Z77-6023

TECHNICAL INFORMATION EXCHANGE

SUGGESTIONS FOR WRITING TWO-CARD

UTILITY PROGRAMS FOR IBM SYSTEM/360

COMPUTERS

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Sept. 13, 1966

This paper suggests methods for developing IBM System/360 computer utility programs which can be used immediately after being keypunched. Any System/360 computer program whose instructions, CAW'S, CCW'S, and constants can be contained within 80 or fewer bytes may be executed as a 2-card program.

Examples of such programs are: 80/80 list, 80/80 reproduce, gangpunch, card-to-tape, tape-to-print, combination upper-lower case 1052 print demo, etc.

Besides not requiring assembly time and also saving library card file space, 2-card programming affords a better insight as to how the 360 CPU and instructions actually function. A practical example is how in a 2-card 80/80 reproduce program, the device address portion of a single start 1/0 instruction can be flip-flopped from reader to punch by using an exclusive OR. The same can be done with the command codes in the CCW. Thus the need for separate series of instructions and CCW'S for both input and output is eliminated.

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INTRODUCTORY NOTES

1. MORE DETAILED INFORMATION CONCERNING THE MATERIAL DISCUSSED IN THIS PAPER CAN BE OBTAINED FROM THE TWO MANUALS:

   PRINCIPLES OF OPERATION #A22-6828-1

   SYSTEM/360 INPUT/OUTPUT OPERATIONS #R23-2959-0
   (5TH MANUAL OF THE FLD. ENG. EDUC. SELF-STUDY COURSE)

2. A COPY OF IBM SYSTEM/360 REFERENCE DATA CARD #X20-1703 IS INDISPENSABLE WHEN FORMULATING 2-CARD PROGRAMS.

3. ALL CORE STORAGE ADDRESSES REFERRED TO IN THIS PAPER ARE IN HEX NOTATION UNLESS OTHERWISE SPECIFIED.

4. NO BASE OR INDEX REGISTERS OR DISPLACEMENT FACTORS ARE USED IN THIS PAPER SO ALL EFFECTIVE ADDRESSES ARE NATURAL BASIC ADDRESSES.

5. LIST OF THE PHYSICAL ADDRESSES OF THE I/O DEVICES USED IN THIS PAPER.

2540	CARD READER	00C
2540	CARD PUNCH	00D
1403	PRINTER	00E
1052	CONSOLE TYPEWRITER	01F
2400	EIGHT TAPE DRIVES	180-187

6. DEVICE ADDRESSES AT VARIOUS INSTALLATIONS MAY DIFFER FROM THOSE LISTED ABOVE. WHEN THIS IS THE CASE, PROPER ADDRESSES MUST BE SUBSTITUTED IN THE 2-CARD PROGRAM WHERE APPLICABLE. IT MAY ALSO BE NECESSARY TO MAKE OTHER ADJUSTMENTS.

CORE STORAGE MAP:

THE INFORMATION BELOW IS A GENERAL DESCRIPTION OF CORE STORAGE FOR THE 2-CARD PROGRAMS DISCUSSED IN THIS PAPER.

HEX ADDR.

00-07, 08-0F, 10-17 ← FIRST 24 BYTES OF CORE STORAGE IS THE AREA INTO WHICH THE IPL DATA FROM THE FIRST CARD OF THE 2-CARD PROGRAM IS PLACED WHEN THE CONSOLE LOAD BUTTON IS PRESSED.

18-1F, 20-27, 28-2F, 30-37, 38-3F ← PERMANENT STORAGE AREA FOR OLD PSW's BUT NOT USED BY THE 2-CARD PROGRAMS IN THIS PAPER BECAUSE NO INTERRUPTS ARE ALLOWED AND CONSEQUENTLY NO INTERCHANGE OF PROGRAM STATUS WORDS WILL OCCUR.

40-47 ← THIS IS THE AREA IN WHICH THE CHANNEL STATUS WORD IS AUTOMATICALLY STORED AT SPECIFIED TIMES BY THE CPU. IT MUST BE RESERVED FOR THIS PURPOSE.

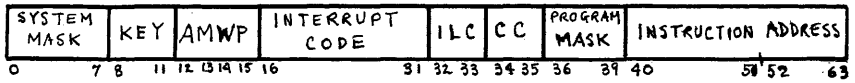
48-4B ← THESE ARE THE FOUR CORE POSITIONS INTO WHICH A CHANNEL ADDRESS WORD MUST BE PLACED BY THE PROGRAMMER BEFORE ANY I/O OPERATION IS STARTED.

4C-9F ← THIS AREA IS NORMALLY USED FOR THE TIMER AND NEW PSW STORAGE BUT, AS STATED ABOVE, THERE WILL BE NO STATUS SWITCHING INVOLVED SO THESE SECTIONS NEED NOT BE RESERVED FOR THEIR ORIGINALLY INTENDED COMMITMENTS. CONSEQUENTLY, THESE 80 POSITIONS WILL BE THE AREA INTO WHICH THE PROGRAM (SECOND CARD OF THE 2-CARD PROGRAM) IS READ.

A0-CORE END. ← AREA WHERE DATA CAN BE READ INTO OR OUT OF OR ACTED UPON BY THE PROGRAM.

GENERAL INFORMATION

PROGRAM STATUS WORD:



IN THIS PAPER THERE WILL BE ONLY ONE PSW PER 2-CARD PROGRAM. THIS PSW WILL ALWAYS BE IN CC 1-8 OF THE FIRST (INITIAL PROGRAM LOAD) CARD AND WILL ALWAYS BE LOADED INTO CORE POSITIONS 00-07 BY THE IPL PROCEDURE. IT RESIDES THERE UNTIL THE IPL CCW ACTIVITY IS COMPLETED AT WHICH TIME IT IS FETCHED FROM THESE POSITIONS AS THE NEW PSW AND STARTS THE CPU.

BITS 0-7 (SYSTEM MASK) WILL ALWAYS BE ZERO IN THIS PAPER TO PREVENT ALL INTERRUPTS.

BITS 8-11 ARE ALWAYS ZERO IN THIS PAPER BECAUSE NO PROTECTION KEY IS USED.

BITS 12-15 (AMWP) ARE ALL ZERO. BIT 15 MUST BE ZERO BECAUSE THE SYSTEM HAS TO BE IN SUPERVISOR STATE FOR I/O INSTRUCTIONS TO BE EXECUTED.

BITS 16-39 ARE ALWAYS ORIGINALLY ZERO IN THIS PAPER. HOWEVER AFTER THE PSW IS FETCHED, CONDITION CODE BITS 34 AND 35 WILL VARY ACCORDING TO THE PREVAILING CONDITIONS.

THE INSTRUCTION ADDRESS IN THE LAST PORTION OF THE PSW WILL ALWAYS POINT TO THE FIRST PROGRAM INSTRUCTION TO BE EXECUTED AFTER IPL IS COMPLETED. IN THIS PAPER THAT INSTRUCTION ADDRESS WILL ALWAYS BE IN LOW CORE SO THE FIRST 12 BITS OF THE ADDRESS FIELD (BITS 40-51) WILL ALWAYS BE ZEROS.

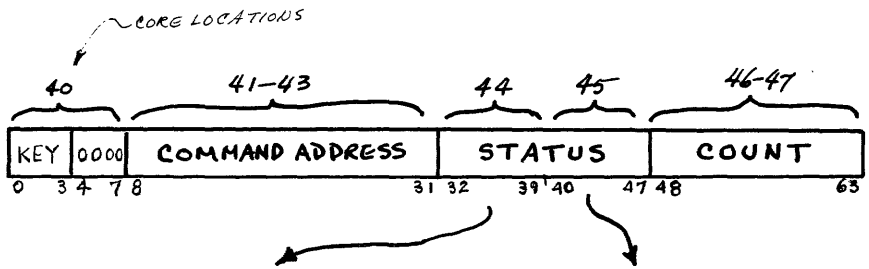
IN HEX, THE PSW FOR A 2-CARD PROGRAM WILL USUALLY APPEAR:

00 00 00 00 00 00 0X XX

ADDRESS OF FIRST PROGRAM INSTRUCTION TO BE EXECUTED

CHANNEL STATUS WORD:

THE CSW IS A DOUBLE WORD WHICH IS GENERATED INTERNALLY AND STORED IN LOCATIONS 40-47 BY THE CPU AT SPECIFIED TIMES. IT IS AVAILABLE TO THE PROGRAM AND FROM IT MANY CONDITIONS CAN BE CHECKED.



32 ATTENTION
33 STATUS MODIFIER
34 CONTROL UNIT END
35 BUSY
36 CHANNEL END
37 DEVICE END
38 UNIT CHECK
39 UNIT EXCEPTION

40 PRGM-CTLD-INTRPTN
41 INCORRECT LENGTH
42 PROGRAM CHECK
43 PROTECTION CHECK
44 CHANNEL DATA CHECK
45 CHANNEL CONTROL CHECK
46 INTERFACE CONTROL CHECK
47 CHAINING CHECK

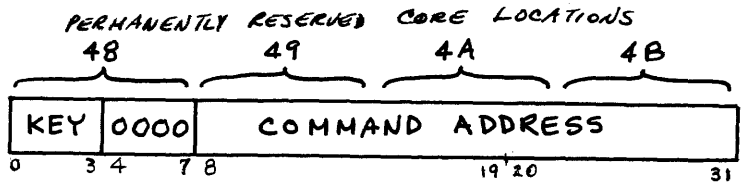
THE MATERIAL IN THIS PAPER WILL REFER TO ONLY BITS 39 AND 42.

BIT 39 (UNIT EXECEPTION BIT) IS TURNED ON BY SENSING AN UNUSUAL CONDITION AT THE DEVICE SUCH AS: RECOGNITION OF A TAPE MARK, A 12 PUNCH ON THE 1403 PRINTER CARRIAGE TAPE, OR LAST CARD ON THE 2540 READER, ETC.

BIT 42 (PROGRAM CHECK BIT) IS TURNED ON BY PROGRAMMING ERRORS SUCH AS INVALID CCW SPEC, INVALID COMMAND CODE, ETC.

CHANNEL ADDRESS WORD:

A CAW CAN BE CLASSIFIED AND TREATED AS A CONSTANT RATHER THAN AN INSTRUCTION. BEFORE AN OPERATION CAN BE PERFORMED ON A PARTICULAR I/O DEVICE, A PERTINENT CAW MUST BE LOCATED IN CORE STORAGE POSITIONS 48-4B. THESE FOUR CORE STORAGE LOCATIONS ARE PERMANENTLY RESERVED FOR CONTAINING A CAW.



BITS 0-3 WILL ALWAYS BE ZERO IN THIS PAPER BECAUSE NO STORAGE PROTECTION KEY IS USED.

BITS 4-7 MUST CONTAIN ZEROS IN EVERY CASE.

BITS 8-31 COMMAND ADDRESS (ADDRESS OF ITS ASSOCIATED CHANNEL COMMAND WORD) WILL ALWAYS BE A POSITION IN LOW CORE IN THIS PAPER SO ITS FIRST 12 BITS (8-19) WILL ALWAYS BE ZEROS.

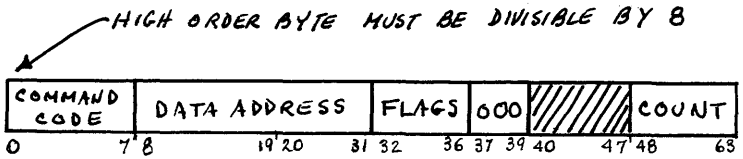
THE HEX FORMAT OF THE CAW IN THE 2-CARD PROGRAMS IN THIS PAPER WILL USUALLY APPEAR AS:

00 00 0X XX

HEX ADDRESS OF PROGRAM CCW

CHANNEL COMMAND WORD:

A CCW IS A DOUBLE-WORD (8 BYTES IN LENGTH) AND MUST ALWAYS BE LOCATED IN CORE SO THAT ITS HIGH-ORDER BYTE (ADDRESS BYTE) IS EVENLY DIVISIBLE BY 8. THE CCW, LIKE THE CAW, CAN BE CONSIDERED A CONSTANT AS FAR AS THE PROGRAMMER IS CONCERNED.



COMMAND CODES IN BITS 0-7 WILL VARY ACCORDING TO THE I/O OPERATIONS BEING PERFORMED BY THE 2-CARD PROGRAM. (SEE COMPLETE LIST ON SYSTEM/360 REFERENCE DATA CARD) 09=WRITE + SPACE 1403, 01=WRITE TAPE, 1B=TRIPLE SPACE, 02=READ (ALL DEVICES), 42=READ + STK SEL. 2540, ETC.

THE DATA ADDRESSES FOR THE PROGRAMS IN THIS PAPER WILL ALWAYS BE IN LOW CORE SO THE FIRST 12 BITS (8-19) OF THAT FIELD WILL ALWAYS BE ZERO.

FLAG BITS 32,33,34,35 (CHAIN DATA, CHAIN COMMAND, SUPPRESS INCORRECT LENGTH INDICATION, AND SKIP FLAG BITS) MAY VARY AND WILL BE EXPLAINED IN DETAIL FOR EACH 2-CARD PROGRAM DISCUSSED. THE SETTING OF THE SILI BIT (BIT 34) IS IMMATERIAL IN MOST CASES.

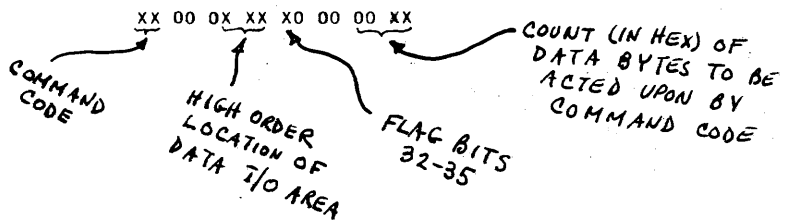
FLAG BIT 36 (PCI) WILL ALWAYS BE OFF (SET TO 0) IN THIS PAPER BECAUSE THERE WILL BE NO PROGRAM CONTROLLED INTERRUPTIONS.

BITS 37-39 MUST ALWAYS BE ZEROS.

BITS 40-47 ARE IGNORED BY THE CPU BUT ARE FILLED IN WITH ZEROS IN THIS PAPER.

BITS 48-63 (COUNT) ARE THE HEX NUMBER OF BYTES TO BE TRANSFERRED OR ACTED UPON BY THE COMMAND CODE IN BITS 0-7. MAXIMUM IS FFFF OR 65,535 BYTES. REMEMBER THAT 80 COLUMNS (BYTES) = HEX 50, 100 POSITIONS = HEX 64, ETC.

HEX FORMAT OF A CCW IN THE 2-CARD PROGRAMS IN THIS PAPER WILL USUALLY APPEAR AS:

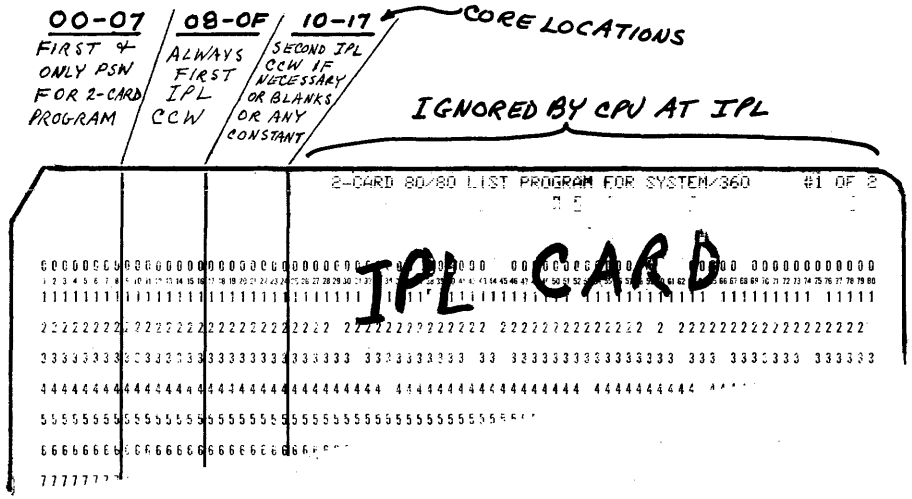


INITIAL PROGRAM LOADING:

INITIAL PROGRAM LOADING FOR THE 2-CARD PROGRAMS IN THIS PAPER WILL ALWAYS BE FROM THE CARD READER.

THE LOAD UNIT DIALS (G,H,J MOD 30) WILL BE SET TO THE PHYSICAL ADDRESS OF THE READER (00C).

WHEN THE LOAD BUTTON IS PRESSED, THE FIRST 24 COLUMNS OF THE FIRST CARD (IPL CARD) ARE READ INTO THE FIRST 24 CORE POSITIONS (HEX ADDRESSES 00-17) ANY OTHER PUNCHES BEYOND COLUMN 24 ARE IGNORED BY THE CPU SO THEY CAN BE USED FOR PROGRAM IDENTIFICATION OR LEFT BLANK AS DESIRED.



00-07 THESE 8 BYTES ARE LOADED FROM CC 1-8 OF THE IPL CARD AND CONTAIN THE FIRST AND ONLY PSW TO BE USED IN EACH 2-CARD PROGRAM. THE ADDRESS IN IT POINTS TO THE FIRST PROGRAM INSTRUCTION TO BE EXECUTED AFTER IPL IS COMPLETED.

08-0F THESE 8 BYTES ARE LOADED FROM CC 9-16 OF THE IPL CARD AND CONTAIN THE FIRST IPL CCW. THIS IS THE CCW WHICH AUTOMATICALLY READS IN THE SECOND CARD (PROGRAM CARD) WHEN IPL ACTION IS INITIATED BY PUSHING THE LOAD BUTTON.

10-17 IF THE FIRST IPL CCW IN 08-0F SPECIFIES CHAINING IN EITHER OF ITS BITS 32 OR 33, THEN THERE MUST BE A SECOND IPL CCW IN CORE LOCATIONS 10-17. IF NO CHAINING IS SPECIFIED IN THE FIRST IPL CCW, THEN THE ADJACENT POSITIONS (10-17) CAN BE USED TO STORE ANY CCW OR CONSTANT THAT THE SECOND CARD (PROGRAM CARD) MAY REQUIRE.

IF CARD COLUMNS 17-24 ARE LEFT BLANK, ANYTHING IN CORE POSITIONS 10-17 FROM THE PREVIOUS PROGRAM WILL BE OVERLAID WITH BLANKS (HEX 40) AFTER THE IPL PROCEDURE IS STARTED.

I/O INSTRUCTIONS:

IN THE INSTRUCTION SET FOR SYSTEM/360, THERE ARE ONLY FOUR INPUT/OUTPUT INSTRUCTIONS. THESE ARE PRIVILEGED INSTRUCTIONS SO THE SYSTEM MUST BE IN SUPERVISOR STATE BEFORE ANY ONE OF THEM IS EXECUTED.

9C	START I/O
9D	TEST I/O
9E	HALT I/O
9F	TEST CHANNEL

THE 2-CARDS PROGRAMS IN THIS PAPER WILL USE ONLY THE FIRST TWO, START I/O AND TEST I/O. THEY ARE GENERALLY USED TOGETHER AND MAY BE IN EITHER SEQUENCE. HOWEVER, IT WAS FOUND THAT IN SOME TAPE OPERATIONS THE FIRST RECORD WOULD BE INCORRECT IF THE TEST I/O WAS GIVEN BEFORE THE START I/O.

START I/O (9C) INITIATES A WRITE, READ, READ-BACKWARDS, OR CONTROL SUCH AS REWIND, WRITE TAPE MARK, SKIP TO CHANNEL 1, ETC. WHEN AN OPERATION IS NOT STARTED SUCCESSFULLY, THE CONDITION CODE IS SET ACCORDINGLY. A PERTINENT CAW MUST BE IN LOCATIONS 48-4B BEFORE A START I/O INSTRUCTION IS GIVEN. THE ADDRESS IN THAT CAW MUST POINT TO A CCW WHOSE COMMAND CODE WILL PERFORM THE CORRECT FUNCTION WHICH THE DEVICE DESIGNATED IN THE START I/O INSTRUCTION DESIRES.

TEST I/O (9D) TESTS THE STATE OF THE ADDRESSED CHANNEL, SUB-CHANNEL, AND DEVICE. THE PSW CONDITION CODE IS SET WHEN AN OPERATION IS NOT TERMINATED SUCCESSFULLY. THIS INSTRUCTION WILL ALSO CAUSE AN ENTIRE CHANNEL STATUS WORD TO BE STORED IN ITS RESERVED CORE LOCATIONS (40-47). NO CAW OR CCW IS NEEDED FOR TEST I/O.

I/O INSTRUCTIONS IN THIS PAPER WILL APPEAR AS:

9D 00 00 0E	TEST I/O	PRINTER
9C 00 00 0E	START I/O	PRINTER
9C 00 00 1F	START I/O	1052 TYPE-WRITER
9D 00 01 85	TEST I/O	TAPE DRIVE 185

SUGGESTIONS FOR WRITING 2-CARD PROGRAMS

NOTE. WHEN STARTING TO CONCEIVE A 2-CARD PROGRAM, IT IS NOT NECESSARY TO BE IMMEDIATELY CONCERNED WITH THE IPL CARD (FIRST CARD OF THE 2-CARD PROGRAM). ITS CONTENTS WILL BE DEVELOPED LATER AT VARIOUS STAGES IN THE PROCEDURE.

STEP 1.

SKETCH PROGRAM IN MACHINE LANGUAGE USING HEX NOTATIONS. IN DOING SO REMEMBER TO ALLOW PROPER SPACING FOR UNKNOWN ADDRESSES AND LENGTH COUNTS WHICH CANNOT BE DETERMINED IMMEDIATELY. IN THIS PAPER THOSE UNDETERMINED POSITIONS ARE TEMPORARILY FILLED IN WITH X'S ONLY TO SIMPLIFY EXPLANATION AND ALLEVIATE THE POSSIBILITY OF WRONG POSITION COUNTING.

EXAMPLE OF A SKETCHED PROGRAM WHICH CAN BE WORKED INTO A 2-CARD PROGRAM PROVIDING ITS INSTRUCTIONS, CAW'S, CCW'S, AND CONSTANTS CAN BE CONTAINED WITHIN 80 OR FEWER BYTES:

```
000000XX 090000XX000000XX 9D00000E 477000XX 9C00000E 47F000XX
```

THE FUNCTION OF THIS PROGRAM IS TO REPEATEDLY PRINT OUT THAT CONSTANT INFORMATION WHICH IS PUNCHED INTO THE SURPLUS COLUMNS OF THE PROGRAM CARD, USING ONLY THE 2-CARD PROGRAM AND NO OTHER SOURCE OF INPUT.

SAMPLE OF REPEATED LISTING OF
DATA PUNCHED IN SURPLUS COLUMNS

```
---NAME OF CUSTOMER----WELCOME TO IBM DATA CENTER---
---NAME OF CUSTOMER----WELCOME TO IBM DATA CENTER---
---NAME OF CUSTOMER----WELCOME TO IBM DATA CENTER---
---NAME OF CUSTOMER----WELCOME TO IBM DATA CENTER---
---NAME OF CUSTOMER----WELCOME TO IBM DATA CENTER---
---NAME OF CUSTOMER----WELCOME TO IBM DATA CENTER---
---NAME OF CUSTOMER----WELCOME TO IBM DATA CENTER---
---NAME OF CUSTOMER----WELCOME TO IBM DATA CENTER---
---NAME OF CUSTOMER----WELCOME TO IBM DATA CENTER---
---NAME OF CUSTOMER----WELCOME TO IBM DATA CENTER---
---NAME OF CUSTOMER----WELCOME TO IBM DATA CENTER---
---NAME OF CUSTOMER----WELCOME TO IBM DATA CENTER---
---NAME OF CUSTOMER----WELCOME TO IBM DATA CENTER---
```

PROGRAM ANALYSIS

PRINTER CAW	PRINTER CCW	TEST I/O PRINTER	COND. BRANCH	START I/O PRINTER	UNCOND. BRANCH
000000XX	090000XX000000XX	9D00000E	477000XX	9C00000E	47F000XX

ULTIMATE ADDRESS OF PROGRAM CCW FOR PRINTER

00 00 00 XX CHANNEL ADDRESS WORD FOR PRINTER

THE FIRST ITEM IN THIS PARTICULAR PROGRAM IS THE CAW WHICH EVENTUALLY MUST BE IN CORE LOCATION 48 BEFORE THE PROGRAMMED I/O OPERATION CAN BE STARTED. IT IS NOT MANDATORY TO HAVE A CAW AS THE FIRST CONSTANT BUT THERE IS A DEFINITE ADVANTAGE TO ITS BEING THERE IN THIS PARTICULAR 2-CARD PROGRAM AS WILL BE SHOWN LATER.

COMMAND CODE WRITE & SPACE AFTER PRINT — DATA ADDRESS — FLAG BITS(32-35) ALL OFF — COUNT

09 00 00 XX 00 00 00 XX PROGRAM CCW FOR PRINTER (NOT IPL CCW)

THE DATA ADDRESS CANNOT BE DETERMINED UNTIL THE PROGRAM IS LAID OUT. THERE WILL BE NO DATA OR COMMAND CHAINING SO NO FLAG BITS NEED BE ON. THE COUNT CANNOT BE ASCERTAINED UNTIL IT IS FOUND OUT HOW MANY SURPLUS COLUMNS REMAIN IN CARD TWO AFTER THE PROGRAM IS ACCOMMODATED.

TEST I/O OP CODE — PHYSICAL ADDRESS OF PRINTER

9D 00 00 0E TEST I/O INSTRUCTION

THIS INSTRUCTION MAY BE GIVEN BEFORE A START I/O INSTRUCTION IS ATTEMPTED. IF THE DEVICE IS BUSY OR NOT OTHERWISE AVAILABLE, THIS INSTRUCTION WILL SET THE PSW CONDITION CODE ACCORDINGLY.

BR. OP. CODE — 0111 8 CONDS — ULTIMATE ADDRESS OF TEST I/O PRINTER INSTRUCTION

47 70 00 XX BRANCH ON CONDITION 7.

THIS INSTRUCTION WILL TEST THE CONDITION CODE AND CAUSE A LOOP BACK TO THE TEST I/O INSTRUCTION. IT WILL FALL THROUGH ONLY WHEN THE PRINTER IS AVAILABLE.

START I/O OP. CODE — PHYSICAL ADDRESS OF PRINTER

9C 00 00 0E START I/O INSTRUCTION.

THIS INSTRUCTION WILL PRINT A LINE STARTING AT THE DATA ADDRESS SPECIFIED IN ITS PROGRAM CCW AND EQUAL TO THE NUMBER OF BYTES SPECIFIED IN THE COUNT FIELD.

BR. — 1111 UNCOND. — ULTIMATE ADDRESS OF TEST I/O PRINTER INSTRUCTION

47 F0 00 XX BRANCH ON 15.

UNCONDITIONAL BRANCH BACK TO THE TEST I/O INSTRUCTION TO START ANOTHER PRINT CYCLE.

STEP 2. CHECK PROGRAM LENGTH

CHECK TO SEE IF THE SKETCHED PROGRAM CAN BE CONTAINED IN 80 COLUMNS. ONLY ONE COLUMN WILL BE REQUIRED FOR EACH PAIR OF HEXADECIMAL CHARACTERS (2 HEX CHARACTERS EQUAL ONE BYTE).

00	00	00	XX	09	00	00	XX	00	00	00	XX	9D	00	00	0E
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

47	70	00	XX	9C	00	00	0E	47	F0	00	XX
17	18	19	20	21	22	23	24	25	26	27	28

ONLY 28 COLUMNS ARE REQUIRED SO IT WILL BE POSSIBLE FOR THIS PROGRAM TO BE EXECUTED AS A 2-CARD PROGRAM.

FOR THIS PARTICULAR PROGRAM, THE SURPLUS COLUMNS (80-28=52) WILL BE USED FOR THE DATA TO BE PRINTED OUT REPETITIVELY ON THE 1403. THESE 52 COLUMNS OF DATA CAN BE ANY VALID PUNCH INCLUDING WHATEVER SPECIAL CHARACTERS ARE ON THE PRINT CHAIN.

CODED PUNCHES FOR LOWER-CASE EBCDIC CHARACTERS WILL PRINT AS THEIR CORRESPONDING UPPER-CASE CHARACTERS ON THE 1403.

EG. EBCDIC PUNCHED CARD CODE FOR LOWER CASE "e" IS 12,0,5. THIS PUNCH CONFIGURATION WILL PRINT A LOWER-CASE "e" ON THE 1052 TYPEWRITER BUT ON THE 1403, AN UPPER-CASE "E" WILL BE PRINTED, THE SAME AS A 12,5 PUNCH.

STEP 3. LAY OUT SKETCHED PROGRAM

IPL CARD			
CC	CORE	hex con-conts	PUNCHD CARD CODE
1	00		
2	01		
3	02		
4	03		
5	04		
6	05		
7	06		
8	07		
9	08		
10	09		
11	0A		
12	0B		
13	0C		
14	0D		
15	0E		
16	0F		
17	10		
18	11		
19	12		
20	13		
21	14		
22	15		
23	16		
24	17		

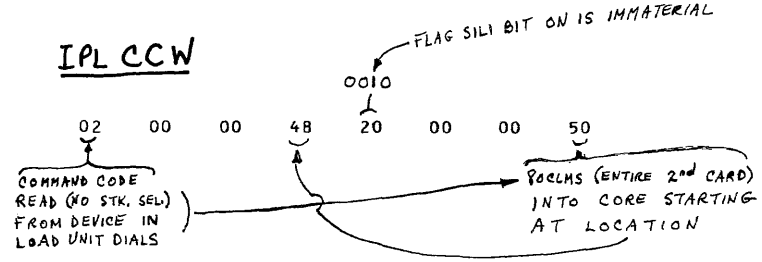
PROGRAM CARD											
CC	hex core addr	hex con-tents	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE
1		00	PRINTER CAW	28		XX		55			
2		00		29				56			
3		00		30				57			
4		XX		31				58			
5		09	PRINTER CCW	32							
6		00		33							
7		00		34							
8		XX		35							
9		00		36							
10		00		37							
11		00		38							
12		XX		39							
13		9D	TEST I/O	40							
14		00		41							
15		00		42							
16		0E		43							
17		47	COND. BR.	44							
18		70		45							
19		00		46							
20		XX		47							
21		9C	START I/O	48							
22		00		49				76			
23		00		50				77			
24		0E		51			CONTINUED	78			
25		47	UNCOND. BR.	52				79			
26		F0		53				80			
27		00		54							

STEP 3

LAY OUT SKETCHED PROGRAM IN "hex contents" COLUMNS ON THE "PROGRAM CARD" SIDE OF 2-CARD PROGRAM LAYOUT SHEET. START WITH THE CAW IN CARD COLUMN ONE AND CONTINUE ON. (2 HEX CHARACTERS PER CC)

STEP 4. ESTABLISH FIRST IPL CCW

PREPARE THE IPL CCW. THE IPL CCW IS USED TO READ IN THE SECOND CARD (PROGRAM CARD). THIS CCW WILL ALWAYS BE IN CC 9-16 OF THE IPL CARD (FIRST CARD) AND WILL ALWAYS BE PLACED INTO CORE LOCATIONS 08-0F DURING THE INITIAL PROGRAM LOAD PROCEDURE.



IN THIS SAMPLE PROGRAM BEING DISCUSSED, SINCE THERE IS ONLY ONE CAW AND SINCE IT IS CONVENIENTLY LOCATED IN THE FIRST FIELD OF THE PROGRAM CARD, IT IS MOST EFFICIENT TO HAVE THE IPL PROCEDURE LOAD THE CAW DIRECTLY INTO ITS RESERVED CORE POSITIONS (48-4B). THIS SAVES THE PROGRAMMER THE TROUBLE OF HAVING TO PLACE THE CAW THERE WITH LOAD-REGISTER AND STORE INSTRUCTIONS OR BY ACCOMPLISHING THE SAME WITH A MOVE INSTRUCTION BEFORE I/O EXECUTION IS STARTED.

TO INSTALL THE CAW PROPERLY WHILE READING IN CARD TWO AT IPL, THE ADDRESS IN THE ADDRESS FIELD OF THE IPL CCW MUST BE 48. THE REMAINDER OF THE PROGRAM IN CARD TWO WILL FALL UPWARD INTO CORE IN CONTIGUOUS LOCATIONS.

THE COUNT IN THE COUNT FIELD IS 80 (HEX 50) TO READ IN THE ENTIRE SECOND CARD (CAW + PROGRAM CCW + PROGRAM + SURPLUS COLUMNS INTO WHICH IS PUNCHED THE MISCELLANEOUS DATA THAT IS TO BE PRINTED REPETITIVELY).

STEP 4. ESTABLISH FIRST IPL CCW

IPL CARD

CC	CORE	hex con-conts	PUNCHD CARD CODE
1	00		
2	01		
3	02		
4	03		
5	04		
6	05		
7	06		
8	07		
9	08	02	
10	09	00	
11	0A	00	
12	0B	48	
13	0C	20	
14	0D	00	
15	0E	00	
16	0F	50	
17	10		
18	11		
19	12		
20	13		
21	14		
22	15		
23	16		
24	17		

READ IN (NO STR SEL) PROGRAM CARD (CARD #2)

STARTING AT CAW RESERVED CORE LOCATION

ALL 80 COLUMNS OF 2nd CARD

PROGRAM CARD

CC	hex core addr	hex con-tents	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE
1		00		28		XX		55			
2		00		29				56			
3		00		30				57			
4		XX		31				58			
5		09		32				59			
6		00		33				60			
7		00		34				61			
8		XX		35				62			
9		00		36				63			
10		00		37				64			
11		00		38				65			
12		XX		39				66			
13		9D		40				67			
14		00		41				68			
15		00		42				69			
16		CE		43				70			
17		47		44				71			
18		70		45				72			
19		00		46				73			
20		XX		47				74			
21		9C		48				75			
22		00		49				76			
23		00		50				77			
24		0E		51				78			
25		47		52				79			
26		F0		53				80			
27		00		54							

STEP 5. ESTABLISH HEX ADDRESSES

IPL CARD

CC	CORE	hex con-conts	PUNCHD CARD CODE
1	00		
2	01		
3	02		
4	03		
5	04		
6	05		
7	06		
8	07		
9	08	02	
10	09	00	
11	0A	00	
12	0B	48	
13	0C	20	
14	0D	00	
15	0E	00	
16	0F	50	
17	10		

STEP 5

FILL IN CORRESPONDING HEX ADDRESSES NOW THAT IT IS KNOWN THE CONTENTS OF COL. 1 IN THE PROGRAM CARD WILL START IN CORE LOCATION HEX 48.

PROGRAM CARD

CC	hex core addr	hex con-tents	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE
1	48	00		28	63	XX		55	7E		
2	49	00		29	64			56	7F		
3	4A	00		30	65			57	80		
4	4B	XX		31	66			58	81		
5	4C	09		32	67			59	82		
6	4D	00		33	68			60	83		
7	4E	00		34	69			61	84		
8	4F	XX		35	6A			62	85		
9	50	00		36	6B			63	86		
10	51	00		37	6C			64	87		
11	52	00		38	6D			65	88		
12	53	XX		39	6E			66	89		
13	54	9D		40	6F			67	8A		
14	55	00		41	70			68	8B		
15	56	00		42	71			69	8C		
16	57	0E		43	72			70	8D		
17	58	47		44	73			71	8E		
18	59	70		45	74			72	8F		
19	5A	00		46	75			73	90		
20	5B	XX		47	76			74	91		
21	5C	9C		48	77			75	92		
22	5D	00		49	78			76	93		
23	5E	00		50	79			77	94		
24	5F	0E		51	7A			78	95		
25	60	47		52	7B			79	96		
26	61	F0		53	7C			80	97		
27	62	00		54	7D						

STEP 6. REPLACE PREVIOUSLY UNKNOWN ADDRESSES

IPL CARD

CC	CORE	hex con-conts	PUNCHD CARD CODE
1	00		
2	01		
3	02		
4	03		
5	04		
6	05		
7	06		
8	07		
9	08	02	
10	09	00	
11	0A	00	
12	0B	48	
13	0C	20	
14	0D	00	
15	0E	00	
16	0F	50	
17	10		

PROGRAM CARD

CC	hex core addr	hex con-tents	PUNCHD CARD CODE
1	48	00	
2	49	00	
3	4A	00	ADDRESS OF PROG. CCW
4	4B	4C	
5	4C	09	
6	4D	00	
7	4E	00	
8	4F	64	STARTING ADDRESS OF DATA TO BE PRINTED REPETITIVELY
9	50	00	
10	51	00	
11	52	00	
12	53	34	NUMBER OF BYTES TO BE PRINTED EQUALS NO. OF SURPLUS COLUMNS. 80-28=52 52=34 HEX
13	54	9D	
14	55	00	
15	56	00	
16	57	0E	
17	58	47	
18	59	70	
19	5A	00	
20	5B	54	BRANCH BACK TO TEST I/O
21	5C	9C	UNTIL DEVICE IS AVAILABLE
22	5D	00	
23	5E	00	
24	5F	0E	
25	60	47	
26	61	F0	
27	62	00	

CC	hex core addr	hex con-tents	PUNCHD CARD CODE
28	63	54	UNCOND. BC, TO TEST I/O TO START ANOTHER PRINT LINE
29	64		
30	65		
31	66		
32			
33			
34			
35			
36			
37			
38			
39			
40			
41			
42			
43			
44			
45			
46			
47			
48			
49			
50			
51			
52			
53			
54			

CC	hex core addr	hex con-tents	PUNCHD CARD CODE
55			
56			
57			
58			
59			
60			
61			
62			
63			
64			
65			
66			
67			
68			
69			
70			
71			
72			
73			
74			
75			
76			
77			
78			
79			
80			

SURPLUS COLUMNS FOR DATA TO BE PRINTED REPETITIVELY

STEP 6.

NOW THAT ALL CORE ADDRESSES ARE ESTABLISHED, REPLACE THE XX's IN THE PROGRAM WITH THEIR KNOWN LOCATIONS. ALSO FILL IN THE PROGRAM CCW COUNT FIELD (IN HEX)

STEP 7. COMPLETE IPL CARD

IPL CARD

CC	CORE	hex con-conts	PUNCHD CARD CODE
1	00	00	PSW
2	01	00	WITH
3	02	00	ADDR. OF FIRST PRGRM INSTR TO BE EXEC.
4	03	00	
5	04	00	
6	05	00	
7	06	00	
8	07	54	
9	08	02	
10	09	00	
11	0A	00	
12	0B	48	
13	0C	20	
14	0D	00	
15	0E	00	
16	0F	50	
17	10		

PROGRAM CARD

CC	hex core addr	hex con-tents	PUNCHD CARD CODE
1	48	00	
2	49	00	
3	4A	00	
4	4B	4C	
5	4C	09	
6	4D	00	
7	4E	00	
8	4F	64	
9	50	00	
10	51	00	
11	52	00	
12	53	34	
13	54	9D	
14	55	00	
15	56	00	
16	57	0E	
17	58	47	
18	59	70	
19	5A	00	
20	5B	54	
21	5C	9C	
22	5D	00	
23	5E	00	
24	5F	0E	
25	60	47	
26	61	F0	
27	62	00	

CC	hex core addr	hex con-tents	PUNCHD CARD CODE
28	63	54	
29	64		
30			
31			
32			
33			
34			
35			
36			
37			
38			
39			
40			
41			
42			
43			
44			
45			
46			
47			
48			
49			
50			
51			
52			
53			
54			

CC	hex core addr	hex con-tents	PUNCHD CARD CODE
55			
56			
57			
58			
59			
60			
61			
62			
63			
64			
65			
66			
67			
68			
69			
70			
71			
72			
73			
74			
75			
76			
77			
78			
79			
80			

STEP 7

FILL IN PSW IN CC 1-8 OF IPL CARD.

STEP 8. ENTER EBCDIC PUNCH CODES

IPL CARD			
CC	CORE	hex con-conts	PUNCHD CARD CODE
1	00	00	12c981
2	01	00	12c981
3	02	00	12c981
4	03	00	12c981
5	04	00	12c981
6	05	00	12c981
7	06	00	12c981
8	07	54	12 11 94
9	08	02	12 92
10	09	00	12c981
11	0A	00	12c981
12	0B	48	12c98
13	0C	20	110981
14	0D	00	12c981
15	0E	00	12c981
16	0F	50	12

STEP 8

REFER TO IBM REF. DATA CARD X20-1703 AND ENTER THE PROPER PUNCHED CARD CODES FOR THE RESPECTIVE CHARACTERS. ALSO FILL IN THE MISC. DATA TO BE PRINTED REPETITIVELY.

PROGRAM CARD											
CC	hex core addr	hex con-tents	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE
1	48	00	12c981	28	63	54	12 11 94	55			E
2	49	0C	12c981	29	64		T	56			
3	4A	C0	12c981	30			H	57			P
4	4B	4C	12 84	31	↓		E	58			R
5	4C	09	12 981	32				59			I
6	4D	60	12c981	33			C	60			N
7	4E	00	12c981	34			H	61			T
8	4F	64	11c94	35			A	62			E
9	50	00	12c981	36			R	63			D
10	51	00	12c981	37			A	64			
11	52	00	12c981	38			C	65			A
12	53	34	94	39			T	66			R
13	54	9D	12 11 85	40			E	67			E
14	55	00	12c981	41			R	68			
15	56	00	12c981	42			S	69			P
16	57	0E	12 986	43				70			U
17	58	47	12c97	44			C	71			N
18	59	70	12 110	45			H	72			C
19	5A	00	12c981	46			O	73			H
20	5B	54	12 11 94	47			S	74			E
21	5C	9C	12 11 84	48			E	75			D
22	5D	00	12c981	49			N	76			
23	5E	00	12c981	50				77			H
24	5F	0E	12 986	51			T	78			E
25	60	47	12c97	52			O	79			R
26	61	F0	0	53				80			E
27	62	00	12c981	54			B				

STEP 9. KEYPUNCH 2-CARD PROGRAM

KEYPUNCH EBCDIC CHARACTERS INTO CARD. YOU WILL NEED TO HOLD DOWN ONLY THE "MULT-PCH" KEY (NUMERIC SHIFT KEY NOT NECESSARY) FOR EACH COLUMN BUT BE SURE TO RELEASE IT BEFORE STARTING ON THE NEXT COLUMN.

A FULL 80 COLUMN CARD CAN BE MULTI-PUNCHED IN LESS THAN FIVE MINUTES IF EVERYTHING IS WELL ORGANIZED.

IN THE APPENDIX, THE TABLE-OF-EBCDIC-PUNCH-CONFIGURATIONS-IN-CARD-ROW-SEQUENCE SHOULD PROVE HELPFUL WHENEVER VISUAL VERIFICATION OF A PUNCH IS NECESSARY.

STEP 10. OPERATING INSTRUCTIONS

AFTER THE IPL CARD AND THE PROGRAM CARD ARE BOTH PUNCHED, SIMPLY SET THE LOAD UNIT DIALS TO THE PHYSICAL ADDRESS OF THE CARD READER, READY THE PRINTER, LOAD AND GO.

POST-MORTEM

IT SO HAPPENS THAT THE SAMPLE PROGRAM AS STATED WOULD NOT GET VERY FAR AFTER A LOAD & GO. IT HAS A MAJOR FLAW. THE PROGRAM JUST DISCUSSED WAS THE ORIGINAL VERSION THAT THE AUTHOR TRIED AND BECAME STUMPED AS TO WHY IT DID NOT WORK. IT WAS NOT UNTIL BIT 42 OF THE CHANNEL STATUS WORD IN STORAGE LOCATIONS 40-47 WAS CHECKED THAT THE REASON FOR THE MALFUNCTION OR LACK OF FUNCTION WAS DETECTED.

THE ERROR WAS SHOWN TO BE A BOUNDARY VIOLATION.

YOU WILL NOTE THAT AT IPL TIME THE HIGH ORDER BYTE OF THE PROGRAM CCW (09 00 00 64 00 00 00 34) WAS LOADED STARTING AT HEX LOCATION 4C. 4C IS DECIMAL 76 WHICH IS NOT EVENLY DIVISIBLE BY 8. ALL CCW'S AND SIMILAR DOUBLE-WORD ENTRIES MUST RESIDE IN CORE ON A DOUBLE-WORD BOUNDARY.

THE LOW ORDER HEX CHARACTER (OF CCW ADDR) MUST BE EITHER A Ø OR 8. (XX XØ) OR (XX X8)

FOR THIS PARTICULAR PROGRAM, THERE ARE MANY WAYS TO REMEDY THE SITUATION AND THREE WILL BE DISCUSSED BRIEFLY.

PROGRAM

CARD RDR	CC	hex core addr	hex contents	PUNCHD CARD CODE	CC	hex core addr	hex contents
	1	48	00	4C=76 DEC. WHICH IS NOT EVENLY DIVISIBLE BY 8	28	63	XX
	2	49	00		29	64	
	3	4A	00		30		
	4	48	4C		31		
	5	4C	09	PRGM CCW	32		
	6	4D	00		33		
	7	4E	00		34		
	8	4F	64		35		
	9	50	00		36		
	10	51	00		37		
	11	52	00		38		
	12	53	34		39		
	13	54	90		40		
	14	55	00		41		
	15	56	00		42		
	16	57	0E		43		
	17	58	47		44		
	18	59	70		45		
	19	5A	00		46		
	20	5B	54		47		
	21	5C	9C		48		
	22	5D	00		49		
	23	5E	00		50		
	24	5F	0E		51		
	25	60	47		52		
	26	61	F0		53		
	27	62	00		54		

CCW BOUNDARY ALIGNMENT---METHOD NO. 1.

THE CAW IS LEFT IN ITS ORIGINAL POSITION BUT THE CCW AND REST OF THE PROGRAM ARE SHIFTED UP FOUR COLUMNS. THIS WORKS, BUT FOUR POSITIONS OF THE DATA AREA HAVE TO BE SACRIFICED. NOW ONLY 48 SURPLUS COLUMNS ARE AVAILABLE IN WHICH TO KEYPUNCH DATA THAT IS TO BE LISTED REPETITIVELY.

THE CAW IS STILL LOADED INTO 48 BUT BY SKIPPING THE NEXT FOUR CARD COLUMNS, THE CCW FALLS INTO LOCATION HEX 50 (DECIMAL 80) WHICH IS EVENLY DIVISIBLE BY 8.

THE ADDRESS IN THE PSW IN THE FIRST FIELD OF THE IPL CARD MUST ALSO BE ALTERED TO PICK UP THE FIRST PROGRAM INSTRUCTION TO BE EXECUTED (9D-TEST I/O) WHICH IS NOW AT LOCATION 58.

THE DATA ADDRESS IN THE PROGRAM CCW IS NOW HEX 68 AND THE COUNT IS REDUCED TO 48 (HEX 30).

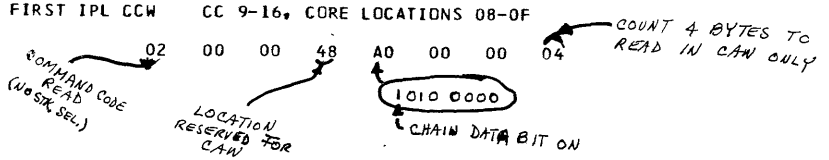
CCW ALIGNMENT--METHOD NO. 1

IPL CARD				PROGRAM CARD											
CC	CORE	hex con-conts	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE
1	00	00		1	48	00		28	63	0E		55			
2	01	00		2	49	00		29	64	47		56			
3	02	00		3	4A	00		30	65	F0		57			
4	03	00		4	4B	50		31	66	00		58			
5	04	00		5	4C		CCW SHIFTED UP FOUR COLUMNS NOW STARTS IN HEX 50 = DEC 80 DIVISIBLE BY 8	32	67	58		59			
6	05	00		6	4D			33	68			60			
7	06	00		7	4E			34				61			
8	07	58		8	4F			35				62			
9	08	02		9	50	09		36				63			
10	09	00		10	51	00		37				64			
11	0A	00		11	52	00		38				65			
12	0B	48		12	53	68		39				66			
13	0C	20		13	54	00		40				67			
14	0D	00		14	55	00	80-32=48	41				68			
15	0E	00		15	56	00	48=HEX 30	42				69			
16	0F	50		16	57	30		43				70			
17	10			17	58	9D		44				71			
18	11			18	59	00		45				72			
19	12			19	5A	00		46				73			
20	13			20	5B	0E		47				74			
21	14			21	5C	47		48				75			
22	15			22	5D	70		49				76			
23	16			23	5E	00		50				77			
24	17			24	5F	58		51				78			
				25	60	9C		52				79			
				26	61	00		53				80			
				27	62	00		54							

CCW BOUNDARY ALIGNMENT---METHOD NO. 2.

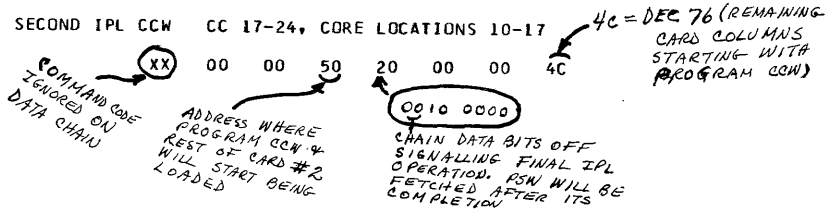
THE FOUR SURPLUS POSITIONS LOST BY THE PREVIOUS EXAMPLE ARE RECAPTURED BY USING THE 360 SCATTER-READ CAPABILITY. IN THIS CASE, TWO IPL CCW's ARE USED WITH THE CHAIN DATA BIT TURNED ON IN THE FIRST ONE.

FIRST IPL CCW CC 9-16, CORE LOCATIONS 08-0F



THIS CCW CAUSES ONLY THE FIRST FOUR BYTES OF THE PROGRAM TO BE READ INTO STORAGE. THUS THE CAW IS LOADED INTO 48-4B AND NOTHING ELSE. BECAUSE THE CHAIN DATA BIT IS ON, THE SECOND IPL CCW IS EXECUTED BEFORE THE PSW IS FETCHED AND THE PROGRAM STARTED.

SECOND IPL CCW CC 17-24, CORE LOCATIONS 10-17



WHEN CHAINING DATA, THE COMMAND CODE IS IGNORED SO THE XX's ARE INTENTIONALLY RETAINED HERE TO PROVE THIS IS THE CASE. HEX ADDRESS 50 (DEC. 80) IS VALID FOR THE CCW WHICH IS THE NEXT FIELD OF THE PROGRAM CARD TO BE ENTERED AFTER THE CAW. THE PROGRAM AND SURPLUS DATA NOW RESIDE IN THE 76 POSITIONS 50-9B AND THE SURPLUS OF 52 DATA COLUMNS IS RESTORED.

THE PSW, CAW, AND PROGRAM CCW MUST BE REVISED ACCORDINGLY.

CCW ALIGNMENT-- METHOD NO. 2

IPL CARD				PROGRAM CARD													
CC	CORE	hex con-conts	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE
1	00	00		1	48	00	READ IN BY FIRST IPL CCW	28	67	58		55	82		
2	01	00		2	49	00		29	68			56	83		
3	02	00		3	4A	00		30	69			57	84		
4	03	00		4	48	50		31	6A			58	85		
5	04	00		5	50	09		32	6B			59	86		
6	05	00		6	51	00		33	6C			60	87		
7	06	00		7	52	00	READ IN BY SECOND IPL CCW	34	6D		52	61	88		
8	07	58		8	53	68		35	6E		SURPLUS	62	89		
9	08	02		9	54	00		36	6F		COLUMNS	63	8A		
10	09	00		10	55	00		37	70			64	8B		
11	0A	00		11	56	00		38	71			65	8C		
12	0B	48		12	57	34		39	72			66	8D		
13	0C	A0	1010 0000	13	58	9D		40	73			67	8E		
14	0D	00	CHAIN DATA BIT ON	14	59	00		41	74			68	8F		
15	0E	00		15	5A	00		42	75			69	90		
16	0F	04		16	5B	0E		43	76			70	91		
17	10	XX		17	5C	47		44	77			71	92		
18	11	00		18	5D	70		45	78			72	93		
19	12	00		19	5E	00		46	79			73	94		
20	13	50		20	5F	58		47	7A			74	95		
21	14	20	0010 0000 Y	21	60	9C		48	7B			75	96		
22	15	00	CHAIN BITS OFF	22	61	00		49	7C			76	97		
23	16	00		23	62	00		50	7D			77	98		
24	17	4C		24	63	0E		51	7E			78	99		
				25	64	47		52	7F			79	9A		
				26	65	F0		53	80			80	9B		
				27	66	00		54	81						

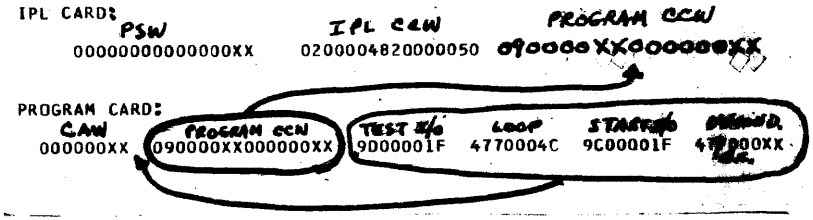
SECOND IPL CCW

CCW BOUNDARY ALIGNMENT---METHOD NO. 3.

THE THIRD METHOD INCREASES THE SURPLUS COLUMNS FOR PRINTOUT TO 60 POSITIONS. WHILE THIS METHOD IS BEING SHOWN, THE OUTPUT DEVICE IS CHANGED TO THE 1052 CONSOLE TYPEWRITER (01F) AND SOME OF THE SURPLUS DATA WILL BE PUNCHED IN LOWER CASE EBCDIC FOR DEMONSTRATION PURPOSES. HOWEVER, THE PRINCIPLE FOR CORRECTLY STORING THE PROGRAM CCW WOULD STILL BE THE SAME IF THE 1403 PRINTER (00E) WAS STILL BEING DISCUSSED.

IF ONLY ONE IPL CCW IS TO BE USED (NO DATA OR COMMAND CHAINING) THE ADJACENT CORE STORAGE BYTES (10-17 WHICH NORMALLY CONTAIN A SECOND IPL CCW) CAN BE USED AS GENERAL STORAGE FOR CONSTANTS OR ANYTHING ELSE. SINCE HEX 10 (DEC. 16) IS DIVISIBLE BY 8, IT SATISFIES THE PREREQUISITES FOR A DOUBLE-WORD BOUNDARY. ANY CCW CAN BE STORED THERE AND USED WITHOUT OBJECTION. CONSEQUENTLY THE PROGRAM CCW WAS REMOVED FROM ITS ORIGINAL POSITION (TRAILING THE CAW) AND STORED IN 10-17 DURING INITIAL PROGRAM LOAD.

THE PSW, CAW, PROGRAM CCW, AND COUNT MUST BE ALTERED ACCORDINGLY.



SAMPLE OUTPUT LISTING

```
1052 UPPER & lower Case 2-Card Print Demonstration Program.
1052 UPPER & lower Case 2-Card Print Demonstration Program.
1052 UPPER & lower Case 2-Card Print Demonstration Program.
1052 UPPER & lower Case 2-Card Print Demonstration Program.
1052 UPPER & lower Case 2-Card Print Demonstration Program.
1052 UPPER & lower Case 2-Card Print Demonstration Program.
1052 UPPER & lower Case 2-Card Print Demonstration Program.
1052 UPPER & lower Case 2-Card Print Demonstration Program.
1052 UPPER & lower Case 2-Card Print Demonstration Program.
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CCW ALIGNMENT--METHOD NO. 3

IPL CARD				PROGRAM CARD											
CC	CORE	hex con-conts	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE
1	00	00	120981	1	48	00	120981	28		P		55		n	12115
2	01	00	120981	2	49	00	120981	29		E		56		t	1103
3	02	00	120981	3	4A	00	120981	30		R		57			
4	03	00	120981	4	4B	10	12 11981	31				58		D	
5	04	00	120981	5	4C	9D	12 11185	32		&	12	59		l	1205
6	05	00	120981	6	4D	00	120981	33				60		m	12114
7	06	00	120981	7	4E	00	120981	34		l	12113	61		o	12116
8	07	4C	12 84	8	4F	1F	11987	35		o	12116	62		n	12115
9	08	02	12 92	9	50	47	120971	36		w	1106	63		d	1107
10	09	00	120981	10	51	70	12110	37		l	1205	64		t	1103
11	0A	00	120981	11	52	00	120981	38		h	12119	65		h	12119
12	0B	48	120981	12	53	4C	12 84	39				66		a	1201
13	0C	20	11 0981	13	54	9C	12 11184	40		C		67		t	1103
14	0D	00	120481	14	55	00	120981	41		a	1201	68		i	1209
15	0E	00	120981	15	56	00	120981	42		d	1107	69		o	12116
16	0F	50	12	16	57	1F	11987	43		l	1205	70		n	12115
17	10	09	12981	17	58	47	120971	44				71			
18	11	00	120981	18	59	F0	0	45		2		72		P	
19	12	00	120981	19	5A	00	120981	46		-	11	73		h	12119
20	13	5C	11 84	20	5B	4C	1284	47		C		74		o	12116
21	14	00	120981	21	5C	1		48		a	1201	75		g	1207
22	15	00	120981	22		0		49		h	12119	76		h	12119
23	16	00	120981	23		5		50		d	1204	77		a	1201
24	17	3C	984	24		2		51				78		m	12114
				25				52		P		79		•	
				26		U		53		h	12119	80			
				27		P		54		i	1209				

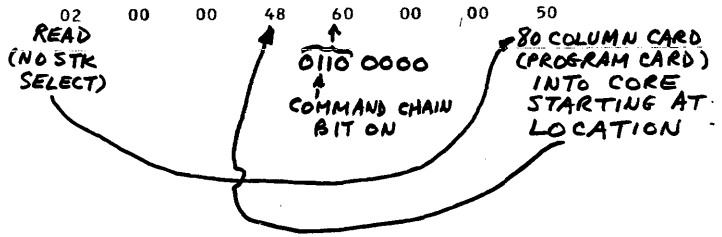
PROGRAM CCW

2-CARD GANGPUNCH PROGRAM

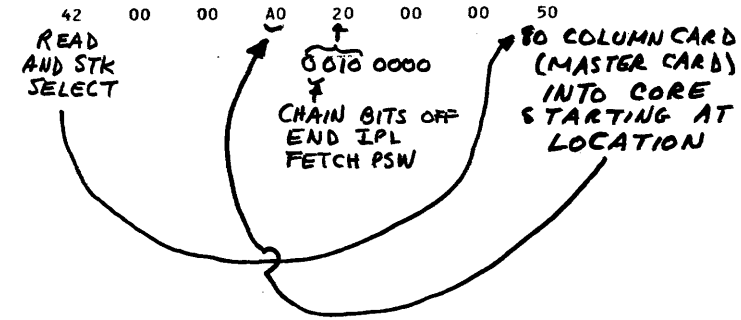
A 2-CARD GANGPUNCH PROGRAM GIVES AN OPPORTUNITY TO DEMONSTRATE COMMAND CHAINING.

THE FIRST IPL CCW IS USED TO READ IN THE PROGRAM CARD. THE COMMAND-CHAINED SECOND IPL CCW IS USED TO READ IN THE MASTER CARD CONTAINING THE DATA TO BE GANGPUNCHED. THE MASTER CARD IS READ INTO STORAGE DURING IPL AND BEFORE THE PSW IS FETCHED TO START PROGRAM EXECUTION.

FIRST IPL CCW CC 9-16, CORE LOCATIONS 08-0F



SECOND IPL CCW CC 17-24, CORE LOCATIONS 10-17



2-CARD GANG PUNCH PROGRAM

IPL CARD			
CC	CORE	hex con-conts	PUNCHD CARD CODE
1	00	00	120981
2	01	00	120981
3	02	00	120981
4	03	00	120981
5	04	00	120981
6	05	00	120981
7	06	00	120981
8	07	58	12 11 98
9	08	02	12 0 9 2
10	09	00	120981
11	0A	00	120981
12	0B	48	12 0 98
13	0C	60	11
14	0D	00	120981
15	0E	00	120981
16	0F	50	12
17	10	42	12 0 9 2
18	11	00	120981
19	12	00	120981
20	13	40	11 0 8 1
21	14	00	120981
22	15	00	120981
23	16	00	120981
24	17	50	12

PROGRAM CARD				
CC	hex core addr	hex con-tents	PUNCHD CARD CODE	
1	48	00	120981	
2	49	00	120981	
3	4A	00	120981	
4	4B	50	12	
5	4C		blank	
6	4D		blank	
7	4E		blank	
8	4F		blank	
9	50	41	12 0 9 1	COMMAND CODE PUNCH & STK. SEL.
10	P	00	120981	
11	R	00	120981	
12	O	A0	11 0 8 1	
13	C	00	120981	
14	C	00	120981	
15	W	00	120981	
16		50	12	
17	58	9D	12 11 85	TEST I/O PUNCH
18		00	120981	
19		00	120981	
20		0D	12 985	
21		47	12 097	CONDITIONAL BRANCH TO TEST I/O UNIT AVAILABLE
22		70	12 11 0	
23		00	120981	
24		58	12 11 98	
25		9C	12 11 84	START I/O PUNCH
26		00	120981	
27		00	120981	

PROGRAM CARD				
CC	hex core addr	hex con-tents	PUNCHD CARD CODE	
28		0D	12 985	
29		47	12 097	
30		F0	0	
31		00	120981	
32		58	12 11 98	
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
46				
47				
48				
49				
50				
51				
52				
53				
54				

PROGRAM CARD				
CC	hex core addr	hex con-tents	PUNCHD CARD CODE	
55				
56				UNCOND. BRANCH TO TEST I/O TO GANG-PUNCH ANOTHER CARD
57				
58				
59				
60				
61				
62				
63				
64				
65				
66				
67				
68				
69				
70				
71				
72				
73				
74				
75				
76				
77				
78				
79				
80				

THE PROGRAMS DISCUSSED THUS FAR HAVE REQUIRED ONLY ONE BURST OF INPUT DATA AND THAT WAS TAKEN CARE OF AT IPL TIME. HOWEVER, THIS IS NOT THE NORMAL SITUATION IN MOST DATA PROCESSING APPLICATIONS.

ORDINARILY, INPUT, OUTPUT, INPUT, OUTPUT TAKE PLACE AS ALTERNATE OPERATIONS. WHEN THIS IS THE CASE, A SEPARATE COMBINATION OF CAW AND CCW IS NEEDED FOR INPUT, AND A DIFFERENT CAW AND CCW COMBINATION IS USED FOR OUTPUT. NOW PROGRAMS INSTRUCTIONS MUST BE INCLUDED TO INTERCHANGE THE CAW'S INTO THE RESERVED LOCATION OF 48-4B WHENEVER THE RESPECTIVE INPUT OR OUTPUT OPERATION IS TO OCCUR.

THERE ARE SEVERAL WAYS TO ACHIEVE THIS AND THREE WAYS ARE OFFERED AS SUGGESTIONS.

THE REMAINING PROGRAMS IN THIS PAPER WILL BE LOADED STARTING IN HEX 140 AND THE DATA I/O AREA WILL START AT HEX 200. THESE LOCATIONS WERE CHOSEN BECAUSE THE CORE PRINT UTILITY 360-UT-056 STARTS DUMPING AT HEX 140. THIS FACILITATES DEBUGGING, IF NECESSARY.

START OF SAMPLE CORE PRINT
360-UT-056

140-18B PROGRAM 76 BYTES (80-CAW)

```
42000200
00000050
05000200
00000050
9C00000C
47700150
9D00000C
47700158
97080048
9C00000D
47700164
9D00000D
4770016C
97080048
47F00150
40404040
40404040  40404040  40404040  00000000
00000000  00000000  00000000  00000000
00000000  00000000  00000000  00000000
00000000  00000000  00000000  00000000
00000000  00000000  00000000  00000000
00000000  00000000  00000000  00000000
00000000  00000000  00000000  00000000
DADADADA  DADADADA  DADADADA  DADADADA  DADADADA  DADADADA  DADADADA  DADAD
DADADADA  DADADADA  DADADADA  DADADADA  DADADADA  DADADADA  DADADADA  DADAD
DADADADA  DADADADA  DADADADA  DADADADA  00000000  00000000  00000000  00000
00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000
00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000
00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000
00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000
```

200-24F 80 BYTE I/O AREA

AREA PRINTED BY INITIAL PRINT COMPONENT

ENTIRE AREA.....000140 TO 0002FF
INIT1 AREA.....000140 TO 00017F
INIT2 AREA.....000180 TO 0001FF
INIT3 AREA.....000200 TO 0002FF

```
FLOATING POINT REGISTERS    0                   2                   4
                            0000000000000000    0000000000000000    0000000000000

REG0     00000000  00000000  00000000  00000000  00000000  00000000  0000
REG8     00000000  00000000  00000000  00000000  00000000  00000000  0000

40-CSW  KEY-00  ADDR-000000  STATUS-0000001000000000  COUNT-000000  48-CAW  KE

PSW CONTENTS        EXTERNAL INTERRUPT  SUPERVISOR CALL     PROGRAM CHECK
FIELD        FORMAT-OLD 18   -NEW 58   -OLD 20   -NEW 60   -OLD 28   -NEW 68
SYSTEM MASK      BIT-00000000 -00000000 -00000000 -00000000 -00000000 -0000000
PROTECTION KEY   HEX-0        -0        -0        -0        -0        -0
AMWP             BIT-0000     -0000     -0000     -0000     -0000     -0000
INTERRUPT CODE   HEX-0000     -0000     -0000     -0000     -0000     -0000
```


80/80 REPRODUCE USING MOVE CAW

IPL CARD:

PSW: 0000000000000158
IPL CCW: 0200014020000050

PROGRAM CARD:

1 4 0 READER CAW	1 4 4 PUNCH CAW	READ CCW	PUNCH CCW
00000148	00000150	4200020000000050	4100020000000050

MOVE D20300480140	9C00000C	47700158	9D00000C	47700166
MOVE D20300480144	9C00000D	47700174	9D00000D	4770017C

47F00158

PROGRAM ANALYSIS:

```
MOVE  TO  FROM
D2 03 00 48 01 40          MOVE READER CAW TO RESERVED AREA.
```

HEX NUMBER EQUALS NUMBER OF BYTES TO BE MOVED MINUS ONE

ADDRESS OF READ CAW

CAW AREA (48-4B)

```
9C 00 00 0C          START I/O (READER)

47 70 01 5E          BRANCH ON 7
FALL THROUGH WHEN READ HAS SUCCESSFULLY STARTED.

9D 00 00 0C          TEST I/O (READER)

47 70 01 66          BRANCH ON 7
FALL THROUGH WHEN READ IS SUCCESSFULLY COMPLETED.

MOVE  TO  FROM
D2 03 00 48 01 44          MOVE PUNCH CAW TO RESERVED AREA.
```

4 BYTES

ADDRESS OF PUNCH CAW

```
9C 00 00 0D          START I/O (PUNCH)

47 70 01 74          BRANCH ON 7
FALL THROUGH WHEN PUNCH HAS SUCCESSFULLY STARTED.

9D 00 00 0D          TEST I/O (PUNCH)

47 70 01 7C          BRANCH ON 7
FALL THROUGH WHEN PUNCH HAS BEEN COMPLETED SUCCESSFULLY.

47 F0 01 58          BRANCH ON 15
UNCONDITIONAL BRANCH BACK TO MOVE-READER-CAW AND REPEAT CYCLE.
```

80/80 REPRODUCE USING MOVE CAW

IPL CARD				PROGRAM CARD															
CC	CORE	hex contents	PUNCHD CARD CODE	CC	hex core addr	hex contents	PUNCHD CARD CODE	CC	hex core addr	hex contents	PUNCHD CARD CODE	CC	hex core addr	hex contents	PUNCHD CARD CODE	CC	hex core addr	hex contents	PUNCHD CARD CODE
1	00	00	120981	1	140	00	120981	28	15B	48	12098	55	176	00	120981				
2	01	00	120981	2	1	00	120981	29	C	01	1291	56	7	0D	12985				
3	02	00	120981	3	2	01	1291	30	D	40	BLANK	57	8	47	12097				
4	03	00	120981	4	3	48	12098	31	E	9C	12 11 84	58	9	70	12 11 0				
5	04	00	120981	5	4	00	120981	32	F	00	120981	59	17A	01	1291				
6	05	00	120981	6	5	00	120981	33	160	00	120981	60	B	74	12 11 94				
7	06	01	1291	7	6	01	1291	34	1	0C	12984	61	C	9D	12 11 85				
8	07	58	12 11 98	8	7	50	12	35	2	47	12097	62	D	00	120981				
9	08	02	1292	9	8	42	12092	36	3	70	12 11 0	63	E	00	120981				
10	09	00	120981	10	9	00	120981	37	4	01	12 91	64	F	0D	12985				
11	0A	01	1291	11	1AA	02	1292	38	5	5E	11 84	65	180	47	12097				
12	0B	40	BLANK	12	B	00	120981	39	6	9D	12 11 85	66	1	70	12 11 0				
13	0C	20	11 0981	13	C	00	120981	40	7	00	120981	67	2	01	1291				
14	0D	00	120981	14	D	00	120981	41	8	00	120981	68	3	7C	84				
15	0E	00	120981	15	E	00	120981	42	9	0C	12984	69	4	47	12097				
16	0F	50	12	16	F	50	12	43	KA	47	12097	70	5	F0	0				
17	10	IPL CCW		17	150	41	12091	44	B	70	12 11 0	71	6	01	1291				
18	11	TO READ		18	1	00	120981	45	C	01	1291	72	7	58	12 11 98				
19	12	PROGRAM		19	2	02	1292	46	D	66	11096	73							
20	13	CARD INTO		20	3	00	120981	47	E	D2	11 2	74							
21	14	CORE		21	4	00	120981	48	F	03	1293	75							
22	15	STARTING		22	5	00	120981	49	170	00	120981	76							
23	16	AT HEX 140		23	6	00	120981	50	1	48	12098	77							
24	17			24	7	50	12	51	2	01	1291	78							
				25	8	D2	11 2	52	3	44	12094	78							
				26	9	03	1293	53	4	9C	12 11 84	80							
				27	15A	00	120981	54	5	00	120981								

ALTHOUGH FOR THE MATERIAL DISCUSSED UP TO THIS POINT THERE WAS NO NEED TO SQUEEZE PROGRAMS IN ORDER TO FIT THEM INTO 80 COLUMNS, THE FOLLOWING TECHNIQUE IS GIVEN IN CASE THAT THAT NEED MAY EVER ARISE. IT WILL ALSO DEMONSTRATE ONE PRACTICAL APPLICATION FOR THE EXCLUSIVE OR INSTRUCTION. BY USING THE XOR, ONLY ONE SERIES OF INSTRUCTIONS IS NEEDED FOR BOTH INPUT AND OUTPUT. PROGRAM LENGTH IS THEREBY SHORTENED CONSIDERABLY.

80/80 REPRODUCE USING EXCLUSIVE OR

IPL CARD:

PSW	IPL CCW	PROGRAM CCW
000000000000004C	2000004820000050	4200020000000050

PROGRAM CARD:

INSTRUCTIONS FOR BOTH INPUT & OUTPUT

SINGLE CAW	START I/O	LOOP	TEST I/O	LOOP
00000010	9C00000C	4770004C	9D00000C	47700054
⇕	⇕			
9701004F	97010057	97030010	47F0004C	
FIRST XOR	SECOND XOR	THIRD XOR	UNCOND BR.	

PROGRAM ANALYSIS:

1. IPL CCW LOADS THIS PROGRAM HAVING ONLY A SINGLE CAW AND A SINGLE CCW, DIRECTLY INTO CORE STARTING AT LOCATION 48.
2. PROGRAM READS A DATA CARD INTO HEX 200.
3. FIRST AND SECOND XOR'S FLIP PHYSICAL READER ADDRESS (00C) TO PHYSICAL PUNCH ADDRESS (00D). SEE DISCUSSION PAGE 36 ---
4. THIRD XOR FLIPS COMMAND CODE IN PROGRAM CCW FROM READ-AND-STACKER-SELECT TO PUNCH-AND-STACKER-SELECT.
5. UNCONDITIONAL BRANCH BACK TO BEGINNING OF ROUTINE.
6. PROGRAM NOW PUNCHES DATA FROM SAME POSITIONS INTO WHICH IT WAS READ.
7. FIRST AND SECOND XOR'S NOW FLOP THE DEVICE ADDRESS BACK TO TO THE READER AND THE THIRD XOR FLOPS THE CCW COMMAND CODE BACK TO ITS ORIGNAL READ-AND-STACKER-SELECT.
8. THIS CYCLE IS REPEATED UNTIL ALL CARDS ARE PROCESSED.

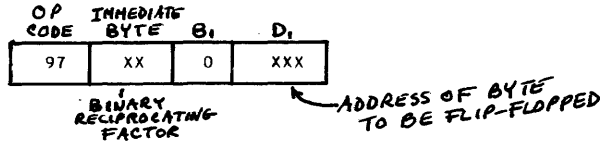
80/80 REARODUCE USING EXCLUSIVE OR

IPL CARD				PROGRAM CARD											
CC	CORE	hex contents	PUNCHD CARD CODE	CC	hex core addr	hex contents	PUNCHD CARD CODE	CC	hex core addr	hex contents	PUNCHD CARD CODE	CC	hex core addr	hex contents	PUNCHD CARD CODE
1	00	00	120981	1	48	00	120981	28	63	57	12 1197	55			
2	01	00	120981	2	49	00	120981	29	64	97	12 117	56			
3	02	00	120981	3	4A	00	120981	30	65	03	12 93	57			
4	03	00	120981	4	48	10	12 11981	31	66	00	120981	58			
5	04	00	120981	5	4C	9C	12 1184	32	67	10	12 11981	59			
6	05	00	120981	6	4D	00	120981	33	68	47	12 C97	60			
7	06	00	120981	7	4E	00	120981	34	69	F0	C	61			
8	07	4C	1284	8	4F	0C	12 984	35	6A	00	120981	62			
9	08	02	1292	9	50	47	120997	36	6B	4C	12 84	63			
10	09	00	120981	10	51	70	12 110	37				64			
11	0A	00	120981	11	52	00	120981	38				65			
12	0B	48	12 098	12	53	4C	12 84	39				66			
13	0C	20	110981	13	54	9D	12 1185	40				67			
14	0D	00	120981	14	55	00	120981	41				68			
15	0E	00	120981	15	56	00	120981	42				69			
16	0F	50	12	16	57	0C	12 984	43				70			
17	10	42	120992	17	58	47	120997	44				71			
18	11	00	120981	18	59	70	12 110	45				72			
19	12	02	1292	19	5A	00	120981	46				73			
20	13	00	120981	20	5B	54	12 1194	47				74			
21	14	00	120981	21	5C	97	12 117	48				75			
22	15	00	120981	22	5D	01	12 91	49				76			
23	16	00	120981	23	5E	00	120981	50				77			
24	17	50	12	24	5F	4F	12 87	51				78			
				25	60	97	12 117	52				79			
				26	61	01	12 91	53				80			
				27	62	00	120981	54							

PROGRAM CCW IN 10-17

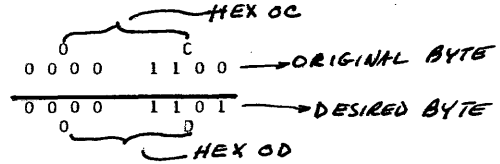
EXCLUSIVE OR INSTRUCTION

IN THE PRECEDING EXAMPLE, SINCE ONLY ONE BYTE OF INFORMATION WAS FLIP-FLOPPED EACH TIME BY EACH XOR INSTRUCTION, THE "SI" FORMAT WAS USED.

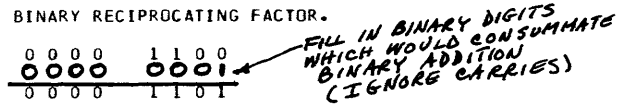


PROCEDURE FOR ESTABLISHING CORRECT BINARY RECIPROCATING FACTOR.

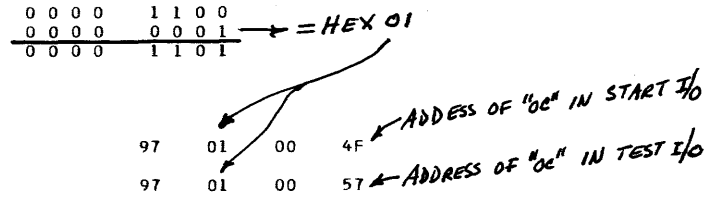
1. DISPLAY BOTH THE ORIGINAL BYTE AND DESIRED FLIPPED BYTE IN THEIR BINARY FORMATS IN THE ARRANGEMENT AS SHOWN BELOW.



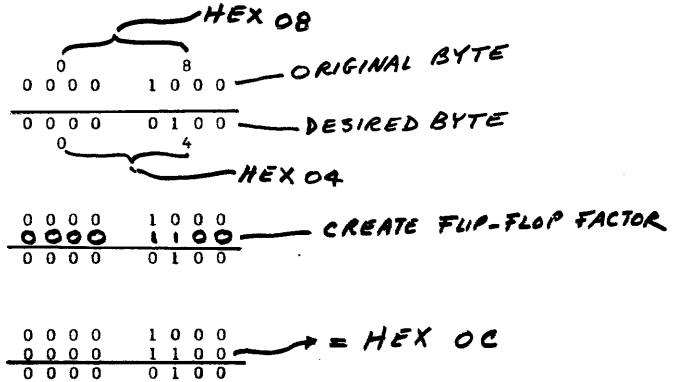
2. CREATE BINARY RECIPROCATING FACTOR.



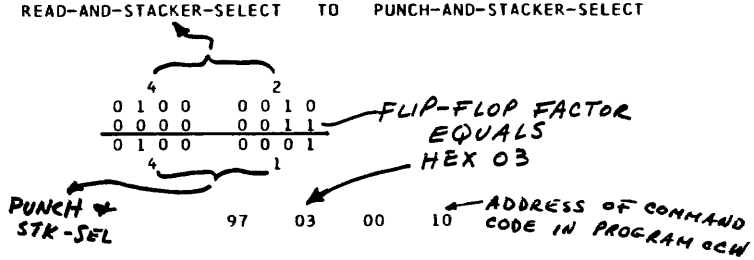
3. CONVERT FLIP-FLOP FACTOR FROM BINARY TO HEX.



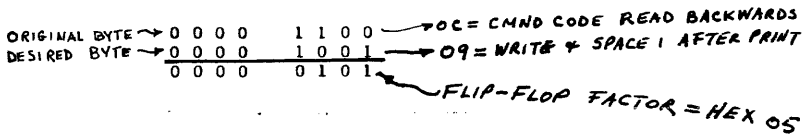
IF THE PHYSICAL ADDRESS OF THE READER WAS 008 AND THE PUNCH 004, THEN THE FLIP-FLOP FACTOR WOULD BE DETERMINED AS FOLLOWS:



FLIP-FLOPPING COMMAND CODE IN CCW FROM READ-AND-STACKER-SELECT TO PUNCH-AND-STACKER-SELECT



ACTUALLY THE RECIPROCATING FACTOR CAN BE DERIVED BY GETTING THE MODULO-TWO SUM DIRECTLY, BUT THE THE PICTURE OF THE MECHANICS OF THE FLIP-FLOP IS NOT AS OBVIOUS.



THE FORMAT OF EITHER OF THE TWO PROGRAMS JUST DISCUSSED COULD BE USED TO COMMUNICATE BETWEEN ANY TWO I/O DEVICES. JUST THE PHYSICAL I/O DEVICE NUMBERS WOULD HAVE TO BE CHANGED AND THE COMMAND CODES ALTERED TO CORRESPONDING I/O OPERATIONS. HOWEVER, THE MOVE CAW METHOD COULD BE PROGRAMMED MORE EFFECIENTLY AND THE SECOND METHOD (USING XOR) IS TOO PAINSTAKING HAVING TO FIGURE OUT THE RECIPROCATING FACTORS FOR ALL THE VARIOUS DEVICES AND COMMAND CODES.

THE FOLLOWING GENERAL PURPOSE FORMAT IS A SORT OF COMPROMISE BETWEEN THE TWO AND SEEMS TO WORK SATISFACTORILY WITH MOST 80 CHARACTER UNBLOCKED RECORD I/O APPLICATIONS.

GENERAL PURPOSE UNIT-TO-UNIT 2-CARD PROGRAM

IPL CARD.

PSW	CCW TO LOAD CAW	CCW TO LOAD REMAINDER OF PROGRAM
0000000000000150	02000048A0000004	000001402000004C

PROGRAM CARD.

SINGLE CAW	INPUT CCW UNIT #1	OUTPUT CCW UNIT #2
00000140	XX000200000050	XX00020000000050

START I/O — 9C000XXX (UNIT #1 PHYS ADDR) — LOOP TO START — 47700150
TEST I/O — 9D000XXX (UNIT #1 PHYS ADDR) — LOOP TO TEST — 47700158
FLIP CAW ADDRESS TO UNIT #2 CCW — 9708004B

START I/O — 9C000XXX (UNIT #2 PHYS ADDR.) — LOOP TO START — 47700164
TEST I/O — 9D000XXX (UNIT #2 PHYS ADDR.) — LOOP TO TEST — 4770016C
FLIP CAW ADDRESS TO UNIT #1 CCW — 9708004B

47F00150
UNCONDITIONAL BRANCH TO REPEAT CYCLE

GENERAL-PURPOSE UNIT-TO-UNIT 2-CARD PROGRAM

IPL CARD				PROGRAM CARD															
CC	CORE	hex con-conts	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE
1	00	00		1	48	00	SINGLE CAW	28	157	50		55	172	01					
2	01	00		2	49	00		29	8	9D		56	173	6C					
3	02	00		3	4A	01		30	9	00		57	4	97	FLOP ADDR. IN CAW TO UNIT #1 CCW				
4	03	00		4	4B	40		31	15A	0X		58	5	08					
5	04	00		5	140	XX	INPUT CCW FOR UNIT NO.1	32	B	XX		59	6	00					
6	05	00		6	1	00		33	C	47		60	7	4B					
7	06	01		7	2	02		34	D	70		61	8	47	UNCOND. BRANCH TO REPEAT CYCLE				
8	07	50		8	3	00		35	E	01		62	9	F0					
9	08	02	CCW TO LOAD CAW	9	4	00		36	F	58		63	17A	01					
10	09	00		10	5	00		37	160	97	FLIP ADDR IN CAW TO UNIT #2 CCW	64	17B	50					
11	0A	00		11	6	00		38	1	08		65							
12	0B	48		12	7	50		39	2	00		66							
13	0C	A0		13	8	XX	OUTPUT CCW FOR UNIT NO.2	40	3	4B		67							
14	0D	00		14	9	00		41	4	9C	OUTPUT START TO UNIT NO.2	68							
15	0E	00		15	14A	02		42	5	00		69							
16	0F	04		16	B	00		43	6	0X		70							
17	10	00	CCW TO LOAD REMAINDER OF PROG	17	C	00		44	7	XX		71							
18	11	00		18	D	00		45	8	47		72							
19	12	01		19	E	00		46	9	70		73							
20	13	40		20	F	50		47	16A	01		74							
21	14	20		21	150	9C	INPUT START TO UNIT NO.1	48	B	64		75							
22	15	00		22	1	00		49	C	9D		76							
23	16	00		23	2	0X		50	D	00		77							
24	17	4C		24	3	XX		51	E	0X		78							
				25	4	47		52	F	XX		79							
				26	5	70		53	170	47		80							
				27	6	01		54	171	70									

80/80 REPRODUCE USING GEN.-PURPOSE FORMAT

IPL CARD				PROGRAM CARD															
CC	CORE	hex con-conts	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE
1	00	00	120981	1	48	00	120981	28	157	50	12	55	172	01	12 91				
2	01	00	120981	2	49	00	120981	29	8	9D	121185	56	3	6C	084				
3	02	00	120981	3	4A	01	1291	30	9	00	120981	57	4	97	12117				
4	03	00	120981	4	4B	40	BLANK	31	15A	00	120981	58	5	08	1298				
5	04	00	120981	5	140	42	12092	32	B	0C	12484	59	6	00	120981				
6	05	00	120981	6	1	00	120981	33	C	47	12097	60	7	4B	1283				
7	06	01	1291	7	2	02	1292	34	D	70	12110	61	8	47	12097				
8	07	50	12	8	3	00	120981	35	E	01	1291	62	9	F0	0				
9	08	02	1292	9	4	00	120981	36	F	58	121198	63	17A	01	1291				
10	09	00	120981	10	5	00	120981	37	160	97	12117	64	17B	50	12				
11	0A	00	120981	11	6	00	120981	38	1	08	1298	65							
12	0B	48	12098	12	7	50	12	39	2	00	120981	66							
13	0C	A0	11081	13	8	41	12091	40	3	4B	1283	67							
14	0D	00	120981	14	9	00	120981	41	4	9C	121184	68							
15	0E	00	120981	15	14A	02	1292	42	5	00	120981	69							
16	0F	04	1294	16	B	00	120981	43	6	00	120981	70							
17	10	00	120981	17	C	00	120981	44	7	0D	12985	71							
18	11	00	120981	18	D	00	120981	45	8	47	12097	72							
19	12	01	1291	19	E	00	120981	46	9	70	12110	73							
20	13	40	BLANK	20	F	50	12	47	16A	01	1291	74							
21	14	20	110981	21	150	9C	121184	48	B	64	11094	75							
22	15	00	120981	22	1	00	120981	49	C	9D	121185	76							
23	16	00	120981	23	2	00	120981	50	D	00	120981	77							
24	17	4C	1284	24	3	0C	12484	51	E	00	120981	78							
				25	4	47	12097	52	F	0D	12985	79							
				26	5	70	12110	53	170	47	12097	80							
				27	6	01	1291	54	171	70	12110								

UNIT-TO-UNIT LAYOUT SHEET

AFTER THE FIRST UNIT-TO-UNIT CARD IS PUNCHED, OTHER DEVICE COMBINATIONS MAY BE MADE BY DUPLICATING ALL COLUMNS EXCEPT THOSE LISTED BELOW:

PROGRAM	CARD-TO-PRINT (80/80 LIST) 00C-00E			CD-TO-TYPEWRITER (FOR CUTTING STENCILS) 00C-01F			CARD-TO-TAPE 00C-180			CARD-TO-TAPE 00C-18X (1 to 7)		
FUNCTION	CC	HEX CONTNT	PUNCHD CARD CODE	CC	HEX CONTNT	PUNCHD CARD CODE	CC	HEX CONTNT	PUNCHD CARD CODE	CC	HEX CONTNT	PUNCHD CARD CODE
CMND. CODE UNIT 1	5	42	12092	5	42	12092	5	42	12092	5	42	12092
CMND. CODE UNIT 2	13	09	12981	13	09	12981	13	01	12 91	13	01	1291
PHYSICAL ADDRESS UNIT NO. 1	23	00	120981	23	00	120981	23	00	120981	23	00	120981
	24	0C	12984	24	0C	12984	24	0C	12984	24	0C	12984
PHYSICAL ADDRESS UNIT NO. 1	31	00	120981	31	00	120981	31	00	120981	31	00	120981
	32	0C	12984	32	0C	12984	32	0C	12984	32	0C	12984
PHYSICAL ADDRESS UNIT NO. 2	43	00	120981	43	00	120981	43	01	1291	43	01	1291
	44	0E	12986	44	1F	11987	44	80	12081	44	8 1/2 7	120 1/2 7
PHYSICAL ADDRESS UNIT NO. 2	51	00	120981	51	00	120981	51	01	1291	51	01	1291
	52	0E	12986	52	1F	11987	52	80	12081	52	8 1/2 7	120 1/2 7

PROGRAM	TAPE-TO-CARD 80 CHARAC. RCD. UNBLOCKED 18X-00D			TAPE-TO-TAPE 80 CHARAC. RCD. UNBLOCKED 18X-18X			TAPE-TO-PRINT FORWARD 80 CHAR. UNBLKD 18X-00E			TAPE-TO-PRINT BACKWARD 80 CHAR. UNBLKD 18X-00E		
FUNCTION	CC	HEX CONTNT	PUNCHD CARD CODE	CC	HEX CONTNT	PUNCHD CARD CODE	CC	HEX CONTNT	PUNCHD CARD CODE	CC	HEX CONTNT	PUNCHD CARD CODE
CMND. CODE UNIT 1	5	02	1292	5	02	1292	5	02	1292	5	0C	12984
CMND. CODE UNIT 2	13	42	12092	13	01	1291	13	09	12981	13	09	12981
PHYSICAL ADDRESS UNIT NO. 1	23	01	1291	23	01	1291	23	01	1291	23	01	1291
	24	8X		24	8X		24	8X		24	8X	
PHYSICAL ADDRESS UNIT NO. 1	31	01	1291	31	01	1291	31	01	1291	31	01	1291
	32	8X		32	8X		32	8X		32	8X	
PHYSICAL ADDRESS UNIT NO. 2	43	00	120981	43	01	1291	43	00	120981	43	00	120981
	44	0D	12985	44	8X		44	0E	12986	44	0E	12986
PHYSICAL ADDRESS UNIT NO. 2	51	00	120981	51	01	1291	51	00	120981	51	00	120981
	52	0D	12985	52	8X		52	0E	12986	52	0E	12986

NOTE: CHANGE ADDRESS IN INPUT CCW WHEN READING TAPE BACKWARD--SEE LAYOUT SHEET

READ 9-TRACK TAPE BACKWARD AND PRINT 2-CARD PROGRAM

IPL CARD

CC	CORE	hex contents	PUNCHD CARD CODE
1	00	STANDARD	
2	01	UNIT-TO-UNIT	
3	02	IPL CARD	
4	03		
5	04		

PROGRAM CARD 185-00E

CC	hex core addr	hex contents	PUNCHD CARD CODE
1	48	00	
2	49	00	
3	4A	01	
4	4B	40	
5	140	0C	12984
6	1	00	CMND. CODE READ BACKWARDS
7	2	02	
8	3	4F	1287
9	4	00	LO-ORD LOCATION OF DATA I/O AREA
10	5	00	
11	6	00	
12	7	50	
13	148	09	CMND CODE PRINT & SPACE 1
14	9	00	
15	14A	02	
16	B	00	HI-ORD LOCATION OF DATA I/O AREA
17	C	00	
18	D	00	
19	E	00	
20	F	50	
21	150	9C	
22	1	00	
23	2	01	
24	3	85	
25	154	47	
26	5	70	
27	6	01	
28	157	50	
29	158	9D	
30	9	00	
31	A	01	
32	B	85	
33	15C	47	
34	D	70	
35	E	01	
36	F	58	
37	160	97	
38	1	08	
39	2	00	
40	3	4B	
41	164	9C	
42	5	00	
43	6	00	
44	7	0E	
45	168	47	
46	9	70	
47	16A	01	
48	B	64	
49	16C	9D	
50	D	00	
51	E	00	
52	F	0E	
53	170	47	
54	171	70	
55	172	01	
56	3	6C	
57	174	97	
58	5	08	
59	6	00	
60	7	4B	
61	178	47	
62	9	F0	
63	17A	01	
64	17B	50	
65			
66			
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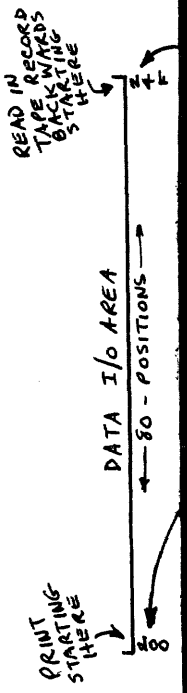
80			



80/80 LIST OF CARD-TO-TAPE INPUT FOR READ-TAPE-BACKWARD DEMO

BLANK CARD--FIRST CARD

```
1.......10........20........30........40........50........60........70........80
SEQUENCE.                                                                       1
REVERSE                                                                         2
IN                                                                              3
ARE                                                                             4
CARDS                                                                           5
THESE                                                                           6
THAT                                                                            7
SEE                                                                             8
WILL                                                                            9
YOU                                                                            10
DECK                                                                           11
INPUT                                                                          12
THE                                                                            13
CHECK                                                                          14
YOU                                                                            15
IF                                                                             16
1.......10........20........30........40........50........60........70........80
```

FIRST CARD MUST BE BLANK BECAUSE IN THE READ-TAPE-BACKWARD PROGRAM, NO PROVISION IS MADE TO TEST END-OF-FILE (NO. 1 RECORD ON TAPE WHEN READING BACKWARDS). CONSEQUENTLY THE PROGRAM KEEPS PRINTING THAT RECORD UNTIL STOPPED MANUALLY BY THE OPERATOR. IF THE FIRST CARD IS A BLANK, THE PRINTER WILL SIMPLY KEEP REPRINTING HARMLESS BLANK RECORDS AFTER THE READ-BACKWARD OPERATION REACHES THE FRONT REFLECTIVE SPOT.

SAMPLE LISTING PRODUCED BY 2-CARD READ-9-TRACK-TAPE-BACKWARD-&-PRINT PRGM.

```
1.......10........20........30........40........50........60........70........80
IF                                                                             16
YOU                                                                            15
CHECK                                                                          14
THE                                                                            13
INPUT                                                                          12
DECK                                                                           11
YOU                                                                            10
WILL                                                                            9
SEE                                                                             8
THAT                                                                            7
THESE                                                                           6
CARDS                                                                           5
ARE                                                                             4
IN                                                                              3
REVERSE                                                                         2
SEQUENCE.                                                                       1
1.......10........20........30........40........50........60........70........80
```

BLANK LINES PRINTED HEREAFTER UNTIL STOPPED BY OPERATOR

8C/80 LIST WITH OVERFLOW 00C-00E

STANDARD 2-CARD UNIT-TO-UNIT IPL CARD:

PSW	FIRST IPL CCW	SECOND IPL CCW
000000000C0CC150	02000048A0000004	02000140200000 4C
	LOAD CAW	LOAD REMAINING 76 COLUMNS OF PROGRAM CARD

PROGRAM CARD:

SINGLE CAW	CARRIAGE CONTROL CCW	SINGLE PROGRAM CCW
00000148	8B00000000000C0X	4200020000C00050
48, 4B	146	148

SKIP TO CHANNEL 1: 10001011 (CHAN=1)

COUNT MUST BE ANYTHING BUT ZERO

TEST I/O READER OR PRINTER	TEST UNDER MASK	BRANCH IF ONES	START I/O READER OR PRINER	CONDITIONAL BRANCH
9C00000C	91010044	47100174	9C00000C	47700150
150, 153	CSW BIT 39 UNIT EXCEPTION	BRANCH IF CHANNEL 12 ON CARRIAGE TAPE	15F	TRY AGAIN IF BUSY

XOR	XOR	XOR	UNCONDITIONAL BRANCH
97020153	9702015F	97480148	47F0C150
FLIP-FLOP RDR/PRINTER IN TEST I/O	FLIP-FLOP RDR/PRINTER IN START I/O	FLIP-FLOP READ/PRINT CMND CODES IN PRGM. CCW	REPEAT ENTIRE I/O CYCLE

OVERFLOW ROUTINE

MOVE IMMED.	TEST I/O	CONDITIONAL BRANCH	START I/O	MOVE IMMED.	UNCONDITIONAL BRANCH
9240004B	9D00000E	47700178	9C00000E	9248004B	47F00150
174 ALTER ADDRESS IN CAW TO ADDRESS OF CARRIAGE CTL CCW. (140)	178	TRY AGAIN IF BUSY	EXECUTE SKIP TO CHANNEL 1	REVERT ADDR IN CAW BACK TO 148 (ADDRESS OF SINGLE PRGM. CCW)	BACK TO START OF MAIN LINE PROGRAM

360 80/80 LIST WITH OVERFLOW 00C–00E

IPL CARD			
CC	CORE	hex con-conts	PUNCHD CARD CODE
1	00	00	120981
2	01	00	120981
3	02	00	120981
4	03	00	120981
5	04	00	120981
6	05	00	120981
7	06	01	1291
8	07	50	12
9	08	02	1292
10	09	00	120981
11	0A	00	120981
12	0B	48	12098
13	0C	A0	11081
14	0D	00	120981
15	0E	00	120981
16	0F	04	1294
17	10	00	120981
18	11	00	120981
19	12	01	1291
20	13	40	BLANK
21	14	20	110981
22	15	00	120981
23	16	00	120981
24	17	4C	1284

PROGRAM CARD											
CC	hex core addr	hex con-tents	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE	CC	hex core addr	hex con-tents	PUNCHD CARD CODE
1	48	00	120981	28	157	44	12094	55	172	01	1291
2	49	00	120981	29	158	47	12097	56	3	50	12
3	4A	01	1291	30	159	10	121981	57	4	92	12112
4	4B	48	12098	31	15A	01	1291	58	5	40	BLANK
5	140	8B	12083	32	B	74	1211094	59	6	00	120981
6	1	00	120981	33	C	9C	121184	60	7	48	1283
7	2	00	120981	34	D	00	120981	61	8	9D	121185
8	3	00	120981	35	E	00	120981	62	9	00	120981
9	4	00	120981	36	F	0C	12984	63	17A	00	120981
10	5	00	120981	37	160	47	12097	64	B	0E	12986
11	6	00	120981	38	1	70	12110	65	C	47	12097
12	7	01	1291	39	2	01	1291	66	D	70	12110
13	8	42	12092	40	3	50	12	67	E	01	1291
14	9	00	120981	41	4	97	12117	68	F	78	1211098
15	14A	02	1292	42	5	02	1292	69	180	9C	121184
16	B	00	120981	43	6	01	1291	70	1	00	120981
17	C	00	120981	44	7	53	1211193	71	2	00	120981
18	D	00	120981	45	8	97	121117	72	3	0E	12986
19	E	00	120981	46	9	02	1292	73	4	92	12112
20	F	50	12	47	16A	01	1291	74	5	48	12098
21	150	9D	121185	48	B	5F	11187	75	6	00	120981
22	1	00	120981	49	C	97	121117	76	7	48	1283
23	2	00	120981	50	D	48	1283	77	8	47	12097
24	3	0C	12984	51	E	01	1291	78	9	F0	0
25	4	91	121111	52	F	48	12098	78	18A	01	1291
26	5	01	1291	53	170	47	12097	80	18B	50	12
27	6	00	120981	54	171	F0	0				

SUGGESTION FOR 3-CARD PROGRAM.

BY COMMAND-CHAINING A SECOND IPL CCW, AN ADDITIONAL PROGRAM CARD CAN BE PLACED IN CORE LOCATIONS IMMEDIATELY FOLLOWING THE FIRST PROGRAM CARD WHICH IS READ IN BY THE FIRST IPL CCW. THIS NOW INCREASES THE INSTRUCTION STREAM TO 160 BYTES.

CARD TO TAPE--BLOCK 10

IPL CARD.

PSW 0000000000000040

FIRST IPL CCW 0200004860000050 (48-97)

SECOND IPL CCW 0200009800000050 (98-E7)

PROGRAM CARD NO. 1

SINGLE CAW	START READER	BUSY LOOP	TEST READER	BUSY LOOP	FLIP ADDR. IN CAW TO OUTPUT CCW
00000080	9C00000C	4770004C	9D00000C	47700054	97F8004B
START TAPE NR	BUSY LOOP	TEST TAPE	BUSY LOOP	FLOP CAW TO INPUT CCW	UNCOND BR. REPEAT CYCLE
9C000185	47700060	9D000185	47700068	97F8004B	47F0004C

SINGLE OUTPUT CCW: 0100030020000320 (WRITE TAPE CMND CODE 7 8; STARTING HERE; 800 BYTES)

START OF IO CCW INPUT CHAIN

420003060000050 (8 0; LOC REC 1; 80 BYTES; COMMAND CHAIN BIT ON)

420003A060000050 (READ STK SEL; LOC REC 3; 9 7)

420003F060000050 (9 8; LOC REC 4)

420004406000005 (5)

PROGRAM CARD NO. 2

4200049060000050 (6)

400004E060000050 (7; CHAIN BIT OFF; END OF INPUT CHAIN)

4200053060000050 (8)

4200058060000050 (9)

420005D020000050 (LOC REC 10)

SURPLUS CCW'S

42000620X0000050

42000670X0000050

420006C020000050 (E 7)

FOR LARGER BLOCKS IF DESIRED

CARD TO TAPE--BLOCK 10

00C-185

IPL CARD 1 of 3

CC	CORE	hex con-tents	PUNCHD CARD CODE
1	00	00	
2	01	06	
3	02	00	PSW
4	03	00	
5	04	00	
6	05	00	
7	06	00	
8	07	4C	
9	08	02	FIRST IPL CCW
10	09	00	
11	0A	00	
12	0B	48	
13	0C	60	
14	0D	00	
15	0E	00	
16	0F	50	
17	10	02	SECOND IPL CCW
18	11	00	
19	12	00	
20	13	98	
21	14	00	
22	15	00	
23	16	00	
24	17	50	

PROGRAM CARD #1 2 of 3

CC	hex core addr	hex con-tents	PUNCHD CARD CODE
1	48	00	SINGLE CAW
2	49	00	
3	4A	00	
4	4B	80	
5	4C	9C	START READER
6	D	00	
7	E	00	
8	F	0C	
9	50	47	BUSY LOOP
10	1	70	
11	2	00	
12	3	4C	
13	54	9D	TEST READER
14	5	00	
15	6	00	
16	7	0C	
17	58	47	BUSY LOOP
18	9	70	
19	A	00	
20	B	54	
21	5C	97	FLIP ADDR IN CAW
22	D	F8	
23	E	00	
24	F	4B	
25	60	9C	START WRITE TAPE
26	1	00	
27	2	01	

CC	hex core addr	hex con-tents	PUNCHD CARD CODE
28	63	85	
29	64	47	BUSY LOOP
30	5	70	
31	6	00	
32	7	60	
33	68	9D	TEST TAPE
34	9	00	
35	A	01	
36	B	85	
37	6C	47	BUSY LOOP
38	D	70	
39	E	00	
40	F	68	
41	70	97	FLOP ADDR IN CAW
42	1	F8	
43	2	00	
44	3	4B	
45	74	47	REPEAT CYCLE
46	5	F0	
47	6	00	
48	7	4C	
49	78	01	SINGLE OUTPUT CCW
50	9	00	
51	7A	03	
52	B	00	
53	C	20	
54	D	00	

CC	hex core addr	hex con-tents	PUNCHD CARD CODE
55	7E	03	
56	7F	20	
57	80	42	START OF 10 CCW INPUT CHAIN
58	1	00	
59	2	03	
60	3	00	
61	4	60	
62	5	00	
63	6	00	
64	7	50	
65	88	42	
66	9	00	
67	A	03	
68	B	50	
69	C	60	
70	D	00	
71	E	00	
72	F	50	
73	90	42	
74	1	00	
75	2	03	
76	3	A0	
77	4	60	
78	5	00	
78	6	00	
80	7	50	

CARD TO TAPE--BLOCK 10

00C-185

IPL CARD

CC	CORE	hex con-tents	PUNCHD CARD CODE
1	00		
2	01		
3	02		
4	03		
5	04		
6	05		

NOTE THAT THE LOW ORDER HEX CHARACTER OF ALL CCW ADDRESSES IS EITHER Ø OR 8

CC	CORE	hex con-tents	PUNCHD CARD CODE
1	18		
2	19		
3	20		
4	21		
5	22		
6	23		
7	24		
8	25		
9	26		
10	27		
11	28		
12	29		
13	30		
14	31		
15	32		
16	33		
17	34		
18	35		
19	36		
20	37		
21	38		
22	39		
23	40		
24	41		

PROGRAM CARD #2 3 of 3

CC	hex core addr	hex con-tents	PUNCHD CARD CODE
1	98	42	CONTINUATION OF 10 CCW INPUT CHAIN
2	9	00	
3	A	03	
4	B	F0	
5	C	60	
6	D	00	
7	E	00	
8	F	50	
9	A0	42	
10	1	00	
11	2	04	
12	3	40	
13	4	60	
14	5	00	
15	6	00	
16	7	50	
17	A8	42	
18	9	00	
19	A	04	
20	B	40	
21	C	60	
22	D	00	
23	E	00	
24	F	50	
25	B0	42	
26	1	00	
27	2	04	

CC	hex core addr	hex con-tents	PUNCHD CARD CODE
28	B3	E0	
29	4	60	
30	5	00	
31	6	00	
32	7	50	
33	B8	42	
34	9	00	
35	A	05	
36	B	30	
37	C	60	
38	D	00	
39	E	00	
40	F	50	
41	C0	42	
42	1	00	
43	2	05	
44	3	80	
45	4	60	
46	5	00	
47	6	00	
48	7	50	
49	C8	42	
50	9	00	
51	A	05	
52	B	D0	
53	C	20	
54	D	00	

CC	hex core addr	hex con-tents	PUNCHD CARD CODE
55	CE	00	END OF INPUT CHAIN
56	CF	50	
57	D0	42	SURPLUS CCW'S
58	1	00	
59	2	06	
60	3	20	
61	4	X0	
62	5	00	
63	6	00	
64	7	50	
65	D8	42	
66	9	00	
67	A	06	
68	B	70	
69	C	X0	
70	D	00	
71	E	00	
72	F	50	
73	E0	42	
74	1	00	
75	2	06	
76	3	C0	
77	4	20	
78	5	00	
78	6	00	
80	7	50	

IN THE PROGRAMS IN THIS PAPER, NO ATTEMPT WAS MADE TO CHANGE THE STATUS OF THE SYSTEM ONCE IT HAD STARTED. CONSEQUENTLY, AT THE COMPLETION OF ANY RUN, THE STOP BUTTON SHOULD BE PRESSED. AFTER THE CPU IS IN THE STOPPED STATE, PRESSING THE START BUTTON WILL ALLOW THE SAME PROGRAM TO CONTINUE PROCESSING WITHOUT HAVING TO RELOAD THE PROGRAM CARDS.

IF AN INTERVAL TIMER FEATURE IS INSTALLED, THE TIMER SWITCH MUST BE OFF WHENEVER ANY PROGRAMS WHOSE INSTRUCTIONS, CAW's, CCW's, OR CONSTANTS ARE LOADED INTO CORE OVERLAYING THE TIMER-USED-AREA, HEX LOCATIONS 50,51,52.

INSTRUCTIONS IN ATTEMPTED PROGRAMS NEED NOT BE RESTRICTED TO ONLY INPUT/OUTPUT FUNCTIONS. LOGICAL AND ARITHMETIC OPERATIONS MAY ALSO BE INCLUDED IN 2-CARD PROGRAMS. BY REFERRING TO T.I.E. PAPER NO. 6504-0079 ENTITLED "SUGGESTIONS FOR WRITING ONE-CARD PROGRAMS FOR IBM 1440 AND OTHER 1400 SERIES COMPUTERS" OTHER IDEAS FOR 2-CARD PROGRAMMING MAY BE STIMULATED SUCH AS: STACKER-SELECTING NEGATIVE BALANCE CARDS, SEQUENCE PUNCHING IN SPECIFIED COLUMNS, ETC. IT MAY ALSO BE POSSIBLE TO FORMULATE A SERIES OF PROGRAMS WHICH COULD BE USED TO ILLUSTRATE AND/OR TEST INDIVIDUALLY EACH OF THE 141 INSTRUCTIONS PLUS THE ADDITIONAL COMMAND CODES OF THE ENTIRE 360 SET.

ANYONE CONCEIVING A UNIQUE OR NOVEL SMALL PROGRAM WHO WOULD LIKE TO SHARE IT WITH OTHERS, FORWARD IT ON COMPLETED LAYOUT SHEETS TO:

WILLIAM BATTEN
IBM TEST CENTER
570 BROAD STREET
NEWARK, N.J., 07102

PROPER WRITTEN PERMISSION AS PRESCRIBED IN SECTION 4 OF THE MANUAL OF SYSTEM ENGINEERING MUST ALSO ACCOMPANY THE PROGRAM. THEY WILL BE ACCUMMULATED AND PUBLISHED, WITH ACKNOWLEDGEMENTS, IN SUBSEQUENT EDITIONS.

EBCDIC PUNCHED-CARD-CODE IN CARD-ROW-SEQUENCE

	HX	DEC
12 11 0 1 8 9	30	48
12 11 0 1 8	B0	176
12 11 0 1 9	71	113
12 11 0 1	B1	177
12 11 0 2 8 9	FA	250
12 11 0 2 8	BA	186
12 11 0 2 9	72	114
12 11 0 2	B2	178
12 11 0 3 8 9	FB	251
12 11 0 3 8	BB	187
12 11 0 3 9	73	115
12 11 0 3	B3	179
12 11 0 4 8 9	FC	252
12 11 0 4 8	BC	188
12 11 0 4 9	74	116
12 11 0 4	B4	180
12 11 0 5 8 9	FD	253
12 11 0 5 8	BD	189
12 11 0 5 9	75	117
12 11 0 5	B5	181
12 11 0 6 8 9	FE	254
12 11 0 6 8	BE	190
12 11 0 6 9	76	118
12 11 0 6	B6	182
12 11 0 7 8 9	FF	255
12 11 0 7 8	BF	191
12 11 0 7 9	77	119
12 11 0 7	B7	183
12 11 0 8 9	78	120
12 11 0 8	B8	184
12 11 0 9	B9	185
12 11 0	70	112

	HX	DEC
12 11 1 8 9	10	16
12 11 1 8	90	144
12 11 1 9	51	81
12 11 1	91	145
12 11 2 8 9	DA	218
12 11 2 8	9A	154
12 11 2 9	52	82
12 11 2	92	146
12 11 3 8 9	DB	219
12 11 3 8	9B	155
12 11 3 9	53	83
12 11 3	93	147
12 11 4 8 9	DC	220
12 11 4 8	9C	156
12 11 4 9	54	84
12 11 4	94	148
12 11 5 8 9	DD	221
12 11 5 8	9D	157
12 11 5 9	55	85
12 11 5	95	149
12 11 6 8 9	DE	222
12 11 6 8	9E	158
12 11 6 9	56	86
12 11 6	96	150
12 11 7 8 9	DF	223
12 11 7 8	9F	159
12 11 7 9	57	87
12 11 7	97	151
12 11 8 9	58	88
12 11 8	98	152
12 11 9	99	153
12 11	6A	106

	HX	DEC
12 0 1 8 9	00	0
12 0 1 8	80	128
12 0 1 9	41	65
12 0 1	81	129
12 0 2 8 9	CA	202
12 0 2 8	8A	138
12 0 2 9	42	66
12 0 2	82	130
12 0 3 8 9	CB	203
12 0 3 8	8B	139
12 0 3 9	43	67
12 0 3	83	131
12 0 4 8 9	CC	204
12 0 4 8	8C	140
12 0 4 9	44	68
12 0 4	84	132
12 0 5 8 9	CD	205
12 0 5 8	8D	141
12 0 5 9	45	69
12 0 5	85	133
12 0 6 8 9	CE	206
12 0 6 8	8E	142
12 0 6 9	46	70
12 0 6	86	134
12 0 7 8 9	CF	207
12 0 7 8	8F	143
12 0 7 9	47	71
12 0 7	87	135
12 0 8 9	48	72
12 0 8	88	136
12 0 9	89	137
12 0	C0	192

	HX	DEC
12 1 8 9	09	9
12 1 8	49	73
12 1 9	01	1
12 1	C1	193
12 2 8 9	DA	10
12 2 8	4A	74
12 2 9	02	2
12 2	C2	194
12 3 8 9	0B	11
12 3 8	4B	75
12 3 9	03	3
12 3	C3	195
12 4 8 9	0C	12
12 4 8	4C	76
12 4 9	04	4
12 4	C4	196
12 5 8 9	0D	13
12 5 8	4D	77
12 5 9	05	5
12 5	C5	197
12 6 8 9	0E	14
12 6 8	4E	78
12 6 9	06	6
12 6	C6	198
12 7 8 9	0F	15
12 7 8	4F	79
12 7 9	07	7
12 7	C7	199
12 8 9	08	8
12 8	C8	200
12 9	C9	201
12	50	80

	HX	DEC
11 0 1 8 9	20	32
11 0 1 8	A0	160
11 0 1 9	E1	225
11 0 1	A1	161
11 0 2 8 9	EA	234
11 0 2 8	AA	170
11 0 2 9	62	98
11 0 2	A2	162
11 0 3 8 9	EB	235
11 0 3 8	AB	171
11 0 3 9	63	99
11 0 3	A3	163
11 0 4 8 9	EC	236
11 0 4 8	AC	172
11 0 4 9	64	100
11 0 4	A4	164
11 0 5 8 9	ED	237
11 0 5 8	AD	173
11 0 5 9	65	101
11 0 5	A5	165
11 0 6 8 9	EE	238
11 0 6 8	AE	174
11 0 6 9	66	102
11 0 6	A6	166
11 0 7 8 9	EF	239
11 0 7 8	AF	175
11 0 7 9	67	103
11 0 7	A7	167
11 0 8 9	68	104
11 0 8	A8	168
11 0 9	A9	169
11 0	D0	208

	HX	DEC
11 1 8 9	19	25
11 1 8	59	89
11 1 9	11	17
11 1	D1	209
11 2 8 9	1A	26
11 2 8	5A	90
11 2 9	12	18
11 2	D2	210
11 3 8 9	1B	27
11 3 8	5B	91
11 3 9	13	19
11 3	D3	211
11 4 8 9	1C	28
11 4 8	5C	92
11 4 9	14	20
11 4	D4	212
11 5 8 9	1D	29
11 5 8	5D	93
11 5 9	15	21
11 5	D5	213
11 6 8 9	1E	30
11 6 8	5E	94
11 6 9	16	22
11 6	D6	214
11 7 8 9	1F	31
11 7 8	5F	95
11 7 9	17	23
11 7	D7	215
11 8 9	18	24
11 8	D8	216
11 9	D9	217
11	60	96

	HX	DEC
0 1 8 9	29	41
0 1 8	69	105
0 1 9	21	33
0 1	61	97
0 2 8 9	2A	42
0 2 8	E0	224
0 2 9	22	34
0 2	E2	226
0 3 8 9	2B	43
0 3 8	6B	107
0 3 9	23	35
0 3	E3	227
0 4 8 9	2C	44
0 4 8	6C	108
0 4 9	24	36
0 4	E4	228
0 5 8 9	2D	45
0 5 8	6D	109
0 5 9	25	37
0 5	E5	229
0 6 8 9	2E	46
0 6 8	6E	110
0 6 9	26	38
0 6	E6	230
0 7 8 9	2F	47
0 7 8	6F	111
0 7 9	27	39
0 7	E7	231
0 8 9	28	40
0 8	E8	232
0 9	E9	233
0	F0	240

	HX	DEC
1 8 9	39	57
1 8	79	121
1 9	31	49
1	F1	241
2 8 9	3A	58
2 8	7A	122
2 9	32	50
2	F2	242
3 8 9	3B	59
3 8	7B	123
3 9	33	51
3	F3	243
4 8 9	3C	60
4 8	7C	124
4 9	34	52
4	F4	244
5 8 9	3D	61
5 8	7D	125
5 9	35	53
5	F5	245
6 8 9	3E	62
6 8	7E	126
6 9	36	54
6	F6	246
7 8 9	3F	63
7 8	7F	127
7 9	37	55
7	F7	247
8 9	38	56
8	F8	248
9	F9	249
NO PUNCHES	40	64

AFTER THE FIRST UNIT-TO-UNIT CARD IS PUNCHED, OTHER DEVICE COMBINATIONS MAY BE MADE BY DUPLICATING ALL COLUMNS EXCEPT THOSE LISTED BELOW:

PROGRAM												
FUNCTION	CC	HEX CONTNT	PUNCHD CARD CODE	CC	HEX CONTNT	PUNCHD CARD CODE	CC	HEX CONTNT	PUNCHD CARD CODE	CC	HEX CONTNT	PUNCHD CARD CODE
CMND. CODE UNIT 1	5			5			5			5		
CMND. CODE UNIT 2	13			13			13			13		
PHYSICAL ADDRESS UNIT NO. 1	23			23			23			23		
	24			24			24			24		
PHYSICAL ADDRESS UNIT NO. 1	31			31			31			31		
	32			32			32			32		
PHYSICAL ADDRESS UNIT NO. 2	43			43			43			43		
	44			44			44			44		
PHYSICAL ADDRESS UNIT NO. 2	51			51			51			51		
	52			52			52			52		

PROGRAM												
FUNCTION	CC	HEX CONTNT	PUNCHD CARD CODE	CC	HEX CONTNT	PUNCHD CARD CODE	CC	HEX CONTNT	PUNCHD CARD CODE	CC	HEX CONTNT	PUNCHD CARD CODE
CMND. CODE UNIT 1	5			5			5			5		
CMND. CODE UNIT 2	13			13			13			13		
PHYSICAL ADDRESS UNIT NO. 1	23			23			23			23		
	24			24			24			24		
PHYSICAL ADDRESS UNIT NO. 1	31			31			31			31		
	32			32			32			32		
PHYSICAL ADDRESS UNIT NO. 2	43			43			43			43		
	44			44			44			44		
PHYSICAL ADDRESS UNIT NO. 2	51			51			51			51		
	52			52			52			52		

IPL CARD			
CC	CORE	hex contents	PUNCHD CARD CODE
1	00		
2	01		
3	02		
4	03		
5	04		
6	05		
7	06		
8	07		
9	08		
10	09		
11	0A		
12	0B		
13	0C		
14	0D		
15	0E		
16	0F		
17	10		
18	11		
19	12		
20	13		
21	14		
22	15		
23	16		
24	17		

PROGRAM CARD												
CC	hex core addr	hex contents	PUNCHD CARD CODE	CC	hex core addr	hex contents	PUNCHD CARD CODE	CC	hex core addr	hex contents	PUNCHD CARD CODE	CC	hex core addr	hex contents	PUNCHD CARD CODE
1				28				55							
2				29				56							
3				30				57							
4				31				58							
5				32				59							
6				33				60							
7				34				61							
8				35				62							
9				36				63							
10				37				64							
11				38				65							
12				39				66							
13				40				67							
14				41				68							
15				42				69							
16				43				70							
17				44				71							
18				45				72							
19				46				73							
20				47				74							
21				48				75							
22				49				76							
23				50				77							
24				51				78							
25				52				79							
26				53				80							
27				54											