APPENDIX 1

BELL TELEPHONE LABORATORIES
INCORPORATED

SUBJECT: GRAPHIC-2 IOT Instructions

DATE: September 25, 1967

FROM: W.H.Ninke
P.E.Rosenfeld

In the following discussion of the GRAPHIC-2 IOT instructions, the word "instruction" refers to a PDP-9 IOT, while the word "command" refers to a display command(executed from the display buffer). The IOT's are given below in ascending numerical order.

In assigning mnemonics to the IOT instructions, the following conventions have been observed. A transfer from the accumulator (AC) to another register is called writing, and all instructions which write start with W. A transfer into the accumulator from another register is called loading and instructions which load start with L. A single status bit which can be controlled by IOT's is turned on by an instruction starting with E for Enable and is turned off by an instruction starting with D for Disable. A flag is cleared by an instruction starting with C (except for CØN).

CDF	700501	Clear Display Flags. The light-pen, edges, stop, conditional-stop, immediate-stop, and display-trap flags are turned off. The vector-component holding registers are cleared. The display cycle control is set to single-step operation.
WDA	700502	Write Display Address. The 13 low-order bits of the AC are written into the display address register.

ECR	700504	Enable Continuous Run. The cycle control is set to the continuous-run state.
ESS	700524	Enable Single-Step. The cycle control is set to the single-step state.

To start the scope after a display-trap flag, stop flag or conditional-stop flag has stopped the cycling, the following instruction is used:

CØN	700545	CONtinue. A CDF is performed. The cycle control is set to the continuous-run state and the data-request signal is turned on. The display starts at the location currently in the display address register.

To start the scope at a specific address, the following instruction is used:

BEG	700547	BEGin. (WDA followed by CØN). The display is started at the location specified by the 13 low-order bits of the AC.
WDBC	700605	Write Display Buffer and Continue. The contents of the AC are written into the display buffer register. The data-request signal is turned off. The display cycle control is set to the continuous-run state. Execution of the command transferred to the display buffer is begun. When this command is completed, the next command will be

taken from the location indicated by the display address register and normal continuous cycling will then take place.

LDB 700612 Load Display Buffer. The display buffer register is loaded into the AC.

WDBS 700625 Write Display Buffer and Single-Step. The contents of the AC are written into the display buffer register. The data-request signal is turned off. The display cycle control is set to the single-step state. Execution of the command transferred to the display buffer is begun. When this command is completed, the data-request signal is turned on and the display awaits further instructions.

ELP 700701 Enable the Light Pen. The light pen is activated so that light sensed within the field of view of the pen will turn the light-pen flag on. This function can also be accomplished using a parameter-mode display command.

DLP 700721 Disable the Light Pen. The light pen is disabled so that light sensed within the field of view of the pen will not turn the light-pen flag on. This function can also

be performed by a parameter-mode display command.

Note: The ability of the pen to respond to light within the field of view is determined by the last LP control IOT or parameter-mode display command (with LP control bits set) that has been given. Thus, if a parameter-mode word enables the light pen and a DLP instruction is then executed by the computer, the pen is disabled until another parameter-mode word or IOT changes the status of the pen.

RLPE	700722	Resume after Light Pen stoppage with pen Enabled. The light-pen flag stops the display. This instruction causes resumption from the exact point of stoppage. The light-pen flag is turned off and the light pen is left enabled.
RLPD	700723	Resume after Light Pen stoppage with pen Disabled. Same as RLPE except the light pen is disabled.
RAEF	700742	Resume After Edges Flag. The edges flag stops the display. This instruction causes resumption from the exact point of stoppage. All edge flags are cleared.

Note: If an RLPD or RLPE is given with the edges flag on, the display will not resume until an RAEF is also given. Similarly, with the light-pen flag on, an RAEF will not cause resumption until an RLPE or RLPD is given. This

method of operation allows the light-pen-flag programming and the edge-flag programming to be separate uncoupled modules. Simultaneous light-pen flag and edges flag will not cause problems in the order of processing.

ECS 701001 Enable Conditional Stop. The conditional-stop feature for slave-mode words is enabled.

LDA 701012 Load Display Address. The display address register is loaded into the 13 low-order bits of the AC. The 5 high-order bits of the AC are cleared. The display address register always points one beyond the display command being executed under normal cycling.

DCS 701021 Disable Conditional Stop. The conditional-stop feature for slave-mode words is disabled.

LPM 701032 Load Parameter-Mode command. The parameters settable by a parameter-mode command are loaded into the AC in the following format: The prefix 0001 is loaded into the high-order bits. Bits 4,6,8,12 and 15 are set to 1. The remaining bits are loaded as follows:

AC5 - Blink
AC7 - LP enable
AC9 - Exchange axes
AC10 - Complement X component
AC11 - Complement Y component
AC13-- Scale 0
AC14 - Scale 1
AC16 - Intensity 0
AC17 - Intensity 1

Thus, the parameters are loaded in the format of a parameter-mode command.

LDS 701052 Load Display Status. The display flags and conditions are loaded into the AC in the following format:

	Bit is 0	Bit is 1
AC0 - Display-Trap Flag	off	on
AC1 - Edges Flag	off	on
AC2 - Light-Pen Flag	off	on
AC3 - Stop Flag	off	on
AC4 - Conditional-Stop Flag	off	on
AC5 - Pushbuttons Flag	off	on
AC6 - Console-Keyboard Flag	off	on
AC7 - Data-Phone Flag	off	on
AC8 - Byte Scan	1st byte	2nd byte
AC9 - Conditional-Stop Enable	off	on
AC10 - Immediate Stop	off	enabled
AC11 - Cycle Control	continuous	single-step
AC12 - Data Request	busy	ready
AC13 - Override	disabled	enabled
AC14 - Right Edge Flag	off	on
AC15 - Left Edge Flag	off	on
AC16 - Top Edge Flag	off	on
AC17 - Bottom Edge Flag	off	on

EIS 701401 Enable Immediate Stop. The immediate-stop condition is enabled.

LX 701412 Load X. The X deflection register is loaded into the low-order 10 bits of the AC. The high-order 8 bits are cleared.

EØV 703401 Enable OVerride. The override condition is enabled (scope beam turned off).

LY 703412 Load Y. The Y deflection register is loaded into the low-order 10 bits of the AC. The high-order 8 bits are cleared.

DØV	703421	Disable OVerride. The override condition is disabled (scope beam turned on).
SCK	704301	Skip on Console-Keyboard flag. If the console-keyboard flag is on indicating that a key has been depressed, the next instruction is skipped.
ØCK	704302	Or Console Keyboard. The code for the currently depressed key is or-gated into the AC. If no key is currently depressed, the AC is unchanged. The bit format is as follows: AC11 - KB0 AC12 - KB1 AC13 - KB2 AC14 - KB3 AC15 - KB4 AC16 - KB5 AC17 - KB6
CCK	704304	Clear Console Keyboard. The console-keyboard flag is cleared.
LCK	704312	Load Console Keyboard. The AC is cleared and then an ØCK is performed.
SPB	704401	Skip on Push-Buttons flag. If the pushbuttons flag indicating that any pushbutton has been pushed is on, the next instruction is skipped.

ØPB	704402	Or Push Buttons. The status of the pushbuttons is or-gated into the AC. If no pushbutton is currently depressed, the AC is unchanged. The bit format is as follows: AC0 - PB0 AC1 - PB1 AC2 - PB2 AC3 - PB3 AC4 - PB4 AC5 - PB5 AC6 - PB6 AC7 - PB7
CPB	704404	Clear Push Buttons. The pushbuttons flag is cleared.
LPB	704412	Load Push Buttons. The AC is cleared and then an ØPB is performed.
WBL	704424	Write Button Lights. The lights in the pushbuttons corresponding to the 1-bits in the AC are turned on. The previous status of the lights is lost. The bit format for the lights is the same as for the corresponding pushbuttons as given in ØPB.
LBL	704432	Load Push Button Lights. The AC is cleared. The pushbutton lights status is loaded into the AC. The bit format is the same as for the corresponding pushbuttons as given in ØPB.

Note: The following IOT (7045x2) applied only to G-2 terminals equipped with the Sylvania Data Tablet option.

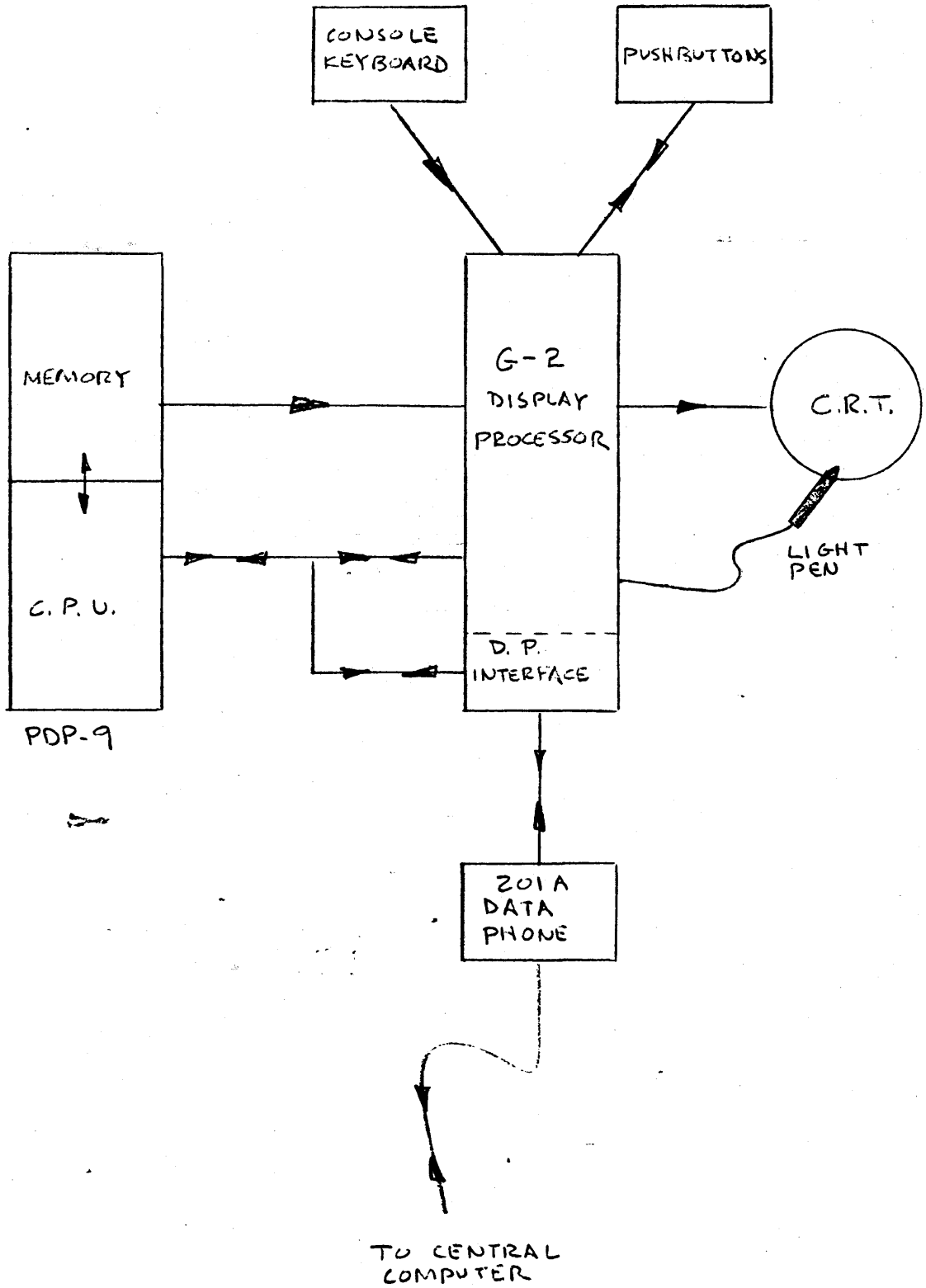
LTX	704512	Load the Tablet X coordinate. Bits 8-17 of the AC are loaded with the X coordinate of the tablet stylus. Bit 0 is set if the data are valid. Bit 0 & 1 are set if the stylus is touching the surface of the tablet, and the data are valid. Bits 0, 1 & 2 are set if the stylus is pressed against the surface of the tablet and the data are valid. The remaining bits are cleared.
LTY	704552	Load the Tablet Y coordinate. (Same as LTX but for Y coordinate).

W. H. NINKE

P. E. ROSENFELD

MH-1375-WHN
6263-PER-LM

Att.
Figures 1-3



ISSUE	ENGR	TITLE	BELL TELEPHONE LABORATORIES INCORPORATED
	DRAWN	FIGURE 1 PSR 4/9/68.	SHEET / NO. OF SHEETS PER SET

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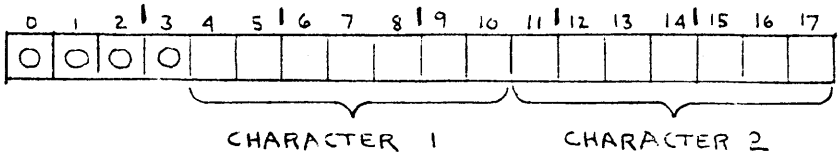
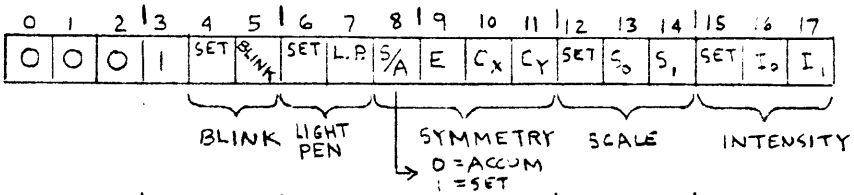
GRAPHIC 2 SCOPE CODES

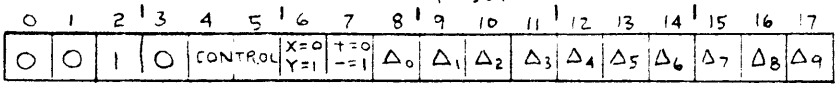
CHAR.



PARAM.



LONG VECTOR



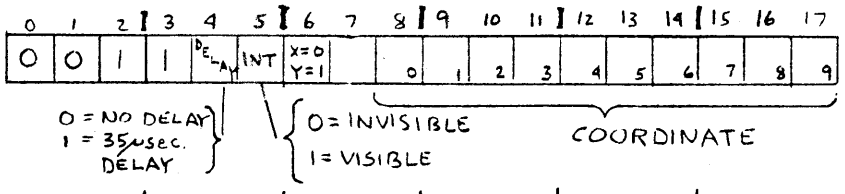
0 0 → LOAD HOLDING REGISTERS ONLY

0 1 → LOAD REG., DRAW INVISIBLE, CLEAR REG'S..

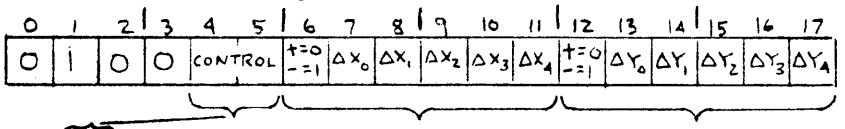
1 0 → LOAD REG., DRAW VIS. (EXCEPT STARTING POINT), CLEAR REG'S..

1 1 → LOAD REG. DRAW INVIS. EXCEPT END POINT (WHICH IS VIS.), CLEAR REG'S..

X-Y



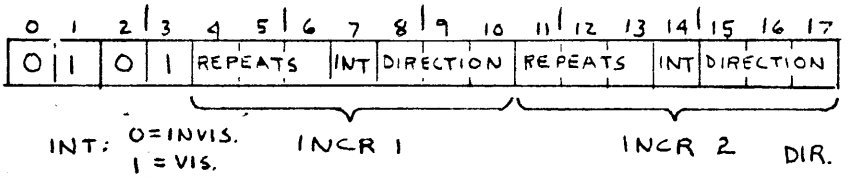
SHORT VECTOR



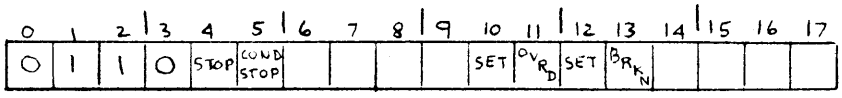
00 → NO OPER. ΔX COMPONENT ΔY COMPONENT

01, 10, 11 → SAME AS IN LONG VECTOR

INCR.



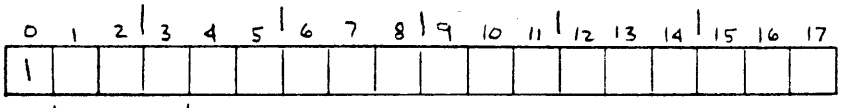
CONTROL



OVERRIDE 1 = ON 0 = OFF

0 = DRAW SOLID LINES
1 = DRAW BROKEN LINES

TRAP



SPECIFIES API CHANNEL LOCATION TO TRAP TO

ISSUE	ENGR	TITLE	BELL TELEPHONE LABORATORIES INCORPORATED
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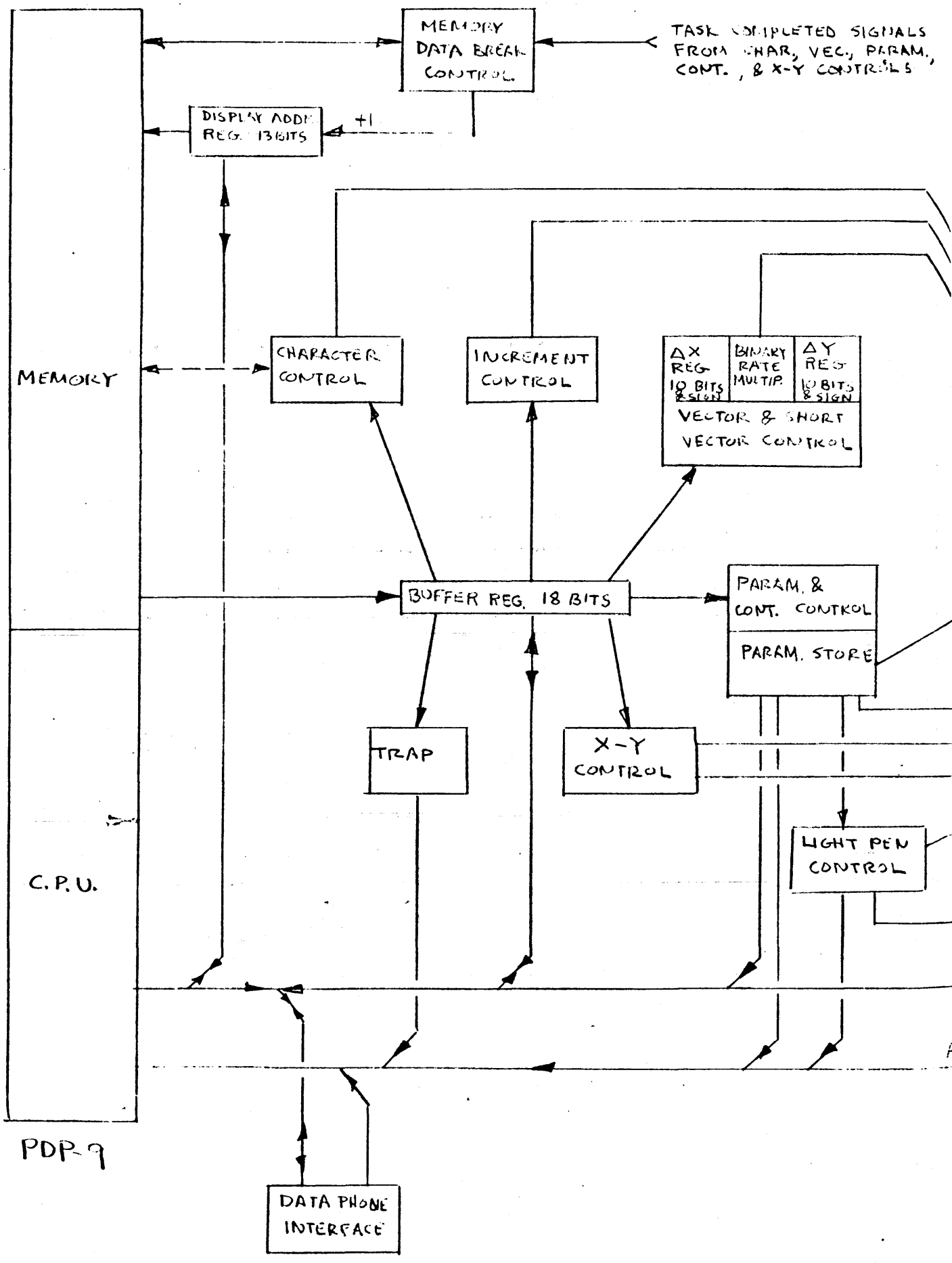
MEMORY
DATA BREAK CONTROL
TASK COMPLETED SIGNALS FROM CHAR, VEC., PARAM., CONT., & X-Y CONTROLS
DISPLAY ADDR REG. 13 BITS
+1
CHARACTER CONTROL
INCREMENT CONTROL
ΔX REG 10 BITS & SIGN
BINARY RATE MULTIP.
ΔY REG 10 BITS & SIGN
VECTOR & SHORT VECTOR CONTROL
BUFFER REG. 18 BITS
PARAM. & CONT. CONTROL
PARAM. STORE
TRAP
X-Y CONTROL
LIGHT PEN CONTROL
C.P.U.
PDP-9
DATA PHONE INTERFACE

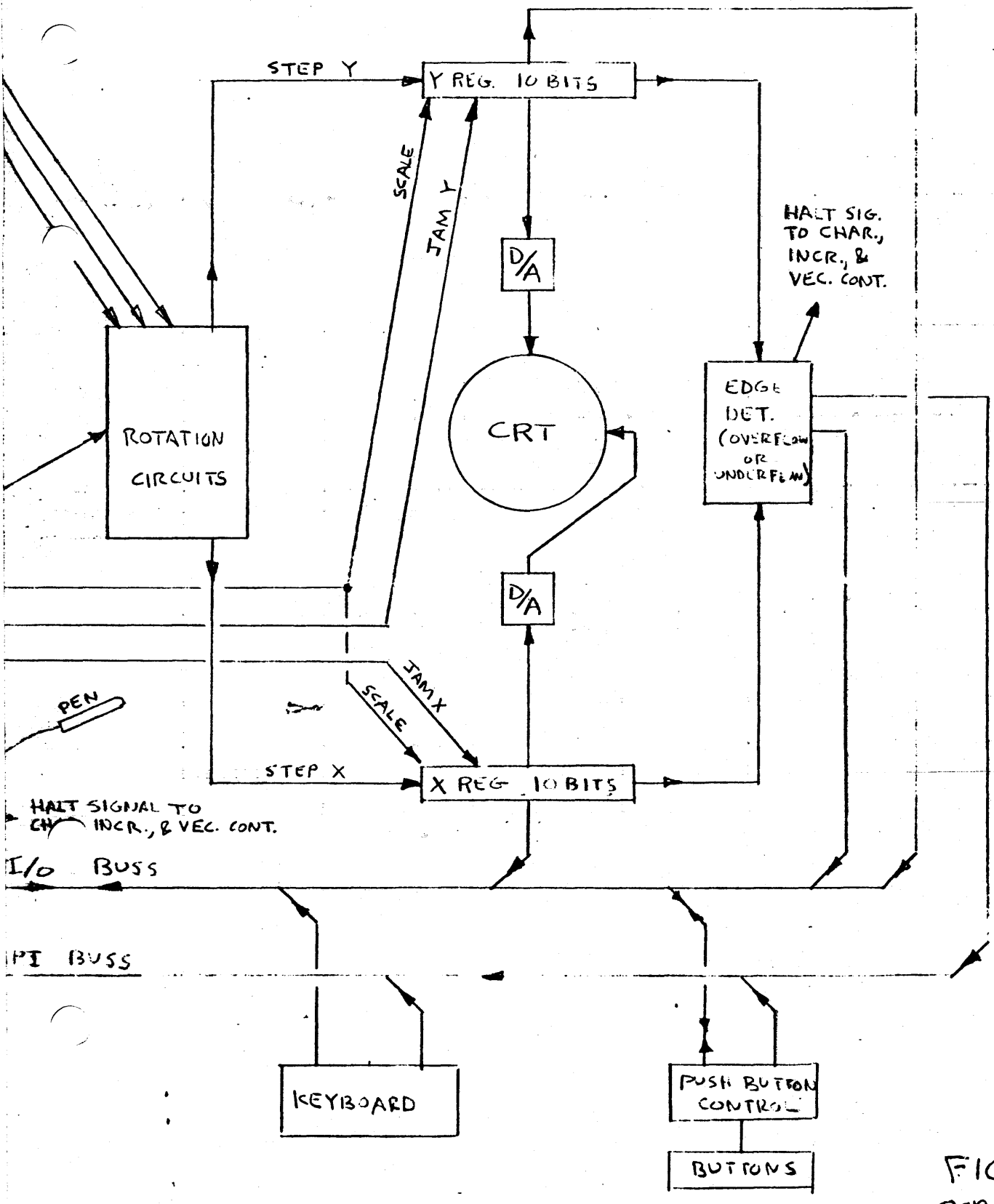

FIG 5
PER 3/12/68

Graphic-2 API Assignments (revised Sept. 12, 1967)

Level	Channel	Name
4	40	Software
5	41	"
6	42	"
7	43	"
	44	
	45	
~~4~~	46	~~Drum (if present)~~
	47	
2	50	Paper-Tape Reader
3	51	Clock Overflow
	52	
	53	
	54	
2	55	Edges Flag
2	56	Light-Pen Flag
~~2~~	57	~~Stop Flag~~ removed 7/9/68
2	60	Conditional-Stop Flag
	61	
	62	
1	63	Pushbuttons Flag
1	64	Console-Keyboard Flag
0	65	Data-Phone Flag
	66	
	67	

Level	Channel	Name
3	70	Display-Trap 40
3	71	" " 44
3	72	" " 50
3	73	" " 54
3	74	" " 60
3	75	" " 64
3	76	" " 70
3	77	" " 74