REV.	ZONE	ECO #	REVISION	APP'D	DATE

APPLE COMPUTER CONFIDENTIAL

NISHA DRIVE SPECIFICATION

DEC 7 1984

DRAWING NUMBER
SH OF

TOLERANCES
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
DECIMALS .X ±
.XX ±
.XXX ±
ANGLES XX.X ±
FRACTIONS ±
DIMENSIONS IN PARENTHESIS ARE IN MILLIMETERS

	DATE
DRAWN BY: HAAHR/R.J.B.	11/84
CHECKED BY	
APPROVED BY	
RELEASED BY	

apple computer inc.

TITLE
SPECIFICATION, NISHA DRIVE

SIZE A | DRAWING NUMBER SK-L170-00

MATERIAL:

NEXT ASSY. | FINISH: | SCALE: ----- | SHEET 1 OF 13

1.0 SERVO

1.1 BASIC SERVO FUNCTIONS

Nisha servo control functions are handled by a Z8 microprocessor. The Z8 handles all I/O operations, timing operations and communication with a host controller. Control functions to the Z8 Servo Controller are made through the serial I/O.

The following commands for the Nisha servo are:

A. INHIBIT SERVO - not detented, heads off data zones located at the inner stop.

B. SET BRAKE - performs recal operation all the way to outer crash stop, holds brake to insure latching then inhibits servo back to inner crash stop.

C. RECAL - 72, -0, +3 tracks from HOME. Used to initialize into data zone.

D ACCESS - coarse track positioning of data head to any desired track location.

E. OFFSET TRACK FOLLOWING - controlled microstepping of fine position system during TRACK FOLLOWING (two modes).

1. COMMAND OFFSET - direction and amount of offset is specified to the servo.

2. AUTO OFFSET - command allows the servo to automatically move off track by the amount indicated by the embedded servo signal on the data surface (disk).

F. STATUS - command can read servo status.

See Table 1 for the actual command description. With the present command structure a SEEK COMMAND can be augmented with an OFFSET COMMAND. Upon completion of a seek, the offset command bit is tested to determine if an offset will occur following a seek (either auto or command offset).

When a SERVO ERROR occurs the Z8 SERVO will attempt to do a short RECAL (ERROR RECAL). Two attempts are made by the system to do the ERROR RECAL function. If either of the two RECAL operations terminate successfully the protocol status will be SERVO READY, SIO READY and -WRITE SAFE. Should the ERROR RECAL fail then the system will complete the error recovery by a inhibit servo function.

The two OFFSET commands will be described. First COMMAND OFFSET is a predetermined amount of microstepping of the fine position servo. Included in the OFFSET BYTE (STATREG) bit B6=0 is a COMMAND OFFSET. Bit B7-1 is a forward offset step (toward the spindle); B7=0 is a reverse step. If bit B6-1, the OFFSET command is AUTO OFFSET.

AUTO OFFSET command normally occurs during a write operation. When the HDA was initially formatted at the factory, special encoded servo data was written on each track "near" the index zone. The reason for this follows:

> "Normal coarse and fine position information for the position servos is derived from an optical signal relative to the actual data head-track location. Over a period of time, the relative position (optical signal) will be misaligned to the absolute head-track position by some unknown amount (less than 100 uIn). This small change is important for reliability during the write operation. Write/Read reliability can be degraded due to this misalignment. The special disk encoded servo signal is available to the fine position servo. It will correct the difference between the relative position signal of the optics and the absolute head to track position under the data head only a index time. The correction signal can be held indefinitely or updated (if desired at each index time) until a new OFFSET command or move command (SEEK or RECAL) occurs."

2.0 COMMUNICATION FUNCTIONS

The servo functions described in the previous section only occur when the servo Z8 microprocessor is in the communication state. Communication states occur immediately after a system reset, upon completing head setting after a system reset, upon completing head setting after a recal, seek, offset, read servo status or set servo diagnostic command. A special communication state exists a servo error has occurred. If + SIO READY is not active, no communication can exist between the external controller and the servo Z8 processor.

Servo commands are serial bits grouped as five seperate bytes total. Refer to Table 1 parts I through V for the total communication string. The first byte is the command byte (i.e. seek, read status, recal, etc.). The second byte is the low order difference for a seek (i.e. Byte 2 = $0A is a ten track seek). The third byte is the offset byte (AUTO or COMMAND OFFSET and the magnitude/direction for command offset). The fourth byte is the status byte (use for reading internal servo status) Byte five is the check sum byte used to check verify that the first four bytes were correctly transmitted (communication error checking).

Part of the communication function requires a specific protocol between the servo Z8 processor and the external controller.

3.0 Z8 SERVO PROTOCOL

The protocol between the Z8 SERVO microcomputer and the CONTROLLER is based on five I/O lines. Two of the I/O lines are serial input (to Z8 servo from controller) serial output (from Z8 servo to controller). Data stream between the Z8 servo and controller is 8 bit ASCII with no parity bit (the fifth byte of the command string contains check sum byte use for error checking). There are three additional output lines between the Z8 servo used as control lines to the controller. Combining the two serial I/O lines and the three unidirectional port lines generates the bases of the protocol between the Z8 servo and controller. The important operations between the Z8 servo and controller are:

1. Send commands to Z8 servo.
2. Read Z8 servo status.
3. Check validity of all four command bytes.
4. I/O timing signals between the Z8 servo and controller.
5. Z8 servo reset.

Sequencing the Z8 servo controller is an important process following a Power Up or if the controller should issue a Z8 Servo Reset at any time. After a Z8 Servo Reset is inhibited, the Z8 I/O ports and internal register are initialized. This takes approximately 75 msec after the Z8 Servo Reset is inhibited. The protocol baud rate is automatically set to 58.59KB and then the system is parked at HOME position by inhibiting the SERVO and SIO READY is set active.

Before the controller transmits the command byte the controller must poll the SIO READY line from the Z8 servo to determine if it is active (+5 volts). If the line is active then a command can be transmitted to the Z8 servo. The program in the Z8 servo will determine what to do with the command bytes (depending upon the current status of the Z8 servo). After the command (five bytes long) has been transmitted to the Z8 servo, the program in the Z8 servo will determine if the command bytes (first four bytes) are in error by evaluating the check sum byte (fifth byte transmitted). After the controller has transmitted the last serial string and -WRITE SAFE is true (0V) it must wait 250 U sec then test for -WRITE SAFE. If -WRITE SERVO is high the command was rejected (check sum error or invalid command). If -WRITE SAFE is set inactive 600 U sec after the command is sent (and not 250 U sec), this was a command reject. This unsafe condition must be cleared by a READ STATUS COMMAND or RECAL COMMAND before transmitting another command. If SERVO READY is low then this protocol is not valid since SERVO READY is gated with SERVO ERROR and on track to generate -WRITE SAFE. This protocol is only effective if the drive is track following (SERVO READY is true).

As long as SIO READY is active the controller can communicate with the Z8 Servo Controller. If SERVO READY is not active the only command that will cause the Nisha Servo to set SERVO READY active is a RECAL COMMND. Read Status will only clear SERVO ERROR if SERVO READY is also true, and all other commands will be rejected.

Next, if SERVO READY is high and -WRITE SAFE is also high, -WRITE SAFE can be cleared by:

1. Any READ STATUS COMMAND.

2. Any RECAL COMMAND.

3. Any other commands will be rejected and maintain -WRITE SAFE

If a SEEK COMMAND is transmitted with both SERVO READY and -WRITE SAFE active, the command will be rejected.

It is important to check the status of all three status lines from the Z8 Servo. It is best to avoid sending a SEEK COMMAND with SERVO READY and -WRITE SAFE inactive. If a seek length of 1024 or great is sent, the command will be rejected and -WRITE SAFE will go high.

Chart V, parts A-I, illustrate some of the serial communciation commands and error conditions that can occur between the controller and Z8 SERVO.

4.0 ERROR HANDLING

-WRITE SAFE will be generated during the following conditions:

1. During Recal mode (velocity control only) access time-out. If a Recal function exceeds 220 msec then an access timeout occurs.

2. During Seek mode (velocity control only) access time-out. If a Seek function exceeds 220 msec then an access time-out occurs.

3. During Settling mode (following a Recal, Seek, or Offset) if there is excessive On Track pulses (3 crossings) indicating excessive head motion, a Settling error check will occur.

4. During a command transmission if a communication error occurs (check sum error).

5. During a command transmission if a invalid command is sent.

Z8 SERVO COMMAND BYTES

TABLE 1

I. BYTE 1: COMMAND BYTE (DIFCNTH)

		B7	B6	B5	B4	FUNCTIONS
	---	1	0	0	0	access only (Seek)
	B7	1	0	0	1	access with offset (seek)
command	B6	0	1	0	0	data recal
bits	B5	0	1	1	1	set brake
	B4	0	0	0	1	offset-trk following
	---	1	1	0	0	inhibit servo
		0	0	0	0	read status command
	---					

access bits

B3 - access direction

B2 - NOT USED(command will be rejected -WRITE SAFE will go high)

B1 - hi diff2 (512)

B0 - hi diff1 (256)

MAXIMUM seek length is +/-1023

access direction = 1 (FORWARD: toward the spindle)
= 0 (REVERSE: away from the spindle)

hi diff2 (512) = 1 (512 tracks to go)
= 0 (not set)

hi diff1(256) = 1 (256 tracks to go)
= 0 (not set)

II. BYTE 2: DIFF BYTE (DIFCNTL)

command BYTE 2 contains the LOW ORDER DIFFERENCE COUNT for a seek

---

B7-bit7 = 128 tracks
B6-bit6 = 64 tracks
B5-bit5 = 32 tracks
B4-bit4 = 16 tracks
B3-bit3 = 8 tracks
B2-bit2 = 4 tracks
B1-bit1 = 2 tracks
B0-bit0 = 1 track

III. BYTE 3: OFFSET BYTE (STATREG)

command BYTE 3 contains the INSTRUCTION for an OFFSET COMMAND (seek or during track following)

B7-offset direction
B6-auto offset function
B5-not used
B4-offset Bit4=16
B3-offset Bit3=8
B2-offset Bit2=4
B1-offset Bit1=2
B0-offset Bit0=1
---

1. if offset command from BYTE 1 is followed by bit6 set (auto offset); offset direction (bit7) read offset (bit5) and bits 4-0 are ignored but should be set to 0 if not used.

2. OFFSET DIRECTION = 1 (FORWARD OFFSET: toward the spindle)
   = 0 (REVERSE OFFSET: away from the spindle

3. AUTO OFFSET = 1 (normally used preceeding a write operation)
   = 0 (manual offset: MUST send direction and magnitude of offset)

IV. BYTE 4: STATUS BYTE (CNTREG)

B7 - NOT USED
B6 - NOT USED
B5 - NOT USED
B4 - NOT USED
B3 - status or diagnostic bits
B2 - status or diagnostic bits
B1 - status or diagnostic bits
B0 - status or diagnostic bits

V. BYTE 5: CHECKSUM BYTE (CKSUM)

[B7 B6 B5 B4 B3 B2 B1 B0]

results of the transmitted CHECKSUM BYTE are derived as

$\overline{\text{(BYTE 1 + BYTE 2 + BYTE 3 + BYTE 4)}}$ = CHECKSUM BYTE

(+) is defined as the addition of each BYTE

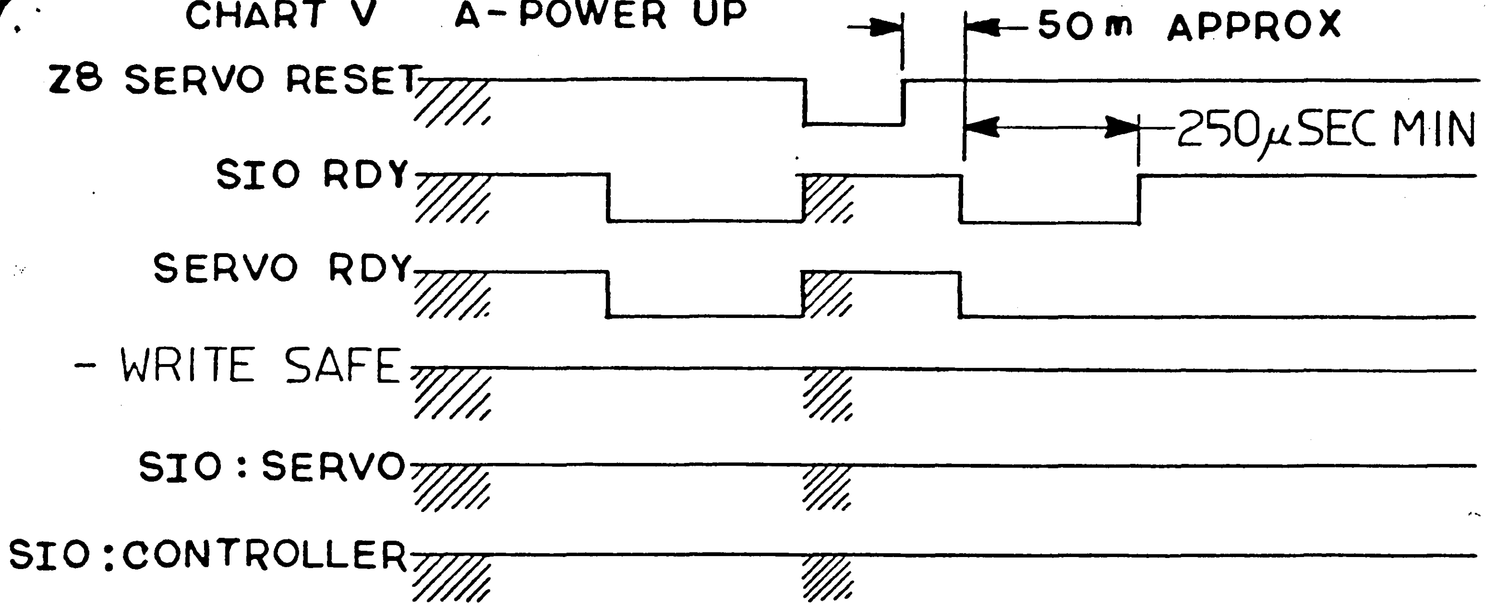
$\overline{\text{(BYTE)}}$ is defined as the compliment of the BYTES (1-4)

VI. The SERVO STATUS lines (SIO RDY, SERVO RDY, SERVO ERROR) must have the following conditions in order to send the listed Z8 COMMANDS:

Z8 SERVO CMD	HEX	SERVO STATUS SIO RDY	SERVO STATUS SRV RDY	SERVO STATUS (-) WRT SAF
access (only)	8X	1	1	0
access(offset)	9X	1	1	0
recal(data)	40	1	X	X
set brake	70	1	X	X
inhibit servo	C0	1	X	X
offset(detent)	10	1	1	0
status	00	1	X	X

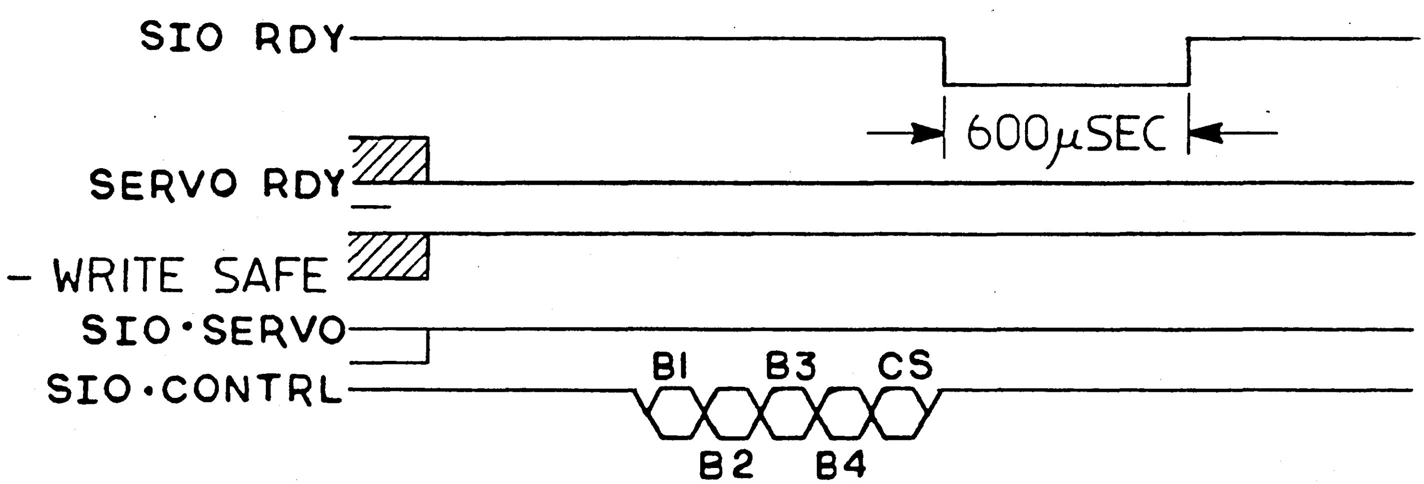
X = either 0, 1

CHART V A-POWER UP



N/S - NOT SPECIFIED

C-AFTER POWER UP - INVALID CMD



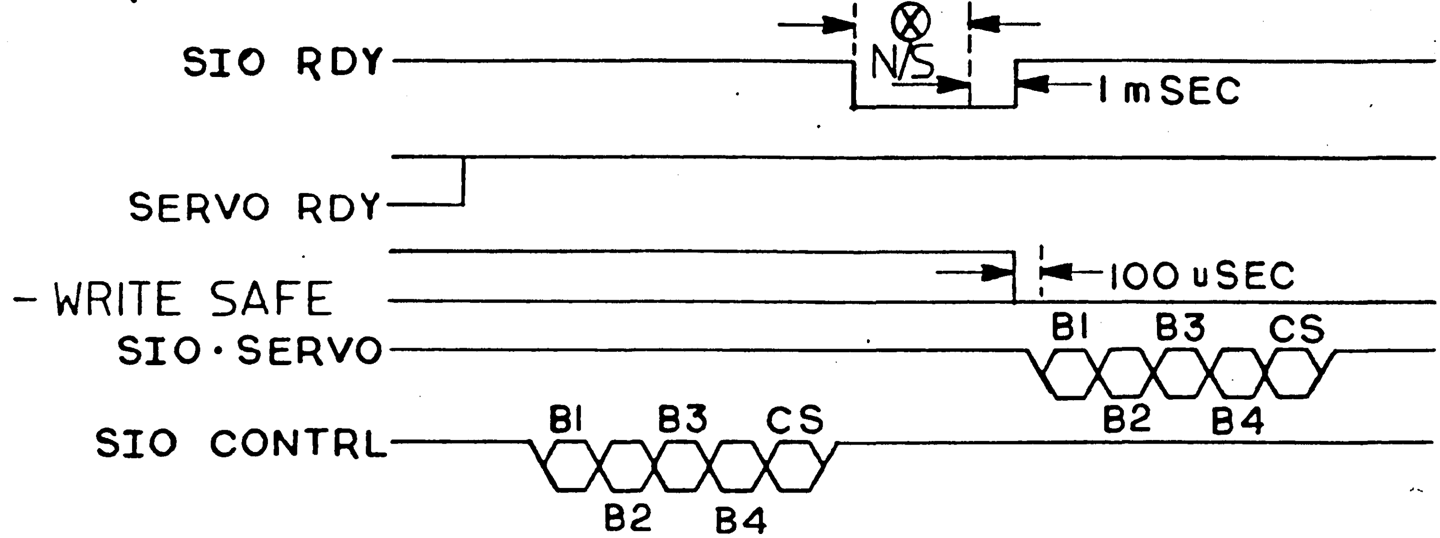
apple computer inc.

SIZE	DRAWING NUMBER
A	

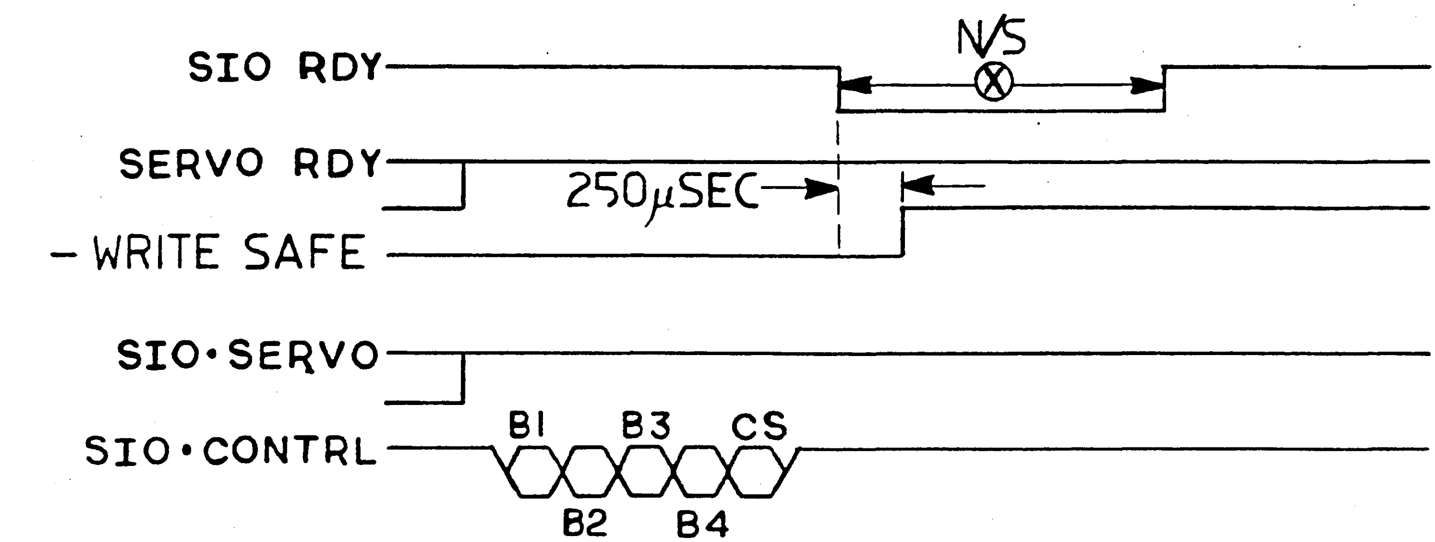
SCALE: N/A	SHEET OF

CHART V

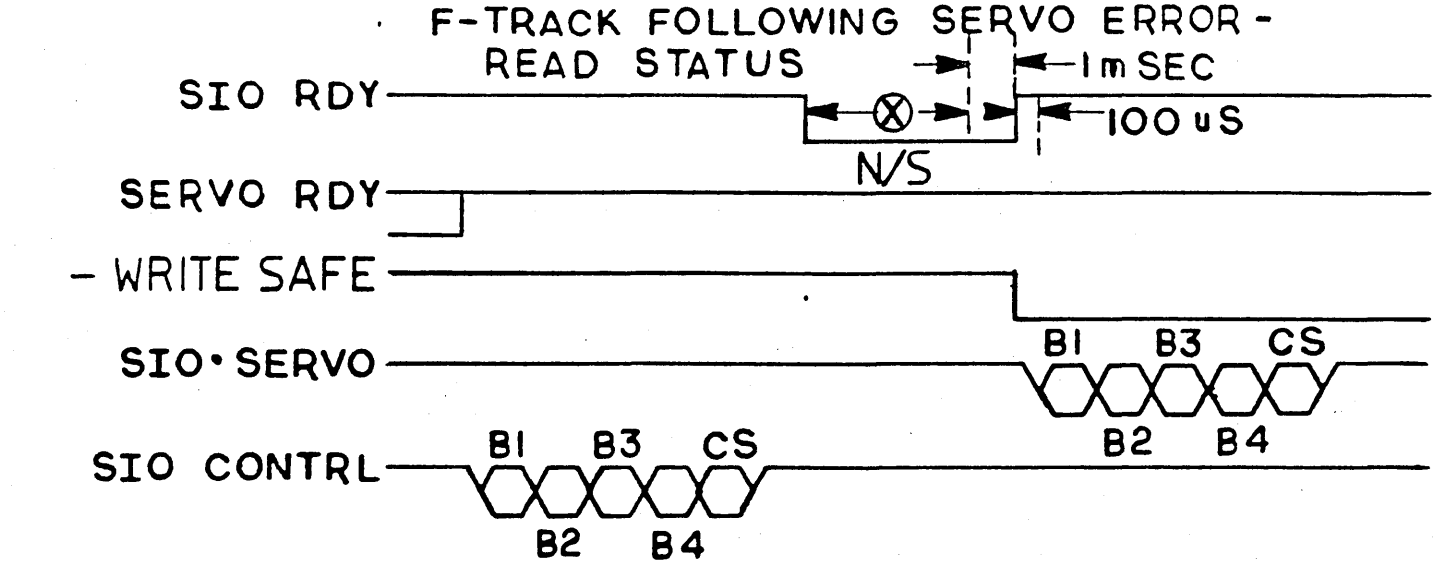
D-READ STATUS COMMAND



E-TRACK FOLLOWING SERVO ERROR - INVALID COMMAND



F-TRACK FOLLOWING SERVO ERROR - READ STATUS



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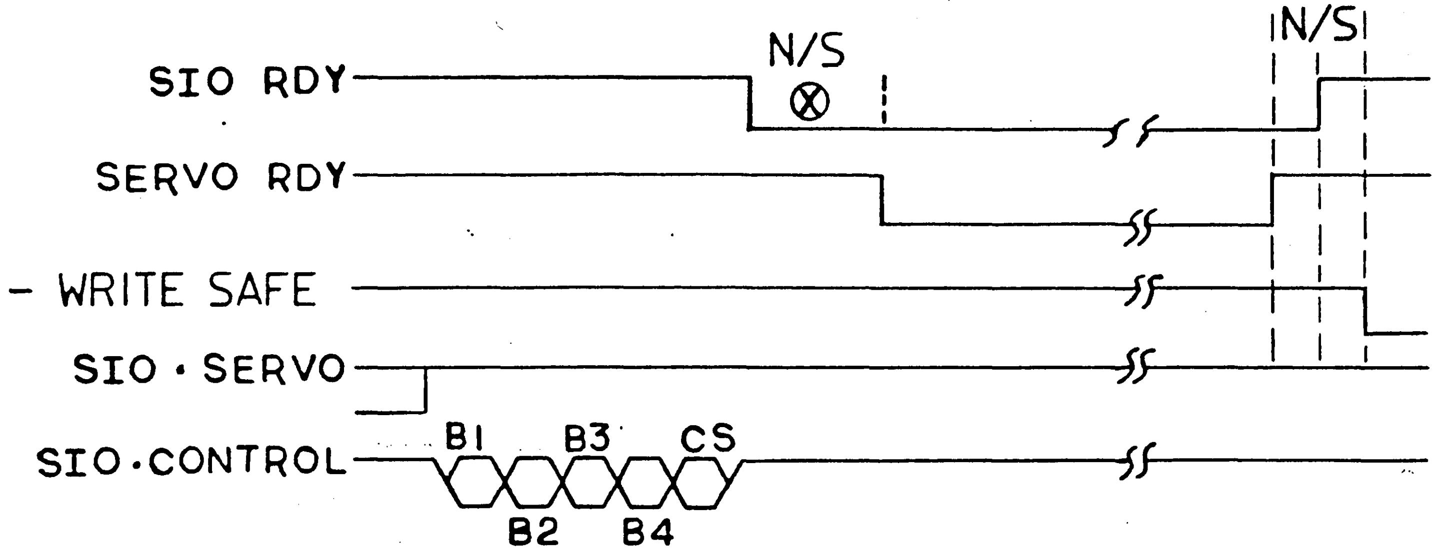
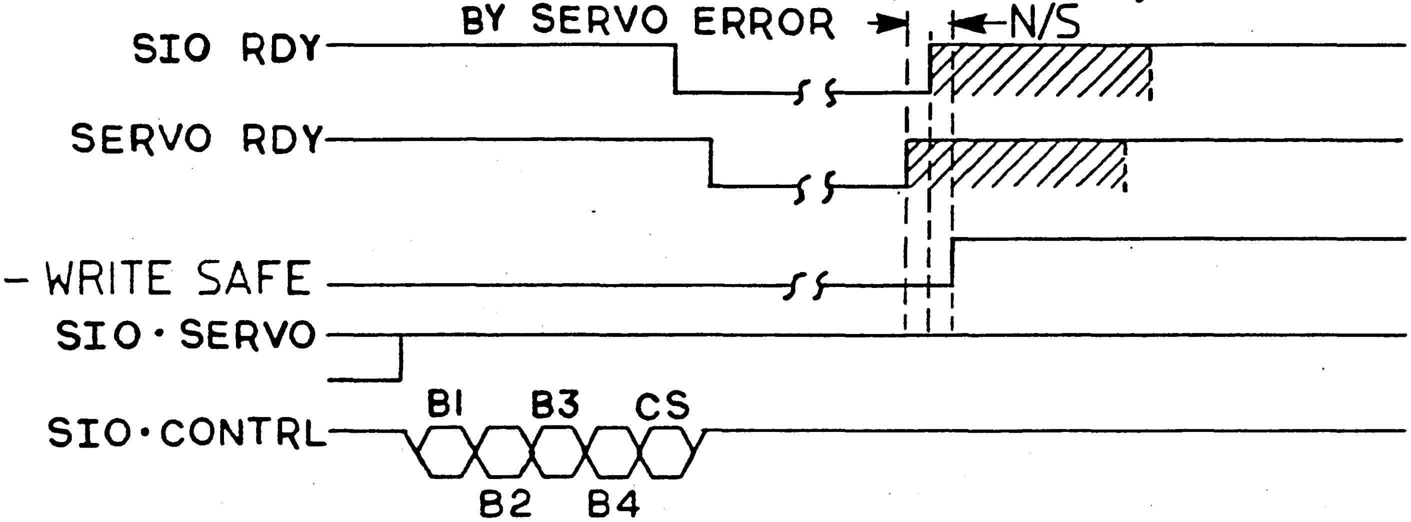
SIZE A	DRAWING NUMBER	
SCALE: N/A		SHEET OF

CHART V

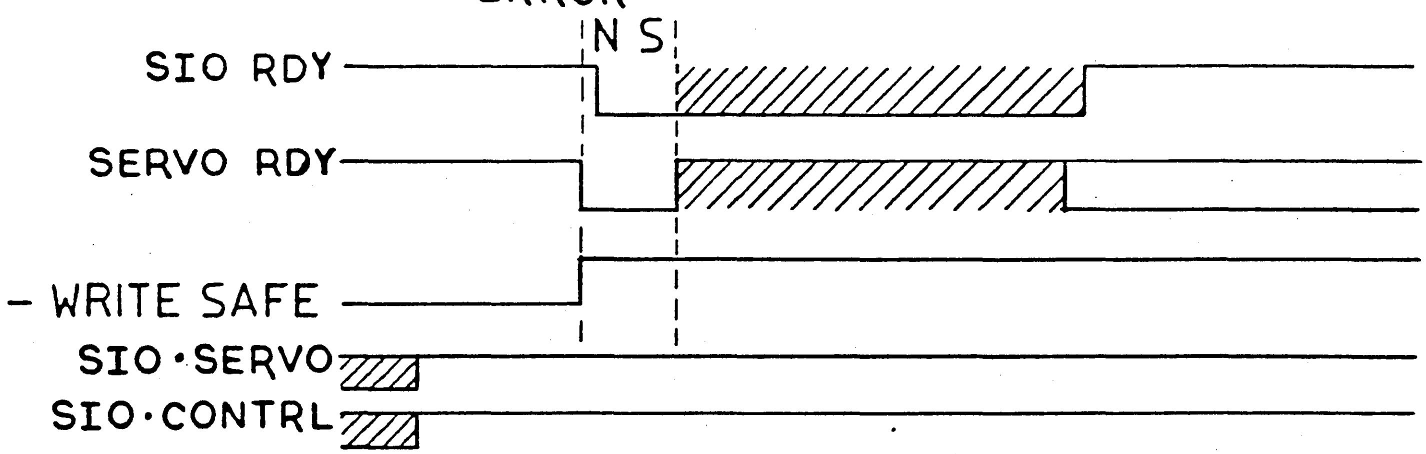
G- TRACK FOLLOWING VALID COMMAND (MOVE)



H - TRACK FOLLOWING (MOVE CMD) FOLLOWED BY SERVO ERROR

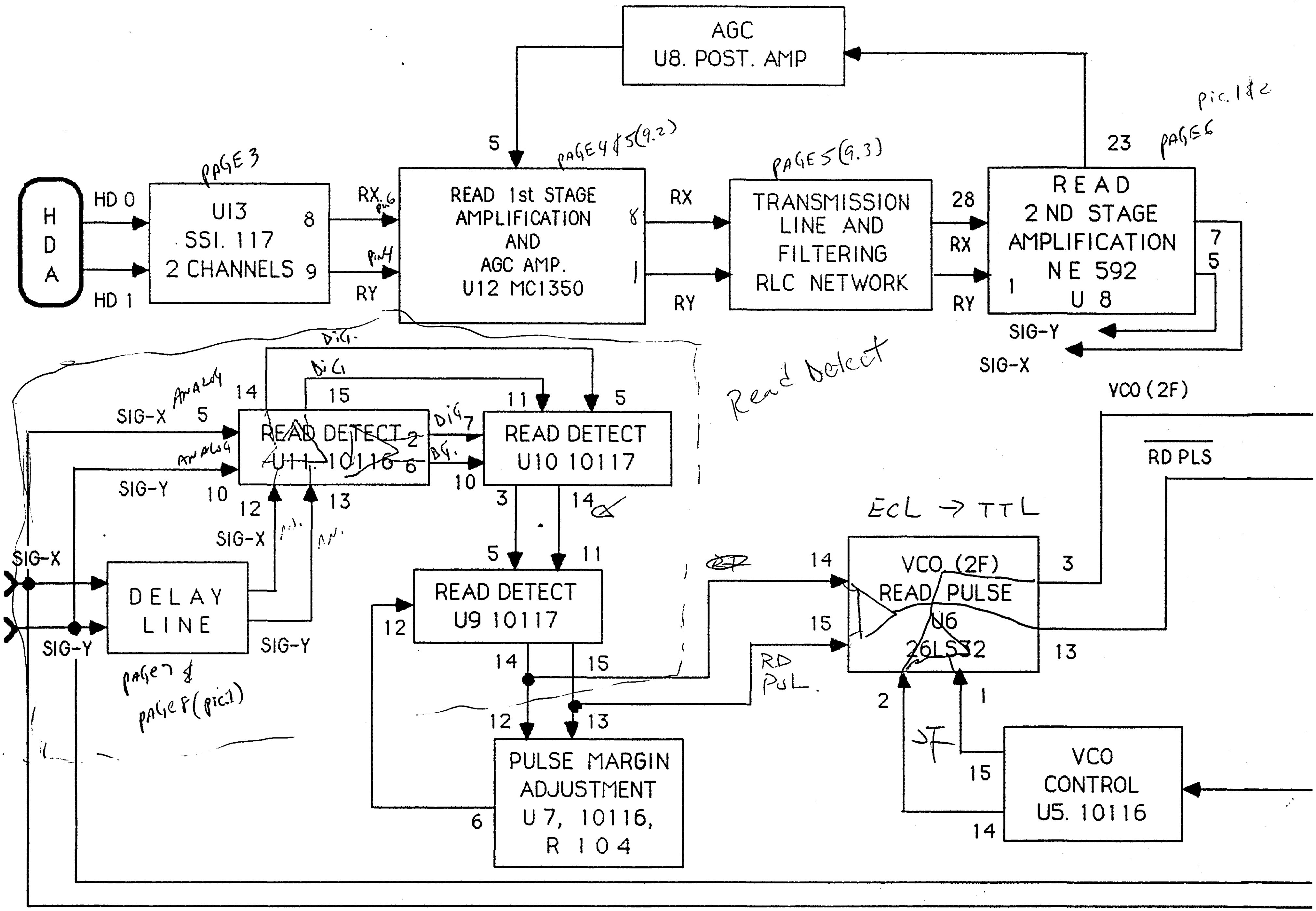


I - TRACK FOLLOWING (NO CMD) SERVO ERROR

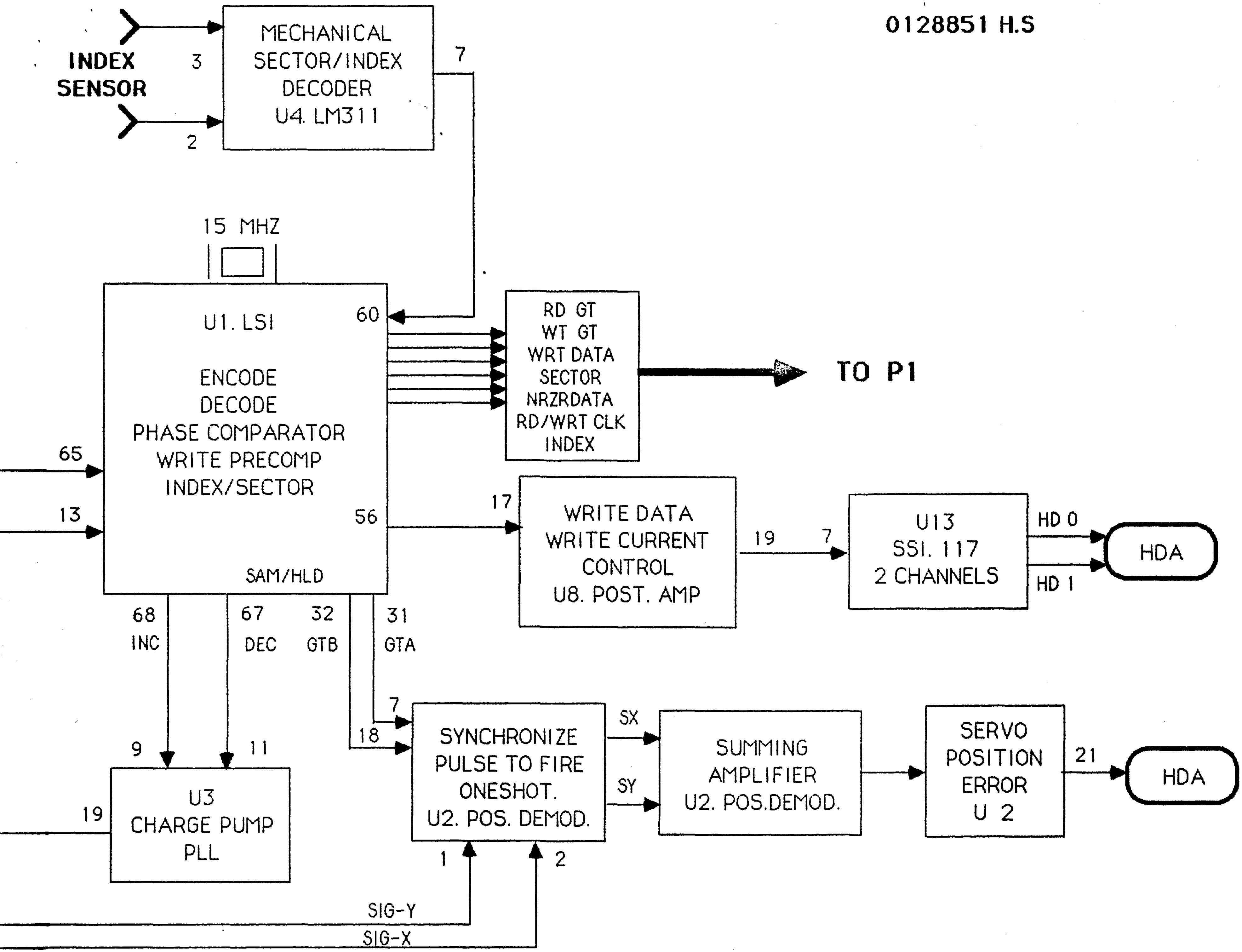


apple computer inc.	SIZE A	DRAWING NUMBER
	SCALE: N/A	SHEET OF

NISHA R/W BLOCK FUNCTIONAL DIAGRAM



0128851 H.S



INDEX
SENSOR
3
2
MECHANICAL
SECTOR/INDEX
DECODER
U4. LM311
7
15 MHZ
U1. LSI
ENCODE
DECODE
PHASE COMPARATOR
WRITE PRECOMP
INDEX/SECTOR
60
56
65
13
SAM/HLD
RD GT
WT GT
WRT DATA
SECTOR
NRZRDATA
RD/WRT CLK
INDEX
TO P1
17
WRITE DATA
WRITE CURRENT
CONTROL
U8. POST. AMP
19
7
U13
SSI. 117
2 CHANNELS
HD 0
HD 1
HDA
68
INC
67
DEC
32
GTB
31
GTA
9
11
U3
CHARGE PUMP
PLL
19
7
18
SYNCHRONIZE
PULSE TO FIRE
ONESHOT.
U2. POS. DEMOD.
1
2
SIG-Y
SIG-X
SX
SY
SUMMING
AMPLIFIER
U2. POS.DEMOD.
SERVO
POSITION
ERROR
U 2
21
HDA

9.1) U13 - SSI 117

FIXED PATTERN

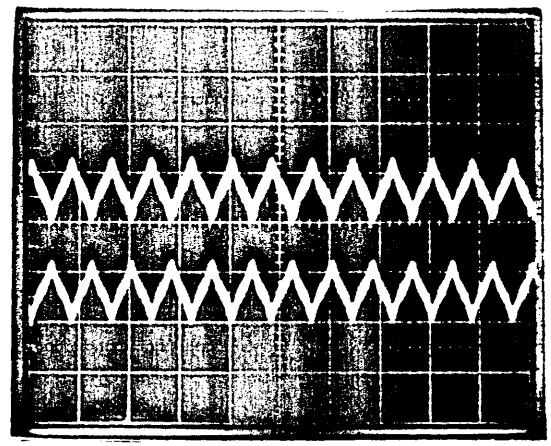
CHA 1 : PIN 8 - RX

CHA 2 : PIN 9 - RY

50 mV/div

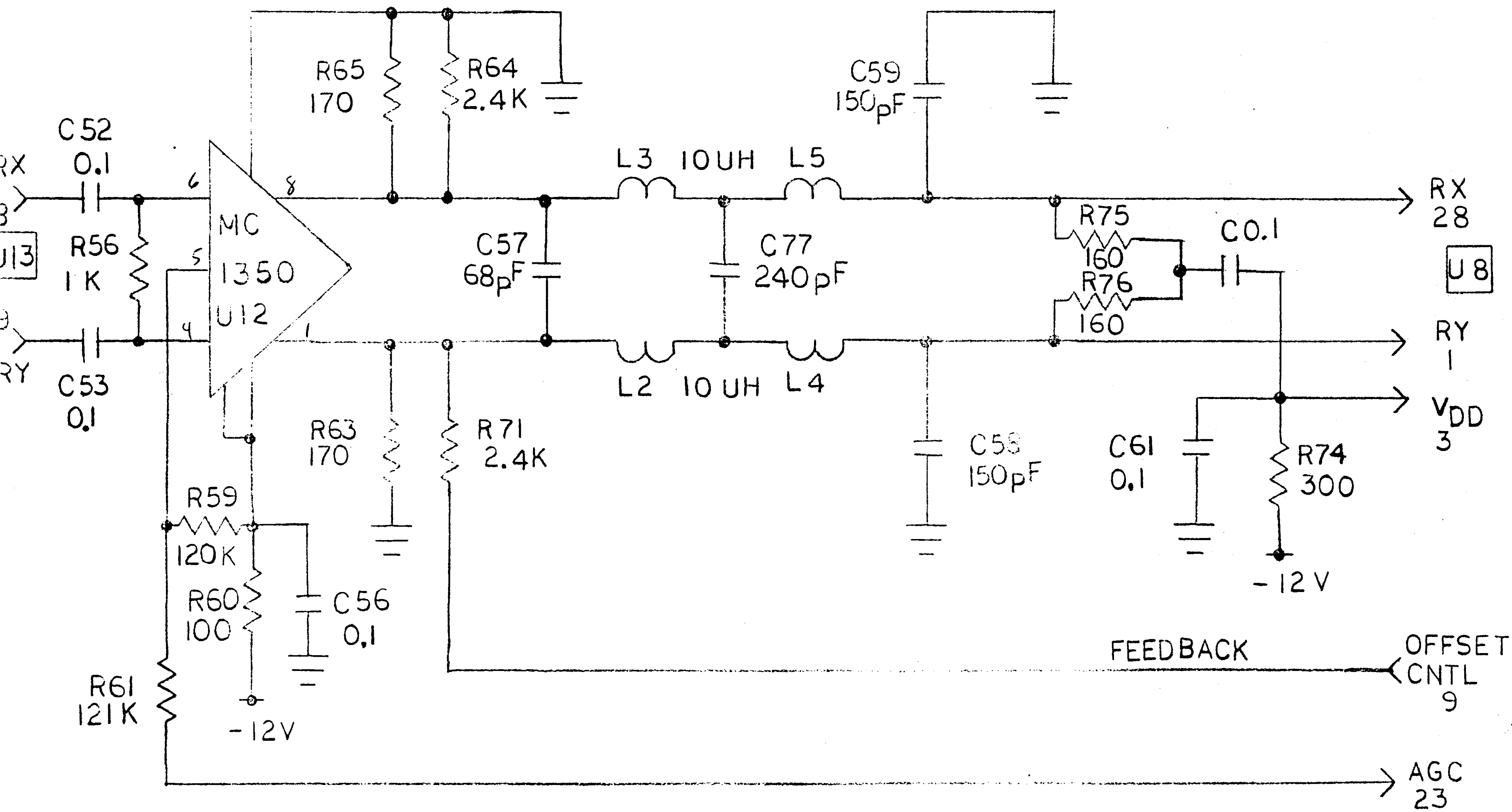
1.0 uS/div

OFFSET - 5.7 V



H.S

AGC RD AMP



RX
RY
U13
C52
0.1
C53
0.1
R56
1K
MC
1350
U12
R65
170
R64
2.4K
R63
170
R71
2.4K
C57
68pF
L3
10UH
L5
L2
10 UH
L4
C77
240pF
C59
150pF
C58
150pF
R75
160
R76
160
C0.1
U8
C61
0.1
R74
300
-12V
RX
28
RY
1
VDD
3
R59
120K
R60
100
C56
0.1
R61
121K
-12V
FEEDBACK
OFFSET
CNTL
9
AGC
23

9.2) U12 - MC 1350

FIXED PATTERN

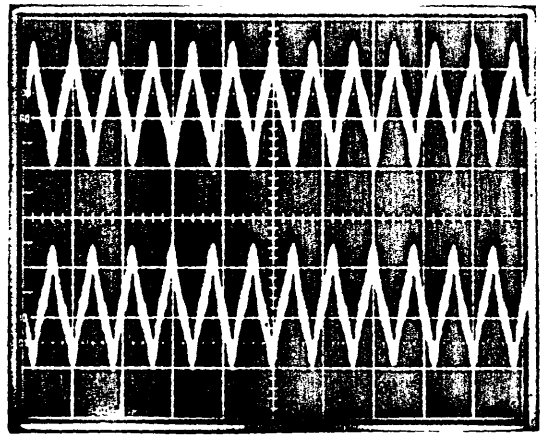
CHA 1 : PIN 8 - RX

CHA 2 : PIN 1 - RY

50 mV/div

1.0 uS/div

OFFSET - 0.42 V



9.3) U6 - POST AMP. MOD.

FIXED PATTERN

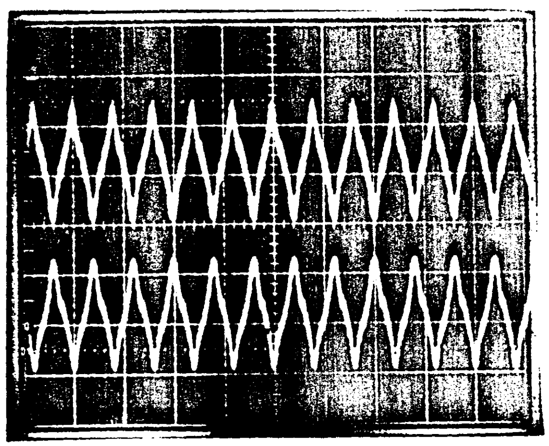
CHA 1 : PIN 28 - RX

CHA 2 : PIN 1 - RY

50 mV/div

1.0 uS/div

OFFSET - 0.42 V



WRITE VARIFY - FIXED PATTERN :

CHECK BOTH HEAD 0 AND HEAD 1

8.6-1) U8 - POST AMP

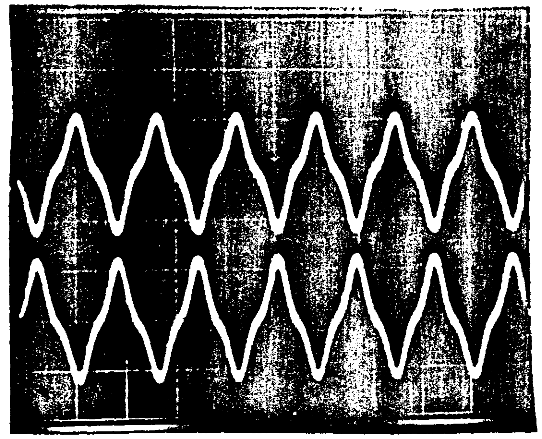
CHA 1 : PIN 7 - SIG X

CHA 2 : PIN 5 - SIG Y

180 DEGREE OUT OF PHASE

1 V/DIV

0.2 uS/DIV



WRITE VARIFY - RANDOM PATTERN :

CHECK BOTH HEAD 0 AND HEAD 1

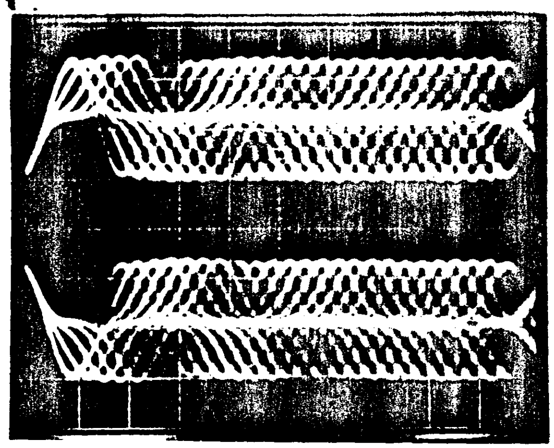
8.6-2) U8 - POST AMP

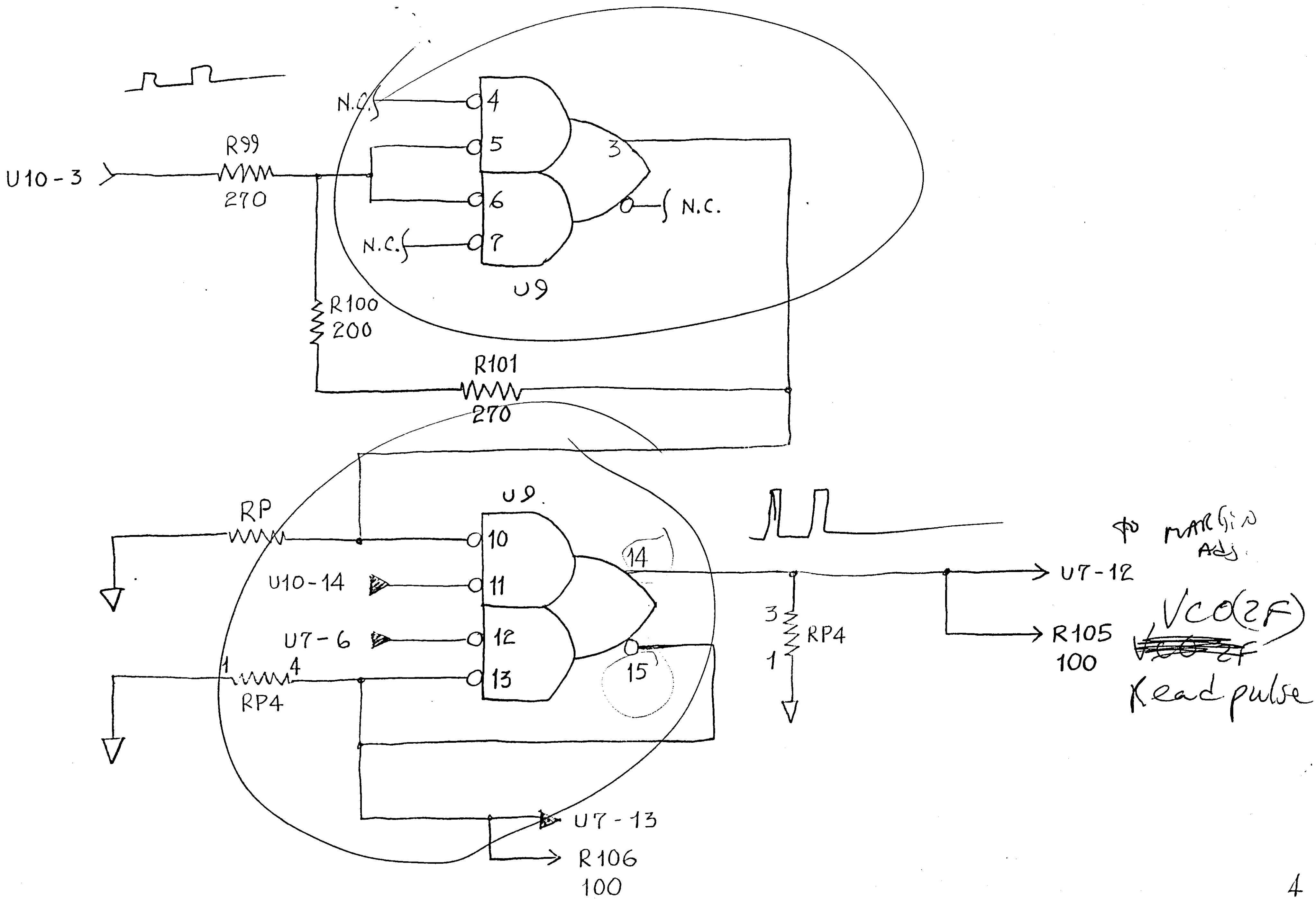
CHA 1 : PIN 7 - SIG X

CHA 2 : PIN 5 - SIG Y

1 V/DIV

0:2 uS/DIV




N.C.
R99
270
U10-3
3
N.C.
N.C.
U9
R100
200
R101
270
U9
RP
10
U10-14
11
U7-6
12
13
14
15
RP4
3
1
to margin Adj.
U7-12
R105
100
VCO(2F)
VCO 2F
Read pulse
U7-13
R106
100

8.7) U8 - POST AMP

PIN 22 - AMPLITUDE CONTROL VOLTAGE : APPROX . **3.15 V**
PIN 6 - COMMAND CONTROL VOLTAGE : APPROX. **3.15 V**
PIN 21 - PEAK FOLLOWER : **4.45 V**

8.8) U8 - POST AMP

PLACE THE DVM PROBE ACROSS **R62** TO MEASURE LOW CURRENET AND NORMAL CURRENT.

LOW CURRENT -- **18 mA ± 1mA**
NOR CURRENT -- **21 mA ± 1mA**

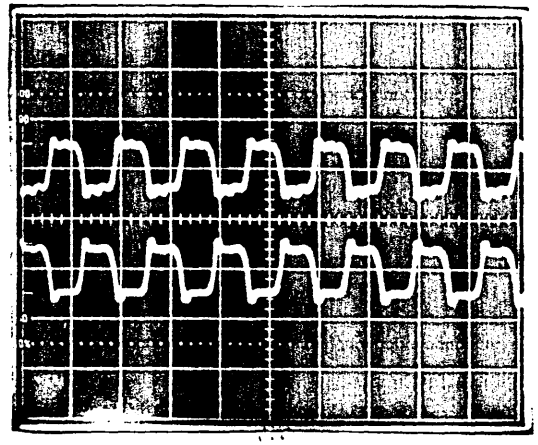
8.9) U2 POSTION DEMOD.

PIN 27 - CLIP THRS. APPROX. **-0.5V** DC.
PIN 21 - POSTION ERROR : **0.0 V ± 0.05V.**

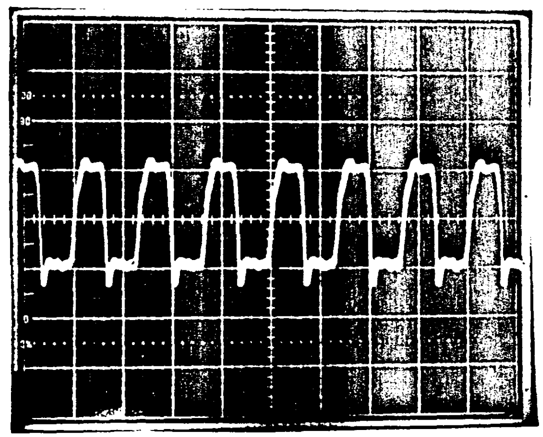
8.10) U2 POSTION DEMOD.

PIN 1 OR TP29 - VCO CONTROL VOLT APPROX. **1.51 V** DC.
PIN 18 - LLNW APPROX. **1.51 V** DC.

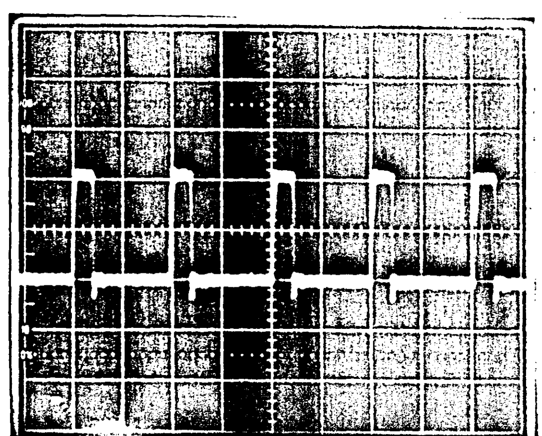
9.14) U6 - 26LS32
CHA 1 : PIN 1 - INPUT
CHA 2 : PIN 2 - INPUT
1 V/DIV
0.05 uS/DIV



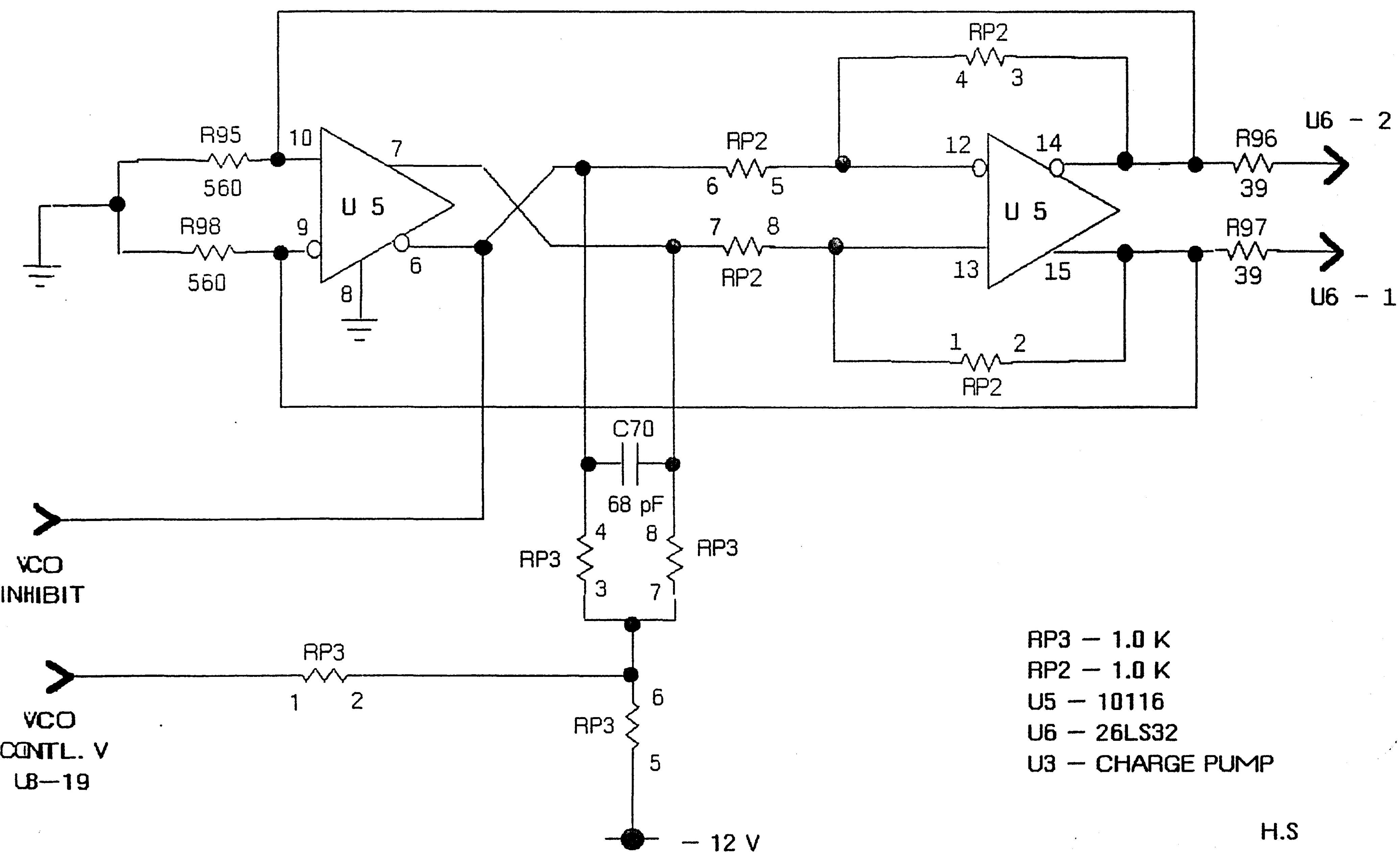
9.12) U6 - 26LS32
CHA 1 : PIN 3 - VCO. (2F-15MHZ)
2 V/DIV
0.05 uS/DIV

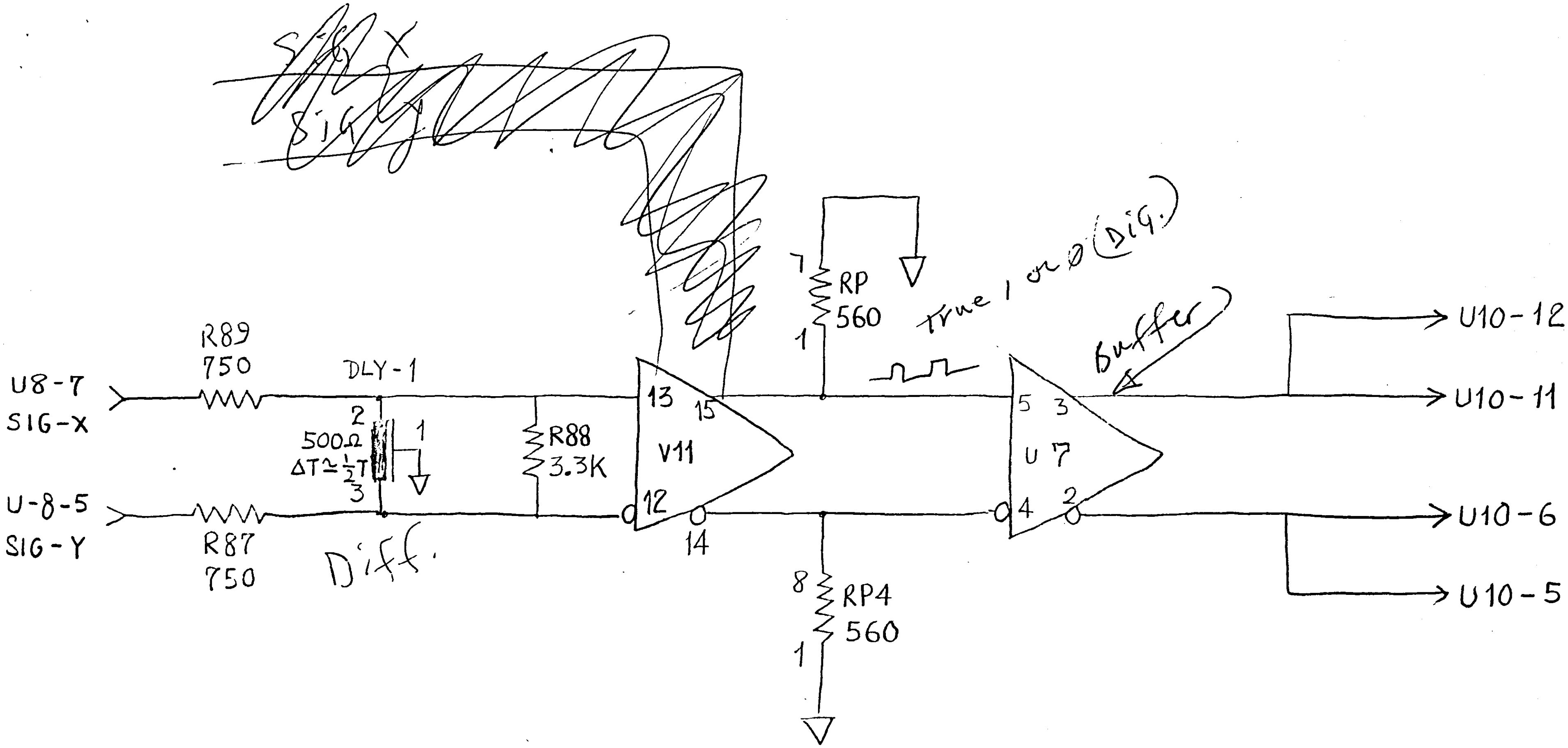


9.13) U6 - 26LS32
CHA 1 : PIN 13 - READ PULSE. (MARGIN)
2 V/DIV
0.2 uS/DIV



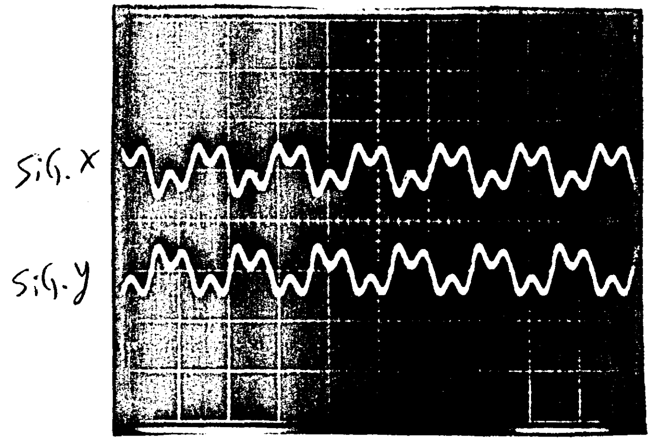
VCO 2—1


R95
560
R98
560
10
9
7
6
8
U 5
RP2
6
5
7
8
RP2
RP2
4
3
12
14
U 5
13
15
1
2
RP2
R96
39
R97
39
U6 - 2
U6 - 1
C70
68 pF
RP3
4
3
RP3
8
7
VCO
INHIBIT
RP3
1
2
VCO
CONTL. V
U8—19
6
RP3
5
— 12 V
RP3 — 1.0 K
RP2 — 1.0 K
U5 — 10116
U6 — 26LS32
U3 — CHARGE PUMP
H.S

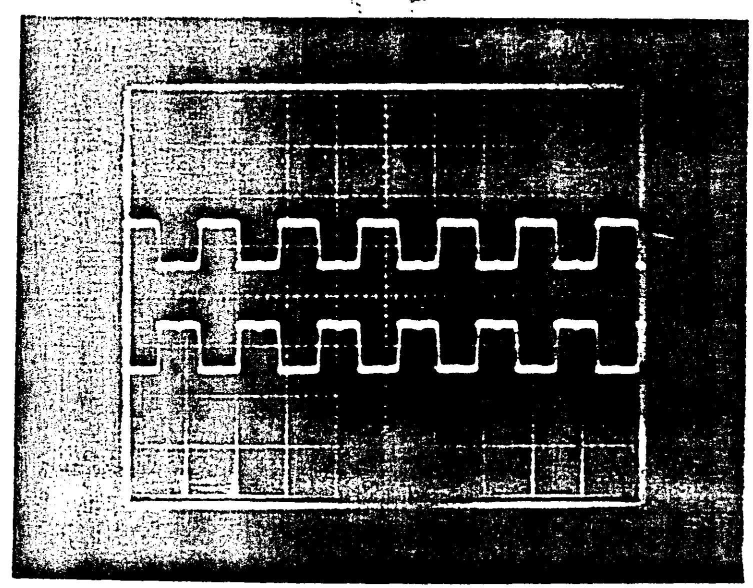


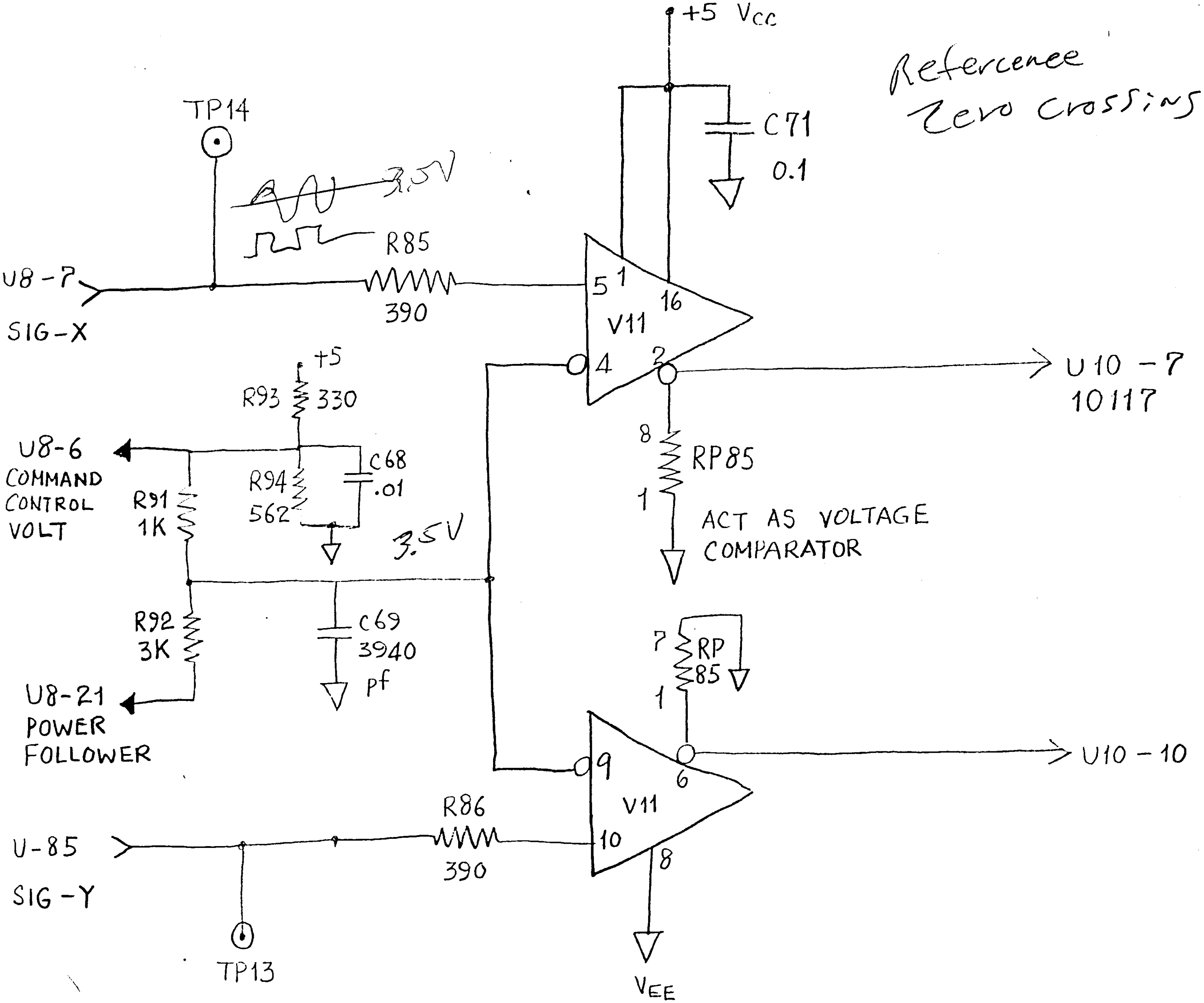
U8-7
SIG-X
U-8-5
SIG-Y
R89
750
R87
750
DLY-1
500Ω
ΔT≃½T
Diff.
R88
3.3K
V11
RP
560
RP4
560
True 1 or 0 (Dig.)
Buffer
U 7
U10-12
U10-11
U10-6
U10-5

U11 - 10116
CHA 1 : PIN 12
CHA 2 : PIN 13
0.5 V/DIV
0.5 uS/DIV

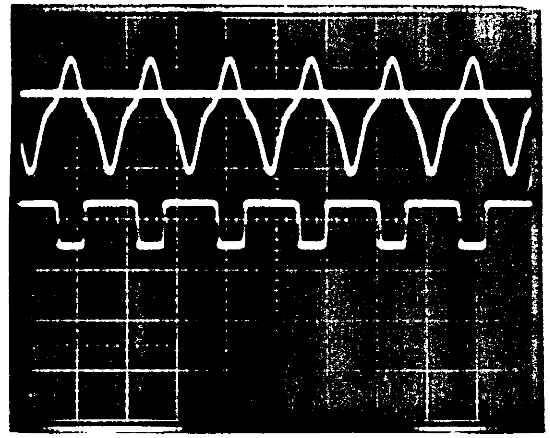


U11 - 10116
CHA 1 : PIN 14
CHA 2 : PIN 15
1 V/DIV
0.5 uS/DIV

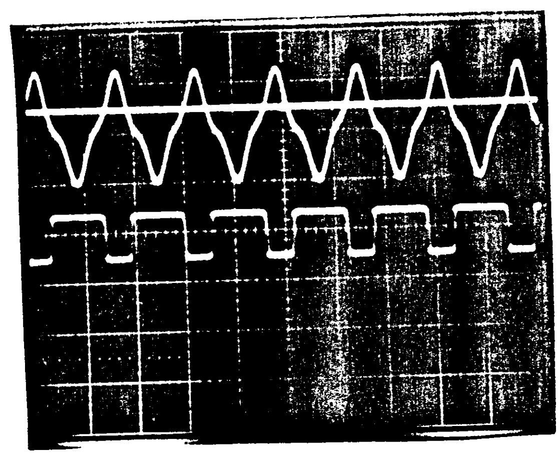



+5 Vcc
Referencee
Zero crossings
TP14
C71
0.1
3.5V
R85
390
U8-7
SIG-X
5
1
16
V11
4
2
U10-7
10117
+5
R93 330
8
RP85
1
U8-6
COMMAND
CONTROL
VOLT
R94
562
C68
.01
R91
1K
ACT AS VOLTAGE
COMPARATOR
3.5V
R92
3K
C69
3940
pf
7
RP
85
1
U8-21
POWER
FOLLOWER
9
6
U10-10
V11
R86
390
10
8
U-85
SIG-Y
TP13
VEE

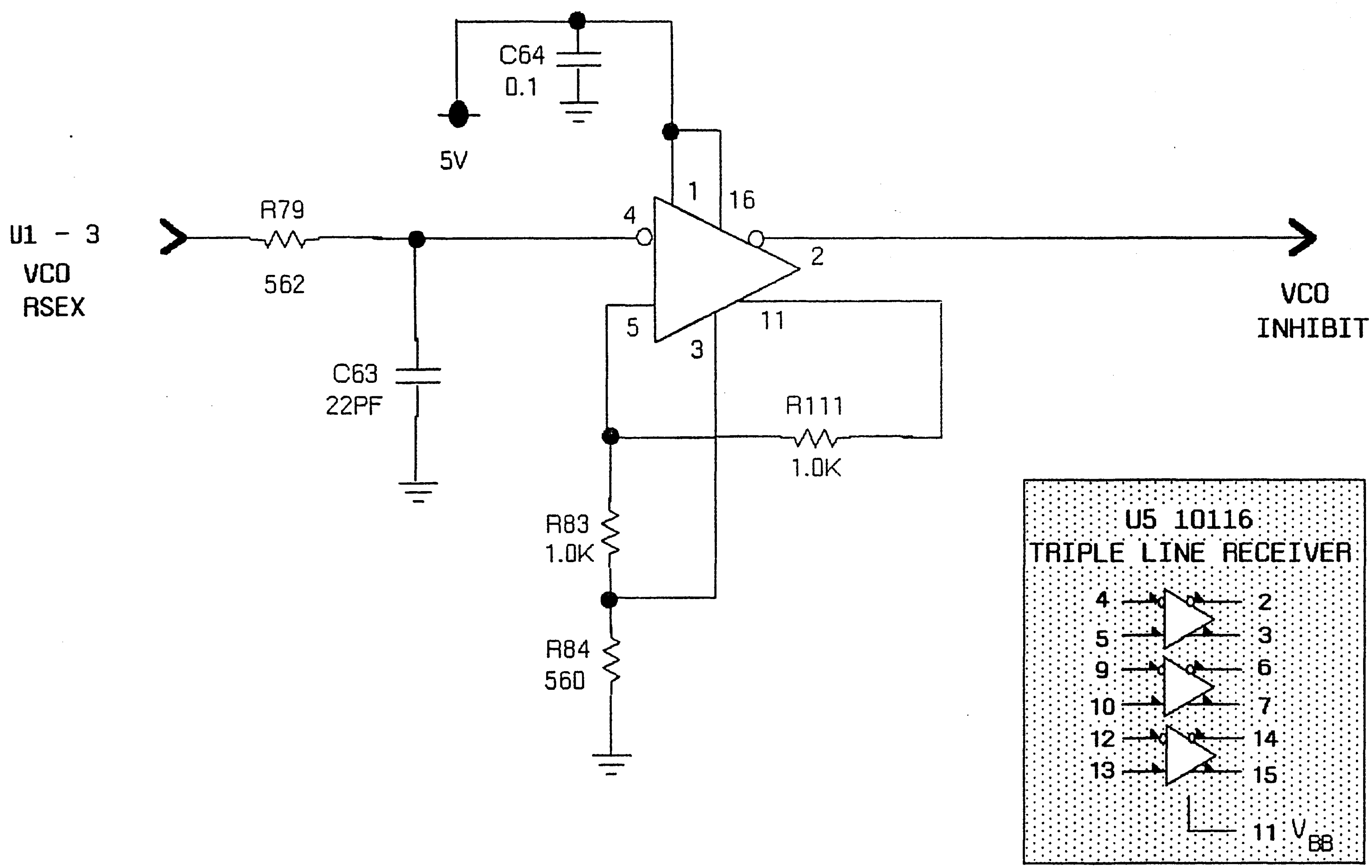
9.7) U11 - 10116
CHA 1 : PIN 5 - SIG X.
CHA 2 : PIN 4 - **3.5 V** DC.
CHA 3 : PIN 2 - OUTPUT
1 V/DIV
0.5 uS/DIV



9.6) U11 - 10116
CHA 1 : PIN 10 - SIG Y
CHA 2 : PIN 9 - **3.5 V** DC.
CHA 3 : PIN 6 - OUTPUT
1.0 V/DIV
0.5 uS/DIV



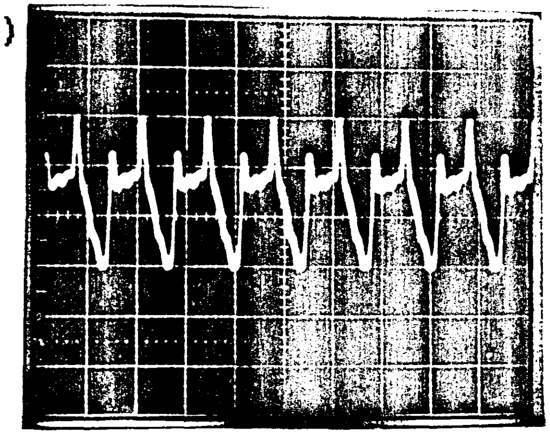
VCO 2—2


C64
0.1
5V
U1 - 3
VCO
RSEX
R79
562
4
1
16
2
VCO
INHIBIT
5
11
3
C63
22PF
R111
1.0K
R83
1.0K
R84
560
U5 10116
TRIPLE LINE RECEIVER
4
5
9
10
12
13
2
3
6
7
14
15
11 V_{BB}

H. S

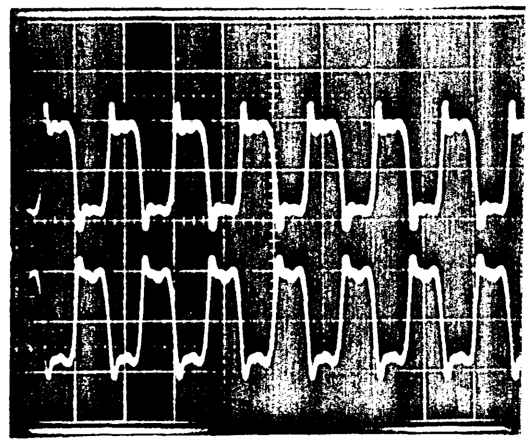
8.11) U5-10116

CHA 1 : PIN 2 AND PIN 6 **(3.9V DC OFFSET)**
CHA 2 : PIN 3 - APPROX. **4.13 V** DC.
0.5 V/DIV
0.05 uS/DIV

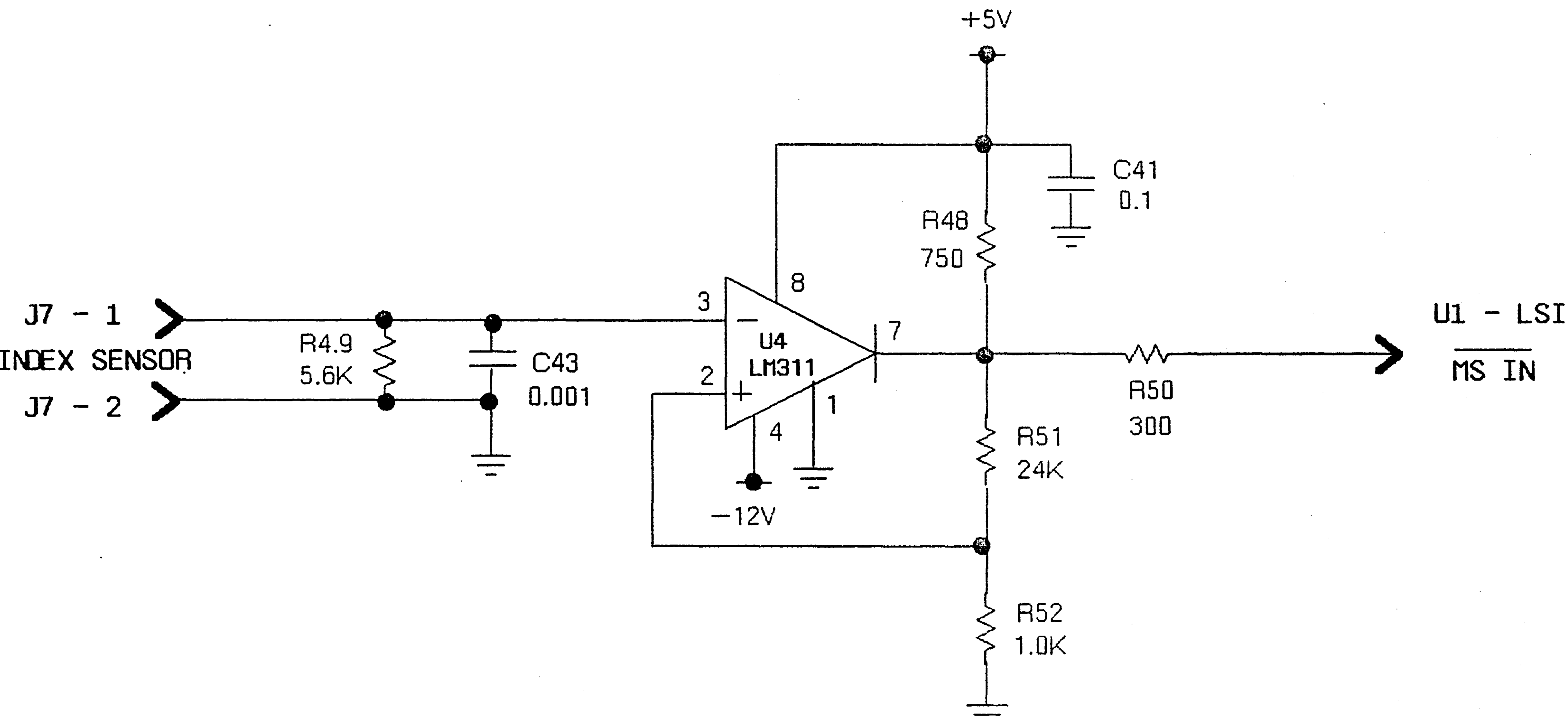


8.12) U5-10116

CHA 1 : PIN 14
CHA 2 : PIN 15 **(3.7 V DC OFFSET)**
0.5 V/DIV
0.05 uS/DIV



MECHANICAL SECTOR



9.15) U4 - LM311

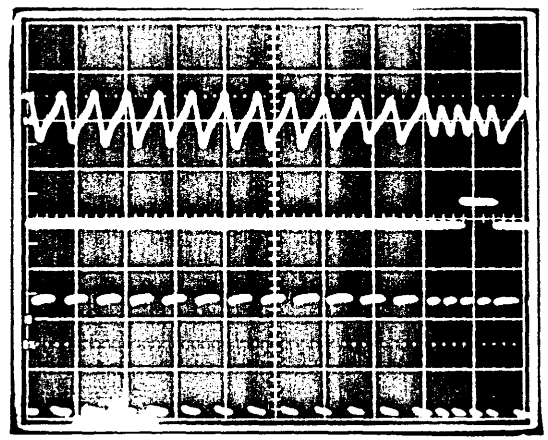
CHA 1 : PIN 3 - INDEX

CHA 2 : PIN 7 - MS IN.

CHA 3 : TRIGGER ON INDEX TP28.

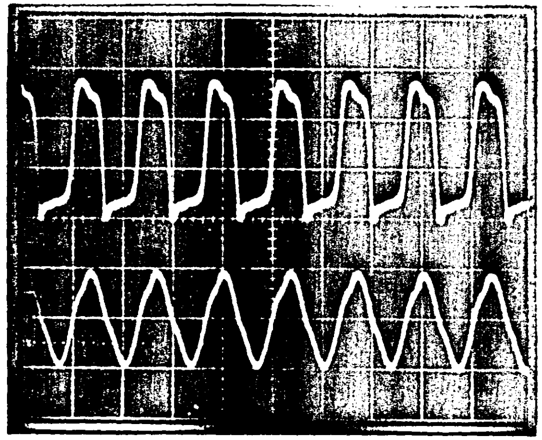
2 V/DIV

1 mS/DIV



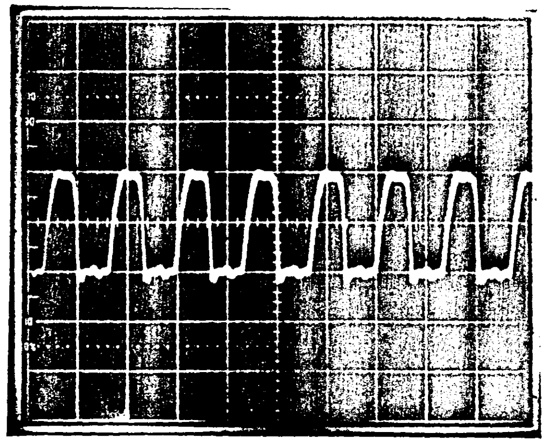
8.1) U1 - LSI CHIP

CHA 1 : PIN 25 -- XTL-X (15MHZ)
CHA 2 : PIN 24 -- XTL-Y (15MHZ)
2 V/DIV
0.05 uS/DIV



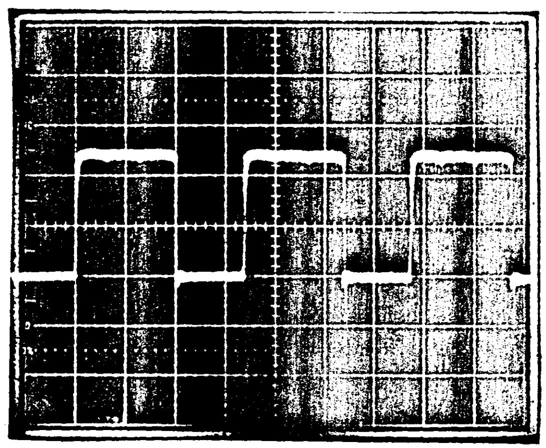
8.2) U1 - LSI CHIP

CHA 1 : PIN 65 - 2FVCO (15MHZ)
2 V/DIV
0.05 uS/DIV

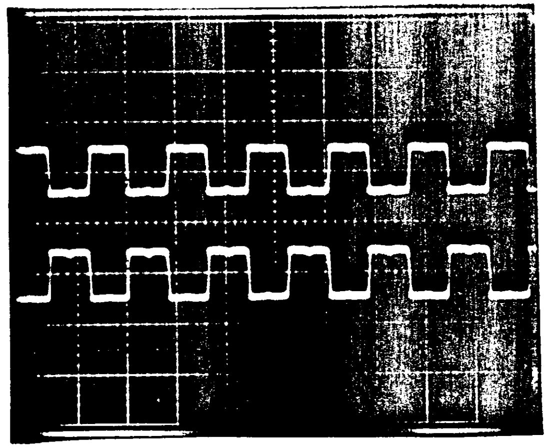


8.3) U1 - LSI CHIP

CHA 1 : PIN 28 - MOTOR CLOCK
2 V/DIV
0.2 uS/DIV

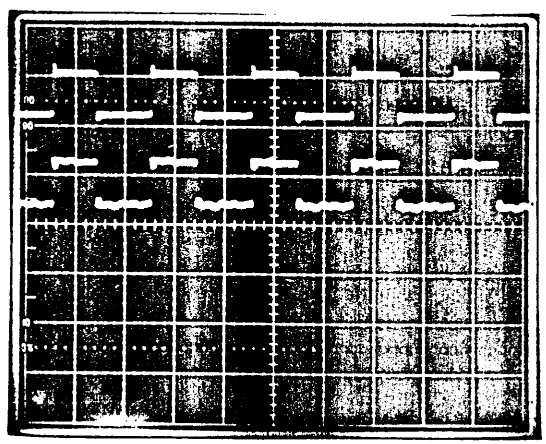


9.8) U10 - 10116
CHA 1 : PIN 14 - OUTPUT
CHA 2 : PIN 15 - OUTPUT
1 V/DIV
0.5 uS/DIV



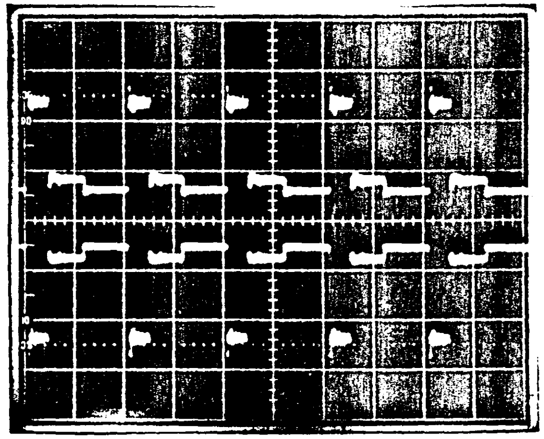
Second.

9.9) U10 - 10117
CHA 1 : PIN 3 - OUTPUT
CHA 2 : PIN ~~24~~ 2 - OUTPUT
1 V/DIV
0.2 uS/DIV

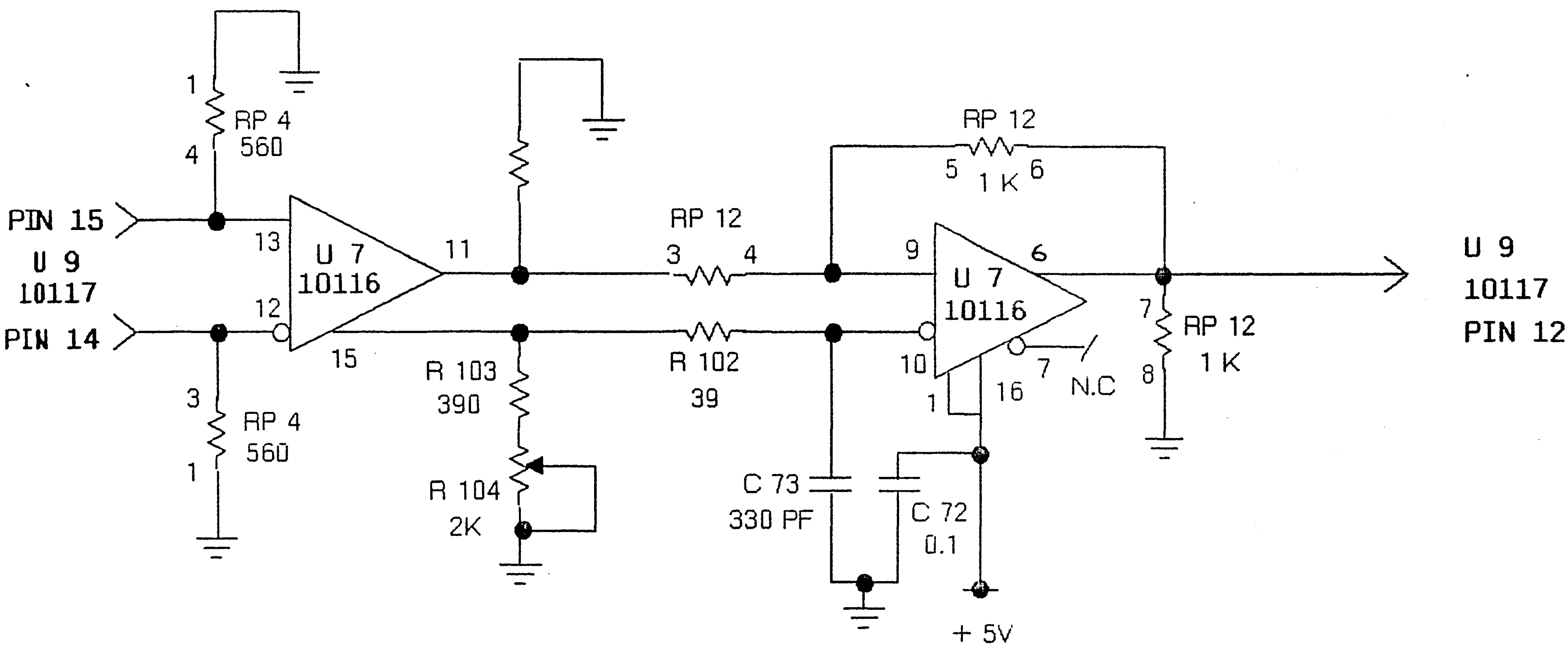


First

9.10) U9 - 10117
CHA 1 : PIN14 - OUTPUT
CHA 2 : PIN 15 - OUTPUT
0.5 V/DIV
0.2 uS/DIV



MARGIN PULSE ADJUSTMENT



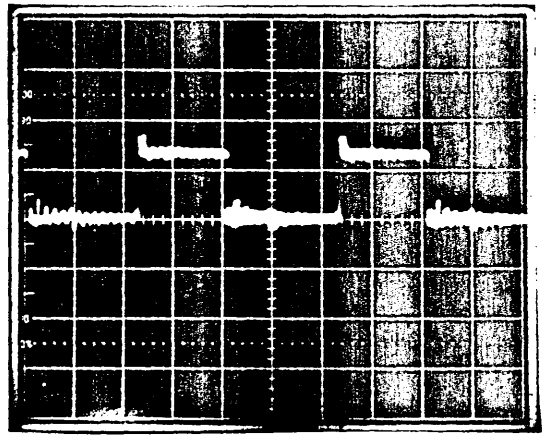
H. S

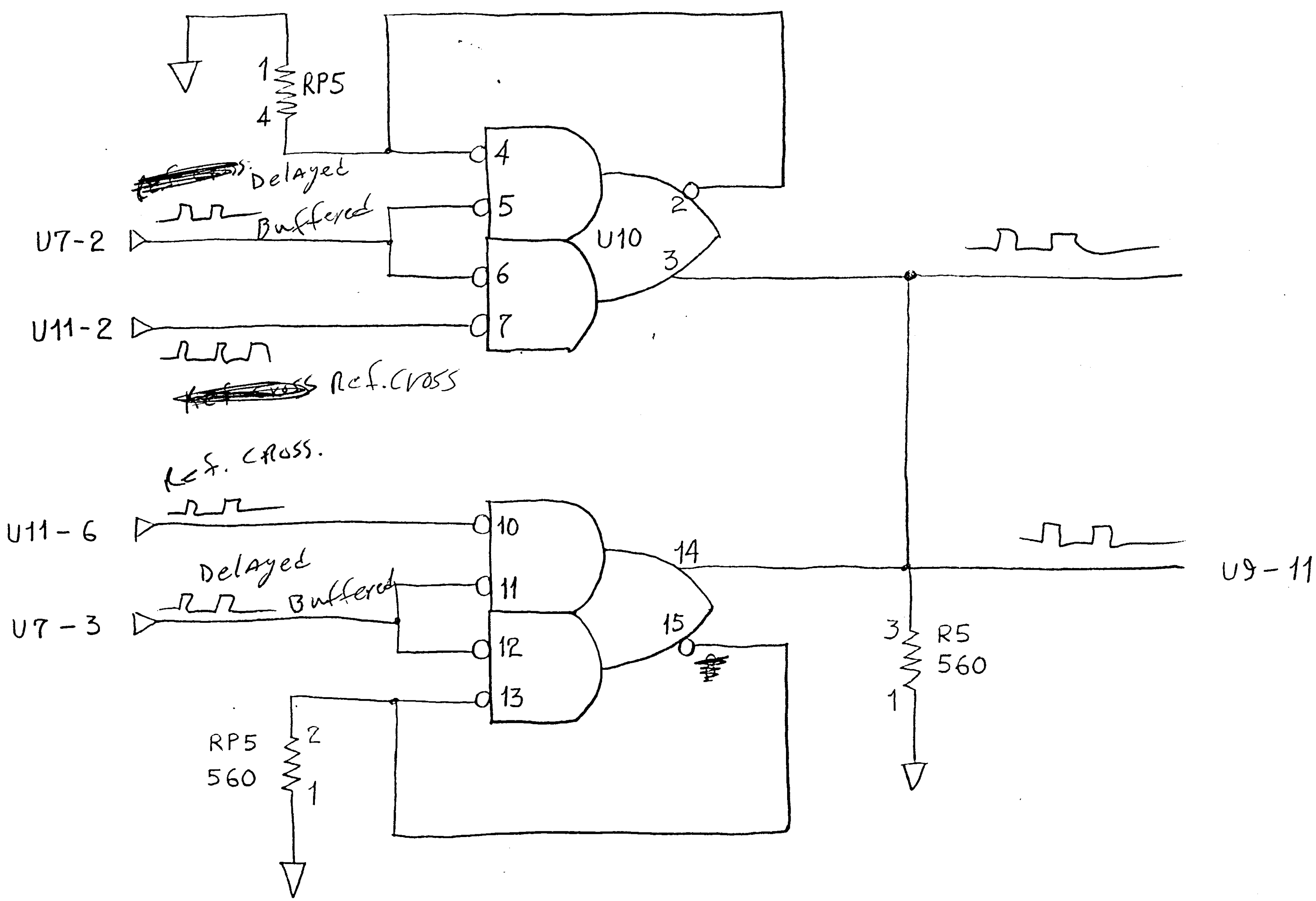
9.11) U7 - 10116

CHA 1 : PIN 6 - OUTPUT

0.2 V/DIV

0.2 uS/DIV




1
RP5
4
Delayed
Buffered
U7-2
U10
2
3
5
6
7
U11-2
Ref. Cross
Ref. Cross.
U11-6
10
11
12
13
14
15
Delayed
Buffered
U7-3
RP5
560
2
1
3
R5
560
1
U9-11