## 1 - SCOPE

The cassette tape unit used on Sagittaire are the Philips professional cassette units ELA or IGPA, or the Ampex one.

The control unit will allow to connect up to 4 cassettes tape units according to the size of the hardware which should be three Sagittaire cards.

## 2 : APPLICABLE DOCUMENTS

Philips professional cassette system (29.1.71)

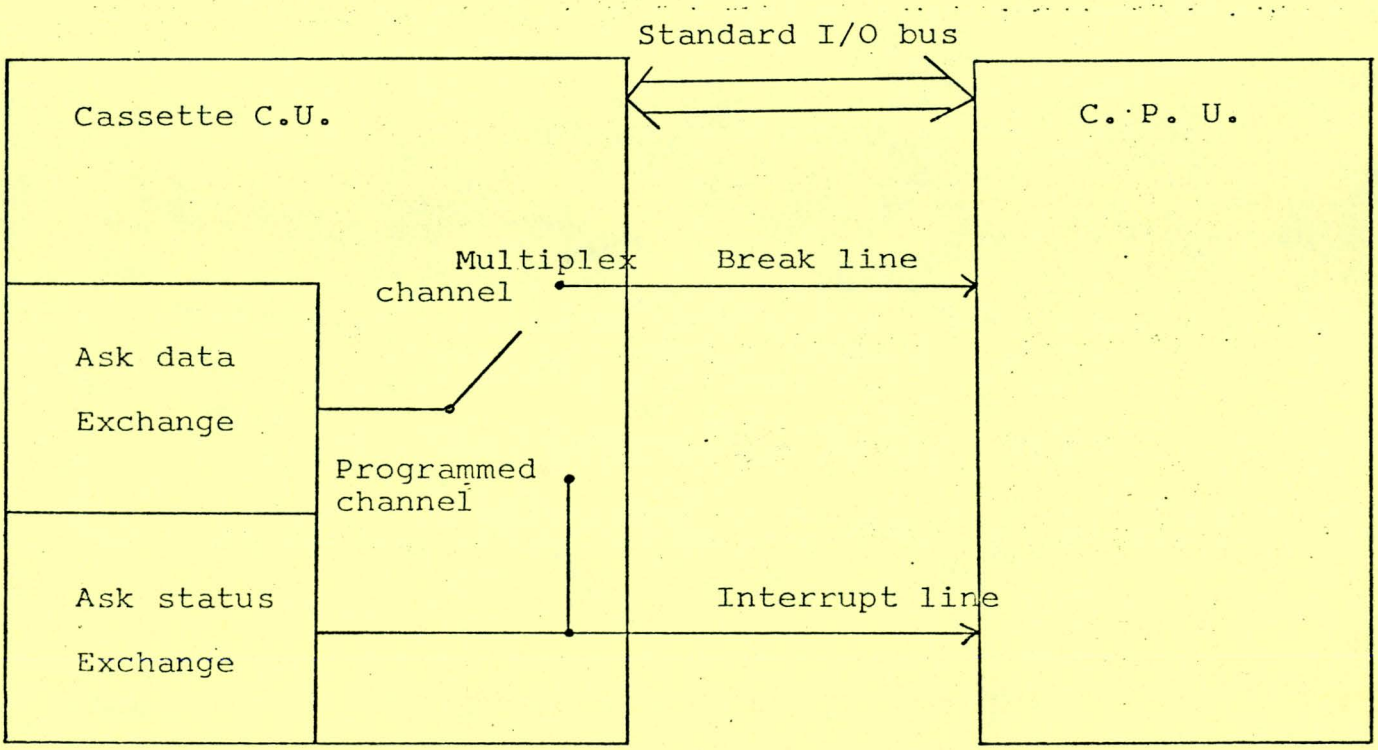
Draft commercial specifications for
Philips Professional Cassette type LG 6003. (4.2.71)

ECMA 34 standard for Data Interchange
on Magnetic Tape Cassette 800 bpi, PE, (September 1971)

Ampex cassette TMC specifications

## 1.5.1. Computer Interface

It is the standard I/O bus interface. Depending on the channel to which the control unit is connected, the following connections are done :



## 1.5.2. Device interface

A/ Signals from the controller to the device

| SIGNAL NUMBER | NAME | ACTIVE / INACTIVE LEVEL PHILIPS ELA | AMPEX | IGPA |
|---|---|---|---|---|
| 0 | | 0 Volt | 0 Volt | 0/5 |
| 1 | SLT/ select | ——— | 0/5 | 0/5 |
| 2 | FWD Forward | 5 | ——— | |
| 3 | REV Reverse | 5 | 5 | 0/5 |
| 4 | FAST Fast | 5 | 5 | 0/5 |
| 5 | WCD Write command | 5/0 | ——— | ——— |
| 6 | WCD/ Write command | ——— | 0/5 | 0/5 |
| 7 | RCD Read command | 5/0 | ——— | ——— |
| 8 | RCD/ Read command | ——— | 0/5 | 0/5 |
| 9 | WDA/Write data | ~~0/5~~ | 0/5 | 0/5 |
| 10 | LCK Lock | 5/0 | ——— | 0/5 |
| | SIGNALS FROM THE DEVICE TO THE CONTROLLER | | | |
| 12 | WEN/ Write enable | 0 | 0 | 0 |
| 13 | RDY/ Ready | 0 | 0 | 0 |
| 14 | BET/ Beginning or end of tape | 0 | 0 | 0 |
| 15 | A/ A or B side | 0/5 | 0/12 | 0/5 |
| 16 | RDA/ Read data | 0 | 0 | 0 |
| 17 | CIP/ Cassette in place | 0 | 0 | 0 |
| 11 | B/ B side | - | - | 0 |

O : Contents

# 1 : Basic information

## 1.1. Tape unit characteristics

### 1.1.1. Tape unit specifications

| | | |
|---|---|---|
| Model | Philips | Ampex |
| Type of encoding | Phase encoded | Phase encoded |
| Tape speed | 7.5 ips | 7.5 ips |
| Number of track per side | 1 | 1 |
| Number of cassette side | 2 (A or B) | 2 (A or B) |
| Type of head | Read after write | Read after write |
| Data rate | 750 ch/s at 7.5 ips | 750 Ch/s at 7.5 ips |
| Start time | 20 ms max. | 40 ms max |
| Stop time | 20 ms max | 40 ms max |
| Maximum time to rewind a 282 feet tape | 45 s | 45 s |
| Error rate | 1 recoverable in $10^6$ bits<br>1 unrecoverable in $10^7$ bits | 1 recoverable in $5.10^6$ bits |
| Density | 800 bpi | 800 bpi |

## 1.1.2. Cassette tape specifications

Cassette type : Twin hub, coplanar

Tape type : Magnetic tape certified for 1600 fcpi

Tape size : 282 ft long
0.15 i wide
750 ui thick

Data capacity : 2.8 million bits on each track

File protect : Two replaceable write enable plug in cut-outs at rear edge of cassette frame

Tape side identification : Asymetrically positioned cut-out in rear edge of cassette frame.

Number of head passes before drop outs occurs :
> 2000

Tape markers : two oblong holes as beginning of tape and End of Tape for optical indication

Location : 3.94 i from the physical beginning of magnetic tape.

### 1.1.3. Record format

The information on the tape is arranged in characters of 8 bits.
The characters are arranged in blocks. A block shall consist of a preamble, data and a postamble. The data portion of a block is 1 to 256 characters long.

Preamble

A/ When running in the forward direction, the preamble pattern "10101010" is the first character of each block.

Postamble

A/ When running in the forward direction, the postamble pattern "10101010" is the last character of each block.

The preamble and postamble characters are generated by the C. U. They are never sent to the CPU when reading a block, as first and last character, except the postamble can be sent as last character if the programmed length of the block is greater than the physical length of the record.

LRC character

When reading or reading after writing a block, the same weigted bits of all the characters are X ored by the cassette control unit. The status word of the ended operation will indicate a data fault if the character sum in the C. U. is different from zero.

For this purpose the program has to generate a LRC character in the data portion of a block when writing.

## 1.2. Control unit characteristics

Up to four tape units can be connected to the control unit.

The tape control unit is connected either to the multiplex channel or to the programmed channel (with or without interrupt handling).

The correspondence between the BIN/BOU lines and the character's bits is the following :

| Bit number | bo | b1 | b2 | b3 | b4 | b5 | b6 | b7 |
|---|---|---|---|---|---|---|---|---|
| BIN/BOU lines | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 |

The least significant bit of a character, $b_7$, is first recorded.

## 2 - INPUT/OUTPUT COMMANDS

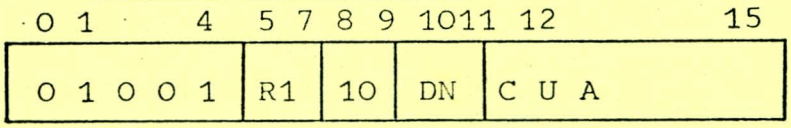
### 2.0. Summary

The control unit has to recognize the following commands :

2.1. TST
2.2. Commands I/O start
- 2.2.1. Erase forward
- 2.2.2. Forward space block
- 2.2.3. Backward space block
- 2.2.4. Write a block forward
- 2.2.5. Read a block forward
- 2.2.6. Search tape mark forward
- 2.2.7. Search tape mark backward
- 2.2.8. Rewind
- 2.2.9. CIO lock/unlock

2.3. CIO stop
2.4. INR
2.5. OTR
2.6. SST

## 2.1. TST Test status command




C.U.A. : Control unit address
D.N : Device number (00 to 11)
R1 : Indicates the register into which status bits are exchanged during this instruction.

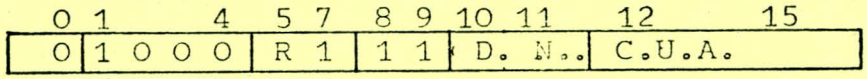
This command must be used before starting any I/O operation, to test if the control unit is in ready state

This command is always accepted by the control unit and does not disturb the eventual running operation of the control unit.

During the execution of TST the BIN contents are sent into R1 register, with the following meaning :

| bit value | 1 | 0 |
|---|---|---|
| bit n° 15 | C.U. busy (not ready) | C.U. ready |

## 2.2 CIO Starting commands




C.U.A. : Control Unit Address

D.N. : Device Number

R1 : The bits number 12, 13, 14, 15 of this register specify the command sent via the BOU lines

R1 Contents FAST/SRCH TRANS READ FWD

| bit number | 12, 13, 14, 15 | command |
|---|---|---|
| | 0 0 0 0 | Lock/Unlock |
| bits value | 0 0 0 1 | Erase forward |
| | 0 0 1 0 | Backward space block |
| | 0 0 1 1 | Forward space block |
| | 0 1 0 1 | Write a block forward |
| | 0 1 1 1 | Read a block forward |
| | 1 0 0 0 | Rewind at fast speed |
| | 1 0 1 0 | Search Tape Mark backward |
| | 1 0 1 1 | Search Tape Marck forward |

2.2.1. Erase forward

Execution time : 380msec

This command is used to erase the tape for a distance of approximately 2.5 inches, on the track according to the side being up, on the addressed tape unit. (The length of a 256 characters block is 2.5.inches)

This command is accepted if the Control Unit is in the inactive state and if the tape unit is not in a rewind operation -

The Condition Register is set to "1" if the command is not accepted. When this command is accepted :

- The condition register is reset to zero,
- The controller switches to the "Execute" state,
- The selected tape unit moves the tape forward, erases a part of the tape and stops, if the device is operable and if the working track is not file protected.
- If the track is file protected, the device does not start, the Control Unit switches to the "wait status" state . The bit n°6 of the status word is set.
- If the device is not ready, the C.U. switches to the "wait status" state and the bit n°15 of the status word is set.

When an erase operation is performed in the end of tape area, the bit 10 of the status word is set.

A/

## 2.2.2. Forward space block

This command is used to move the working track forward to the next interblock gap on the addressed unit.
This command is accepted if the control unit is in the inactive state and if the tape unit is not in a rewind operation.
The condition register is set to "1" if the command is not accepted and nothing else happens.
When this command is accepted :

- the condition register is reset to zero
- the controller switches to the "Execute state"
- the selected tape unit moves the tape forward

There is no data exchange and no parity check.

- When the next interblock gap is reached, the tape stops. If an End of Tape is encountered, the tape stops normally in the gap and the bit N° 10 of the status word is set. A/
- If the block was a tape mark, the bit N° 3 of the status word is set.

Even following a write block or erase gap command an accepted forward space command is performed, and the tape moves until the end of a previously recorded block is found. If the tape is raw, it moves until the ending of the tape and there will be no interrupt. A/

## 2.2.3. Backward Space Block

This command is used to move the working track backward of the addressed unit to the next interblock gap.
This command is accepted if the C.U. is in the inactive state and if the tape unit is not in a rewind operation.
The Condition Register is set to "1" if the command is not accepted and nothing else happens.
When this command is accepted :

- the Condition Register is reset to zero,
- the Controller switches to the "Execute state"
- the selected tape unit moves the tape backward There is no data exchange , and no parity check.
- When the next interblock gap is reached, the tape stops. If the space is performed in the End or Beginning of tape area, the tape stops in the next interblock gap and the N° 10 of the Status word is set. If the track is raw the tape moves until the beginning of tape area, and there will be no interrupt.
- If the block was a tape mark, the bit N° 3 of the status word is set.

A/

## 2.2.4. Write a Block Forward

This command is used to write a block fetched from the main storage, on the working track of the addressed tape unit.
This command is accepted if the Control Unit is in the inactive state and if the tape is not in a rewind operation.

The Condition Register is set to "1" if the command is refused, and nothing else happens.

When this command is accepted :

- The Condition Register is reset to zero,
- The C.U. switches to the "Execute" state.
- The selected tape unit moves the tape forward and writes characters taken on the BOU lines. At the end of the Multiplex transfer or if a STOP command is received, the C.U. realizes the Interblock Gap and stops the tape.

A write command assigned to a file protected track is accepted but not performed. In this case the C.U. switches to the "Wait Status" state ; the bit n°6 of the Status Word is set.

(2.2.4)

If a parity error is detected during a write command the C.U. realizes the Inter block gap and stops the tape. The bit N° 13 of the Status Word is set.

If a throughput error occurs during a write operation, the data transfer is interrupted, the C.U. realizes the Interblock Gap and stops the tape. The bit N° 14 of the Status word will be set.

After the first write operation performed in the End of Tape area, the bit N° 10 of the Status Word is set. The tape will be long enough to allow another block with the maximal length to be written, but the bit n° 10 of the status word will be not set.

(2.2.5.)

The data transfer stops as soon as the EOR signal or Stop command or Interblock Gap occur.

If a throughput error occurs during a read command the data transfer is interrupted. The C.U. switches to the "Wait Status" state after the tape is stopped in the Interblock Gap and the bit 14 of the Status Word is set.

If a parity error is detected during a read command the operation is ended like for a throughput error, but the bit 13 instead of the bit 14 of the Status Word will be set.

A/ As soon as an ending hole is detected, the bit n° 10 of the status word is set.
If the block was a Tape mark, the bit N° 3 of the status word is set.
Even following a write block or erase gap command, an accepted Read forward command is performed ant the tape moves until the end of a previously recorded block is found.
The tape moves until the end of tape if the tape is raw and there will be no interrupt.

## 2.2.6. Search Tape Mark Forward

A/ This command is used to search forward a block of 1 data character, on the working track of the addressed tape unit
This command is accepted if the C.U. is in the inactive state and if the tape is not in a rewind operation.
The conditionregister is set to "1" if the command is refused and nothing else happens.
When this command is accepted :

- The condition register is reset to zero ;
- The C.U. switches to the Execute State,
- The selected tape unit moves the tape forward and the C.U. stops the tape after the next tape mark block, it switches to the wait status state and the bit n° 3 of the status word is set.

## 2.2.7. Search Tape Mark Backward

See 2.2.6 with the tape moving in the backward direction.

## 2.2.8. Rewind

This command is used to rewind the working track on the addressed tape unit to the nearer ending hole.

This command must be programmed when starting a job on a new track if this track is not at the beginning of tape hole.

This command is accepted if the control unit is in inactive state and if the tape is not already in a rewind operation.

The condition register is set to "1" if the command is refused and nothing else happens.

When this command is accepted :

- the condition register is reset to zero
- the C. U. switches to the "Execute" state and initiates the tape rewind
- the selected tape unit moves the tape backward and stops after the first encountered ending hole.

After the C. U. has initiated the tape movement it switches in the inactive state, 170ms later. The tape does not stop if a hole occurs during this time, while the detection is inhibited.

A/ When the tape stops and if the CU is inactive, it switches to the "Wait status" state and the bit 10 of the status word is set.

Execution time : 45 sec. max. for a 282 feet tape

CIO Halt

## 2.3. STOP Command

| 0 | 1 4 | 5 7 | 8 9 | 10 11 | 12 15 |
|---|---|---|---|---|---|
| 0 | 1 0 0 0 | R 1 | 1 0 | X X | C.U.A. |

C.U.A. : Control Unit address
D.N. : Device Number is don't care
R1 : The contents of the Register R1 is not significant.

This command is used to stop data transfer between the C.U. and the C.P.U.

The execution of the following commands :

- Forward and Backward space block
- Erase gap
- Rewind

is not disturbed by a stop command.

This command is always accepted and the condition register is reset to zero.

This command must be programmed after the last character to be exchanged.

(2.5.)

When this command is accepted :

- The Condition Register is reset to zero,

- The right half of the R1 register is sent into the C.U. buffer via the BOU lines,

- The ask for exchange line is desactivated,

- The C.U. switches to the "Execute" state and serializes the character.

### 3.4. Incorrect length

This bit is set when reading whenever the tape block length is different from the channel block length.

### 3.5. Program error

This bit is set whenever the C.U. receives from the Multiplex channel an invalid code, or if an invalid CIO starting command is attempted.
A program error stops any data exchange.

### 3.6. End of tape :

This bit is set when an End of tape area is reached.or when a rewind operation is ended.

### 3.7. Device address

Bits 09, 08 give the device number concerned by the status word. Bit N° 8 is the most weighted bit

### 3.8. A or B side

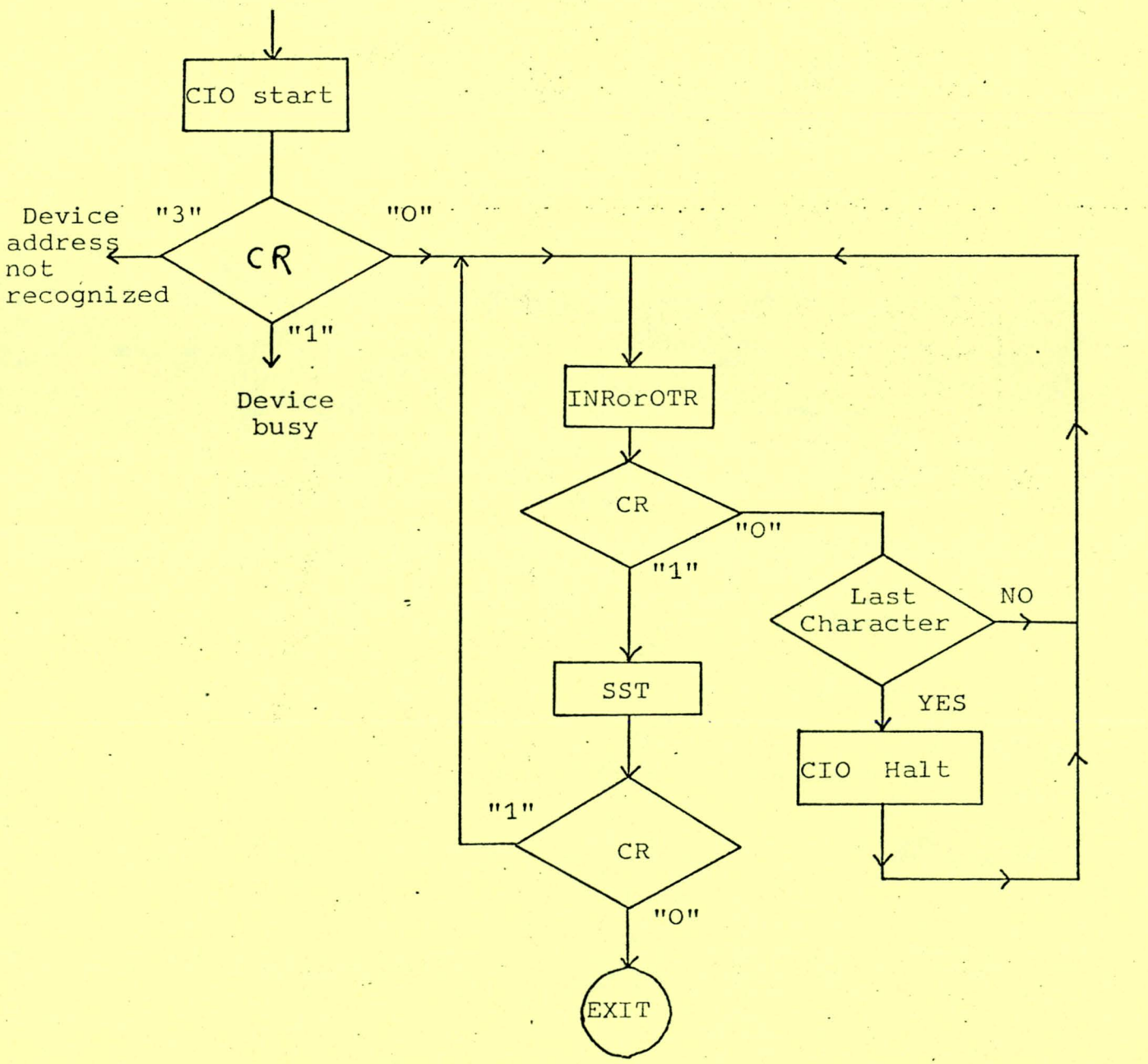
This bit is set during a SST command if the A side was up.

### 3.9. Write unable

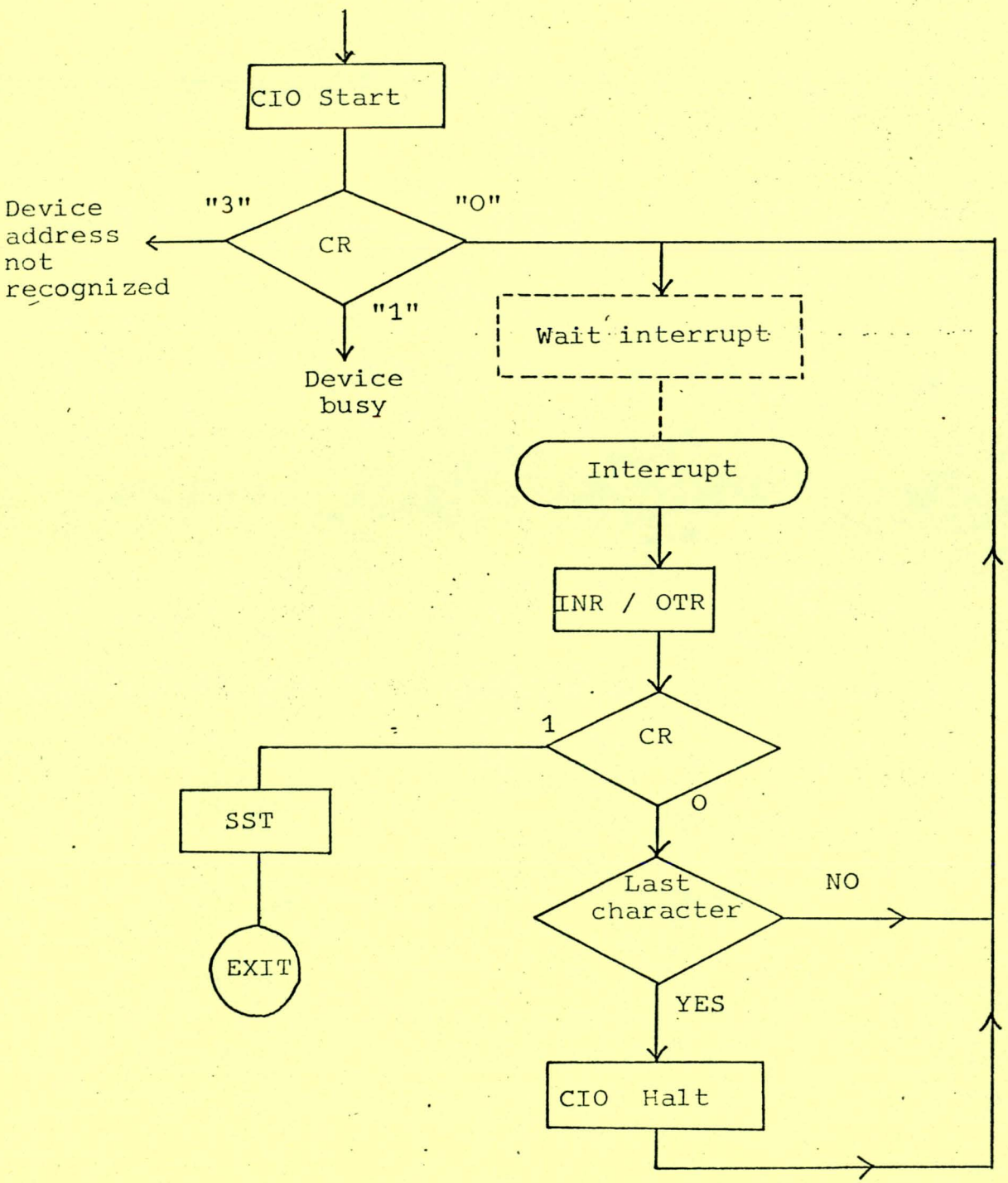
This bit is set whenever the C.U. receives a write or erase command while the working track is file protected.
A write unable declaration stops any data exchange.

## 4. PROGRAMMING RULES

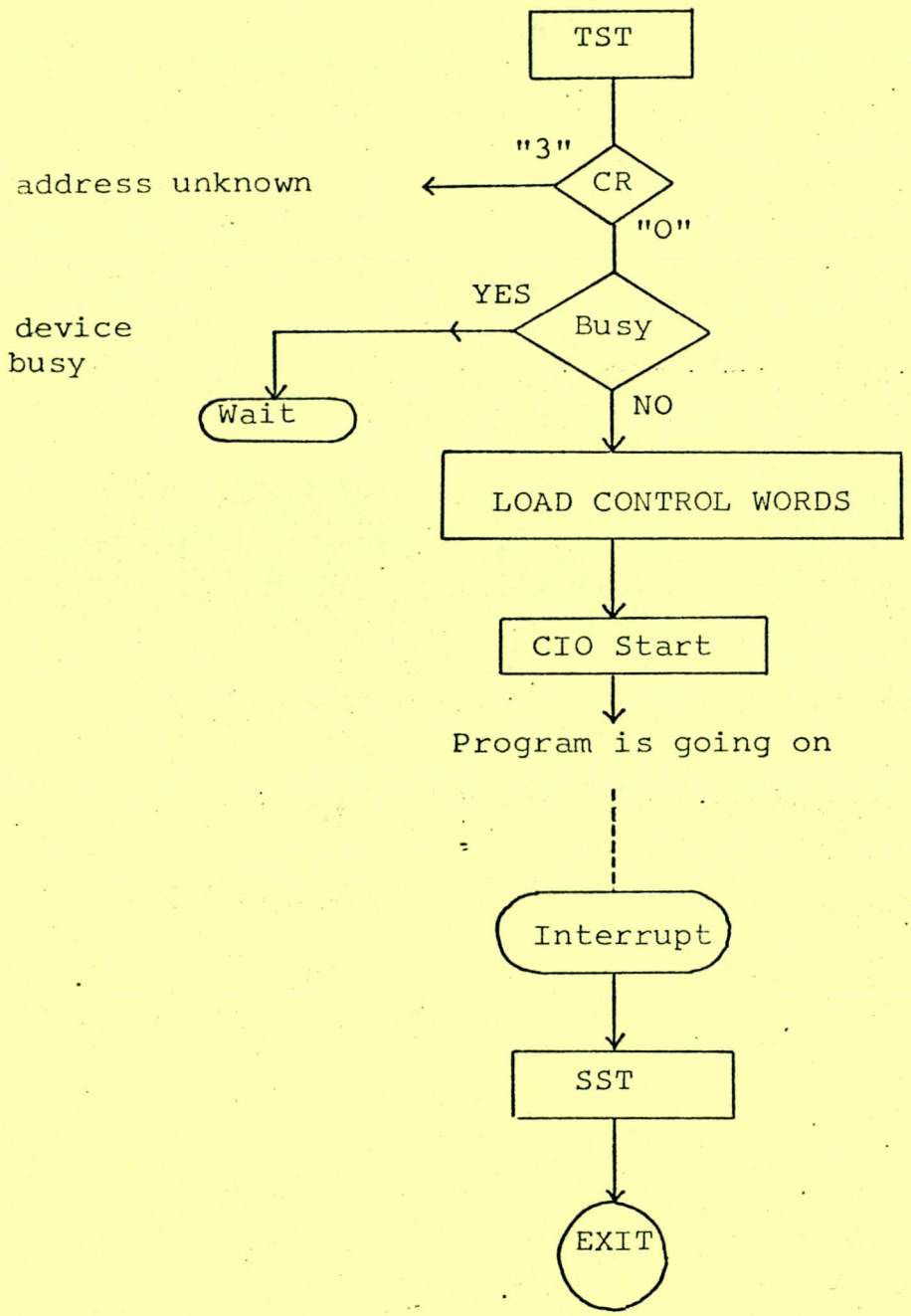
### 4.1. Programmed channel without interrupt handling



## 4.2. Programmed channel with interrupt handling



## 4.3. Multiplex channel



## 4.4. Interrupt activation

### 4.4.1. Control unit connected on the I/O bus with interrupt handling

The interrupt line is activated only when a CIO start command has been accepted by the control unit.

An interrupt activation appears when the control unit asks for a data exchange or for an SST command.

### 4.4.2. Control unit on multiplex channel

In this mode of connection the interrupt line is only used to ask for a status exchange. For the data exchange requests, the break line is activated.

## A. ELA AND AMPEX

### 1 - GENERAL ELA AND AMPEX

The circuits, which have to be developped are clock circuits, interface circuits between the C. U. and the peripherals and power supply for the cassette models :

- Philips Digital Cassette Deck

- Ampex TMC 200

## 2 - FUNCTIONAL REQUIREMENTS

### 2.1. General wiring diagram

#### 2.1.1. Interface circuits

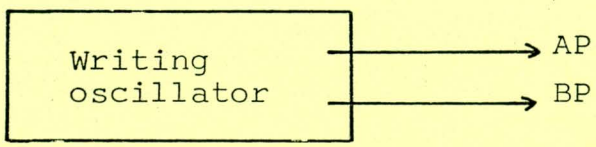
The circuits must not invert the signals.
The correspondance between the AMPEX and PHILIPS is the following.

| Circuit number | AMPEX | PHILIPS |
|---|---|---|
| CSO C.U → Cassette drive | | |
| 1 | FAST → [ ] → FAST* | FAST → [ ] → FAST* |
| 2 | | FWD → [ ] → FWD* (forward) |
| 3 | | LOCK → [ ] → LOCK* |
| 4 | RCD/ → [ ] → RCD/* (read command) | |
| 5 | | RCD → [ ] → RCD* (read command) |
| 6 | REV → [ ] → REV* (reverse) | REV → [ ] → REV* |
| 7 | SEL/ → [ ] → SEL/* (run) | |
| 8 | WCD/ → [ ] → WCD/* (write command) | |
| 9 | | WCD → [ ] → WCD* (write command) |
| 10 | WDL/ → [ ] → WDL/* (write data) | WDL/ → [ ] → WDL/* |

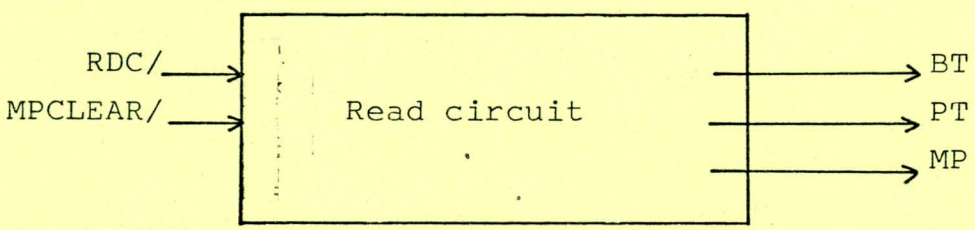
| Circuit number | AMPEX | PHILIPS |
|---|---|---|
| CSI CASSETTEC.U. | | |
| 12 | A/* → [ ] → A/ | A/* → [ ] → A/ |
| 13 | BET/* → [ ] → BET/ | BET/* → [ ] → BET/ |
| 14 | CIP/* → [ ] → CIP/ (cassette not in place) | CIP/* → [ ] → CIP/ |
| | RDY/* → [ ] → RDY/ (not ready) | RDY/* → [ ] → RDY/ |
| 16 | RDA/* → [ ] → RDA/ (read data) | RDA/* → [ ] → RDA/ |
| 17 | WUN* → [ ] → WUN (write unable) | WUN* → [ ] → WUN |

All the interface circuits and signals are indexed by 0, 1, 2, 3 according to the cassette drive number 0, 1, 2, 3.

## 2.1.2. Writing oscillator




## 2.1.3. Read circuit



## 2.1.4. Cassette power supply

AMPEX : + 12 V ; 3A for control and electronics
+ 24 V ; 1A for motor drive

PHILIPS : + 5 V ; 1.8 A for control
+ 24 V ; 1A for motor drive
(1.4A during the power on)

## 2.1.5. PHILIPS power failure protection

The four write command signals :
WCDO*, WCD1*, WCD2*, WCD3* must be forced to the inactive state (0 Volt) in case of + 5V voltage failure.

## 3 - ELECTRICAL REQUIREMENTS

### 3.1. Special circuits power supply

Vcc = + 5 V $\overline{+}$ 5 %

### 3.2. Interface circuits

#### 3.2.1. Wiring

The transmission lines are 120 ohms twisted lines
Max length : 3 m.
All the special circuits outputs not connected to an interface line must be terminated on the C. U. cards.

#### 3.2.2. Timing requirements

t rise $\leqslant$ 500 ns
t fall $\leqslant$ 500 ns

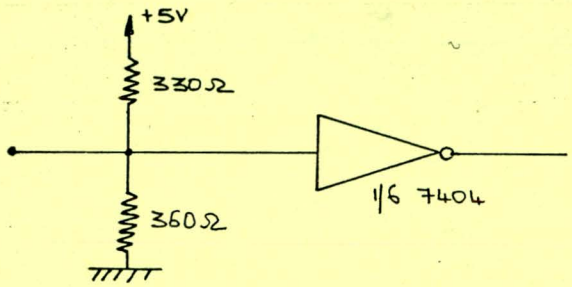
#### 3.2.3. Loading

##### 3.2.3.1. Output circuits

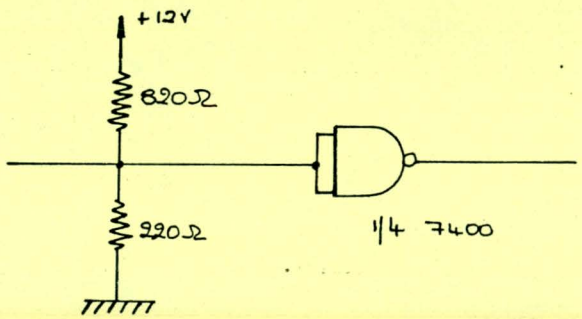
The driving circuits of the logic signal number 1 to 11 are standard TTL output ; fan out 10.

## 3.2.3.1. a - Ampex loading circuits

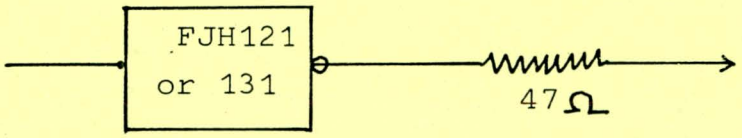
Circuit number : 1, 6, 7




Circuit number : 4, 8, 10



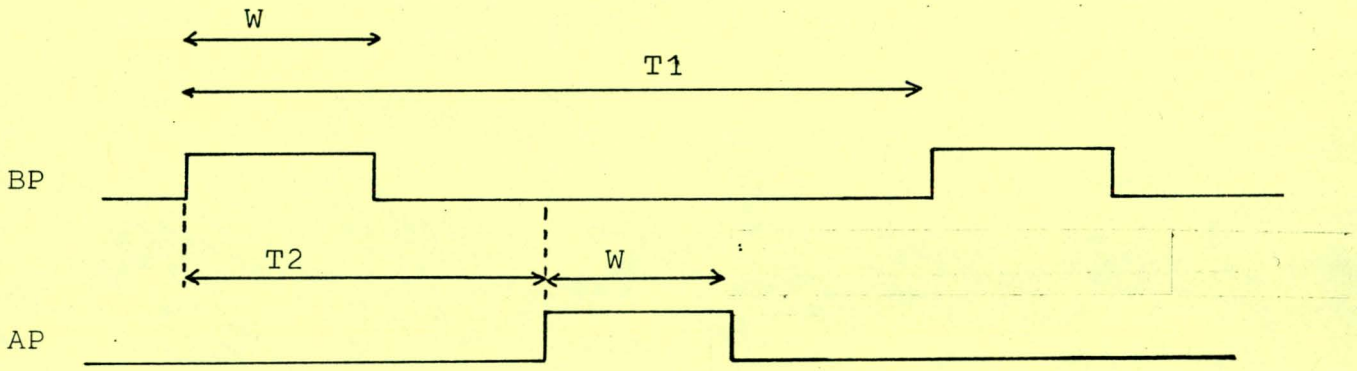
### 3.2.3.2. b-Philips driving circuits



## 3.3. Writing oscillator

### 3.3.1. Timing requirements

The writing oscillator delivers a biphased clock BP and AP.




T1 = 83,33 us ± 1 % long term ; ± 6 % short term (0.15 % per cell)
T2 = 41,66 us ± 1 % " " " " "
W = 135 ns min ; 30 us max.

### 3.3.2. Fan out requirements

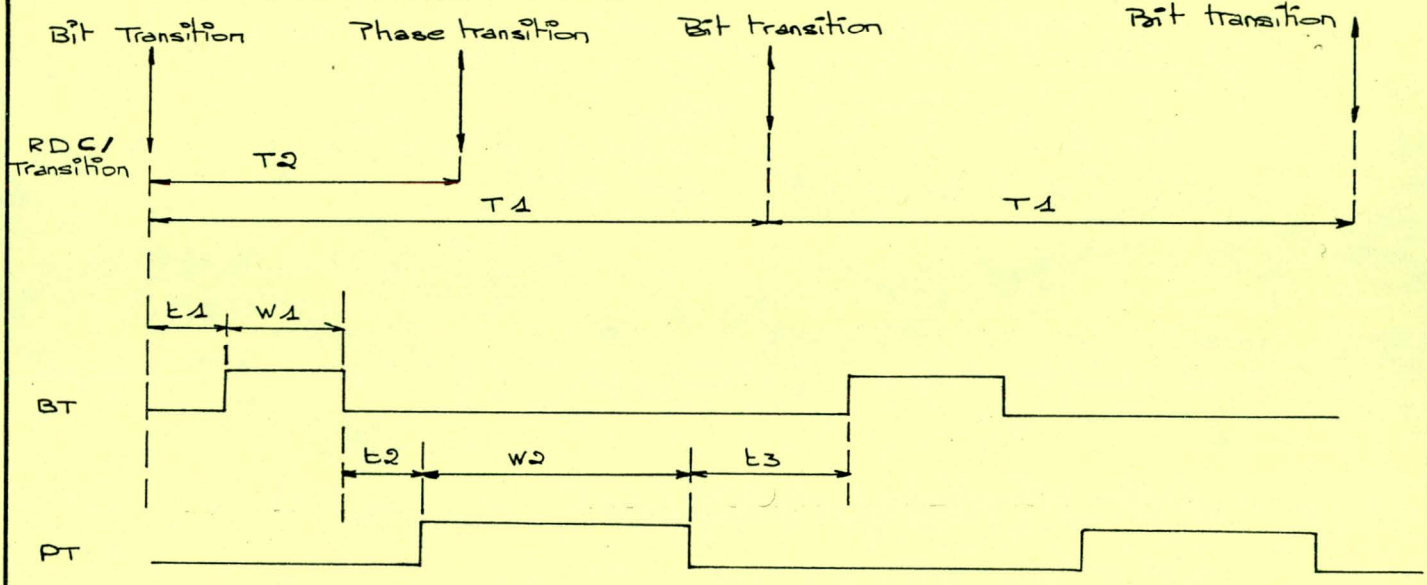
BP : 8
AP : 4

## 3.4. Read circuit

### 3.4.1. Timing requirements

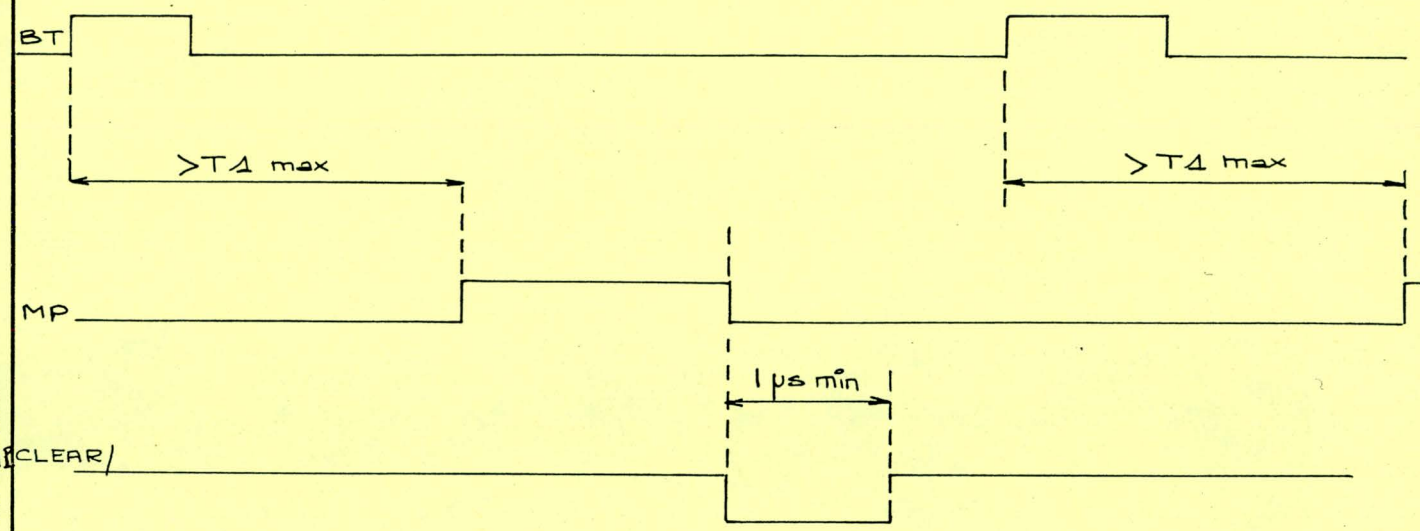
The generator delivers a biphased clock BT and PT according to the transition on the RDC/ signal (the first transition is a bit transition followed by a positive phase transition).

A




T1 = 166,66 us ∓ 11 % long term ; ∓ 12 % short term
T2 = 83,33 us ∓ 11 % long term ; " " "
W1 = 200 ns min ; 70 us max.
W2 = 200 ns min ;
t1 = 35 ns min ; 70 us max.
t2 ⩾ 100 ns
t3 ⩾ 35 ns

When the reading is ended, no more transition occurs, so the read circuit must indicate a missing BT pulse by a MP signal high until the reset of this signal by the logic signal MP CLEAR/




### 3.4.2. Loading requirements

| | | |
|---|---|---|
| BT | F.O. | 12 |
| PT | F.O. | 1 |
| MP | F.O. | 5 |
| RDC/ | F.I. | 9 |
| MPCLEAR/ | F.I. | 3 |

## B. I.G.P.A.

### 1. General IGPA

The circuits, which have to be developped are clock circuits, interface circuits, and power supply for the IGPA cassette.

### 2. Functional requirements

### 2.1 General Wiring Diagram

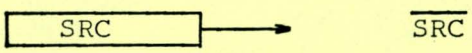
#### 2.1.1. Interface circuits

The circuits must not invert the signals

| Output Circuits | Names | |
|---|---|---|
| | Logic signal | To connector |
| AOKI | $\overline{FST}$ → | $\overline{FST}$* |
| " | $\overline{REV}$ → | $\overline{REV}$* |
| " | $\overline{FWD}$ → | $\overline{FWD}$* |
| " | $\overline{LCK}$ → | $\overline{LCK}$* |
| " | $\overline{WDL}$ → | $\overline{WDL}$* |
| " | $\overline{RCD}$ → | $\overline{RCD}$* |
| " | $\overline{WCD}$ → | $\overline{WCD}$* |
| " | $\overline{SRC}$ → | $\overline{SRC}$* |

| Input Circuits | from connector | Logic signal |
|---|---|---|
| AIKI | $\overline{A}$* | $\overline{A}$ |
| " | $\overline{BET}$* | $\overline{BET}$ |
| " | $\overline{CIP}$* | $\overline{CIP}$ |
| " | $\overline{RDY}$* | $\overline{RDY}$ |
| " | $\overline{RDA}$* | $\overline{RDA}$ |
| " | WUN* | WUN |

2.1.2 Speed reference clock circuit




2.1.3 Cassette power supply

Voltage : +12V : tolerance ±10% current 1.3A max
-12V " ±10% " 50mA max
+5V " ±10% " 1.0A max

## 3. Electrical Requirements

### 3.1 Special circuits power supply

Vcc = +5V ± 5%

### 3.2 Interface circuits

#### 3.2.1 The transmission lines

Cable = 0712 220 04001

Max length = 3m

#### 3.2.2 Timing requirements

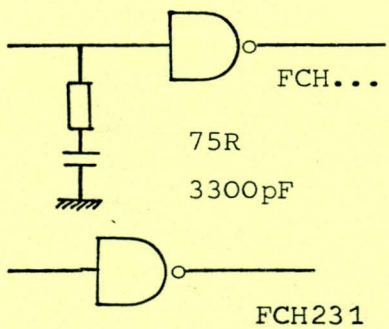
trise 500ns

t fall 500ns

#### 3.2.3 Loading

3.2.3.1 Output circuits

Fan in 10
Loading circuit



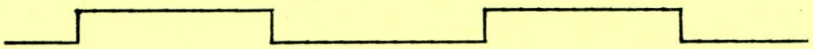

3.2.3.2 Input circuit

Fan out : 2
Driving circuit

## 3.3 Speed reference clock circuit

This circuit delivers a square wave $\overline{SRC}$ which frequency is 768KHZ ± 2%

Fan out : 10

$\overline{SRC}$ 

Duty cycle 30% to 70%

## 4 - MECHANICAL REQUIREMENTS

See document :

## 5 - ENVIRONMENTAL REQUIREMENTS

See document : SAG Specs. Section 3.2.2.1.



PHILIPS

## 6 - RELIABILITY REQUIREMENTS

MTBF : T.B.F.