with an information ready signal to indicate that data is available to the external equipment.

4. The external equipment recognizes the information ready signal after a 2 usec. delay, stores the data at its own rate, and returns an output resume signal to the TeleProgrammer.

5. The TeleProgrammer accepts the output resume signal and turns off the information ready signal. Termination of the information ready signal must turn off the output resume in the external equipment within 4 usec. At that time, the TeleProgrammer reads another word in 8 usec., generates an information ready signal, and repeats step 4 until all words are transferred into the external equipment. Transfer of output data is terminated by failure of the TeleProgrammer to issue an information ready signal.
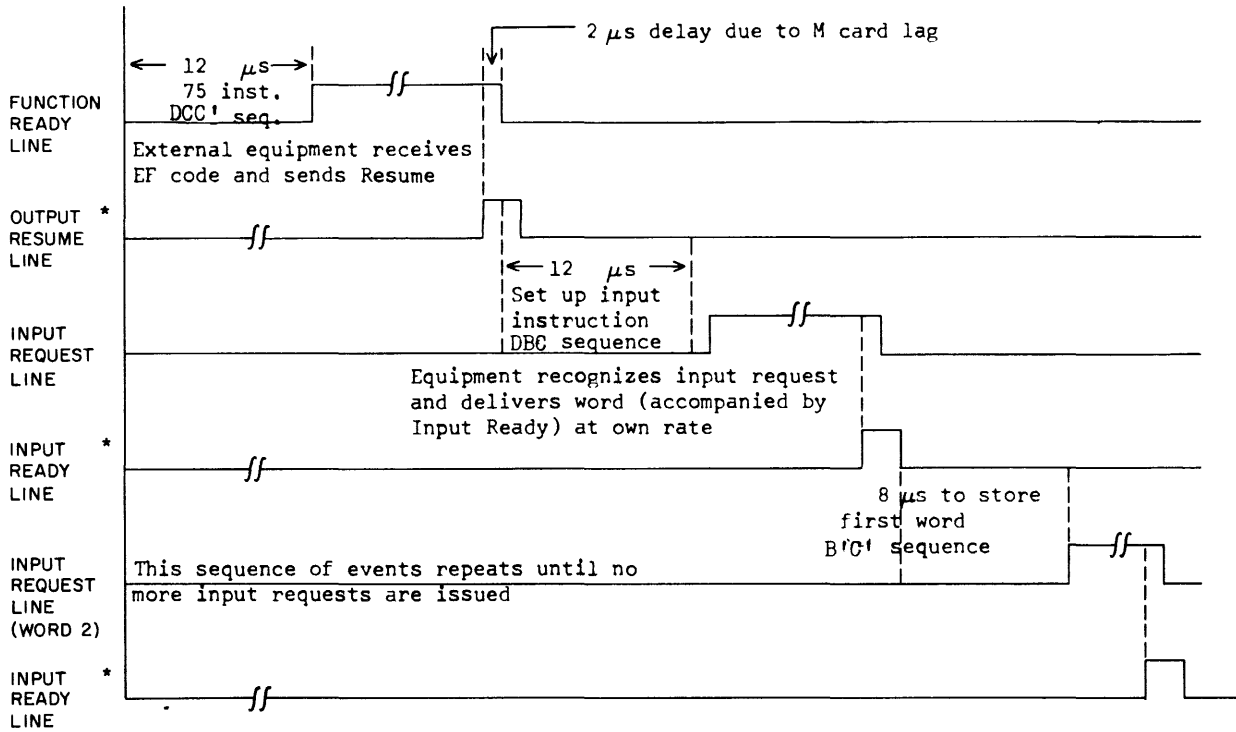
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2 μs delay due to M card lag

FUNCTION READY LINE

← 12 μs →
75 inst.
DCC' seq.

External equipment receives
EF code and sends Resume

OUTPUT RESUME LINE *

INPUT REQUEST LINE

←12 μs →
Set up input
instruction
DBC sequence

Equipment recognizes input request
and delivers word (accompanied by
Input Ready) at own rate

INPUT READY LINE *

8 μs to store
first word
B'C' sequence

INPUT REQUEST LINE (WORD 2)

This sequence of events repeats until no
more input requests are issued

INPUT READY LINE *

Figure 3. Normal Input 8092 TeleProgrammer

INFO READY LINE

16 μs set up output
instruction and
deliver word 1
DBCB sequence

Store

OUTPUT RESUME LINE *

8 μs
Read word 2
B'C' sequence

INFO READY LINE

Word 2 and all after

Store
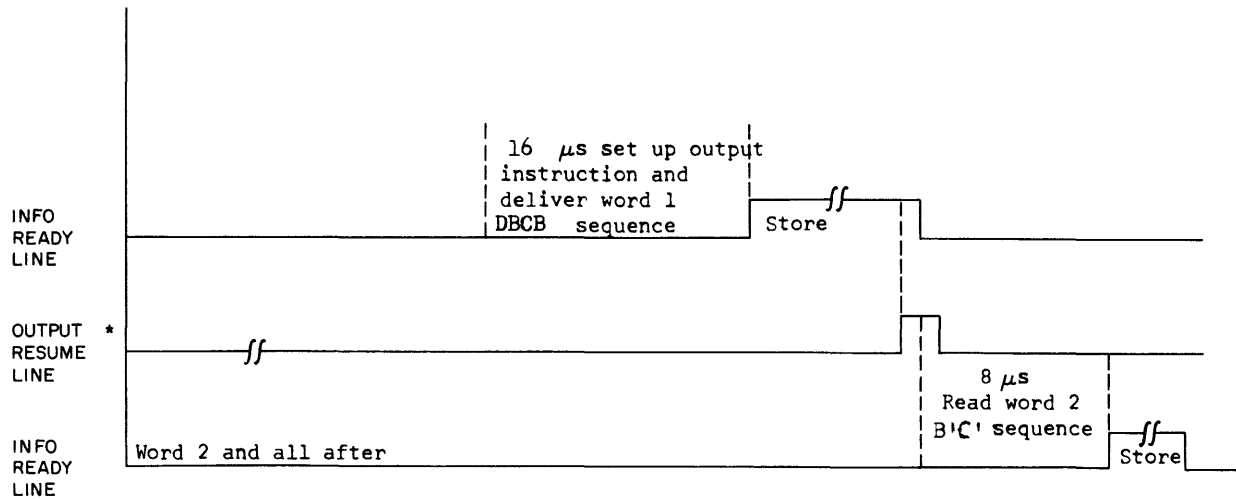
Figure 4. Normal Output 8092 TeleProgrammer

* Signals generated by external equipment

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BUFFERED INPUT/OUTPUT

<u>Sequence of Events in Buffered Input</u> (Refer to figure 5a)

1. Same as normal input.

2. Same as normal input.

3. The TeleProgrammer reads the 70 instruction in 4 usec. It then generates an input request, releasing the TeleProgrammer for computation.

4. The external equipment accepts the input request signal, places a word on the data lines, and generates an input ready signal.

5. The TeleProgrammer accepts the input ready signal and stores the word.* Recognition of the input ready signal terminates the input request which turns off the input ready signal in the external equipment. (Termination of the input request signal must turn off the input ready signal within 4 msec.)

6. The TeleProgrammer issues another input request and steps 4 and 5 repeat until all words are buffered into the TeleProgrammer.

<u>Sequence of Events in Buffered Output</u> (Refer to figure 5b)

1. Same as normal input.

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* It may take the TeleProgrammer up to 18 usec. to recognize the input ready and store the word, depending on which cycle the TeleProgrammer is in when the input ready signal occurs.

2. Same as normal input.

3. The TeleProgrammer reads the 71 instruction in 4 usec.
    and initiates a buffer cycle to place the first word on the
    data lines and issue an information ready signal. The Tele-
    Programmer is then free for computation.

4. The external equipment accepts the information ready signal
    and data at its own rate and returns an output resume signal.

5. Recognition of the output resume signal initiates another buffer
    cycle and terminates the information ready signal.*

6. Termination of the information ready signal in the TeleProgrammer
    turns off the output resume signal in external equipment.
    (Output resume must turn off within 4 msec.)

7. Steps 3-5 are repeated for each word until all words are
    buffered out of the TeleProgrammer.

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*   It may take the TeleProgrammer up to 18 usec. to recognize
    the output resume and put the next word on the output lines,
    depending on which cycle the TeleProgrammer is in when the
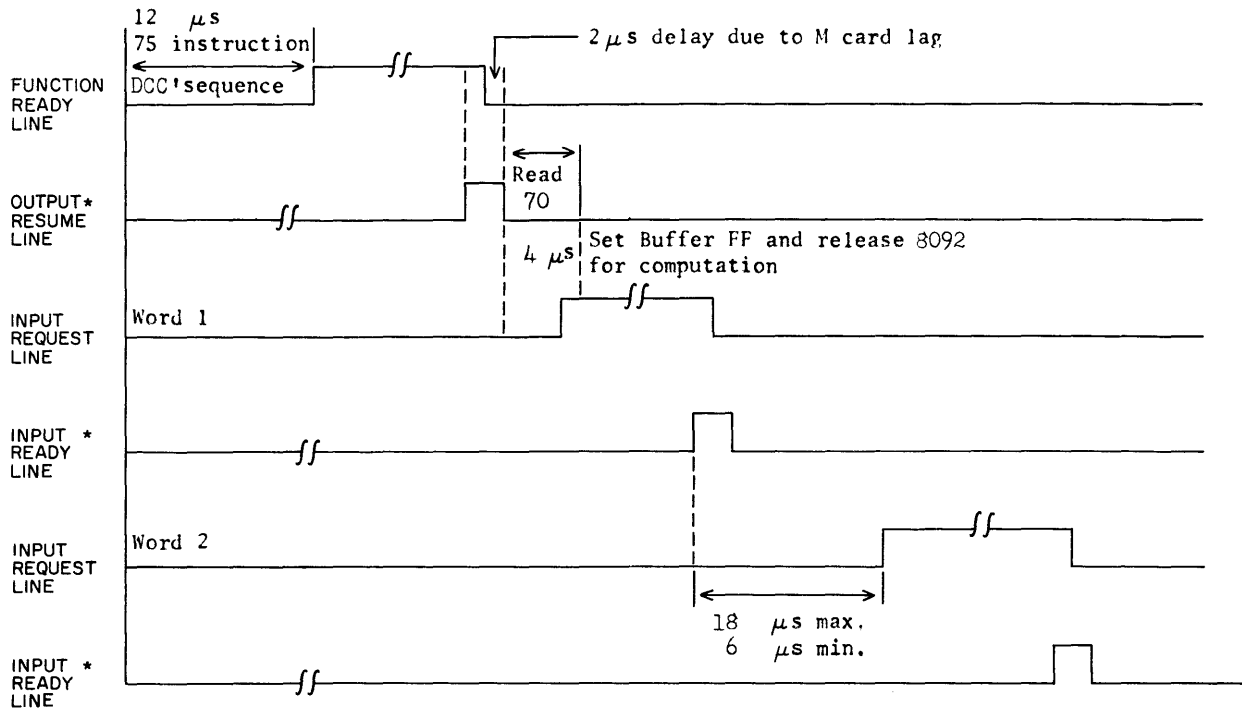   output resume occurs.

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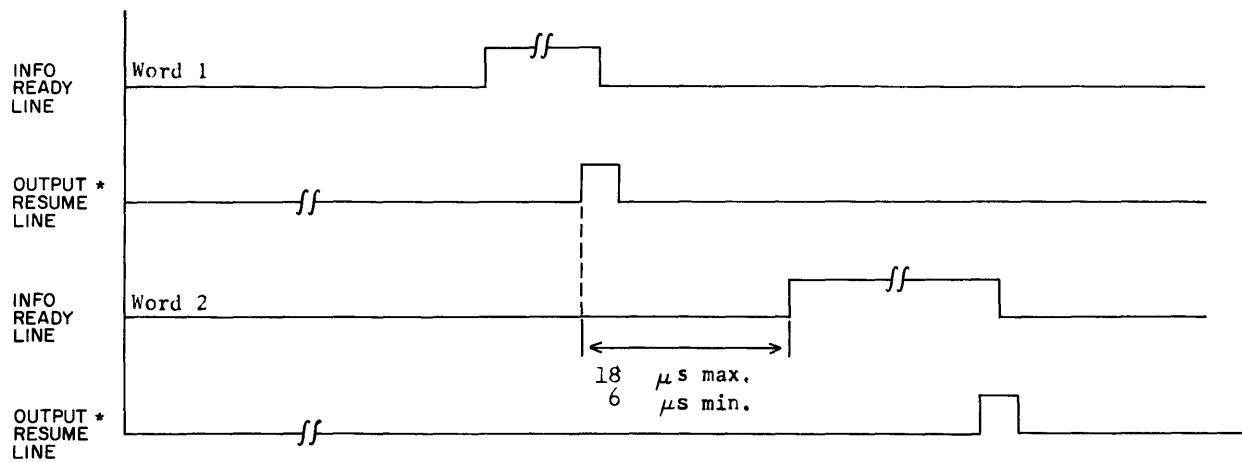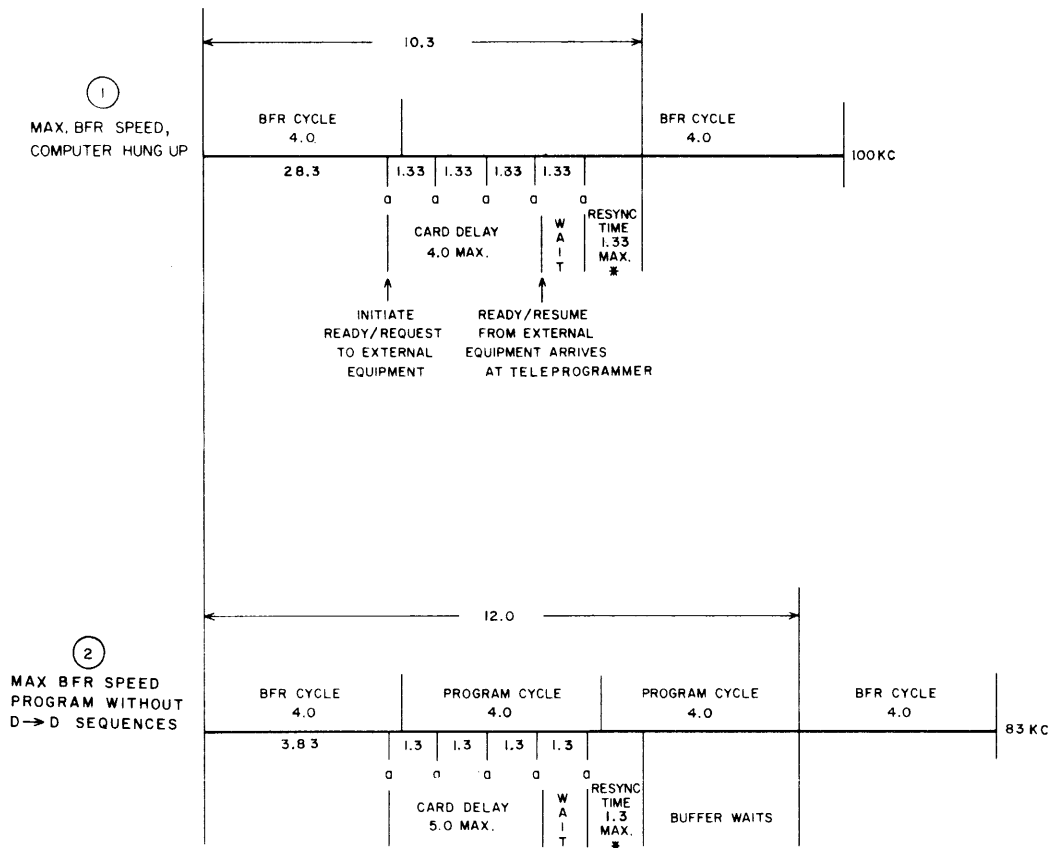Figure 5a.   Buffered Input, 8092 TeleProgrammer

Figure 5b.   Buffered Output, 8092 TeleProgrammer

*   Signals generated by external equipment

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10.3

① MAX. BFR SPEED, COMPUTER HUNG UP

BFR CYCLE 4.0   BFR CYCLE 4.0   100KC

28.3   1.33   1.33   1.33   1.33

a   a   a   a   a

CARD DELAY 4.0 MAX.   W A I T   RESYNC TIME 1.33 MAX. *

INITIATE READY/REQUEST TO EXTERNAL EQUIPMENT

READY/RESUME FROM EXTERNAL EQUIPMENT ARRIVES AT TELEPROGRAMMER

12.0

② MAX BFR SPEED PROGRAM WITHOUT D → D SEQUENCES

BFR CYCLE 4.0   PROGRAM CYCLE 4.0   PROGRAM CYCLE 4.0   BFR CYCLE 4.0   83 KC

3.83   1.3   1.3   1.3   1.3

a   a   a   a   a

CARD DELAY 5.0 MAX.   W A I T   RESYNC TIME 1.3 MAX. *   BUFFER WAITS

a   Sampling of incoming signals occurs at 1.33 usec intervals during all machine cycles.

*   This resync period may start earlier with a shorter card delay (at previous sample time "a").

Figure 6   Maximum Permissible Transfer Rates Using Buffer Channel

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TELEPROGRAMMER COMMUNICATION CIRCUITS

TELEPROGRAMMER COMMUNICATION CIRCUITS

In communicating with external devices the TeleProgrammer signals undergo a level change to minimize effects of cable impedance. The TeleProgrammer signals are referred to as logic levels, the cable signals as line levels. The binary representation for the two levels are:

Logic	"1"	-3.0v ($\pm$ 0.25v)
	"0"	-0.5v ($\pm$ 0.25v)
Line	"1"	-0.5v ($\pm$ 0.25v)*
	"0"	-16v ($\pm$ 2.5v)

Both line and logic levels are encountered in the input and output amplifier cards. All external equipment control signals are resynchronized upon entering the TeleProgrammer.

INPUT CIRCUITS

In the schematic diagram of the input amplifier circuit (figure 7), resistor R01 and the -20v supply hold the input to the circuit (point a) to line "0" when no input signal is supplied, or when no data or control line is tied to the circuit. If a line "1" is supplied to the input pin, the base of Q01 (point b) rises due to the voltage divider action of R02, R06, and R08. Subsequently Q01 stops conducting, and the output to the computer circuits represents a logic "1".

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* Tolerances given are for Control Data equipment. When other equipment is connected to Control Data TeleProgrammers, the following variation may be tolerated on the "1" line level: + 0.5v, -2.5v.

Conversely, if a line "0" is applied to the circuit, Q01 conducts and the output to the computer circuits approaches -0.5v (logic "0"). Stated simply, the input amplifier inverts the signal electrically, but not logically.
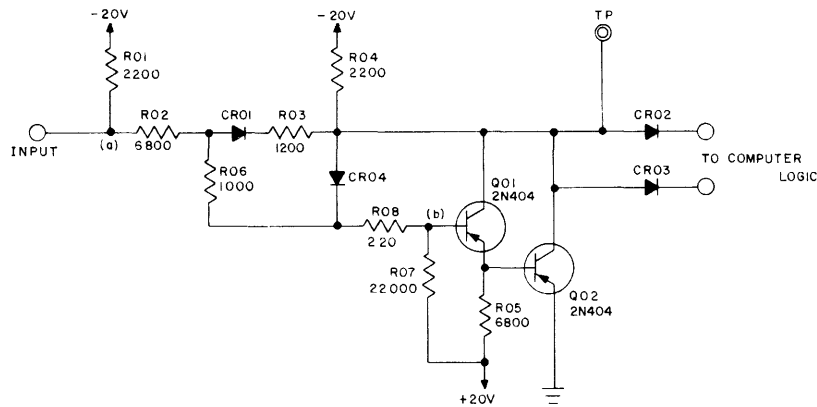

Figure 7. Input Amplifier Circuit

Maximum steady-state current drawn by an input amplifier circuit does not exceed 10 ma. If the wire to the input pin is disconnected, the effect is as though a line "0" were present continually. The current waveform has a slope which does not exceed 5 ma per usec.

OUTPUT CIRCUITS

In the output amplifier circuit (figure 8), resistor R01 and the -20v supply hold the input to the circuit (Point a) at a logic "1" when no signal is applied, or when no data or control line is tied to the circuit. The collector of transistor Q01 is connected to its base through a 150uuf capacitor (C01) which integrates this output of Q01.

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When a logic "1" is applied to either input pin, Q01 turns on, placing a low impedance between ground and the output line. Capacitor C01 tends to oppose the initial conduction of Q01 by feeding back a signal less positive than that initially placed on the base. When C01 is fully charged, Q01 reaches full conduction and the output rises to -0.5v (line "1"). If a logic "0" is applied to this circuit, the voltage divider action of the circuit turns off Q01, and the output stabilizes at -16v (line "0"). Stated simply, the output amplifier inverts the signal electrically, but not logically.

The output amplifier need supply no more than 10 ma to any input amplifier in another piece of equipment. Transition time of the signal waveform from the output amplifier circuit is 2 usec. minimum , 4 usec. maximum. Total line capacity may vary between 0 and 0.002 uf.

Voltage level rise and fall rates are 8v/usec.; d-c resistance of cable ground return must not exceed 0.5 ohm. All data lines are stable before information is sampled.
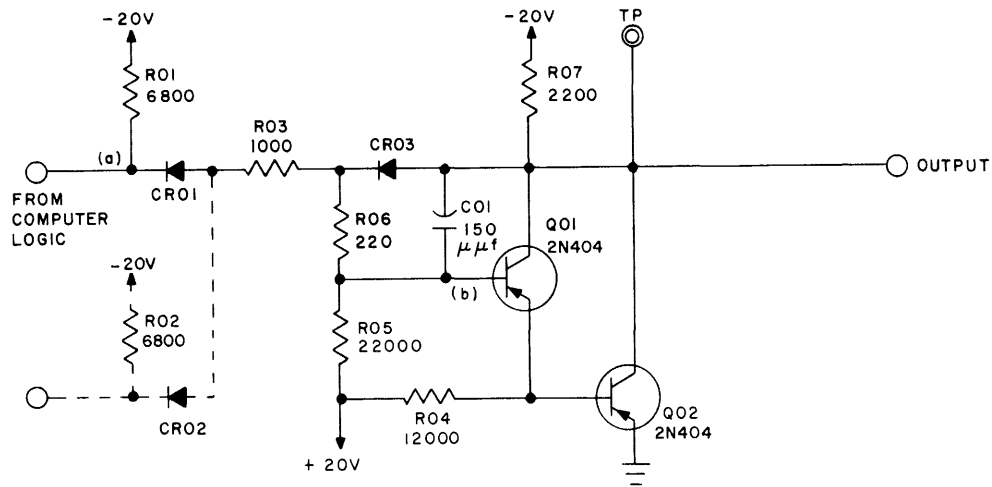
Figure 8. Output Amplifier Circuit

CABLE CONNECTORS

All data and signal connections between the 8092 TeleProgrammer and peripheral equipment are made using 24-pin Amphenol twist-lock connectors. The Amphenol part numbers are given for the male (P) connectors used on all cable ends and the female (S) connectors used for panel mounting.

67-06P-18-24P   (cable)

67-02E-18-24S   (panel)

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