

INDEX OF LOGICAL DRAWINGS FOR PAC CONTROL (WGC.07)

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## Logic Description of PAC Character Data Buffer

The Character Data Buffer (WGC07/3) has very similar "hardware" to the standard Word Data Buffer (WGC07/1). The only changes to the logic drawings are that sheet 2 of WGC07/1 has been replaced by new sheets 2 and 3, the rest being identical except for one wire on sheet 1.

### Inwards Transfers

Now consider the case of an R request from a character peripheral after being initiated by a 174 read order. Control Words will be loaded in the usual way by means of steps 1 and 2 and then step 5 which sets the OUT stat A27/2 (Sh.1) to IN, thus producing PANTC+ which sets the BTD (Buffer Transferring Data) stat. PANTC+ also sets the A stat A36/1 (Sh.2) because PANR+ will be +ve.

Since A36/1 (Sh.2) is set then PANGC+ will be -ve and allowing the A line to the peripheral to be activated (see standard interface logic sheets). The second PANTC+ will set the GT stat A29/2 (Sh.2) producing PANGTP+ which will allow a T pulse to be emitted from A35/2 (Sh.1). The second PANTC+ will also allow a PANTINO+ which gates the first character into the buffer. The third PANTC+ will reset the A stat A36/1 (Sh.2) and PANTC+ pulses will be continued to be produced at 1  $\mu$ S intervals also the buffer will remain selected but no further action occurs until the next R request arrives i.e. PANR+ (Sheet 2).

The second R will set the A stat again thus producing PANGTP+ which allows another T pulse at the next PANTC+ and gates in the second character into the buffer, the A stat A36/1 (Sh.2) being reset again by the third PANTC+.

This procedure is repeated until the fourth character is strobed, in which case the BTD stat (Sh.1) is reset by PANGTP- and PANCH3- and causing PAEOTI- which will eventually lead to step 6. Step 6 writes the word now in the data buffer into the store.

If however the peripheral which was engaged in the inwards transfer terminates part way through a word, then the following sequence would be initiated. Obviously if say the second character had been strobed into the data buffer and then the peripheral had terminated, then nothing further could happen until the B interrupt arising from the terminated condition is interrogated and identified.

Continued..../

Considering when the peripheral on this particular interface is interrogated via the 174 SSQ command then PANESM+ (Sh.2) will be +ve thus setting the C stat A29/3 (Sh.2) (because PANRBTD+ (Sh.1) will be -ve

Hence, PANC- (Sh.2) will be -ve and PANGC- will be -ve also, PASIT+ (Sh.3) will be +ve because of the terminated state of the peripheral, therefore the PWT (partial word terminated) stat will be set. PWT stat being set will make the outputs of power inverters A35/1, A35/2, A35/3, A35/4 all positive, thus forcing \*74 on the DI lines. PANPWT- is also now -ve thus enabling PANGTP+ to be +ve with alternate PANTC+ pulses via A34/4 (Sh.2).

The remaining character positions in the buffer will be filled with \*74s and when CH3- (Sh.1) is -ve on the last character, the BTD stat (Sh.1) will be reset allowing the PWT stat (Sh.3) to be reset and leaving the DI lines free again.

Also at this time PAEOTI- becomes -ve and eventually leads to a step 6 which writes the final word away, including the \*74 dummy characters.

#### Outwards Transfers

On Outward transfers the action of the A stat A36/1 is the same. It allows one T pulse at a time to be sent with each character, PANGDO- now being -ve lets the data in the data buffer to be gated on the DO lines, one character for every R request from the peripheral.

If the peripheral terminates part way through an outward transfer and is then interrogated by a 174 SSQ command, the PWT stat will be set (as mentioned previously for an inwards transfer) and \*74s will appear on the DI lines which do not matter, also the unwanted characters will be placed in the DO lines and T pulses occur until the last character is strobed. Note that the peripheral will not respond to these dummy characters because the A stat A36/1 is not set again after the peripheral terminates.

When the BTD stat is reset on the fourth character, the buffer is freed for further use.

Special case when Count Control Word = 1

It is necessary in order to write file marks on 20 Kc/s to send 1 character which must be accompanied by Limit. Normally one would expect 4 characters to be transferred with a CCW = 1.

When a CCW=1 has been loaded in step 2, it is detected by logic on sheet 3. The EL (early limit) stat which is used upside down is set by loading control word 0 (PALCWO-) i.e. step 2 at the end of step 2, clocked by PATDB. There are two ways of resetting the EL stat, one way is by means of A30/4 (Sh.2) which is +ve if the mill test  $\neq$  0. If the loaded CCW=1 then PAMT =  $\emptyset$ - would be -ve and thus A30/4 would be -ve and would not reset the EL stat.

The other way of resetting the EL stat is by A24/6 (Sh.1) which is +ve if an inwards transfer is to be started, i.e. step 5. In summary, the EL stat is set by step 2 and only remains set if an outward transfer is to take place and the loaded CCW=1.

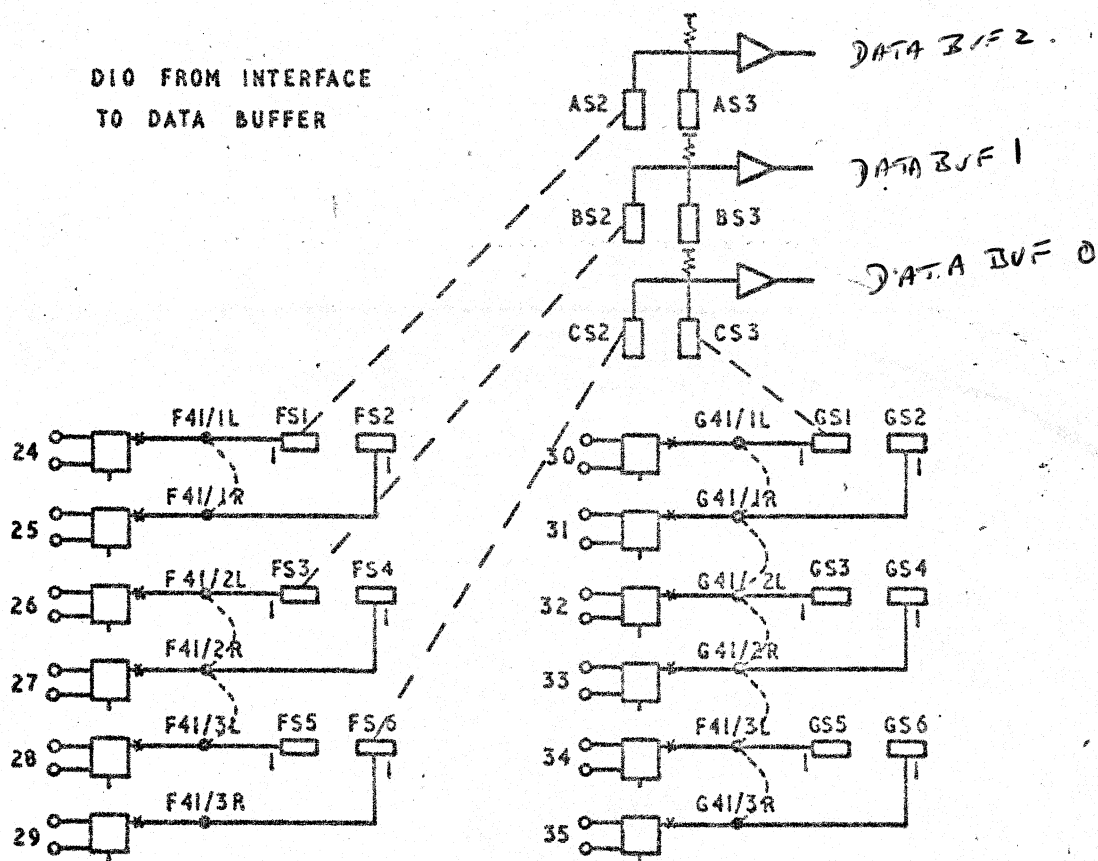
A33/4 (Sh.3) which is collector-orred with PANL+ (Sh.2) will therefore be positive when the A stat (Sh.2) is set, thus sending L with the first character to the peripheral.

Now element A28/2 which produces PAINHT+ (Sh.3), is also +ve when the EL stat is set, and returns -ve when PA DBS- (Sh.1) goes +ve which occurs at the end of step 4. PAINHT+ is connected to A30/2 mix which inhibits T pulses until the end of step 4, by which time the test on CCW=1 will have been effected.

The buffer will be freed as explained previously by the action of sending a SSQ command after the peripheral terminates.

J.N. Trainor  
19th June 1968

DIO FROM INTERFACE  
TO DATA BUFFER



|   |    | 26 WAY              |                    | LINK BOARD CONNECTIONS |    |    |     |     |     |         |         |  |
|---|----|---------------------|--------------------|------------------------|----|----|-----|-----|-----|---------|---------|--|
|   |    | S.I. N <sup>o</sup> | SKT N <sup>o</sup> | 1L                     | 4L | 7L | 10L | 13L | 16L |         |         |  |
| A | 24 | FS1                 |                    | 1L                     | 4L | 7L | 10L | 13L | 16L | } BOX F |         |  |
|   | 25 | FS2                 |                    | 1R                     | 4R | 7R | 10R | 13R | 16R |         |         |  |
|   | 26 | FS3                 |                    | 2L                     | 5L | 8L | 11L | 14L | 17L |         |         |  |
| B | 27 | FS4                 |                    | 2R                     | 5R | 8R | 11R | 14R | 17R |         |         |  |
|   | 28 | FS5                 |                    | 3L                     | 6L | 9L | 12L | 15L | 18L |         |         |  |
|   | 29 | FS6                 |                    | 3R                     | 6R | 9R | 12R | 15R | 18R |         |         |  |
| C | 30 | GS1                 |                    | 1L                     | 4L | 7L | 10L | 13L | 16L |         | } BOX G |  |
|   | 31 | GS2                 |                    | 1R                     | 4R | 7R | 10R | 13R | 16R |         |         |  |
|   | 32 | GS3                 |                    | 2L                     | 5L | 8L | 11L | 14L | 17L |         |         |  |
|   | 33 | GS4                 |                    | 2R                     | 5R | 8R | 11R | 14R | 17R |         |         |  |
|   | 34 | GS5                 |                    | 3L                     | 6L | 9L | 12L | 15L | 18L |         |         |  |
|   | 35 | GS6                 |                    | 3R                     | 6R | 9R | 12R | 15R | 18R |         |         |  |

CONNECTING FROM A STANDARD INTERFACE TO A DATA BUFFER

PLUG A LINKING CABLE BETWEEN THE SOCKET ON THE DATA BUFFER AND THE 26 WAY SOCKET ASSOCIATED WITH THE STANDARD INTERFACE. ADD LINKS ON THE LINK BOARDS TO CONNECT THIS DATA BUFFER TO FURTHER STANDARD INTERFACES. THE DOTTED LINES ABOVE SHOW THE CONNECTIONS NECESSARY TO CONNECT DATA BUFFER A TO 24 AND 25, B TO 26, 27 AND 28 AND C TO 29, 30, 31, 32, 33, 34 AND 35.

MAC  
**SOCKET AND LINK BOARD CONNECTIONS**  
DATA BUFFER ALLOCATION

| NAME OF SIGNAL | 26 WAY SOCKET PINS | LINK BOARD LOCATION | LINK BOARD DEVICES ON BOX F |     |     |     |     |     | LINK BOARD DEVICES ON BOX G |     |     |     |     |     |
|----------------|--------------------|---------------------|-----------------------------|-----|-----|-----|-----|-----|-----------------------------|-----|-----|-----|-----|-----|
|                |                    |                     | 24                          | 25  | 26  | 27  | 28  | 29  | 30                          | 31  | 32  | 33  | 34  | 35  |
| DI0            | +                  | 41                  | 1L                          | 1R  | 2L  | 2R  | 3L  | 3R  | 1L                          | 1R  | 2L  | 2R  | 3L  | 3R  |
| DI1            | +                  |                     | 4L                          | 4R  | 5L  | 5R  | 6L  | 6R  | 4L                          | 4R  | 5L  | 5R  | 6L  | 6R  |
| DI2            | +                  |                     | 7L                          | 7R  | 8L  | 8R  | 9L  | 9R  | 7L                          | 7R  | 8L  | 8R  | 9L  | 9R  |
| DI3            | +                  | 42                  | 10L                         | 10R | 11L | 11R | 12L | 12R | 10L                         | 10R | 11L | 11R | 12L | 12R |
| DI4            | +                  |                     | 13L                         | 13R | 14L | 14R | 15L | 15R | 13L                         | 13R | 14L | 14R | 15L | 15R |
| DI5            | +                  |                     | 16L                         | 16R | 17L | 17R | 18L | 18R | 16L                         | 16R | 17L | 17R | 18L | 18R |
| DO0            | +                  | 43                  | 1L                          | 1R  | 2L  | 2R  | 3L  | 3R  | 1L                          | 1R  | 2L  | 2R  | 3L  | 3R  |
| DO1            | +                  |                     | 4L                          | 4R  | 5L  | 5R  | 6L  | 6R  | 4L                          | 4R  | 5L  | 5R  | 6L  | 6R  |
| DO2            | +                  |                     | 7L                          | 7R  | 8L  | 8R  | 9L  | 9R  | 7L                          | 7R  | 8L  | 8R  | 9L  | 9R  |
| DO3            | +                  | 44                  | 10L                         | 10R | 11L | 11R | 12L | 12R | 10L                         | 10R | 11L | 11R | 12L | 12R |
| DO4            | +                  |                     | 13L                         | 13R | 14L | 14R | 15L | 15R | 13L                         | 13R | 14L | 14R | 15L | 15R |
| DO5            | +                  |                     | 16L                         | 16R | 17L | 17R | 18L | 18R | 16L                         | 16R | 17L | 17R | 18L | 18R |
| E0TI           | -                  | 44                  | 10L                         | 10R | 11L | 11R | 12L | 12R | 10L                         | 10R | 11L | 11R | 12L | 12R |
| E0TO           | -                  |                     | 13L                         | 13R | 14L | 14R | 15L | 15R | 13L                         | 13R | 14L | 14R | 15L | 15R |
| G C            | -                  |                     | 16L                         | 16R | 17L | 17R | 18L | 18R | 16L                         | 16R | 17L | 17R | 18L | 18R |
| G C            | +                  | 44                  | 11L                         | 1R  | 2L  | 2R  | 3L  | 3R  | 11L                         | 1R  | 2L  | 2R  | 3L  | 3R  |
| ESM            | +                  |                     | 4L                          | 4R  | 5L  | 5R  | 6L  | 6R  | 4L                          | 4R  | 5L  | 5R  | 6L  | 6R  |
| RSM            | +                  |                     | 7L                          | 7R  | 8L  | 8R  | 9L  | 9R  | 7L                          | 7R  | 8L  | 8R  | 9L  | 9R  |
| AM             | +                  | 44                  | 10L                         | 10R | 11L | 11R | 12L | 12R | 10L                         | 10R | 11L | 11R | 12L | 12R |
|                |                    |                     | 13L                         | 13R | 14L | 14R | 15L | 15R | 13L                         | 13R | 14L | 14R | 15L | 15R |
|                |                    |                     | 16L                         | 16R | 17L | 17R | 18L | 18R | 16L                         | 16R | 17L | 17R | 18L | 18R |

TO CONNECT A PERIPHERAL OR A GROUP OF PERIPHERALS TO A DATA BUFFER, LINK THE CORRESPONDING PINS ON THE LINK BOARDS FOR EACH SIGNAL, AND CONNECT ANY SOCKET INCLUDED IN THE GROUP TO ANY SOCKET ON THE DATA BUFFER WITH A LINKING CABLE (26 WAY).

| PERIPHERAL DEVICE No. | S. I. 26 WAY SOCKETS. |
|-----------------------|-----------------------|
| 24                    | FS1                   |
| 25                    | FS2                   |
| 26                    | FS3                   |
| 27                    | FS4                   |
| 28                    | FS5                   |
| 29                    | FS6                   |
| 30                    | GS1                   |
| 31                    | GS2                   |
| 32                    | GS3                   |
| 33                    | GS4                   |
| 34                    | GS5                   |
| 35                    | GS6                   |

| DATA BUFFER | BOX WGC | 26WAY SOCKETS DATA BUFFER |
|-------------|---------|---------------------------|
| 2           | A       | AS2 - AS3                 |
| 1           | B       | BS2 BS3                   |
| 0           | C       | CS2 CS3                   |

NOTE: SOCKETS ON DATA BUFFERS ARE COMMON.



Fault Finding on P.A.C.

The majority of the logic on P.A.C. can be tested with the use of a few "status symbols" i.e. jumper leads, and a little know how, without utilising complicated devices called peripherals.

A P.A.C. channel will operate when its R line receiver is connected with a "status symbol" to 0v.

To continually cycle steps 1 & 2 earth the reset side of a CWL stat in WGC 08.

To continually cycle steps 3 & 4 or steps 5 & 6 allow P.A.C. to load then earth E26/1 & E25/3 in WGC 07. This stops the address & count being updated but allows the transfer to take place. If the BTD stat in a data buffer has its reset side earthed the transfer will not take place.

To continually cycle steps 1, 2, 7 & 8 link D7/7 to D10/3 in WGC 08.

To continually cycle step 8 earth the set side of a CT stat in WGC 08.

To cause a Data Buffer to continuously send or receive data operate INH PAC switch and PAC RUN switch and earth the set side of its BTD stat.

To continually cycle steps 9 & 10 set CWL & CWO bit 19 and earth the set side of the CT stat on the required channel.

If the PAC timing logic locks up because it does not receive end of read or end of cycle or both, the contents of the control word buffers can be shown on the K highway lights by operating the CPRZ switch, earthing the set side of the CWL stat of the relevant channel & then pushing the 'GO' button until the steps for that channel show the contents of the control word buffers which have both been incremented by one from the point of failure. P.A.C. can be made to operate with the mains ticker (timer) when PACRUN and TICKER switches are operated.

A fault finding program has been written called PACB to locate and display faults in the PAC data flow and to test the PAC timing logic. When this program runs successfully on each channel, it should then be used to test time sharing if more than one data buffer is fitted. One channel per data buffer can be operated simultaneously.

To make one data buffer timeshare between N channels, earth R of lowest priority peripheral on that buffer and connect its A line to the N-1's R line. Then connect the N-1's A line to the N-2's R line.

A useful test of the control logic and the core store is to transfer the entire contents of the core store outwards through PAC using a status symbol in an R line receiver and the outward and control word recharge style bits in control word 0, while FLIT is running.

Useful scope trigger points for all the above tests are STEP2+ (E31/1), STEP4+ (E31/6), STEP10+ (E29/3) when examining the microprogram & timing logic, SBUSY (D28/1) when checking core store timing, PAC (D31/1) when PAC & CPU are time sharing the core store, BTD (A or C 29) in a data buffer to see data being transferred to or from the data buffer, A (24 to 35) when watching data go through a channel. When a real peripheral is transferring data CWL stat in WGC 08 provides a trigger at the beginning of each transfer.

The standard interface for each peripheral can be tested by sending a selection of commands using the handkeys i.e. 100 order followed by 174 order. With the peripheral on line send \*20 (Q status) the response will be bits 5, 4 & 3 at least and can be seen on the CPU Q highway (fanned to 4 characters) on the beat before the T stat sets on the 174 order or in the A register after the 174 order. Similarly bits 2 & 0 can be tested by sending the peripheral its normal read or write command. Bit 1 can be tested if the peripheral HOLD button is pushed and \*24 is sent.

The P.A.C. ONLY switch can be usefully employed if one needs to check what happens after a peripheral has transferred some data e.g. to see if the peripheral terminates properly or to examine the control words. Operating the PACONLY switch can be done in complete safety with normal mode or executive mode programs. P.A.C. will take and keep control of the store when a data transfer is started causing the CPU to stop. Switch the CPU off 'RUN' and go off PACONLY. The CPU can then proceed.

WGC 07/GEN 4

|     |      |  |  |
|-----|------|--|--|
| SUB | ISS  |  |  |
| ACW | 1566 |  |  |
| ACD |      |  |  |



SETTING UP TIMING OF PAC

WGC 07

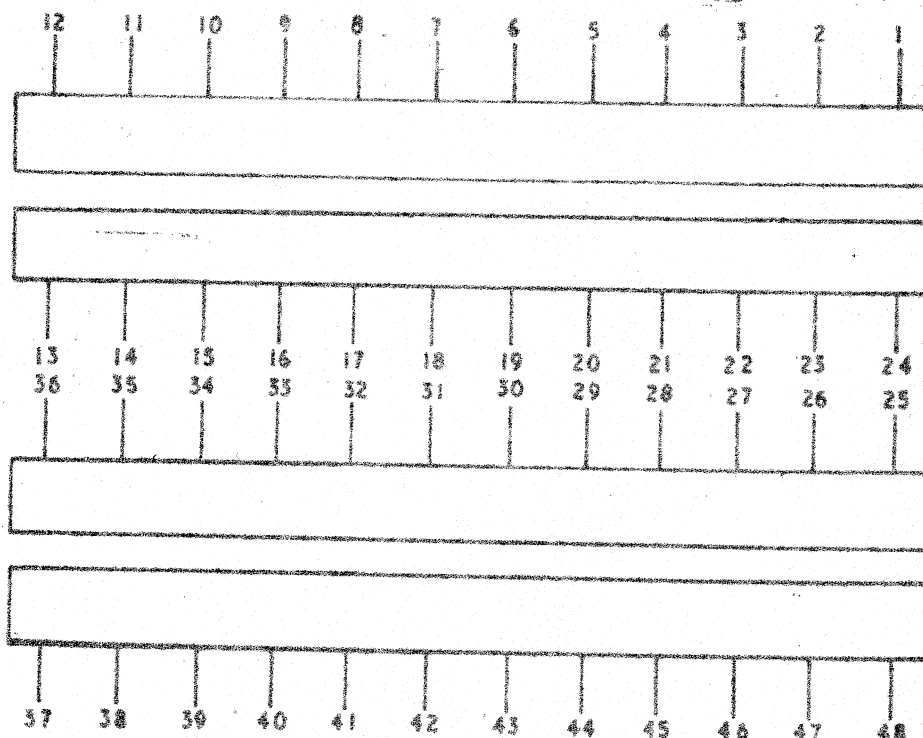
- a) Set 4.5 volt bias on D22 (Monitor point 2) using an AVO.
- b) Set D21/2 to produce a pulse 450 n/sec wide to mask the selection of a STEP (Pot 9)
- c) Set D21/1 to produce a pulse
  - (i) 150 n/sec wide for no 'Step' (Pot 2)
  - (ii) 450 n/sec wide for 'Sout-Q' (Pot 3)
  - (iii) 700 n/sec wide for 'Sub' (Pot 4)
  - (iv) 700 n/sec wide for 'Add' (Pot 5)
  - (v) 630 n/sec wide for 'Sub' & 'Variable' (Pot 8)

(Can be set with 1 word recharge outward transfer, on PAC ONLY Trigger Step 10+)
- d) Set D37/2 to produce a cycle initiate 150 n/sec wide. Monitor D26/6- (Approx Tap 40)
- e) Set D25/1 so that PASDD+ is true until 50 n/sec after PABUSYB+ sets when loading control word 1 (i.e. Step 9). Should be set with a 1 word outwards transfer (Approx. Tap 6)
- f) Set D34/2 so that SNR+ (D29/2) goes negative 650 nsec or 1.8 usec after SCI (D26/8).
- g) Set D25/2 to Tap 25 except if one or more 650 n/sec stores are connected when this delay allows the parity to be calculated for some time before a write cycle is initiated, such that SCI+ (D26/8) occurs no earlier than 250 n/sec after PATSELD+ (D27/1) during Step 6 (Approx Tap 33)
- h) Set D34/1 to allow the 'Enable' logic in WGC 02 to become steady before a cycle initiate is given by WGC 01 after PAC relinquishes the store (Approx Tap 6)  
(Set with a 1 word outwards recharge transfer, transferring data to the upper store and with the C.P.U. doing an O45 function on "ORDER")
- j) Set D37/1 to allow the parity fail stat to be strobed at least 150 n/sec after its input (D20/6) is steady when reading from store (Approx Tap 24)

WGC 07/1 & WGC 07 Box 'C'

- a) Set 32/1 to produce clock pulses from 23/1 1 u/sec apart minimum (Approx Tap 24)
- b) Set 32/2 so that its output goes negative 0-50 ns after 31/6 goes negative (Approx TAP 42)

Numbering of Delay Line Taps

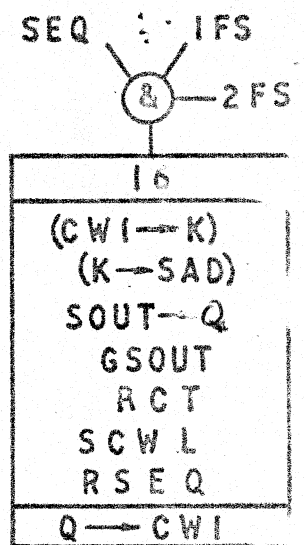
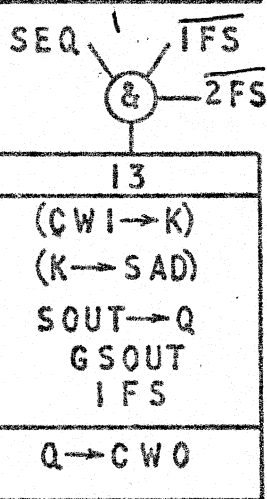
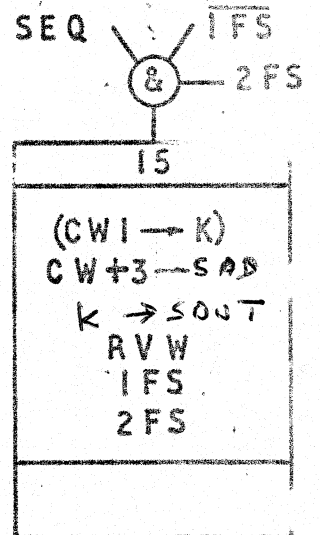
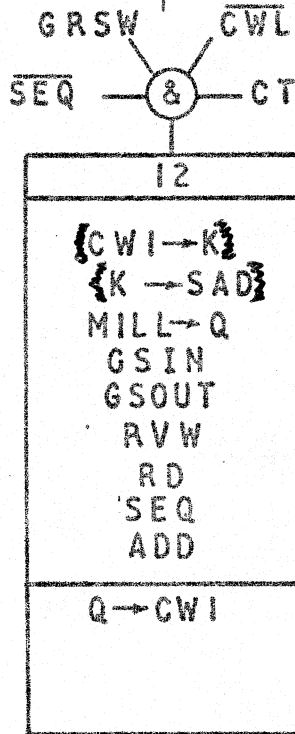
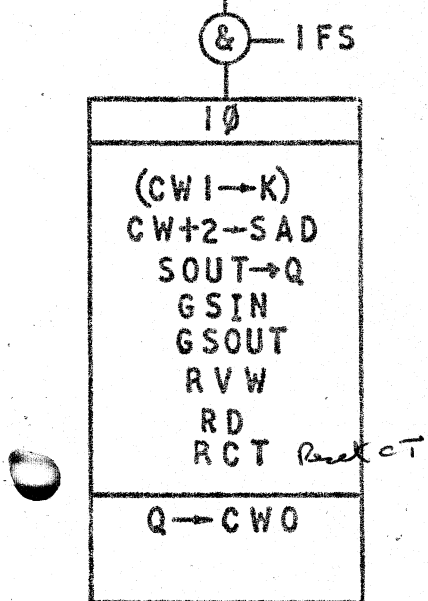
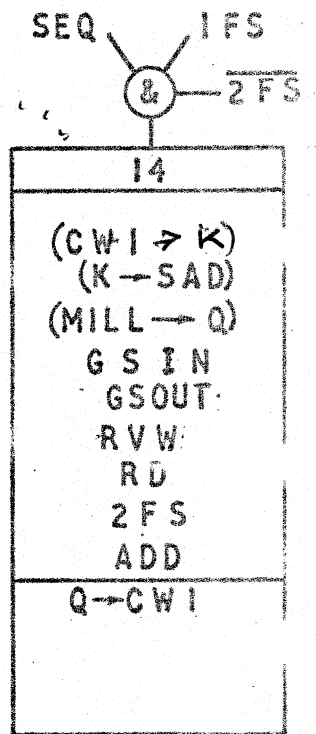
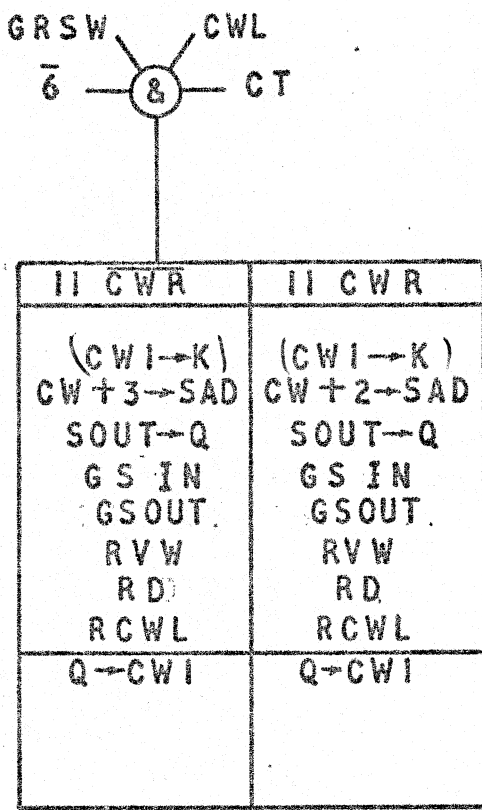
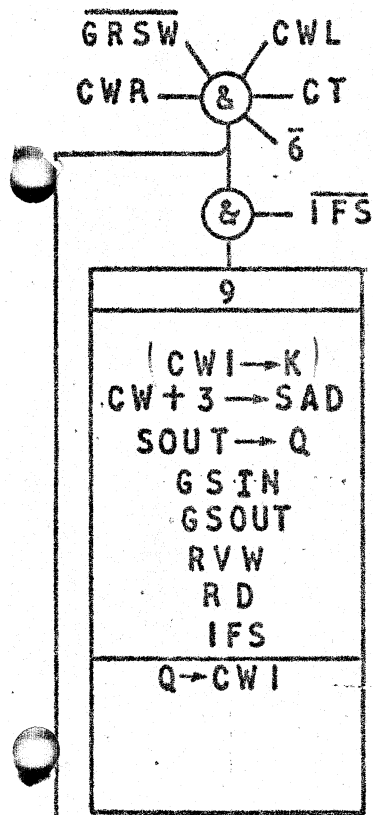


WGC 07/PAC 3

|      |          |        |         |          |
|------|----------|--------|---------|----------|
| SUB  | ISS      | 1      | 2       | 3        |
| ACW  | 0912     | 0970   | 1517    | 1546     |
| ACD  | -        | -      | -       | -        |
| DATE | 19/12/67 | 4/3/68 | 20/6/68 | 29/10/68 |



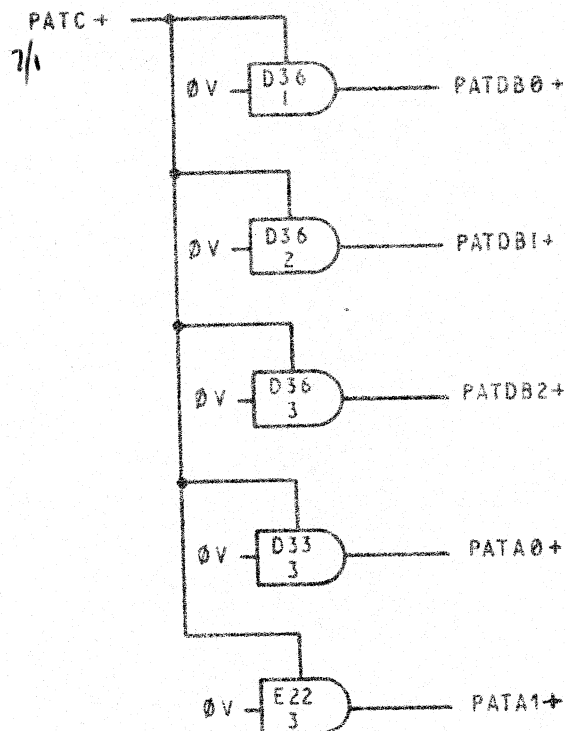
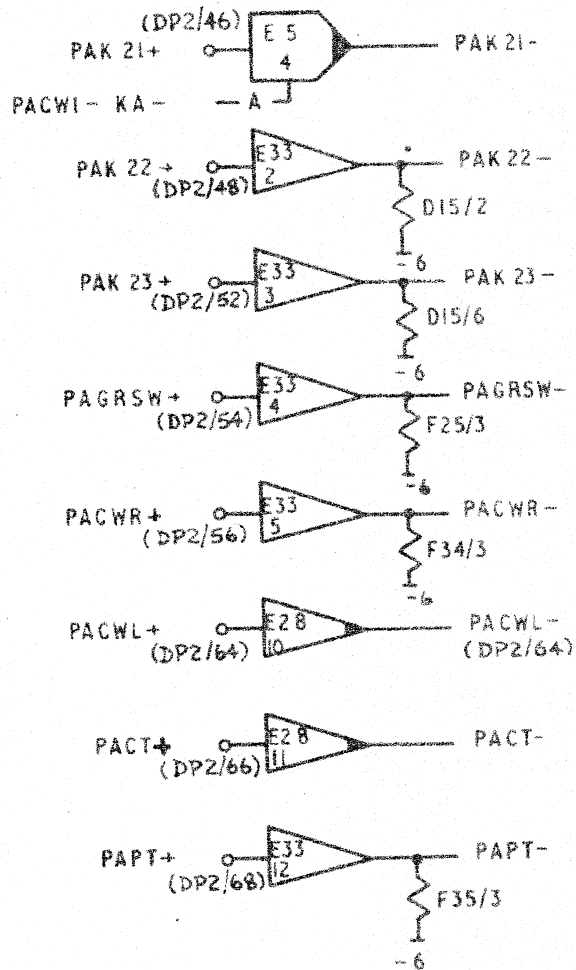
*gather Res  
Scattered With*







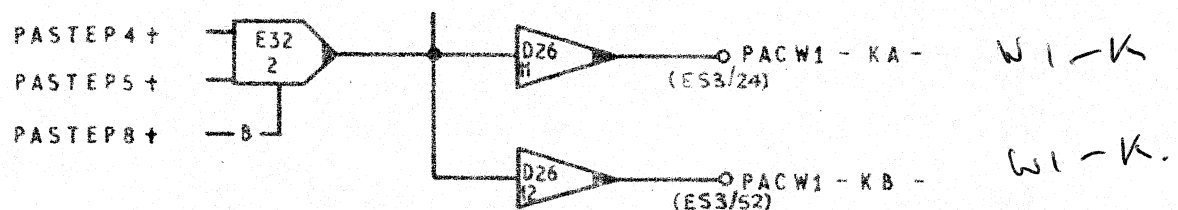
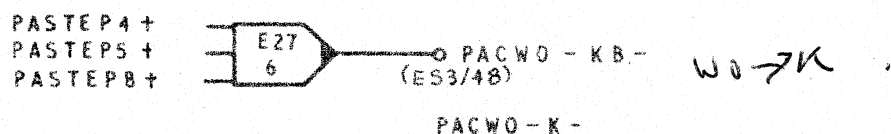
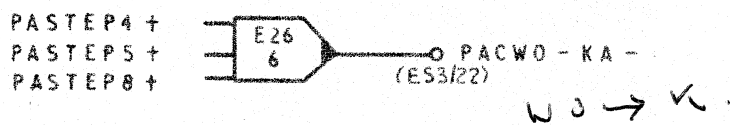
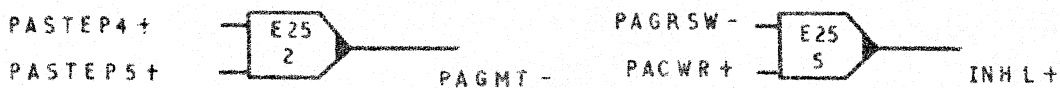
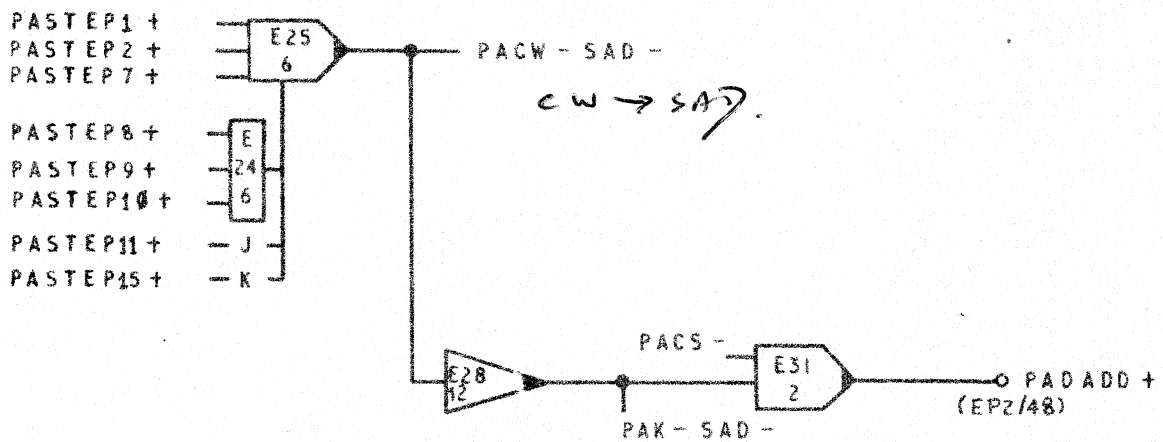
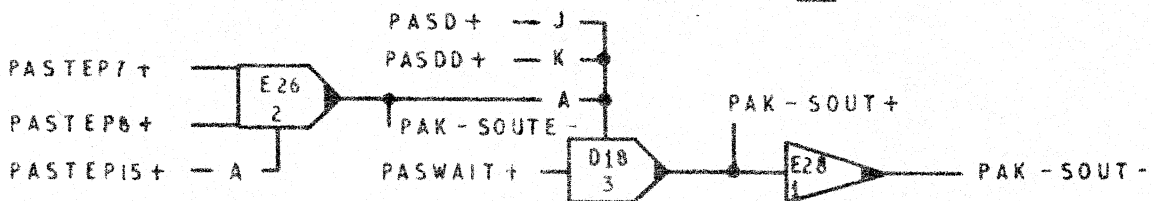
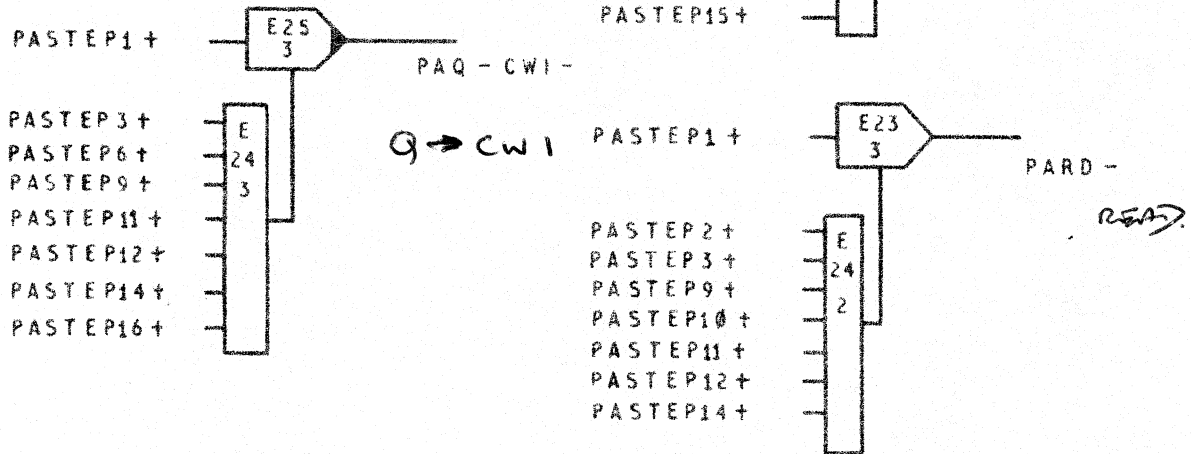
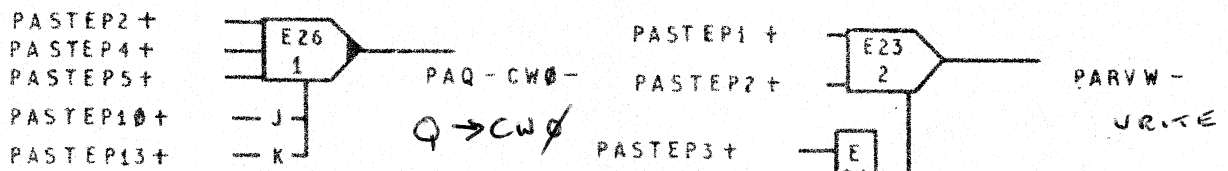






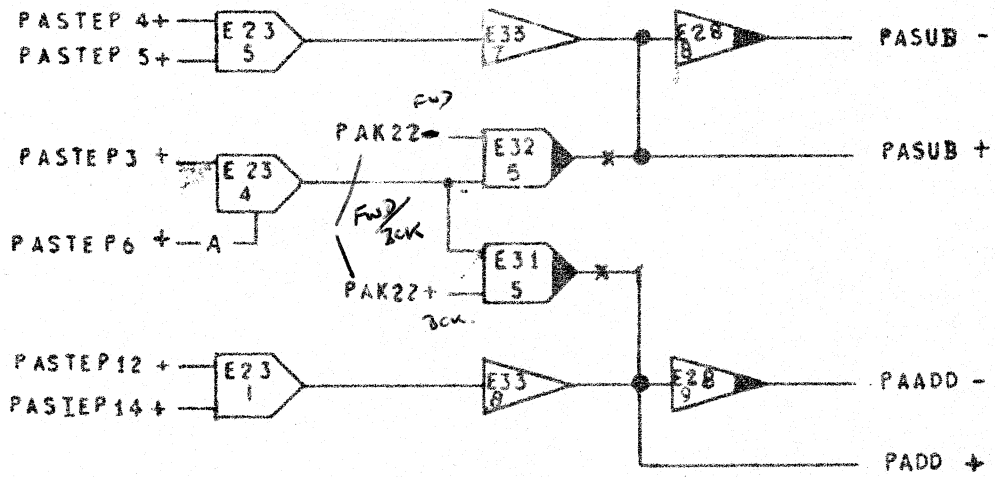
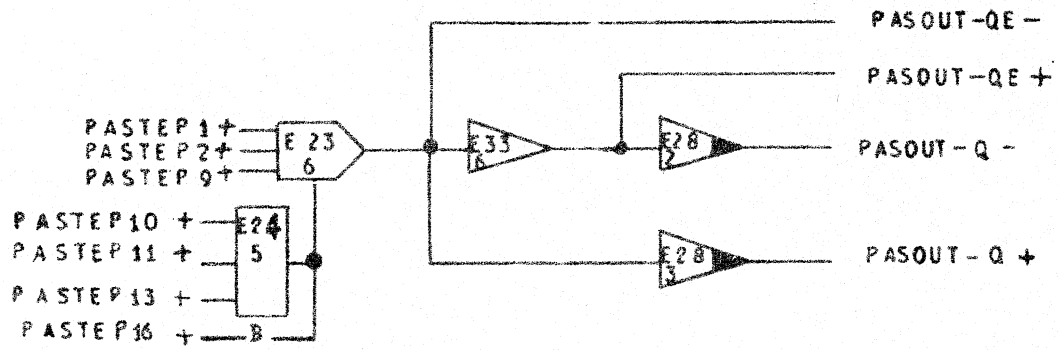


PART DECODED OF STEPS.





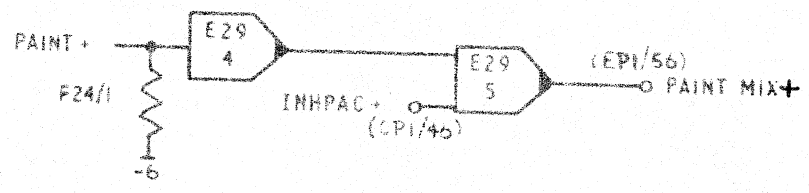
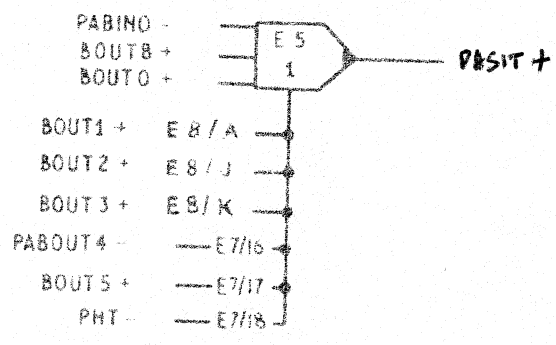
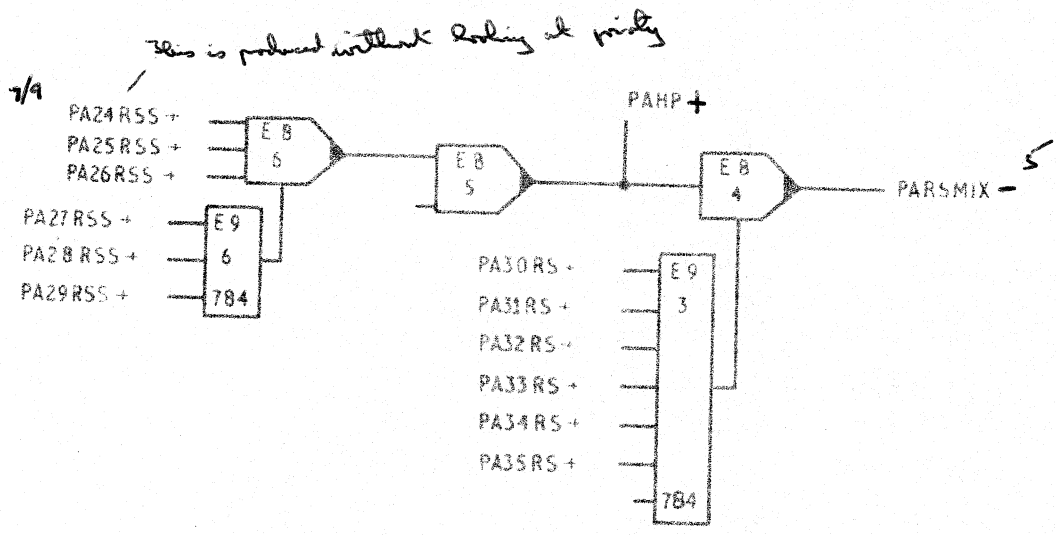
# DECODE OF STEPS



WGC07/8



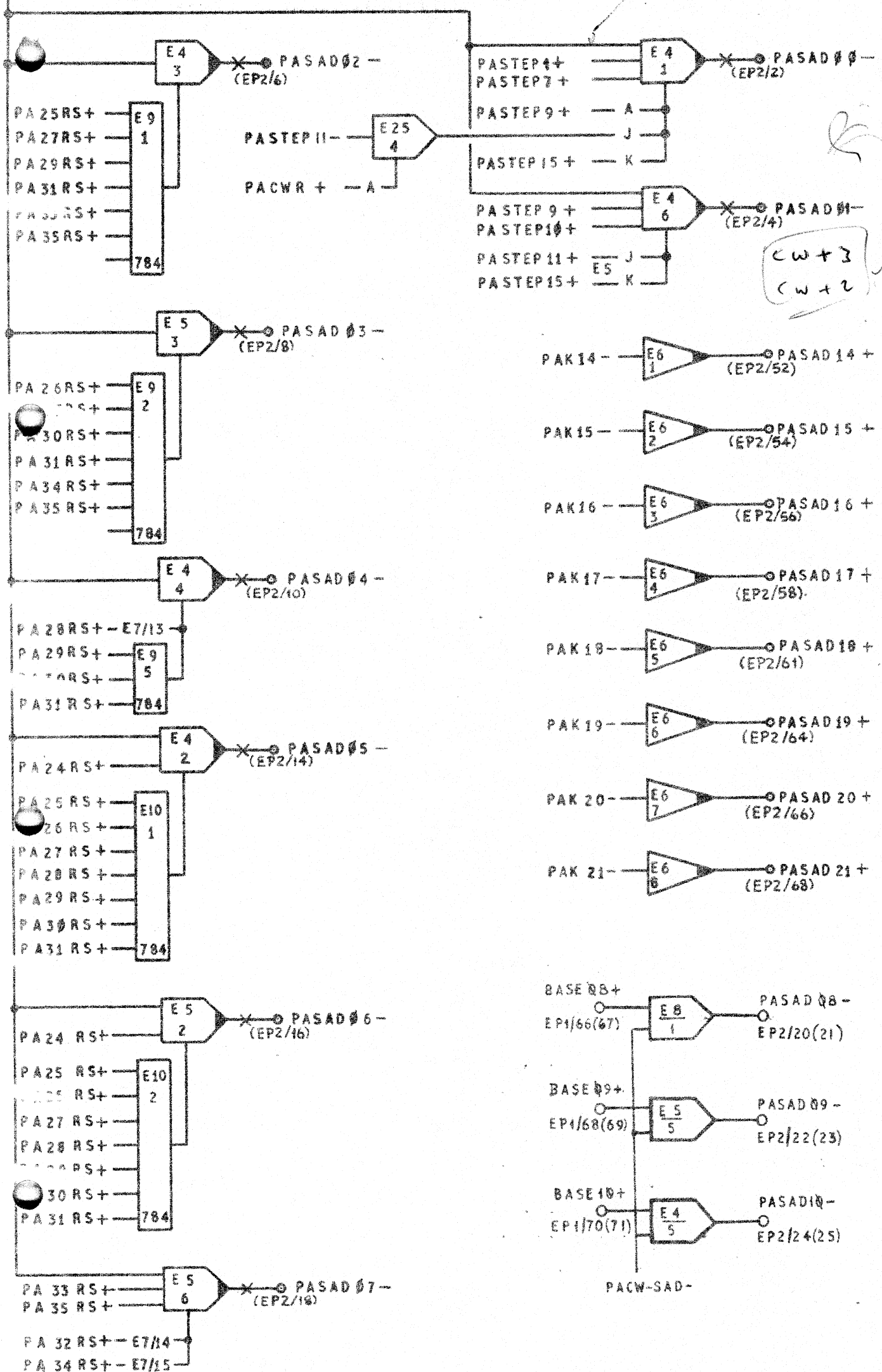






# CONTROL WORD ADDRESS ENCODER.

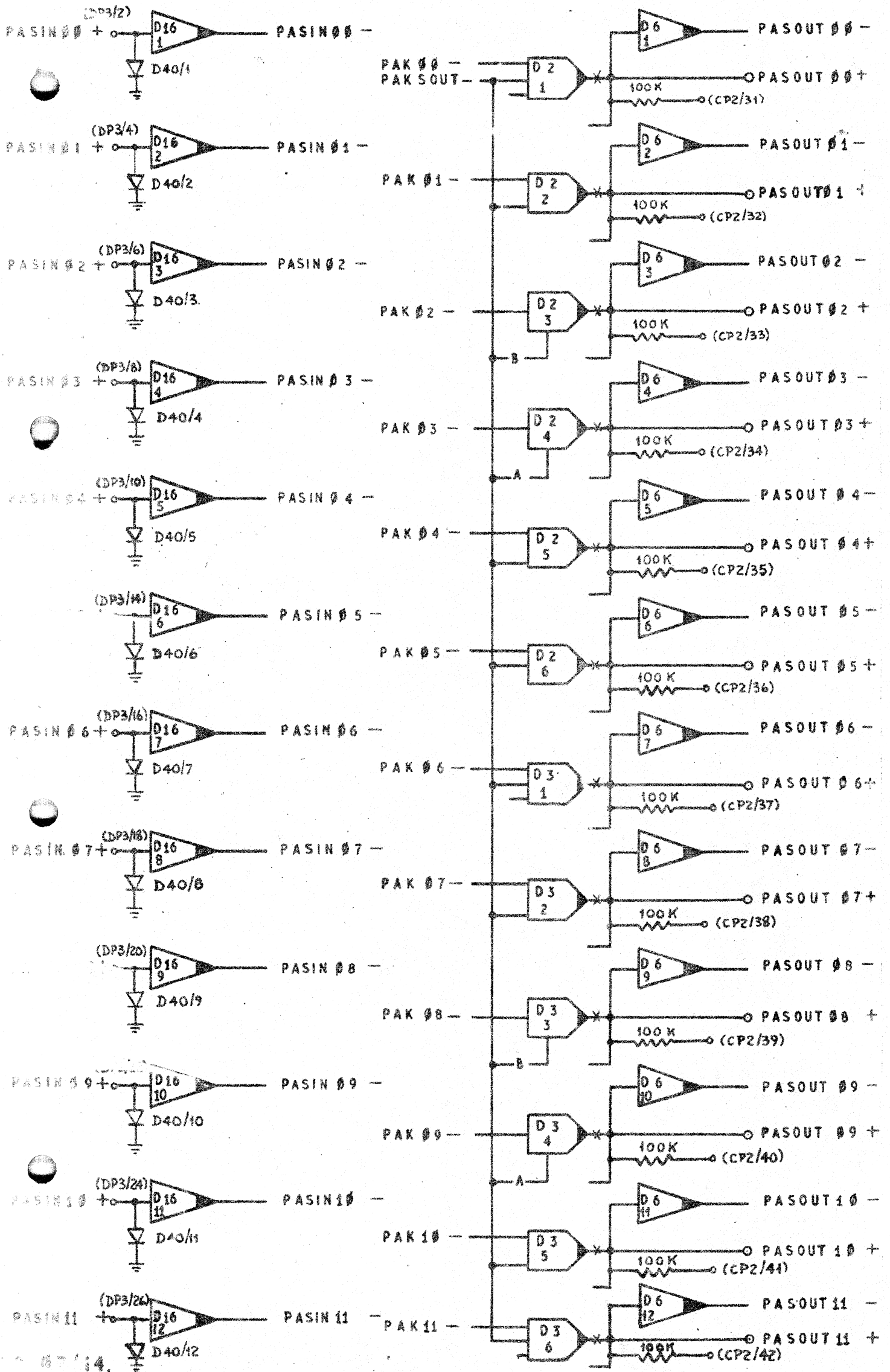
PACW - SAD -

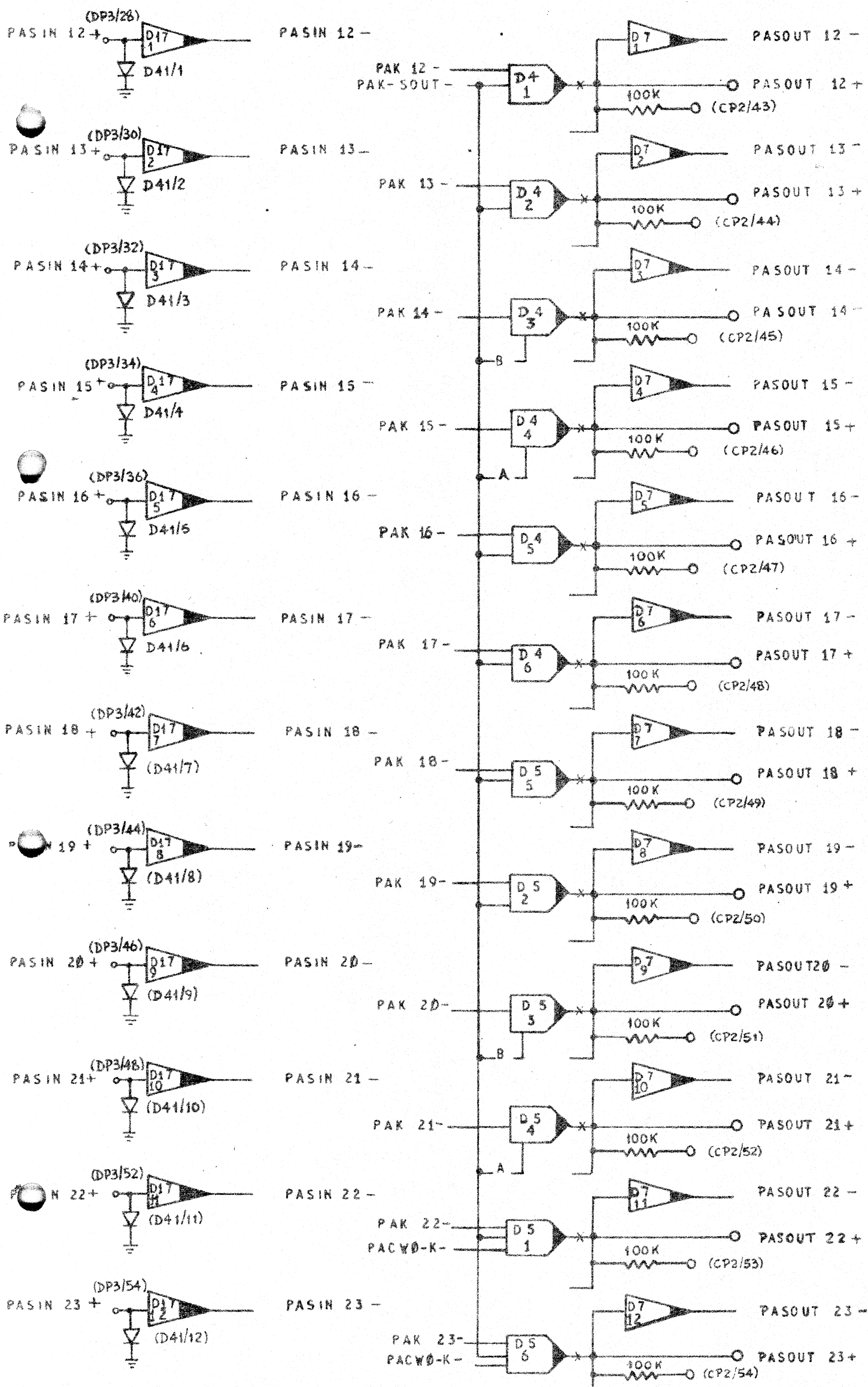


CW + 3  
 CW + 2



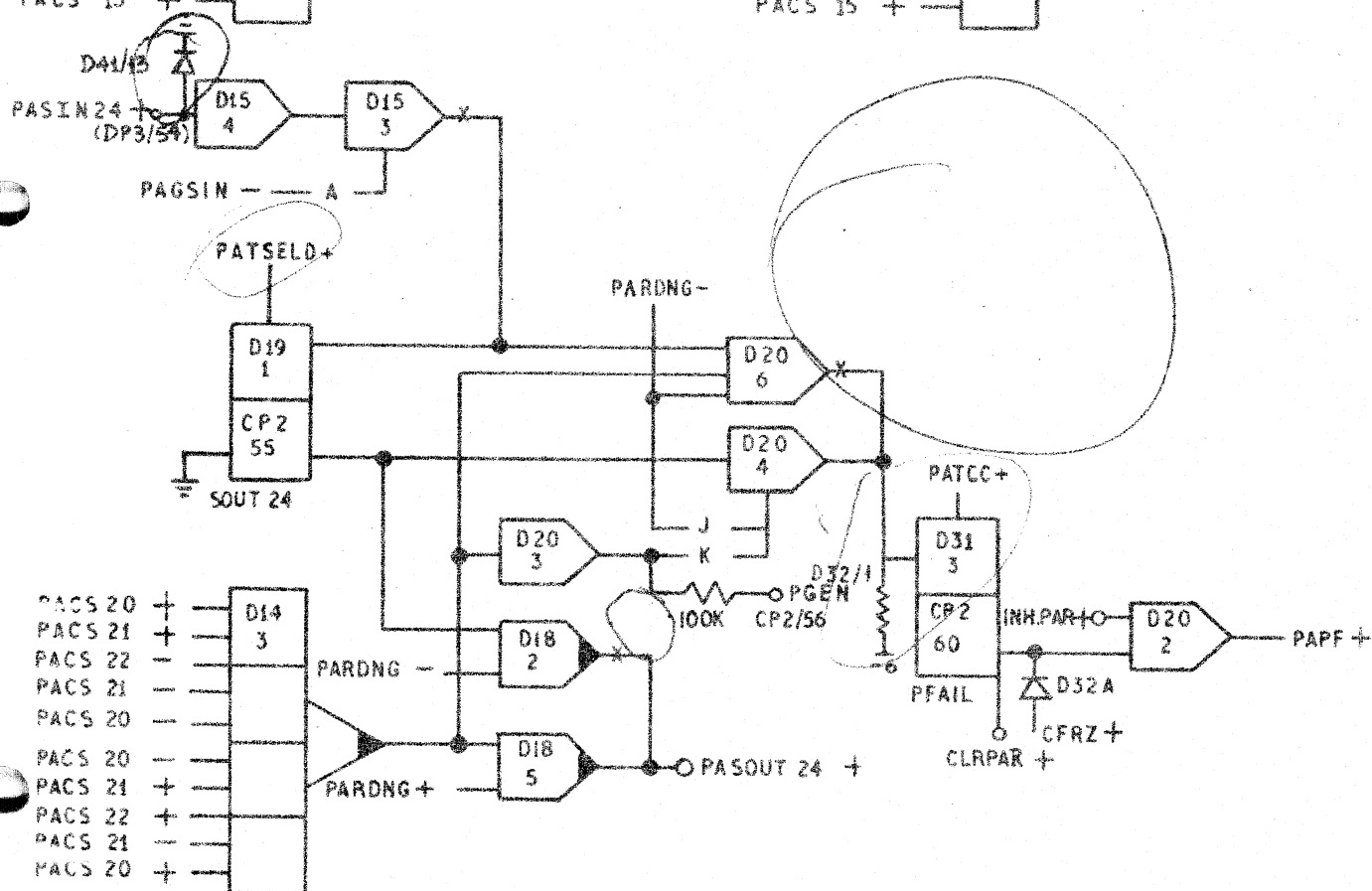
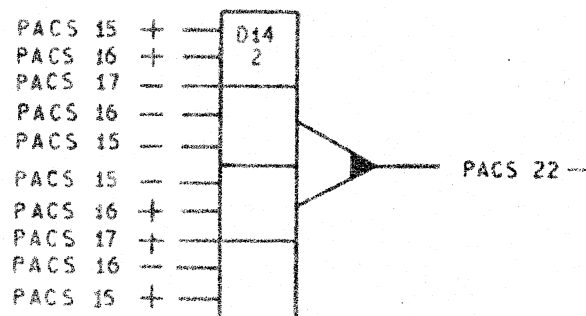
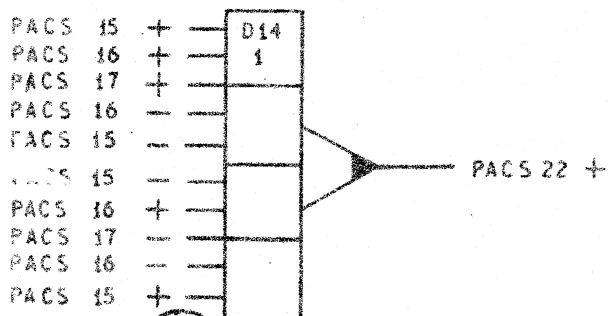
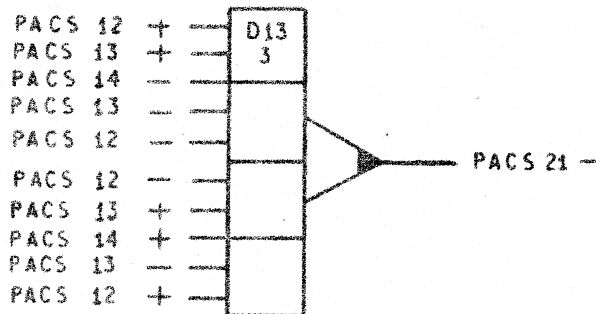
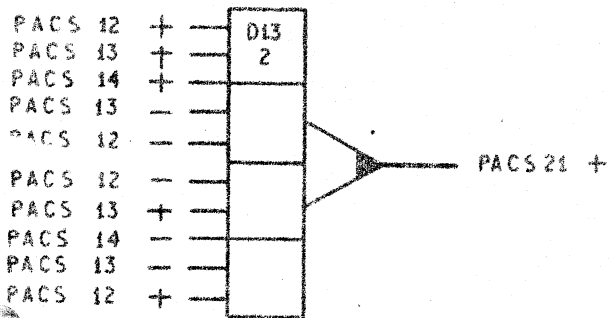
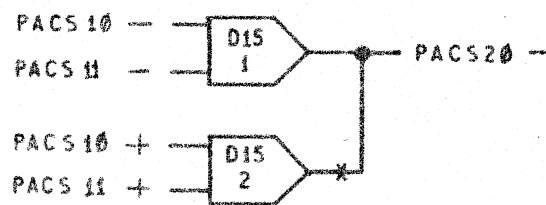
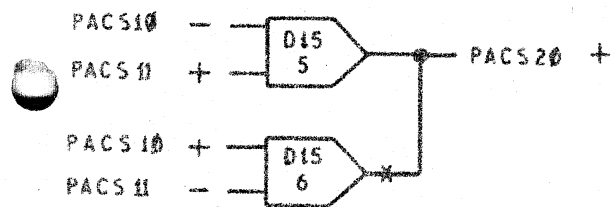
# CENTRAL CONTROL SIN & SOUT



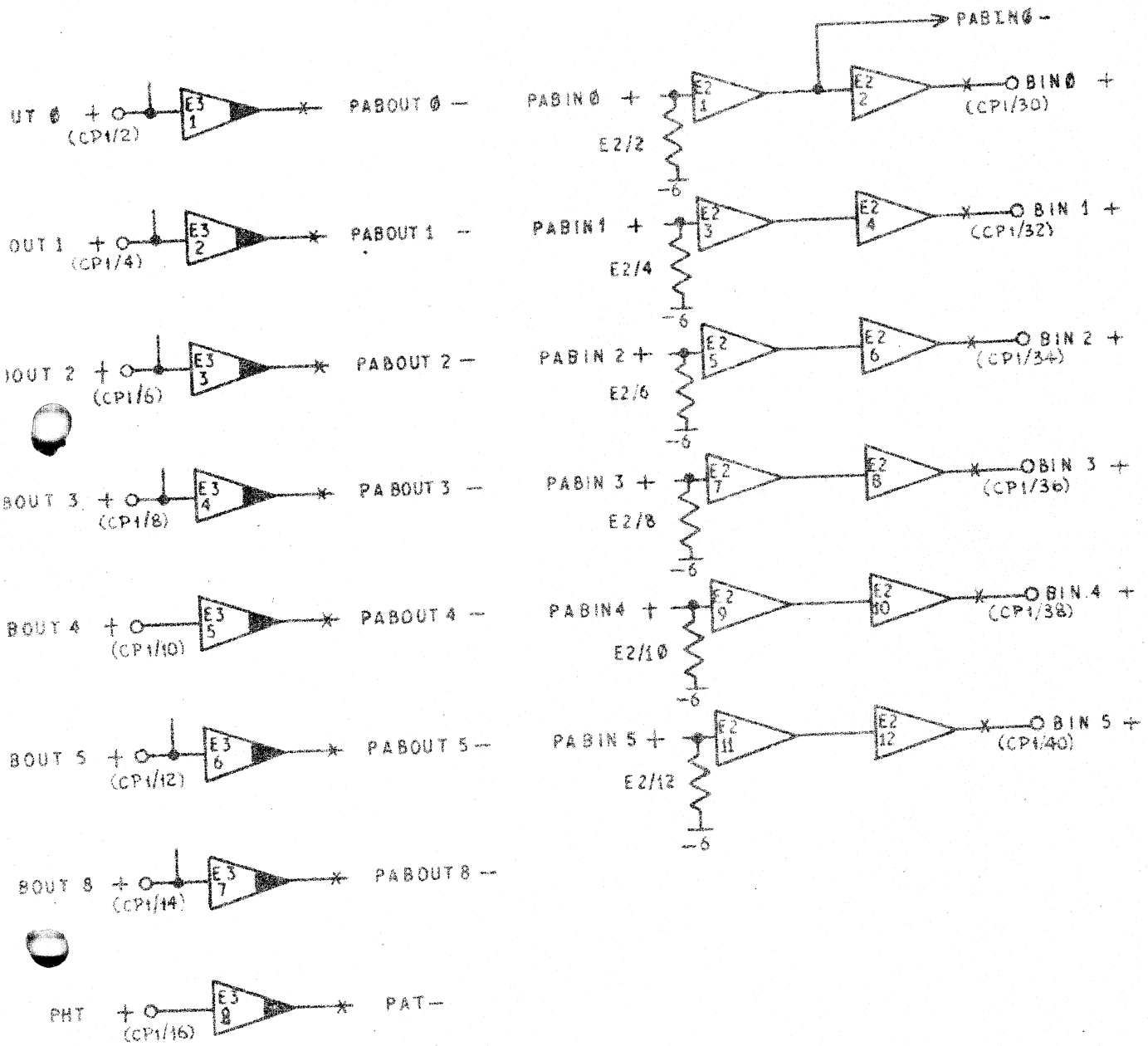






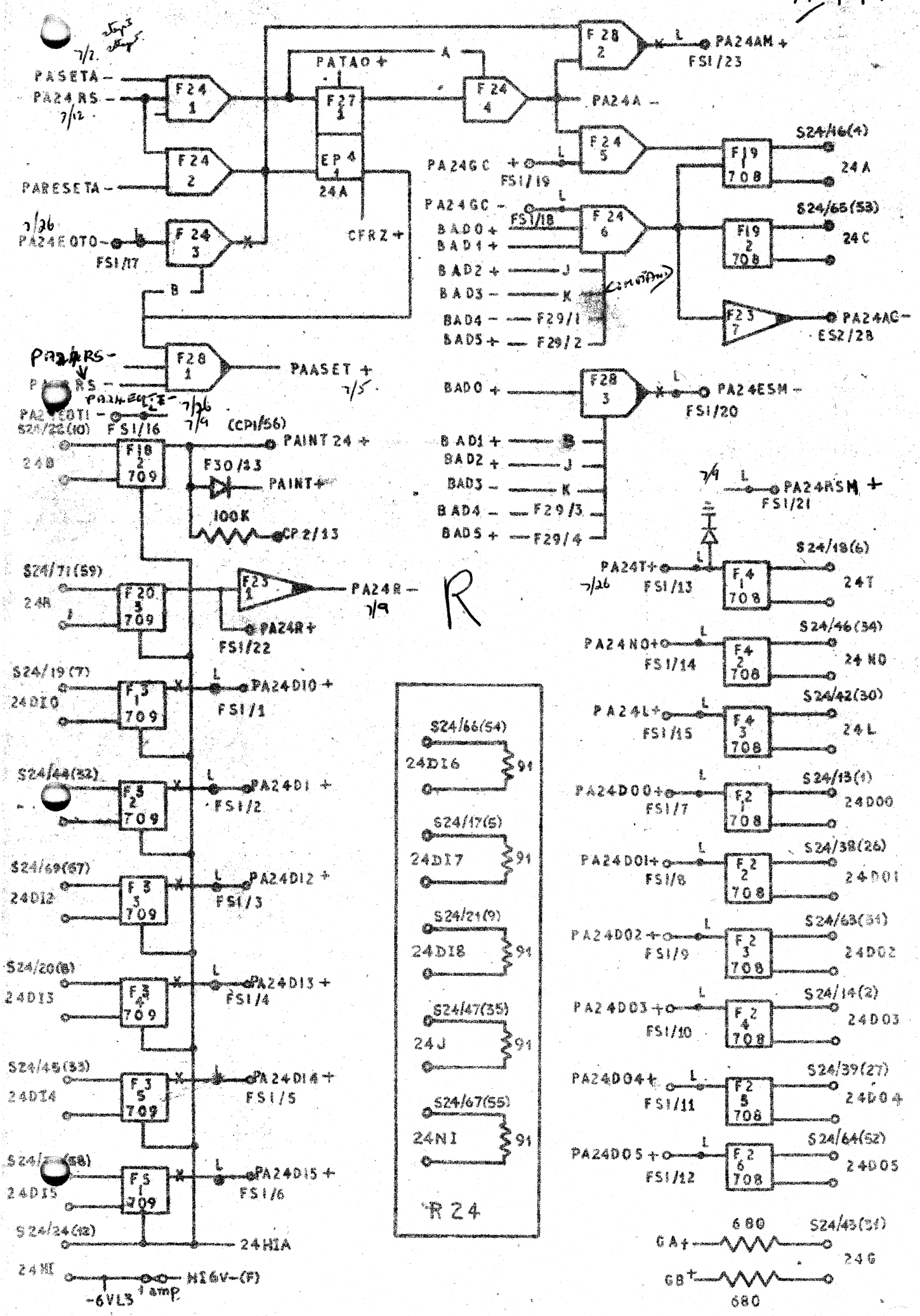


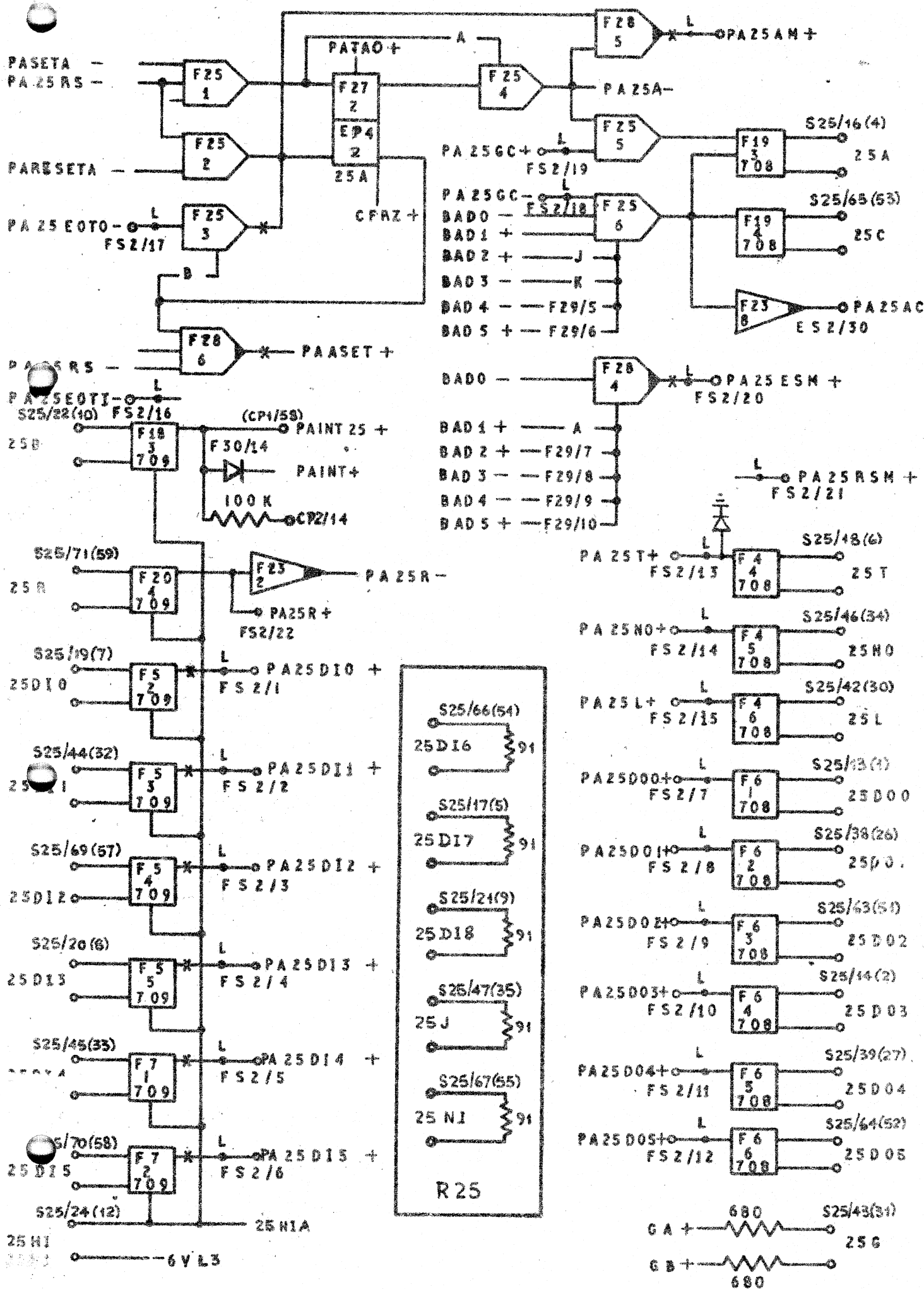
BIN & BOUT



S.I. 24

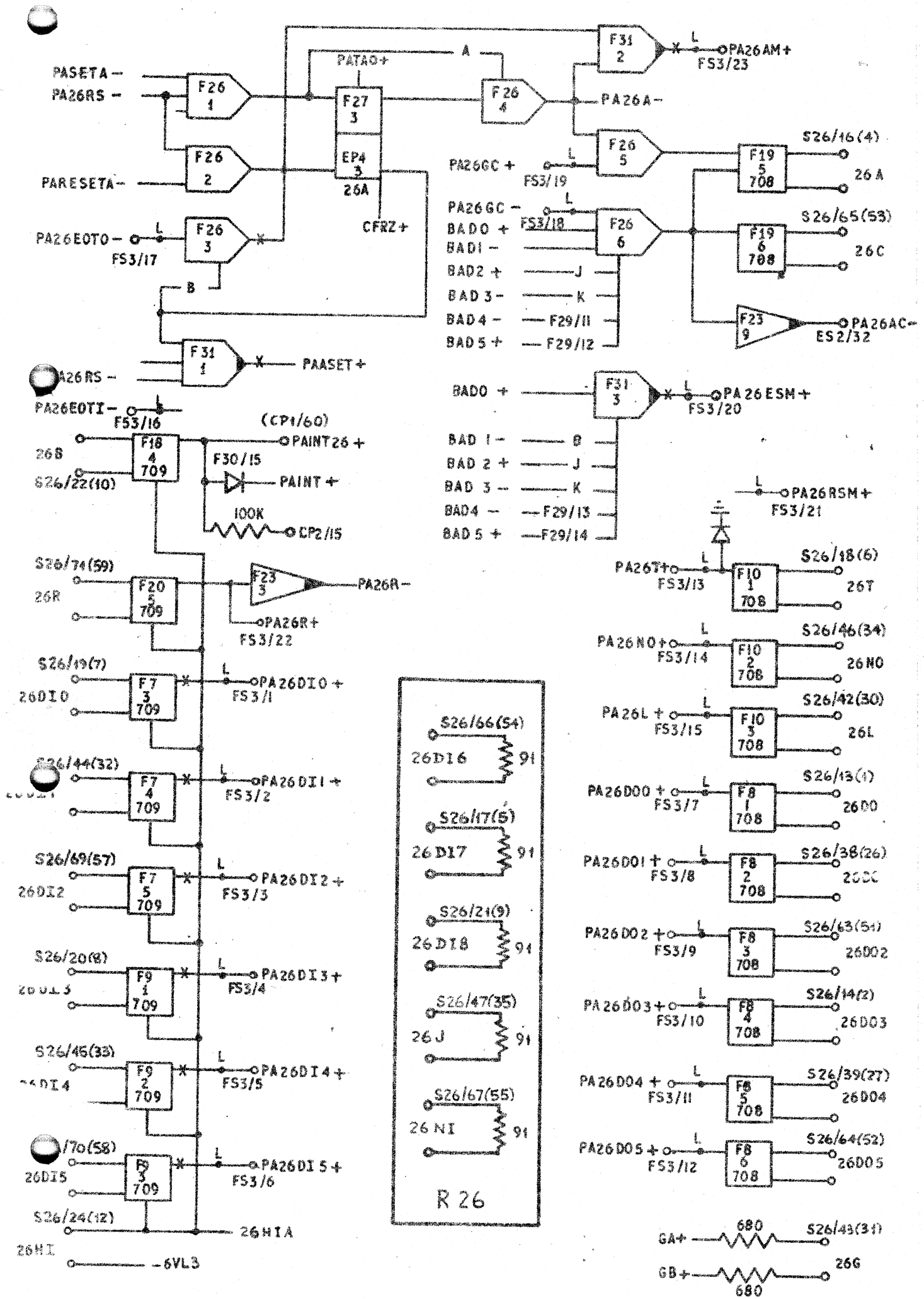
Any A line of  
 part if possible  
**A MIX**



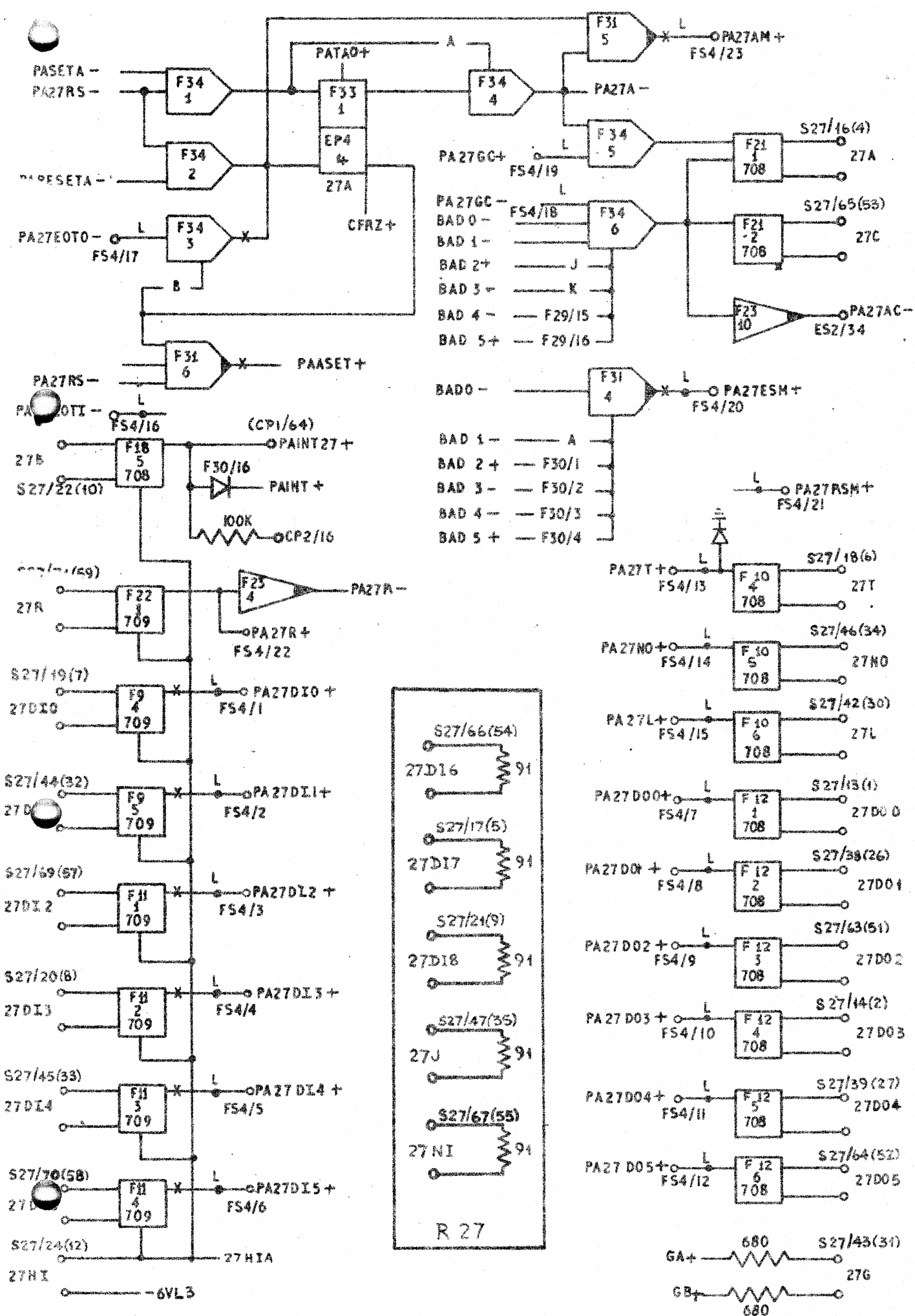


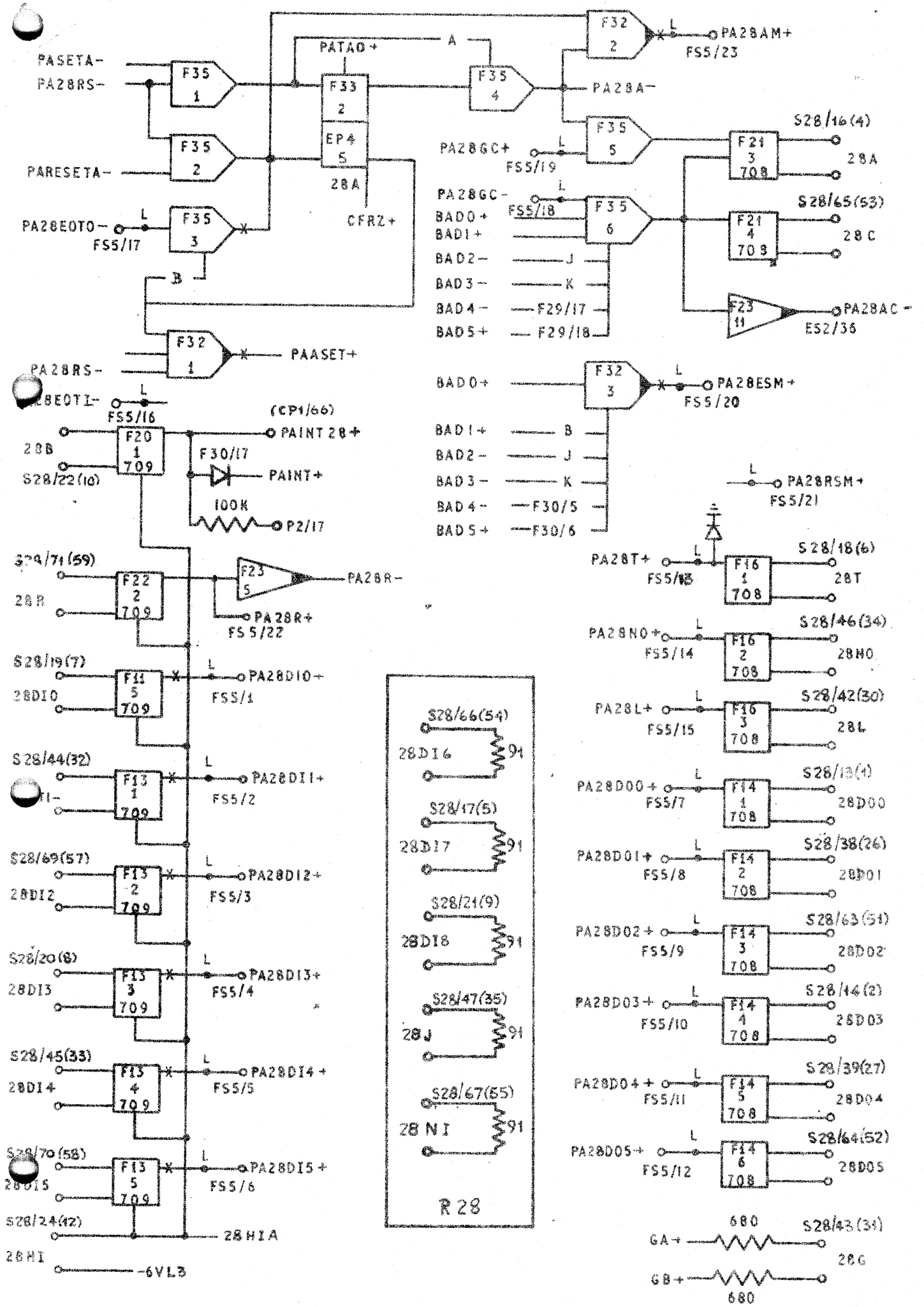


S. I. 26



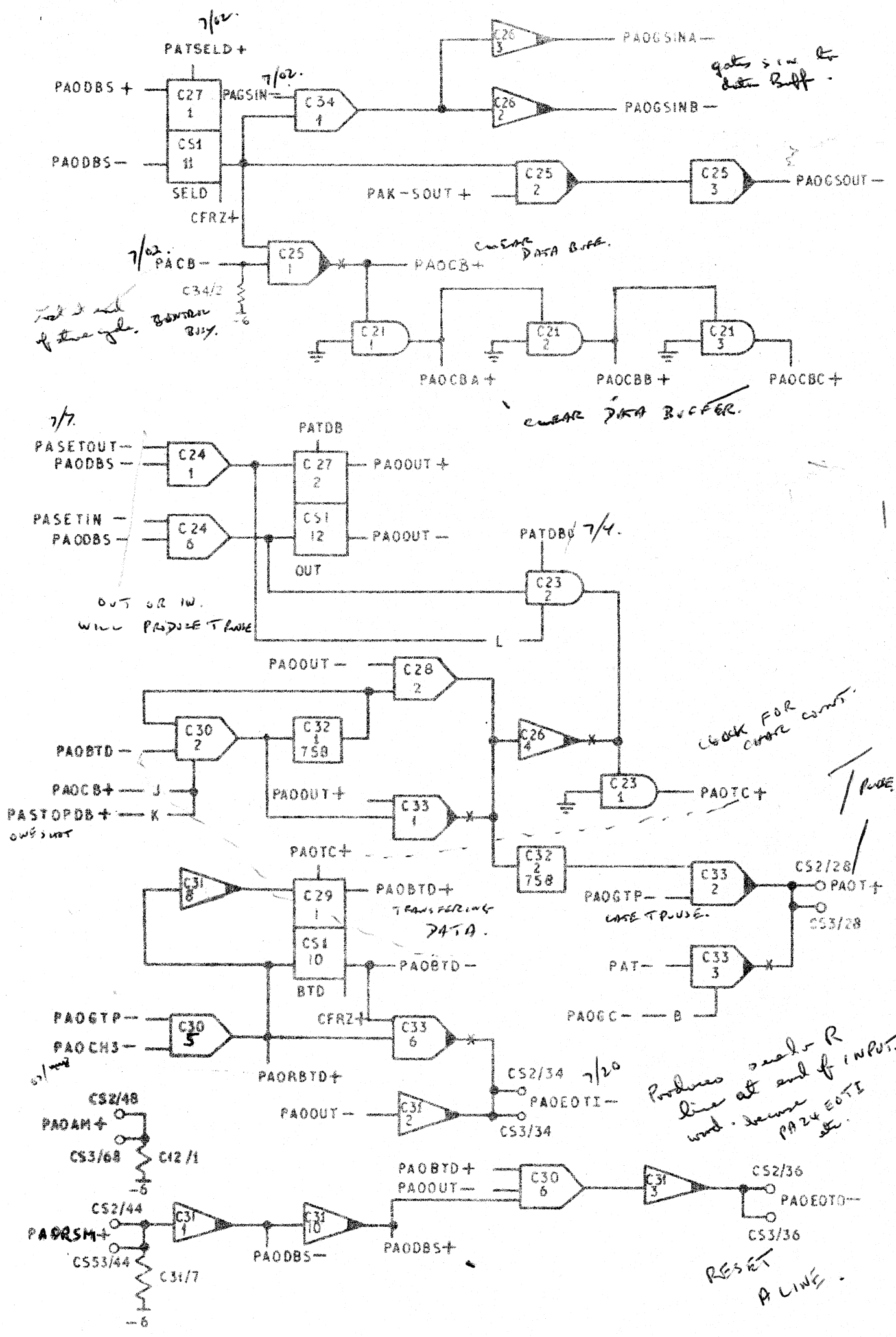
S. I. 27











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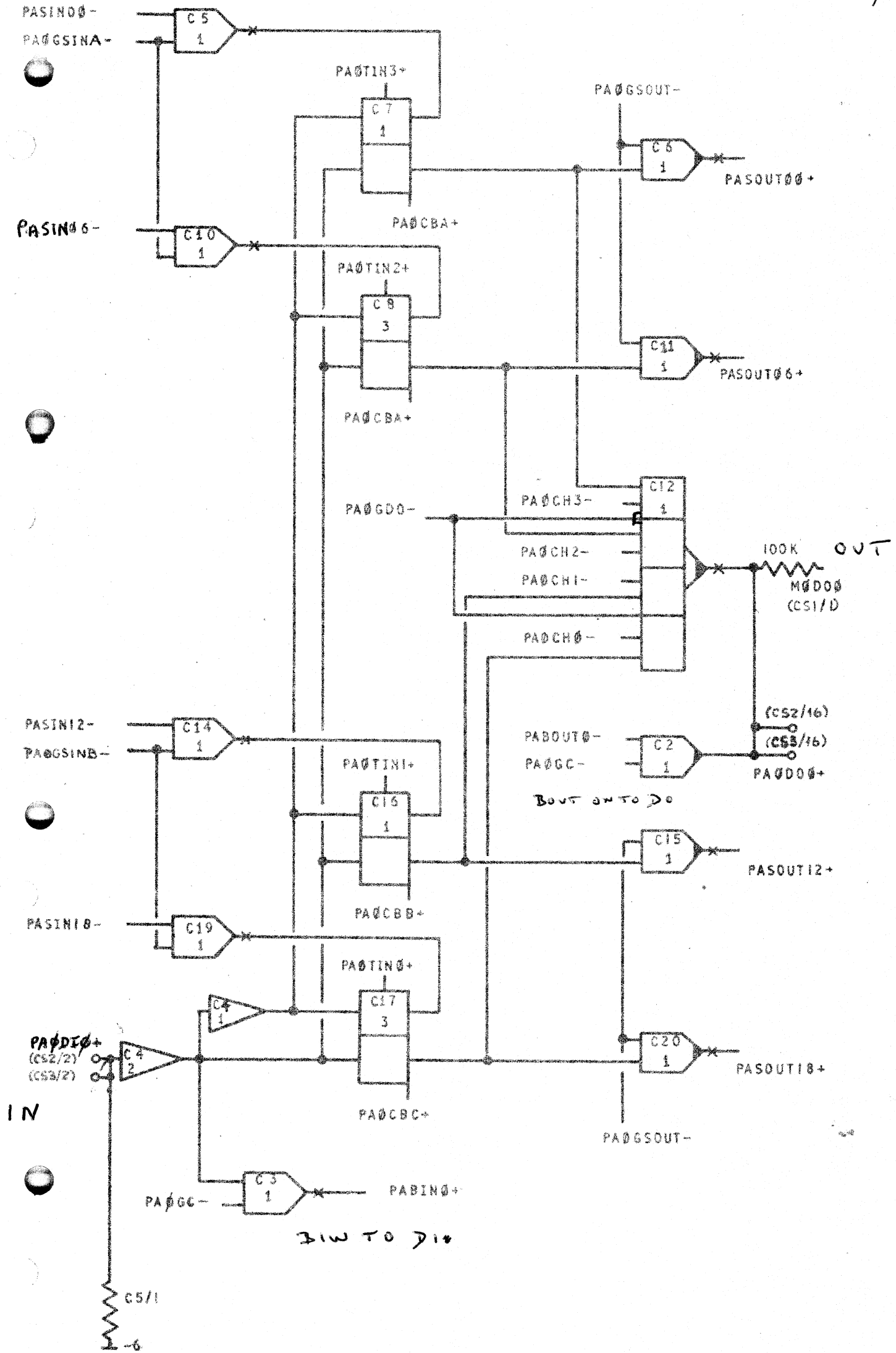
| ISS      | 1      | 2      | 3       | 4       |  |  |  |  |  |
|----------|--------|--------|---------|---------|--|--|--|--|--|
| 0874     | 0931   | 0970   | 1516    | 1560    |  |  |  |  |  |
| 31/10/67 | 2/1/68 | 4/3/68 | 30/4/68 | 19/9/68 |  |  |  |  |  |



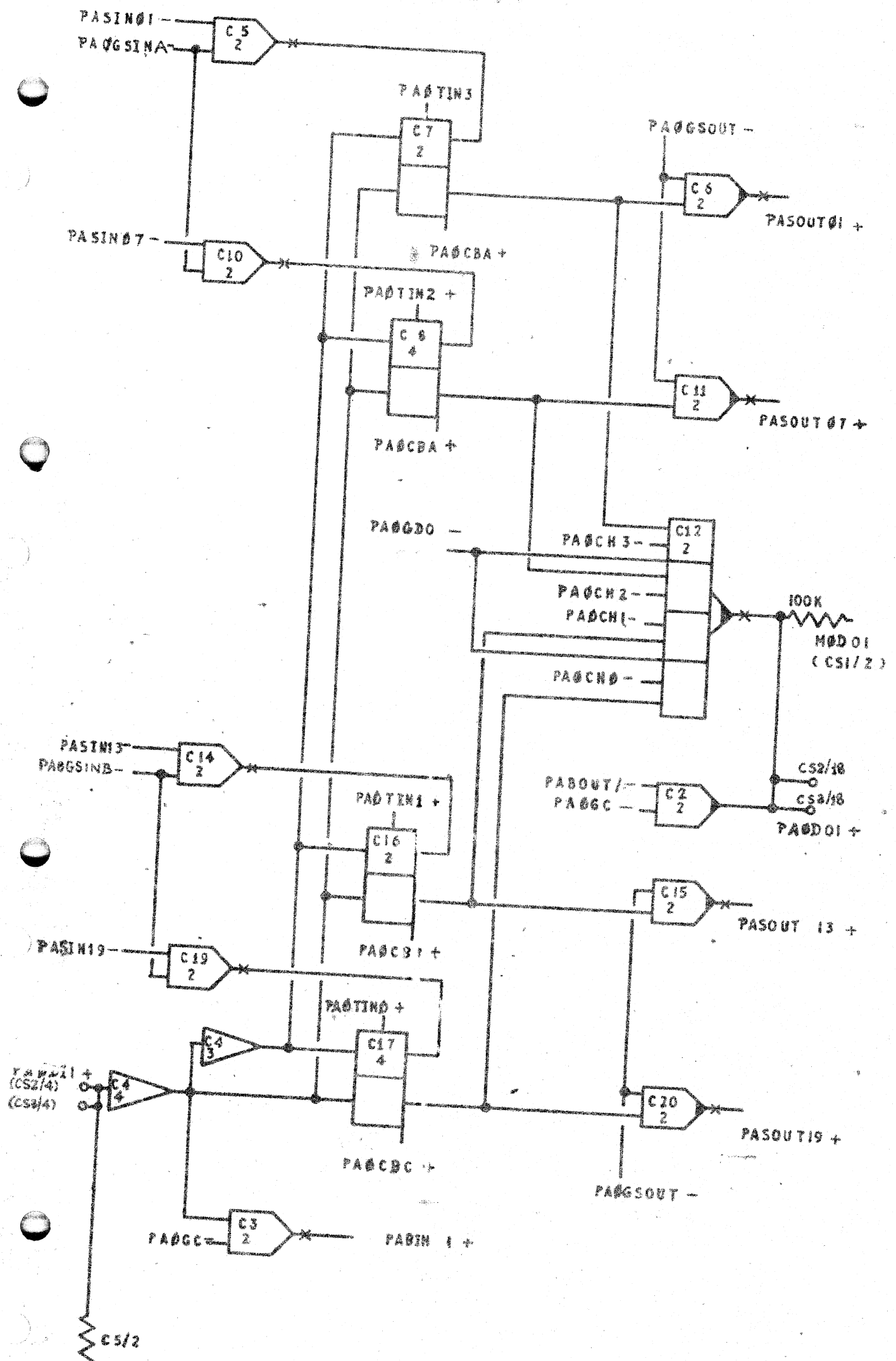




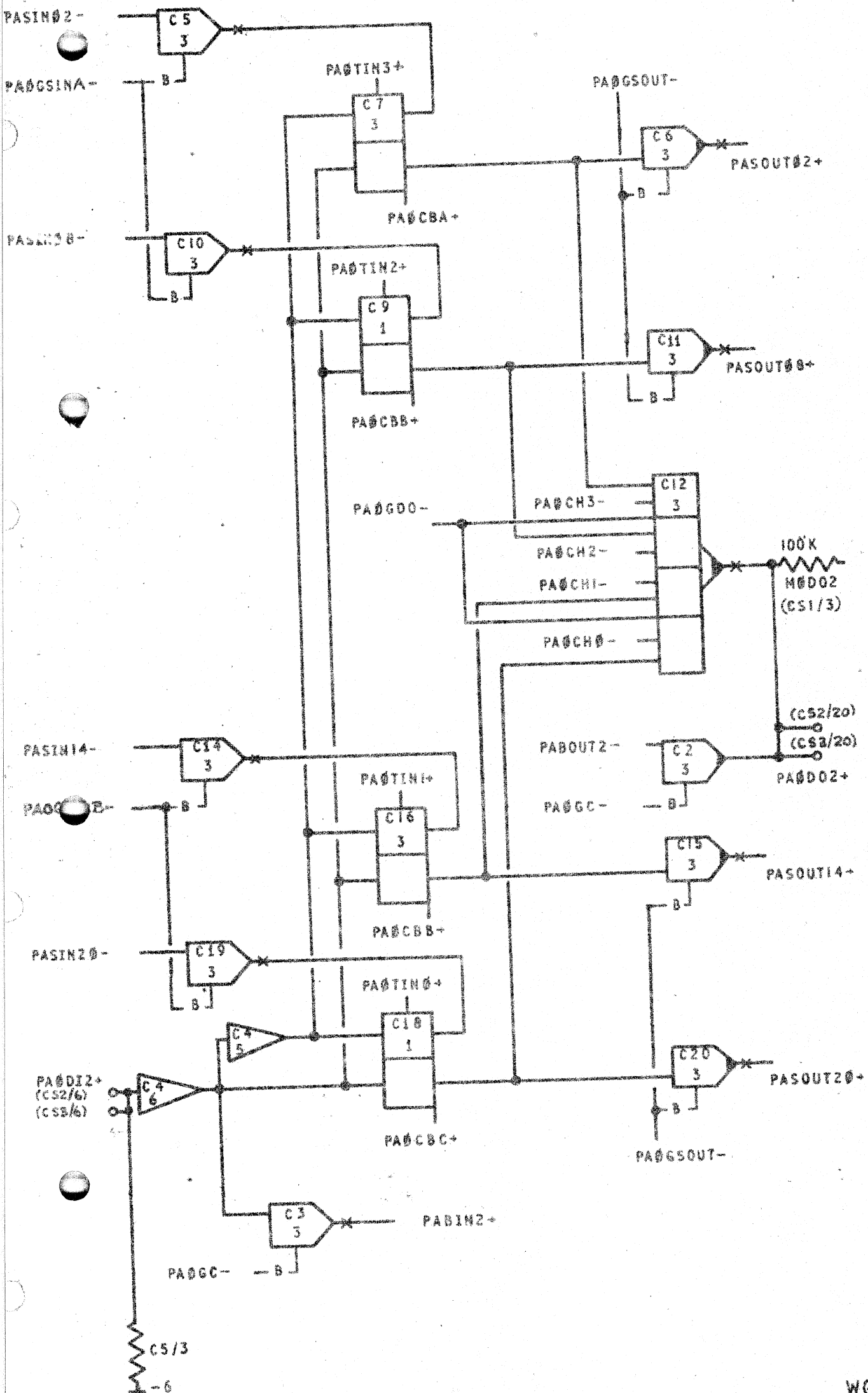
DATA BUFF  $\phi$   
 BIT  $\phi$  OF CHARS 3, 2, 1, 0  
 3 2 1 0



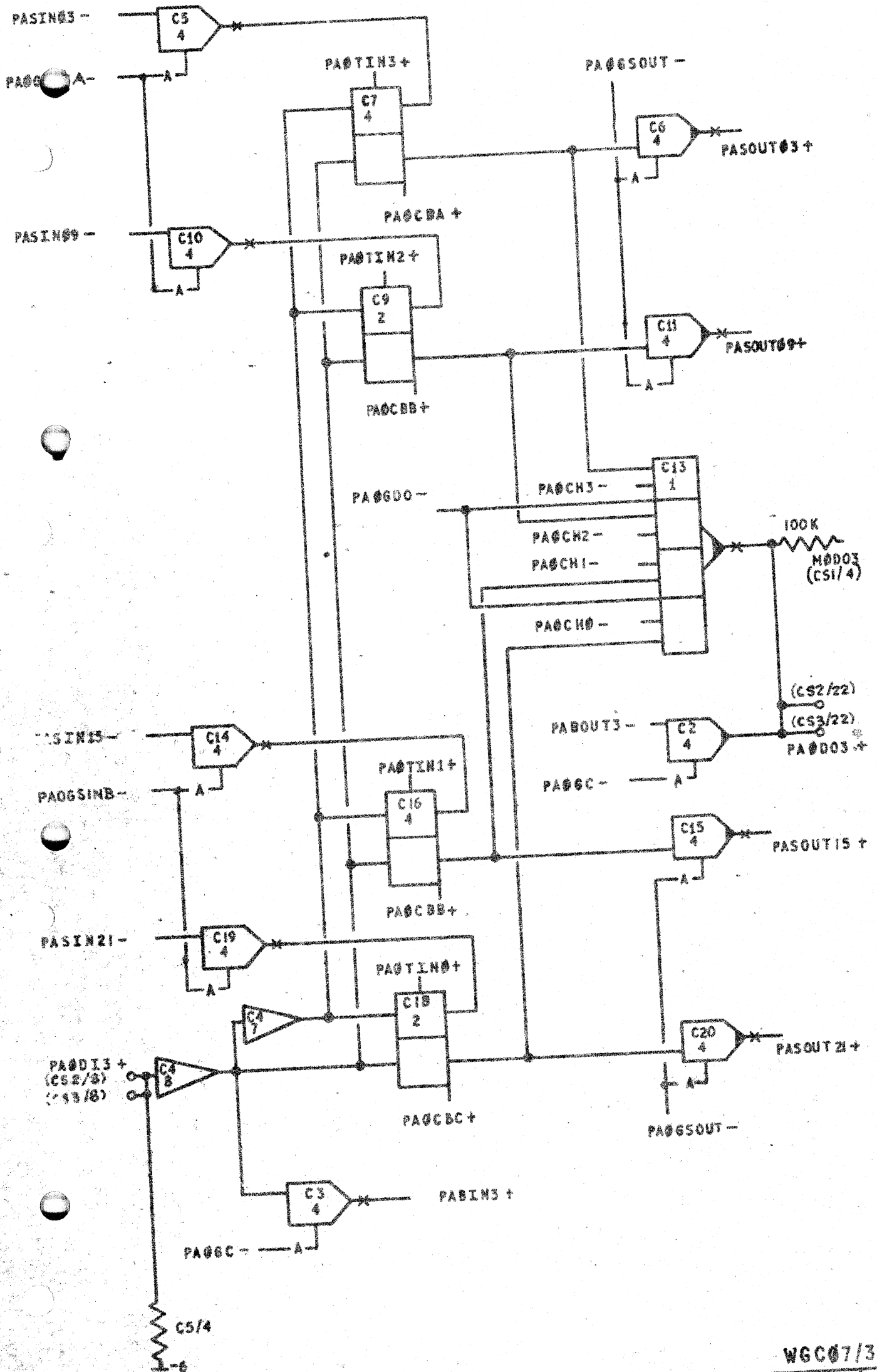
BIT 1



BIT 2



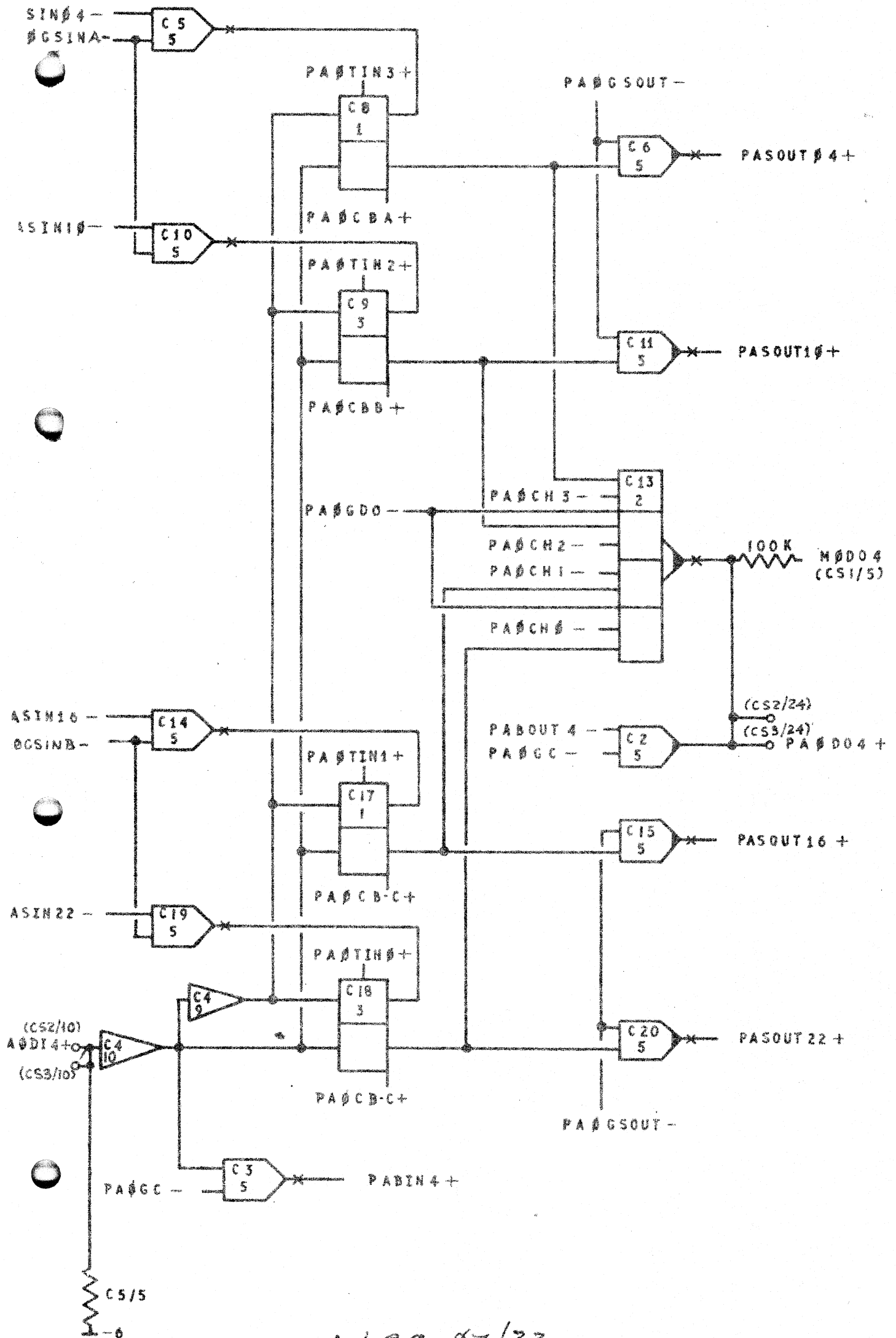
BIT 3



DATA BUFFER 0

WGC07/32

BIT 4

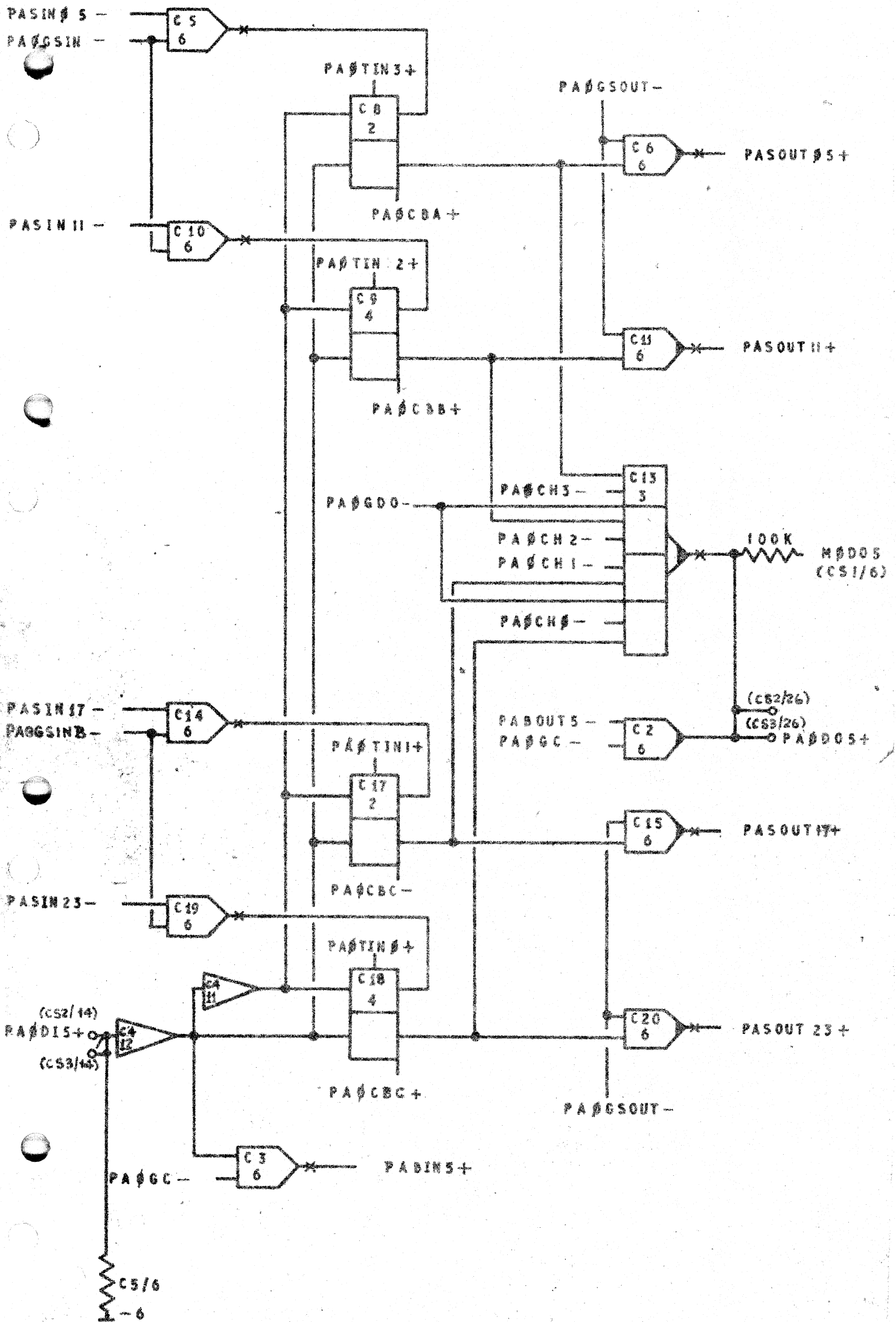


TA BUFFER 0

W.G.C. 07/33

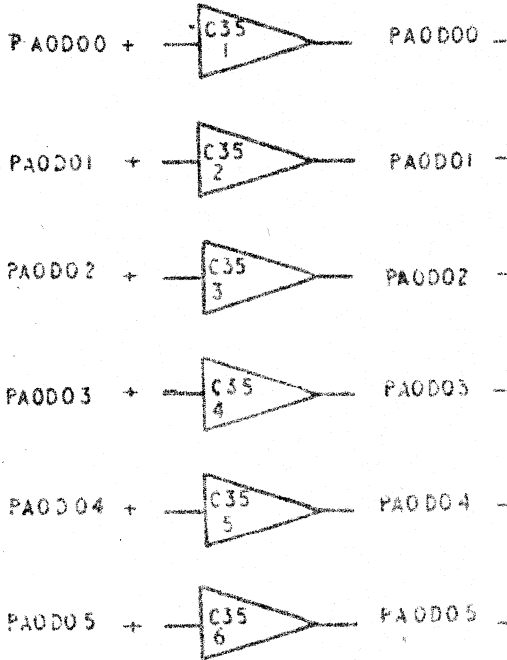
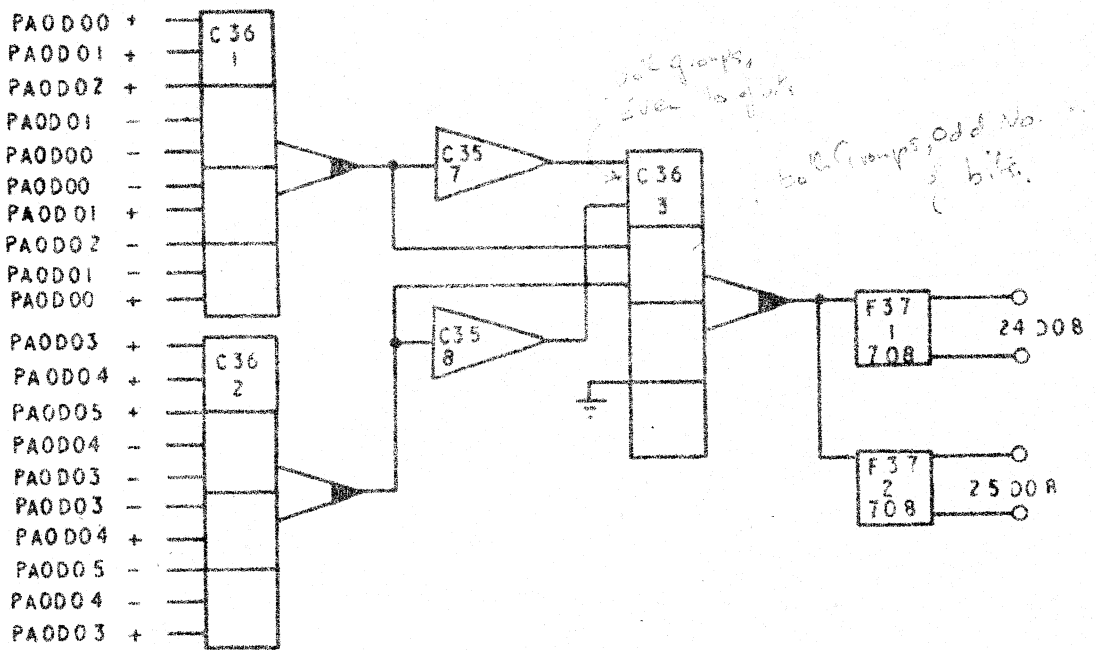
W.G.C. 07/33

BIT 5



PARITY FOR ORION II LINK

Even No of Bits  
give +ve OP.



Re WGC 07/27 PAOD00 - made as shown below:-

