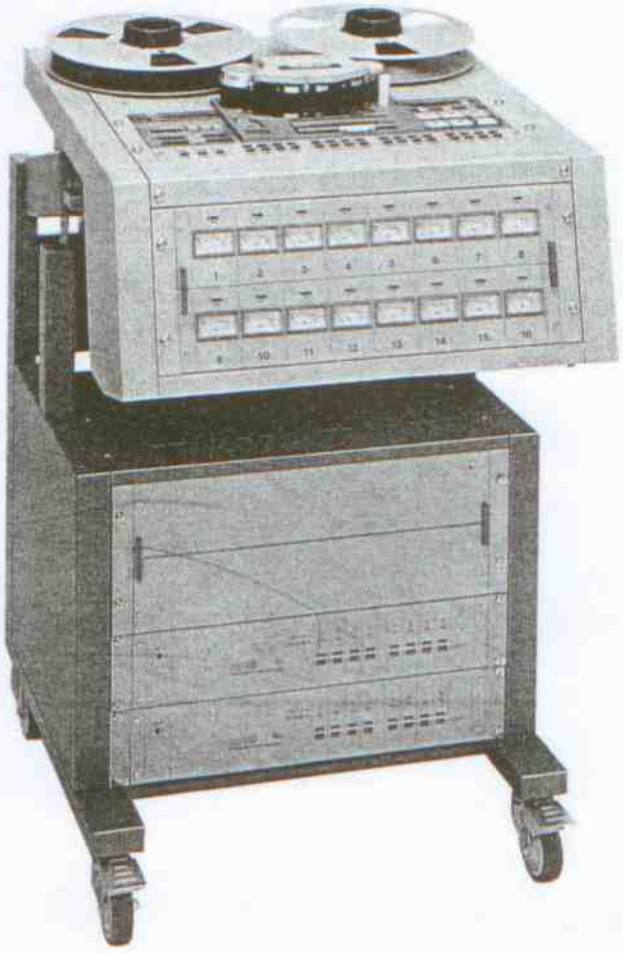
TASCAM

TEAC Professional Division

MS-16

16-Track Recorder/Reproducer



OPERATION/MAINTENANCE

5700067800

The guarantee of performance that we provide for the MS-16 must have several restrictions. We say that the recorder will perform properly only if it is adjusted properly and the guarantee is that such adjustment will be possible. However, we cannot guarantee your skill in adjustment or your technical comprehension of this manual. Therefore, Basic Daily Setup is not covered by the Warranty. If your attempts at internal adjustments such as rebias and record EQ trim are unsuccessful, we must make a service charge to correct your mistakes.

Recording is an art as well as a science. A successful recording is often judged primarily on the quality of sound as art, and we obviously cannot guarantee that. A company that makes paint and brushes for artists cannot say that the paintings made with their products will be well received critically. The art is the provice of the artist. TASCAM can make no guarantee that the MS-16 *by itself* will assure the quality of the recordings you make.
Your skill as a technician and your abilities as an artist will be significant factors in the results you achieve.

WARNING: TO PREVENT FIRE OR SHOCK HAZARD, DO NOT EXPOSE THIS APPLIANCE TO RAIN OR MOISTURE.

CAUTION RISK OF ELECTRIC SHOCK DO NOT OPEN	CAUTION: TO REDUCE THE RISK OF ELECTRIC SHOCK, DO NOT REMOVE COVER (OR BACK). NO USER-SERVICEABLE PARTS INSIDE. REFER SERVICING TO QUALIFIED SERVICE PERSONNEL.
	The lightning flash with arrowhead symbol within an equilateral triangle, is intended to alert the user to the presence of uninsulated "dangerous voltage" within the product's enclosure, that may be of sufficient magnitude to constitute a risk of electric shock to persons.
	The exclamation point within an equilateral triangle is intended to alert the user of the presence of important operating and maintenance (servicing) instructions in the literature accompanying the appliance.

*dbx is a trademark of dbx Incorporated. dbx noise reduction system manufactured under license from dbx Incorporated.

This recorder/reproducer has a serial number located on the rear panel. Please record the model number and serial number and retain them for your records.
Model Number _____
Serial Number _____

TABLE OF CONTENTS

1. GENERAL INFORMATION
1-1 General Description . . . . . 1 - 1
1-2. Tape Transport . . . . . 1 - 1
1-3. Head Assembly . . . . . 1 - 5
1-4. Electronics . . . . . 1 - 5
1-5. Power Supply . . . . . 1 - 5
1-6. Remote Control/Auto Locator Functions . . . . . 1 - 6
1-7. Output Select Controls . . . . . 1 - 6
1-8. Line Input and Line Output Connections . . . . . 1 - 6
1-9. Transport Control Functions . . . . . 1 - 6
1-10. Motor Drive Circuit . . . . . 1 - 7
2. SPECIFICATIONS . . . . . 2 - 1
3. FEATURES AND CONTROLS . . . . . 3 - 1
Transport Unit . . . . . 3 - 2
Amplifier Unit . . . . . 3 - 7
ACCESSORY "SMPTE" CONNECTOR . . . 3 - 8
REMOTE CONTROL CONNECTOR AND SIGNALS . . . . . 3 - 9
METER CONNECTOR AND SIGNALS . . . . . 3 - 13
4. OPERATION
4-1. Basic Information
4-1-1. Reel Installation . . . . . 4 - 1
4-1-2. Threading Tape . . . . . 4 - 1
4-1-3. Erasing the Tape . . . . . 4 - 1
4-1-4. Cleaning . . . . . 4 - 1
4-1-5. Degaussing (Demagnetizing) . . . . . 4 - 2
4-2. Monitoring the Line Outputs . . . . . 4 - 3
4-2-1. Synclock Operation . . . . . 4 - 4
4-3. Recording . . . . . 4 - 4
4-3-1. Punch-In Using the RECORD Button . . . . . 4 - 5
4-3-2. Punch-In Using the REC Function Switches . . . . . 4 - 5
4-4. Examples of Punch-Ins and Inserts . . 4 - 5
4-5. Another Look at Sync Function . . . 4 - 6
4-6. Built-In Auto Locator Function . . . . 4 - 6
4-7. Fast Winding . . . . . 4 - 6
4-8. Reproduction (Playback) . . . . . 4 - 6
4-9. Editing . . . . . 4 - 6
4-9-1. Manual Editing . . . . . 4 - 7
4-9-2. Dump Editing . . . . . 4 - 7
4-10. Spooling . . . . . 4 - 7
4-11. Voltage Conversion . . . . . 4 - 8
4-12. Note for U.K. Customers . . . . . 4 - 8
4-13. DX-8DS dbx Noise Reduction Unit . . . . . 4 - 9
4-14. Optional Equipment and Useful Accessories . . . . . 4 - 11
MAINTENANCE
5. THEORY OF OPERATION
5-1. Logic Symbols . . . . . 5 - 1
5-2. Microprocessor Input Circuit . . . . . 5 - 2
5-3. Entry of Tape Speed and Direction Information . . . . . 5 - 4
5-4. Entry of Tape End Information . . . . 5 - 4
5-5. Entry of Power On/Off Information . . . . . 5 - 8
5-6. Microprocessor Output Circuit . . . . . 5 - 9
5-7. Tape Transport Control Circuit Output
5-7-1. Play Mode . . . . . 5 - 12
5-7-2. Record Mode . . . . . 5 - 12
5-7-3. FF Mode . . . . . 5 - 16
5-7-4. REW Mode . . . . . 5 - 16
5-7-5. STC (Search-To-Cue) Mode . . . . 5 - 16
5-7-6. RTZ (Return-To-Zero) Mode . . . 5 - 16
5-7-7. Other Modes . . . . . 5 - 16
5-7-8. Reel Servo Circuit . . . . . 5 - 20
5-7-9. Capstan Motor Servo Circuit . . . 5 - 24
5-8. Amplifier Control Circuit
5-8-1. Input Mode . . . . . 5 - 28
5-8-2. Reproduce Mode . . . . . 5 - 28
5-8-3. SYNC Mode . . . . . 5 - 28
5-8-4. Record Mode . . . . . 5 - 31
5-8-5. Record/Reproduction Switching Noise Protection Circuit . . . . . 5 - 31
5-8-6. Input and Output Levels . . . . . 5 - 36
5-8-7. Block and Amplifier Level Diagram . . . . . 5 - 36
5-8-8. Meter Connector and Signals . . . 5 - 38
5-8-9. "ACCESSORY" Connector and Signals . . . . . 5 - 39
5-8-10. Remote Control Connector and Signals . . . . . 5 - 41
6. — Space reserved —
7. CHECKS AND ADJUSTMENTS
7-1. Parts Location Diagrams . . . . . 7 - 1
7-2. Essential Test Equipment Required . 7 - 3
7-3. — Space reserved —
7-4. Removal of the Main Parts
7-4-1. Outer Parts . . . . . 7 - 5
7-4-2. Head . . . . . 7 - 7
7-4-3. Reel Motor . . . . . 7 - 7
7-4-4. Capstan Motor Ass'y . . . . . 7 - 8
7-4-5. Fuses . . . . . 7 - 8
7-5. Tape Transport Checks and Adjustments
7-5-1. Brake Mechanism . . . . . 7 - 9
7-5-2. Brake Torque . . . . . 7 - 9
7-5-3. Pinch Roller Pressure . . . . . 7 - 10

7-5-4. Tape Tension Servo . . . . . 7 - 11
7-5-5. Re-installation of the Arm Stopper . . . . . 7 - 14
7-5-6. Adjustment and Re-installation of the End Sensor Assembly . . . . . 7 - 14
7-5-7. Adjustment after Replacement of the Speed Sensor Assembly . . . 7 - 14
7-5-8. Reel Table Height . . . . . 7 - 15
7-5-9. Tape Speed . . . . . 7 - 15
7-5-10. Wow and Flutter (Reproduce Method) . . . . . 7 - 15
7-5-11. Capstan Servo . . . . . 7 - 16
7-5-12. Tape Path Fine Adjustment . . . . . 7 - 17
7-6. Record/Reproduce Amplifier Cehecks and Adjustments . . . . . 7 - 20
7-6-1. Before Making any Checks or Adjustments . . . . . 7 - 21
7-6-2. Input Level Calibration . . . . . 7 - 24
7-6-3. Meter . . . . . 7 - 24
7-6-4. Peak LED . . . . . 7 - 24
7-6-5. Reproduce Level Calibration . . . 7 - 24
7-6-6. Reproduce Frequency Response . . . . . 7 - 24
7-6-7. Bias Tuning and Bias Trap Adjustments . . . . . 7 - 25
7-6-8. Bias Level . . . . . 7 - 25
7-6-9. Recording Level . . . . . 7 - 26
7-6-10. Frequency Response (OVERALL) . . . . . 7 - 26
7-6-11. Signal-to-Noise Ratio (OVERALL) . . . . . 7 - 26
7-6-12. Erase Ratio . . . . . 7 - 27
7-6-13. Adjacent Channel Crosstalk . . . . 7 - 27
7-6-14. Distortion . . . . . 7 - 28
7-6-15. Output Level Switching . . . . . 7 - 28
7-6-16. Service Chart . . . . . 7 - 29
8. EXPLODED VIEWS, ASSEMBLIES, PARTS LISTS AND CIRCUIT SCHEMATICS
(see index on page 8-1)

Note:
If you notice any differences, either on the outside or the inside of the unit from the illustrations and descriptions in this manual, talk to your dealer. He may have revision sheets that will show manufacturing changes, or notifications of how to deal with any changes in set-up or maintenance procedures.
Save this manual, refer to it when necessary, and good luck with your MS-16.

1. GENERAL INFORMATION

This manual contains operation and maintenance information for the TASCAM MS-16 Tape Recorder/Reproducer.

1-1. GENERAL DESCRIPTION

The MS-16 is an exceptionally versatile high-performance 16-track, 16-channel multitrack tape recorder/reproducer that uses 1-inch wide tape and operates at 15 ips (38 cm/sec). The head configuration consists of an erase head and two record/reproduce heads, one of which is used for recording and sync playback, and the other for playback only. This is an advantage primarily during alignment, since sync response is equal to repro response.

Designed especially for demanding professional production applications, including lock-up to Time Code based controller/synchronizers, the MS-16 transport is built on a new, extra heavy-duty chassis that ensure stable tape motion and stable alignment despite the long hours of high speed, start-stop shuttling that are typically part of editing (especially when locked up to film or video systems). The MS-16 is quick enough to keep up with your tight deadlines. Tape motion is fast, smooth, and accurate thanks to a built-in microprocessor which commands two direct drive reel motors under full tension servo-control and a single PLL servo capstan motor.

The MS-16's electronics are mounted on plug-in printed circuits boards for ease of service. Access for routine alignment is provided through the front of the amplifier unit; the VU meter panel swings out and down for easy access to EQ, bias and level calibration trimmers. This facilitates alignment while observing the results on the meters. Alignment is equally easy whether the MS-16 is housed in a verticla equipment rack or in a roll-around console. (More detailed information on these adjustment is provided in the "Maintenance" section of this manual.)

The MS-16 includes many user programmable automatic functions and features that are essential to high speed, error free professional audio production. Naturally the basics of synchronous recording and playback are provided with separate Output Select and REC Function Select Switches for each track. These can be individually programmed to present either input or playback as the output in the record ready mode, making trial edits and talent cue mixes easy to set up. For fast one button communications between the control room and talent without your having to reset mixer or recorder controls, Input enable automatically switches the input of the MS-16 to the output during Rewind, Fast Forward and Stop Modes.

The MS-16 is a modular system. You can tailor your MS-16's configuration to suite your work style or environment. It can be mounted in a standard 19" EIA rack for mobil installations or in its optional CS-65 Roll-around console for the production room. If you wish, you can control the MS-16 remotely with the RC-65 Remote transport control. The RC-65 gives you all the functions that you need including pitch control. Or you may choose the AQ-65 multi-function auto locator, for 10 cue point memory, programmable pre-roll and two point repeat. The Remote Function Control of the MS-16 can also be remoted, for control of track record and Insert status. The VU meter panel is also remoteable.
When working with Time Code based systems, Lifter Defeat Mute and Synclock Insert Function, allow you automatic options to insure uninterrupted time code playback, is available and under the control of your system. And, interfacing the MS-16 to your system only requires a single connector. The MS-16 Accessory connector has all the necessary logic and tally signals for control by Adams Smith, BTX, Convergence, Fernseh, ISC, GTC, MCI/Sony, Q-Lock (Audio Kinetics), United Media, Video Media and other similar systems. It also has a function remote connector for system interface and control of individual track record select.

1-2. TAPE TRANSPORT

Mounted on a rigid, precision-machined aluminum plate are the main transport components, including: the supply and take-up reel motors, the capstan motor, impedance roller, pinch roller, tachometer roller, digital counter, and the tape tension arms, with their guide rollers.

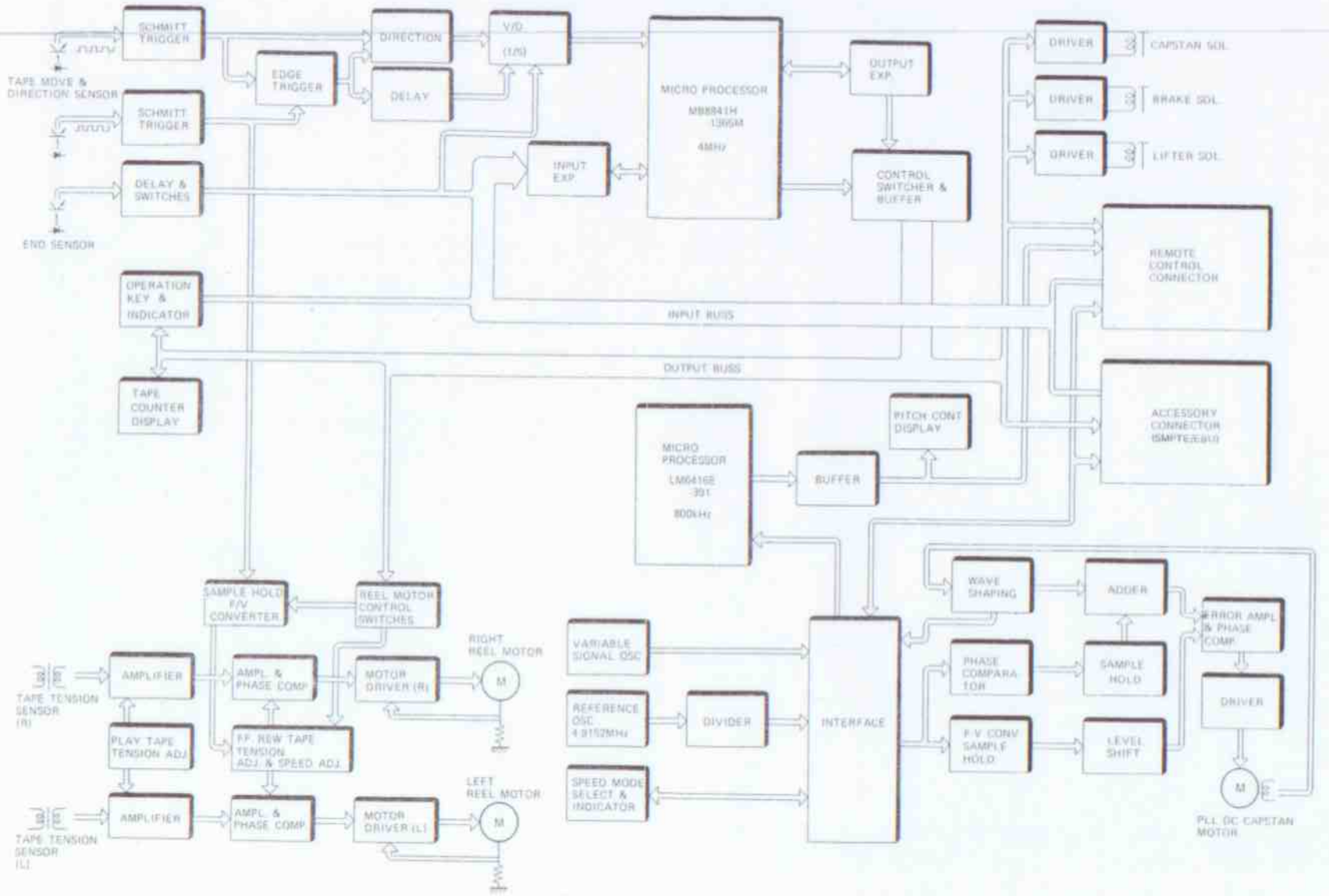
All modes of operation, including fast-forward, rewind and spooling, are commanded by the MS-16's specially programmed microprocessor controller. Tape tension is controlled by a full

servo reel system. The PLL (Phase-Lock Loop) servo capstan motor ensures precise tape speed. The motor's large size, its brushless design, and the ceramic, Direct Drive (DD) capstan motor shaft all serve to minimize cogging and other speed variations while providing extended service life.

The tension servo employs a "non-contacting" detector, a photo interruptor which senses the position of the tension arm so the servo can adjust the reel motor torque. Also, the servo adjusts tension arm position to further optimize tape tension. The reel motor servo system is very stable, and is not easily influenced by environmental conditions.

Major rotating components, including the tension arm guides and the pinch roller, are supported by ball bearings to provide minimum friction while retaining close tolerances. In fact, the tension arm itself is ball-bearing supported for more sensitive response and greater motor and servo durability.

The tachometer roller measures linear tape footage, although the readout is converted to elapsed time from whatever zero point is entered. As tape moves, it turns the roller, causing a radially marked disk on the roller shaft to interrupt a photo sensor, which drives the digital counter circuitry. A thin rubber coating on the roller avoids tape slippage (for the most accurate results), and also protects the surface of the tape.


SCHMITT TRIGGER
TAPE MOVE & DIRECTION SENSOR
SCHMITT TRIGGER
DELAY & SWITCHES
END SENSOR
EDGE TRIGGER
DIRECTION
DELAY
V/D (1/5)
INPUT EXP.
MICRO PROCESSOR M88841H 1366M 4MHz
OUTPUT EXP.
CONTROL SWITCHER & BUFFER
DRIVER
CAPSTAN SOL.
DRIVER
BRAKE SOL.
DRIVER
LIFTER SOL.
REMOTE CONTROL CONNECTOR
OPERATION KEY & INDICATOR
INPUT BUSS
OUTPUT BUSS
TAPE COUNTER DISPLAY
MICRO PROCESSOR LM6416E -391 800kHz
BUFFER
PITCH CONT DISPLAY
ACCESSORY CONNECTOR (SMPTE/EBU)
SAMPLE HOLD F/V CONVERTER
REEL MOTOR CONTROL SWITCHES
RIGHT REEL MOTOR
AMPLIFIER
AMPL. & PHASE COMP.
MOTOR DRIVER (R)
TAPE TENSION SENSOR (R)
PLAY TAPE TENSION ADJ.
FF. REW TAPE TENSION ADJ. & SPEED ADJ.
LEFT REEL MOTOR
AMPLIFIER
AMPL. & PHASE COMP.
MOTOR DRIVER (L)
TAPE TENSION SENSOR (L)
VARIABLE SIGNAL OSC
REFERENCE OSC 4.9152MHz
DIVIDER
SPEED MODE SELECT & INDICATOR
INTERFACE
WAVE SHAPING
ADDER
ERROR AMPL & PHASE COMP.
PHASE COMPARATOR
SAMPLE HOLD
DRIVER
F-V CONV SAMPLE HOLD
LEVEL SHIFT
PLL DC CAPSTAN MOTOR

1-3. HEAD ASSEMBLY

Access to the heads for cleaning or editing is provided by a flip-up head access cover, and a latching push-in head shield (head gate).

The assembly has three heads: erase, record/sync and repro and two fixed guides. The record/sync head and repro head will provide the same high-quality reproduction for playback. This means that artistic performance judgements and mixing decisions which are made during an overdub or an insert will be based upon the correct frequency balance (unlike machines with lesser sync playback response).

A solenoid-actuated tape lifter automatically pushes tape away from the heads during any of the fast winding modes, including fast forward, rewind, and spooling. This prevents unnecessary wear on the heads and tape, and avoids the disturbing loud, high-frequency sounds that could otherwise damage monitor speakers. For added protection, the MS-16 line outputs are also electronically muted. However, for editing, or for readout of the time code, progressive engagement of the cue lever defeats the tape lifter so cues can be heard or monitored while fast winding.

1-4. ELECTRONICS

Strong emphasis has been placed on the audio quality of the MS-16's electronics. All amplifiers are direct coupled (DC) for lowest distortion and optimum low-frequency response. The first stage of the reproduce amplifier consists of a pair of ultra-low noise FETs (field effect transistors). This differential amplifier eliminates the necessity of having to insert a coupling capacitor between the heads; instead, the DC servo amplifier brings the offset voltage to zero. The result is a smoother, wider frequency response with better transient and phase characteristics.

The amplifier section is constructed using plug-in printed circuit boards. Connections between circuit boards are made via a mother board for access to electronic adjustments. The usual bias, level and EQ trimmers are provided, with separate controls for SYNC and REPRO playback. The trimmers are all metal-glazed to enhance mechanical durability and avoid susceptibility to environmental conditions.

There is a master bias oscillator, plus a separate bias amplifier for each track. This avoids interactions through the bias circuit for quieter punch-in and punch-out operations (i.e., minimum "click" noise). Levels can be monitored via 16 VU meters that incorporate peak indicating LEDs. The VU meters provide a familiar "average" level reference by which loudness can be judged, while the peak LEDs respond to brief transients that might not show on the meter, allowing operator to avoid tape saturation (transient to transient).

1-5. POWER SUPPLY

The MS-16's power transformer is factory adjusted for various line voltage prior to shipment, depending upon where the machine is to be sold. The following standards are used:

European models:	220 V, 50 Hz
U.K./Australia models:	240 V, 50 Hz
U.S.A./Canadian models:	120 V, 60 Hz
General Export models: (switchable voltage)	100/120/220/240 V, 50 or 60 Hz

The front panel switches are electro-mechanically linked with the following power supply circuits:

1. A regulated bipolar 15 volt DC supply for the audio amplification circuitry. This ±15 volt supply includes an exclusive tracking filter circuit to eliminate AC ripple.
2. A regulated bipolar 20 volt DC supply for the operatoin status indicators.
3. +5 volt DC supply for the microprocessor and related logic circuitry.
4. A +24 volt DC supply for the reel motors.
5. A +24 volt DC supply for the capstan motor and the relay which switches the amplifiers. This supply is independent of the reel motor 24 volt supply.
6. +5 volt DC and +24 volt DC supplies to the capstan servo system.
7. Two DC voltage for the pinch roller solenoid: a higher voltage (+24 V) is used initially to ensure the strong, positive actuation of the solenoid. Once engaged, the solenoid is held in place by a lower voltage (+12 V) which thereby avoids generation of excessive heat. Both the supplies include a ripple filter to avoid any chance of mechanical buzz, and to avoid any chance of hum leaking into the audio amplifiers.

8. A 6 volt AC supply for illumination of the VU meters. The microcomputer also uses this supply voltage to detect when the power is turned on or off to activate the muting circuit. If the central processing unit should erroneously function or if the power is cut off during the rewind or fast-forward modes, this circuit acts as a power loss sensor. Automatically applying the reel brakes and putting the unit into the stop mode as a safety precaution. Which will prevent tape spill or snapping.

1-6. REMOTE CONTROL/AUTO LOCATOR FUNCTIONS

With the optional remote transport control, RC-65, connected to the REMOTE CONTROL connector on the rear, the tape transport controls (except EDIT), search functions (CUE, STC and RTZ), digital counter and PITCH CONTROL can be controlled from a distance.

Note: When using the RC-65, its PITCH CONTROL will not function unless the SPEED MODE selector of the MS-16 is in the EXT position.

The optional Auto Locator, AQ-65 can also be used with the MS-16. It has been designed to extend the MS-16's versatility to meet the increasing requirements of the professional production facilities. For details on its functions and uses, refer to the section "OPTIONAL EQUIPMENT AND USEFUL ACCESSORIES" of this manual.

1-7. OUTPUT SELECT CONTROLS

a) Pressing the INPUT button feeds the MS-16 line outputs with the same signals applied to the line inputs.

b) Pressing the SYNC button will feed one of two signal sources to the line outputs depending on the setting of the REC function select switches: the input to the machine, or sync playback from the record/sync head.

c) Pressing the REPRO button feeds the MS-16 line outputs with a signal played back from the tape via the repro head.

Besides the OUTPUT SELECT switches there are some features which affect the line outputs. The functions of each of these features are explained in the section "FEATURES AND CONTROLS", page 3-1.

1-8. LINE INPUT AND LINE OUTPUT CONNECTIONS

Standard 3-pin XLR-type connectors as well as RCA jacks make it easy to connect cables from INPUT and OUTPUT to the sound system. These transformerless balanced XLR-type connectors are specified as follows: Input impedance: 10 k ohms, nominal input level: +4 dBm (1.23 V), output impedance: 20 ohms, nominal output level: +4 dBm (1.23 V).

1-9. TRANSPORT CONTROL FUNCTIONS

1. Auto Locator Functions (STC, RTZ)
   There is a built-in auto locator function which permits automatic searching to a precise location on the tape for convenient replay, copying, overdubbing, editing, etc. The auto locator relies upon the tape counter, and provides two search points: one is the zero point, and the other is a designated cue point. Pressing the RTZ button (Return To Zero) causes the transport to rewind or fast forward the tape to 00.00 and stop. Pressing the STC button (Search To Cue) causes the transport to rewind or fast forward the tape to whatever point was earlier designated as a cue, and then stop. (Note: the cue point is originally designated by pressing the CUE button when the tape is stopped at or moving past the desired location.)
2. Dynamic Braking
   When the tape enters stop mode at the end of RTZ or STC search operations, or after rewinding or fast forwarding, the reels are slowed to a stop by means of dynamic braking. This application of opposite electrical torque to the reel motors stops the tape more gently than mechanical braking; it avoids slippage and stretching by maintaining a more constant tension throughout the deceleration.
3. Fast-Forward, Rewind and Spooling Modes
   Pressing either the F. FWD or REW button once causes the tape to run rapidly in the designated direction. Pressing the button a second time causes the unit to enter spooling mode (tape runs at an intermediate speed).
4. Play and Related Modes
   Pressing the PLAY button from stop mode causes the transport to run forward at 15 ips (fixed speed mode) or whatever constant speed has been set with the PITCH CON-

TROL. Pressing PLAY while the unit is in a forward or rewind mode causes the tape to come to a stop and then immediately enter play mode. Pressing PLAY while in the Record will terminate the Recording.

5. Record Mode
   Pressing the PLAY and RECORD buttons together places the transport in record mode, although recording does not actually occur unless one or more REC function switches has also been set to record-ready status. If tape is already playing, pressing RECORD accomplishes a punch-in (starting the recording). Punch-out (ending recording while still rolling tape) is accomplished by pressing PLAY second time. Recording can also be stopped by pressing STOP, F. FWD, REW, STC or RTZ.
6. Edit Modes
   Pressing the EDIT button releases the reel brakes and sets the reel servo system so that very little tension is held. This permits reels to be manually turned in either direction while listening (or looking) for a precise cue point on the tape. Tape can be "dump edited" by simultaneously pressing the PLAY and EDIT buttons. In this mode, the capstan pulls tape past the heads, but the take-up reel motor does not operate. Cancel the dump edit mode by pressing STOP.
7. REMOTE CONTROL Connections
   There are two multipin remote control connections on the MS-16 rear panel, REMOTE CONTROL and FUNCTION REMOTE. The REMOTE CONTROL connection is for use with the optional RC-65 Remote Transport Control. FUNCTION REMOTE accepts the cable from the Record Function Control panel when it is remotely mounted using the optional CS-63 mounting kit. For more information on the options see Page 4-11.
8. ACCESSORY Connector
   This 38 pin connector is designed for interfacing the MS-16 with its optional AQ-65 Autolocator/Session Controller or most any Time Code Based Synchronizer/editing system. The ACCESSORY Connector has all the necessary logic and tally lines for control of the MS-16 by Adams Smith, BTX, Convergence, Fernseh, ISC, G.T.C., MCI/Sony, Q-Lock (Audio Kinetics), United Media, Video Media and other similar systems. Detailed physical dimensions, and pin connections can be found on page Page 3-9.

1-10. MOTOR DRIVE CIRCUIT

The MS-16 is designed so that the tape tension on both reels is proportionally maintained while the system is in play mode. During the fast winding modes, back tension is held to a constant value, and the servo control system regulates the reel motors to maintain a constant tape speed as well.

2. SPECIFICATIONS

MECHANICAL CHARACTERISTICS

Tape:	1 inch 1.5 mil
Track Format:	16-track, 16-channel
Reel Size (max):	10-1/2", NAB
Tape Speed:	15 ips (38 cm/sec.)
Speed Accuracy[1]:	±0.2 % deviation
Pitch Control:	FINE ±0.7 % COARSE ±15 %
Wow and Flutter[1]:	0.04 % (NAB weighted) 0.07 % (NAB unweighted) ±0.08 % peak (DIN/IEC/ANSI weighted) ±0.12 % peak (DIN/IEC/ANSI unweighted)
Fast Wind Time:	120 seconds for 10-1/2" reel, 2,400 feet
Spooling Wind Time:	370 seconds for 10-1/2" reel, 2,400 feet
Start Time:	Less than 0.8 sec. to reach standard Wow and Flutter
Capstan Motor:	PLL (Phase Locked Loop) DC direct drive motor
Reel Motors:	Slotless DC motor x 2
Head Configuration:	3-head; erase, record/sync and reproduce
Tape Cue:	Manual and automatic (RTZ and STC)
Dimensions (W x H x D):	
Transport Unit:	482 x 459 x 310 mm (19" x 18-1/16" x 12-3/16")
Amplifier Unit:	482 x 193 x 321 mm (19" x 7-5/8" x 12-5/8")
Weight (net):	
Transport Unit:	38 kg (83-12/16 lbs)
Amplifier Unit:	16.5 kg (36-6/16 lbs)

ELECTRICAL CHARACTERISTICS

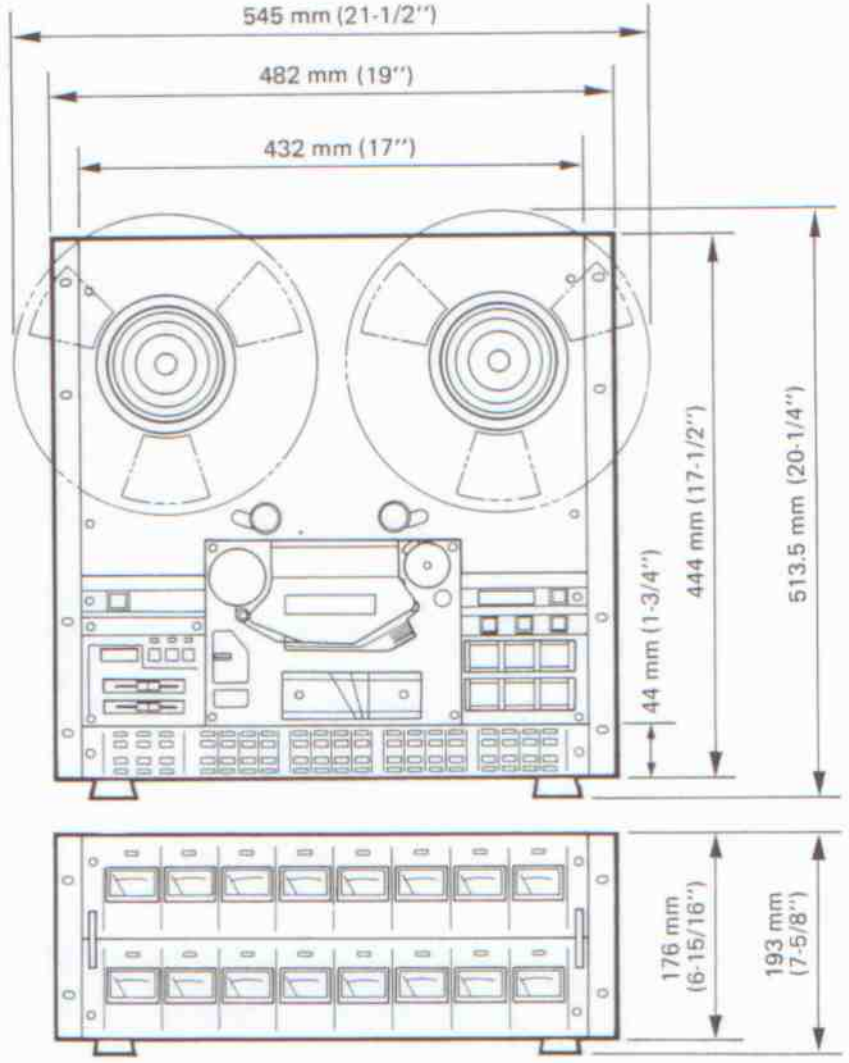
Line Input:	Balanced	Unbalanced
Input Impedance:	10 k ohms	50 k ohms
Maximum Source Impedance:	2 k ohms	10 k ohms
Nominal Input Level:	+4 dBm (1.23 V)	-10 dBV (0.316 V)
Maximum Input Level:	+28 dBm (19.5 V)	+18 dBV (8.0 V)
Line Output:	Balanced	Unbalanced
Output Impedance:	20 ohms	500 ohms
Minimum Load Impedance:	200 ohms	10 k ohms
Nominal Load Impedance:	600 ohms	50 k ohms
Nominal Output Level:	+4 dBm (1.23 V)	-10 dBV (0.316 V)
Maximum Output Level:	+28 dBm (19.5 V)	+18 dBV (8.0 V)
Bias Frequency:	145 kHz	
Equalization:	IEC; ∞ +35 μsec. 250 nWb/m tape flux level	
Record Level Calibration: (0 VU reference)		
Power Requirements:		
USA/CANADA:	120 V AC, 60 Hz	
EUROPE:	220 V AC, 50 Hz	
UK/AUX:	240 V AC, 50 Hz	
GENERAL EXPORT:	100/120/220/240 V AC, 50/60 Hz	
Power Consumption:	80 W	

TYPICAL PERFORMANCE

Frequency Response:	
Overall[3]:	40 – 22 kHz, ±3 dB at 0 VU 40 – 22 kHz, ±2 dB at -10 VU
Reproduce (Both Sync and Repro Heads)[2]:	40 – 22 kHz, ±2 dB
THD[3]:	0.8 % at 0 VU, 1,000 Hz, 250 nWb/m 3 % at 13 dB above 0 VU, 1,000 Hz, 1,120 nWb/m
3rd Harmonic Distortion[3]:	0.6 % at 0 VU, 1,000 Hz

Signal-to-Noise Ratio[3]: (Reference 3 % THD)	69 dB A weighted (NAB) 62 dB unweighted (0 – 100 kHz) 107 dB A weighted (NAB), with dbx* 100 dB unweighted, with dbx*
Adjacent Channel Crosstalk (Overall)[3]:	Better than 55 dB down at 1,000 Hz, 0 VU
Erasure[3]:	Better than 70 dB at 1,000 Hz, +10 VU reference
Record/Reproduce Amplifier Headroom:	Better than 28 dB above 0 VU at 1,000 Hz

Connectors:
Line Inputs and Outputs: XLR type connectors & RCA jacks
Remote Control: Multi-pin type connector (See page 3-11 for detail)
Function Remote: Multi-pin type connector
Accessory: Multi-pin type connector (See page 3-9 for detail)
dbx unit (audio and control signal): Multi-pin type connector



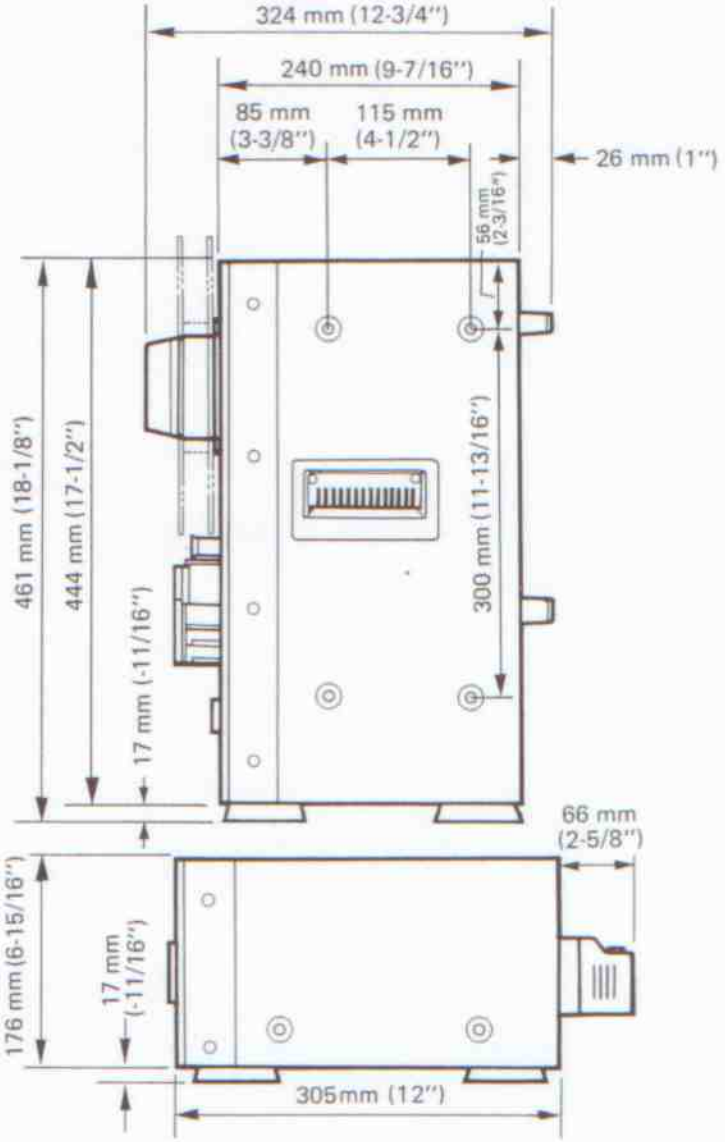
Specifications were determined using:
1) STL #72 Speed/Wow Flutter Measurement Tape
2) TEAC YTT-1244 Reproduce Alignment Tape (NAB EQ)
3) Ampex #456 Blank Tape for Recording
In these specifications: 0 dBV is referenced to 1.0 Volt; 0 dBm is referenced to 0.775 Volt.
Actual voltage levels are also given in parenthesis.
Changes in specifications and features may be made without notice or obligation.
*dbx is a trademarks of dbx Inc.

Options for:

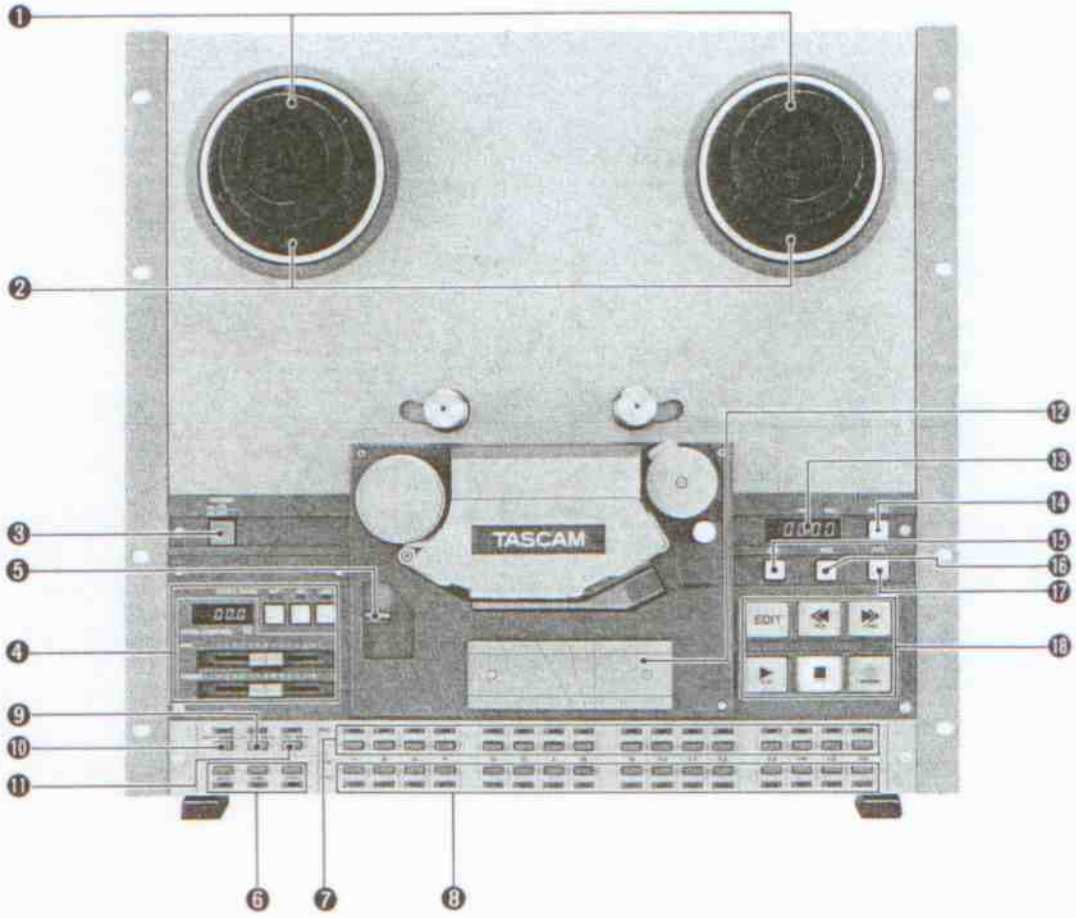
Mounting (EIA standard 19-inch rack): CS-65 Console Rack, T-0865 Panel and Cable Kit, CS-61 Overbridge Meter Mount.

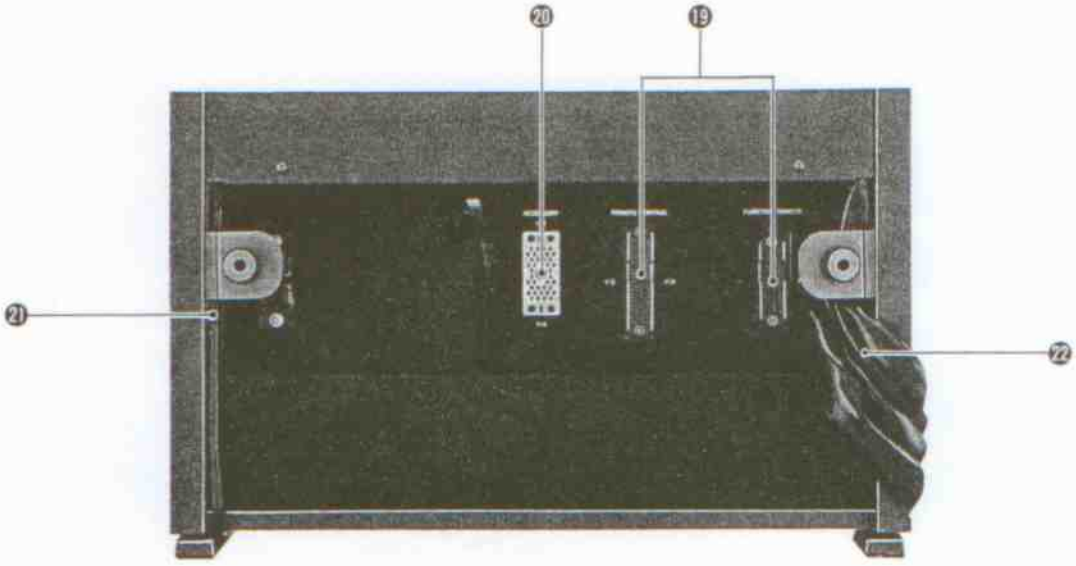
Remote Control: RC-65 Remote Control Unit, AQ-65 Auto Locator, CS-64 Roll-Around Stand, CS-63 Mount Kit.

Tape Mounting: TZ-65 Metal Clamper, RE-1050 TASCAM Metal Reel.



3. FEATURES AND CONTROLS





TRANSPORT UNIT

❶ NAB Hub Adaptors

These large hub adaptors are permanently mounted, and are for use with the reels up to 10-1/2 inches in diameter. Rotate the adaptor ring clockwise to fully tighten the reel.

❷ Reel Tables

Only 1" tapes are to be used. We recommend using the same size and type of reel for both the supply and take-up sides so that the servo system maintains proper tape tension.

❸ POWER Switch

This switch turns on the AC power to the unit. As soon as power is turned on: the digital counter indicates "00.00", the PITCH CONTROL indicator shows the amount of pitch adjustment, the STOP button begins flashing at a rate of 1 Hz and the VU meters on the amp unit are illuminated. After about 3 seconds, the STOP button stops flashing and light steadily, indicating the machine's logic circuity has been initialized (i.e., all the control lines have achieved stand-by status).

❹ SPEED MODE/PITCH CONTROLs and Indicator

These three switches are used to select tape speed.

One of the three LED's above the switches is always lit or blinking to show which speed has been selected.

FIX: Indicates that the MS-16 is in fixed speed/pitch mode. It will record or reproduce at exactly 15 ips (38 cm/sec.). In the FIX mode, the indicator will always show 00.0 %.

VARI: Is used to change the tape speed with the PITCH CONTROL. COARSE control is ±15 % and FINE control is ±0.7 %. Using these controls in conjunction with the indicator will ensure repeatable VARI(able) pitch settings.

EXT: Assigns the MS-16 speed control to external equipment. The external equipment can be the optional RC-65 Remote Transport Control or a SMPTE/EBU Synchronizer/Controller.
The EXT LED will remain lit if the capstan is under external speed control or blink if external control is interrupted. The indicator will show the amount of speed change. The indicator display will begin to flash on and off if the speed change is outside of the display range (-49.9 %, +99.9 %).

❺ TAPE LIFTER Lever

Sliding this lever toward the reels (up), while the machine is in the fast forward or rewind mode, disables the muting circuit (i.e., the line outputs are no longer muted). Sliding the lever further up progressively retracts the tape lifters so the tape contacts the heads, allowing monitoring of the tape to find a cue (slate tone) or the end of a program during a high speed wind.

CAUTION: Sliding the TAPE LIFTER lever to monitor tape during a high speed wind will cause high-level, very high frequency audio signals to appear at the MS-16 outputs. Be sure that you turn down the level of your monitor speaker amplifier prior to operating the TAPE LIFTER lever so that speaker components will not be damaged by excess high frequency energy. It's your responsibility to protect your monitors.

❻ OUTPUT SELECT Switch

These three switches determine which signal is to be fed to the VU meters and output jacks, as follows:

INPUT: Selects the input to the track (for alignment)

SYNC: Selects the record/sync head signal for synchronous reproduction, or the input signal, depending on the record or reproduce status of the machine, on the setting of the track's REC function switch, and on the setting of the track's INSERT (SYNC/INPUT) switch, INPUT ENABLE switch, LIF/DEF MUTE switch and STOP MUTE switch, as explained in subsequent paragraphs. This setting is the one used most often during production.

REPRO: Selects signal from the repro head. Used during alignment, and can be used for mixdown.

❼ REC Function Switches and LEDs

These 16 switches determine whether a particular track will enter record mode when the RECORD and PLAY buttons are pressed. With the switch up (OFF), no recording is possible on that track, and track's REC LED is off. With the switch down (ON), the track is able to record and, if the machine is in record-ready mode [after pressing RECORD and PLAY], the LED will stay on. If the machine is in any other mode with the REC function switch down, the LED will flash on and off to indicate the track is ready to record. If the machine is already in record ready mode, engaging a REC function switch will place the track in record.
Assuming the "SYNC" OUTPUT SELECT switch is engaged, whenever a track's REC function switch is up (OFF), that channel's output will be derived from the record/sync head regardless of the machine's record or play status.

❽ INSERT (SYNC/INPUT) Switches

When making an insert (punch-in), the performer needs to hear synchronous playback from the track (via the record/sync head) up to the point where recording is initiated. Then the performer must hear himself. For this function, any number of tracks can be programmed by setting the INSERT switch(es) to SYNC.
SYNC can also be used for making overdubs, although when making an overdub, the performer usually needs to hear himself continuously playing (or singing or speaking) in sync with previously recorded tracks prior to and during the overdub. Setting the INSERT switch(es) to INPUT accomplishes this goal. For further details, refer to the "OPERATION" section of this manual.

NOTES:

1. It is possible that the line outputs may produce unwanted sounds. To eliminate these sounds, the MS-16 is equipped with:
   a) LIF/DEF MUTE – serves to mute high-speed cueing sounds during RTZ/STC, or when the time code controller retracts the tape lifter during fast-winding.
   b) STOP MUTE – functions at the moment the tape starts moving from the stop mode or just as the recorder/reproducer re-enters the stop mode.

c) One other muting circuit is incorporated which is activated automatically. It momentarily mutes the outputs when Record is engaged to prevent spurious signals from appearing in the monitor chain.

2. When a REC function switch is turned on, its LED begins flashing to indicate that the unit is in the record ready mode. Steady illumination of this LED means the unit is recording.
3. When an INSERT (SYNC/INPUT) switch is set to SYNC (switch down), its LED lights if the RECORD button is off; the LED turns off when record mode is engaged.
4. The INSERT switches have no effect if the REC function switch is off except for channel 16 which can be SYNCLOCKED to the reproduce head to insure uninterrupted time code playback. For more details see 4-2-1. SYNCLOCK OPERATION, Page 4-4.

❾ LIF/DEF (Lifter/Defeat) MUTE Switch
Mutes the audio output of tracks 1 through 15 during RTZ, STC modes, and when the MS-16 is under the control of a synchronizing/editor, which can independently control the action of the TAPE LIFTER. With the LIF/DEF MUTE Switch on, external control of the tape lifters will automatically mute the output of tracks 1 through 15. At the same time track 16 is opened for output of high speed time code data to the synchronizer/editor for located control.

❿ INPUT ENABLE Switch
When depressed in conjunction with the OUTPUT SELECT SYNC switch, this programs the inputs of the MS-16 to be automatically switched to the outputs during F. FWD, REW and STOP modes. This automatic programmable function allows for convenient communications between the control room and talent without the need to reset any console or recorder controls thus eliminating the possibility of mis-set controls and the need for retakes.

⓫ STOP MUTE Switch
When depressed, STOP MUTE mutes the audio output momentarily as the MS-16 starts and as the tape comes to a stop eliminating the dragging sound of the audio program.
Note: When using the Stop Edit mode be sure to disengage STOP MUTE, otherwise audio cueing is not possible.

⓬ Splicing Block
This precision aluminum splicing block has been provided to facilitate editing. Neat, uniform splices can be made by laying the magnetic tape in the slot, and using the block's pre-cut grooves to guide your razor blade.

⓭ Digital Counter Display
The counter displays the elapsed time of the tape, as wound from initial "00.00" point. The counter measures linear tape footage, then computes elapsed time based on a 15 ips (38 cm/sec) play/record speed. Thus, even if the tape is actually wound to a cue point at high speed, the counter will indicate the correct running time. The maximum time displayed is 99 minutes, 59 seconds *in either direction.* [When counting prior to the "00.00" point, a minus (-) sign is displayed at the left of the counter.] The counter will indicate "00.00" when power is first turned on, or when the RESET button is pressed.

⓮ RESET Pushbutton
Pressing this button resets the tape counter to 00.00. Because the RESET button does *not* affect the stored Cue point, the memorized cue *point* remains as set. Refer also to CUE Pushbutton.

⓯ CUE Pushbutton
Press this button to set a cue point. The cue is not actually placed on the tape; instead, the MS-16 "remembers" the precise position of the

INPUT ENABLE Switch

OUTPUT SELECT Switch	INPUT ENABLE Switch	REC Function Switch	INSERT (INPUT/SYNC) Switch	RECORD Button	Operation Mode	OUTPUT Source
SYNC	ON	–	–	–	STOP, F. FWD, REW	INPUT

tape at the moment the CUE button was pressed, and will return to that point whenever the STC button is subsequently pressed (Search-To-Cue). Until a "cue" is entered, the machine will assume a "00:00" cue point. Whatever cue point had been memorized remains valid until a new cue is established by again pressing the CUE button, or until power is turned off.

⑯ STC Pushbutton

Pressing the STC button activates the search-to-cue function, which winds tape rapidly forward (or rewinds) and stops at the established cue point (which must previously have been entered using the CUE button). The search-to-cue operation may be commanded from any tape motion status (i.e., from stop mode, or during play, rewind, etc.). If play is depressed after depressing the STC button, the MS-16 will go to the cue point and then enter the play mode.

⑰ RTZ Pushbutton

Pressing the RTZ button activates the return-to-zero function, which causes the transport to fast wind to "00.00" on the tape counter. The RTZ function, like the STC function, can be activated from any tape motion status, and be programmed to enter play on reaching "00.00" by depressing PLAY after RTZ.

⑱ Transport Controls

EDIT Pushbutton

The EDIT button has no effect unless pressed when the machine is in stop mode. Then the EDIT button turns on to indicate the unit is in edit mode.

If EDIT is pressed when tape is stopped, the reel motor brakes are disengaged and a small, proportional amount of back tension is held by each reel motor so that the reels may be moved easily by hand for editing purposes, yet slack will be eliminated.

If EDIT and PLAY are pressed simultaneously, the transport enters dump edit mode. The capstan and pinch roller pull tape past the heads at the set 15 ips (38 cm/sec) or at the adjusted pitch, allowing the operator to listen to playback for a particular edit point. However, the take-up reel does not turn, allowing tape to spill off the machine until the edit point is reached (take-up tension arm position is "ignored" by the shut-off sensing logic). Upon reaching the desired point, pressing the STOP button stops the tape and cancels edit mode.

NOTE: If the EDIT button has been pressed (the EDIT button lights up) to place the machine in edit mode, and the PLAY button is pressed subsequently, the machine will not enter dump edit mode (the two buttons must be pressed simultaneously). Instead, edit mode will be cancelled, and tape will begin moving normally as the machine enters reproduce (play) mode.

REWind Pushbutton

Pressing this button selects the rewind mode, which may be entered from any other mode. Pressing it a second time after the machine is placed in rewind mode causes the tape to slow to an intermediate winding speed, the reverse spooling mode and the rewind button begins flashing on and off. Spooling is used for a rapid yet extremely uniform, tight tape pack. The third pressing of this button returns the machine to rewind mode (the rewind button lights up steadily). The approximate tape speeds are: for rewind, 240 ips (610 cm/sec), and for spooling, 80 ips (203 cm/sec).

F. FWD (Fast-Forward) Pushbutton

Pressing this button selects the fast-forward mode. The button functions similarly to the rewind button in that pressing it a second time causes the machine to enter forward spooling mode.

PLAY Pushbutton

Pressing the PLAY button places the machine in play mode. When PLAY is pressed during fast-forward, rewind or spooling mode, the machine will enter play mode after tape has stopped. If PLAY is pressed during a search operation (using STC or RTZ), the machine will enter play after the cue or "00.00" point has been reached.

To enter record mode, simultaneously press the PLAY and RECORD buttons. To punch out of record mode, while keeping tape rolling at play speed, press PLAY button. Subsequently pressing the RECORD button will switch the machine into the record mode.

STOP Pushbutton

Pressing this button stops tape motion, and cancels any other mode of operation.

This button flashes for about three seconds when the AC power is first turned on, indicating the machine is not yet ready to operate while

the logic is being initialized.
In stop mode with the STOP MUTE switch OFF, the STOP Edit can be operated.

RECORD Pushbutton
Pressing this button simultaneously with the PLAY button initiates record mode. Recording actually occurs only on those tracks whose REC function pushbutton are down (ON); on those channels, the REC LEDs will cease flashing and stay on, indicating recording is in progress. Pressing PLAY button cancels record mode but allows tape to continue playing.
The RECORD button lights up in the RECORD/play mode. The RECORD button will remain on continuously if one or more REC function switches are ON, indicating that recording is taking place; if none of the REC function switches are ON, the RECORD button will flash at a rate of 1 Hz, indicating the unit is ready to begin recording.

REAR PANEL

⑲ Remote Control Connections
There are two multipin remote control connections on the MS-16 rear panel, REMOTE CONTROL and FUNCTION REMOTE. The REMOTE CONTROL connection is for use with the optional RC-65 Remote Transport Control. FUNCTION REMOTE accepts the cable from the Record Function Control panel when it is remotely mounted using the optional CS-63 mounting kit. For more information on the options see Page 4-11.

⑳ ACCESSORY Connector
This 38 pin connector is designed for interfacing the MS-16 with its optional AQ-65 Auto Locator/Session Controller or most any Time Code Based Synchronizer/editing system. The ACCESSORY Connector has all the necessary logic and tally lines for control of the MS-16 by Adams Smith, BTX, Convergence, Fernseh, ISC, G.T.C., MCI/Sony, Q-Lock (Audio Kinetics), United Media, Video Media and other similar systems. Detailed physical dimensions, and pin connections can be found on Page 3-9.

㉑ AC Power Cord

㉒ Connecting Cables to Amplifier Unit
POWER SUPPLY
ERASE HEAD – 1
SYNC HEAD – 2
REPRO HEAD – 3

AMPLIFIER UNIT

FRONT PANEL

㉓ VU Meters with PEAK Indicators
These meters indicate the signal levels being fed to the MS-16's line outputs. The signal source will be the line input, reproduction from the record/sync head, or reproduction from the repro head, depending on the setting of the OUTPUT SELECT, REC function, INSERT (SYNC/INPUT) switches, INPUT ENABLE switch, LIF/DEF MUTE switch and STOP MUTE switch.

㉔ RECord LEDs
These LEDs light up to indicate the corresponding track or tracks are in the record mode. Different from the REC function LEDs, these LEDs show not the rec-ready mode by flashing but only the record mode.

REAR PANEL

㉕ INPUT XLR Type Connectors
Input impedance is 10 k ohms (balanced), input level is +4 dBm (1.23 V), and maximum source impedance is 2 k ohms.
Caution: Signals which are input through the XLR type connectors are fed to the record/reproduce amplifier via the circuit path of the RCA jack. Therefore, be sure to disconnect any cable from the RCA jacks when the XLR type connectors are used.

㉕ OUTPUT XLR Type Connectors

Output level is +4 dBm (1.23 V). Minimum load impedance is 200 ohms (balanced).

If necessary, the nominal output level of the MS-16 can be switched from +4 dBm to +8 dBm by simply resetting the switch on the REC/REPRO amplifier circuit board. The "ON" position corresponds to +4 dBm, and the "OFF" position to +8 dBm.

Caution: As there are power boosters in the output circuitry, be careful not to short-circuit pin 1 (GND) and pin 2 (Cold) or pin 3 (Hot). If the output is connected to an unbalanced cable, pin 1 and 2 or 3 connected, the output level will be about 6 dB lower than when the output is connected to a balanced 3 wire cable.

㉗ INPUT RCA Jacks

Input level is -10 dBV (0.3 V). Input impedance is 50 k ohms (unbalanced).

㉖ OUTPUT RCA Jacks

Output level is -10 dBV (0.3 V). Minimum load impedance is 10 k ohms (unbalanced).

㉙ TO DBX UNIT Connectors CH1–8/CH9–16

The control and audio signals from the MS-16 are fed to the TASCAM DX-8DS dbx Noise Reduction System from these connectors.

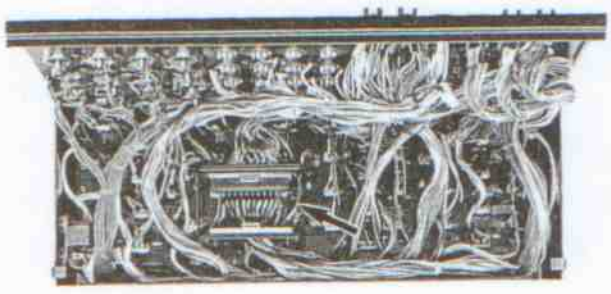
WARNING: When the DX-8DS units are not used the bridging connectors shipped with the MS-16 must be installed in the CH 1 – 8 and CH 9 – 16 sockets or the MS-16 WILL NOT operate. NO AUDIO!

㉚ TO TRANSPORT Connectors

POWER SUPPLY
ERASE HEAD – 1
SYNC HEAD – 2
REPRO HEAD – 3

㉛ Meter Connector

This connector is used to drive the meter panel when it mounted in front of the optional CS-65 Console or mounted in a remote location. The maximum cable length to the meter panel is 5 m (16 ft.) Detailed pin connections can be found on Page 3-13.



ACCESSORY "SMPTE" CONNECTOR

SMPTE/EBU Time Code

SMPTE is an acronym for the Society of Motion Picture and Television Engineers. The SMPTE Time Code (C98.12: time and control code for video and audio tape for 525/30 television system) was defined in 1970, and it is now accepted as a universal standard.

This reference is to an 80-bit digital code developed by SMPTE and used to designate the exact location in hours, minutes, seconds and frames (24 frames/sec. for film or 30 frames/sec. for video) on a film, video tape, or audio tape. Suitable equipment can synchronize ("lock up") two or more machines by using the SMPTE time code recorded on each.

SMPTE European Standard, that refers to 25 frames per second, states the EBU (abbrev. for European Broardcasting Union) time code when it is especially necessary to distinguish from the USA Standard with 30 frames per second.

A *time code generator* is used to record SMPTE code onto one track of the tape. A *time code controller* can then read the code from two or more tape machines, and by also servo-controlling the reel motors of those machines, bring them to specific cue points. A *time code synchronizer* further controls the capstan motors to keep both of the tape machines running synchronously. These techniques can be used to obtain more tracks for recording (two or more audio machines "locked up" together), to mix audio signals in sync with video or film images, to make complex edits by transferring material from one or more audio machines to another, and so forth.

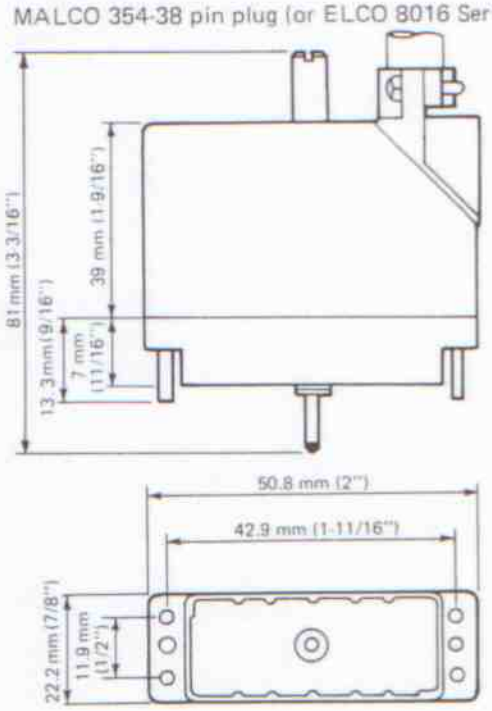
Connecting a Synchronizer to the TASCAM MS-16

Generally speaking, the manufacturer of an SMPTE time code synchronizer or controller will provide interface information for use with the TASCAM MS-16. We work closely with those manufacturers to ensure that they have the information needed, and to do everything possible to ensure that our equipment will operate satisfactorily with a variety of manufacturers' products, such as Adams Simith, BTX, Convergence, Fernseh, ISC, G.T.C., MCI/Sony, Q-Lock (Audio Kinetics), United Media, Video Media and other similar systems.
The TASCAM MS-16 provides signals to the synchronizer (via the ACCESSORY "SMPTE" connector) which indicate its speed, the direction of the tape travel, and a reference power supply. Also, tally signals indicating the MS-16's mode (PLAY, F. FWD, REW, STOP) are given to the synchronizer so it knows the current transport status. Inputs on the same ACCESSORY connector are provided for status commands from the synchronizer (PLAY, F. FWD, REW, STOP, REC, LIFTER CONT). Also, there is an input for a capstan drive reference frequency signal from the synchronizer so that the actual record/play speed can be varied to maintain synchronization.

In any case, the manual of the synchronizer you are using should provide you with enough information to successfully hook it up with your MS-16. If not, please contact the synchronizer manufacturer or representative for further details on interfacing.

"ACCESSORY" Connector and Signals

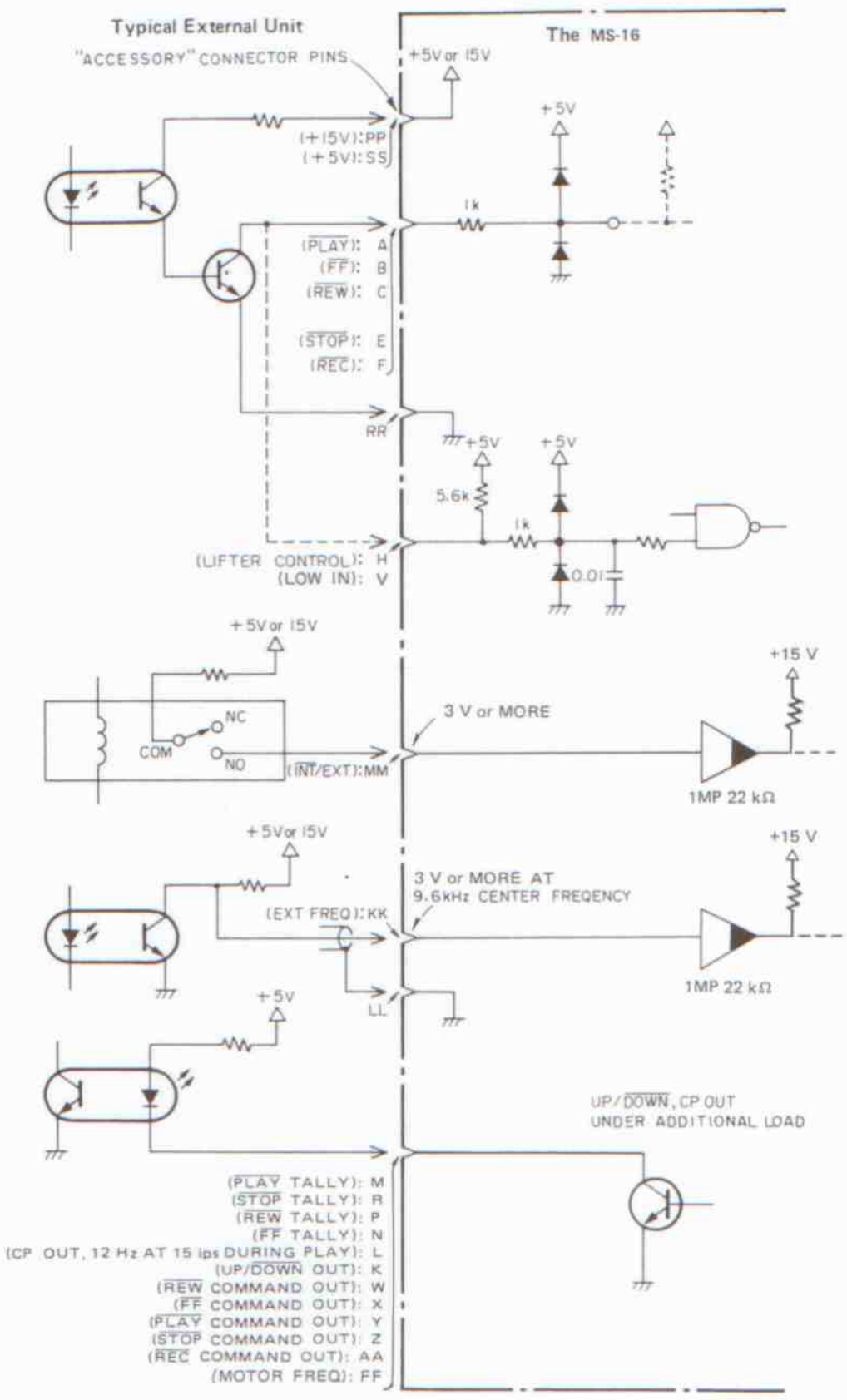
MALCO 354-38 pin plug (or ELCO 8016 Series)



Pin #	IN(put)–OUT(put) signals		Function
A	$\overline{\text{PLAY}}$	IN	Inputs PLAY signal at L level.
B	$\overline{\text{FF}}$	IN	Inputs FF signal at L level.
C	$\overline{\text{REW}}$	IN	Inputs REW signal at L level.
D	open terminal		
E	$\overline{\text{STOP}}$	IN	Inputs STOP signal at L level.
F	$\overline{\text{REC}}$	IN	Inputs REC signal at L level.
H	$\overline{\text{LIFTER CONT}}$	IN	Inputs LIFTER shift cancellation signal at L level.
J	open terminal		
K	UP/$\overline{\text{DOWN}}$	OUT	Outputs tape running control signal at H or L level.
L	CP	OUT	Outputs open-collector signal (12 Hz pulse at 15 ips.)
M	$\overline{\text{PLAY}}$ TALLY	OUT	Outputs open-collector signal (Low level during PLAY mode.)
N	$\overline{\text{FF}}$ TALLY	OUT	Outputs open-collector signal (Low level during FF mode.)
P	$\overline{\text{REW}}$ TALLY	OUT	Outputs open-collector signal (Low level during REW mode.)
R	$\overline{\text{STOP}}$ TALLY	OUT	Outputs open-collector signal (Low level during STOP mode.)

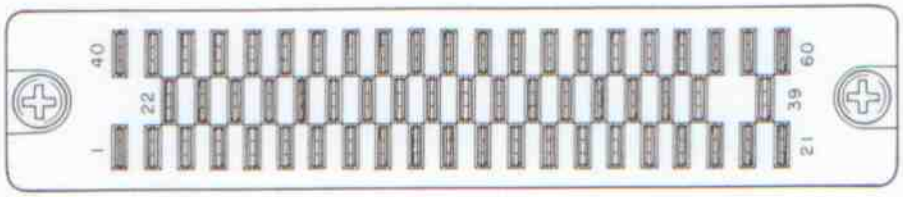
Pin #	IN(put)–OUT(put) signals		Function
S	$\overline{\text{REC}}$ TALLY	OUT	Outputs open-collector signal (Low level during record mode)
T	$\overline{\text{SHUT-OFF}}$ TALLY	OUT	Outputs open-collector signal (Low level during tape stop)
U	$\overline{\text{RESET}}$	SW IN	Inputs electronic counter reset signal low level.
V	$\overline{\text{LOW}}$	IN	Reduces tape speed to "Low" during fast winding.
W	$\overline{\text{REW}}$ COMMAND	OUT	Outputs open-collector signal (Low level when REW is pressed)
X	$\overline{\text{FF}}$ COMMAND	OUT	Outputs open-collector signal (Low level when F. FWD is pressed)
Y	$\overline{\text{PLAY}}$ COMMAND	OUT	Outputs open-collector signal (Low level when PLAY is pressed
Z	$\overline{\text{STOP}}$ COMMAND	OUT	Outputs open-collector signal (Low level when STOP is pressed)
AA	$\overline{\text{REC}}$ COMMAND	OUT	Outputs open-collector signal (Low level when REC is pressed)
BB CC DD EE	open terminal		
FF	MOTOR FREQ	OUT (HOT)	Capstan motor F.G. out: 600 Hz at 15 ips
HH	MOTOR FREQ	OUT (COLD)	Capstan motor F.G. out: 600 Hz at 15 ips
JJ	open terminal		
KK	EXT FREQ	IN (HOT)	Inputs speed control signal at input signal of 3.0 V or more and of 4.8 k to 19.2 kHz (HOT side)
LL	EXT FREQ	IN (COLD)	Inputs speed control signal (COLD side)
MM	$\overline{\text{INT}}$/EXT	IN	Inputs internal/external speed control select signal Internal: LOW level (0 V) External: HIGH level (3.0 V or more)
NN	open terminal		
PP	+15 V supply voltage	OUT	Maximum: 50 mA
RR	0 V terminal		
SS	+5 V supply voltage	OUT	Maximum: 50 mA
TT	Main unit GND		

"ACCESSORY" Connector Pins and External Signal Connections



REMOTE CONTROL CONNECTOR AND SIGNALS

HIROSE P-1660 BA-CA Multi-pin Connector



Pin #	IN(put) – OUT(put)		Function
1	$\overline{\text{PLAY}}$	IN	Inputs PLAY signal at L level.
2	$\overline{\text{REW}}$	IN	Inputs REW signal at L level.
3	$\overline{\text{STOP}}$	IN	Input STOP signal at L level.
4	Open Terminal		
5	$\overline{\text{RTZ}}$	IN	Inputs RTZ signal at L level.
6	$\overline{\text{STC}}$	IN	Inputs STC signal at L level.
7	D4	OUT	Counter display
8	D2	OUT	
9	$\overline{\text{a}}$	OUT	
10	$\overline{\text{c}}$	OUT	
11	$\overline{\text{e}}$	OUT	
12	$\overline{\text{g}}$	OUT	
13	UP/$\overline{\text{DOWN}}$	OUT	Outputs tape running control signal at H or L level.
14	$\overline{\text{CP}}$	OUT	Outputs open-collector signal (12 Hz pulse at 15 ips.)
15	STOP	OUT	High level when STOP is pressed (+5 V, 10 kΩ or more of load)
16	PLAY	OUT	High level when PLAY is pressed (+5 V, 10 kΩ or more of load)
17	REW	OUT	High level when REW is pressed (+5 V, 10 kΩ or more of load)

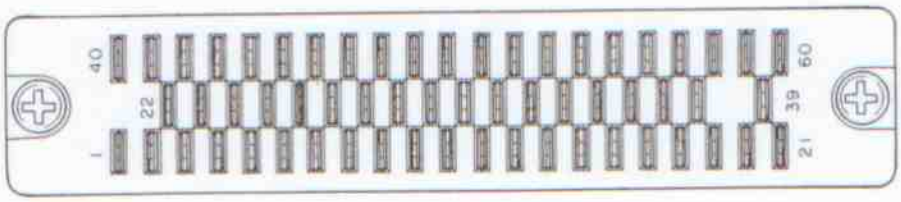
Pin #	IN(put) – OUT(put)		Function
18	FF	OUT	High level when F. FWD is pressed (+5 V, 10 kΩ or more of load)
19	REC	OUT	High level when REC is pressed (+5 V, 10 kΩ or more of load)
20	$\overline{\text{LOW}}$	IN	Reduces tape speed to "Low" during fast-winding.
21	GND		
22	$\overline{\text{REC}}$	IN	Inputs REC signal at L level.
23	$\overline{\text{RESET}}$	IN	Inputs electronic counter reset signal low level.
24	$\overline{\text{CUE}}$	IN	Inputs CUE signal at L level.
25	D5	OUT	Counter display
26	D3	OUT	
27	D1	OUT	
28	$\overline{\text{b}}$	OUT	
29	$\overline{\text{d}}$	OUT	
30	$\overline{\text{f}}$	OUT	
31	$\overline{\text{a}}$	OUT	Speed display
32	$\overline{\text{c}}$	OUT	
33	$\overline{\text{e}}$	OUT	
34	$\overline{\text{g}}$	OUT	
35	↑		
36	Open Termianl		
37	↓		

Pin #	IN(put)—OUT(put)		Function
38	EDIT	OUT	High level when EDIT is pressed in STOP mode. (+5 V, 10 kΩ or more of load)
39	Open Termianl		
40	+5 V Supply		Counter display
41	$\overline{FF}$	IN	Inputs FF signal at L level.
42	↑		
43	Open Terminal		
44	↓		
45	+5 V Supply		
46	D4	OUT	
47	D3	OUT	
48	D2	OUT	
49	D1	OUT	Speed display
50	$\overline{b}$	OUT	
51	$\overline{d}$	OUT	
52	$\overline{f}$	OUT	
53	$\overline{d\text{-}p}$	OUT	
54	Open Termianl		
55	GND		
56	Open Terminal		
57	EXT VARI	IN	Inputs speed control signal at input signal of 3.0 V or more and of 9.6 kHz ±15 %.
58	+15 V Supply		
59	+15 V Supply		
60	GND		

For REMOTE connector's signal connections, refer to page 9-16.

METER CONNECTOR AND SIGNALS

HIROSE P-1660 BA-CA Multi-pin Connector



Pin #	Function	
1	Meter Drive Output	CH1
2	Peak LED Activating Output	CH1
3	Meter Drive Output	CH2
4	Peak LED Activating Output	CH2
5	Meter Drive Output	CH3
6	Peak LED Activating Output	CH3
7	Meter Drive Output	CH4
8	Peak LED Activating Output	CH4
9	Meter Drive Output	CH5
10	Peak LED Activating Output	CH5
11	Meter Drive Output	CH6
12	Peak LED Activating Output	CH6
13	Meter Drive Output	CH7
14	Peak LED Activating Output	CH7
15	Meter Drive Output, CH8	CH8
16	Peak LED Activating Output	CH8
17	Meter Drive Output	CH9
18	Peak LED Activating Output	CH9
19	Meter Drive Output	CH10
20	Peak LED Activating Output	CH10
21	Open terminal	
22	Meter Drive Output	CH11
23	Peak LED Activating Output	CH11
24	Meter Drive Output	CH12
25	Peak LED Activating Output	CH12
26	Meter Drive Output	CH13
27	Peak LED Activating Output	CH13
28	Meter Drive Output	CH14
29	Peak LED Activating Output	CH14
30	Meter Drive Output	CH15
31	Peak LED Activating Output	CH15

Pin #	Function	
32	Meter Drive Output	CH16
33	Peak LED Activating Output	CH16
34	REC/READY Signal Output	CH1
35	REC/READY Signal Output	CH2
36	REC/READY Signal Output	CH3
37	REC/READY Signal Output	CH4
38	REC/READY Signal Output	CH5
39	REC/READY Signal Output	CH6
40	REC/READY Signal Output	CH7
41	REC/READY Signal Output	CH8
42	REC/READY Signal Output	CH9
43	REC/READY Signal Output	CH10
44	REC/READY Signal Output	CH11
45	REC/READY Signal Output	CH12
46	REC/READY Signal Output	CH13
47	REC/READY Signal Output	CH14
48	REC/READY Signal Output	CH15
49	REC/READY Signal Output	CH16
50	$\overline{\text{REC}}$ Signal	
51	+15 V supply	
52	GND	
53	AC 6 V supply	
54		
55		
56		
57	Open terminal	
58		
59		
60		

4. OPERATION

4-1. BASIC INFORMATION

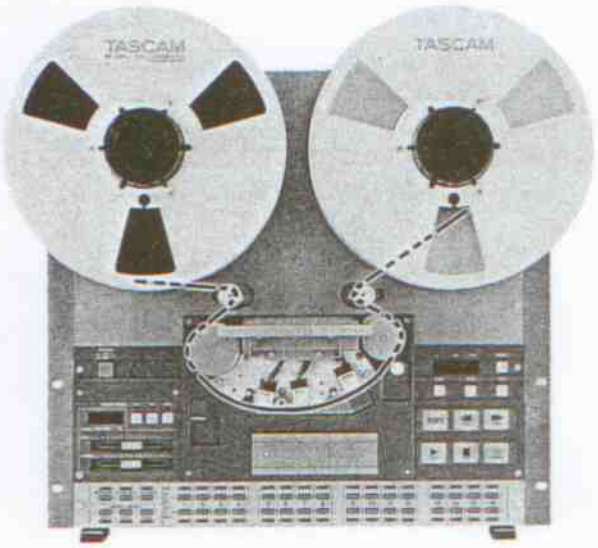
4-1-1. Reel Installation

Use only 10-1/2" reels and 1" wide tape. Even with a short tape, use 10-1/2" reels on both the supply and take-up reel tables, since the servo system is balanced to provide proper tension based on this reel size.

4-1-2. Threading Tape

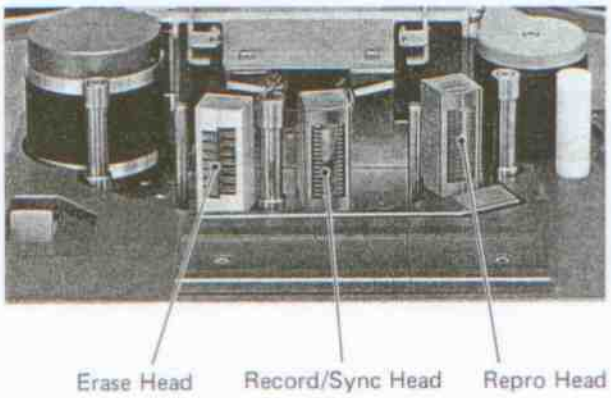
Lift the head access cover and press the head shield (head gate) in to gain access to the heads for threading tape. Thread the tape as shown in the illustraiton below.

NOTE: If the tape has been stored "tails out" (a recommended practice), remember to place it on the take-up reel table and rewind it onto the supply reel prior to use.



4-1-3. Erasing the Tape

A previously recorded track is automatically erased when you make a new recording on it.



4-1-4. Cleaning

IMPORTANT:

Do not overlook the importance of cleaning. Insufficient cleaning is the number one cause of the degradation of performance levels.

The first thing you will need for service is definitely the least expensive – Cleaning fluids and swabs. The whole outfit, 2 fluids and all the cotton swabs you'll need for months cost less than one roll of high quality tape. We can't stress the importance of cleaning too much. Clean up before every session. **Clean up after every session. Clean up every time you take a break in the middle of a session (we're serious).** How come? Well there are two good reasons we can think of right off the top:

1. Any dirt or oxide buildup on the heads will force the tape away from the gaps that record and playback. This will drastically affect the response. Even as small a layer of dirt as one thousandth of an inch will cause big trouble. All the money you have paid for high performance will be wiped out by a bit of oxide. Wipe it off with head cleaner and get back to normal.

2. Tape and tape oxide act very much the same as fine sandpaper. The combination will grind down the tape path in time. If you don't clean off this abrasive on a regular basis, the wear will be much more rapid and, what's worse, it will become irregular. Even wear on heads can be compensated for by electronic adjustments for a time, but uneven wear can produce notches on heads and guides that will cause the tape to "skew" and skip around from one path to another, making adjustment impossible. This ragged pathway chews up the tape, thus dropping more abrasive, thus causing more uneven wear and so – a vicious spiral that can't be stopped once it gets a good start. The only solution will then be to replace not only the heads, but all the tape guides as well. Being conscientious about cleaning the tape path on the will more than double the service life of the head assembly.

4-1-5. Degaussing (Demagnetizing)

IMPORTANT:

1. **Do not overlook the importance of degaussing. Magnetism in the tape path can significantly degrade performance. In extreme cases, the heads may not respond to signals at all.**
2. **Turn off the deck before degaussing.**
3. **Do not turn the degausser (E-3) off or on while it is in close proximity to the tape path.**
4. **Keep all recorded tape a safe distance from the degausser.**

A little stray magnetism goes a long way. A long way towards making trouble for your tapes. It only takes a small amount (.2 gauss) to cause trouble on the record head and playing 10 rolls of tape will put about that much charge on the heads and other ferrous parts of the tape path. A little more than that (.7 gauss) will start to erase high frequency signal on previously recorded tapes. Demagnetize the whole tape path, including the tips of the tension arms every six fully played 10-1/2 reels. This is a fair "rule of thumb" even though it may be a bit hard to keep track of. Fast motion isn't as significant to the heads, so we don't give an hourly reference. It's the record/play time that counts.

Degaussing is always done with the recorder turned off. If you try it with the electronics on, the 60 cycle current pulses produced by the degausser will look just like 60 Hz audio to the heads, at about 10,000 VU and will seriously damage the electronics and/or the meters. Turn off the machine, turn on the degausser at least 1 m (3 feet) away from the recorder. Move slowly up and down in close proximity to all ferrous parts and, slowly move away to at least 1 m (3 feet) before turning off.

It's a good idea to concentrate when you are degaussing. Don't try to hold a conversation or think of anything else but the job you are doing. If the degausser is turned off or on by accident while it is near the heads, you may put a permanent charge on them that no amount of careful degaussing will remove – head replacement time again, we're sorry to say. Make sure you are wide awake for this procedure.

A clean and properly demagnetized tape recorder will maintain its performance without any other attention for quite some time. Even if it does drift as a recorder, it won't ruin previously recorded material, and getting it back in good shape will not be too difficult.

4-2. MONITORING THE LINE OUTPUTS

The OUTPUT SELECT switches determine the source of the signals present at the output terminals. INPUT always selects the input jacks as a source, and REPRO always selects the repro head as the source (depending on some operation status, the output signals can be muted), but SYNC selects either the input jacks or sync reproduction from the record/sync head, depending on the setting of the REC function switches, the INSERT (SYNC/INPUT) switches, INPUT ENABLE switch, and other operating controls (which will also mute the output signals). The table below graphically depicts the output source.

Determining the signal source for the MS-16's output

<table>
<tr><th>OUTPUT SELECT Switch</th><th>INPUT ENABLE Switch</th><th>REC Function Switch</th><th>INSERT (INPUT/SYNC) Switch</th><th>RECORD Button</th><th>Operation Mode</th><th>OUTPUT Source</th></tr>
<tr><td>INPUT</td><td>–</td><td>–</td><td>Ch. 1 – 15: –
Ch. 16: INPUT</td><td>–</td><td>–</td><td>INPUT</td></tr>
<tr><td rowspan="2">REPRO</td><td rowspan="2">–</td><td rowspan="2">–</td><td rowspan="2">Ch. 1 – 15: –
Ch. 16: INPUT</td><td rowspan="2">–</td><td>PLAY, EDIT
CUE △
LIF/DEF △
STOP ●</td><td>REPRO</td></tr>
<tr><td>FAST</td><td>Muted</td></tr>
<tr><td rowspan="7">SYNC</td><td>ON*</td><td>–</td><td>–</td><td>–</td><td>STOP, FAST</td><td>INPUT</td></tr>
<tr><td rowspan="6">OFF</td><td rowspan="3">ON</td><td>INPUT</td><td>–</td><td>–</td><td>INPUT</td></tr>
<tr><td rowspan="3">SYNC</td><td rowspan="3">OFF</td><td>PLAY, EDIT
CUE △
LIF/DEF △
STOP ●</td><td rowspan="2">SYNC
REPRO</td></tr>
<tr><td>FAST</td><td>Muted</td></tr>
<tr><td>ON</td><td>RECORD</td><td>INPUT</td></tr>
<tr><td rowspan="3">OFF</td><td rowspan="3">Ch. 1 – 15: –
Ch. 16: INPUT</td><td rowspan="3">–</td><td>PLAY, EDIT
CUE △
LIF/DEF △
STOP ●</td><td rowspan="2">SYNC
REPRO</td></tr>
<tr><td>FAST</td><td>Muted</td></tr>
<tr><td>LED beneath the switch pressed lights.</td><td>LED above the switch pressed lights.</td><td>LED flashes with RECORD switch off, and stays on with RECORD switch on.</td><td>LED is on with RECORD switch off, and is off with RECORD switch on.</td><td>LED flashes with RED function switch off, and is on with REC function on.</td><td>LIF/DEF MUTE and STOP MUTE LEDs are on with respective switches pressed, regardless of whether muting is actually in function or not.</td><td></td></tr>
</table>

Channel 16 SYNCLOCK Mode

OUTPUT SELECT Switch	INPUT ENABLE Switch	REC Function Switch	INSERT (INPUT/SYNC) Switch	RECORD Button	Operation Mode	OUTPUT Source
–	–*	OFF	SYNC	–	PLAY, EDIT, CUE, LIF/DEF	SYNC REPRO
					STOP •	SYNC REPRO
					FAST	Muted
LED beneath the switch pressed lights.	LED above the switch pressed lights.	LED flashes with RECORD switch off, and stays on with RECORD switch on.	LED of the ch. lights red when SYNCLOCKed (yellow when not locked).	LED flashes with RED function switch off, and is on with REC function on.	LEF/DEF MUTE and STOP MUTE LEDs are on with respective switches pressed, regardless of whether muting is actually in function or not.	

NOTES:

"–" ——— setting of this switch or the operating mode has no effect on the line output source.

CUE ——— fast-winding modes (STC, RTZ included) in which tape lifters are retracted using the TAPE LIFTER lever and the tape contacts the heads.

LIF/DEF — mode in which tape lifters are retracted by the time code controller during fast-winding.

FAST ——— fast-winding modes with tape lifters engaged and the tape pulled away from the heads.

△ ——— LIF/DEF MUTE possible during SYNCLOCKed fast-winding (ch. 1 – 15).

• ——— STOP MUTE possible (all channels).

* ——— INPUT ENABLE functions while in STOP or FAST with OUTPUT SELECT set to SYNC.

4-2-1. SYNCLOCK OPERATION

Track 16 is used to record the SMPTE time code and needs to be held in the SYNC output mode so that the time code can be continuously read by the synchronizer/controller, regardless of OUTPUT SELECT switching.

To SYNCLOCK channel 16 to the sync head, reproduce mode, set its REC function switch to OFF and its INSERT (INPUT/SYNC) to SYNC. The channel's INSERT LED lights up in the red, a color different than other LEDs, providing a positive visualization of the "locking up".

Note that in the fast-winding mode the controller/synchronizer reads the time code by retracting the tape lifter. Therefore during this period audio signals appear at the line outputs (channels 1 – 15) unless LIF/DEF MUTE is engaged.

4-3. RECORDING

Prior to recording, check to see that the MS-16 is properly wired to the recording mixer and associated equipment. Remember that the recording level is controlled at the output of the mixer, not on the MS-16. Initially, we suggest setting the MS-16 as listed.

To begin recording on those channels whose REC function switches are engaged, press the PLAY and RECORD buttons. And press PLAY to end the recording or STOP to end the recording and stop the tape.

Switch	Setting	Indicator
OUTPUT SELECT	INPUT (to preset the record level) or SYNC (to monitor playback until recording begins)	LED turns on beneath corresponding switch
REC function	For those tracks to be recorded, press in the switch to turn on the channel.	LED(s) turn on corresponding to tracks to be recorded.
INSERT (SYNC/INPUT)	INPUT	–

4-3-1. Punch-In Using the RECORD Button

Press the SYNC switch, set the desired INSERT (SYNC/INPUT) switch(es) to the SYNC position and also press the desired REC function switch ON. Now press PLAY to place the machine in record ready mode. Tape will rolling, but the track(s) will not be recording. Monitor the playback and at the point where you want to "punch in", press the RECORD. To "punch out" of the record on all channels, press PLAY or press the STOP.

4-3-2. Punch-In Using the REC Function Switches

Press the SYNC switch, set the desired INSERT (SYNC/INPUT) switch(es) to the SYNC position, and turn off all REC function switches (unless you want a track to begin recording immediately). Now simultaneously press the RECORD and PLAY buttons to place the machine in record ready mode. Tape will be rolling, but the track(s) will not be recording. You can "punch in" to record on a particular channel by pressing in its REC function switch. To "punch out" of record on that channel, release its REC function switch. To "punch out" of record on all channels, press PLAY or press the STOP button.

4-4. EXAMPLES OF PUNCH-INS AND INSERTS

Consider two different situations where it is desirable to re-record portions of a track rather than recording the entire part all over again.

EXAMPLE 1:

Suppose there is a hesitant start at the beginning of a tune, one slightly out of time with the downbeat. In order to make a correction at this point, there is no need to monitor the playback (sync) from the problem track. In fact, the "bad start" may only serve to confuse the performer. To punch in on the track, set the corresponding REC function switch on, then press the RECORD and PLAY buttons after hearing the slate at the beginning of the tune. To end the insert, press STOP.

EXAMPLE 2:

Suppose an error is made in the middle of or near the end of a tune. Now the performer will need to hear his performance up to the "problem" point so that the punch-in (an "insert") will have the same style and feel as the existing track.

In this instance, it would be rather risky to attempt punch-in without rehearsal, because you could easily erase too much of the track you want to correct. Here is a practical method for

Rehearsing a Punch-In Using the INSERT (SYNC/INPUT) Switches.

Press the OUTPUT SELECT's SYNC switch, set the INSERT switch of the channel you want to punch-in to SYNC, and press that track's REC function switch. Now press the PLAY button to begin playing the tape. The outputs will carry playback from the record/sync head, and the performer may be playing along with this sync playback to "warm up". At the desired moment for punch-in, disengage the punch-in track's INSERT switch to INPUT, this switches the monitor out from the tape playback to the input source without actually recording. To "punch-out" of the supposed record, press again the same INSERT switch to SYNC; the output will be switched back to the tape playback from the input source. Practice the punch-in until you are sure that you will get it right when actually recording.

Actual Punch-In Recording

Press the OUTPUT SELECT's SYNC switch, engage the punch-in track's INSERT switch to SYNC and also turn that track's REC function switch on. Now press the PLAY button to begin playing the tape.
At the moment the insert is to be made, press the RECORD. Two things then occur: (1) you instantly enter record mode on the track so the new part will replace the previous portion of the track (in sync), and (2) the output is automatically switched from tape playback to input source so the performer can hear the new part as it is being added.

4-5. ANOTHER LOOK AT SYNC FUNCTIONS

Since the sync mode allows "in synchronization" recording of new signals with previously recorded tracks, it serves as a means to perform overdubbing as well as normal recording. When the machine is in the sync mode, the performer can monitor the previously recorded tracks via playback through the record/sync head while, at the same time, his new material is being added on another track (or tracks) of the same head.

For example, suppose we load a tape on which five tracks are already recorded, and the other eleven tracks are blank. In sync mode, the five existing tracks are played back, mixed at the console, and fed to performer's cue headphones. The performer now monitors that mixed signal from the five tracks while he records new signal on one (or several) of the formerly blank tracks. Since the same head is used for playback and recording, all the signals remain "in sync" for proper playback.

When making an overdub or an insert, the performer can begin playing prior to the actual initiation of recording, allowing time for him to "get up to speed" and play along with the existing tracks. At the time the punch-in is made, the signal being monitored by the performer instantly and automatically changes from playback of the existing track (which is to be re-recorded) to the input to that track as it is being re-recorded. Monitoring is unchanged on those tracks which are not being re-recorded.

4-6. BUILT-IN AUTO LOCATOR FUNCTION

The MS-16 has a digital counter which indicates the elapsed tape running time from 00 minutes, 00 seconds ("00.00") up to maximum of 99 minutes, 59 seconds ("99.59") – not that you can get a 100 minute tape to fit on the machine. From any mode, the MS-16 can be made to fast wind (forward or reverse) to a "00.00" counter readout by pressing the RTZ button. Additionally, the counter has an associated memory register that allows any specific time on the tape to be "remembered" by pressing the CUE button as that point is displayed on the counter. The tape can then be made to fast wind (forward or reverse) to the memorized cue point by pressing the STC button - again, from any mode.

When the RESET button is pressed, the MS-16's digital display will indicate "00.00". So, too, will the counter display on the RC-65 remote control unit that may be plugged into the MS-16.

4-7. FAST WINDING

To fast wind a tape in the forward direction (onto the take-up reel) or reverse direction (onto the supply reel), press the fast forward F. FWD or rewind REW button. These fast winding modes can be initiated from the stop, play or record modes. The tape lifter arms pull the tape away from the heads as soon as fast winding is initiated, and the line outputs are also electrically muted, except when defeated by 1) the manual TAPE LIFTER control for monitoring the signal on the tape or 2) the INPUT ENABLE switch for allowing the performer to talk to the engineer during fast-winding also.

4-8. REPRODUCTION (PLAYBACK)

Thread a record tape onto the MS-16, and set the following controls as indicated:

POWER Switch: On
OUTPUT SELECT Switch: SYNC or REPRO
REC Function Switches: All channels off (buttons up)
INSERT (SYNC/INPUT) Switches:
channels 1 – 15: INPUT or SYNC
channel 16: INPUT

Then press the PLAY button. Tape will run onto the take-up reel at 15 ips (38 cm/sec), assuming the PITCH CONTROL switch is not engaged (FIX position), the line outputs will carry the reproduced signal from the tape. Press STOP to stop the tape.

4-9. EDITING

NOTES:

1. When splicing tape, never use ordinary adhesive or pressure sensitive tape. Use only special tapes made for splicing (editing) recording tape. Splicing tape has a small amount of low tack adhesive which is adequate to grip the backing of the recording tape, yet which will not "ooze" out beyond the splice after being wound under tension and shuttled over the heads. Conventional tape almost always "leaks" adhesive onto the heads and onto adjacent windings of tape on the reel.

2. Always use non-magnetic tools, including razor blades, when splicing tape. Magnetized tools will cause a "click" upon playback.

4-9-1. Manual Editing

To locate a cue point, use the TAPE LIFTER lever during the fast winding or spooling mode, then press STOP. Once the approximate cue point is thus located, and tape is stopped, press the EDIT button; an EDIT button lights, and the tape reels may then be "hand rocked" to find the exact cue point. (Note that the tape counter still operates.) When that point is heard to play back: flip up the head access cover, push in the head shield (if it is up), and use a grease pencil (a "china marker") to mark the cut point opposite the head through which you are listening (the record/sync head if OUTPUT SELECT is set to SYNC, or the repro head if set to REPRO).

When the Stop Edit is required, set the EDIT button off and pull out the tape from the supply reel. In this Stop Edit mode, be sure the STOP MUTE switch is off.

4-9-2. Dump Editing

Once the initial cue point is marked, pull tape forward and lay it into the splicing block (oxide down) and cut the tape diagonally at the mark using a non-magnetic single-edged industrial razor blade. If a substantial length of tape is to be removed, rethread the tape from the supply reel past the heads, capstan and pinch roller... and let the end hang off the right side of the transport. Then, press the EDIT button and the PLAY button simultaneously. Tape will begin unthreading itself (dumping) from the supply reel as you listen to it play, and the take-up reel will not turn to take up slack; tension arm positions are disregarded by the transport logic. When you reach the next edit point, press STOP. Once again, press EDIT and manually move the tape so the splice point is opposite the head being used for reproduction, mark that point, and make the second diagonal cut. Then butt the two cut ends from the supply and take-up reels, apply a small piece of splicing tape, and trim the excess along both edges of the recording tape.

NOTES:

1. If the PLAY button is pressed alone, after the EDIT button lights, the unit will go into play mode and the EDIT button will turn off. To enter "dump edit" mode, both the EDIT and PLAY buttons must be pressed at the same time.
2. If the STOP button is pressed during dump edit mode, the edit mode will be disengaged and tape will stop.

4-10. SPOOLING

The spooling mode is used to transfer tape from one reel to the other at a constant speed of approximately 80 ips (203 cm/sec) to obtain a tight, uniform tape pack... as compared to approximately 240 ips (610 cm/sec) for normal fast wind speed. Generally, spooling will be done onto the take-up reel at the end of a recording or editing session so the tape can be stored "tails out", which reduces audible print-through effects (pre-echoes). Fast winding is not used here because the tape pack is less uniform, and edge damage to the tape is therefore more likely during storage. When the tape is again to be used, it is first rewound onto the supply reel at normal rewind speed. It may be helpful to use a white leader tape at the head (beginning) of the tape, and a red leader tape at the tail (end) of the tape to avoid any possible confusion as to which end is which.

To select the forward spooling mode press the F. FWD (fast-forward) button once to begin fast-forward winding. Then immediately press it a second time; this initiates the forward spooling mode and F. FWD button begins to flash on and off. A third pressing of the F. FWD button will return the transport to normal fast-forward winding (F. FWD button lights steadily), or pressing STOP will stop any tape motion.

To select the reverse spooling mode, press the REW (rewind) button twice consecutively. Just like F. FWD, a third pressing of this button will cause the transport to return to normal rewind speed, or pressing STOP will disengage spooling mode and stop all tape motion.

4-11. VOLTAGE CONVERSION

The MS-16 is factory preset to operate at the AC line voltage specified on the power cord tag and on the packing carton.

NOTE: Field conversion of this line voltage to other voltages is not possible on models sold in the U.S.A., Canada, the U.K., Australia or Europe. If your MS-16 is a "general export" model and it does become necessary to change the line voltage requirements to suit local AC power mains, use the following procedures.
ALWAYS DISCONNECT THE POWER CORD BEFORE MAKING THESE CHANGES.

1. Locate the voltage selector at the left end of the rear panel of the transport unit.
2. Remove the plug by pulling it out, then reinsert it so that the arrow on the plug points to the white line indicating the power voltage.

4-12. NOTE FOR U.K. CUSTOMERS

U.K. Customers Only:
Due to the variety of plugs being used in the U.K., this unit is sold without an AC plug. Please request your dealer to install the correct plug to match the mains power outlet where your unit will be used as per these instructions.

IMPORTANT

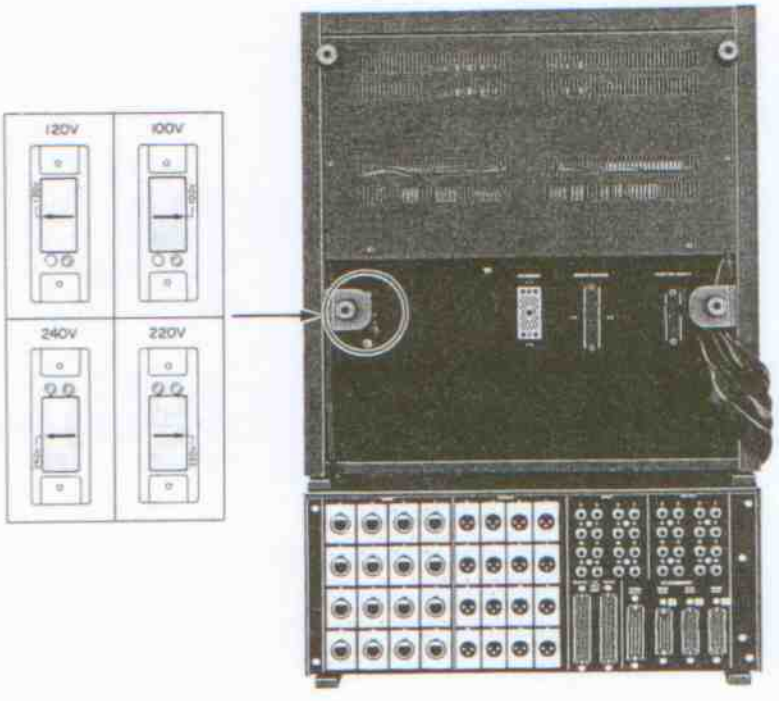
The wires in this mains lead are coloured in accordance with the following code:

BLUE:	**NEUTRAL**
BROWN:	**LIVE**

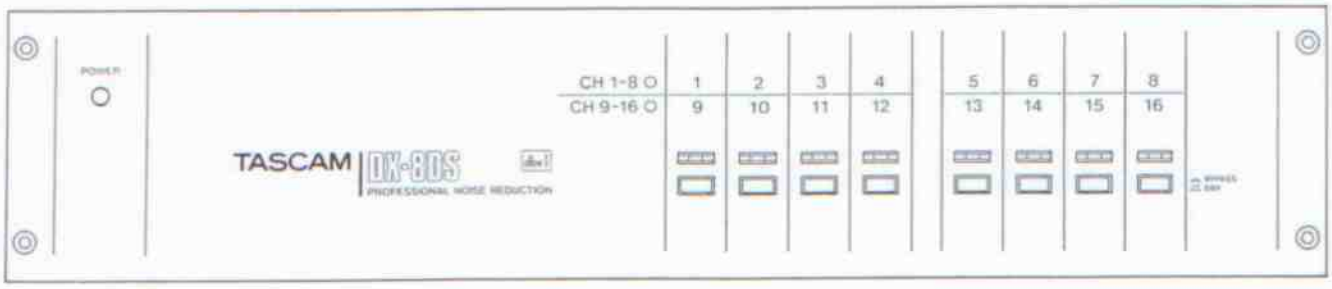
As the colours of the wires in the mains lead of this apparatus may not correspond with the coloured markings identifying the terminals of your plug, proceed as follows.

The wire which is coloured BLUE must be connected to the terminal which is marked with the letter N or coloured BLACK. The wire which is coloured BROWN must be connected to the terminal which is marked with the letter L or coloured RED.

This product is manufactured to comply with the radio interference of EEC directive "82/499/EEC."



4-13. DX-8DS DBX NOISE REDUCTION UNIT



The 8 channel DX-8DS dbx Noise Reduction unit has been designed to be used with the MS-16 and other TASCAM 8 and 16 channel reproducers using a multi-pin connector interface. The DX-8DS is a dual process design, capable of simultaneous encode and decode of 8 channels of audio. The function of each channel is automatically controlled so that non-encoded signals are always available at the outputs of the recorder.

The DX-8DS, as with all other TASCAM dbx units, will only function when connected to a TASCAM unit. They have been designed to operate as a system, once they are connected you can virtually forget them. Since, they function automatically, once they have been connected they become an integral part of the MS-16. There is no need for record or reproduce calibration or level adjustments for the unit. There will however need to be some adjustments in your recording technique. After you have connected the DX-8DS to your MS-16 you will find that the meters will read at a lower level with the dbx engaged than without it. This is because the meters are displaying the encoded signal level (after compression), and looking at reduced levels on the meters may take some getting used to. DO NOT attempt to adjust the input and output levels of the MS-16 to reflect 0 VU with the dbx engaged as this elevated level will induce decoding errors.

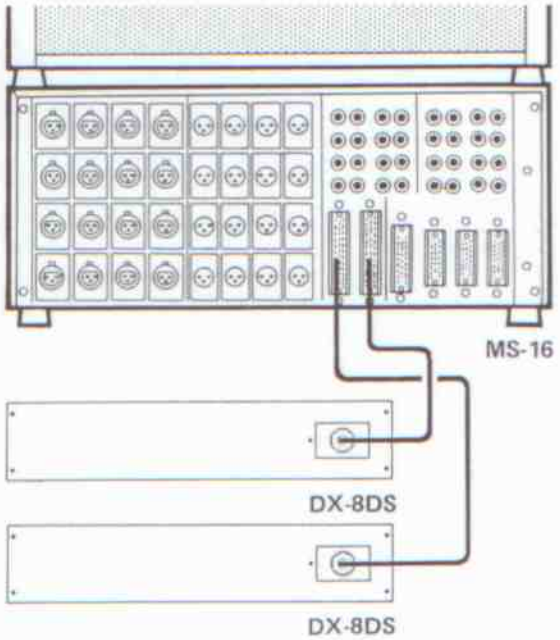
Always calibrate your mixer and MS-16 with the dbx in the bypass position. This will insure optimum performance of the system. Following these environmental guide lines will also help to insure quality performance of your system.

* Avoid temperatures beyond the range of 5°C to 30°C (40°F to 87°F).
* Avoid using AC power inputs that fluctuate greatly.
* Avoid areas where there is extremely high humidity.
* If the surface of the unit gets dirty, wipe with a soft cloth or use a diluted neutral cleaning liquid. Clean off thoroughly. Do not use thinner, benzine or alcohol as they may damage the surface of the unit.

HOOK UP

Because the DX-8DS is an 8-channel dbx system, it is necessary to connect two of these units to operate all the MS-16's 16 channels simultaneously. LEDs "CH 1–8" or "CH 9–16" on the DX-8DS illuminate to indicate which group of channels the unit is connected to on the MS-16.

Note: There is no specific order of channels (CH 1–8/CH 9–16) in which the dbx unit must be connected; all channels of processing are identical. Tape noise reduction units built by dbx also may be used with the MS-16, in which case these connectors are not used.



FEATURES AND CONTROLS

Power LED
The DX-8DS has no power switch. When the power switch of the MS-16 is depressed, this LED lights to indicate that the DX-8DS is also turned on. This LED will turn off when the power of the MS-16 is turned off.

DBX/BYPASS Switches
These switches allow you to control the function of each channel.
DBX – up position: the LED is on and the dbx circuits are engaged.
BYPASS – down position: the LED is off and the dbx circuits are disengaged, not in the audio path.

Note: Use the BYPASS position when you are playing back tapes which have not been recorded with dbx or when you are recording and working with individual tracks containing time code or control code information.

Channel Indicators (1–8, 9–16)
Because the DX-8DS is an 8-channel unit you will need 2 units for the MS-16. The DX-8DS is a universal unit, all of the channels are identical. There is no specific order for connection. The Channel Indicators, 1–8 or 9–16, on the DX-8DS will light to indicate the channels the unit is connected to on the MS-16.

Connecting Cable
Connect this cable to the "TO DBX UNIT" connector on the rear panel of the MS-16's amplifier unit.
The control and audio signals from the MS-16 are fed through this cable.

Note: When connecting the DX-8DS to the MS-16, be sure to turn off the power of the MS-16.

WARNING: When the DX-8DS units are not used, the bridging connectors shipped with the MS-16 must be installed in the CH 1 – 8 and CH 9 – 16 sockets or the MS-16 WILL NOT operate. NO AUDIO!

SPECIFICATIONS

Number of Channels	8 channels (8 Encode/ 8 Decode, separate controls), Type I
Encoder Section	
Input (at 1 kHz):	
Input impedance	50 kΩ
Nominal Input Level	-10 dBV (0.3 V)
Maximum Input Level	+16 dBV (6.3 V)
Output (at 1 kHz):	
Output Impedance	220 Ω
Nominal Load Impedance	50 kΩ
Minimum Load Impedance	4 kΩ
Nominal Output Level	-10 dBV (0.3 V)
Maximum Output Level	+16 dBV (6.3 V)
Decoder Section	
Input (at 1 kHz):	
Input Impedance	50 kΩ
Nominal Input Level	-10 dBV (0.3 V)
Maximum Input Level	+16 dBV (6.3 V)
Output (at 1 kHz):	
Output Impedance	220 Ω
Nominal Load Impedance	50 kΩ
Minimum Load Impedance	5 kΩ
Nominal Output Level	-10 dBV (0.3 V)
Maximum Output Level	+16 dBV (6.3 V)
Frequency Response (Back to Back)	40 Hz – 15 kHz ±1 dB 30 Hz – 20 kHz ±2 dB
Distortion (Back to Back)	0.2 % at 1 kHz
Noise Reduction	More than 30 dB
Dynamic Range	100 dB
Power Requirements	Powered from the MS-16
Dimensions (W x H x D)	482 x 88 x 300 mm (19" x 3-7/16" x 11-13/16")
Weight	Approx. 5 kg (11 lbs.), including cable

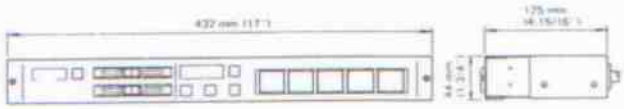
4-14. OPTIONAL EQUIPMENT AND USEFUL ACCESSORIES

RC-65 Remote Control Unit

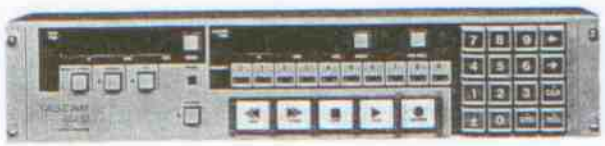
The RC-65 is a remote control unit which allows remote operation of the MS-16 from as far away as 8 meters. All transport controls (except EDIT) including RTZ/STC, counter read-out and pitch control function of the MS-16 can be remote-controlled from this unit. Integrating the RC-65 with the record function control panel, separated from the MS-16 transport section, enhances operability of the recorder/reproducer.

SPECIFICATIONS

Description	Remote Control Unit
Function	
Transport:	PLAY, STOP, F. FWD, REW, spooling and RECORD
Pitch Control:	FINE ±0.7 %, COARSE ±15 % with ON/OFF switch and 3-digit indicator
Tape Counter:	4-digit, minute and second read-out, with RESET button
Auto Locator:	CUE, single-point memory RTZ, Return-To-Zero STC, Search-To-Cue
Others	
Connecting cable:	8 m, 51-core shielded, with 60 pin connector (HIROSE P-1660 BA-CA)
Dimensions (W x H x D)	432 x 44 x 125 mm (17" x 1-3/4" x 4-15/16")
Weight	4.0 kg (8-13/16 lbs), including cable



AQ-65 Auto Locator



The AQ-65 is a programmable multipoint locator that allows computer-precision transport control from a distance. It features among other capabilities: ten digit keys for writing cue times into memory, pre-roll (20 sec. max.), two-point repeat (between TAPE TIME and LOCATE TIME points) and a duplication of the MS-16's transport control.
It can be integrated with the record function control panel, separated from the deck's transport section, and arranged in a single chassis by using the CS-63 — a mount kit designed especially for this purpose — thereby virtually becoming a multi-function control center.

SPECIFICATIONS

Description	Auto locator
Function	
Transport:	PLAY, STOP, F. FWD, REW, spooling and RECORD
Cue programming and location:	Ten-point (0 — 9) memory, cue point setting with ten digit keys RTZ, Return-To-Zero
Counters:	2-Tape Time, Locate Time 5 digit, hour, minute and second read-out, with RESET button
Others	
Connecting Cable:	8 m, 34-core shielded, with 38 pin (MALCO 354 or ELCO 8016 Series)
Dimensions (W x H x D)	432 x 88 x 125 mm (17" x 3-7/16" x 4-15/16")
Weight	5 kg (11 lbs), including cable

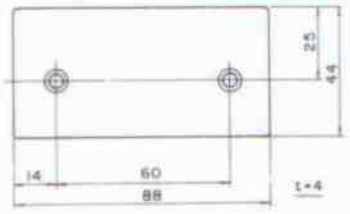
CS-64 Roll-Around Stand

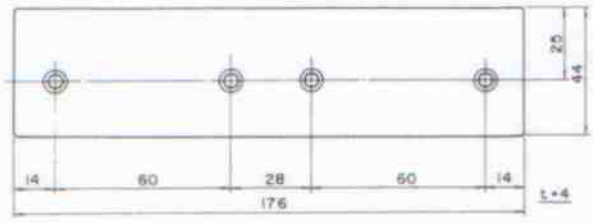
The CS-64 is a roll-around stand for the record function control panel of the MS-16, the RC-65 Remote Control Unit and AQ-65 Auto Locator.

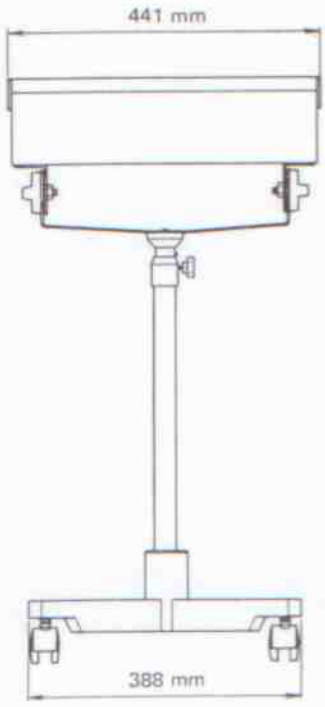
The CS-64 includes two sets of side panel adaptors: one measures in height 2 EIA units and the other 4 units.

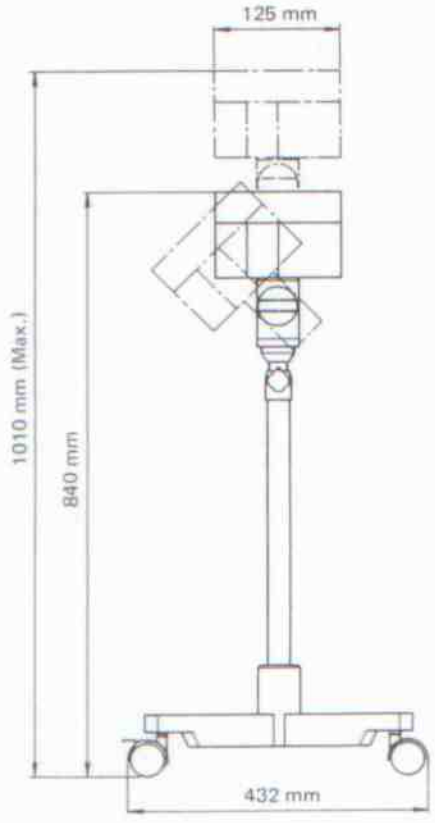
Side Panel Adaptors

unit: mm



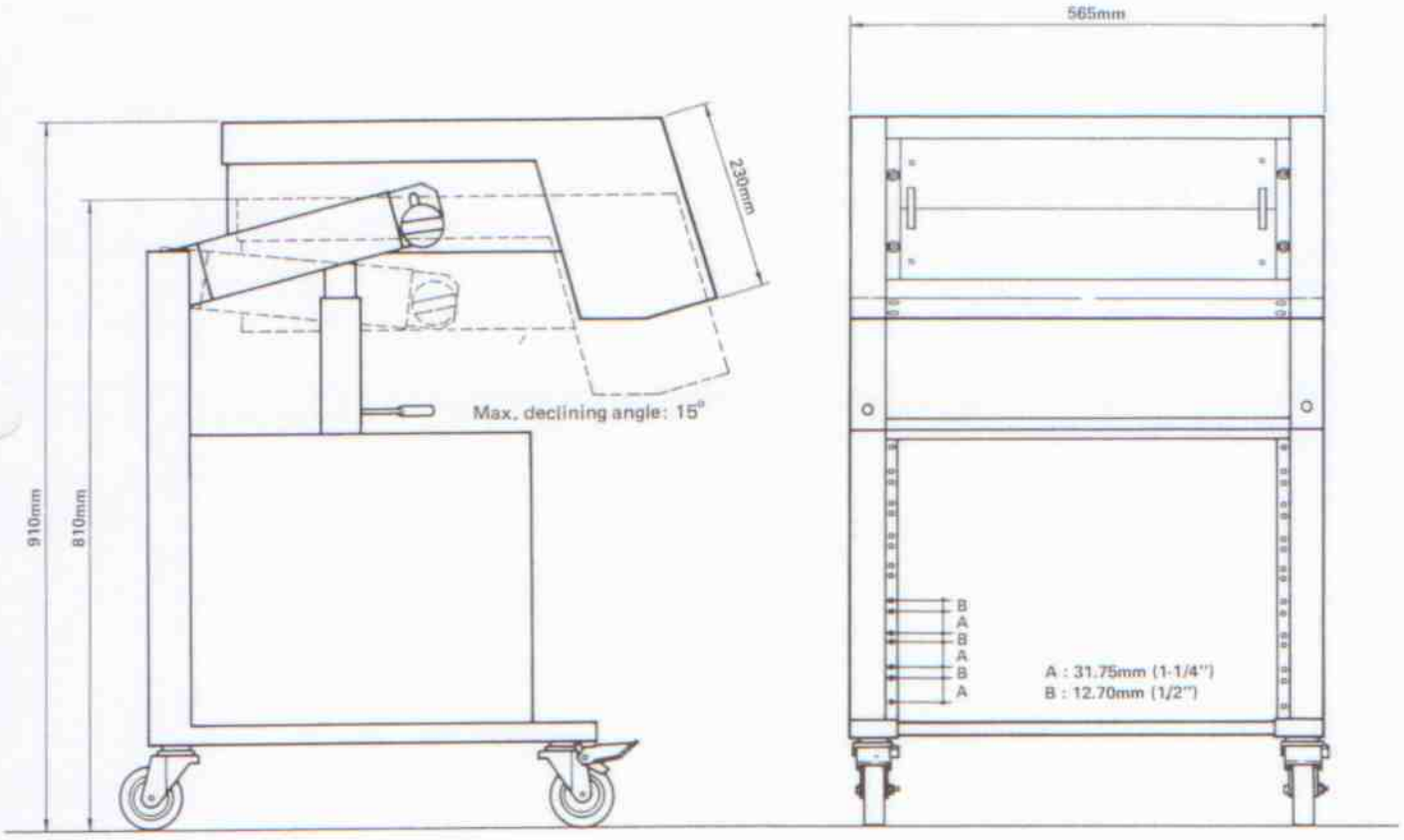


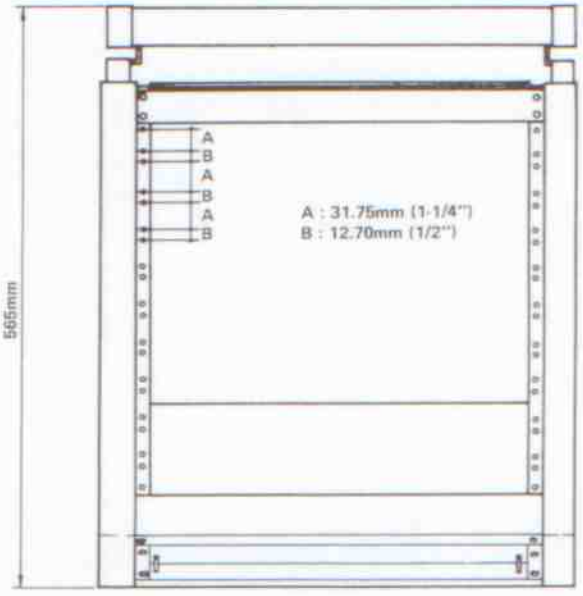




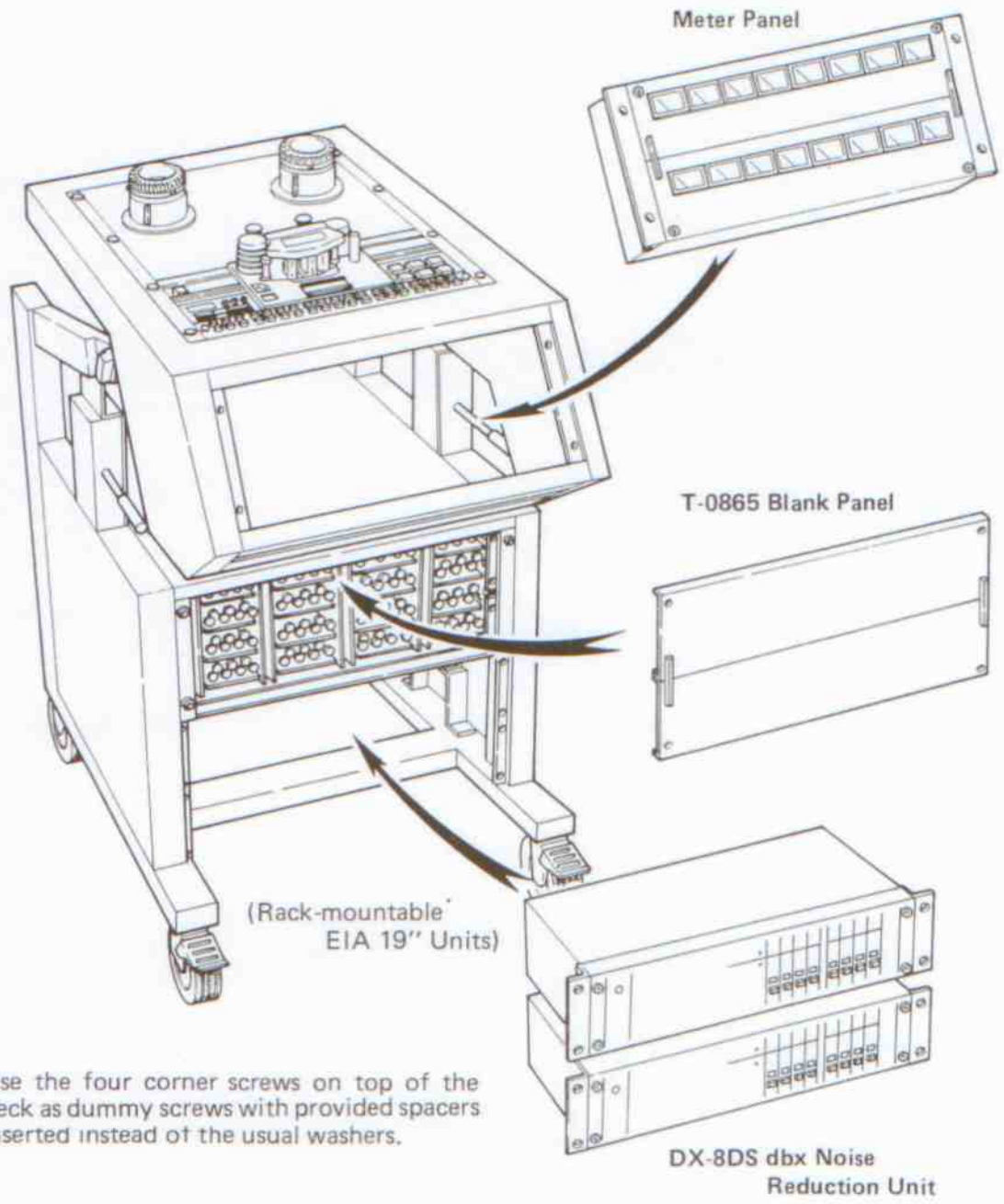
CS-65 Console Rack (EIA 19-inch)

The CS-65 is a standard 19-inch console rack to be used for mounting of the TASCAM MS-16.





CONSOLE AND MOUNTING FOR MS-16



Use the four corner screws on top of the deck as dummy screws with provided spacers inserted instead of the usual washers.

CS-63 Mount Kit

This is for mounting the record function control panel, separated from the transport section of the MS-16, in the CS-64 Roll-around Stand or a standard 19" EIA rack.

It consists of: 1) a chassis equipped with a connecting cable for connecting the record function control panel to the FUNCTION REMOTE connector on the rear of the MS-16, 2) a blank panel for covering the vacant record function control panel space, and 3) rack mount angles (1 EIA unit).

T-0865 Panel and Cable Kit

The T-0865 is used to cover the front of the MS-16's amplifier module when the meter panel is separated for remote mounting. The T-0865 comes with a cable for connecting the meter panel to the amplifier module.

CS-61 Overbridge Meter Mount

The CS-61 allows the meter panel to be mounted in an overbridge configuration on the optional CS-65 console. This mounting configuration requires the T-0865 Panel and Cable Kit.

TZ-65 Metal Clamper

The TZ-65 is a special metal clamper designed exclusively for the MS-16. Mounting the TZ-65 requires special precautions and adjustments. Please consult your TASCAM dealer or service center.

TO-122A Test Tone Oscillator

This compact, battery powered unit can be used to check the input/output levels, channel balance, and electronic alignment calibration of the MS-16. It has an RCA jack output, switchable output levels of -10 dBV (line level) or -40 dBV (mic/instrument level). Frequency is switchable to 40 Hz, 400 Hz, 1 kHz, 4 kHz, 10 kHz or 15 kHz. The TO-122A is also useful for calibration and troubleshooting of entire recording systems.

E-3 Head Demagnetizer

RE-1050 TASCAM Metal Reel (10-1/2", 1" tape)

TASCAM Cables

Cable, because of its inherent capacitance and resistance, is an active component in an audio system. There are vast differences in cable design and performance that have significant effect on the sound quality you'll get from your equipment. TASCAM Professional Audio Cables are the best available.

Our cables feature very low capacitance (under 15 picofarads/foot) so they don't act as low pass filters and roll off high frequencies. The capacitance is also consistent; it doesn't change when the cable is bent or compressed. You don't get noise or degraded results when the cable has been used a while. Our cable's long term stability is provided by a special insulator that is as flexible as foam core dielectrics, but far more resistant to extreme cold or heat, and it doesn't let the center strands migrate. It also avoids the possibility of shearing the center conductor when the cable is crushed, so the cable does not suddenly fail.

Rather than loosely braided shield or spiral wrapped shield that can open up, we use bare copper braided shield with 97 % coverage. This excludes electrostatic noise (buzz) and RFI (CB interference, etc.). We also use a 7-strand center conductor: 4 pure copper strands for minimum resistance and 3 copper weld stainless steel strands for strength. The multiple strands increase flexibility and strength while offering less resistance at ultra high frequencies due to increased surface area for the "skin effect." This improves transient response.

The outer PVC insulating jacket resists abrasion, and is tightly fitted to the shield so it will not elongate. The connectors are special, too. Their niclel plated brass center pins are a bit longer than most to establish good contact in all RCA jacks. The cadmium plated steel outer shell includes a gentle ridge which burnishes the mating jack when the connector is twisted to ensure good contact. For maximum RF shielding, the braid is terminated inside the shell and 2-radian soldered, not just spot soldered, for maximum strength. The plugs are clad with an oval jacket of molded plastic to further increase strength and make the ends easier to handle. TASCAM cable is available in lengths from 6 inches to 20 feet, or in color-coded sets of 8 for fast channel or function identification. TASCAM cable is also available in 500 foot spools.

If TASCAM professional cables are not available in your area, please try to find the next best cables. It really does make a difference in system performance.

MAINTENANCE

5. THEORY OF OPERATION

This section of the manual provides a functional description of the basic operations, followed by a detailed explanation of the circuit operation with the recorder/reproducer in a specific operating mode. The unit, with its easy-to-use operating controls provides a host of professional functions, and incorporates a microprocessor to control the tape transport and the record/reproduce amplifiers for improved reliability. Also incorporated are various ICs which are employed for the interfacing of the microprocessor and its associated devices.

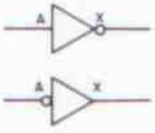
All operating conditions such as switching the tape operation modes and display operation modes, conditions of tape travel, etc. are under the control of a microprocessor. The microprocessor requires various inputs to control these conditions and output instruction signals according to a predetermined program which tests the input conditions, thus controlling operating conditions of the deck according to the instruction signals.

5-1. LOGIC SYMBOLS

The logic operation elements used in this unit and their definitions are as follows:

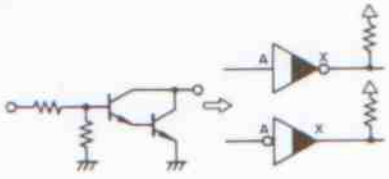
(1) INVERTER

a. TC4049BP



A	X
H	L
L	H

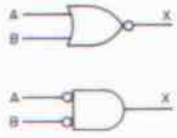
b. M54517P



A	X
H	L
L	H

(2) NOR or NAND GATE

a. TC4001BP

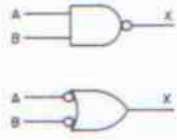


Ⓟ NOR GATE

(Ⓝ NAND GATE)

A	B	X
H	H	L
H	L	L
L	H	L
L	L	H

b. TC4011BP



Ⓟ NAND GATE

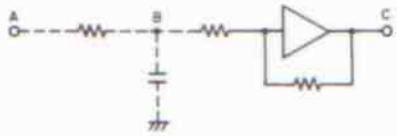
(Ⓝ NOR GATE)

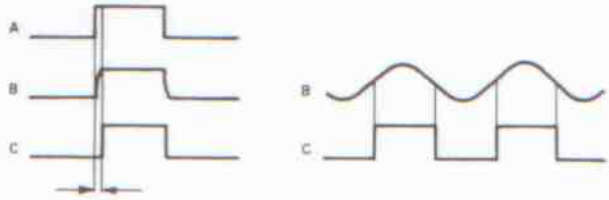
A	B	X
H	H	L
H	L	H
L	H	H
L	L	H

(3) EX-OR GATE (TC4030BP)

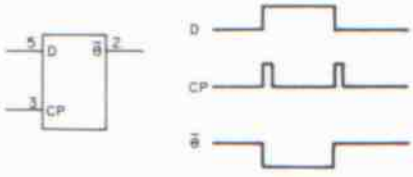
A	B	X
H	H	L
H	L	H
L	H	H
L	L	L

(4) BUFFER (TC4050BP)





(5) D-FF (TC4013BP)



(6) TC4510BP
UP/DOWN decimal counter controlled as Quintary counter

Fig. 5-1. Logic Symbol Chart

5-2. MICROPROCESSOR INPUT CIRCUIT

The microprocessor U9 provides four scanning pulses with different phases from terminals P0, P1, P2, and P3 to terminals SA, SB, SC, and SD of the interface IC U20 as shown in Fig. 5-2.
These pulse input terminals and the terminals A0 – A3, B0 – B3, C0 – C3, D0 – D3 of U20 (each of which is connected to a keyboard switch) are connected inside the IC and form a matrix circuit. The matrix circuit outputs are fed to terminals K0 – K3 of microprocessor U9 through terminals Q0 – Q3 of U20.
Thus, the microprocessor will know which mode key is pressed from one of scanning pulses (t0, t1, t2, t3). However, two keys may possibly be pressed simultaneously. In such a case, operation priority, depending upon the combination of keys pressed, is determined as shown in Table 5-1. For example, if both keys FF and REC are pressed simultaneously, the microprocessor will judge that the FF key has been pressed. That is, the microprocessor will judge the operation mode requested by testing which of terminals K0, K1, K2, and K3 is "H" or "L" at times t0, t1, t2, and t3.

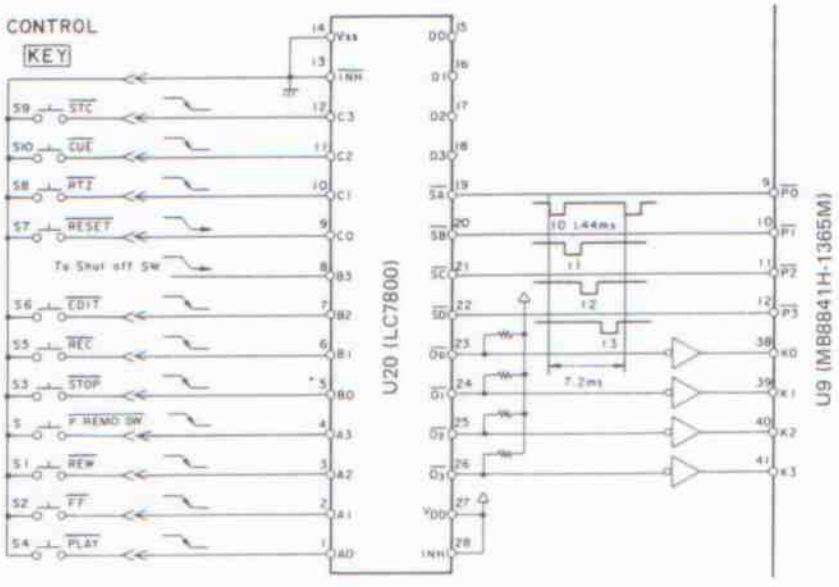


Fig. 5-2. Operation Instruction Input Circuit

KEY SW

KEY SW / INPUT	STOP	PLAY	F.F	REW	REC	EDIT	STC	CUE	RTZ	RESET
STOP										
PLAY	STOP									
F.F	STOP	PLAY								
REW	STOP	PLAY	F.F							
REC	STOP	[REC. PLAY]	F.F	REW						
EDIT	STOP	[DUMP EDIT]	F.F	REW	M. EDIT					
STC	STOP	STC ↓(STOP) PLAY	F.F	REW	STC	STC				
CUE	PLAY CUE MEMORY	PLAY CUE MEMORY	F.F CUE MEMORY	REW CUE MEMORY	STOP CUE MEMORY	M. EDIT CUE MEMORY	STC CUE MEMORY			
RTZ	STOP	RTZ ↓(STOP) PLAY	F.F	REW	RTZ	RTZ	RTZ	RTZ CUE MEMORY		
RESET	STOP 00.00	PLAY 00.00	F.F 00.00	REW 00.00	STOP 00.00	M. EDIT 00.00	STC 00.00	STOP 0.00 CUE MEMORY	RTZ 00.00	

Table 5-1

5-3. ENTRY OF TAPE SPEED AND DIRECTION INFORMATION

To control tape speed and tape travel direction, the microprocessor needs information on the tape speed and direction. Two photo sensors are provided to detect the speed and direction. Each sensor consists of an LED, a photo-transistor and a toothed disc inserted between the LED and photo-transistor which is rotated at a speed proportional to the tape speed. The teeth of the disc interrupt the light beam from the LED entering the photo transistor as the disc rotates, thus the photo-transistor develops a pulse output proportional to the tape speed. Fig. 5-3 shows a symbolic diagram of the sensor. The mechanical positions of the two discs have been adjusted so that the photo-transistor pulse outputs have a phase difference of 90°. In this way, the microprocessor is able to judge the direction of tape travel by testing the relative phase relationship.

Furthermore, the microprocessor judges the tape speed by counting the number of pulses for a specified period. The circuit shown in Fig. 5-3 operates as follows:

Outputs from S1 and S2 are wave-shaped by U23 (3, 2) and U23 (14, 15) and the output of pin 2 of U23 is applied to input terminal D of U3 (flip-flop IC).

At the same time, pulses developed at TP3 and TP4 are logically processed by gates U2 (4, 5, 6), U4 (8, 9, 10), and U4 (9, 10) to create a train of narrow pulses that are fed to the CP (clock) terminal of U3. As a result, the flip-flop's θ terminal develops an "H" output when the tape is running in the forward direction and an "L" output when it is running in the reverse direction. (Terminal $\overline{\theta}$ develops the opposite output to that of terminal θ). The terminal θ output indicating the tape travel direction is applied to input terminal R8 of the microprocessor, thus the microprocessor can judge the tape direction.

The clock pulses entering terminal CP of U3 are fed to the divider U13 and counted down to one fifth, and the resultant output is applied to the $\overline{IRQ}$ input of the microprocessor. The microprocessor counts the pulses, calculates the tape speed and tape running time, and uses the results for the required control. For further details, refer to the counter timing chart shown in Fig. 5-4.

5-4. ENTRY OF TAPE END INFORMATION

To detect the tape end, an end sensor which works in the same way as the speed sensors is provided. As long as the tension arm is enabled, the photo transistor is on and its output is L. This output enters the CARRY IN terminal of U13 passing through U12 (11, 12, 13) and U14 (11, 12). When the tape reaches its end and stops, the output of pin 11 of U12 changes to L, then the CARRY IN (U13) terminal goes H, thereby entering the counter stop mode. The L signal at pin 11 also enters terminal B3 of the interface U20 to signal that the tape has stopped.

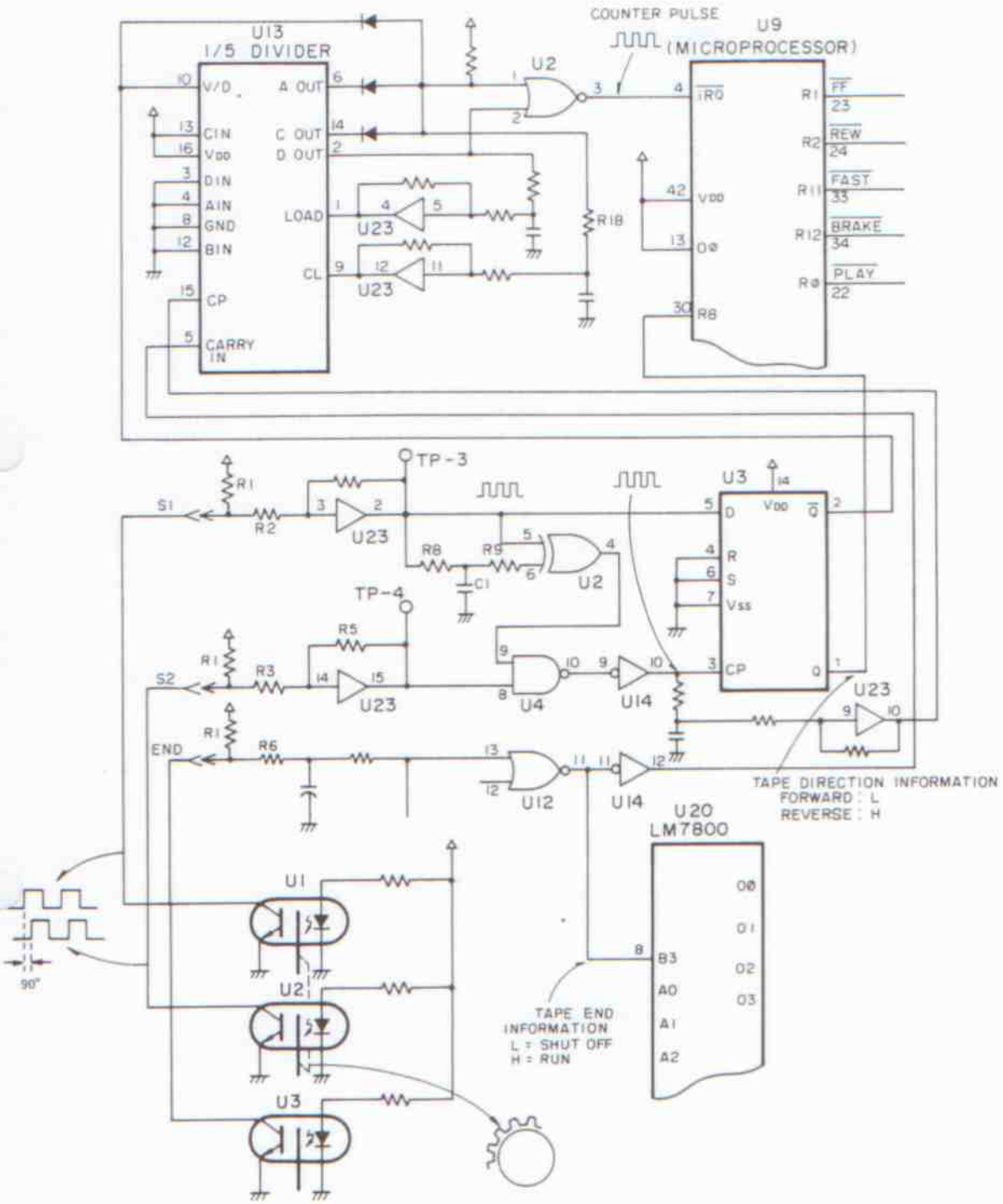


Fig. 5-3. Tape Direction Information

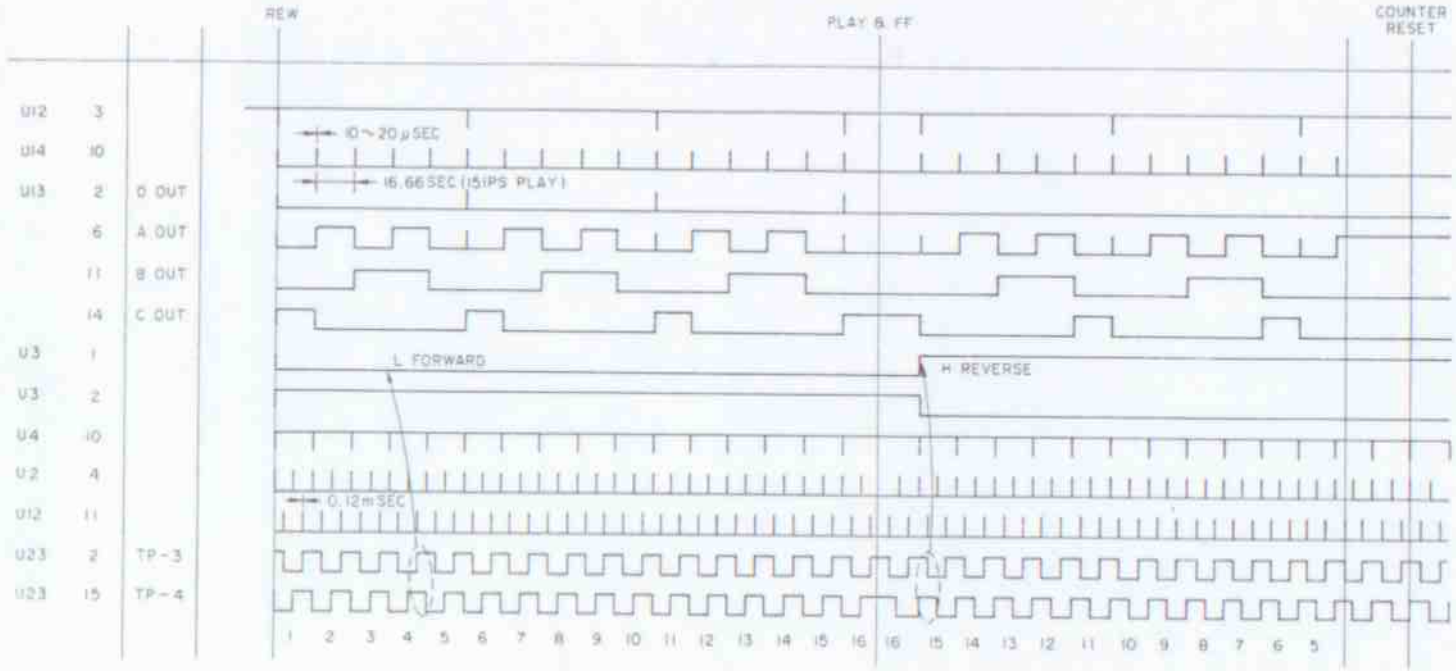


Fig. 5-4. Counter Timing Chart

5-5. ENTRY OF POWER ON/OFF INFORMATION

The microprocessor and the various associated operation circuits, etc. will work as expected as long as their power supply voltage is at the specified steady state, but may possibly work erroneously during transient periods of the power supply voltage when it is turned on or off. To prevent this erroneous operation, a power on-off reset circuit is provided and is connected to the RESET terminal of the microprocessor. (Refer to Fig. 5-5)

AC 6 V is applied to D10 immediately after power on and the rectified positive voltage flows to the cathode of D17, thus cutting off D17. Accordingly, the +5 V line voltage is applied to C13 and the voltage across C13 increases gradually because of its relatively large capacitance. Since the $\overline{\text{RESET}}$ terminal of the microprocessor maintains "L" level during this period, the microprocessor is set to its reset condition or the specified initial condition, so no erroneous operation will result.

Next, when power is turned off, the AC 6 V immediately becomes zero, so D17 conducts. That is, the electric charge stored in capacitor C13 is rapidly discharged through D17. Since the discharging time constant is set at a value shorter than the discharging time constants of the general power lines, the $\overline{\text{RESET}}$ terminal voltage of the microprocessor drops to "L" before the general power line voltages fall to low level.

That is, erroneous operation is prevented since the microprocessor is reset before any erroneous operation could occur due to the decreased line voltages.

As can be seen from Fig. 5-5, AC 6 V is also rectified by half-wave rectifier diode D9, wave-shaped by U25, and then fed to terminal R10 of the microprocessor. The microprocessor judges the power condition by referring to the pulses continuously entering this terminal. That is, if the pulses do not enter continuously, the microprocessor judges that a failure could be caused in the output amplifier line and sets the deck to the power off mode.

When the microprocessor is reset, terminal R15 develops an H level signal for approx. 3.3 sec, and the H level signal is used for OUTPUT signal muting and to make an LED blink to show the user that the deck is in its initial condition.

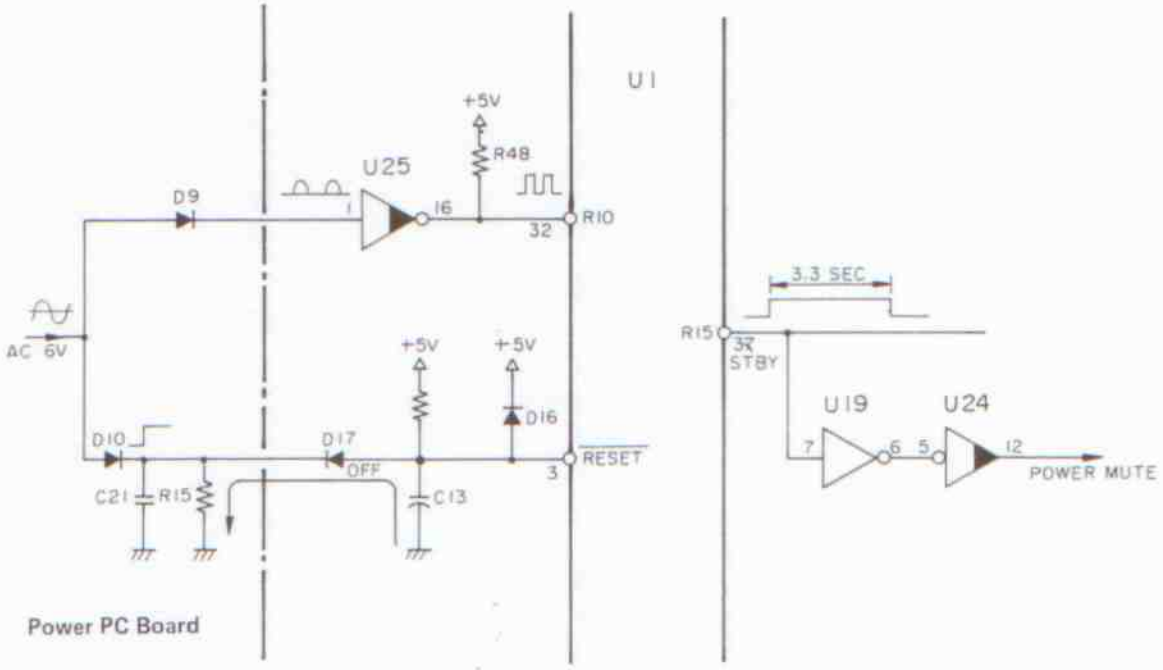


Fig. 5-5. Power On/Off Reset Circuit

5-6. MICROPROCESSOR OUTPUT CIRCUIT

When the microprocessor receives the various input signals described above, it develops the outputs shown in Fig. 5-6 according to its internal program. U8 is an interface IC to extend operation and creates the outputs shown when it receives the signals from terminals R3 – R7 of the microprocessor. For further details, also refer to "Control Signal Timing Chart" in Fig. 5-9.

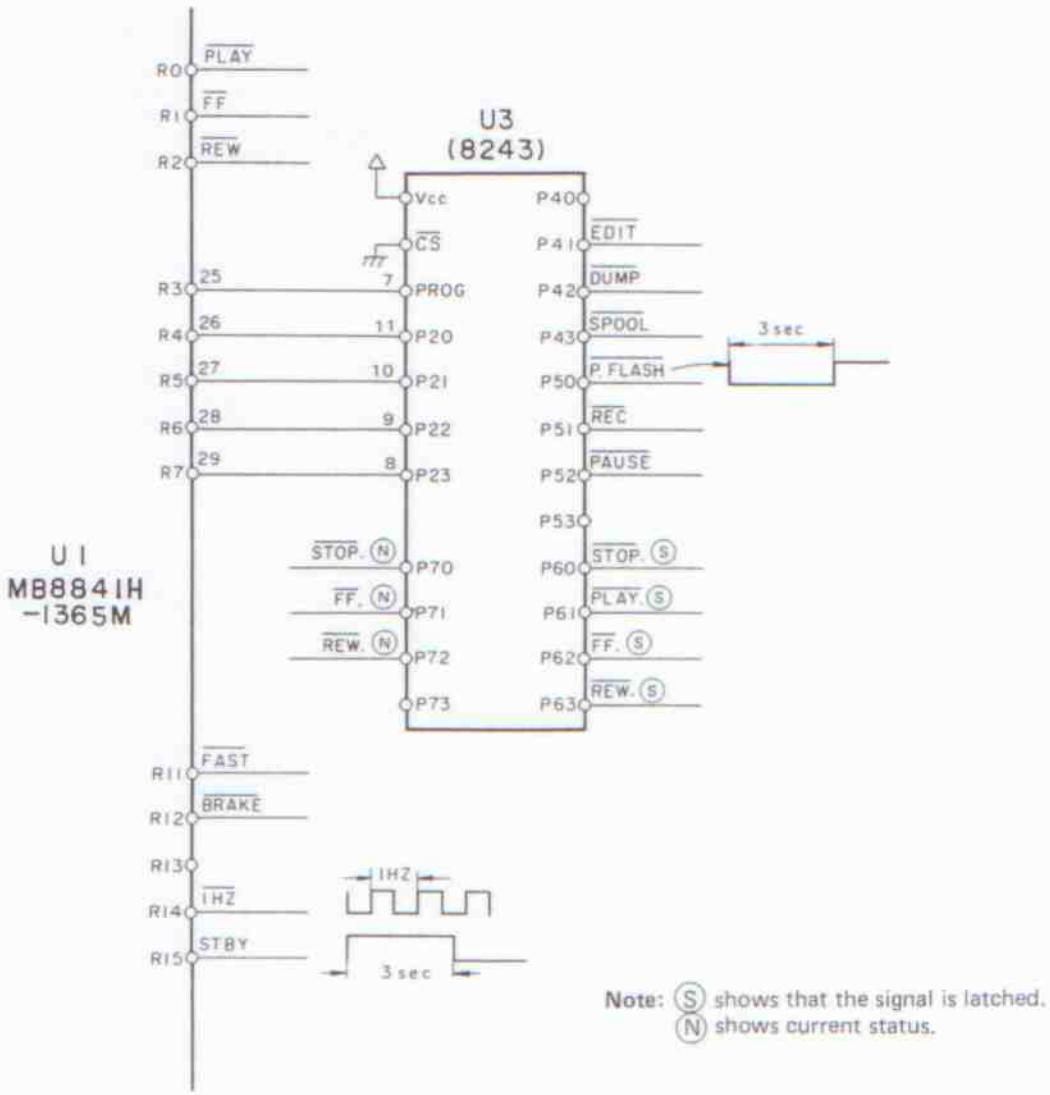


Fig. 5-6. Microprocessor Output Signals

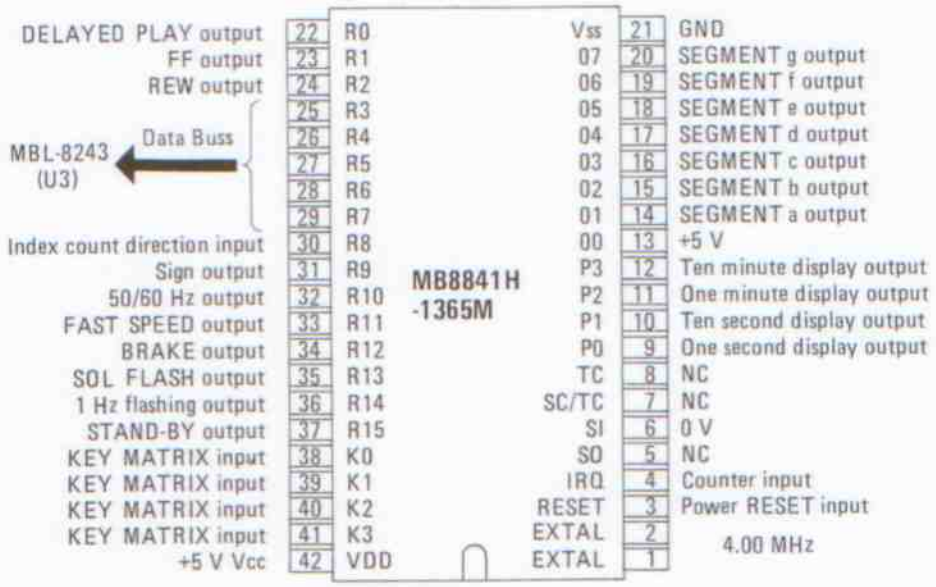
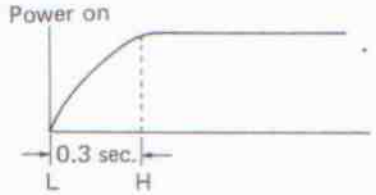
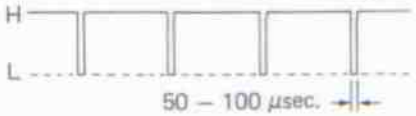
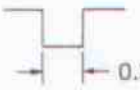
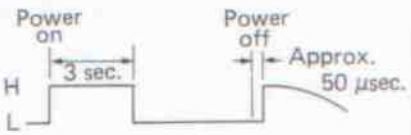


Fig. 5-7. U9 (MB8841H-1365M) Pin Assignment and Function

MB8841H	
PINS NO	FUNCTIONS
1. ~ 2.	Connects 4-MHz ceramic oscillator.
3.	Microprocessor reset terminal (L H) └— operation level └— start level before power on Goes H 0.3 sec. later when power turns on. 
4.	Receives counter display pulses (12 Hz in PLAY at 38 cm/sec.). 
5. ~ 8.	NC
9. ~ 12.	Send out keymatrix & counter display driver output control sig.
13.	+5 V
14. ~ 20.	Counter display segments (a) ~ (g) output
21.	GND

22.	PLAY output (H —→L) Goes L when PLAY is pressed and pinch roller is activated. When PLAY is pressed during F. FWD, REW or RTZ/STC and tape speed drops to 100 cm/sec., it goes L 0.5 sec. later.
23.	F. FWD output (H —→L) Goes L when F. FWD is pressed, or when electrical brake is activated if F. FWD is pressed during fast-reverse winding at a speed higher than 100 cm/sec.
24.	REW output (H —→L) Goes L when REW is pressed (and electrical brake is activated).
25. ~ 29.	Feed output expander.
30.	Receives counter display counting direction information. L – counting-up (PLAY and fast-forward winding) H – counting-down (fast-reverse winding)
31.	Outputs counter display driver output control sig.
32.	50/60 Hz input While power is on, the same square wave frequency of sig. as that of AC line enters.

33.	FAST output (H → L) Goes L when F. FWD or REW is pressed or RTZ/STC is initiated. In RTZ/STC, it returns to H when a point 7 m apart from zero/cue points (18 sec. distance on counter) is attained.
34.	BRAKE output (H → L) Goes L when EDIT, PLAY, F. FWD or REW is pressed.
35.	SOL FLASH output (H → L) Goes L for 0.3 sec. when EDIT, PLAY, F. FWD or REW is pressed. 
36.	1-Hz output 
37.	STB output (L → H) Goes H for 3 sec. when power is applied. When power is turned off also it goes H instantaneously (50 msec. later). 
38. ~ 44.	Keymatrix inputs.
42.	Vcc +5 V

MBL8243	
PINS NO	FUNCTIONS
1.	P. FLASH (H → L → H) Goes L for 3 sec. when PLAY is pressed (DUMP EDIT engagement included).
2.	LIFT SOL unused
3.	EDIT output (H → L) Goes L when EDIT only is pressed (in STOP)
4.	DUMP output (H → L) Goes L when PLAY and EDIT are pressed simultaneously. (DUMP is accessible from STOP, PLAY or EDIT, or by manually disengaging the right tension arm.)
5.	SPOOLING output (H → L) Goes L when F. FWD is pressed during fast-forward winding or REW during rewinding. Returns to H when F. FWD is pressed during forward SPOOLING or REW during reverse SPOOLING. Does not go L if F. FWD or REW is pressed opposing to the tape running direction.
6.	Chip Select "L"
7. ~ 11.	DATA BUSS
12.	GND
13.	Ⓝ STOP (H → L) Goes L when transport enters STOP.
14.	Ⓝ F. FWD (H → L) Goes L when F. FWD is pressed and the tape starts running in forward direction (forward SPOOLING mode included).
15.	Ⓝ REW (H → L) Goes L when REW is pressed and the tape starts running in reverse direction (reverse SPOOLING mode included).
16.	Ⓢ EDIT (H → L) unused
17.	Ⓢ REW (H → L) Goes L when REW is pressed.
18.	Ⓢ F. FWD (H → L) Goes L when F. FWD is pressed.
19.	Ⓢ PLAY (H → L) Goes L when PLAY is pressed.
20.	Ⓢ STOP (H → L) Goes L when STOP is pressed or end sensor is activated.
21. ~ 22.	NC
23.	RECORD (H → L) Goes L when recording (Punch-In included) is initiated. RECORD indicator turns on.
24.	+5 V

5-7. TAPE TRANSPORT CONTROL CIRCUIT OUTPUT

5-7-1. Play Mode

When the PLAY button is pressed the microprocessor decodes its instruction as described, previously and develops outputs from U9 and U8 as shown in the timing chart (Fig. 5-9) according to its internal program.

That is:

U9 $\overline{\text{PLAY}}$ terminal goes L
U9 $\overline{\text{BRAKE}}$ terminal goes L
While U9 $\overline{\text{FF}}$ terminal is H
U9 $\overline{\text{REW}}$ terminal is H
U8 $\overline{\text{P. FLA}}$ terminal goes L for 3 sec. only.
PLAY Ⓢ terminal goes L.

From the above conditions, U16 (1, 2, 3), U5 (11, 12, 13), U5 (8, 9, 10), U5 (4, 5, 6), etc. perform the logical operations shown in Fig. 5-8, resulting in the control outputs shown below:

P-6	BRAKE	output goes H
	PLAY	output goes H
P-4	PLAY FLASH	output goes H for only 3 sec.
	PINCH	output goes H
	BRAKE	output goes H
	SOL FLASH	output goes H
P-3	$\overline{\text{BRAKE}}$	output goes L

These control outputs are fed to the motor drive circuit, amplifier function circuit, etc. and control associated functions in playback operation.

Capacitors C17, C18 and C19 connected to U31, U32, and U33 respectively, develop a control signal that generates flashing current with a short period to start the solenoid when it is actuated, and the SOL FLASH terminal goes H until the charging of the capacitors is completed.

5-7-2. Record Mode

The record mode is the same as the play mode in terms of the mechanism, so the same control outputs as those for the play mode are developed except for the following. As the RECORD button is pressed, the $\overline{\text{REC}}$ output of U8 goes L. As a result, the $\overline{\text{REC}}$ terminal of P-3 goes L and this is used to make the amplifier circuit change to the record mode.

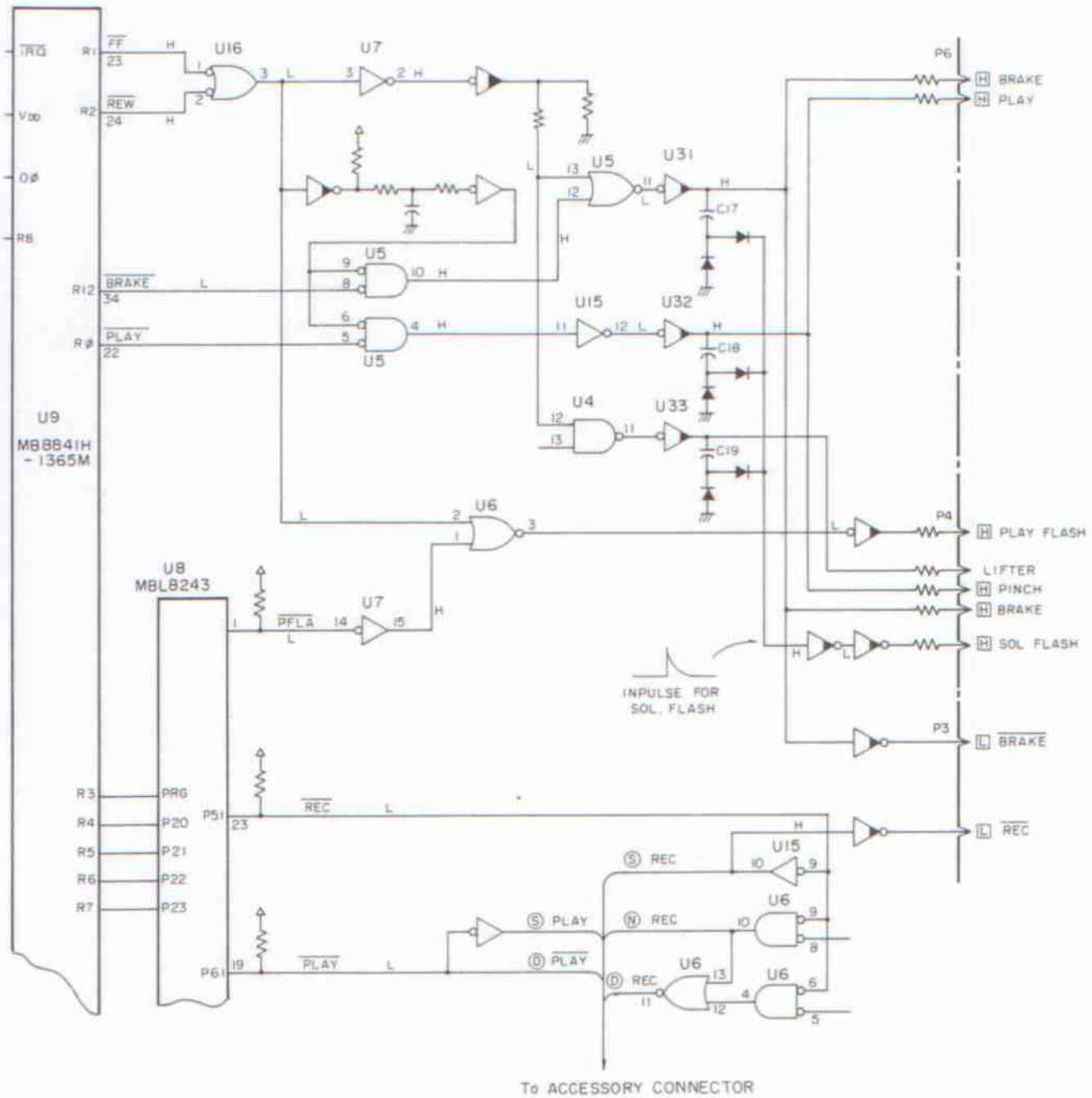
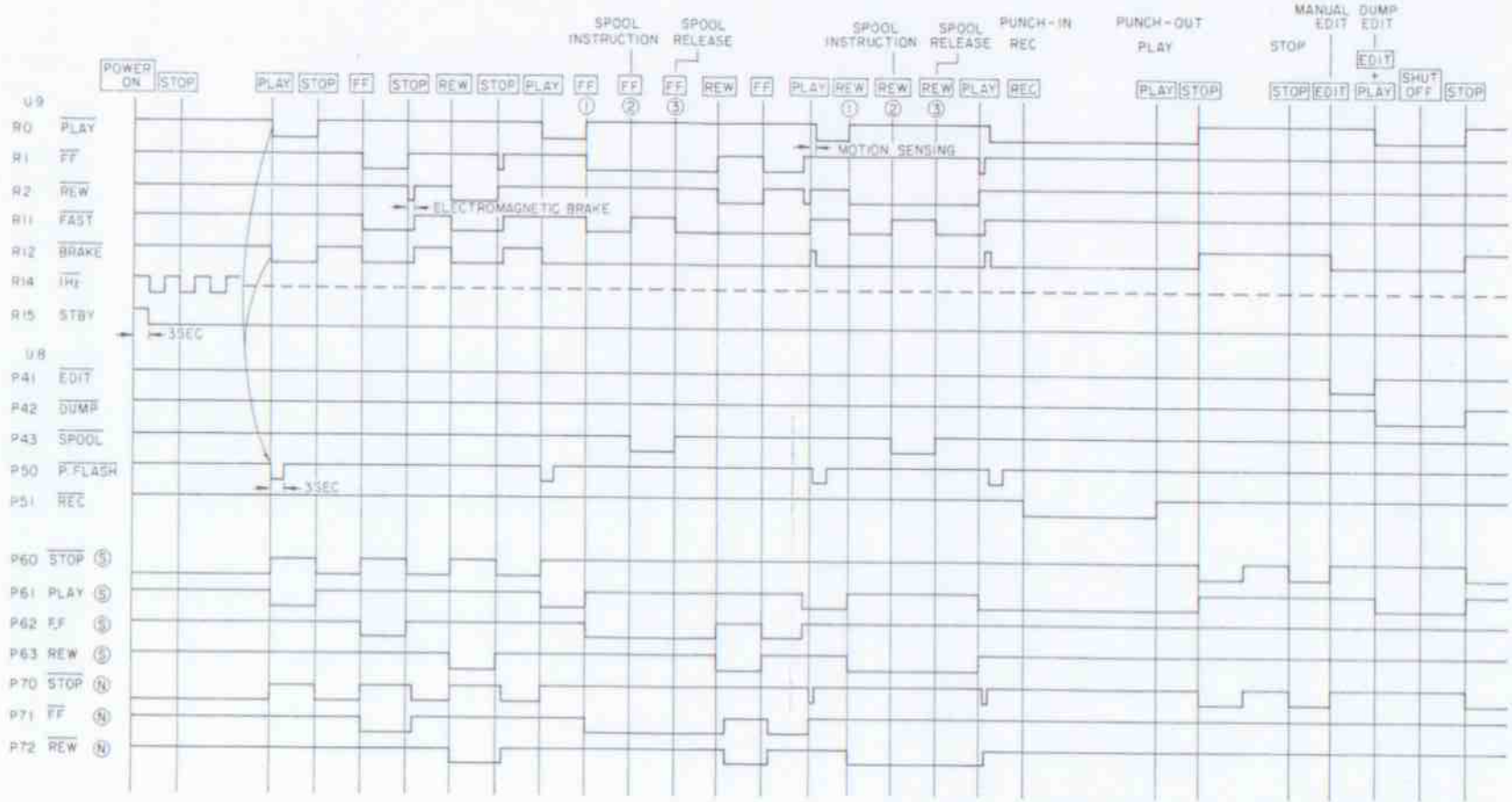


Fig. 5-8. Play/(Rec) Mode Control Signal



Note: (S) .... COMMAND OUT
(N) .... TALLY

Fig. 5-9. Control Signal Timing Chart

5-7-3. FF Mode

When FF mode button is pressed

U9 $\overline{\text{FF}}$ terminal goes L
$\overline{\text{FAST}}$ terminal goes L
$\overline{\text{BRAKE}}$ terminal goes L
U8 $\overline{\text{STOP}}$ Ⓢ terminal goes H
$\overline{\text{FF}}$ Ⓢ terminal goes L
$\overline{\text{STOP}}$ Ⓝ terminal goes H
$\overline{\text{FF}}$ Ⓝ terminal goes L

As the result, logical operations are performed in the same way as in the PLAY mode and result in following outputs on the control PCB.

P6 FF terminal goes H
FAST terminal goes H
BRAKE terminal goes H
P4 $\overline{\text{BRAKE}}$ terminal goes H
P3 $\overline{\text{BRAKE}}$ terminal goes L

(Refer to Fig. 5-12)

5-7-4. REW Mode

In the same way, when the REW mode button is pressed.

U9 $\overline{\text{REW}}$ terminal goes L
$\overline{\text{FAST}}$ terminal goes L
$\overline{\text{BRAKE}}$ terminal goes L
U8 $\overline{\text{STOP}}$ Ⓢ terminal goes H
$\overline{\text{REW}}$ Ⓢ terminal goes L
$\overline{\text{REW}}$ Ⓝ terminal goes L
$\overline{\text{STOP}}$ Ⓝ terminal goes H

As a result, P6 REW terminal goes H
FAST terminal goes H
BRAKE terminal goes H
P4 $\overline{\text{BRAKE}}$ terminal goes H
P3 $\overline{\text{BRAKE}}$ terminal goes L

(Refer to Fig. 5-13)

5-7-5. STC (Search-To-Cue) Mode

The function of the STC is to automatically detect arbitary index points on the tape and to stop the tape at these points.

For example, if the tape is run with the tape counter set to "00:00" and the "CUE" button is pressed when the point to be referenced later is found (assume the counter reading is "10:00" at this point). The tape is then run for more than 5 minutes in the same direction, then the STC button is pressed. The tape is then rewound in the forward direction and stops at the position at which "CUE" button was pressed 5 minutes earlier. This operation is shown by the timing chart shown in Fig. 5-10. In the above example, the cue point is searched during tape travel in the FF mode, but the search will be made in a similar way in the rewind direction.

When the STC button is pressed in above example, the transport mode of the tape is changed to fast-forward and the tape is rewound up to the position 7 m (23 ft) from the cue point in the FF mode and the electromagnetic brake is automatically applied (electrically, the FF mode is changed to the REW mode as illustrated in the timing chart) to reduce the tape speed temporarily. When the tape speed is reduced to 100 cm/sec (40 ips), the electromagnetic brake is released. The FAST signal goes H and the FF signal goes L again; in this way the tape is also rewound in the FF mode and it reaches the cue point, then the mechanical brake is actuated and this makes the tape stop completely.

* If the STC button is pressed within 7 m (23 ft) from the cue point, the tape is driven at a lower tape speed and stops in the same way as explained above.
* If the tape speed is not reduced to a value lower than 100 cm/sec, the tape may overrun the cue point depending upon the amount of tape wound on each reel, but the tape will return and stop precisely at the cue position. The stop error is approx. 1 second.
* If the CUE button is not pressed in the STC mode, the counter reading of "00:00" is automatically registered as the CUE position. Once the cue point has been registered, it is held until the CUE button is set again, and is not affected by the counter reset button because the relative CUE position is not altered as shown in Fig. 5-11 when the counter reading is changed.

5-7-6. RTZ (Return-To-Zero) Mode

The RTZ mode is the same as the STC mode except that the search is carried out to find the tape position at which the counter was set to "00:00".

5-7-7. Other Modes

For any other mode, the status of the output at each terminal can be found by following the logical process from the outputs developed by U9 and U8 as shown in Fig. 5-9. The actual output states for the remaining modes are not shown.

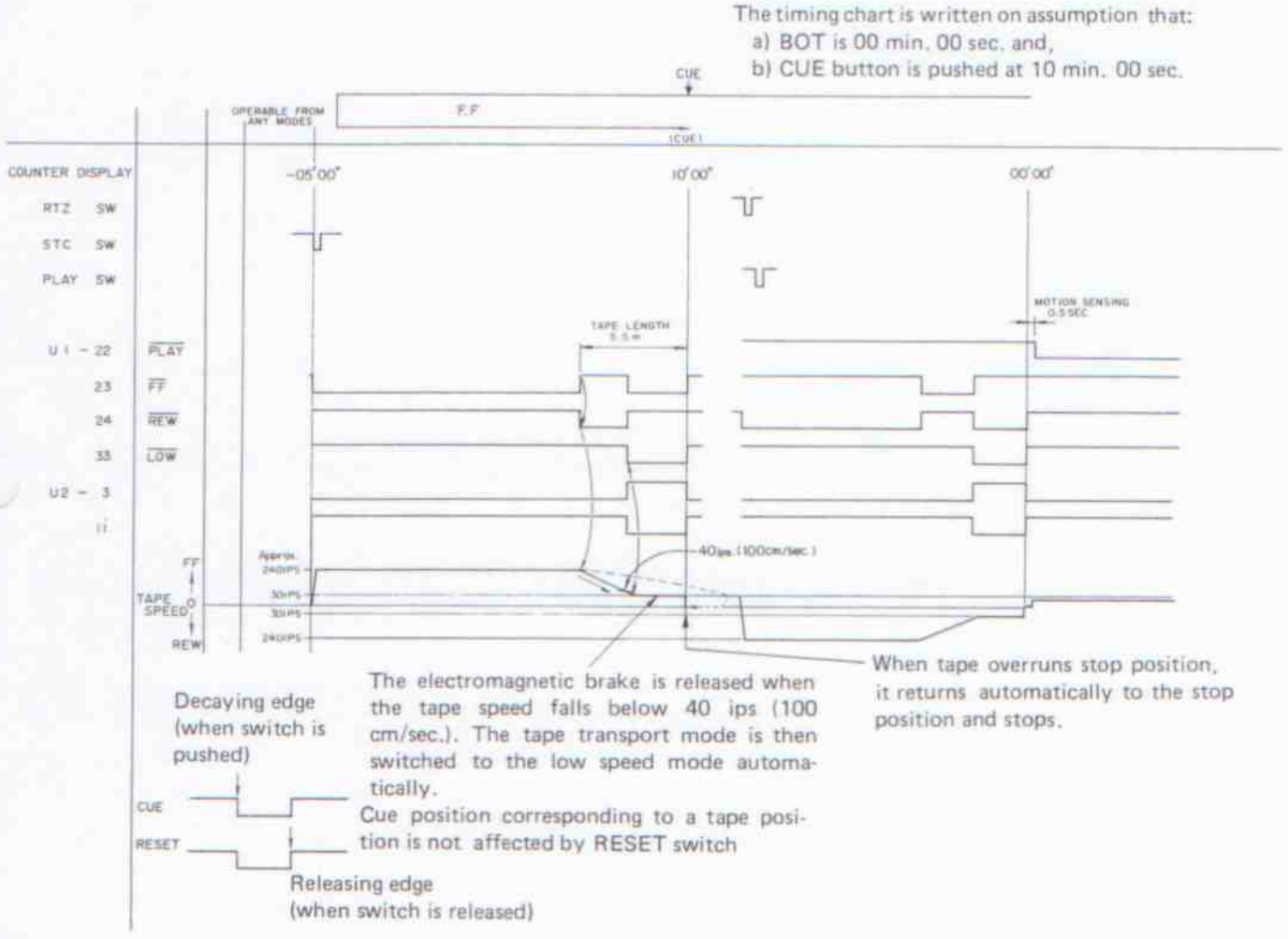


Fig. 5-10. Timing Chart for Search Mode

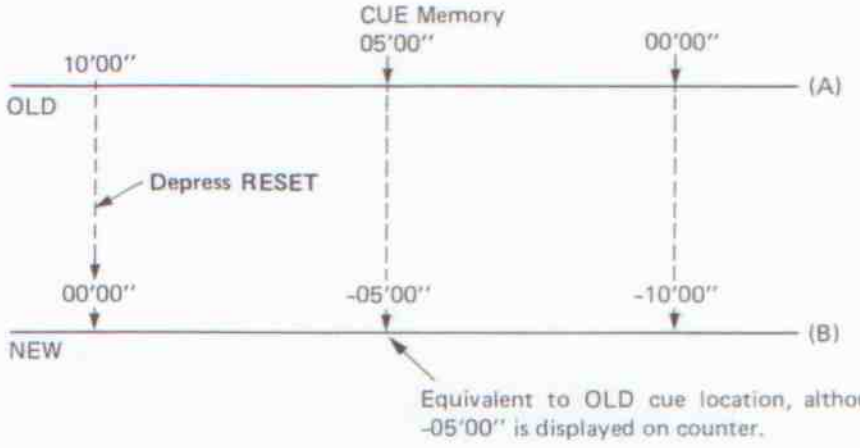


Fig. 5-11.

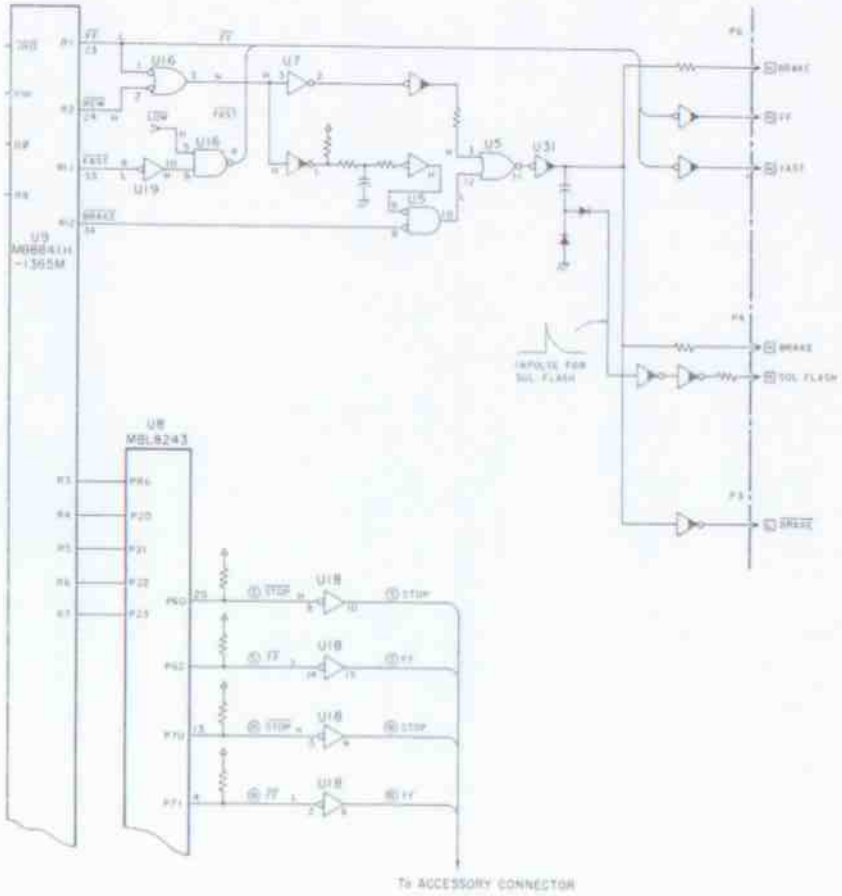


Fig. 5-12. FF Mode Control Signal

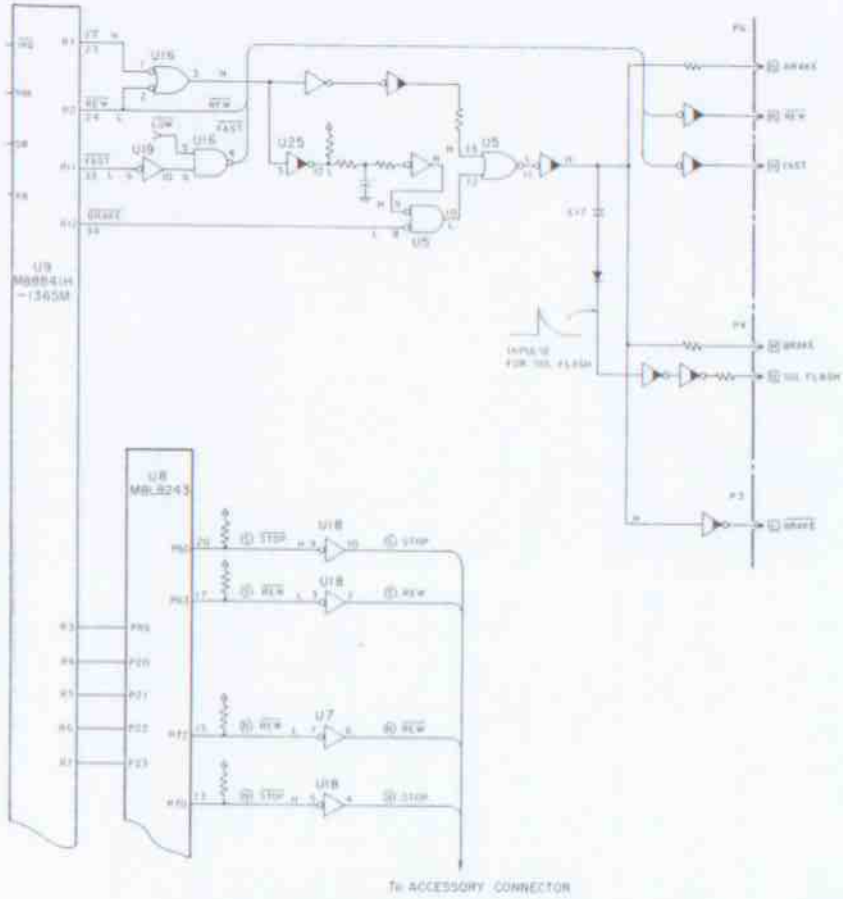


Fig. 5-13. REW Mode Control Signal

5-7-8. Reel Servo Circuit

Fig. 5-14 shows the reel servo circuit.
Two identical circuits, each of which consists of Q1, T1, D1, etc. operate as tape tension detector circuits for the left and right reels. Q1 functions as an oscillator and its oscillation voltage passes through T1 and is rectified by D1. Since a metal piece is inserted between the primary and secondary windings of T1, the coupling factor of the transformer will change as the metal piece moves in response to tape tension, thus varying the voltage input to the diode. That is, the output voltage rectified by the diode will change as the tape tension changes. This tape tension voltage is applied to the inverted terminal 9 of comparator U24.
The non-inverted terminal 10 of the comparator is connected to an external variable resistor. This functions to adjust the reference voltage at pin 10 of the comparator and to set tape tension threshold (voltage) for the left reel. The output of pin 8 of U24 is further applied to the inverted terminal of U24 (12, 13, 14). Another reference voltage which varies according to a mode (FF, REW, etc) is applied to the non-inverted terminal in this stage. For example, in the FF mode, the "H" level voltage from the control PCB is applied to the FF terminal of P10, and this closes analog switch U16 (8-9).
In this condition, as the REW terminal of P-10 is at L, U16 (10-11) is open and this allows the output from D21 to enter the non-inverted terminal of comparator U24. As can be seen from the schematic diagram, the input voltage depends upon the conditions of the following three inputs:

a. Whether the FAST signal from the control circuit is H or L.
b. Whether the SPOOL signal from the control circuit is H or L.
c. Status of PG pulse.

and controls the tension to the optimum condition matching to each mode.
For example, when the FF or REW mode is selected, the FAST signal becomes H, and this makes the analog switch U6 (1-2) close, connecting R146 and R149 in series to R145.
When the SPOOL mode is selected, U6 (4-3) closes and R147 and R150 are connected in series to R145.
At the same time, the PG pulse entering pin 1 of P-10 is wave-shaped and inverted by U17 (7-6), and the resultant output is split into two, each of which is rectified by D23 and D24. Since the rectified output is inversely proportional to the tape speed, the output from pin 12 of buffer U18 decreases as the tape speed increases. At the same time, the output D24 goes H and L alternately and opens or closes the sampling switch U6 (8-9). The voltage output determined in this way by the tape speed and operation mode changes the sampling and hold capacitor C55, the voltage across C55 enters pin 5 of operational amplifier U5, and the pin 7 output is applied to the inverted terminal 2 of operational amplifier U5.
That is, the output of pin 1 of U5 increases as the tape speed increases, and the voltage is applied to pin 12 of U24 through D21. Since the tape tension is arranged to increase as the voltage at pin 12 of U24 increases, the back tension of the supply reel motor is increased in this case (FF mode), thus reducing the rotational speed of the take-up reel.

* In the REW mode, analog switch U16 (8-9) is opened and U16 (11-10) is closed, so the output of D21 enters pin 3 of U24 and controls the back tension of the take-up reel motor in a similar way.
  U23 (5, 6, 7), Q11 and the external transistor connected to the Q11 form the drive circuit for the left reel motor, and the tension control voltage described just above is applied to pin 5 of U23. Feedback is applied from the emitter of the external transistor to the inverted terminal 6 of U23 to drive the motor in the constant current mode. The same drive circuit is also used to drive the right reel motor.
* The flashing voltage which allows starting of the take-up motor in the playback mode is created as follows:
  The H pulse supplied to the PLAY terminal of P-10 is fed to U18 through C60 and its output is applied through U28 to pin 3 of comparator U24 which controls the take-up reel

motor. When power is initially turned on, the H signal applied to STBY input terminal of P-10 keeps its H level for three seconds. The H level signal passes through D29 and D32 and enters pins 3 and 4 of U18 respectively and makes each output low (L), thus disabling the reel motor drive circuits. That is, both the left and right reel motor cannot rotate for the first 3 seconds.

When the STBY input becomes L after the three seconds have elapsed and the BRAKE signal which releases the brakes becomes H, the circuit operates logically as illustrated, and both pins 14 and 13 of U18 become H. Then the motor drive circuits start to function and motors rotate.

* In the DUMP mode, as the DUMP terminal of P-10 goes H, pin 1 of U18 (1, 16) goes H, then pin 13 of U18 (4, 13) goes L and makes the take-up side motor stop.

At the same time, pin 1 of U18 goes H and pin 16 goes L, but as pin 2 of U18 is being set to H by the BRAKE signal, pin 14 or U18 is kept at H, thus turning the supply reel motor.

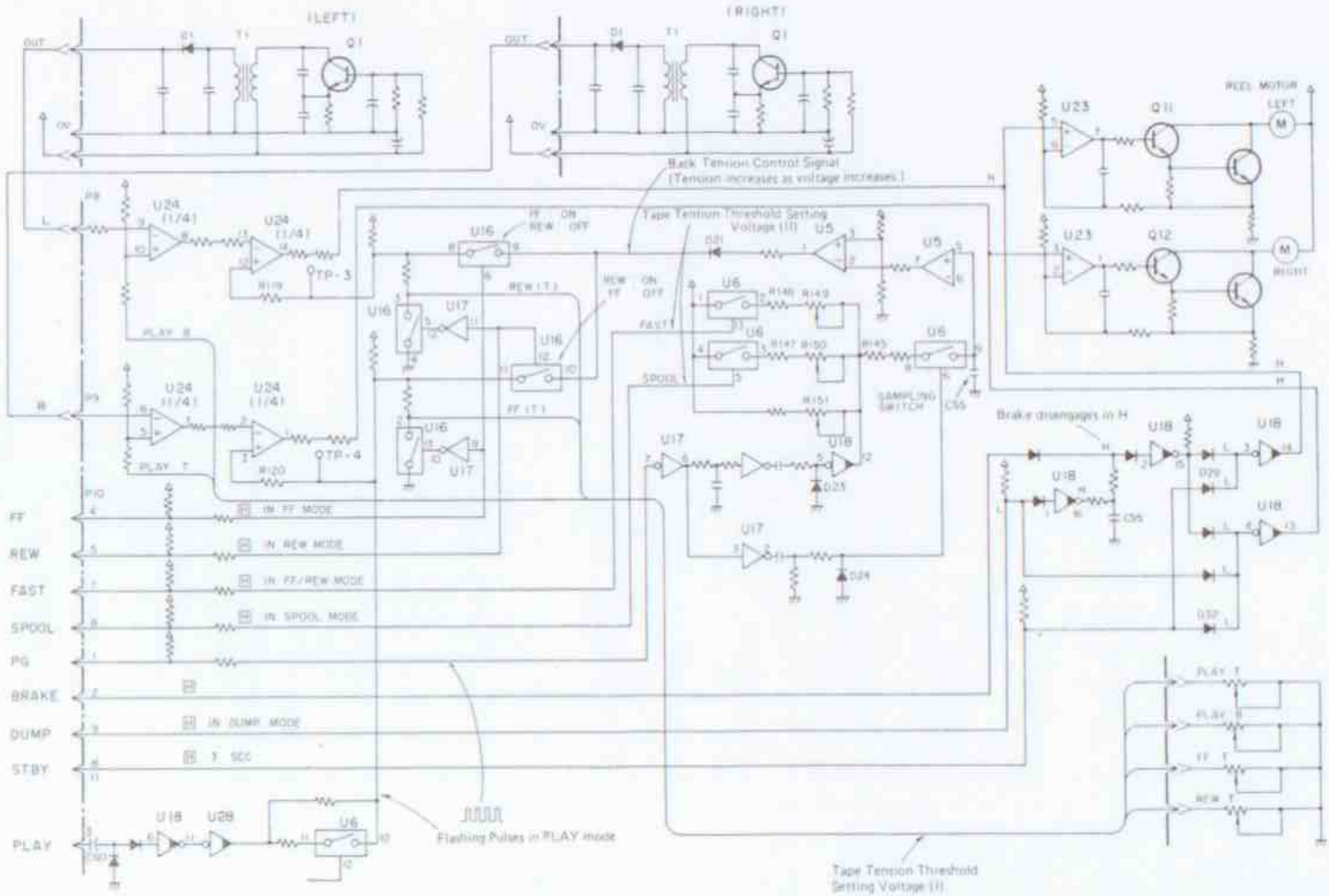


Fig. 5-14. Reel Servo Circuit

5-7-9. Capstan Motor Servo Circuit

The capstan motor servo circuit consists of a crystal oscillator which functions as the reference for control, gate processing circuits which determine whether the control is carried out by means of a) the reference frequency, b) pitch control, or c) synchronization with an external frequency, F-V converter (I) which converts the fluctuations of the capstan motor (or variations of the FG frequency) into a voltage, a phase detector circuit which detects phase differences between the FG frequency of the capstan motor and the control frequency (either the reference frequency, variable frequency for pitch control, or external synchronization frequency), a ϕ-V converter which converts the phase difference into a control voltage, F-V converter (II) which conterts the control frequency into the control reference voltage, an adder which mixes the above three control voltages, and the drive circuit which receives the adder output and drives the capstan motor.

Fig. 5-15 shows the block diagram of the capstan servo circuit.

1. When the speed mode switch on the pitch control display PC board is set to the VARI, FIX or EXT positions, the selected circuit becomes L (Refer to Fig. 5-16).
2. Since capstan motor speed control is carried out by varying the control frequency, a variable oscillator is needed to control the pitch continuously. U2 (1, 2, 3), U2 (5, 6, 7) and U1 (5, 12) constitute the variable frequency oscillator, and R33 functions as a coarse frequency control and R32 as a fine frequency control. The frequency output adjusted by these controls is applied to the gate processing circuit (pin 6 of U9) on the motor drive PC board as the control frequency (VARI-F) for the pitch control, and then the output of U9 (4, 5, 6) is fed to pin 1 of U10 (1, 2, 8, 9).
3. On the other hand, the external frequency for the external pitch control enters pin 2 of U10 (1, 2, 8, 9) through terminal 4 of connector P3.
4. Pitch control reference frequency of 9.6 kHz is applied to pin 8 of U10 through gate circuit

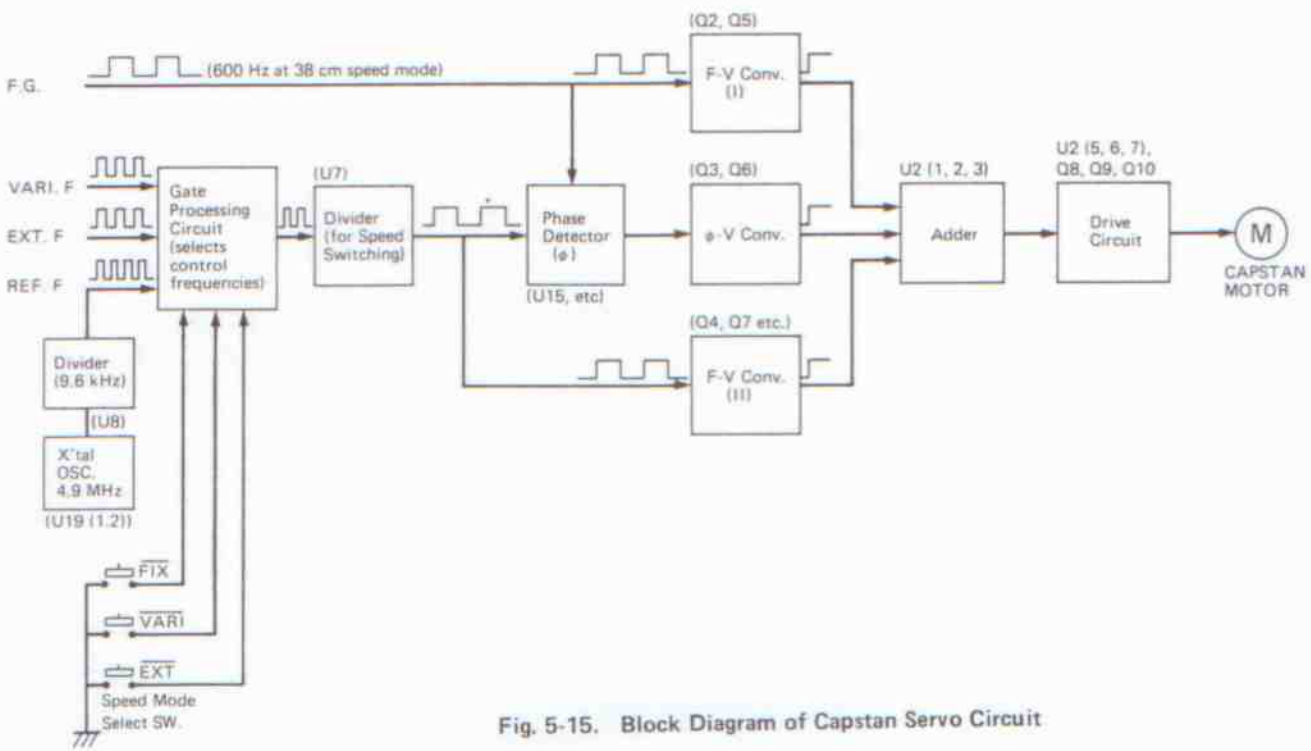


Fig. 5-15. Block Diagram of Capstan Servo Circuit

U9 (1, 2, 3).

5. One of above three control frequencies is selected by the signal (FIX, VAR1, EXT) from the speed mode switch, and the selected output is obtained at pin 9 of U10. Since the output frequency is around 9.6 kHz (depending upon the selected mode) and is much higher than the FG frequency (approx. 600 Hz in 38 cm speed mode), it cannot be compared with the FG frequency directly. That is, the control frequency at pin 9 of U10 must be counted down to the level of the FG frequency. This counted-down control frequency enters pins 1 and 9 of U12 and is output from pin 4 of U12. The signal developed at pin 4 of U12 has the frequency to be compared with the PG frequency in their phases, and is 600 Hz.
6. The control reference frequency obtained in this way is applied to pin 9 of U14 through U11 (9, 10) and U11 (5, 4), and to pin 3 of U15. At the same time, the FG pulse enters pin 5 of U14 and pin 13 of U15. The phases of both signals entering pins 3 and 13 of U15 are compared and the phase difference is detected in U3 and U14.
   U3 pin 1 develops an error voltage proportional to the phase difference. The error voltage passes U13 (7, 6), U13 (9, 10), and Q3 and is sampled by the analog switch U1 (9, 8) which is actuated to be synchronized with the PG pulse. The sampled or charged voltage across C11 is fed to pin 3 of adder U2 through buffer Q6.
7. In a similar way, the FG signal applied to the other analog switch U1 (10, 11) passing through U13 (14, 15) and Q2 is also sampled by the switch and charges capacitor C8.
   The charged voltage is also applied to pin 3 of U2 (adder) through buffer Q5.
   Since the FG frequency increases as the capstan motor speed increases, the output of Q5 will be reduced as the speed increases.
8. At the same time, the control reference frequency developed at pin 4 of U12 passes U11 (9, 10), U11 (5, 4) and Q4, enters the sampling switch U1 (3, 4), and is sampled.
   The sampled voltage charges C19 and the charged voltage is also applied to pin 2 of adder U2 through buffer Q7 and operational amplifier U2 (8, 9, 10) as the reference voltage of the speed.
   As a result, pin 1 of adder U2 develops a capstan motor control voltage depending upon the three input signals described above.
9. Since the output signal developed at pin 1 of U2 will reduce as the speed increases, the output at pin 7 of U2 also reduces. Consequently, Q8 collector current will increase, and Q9 emitter current or Q10 emitter current decreases, thus lowering the speed of the motor. In this way, the capstan motor is controlled to rotate at the specified speed.

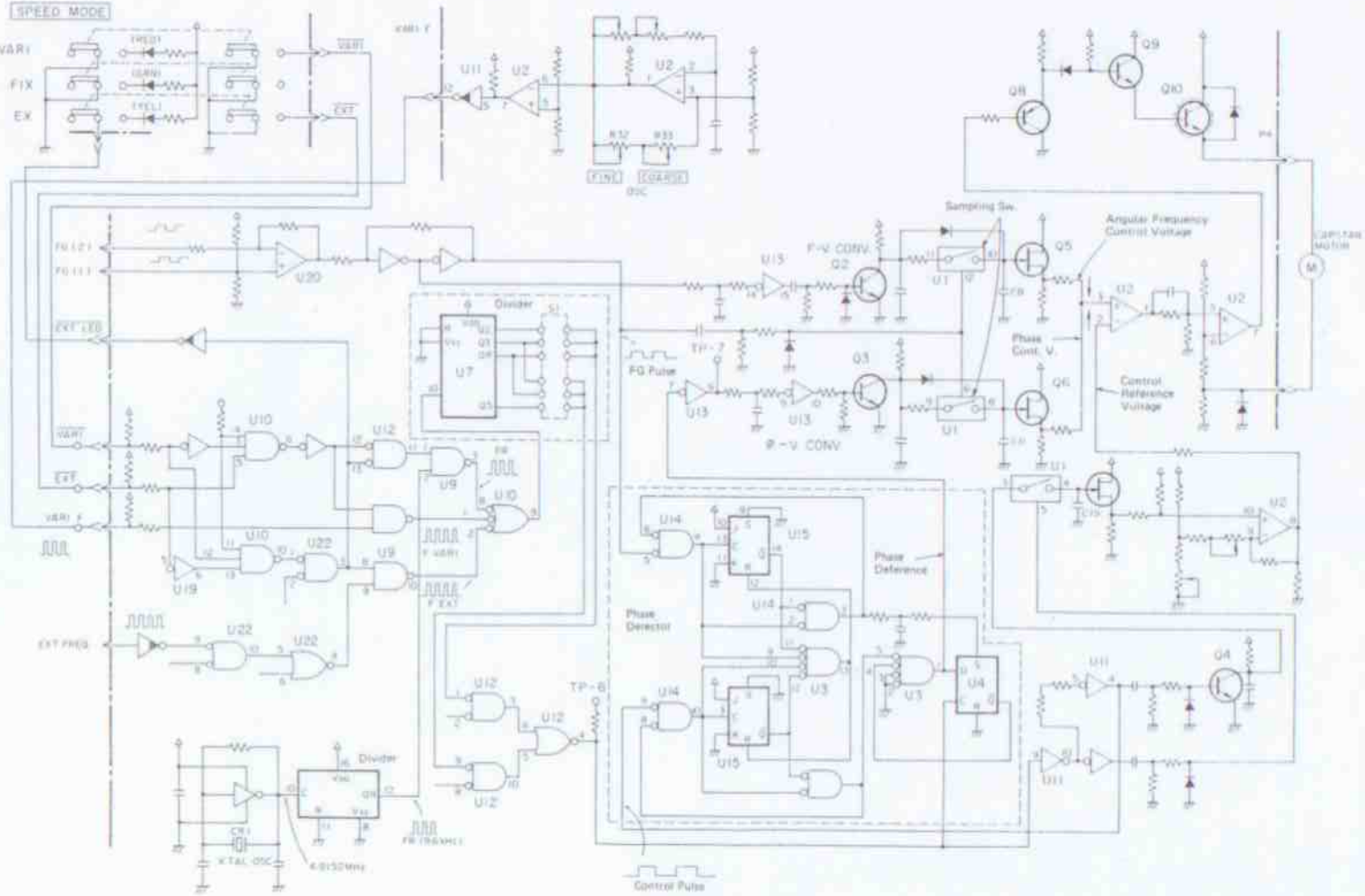


Fig. 5-16 Capstan Motor Servo

5-8. AMPLIFIER CONTROL CIRCUIT

The description will be made on the REC/PLAY AMPL, FUNCTION A and FUNCTION B PCB ASSY circuits shown in Fig. 5-19 on page 5-35, so fold out this page and refer to it while following this description.

5-8-1. Input Mode

As for channels 1-15, when the OUTPUT SELECT switch on the FUNCTION A PCB is placed in the INPUT position, input terminal 7 of the inverter U6 (6, 7) becomes L to cause pin 7 of the connector P-2 to output INPUT sig. Thus produced the L level output is then fed to terminal 16 of the REC/PLAY AMPL PCB ASSY.

The L level signal sent to the INPUT terminal is fed through U6 (11, 12) to D13, and then sent back to the inverter U6 (14, 15) for voltage shifting to approx. -5 V via a resistor network consisting of R60, R61 and R62. The negative voltage is applied to the FET switch Q12 through D2, making it turn off.

On the other hand, the output voltage from pin 15 of U6 (14, 15) inverter is also fed to pin 3 of another U6 (2, 3) inverter, and its output voltage is fed to Q13 gate after the voltage is shifted to approx. +5 V via a resistor network consisting of R64, R65 and R66, thus making Q13 conductive. The INPUT signals are accordingly output to the OUTPUT terminals after passing through C19, U3 (1, 2, 3) — an input buffer amplifier, R206, Q13, U2 (1, 2, 3) — an output amplifier, and C17 and R37. In other words, input signals are output via an OUTPUT terminal regardless of operations such as REC, PLAY, etc.

On channel 16, while the channel's SYNC/INPUT switch is in the "off" position (INPUT), input pin 2 of U5 (1, 2, 3) remains L to allow terminal 6 of the connector P-2 (on the FUNCTION A PCB ASSY) to output INPUT Sig for accomplishing the same signal operations as on channels 1-15.

5-8-2. Reproduce Mode

When the OUTPUT SELECT switch is placed in the REPRO position with the reproduce mode selected, output pin 4 of U3 (4, 5, 6) on the FUNCTION A PCB ASSY goes L. Consequently terminals 2 and 3 of the connector P-2 to which U7 (2, 15) and U7 (3, 14) are connected, respectively, become H. The H level output is connected to terminal 19 of the REC/PLAY AMPL PCB ASSY to turn Q15 on. This is turn, turns on PLAY MUTE transistor Q9 to release the muting circuit. With the reproduce mode selected, U6 (11, 12) input is supplied from the +15 V line, causing it to go H as terminal 16 is opened. Therefore, U6 (11, 12), U6 (14, 15) and U6 (2, 3) are inverted from as originally described under the INPUT mode of operation which causes Q13 to turn off and Q12 to turn on. In other words, reproduce signals are now obtainable from the OUTPUT terminals.

Furthermore, because the SYNC signal is in a non-SYNC state (H), Q17 is turned off and relay K1 is switched to the REPRO side, causing Q10 to turn on. This means that the reproduce circuit is able to function normally.

5-8-3. SYNC Mode

Output mute when switching the OUTPUT SELECT SYNC switch on and off:

a) When the SYNC switch is operated, levels at each input pin of the EX-OR gate U3 (1, 2, 3) become as shown in Fig. 5-17. Pulse ⓐ appears at output pin 3 of U3 (1, 2, 3) for a period equal to the time constant of C3·R14. This pulse causes C4 installed ahead of pin 5 of U3 (4, 5, 6) to store and release the charge through R48 as the SYNC switches on and off.

   Output from pin 4 of U3 (4, 5, 6) goes H while its input pin 5 is L (during the C4 discharging time or time period determined by C4·R48 time constant; i.e. 450 msec.), which allows output pin 14 of U7 (3, 14) to generate PLAY MUTE sig., and outputs of channels 1-15 are muted.

   Output pin 15 of U7 (2, 15) (assigned to control the muting circuit of channel 16) does not generate PLAY MUTE sig. during Sync Lock Mode.

b) When the OUTPUT SELECT SYNC switch is turned on, the REC/SYNC head is switched to the reproduce function, and when the SYNC switch is turned off, the REPRO head is switched to the reproduce function.

   This head selection is accomplished by the SYNC sig. With SYNC engaged, the SYNC sig. is generated after being delayed for 60 msec [time determined by time constant of C5·R51 (ch. 1-15) or C6·R54 (ch. 16)] and the reproduce amplifier is connected to the REC/SYNC head. With SYNC disengaged, the SYNC sig. is interrupted with the same delay of 60 msec. and the reproduce amplifier is

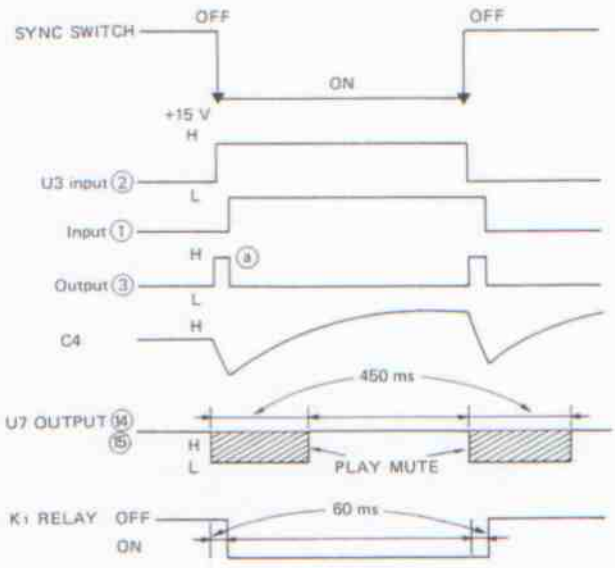


Fig. 5-17. Play Mute

OUTPUT SELECT Switch	INPUT ENABLE Switch	REC Function Switch	INSERT (INPUT/SYNC) Switch	RECORD Button	Operation Mode	OUTPUT Source
INPUT	–	–	Ch. 1 – 15: – Ch. 16: INPUT	–	–	INPUT
REPRO	–	–	Ch. 1 – 15: – Ch. 16: INPUT	–	PLAY, EDIT CUE △ LIF/DEF △ STOP ●	REPRO
					FAST	Muted
SYNC	ON*	–	–	–	STOP, FAST	INPUT
	OFF	ON	INPUT	–	–	INPUT
			SYNC	OFF	PLAY, EDIT CUE △ LIF/DEF △ STOP ●	SYNC REPRO
					FAST	Muted
				ON	RECORD	INPUT
		OFF	Ch. 1 – 15: – Ch. 16: INPUT		PLAY, EDIT CUE △ LIF/DEF △ STOP ● FAST	SYNC REPRO Muted
LED beneath the switch pressed lights.	LED above the switch pressed lights.	LED flashes with RECORD switch off, and stays on with RECORD switch on.	LED is on with RECORD switch off, and is off with RECORD switch on.	LED flashes with RED function switch off, and is on with REC function on.	LIF/DEF MUTE and STOP MUTE LEDs are on with respective switches pressed, regardless of whether muting is actually in function or not.	

Ⓑ Ⓐ

Channel 16 SYNCLOCK Mode

OUTPUT SELECT Switch	INPUT ENABLE Switch	REC Function Switch	INSERT (INPUT/SYNC) Switch	RECORD Button	Operation Mode	OUTPUT Source
–	–*	OFF	SYNC	–	PLAY, EDIT, CUE, LIF/DEF	SYNC REPRO
					STOP •	SYNC REPRO
					FAST	Muted
LED beneath the switch pressed lights.	LED above the switch pressed lights.	LED flashes with RECORD switch off, and stays on with RECORD switch on.	LED of the ch. lights red when SYNCLOCKed (yellow when not locked).	LED flashes with RED function switch off, and is on with REC function on.	LEF/DEF MUTE and STOP MUTE LEDs are on with respective switches pressed, regardless of whether muting is actually in function or not.	

NOTES:

"–" ——— setting of this switch or the operating mode has no effect on the line output source.

CUE ——— fast-winding modes (STC, RTZ included) in which tape lifters are retracted using the TAPE LIFTER lever and the tape contacts the heads.

LIF/DEF — mode in which tape lifters are retracted by the time code controller during fast-winding.

FAST ——— fast-winding modes with tape lifters engaged and the tape pulled away from the heads.

△ ——— LIF/DEF MUTE possible during SYNCLOCKed fast-winding (ch. 1 – 15).

• ——— STOP MUTE possible (all channels).

* ——— INPUT ENABLE functions while in STOP or FAST with OUTPUT SELECT set to SYNC.

Table 5-2 Determining the Signal Source for MS-16's Output

disconnected from the REC/SYNC head and connected to the REPRO head.

Monitor signal switching operations are made as shown in Table 5-2 Ⓐ when REC ON-OFF (punch-in and punch-out) operations are conducted.

When the OUTPUT SELECT switch is placed in the SYNC position during the record mode, output pin 4 goes H because input pins 5 and 6 of U5 (4, 5, 6) are being set to L, and an H level signal is applied to input pin 14 of U6 (14, 15) through D12. Since the above condition is the same as that of the previously described INPUT mode, the INPUT signals are output and monitored. When the REC function switch is placed in the OFF position, input pin 5 of U5 (4, 5, 6) goes H and this makes output pin 4 L. Consequently, the amplifier circuit is switched to the SYNC reproduction mode and the SYNC signals are monitored.

Table 5-2 Ⓑ also denotes the monitor signal switching operations as functions of the SYNC/INPUT switch.

When the SYNC/INPUT switch is set to "off" (INPUT) during the reproduce mode with the OUTPUT SELECT switch set to SYNC and the REC function switch ON, output pin 10 of U5 (8, 9, 10) goes H, because input pins 8 and 9 are both in L. Namely, the same condition as that of the INPUT mode is established, and the INPUT signals are monitored.

On the other hand, when the SYNC/INPUT switch is placed in "on" (SYNC) position, input pin 8 of U5 (8, 9, 10) in the Record/Playback Amp. PCB are changed to H. Then, output pin 10 is changed from H to L which in turn, makes the operating mode of the amplifier change from INPUT to SYNC, and thus the SYNC signals are monitored.

5-8-4. Record Mode

When the RECORD button is pressed, the $\overline{\text{REC MODE}}$ Sig. terminal goes L, and if a recording channel is designated by the selection of the $\overline{\text{REC}}$ function (ON-OFF) switch, the $\overline{\text{REC READY}}$ Sig. corresponding to the channel selected also goes L. Then, input pins 12 and 13 of U5 (11, 12, 13) on the Record/Playback Amp. PCB go L and output pin 11 goes H, and transistors Q18 and Q22 on the Record/Playback Amp. PCB turn off because their bases are lowered to L. When Q22 turns off, Q24 goes on and the record relay K_2 actuates to switch on the record circuit.

When Q24 turns on, Q25 goes off and input pin 5 of U6 (4, 5) on the Record/Playback Amp. PCB goes H, and this causes input pin 5 of U5 (4, 5, 6) on the Record/Playback Amp. PCB to decrease to an L level. If the OUTPUT SELECT switch set to SYNC, input pin 6 of U5 (4, 5, 6) also goes L, so output pin 4 goes H and Q12 goes off, causing Q13 to go on as described in the input mode of operation to enable monitoring of the input signals via the OUTPUT terminals.

When Q18 on the Record/Playback Amp. PCB is turned off, Q18 collector voltage is applied to the base of Q20, causing it to turn on, followed by Q21 also turning on. Then, the Bias Amplifier module U7 on the Record/Playback Amp. PCB starts to function and supplies bias voltage to the recording and erase heads.

Transistors Q19 and Q23 are turned on by the charging currents being respectively applied through C35 and C36 on the Record/Playback Amp. PCB. Immediately after this, Q19 and Q23 are turned off, causing rapid discharge of the charges stored in C37 and C38 through C37 – R96 and C38 – R108.

That is, without Q19 and Q23, the charges that were stored in C37 and C38 could not be discharged so rapidly, and possibly resulting in Q21 staying on when REC ON-OFF (punch-in and -out) operations are repeated quickly. Transistors Q19 and Q23 function to prevent this erroneous operation.

During recording, an H level signal is applied to input pin 8 of U4 (8, 9, 10) on the Function A PCB and Q3 and Q4 on the same PCB, is turned on. However, during punch-out operation, a 1 Hz pulse signal is applied to input pin 9 of U4 (8, 9, 10) and the REC function LED(s) designated by the REC (ON-OFF) switch begins blinking.

During the REC mode of operation, an L level signal is being applied to input pin 14 of U6 (14, 15) on the Function A PCB, and Q1 and Q2 on the same is turned off. In addition, as output pin of the digital transistor U8 on the Function A PCB is at L level, thus switching operations as shown in Table 5-2 can be performed with switching combinations of REC (ON-OFF) and SYNC/INPUT switches.

5-8-5. Record/Reproduction Switching Noise Protection Circuit

Eliminating switching noises caused during record and reproduction switching is very important to enhance operationability of the unit. This section describes how the switching noises are eliminated in this unit. To simplify the description, first suppose that the SYNC and REC function switches are set to ON and the unit is being operated in the sync reproduction mode. For SYNC switch noise protection (generation of muting signals) refer to 5-8-3 "SYNC Mode".

1. When a record-in operation is conducted (or RECORD and PLAY buttons are pressed at the same time), REC terminal 17 on Record/Reproduce Circuit goes L: then output pin 11 of U5 (11, 12, 13) goes H and output pin 6 of U6 (6, 7) goes L, and the MUTE terminal 19 on the same circuit schematic also changes from H to L.
2. Since Q15 base bias falls as the MUTE terminal goes L, Q15 is cut off and the voltage at junction R68 and C31 rises for the time period determined by R70/R68 and C31 time constant. Since voltage is applied to the base of Q9, Q9 is turned on after the time constant time (approx. 25 msec), and the sync reproduction signal is shorted at ground through the emitter-collector path of Q9, thus disconnecting sync output from the OUTPUT terminals. Refer to Fig. 5-18 ⓐ.
3. Q22 is cut off as output pin 6 of U6 goes L. Then, +15 V voltage is applied to Q23 base for a brief period of time through C36 to make Q23 turn on to discharge the residual electric charges stored in capacitor C38. When the charging to C36 is completed, Q23 is again cut off, and C38 charging starts. When this charging to C38 is completed, Q24 is turned on and the REC relay K2 is actuated and the record/sync head is switched in the record circuit.

The time required for this switching has been adjusted to approx. 50 msec through the time constant circuits including C38, R112, C36, R110, etc. Refer to Fig. 5-18ⓑ.

4. Since Q25 base bias decreases as Q24 is turned on, Q25 is cut off, and this turns input pin 5 of U6 to H and output pin 4 to L. Then input pin 5 of U5 (4, 5, 6) goes L. Pin 6 of U5 (4, 5, 6) is in L because SYNC terminal 20 is L (as the SYNC switch has been set to ON). Thus output pin 4 of U5 (4, 5, 6) becomes H.
5. Then output pin 15 of U6 (14, 15) goes L and output pin 2 of U6 (2, 3) goes H. Consequently; the 5 V positive voltage developed by the dividing network, which consists of R64 and R65, is applied to the cathode side of diode D3 through R66, and transistor Q13 is turned on. In this operation Q13 is gradually turned on because of a large time constant provided by R66 and C32. Therefore, the INPUT signal being applied to the drain side of Q13 is transferred to the output side gradually, thus suppressing switching noises in the monitor signals.
6. On the other hand, another voltage dividing network R60 and R61 develops -5 V, as input pin 3 of U6 (2, 3) is in L, and the negative voltage is applied to D2 cathode via R61, cutting Q12 off. In this case also, the cut off operation is accomplished gradually because of a large time constant provided by R61 and C30.
7. In this way, switching operations for both Q12 and Q13 are made under influence of four time constants, each relating to capacitors C36, C38, C39 & C30, and C36, C38, C39 & C32 (as stated in 4, 5 and 6 above). Accordingly, their total time required for switching operation becomes considerably long as shown in Fig. 5-18 (A).
8. When Q18 is cut off, Q19 is turned on until C35 is charged; thereby, discharging the residual charges stored in C37. Then C37 is recharged through R93, R94, R95 and, when recharging is completed, Q20 is turned on. After this, charging to C45 begins through R101, R102 and the charged voltage reaches approx. 0.6 V, which causes Q21 to turn on to actuate the bias oscillator amp. In this way, the operation of bias amp is influenced by the corresponding C35, C37, and C45 time constants, causing the bias oscillator to start functioning at approx. 75 msec, after the punch-in operation has been set, to gradually increase the bias amplitude as shown in Fig. 5-18 ⓒ. Accordingly, the amplitude of the signal being recorded on the tape is also gradually changed to the steady state, thus eliminating switching noises.
9. Next, when punch-out operation is made, the microcomputer outputs Play instructions to make the MUTE terminal 19 and also the REC terminal change to H. Accordingly, output pin 11 of U5 (11, 12, 13) goes L, output pin 6 of U6 (6, 7) goes H, and both Q18 and Q22 are turned on.
10. The charges stored in C37 is discharged through D16, R94, Q18 (emitter-collector path) as Q18 is turned on. Then Q20 is cut off, followed by Q21 cutting off. The time required to cut Q21 off depends upon the sum of the discharging time constants of C37 and C45, and is set to approx. 205 msec, as shown in Fig. 5-18ⓓ. As the result, the bias oscillator voltage amplitude of the bias amplifier is gradually attenuated as illustrated, and the amplitude of signals being recorded is also attenuated gradually.
11. When Q22 is turned on, the charges stored in C38 is discharged through R107 and Q22 (emitter-collector path), cutting off Q24 as the discharging potential is decreased. Then the REC relay is switched in to the SYNC side. The time required to actuate the REC relay is set to approx. 270 msec, completely after the bias oscillator voltage amplitude has been attenuated to zero. Refer to Fig. 5-18ⓔ.
12. When Q24 is cut off, Q25 is turned on after the time period, determined by the charging time constant of R113, R114, C39 and this makes input pin 5 of U6 (4, 5) change to L. Then, output pin 4 of U6 or input pin 5 of U5 (4, 5, 6) changes to H. (These pins 4 and 5 are in L until C39 is charged.)
13. Accordingly, output pin 4 of U5 (4, 5, 6) goes L, and output pin 15 of U6 (14, 15) goes H. As a result, +5 V developed by the dividing network, consisting of R60 and R62, is applied to D2 cathode through R61 and this makes Q12 turn on. Because of the large charging time value constant of C30, Q12 is gradually turned on.

14. On the other hand, as output pin 2 of U6 (2, 3) goes L, -15 V voltage is applied across R64 and R65, and the resultant divided voltage (-5 V) is applied to D3 cathode through R66, making Q13 cut off. Since the charging time constant of C32 is also of a considerably large value, the gradual cut off operation is made similarly as that of Q12.
15. When punch-out operation is made, when the insert switch (SYNC/INPUT) is set to SYNC, SAFE/RDY terminal 18 on Record/Playback Amp. PCB goes H, and this makes output pin 10 of U5 (8, 9, 10) and input pin 2 of U5 (1, 2, 3) change to L.
    As previously stated, input pin 5 of U5 (4, 5, 6) is not changed to H immediately after the punch-out operation has been made, but goes to H after Q25 is turned on for a brief time period that is determined by C38, C39, etc. charging time constants. Namely, input pin 5 of U5 (4, 5, 6) is L until Q25 is turned on. Accordingly, output pin 4 of U5 (4, 5, 6) is H, and output pin 3 is L because of input pin 2 of U5 (1, 2, 3) being L.
    On the other hand, MUTE terminal 19 goes H immediately after the punch-out operation, but Q15 base bias voltage is unable to rise because, at this time, output pin 3 of U5 (1, 2, 3) is being set to L. Therefore, Q15 is maintained cut off and Q9 is also held in its conductive state. Next, when Q25 is turned on, input pin 5 of U5 (4, 5, 6) goes H and output pin 4 and input pin 1 of U5 (1, 2, 3) go L, causing output pin 3 to go H. Accordingly, Q15 is turned on, and this makes Q9 cut off, thus releasing the short-out circuit for SYNC reproduction signals. In other words, Q9 can not be turned off until the REC relay completes switching in to the SYNC position. Thus no switching noise is developed in the monitor output circuit. Refer to Fig. 5-18 ⓕ.

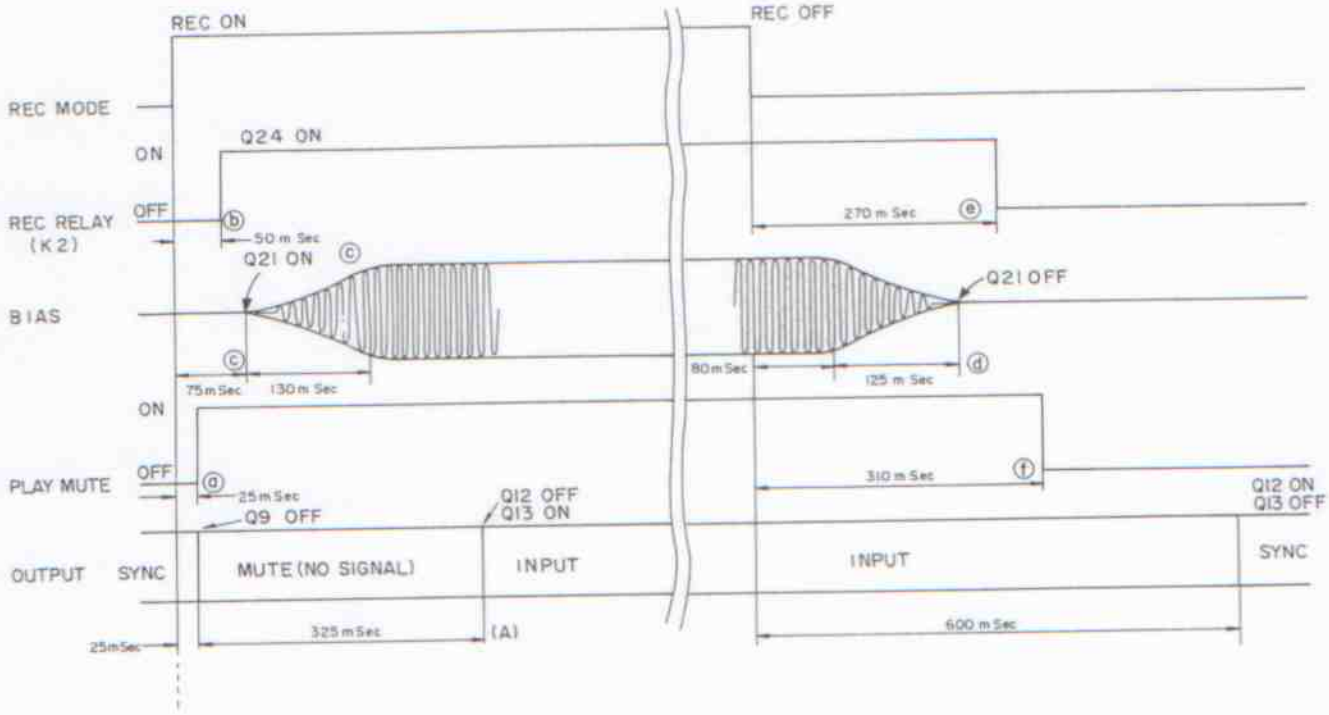

REC ON
REC OFF
REC MODE
ON
Q24 ON
REC RELAY
(K2)
OFF
50 m Sec
270 m Sec
Q21 ON
Q21 OFF
BIAS
75m Sec
130 m Sec
80m Sec
125 m Sec
ON
PLAY MUTE
OFF
25m Sec
310 m Sec
Q9 OFF
Q12 OFF
Q13 ON
Q12 ON
Q13 OFF
OUTPUT
SYNC
MUTE (NO SIGNAL)
INPUT
INPUT
SYNC
325 m Sec
(A)
600 m Sec
25m Sec

Fig. 5-18.

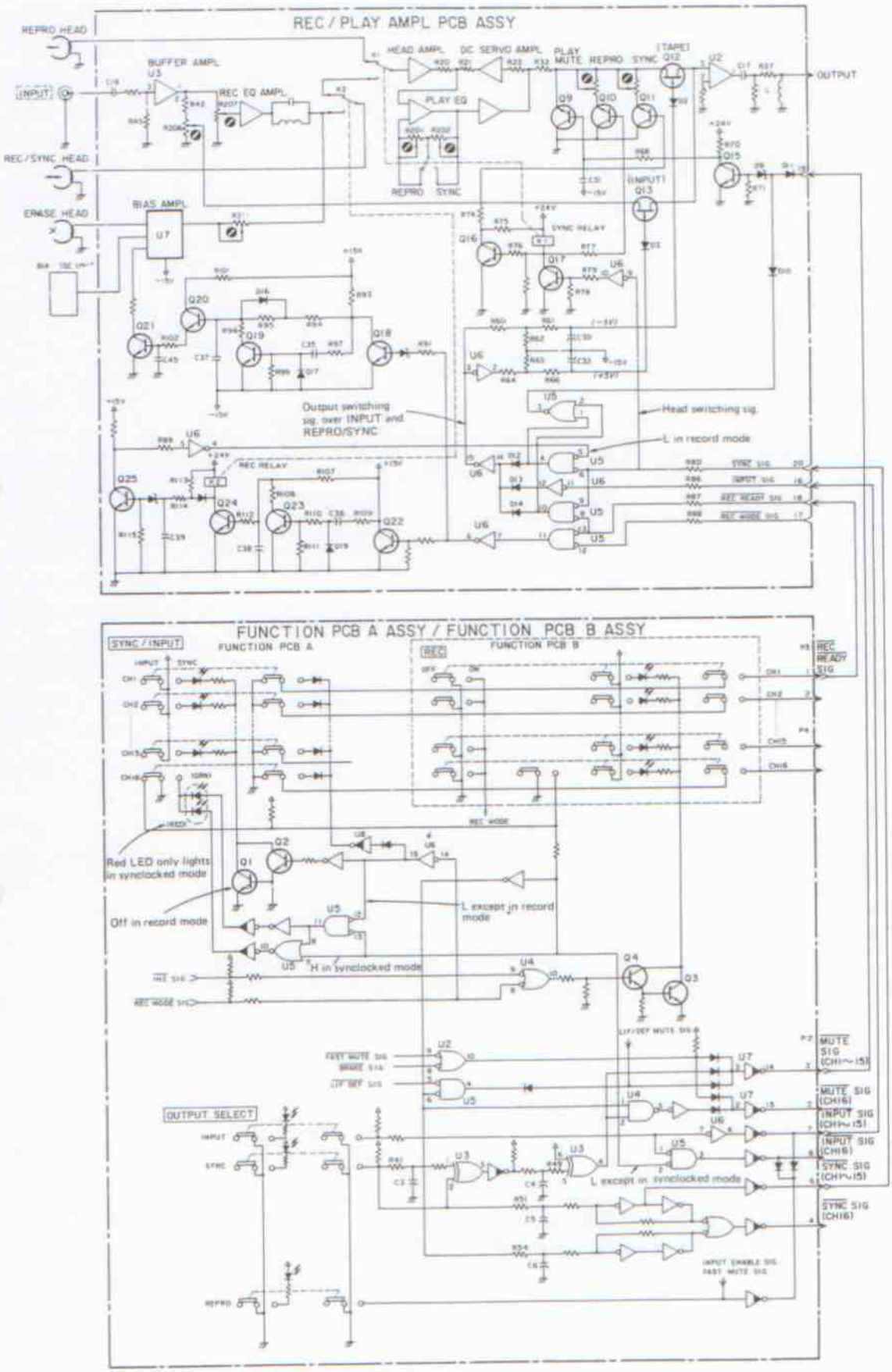
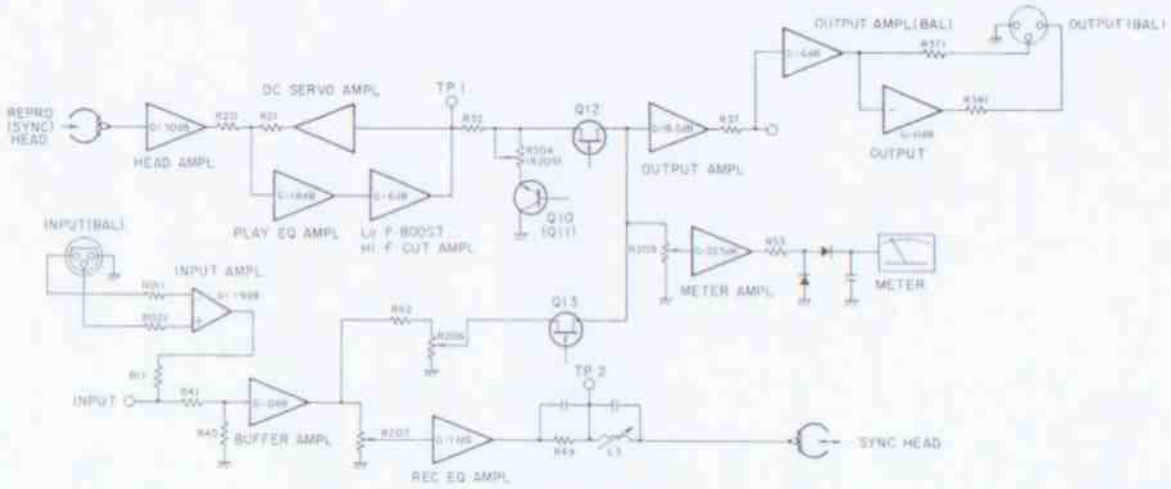

REC / PLAY AMPL PCB ASSY
REPRO HEAD
BUFFER AMPL
INPUT
REC EQ AMPL
REC / SYNC HEAD
ERASE HEAD
BIAS AMPL
HEAD AMPL
DC SERVO AMPL
PLAY MUTE
REPRO
SYNC
[TAPE]
OUTPUT
PLAY EQ
[INPUT]
SYNC RELAY
REC RELAY
Output switching sig. over INPUT and REPRO/SYNC
Head switching sig.
L in record mode
FUNCTION PCB A ASSY / FUNCTION PCB B ASSY
SYNC / INPUT
FUNCTION PCB A
FUNCTION PCB B
REC
REC READY SIG
Red LED only lights in synclocked mode
Off in record mode
L except in record mode
H in synclocked mode
OUTPUT SELECT
MUTE SIG (CH1~5)
MUTE SIG (CH6)
INPUT SIG (CH1~5)
INPUT SIG (CH6)
SYNC SIG (CH1~5)
SYNC SIG (CH6)
L except in synclocked mode

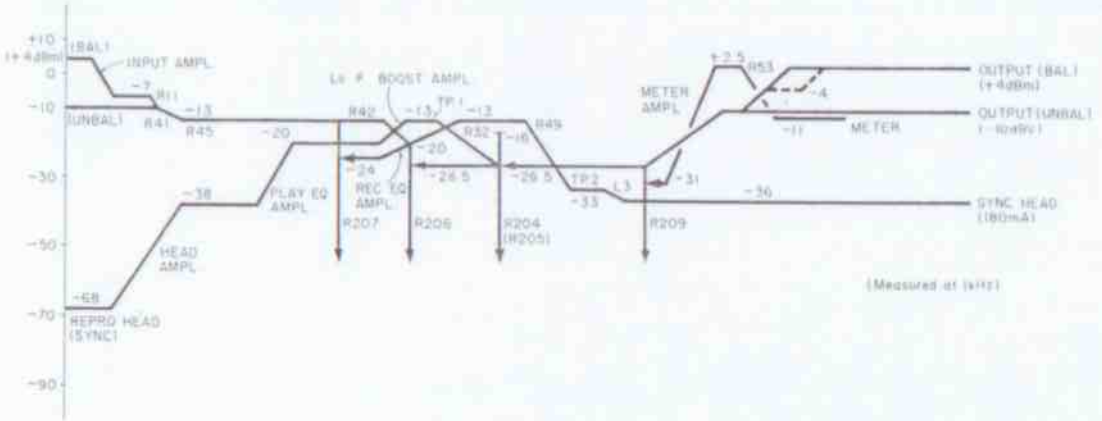
Fig. 5-19.

5-8-6. Input and Output Levels

A 9 dB attenuating operation amplifier and a +12 dB complimentary amplifier are inserted on the input and output sides so that an input/output level of +4 dBm (1.23 V) can be obtained when the XLR type connectors are used. In addition, the output level can be switched to +8 dBm (1.95 V) by resetting switches S1 – S16 (CH-1 – CH-16) on the Input/Output Amplifier PCB Ass'y.

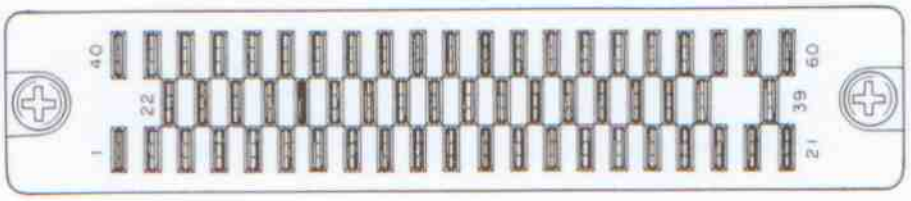
5-8-7. Block and Amplifier Level Diagram





5-8-8. Meter Connector and Signals

HIROSE P-1660 BA-CA Multi-pin Connector

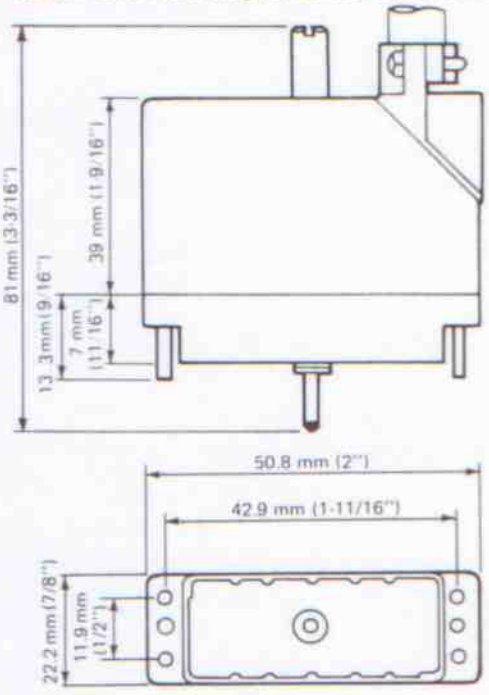


Pin #	Function	
1	Meter Drive Output	CH1
2	Peak LED Activating Output	CH1
3	Meter Drive Output	CH2
4	Peak LED Activating Output	CH2
5	Meter Drive Output	CH3
6	Peak LED Activating Output	CH3
7	Meter Drive Output	CH4
8	Peak LED Activating Output	CH4
9	Meter Drive Output	CH5
10	Peak LED Activating Output	CH5
11	Meter Drive Output	CH6
12	Peak LED Activating Output	CH6
13	Meter Drive Output	CH7
14	Peak LED Activating Output	CH7
15	Meter Drive Output	CH8
16	Peak LED Activating Output	CH8
17	Meter Drive Output	CH9
18	Peak LED Activating Output	CH9
19	Meter Drive Output	CH10
20	Peak LED Activating Output	CH10
21	Open terminal	
22	Meter Drive Output	CH11
23	Peak LED Activating Output	CH11
24	Meter Drive Output	CH12
25	Peak LED Activating Output	CH12
26	Meter Drive Output	CH13
27	Peak LED Activating Output	CH13
28	Meter Drive Output	CH14
29	Peak LED Activating Output	CH14
30	Meter Drive Output	CH15
31	Peak LED Activating Output	CH15

Pin #	Function	
32	Meter Drive Output	CH16
33	Peak LED Activating Output	CH16
34	REC/READY Signal Output	CH1
35	REC/READY Signal Output	CH2
36	REC/READY Signal Output	CH3
37	REC/READY Signal Output	CH4
38	REC/READY Signal Output	CH5
39	REC/READY Signal Output	CH6
40	REC/READY Signal Output	CH7
41	REC/READY Signal Output	CH8
42	REC/READY Signal Output	CH9
43	REC/READY Signal Output	CH10
44	REC/READY Signal Output	CH11
45	REC/READY Signal Output	CH12
46	REC/READY Signal Output	CH13
47	REC/READY Signal Output	CH14
48	REC/READY Signal Output	CH15
49	REC/READY Signal Output	CH16
50	$\overline{\text{REC}}$ Signal	
51	+15 V supply	
52	GND	
53	AC 6 V supply	
54		
55		
56		
57	Open terminal	
58		
59		
60		

5-8-9. "ACCESSORY" Connector and Signals

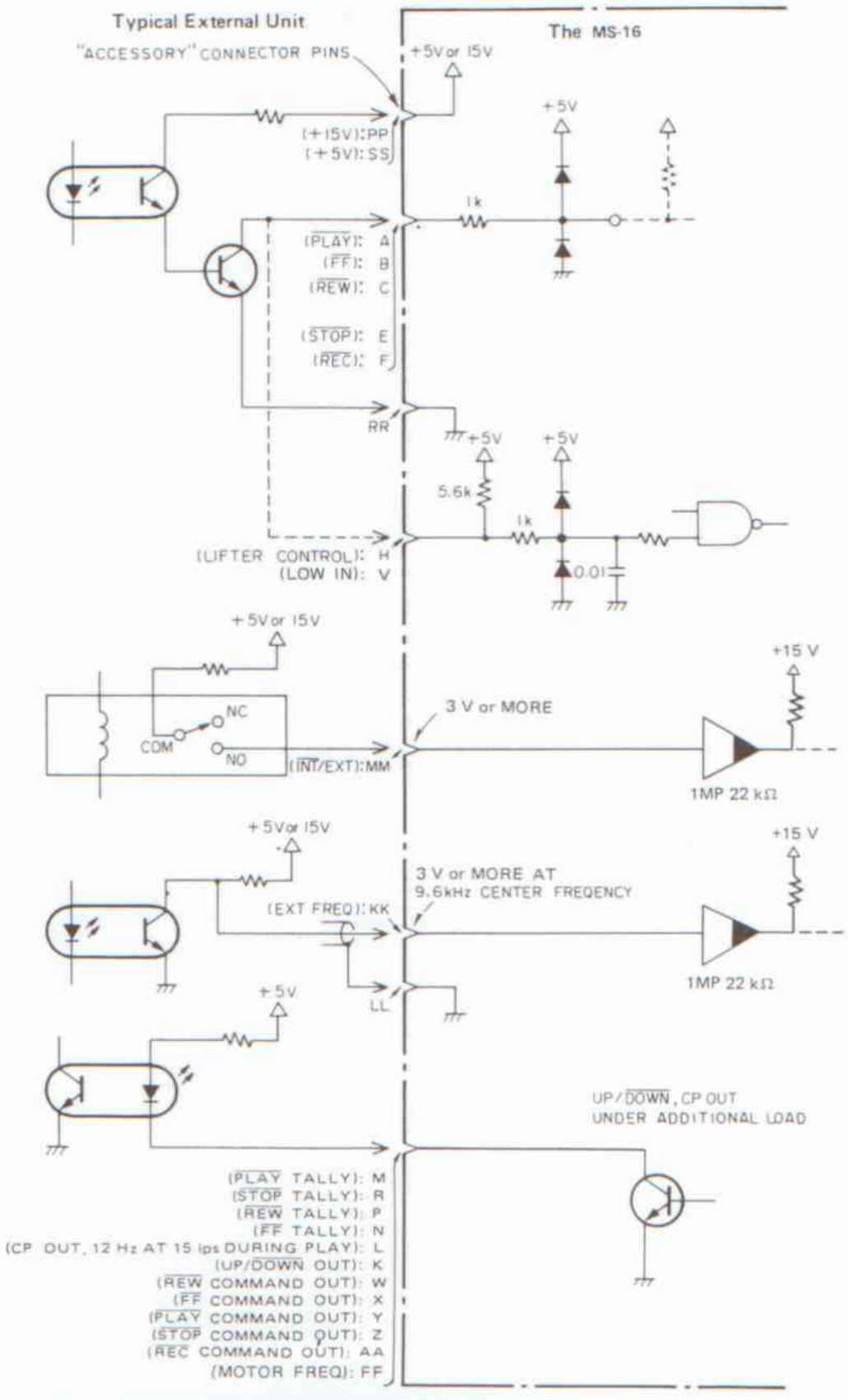
Malco 354-38 pin plug (or ELCO 8016 Series)



Pin #	IN(put)–OUT(put) signals		Function
A	$\overline{\text{PLAY}}$	IN	Inputs PLAY signal at L level.
B	$\overline{\text{FF}}$	IN	Inputs FF signal at L level.
C	$\overline{\text{REW}}$	IN	Inputs REW signal at L level.
D	open terminal		
E	$\overline{\text{STOP}}$	IN	Inputs STOP signal at L level.
F	$\overline{\text{REC}}$	IN	Inputs REC signal at L level.
H	$\overline{\text{LIFTER CONT}}$	IN	Inputs LIFTER shift cancellation signal at L level.
J	open terminal		
K	UP/$\overline{\text{DOWN}}$	OUT	Outputs tape running control signal at H or L level.
L	CP	OUT	Outputs open-collector signal (12 Hz pulse at 15 ips.)
M	$\overline{\text{PLAY}}$ TALLY	OUT	Outputs open-collector signal (Low level during PLAY mode.)
N	$\overline{\text{FF}}$ TALLY	OUT	Outputs open-collector signal (Low level during FF mode.)
P	$\overline{\text{REW}}$ TALLY	OUT	Outputs open-collector signal (Low level during REW mode.)
R	$\overline{\text{STOP}}$ TALLY	OUT	Outputs open-collector signal (Low level during STOP mode.)

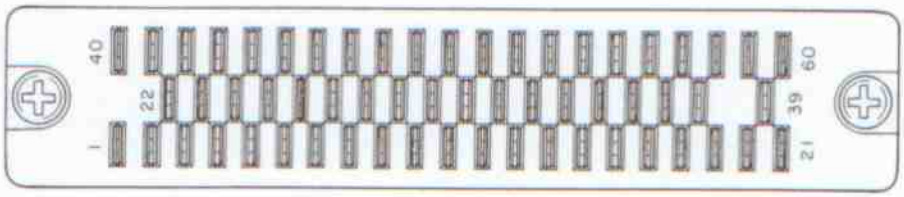
Pin #	IN(put)–OUT(put) signals		Function
S	$\overline{\text{REC}}$ TALLY	OUT	Outputs open-collector signal (Low level during record mode)
T	$\overline{\text{SHUT-OFF}}$ TALLY	OUT	Outputs open-collector signal (Low level during tape stop)
U	$\overline{\text{RESET}}$	SW IN	Inputs electronic counter reset signal low level.
V	$\overline{\text{LOW}}$	IN	Reduces tape speed to "Low" during fast winding.
W	$\overline{\text{REW}}$ COMMAND	OUT	Outputs open-collector signal (Low level when REW is pressed)
X	$\overline{\text{FF}}$ COMMAND	OUT	Outputs open-collector signal (Low level when F. FWD is pressed)
Y	$\overline{\text{PLAY}}$ COMMAND	OUT	Outputs open-collector signal (Low level when PLAY is pressed
Z	$\overline{\text{STOP}}$ COMMAND	OUT	Outputs open-collector signal (Low level when STOP is pressed)
AA	$\overline{\text{REC}}$ COMMAND	OUT	Outputs open-collector signal (Low level when REC is pressed)
BB CC DD EE	↑ open terminal ↓		
FF	MOTOR FREQ	OUT (HOT)	Capstan motor F.G. out: 600 Hz at 15 ips
HH	MOTOR FREQ	OUT (COLD)	Capstan motor F.G. out: 600 Hz at 15 ips
JJ	open terminal		
KK	EXT FREQ	IN (HOT)	Inputs speed control signal at input signal of 3.0 V or more and of 4.8 k to 19.2 kHz (HOT side)
LL	EXT FREQ	IN (COLD)	Inputs speed control signal (COLD side)
MM	$\overline{\text{INT}}$/EXT	IN	Inputs internal/external speed control select signal Internal: LOW level (0 V) External: HIGH level (3.0 V or more)
NN	open terminal		
PP	+15 V supply voltage	OUT	Maximum: 50 mA
RR	0 V terminal		
SS	+5 V supply voltage	OUT	Maximum: 50 mA
TT	Main unit GND		

"ACCESSORY" Connector Pins and External Signal Connections



5-8-10. Remote Control Connector and Signals

HIROSE P-1660 BA-CA Multi-pin Connector



Pin #	IN(put)–OUT(put)		Function
1	$\overline{\text{PLAY}}$	IN	Inputs PLAY signal at L level.
2	$\overline{\text{REW}}$	IN	Inputs REW signal at L level.
3	$\overline{\text{STOP}}$	IN	Input STOP signal at L level.
4	Open Terminal		
5	$\overline{\text{RTZ}}$	IN	Inputs RTZ signal at L level.
6	$\overline{\text{STC}}$	IN	Inputs STC signal at L level.
7	D4	OUT	Counter display
8	D2	OUT	
9	$\overline{a}$	OUT	
10	$\overline{c}$	OUT	
11	$\overline{e}$	OUT	
12	$\overline{g}$	OUT	
13	UP/$\overline{\text{DOWN}}$	OUT	Outputs tape running control signal at H or L level.
14	$\overline{\text{CP}}$	OUT	Outputs open-collector signal (12 Hz pulse at 15 ips.)
15	STOP	OUT	High level when STOP is pressed (+5 V, 10 kΩ or more of load)
16	PLAY	OUT	High level when PLAY is pressed (+5 V, 10 kΩ or more of load)
17	REW	OUT	High level when REW is pressed (+5 V, 10 kΩ or more of load)

Pin #	IN(put)–OUT(put)		Function
18	FF	OUT	High level when F. FWD is pressed (+5 V, 10 kΩ or more of load)
19	REC	OUT	High level when REC is pressed (+5 V, 10 kΩ or more of load)
20	$\overline{\text{LOW}}$	IN	Reduces tape speed to "Low" during fast-winding.
21	GND		
22	$\overline{\text{REC}}$	IN	Inputs REC signal at L level.
23	$\overline{\text{RESET}}$	IN	Inputs electronic counter reset signal low level.
24	$\overline{\text{CUE}}$	IN	Inputs CUE signal at L level.
25	D5	OUT	Counter display
26	D3	OUT	
27	D1	OUT	
28	$\overline{b}$	OUT	
29	$\overline{d}$	OUT	
30	$\overline{f}$	OUT	
31	$\overline{a}$	OUT	Speed display
32	$\overline{c}$	OUT	
33	$\overline{e}$	OUT	
34	$\overline{g}$	OUT	
35	↑		
36	Open Termianl		
37	↓		

6. — Space reserved —

Pin #	IN(put)—OUT(put)		Function
38	EDIT	OUT	High level when EDIT is pressed in STOP mode. (+5 V, 10 kΩ or more of load)
39	Open Termianl		
40	+5 V Supply		Counter display
41	$\overline{FF}$	IN	Inputs FF signal at L level.
42	↑		
43	Open Terminal		
44	↓		
45	+5 V Supply		
46	D4	OUT	
47	D3	OUT	
48	D2	OUT	
49	D1	OUT	> Speed display
50	$\overline{b}$	OUT	
51	$\overline{d}$	OUT	
52	$\overline{f}$	OUT	
53	$\overline{d\text{-}p}$	OUT	
54	Open Termianl		
55	GND		
56	Open Terminal		
57	EXT VARI	IN	Inputs speed control signal at input signal of 3.0 V or more and of 9.6 kHz ±15 %.
58	+15 V Supply		
59	+15 V Supply		
60	GND		

For REMOTE connector's signal connections, refer to page 9-16.

7. CHECKS AND ADJUSTMENTS

7-1. PARTS LOCATION DIAGRAMS

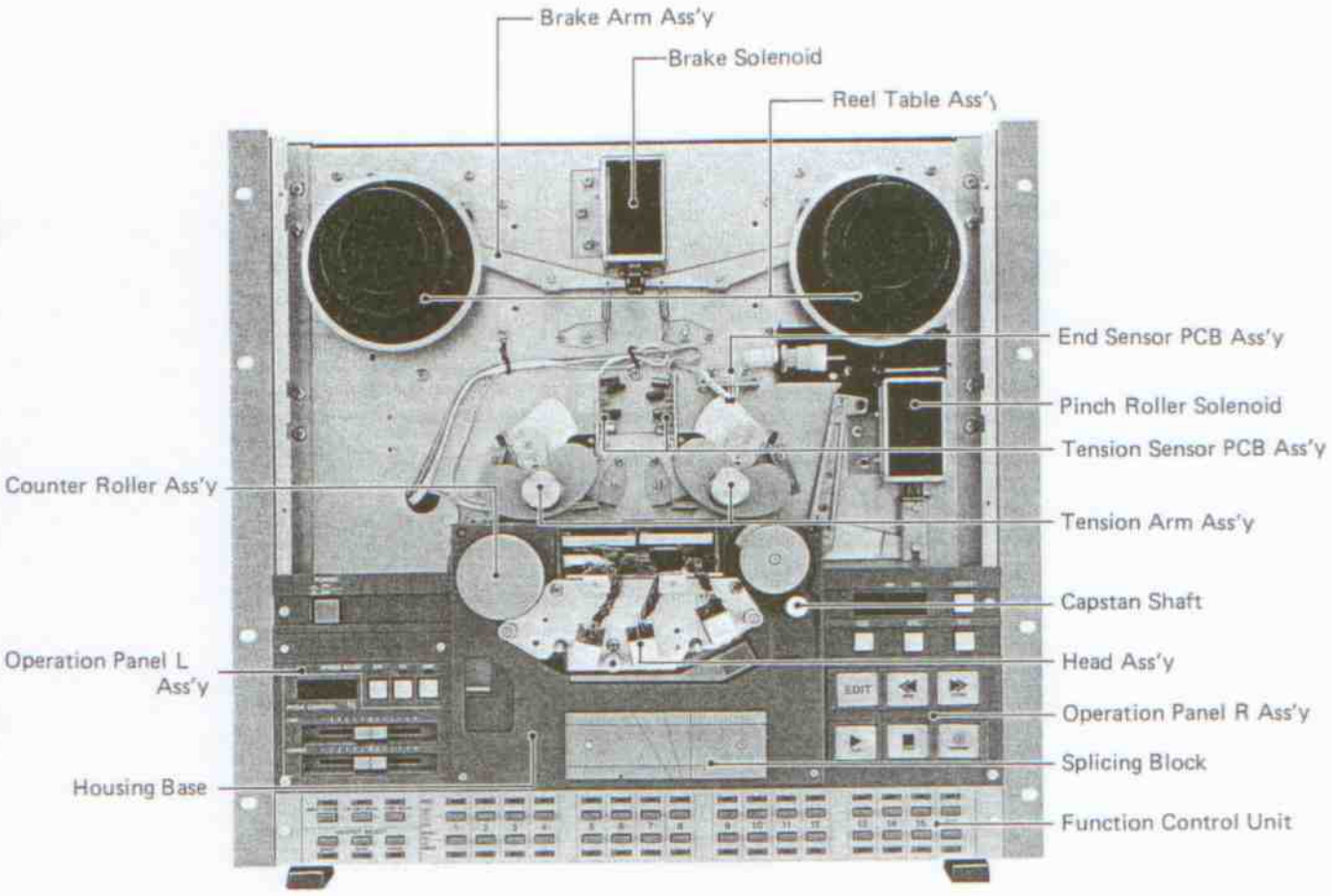


Fig. 7-1. Front Parts Location

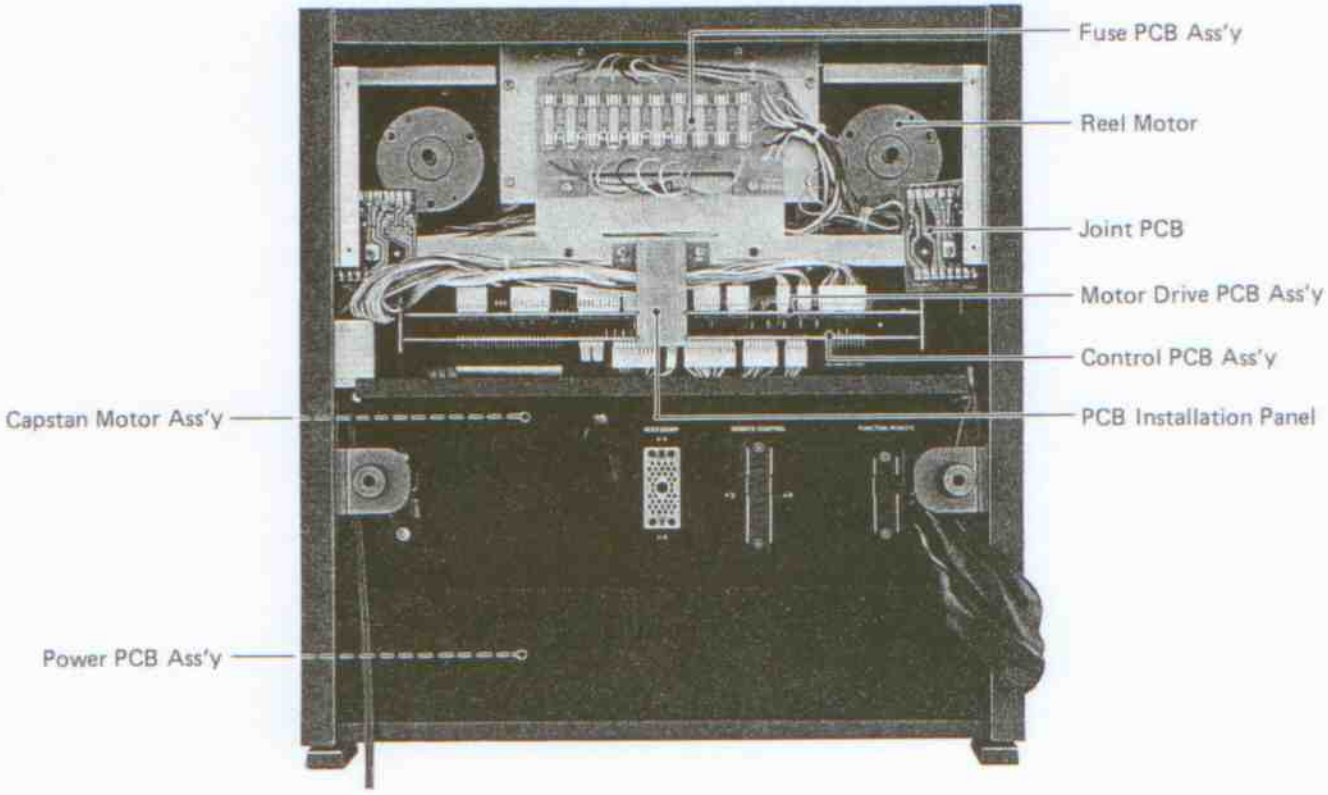


Fig. 7-2. Rear Parts Location

7-2. ESSENTIAL TEST EQUIPMENT REQUIRED

Wow & Flutter Meter	Meguro Denpa Sokki K.K., Model MK-668C (JAPAN), or Mincom Division, 3M Co, Model 8155 (U.S.A.)
Audio Oscillator	Hewlett Packard, Model 204C or equivalent
Digital Frequency Counter	Range: 10 Hz ~ 1 MHz; sensitivity; 0.1 Vrms; imp.: > 1 MΩ, < 25 pF
Band-Pass-Filter	1 kHz narrow band pass type
AF Level Meter	Range; -80 dB ~ +40 dB; imp.: > 1 MΩ, < 25 pF (example—HP 400GL)
Distortion Meter	General purpose (400 Hz, 1 kHz)
Oscilloscope	General purpose
Attenuator	General purpose
Tools	Spring scale: 0 ~ 8 lbs (0 ~ 4 kg) 0 ~ 2.2 lbs (0 ~ 1 kg) Hex head Allen wrenches, Plastic alignment tool
Cleaning fluid:	TEAC TZ-261 or equivalent TEAC Spindle Oil TZ-255 or equivalent
Head Demagnetizer	TEAC E-3 or equivalent
Test Tapes	Reproduce Alignment Test Tape: TEAC YTT-1244 Equalization Standard: IEC, CCIR Time Constant: 15 ips = ∞ μs + 35 μs Wow and Flutter Test Tape: STL Test Tape #72 Blank Test Tape (Recording): Ampex #456

7-3. — Space reserved —

7-4. REMOVAL OF THE MAIN PARTS

7-4-1. Outer Parts

A. Head Housing

The head housing can be removed by simply removing the two screws marked ⓐ in Fig. 7-3.

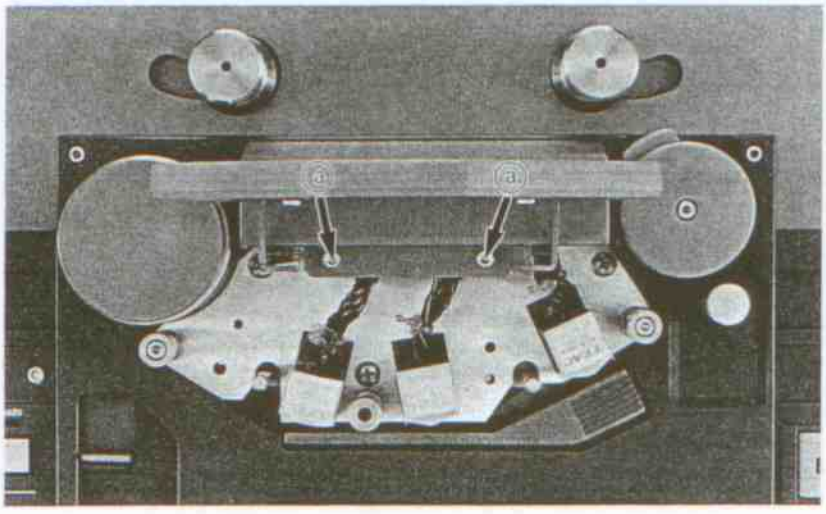


Fig. 7-3. Head Housing

B. Front Panel Ass'y

1. Using a 3 mm Allen wrench, remove the four Allen screws ⓐ from both the left and right sides of the front panel, the two screws ⓑ located on the housing base and the four screws ⓒ on the top of the deck, as shown in Fig. 7-4.
   (Allen wrench sizes are identified by cross-sectional side-to-side measurement of the end of the wrench)
2. The dress panel can now be separated from the unit by lifting upwards on it. It is also advisable to remove the reel clamper at this time.

C. Housing Base

1. To remove this base, the head housing, splicing block and pinch roller are removed first. The pinch roller is removed by loosening the retaining screw from the top of the pinch roller.
2. Next, remove the screws ⓑ ⓓ located on the housing base.

D. Operation Panel R & L Assemblies

1. Remove the housing base before taking off these assemblies.
2. Remove the screws ⓔ to remove the operaiton panel R ass'y, or the screws ⓕ to remove its L ass'y.

E. Side Panels

As shown in Fig. 7-5, loosen the four retaining screws ⓐ from the feet of the deck, then remove the two screws ⓑ and the remaining four screws ⓒ to enable removal of the side panels.

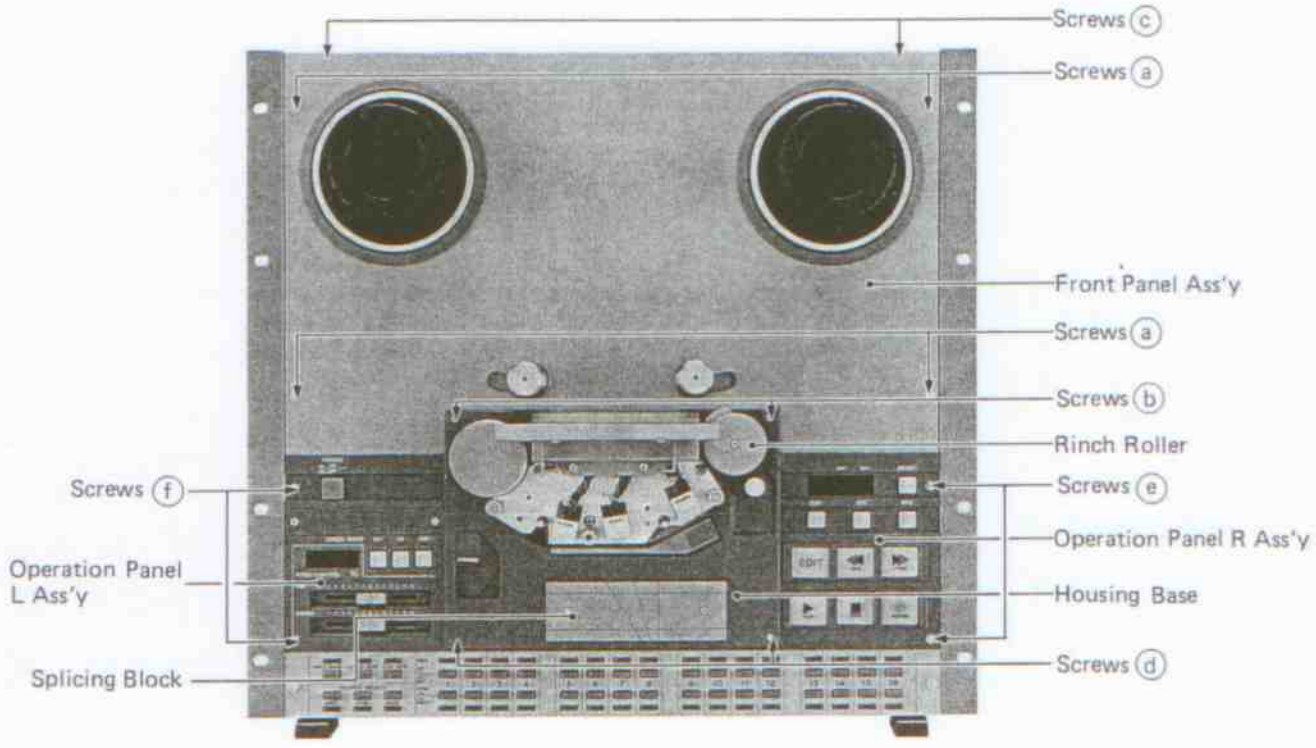


Fig. 7-4. Front Panels

Fig. 7-5. Side Panels

7-4-2. Head

1. First, remove the head housing as described in 7-4-1 (A).
2. Using a 3 mm Allen wrench, remove the three Allen screws (a) holding the head as shown in Fig. 7-6.
3. The head can be removed by first removing Allen screws (b) located on the rear of the head and then removing the other screws (c) from the rear of the head base. Finally, unplug the connectors (A) .

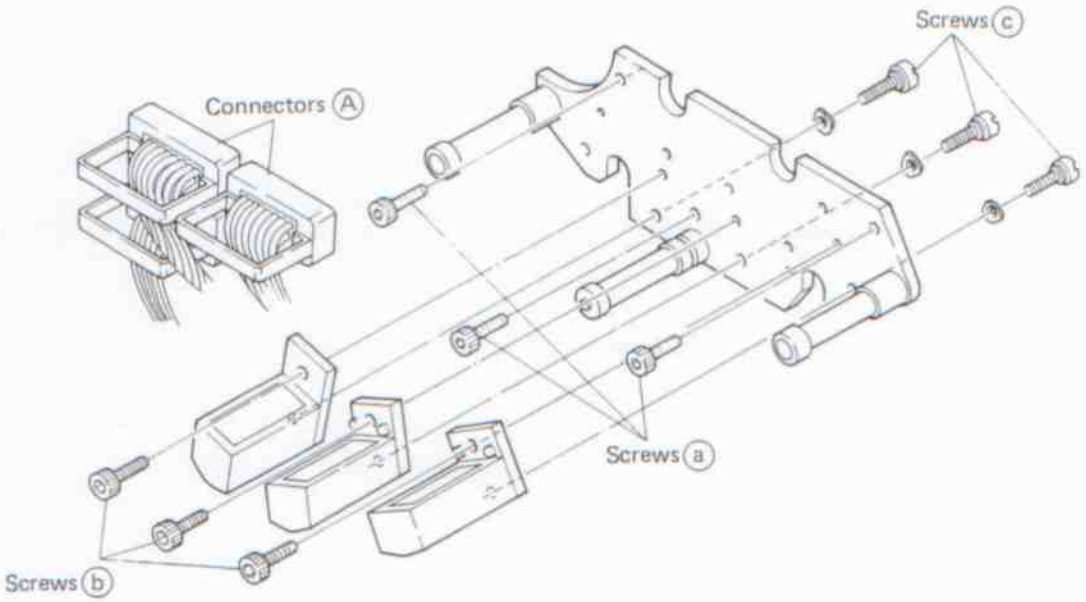


Fig. 7-6. Head Ass'y

7-4-3. Reel Motor

1. After removing the front panel as described in 7-4-1 (B), remove the reel table assembly and as shown in Fig. 7-7, remove the three screws holding the reel motor.
2. Finally, undo the wire running to the JOINT PCB with the use of a soldering iron.

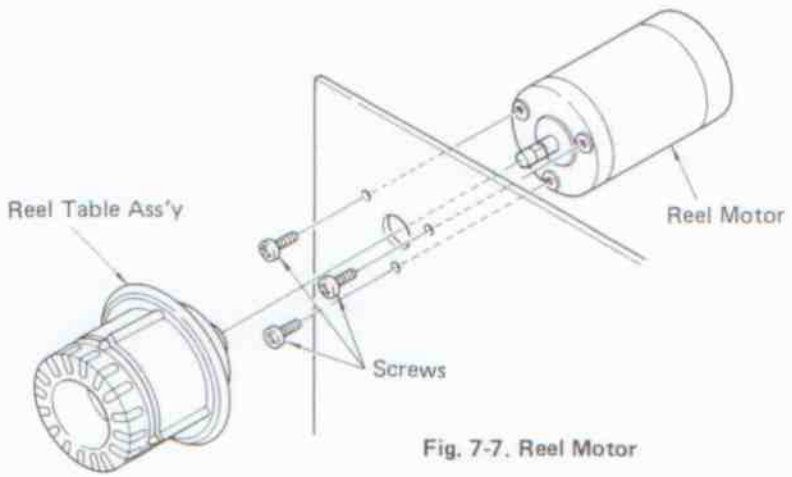


Fig. 7-7. Reel Motor

7-4-4. Capstan Motor Ass'y

1. As described in 7-4-1, remove the head housing, front panel assembly, pinch roller, housing base, operation panel R assembly and rear panel.
2. Remove the three screws (a) that are holding the motor section onto the capstan motor assembly as shown in Fig. 7-8. Next, unplug the connector to completely remove the capstan motor assembly.

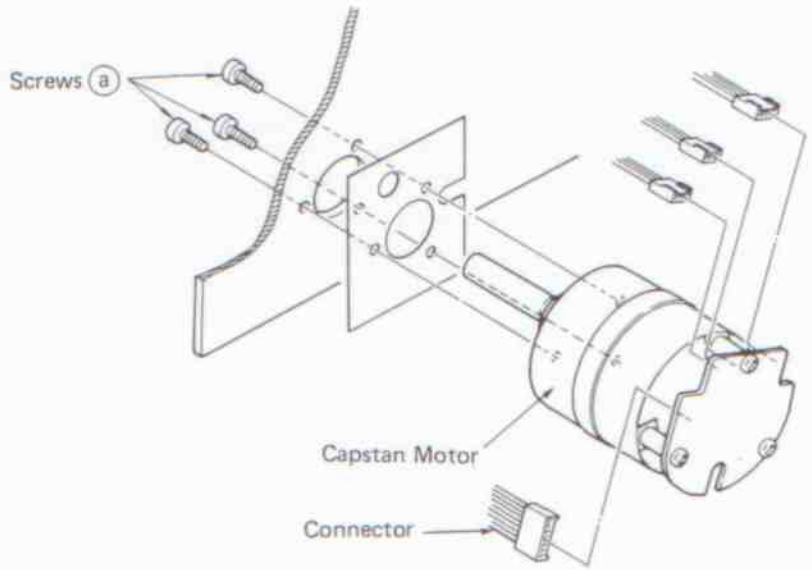


Fig. 7-8. Capstan Motor Ass'y

7-4-5. Fuses

All together ten fuses will be visibly noticeable when the rear panel is taken off.

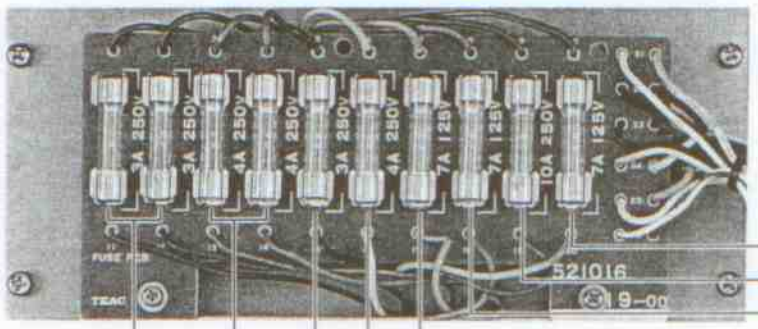


Fig. 7-9. Fuse PCB Ass'y

F10 (+11 V Reel Motor, Regulated +5 V)
F9 (+22 V Reel Motor Flash V., Regulated +15 V)
F8 (+12 V Solenoid)
F7 (+24 V, Solenoid Flash V.)
F6 (Regulated +24 V Relay, Capstan Motor)
F5 (AC 6 V Lamp)
F3, F4 (Regulated ±15 V Rec/Rep Amp)
F1, F2 (Regulated ±20 V Balanced Amp)

7-5. TAPE TRANSPORT CHECKS AND ADJUSTMENTS

7-5-1. Brake Mechanism

Note: Be sure that the power is turned off prior to making any adjustments to the brakes.

1. Make sure that the tip (A) of the brake arm assembly does not come into contact with the upper and lower sides of the recessed part of the brake plunger. If contact is noticeable, adjust the screws (a) of the hanger until tip (A) retains a centered position between the recessed part of the brake plunger.
   Note: Take care that the brake band is not twisted in any way when making this adjustment.
2. Manually operate the brake plunger to be sure that the brake band is separated from the brake drum. Then turn the left and right reels motors by hand and check that they move freely.
   If the brake band is still making contact with the brake drum at this point, adjust the position of the brake solenoid by loosening the three screws (b).

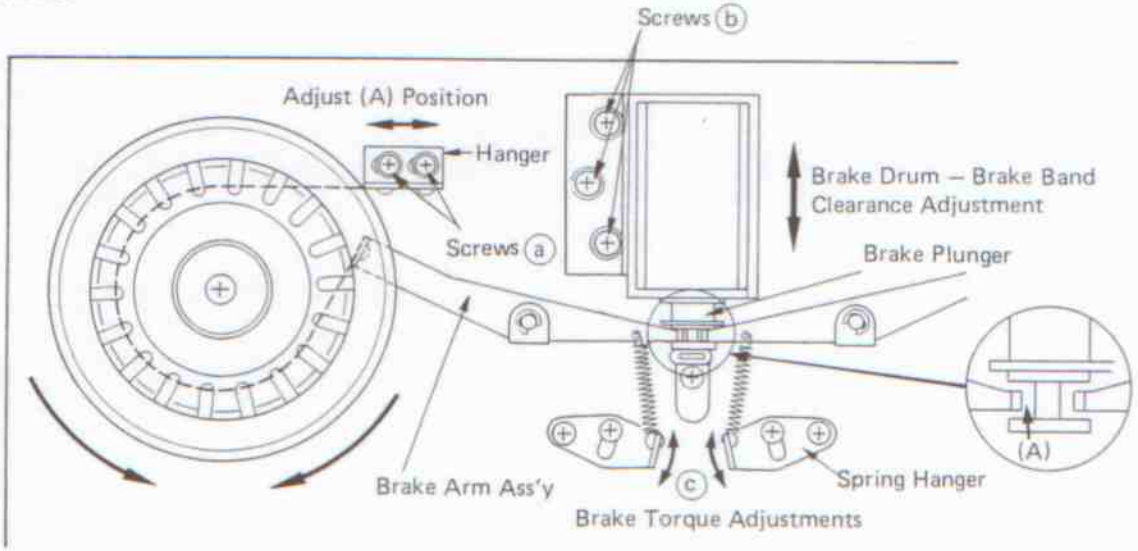


Fig. 7-10 Brake Mechanism Adjustments

7-5-2. Brake Torque

Note: Before making any brake adjustments or measurements, make sure the power is off.

1. Mount an empty 10-1/2" reel onto either reel table and attach a spring scale to the reel with a string. See Fig. 7-11.
2. Smoothly pull the scale away from the reel under test and note the torque value when the reading on the scale is steady. The proper torque values are given in the chart on the next page.
3. Follow steps 1 and 2 for each measuring condition; i.e., (D) through (A) in Fig. 7-11.
4. If the forward-direction torque is not correct, change the hooking position of the spring hanger (reference (c) in Fig. 7-10) for the corresponding brake requiring adjustment, if, after the forward-direction torque has been properly adjusted, the reverse-direction torque is not correct, or the forward-direction torque is still not correct, replace the brake felt pad with a new one after cleaning the inner-side of the brake belt with an alcohol cleaning solution, and also check that the brake mechanism is properly aligned as explained in Section 7-5-1. "Brake Mechanism". If necessary, replace the entire reel table.

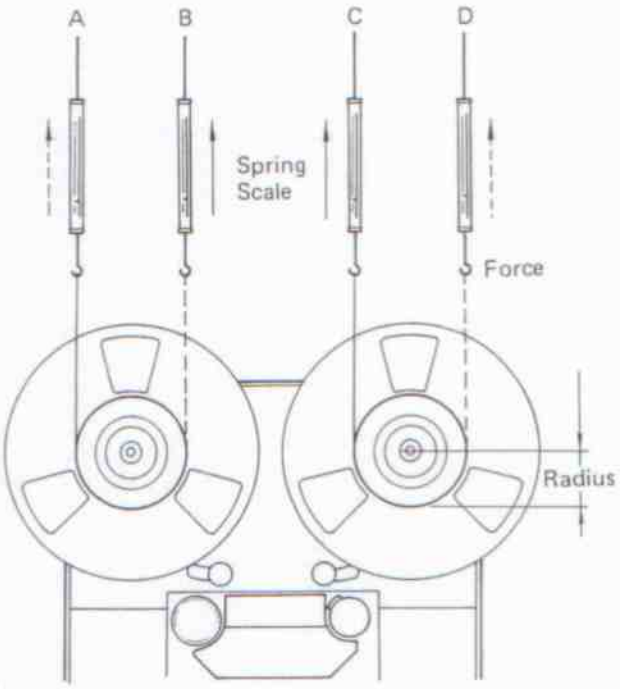


Fig. 7-11. Brake Torque Measurement

Forward direction (B) (C)	6500 – 7000 g-cm (90.4 – 97.3 oz-inch)
Left/Right deviation	300 g-cm (4.17 oz-inch)

Table 7-1. Brake Torque Values

Torque calculating formulas:

1. Torque (in g-cm or oz-inch)
   = Force or Weight (in g or oz) x Radius (in cm or inch)
2. Conversion of g-cm to oz-inch:
   g-cm x 0.0139 = oz-inch

7-5-3. Pinch Roller Pressure

Note: Pinch roller pressure is supplied by the pinch roller spring arm, and it is most important that the solenoid plunger be fully bottomed before taking pressure measurements.

1. Insert something soft or foldable between the tension arm and the opening on the front panel (A) so that the unit will be operative.
2. Replace the screw attached to the top of the pinch roller with a slightly longer one and hook the string from the spring scale onto it.
3. Place the deck in the reproduce mode without threading the tape.
4. Pull the pinch roller away from the capstan shaft (on a plane intersecting the center of the capstan shaft and the pinch roller) until the capstan shaft and the pinch roller are separated.
5. Ease pressure on the scale until the pinch roller just begins to turn. The scale should then read 3.0 kg to 3.5 kg (6-10/16 lbs to 7-11/16 lbs).
6. If you don't get this reading on the scale, adjust the position of the capstan solenoid by loosening the three screws.

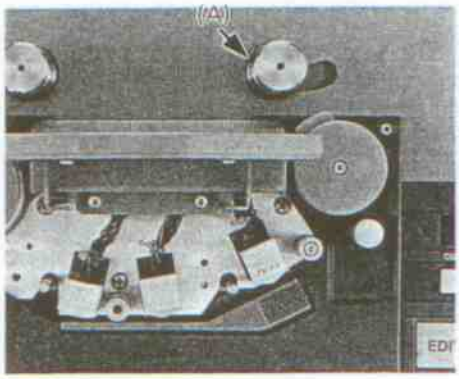


Fig. 7-12.
Right Tension Arm

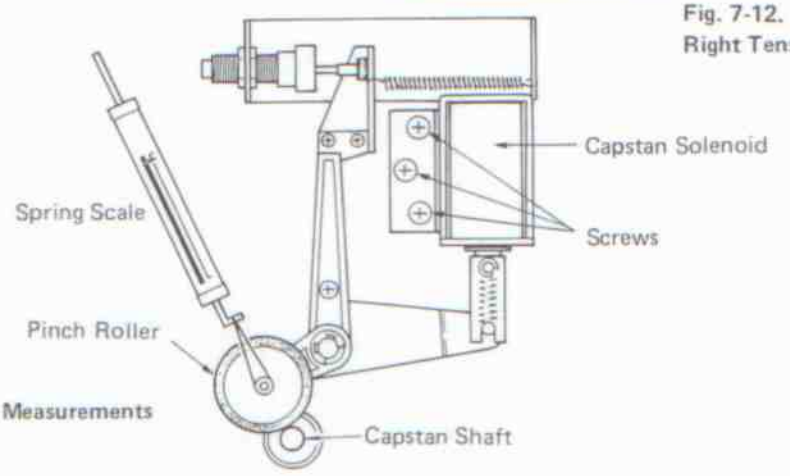


Fig. 7-13. Pinch Roller Pressure Measurements and Adjustments.

7-5-4. Tape Tension Servo

Tension Arm Positions and Detection Characteristics

The tape tension servo detects and controls the tape tension through either left or right tension sensor assemblies located under the front transport panel and each function exactly the same.
The assembly includes two coils with an aluminum plate inserted between them. The aluminum plate moves as tape tension varies and, accordingly, mutual inductance between the coils varies. This causes the sensor oscillation frequency and output voltage to vary proportionately. The variation of the output voltage is used to detect the movement of the tension arm.

The movement of the tension arm between A – C in Fig. 7-14 causes the voltage at TP-1 (left tension sensor output voltage) and TP-2 (right tension sensor output voltage).
Reference voltages for comparing the tension sensor output voltage are obtainable at TP-3 (left tension) and TP-4 (right tension). Their values are:

STOP, PLAY and EDIT modes	: +3.7 V
F. FWD mode	: +5.2 V
REW mode	: +3.5 V

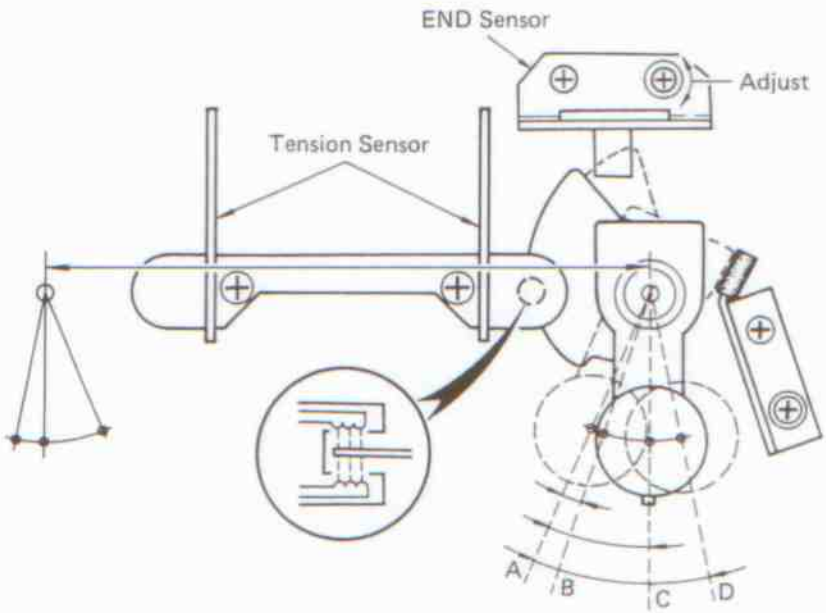


Fig. 7-14. Moving Position of Tension Arm Ass'y

A – D: Variable range of the arm
A – B: Detection range of END sensor
C : Position of arm setting while in the reproduce mode

A. Position of the tension arms while in the reproduce mode.

1. Remove the front panel assembly as described in 7-4-1 (B).
2. Thread a blank tape onto the deck and wind half of the tape onto the take-up reel so that there is an equal amount of tape on both reels. Then set the deck into the edit mode of operation.
3. With the deck in the edit mode, confirm that both tension arms are near the C position shown in Fig. 7-14 – about 22.5° from the free position A.
4. If adjustment of the angle is necessary, adjust by adjusting the trimmer resistor located on the upper part of the Operation Panel L assembly. Refer to Fig. 7-15.
   REPRO (T) R38: Right tension arm (Take up reel)
   REPRO (B) R39: Left tension arm (Supply reel)

B. Tape tension while in the reproduce mode.
   If proper tension arm positions have been obtained as described in A, proceed with the tape tension measurements.
   Thread a blank tape onto the deck in the same manner as described in A (2) and set the deck into the reproduce mode. Now, with the tape running, measure the tape tension at both the take-up side and supply reel side with a tension analyzer or a tentelo meter. The measurement should be made at both the supply side and take-up side at points A and B as shown in Fig. 7-16.
   The value to be obtained is 210 – 230 g. If you can't get this reading on your analyzer, adjust the tension strength of the spring by changing the position of the spring hook: Ⓐ and Ⓑ.
   Note: As 10-1/2" reels cover more area than 8" reels, we suggest that you use the smaller 8" reels to ensure sufficient working room to get at the A and B points with the tentelo meter probes.

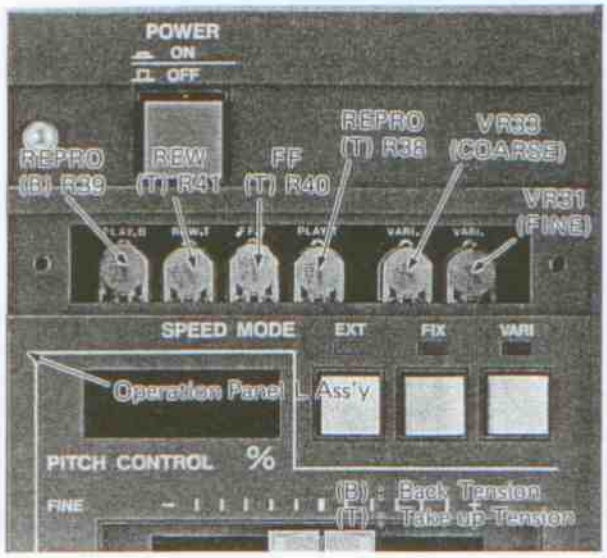
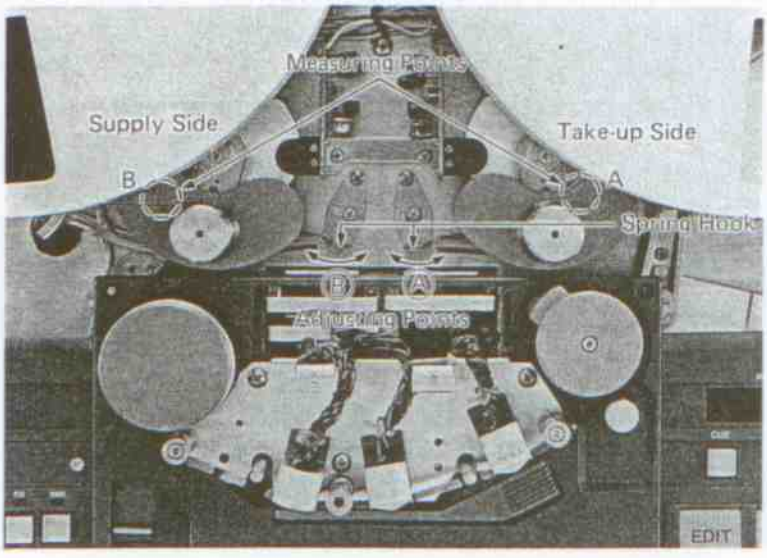


Fig. 7-15. Tape Tension Servo, Tape Speed



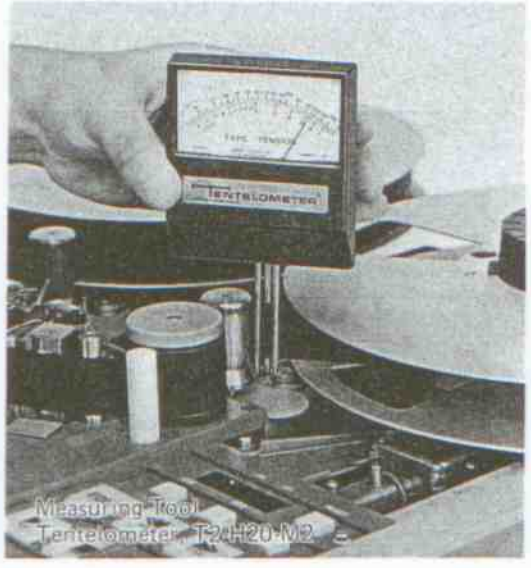


Fig. 7-16. Tape Tension Measurement and Adjustment Points

C. Tape tension while in the fast forward and rewind modes.

1. Load a tape and run it in fast forward. Check that the tension arm on the take-up side stabilizes at the C position shown in Fig. 7-14. If it does not, correct it by adjusting FF(T), R40 shown in Fig. 7-15. Then, run the tape in rewind and check, as in fast forward, that the tension arm on the take-up side stabilizes at C. If it does not, adjust REW(T), R41.
   If a tentelometer is used to measure tape tension, run tape in the Spooling mode, then stop the supply reel by hand and read the meter at A (in forward spooling) and B (in reverse spooling) shown in Fig. 7-16. Reading should be 300 ±20 g at both the measurement points. Adjustment pots to be used are the same as in the fast forward and rewind modes:
   FF (T), R40 (forward)
   REW (T), R41 (reverse)

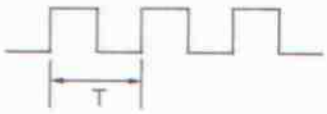
D. Motor Drive Adjustment

This adjustment must be performed when:

* Motor drive PCB assembly has been replaced, or
* Irregular tape speed is observed.

1) Fast-winding "low" speed (40 ips, 100 cm/sec.) — the speed at which the tape runs at approaching the zero/cue points during the RTZ/STC modes.

1. Connect an oscilloscope between TP3 and GND on the Control PCB Ass'y, Fig. 7-17.
2. Short-circuit TP1 and GND on the same Control PCB Ass'y. (This allows the tape to run at the "low" speed when F. FWD or REW is engaged.)
3. Thread a blank tape on the recorder/reproducer, fast-wind the tape and stop when the middle portion of the tape is reached.
4. Engage the F. FWD mode and adjust LOW (R151) on the Motor Drive PCB Ass'y so that the square wave cycle time "T" becomes 8 msec.



2) FAST speed adjustment

5. Disconnect the shorting wire from TP1 and GND that was connected in step 1) -2.
6. Run the tape in the F. FWD mode.
7. Adjust FAST (R149) on the Motor Drive PCB Ass'y so that the square wave cycle time "T" becomes 0.9 msec.

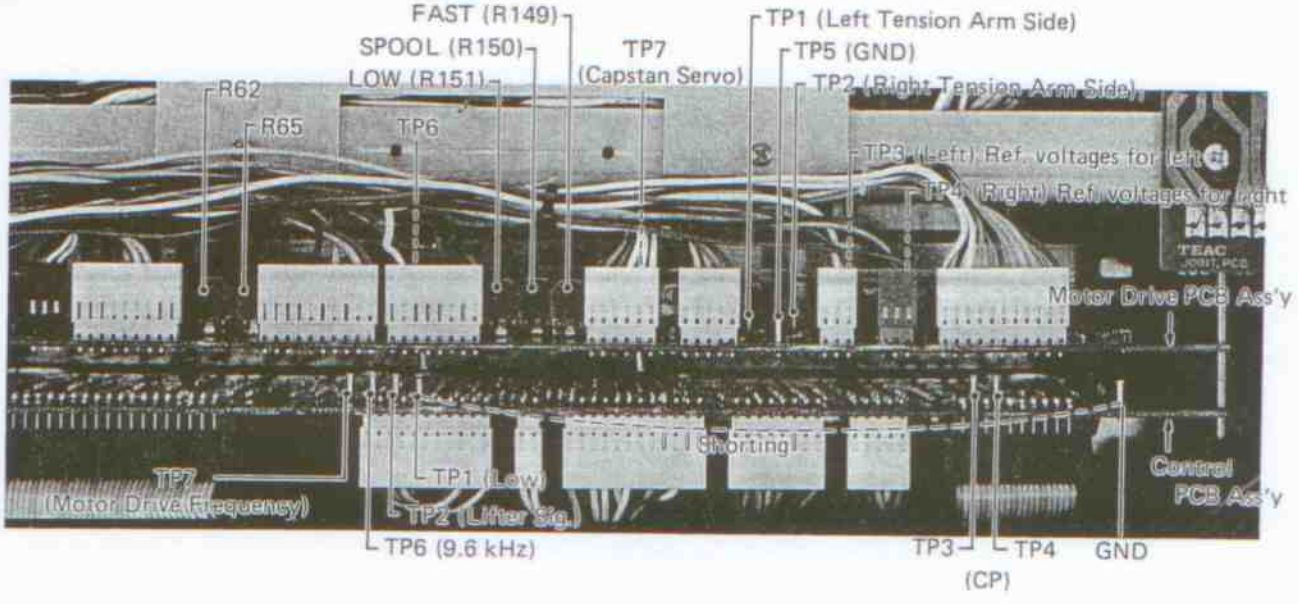


Fig. 7-17. Control PCB Ass'y and Motor Drive PCB Ass'y

3) Spooling speed adjustment

8. Run the tape in the spooling mode.
9. Adjust SPOOL (R150) so that the square wave cycle time "T" becomes 3 msec.

7-5-5. Re-installation of the Arm Stopper

Adjust the mounting position of the arm stopper so that it reaches point ⓐ in Fig. 7-18 with tape unloaded (no tension applied to the tension arm: i.e., the right tension arm rests at point A in Fig. 7-14.).

7-5-6. Adjustment and Re-installation of the End Sensor Assembly

1. First loosen the adjustment screw on the end sensor assembly, lift the assembly upwards and temporarily secure; this will disable the end sensor.
2. Set the deck into the edit mode without loading a tape.
3. Gradually move the end sensor assembly downwards, and tighten the adjustment screw at the point where the end sensor is activated.

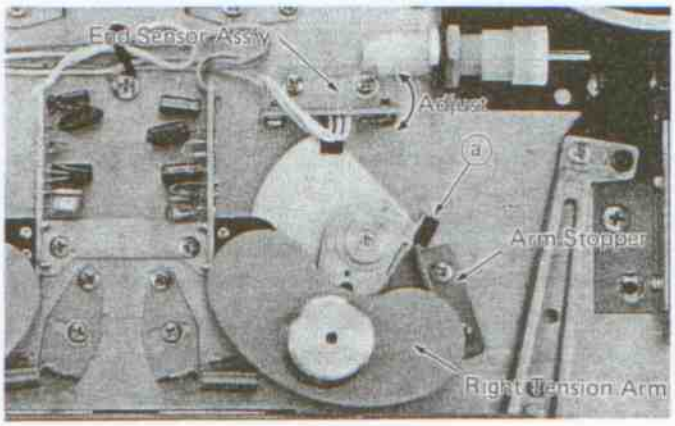


Fig. 7-18. Adjustment Position of the Arm Stopper, the End Sensor Ass'y

7-5-7. Adjustment after Replacement of the Speed Sensor Assembly

After replacement of the speed sensor assembly which requires removal and reinstallation of the footage roller, it is necessary to check if the tape runs at stable speeds. Proceed as follows:

1. Connect an oscilloscope (double trace type) to two sets of test points, TP3 and GND, and TP4 and GND, on the Control PCB Ass'y, Fig. 7-17.
2. Thread a tape on the recorder/reproducer and run in the Repro mode.
3. Adjust the mounting position of the speed sensor assembly by loosening two mounting screws so that phase shift of the two inputs becomes 90°.
4. After adjustment, repeat switching between F. FWD and REW to confirm that the oscilloscope display remains stable.

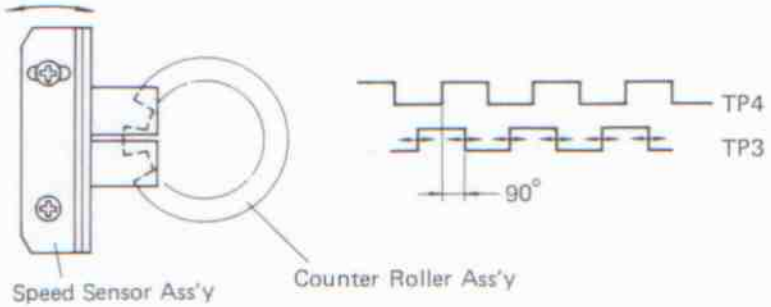


Fig. 7-19. Adjustment of the Speed Sensor Ass'y

7-5-8. Reel Table Height

Run a tape in Play or Spooling mode. If the tape rubs on either flange of the reel, the reel height must be adjusted as follows:

1. Remove the reel clamper by removing the center screw.
2. Loosen the two screws which fasten the brake drum to the motor shaft.
3. With a hex-head wrench inserted into the central access hole, turn the hex. socket set-screw clockwise to move the reel table out, or, while pushing the reel table downward, turn the setscrew counterclockwise to move the reel table in, so that the distance from the transport base surface to the rubber sheet upper surface becomes 40.91 mm.
4. When the specified height is obtained, tighten the two screws loosened in step 2.
5. Replace the reel clamper using screws removed in step 1 and run the tape to check the adjustment.

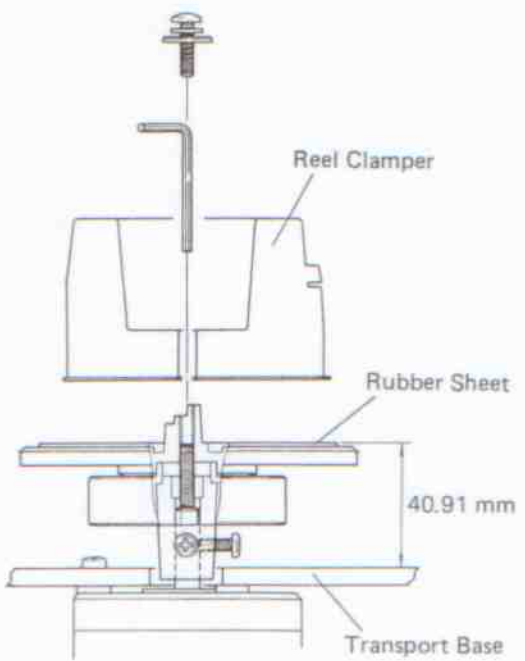


Fig. 7-20. Reel Tabel Height

7-5-9. Tape Speed

Tape speed is measured by using Flutter Test Tape which contains a highly accurate, continuous 3 kHz tone.

A. "FIX" Tape Speed

1. Connect a digital frequency counter to any OUTPUT, set the SPEED MODE switch on the deck to FIX.
2. Playing the tape at both the beginning and the end, check that the tape speed does not vary any more than the limits prescribed in the specifications. This is to assure that there will not be a total deviation of more than ±0.2 % from the 3000 Hz test tone.
3. If tape speed has greatly diverged from specification, check pinch roller pressure and takeup tension for correct values, and check to see that the tape path is clean.

B. "VARI" Tape Speed

1. Connect a digital frequency counter to any OUTPUT jack, and set the SPEED MODE switch to VARI, and the PITCH CONTROL sliders (FINE and COARSE) to the center position.
2. Play the middle portion of the test tape. Then, with the PITCH CONTROL sliders set fully left and right, take the necessary measurements. The measured results should be approx. 2,550 Hz or less with the PITCH CONTROL sliders set fully left (minimum speed), and 3,450 Hz or more with the PITCH CONTROL sliders set fully right (maximum speed).
3. If the obtained values differ from the above suggested values, adjust as follows:
   a. Set the SPEED MODE switch to VARI and the PITCH CONTROL sliders to the center position.
   b. Connect the frequency counter to TP6 and GND on the Control PCB Ass'y, Fig. 7-17. Then, while keeping an eye on the frequency counter, adjust VR33 (COARSE) shown in Fig. 7-15 until a 9,600 Hz ±15 Hz reading is obtained, and then fine-adjust VR31 (FINE) to 9,600 Hz.

7-5-10. Wow and Flutter (Reproduce Method)

1. Connect a wow and flutter meter to any OUTPUT jack on the deck.
   These meters will measure the DIN/IEC/ANSI peak value or the NAB rms value, depending on the switch selection on the meter.
2. Playback the appropriate wow and flutter test tape, at nominal "FIX" speed.
3. If the peak or rms weighted value is to be

read, set the wow and flutter meter for "weighted" readings and make sure that it is properly calibrated.

4. As the measured results may vary with respect to the location on the tape at which the measurement is taken, at least two locations — the beginning and end of the tape — should be checked. There may also be a slight difference in measured absolute values, depending on the brand of the meter being used.

Values should be as shown:

DIN/IEC/ANSI (peak value)		NAB (rms value)	
Weighted	Unweighted	Weighted	Unweighted
±0.08 %	±0.12 %	0.04 %	0.07 %

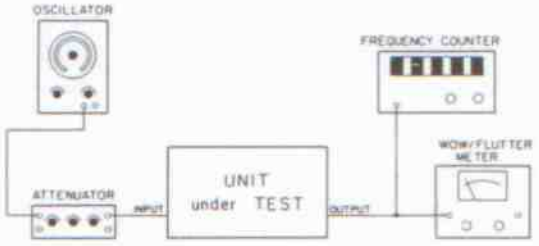
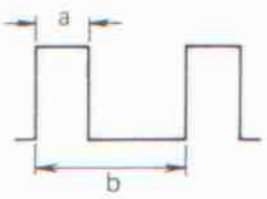


Fig. 7-21. Wow and Flutter Measurement Set-Up

7-5-11. Capstan Servo

The capstan servo will only require adjustment when the motor drive PCB has been replaced, or when the wow and flutter characteristics have greatly degraded because of the capstan servo itself.

1. Prior to making any adjustments to the capstan servo, connect an oscilloscope between test point TP7 and GND on the Motor Drive PCB Ass'y, Fig. 7-17; set R65 and R62 to their center positions and place the deck in play mode with a tape loaded.
2. While the tape is running at the fixed speed (15 ips, 38 cm/sec), adjust R62 for an output duty factor of approx. 35 % (a/b) at TP7.



3. Next, with the SPEED MODE switch set to VARI, check that the PLL does not become unlocked when tape speed is changed by moving the PITCH CONTROL sliders fully left and right. If an unlock is detected with the PITCH CONTROL sliders set fully right (maximum), rotate R65 clockwise to lock the loop. If the loop becomes unlocked when the PITCH CONTROL sliders is set fully left (minimum), repeat steps 2 and 3.

7-5-12. Tape Path Fine Adjustment

Proceed to the following adjustments only when the adjustment described in "B. Tape Path", under paragraph "7-6-1. Before Making any Checks or Adjustments", page 7-21, does not result in correct tape travel.
Through experience in applying the following basic adjustment procedures, you will be able to do it without much difficulty.
As a preliminary step, confirm that the reel tables are at the specified height.

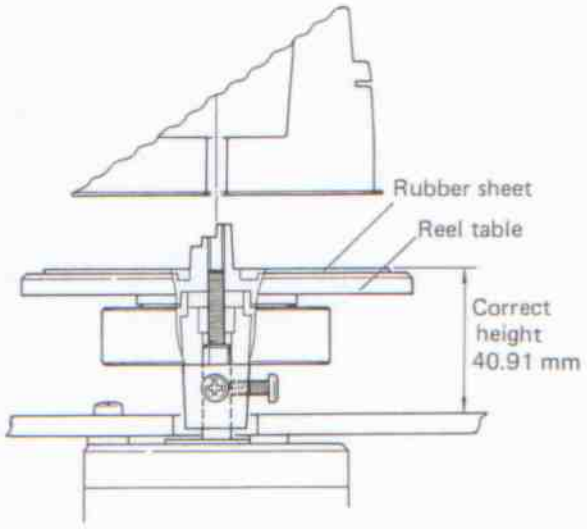


Fig. 1. Reel Table Height

A. Left and Right Tension Rollers

The following tension roller adjustments must be performed when the left and/or right tension roller assemblies have been replaced or when "slack" is observed in either the upper or lower edge of the tape in the path between the left tension roller and the tachometer roller or between the right tension roller and the pinch roller.
Remember that, since the tension roller ass'y is shipped from the factory after being adjusted to a very precise degree, the replacement of the whole ass'y should be the final measure when all else has failed.

Azimuth Adjustment

Tools required: Hex-head wrench (M4) x 3
Adjustment points: Three (3) hex. socket setscrews on the tension roller arm shaft

1. *Remove the head ass'y.*
2. Refer to Fig. 2 and locate the three hex. socket setscrews that hold the tension roller arm shaft.
3. Tighten the setscrew in the direction of which the tension roller tilts while loosening the remaining two setscrews on the opposite side, as shown in Fig. 2.

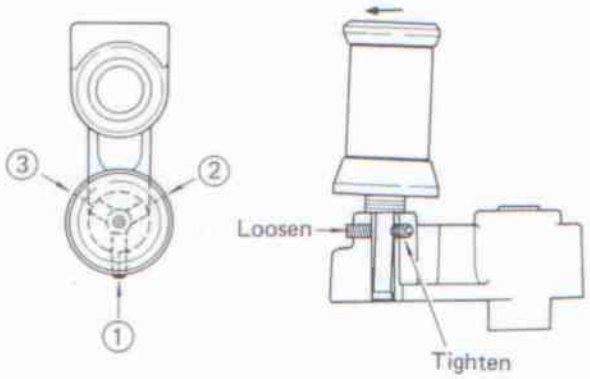


Fig. 2. Tension Roller Azimuth

Height Adjustment

Tools required: Hex-head wrench (M3), Vernier caliper
Adjustment point: Tension roller upper flange

4. Loosen the setscrew located in the top center of the tension roller and rotate the whole upper flange part in or out to the specified height. (For detailed procedures, refer to "B. Tape Path", page 7-21.)

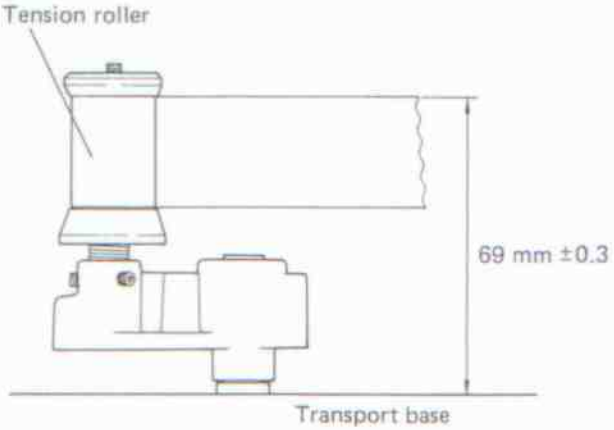


Fig. 3. Tension Roller Height

B. Tachometer Roller and Pinch Roller Azimuth and Height

Material required: Shims

5. *With the head ass'y still removed,* run tape in REW mode and if the tape has a tendency to:
   a. slide upward at the tachometer roller, apply a shim to Ⓐ .
   b. slide downward at the tachometer roller, apply a shim to Ⓑ .
   c. slide upward at the pinch roller, lower the right tension roller as in step 4.
   d. slide downward at the pinch roller, raise the right tension roller.
6. Run tape in F. FWD and if the tape has a tendency to:
   a. slide upward at the tachometer roller, lower the left tension roller.
   b. slide downward at the tachometer roller, raise the left tension roller.
   c. slide upward at the pinch roller, apply a shim to Ⓒ .
   d. slide downward at the pinch roller, apply a shim to Ⓓ .
7. Check the adjustment by running tape in F. FWD then in REW. If the tape still slides up or down at any specified points, correct it by applying the "knack" you got in steps 5 through 6.

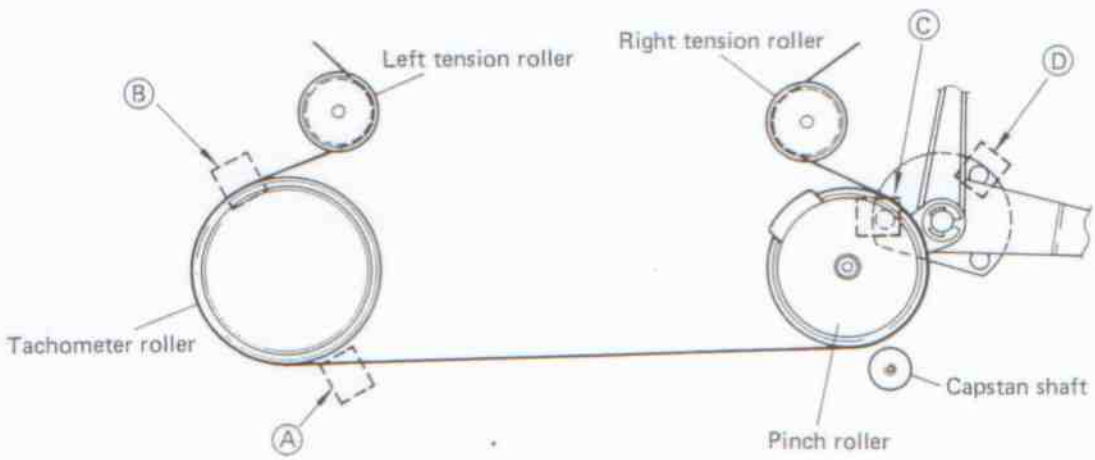


Fig. 4. Tachometer Roller and Pinch Roller Azimuth and Height

C. Tape Lifter Azimuth

Adjustment point: Tape lifter base

Purpose of this adjustment: To make sure that the tape has no tendency to slide upward/downward even when the tape lifters are engaged, neither at the tachometer roller in REW nor at the pinch roller in F. FWD.

8. Refer to Fig. 5 and thread the tape onto the left lifter and run the tape in REW, then rethread the tape onto the right lifter and again run the tape in REW.
   If the tape has a tendency to:
   a. slide upward at the tachometer roller, apply a shim to recessed side Ⓐ shown in Fig. 5.
   b. slide downward at the tachometer roller, apply a shim to front side Ⓑ shown in Fig. 5.
9. Run the tape in F. FWD in the two paths as in step 8. If the tape has a tendency to:
   a. slide upward at the pinch roller, apply a shim to recessed side Ⓒ shown in Fig. 4.
   b. slide downward at the pinch roller, apply a shim to outer side Ⓓ shown in Fig. 4.

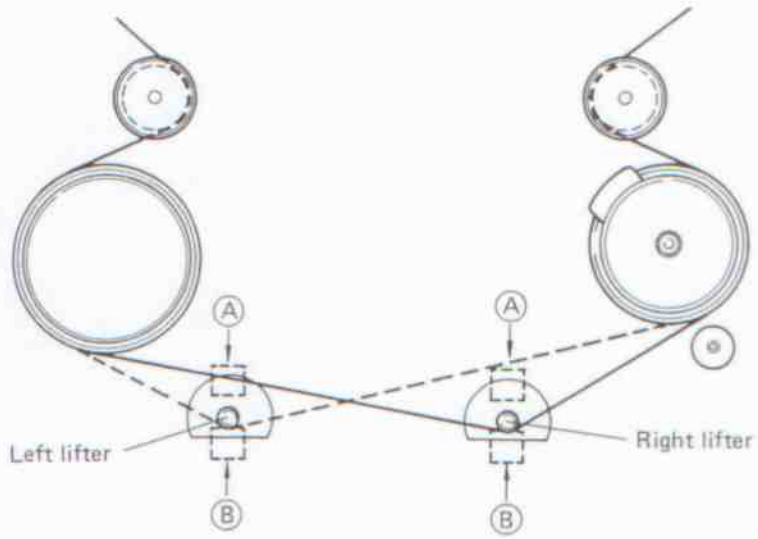


Fig. 5. Tape Lifter Azimuth

D. Pinch Roller Height

Purpose of this adjustment: To make sure that the tape runs in play mode.

10. *Replace the head ass'y.*
11. Run tape in play mode and check relative height of the right guide pin and pinch roller.
12. If necessary, insert a proper washer into upper or lower part of the pinch roller shaft.

F Capstan Azimuth

Purpose of this adjustment: To make sure that, in the play mode, the lower flange of the right guide pin touches the tape's lower edge, providing a positive tape travel guide.

13. Run tape in play mode.
14. If the tape does not rub properly the lower flange of the right guide pin, loosen the three screws shown in Fig. 6.
15. a. If the tape runs off the lower flange of the right guide pin, apply a shim to Ⓐ by inserting it through the service hole that provides access to Ⓐ.
    b. If the tape adheres too much to the lower flange of the right guide pin, apply a shim to Ⓒ by inserting it through the service hole that provides access to Ⓒ.
16. Retighten the three screws.

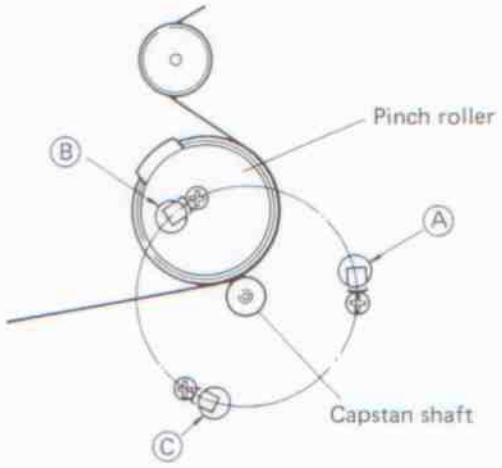
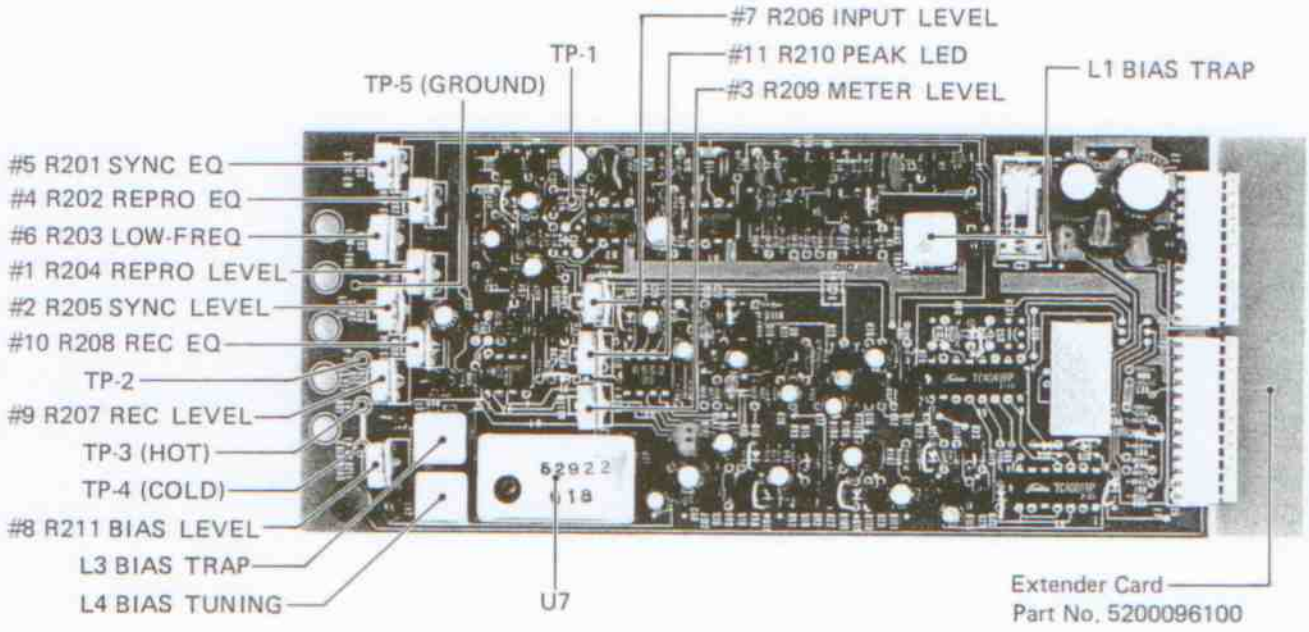


Fig. 6. Capstan Azimuth

17. Run tape in play and confirm that there is no "slack" or "curling" at the upper or lower edge of the tape in the path, neither between the left tension roller and tachometer roller, nor between the right tension roller and pinch roller.
    If slack persists, repeat necessary azimuth adjustments. If curling is observed at the left guide pin when tape runs in the play mode, the left tension roller azimuth must be readjusted.

7-6. RECORD/REPRODUCE AMPLIFIER CHECKS AND ADJUSTMENTS



Record/Reproduce Amplifier Adjustment Positions

TRIM POT NUMBER	REFERENCE NUMBER		FUNCTION
#1	R204	5 k ohms	REPRO LEVEL
2	R205	5 k ohms	SYNC LEVEL
3	R209	50 k	METER LEVEL
4	R202	2 k	REPRO EQ (HIGH-FREQ)
5	R201	20 k ohms	SYNC EQ (HIGH-FREQ)
6	R203	50 k ohms	REPRO, SYNC EQ (LOW-FREQ)
7	R206	2 k ohms	INPUT LEVEL
8	R211	100 k ohms	BIAS LEVEL
9	R207	5 k ohms	REC LEVEL
10	R208	5 k ohms	REC EQ
11	R210	50 k ohms	PEAK LED
–	L1		REPRO BIAS TRAP
–	L3		RECORD BIAS TRAP
–	L4		BIAS TUNING

Table 7-1. Reference and Function Table

7-6-1. Before Making any Checks or Adjustments

This section contains the general descriptions and cautions required for these kinds of checks and adjustments.

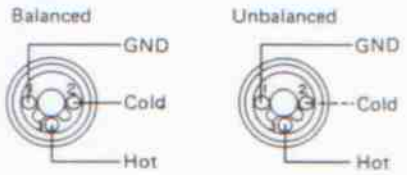
Before going ahead with any of the electrical performance checks or adjustments, make sure the tape transport mechanism has been completelv aligned as mentioned in the preceeding section, or at least make sure that the tape path and head contact are aligned correctly as mentioned later.

A. INPUT/OUTPUT connectors

The nominal input/output level at the RCA jacks is -10 dBV (0.3 V), and +4 dBm (1.23 V) at the XLR type connectors.

CAUTION:

* Be sure not to use both the "Hot" pin (3) and the "Cold" pin (2) when making your own balanced-unbalanced conversion cable. Always use pin 1 (GND) and either of the other pins. [Never short circuit pin 1 (GND) to pin 2 or 3]. Also note that in such a case, the unbalanced output signals are about 6 dB lower than the nominal balanced output level.



Input Connector Wiring

Fig. 7-6-1

When performing electrical checks/measurements through the XLR terminals, the use of the LA-40, low impedance adapter, will be a handy aid.

* Signals which are input through the XLR type connectors are fed to the record/reproduce amplifier via the circuit path of the RCA jack. Consequently, if the XLR type connectors are used for measurements, be sure that no load is applied to the RCA input jacks.

B. Tape path

The height of the tape guide ② and tension rollers should be so adjusted that the tape travels along the center width of the three heads (Erase, Rec/Sync, and Repro).

Check and adjust as follows:

1. Load a tape and run it in repro mode. Check that the upper edge of the tape is just touching the upper flange of the tape guide ② , and the lower edge of the tape the lower flange of the tape guides ① and ③ (see Fig. 7-6-3).

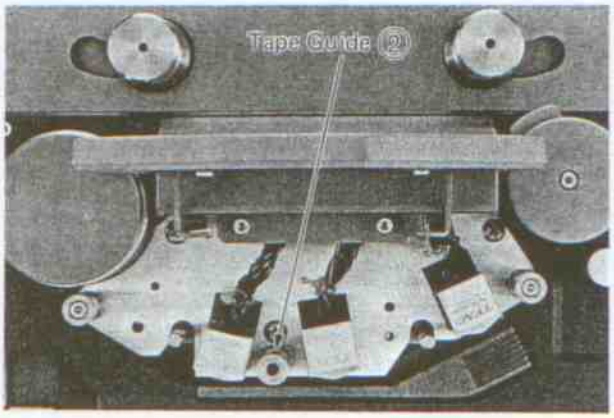


Fig. 7-6-2. Tape Guide Adjustment Point

2. If it does not and curling is observed at:
   a. Tape guide ②
      1. Loosen the screw located in the top center of the tape guide ② .
      2. Rotate the upper flange part of the tape guide ② in or out.
   b. Tape guide ①

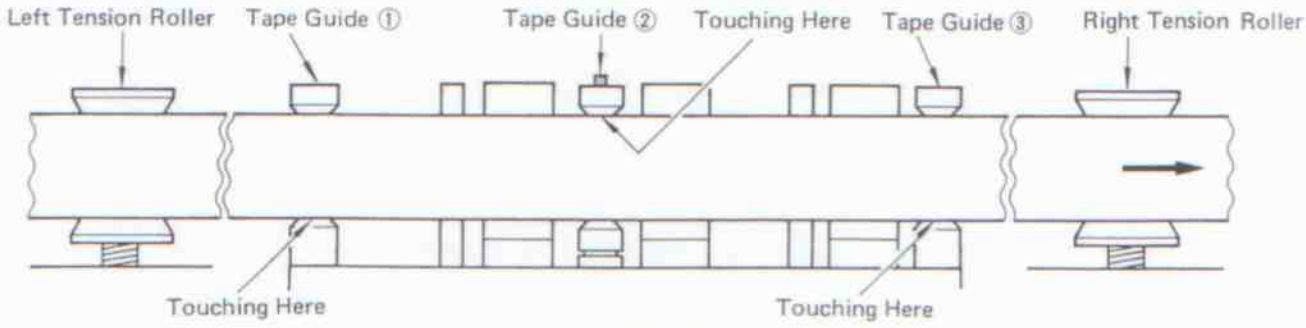


Fig. 7-6-3. Correct Tape Travel

1. Loosen the screw located in the top center of the left tension roller.
2. – To remove curling of the upper edge of the tape:
   Rotate clockwise the upper flange part of the left tension roller.
   – To remove curling of the lower edge of the tape:
   Rotate counterclockwise the upper flange part of the left tension roller.

c. Tape guide ③

1. Loosen the screw located in the top center of the right tension roller.
2. – To remove curling of the upper edge of the tape:
   Rotate clockwise the upper flange part of the right tension roller.
   – To remove curling of the lower edge of the tape:
   Rotate counterclockwise the upper flange part of the right tension roller.
3. Check the adjustment. If curling persists, repeat necessary adjustments.
   If necessary, refer to 7-5-12 "Tape Path Fine Adjustment", page 7-17.

C. Head contact

Contact of the record/sync heads and the repro head is properly aligned by following the below methods.

1. Set the OUTPUT SELECT switch to REPRO to place the deck in the repro mode.
2. Load a test tape, or a prerecorded tape with a constant level tone and reproduce.
3. While observing the VU meters, temporarily increase the back tension to the left reel by lightly applying pressure by hand. If sufficient contact pressure is applied to the head while the tape is running, no change will be noticed on any meters when the back tension is increased. However, if insufficient pressure is applied to the head, the deflection needle will show increased deflection due to contact pressure caused by the back tension. This method will help determine whether head contact is properly adjusted or not. To adjust, loosen the retaining screws (A), that'll be the center screw at the rear of the head as shown in Fig. 7-6-4. Then, change the direction of the head for proper alignment.
   Note: The amount of pressure to be applied to the reel is very important; too strong of pressure lowers the speed of the tape, while too light of pressure does not ensure contact. However, by practicing a few times, you will be able to judge approximate pressure to be applied.
4. With the test tape signal at 10 kHz and 16 kHz, determine the point where maximum level of each channel is obtained and retighten the retaining screws (A) at that position.
5. To adjust the record/sync head height, switch the OUTPUT SELECT switch to SYNC, and set both the REC function and SYNC/INPUT switches to the "down" position, to place the deck in the sync mode. Then, repeat the same steps as those used for the repro head adjustment.

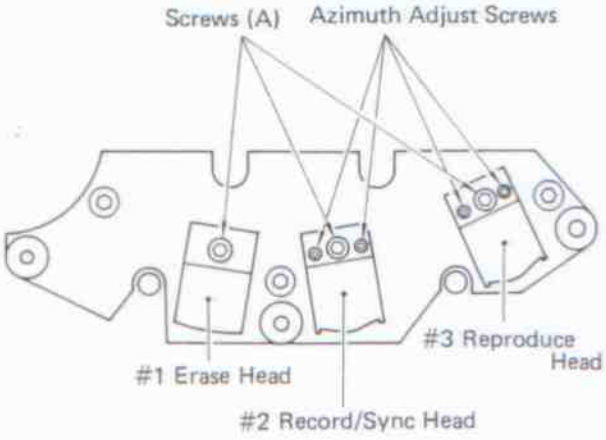


Fig. 7-6-4. Head Adjustment Screws

D. Head azimuth adjustment

1. Connect the OUTPUT connector for channel 2 of the deck to the vertical input terminals of an oscilloscope.
2. Connect the OUTPUT connector for channel 15 of the deck to the horizontal input terminals of the oscilloscope.
3. Connect an AF level meter to the OUTPUT connector(s) as shown in Fig. 7-6-5.
4. Switch the OUTPUT SELECT switch to REPRO.
5. Load the reproduce alignment test tape to reproduce. Then, a scope display reading showing phase relations between both channels will be obtained as shown in Fig. 7-6-6.
6. Adjust the repro head azimuth screw until the scope display shows less than 90° out of phase at 10 kHz with the AF level meter showing approximately maximum value for both channels.

7. Set the deck to sync mode, reproduce the test tape and adjust the record/sync head azimuth screw the same way.

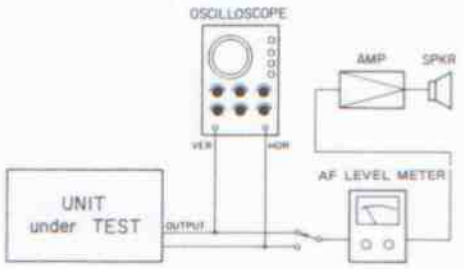


Fig. 7-6-5. Head Azimuth Test Set-Up

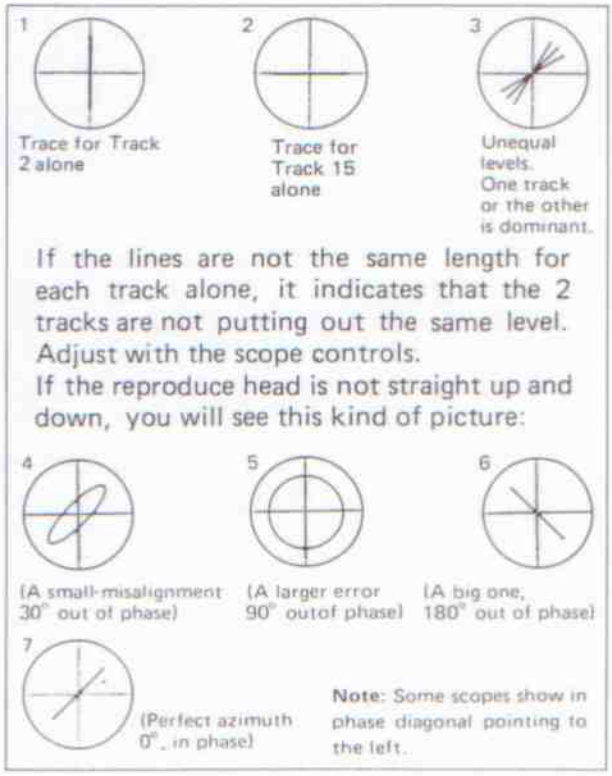


Fig. 7-6-6. Phase Shift

E. Others

* To get at the trim pots for record/reproduce amplifier circuit adjustments, open the service door by removing the two set screws, one on each side of the front door. (Refer to Fig. 7-6-7.) With the cover removed, you will see the amplifier boards to which the trim pots are mounted as shown in the photograph. The boards are identical, and are exclusively used for their respective channels.
* Record/reproduce amplifier checks and adjustments are given for only one of the channels, but they should be applied for all the other channels as well.

Fig. 7-6-7. Opening the Front Panel of the Amplifier Section

* 0 dBm = 0.775 V (600 ohms)
  0 dBV = 1 V
* The power should always be off when inserting or removing the record/reproduce amplifier PCB assembly.
* To simplify record/reproduce amplifier PCB assembly identification, mark the corresponding channel number on the silk-screen on the foil side of the PCB with a magic marker, or equivalent.

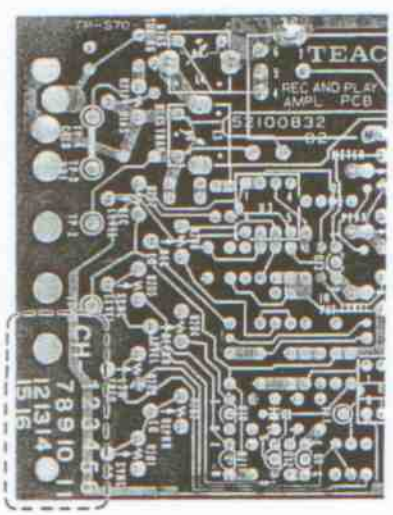


Fig. 7-6-8. Channel Identification

7-6-2. Input Level Calibration

1. Connect the test equipment to INPUT 1 and OUTPUT 1, as shown in Fig. 7-6-8.
2. Apply a 1 kHz, +4 dBm (1.23 V) test signal to the INPUT 1 connector on the rear panel, and switch the OUTPUT SELECT switch to INPUT.
3. Make sure the AF level meter reads +4 dBm (1.23 V) output. If it doesn't, adjust the R206, 2 k ohm trim pot on the record/reproduce amplifier PCB.
4. Adjust the remaining channels in the same way.

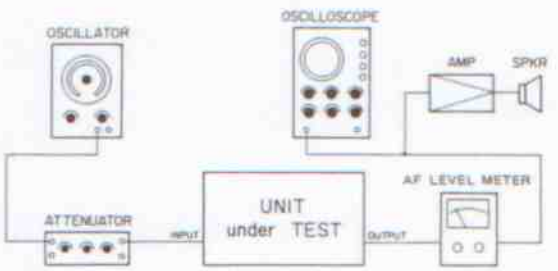


Fig. 7-6-8 Level of Frequency Response Measurement Set-up

7-6-3. Meter

1. Make sure that the meter indicates 0 VU after completion of the above steps 2-3, or after setting the input level to read +4 dBm output. If the meter does not indicate 0 VU, adjust R209, 50 k ohms on the record/reproduce amplifier PCB.
2. Check and adjust all channels in the same way.

7-6-4. Peak LED

1. With the conditions the same as described in 7-6-2, adjust R210, 50 k ohms so that the peak LED lights when the input level is raised 12 dB (input voltage +16 dBm) and turns off when reduced 0.5 dB (+15.5 dBm).
2. Check and adjust all channels in the same way.

7-6-5. Reproduce Level Calibration

1. Connect the AF level meter, oscilloscope to the OUTPUT 1 connector on the rear panel.
2. Switch the OUTPUT SELECT switch to REPRO.
3. Load the reproduce alignment test tape and reproduce. Observe the AF level meter, it should indicate +4 dBm, if not, adjust trim pot R204, 5 k ohms on the record/reproduce amplifier PCB.
4. Switch the OUTPUT SELECT switch to SYNC, set both the REC function and SYNC/INPUT switches to the "down" position to reproduce the tape in the sync mode and reproduce the same tape. Check the AF level meter, it should read +4 dBm. If not, adjust trim pot R205, 5 k ohms on the record/reproduce amplifier PCB.
5. Check and adjust all channels in the same way.

7-6-6. Reproduce Frequency Response

After the level of all 16 channels have been set, rethread the test tape.

1. When making checks and adjustments of the reproduce frequency response, you will find that it's easier to check all 16 channels at the same time by using the VU meters on the front panel, instead of checking them one at a time, and having to use an AC voltmeter and go through the trouble of plugging it into each OUTPUT connector to do the check. To do this though, 7-6-3 must be completed first.
2. Switch the OUTPUT SELECT switch to REPRO.
3. Reproduce the test tape and take a reading of the output levels at the specified frequencies shown in Fig. 7-6-9. They should be within the specified limits shown below. If they aren't, adjust trim pot R202, 2 k ohms on the record/reproduce amplifier PCB so that the high range 16 kHz signal provides the same level reading as the 1 kHz signal.

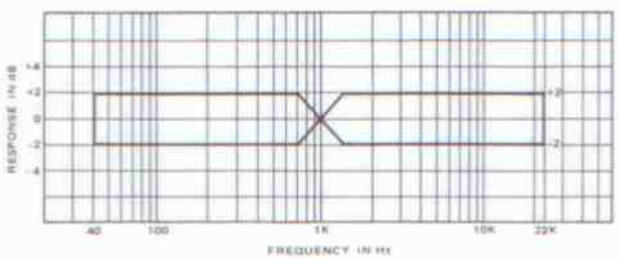


Fig. 7-6-9. Reproduce Frequency Response

4. Switch the OUTPUT SELECT switch to SYNC, set both the REC function and SYNC/INPUT switches to the "down" position to place the deck in the sync mode.
5. Reproduce the same tape and also read the output levels the same way to learn whether

the frequency response is within the specified limit. If the frequency response is not within the specified limit, adjust trim pot R201, 2 k ohms in the same way.

6. If the specified frequency response cannot be obtained with the trim pot(s) adjusted;
   * Check and compare the measurements of the other channels. Adjust so that the level differences between channels is within 3 dB at the frequency range of 40 Hz – 20 kHz.
   * If all channels are off spec, check power line, incorrect head adjustments or whether heads should be cleaned.
   * Demagnetize the heads.
   * Finally, if all else fails, replace the heads.

7-6-7. Bias Tuning and Bias Trap Adjustments

These adjustments have been made at the factory and realignment will not be necessary except for the following circumstances:

* When the sync head, erase head and/or bias amplifier is replaced.
* When the master BIAS OSC PCB card or master BIAS OSC unit is replaced.

Use the following procedures to adjust.

Note

* Be sure to use a non-conductive screwdriver (i.e. wood, plastic).
* For bias level measurements, use an AC level meter of which input terminal has a floating capacitance of 100 pF or lower.

A. BIAS TUNING (L4)

1. Place all channel REC function switches to ON and set the tape deck into the record-reproduce mode.
2. Connect a DC voltmeter between TP-3 (Hot) and TP-4 (Cold). By using an insulated screwdriver, adjust L4 so that a minimum reading is obtained on the DC meter. The minimum reading should be approximately 0.35 V if the bias level trim pot R211 is correctly set to the 3 o'clock position. The voltage at pin 5 of IC U7 of the master bias oscillator should be AC 70 V ±5 V.
   An extender card is required for the adjustment of the bias tuning coil L4. Pull out the PCB assembly of the channel that's to be adjusted and insert the extender card.
   Extender Card: TEAC part No. 5200096100

CAUTION:	Do not try to obtain maximum reading on the DC voltmeter. This could occasion an extreme amount of bias amplifier output load.

B. BIAS TRAP (L3, L1)

1. Connect an AC level meter between TP-2, TP-5 and ground.
2. Place all the REC function switches to ON and set the deck into the record-reproduce mode.
3. Adjust L3 so that a minimum reading is obtained on the level meter.
4. Connect an oscilloscope to the OUTPUT connectors.
5. Set the OUTPUT SELECT switch to REPRO.
6. With the deck set in the record-reproduce mode, check the amount of bias signal leaking into the reproduce amplifier.
7. Adjust trim conductor L1 so that the amount of bias leakage is minimized.

7-6-8. Bias Level

This adjustment is made while you are recording a tone on the type of tape you'll be using for the session. It will be different for each brand of tape. Before proceeding with this adjustment, make sure that the tape path and head contact have been adjusted correctly as mentioned earlier and that no tape curling is noticed.

1. Connect an AF oscillator, oscilloscope, AF level meter to the tape deck as shown in Fig. 7-6-8.
2. Adjust the AF oscillator to apply a 10 kHz, -1 dBm (690 mV, -5 VU) signal to INPUT connector on the rear panel.
3. Switch the OUTPUT SELECT switch to REPRO and set all REC function switches to ON.
4. Begin recording channel 1. Now adjustments can be made while recording a 10 kHz tone.

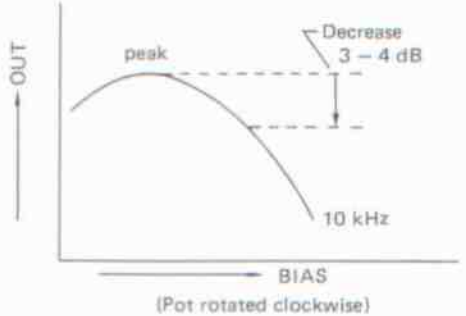


Fig. 7-6-10. Bias Level Adjustment

5. Begin the adjustments by turning trim pot R211, 100 k ohms completely counterclockwise. Next, turn the trim pot itself clockwise and the AF level meter will rise to give peak reading. Slowly continue the clockwise rotation until the reading on the level meter drops 3 – 4 dB from the peak reading as shown in Fig. 7-6-10.
6. Repeat the same procedures on the remaining channels.

7-6-9. Recording Level

Recording level adjustments should be done only after the reproduce level and recording bias have been properly set as specified above.

1. Connect an AF oscillator, oscilloscope and AF level meter to the tape deck as shown in Fig. 7-6-8.
2. Apply a 1 kHz, +4 dBm (1.23 V) signal to the INPUT 1 connector.
3. Switch the OUTPUT SELECT switch to REPRO and record the 1 kHz input signal on the specified recording test tape.
4. Check the AF level meter, it should indicate +4 dBm (1.23 V). If it doesn't, adjust trim pot R207, 5 k ohms to obtain the +4 dBm indication. At this time, make sure that the front panel VU meter indicates 0 VU.
   * Recording Reference Level = 250 nWb/m.
5. Switch the OUTPUT SELECT switch to SYNC, set both the REC function and SYNC/INPUT switches to the "down" position to reproduce the tape in the sync mode. Make sure that both the AF level meter and the VU meter indicate +4 dBm and 0 VU, respectively.
6. If it's impossible to obtain a VU meter reading of 0 VU in steps 4 and 5 above, check to see whether the reproduce meter is set properly as described under 7-6-3. "Meter".
7. Check and adjust the remaining channels in the same way.

7-6-10. Frequency Response (OVERALL)

After completing the recording level check and adjustments, proceed onto the overall frequency response checks.

1. Connect the test equipment to the tape deck as shown in Fig. 7-6-8 and load a blank test tape onto the tape deck.
2. Apply a +4 dBm test signal to the INPUT connector on the rear panel.
3. Switch the OUTPUT SELECT switch to REPRO and record the test signal with the frequency varied from 40 Hz to 20 kHz. Read the reproduced output levels at the proper test frequencies during recording. Make sure the frequency response obtained is within the specified limit shown in Fig. 7-6-11.
4. Switch the OUTPUT SELECT switch to SYNC, set both the REC function and SYNC/INPUT switches to the "down" position to reproduce the tape in the sync mode. Measure the reproduced output levels at the proper test frequencies, and make sure that the frequency response is within the specified limit shown.
5. If the frequency response reading is not within the specified limit, adjust the high frequency range through trim pot R208, 5 k ohms, or readjust the bias level setting within its specified range by refering to 7-6-8 "Bias Level". When the frequency response in the lower frequency spectrum is not within the specified limits, adjust trim pot R203, 50 k ohms. If the bias level is readjusted, the recording level adjustment will be upset, so repeat the recording level adjustments again as described in 7-6-9 "Recording Level".

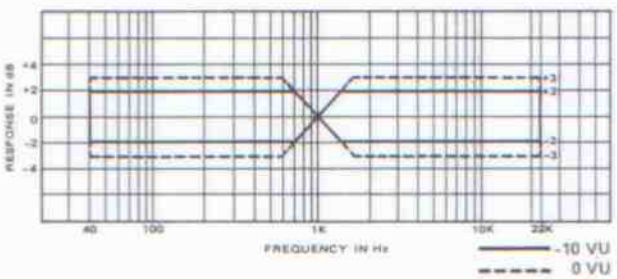


Fig. 7-6-11. Overall Frequency Response

7-6-11. Signal-to-Noise Ratio (OVERALL)

Before going ahead with any measurements, demagnetize all heads and tape guides.

1. Connect test equipment as shown in Fig. 7-6-8 (with a 20 Hz – 20 kHz filter inserted between deck's output and AF level meter).
2. Apply a 1 kHz +4 dBm (1.23 V = 0 VU) input signal to the INPUT 1 connector on the rear panel.
3. Record a short length of the input signal. Then, while still in the recording mode, unplug the AF oscillator connected to the INPUT connector, and make another length of no-signal recording.
4. Rewind the recording made in step 3 to the beginning and reproduce.
5. Switch the OUTPUT SELECT switch to

SYNC, set both the REC function and SYNC/INPUT switches to the "down" position to reproduce the tape in the sync mode.

6. While making sure the reproduce output of the perviously recorded 1 kHz 0 VU signal is +4 dBm, raise the sensitivity of the AF level meter and measure the level of the no-signal portion of the tape.
7. With +4 dBm (0 VU) as the reference level, the signal-to-noise ratio, as measured by the AF level meter, should be better than 50 dB.
8. If it is off spec,
   * Check and compare the measurement of the other channels. If they stand up to spec, correct or replace the off spec channel record/reproduce amplifier PCB.
   * Demagnetize the heads.
   * Check erasure, refer to 7-6-12.
   * Check for proper adjustment of the bias trap.
   * Try another tape of the same type number.

Test point TP-1, located on the record/reproduce amplifier PCB, is an output terminal reserved for performing checks when noise is generated. Voltage at this terminal is DC 5 mV, or lower when offset.

7-6-12. Erase Ratio

1. Connect test equipment to the tape deck as shown in Fig. 7-6-12.
2. Use a 1 kHz bandpass filter to check the erasing ratio.
3. Switch the OUTPUT SELECT switch to SYNC and record a short length of the 1 kHz, +14 dBm (3.88 V) signal and unplug the AF oscillator connected to the INPUT connector on the rear panel.
4. Rewind the tape to the beginning of the recorded section.
5. Record a no-signal portion over the recording of the 1 kHz signal.
6. Switch the OUTPUT SELECT switch to SYNC, set both the REC function and SYNC/INPUT switches to the "down" position to reproduce the tape in the sync mode.
7. Measure the difference between the 1 kHz signal level and the no-signal portion. The difference should be at least 70 dB.
8. If the level difference is below this specification, check erase head output voltage for 60 – 70 V using an AC voltmeter.
   If necessary, adjust the erase head position by loosening the screw located behind the erase head.

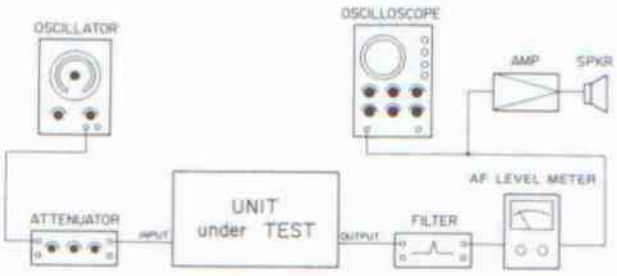


Fig. 7-6-12. Erase Ratio Test Set-Up

7-6-13. Adjacent Channel Crosstalk

1. Connect test equipment as shown in Fig. 7-6-13.
2. While making a no-signal recordings on one of the channels, apply a 1 kHz +4 dBm (1.23 V) test signal to the adjacent channel.
3. Rewind the tape to the beginning of the recording.
4. Switch the OUTPUT SELECT switch to SYNC, set both the REC function and SYNC/INPUT switches to the "down" position to reproduce the tape in the sync mode.
5. Reproduce the tape and measure the output (signal leakage) of the no-signal recorded channel.
6. Measure the difference between the 1 kHz nominal output level and the no-signal portion. The difference should be 55 dB or greater.

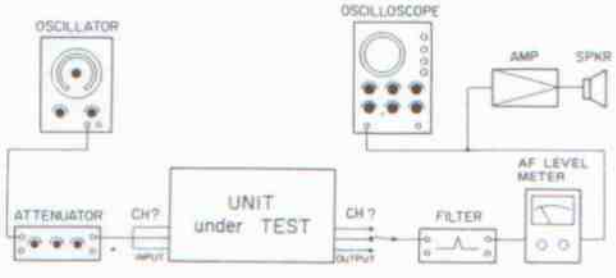


Fig. 7-6-13. Crosstalk Measurement Set-Up

7-6-14. Distortion

1. Connect test equipment as shown in Fig. 7-6-14.
2. Switch the OUTPUT SELECT switch to REPRO.

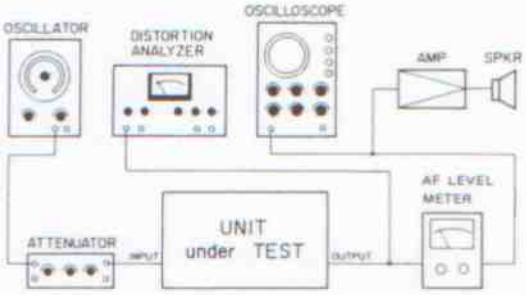


Fig. 7-6-14. Distortion Measurement Set-Up

3. Apply a 1 kHz, +4 dBm (1.23 V) test signal to the INPUT connector and reproduce. Measure the distortion of the reproduced output with a distortion analyzer connected to the OUTPUT connector.
4. Stop the recording, switch the OUTPUT SELECT switch to SYNC, set both the REC function and SYNC/INPUT switches to the "down" position to place the deck in the sync mode.
5. Rewind the tape to its beginning and reproduce. Measure the distortion of the reproduced output.
6. The distortion measured should be less than 0.8 % for a +4 dBm recording.
7. If the distortion is higher:
   * Check and compare the measurements of the other channels. If they stand up to spec, correct or replace the off-spec channel's record/reproduce amplifier PCB.
   * Check bias level setting and readjust if necessary.
   * Demagnetize the heads.
   * If all else fails, replace the heads.

7-6-15. Output Level Switching

Nominal output level can be changed from +4 dBm (1.23 V) to +8 dBm (1.95 V). Figure 7-6-15 shows switches S1 – S16 (CH-1 – CH-16) on the Input/Output Amplifier PCB Ass'y by removing bottom cover. By resetting these switches, the gain of the output amplifier is boosted 4 dB to achieve the nominal output level of +8 dBm (1.95 V).

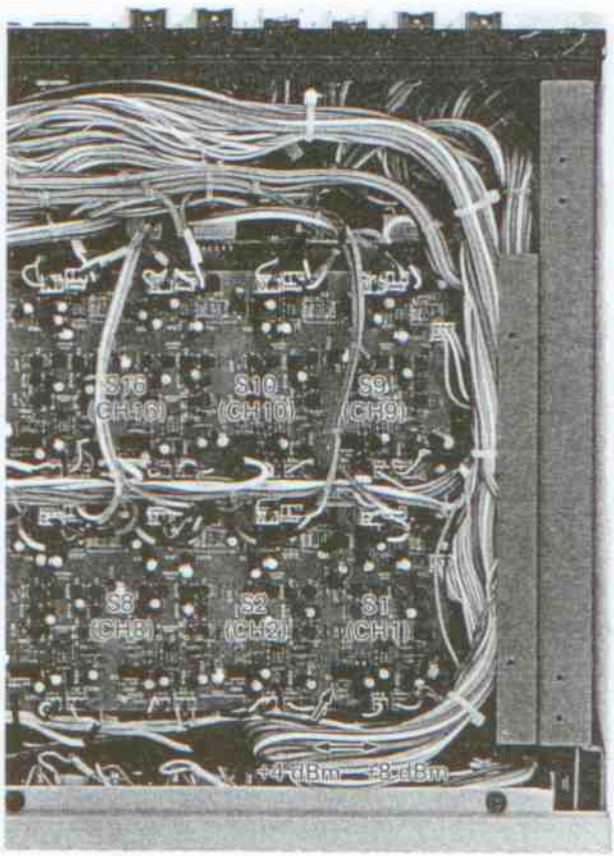


Fig. 7-6-15. Output Level Switching

7-6-16. Service Chart

AD-JUST STEP	WHAT IS IT CALLED	SIGNAL SOURCE AND AMOUNT	WHAT TEST GEAR TO USE	WHAT IS THE RE-CORDER DOING?	POINT TO AD-JUST	WHAT READING TO ADJUST FOR
1	Reproduce Head Alignment	Reproduce Align-ment Test Tape	VTVM and Oscillo-scope with vertical and horizontal inputs connected to OUTPUT tracks 2 and 15.	OUTPUT SELECT at REPRO Reproduce at 15 ips Speed	Repro head #3 azimuth adjusting screw. See Fig. 7-6-4	Adjust for maxi-mum output and for output of tracks 2 and 15 less than 90° out of phase. (at 10 kHz)
2	Record/Sync Head	Same as above	Same as above	OUTPUT SELECT at SYNC REC function and SYNC/INPUT at OFF Reproduce at 15 ips Speed	Sync head #2 azimuth adjusting screw. See Fig. 7-6-4	Same as above
3*	Input Level	1 kHz signal at +4 dBm from oscilla-tor connected to input terminal	VU meters	Stop mode OUTPUT SELECT at INPUT	Trim pot #7 R206 (INPUT LEVEL)	Adjust for 0 VU on VU meters
4*	Meter Adjustment	Same as above	VU meters	Same as above	Trim pot #3 R209 (METER)	Same as above
5*	PEAK LED	1 kHz Input signal at +16 dBm level (+12 VU on VU meters). Apply signal for short time only.	PEAK LED in VU meters	Same as above	Trim pot #11 R210	Adjust until PEAK LED goes ON
6*	Reproduce Level (head #3)	Reproduce Align-ment Test Tape Reproduce 1 kHz	VTVM connected to OUTPUT terminal	OUTPUT SELECT at REPRO. Reproduce at 15 ips Speed	Trim pot #1 R204 REPRO LEVEL	+4 dBm (1.23 V) on VTVM
7*	Sync Reproduce Level (head #2)	Same as above	Same as above	OUTPUT SELECT at SYNC. REC function and SYNC/INPUT at OFF Reproduce at 15 ips Speed	Trim pot #2 R205 (SYNC LEVEL)	+4 dBm (1.23 V) on VTVM
8*	Reproduce EQ (head #3)	Play 16 kHz signal on the test tape.	VTVM connected to OUTPUT ter-minal or use VU meters	OUTPUT SELECT at REPRO Reproduce at 15 ips Speed	Trim pot #4 R202 (REPRO-EQ)	Adjust for same level as per 1 kHz signal.
9*	Sync EQ (head #2)	Same as above	Same as above	OUTPUT SELECT at SYNC. REC function and SYNC/INPUT at OFF Reproduce at 15 ips Speed	Trim pot #5 R201 (SYNC-EQ)	Same as above
10*	Bias Trap (RE-CORD) Adjustment	No input signal	VTVM connected to Bias Trap test point, TP-2, nega-tive lead to ground TP-5, positive lead to test point.	Record mode, no input signal	Inductor L3	Adjust inductor for minimum output at Bias Trap test point. See page 7-24.
11*	Bias Trap (RE-PRO) Adjustment	Same as above	Oscilloscopes con-nected to OUTPUT connector	Record mode, OUTPUT SELECT at REPRO.	Inductor L1	Adjust inductor for minimum bias leakage level at OUTPUT con-nector.
12*	Bias Level Adjust-ment	10 kHz, -1 dBm oscillator signal connected to Input connectors	VTVM connected to OUTPUT con-nector or use VU meters	Record signal on type of tape that will be used for actual recording. OUTPUT SELECT at REPRO	Trim pot #8 R211 (BIAS LEVEL)	Adjust for drop off by 3 – 4 VU from the peak (over-bias).

AD-JUST STEP	WHAT IS IT CALLED	SIGNAL SOURCE AND AMOUNT	WHAT TEST GEAR TO USE	WHAT IS THE RE-CORDER DOING?	POINT TO AD-JUST	WHAT READING TO ADJUST FOR
13*	Record Level	1 kHz signal at +4 dBm (0 VU on VU meters) connected to input terminals	VTVM connected to OUTPUT con-nector, or use VU meters	Record on selected tape at 15 ips OUTPUT SELECT at INPUT (to set reference), then, OUTPUT SELECT at REPRO	Trim pot #9 R207	Set for +4 dBm (1.23 V) at OUT-PUT connectors or 0 VU on VU meters
14*	High Frequency (REC EQ)	18 kHz signal at +4 dBm connected to input connectors	VTVM connected to OUTPUT con-nector or use VU meters	Record signal on type of tape that will be used for actual recording. OUTPUT SELECT at REPRO	Trim pot #10 R208	Adjust to read peak indication See for +4 dBm at OUTPUT connec-tors or 0 VU on VU meters
15*	Overall Frequency Response	40 Hz to 22 kHz signal at +4 dBm connected to Input connectors	Same as above	Same as above	Check only. Adjustment done in step 10.	Check that fre-quency response matches limit given in Fig. 7-6-11
16*	Overall Signal-to-Noise Ratio	No input signal	VTVM connected to OUTPUT con-nector	Record mode. OUTPUT SELECT at REPRO		Check for -54 dBm or better

REPEAT STEPS MARKED WITH AN ASTERISK FOR EACH CHANNEL. THE ADJUSTMENT VALUES ARE THE SAME BUT THE CIRCUIT BOARD LOCATION, INPUT/OUTPUT TERMINALS, VU METERS, ETC., WILL BE DIFFERENT DEPENDING ON THE CHANNEL.

8. EXPLODED VIEWS, ASSEMBLIES, PARTS LISTS AND CIRCUIT SCHEMATICS

INSTRUCTIONS FOR SERVICE PERSONNEL

BEFORE RETURNING APPLIANCE TO THE CUSTOMER, MAKE LEAKAGE-CURRENT OR RESISTANCE MEASUREMENTS TO DETERMINE THAT EXPOSED PARTS ARE ACCEPTABLY INSULATED FROM THE SUPPLY CIRCUIT.

NOTES

- ★ Parts marked with * require longer delivery time.
- ★ Resistor values are in ohms (K = 1,000 ohms, M = 1,000,000 ohms).
- ★ All capacitor values are in microfarads (p=pico-farads).
- ★ ⚠ Parts marked with this sign are safety critical components. They must always be replaced with identical components – refer to the TEAC Parts List and ensure exact replacement.
- ★ 0 dB is referenced to 1 V in this manual unless otherwise specified.
- ★ PC boards shown viewed from foil side.

INDEX

8. EXPLODED VIEWS, ASSEMBLIES, PARTS LISTS AND CIRCUIT SCHEMATICS

8-1. MECHANICS – EXPLODED VIEWS AND PARTS LISTS

8-1-1. Exploded View – 1 ..... 8 - 3
8-1-2. Exploded View – 2 ..... 8 - 6
8-1-3. Exploded View – 3 ..... 8 - 10
8-1-4. Exploded View – 4 ..... 8 - 12
8-1-5. Exploded View – 5 ..... 8 - 14
8-1-6. Exploded View – 6 ..... 8 - 15
8-1-7. Exploded View – 7 ..... 8 - 18
8-1-8. Exploded View – 8 ..... 8 - 20

8-2. ELECTRONICS – PCB'S AND ELECTRONIC COMPONENTS

8-2-1. Control PCB Ass'y ..... 8 - 22, 8 - 24
8-2-2. Joint PCB Ass'y, Speed Sensor PCB Ass'y, End Sensor PCB Ass'y ..... 8 - 25
8-2-3. Motor Drive PCB Ass'y ..... 8 - 26, 8 - 28
8-2-4. Key Board PCB Ass'y, CM Drive PCB Ass'y ..... 8 - 30, 8 - 31
8-2-5. Pitch Cont. PCB Ass'y, Remote Connector PCB Ass'y ..... 8 - 32, 8 - 33
8-2-6. Rec/Play Amplifier PCB Ass'y ..... 8 - 34, 8 - 36
8-2-7. Mother PCB Ass'y ..... 8 - 38, 8 - 41
8-2-8. Input PCB Ass'y, Output PCB Ass'y, Remote Function CN PCB Ass'y, OSC PCB Ass'y (PCB omitted), Fuse PCB Ass'y (PCB omitted) .. 8 - 40, 8 - 41
8-2-9. Function PCB A Ass'y, Function PCB B Ass'y ..... 8 - 42, 8 - 44
8-2-10. REC Select PCB Ass'y ..... 8 - 45
8-2-11. Input/Output Amplifier PCB Ass'y ..... 8 - 46
8-2-12. Power PCB Ass'y ..... 8 - 48, 8 - 50

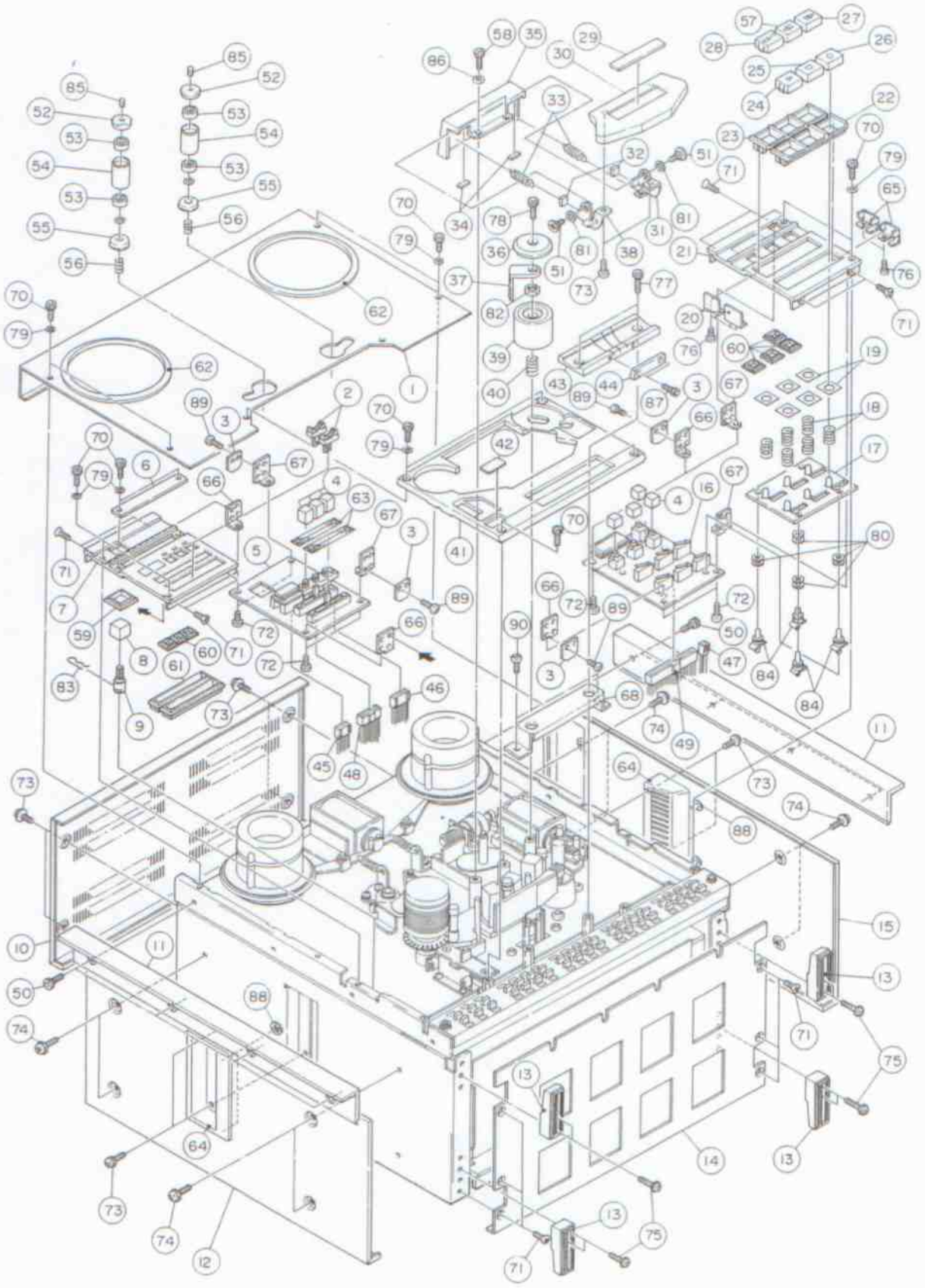
9. CIRCUIT SCHEMATICS

9-1. Wiring Diagram – Control Section ..... 9 - 1
9-2. Wiring Diagram – Amplifier Section ..... 9 - 2
9-3. Control PCB Ass'y ..... 9 - 3
9-4. Key Board PCB Ass'y ..... 9 - 4
9-5. Motor Drive PCB Ass'y ..... 9 - 5
9-6. Capstan Servo PCB Ass'y ..... 9 - 6
9-7. Pitch Control PCB Ass'y ..... 9 - 7
9-8. Remote Connector PCB Ass'y ..... 9 - 8
9-9. Remote Function CN PCB Ass'y ..... 9 - 9
9-10. Rec/Play Amplifier PCB Ass'y ..... 9 - 10

9-11. Meter PCB Ass'y ..... 9 - 11
9-12. Function A PCB Ass'y, Function B PCB Ass'y ..... 9 - 12
9-13. Input/Output Amplifier PCB Ass'y ..... 9 - 13
9-14. Power Supply PCB Ass'y ..... 9 - 14
9-15. IC Internal Block Diagrams ..... 9 - 15
9-16. Remote Control RC-65 (Option) ..... 9 - 16

8-1. MECHANICS-EXPLODED VIEWS AND PARTS LISTS

8-1-1. Exploded View – 1



Exploded View—1

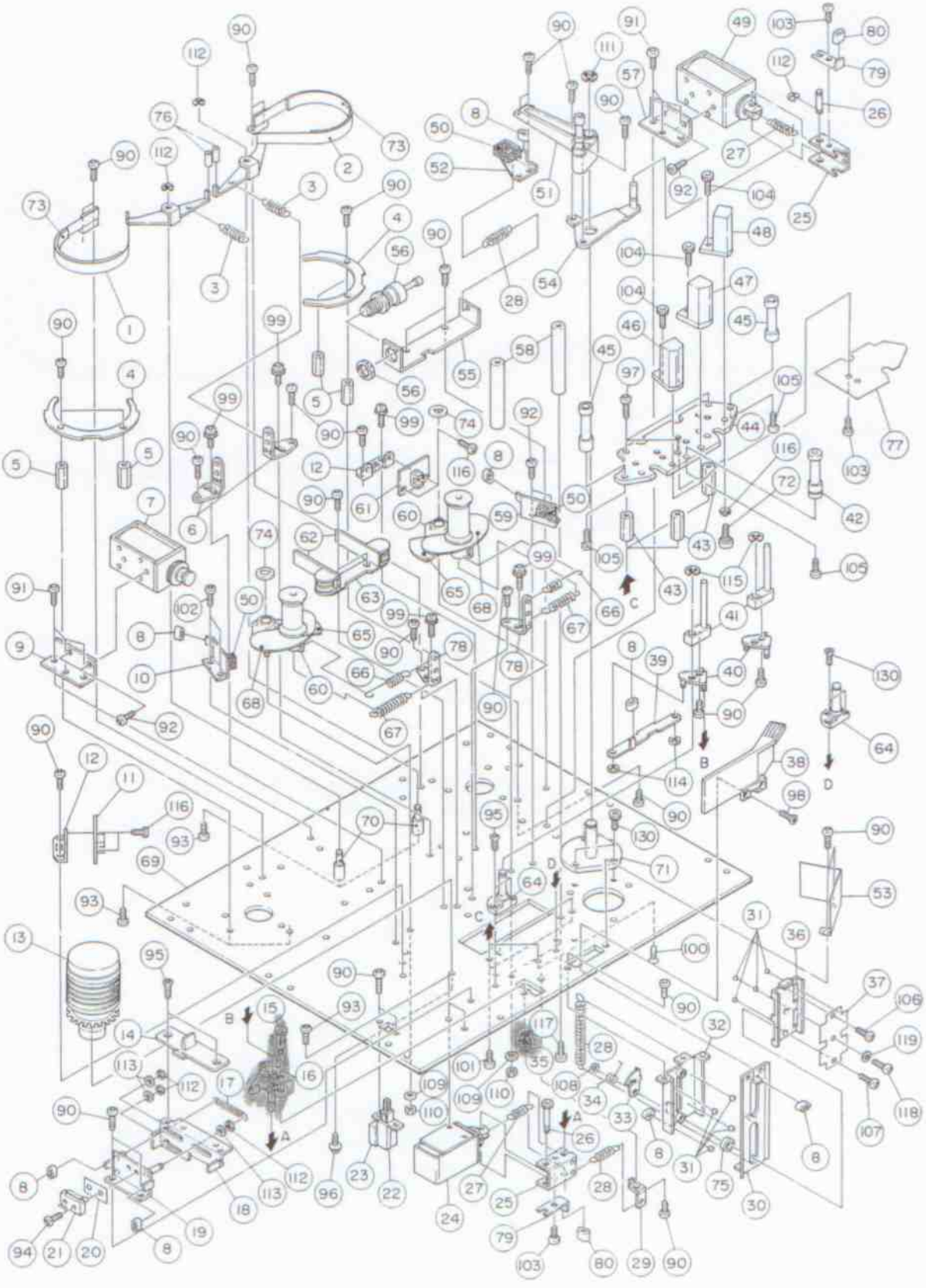
Parts marked with * require longer delivery time.

REF. NO.	PARTS NO.	DESCRIPTION	REMARKS
1 - 1	*5800656900	Panel, Front	
1 - 2	5800341701	Knob, Fader	58
1 - 3	*5800687300	Stopper, Panel	
1 - 4	5800657700	Button	
1 - 5	*5200161200	PCB Assy, PITCH CONT.; A	
1 - 6	*5800658000	Cover	
1 - 7	*5800658500	Panel, Control; L	
1 - 8	5800173100	Button, Power	133
1 - 9	5534713000	Rod, Switch; C	X-10R
1 - 10	*5800639900	Cover, Top	
1 - 11	*5800639700	Angle, Rack Mount	
1 - 12	*5800653301	Panel, Side; L	
1 - 13	*5800288502	Foot	38
1 - 14	*5800639800	Plate, Bottom	
1 - 15	*5800653201	Panel, Side; R	
1 - 16	*5200161000	PCB Assy, KEYBOARD; A	
1 - 17	*5200161100	PCB Assy, KEYBOARD; B	
1 - 18	5800658400	Spring, Button	
1 - 19	5800658201	Guide, Spring	
1 - 20	*5800659500	Lock Plate, Key Button	
1 - 21	*5800658600	Panel, Control; A	
1 - 22	*5800657601	Escutcheon, Button; B	
1 - 23	*5800657501	Escutcheon, Button; A	
1 - 24	5800657000	Button; A	
1 - 25	5800657100	Button; B	
1 - 26	5800657200	Button; C	
1 - 27	5800657400	Button; E	
1 - 28	5800671300	Button; F	
1 - 29	*5800482300	Plate, Name	42-NB
1 - 30	*5800656100	Housing, Head; A	
1 - 31	*5800656002	Arm, Housing; R	
1 - 32	*5800476400	Cushion, Housing; B	42-NB
1 - 33	*5800396800	Spring; A	58
1 - 34	*5800476300	Cushion, Housing; A	42-NB
1 - 35	*5800656200	Housing, Head; B	
1 - 36	5800640500	Cap, Pinch Roller	
1 - 37	5800640400	Protector	
1 - 38	*5800655902	Arm, Housing; L	
1 - 39	5800640601	Roller Assy, Pinch	
1 - 40	5800674700	Spring	
1 - 41	*5800656801	Base, Housing	
1 - 42	*5800680600	Plate, Name	
1 - 43	*5800658700	Block, Splicing; 1 inch	
1 - 44	*5800679400	Stopper, Cutter	
1 - 45	*5122167000	Connector Socket, 5P	
1 - 46	*5122169000	Connector Socket, 7P	
1 - 47	*5122164000	Connector Socket, 2P	
1 - 48	*5336214500	Connector Plug, 20P	
1 - 49	*5336214900	Connector Plug, 50P	
1 - 50	*5800509700	Screw, Cap	52

Parts marked with * require longer delivery time.

REF. NO.	PARTS NO.	DESCRIPTION	REMARKS
1 - 51	*5800404400	Screw, Shoulder; B	58
1 - 52	5800631800	Top, Roller	
1 - 53	5730005900	Bearing; NTN696ZZ-P5	
1 - 54	5800631900	Roller, Tension	
1 - 55	5800631700	Base, Tension	
1 - 56	5800380400	Spring, Tension Roller	58
1 - 57	5800657300	Button; D	
1 - 58	*5800509700	Screw, Cap; M4 x 6	52
1 - 59	*5800173000	Escutcheon, Power Switch	133
1 - 60	*5800657800	Escutcheon; B	
1 - 61	*5800657900	Escutcheon; A	
1 - 62	*5800340300	Protector, Reel	58
1 - 63	*5800609300	Mask, Slide Volume; A	106
1 - 64	*5800344900	Handle	
1 - 65	*5800684900	Holder, Button; A	
1 - 66	*5800686200	Holder, PCB; L	
1 - 67	*5800686300	Holder, PCB; R	
1 - 68	*5800685400	Holder, Splicing Block	
1 - 70	*5781703008	Screw, Cap; M3 x 8 (Ni)	
1 - 71	*5780203006	Screw, Flat Countersunk; M3 x 6	
1 - 72	*5780030006	Screw, Bind Head; M3 x 6	
1 - 73	*5780023006	Screw, Bind Head; M3 x 6 (BLK Ni)	
1 - 74	*5783114006	Screw, Round Washer Head; M4 x 6 (BLK Ni)	
1 - 75	*5783583014	Screw, Washer Head Taptite; M3 x 14 (BLK Ni)	
1 - 76	*5781002008	Screw, Pan Head Taptite Type-1; M2 x 8	
1 - 77	*5781703010	Screw, Cap; M3 x 10 (Ni)	
1 - 78	*5781703012	Screw, Cap; M3 x 12 (Ni)	
1 - 79	*5785213200	Washer, Fiber WHT; ϕ3 x ϕ5.5 x t0.25	
1 - 80	*5785214200	Washer, Fiber WHT; ϕ4 x ϕ6.5 x t0.25 .	
1 - 81	*5785150500	Washer, Wave; WW-05	
1 - 82	*5781851000	Nut, M10	
1 - 83	*5786360500	Pin, Snap; R Pin ϕ5	
1 - 84	*5787010600	PCB Support, Locking; CBS-6N	
1 - 85	*5782003003	Setscrew, Hex Socket (Flat Type); M3 x 3	
1 - 86	*5785214200	Washer, Fiber WHT; ϕ4 x ϕ6.5 x t0.5	
1 - 87	*5780112606	Screw, Pan Head; M216 x 6 (Ni)	
1 - 88	*5781880500	Nut, Push; ϕ3	End
1 - 89	*5783043006	Screw, Flat Countersunk S tite; M3 x 6	

8-1-2. Exploded View – 2



Exploded View–2

Parts marked with * require longer delivery time.

REF. NO.	PARTS NO.	DESCRIPTION	REMARKS
2 - 1	5800634900	Arm Assy, Brake; L	
2 - 2	5800634800	Arm Assy, Brake; R	
2 - 3	*5800674900	Spring, Brake	
2 - 4	*5555272000	Retainer, Band	A-3300SX
2 - 5	*5800335401	Stud, Band	58
2 - 6	*5800336100	Hook, Spring	58
2 - 7	5313002900	Solenoid, Brake	
2 - 8	*5027569000	Cushion, Stopper	A-2300
2 - 9	*5800675300	Bracket, Solenoid; B	
2 - 10	*5800336300	Stopper; L	58
2 - 11	*5200160800	PCB Assy, SPEED SENSOR	
2 - 12	*5800336201	Holder, Sensor PCB	
2 - 13	5800636901	Roller Assy, Counter	
2 - 14	5800640300	Knob, CUE	
2 - 15	*5800636600	Shaft; Kick Lever; B	
2 - 16	*5800632600	Lever Assy; Kick	
2 - 17	*5800674400	Spring, Return	
2 - 18	*5800633900	Slider Assy	
2 - 19	*5800632900	Base Assy	
2 - 20	*5550025100	Plate, Insulating	A-450
2 - 21	5301455500	Switch, Micro; SS5GL13-F	
2 - 22	5300040100	Switch, Power	
2 - 23	⚠ 5052907000	Spark Killer; 0.01μF + 300Ω/300V [J, GE]	
	⚠ 5052910000	Spark Killer; 0.033μF + 120Ω/125V [U]	
	⚠ 5292002600	Spark Killer; 0.033μF + 120Ω/250V [C]	
	⚠ 5267703700	Spark Killer; 0.0047 μF/400V [E, UK, A]	
2 - 24	5313001800	Solenoid, Pinch Roller	58
2 - 25	*5800636301	Arm, Bias	
2 - 26	*5800636700	Pin, Solenoid; M	
2 - 27	5800674600	Spring, Pinch Roller Pressure	
2 - 28	5800674800	Spring, Pinch Roller Return	
2 - 29	*5800632800	Hanger, Spring	
2 - 30	*5600100100	Slide Assy, Shield	
2 - 31	5540056000	Bearing, ϕ3	A-450
2 - 32	*5800635100	Base Assy, Shield	
2 - 33	*5084643200	Plate, Lock	
2 - 34	*5800380000	Spring, Lock	58
2 - 35	*5800636500	Shaft; Kick Lever; A	
2 - 36	*5800635801	Retainer, Ball	
2 - 37	*5800635900	Plate, Ball Pressure	
2 - 38	*5600100200	Shield Assy, Head	
2 - 39	*5800636800	Arm, Lifter	
2 - 40	*5800633600	Plate Assy, Lifter	
2 - 41	5800633300	Lifter Assy	
2 - 42	5800630200	Guide Assy, Tape; A	
2 - 43	*5800634301	Stud, Head Base	
2 - 44	*5800637401	Base, Head	
2 - 45	5800630700	Guide Assy, Tape; B	
2 - 46	5378304900	Head, Erase; 16T 16ch	
2 - 47	5378304800	Head, Sync; 16T 16ch	

[U]: U.S.A.
[C]: CANADA
[GE]: GENERAL EXPORT
[A]: AUSTRALIA
[E]: EUROPE
[UK]: U.K.
[L]: LIMITED AREA
[J]: JAPAN

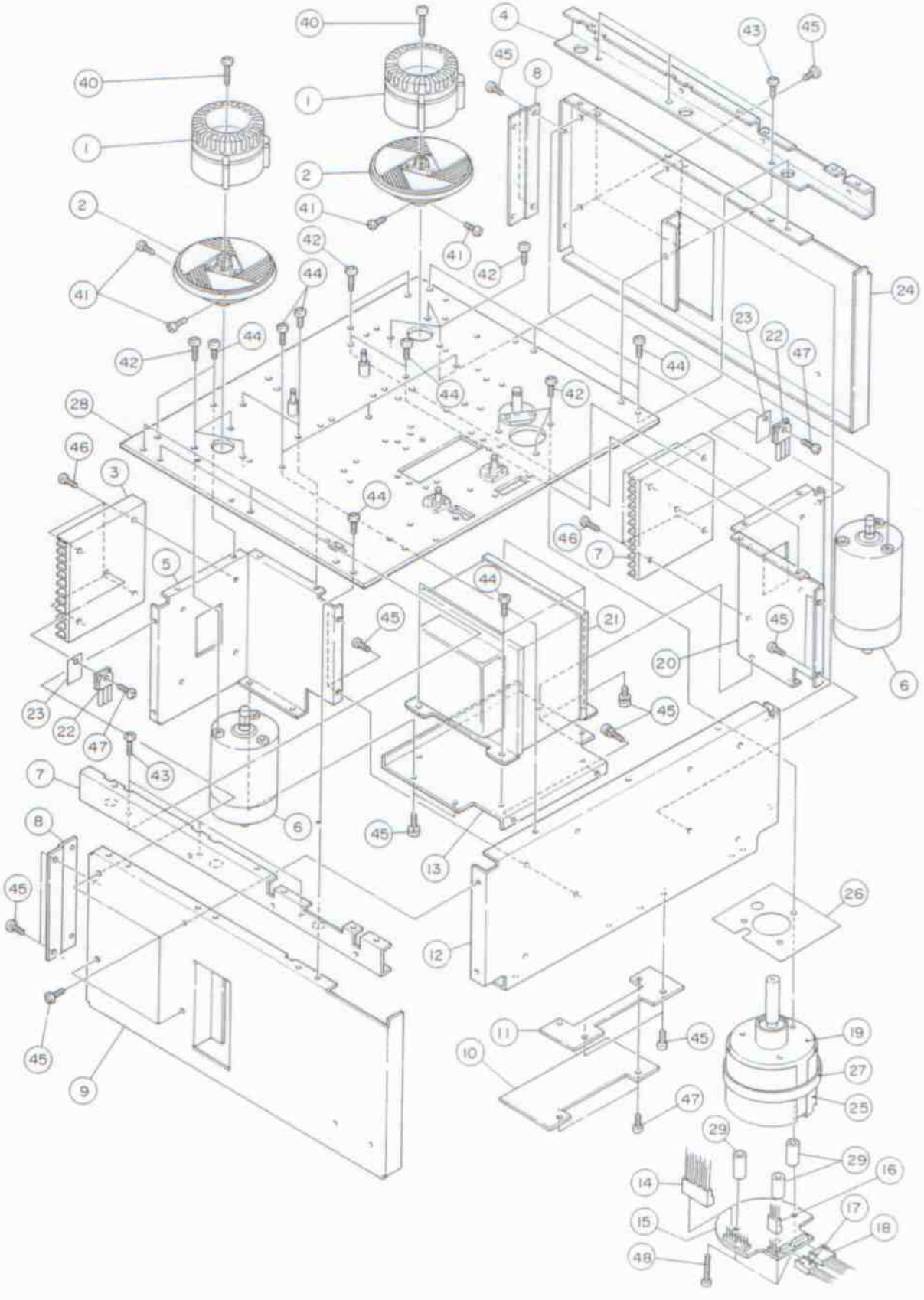
Parts marked with * require longer delivery time.

REF. NO.	PARTS NO.	DESCRIPTION	REMARKS
2 - 48	5378304700	Head, Repro; 16T 16ch	
2 - 49	5313001800	Solenoid, Pinch Roller	
2 - 50	*5534851000	Cushion, Arm Dumper	
2 - 51	*5800632101	Arm Assy, Pinch Roller	
2 - 52	*5800652100	Arm, Dumper	
2 - 53	*5800679200	Plate, Shield; D	
2 - 54	*5800632300	Arm Assy, Sub	
2 - 55	*5800636100	Holder, Dumper	
2 - 56	5730006100	Absorber, Soft	
2 - 57	*5800636200	Bracket, Solenoid	
2 - 58	*5800675200	Pole, Housing	
2 - 59	*5800336400	Stopper; R	
2 - 60	5800688800	Arm Assy, Tension	
2 - 61	*5200160900	PCB Assy, END SENSOR	
2 - 62	*6085490000	PCB Assy, TENSION SENSOR	
2 - 63	*5800634200	Base, Sensor	
2 - 64	*5800689200	Shaft Assy, Lifter Arm	
2 - 65	5800631500	Shutter	
2 - 66	5800450201	Spring, Tension; B	52
2 - 67	5800674300	Spring, Tension → 5800647301	
2 - 68	*5800331400	Plate, Mask	58
2 - 69	*5800640201	Base, Transport	
2 - 70	*5800335300	Shaft, Brake Arm	58
2 - 71	*5800687000	Shaft Assy, Arm	
2 - 72	*5800348701	Screw, Head Bracket	38
2 - 73	*6012041000	Shoe, Brake	85-16
2 - 74	*5800685800	Cushion, Panel	
2 - 75	*5800680700	Spacer	
2 - 76	*5800532600	Cushion, Rubber; A	58
2 - 77	*5800679300	Plate, Shield; E	
2 - 78	*5800670700	Hook, Spring; B	
2 - 79	*5800686500	Plate, Cushion	
2 - 80	*5800689500	Cushion	
2 - 90	*5780033006	Screw, Bind Head Sems; A M3 x 6	
2 - 91	*5780044008	Screw, Bind Head Sems; F M4 x 8	
2 - 92	*5780033005	Screw, Bind Head Sems; A M3 x 5	
2 - 93	*5780033010	Screw, Bind Head Sems; A M3 x 10	
2 - 94	*5780002010	Screw, Bind Head; M2 x 10	
2 - 95	*5780203006	Screw, Flat Countersunk; M3 x 6	
2 - 96	*5780034012	Screw, Bind Head Sems A; M4 x 12	
2 - 97	*5781704012	Screw, Cap Head; M4 x 12 (Ni)	
2 - 98	*5780223006	Screw, Flat Countersunk; M3 x 6 (Ni BLK)	
2 - 99	*5780043006	Screw, Bind Head Sems B; M3 x 6	

Parts marked with * require longer delivery time.

REF. NO.	PARTS NO.	DESCRIPTION	REMARKS
2 - 100	*5780204010	Screw, Flat Countersunk; M4 x 10	
2 - 101	*5780034010	Screw, Bind Head Sems A; M4 x 10	
2 - 102	*5780043006	Screw, Bind Head Sems B; M3 x 6	
2 - 103	*5780133006	Screw, Pan Head Sems A; M3 x 6	
2 - 104	*5781733010	Screw, Cap Head; M3 x 10	
2 - 105	*5781703008	Screw, Cap Head; M3 x 8 (Ni)	
2 - 106	*5780003004	Screw, Bind Head; M3 x 4	
2 - 107	*5780002004	Screw, Bind Head; M2 x 4	
2 - 108	*5786102400	Ring, CS ϕ2.4	
2 - 109	*5785104000	Washer, Spring; ϕ4	
2 - 110	*5781824000	Nut, M4	
2 - 111	*5786007000	Ring, E-Type; ϕ7	
2 - 112	*5786003000	Ring, E-Type; ϕ3	
2 - 113	*5785003000	Washer, Flat; ϕ3 x t0.5	
2 - 114	*5786002500	Ring, E-Type; ϕ2.5	
2 - 115	*5786004000	Ring, E-Type; ϕ4	
2 - 116	*5785150400	Washer, Wave; WW-04	
2 - 117	*5780143010	Screw, Pan Head Sems B; M3 x 10	
2 - 118	*5780002003	Screw, Bind Head; M2 x 3	
2 - 119	*5785012000	Washer, Flat; ϕ2.3 x ϕ6 x t0.4	
2 - 120	*5781703006	Screw, Cap; M3 x 6 (Ni)	

8-1-3. Exploded View – 3



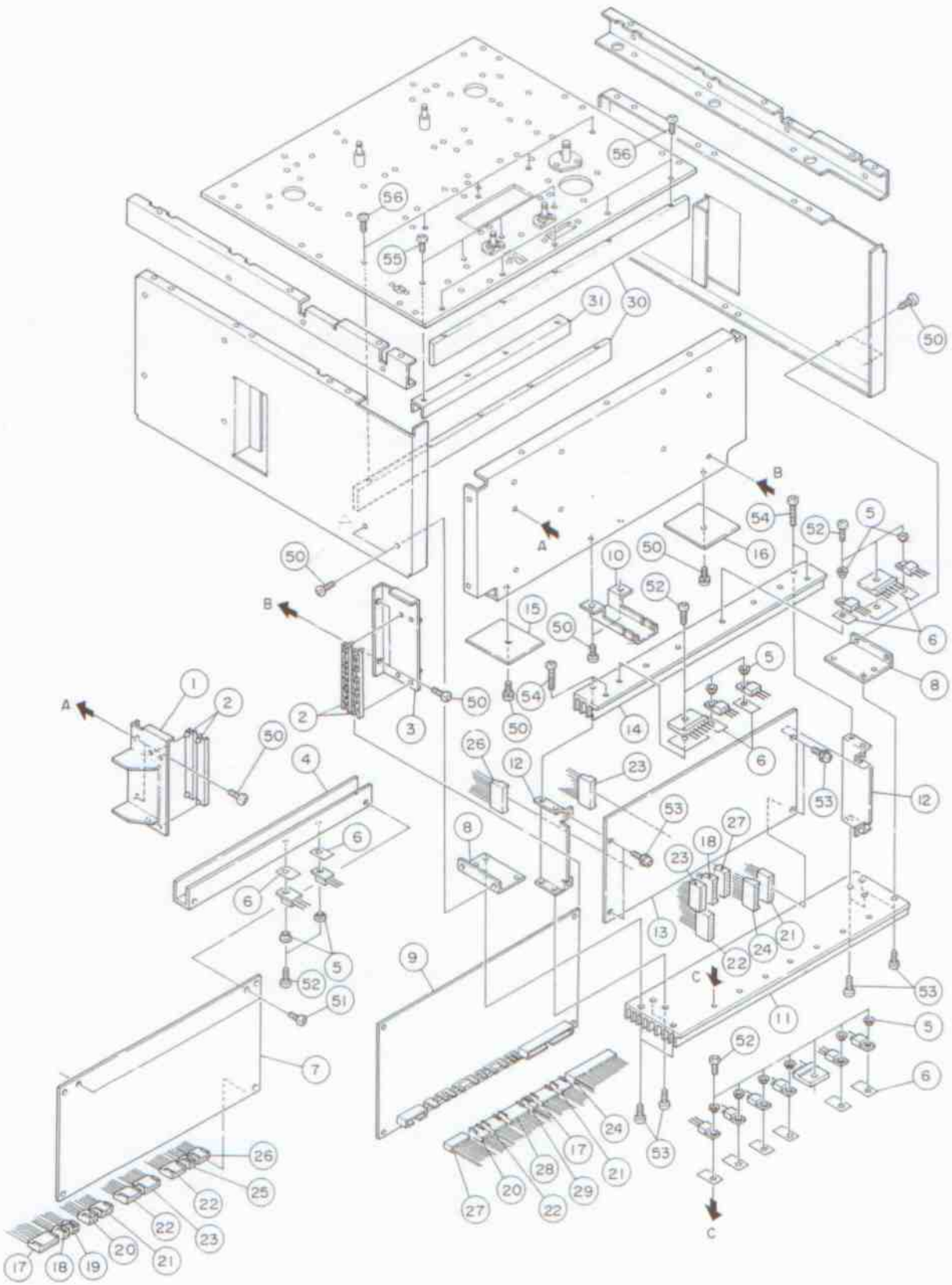
Exploded View–3

Parts marked with * require longer delivery time.

REF. NO.	PARTS NO.	DESCRIPTION	REMARKS
3 - 1	5600100300	Clamper Assy, Reel	
3 - 2	5800637501	Table Assy, Reel	
3 - 3	*5800525900	Heat Sink, B	52-NB
3 - 4	*5800639500	Angle, Side; R	
3 - 5	*5800639100	Bracket, Heatsink; L	
3 - 6	5370005300	Motor, DC Reel	
3 - 7	*5800639600	Angle, Side; L	
3 - 8	*5800638100	Stay, Top Cover	
3 - 9	*5800639401	Chassis, Side; L	
3 - 10	*5200161900	PCB Assy, FUSE [J, U, C, GE]	
	*5200162000	PCB Assy, FUSE [E, U.K., A]	
3 - 11	*5800652700	Holder, PCB	
3 - 12	*5800639200	Chassis, Middle	
3 - 13	*5800653101	Bracket, Transformer	
3 - 14	*5122173000	Connector, Socket; 11P (WHT)	
3 - 15	*5200162200	PCB Assy, CM-DRIVE	
3 - 16	*5122165000	Connector, Socket; 3P (WHT)	
3 - 17	*5122222000	Connector, Socket; 3P (BLK)	
3 - 18	*5122168000	Connector, Socket; 6P (WHT)	
3 - 19	5370005400	Motor Assy, DC Capstan	
3 - 20	*5800639000	Bracket, Heatsink; R	
3 - 21	⚠ 5320032200	Transformer, AC Power [J]	
	⚠ 5320032300	Transformer, AC Power [U, C]	
	⚠ 5320032400	Transformer, AC Power [GE]	
	⚠ 5320032500	Transformer, AC Power [E, U.K., A]	
3 - 22	5231758800	Transistor, 2SD1047E; (Q3)	
3 - 23		Plate, Insulating	
3 - 24	*5800639301	Chassis, Side; R	
3 - 25	*5800679000	Plate, Shield; A	
3 - 26	*5800679101	Plate, Shield; B	
3 - 27	*5800637800	Band, Cord	
3 - 28	*5800640201	Base, Transport	
3 - 29	*5800680700	Stay, PCB	
3 - 40	*5780005025	Screw, Bind Head; M5 x 25	
3 - 41	*5783004010	Screw, Taptite; M4 x 10	
3 - 42	*5780034012	Screw, Bind Head Sems A; M4 x 12	
3 - 43	*5780034008	Screw, Bind Head Sems A; M4 x 8	
3 - 44	*5780034010	Screw, Bind Head Sems A; M4 x 10	
3 - 45	*5780034006	Screw, Bind Head Sems A; M4 x 6	
3 - 46	*5783003006	Screw, Washer Head Taptite; M3 x 6	
3 - 47	*5780003010	Screw, Bind Head; M3 x 10	
3 - 48	*5780133006	Screw, Pan Head Sems A; M3 x 6	

[U]: U.S.A.
[C]: CANADA
[GE]: GENERAL EXPORT
[A]: AUSTRALIA
[E]: EUROPE
[UK]: U.K.
[L]: LIMITED AREA
[J]: JAPAN

8-1-4. Exploded View – 4

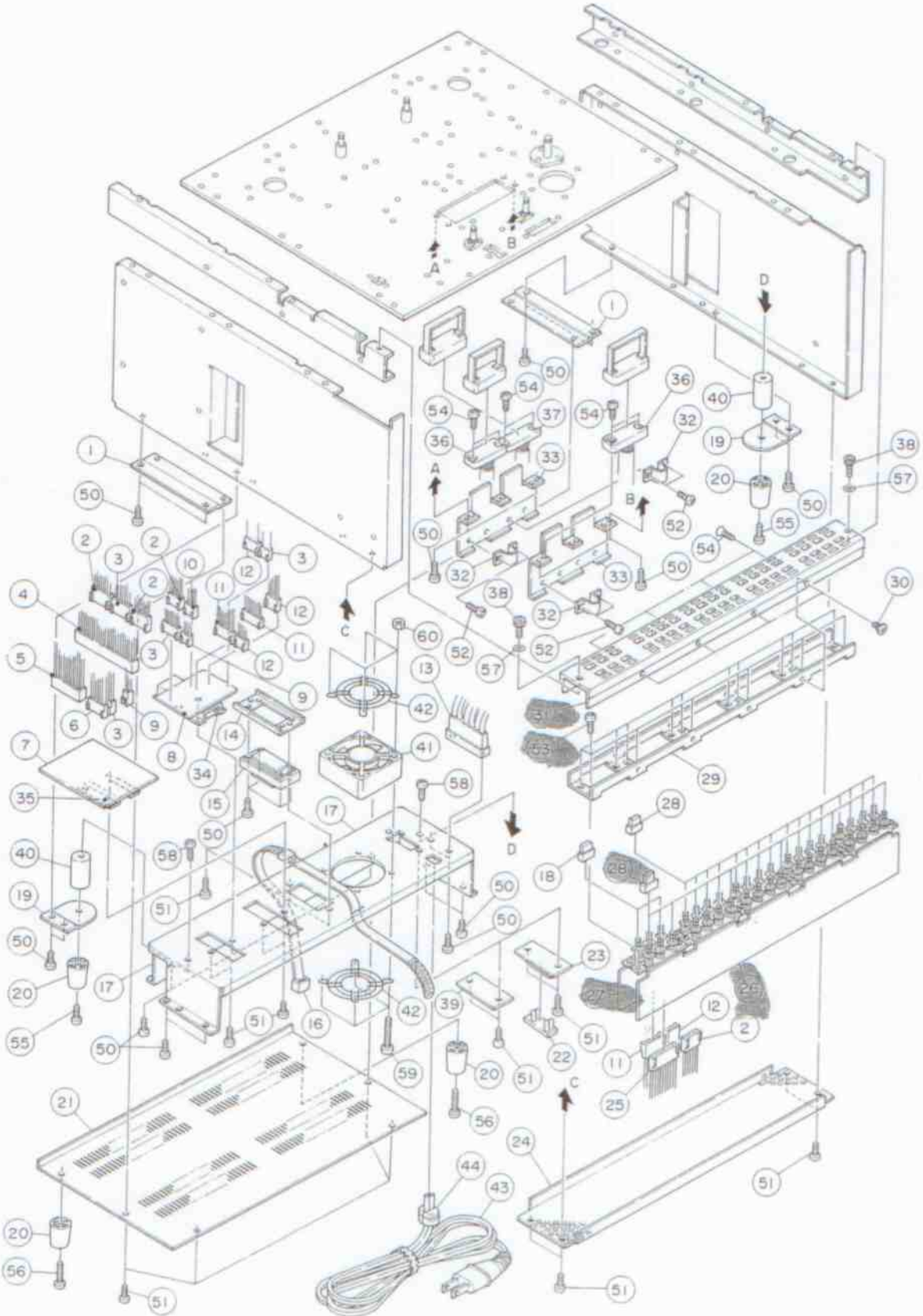


Exploded View—4

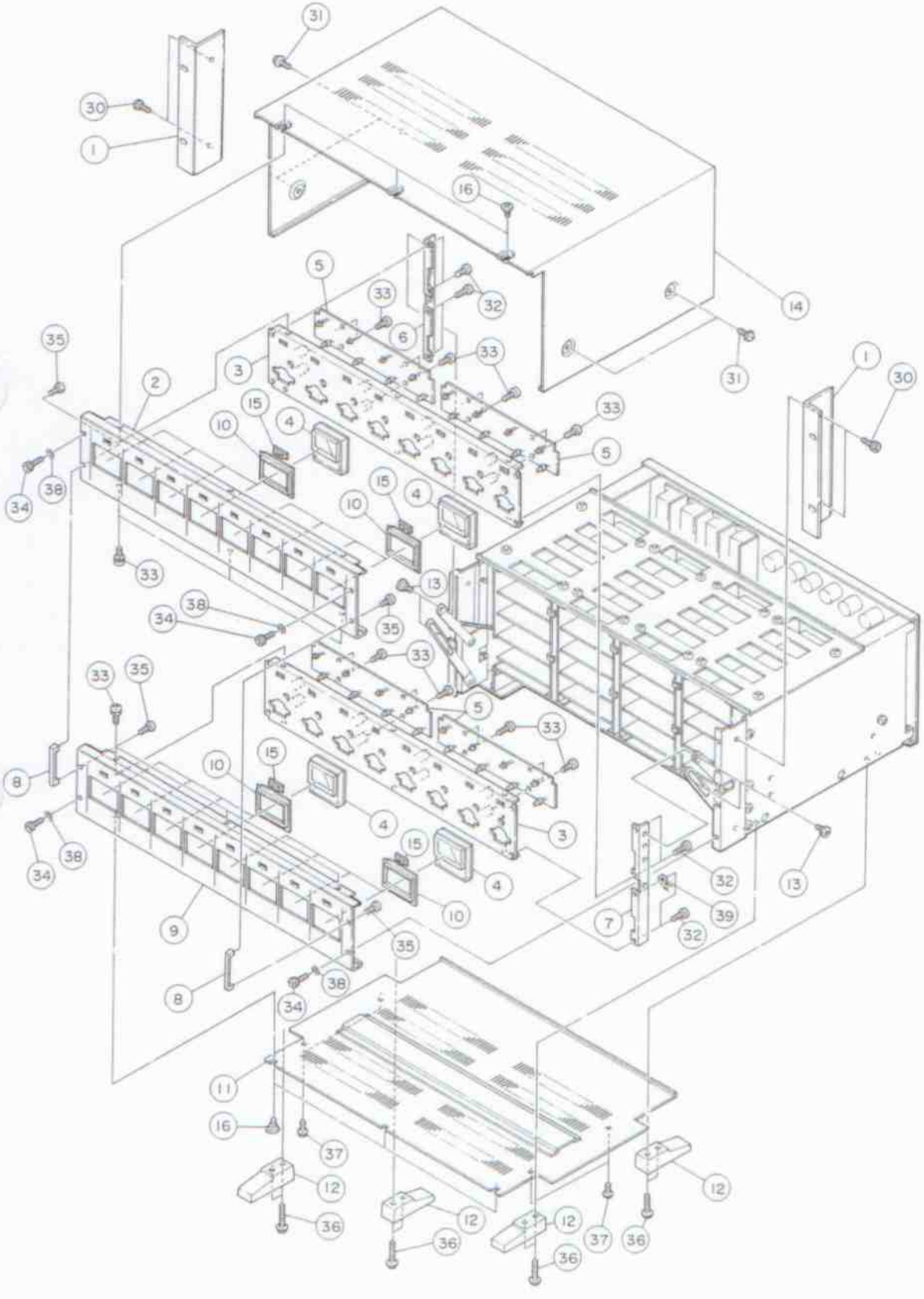
Parts marked with * require longer delivery time.

REF. NO.	PARTS NO.	DESCRIPTION	REMARKS
4 - 1	*5800656701	Plate, PCB Guide; L	
4 - 2	*5730003200	Guide, PCB; TRCG-3925	
4 - 3	*5800656601	Plate, PCB Guide; R	
4 - 4	*5800638001	Heatsink	
4 - 5	*5033295000	Tube, Insulated	
4 - 6	*5033291000	Plate, Insulated	
4 - 7	*5200160600	PCB Assy, MOTOR DRIVE	
4 - 8	*5800652300	Angle, PS Unit	
4 - 9	*5200160500	PCB Assy, CONTROL	
4 - 10	*5800637900	Clamper, PCB	
4 - 11	*5800652801	Heatsink; A	
4 - 12	*5800652401	Holder, Power PCB	
4 - 13	*5200160300	PCB Assy, POWER SUPPLY	
14	*5800652900	Heatsink, B	
15	*5200160700	PCB Assy, JOINT; L	
4 - 16	*5200160710	PCB Assy, JOINT; R	
4 - 17	*5122173000	Connector Socket; 11P (WHT)	
4 - 18	*5122281000	Connector Socket; 3P (RED)	
4 - 19	*5122165000	Connector Socket; 3P (WHT)	
4 - 20	*5122167000	Connector Socket; 5P (WHT)	
4 - 21	*5122168000	Connector Socket; 6P (WHT)	
4 - 22	*5122171000	Connector Socket; 9P (WHT)	
4 - 23	*5122172000	Connector Socket; 10P (WHT)	
4 - 24	*5336214900	Connector Socket; 50P	
4 - 25	*5122222000	Connector Socket; 3P (BLK)	
4 - 26	*5122169000	Connector Socket; 7P (WHT)	
4 - 27	*5336214500	Connector Socket; 20P	
4 - 28	*5122174000	Connector Socket; 12P (WHT)	
4 - 29	*5122164000	Connector Socket; 2P (WHT)	
4 - 30	*5800686600	Plate	
31	*5800685700	Frame	
4 - 50	*5780033006	Screw, Bind Head Sems A; M3 x 6	
4 - 51	*5780003008	Screw, Bind Head; M3 x 8	
4 - 52	*5783003006	Screw, Pan Head Taptite; M3 x 6	
4 - 53	*5780033008	Screw, Bind Head Sems A; M3 x 8	
4 - 54	*5780033025	Screw, Bind Head Sems A; M3 x 25	
4 - 55	*5780134006	Screw, Pan Head Sems A; M4 x 6	
4 - 56	*5780134012	Screw, Pan Head Sems A; M4 x 12	

8-1-5. Exploded View – 5



8-1-6. Exploded View – 6



Exploded View–5

Parts marked with * require longer delivery time.

REF. NO.	PARTS NO.	DESCRIPTION	REMARKS
5 - 1	*5800638400	Stay, Rear Panel	
5 - 2	*5122169000	Connector, Socket; 7P (WHT)	
5 - 3	*5122170000	Connector, Socket; 8P (WHT)	
5 - 4	*5336214900	Connector, Socket; 50P	
5 - 5	*5336214500	Connector, Socket; 20P	
5 - 6	*5122171000	Connector, Socket; 9P (WHT)	
5 - 7	*5200161300	PCB Assy, REMOTE CONNECTOR	
5 - 8	*5200161700	PCB Assy, REMOTE FUNC. CN	
5 - 9	*5122164000	Connector, Socket; 2P (WHT)	
5 - 10	*5122283000	Connector, Socket; 5P (RED)	
5 - 11	*5122172000	Connector, Socket; 10P (WHT)	
5 - 12	*5122168000	Connector, Socket; 6P (WHT)	
5 - 13	*5043849000	Connector, 3P	
5 - 14	*5800194101	Plate, Connector; C	
5 - 15	*5334012900	Connector	
5 - 16	*5800637800	Band, Cord	
5 - 17	*5800638900	Plate, Connector	
5 - 18	5800676800	Button, Function	
5 - 19	*5800660600	Plate, Cable Hold	
5 - 20	*5504552000	Foot, T-A	C-1
5 - 21	*5800640000	Cover, Rear	
5 - 22	⚠ *5133014000	Connector Plug, Voltage Selector [GE]	
5 - 23	⚠ *5133015001	Connector Socket, Voltage Selector [GE]	
5 - 24	*5800653000	Cover, Heatsink	
5 - 25	*5122173000	Connector Socket, 11P (WHT)	
5 - 26	*5200161500	PCB Assy, FUNCTION; A ↻	
5 - 27	*5200161600	PCB Assy, FUNCTION; B ↻	
5 - 28	5800378900	Button, Function	58
5 - 29	*5800656500	Chassis, Function	
5 - 30	*5800400900	Screw, Shoulder	58
5 - 31	*5800656400	Panel, Function	
5 - 32	*5800634400	Clamper, Cable; B	
5 - 33	*5800634600	Bracket, Connector; C	
5 - 34	*5800640901	Bracket, Connector; B	
5 - 35	*5800640801	Bracket, Connector; A	
5 - 36	*5355109000	Cord Assy, ES Head	
5 - 37	*5355109200	Cord Assy, R Head	
5 - 38	5800509700	Screw, Cap; M4 x 6	52
5 - 39	*5800676700	Plate, Selector Mask	
5 - 40	*5800675101	Pole, Foot	
5 - 41	5600103500	Motor Assy, DC Fan	
5 - 42	*5730006300	Guard, Finger	
5 - 43	⚠ *5128027000	Cord, AC Power [J]	[U]: U.S.A.
	⚠ *5350010700	Cord, AC Power [U]	[C]: CANADA
	⚠ *5350011200	Cord, AC Power [C]	[GE]: GENERAL EXPORT
			[A]: AUSTRALIA
	⚠ *5350010800	Cord, AC Power [GE]	[E]: EUROPE
	⚠ *5350008200	Cord, AC Power [E]	[UK]: U.K.
	⚠ *5128047000	Cord, AC Power [UK]	[L]: LIMITED AREA
	⚠ *5350008300	Cord, AC Power [A]	[J]: JAPAN

Parts marked with * require longer delivery time.

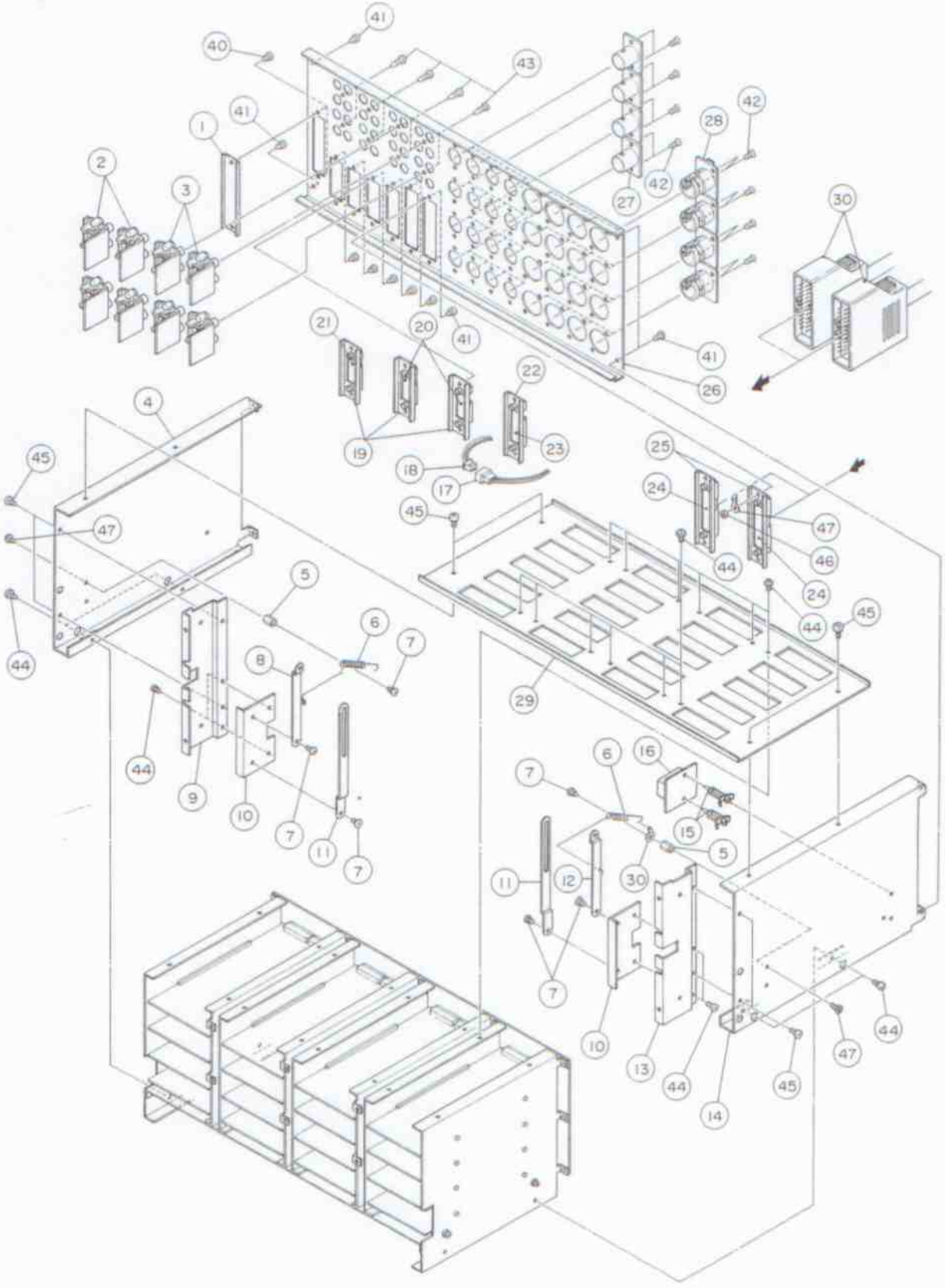
REF. NO.	PARTS NO.	DESCRIPTION	REMARKS
5 - 44	⚠ *5534660000	Strain, Relief; 4N-5 [All except U, C, UK]	
	⚠ *5317001700	Strain, Relief; 4N-5 [U, UK]	
	⚠ *5317001800	Strain, Relief; 4N-5 [C]	
5 - 50	*5780033006	Screw, Bind Head Sems A; M3 x 6	
5 - 51	*5780023006	Screw, Bind Head; M3 x 6 (BLK Ni)	
5 - 52	*5780003008	Screw, Bind Head; M3 x 8	
5 - 53	*5780133008	Screw, Pan Head Sems A; M3 x 8	[U]: U.S.A.
5 - 54	*5780102608	Screw, Pan Head; M2.6 x 8	[C]: CANADA
			[GE]: GENERAL EXPORT
5 - 55	*5780133010	Screw, Pan Head Sems A; M3 x 10	[A]: AUSTRALIA
5 - 56	*5780134010	Screw, Pan Head Sems B; M4 x 10	[E]: EUROPE
5 - 57	*5785214200	Washer, Fiber; ϕ4 x ϕ6.5 x t0.5 (WHT)	[UK]: U.K.
5 - 58	*5780034006	Screw, Bind Head Sems A; M4 x 6	[L]: LIMITED AREA
59	*5780013045	Screw, Bind Head; M3 x 45 (Ni)	[J]: JAPAN
60	*5781813000	Nut, M3 Type (Ni)	

Exploded View–6

Parts marked with * require longer delivery time.

REF. NO.	PARTS NO.	DESCRIPTION	REMARKS
6 - 1	*5800566000	Angle, Rack Mount; 4U	52S
6 - 2	*5800654700	Panel, Ampl.; 1	
6 - 3	*5800654900	Chassis, Ampl.	
6 - 4	5296005000	Meter, VU	58
6 - 5	*5200160100	PCB Assy, REC SELECT	
6 - 6	*5800654500	Plate, Joint; L	
6 - 7	*5800654600	Plate, Joint; R	
6 - 8	*5800349700	Angle	58
9	*5800654800	Panel Assy, Ampl.; 2	
10	*5800349301	Escutcheon, Meter	58
6 - 11	*5800655700	Plate, Bottom	
6 - 12	*5800288502	Foot	38
6 - 13	*5581056000	Screw, Shoulder; A	A-304
6 - 14	*5800655800	Cover, Top	
6 - 15	*5800340400	Escutcheon, LED	58
6 - 16	*5800400900	Screw, Shoulder	58
6 - 30	*5783144010	Screw, Round Washer Head; M4 x 10 (Ni)	
6 - 31	*5783114006	Screw, Round Washer Head; M4 x 6 (BLK Ni)	
6 - 32	*5780133006	Screw, Pan Head Sems A; M3 x 6	
6 - 33	*5780003006	Screw, Bind Head; M3 x 6	
6 - 34	*5781703006	Screw, Cap; M3 x 6 (Ni)	
6 - 35	*5781002606	Screw, Pan Head Taptite; M2.6 x 6	
6 - 36	*5783103014	Screw, Round Washer Head; M3 x 14	
6 - 37	*5780023008	Screw, Bind Head; M3 x 8 (BLK Ni)	
6 - 38	*5785213200	Washer, Flat; ϕ3 x ϕ5.5 (WHT)	
6 - 39	*5581038000	Harness Clip; A	

8-1-7. Exploded View – 7

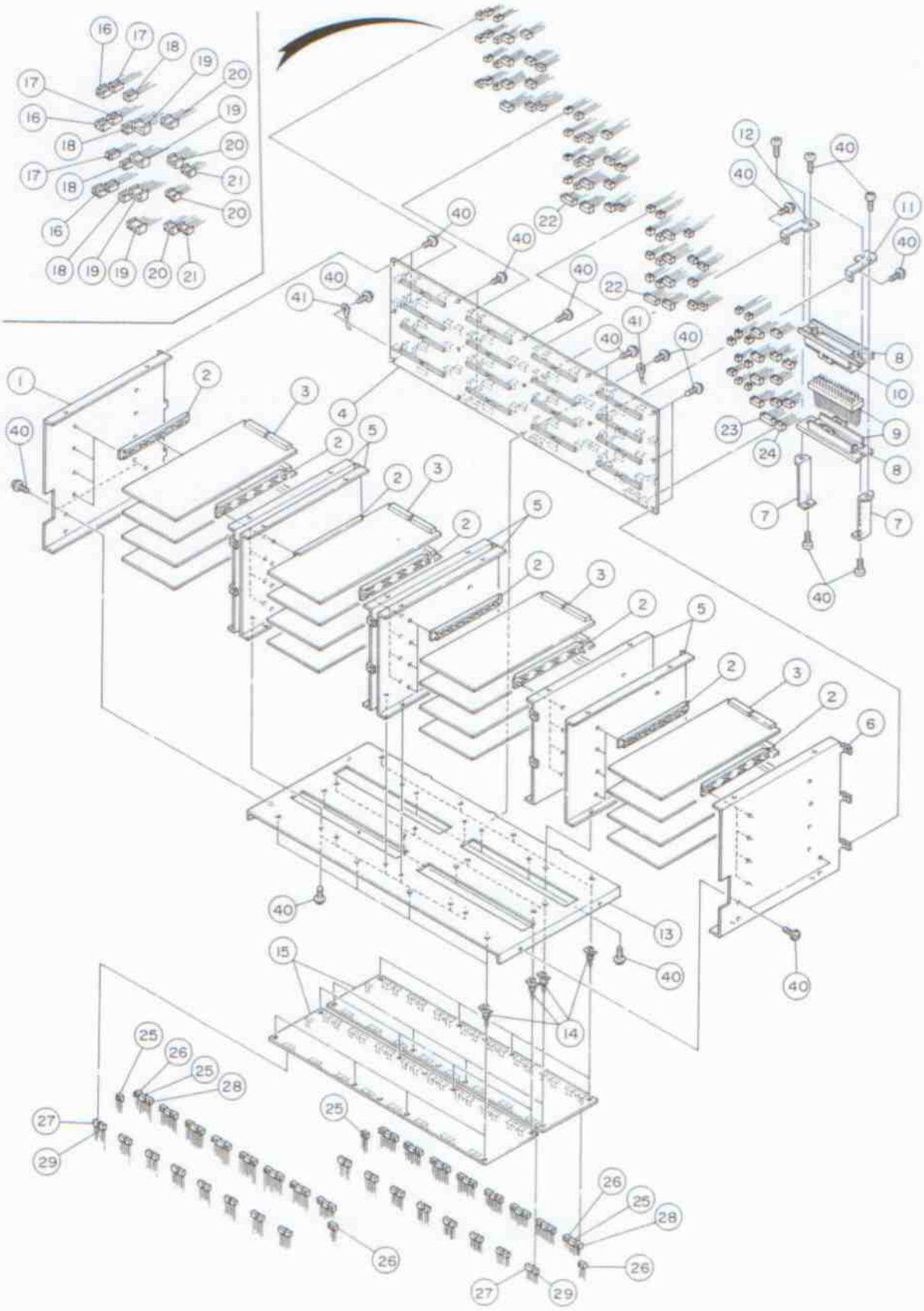


Exploded View–7

Parts marked with * require longer delivery time.

REF. NO.	PARTS NO.	DESCRIPTION	REMARKS
7 - 1	*5800653700	Plate, Dummy	
7 - 2	*5200161800	PCB Assy, OUTPUT	
7 - 3	*5200160200	PCB Assy, INPUT	
7 - 4	*5800655101	Chassis, Ampl. Side; L	
7 - 5	*5800677000	Stud, Spring	
7 - 6	*5791603160	Spring, Arm	
7 - 7	*5581056000	Screw, Shoulder; A	A-304
7 - 8	*5800653800	Arm, Upper; L	
7 - 9	*5800654300	Bracket, Angle; L	
7 - 10	*5800654100	Bracket, Arm	
7 - 11	*5800654000	Arm, Lower	
7 - 12	*5800653900	Arm, Upper; R	
7 - 13	*5800654400	Bracket, Angle; R	
7 - 14	*5800655201	Chassis, Ampl. Side; R	
7 - 15	*5787010400	Support, PCB	
7 - 16	*5200160400	PCB Assy, OSC	
7 - 17	*5336111300	Connector Plug, 3P	
7 - 18	*5336122300	Connector Socket, 3P	
7 - 19	*5800653501	Plate, Connector; 34P	
7 - 20	*6052392004	Connector, Socket; 34P	
7 - 21	*6052393004	Connector, Plug; 34P	
7 - 22	*5800562901	Plate, Connector; 45P	
7 - 23	*5334033000	Connector, Plug; 45P	
7 - 24	*6052392006	Connector, Socket; 60P	
7 - 25	*5800653601	Plate, Connector; 60P	
7 - 26	*5800655601	Panel, Rear	
7 - 27	5334027300	Connector, Canon; XLB-3-31	
7 - 28	5334027200	Connector, Canon; XLB-3-32	
7 - 29	*5800655001	Chassis, Top	
7 - 30	~~5052394006~~	Connector, Plug; 60P 6052394006	
7 - 40	*5780023006	Screw, Bind; M3 x 6 (BLK Ni)	
7 - 41	*5780023008	Screw, Bind; M3 x 8 (BLK Ni)	
7 - 42	*5783653008	Screw, Oval Countersunk Head; M3 x 8 (Ni)	
7 - 43	*5781063008	Screw, Pan Head Tapping Type-1; M3 x 8 (BLK Ni)	
7 - 44	*5780133008	Screw, Pan Head Sems A; M3 x 8	
7 - 45	*5780134008	Screw, Pan Head Sems A; M4 x 8	
7 - 46	*5781813000	Nut, M3	
7 - 47	*5786700400	Lug, GND	

8-1-8. Exploded View – 8

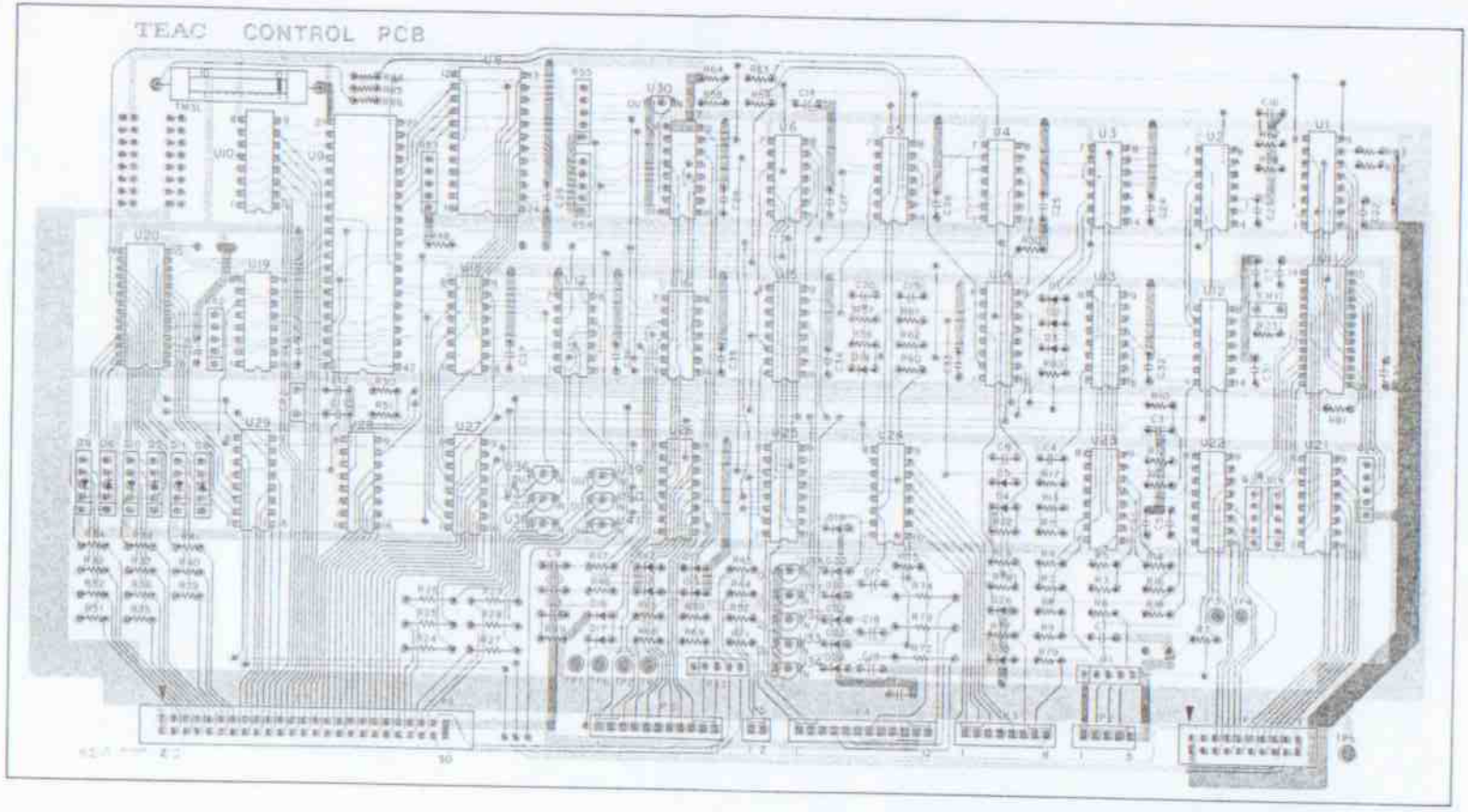


Exploded View–8

Parts marked with * require longer delivery time.

REF. NO.	PARTS NO.	DESCRIPTION	REMARKS
8 - 1	*5800655400	Bracket, PCB; L	
8 - 2	*5730003200	Guide, PCB; TRCG-3925	
8 - 3	*5200083220	PCB Assy, REC/PLAY AMPL.	
8 - 4	*5200160000	PCB Assy, MOTHER	
8 - 5	*5800654200	Plate, PCB Guide	
8 - 6	*5800655500	Bracket, PCB; R	
8 - 7	*5800673300	Holder, Connector; A	
8 - 8	*5800653601	Plate, Connector, 60P	
8 - 9	*5334040400	Connector; 60P	
8 - 10	*5334038700	Connector, 60P	
8 - 11	*5800673500	Holder, Connector; R	
8 - 12	*5800673400	Holder, Connector; L	
8 - 13	*5800655300	Chassis, Bottom	
14	*5787010400	Support, PCB; CBS-4N	
15	*5200128820	PCB Assy, IN/OUT AMPL.	
8 - 16	*5336124300	Connector Socket; 3P (WHT)	
8 - 17	*5336124200	Connector Socket; 2P (WHT)	
8 - 18	*5336131200	Connector Socket; 2P (RED)	
8 - 19	*5336124500	Connector Socket; 5P (WHT)	
8 - 20	*5336124400	Connector Socket; 4P (WHT)	
8 - 21	*5336131400	Connector Socket; 4P (RED)	
8 - 22	*5336124600	Connector Socket; 6P (WHT)	
8 - 23	*5336124800	Connector Socket; 8P (WHT)	
8 - 24	*5336143400	Connector Socket; 4P (YEL)	
8 - 25	*5336109300	Connector Socket; 3P (YEL)	
8 - 26	*5122222000	Connector Socket; 3P (BLK)	
8 - 27	*5122281000	Connector Socket; 3P (RED)	
8 - 28	*5122165000	Connector Socket; 3P (WHT)	
8 - 29	*5122280000	Connector Socket; 2P (RED)	
8 - 40	*5780133008	Screw, Pan Head Sems A; M3 x 8	
8 - 41	*5786700400	Lug, GND	

8-2-1. Control PCB Ass'y

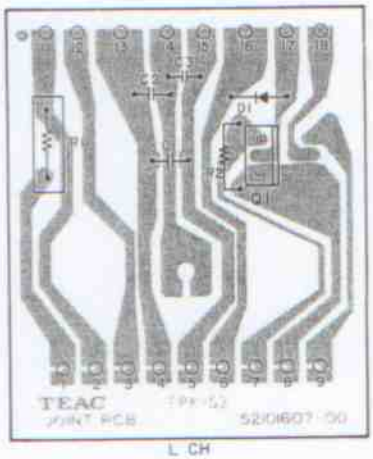


CONTROL PCB Ass'y

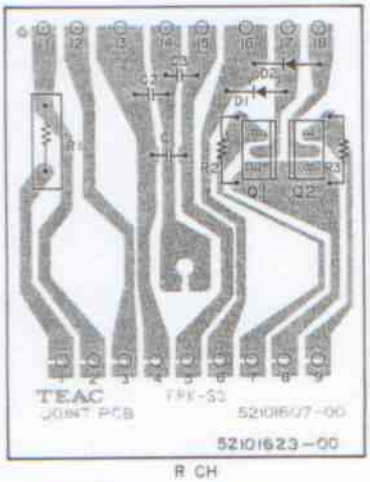
REF. NO.	PARTS NO.	DESCRIPTION
	5200160500	PCB Assy
	5210160500	PCB
	IC's	
U1	5220036400	TC4518BP
U2	5220020200	TC4030BP
U3	5220019200	TC4013BP
U4	5220019100	TC4011BP
U5, U6	5220019000	TC4001BP
U7	5220020000	TC4049BP
U8	5220021800	MBL8243
U9	5220805200	MB8841-H1365M
U11	5220805100	LM6416E-391
U12	5220019000	TC4001BP
U13	5220020300	TC4510BP
U14, U15	5220020000	TC4049BP
U16, U17	5220019100	TC4011BP
U18, U19	5220020000	TC4049BP
U20	5220019700	LC7800
U23	5220020100	TC4050BP
	TRANSISTORS	
U10	6048661000	Array M54517P
U21, U22	6048661000	Array M54517P
U24~U29	6048661000	Array M54517P
U30~U41	5232251620	2SA-1346
	DIODES	
D1~D5	5224015000	ISS133HV
D6~D8	5228009200	Array DAP401
D9~D11	5228009100	Array DAN401
D12~D26	5224015000	ISS133HV
	RESISTORS	
	All resistor are rated ±5%, 1/5W and of carbon type unless otherwise noted.	
R1	5242110200	4.7kΩ x 4, Array
R2, R3	5240031420	22kΩ
R4, R5	5240035400	1M
R6	5240027000	330Ω
R7	5240030020	5.6kΩ
R8	5240031000	15kΩ
R9, R10	5240030020	5.6kΩ
R11	5240030020	5.6kΩ
R12~R14	5240035420	1MΩ
R15, R16	5240030020	5.6kΩ
R17, R18	5240031020	15kΩ
R19~R21	5242110200	4.7kΩ x 4, Array
R22	5240032220	47kΩ
R23	5240035420	1MΩ
R24~R29	5184908000	100Ω 1/4 W
R30	5240029820	4.7kΩ
R31~R41	5240028220	1kΩ
R42	5242110200	4.7kΩ x 4, Array
R43	5242108000	1 kΩ x 4, Array
R44, R45	5240028220	1kΩ
R46, R47	5240030020	5.6kΩ
R48	5240030620	10kΩ
R49	5240032220	47kΩ
R50, R51	5240028420	1.2kΩ
R52	5240030620	10kΩ
R53~R55	5242110200	4.7kΩ x 4, Array

REF. NO.	PARTS NO.	DESCRIPTION
R56	5240025020	47Ω
R57	5240030020	5.6kΩ
R58	5240028220	1kΩ
R59	5240025820	100Ω
R60	5240031820	33kΩ
R61	5240025820	100Ω
R62, R63	5240030020	5.6kΩ
R64	5240031820	33kΩ
R65, R66	5240025020	47Ω
R67	5240032220	47kΩ
R68~R70	5240030020	5.6kΩ
R71	5240028220	1kΩ
R72~R74	5180062000	150Ω 1/2 W
R75	5240028220	1kΩ
R76	5240030020	5.6kΩ
R77	5240029820	4.7kΩ
R78	5240030020	5.6kΩ
R79	5240028220	1kΩ
R80~R83	5240030620	10kΩ
R84	5240031220	18kΩ
R85	5240034420	390kΩ
R86	5240035420	1MΩ
	CAPACITORS	
C1	5054896500	Mylar 0.0015μF 100V
C3	5054878500	Mylar 0.001μF 100V
C4, C5	5054891500	Mylar 0.0047μF 100V
C6, C7	5172216000	Ceramic 220pF 50V
C8	5260162050	Elec. 4.7μF 35V
C9, C10	5173433000	Ceramic 0.01μF 50V
C11, C12	5172206000	Ceramic 33pF 50V
C13	5260162050	Elec. 4.7μF 35V
C14	5260164252	Elec. 33μF 25V
C15	5260165252	Elec. 47μF 25V
C16	5260162050	Elec. 4.7μF 35V
C17~C19	5260162650	Elec. 10μF 25V
C20	5260162050	Elec. 4.7μF 35V
C21	5260165252	Elec. 4.7μF 25V
C22~C40	5173433000	Ceramic 0.01μF 50V
	MISCELLANEOUS	
P1	5336213500	Cable Connector, Ribon; 5332-20GSI
P2	5122129000	Connector Plug, 5P
P3	5122132000	Connector Plug, 8P
P4	5122136000	Connector Plug, 12P
P5	5122126000	Connector Plug, 2P
P6	5122135000	Connector Plug, 11P
P7	5336213900	Cable Connector, Ribon; 5332-50GSI
CR1	5347000900	OSC Unit; KBR-800kHz
CR2	5347001000	OSC Unit; KBR-4.0MHz
TP1~TP7	5317002100	Check Pin, DH
	5347002900	Timer, FC; TM3L

8-2-2. Joint PCB Ass'y

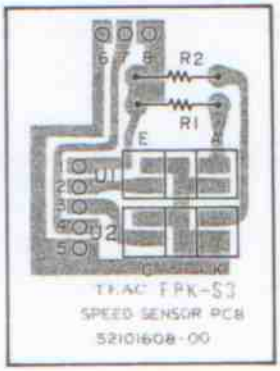


L CH

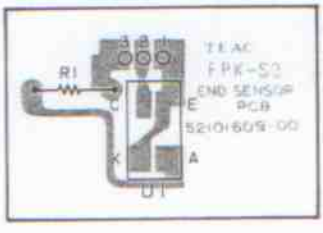


R CH

Speed Sensor PCB Ass'y



End Sensor PCB Ass'y



JOINT PCB Ass'y

REF. NO.	PARTS NO.	DESCRIPTION
	5200160700	PCB Assy or (5200160710)
	5210160700	PCB
	TRANSISTORS	
Q1, Q2	5145087000	2SD-313E (Q2: R only)
	DIODES	
D1, D2	5143243000	ERB12-02G1 (D2: R only)
	RESISTORS	
	All resistor are rated ±5%, 1/4W and of carbon type unless otherwise noted.	
R1	5241262100	0.15Ω Metal film
R2, R3	5181490000	2.2kΩ (R3: R only)
	CAPACITORS	
C1	5260067610	Elec. 10μF 100V (B.P.)
C2, C3	5173433000	Ceramic 0.01μF 50V

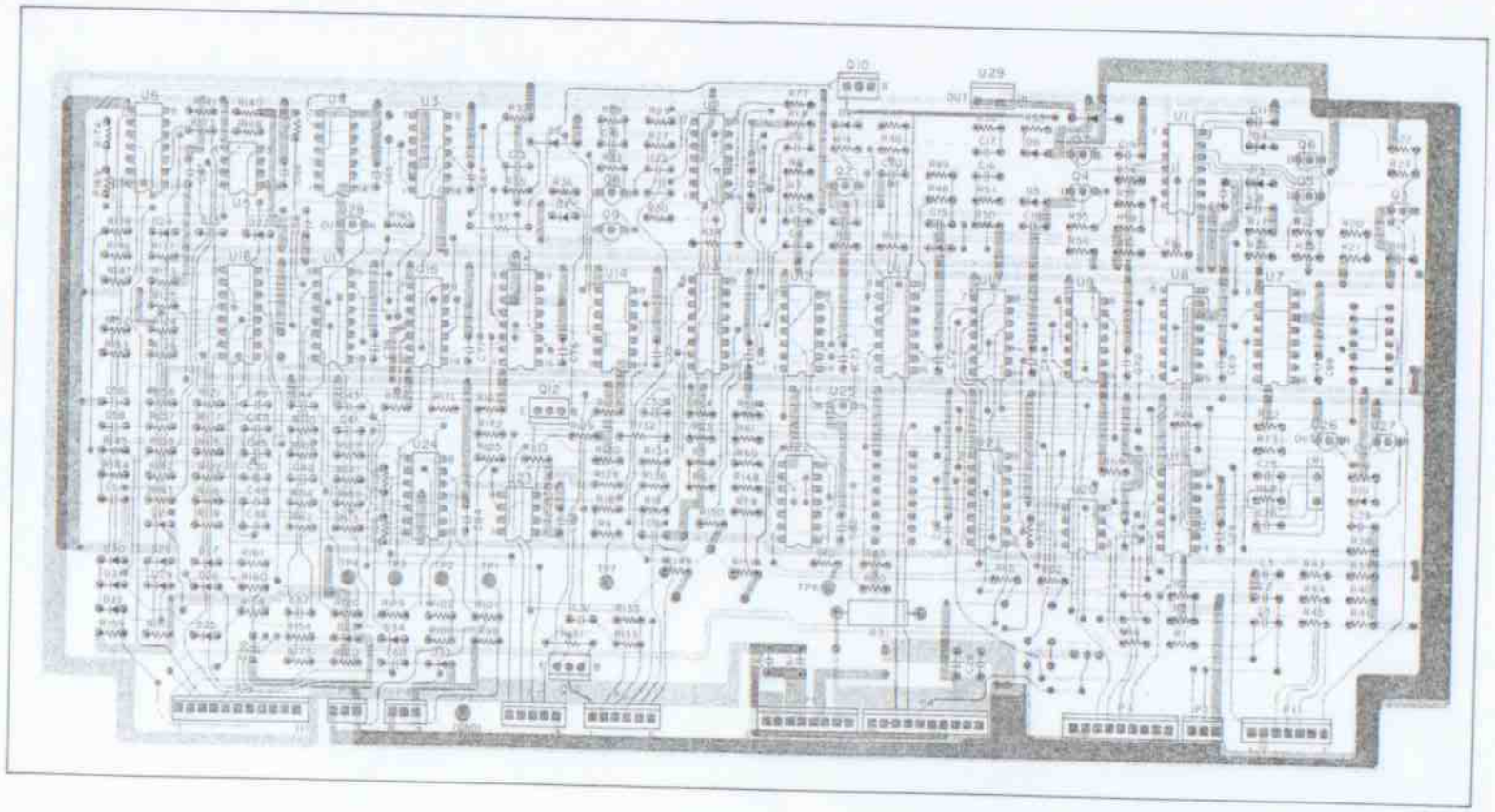
SPEED SENSOR PCB Ass'y

REF. NO.	PARTS NO.	DESCRIPTION
	5200160800	PCB Assy
	5210160800	PCB
U1, U2	5228008200	Photo Interrupter, EE-SJ3-B
R1, R2	5181462000	Carbon Resistor, 150Ω ±5%, 1/4 W

END SENSOR PCB Ass'y

REF. NO.	PARTS NO.	DESCRIPTION
	5200160900	PCB Assy
	5210160900	PCB
U1	5228007500	Photo Interrupter, S13W
R1	5181462000	Carbon Resistor, 150Ω ±5%, 1/4 W

8-2-3. Motor Drive PCB Ass'y



MOTOR DRIVE PCB Ass'y

REF. NO.	PARTS NO.	DESCRIPTION
	5200160600	PCB Assy
	5210160601	PCB
	IC'S	
U1	5220013400	TC4066BP
U2	6048609000	NJM2902
U3	5220015800	HD14002BP
U4	5220019200	TC4013BP
U5	5220407200	LM2904N
U6	5220013400	TC4066BP
U7, U8	5220016600	HD14040BP
U9	5220019100	TC4011BP
U10	5220016300	HD14023BP
U11	5220020000	TC4049BP
U12	5220019000	TC4001BP
U13	5220020000	TC4049BP
U14	5220019000	TC4001BP
U15	5220016400	HD14027BP
U16	5220013400	TC4066BP
U17	5220020000	TC4049BP
U19	6048937000	MC14069B
U20	5220407200	LM2904N
U22	5220019000	TC4001BP
U23	5220407200	LM2904N
U24	6048609000	NJM2902
U29	5220415600	NJM7815A
	TRANSISTORS	
U18	6048661000	Array M54517P
U21	6048661000	Array M54517P
Q2 ~ Q4	5145151000	2SC-1815GR
Q5 ~ Q7	5145102000	2SK-68AL, FET
Q8	5145150000	2SA-1015GR
Q9	5230773800	2SD-2655Y
Q10	⚠ 5231755100	2SD-880Y
Q11, Q12	⚠ 5145077000	2SD-600K
U25 ~ U27	5232252020	Digital 2SC-3400
U28	5232251620	Digital 2SA-1346
	DIODES	
D1 ~ D7	5224015000	ISS133HV
D8, D9	5143243000	ERB-12-02GI
D10	5224015000	ISS133HV
D21 ~ 34D	5224015000	ISS133HV
	RESISTORS	
	All resistor are rated ±5%, 1/5W and of carbon type unless otherwise noted.	
R1	5240028220	1kΩ
R2, R3	5240030620	10kΩ
R4	5240035420	1MΩ
R5	5240030620	10kΩ
R6	5240033020	100kΩ
R7, R8	5240031420	22kΩ
R9, R10	5240033020	100kΩ
R11	5240030620	10kΩ
R12	5240028220	1kΩ
R13	5240030620	10kΩ
R14	5240028220	1kΩ
R15	5240033820	220kΩ
R16	5240027820	680kΩ
R17	5240030620	10kΩ
R18, R19	5240031420	22kΩ

REF. NO.	PARTS NO.	DESCRIPTION
R20	5240032220	47kΩ
R21	5240030620	10kΩ
R22	5240033020	100kΩ
R23	5240027820	680Ω
R24	5240030620	10kΩ
R25	5240033820	220kΩ
R26	5240032220	47kΩ
R27	5240034620	470kΩ
R28	5240033820	220kΩ
R29	5240032220	47kΩ
R30	5240032020	39kΩ
R31	⚠ 5184550000	1Ω (2 W) Nonflammable
R32	5240032220	47kΩ
R33	5240030620	10kΩ
R34	5181482000	1kΩ 1/4 W
R35	5240029420	3.3kΩ
R36	5240030620	10kΩ
R37	5180050000	47Ω 1/2 W
R38 ~ R41	5240029820	4.7kΩ
R43 ~ R45	5240031020	15kΩ
R46, R47	5240030620	10kΩ
R48, R49	5240031420	22kΩ
R50	5240030620	10kΩ
R51	5240028220	1kΩ
R52	5240030620	10kΩ
R53	5240028220	1kΩ
R54	5240033820	220kΩ
R55	5240027820	680Ω
R56	5240028220	1kΩ
R57	5240030620	10kΩ
R58	5240030420	8.2kΩ
R59	5240026620	220Ω
R60	5240029020	2.2kΩ
R61	5240032420	56kΩ
R63	5240033020	100kΩ
R64	5240028220	1kΩ
R68	5240035420	1MΩ
R69, R70	5240031020	15kΩ
R71	5240029820	4.7kΩ
R72	5240030620	10kΩ
R73	5240031420	22kΩ
R74	5240035420	1MΩ
R75	5240031020	15kΩ
R76, R77	5240030620	10kΩ
R78	5240031020	15kΩ
R99, R100	5240032220	47kΩ
R101, R102	5240033020	100kΩ
R103, R104	5240032020	39kΩ
R105, R106	5240029820	4.7kΩ
R107, R108	5240034020	100kΩ
R109, R110	5240028220	1kΩ
R111, R112	5240030620	10kΩ
R113, R114	5240033020	100kΩ
R115, R116	5240033820	220kΩ
R117, R118	5240028220	1kΩ
R119, R120	5240033020	100kΩ
R121, R122	5240033820	220kΩ
R123, R124	5240033020	100kΩ
R125 ~ R128	5240031820	33kΩ
R129, R130	5240032220	47kΩ

REF. NO.	PARTS NO.	DESCRIPTION
R131, R132	5181482000	1kΩ 1/4 W
R133, R134	5240029020	2.2kΩ
R135, R136	5240028220	1kΩ
R137	5240032220	47kΩ
R138	5240030620	10kΩ
R139, R140	5240033020	100kΩ
R141	5240032420	56kΩ
R142	5240032220	47kΩ
R143	5240029820	4.7kΩ
R144	5240025820	100Ω
R145	5240025020	47Ω
R146	5240030620	10kΩ
R147	5240031820	33kΩ
R148	5240033020	100kΩ
R152, R153	5240031420	22kΩ
R154	5240028220	1kΩ
R156	5240030620	10kΩ
R157	5240028220	1kΩ
R158, R159	5240029820	4.7kΩ
[illegible]30	5240025820	100Ω
R161	5240028220	1kΩ
R162	5240029820	4.7kΩ
R163	5240031020	15kΩ
R165	5240033020	100kΩ
R166 ~ R170	5240029820	4.7kΩ
R171 ~ R175	5240021020	15kΩ

CAPACITORS

C1	5170352000	Mylar	0.001μF	100V
C2, C3	5173433000	Ceramic	0.01μF	50V
C4	5263106420	Polyst.	270pF	100V
C5, C6	5263107220	Polyst.	560pF	100V
C7	5263103720	Polyst.	0.022μF	100V
C8	5170364000	Mylar	0.0033μF	100V
C9	5263107220	Polyst.	560pF	100V
C10	5263103720	Polyst.	0.022μF	100V
C11	5170364000	Mylar	0.0033μF	100V
C12	5263107220	Polyst.	560pF	100V
C13	5170352000	Mylar	0.001μF	100V
C14	5170453000	Mylar	0.15μF	100V
[illegible]i, C16	5263107220	Polyst.	560pF	100V
[illegible]7	5263106420	Polyst.	270pF	100V
C18	5263103720	Polyst.	0.022μF	100V
C19	5170364000	Mylar	0.0033μF	100V
C20	5263107220	Polyst.	560pF	100V
C23	5171864000	Mylar	0.022μF	100V
C24	5173434000	Ceramic	0.022μF	50V
C25, C26	5054741000	Dip Mica	22pF	50V
C27	5260165352	Elec.	47pF	35V
C28	5173433000	Ceramic	0.01μF	50V
C21,C22,C30	5181761000	Jumper P=5.0		
C41, C42	5170368000	Mylar	0.0047μF	100V
C43, C44	5263167923	Metalized	0.1μF	50V
C45, C46	5263168523	Metalized	0.33μF	50V
C47, C48	5170352000	Mylar	0.001μF	100V
C49, C50	5263167923	Metalized	0.1μF	50V
C51, C52	5171856000	Mylar	0.01μF	100V
C53	5260162650	Elec.	10μF	25V
C54	5263168123	Metalized	0.15μF	50V
C55	5170364000	Mylar	0.0033μF	100V
C56	5263107220	Polyst.	560pF	100V
C57	5263100520	Polyst.	0.001μF	100V
C58	5263107220	Polyst.	560pF	100V
C59	5260163452	Elec.	22μF	25V
C60	5260162050	Elec.	4.7μF	35V
C61	5260165352	Elec.	47μF	35V
C62 ~C84	5173433000	Ceramic	0.01μF	50V

VARIAVLE RESISTORS

R62	5280132702	Semi-fixed	50kΩ (B)
R65	5280131602	Semi-fixed	2kΩ (B)
R149	5280132702	Semi-fixed	50kΩ (B)
R150	5280132902	Semi-fixed	100kΩ (B)
R151	5280133002	Semi-fixed	200kΩ (B)

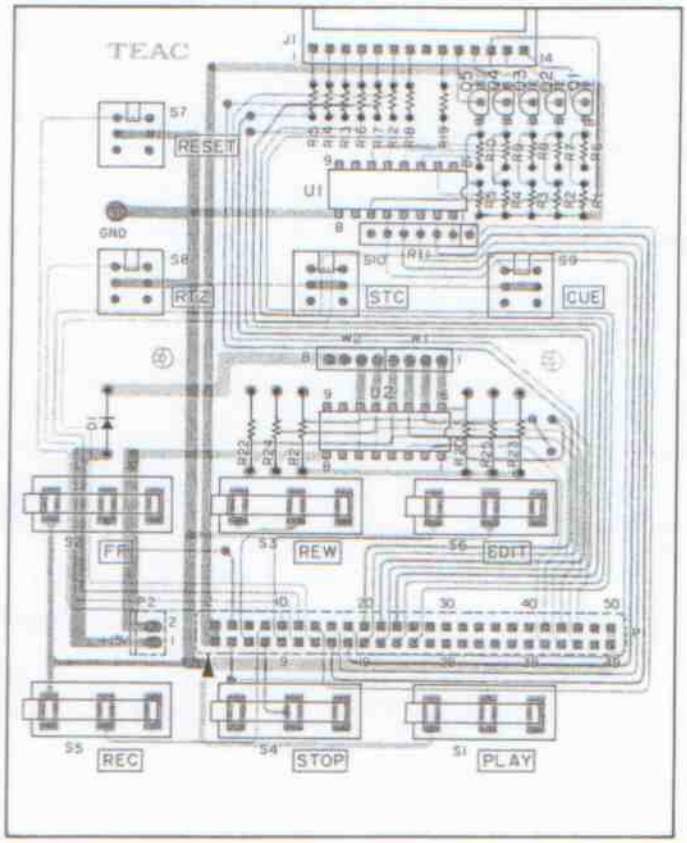
CONNECTOR PLUGS

P1	5122131000	7P
P2	5122184000	3P(BLK)
P3	5122133000	9P
P4	5122134000	10P
P5	5122132000	8P
P6	5122130000	6P
P7	5122129000	5P
P8	5122127000	3P
P9	5122300000	3P(RED)
P10	5122135000	11P

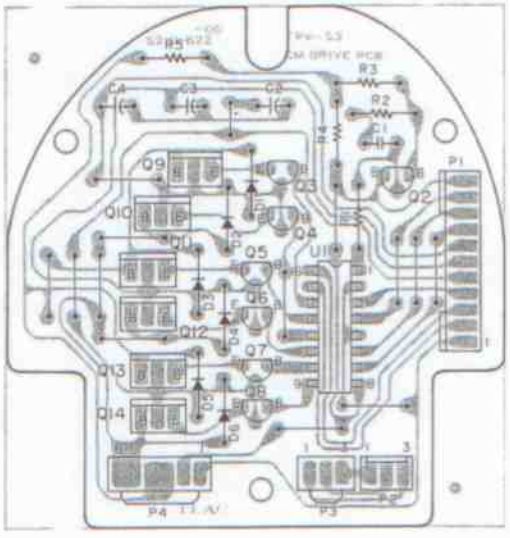
MISCELLANEOUS

CR1	5347001600	OSC Unit; 4.9152MHz
TP1 ~ TP7	5317002100	Check Pin, DH
	5033291000	Plate, Insulating (2 used)
	5033295000	Tube, Insulating (2 used)
	5181762000	Jumper PF 7.5 (2 used)
	5800638000	Heat sink (1 used)

8-2-4. Key Board PCB A Ass'y



CM Drive PCB Ass'y



KEY BOARD PCB A Ass'y

REF. NO.	PARTS NO.	DESCRIPTION
	5200161000	PCB Assy
	5210161000	PCB
	IC's	
U1, U2	6048661000	M54517P
	TRANSISTORS	
Q1~Q5	5230016100	2SA-950Y
	D10DE	
D1	5143243000	ERB12-02G1
	RESISTORS	
	All resistor are rated ±5%, 1/5W and of carbon type unless otherwise noted.	
R1~R5	5240032220	47kΩ
R6~R10	5240028220	1kΩ
R11	5242110400	4.7kΩ x 6, Array
R12~R19	5240025620	82Ω
R20~R25	5180076000	560Ω 1/2 W
	MISCELLANEOUS	
S1~S6	5301455200	Switch, Micro; SS5GL13-N
S7~S10	5300028100	Switch, Push; 2-2N SPH-122A
J1	5336116400	Connector Socket, 14P
P1	5336213900	Cable Connector, Flat; 50P
P2	5122126000	Connector Plug, 2P
P3	5122366000	Connector Plug, 14P
W1, W2	5354024000	Jumper, Reed; 4P-30
	5317002100	Check Pin, DH
	5225009600	LED Indicator SL-2585

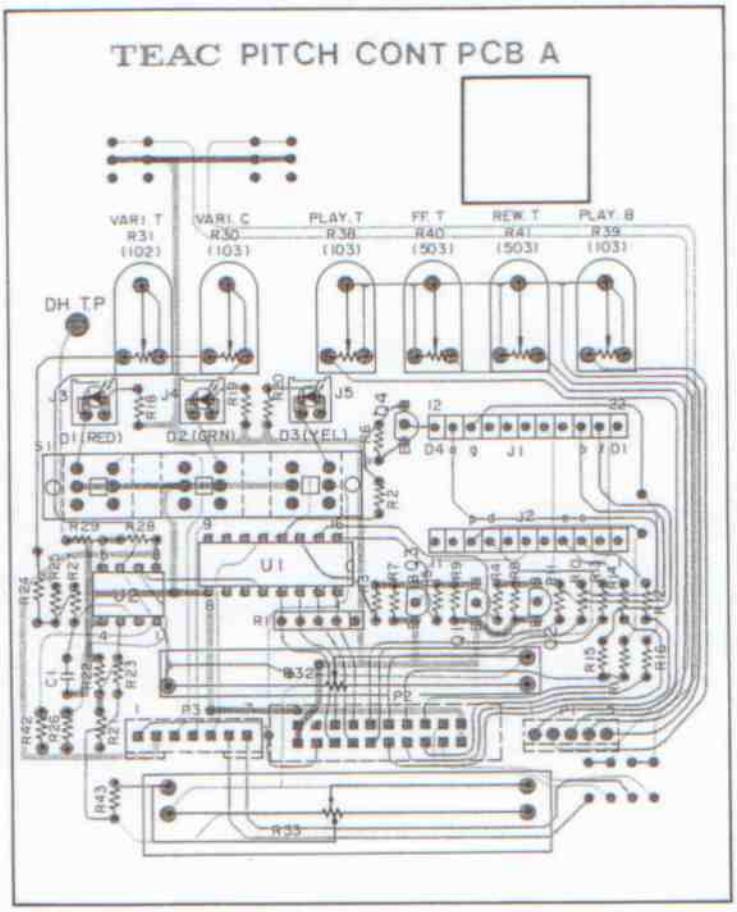
KEY BOARD PCB B Ass'y (PCB Omitted)

REF. NO.	PARTS NO.	DESCRIPTION
	5200161100	PCB Assy
	5210161100	PCB
DS1	5310007100	Lamp, Mini Base; 14V 80mA (RED)
DS2~DS5	5310007200	Lamp, Mini Base; 14V 80mA (YEL)
DS6	5310007300	Lamp, Mini Base; 14V 80mA (GRN)

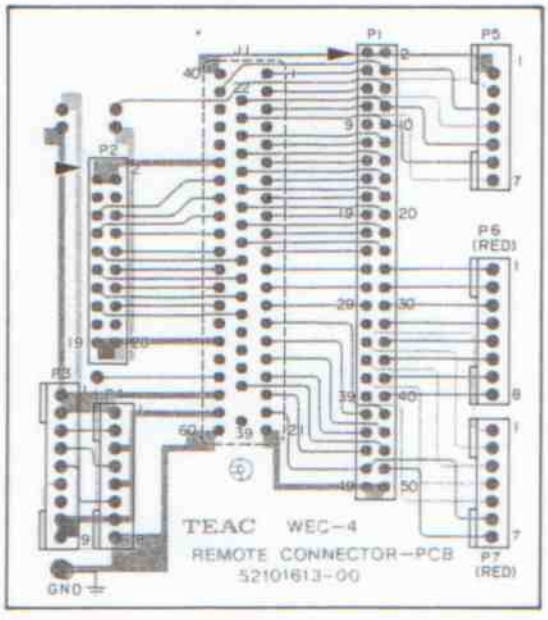
CM DRIVE PCB Ass'y

REF. NO.	PARTS NO.	DESCRIPTION
	5200162200	PCB Assy
	5210162200	PCB
	IC	
U1	5220036500	M51724P
	TRANSISTORS	
Q2	5145151000	2SC-1815GR
Q3	5230014000	2SA-1020Y
Q4	5230773800	2SC-2655Y
Q5	5230014000	2SA-1020Y
Q6	5230773800	2SC-2655Y
Q7	5230014000	2SA-1020Y
Q8	5230773800	2SC-2655Y
Q9	5230505700	2SB-834Y
Q10	5231755100	2SD-880Y
Q11	5230505700	2SB-834Y
Q12	5231755100	2SD-880Y
Q13	5230505700	2SB-834Y
Q14	5231755100	2SD-880Y
	DIODES	
D1~D6	5143243000	ERB12-02G1
	CARBON RESISTORS	
	All resistor are rated ±5%, 1/4W and of carbon type unless otherwise noted.	
R1	5181524000	56kΩ
R2	5181502000	6.8kΩ
R3	5181506000	10kΩ
R4	5181498000	4.7kΩ
R5	5181502000	6.8kΩ
	CAPACITORS	
C1	5171856000	Mylar 0.01μF 100V
C2, C3	5260165452	Elec. 47μF 50V
	MISCELLANEOUS	
P1	5122135000	Connector Plug, 11P
P2	5122127000	Connector Plug, 3P
P3	5122203000	Connector Plug, 3P (BLK)
P4	5122149000	Connector Plug, 6P
W1~W13	5181763000	Jumper P = 10.0
W14	5181761000	Jumper P = 5.0

8-2-5. Pitch Cont. PCB Ass'y



Remote Connector PCB Ass'y



PITCH CONT. PCB A Ass'y

REF. NO.	PARTS NO.	DESCRIPTION
	5200161200	PCB Assy
	5210161200	PCB
	IC'S	
U1	6048661000	M54517P
U2	5220012500	μPC393C
	TRANSISTORS	
Q1~Q4	5230016100	2SA-950Y
	RESISTORS	
	All resistor are rated ±5%, 1/5W and of carbon type unless otherwise noted.	
R1	5242110200	4.7kΩ x 6, Array
R2~R5	5240028220	1kΩ
R6~R9	5240030620	10kΩ
R10~R17	5240025620	82Ω
[illegible]	5240027420	470Ω
[illegible], R20	5240026620	220Ω
R21, R22	5240033020	100kΩ
R23	5240031420	22kΩ
R24	5241426602	5.1kΩ 1/4 W
R25	5240032220	47kΩ
R26	5240030020	5.6kΩ
R27	5240031820	33kΩ
R28, R29	5240033020	100kΩ
R42	5240029820	4.7kΩ
R43	5240033420	150kΩ
	CAPACITOR	
C1	5171156000	Polyst. 820pF 125V
C2	5260165352	Elec. 47μF 35V
	VARIABLE RESISTORS	
R30	5150274000	Semi-fixed; 10kΩ
R31	5150267000	Semi-fixed; 1kΩ
R32	5284006100	Slide, 1kΩ (B)
R33	5284008800	Slide, 20kΩ (B)
[illegible], R39	5150274000	Semi-fixed 10kΩ
R40, R41	5150279000	Semi-fixed 50kΩ
	MISCELLANEOUS	
D1	5225007900	LED, GL-9PR2
D2	5225007100	LED, GL-9NG2 (GRN)
D3	5225010600	LED, GL-9HY2 (YEL)
S1	5300038800	Switch, Push; SUZ3-2-2
P1	5122129000	Connector Plug, 5P
P2	5336213500	Cable Connector, Flat 20P
P3	5122131000	Connector Plug, 7P
J1, J2	5336116100	Connector Socket, 11P
J3~J5	5336115200	Connector Socket, 2P
	5317002100	Check Pin, DH

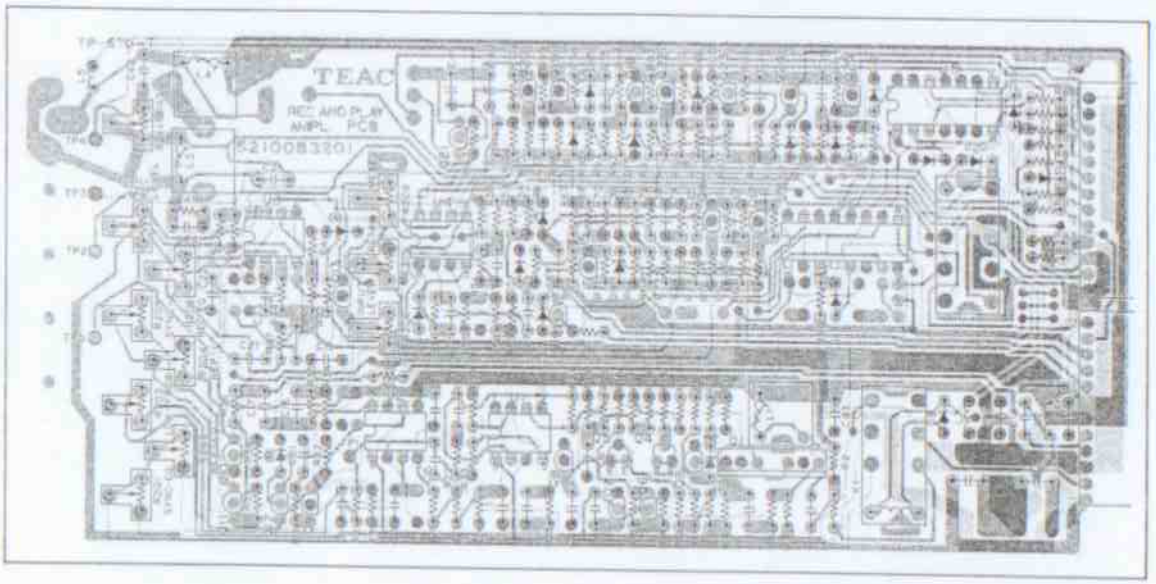
PITCH CONT. PCB B Ass'y

REF. NO.	PARTS NO.	DESCRIPTION
	5200162100	PCB Assy
	5210162100	PCB
	5225008900	LED Indicator; SL-2405-20
P1, P2	5122363000	Connector Plug; 11P

REMOTE CONNECTOR PCB Ass'y

REF. NO.	PARTS NO.	DESCRIPTION
	5200161300	PCB Assy
	5210161301	PCB
J1	5336217700	Connector Socket, SD-1660A-STA
P1	5336213900	Cable Connector, Ribon; 3332-50GS1
P2	5336213500	Cable Connector, Ribon; 3332-20GS1
P3	5122133000	Connector Plug, 9P
P4	5122132000	Connector Plug, 8P
P5	5122131000	Connector Plug, 7P
P6	5122305000	Connector Plug, 8P (RED)
P7	5122304000	Connector Plug, 7P (RED)

8-2-6. Rec/Play Amplifier PCB Ass'y



Rec/Play Amplifier PCB Ass'y

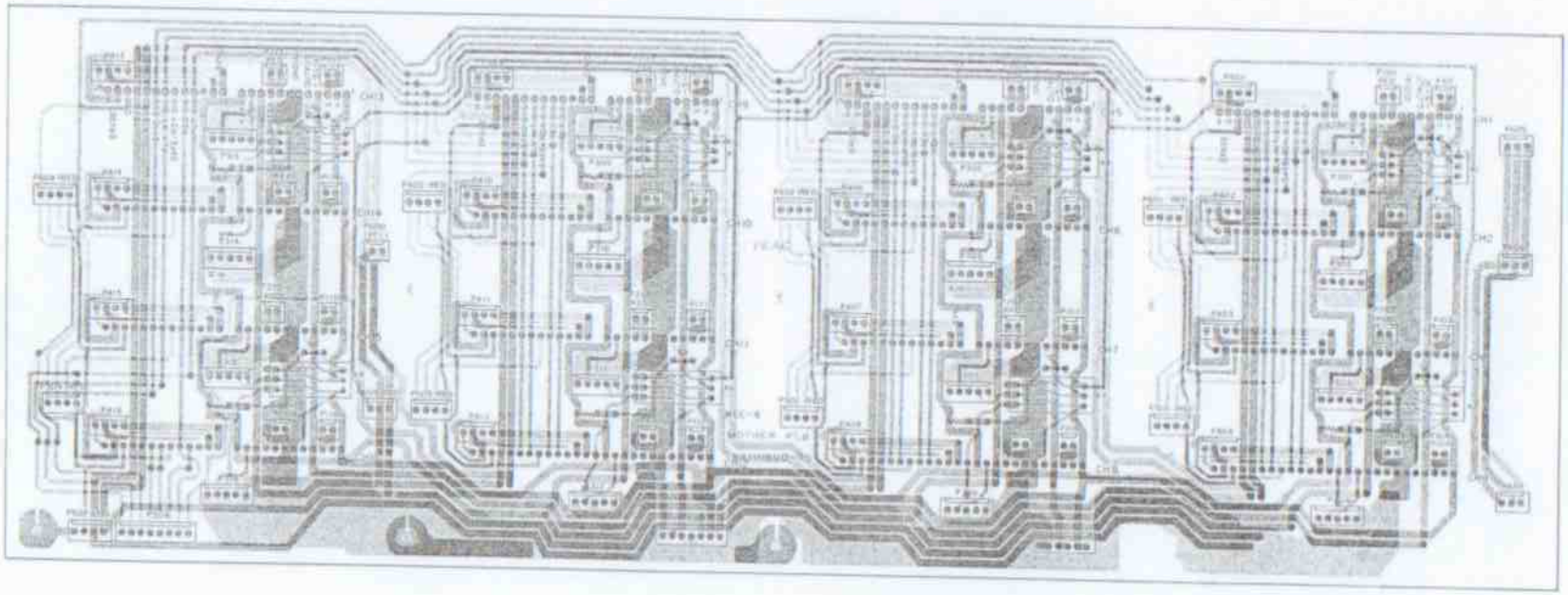
REF. NO.	PARTS NO.	DESCRIPTION
	5200083220	PCB Assy
	5210083202	PCB
	IC'S	
U1~U4	5220411600	TL4558P
U5	5220019000	TC4001BP
U6	5220020000	TC4049BP
U7	5292202400	BIAS Ampl. Module
	TRANSISTORS	
Q1	5232008600	FET, 2SK-389BL
Q3	5145151000	2SC-1815GR
Q4, Q5	5145149000	2SA-970GR
Q6, Q7	5145151000	2SC-1815GR
Q8	5145150000	2SA-1015GR
Q9	5145185000	2SD-655E
Q10, Q11	5145151000	2SC-1815GR
Q12, Q13	5145103000	FET, 2SK-68AM
Q14~Q20	5145151000	2SC-1815GR
Q21	5230771000	2SC-2274K (E)
Q22~Q25	5145151000	2SC-1815GR
	DIODES	
D1~D3	5224015010	1SS133HV
D4, D5	5224015400	1K60
D6~D8	5224015010	1SS133HV
D9	5143154000	EQA01-06S, Zener
D10~D14	5224015010	1SS133HV
D15	5143174000	EQA01-09R, Zener
D16, D17	5224015010	1SS133HV
D19~D21	5224015010	1SS133HV
D22	5143154000	EQA01-06S, Zener
	CARBON RESISTORS	
	Except for R3, R4, all resistors are rated ±5% tolerance at 1/5 W.	
R1	5240023420	10Ω
R2	5240030620	10kΩ
R3, R4	5241318200	1.0kΩ Metalized 1/4W
R5	5240025420	68Ω
R6, R7	5240027020	330Ω
R8	5240028620	1.5kΩ
R9	5240025020	47Ω
R10	5240028020	820Ω
R11, R12	5240025420	68Ω
R13	5240030320	7.5kΩ
R14	5240029220	2.7kΩ
R15	5240028820	1.8kΩ
R16	5240030320	7.5kΩ
R17	5240028620	1.5kΩ
R18, R19	5240024620	33Ω
R20	5240028220	1.0kΩ
R21	5240031020	15kΩ
R22, R23	5240032820	82kΩ
R24	5240027920	750Ω
R25	5240033420	150kΩ
R26	5240027420	470Ω
R27	5240029220	2.7kΩ
R28	5240029620	3.9kΩ
R29	5240030620	10kΩ
R31	5240030620	10kΩ

REF. NO.	PARTS NO.	DESCRIPTION
R32	5240029020	2.2kΩ
R34	5240029820	4.7kΩ
R35	5240031620	27kΩ
R36	5240032420	56kΩ
R37	5240026620	220Ω
R38, R39	5240029820	4.7kΩ
R41	5240032220	47kΩ
R42	5240029020	2.2kΩ
R43	5240029220	2.7kΩ
R44	5240029420	3.3kΩ
R45	5240032220	120kΩ
R47	5240028620	1.5kΩ
R48	5240027620	560Ω
R49	5240028420	1.2kΩ
R50	5240029020	2.2kΩ
R51	5240033420	150kΩ
R52	5240025820	100Ω
R53	5240029420	3.3kΩ
R54	5240030620	10kΩ
R55	5240031420	22kΩ
R56	5240034820	560kΩ
R58	5240030620	10kΩ
R59	5240028800	1.8kΩ
R60	5240031620	27kΩ
R61, R62	5240032420	56kΩ
R63	5240029420	3.3kΩ
R64	5240031620	27kΩ
R65, R66	5240032420	56kΩ
R67	5240032220	47kΩ
R68	5240031620	27kΩ
R69	5240029020	2.2kΩ
R70	5240030620	10kΩ
R71~R73	5240032220	47kΩ
R74	5240031620	27kΩ
R75	5240030620	10kΩ
R76, R77	5240031620	27kΩ
R78	5240032220	47kΩ
R79	5240031620	27kΩ
R80	5240031020	15kΩ
R81~R85	5240031620	27kΩ
R86~R89	5240031020	15kΩ
R90	5240031620	27kΩ
R91	5240030620	10kΩ
R92	5240032220	47kΩ
R93	5240030620	10kΩ
R94	5240028820	1.8kΩ
R95	5240031420	22kΩ
R96, R97	5240026620	220Ω
R98	5240030620	10kΩ
R99	5240032220	47kΩ
R100	5240030620	10kΩ
R101	5240032220	47kΩ
R102	5240029820	4.7kΩ
R103	5240023220	8.2Ω
R104	5240031620	27kΩ
R105	5240032220	47kΩ
R106	5240032220	47kΩ
R107	5240030420	8.2kΩ
R108, R109	5240026620	220Ω
R110	5240030620	10kΩ
R111	5240032220	47kΩ

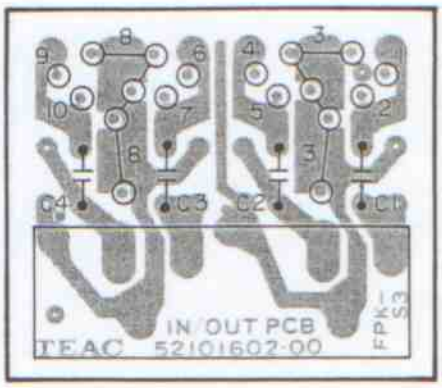
REF. NO.	PARTS NO.	DESCRIPTION			
R112	5240030020	5.6kΩ			
R113	5240031820	33kΩ			
R114	5240026620	220Ω			
R115	5240029820	4.7kΩ			
R116	5240031620	27kΩ			
R117	5240029220	2.7kΩ			
R118	5240029820	4.7kΩ			
	CAPACITORS				
C1	5263106820	Polyst.	390pF	100V	5%
C2	5054878500	Mylar	0.001μF	100V	5%
C3	5172218000	Ceramic	330pF	50V	10%
C4, C5	5172204000	Ceramic	22pF	50V	10%
C6	5263107620	Polyst.	820pF	100V	5%
C7	5173055800	Elec.	220μF	25V	
C8	5173073000	Elec.	470μF	25V	
C9	5260254210	Elec. (B.P)	6.8μF	16V	20%
C10	5054899500	Mylar	0.027μF	100V	5%
C11, C12	5054878500	Mylar	0.001μF	100V	5%
[illegible], C14	5054928500	Mylar	0.1μF	100V	5%
C15	5054878500	Mylar	0.001μF	100V	5%
C16	5172307000	Ceramic	39pF	50V	10%
C17	5260067050	Elec. (B.P)	10μF	16V	20%
C18	5054727500	Mylar	0.0036μF	100V	5%
C19	5260065650	Elec. (B.P)	1μF	50V	20%
C21	5054891500	Mylar	0.0047μF	100V	5%
C22	5260067850	Elec. (B.P)	22μF	16V	20%
C23	5263106620	Polyst.	330pF	100V	5%
C24	5054890500	Mylar	0.0039μF	100V	5%
C25	5263106820	Polyst.	390pF	100V	5%
C26	5260067050	Elec.	10μF	16V	20%
C27	5054878500	Mylar	0.001μF	100V	5%
C28	5260165052	Elec.	47μF	10V	20%
C29	5260160750	Elec	1μF	50V	20%
C30~C34	5260162050	Elec.	4.7μF	25V	20%
C35, C36	5171912000	Elec.	0.22μF	50V	20%
C37~C39	5260163452	Elec.	22μF	25V	20%
C40	5260164452	Elec.	33μF	35V	20%
C42	5263105420	Polyst.	100pF	100V	5%
[illegible]	5263107620	Polyst.	820pF	100V	5%
[illegible]	5260160750	Elec.	1μF	50V	20%
C46	5054878500	Mylar	0.001μF	100V	5%
C48	5054878500	Mylar	0.001μF	100V	5%
	VARIABLE RESISTORS				
R201, R202	5280131602	Semi-fixed	2kΩ (B)		
R203	5280132702	Semi-fixed	50kΩ (B)		
R204, R205	5280132002	Semi-fixed	5kΩ (B)		
R206	5280131602	Semi-fixed	2kΩ (B)		
R207	5280132002	Semi-fixed	5kΩ (B)		
R208	5280132102	Semi-fixed	6.8kΩ (B)		
R209~R211	5280132702	Semi-fixed	50kΩ (B)		
	COILS				
L1	5160044000	Trap	3mH	20%	
L2	5286020400	Choke	330μH	10%	
L3	5160044000	Trap	3mH	20%	
L4	5286010000	Choke	1mH		
L5	5286011500	Choke	220μH		
L6, L7	5286021100	Choke	1200μH	5%	

REF. NO.	PARTS NO.	DESCRIPTION
	MISCELLANEOUS	
K1, K2	5290009400	Relay; 24V, G2V-282P
J1	5122383000	Connector Socket, 12P
J2	5122384000	Connector Socket, 13P
TP1~TP5	5317001200	Pin φ0.7
	5800303900	Case, Shield
W1	5181761000	Jumper P-5
W2	5355051800	Cord

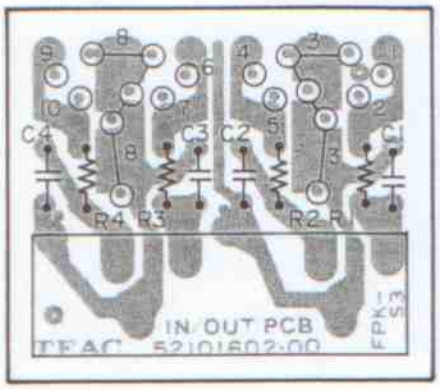
8-2-7. Mother PCB Ass'y



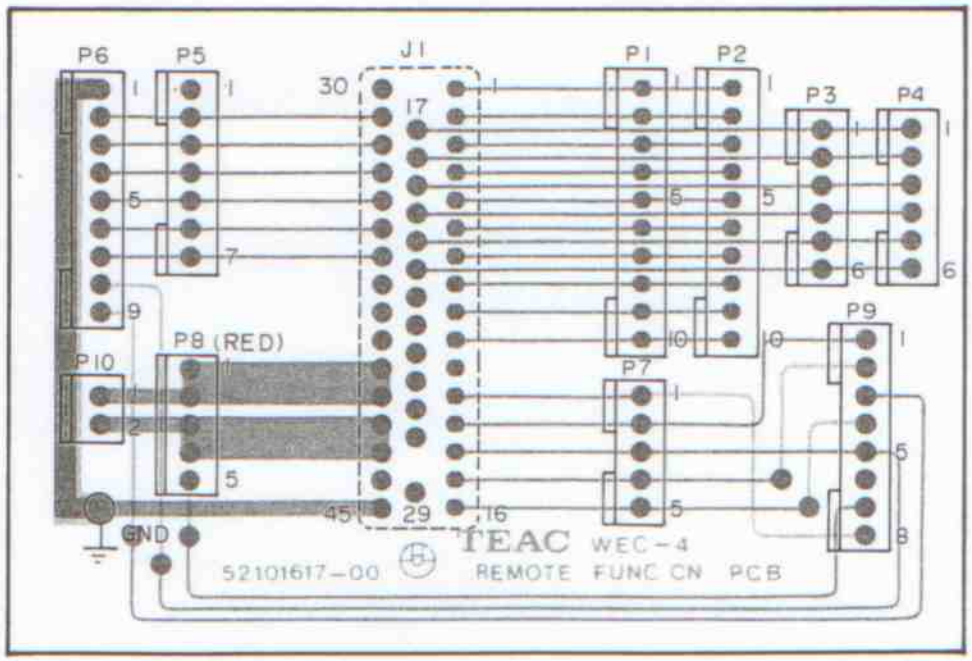
8-2-8. Input PCB Ass'y



Output PCB Ass'y



Remote Function CN PCB Ass'y



MOTHER PCB Ass'y

REF. NO.	PARTS NO.	DESCRIPTION
	5200160000	PCB Assy
	5210160000	PCB
		DIODES
D1~D8	5224015010	ISS133HV
		RESISTORS
R1~R8	5240028420	Carbon 1.2kΩ ±5% 1/4 W
		RELAYES
K1~K8	5061137000	Read Relay; LA82L (12V)
		CONNECTOR PLUGS
P101~P116	5336126200	2P
P201~P216	5336135200	2P (RED)
P301~P316	5336126500	5P
P401~P416	5336126400	4P
P501~P504	5336135400	4P (RED)
P505	5336126700	7P
P506	5336126800	8P
P507	5336145400	4P (YEL)
P508	5336126600	6P
P509	5336135300	3P (RED)
P600	5336145200	2P (YEL)
P601~P604	5336135400	4P (RED)
P605~P607	5336126300	3P
P701~P716	5122365000	13P
P801~P816	5122364000	12P

INPUT PCB Ass'y

REF. NO.	PARTS NO.	DESCRIPTION
	5200160200	PCB Assy
	5210160200	PCB
C1~C4	5260067050	Capacitor, Elec,; 10μF 16V (B.P)
	5330507200	Pin Jack, 4P (1 used)

OUTPUT PCB Ass'y

REF. NO.	PARTS NO.	DESCRIPTION
	5200161800	PCB Assy
	5210160200	PCB
R1~R4	5240026620	Carbon Resistor 220Ω ±5% 1/4 W
C1~C4	5170368000	Maylar 0.0047μ
	5330507200	Pin Jack, 4P

REMOTE FUNCTION CN PCB Ass'y

REF. NO.	PARTS NO.	DESCRIPTION
	5200161700	PCB Assy
	5210161700	PCB
		CONNECTOR PLUGS
P1, P2	5122134000	10P
P3, P4	5122130000	6P
P5	5122131000	7P
P6	5122133000	9P
P7	5122129000	5P
P8	5122302000	5P (RED)
P9	5122126000	2P
P10	5122132000	8P
		CONNECTOR SOCKET
J1	5336217600	SD-1645A-STA

OSC PCB Ass'y (PCB Omitted)

REF. NO.	PARTS NO.	DESCRIPTION
	5200160400	PCB Assy
	5210160400	PCB
U1	5292201900	OSC Unit; 145kHz

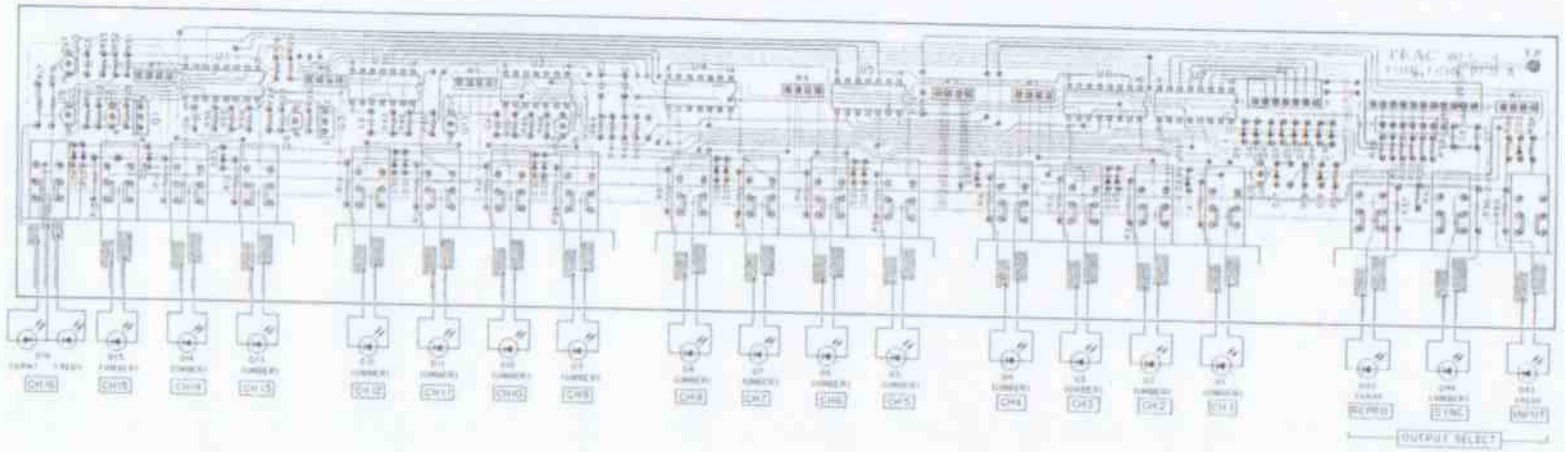
FUSE PCB Ass'y (PCB Omitted)

REF. NO.	PARTS NO.			
	5200161900	PCB Assy		[J, U, C, GE]
	5200161900	PCB		[J, U, C, GE]
	5200162000	PCB Assy		[E, UK, A]
	5210162000	PCB		[E, UK, A]
		FUSES		
F1, F2	⚠ 5307004300	3A	250V	[J, U, C, GE]
	⚠ 5142190000	T2.5A	250V	[E, UK, A]
F3, F4	⚠ 5307004400	4A	250V	[J, U, C, GE]
	⚠ 5142191000	T3.15A	250V	[E, UK, A]
F5	⚠ 5307004300	3A	250V	[J, U, C, GE]
	⚠ 5142190000	T2.5A	250V	[E, UK, A]
F6	⚠ 5307004400	4A	250V	[J, U, C, GE]
	⚠ 5142191000	T3.15A	250V	[E, UK, A]
F7, F8	⚠ 5307004700	7A	125V	[J, U, C, GE]
	⚠ 5142193000	T5A	250V	[E, UK, A]
F9	⚠ 5307004900	10A	125V	[J, U, C, GE]
	⚠ 5142194000	T6.3A	250V	[E, UK, A]
F10	⚠ 5307004700	7A	125V	[J, U, C, GE]
	⚠ 5142193000	T5A	250V	[E, UK, A]
		MISCELLANEOUS		
	5041237000	Holder, Fuse (20 Used)		[J, U, C, GE]
	5332014200	Holder, Fuse (20 Used)		[E, UK, A]

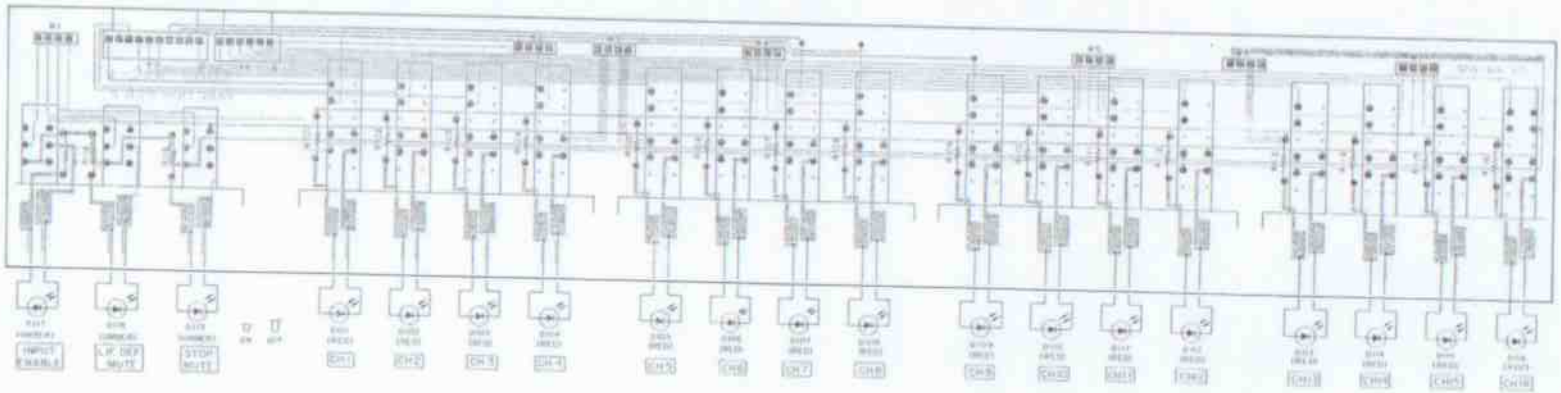
5307046200 10A/250V

[U]: U.S.A. [C]: CANADA [GE]: GENERAL EXPORT
[A]: AUSTRALIA [E]: EUROPE [UK]: U.K.
[L]: LIMITED AREA [J]: JAPAN

8-2-9. Function PCB A Ass'y



Function PCB B Ass'y



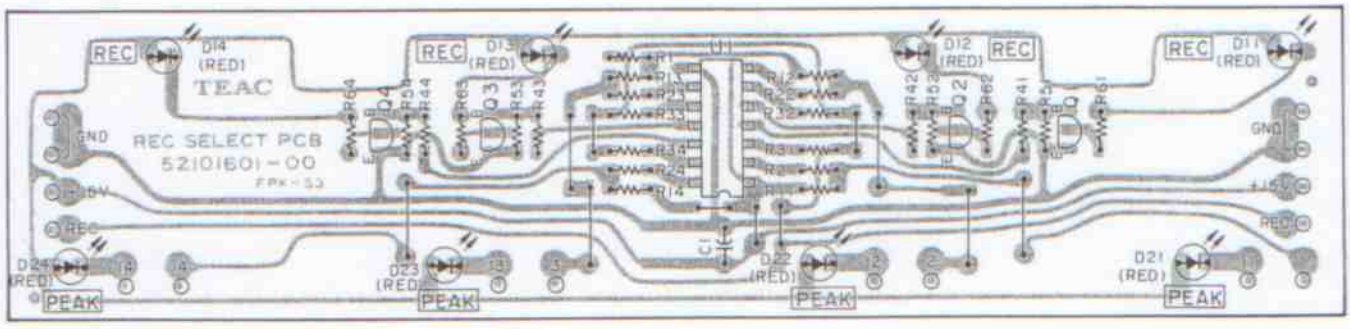
FUNCTION PCB A Ass'y

REF. NO.	PARTS NO.	DESCRIPTION
	5200161501	PCB Assy
	5210161501	PCB
	IC'S	
U1	5220020000	TC4049BP
U2	5220019100	TC4011BP
U3	5220020200	TC4030BP
U4	5220019100	TC4011BP
U5	5220019000	TC4001BP
U6	5220020000	TC4049BP
	TRANSISTORS	
Q1	5231755400	2SD-794Q
Q2	5145151000	2SC-1815GR
Q3	5231755400	2SD-794Q
Q4	5145151000	2SC-1815GR
U8	5232252000	Digital 2SC-3400
U7	6048661000	Array M5451TP
U9, U10	5232251620	2SA-1346
U11, U12	5232252000	Digital 2SC-3400
	DIODES	
D17	5224015010	ISS133HV
D19~D42	5224015010	ISS133HV
D46, D47	5224015010	ISS133HV
	RESISTOR	
	All resistor are rated ±5%, 1/5W and of carbon type unless otherwise noted.	
R1~R15	5181484000	1.2kΩ 1/4 W
R16, R17	5181488000	1.8kΩ 1/4 W
R18	5240030620	10kΩ
R19, R20	5240031020	15kΩ
R21	5240031420	22kΩ
R22	5240032220	47kΩ
R23	5240028220	1kΩ
R24	5240031420	22kΩ
R25	5240032220	47kΩ
R26	5240028220	1kΩ
R27	5242110400	4.7kΩ x 6, Array
R28~R34	5240031020	15kΩ
R35	5181492000	2.7kΩ 1/4 W
R36	5181484000	1.2kΩ 1/4 W
R37	5181480000	820Ω 1/4 W
R38	5240030620	10kΩ
R39	5240031020	15kΩ
R40	5240049820	4.7kΩ
R41, R42	5240032220	47kΩ
R43, R44	5240031020	15kΩ
R45	5240032820	82kΩ
R46	5240026620	220Ω
R47	5240031020	15kΩ
R48	5240032820	82kΩ
R49	5240026620	220Ω
R50	5240031020	15kΩ
R51	5240032620	68kΩ
R52	5240031020	15kΩ
R53	5240035420	1MΩ
R54	5240032620	68kΩ
R55	5240031020	15kΩ
R56	5240035420	1MΩ
R57	5240031020	15kΩ
	CAPACITORS	
C1	5260160750	Elec. 1μF 50V
C2	5260162650	Elec. 10μF 25V
C3	5260160750	Elec. 1μF 50V
C4	5260162650	Elec. 10μF 25V
C5, C6	5260160750	Elec. 1μF 50V
C7	5260165252	Elec. 47μF 25V
C8	5173433000	Ceramic 0.01μF 50V
	LED'S	
D1~D15	5225011300	SLP-455B
D16	5225014100	GL-9ND2
D43	5225010100	SLP-155B
D44	5225011300	SLP-455B
D45	5225010200	SLP-255B
	MISCELLANEOUS	
P1	5122135000	Connector Plug; 11P
P2	5122131000	Connector Plug; 7P
W1~W7	5354024000	Jumper; 4P-30
	5300038500	Switch, Push; 4 reams 2-2 (SUN) (4 used)
	5300028000	Switch, Push; 3 reams 2-2 (SUN) (1 used)
	5317002100	Check Pin, DH (1 used)

FUNCTION PCB B Ass'y

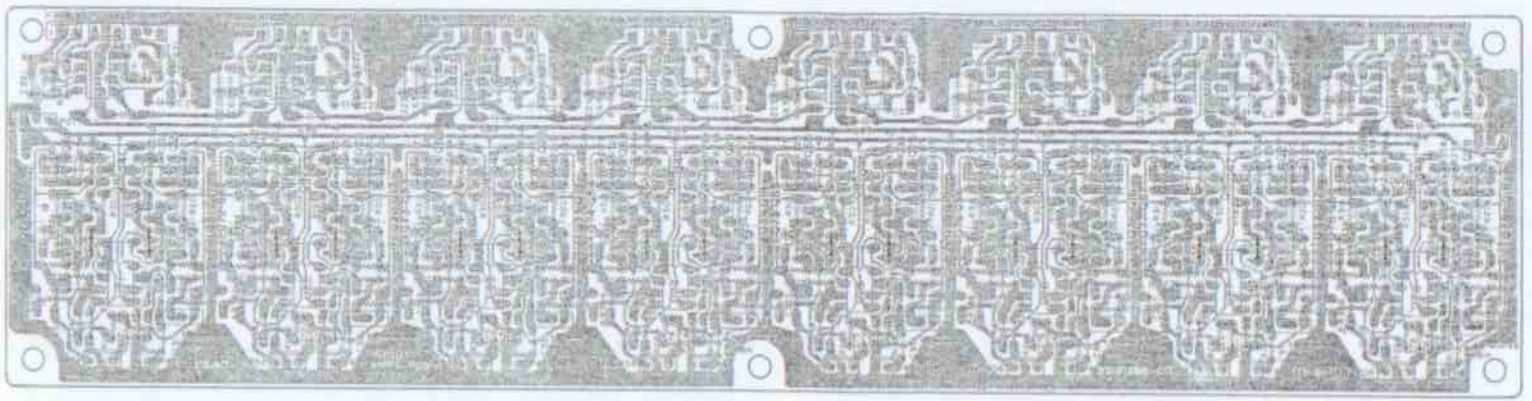
REF. NO.	PARTS NO.	DESCRIPTION
	5200161600	PCB Assy
	5210161600	PCB
	RESISTORS	
R101~R116	5181492000	Carbon 2.7kΩ ±5% 1/4 W
R117~R119	5181484000	Carbon 1.2kΩ ±5% 1/4 W
	LED'S	
D101~D116	5225010100	SLP-155B (RED)
D117~D119	5225011300	SLP-455B (AMBER)
	MISCELLANEOUS	
P3	5122153000	Connector Plug, 10P
P4	5122149000	Connector Plug, 6P
	5300038600	Switch, Push; 4 reams 4-2 (SUN) (4 used)
	5300038700	Switch, Push; 3 reams 2-2 (SUN) (1 used)

8-2-10. REC Select PCB Ass'y



REC SELECT PCB Ass'y

REF. NO.	PARTS NO.	DESCRIPTION
	5200160100	PCB Assy
	5210160100	PCB
	IC	
U1	6048940000	MC4001B
	TRANSISTORS	
Q1 ~ Q4	5145151000	2SC-1815GR
	RESISTORS	
	All resistor are rated ±5%, 1/5W and of carbon type otherwise noted.	
R1	5240029220	2.7kΩ
R11 ~ R14	5240029220	2.7kΩ
R21 ~ R24	5240031020	15kΩ
R31 ~ R34	5240031020	15kΩ
R41 ~ R44	5240030620	10kΩ
R51 ~ R54	5240030620	10kΩ
R61 ~ R64	5240029220	2.7kΩ
	CAPACITOR	
C1	5260165252	Elec 47μF 25V
	LED'S	
D11 ~ D14	5225007900	GL9PR2 (RED)
D21 ~ D24	5225011400	SLP-144B (RED)
	MISCELLANEOUS	
W11 ~ W15	5181761000	Jumper P = 5mm
W21 ~ W26	5181763000	Jumper P = 10mm



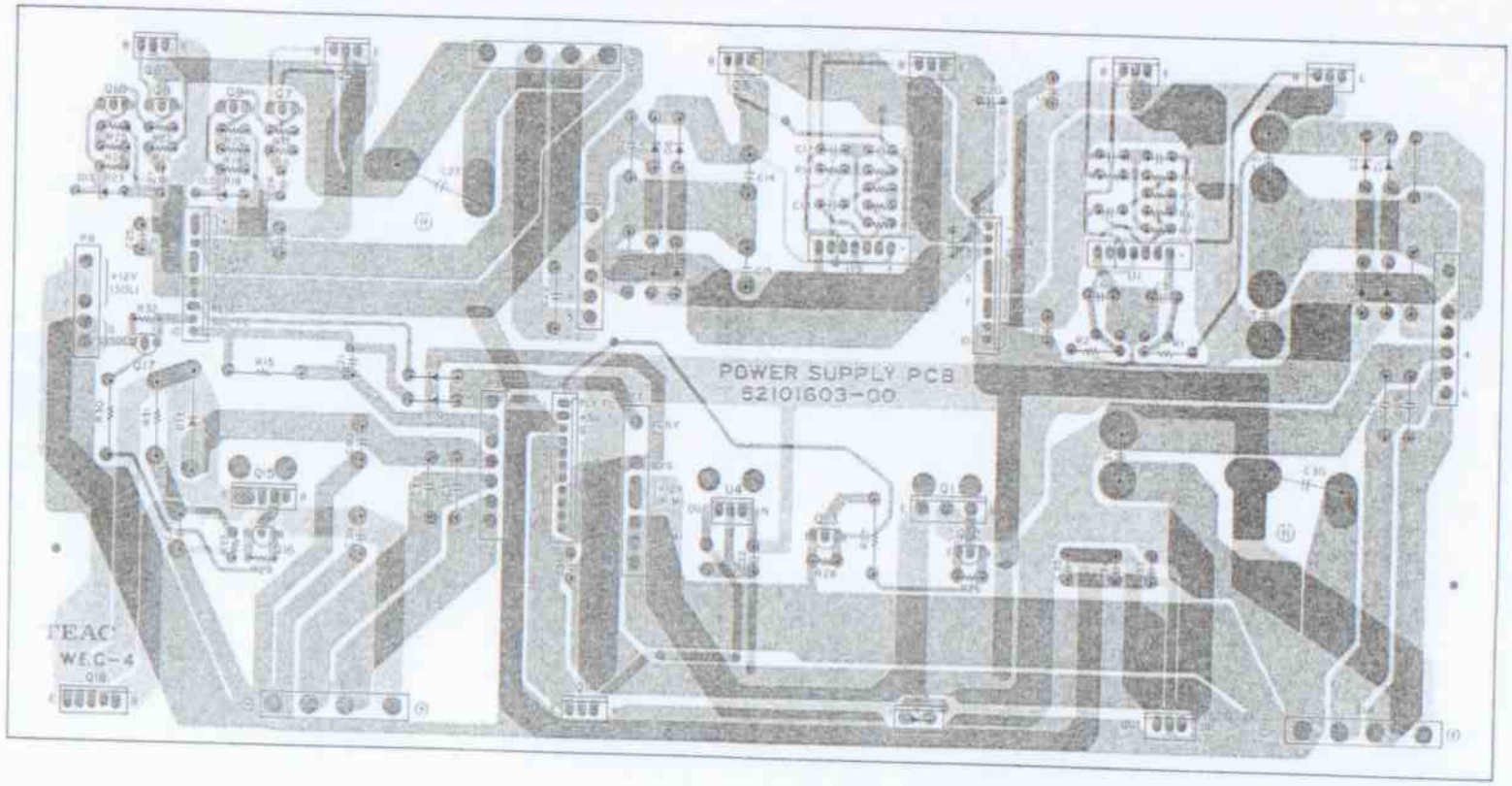
IN/OUT AMPL PCB ASS'y

REF. NO.	PARTS NO.	DESCRIPTION
	5200128820	PCB Assy
	5210128800	PCB
	IC's	
U011~U018	5220416600	NJM2041D-D
U021~U028	5220416600	NJM2041D-D
	TRANSISTORS	
Q011~Q018	5145151000	2SC 1815GR
Q021~Q028	5145150000	2SA-1015GR
Q031~Q038	5230773800	2SC 2655Y
Q041~Q048	5230014000	2SA-1020Y
Q051~Q058	5145151000	2SC-1915GR
Q061~Q068	5145150000	2SA-1015GR
Q071~Q078	5230773800	2SC 2655Y
Q081~Q088	5230014000	2SA-1020Y
	DIODES	
D011~D018	5224015300	MC931
D021~D028	5224015300	MC931
	CARBON RESISTORS	
	All resistor are rated ±5%, 1/5W and of carbon type unless otherwise noted.	
R011~R018	5241319900	5.1kΩ Metalized 1/4W
R021~R028	5241319900	5.1kΩ Metalized 1/4W
R031~R038	5241318800	1.8kΩ Metalized 1/4W
R041~R048	5241318800	1.8kΩ Metalized 1/4W
R051~R058	5240033620	180kΩ
R061~R068	5240032620	68kΩ
R091~R098	5240022420	56kΩ
R131~R138	5240029258	100Ω
R141~R148	5240031420	22kΩ
R151~R158	5240030620	10kΩ

REF. NO.	PARTS NO.	DESCRIPTION
R161~R168	5240030620	10kΩ
R171~R178	5240030820	12kΩ
R181~R188	5240031020	15kΩ
R191~R198	5240031020	15kΩ
R201~R208	5240029820	4.7kΩ
R211~R218	5240029820	4.7kΩ
R221~R228	5240028220	1kΩ
R231~R238	5240028220	1kΩ
R241~R248	5182546000	4.7Ω Nonflammable 1/4W
R251~R258	5182546000	4.7Ω Nonflammable 1/4W
R261~R268	5241320600	10kΩ, metalized 1/4W
R271~R278	5241320600	10kΩ, metalized 1/4W
R281~R288	5240030620	10kΩ
R291~R298	5240031020	15kΩ
R301~R308	5240031020	15kΩ
R311~R318	5240029820	4.7kΩ
R321~R328	5240029820	4.7kΩ
R331~R338	5240028220	1kΩ
R341~R348	5240028220	1kΩ
R351~R358	5182546000	4.7Ω Nonflammable 1/4W
R361~R368	5182546000	4.7Ω Nonflammable 1/4W
R371~R378	5183554000	10Ω Nonflammable 1/4W
R381~R388	5182554000	10Ω Nonflammable 1/4W
	CAPACITORS	
C011~C018	5260067050	Elec. B.P. 10μF 16V
C021~C028	5260067050	Elec. B.P. 10μF 16V
C061~C068	5172212000	Ceramic 100pF 50V
C071, C073	5260165252	Elec. 47μF 25V
C075, C077	5260165252	Elec. 47μF 25V
C082, C084	5260165252	Elec. 47μF 25V
C086, C088	5260165252	Elec. 47μF 25V
C091~C098	5260067050	Elec. B.P. 10μF 16V 20%
C101~C108	5260067050	Elec. B.P. 10μF 16V 20%
C111~C118	5172212000	Ceramic 100pF 50V 10%

REF. NO.	PARTS NO.	DESCRIPTION			
C121~C128	5172204000	Ceramic	22pF	50V	10%
C131~C138	5172204000	Ceramic	22pF	50V	10%
C141~C148	5260067050	Elec. B.P.	10μF	16V	20%
C151~C158	5172214000	Ceramic	150pF	50V	10%
C161~C168	5172204000	Ceramic	22pF	50V	10%
C171~C178	5172204000	Ceramic	22pF	50V	10%
C181~C188	5260067050	Elec. B.P.	10μF	16V	20%
C191~C198	5260067050	Elec. B.P.	10μF	16V	20%
C201, C203	5260165252	Elec.	47μF	25V	20%
C205, C207	5260165252	Elec.	47μF	25V	20%
C213, C214	5260165252	Elec.	47μF	25V	20%
C216, C218	5260165252	Elec.	47μF	25V	20%
C221~C228	5260067050	Elec. B.P.	10μF	16V	
	CONNECTOR PLUGS				
P1	5122184000	3P (BLK)			
P2	5336107300	3P (YEL)			
P011~P018	5122127000	3P (WHT)			
P021~P028	5122126000	3P (WHT)			
P041~P048	5122299000	2P (RED)			
P051~P058	5122300000	3P (RED)			
	MISCELLANEOUS				
S1~S8	5300908100	Switch, Slide 1.2N			
P021~P028	5336107300	Connector Plug, 3P (YEL)			
P031~P038	5122184000	Connector Plug, 3P (BLK)			
W012~W018	5181762000	Jumper P = 7.5			
W021~W028	5181761000	Jumper P = 5.0			
W031~W038	5181761000	Jumper P = 5.0			
W071~W078	5181761000	Jumper P = 5.0			

8.2.12. Power PCB Ass'y



POWER PCB Ass'y

REF. NO.	PARTS NO.	DESCRIPTION
	5200160300	PCB Assy
	5210160300	PCB
	IC'S	
U1, U2	5220416400	M5230L
U3	⚠5220415100	NJM7805A
U4	5220415600	NJM7815A
	TRANSISTORS	
Q1	⚠5145087000	2SD-313E
Q2	⚠5145129000	2SB-507E
Q3	⚠5145087000	2SD-313E
Q4	⚠5145129000	2SB-507E
Q5, Q6	⚠5145087000	2SD-313E
Q7, Q8	5230771000	2SC-2274K (E)
Q9, Q10	5145151000	2SC-1815GR
Q11	⚠5145165000	2SD-716 (O)
Q12	5230016000	2SA-950 (O)
Q13	5230771000	2SC-2274K (E)
Q14, Q15	⚠5145087000	2SD-313E
Q16	5230016000	2SA-950 (O)
Q17	5230771000	2SC-2274K (E)
Q18	⚠5145087000	2SD-313E
	DIODES	
D1~D10	⚠5143243000	ERB12-02G1
D11	⚠5228010000	D5SB20
D12, D13	5143154000	EQA01-06S, Zener
D14	⚠5228010000	D5SB20
D15	⚠5224016200	S5S4M
D16	⚠5228010000	D5SB20
D17	⚠5224014700	S3V20H
	RESISTOR	
	All resistor are rated ±5%, 1/5W and of carbon type unless otherwise noted.	
R1, R2	⚠5184237000	33Ω Nonflammable 1/4W
R5	5240031420	22kΩ
R6	5240029020	2.2kΩ
R7	5240029420	3.3kΩ
R8, R9	5240031020	15kΩ
R10	5240031820	33kΩ
R11	5240027220	390Ω
R12	5240029420	3.3kΩ
R13, R14	5240031020	15kΩ
R15	⚠5184755000	100Ω (1 W) Nonflammable
R16	5240030220	6.8kΩ
R17	5240030620	10kΩ
R18	5240029620	3.9kΩ
R19	5240031220	18kΩ
R20, R21	5240030220	6.8kΩ
R22	5240030620	10kΩ
R23	5240029620	3.9kΩ
R24	5240031220	18kΩ
R25	5240030200	6.8kΩ
R26	5240029420	3.3kΩ
R27	⚠5184763000	220Ω (1 W), Nonflammable
R28	5240032220	47kΩ
R29	5240029420	3.3kΩ
R30	⚠5184763000	220Ω (1 W), Nonflammable
R31	⚠5184688000	15Ω (1 W), Nonflammable

REF. NO.	PARTS NO.	DESCRIPTION
R32	5240032220	47kΩ
R33	5240029020	2.2kΩ
	CAPACITORS	
C1, C2	⚠5263164500	Metalized 0.047μF 250V
C3, C4	⚠5262001500	Elec. 4700μF 35V (B.K)
C5, C6	⚠5173047800	Elec. 100μF 35V
C7, C8	5260160550	Elec. 0.47μF 50V
C9~C11	5260165252	Elec. 47μF 25V
C12, C13	⚠5263164500	Metalized 0.047μF 250V
C14, C15	⚠5173090000	Elec. 2200μF 35V
C16, C17	5260160550	Elec. 0.47μF 50V
C18	5260166152	Elec. 100μF 25V
C19, C20	5260165252	Elec. 47μF 25V
C21	⚠5260166852	Elec. 220μF 10V
C22	⚠5263164500	Metalized 0.047μF 250V
C23	⚠5262001600	Elec. 4700μF 50V (B.K)
C24	5173047800	Elec. 100μF 35V
C25, C26	5173056800	Elec. 220μF 35V
C27	5173047800	Elec. 100μF 35V
C28, C29	5263164500	Metalized 0.047μF 250V
C30	5262006600	Elec. 6800μF 35V
C31	5262006500	Elec. 6800μF 25V
C32, C33	5172882000	Elec. 1μF 50V
C34	5054928500	Mylar 0.1μF
C35	5173071000	Elec. 470μF 10V
C36	5054928500	Mylar 0.1μF
C37, C38	⚠5273164500	Metalized 0.047μF 250V
C39	⚠5173084000	Elec. 1000μF 50V
C40	⚠5173094000	Elec. 3300μF 25V
C41	⚠5173090000	Elec. 2200μF 35V
	CONNECTOR PLUGS	
P1	5336172600	6P
P2	5336172500	5P
P3	5336172600	6P
P4, P5	5122134000	10P
P6	5122135000	11P
P7	5336172700	7P
P8	5336172400	4P
	MISCELLANEOUS	
	5033291000	Plate, Insulating (10 used)
	5033295000	Tube, Insulating (10 used)