



**USER'S MANUAL**  
**FOR**  
**RAYCORDER SERIES 6106/6406**  
**MAGNETIC TAPE CASSETTE TRANSPORT**

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**1 December 1972**

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RAYRECORDER CASSETTE TAPE TRANSPORT

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USER'S MANUAL  
FOR  
RAYCORDER SERIES 6106  
MAGNETIC TAPE CASSETTE TRANSPORT

INTRODUCTION

This User's Manual for the Raycorder Model 6106 Cassette Tape Transport System (See Figure 1) presents detailed information to unpack, inspect, install, use and maintain the unit. Information is presented in this sequence for the convenience of the user. Appended to this manual is a Supplement which describes the 6406 Transport Controller Electronics. Although not normally included in this manual for 6106 users, the transport controller electronics is available as an option.

The Raycorders Series 6106 are precision digital cassette recorders designed and manufactured by Raymond Engineering, Inc. for reliable digital data storage on magnetic tape for commercial and industrial applications. The Model 6106 consists of a tape transport mechanism, read preamplifiers, write amplifiers, EOT (end-of-tape) and BOT (beginning-of-tape) sensor amplifiers, and voltage regulators. Of primary significance to the user are the incorporation of electrical and mechanical design concepts that facilitate installation and operation, and insure accurate data storage and reliable performance during the normal life of the Raycorder.

Modular construction permits the unit to be easily adapted to a variety of OEM applications. The Raycorder is available with either AC or DC capstan motor drive option. Standard electrical connections and versatile mechanical mounting allows the transport units to be easily interchanged.

A sliding carriage feature of the transport assembly assures positive alignment of the tape guides, head, and pressure rollers within the cassette. Because of the die cast aluminum construction of the carriage, the mounted components remain in a fixed position over the life of the transport. Data written on a tape by one Raycorder unit can be read with accuracy by other Raycorder units without adjustments to the transport. Some of the salient features of the Raycorder are:

MECHANICAL

- Capstan processed to controlled degree of roughness for better coupling with tape
- Die cast aluminum frame and sliding carriage
- Direct reel and capstan drive
- Low tape tension
- Interchangeability of recorder units

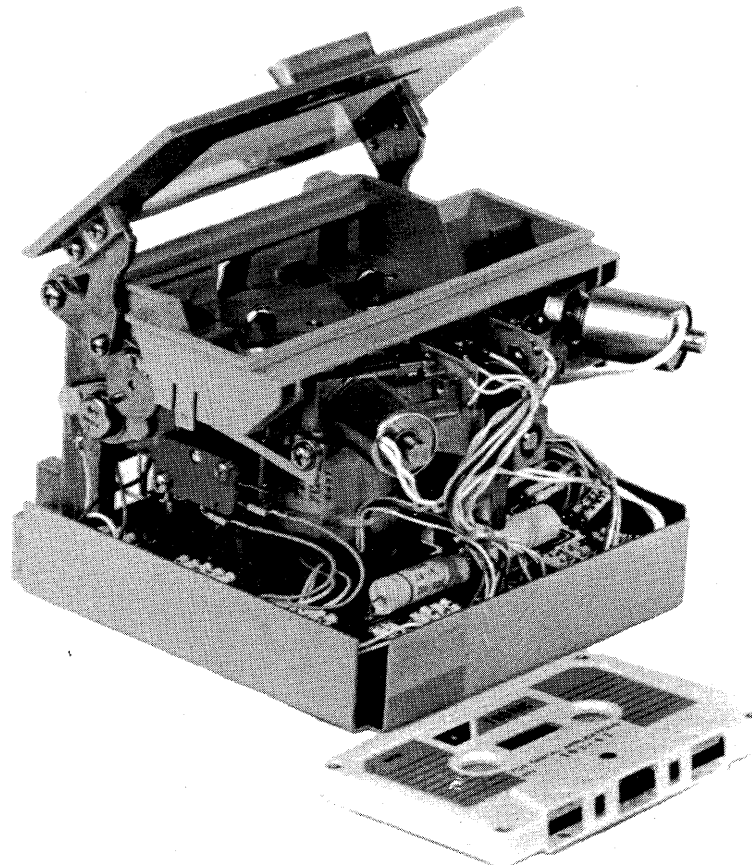


Figure 1. Model 6106 Tape Transport Unit

## RAYRECORDER CASSETTE TAPE TRANSPORT

Precise tape-head alignment. Head and guides always engaged  
Friction free, ball bearing capstan motors and pinch rollers  
Simplified rack or console mounting  
Positive cassette positioning

### ELECTRICAL

Extensive use of integrated circuits  
Gold plated electrical connector contacts  
DTL or TTL acceptable interface control signals  
AC or DC capstan motors and drive circuits  
Dual track, recording  
Fast search capability  
Remote programming of tape speed

### RAYRECORDER TRANSPORT ORDERING INFORMATION

The part number information applies to tape transports Model 6106 series only. For information on part numbers for transports together with controller electronics, please see the Supplement. As shown on Table 1, either AC or DC capstan models are available as standard units in either "READ OR WRITE" or "READ-WHILE-WRITE" data recording.

TABLE 1

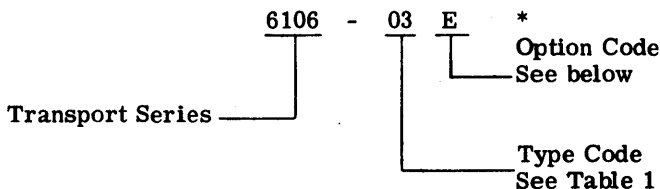
RAYRECORDER MODEL DESIGNATIONS

TYPE	READ OR WRITE	READ-WHILE-WRITE
AC Capstan	6106-01	6106-03
DC Capstan	6106-02	6106-04

EXAMPLE: 6106-02, DC Capstan, Read or Write

In addition, the four models can be provided as a single direction device that allows reading and writing in the forward direction only. Units of this configuration do not include a left pinch roller and capstan motor.

The following equipment ordering code specifies the type and configuration of the model required.



\*Custom requested option will be assigned option code letters.

Code

E	Single Direction (FWD Capstan Only)
No Letter	Dual Direction

## RAYRECORDER TRANSPORT SPECIFICATIONS

The recorder accepts a Philip's type magnetic tape cassette and permits both reading and writing of serial data on two track tape under control of an external system.

Table 2 lists the equipment specifications for the AC Capstan Transport Unit Models 6106-01, 03 and for the DC Capstan Transport Unit Models 6102-02, 04.

### UNPACKING

The 6106 transport is protected during shipment by a closely fitted layer of resilient plastic foam contained within a cardboard carton. This method of packing gives maximum protection to the transport and associated electronics during shipment. Retain these packing materials for future use, particularly if further shipment is necessary.

To unpack the Rayrecorder, carefully remove the unit from this packaging and prepare to immediately perform an initial inspection of the equipment.

### INSPECTION

When the equipment is received it is important to first visually inspect the unit for any gross damage, then proceed with an initial visual and mechanical operation inspection of the unit. Should any damage or defect be detected that may have occurred during shipment, immediately report this damage to both the manufacturer and to the carrier.

Do not return damaged transports to Raymond Engineering or the carrier until permission is granted and instructions for reshipment are understood.

For inspection reference use Figure 2 through 4 inclusive. Visual inspection should include a careful check for external signs of damage and for any apparent loosening of components or unwarranted play of mountings. Mechanical checks should include manipulation of the Cover and Carriage assemblies and careful observation of alignments and free movement of these elements.

### INSTALLATION

The transport can be mounted with the cassette plane horizontal or vertical. Installation measurements are contained on Figure 5, Model 6106 Transport Unit, Overall Clearance Dimensions and Figure 6, Model 6106 Transport Unit, Mounting Dimensions.

For overall clearance, allow 2 inches beyond overall dimensions shown for normal cable bend at the connectors, either back or bottom cable connection. For mounting dimensions, the hole pattern is not identical for back and bottom mounting. Tapped holes (6-32-UNC-2B) are provided on the mounting faces. The cover is designed to open in a way that clears the metal facing panels of a user's installation.

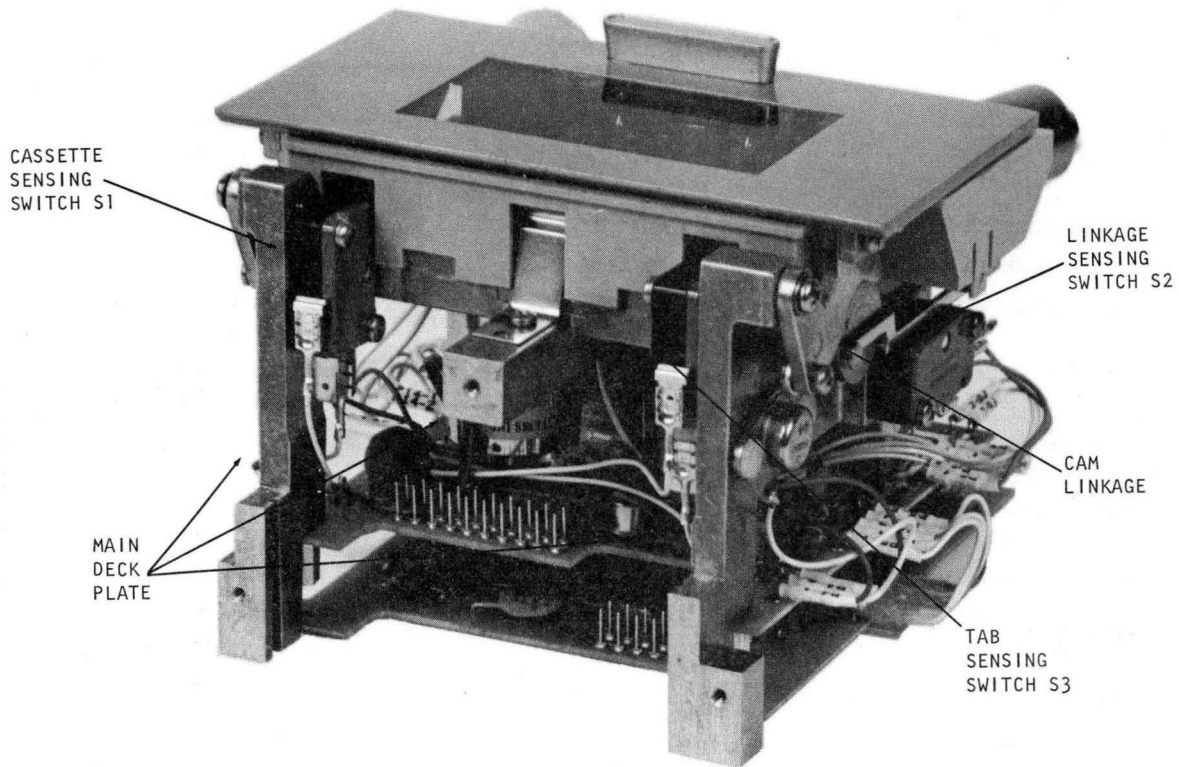


Figure 2. TTU, Rear View

### Ventilation

In accordance with good engineering practice, an installation should provide for a free flow of cooling air over the transport. The large cross section of the castings in the Model 6106 provide extensive heat conduction from the heat generating parts of the transport to the mounting faces and the support structure.

### USE

The following pages contain descriptions of system components and functions, connector pin arrangements, and special considerations and requirements for operations.

### Inserting and Removing a Cassette

The main frame of the transport is shown on Figure 2 and forms the base of the unit. It is constructed of cast aluminum to insure transport dimensional stability, and provides a mounting deck plate for the reel and capstan motors, cassette positioning posts, transport cover and printed wiring boards. Attached to the top of the deck plate is a plastic liner in which the cassette is inserted. Two ejector levers, one on each side of the liner, facilitate removal of the cassette.

The cast aluminum carriage assembly shown on Figure 3 provides mounting for the left and right

pinch rollers and activating solenoids, the tape head, the EOT and BOT photo transistors, and the tape positioning guides. The carriage alignment in relation to the main frame and cassette is maintained by two rods which are inserted into the main frame. An oilless bearing and teflon guide allow free movement of the carriage on the rods.

The transport cover assembly protects the cassette from environmental contamination and pivots by means of two brackets attached to the main frame. A plastic window in the cover allows a visual indication of tape levels on the reels and reel motion. The precision cam linkages, activated by the cover, control the position of the sliding carriage in relation to the main deck plate as shown on Figure 4.

Opening the cover retracts the carriage to enable the insertion of the cassette. Closing the cover advances the carriage to engage the head and guides with the tape. Since the head and tape guides are precisely positioned within the cassette, optimum tape alignment is maintained. When the cover is closed, a following arm on each side of the carriage moves the cassette downward and into position in the transport liner if not properly seated. If the cassette is improperly loaded, the following arms prevent the carriage from sliding completely forward thereby protecting the tape head and guides. A forward positioning leaf spring at the rear of the transport liner holds the cassette firmly toward the front of the unit.

RAYRECORDER CASSETTE TAPE TRANSPORT

TABLE 2

MODEL 6106 SPECIFICATIONS

	AC Capstan	DC Capstan
Tape Speed	8.0 IPS	3.0 to 15.0 IPS
Fast Tape Speed (Fast FWD, Fast REV)	60.0 IPS average (300 ft cassette)	60.0 IPS average (300 ft cassette)
Rewind Time (300 ft)	60 secs max	60 secs max
Start Time (Read/Write Speed)	100 mS max	20 mS max at 3.0 IPS 60 mS max at 15.0 IPS
Stop Time (Read/Write Speed)	100 mS max	20 mS max at 3.0 IPS 60 mS max at 15.0 IPS
Speed Variation, Long Term (Read/Write Speed)	+ 0.5%	+ 2.0%
Speed Variation, Short Term (Read/Write Speed)	+ 4.0 %	+ 2.0%
Bit Packing Density	800 BPI max	800 BPI max
Transfer Rate (Read/Write Speed)	6,400 BPS max	12,000 BPS max
Interrecord Gap	0.8 ins	0.6 in. at 12 IPS (typical)
Direction Solenoid Engagement Time	20 mS max	20 mS max
Recording Method	Phase encoded	Phase encoded
Cassette Capacity	5.6 x 10 <sup>6</sup> bits (gapless format)	
Crosstalk (Read-After-Write TTU only)	5% max per track at 10.0 IPS	
Signal to Noise Ratio (R/W TTU) (8.0 IPS)	Typically 40 db per track (400 BPI)	
Signal to Noise Ratio (Read-After-Write) (10 IPS)	Typically 34 db per track (400 BPI)	
Read Preamp Output Measured at 8.0 IPS and 400 BPI	250 mV P-P differential min 450 mV P-P differential max	
Temperature Range (Operating)	40°F min 120°F max	
Humidity Range	10% to 90% R. H. (non-condensing)	
Vibration	0.5g 50 Hz to 500 Hz	
MTBF	2000 hrs	
Power Requirements, AC Capstan	+12V DC ± 1V at 0.9 AMP -12V DC ± 1V at 0.05 AMP +5V DC ± 0.5V at 0.25 AMP 115V AC 60 Hz, 0.15 AMP	
Power Requirements, DC Capstan	+12V DC ± 1V at 1.0 AMP -12V DC ± 1V at 0.1 AMP +5V DC ± 0.5V at 0.25 AMP	
Dimensions	5.5 in. wide 5.8 in. deep 3.9 in. high	
Weight	4.5 lbs max	
Read System Response (Including Read Head)	Preamp output is 3 db down at 6400 BPS from 3200 BPS output	

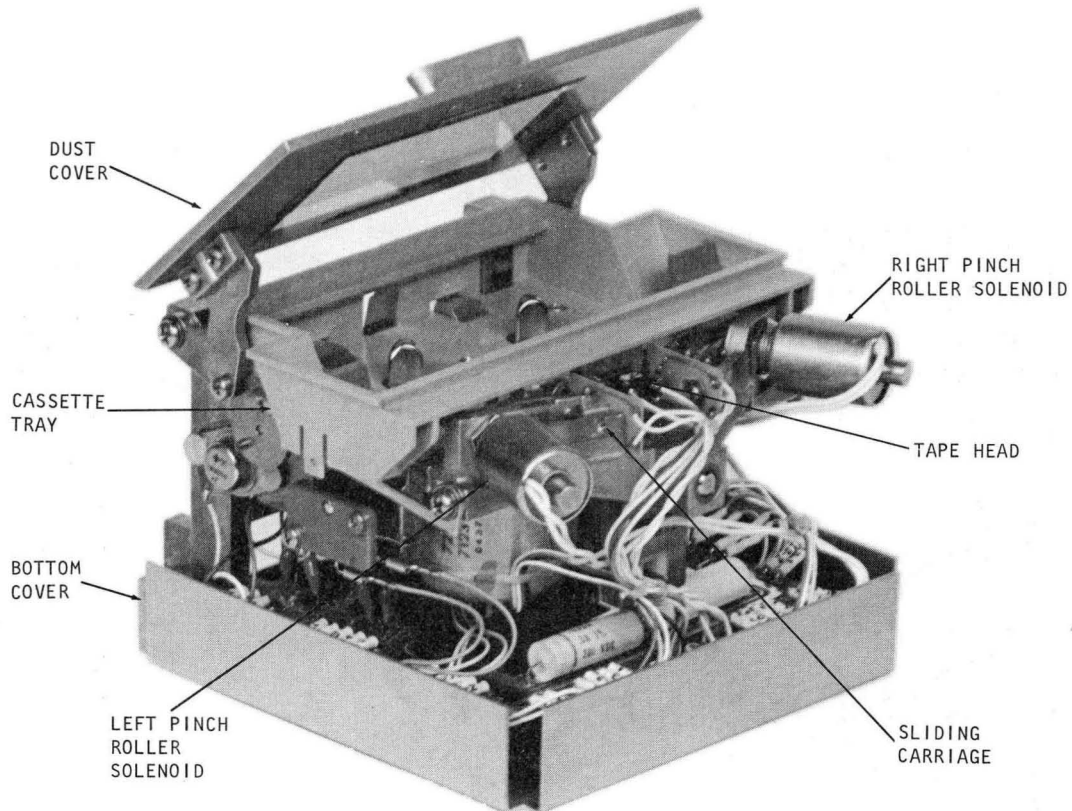


Figure 3. TTU, Front View

Figure 7, Tape Transport Control Functions, is the top view of the transport showing the location of the controlling elements with the sliding carriage fully retracted. The left and right reel drivers are connected directly to the motor shafts and control the pay-out and take-up reels of the cassette. The cassette is inserted over the reel drivers and precisely positioned by the cassette locating posts. The rear of the cassette rests directly on the positioning lands and against the forward positioning leaf spring. When the sliding carriage is advanced toward the cassette, the front of the cassette is held firmly in place by the two cassette hold down arms. The left and right ejector levers, when pressed toward the rear of the transport, raise the front of the cassette for ease of removal.

Two tape guides on either side of the head engage the tape within the cassette when the carriage is in the advanced position and maintain precise alignment of the tape in relation to head gaps. The position of the sliding carriage in relation to the main deck plate is shown on Figure 3.

#### Interlocks

The transport unit contains three microswitches that provide interlock safeguards. Two microswitches are mounted at the rear and one microswitch is mounted at the left side of the unit. (See Figure 2). Improper cassette loading is detected by

the cassette sensing microswitch (S2), which is activated by physical contact with the rear of the cassette when the cassette is properly seated in transport liner.

The linkage sensing microswitch (S1) is activated by the cover linkage when the cover is completely closed. Switches S1 and S2 can be used to inhibit tape transport operation if a cassette is improperly seated or the cover is not properly closed; they also can provide an indication on a cassette loaded status line. The tab sensing microswitch (S3) can be used to prevent data from being written on tape if the tabs on the rear of the cassette have been removed. These microswitches are connected to the interface connector as shown on Figure 8, and the interface pin assignments appear in Table 4, Pin Assignments to Interface Connector.

#### Reel Motors and Tape Tensioning

Low Speed Mode. - When the transport is operated at low speed under capstan motor control to read or write tape, it is important that gentle tension be applied to the tape. To achieve this, the reel motors are energized at a low torque in opposite directions from one another. The reel motor, towards which the tape is fed by the capstan, turns in a direction that accomplishes take-up of the released tape and exerts tension in the tape across the face of the read/write head. The supply reel motor maintains tension in the tape between the supply reel and the capstan.



## RAYCORDER CASSETTE TAPE TRANSPORT

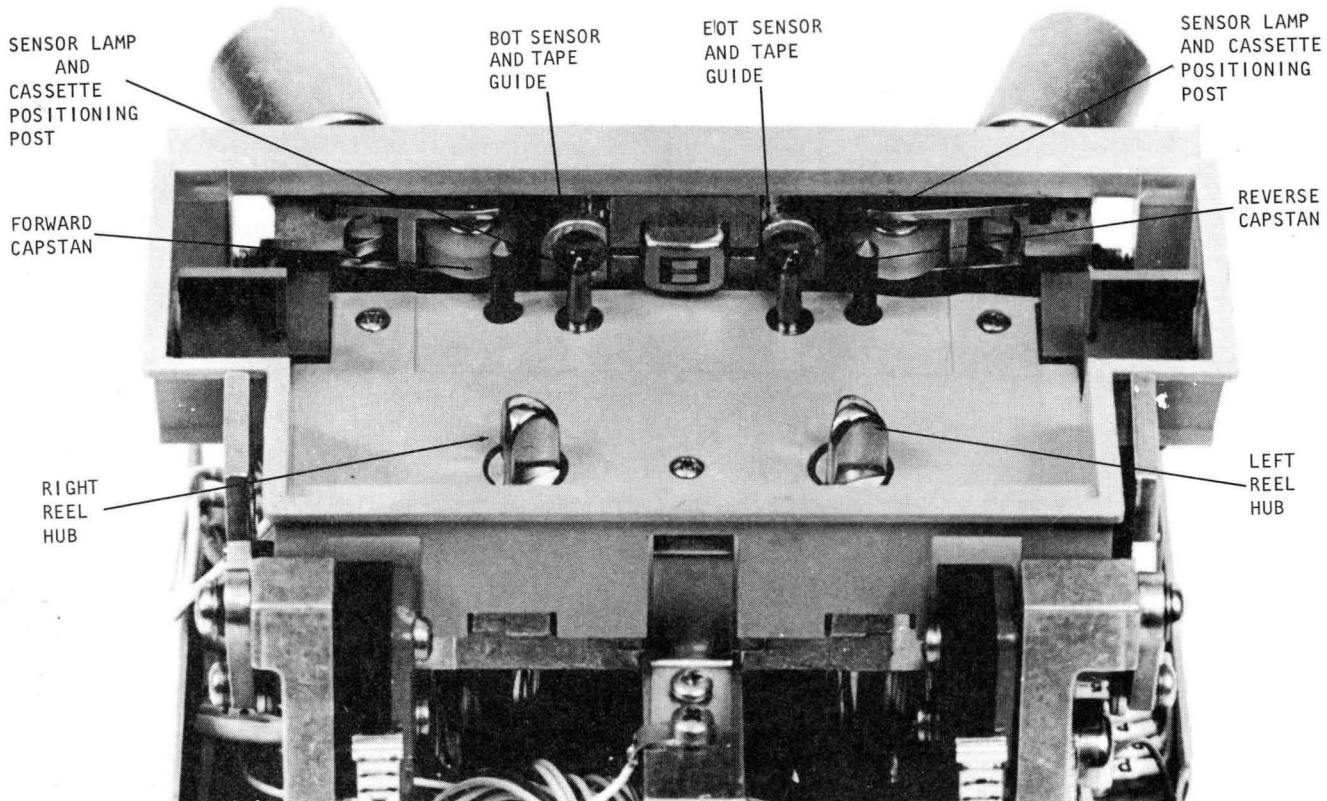


Figure 4. Transport and Carriage Components

Tape tension in this mode does not exceed 20 grams. The electrical connections between the reel motors and the interface connector are shown on Figure 9 and the control signals necessary to achieve correct operation are detailed in tabular form. Control of the reel motors is achieved by connecting one or more of the interface lines to ground (0 volt).

**High Speed Mode.** - To move the tape at high speed either forward or reverse, the motor that operates as the take-up reel is energized to produce a high torque, while the supply reel motor is de-energized. The supply reel motor has a diode connected across it in a manner that produces dynamic braking in the motor. This ensures sufficient tape tension across the head to achieve good tape guidance and to enable tape signals to be detected in the high speed mode.

Because the data rate is extremely high at tape speeds that average 60 IPS, it is possible only to detect the presence or absence of data. This, however, provides a fast-search capability, as inter-record gaps can be counted as the tape advances at high speed. The tape motion must be stopped gently when operating in the fast mode to prevent the reel and tape inertia from causing damage to the tape. This can be accomplished by applying the normal mode command immediately after cessation of the fast command. This is shown in the timing diagram on Figure 10, Reel Motor Timing.

The 400 mS stopping interval shown is a nominal value and may vary due to differences in the frictional qualities of cassettes chosen. The pinch roller control operations are described in the next subsection. Typical solid state switches that can perform these line switching functions are shown in the Supplement appended to this manual on drawing No. 100591.

### Capstan and Pinch Rollers

**Pinch Rollers.** - The operating sequence of the pinch roller and tape capstan is an important consideration when controlling tape motion. To achieve gentle and effective tape handling, the pinch roller must be engaged against the capstan while the capstan is stationary. The "slamming starts" caused by the pinch roller engaging with a rotating capstan, subjects the tape and the transport to shock and wear which can result in a deterioration in performance. Under the condition of a "slamming start" there is no control by the user over the acceleration of the tape. Therefore, the user must adhere to the following sequence of operation:

1. Engage FWD or REV pinch roller with its associated stationary capstan by energizing the appropriate solenoid.
2. Start, run and stop the capstan motor in a controlled manner, using driving circuits of a type recommended in this manual.

# RAYCORDER CASSETTE TAPE TRANSPORT

3. Disengage the solenoid and pinch roller and energize the other solenoid and pinch roller if required.

### NOTE

To ensure that the tape does not creep or move under vibration when in the stopped condition, one pinch roller should be constantly engaged against its stationary capstan.

This is a design feature and the solenoids are continuously rated for this type of operation. The material used for the pinch roller has been carefully chosen to take the least possible "set" or deformation by being pressed against the capstan. The operation of these components is illustrated in the timing diagram, Figure 11, Starting and Stopping Tape at Read/Write Speed. Figure 12 shows the interface pin connections for the solenoids. For magnitude of start/stop time and solenoid actuation times, see Specifications.

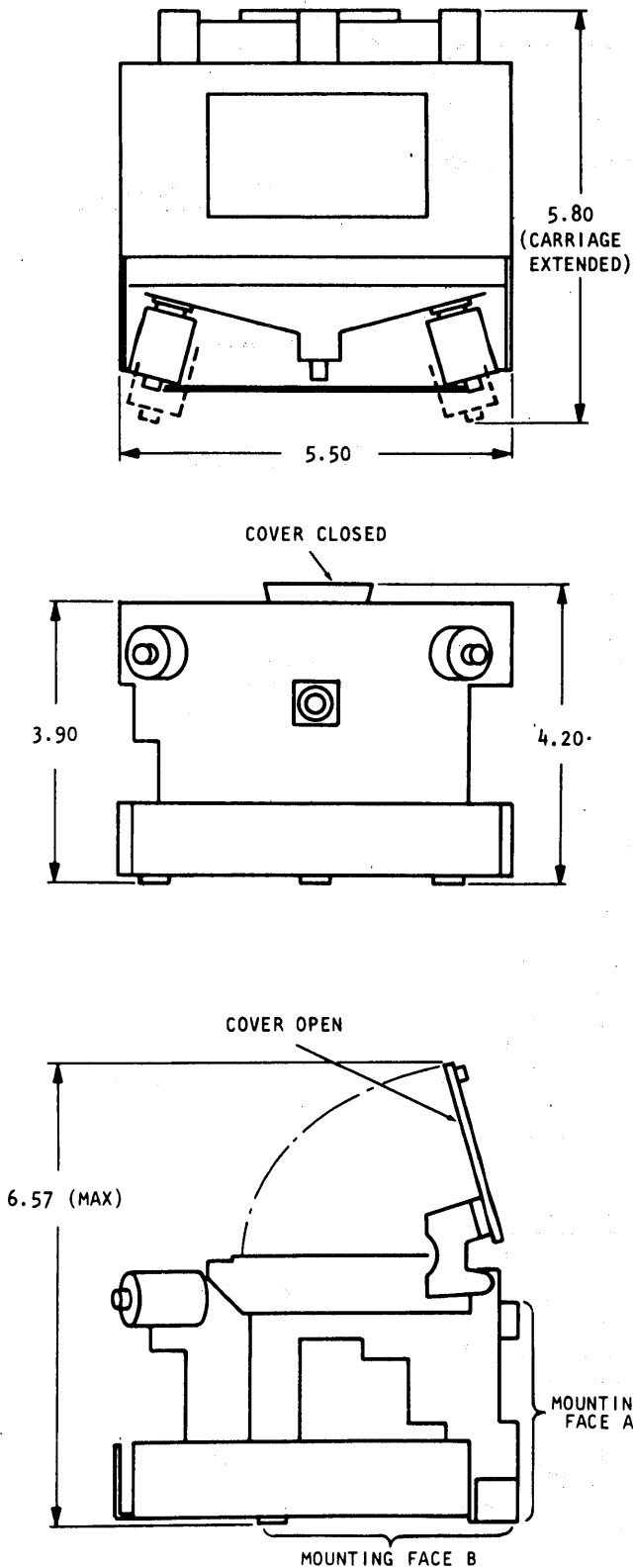


Figure 5. Transport Unit, Overall Dimensions

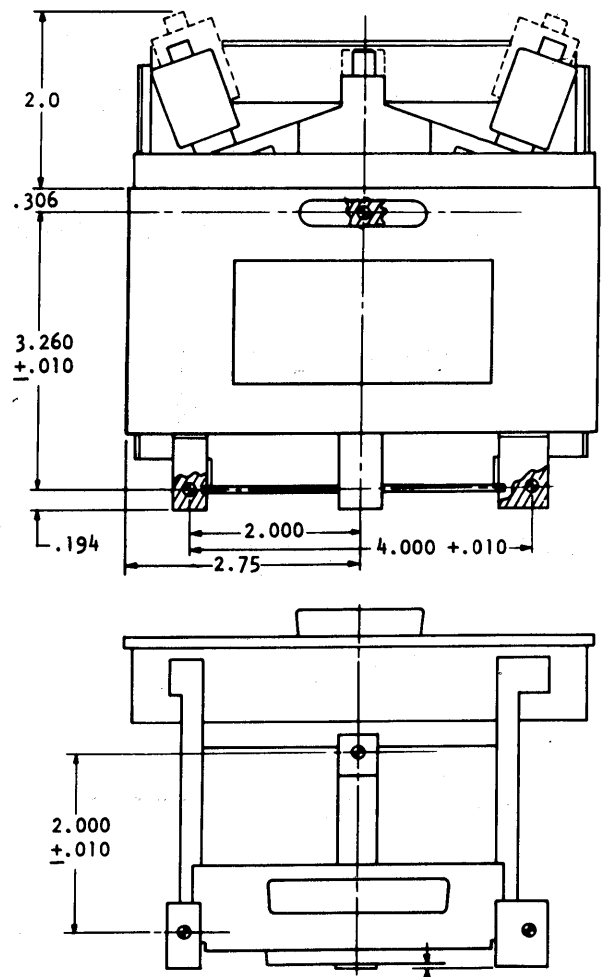


Figure 6. Transport Unit, Mounting Dimensions

# RAYCORDER CASSETTE TAPE TRANSPORT

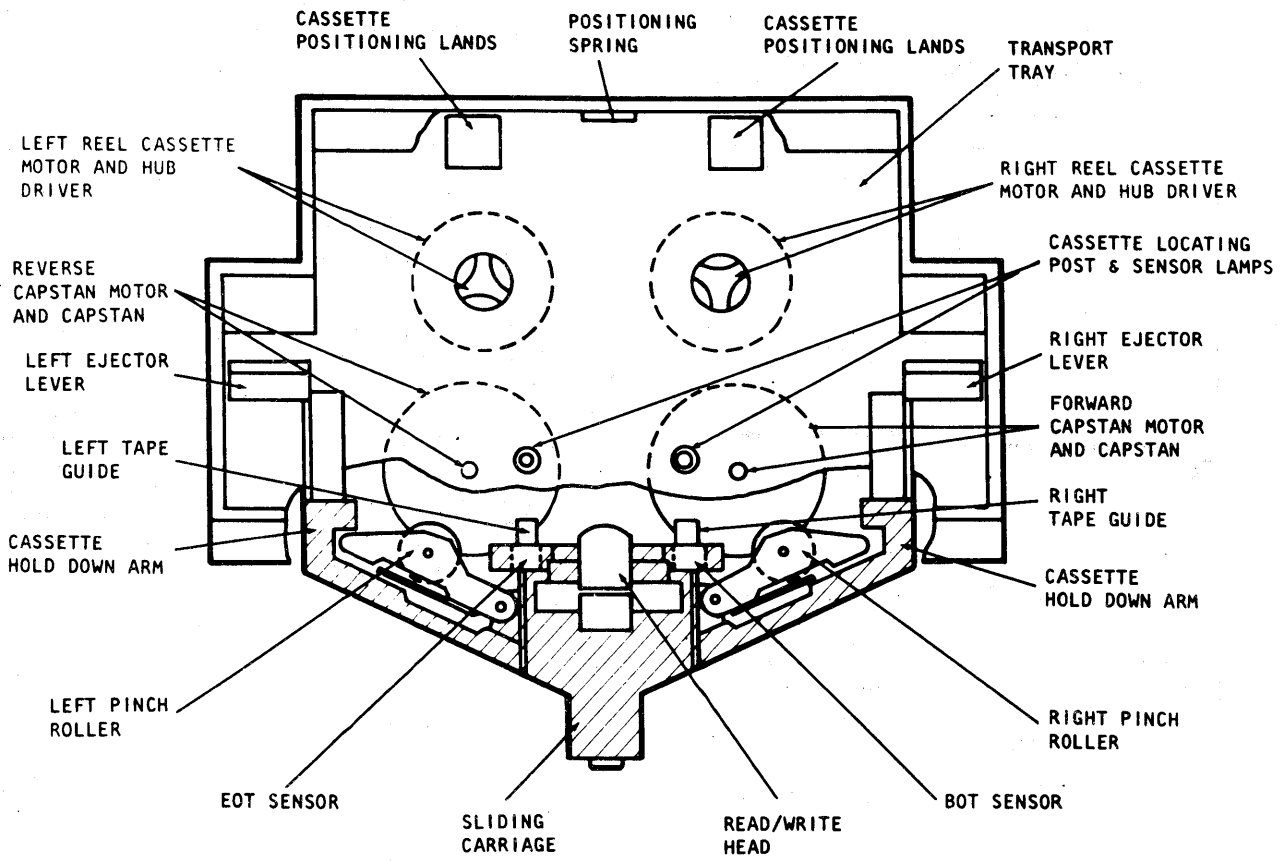


Figure 7. Transport Control Functions

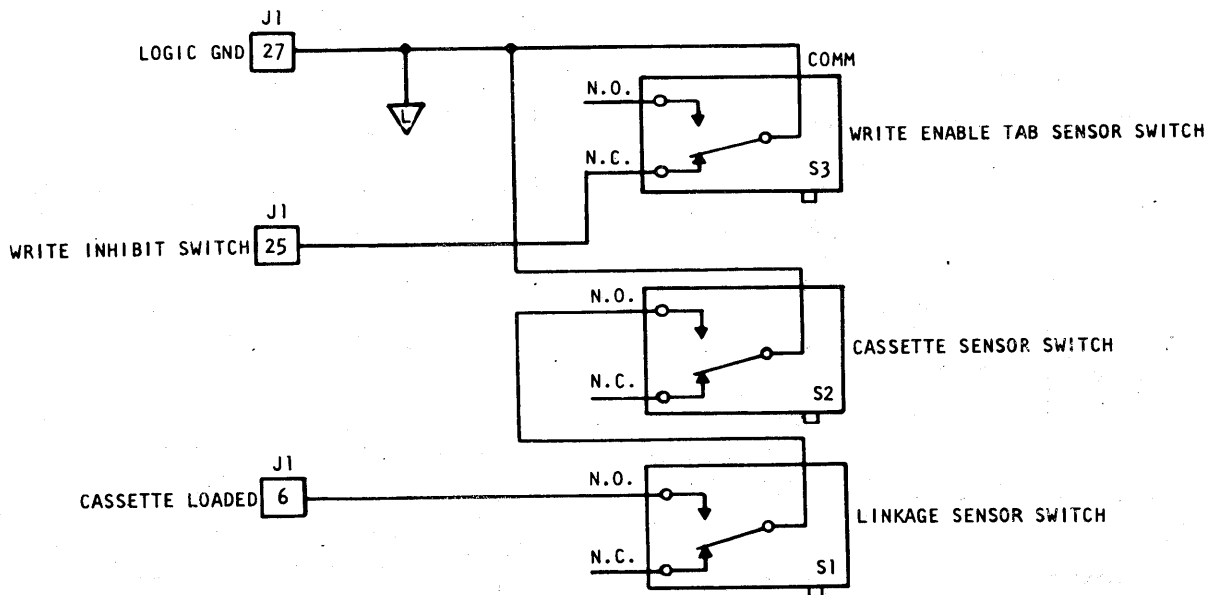
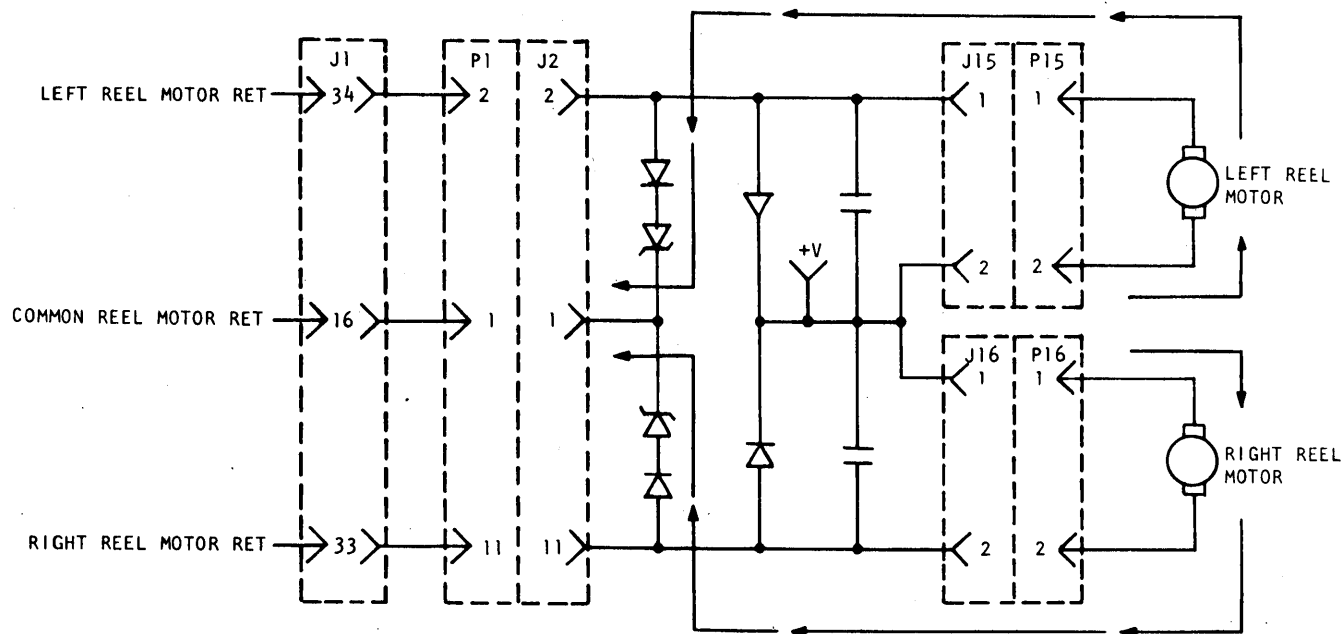


Figure 8. Interlocks



FUNCTION	J1 PIN NUMBER		
	34	16	33
NORMAL (LOW SPEED FWD OR REV)	OPEN	OV	OPEN
FAST FWD	OPEN	OPEN	OV
FAST REV	OV	OPEN	OPEN

Figure 9. Reel Motor Connections

**AC Capstan Motors**

**AC Capstan Motor and Connections.** - The AC capstan motors are a hysteresis synchronous type with two phase windings. One winding is connected to the 60 Hz 115 VAC line supply through a switching circuit and the second winding is connected to a series capacitor to provide the desired phase relationship between the two winding currents. The nominal value of this capacitor is 1.0 uF and a tolerance of 1%. The value of this capacitor is critical and has an important effect on motor torque and short term speed variations. In addition, the capacitor value must be such as to complement the inductance of the motor winding.

**NOTE**

So that the user will be free of consideration of motor inductance, this capacitor has been arranged in two parts. One part, 0.18 uF, 1%, is fitted into the transport and may be varied in value by REI if the motor inductance varies. The second part,

0.82 uF, 1%, is supplied by the user and is part of the motor control circuit recommended. It is important that the suggested capacitor tolerance and working voltage is adhered to - 1%, 200VDC.

The capstan motors rotate at 1200 rpm and are synchronized to the 60 Hz line. The long term tape speed variation is + 0.5%. The motor shaft is extended to form the capstan and shielded preloaded ball bearings are used. Direct capstan drive eliminates the need for belts, idlers, clutches, etc, which tend to decrease reliability.

The capstan shaft is processed to a controlled degree of roughness to improve the coupling between the shaft and the tape when the pinch roller is engaged. Because the capstan rpm is held constant at 1200 rpm and the capstan shaft is a fixed diameter of 0.118 in. (3.0 mm), the tape speed in AC capstan transports is fixed at 8.0 IPS. AC capstan motor connections are shown on Figure 13 and listed on Table 4.

# RAYRECORDER CASSETTE TAPE TRANSPORT

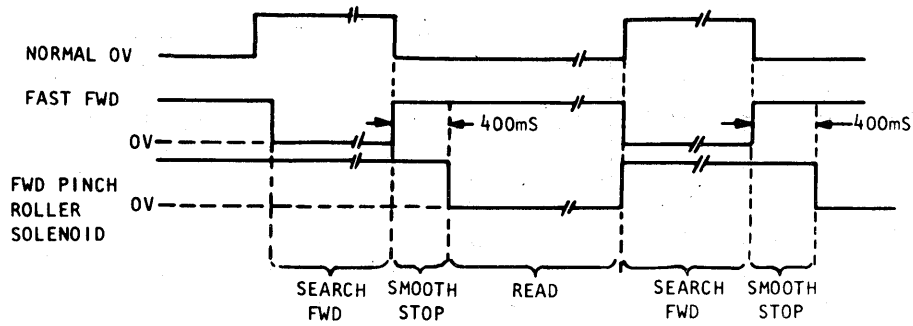


Figure 10. Reel Motor Timing

**AC Capstan Motor Control.** - To start and stop the AC capstan motor so that the tape accelerates up to speed at a uniform rate, it is necessary to prevent the motor from overshooting and to provide optimum damping. This is readily achieved by passing a small direct current through the motor. This has the additional effect of preventing the capstan from rotating freely when in the stopped condition.

A circuit which achieves this is shown in simplified form in Figure 14, AC Capstan Motor Drive, Simplified Diagram. A detailed description of its operation and a complete schematic appears in the Supplement (schematic 100590).

**NOTE**

The start/stop times quoted in the transport specification are achieved only if this circuit, or one of a similar type, is used.

**DC Capstan Motors**

**DC Capstan Motor and Connections.** - Permanent magnet DC motors with specially wound ironless armatures are used as DC capstan motors. These motors possess high efficiency and low inertia and have very low cogging effects. They are fitted with shielded pre-loaded ball bearings and their shafts are extended to form the capstan. The shafts are processed to a controlled degree of roughness to improve the coupling between the tape and the capstan when the pinch roller is engaged. The capstan has a constant diameter of 0.118 in. but the speed of the motor can be varied by the control electronics so that a range of tape speeds is possible. The DC capstan motor connections are shown on Figure 15 and listed on Table 4.

The rpm of the capstan shaft is monitored by a magnetic pickup which obtains its signals from a toothed wheel attached to the capstan. These signals are available at the interface connector for use in controlling the DC motor.

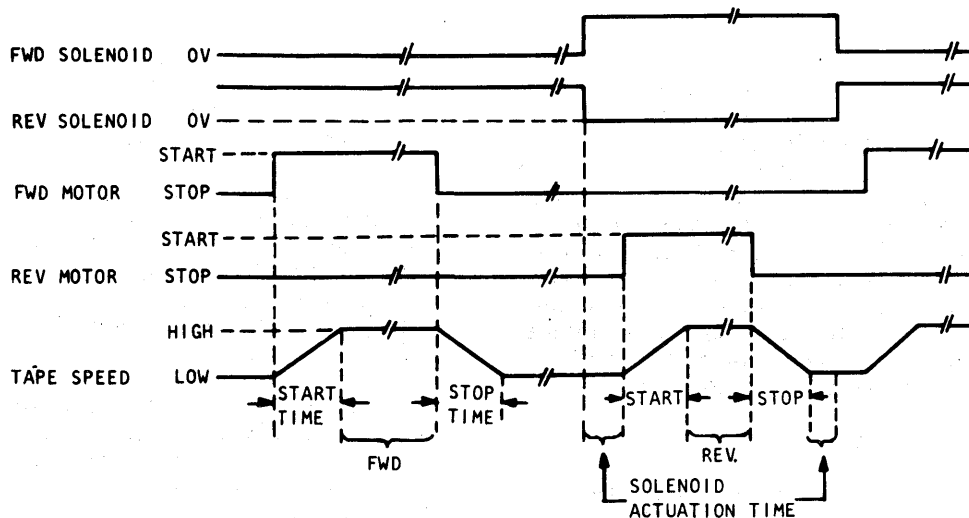
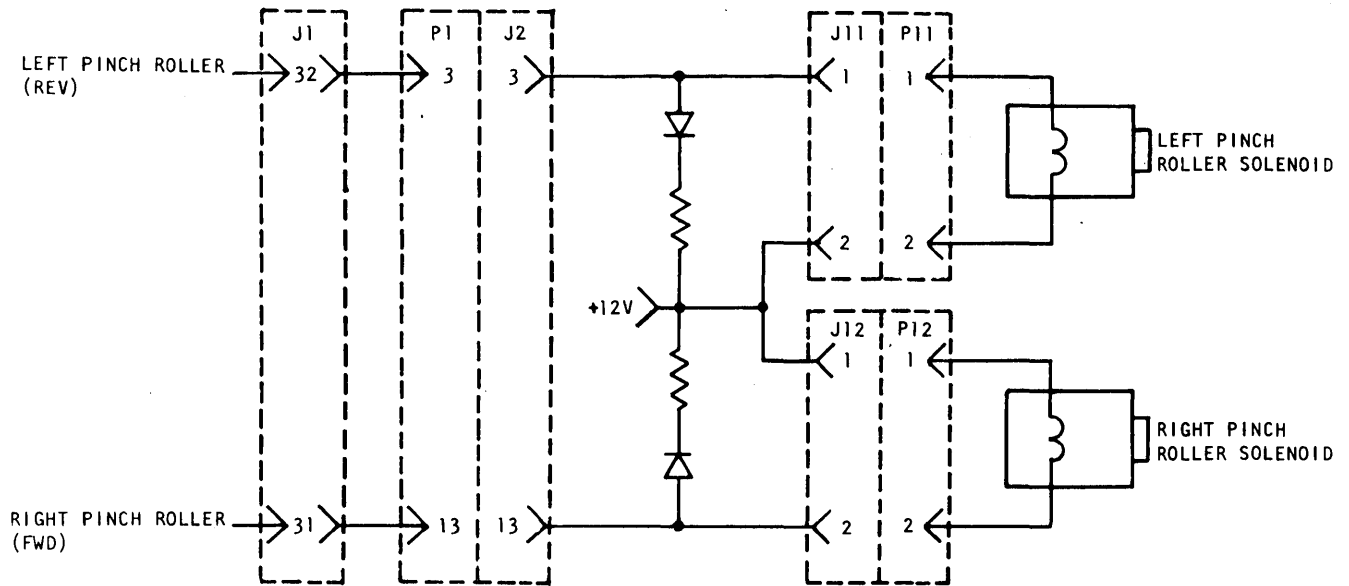


Figure 11. Starting and Stopping Tape at Read/Write Speed



FUNCTION	J1 PIN NUMBER	
	31	32
FORWARD (RIGHT SOLENOID)	0V	+ 12V
REVERSE (LEFT SOLENOID)	+ 12V	0V

Figure 12. Pinch Roller Solenoid Connections

**DC Capstan Motor Control.** - The capstan motor should be controlled by a critically damped closed loop servo mechanism to ensure accurate and complete control of the tape speed. The servo described in Schematic 100882 of the Supplement is recommended. Use of a servo of this type results in performance according to the specifications. This design also has the capability of remote digital programming of tape speed, a feature that can greatly enhance a user's system performance.

The minimum tape speed of 3.0 IPS is dictated by the decrease in tachometer pickup output below this speed. The maximum tape speed of 15.0 IPS is not normally exceeded because the increased motor rpm would result in shortening of motor life.

**Tape Head and Associated Electronics**

**Tape Heads - Single Gap, Two Track, Read/Write.** - The track configuration for this tape head is shown on Figure 16. The head is in contact with the tape at all times while the cover is closed. The tape guides are located on either side of the head to accurately position tape during movement in both low and high speed operation. Characteristics of the facing material of

the head provide long life and tend to resist dust, grit, and magnetic particles. The head is mounted in a machined cradle with fulcrum adjustment of azimuth and skew.

**CAUTION**

These adjustments are made by the manufacturer and the sealed screws should not be tampered with.

**Read and Write Electronics - Single Gap Two Track Head.** - Each track is equipped with a differential write amplifier (Models 6106-01, 02) which accepts true (Q) and false (Q̄) DTL/TTL digital data and impresses the appropriate magnetic flux on the tape. This is shown diagrammatically on Figure 17 and in detail in the relevant TTU schematic. The connections are listed on Table 4. The maximum recommended packing density is 800 BPI (1600 frpi).

When the write +12 supply is present, both tracks will be written or erased. Users desiring to write on one track without modifying existing information on the other should contact REI for information on how to do this.

# RAYCORDER CASSETTE TAPE TRANSPORT

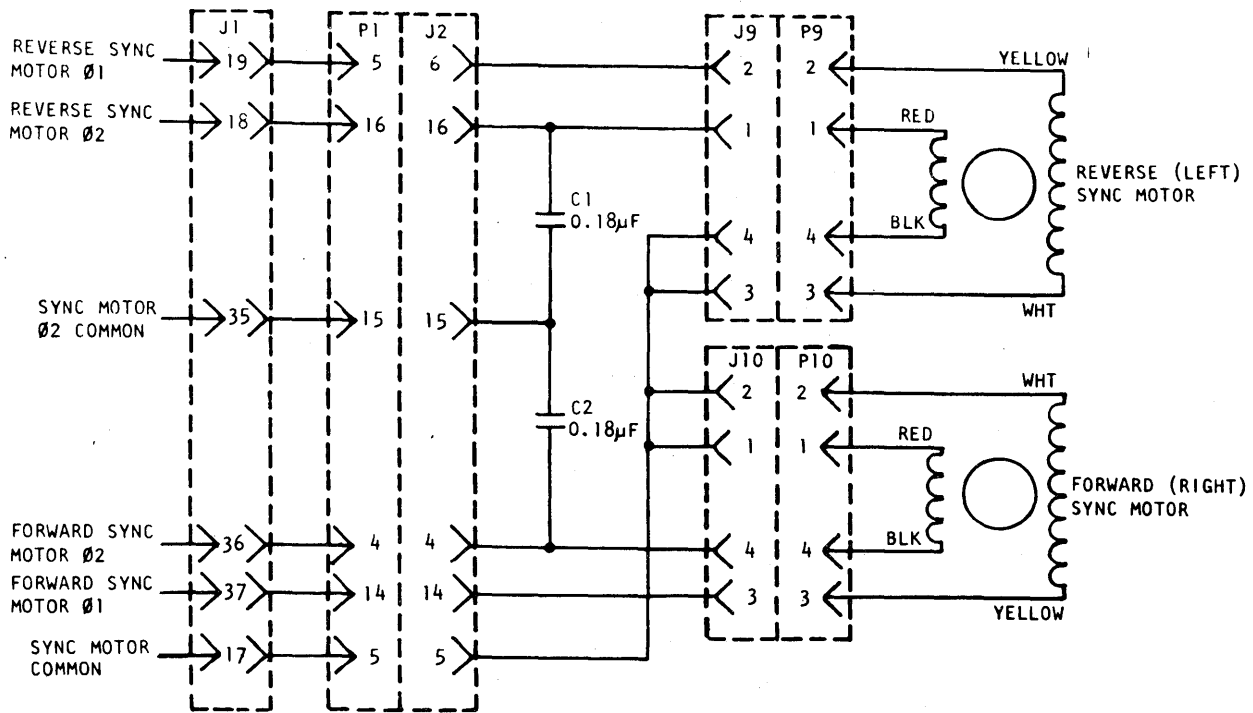


Figure 13. AC Capstan Motor Connections

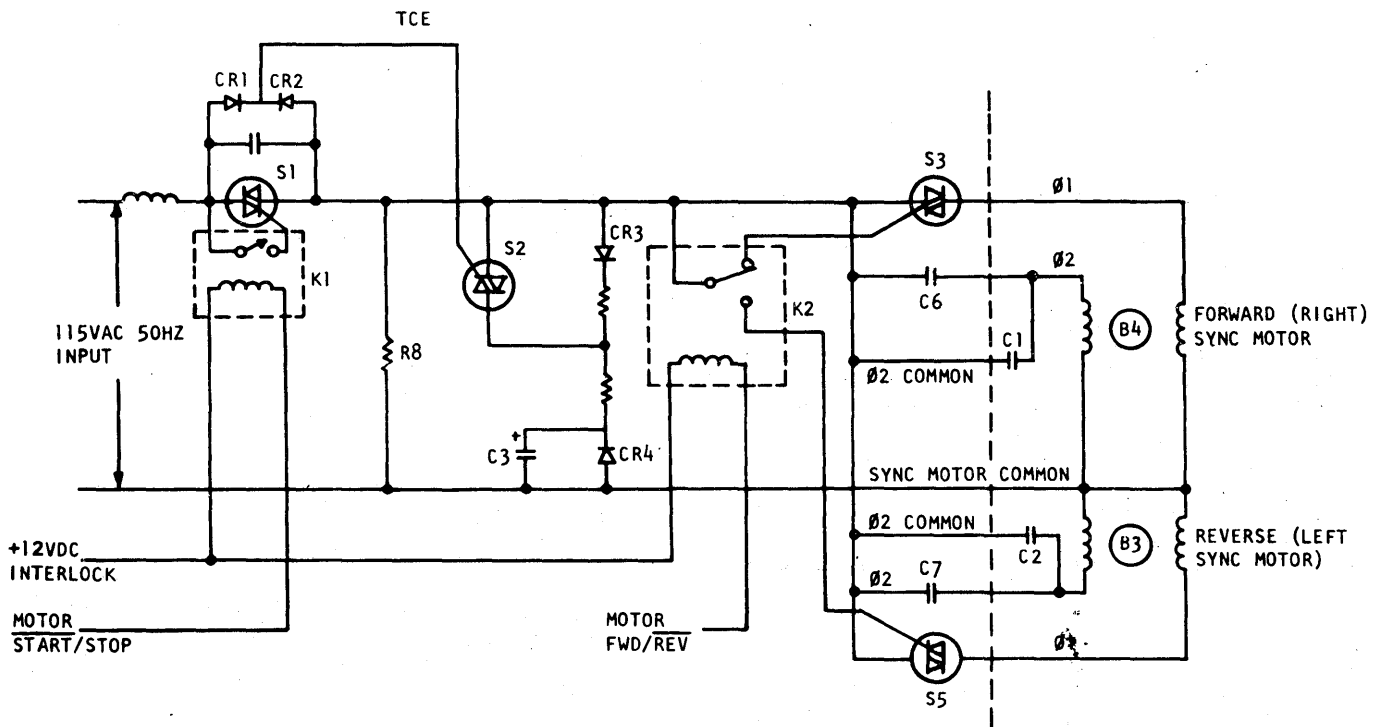


Figure 14. AC Capstan Motor Drive, Simplified Schematic Diagram

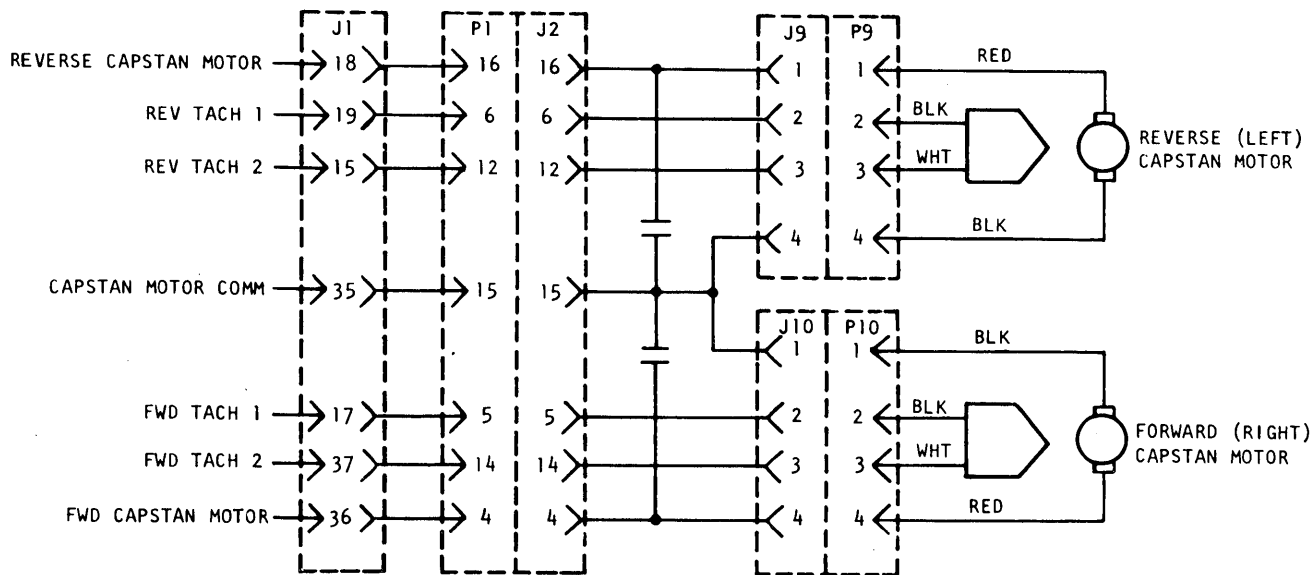


Figure 15. DC Capstan Motor Connections

Each track is equipped with a differential pre-amplifier (Models 6106-01, 02) which amplifies the low level signals from the head to approximately 300 mV (P-P). The signal then passes through a roll-off filter and is available at the interface connector. As the head is connected to both the output of the write amplifiers and the input of the read preamplifiers, it is necessary to avoid overloading the input stage of the preamplifiers during the writing process. This overload protection is provided by the network of 1K resistors and 1N746 diodes as shown in the relevant TTU schematic. The read preamplifiers are shown on Figure 18, Read Preamplifiers and Roll-Off Network and their interface connections are listed on Table 4.

**Tape Head - Dual Gap Twin Track, Read-After-Write.** - The track configuration of this head is shown on Figure 19, Read-While-Write Option. This head has two gaps per track, so that the tape signal can be read concurrently with the writing process. This is especially valuable in applications where the same data is not readily repeated and it is required to verify that the data has been correctly written on the tape.

Crosstalk takes place between the writing and reading sections of the tape head and this can be minimized by careful head construction and modified write and read amplifiers. The tape head used in the 6106-03 and 6106-04 transports has crosstalk of less than 5% of the reproduced signal, per track, at 10.0 IPS tape speed.

**Read and Write Electronics - Dual Gap, Two Track, Read-After-Write.** - Each track is equipped with a differential write amplifier (Models 6106-03, 04) which accepts true (Q) and false (Q̄) DTL/TTL digital data and impresses the appropriate magnetic flux on the tape. To reduce the effects of crosstalk, the rise time of the current flowing in the head write winding

is increased by the addition of capacitors across the amplifier output. Also the magnitude of the write current is kept as low as possible consistent with good erasing capability. This is shown diagrammatically on Figure 20, Write Amplifier (Read-After-Write), and in detail in the relevant TTU schematic. Interface connections are shown on Table 4.

When the write +12 supply is present, both tracks will be written or erased. Users desiring to write on one track without erasing or modifying existing information on the other should contact REI for detailed information.

Each track is equipped with a differential pre-amplifier which accepts the low level signals from the read windings of the head and amplifies them to approximately 300 mV (P-P). The signal then passes through a roll-off filter and is available at the interface connector. To further reduce the crosstalk effect between the writing and reading signals, the high frequency components of the crosstalk signals are filtered out by the addition of small capacitors at the input to the preamplifiers. The read preamplifiers are shown diagrammatically on Figure 21, Read Preamplifiers and Roll-Off Network (Read-After-Write) and in detail in the relevant 6106-03 and 6106-04 schematics (see Supplement).

Read Data Detection

The electronics contained within the transport supplies an analog read signal of nominally 300 mV (P-P). To detect this data, the peaks must be identified and their polarity noted. A recommended circuit for achieving this is shown on Figure 22.

The differential output of the read preamplifier should be subjected to a further stage of amplification to achieve a nominal signal amplitude of 6 volts (P-P).



# RAYRECORDER CASSETTE TAPE TRANSPORT

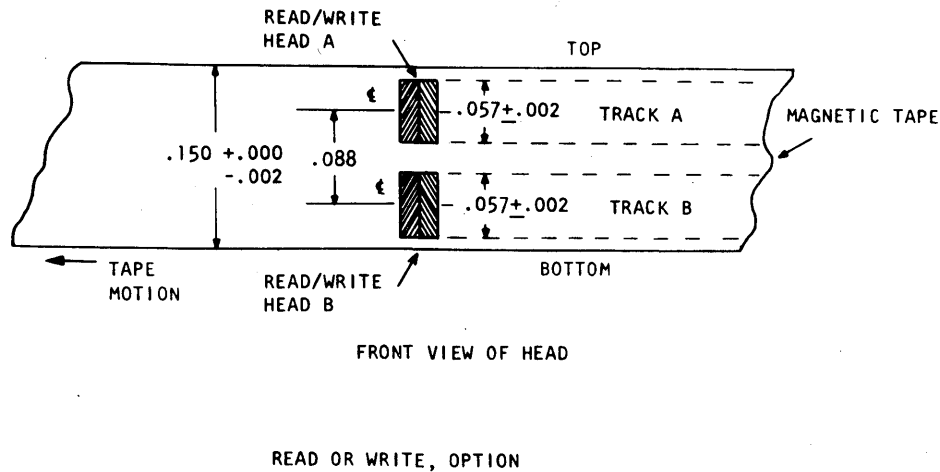


Figure 16. Magnetic Tape Track Configuration

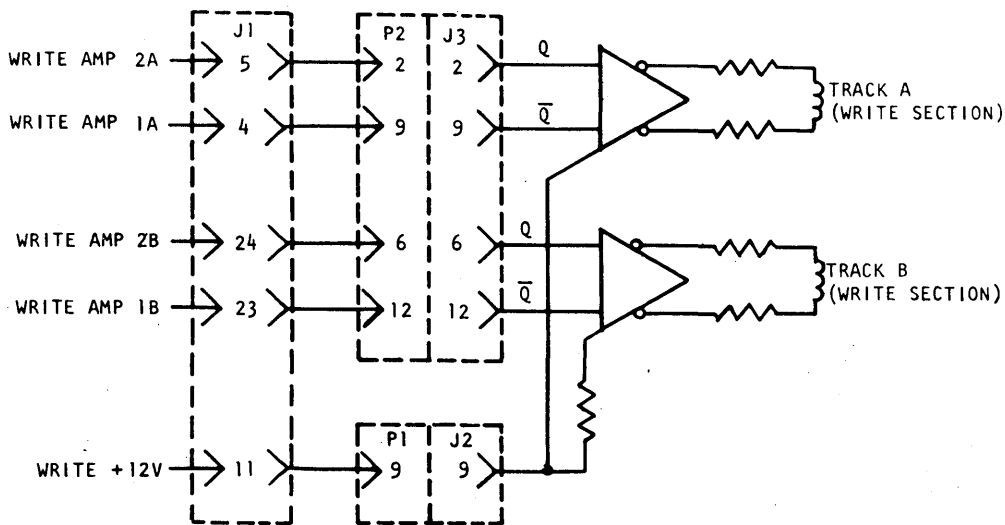


Figure 17. Write Amplifier

This is shown on Figure 22 as a differential input amplifier with a nominal voltage gain of 20. The amplified signal is compared with a small threshold (+ 0.6V) to identify the polarity of each half cycle and also to eliminate noise.

At the same time the peak detector produces a narrow pulse at a time coincident with the waveform peaks. The peak pulses are fed to a pair of AND gates, through which they are successively gated by the enabling signals from the polarity detectors. The outputs of the AND gates are fed to a latch circuit from which the data and its inverse are available at the Q and  $\bar{Q}$  terminals. It is necessary to have a data-enable line to the latch so that its initial condition can be preset; for example, after applying system power.

A circuit of this type is shown in detail in schematic 100592 in the Supplement.

**Redundant Writing and Reading.** - The 6106 series transports are two track machines. Each track is capable of a low bit error rate, but this rate can be further reduced as a system consideration if redundant data recording and reading is used. This is achieved by connecting together the Q and  $\bar{Q}$  inputs to the track A and B write amplifiers as shown on Figure 23.

In this way there is complete duplication of the write amplifiers, head windings and head-to-tape interface. When these signals are read from the tape, the outputs of the A and B preamplifiers are alge-

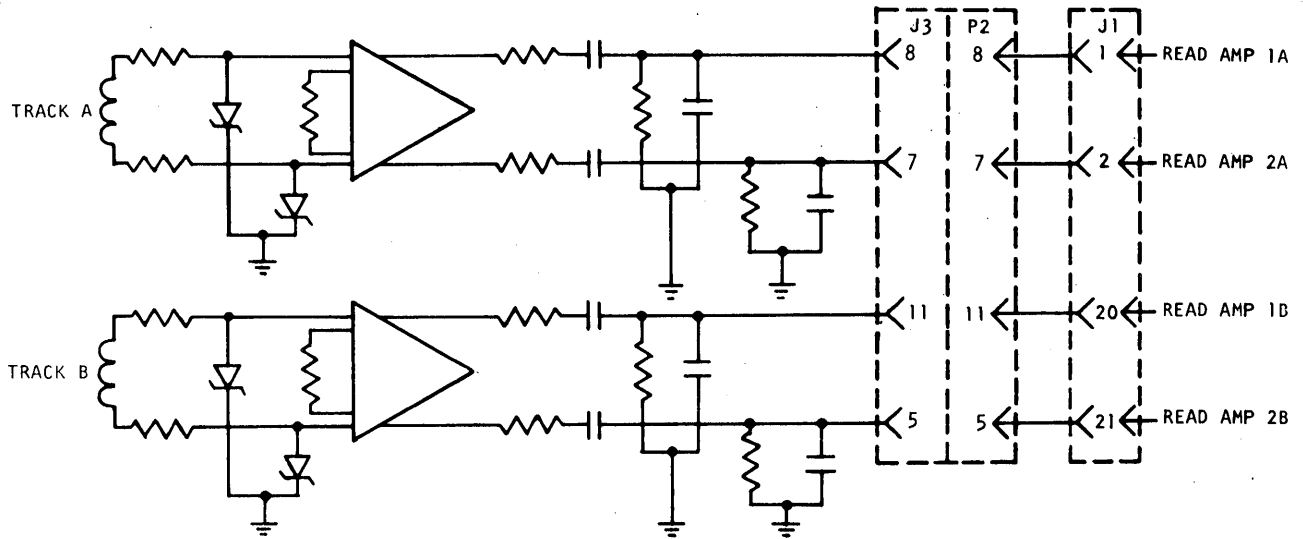


Figure 18. Read Preamplifiers and Roll-Off Network

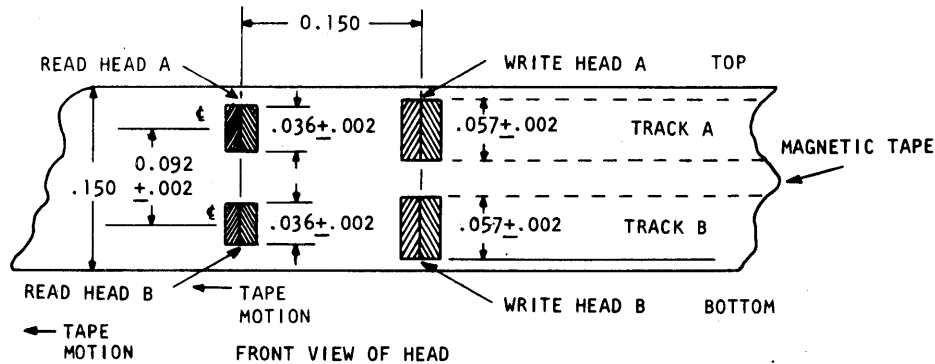


Figure 19. Read-While-Write Option

braically summed at the input to the read amplifier as shown on Figure 24. If a drop out occurs in one track, the remaining track will sustain the detection system.

**EOT and BOT Detection**

The EOT and BOT sensors are mounted behind the tape guides and detect the light from the sensor lamps within the cassette locating posts when the end of tape transparent leaders are present.

When the tape is moving in the forward direction as specified by the FORWARD COMMAND the EOT detector circuit will initially sense the end-of-tape as shown on Figure 25.

The light from the sensor lamp activates the EOT photo transistor and the output is amplified and made available at the interface connector.

If a small hole has been punched in the tape to serve as an end-of-tape warning, the EOT detection circuit will respond to this at read/write speeds but the signal will be of short duration (1.0 mS minimum).

When tape motion is in the reverse direction, as specified by the REVERSE COMMAND, the BOT detector circuit is initially activated as the tape reaches the end-of-reel as shown on Figure 26. The output of the BOT sensor is amplified and made available at the interface connector.

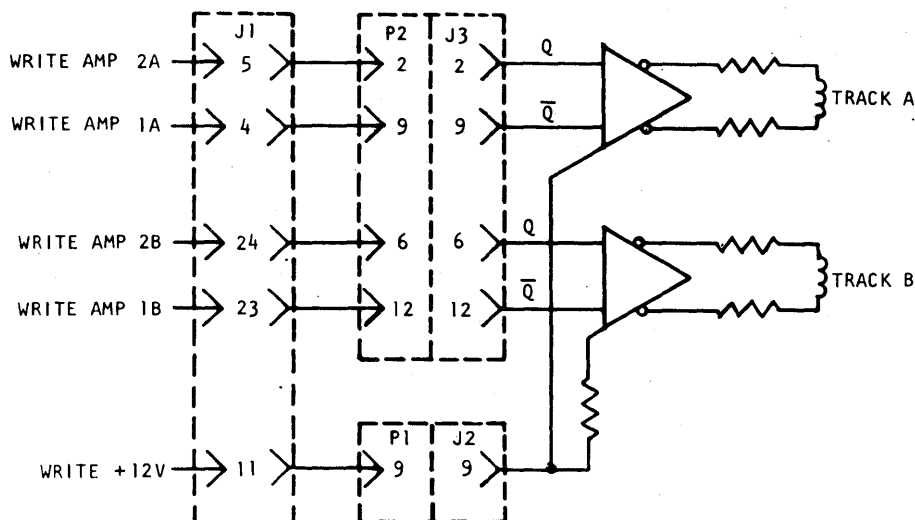


Figure 20. Write Amplifier (Read-After-Write)

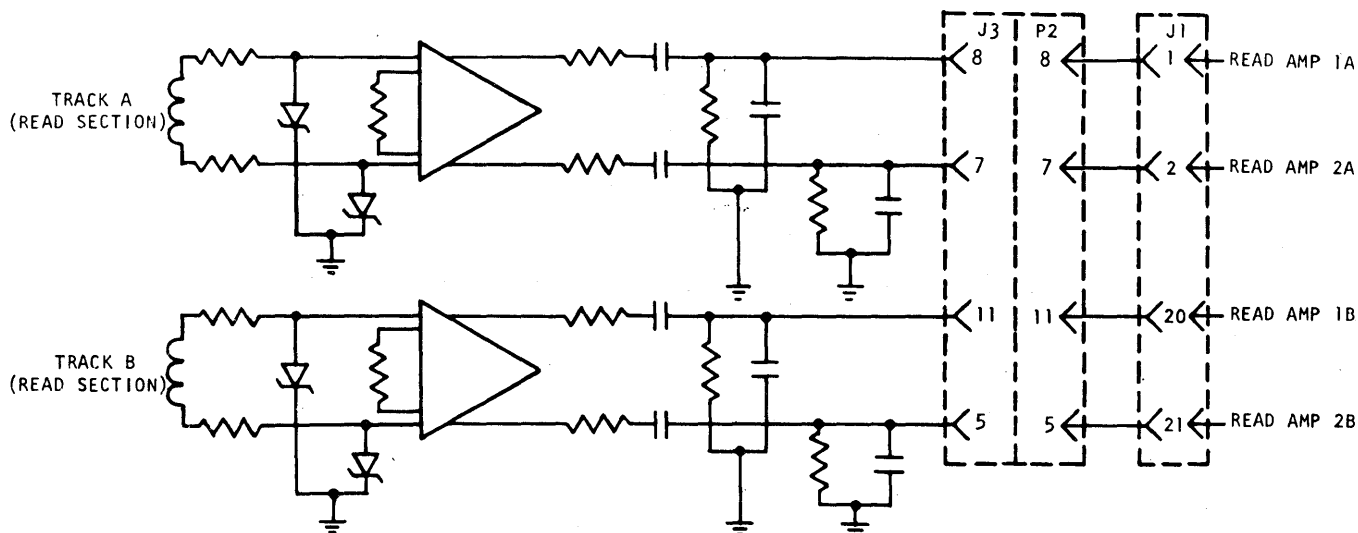


Figure 21. Read Preamplifiers and Roll-Off Network (Read-After-Write)

If a small hole has been punched in the tape to serve as a BOT warning, the BOT detection circuit will respond to this at read/write speeds but the signal will be of short duration (1.0 mS minimum).

End-of-tape and beginning-of-tape warning holes are discussed in more detail in the section on ANSI/ECMA/ISO Standards. The connections for the EOT/BOT circuits are shown diagrammatically in Figure 27 and in detail on the relevant TTU schematics.

### Control

**Control of Tape Movement.** - This section indicates those parts of the transport that must be energized to achieve the desired TTU operating modes. Table 3, TTU Operating Modes presents this information in tabular form. The user should design a logic control system which energizes the appropriate components for the required operation, keeping in mind the response time, energization time, etc., of each part.

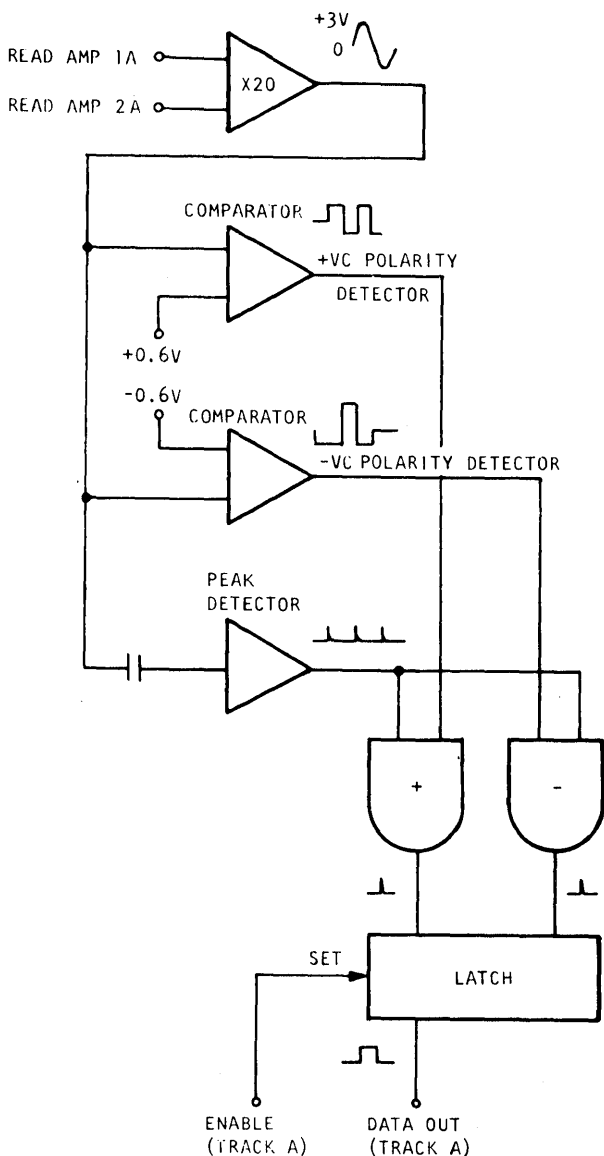


Figure 22. Read Data Detection

The EOT/BOT signals together with the interlock switches should also interface to the control system. A typical logic system, which does not, however, fully utilize the capabilities of the transport in the manner of Table 4, is illustrated in the Supplement and is covered in schematic 100591.

**Control of Reading and Writing.** - When recording in bi-phase encoded form, it is necessary to begin each data block with a "0" synchronous bit, effectively a single-bit pre-amble, and end the recording with a "1" synchronous bit, a post-amble.

It is also necessary to allow time for the input information to settle on the data input lines before applying the W+12 write voltage. Proper phasing is also required for block formatting the data on tape. A "0" bit to be written on tape is represented by a flux change from the reference, and a "1" bit by a flux

change to the reference in the center of a bit cell. Additional flux changes occur, as required, at bit cell boundaries. If erasure of the tape information is desired, the data input line is held at a logical "0" until erasure is complete. The data timing limits in relation to the bit cell duration for the AC and DC Capstan TTU's respectively when operating at a tape speed of 8 inches per second with a recording density of 500 bits per inch are shown on Figure 28.

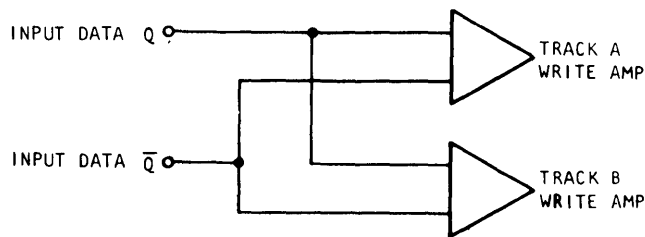


Figure 23. Redundant Write Connection

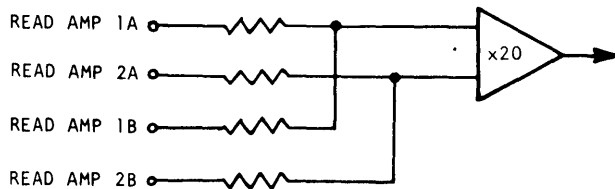


Figure 24. Redundant Read Connection

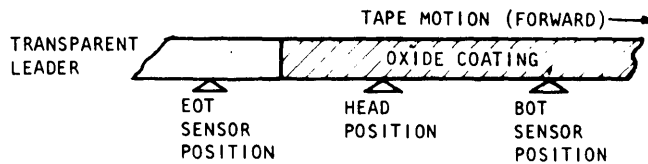


Figure 25. End-of-Tape Sensing

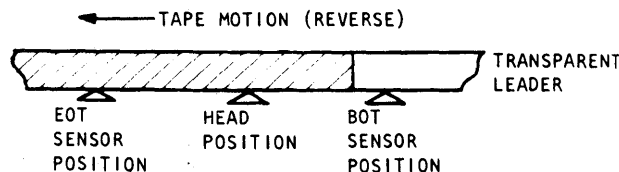


Figure 26. Beginning-of-Tape Sensing

RAYRECORDER CASSETTE TAPE TRANSPORT

TABLE 3.  
TTU OPERATING MODES

Interface Connector Pins In Brackets

Note	Transport Components							Remarks
	L. H. Solenoid	R. H. Solenoid	L. H. Reel Motor	R. H. Reel Motor	Reel Comm	L. H. Capstan Motor	R. H. Capstan Motor	
Normal, FWD, Ready (Stopped)	HI	LOW	HI	HI	LOW	LOW	LOW	
Normal, FWD, Run (Start)	HI	LOW	HI	HI	LOW	LOW	HI	
Normal, REVERSE, Ready (stopped)	LOW	HI	HI	HI	LOW	LOW	LOW	
Normal, REVERSE, Run (Start)	LOW	HI	HI	HI	LOW	HI	LOW	
Fast, FWD, Ready (Stopped)	HI	HI	HI	HI	HI	LOW	LOW	
Fast, FWD, Run (Start)	HI	HI	HI	LOW	HI	LOW	LOW	
Fast, FWD, Arrest Motion	HI	HI	HI	HI	LOW	LOW	LOW	Approx. 400 mS Duration
Fast, Reverse, Run (Start)	HI	HI	LOW	HI	HI	LOW	LOW	
Fast, Reverse, Arrest Motion	HI	HI	HI	HI	LOW	LOW	LOW	Approx. 400 mS Duration
Fast, REV, Ready (Stopped)	HI	HI	HI	HI	HI	LOW	LOW	

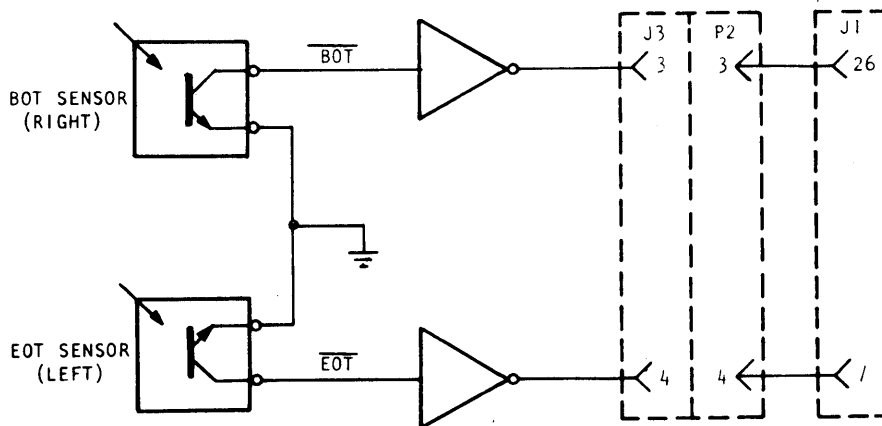


Figure 27. EOT/BOT Detection and Amplification

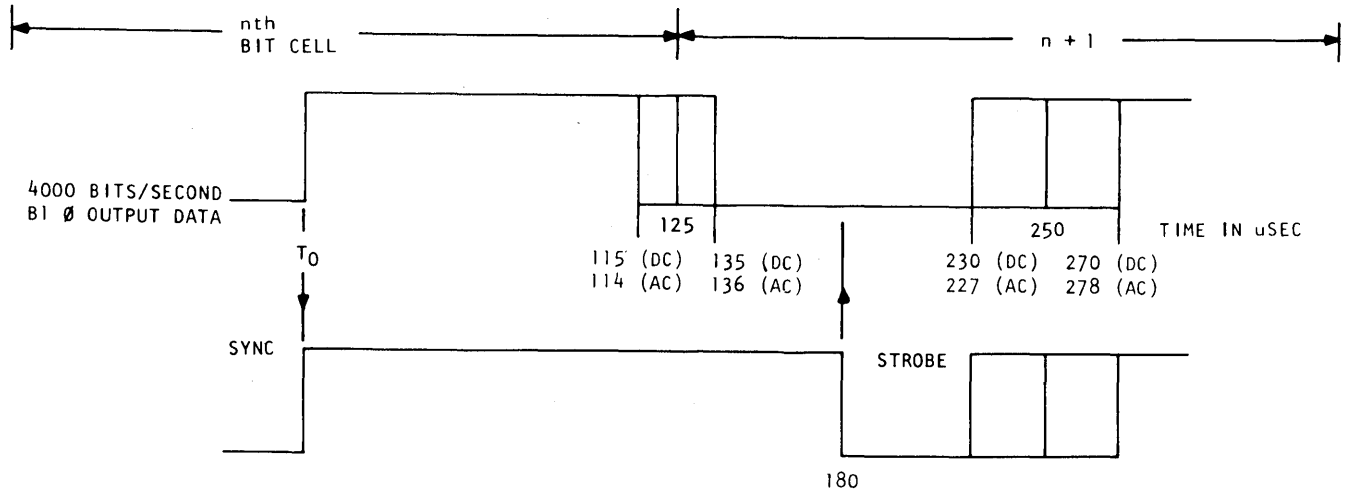


DIAGRAM BASED ON OPERATION AT 8 IPS @ 500 BPI

Figure 28. AC and DC Capstan Motor, Data Timing Diagram

The bit cell duration is determined by the following formula:

$$\text{BIT CELL DURATION (SEC)} = \frac{1}{\text{TS} \times \text{BITS/INCH}}$$

TS = (Tape speed in inches per second)

An initial flux transition to the reference in the center of a bit cell provides a sync level to the receiving device indicating the start of a data block. Any additional flux changes required will occur at the end of the bit cell within the timing limits specified. The first data strobe signal is required at 180 usec after the sync pulse and this strobe will set the first data bit, occurring between the time limits specified, into the external read data register. The data strobes then occur at the same interval as the bit cell duration. The control timing diagrams, Figures 29 and 30, provide a recommended timing sequence of commands for the AC and DC capstan drive tape transports during both read and write operations.

Notice that a delay is shown (nominally 20 mS) between the removal of the WRITE command and the issuance of a STOP command. This delay is required in read-while-write transports (6106-03 and 04) so that the tape motion will continue at normal speed while the data that has been written passes across the space between the head gaps. The distance to be traveled is 0.150 in. (3.80 mm) so the length of this delay will be 19 mS at 8.0 IPS and 11 mS at 15.0 IPS.

ANSI/ECMA/ISO Compatibility

The American National Standards Institute, European Computer Manufacturers Association, and the International Standards Organization are preparing standards for the 0.150 in. (3.81 mm) tape cassette. The Raycorder 6106 series transports are in compliance with the unrecorded format of the proposed standards, with the exception of the following items:

Head Penetration into the Cassette.- In 6106-01, 02 transports, the tape head penetrates into the cassette a distance that establishes the dimensions between the face of the head and the opposite side of the cassette position post (lamp housing) as 0.180 in.  $\pm$  0.002 in. (4.6 mm  $\pm$  0.05 mm).

In 6106-03 and 04 transports, this distance is 0.155 in.  $\pm$  0.002 in. (3.95 mm  $\pm$  0.05 mm) because of the additional wrap angle required by the head. This is shown on Figure 31 as dimension A.

Notch in Rear Edge of the Cassette. - The proposed standards specify a notch cut in the rear edge of the cassette body, offset from the center of the center of the rear face. These notches would be present only on digital cassettes certified for information interchange and would enable a transport to detect that an audio cassette had been inserted in the transport in error. As the notch is offset, it will be possible to detect which side of the cassette is uppermost.

# RAYRECORDER CASSETTE TAPE TRANSPORT

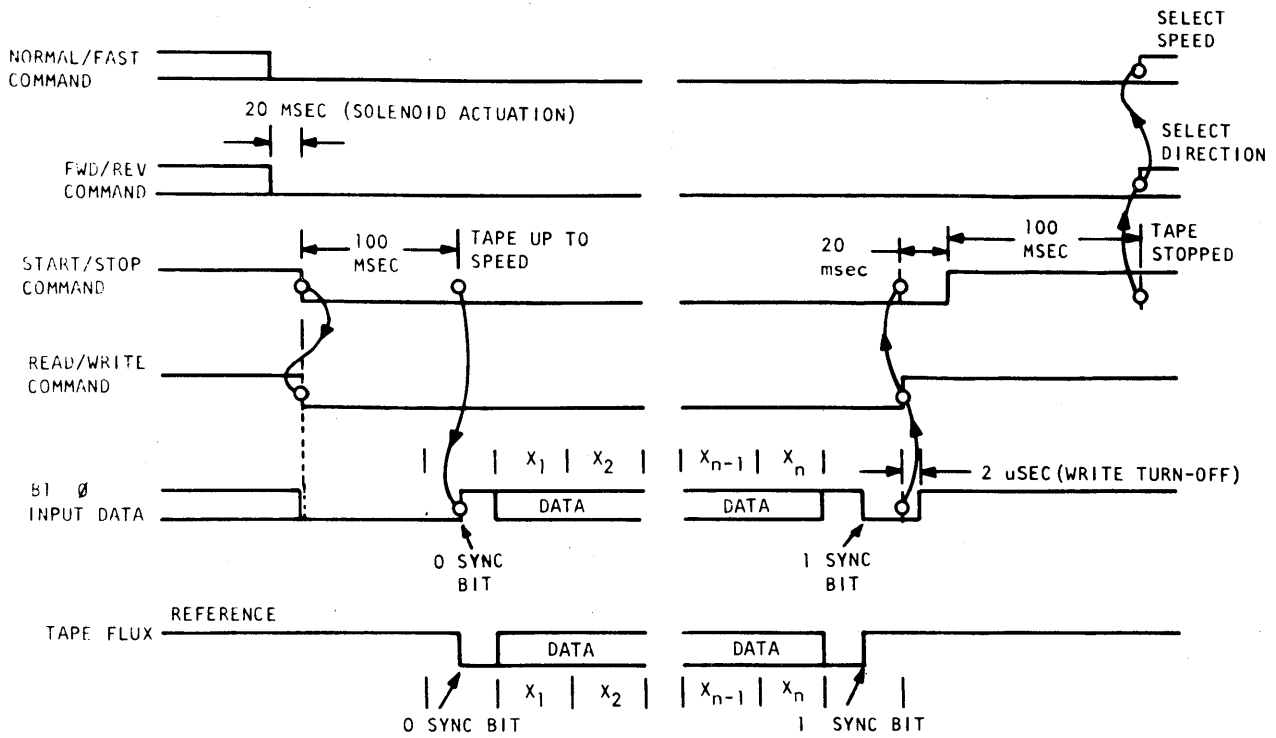


Figure 29. AC Capstan TTU, Control Timing Sequence

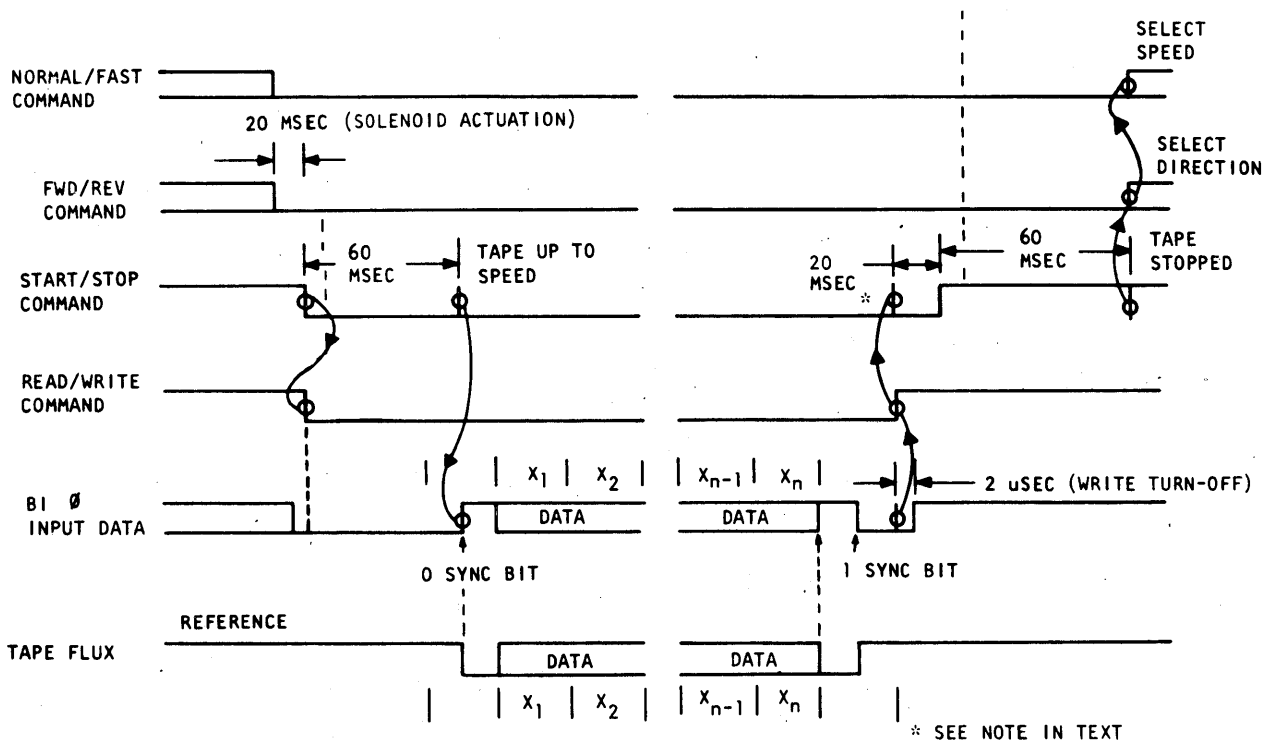


Figure 30. DC Capstan TTU, Control Timing Sequence

MAINTENANCE

Preventive Maintenance

Major servicing of the transport unit can be minimized by adherence to the following simple procedures.

Storage of Cassettes. - Store cassettes in their plastic containers and return them to these containers after use. Avoid the accumulation of cassettes outside their containers in the immediate work area.

Rewinding. - Rewind cassettes to clear the leader (BOT) immediately after use and before removal from the transport for storage. This provides maximum protection for the magnetic surface.

Transport Cover. - Keep the transport cover closed at all times when not loading or unloading a cassette.

Cleaning. - Remove dust, film and dirt that has accumulated on the transport cover and liner using a clean damp cloth and a mild soap or detergent. Periodically clean the tape head using a cotton swab and denatured alcohol. Take care that the unit is free from lint and fibers after cleaning.

No hard and fast recommendation can be made as to the frequency of head cleaning. However, the life of a cassette is dependent on the cleanliness of the parts of the transport in contact with the tape and for this reason the tape head should be cleaned at intervals of approximately 50 operating hours. As the OEM customer will incorporate the 6106 transport into his own system with a preventative maintenance schedule, this figure of 50 hours can be modified to accommodate the user's system maintenance schedule.

Repair

Transport repair should be limited to simple replacement of major sub-assemblies or modules.

CAUTION

Under no circumstances is the typical user to attempt complete dismantling of the transport. This would disturb settings and critical alignments and result in a transport failing to meet specifications. Such users should return the transport to REI for replacement or rework.

Customers whose mechanical and electrical technical personnel have been trained by REI in the complete dismantling, rebuilding and re-alignment of the 6106 series transports can however, carry out such dismantling. This is discussed in the section Major Dismantling and Repair and includes a list of recommended spare parts and tools.

Troubleshooting. - Elementary troubleshooting is presented here in the form of a chart. By following the

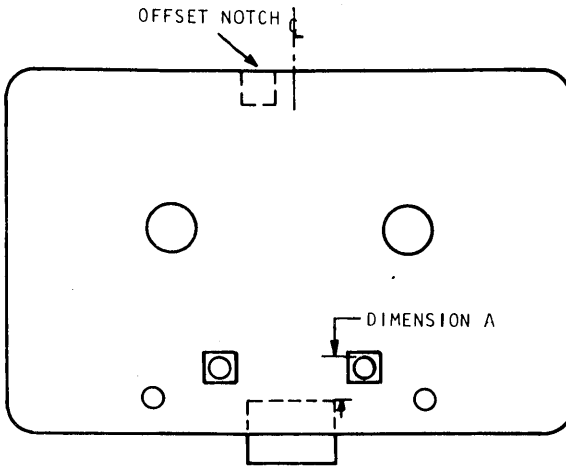


Figure 31. Head Penetration

At the present moment, the Raycorder 6106 series transports do not have the necessary switches fitted to accommodate this detection.

Cassettes. - Unlike other cassette transport manufacturers, Raymond Engineering does not insist on the user confining his operations to a single cassette or group of cassettes.

It is necessary only to use a cassette containing tape that has been certified for digital applications, and it is recommended that the cassette be manufactured to the ANSI/ECMA/ISO proposed outline dimensions and frictional torque limits (see Figure 31). Avoid the use of a cassette which is loaded with tape that has markedly different magnetic coercive force values from the majority. This will avoid variations in read preamplifier output. Also avoid the use of cassettes of a different opacity from that laid down in the proposed standards, as spurious EOT/BOT operation may be experienced with translucent tapes.

Avoid the use of cassettes with a large number of tape rollers incorporated in the design (more than 2). The extra guidance built into these cassettes conflicts with the precision guidance of the REI 6106.

NOTE

It is essential that in read-after-write applications (6106-03 and 04), cassettes fitted with extra large pressure pads be used in order to assure good head-to-tape contact across the 0.150 in. spaced dual gaps.

Pin Assignments to Interface Connector

Pin assignments are listed on Table 4. The interface connector is a 37 pin, male Type 17-20370-1 (Amphenol), or Type 205210-1 (AMP).



RAYCORDER CASSETTE TAPE TRANSPORT

TABLE 4.  
PIN ASSIGNMENTS TO THE INTERFACE CONNECTOR  
Connector J1 - 6106-01, 03



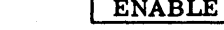


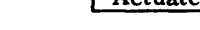




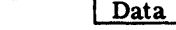


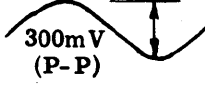
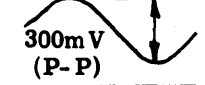



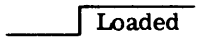
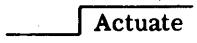
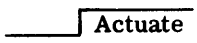
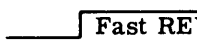
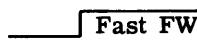
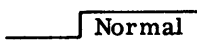

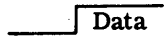
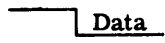

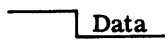
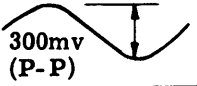
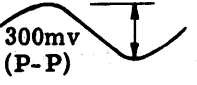
Pin No.	Title	Waveform	Remarks
30	Power Ground		
27	Logic Ground		
28	Chassis Ground		
2	Signal Ground		
9	+5 V		+ 0.5 V
12	+12 V		+ 1.0 V
29	-12 V		+ 1.0 V
11	Write +12 V		+ 0.5 V
26	BOT		
7	EOT		
25	Write Interlock		GND When Enabled
6	Cassette Loaded		GND When Loaded
32	Left Solenoid		High is +12 V
31	Right Solenoid		High is +12 V
34	Left Reel Motor		High is +8.5 V
33	Right Reel Motor		High is +8.5 V
16	Reel Motor Common		High is +8.5 V
19	REV Capstan P1	60Hz	
18	REV Capstan P2	60Hz	
35	REV Capstan P2 Common	60Hz	
17	REV Capstan P1 Common	60Hz	
36	FWD, Capstan P2	60Hz	
57	FWD, Capstan P1	60Hz	
4	Write Input 1A (Top Track)		True (Q)
5	Write Input 2A (Top Track)		False (Q)
23	Write Input 1B (Bottom Track)		True (Q)
24	Write Input 2B (Bottom Track)		False (Q)
1	Read Output 1A (Top Track)		Differential
2	Read Output 2A (Top Track)		
20	Read Output 1B (Bottom Track)		Differential
21	Read Output 2B (Bottom Track)		

TABLE 4.  
PIN ASSIGNMENTS TO THE INTERFACE CONNECTOR (Cont)

Connector J1 - 6106-02, 04

Pin No.	Title	Waveform	Remarks
30	Power Ground		
27	Logic Ground		
28	Chassis Ground		
3	Signal Ground		
9	+ 5 V		+ 0.5 V
12	+ 12 V		+ 1.0 V
29	- 12 V		+ 1.0 V
11	Write + 12 V		+ 0.5 V
26	BOT		
7	EOT		
25	Write Interlock		GND When Enabled
6	Cassette Loaded		GND When Loaded
32	Left Solenoid		High is + 12 V
31	Right Solenoid		High is + 12 V
34	Left Reel Motor		High is + 8.5 V
33	Right Reel Motor		High is + 8.5 V
16	Reel Motor Common		High is + 8.5 V
18	REV Capstan Motor		
19	REV TACHO (1)	Sine Wave	Differential
15	REV TACHO (2)		
35	Capstan Motor Common		Power GND of Capstan Servo
17	FWD TACHO (1)	Sine Wave	Differential
37	FWD TACHO (2)		
36	FWD Capstan Motor	Run	
4	Write Input 1A (Top Track)		True (Q)
5	Write Input 2A (Top Track)		False (Q)
23	Write Input 1B (Bottom Track)		True (Q)
24	Write Input 2B (Bottom Track)		False (Q)
1	Read Output 1A (Top Track)		Differential
2	Read Output 2A (Top Track)		
20	Read Output 1B (Bottom Track)		Differential
21	Read Output 2B (Bottom Track)		

## RAYCORDER CASSETTE TAPE TRANSPORT

procedures outlined, the user can isolate a fault to a particular major sub-assembly that he can replace.

The troubleshooting chart, Table 5, presents a convenient way to check the system. Proceed as follows:

1. Open the cover and remove the cassette tray.
2. Continue to press the cover upwards, continuing the opening movement and grip the metal discs forming the pivot points of the cover linkage.
3. Apply rotational force to these discs so as to force the cover into a near vertical position. The mechanism will snap into position with the cover vertical. In this position, the carriage is in the engaged position and the cover microswitch is operated.
4. Slip small lengths of opaque sleeving over the EOT/BOT lamp parts.
5. Apply system power.
6. Defeat the left rear microswitch. Commands can now be issued to the transport and it will respond as though a cassette was loaded and the cover closed.
7. This test method can also be used with a cassette loaded, if it is felt necessary to observe cassette tape movement. It will not be necessary to "blind" the sensors (step 4 above) or to defeat the cassette microswitch (step 7 above).

Major Subassemblies. - The TTU is designed to require a minimum amount of servicing. No oil is necessary to lubricate any of the moving parts. Due to the critical alignments of the transport, it is recommended that field servicing of the unit be limited to the major subassemblies which can be easily removed without affecting the unit alignments. An exploded view of the transport is shown on Figure 32. The subassemblies shown are:

1. Cover, with window.
2. Cassette tray, with ejector lever assembly.
3. Main frame assembly, with motors, microswitches, carriage and head assembly.
4. Upper PW board.
5. Lower PW board.
6. Base cover with interface connector.

Any additional service required should be performed by the manufacturer or personnel trained by

the manufacturer. In addition to replacement of major subassemblies, it is permissible for the user to replace the following modules:

1. Microswitch assemblies.
2. EOT and BOT sensors.
3. Reel motors.
4. Power transistor regulator assembly.

### CAUTION

It is not possible for the untrained user to replace the carriage assembly, head assembly, pinch roller solenoid assembly or capstan motor assemblies without causing the TTU to fail specification.

Replacement of Major Subassemblies. - The following procedure is recommended for disassembly of the TTU.

1. Remove the Philips head screw on the center mounting post at the rear of the unit which retains the frame ground lead of connector J1.
2. From the rear of the unit, remove connector P1 and connector P2 from the high and low level PW boards respectively, by easing the connectors up and over the male pins.
3. With the transport inverted and resting on the transport cover remove the three Philips head screws holding the bottom cover.
4. Remove the bottom cover by lifting the cover up and out of the slot in the main frame.
5. Remove the connecting terminals from J17, and connectors P18, P19, and P20 from the low level PW board.
6. Remove the low level PW board.
7. Remove all connector terminals from the high level PW board by pulling away from the board edge in the same plane as the connector.
8. Remove the hexagonal spacers which hold the high level PW board to the main frame.
9. Remove the high level PW board.
10. Turn the TTU over with the transport cover up.
11. Remove the five Philips head screws that retain the cassette tray and remove the tray.
12. Remove the three Philips head screws which retain each of the reel motors and remove the motors.
13. Remove the transport cover by removing the two Philips head screws on each side of the cover.

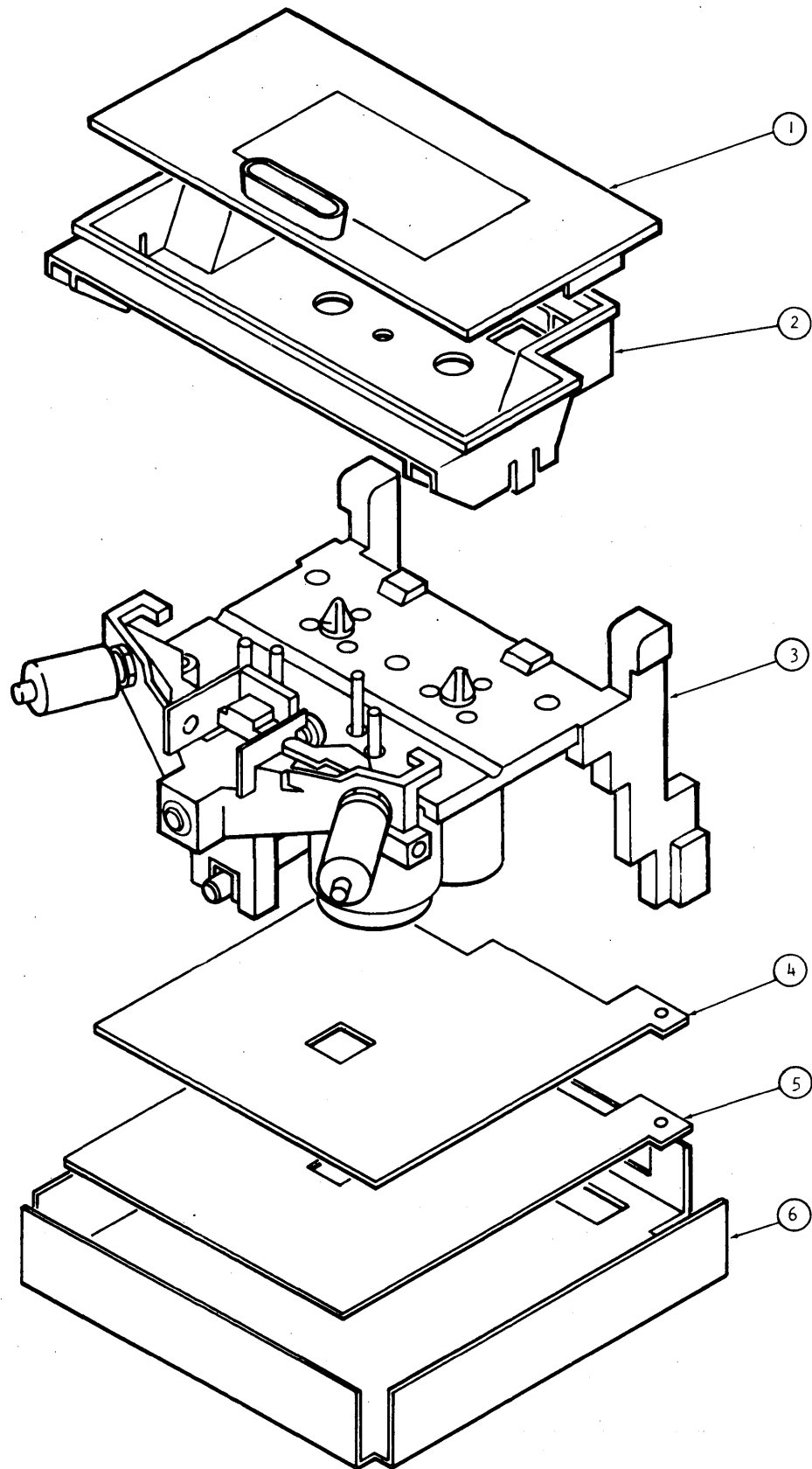


Figure 32. TTU Exploded View

RAYRECORDER CASSETTE TAPE TRANSPORT

TABLE 5.  
TROUBLESHOOTING

Fault	Problem	Solution
Reel Motors: no motion in normal and fast modes	TTU internal 9 V supply not operative  Reel motors not connected Reel motors open circuit	<u>Replace Hi-Level card</u> <u>Replace Q8 regulator</u>  Connect P15 and P16  Replace
Reel Motors: OK in normal No motion in fast mode	EOT or BOT high falsely Fast command not 0V	Check and replace EOT/BOT Check command switch
Reel Motors: OK in fast No motion in normal mode or low torque in normal	Normal command not 0V Faulty zener diodes Reel motor faulty	Check command switch Replace Hi-level card Replace motor
Solenoid not engaged	+12 V supply failed Solenoid command not 0V Solenoid not connected Solenoid open circuit	Check Check command switch Check P11 and P12 Replace
Capstan not rotating	EOT or BOT high Bad motor connection Motor not connected One or both phases open Capacitance does not total 1.0 MFD (AC capstan only)	Check EOT/BOT Adjust connector Connect Replace motor Correct capacitor value
No tape motion (capstan rotates)	Cassette carelessly inserted with tape behind capstan	Remove and reinsert cassette
EOT/BOT non-function	Lamps not lit Phototransistors disconnected Phototransistors failed Bad lamp connections Bad connector P5 & P17 Failed EOT/BOT amplifiers	Check lamp circuits Rework connectors Replace Rework connections Rework connectors Replace Lo-level card
Transport does not write (write waveform present)	Head penetration inadequate No pressure pad or inadequate pad pressure	Readjust penetration Change cassette
Transport does not write (write waveform absent)	No cassette present Cassette write plugs out No write command Write data input absent Faulty write protect Bad connector P5 & P17 Faulty Lo-level card	Insert cassette Change cassette Issue command Apply input data Troubleshoot Rework connectors Replace

TABLE 5.  
TROUBLESHOOTING (Cont)

Fault	Problem	Solution
Transport does not write (write waveform basent) (cont)	W + 12 supply failed	Troubleshoot
	Write head open circuit	Replace head
Transport does not read	No cassette present	Insert cassette
	Tape not moving	Troubleshoot
	Write command on	Remove write command
	Head penetration inadequate	Adjust penetration
	Inadequate pad pressure	Replace cassette
	Head not connected	Check connections
	Head open circuit	Replace head
	Bad connector P5 & P17	Rework connectors
	Faulty Lo level card	Replace Lo level card

The microswitches, without their connecting leads, and the EOT and BOT sensors may be removed without engaging in the step-by-step procedure above. However, removal of the power transistor assembly and the connecting leads to the microswitches requires that the base cover be removed as described in Step 4 above.

Major Dismantling and Repair

Recommended List of Spare Parts. - The following list of spares includes REI drawing numbers.

Transport Cover with Window	100614-101
Mainframe Assembly	
Reel Motor Assembly (FWD)	
Reel Motor Assembly (REV)	
AC Capstan Motor Assembly (FWD)	
AC Capstan Motor Assembly (REV)	
DC Capstan Motor Assembly (FWD)	
DC Capstan Motor Assembly (REV)	
Switch Assembly, Linkage	
Switch Assembly, Tab Sense	
Switch Assembly, Cassette	
Transistor PNP	
Board, PW Assembly, High Level (DC capstan)	100957-101
Board, PW Assembly, High Level (AC capstan single direction)	101021-101
Board, PW Assembly, High Level (AC capstan dual direction)	100743-101
Board, PW Assembly, Low Level (read or write)	100649-101
Board, PW Assembly, Low-Level (read-while-write)	100959-101
Cover, Bottom	100652-103
Cable Assembly, Interface	100896-101

Dismantling the Mainframe. - Steps 1 through 6 below must be performed in sequence. Only trained users may proceed as follows:

1. Carry out the dis-assembly procedure outlined in Replacement of Major Subassemblies above.
2. Using a sharp pointed tool, remove the plastic resin out of slots in the Philips screws at the outer ends of the carriage casting.
3. With the TTU cover closed, press the carriage into engagement with the mainframe (towards the rear of the TTU) using one hand, while removing the two Philips screws with the other. These screws are held in position against the effect of vibration by Loctite "C" on the threads, so that torque in excess of 15 lb/ins. is required to loosen them.
4. With these screws removed, the carriage is free to move forward on its slides and may be removed completely for replacement or repair. Retain the screws, washers, the two bushings, and the spring.
5. The capstan motor assemblies may now be removed. Each is held in place by three Philips head screws which also have Loctite "C" on the threads. The capstan motor assemblies are made in left and right form. It is important that they should be replaced with the appropriate left or right version. The relevant transport schematic makes this plain, as the connector attached to the capstan motor assembly is clearly marked in accordance with the schematic.
6. The EOT/BOT lamp assemblies may now be removed. These assemblies are slipped into the hole drilled in the mainframe casting and up into the lamp posts. They are held in position by a number of methods. Some early models used polyethylene sleeving, later models used an RTV silicon rubber material. These methods are still satisfactory, as the lamps are held in place by the mounting flange of the capstan motor assembly. The preferred

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method and the one which has been in use since TTU Serial No. 0425 is to use a quantity of kneaded rubber Type 1224 by Eberhard-Faber. Pick out the adhesive, replace the lamp assemblies and force a small quantity of 1224 into the channel in the casting to retain the cables in position. Make sure that the replacement lamps are as high in the lamp posts as they will go and that the light is shining out of the hole in the lamp post. Check that the filament is visible in the hole.

Dismantling the Carriage Assembly. - The steps shown below can be performed independently; they need not be done in sequence.

1. To replace the left or right pinch roller and carrier assembly, carefully remove and retain the "C" clip at the top of the carrier pivot pin. Remove the pin and the carrier assembly may be removed from the carriage. Retain the small helical spring. Note which spring is required; this part is either left or right and only the left spring can be used for the left pinch roller carrier assembly. Place the new pinch roller carrier assembly in the carriage and hold the helical spring in position with tweezers while slipping the pivot pin through the holes in the carrier, carriage, and spring. Make sure that the inner arm of the spring is bearing against the carriage. Replace the "C" clip.
2. To replace a solenoid assembly, loosen the hexagonal holding nut by turning it counterclockwise with a wrench. Unscrew the solenoid assembly. Screw the new assembly into position. Do not fully screw it in; the solenoid body should not quite protrude from the inner face of the carriage. Tighten the holding nut moderately by turning it clockwise so that it bears on the outer face of the carriage. It will be tightened properly after alignment of the carriage with the mainframe.
3. Remove the head connector cable. If a sketch is made of the connectors before removal, it will assist in replacing the connectors correctly. The read/write head assembly is held on the carriage by the two Allen-head screws nearest to the front of the carriage. The right screw is fixed in position by an adhesive material. Remove this material using a pointed tool. The left screw is fitted with a spring and washer. Remove these screws and the head can be lifted off the carriage still contained in the clamp assembly. Retain the two screws and the spring and washer.

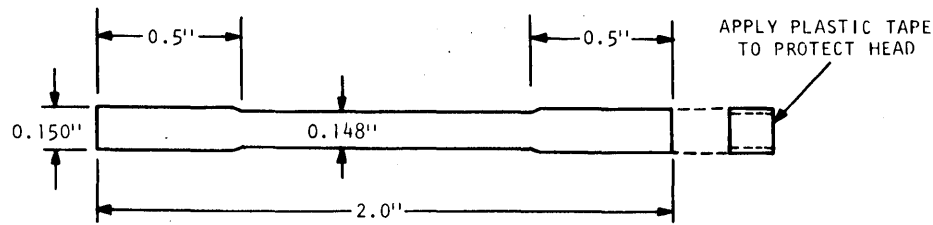
### NOTE

The azimuth (skew), zenith (pitch) and tracking characteristics of the carriage and head assembly have now been disturbed and must be realigned after re-assembly.

4. The head clamp assembly can be replaced by removing the two remaining Allen screws. A new head can be placed in the clamp assembly, or a new clamp assembly can be placed around the existing head, but it is important that the shims under the head be placed back in position. Re-tighten the two Allen screws.
5. Place the new head and clamp assembly on the carriage. The fulcrum cast into the bottom of the clamp assembly must fit correctly into the slots cast in the carriage. Place the Allen screw with the spring and washer in the left position and the other screw in the right position. Tighten both screws half way and then tighten the right screw until it bears against the head clamp and "rocks" it. Tighten the left screw until the coils of the spring are almost touching. Adjust the right screw until the head appears to be level. Precise adjustment will be made when the carriage is attached to the mainframe. Replace the head connector cable.
6. Perform a preliminary vertical alignment of the read/write head by placing a ground steel bar (see Figure 33) 0.150 in. (3.81 mm) wide across the head so that it fits into the guides. Adjust the number and thickness of shims under the head until the head tracks are in line with the bar when viewed through a microscope.

Re-assembling the Carriage to the Mainframe. - Assuming that the EOT/BOT lamp and the capstan motors are in position proceed as follows:

1. Place the left and right linkage arms in the same position on either side of the mainframe. Attach the cover so that the linkages and their metal discs will act together. Close the cover.
2. Place the carriage helical spring in the hole in the front face of the mainframe and engage the carriage assembly with the steel slide rods protruding from the front of the mainframe. Slide the carriage onto the rods, making sure that the spring is engaged with the hole in the carriage as well as the hole in the mainframe.
3. Press the carriage hard up against the face of the mainframe and clamp it in this position. Place the steel bushings in the holes at the front ends of the linkage arms, fit the washers and screw the Philips screws into the tapped holes in the ends of the carriage after passing them through the bushings. Tighten these screws several turns, apply Loctite "C" to the threads, and tighten them fully, to a torque of 15 in. lbs. Release the clamp holding the carriage to the mainframe.
4. With the cover still closed, press the plunger of the left solenoid so that it is fully seated. Check to see that the pinch roller carrier has moved forward so that the pinch roller is bear-



MATERIAL: 0.150" SQUARE GROUND STEEL STOCK

Figure 33. Head Vertical Positioning Bar

ing against the left capstan shaft. Adjust the solenoid by slackening its retaining nut and turning the solenoid body clockwise or counter-clockwise until the leaf spring inside the carrier is deflected away from its seating against the carrier by 0.015 in. + 0.005 in. This is most readily checked with a 0.015 in. shim. It is important that the solenoid plunger be properly seated at this time. This setting of the leaf spring ensures that when the solenoid is engaged, the pinch roller will be pressed against the capstan with a force of 1.5 lbs (nominal). Repeat this procedure with the right solenoid. Make sure that the clamping nuts are tightened after this adjustment. Check that no additional rotation of the solenoid body took place when the nut was tightened.

5. Check that when the cover is opened and closed the carriage slides smoothly back and forth on its guide rods, with no squeaking sounds or excess friction. When the front of the cover is raised about 1 in. the action of the spring and linkages will "snap" the cover into the open position. Do not put oil on the plastic insert at the fork at the base of the carriage where it runs on the bottom guide rod. This will cause the plastic to swell and make the cover action stiff.
6. Adjust the read/write head penetration as follows:

Open the cover and fit the penetration gage down onto the lamp posts as shown on Figure 34. This gage is part number 100542-001 for read/write TTU's (6106-01 and 02) and 100542-002 (black) for TTU's 6106-03 and -04 (read-after-write). Note that in 6106-03 and -04 models the gage is colored black as is the head clamp assembly. Slacken the screws holding the head clamp assembly. Do not slacken the two front screws. Close the cover and push the head forward in the clamp until the face of the head is gently touching the front face of the gage. Tighten the head clamp screws at this point. Open the cover and remove the gage. It is important to use the correct gage according to the TTU type because read-while-write heads should penetrate further into the cassette. This penetration

may have to be checked again later if the head vertical alignment tests require insertion or removal of head shims.

**Alignment of an Assembled TTU.** - After the carriage has been assembled to the mainframe as described, the transport should be completely assembled by reversing the procedure listed in discussion of Replacement of Major Subassemblies. However, the cassette tray should not yet be attached. Transport alignment can now be carried out:

1. Place an old cassette or a cassette that does not contain valuable information in the TTU, close the cover, and cycle the TTU through its functions; starting, stopping, rewinding, fast forward wind, EOT/BOT automatic stop, reading and writing. If the TTU is functionally correct, continue with alignment. If there is some problem, refer to the troubleshooting chart Table 5.
2. Place a 400 BPI standard alignment tape cassette in the TTU and read forward. Display the outputs of both pre-amplifiers on an oscilloscope (see Figure 35) and adjust the right front head screw (Allen screw) with an Allen wrench until the skew between both outputs is minimum in both forward and reverse directions. Remove the alignment cassette. The tape head azimuth is now aligned.
3. Place an unprotected cassette in the transport and rewind to BOT. Now write forward on both tracks with a 400 BPI signal for about 10 ft. Switch off the write command and re-

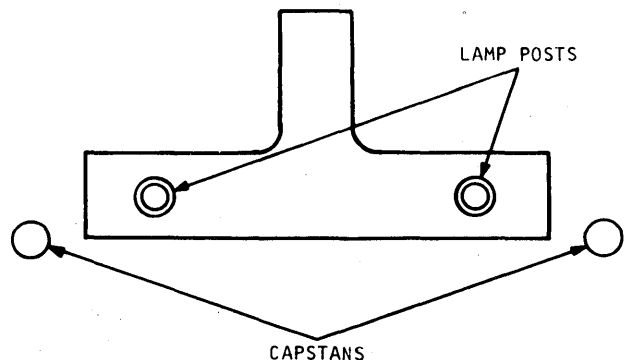


Figure 34. Head Penetration Gage in Position



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wind to BOT. Read forward and make a note of the amplitude of the output from each pre-amplifier (V). At the end of the 10 ft., stop, remove the cassette and replace it in the TTU upside down. Remove the input data connector cables so that no data can be fed into the TTU and write forward to EOT. This will erase the information previously recorded. However, if the head is not accurately aligned with respect to the centerline of the tape, a narrow band of unerased signal will remain. Remove the write command, remove the cassette and insert it correct way up, and read forward. Increase the sensitivity of the oscilloscope and observe the magnitude of the tape signal from each pre-amplifier (R). The head vertical misalignment, expressed as a percentage of the track is given by the following:

$$\%e_v = \frac{R \text{ (Volts)}}{V \text{ (Volts)}} \times 50$$

Where R = residual signal after erasing

V = output from pre-amplifier on first read pass after write

$e_v$  = percentage vertical misalignment

The transport is correctly aligned if  $e_v$  is less than 2 percent.

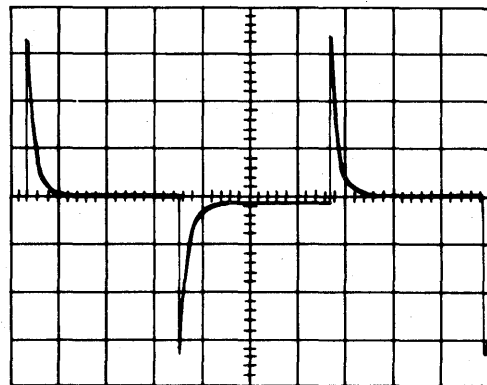
4. If  $e_v$  is greater than 2 percent, adjust the quantity of shims under the head, re-tighten the head clamp screws, repeat the head penetration check and repeat step 3 above until the alignment is within 2 percent.
5. Attach the cassette tray and hold it in position with its five Philips screws.
6. Re-attach the cover stop if it has been removed. (See Troubleshooting).

### Required Tools and Test Equipment

1. Azimuth alignment tape (400 BPI)
 

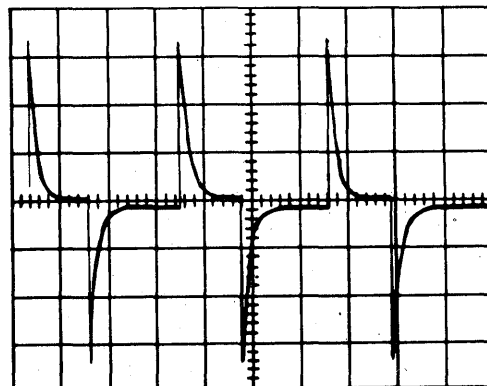
USA	Ktronic Inc. 10601 Saratoga - Sunnyvale Rd. Cupertino, CA. 95014
Europe	10 Salmon Close Spencers Wood Reading, England
2. Set of Philips screwdrivers.
3. Allen wrenches, size 5/64 in.
4. Amphenol insertion/removal tool Type 358-200.
5. Amphenol insertion/removal tool Type 91087-2-20.
6. Philips head torque-indicating screwdriver.

7. Kneaded rubber type 1224 Eberhard-Faber.
8. Tweezers.
9. Open ended wrench size 9/16 in., H. Smith Inc., N. Y. C.
10. Steel shims, 0.002 in., 0.003 in., 0.005 in., 0.010 in., 0.015 in.
11. Head vertical positioning bar. See Figure 33.
12. Penetration gage (100542-001 for 6106-01, -02, and 100542-002 for 6106-03, -04). See Figure 34. This is available from Raymond Engineering.
13. Loctite "C".



A

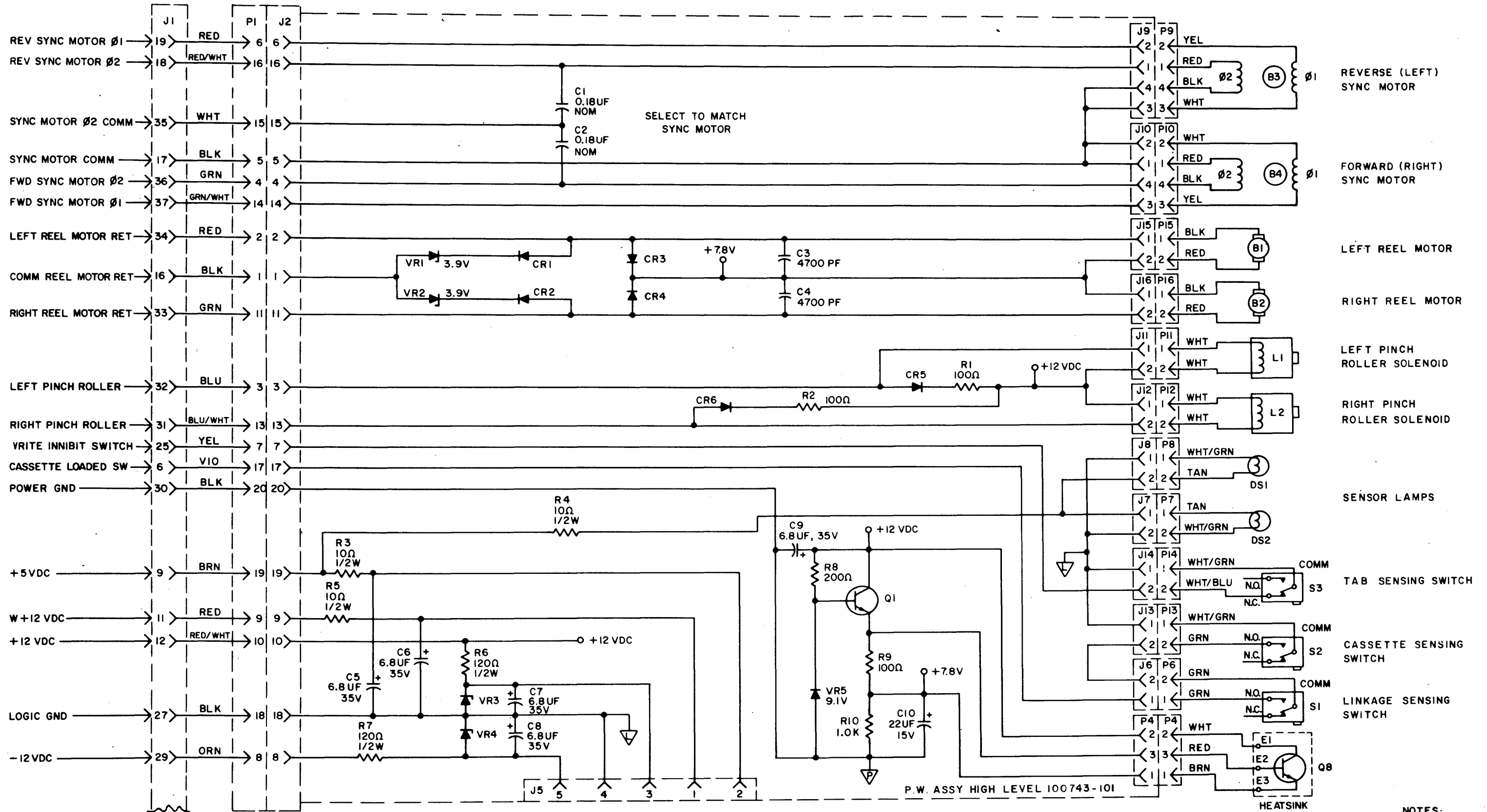
Models: 6106-01, 02 only  
 Source: Waveform at output of read pre-amplifiers during write mode  
 Scale: 1 V per division  
 Bit Rate: 400 BPI  
 Tape Speed: 8.0 IPS



B

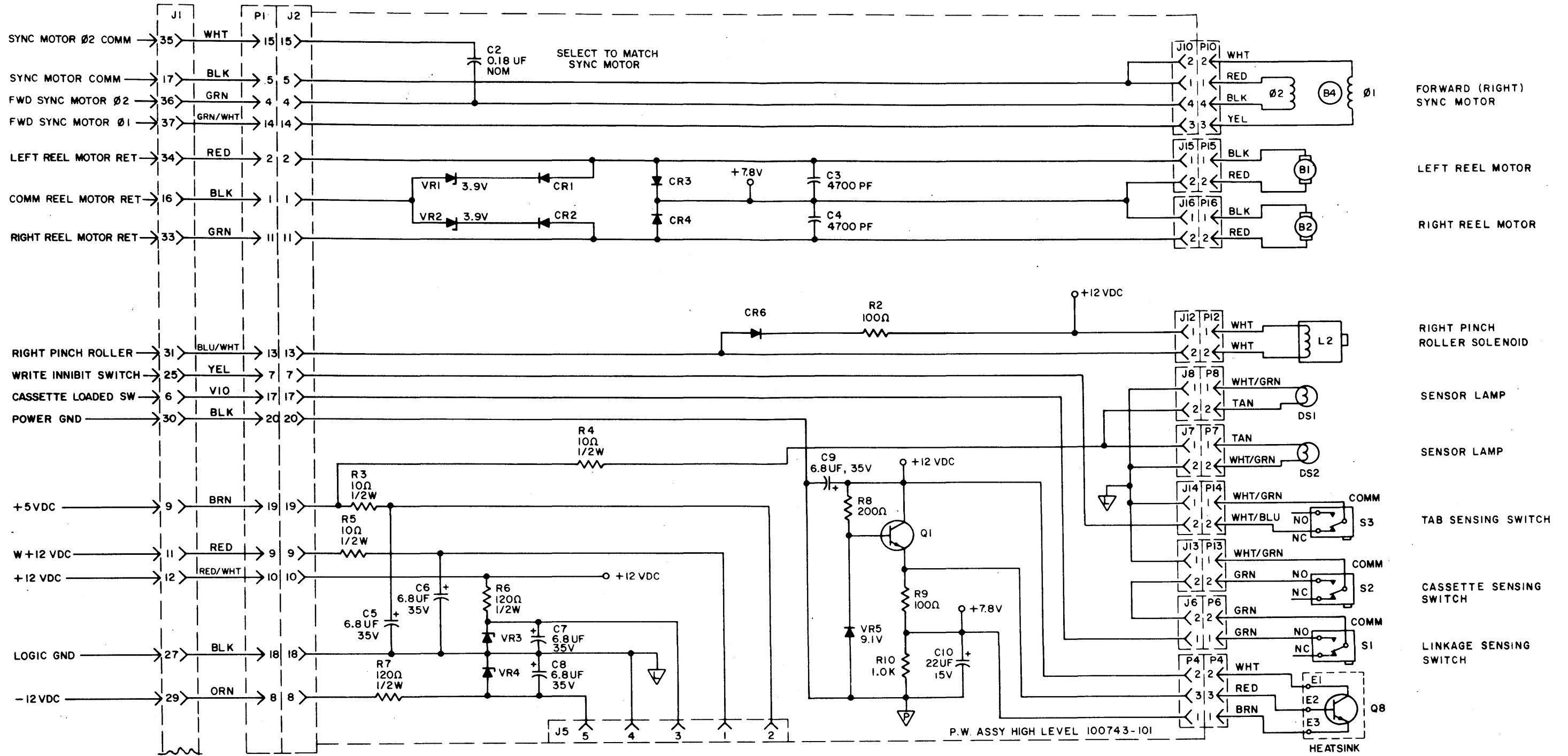
Models: 6106-01, 02 only  
 Source: Waveform at the output of read pre-amplifiers during write mode  
 Scale: 1 V per division  
 Bit Rate: 800 BPI  
 Tape Speed: 8.0 IPS

Figure 35. Waveforms at Output of Pre-amplifiers during Write Mode



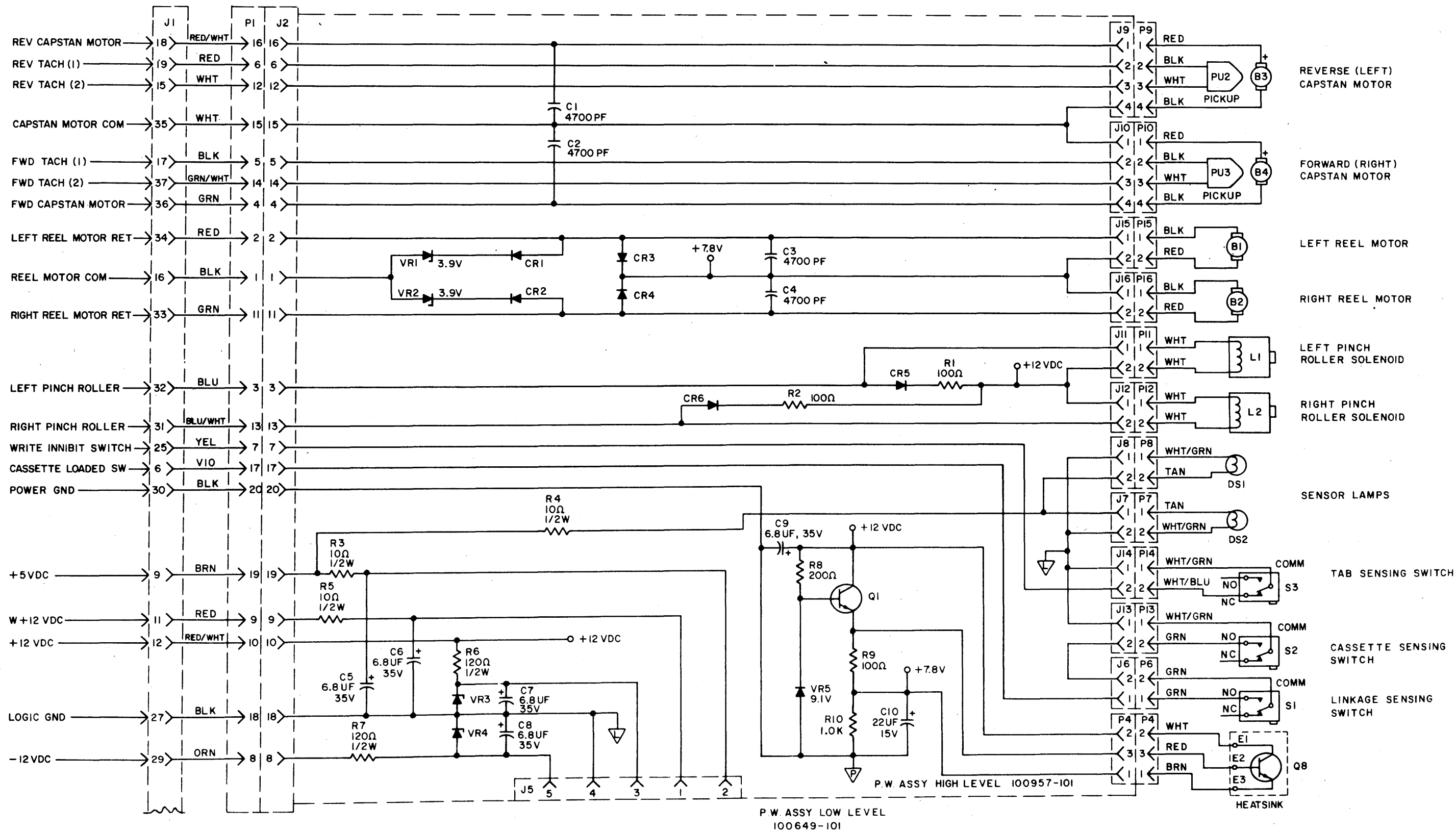
NOTES:  
 1. UNLESS OTHERWISE SPECIFIED:  
 RESISTORS 1/4 W 5%

Figure 36. AC Capstan Motor TTU, Schematic Diagram



NOTES:  
 1. UNLESS OTHERWISE SPECIFIED:  
 RESISTORS 1/4 W 5%

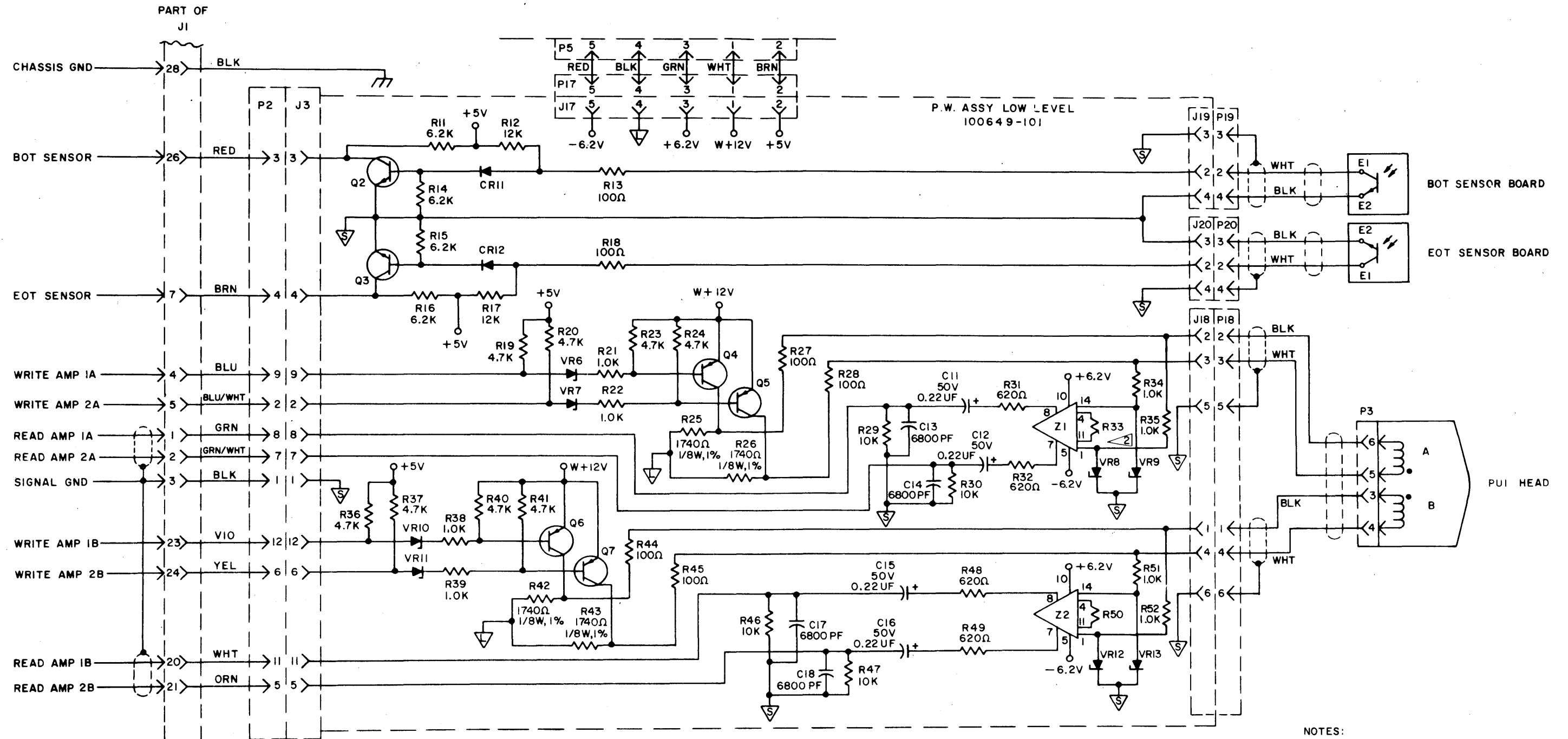
Figure 37. AC Capstan Motor TTU, Single Direction, Schematic Diagram



NOTES:

1. UNLESS OTHERWISE SPECIFIED:  
RESISTORS 1/4 W 5%

Figure 38. DC Capstan Motor TTU, Schematic Diagram



NOTES:  
 1. UNLESS OTHERWISE SPECIFIED:  
 RESISTORS 1/4 W 5%  
 2. SELECT FOR .300V PP OUTPUT.  
 NOMINAL RESISTANCE 261Ω.

Figure 39. Read or Write TTU, Schematic Diagram

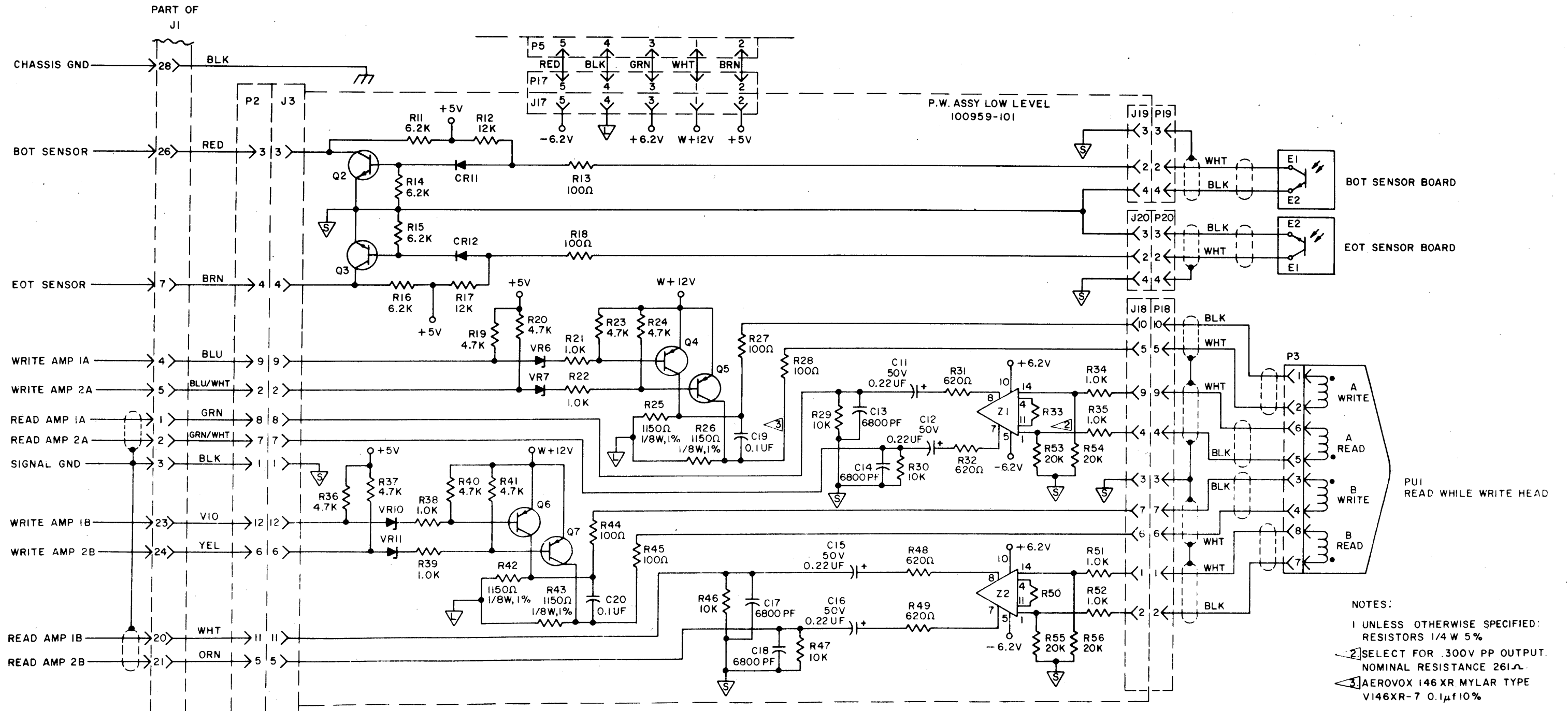
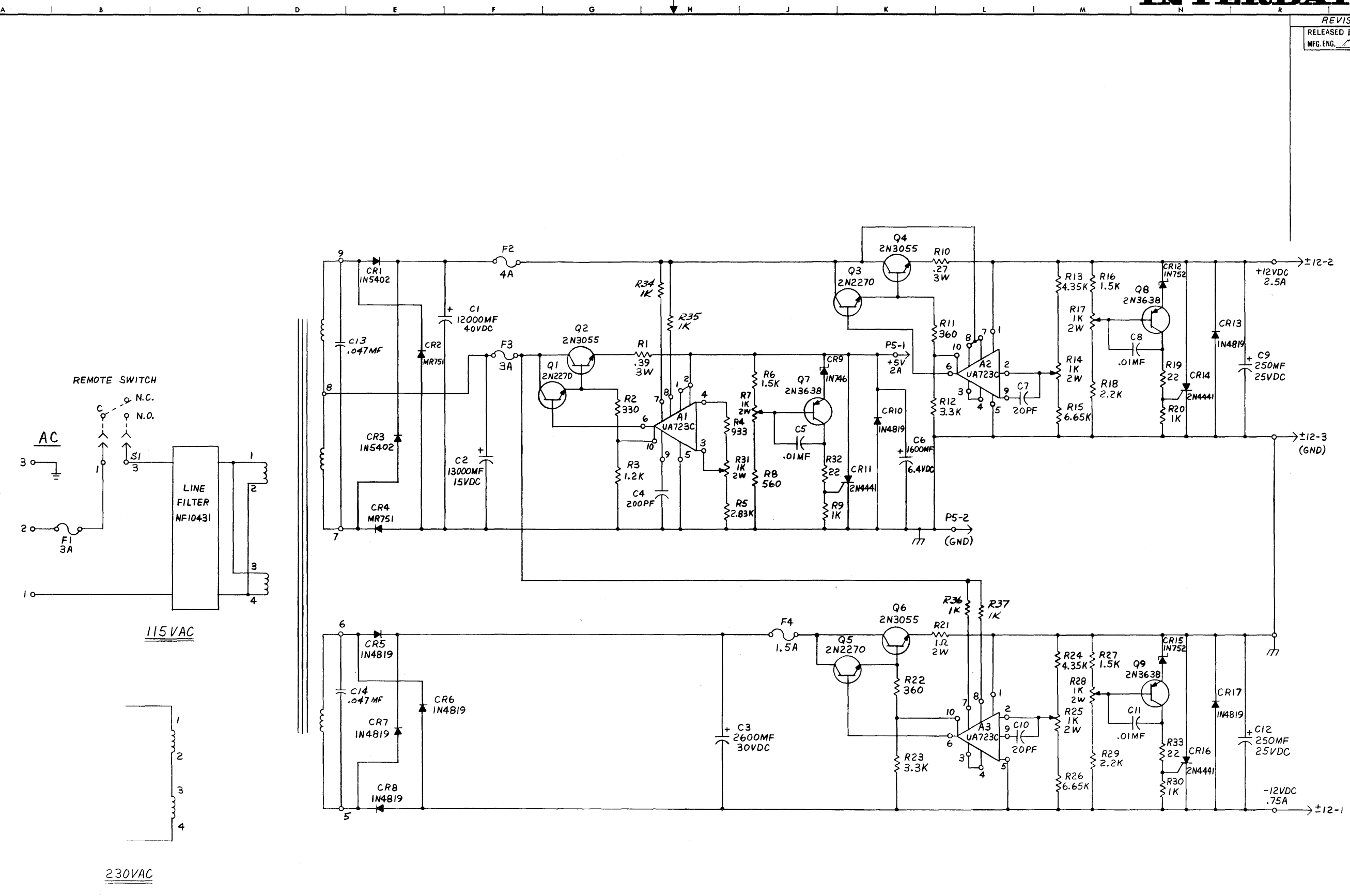


Figure 40. Read-While-Write TTU, Schematic Diagram



NOTES  
1. UNLESS OTHERWISE SPECIFIED, RESISTORS ARE 1/2W, ±10%.  
PRECISION RESISTORS ARE 1/4W, ±1%.

NAME	TITLE	DATE	TITLE
K. LAFFERTY	DRAFT	6-16-72	SCHEMATIC CASSETTE POWER SUPPLY
D.W. YOUNG	SVS TEST	7-19-72	
R. SAGER	ENGR	7-19-72	
M. FUCHS	Q.C.	7-21-72	
R.E. JONES	DIR ENGR	7-25-72	