INSTRUCTION MANUAL

MODEL 405-00

"TENTROL"

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INOVONICS
INCORPORATED

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I. GENERAL INFORMATION

TENTROL is a tape tension control kit which is active in the Record and Reproduce modes of a tape recorder. It may be used to control either the holdback or the takeup tension (or both), depending upon whether it is installed on the existing supply or takeup motors. TENTROL does not disturb the tape path, utilizing instead a tachometer that is attached to the reel motor.

When TENTROL is installed on the supply motor and adjusted for constant holdback tension, the following advantages are gained:

1. Speed and timing accuracy are improved because capstan slippage caused by excessive tension differential across the capstan is significantly reduced.
2. Pitch change from beginning to end of reel is eliminated since it is caused by change in tape length with tension variations.
3. Poor transport starting characteristics, caused by capstan slippage while the reel idler accelerates, can be eliminated by the reduction of excessive tension.
4. Head life can be increased by eliminating excessive tape tension.
5. High frequency response is improved through consistent head-to-tape pressure and through reduction of tape tracking, and consequent azimuth variations caused by tension changes.
6. In multi-channel recorders, phase shift variation from beginning to end of reel is improved through the improvement in tape tracking.

When TENTROL is installed on the takeup motor, the following advantages occur:

1. To accelerate heavy reels, TENTROL provides an initial torque boost which smoothly changes to a controlled tension.
2. TENTROL provides fast start capability with 14-inch reels at 30 ips tape speed.
3. TENTROL may be adjusted to produce a variable tension with pack diameter that is a compromise between constant torque and constant tension.

When TENTROL is installed on both reel motors, it can hold the tension differential across the capstan constant throughout the tape pack.

The Inovonics Model 405-00 TENTROL Kit consists of the following components:

1. Electronic Control Module - 6" long, 4½" wide, 2½" high.
2. Tachometer Assembly which mounts to the hub of the brake drum with setscrews.
3. Photocell Assembly with cable which mounts under existing screws on the transport brake housing.
4. Nine-wire Cable Assembly that is connected to the transport control circuitry and plugs into the TENTROL Control Module.
5. A Dummy Plug which allows bypass of TENTROL for service of the transport.

TENTROL SPECIFICATIONS

Applicable to:

Ampex Models 300, AG 300, 350, AG 350, 351, 354, AG 440, AG 440-8, AG 440B, 3200, 3300 and 3400 Duplicator Transports.

Tape Widths:

150-mil Cassette; quarter-, half-, and one-inch

Reel Sizes:

"Cine" (1-7/8" hub) through 14" with NAB hub

Nominal Constant Tension at Head:

Adjustable from 3 to 9 ounces within motor torque limits.* High tensions at the lower tape speeds will cause the motor to overheat unless forced ventilation is available. See page 16 for suggested tension limits.

Tension Variation Throughout Reel:

± ½ ounce

Maximum Torque Available:

85 % of maximum rated motor torque

Power Line Voltage:

Provided by tape transport

Power Line Frequency:

50 or 60 Hz.

Additional Features:

1. Adjustable starting torque for optimum starting characteristics.
2. Two tension adjustments allow for close matching of tension requirements to the motor characteristics and provide the capability of changing tension with pack size for special requirements.

3. A switch on the Control Module allows selection of constant torque operation for special requirements.

* Motor torque is usually insufficient to produce a 9 ounce constant tension with 14" reels.

II. INSTALLATION

Upon receipt of the equipment, inspect for shipping damage. Should any such damage be observed, notify the carrier at once; if not, proceed as outlined below. It is suggested that the original shipping carton and materials be saved should future reshipment become necessary.

2.1 Tachometer and Photocell Mounting

2.1.1 Slip the tachometer and hub over the transport brake drum hub and push all the way down, rotating as necessary so that the slot provides clearance for the brake drum roll pin. Tighten the three Allen set screws with a right-angle Allen wrench. If the transport is equipped with a clutch, such that the motor shaft turns independently from the brake drum in one direction, leave .005" to .010" clearance between the tach hub and the brake drum. It is not necessary to be concerned over slight eccentricities since they will not affect the performance of the system.

2.1.2 To mount the photocell assembly to the motor, loosen the two screws that hold the brake solenoid bracket to the brake housing. Slip the photocell assembly between the screw heads and the solenoid bracket. If a capacitor is mounted with these screws, slip the photocell assembly between the capacitor and the bracket. Adjust the height of the photocell assembly so the tach disc is roughly centered in the photocell. Check that the brakes are still in proper alignment and tighten the two screws.

2.2 Control Module Mounting

2.2.1 Prior to mounting, check the section on circuit connections to see if any circuit board strapping is required. Jumper terminals are provided to adapt the control module to a wide variety of tape transports. To obtain access to the jumper terminals, remove the perforated metal cover from the control module. The Model 405-00 is shipped with a strap between E3 and E4. This provides optimum tension linearity for holdback applications on Ampex transports. For high tension takeup applications, remove this jumper. The general rules for using terminals E3 and E4 are explained in the adjustment section. E5, E6 and E7 are associated with the transport reel size switch with the required jumpers called for under Circuit Connections. A jumper between E1 and E2 is advisable if the transport incorporates a slow start, where the capstan motor does not commence rotating until the PLAY button is depressed. This will hold a constant torque on the supply motor while the tape is coming up to speed, and will smoothly change to constant tension after several seconds.

2.2.2 The control module may be mounted in any convenient place where the adjustments are accessible; on the transport, console or rack. It may be mounted in any position; however, it should be remembered that the module may dissipate up to 25 watts with certain combinations of motors and tension adjustments. If high ambient temperatures are anticipated, it is recommended that the module be mounted with the heat sink fins vertical for maximum convection cooling.

2.3 Circuit Connections - Ampex Models 350, AG350, 351, 354

2.3.1 If small EIA plastic reels are to be used, remove the bottom cover of the control module and solder a jumper wire between terminals E5 and E7 on the printed circuit board.

2.3.2 Remove the cover of the transport control box. If TENTROL is to be installed on the holdback motor, cut the wire that goes from the rewind (holdback) tension resistor, R505, to the rewind relay, K504. If TENTROL is to be used for takeup, cut the wire going from the takeup tension resistor, R503, to the fast forward relay, K503.

2.3.3 Connect the ends of the wires of the nine-pin cable to the following points in the transport control box:

CABLE CONDUCTOR	CONNECT TO:		CONTROL FUNCTION
Brown	J501 (21 pin Jones)	Pin 10	Speed
Red	" " " "	Pin 16	AC Neutral
Orange	" " " "	Pin 6	+ Capst. Solenoid
Yellow	" " " "	Pin 7	- Capst. Solenoid
Green	" " " "	Pin 8	Reel Size Switch
Blue	" " " "	Pin 9	AC "Hot"
(If TENTROL is to be used for HOLDBACK):			
Grey	J506 (Rewind Motor Plug)	Pin 5 or 6	Motor "Hot"
(If TENTROL is to be used for TAKEUP):			
Grey	J505 (Takeup Motor Plug)	Pin 5 or 6	Motor "Hot"
Violet	Splice to wire removed from tension resistor in step 2.3.2		Bypass of TENTROL with Dummy Plug
White	Connect to tension resistor in place of wire removed in step 2.3.2		
Black	(no connection)		

2.4 Circuit Connections - Ampex Models AG440, AG440B

(REQUEST SPECIAL INSTRUCTIONS FOR 440-8)

2.4.1 If small EIA plastic reels are to be used, remove the bottom cover of the control module and solder a jumper wire between terminals E5 and E6 on the printed circuit board. Remove the cover of the transport control box and mount the tie point supplied under the sheet metal screw holding the shield to the power transformer. If small reels are to be used solder the 5.6K, 2 watt resistor supplied across the terminals of this tie point.

2.4.2 If TENTROL is to be installed on the holdback motor, identify the wire that goes from the holdback adjustment resistor, R604, to pin 2 of the rewind relay, K601. Cut this wire, connecting the resistor end to terminal 1 of the tie point installed in step 2.4.1. Connect the relay end of the wire to terminal 2 of the tie point. If TENTROL is to be installed on the takeup motor, cut the wire that goes from the takeup adjustment resistor, R605, to pin 2 of the fast forward relay, K604, and connect the resistor end to tie point terminal 1, relay end to terminal 2.

2.4.3 Connect the ends of the wires of the nine pin cable to the following points in the transport control box:
NOTE: If the Ampex 440 is equipped with a DC capstan servo, connect a 100K, ¼ watt resistor from J602 pin 1, to J602 pin 5. Any value from 75K to 180K will work.

CABLE CONDUCTOR	CONNECT TO:	CONTROL FUNCTION
Brown	J602 (Capst. Motor) Pin 1	Speed
Red	J602 " " Pin 6	AC Neutral
Orange	K602 (Play Relay) Pin 7	+ Capst. Solenoid

(continued)

Yellow	Neg. end C614 (150uF, 180V)	- Capst. Solenoid
Green	Term 2 of tie point (2.4.2)	Reel Size Switch
Blue	J606 (Pwr. Suppl. Conn.) Pin 2	AC "Hot"
(If TENTROL is to be used for HOLDBACK):		
Grey	J607 (Rewind Motor) Pin 2	Motor "Hot"
(If TENTROL is to be used for TAKEUP):		
Grey	J603 (Takeup Motor) Pin 2	Motor "Hot"
Violet	Term 2 of tie point (2.4.2)	Bypass of TENTROL with Dummy Plug
White	Term 1 of tie point "	
Black	(no connection)	

2.5 Circuit Connections - Ampex Models 300, AG300

2.5.1 In order to supply speed information to TENTROL, it is necessary to identify the correct point on the speed switch, S503. With Ashland drive motors, labeled B501 on the transport schematic, the correct point is the red motor wire which usually connects to a red wire on the speed switch. If in doubt, apply power to the transport, and using an AC voltmeter, locate the point that is directly connected to AC Neutral in high speed, but in low speed sits at the 117V "hot" potential through inactive motor windings.

2.5.2 If TENTROL is to be used on the holdback motor, remove the wire attached to the slider of the holdback adjustment resistor, R801 (nearest the top plate). If TENTROL is to be used on the takeup motor, remove the wire attached to the slider of the takeup adjustment resistor, R803 (farthest from the top plate).

2.5.3 Connect the ends of the nine pin cable to the following points in the transport control circuit:

CABLE CONDUCTOR	CONNECT TO:	CONTROL FUNCTION
Brown	Point selected in 2.5.1	Speed Switch
Red and Yellow	TS501 (Drive motor terminal strip) Terminal 1	AC Neutral and - Capst. Solenoid
Orange	TS501 Terminal 2	+ Capst. Solenoid
Green	(no connection)	
Blue (300)	TS501 Terminal 4	AC "Hot"
Blue (AG300)	Rear (input) terminal of F803 - Electronics fuse	" "
(If TENTROL is to be used for HOLDBACK):		
Grey	J807 Pin 5 or 6; or end term. of R801 (H'back res.)	Motor "Hot"
(If TENTROL is to be used for TAKEUP):		
Grey	J808 Pin 5 or 6; or end term. of R803 (T'up resis.)	Motor "Hot"
Violet	Splice to wire removed from slider of tension resistor in step 2.5.2	Bypass of TENTROL with Dummy Plug
White	Connect to slider of tension resistor in place of wire removed in step 2.5.2	
Black	(no connection)	

2.6 Circuit Connections - Ampex Models 3200, 3300, 3400 Duplicators

2.6.1 In order to supply speed information to TENTROL, it is necessary to identify the correct point on the speed switch, S503. With Ashland drive motors, labeled B501 on the transport schematic, the correct point is the red motor wire which usually connects to a red wire on the speed switch. If in doubt, apply power to the transport, and using an AC voltmeter, locate the point that is directly connected to AC Neutral in high speed, but in low speed sits at the 117V "hot" potential through inactive motor windings.

2.6.2 If TENTROL is to be installed on the holdback motor, remove the wire from the "swinger" of the holdback reel size switch, S807.

If TENTROL is to be installed on the takeup motor, identify the wire that goes from J805S Pin 3 to one of the "swingers" of the takeup reel size switch, S808. Remove all wires from this swinger.

2.6.3 Connect the ends of the nine pin cable to the following points in the transport control circuit:

CABLE CONDUCTOR	CONNECT TO:	CONTROL FUNCTION
Brown	Point selected in 2.6.3	Speed Switch
Red and Yellow	TS501 (Drive motor terminal strip) Terminal 1	AC Neutral and - Capst. Solenoid
Orange	TS501 Terminal 2	+ Capst. Solenoid
Green	(no connection)	
Blue	TS501 Terminal 4	AC "HOT"
(If TENTROL is to be used for HOLDBACK):		
Grey	J807 Pin 5 Or 6; or end terminal of R801 (Holdback resis.)	Motor "Hot"
(If TENTROL is to be used for TAKEUP):		
Grey	J808 Pin 5 or 6; or end terminal of R803 (Takeup resis.)	Motor "Hot"
Violet	Splice to wire removed from "swinger" of reel size switch in step 2.6.2	Bypass of TENTROL with Dummy Plug
White	Connect to "swinger" of reel size switch in place of wire removed in step 2.6.2	
Black	(no connection)	

NOTE: If the fast mode holdback tension is set too high (R802 shorted out), constant tension will not be achievable.

2.7 Circuit Connections - Modified Ampex or Ampex copies

2.7.1 TENTROL may be installed on any tape transport that uses a brake assembly similar to Ampex. The general rules for connecting the nine pin cable will be described.

2.7.2 Speed information - Brown wire: Follow paragraph 2.5.1

2.7.3 AC Neutral - Red wire: If there is switching in the AC Neutral line, connect to the AC Neutral that goes to the supply motor.

2.7.4 Capstan Solenoid "plus" (Orange wire) and Capstan Solenoid "minus" (Yellow wire): Connect these wires across the solenoid, observing polarity. If the solenoid operates at a voltage other that 130VDC (nominal), it will be necessary to change the value of R22 (presently 7.5K). Select a value of resistor that will pass 16 to 25mA of current. For example, if the solenoid voltage is 24V, a 560 or 680 ohm, ½W resistor will do.

2.7.5 117V AC "Hot" - Blue wire: If the Safety switch is located in the AC hot circuit, connect to the side of the switch that is off when the tape is not threaded.

2.7.6 Motor - Grey wire: Connect this wire directly to the AC hot line of the motor. Cut the wire that normally supplies power to the motor in the play mode. On many transports other circuit paths may feed power to the motor in play. One such circuit is the fast wind holdback circuit. Usually the torque supplied from the sources is negligable. If not, it may be necessary to disconnect these circuits in play.

III. ADJUSTMENT

3.1 General

CAUTION

TENTROL CIRCUITRY AND TEST POINTS 1, 2, AND 3 ARE CONNECTED TO THE AC POWER LINE. MAKE SURE THAT ANY TEST INSTRUMENTS USED ARE FREE FROM GROUND.

IN THE TESTING OF TENTROL, SOME TEST EQUIPMENT CHASSIS WILL BE AT POWER LINE POTENTIAL. SHOCK HAZARD WILL EXIST - TAKE EXTREME CARE!

3.1.1 The easiest method for adjusting Tentrol tape tensions is to use a tension meter such as the Tentel Model T2-H2O-MS (Tentel, 1210 Camden Ave., Campbell, CA. 95008). A DC voltmeter plus spring scale may also be used for tension adjustment. Both methods will be described. For holdback applications, we recommend the following tape tensions at the input to the head assembly: ¼" tape, 4 oz.; ½" tape, 6 oz.; 1" tape, 8 oz. These nominal tensions are none too critical and can be varied as much as ±2 oz. with no adverse effects. The important consideration for azimuth and speed stability is to keep the tension from beginning to end of reel as close as possible to the nominal selected. If you have a problem of slow speed during starting, the tension should be kept on the low side of nominal. If you have a problem with high frequency signal variation, the tension can be adjusted to the high side of nominal to increase the tape-to-head pressure. In takeup applications the tension selected is a matter of personal preference. For ¼" tape the maximum tension at the input to the takeup reel should be limited to 8 oz. Improved tape packing may result if the tension is adjusted to be a compromise between constant torque and constant tension so that the tension decreases somewhat as the reel pack gets larger.

CAUTION

The torque motor may overheat with high tension settings, continuous operation and poor transport ventilation. Absolute tension limits are difficult to establish due to differences in motors and effective cooling. In takeup applications where high tensions are normally used, it is advisable to use an external fan to cool the motor. In holdback applications the following maximum nominal input tensions at the head input for convection cooled tape transports are considered safe.

TAPE SPEED	10½ MAX REEL SIZE	14" MAX REEL SIZE
3-3/4 IPS	5 OZ	4 Oz
7 ½ IPS	6 Oz	5 Oz
15 IPS	7 Oz	6 Oz
30 to 120 IPS	8 Oz	7 Oz

If higher tensions are required or if the motor case temperature exceeds 90 c for class A insulated motors, external cooling should be installed.

3.1.2 There are four adjustments associated with the Tentrol kit: Tach Sensitivity R1, Empty Reel Tension R9, Full Reel Tension R16, and Start Torque R23. The Tach Sensitivity has been factory adjusted to match the photocell to the control module. The serial number of the control module appears on the photocell bracket. The Empty Reel Tension control affects the tension throughout the tape pack and must be readjusted should the speed pair of the transport be changed. The Full Reel Tension control will only be effective when the motor torque demand is high (full tape pack at medium tensions or at both ends of an NAB reel at tensions above 5 oz.). The Start Torque control adjusts the initial motor torque developed when entering play. It also adjusts the motor torque if the constant torque mode of operation is selected by placing the Run/Setup switch in the Setup position.

3.1.3 Jumper terminal E4, E3 and E2 are used to adjust an offset voltage which determines the minimum motor torque at the smallest diameter tape pack. In Ampex transports, the fast wind holdback resistor connects the two torque motors in the play mode as well as in the fast winding modes. This acts in the same manner as the Tentrol offset voltage and dictates less Tentrol offset for a given motor torque. The Model 405-00 Tentrol kit is therefore shipped with a jumper between terminals E3 and E4 to provide optimum tension linearity for most Ampex transports. If it is difficult to obtain constant tension, changing the offset voltage by changing the offset jumpers will improve the linearity. If the tension is too high with small diameter tape packs, less offset is needed so either increase the fast wind holdback resistance or jumper E4 to E2. If the tension is too high at the large diameter tape pack and cannot be reduced sufficiently with R16, more offset voltage is needed so remove the jumper between E3 and E4.

3.2 Verification of Installation

3.2.1 Install the Dummy Plug supplied for bypassing the Tentrol kit. The Dummy Plug connects to the end of the nine-pin cable attached to the transport circuitry. Check that the transports performs normally in all operating modes.

3.2.2 Connect the nine-pin cable and the tachometer cable to the Tentrol control module. Place the Run/Setup switch in Setup. The setup torque (adjusted by R23) is factory adjusted to be approximately 5 oz. measured at the NAB hub diameter. Again check that the transports functions normally in all modes.

3.3 Adjustment Using a Tension Gauge

3.3.1 Thread a 10½" or 14" reel of tape on the transport. Place the reel size switches in the large reel position. Either speed

may be selected. Make sure the tension gauge is calibrated for the tape being used. Fast wind the tape such that only ½" of tape remains on the supply reel. Make sure the Full Reel Tension control R16 is full clockwise. Place the Run/Setup switch in Run. Start the transport in play and after the reel idler comes up to speed, insert the tension gauge between the reel idler and the head assembly. Make sure the tape touches all three prongs of the gauge. If the tension gauge will not fit, remove the head assembly for this adjustment. Adjust the Empty Reel Tension control R9 for the nominal tension desired.

3.3.2 Fast wind the tape until the full pack is on the supply reel. Start the tape in play and if the tension is higher than nominal, reduce it to nominal by turning the Full Reel Tension control R16 counter clockwise. If adjusting for a nominal tension greater than 5 oz., this reduction may also reduce the tension at the end of the reel. Fast wind to the end of the reel and readjust R9. Work back and forth until optimum linearity is achieved.

3.3.3 Spot check the tensions at several places between minimum and maximum tape packs. Always make sure that tensions are measured with the reel idler coupled to the tape. Always wait at least five seconds after pressing play since it can take that long for Tentrol to change from the constant torque start to the constant tension run condition. If small EIA reels will be used, check the tension at various spots on the small reel. If the tape type is not the same on the small reel, check the calibration of the tension gauge. Up to this point all tension measurements were made with both reel switches in the large reel position. Movement of the holdback reel size switch has no effect on the holdback tension; however, change of the takeup reel size switch from large to small will cause a slight reduction in holdback tension. This is caused by the fact that the fast winding holdback resistor is connected be-

tween the two motors in the play mode as well as in the fast winding modes. Since the takeup reel size switch changes the voltage to the takeup motor, this change is fed to the holdback motor through the fast winding resistor and changes the holdback motor voltage slightly. Normally this change will not exceed ½ oz. The effect may be minimized by increasing the small reel takeup tension to 4 oz. measured on an NAB hub, and reducing the fast winding holdback torque if it is adjustable.

3.3.4 Start Torque adjustment. The starting torque cannot be stated to be optimum at a given number of ounces. It will vary with the mounting style and the spring tensions in the tape idler arms. It should be kept low to avoid capstan slippage during reel idler acceleration, but if too low, the tape will bounce off the heads during start. Five to six ounces measured with a spring scale on an NAB hub with the selector switch in Setup is a good starting point. The best method for making this adjustment is to reproduce a pre-recorded tape and adjust R23 for the best sounding starts. Make sure to check both ends of the reel. When Tentrol is used on takeup, the starting torque is normally set high to minimize the loop thrown at the takeup tension arm. Again, a listening test is the best aid in adjustment.

3.4 Adjustment Using a Spring Scale and a DC Voltmeter

3.4.1 In this method of adjusting tension, the DC control voltage required to produce the desired motor torque for two reel diameters is determined by static test, and then programmed into the unit as it operates in the play mode. Since there is a buildup of tension around the reel idler tape guide, the tension at the supply reel will not be the same as the head input tension. The tension buildup depends upon the wrap around the tape guide which will vary with the absolute tension, reel idler spring tension, and mounting of transport. At low absolute tensions it also varies with pack diameter.

TABLE I charts the holdback motor torque in ounces at the NAB hub diameter of 4½" for two tape pack diameters and for several nominal constant tape tensions.

TABLE I HOLDBACK MOTOR TORQUE REQUIREMENTS

PACK DIA.	NOMINAL HOLDBACK TENSION AT HEAD INPUT 4 oz.	5 oz.	6 oz.	8 oz.	
5 inch	3.5	4.5	5.5	7.5	MOTOR TORQUE IN OZ. AT NAB 4½" HUB WITH SPRING SCALE
9 inch	6.0	7.7	9.5	13.0	

When setting up TAKEUP torque requirements at the input to the takeup reel, TABLE I is not required. The torque required at the NAB hub diameter of 4½" can be easily calculated as the nominal tension desired times the pack diameter in inches, divided by 4½ (inches).

3.4.2 Attach an NAB hub to the spring scale using twine and place on the supply turntable.

3.4.3 Connect a DC voltmeter to TP2 (positive) and TP3 (negative). CAUTION: THE TEST LEADS OF THIS METER WILL NOW BE AT POWER LINE POTENTIAL.

3.4.4 Place the selector switch to the Setup position. Set the Full Reel Tension control R16 to the full clockwise position.

3.4.5 Tape the Takeup Tension arm to enable the transport.

3.4.6 Using TABLE I, select the torque that corresponds with the desired nominal tension and the 5 inch pack diameter. Start the transport in play. Hold the spring scale stationary. Adjust the Start Torque control R23 to produce this reading on the spring scale. Record the reading of the DC voltmeter.

3.4.7 Repeat this procedure, setting the torque that corresponds with the 9 inch pack diameter and record the voltmeter reading.

3.4.8 Remove the spring scale. Mark the 5" and 9" pack diameters on a full NAB reel of tape. Thread this on the transport. Place the selector switch in the Run position.

3.4.9 Fast wind to the 5" diameter mark. Start the tape in play at either tape speed. Adjust the Empty Reel Tension control R9 to give the DC voltage reading for the 5" pack.

3.4.10 Fast wind to the 9" mark. Start the tape and adjust the Full Reel Tension control R16 to give the DC voltage reading for the 9" pack.

3.4.11 When setting for 6 or 8 oz. nominal tensions, recheck the 5" pack voltmeter reading and readjust the Empty Reel Tension control R9 as required. Then recheck the 9" reading, working back and forth until the curve is matched.

3.4.12 Remove the voltmeter. Adjust the Start Torque control as described in paragraph 3.3.4.

3.5 Tachometer Sensitivity Adjustment (R1)

3.5.1 This is a factory adjustment that matches the photocell characteristics to the Control Module, and need be readjusted only when a photocell is replaced. The serial number of the Control Module also appears on the photocell bracket to assure correct assembly when multiple kits are being installed. An oscilloscope is required for this adjustment.

3.5.2 Connect an oscilloscope to TP-1 and TP-3, common to TP-3. CAUTION: MAKE SURE THAT THE 'SCOPE IS UNGROUNDED SINCE THESE TEST POINTS ARE AT POWER LINE POTENTIAL. THE 'SCOPE HOUSING MAY ALSO BE

AT POWER LINE POTENTIAL AND MUST NOT BE TOUCHED SIMULTANEOUSLY WITH ANY GROUNDED OBJECT.

3.5.3 Place the Tentrol Run - Setup switch in Run. Select the low tape speed of the transport. Start the transport in the play mode.

3.5.4 Adjust R1 until a sawtooth wave appears. Fine-adjust R1 so that the amplitude of adjacent pulses are approximately equal in peak-to-peak amplitude (variation less than 20%).

3.6 Application Notes

3.6.1 To obtain tensions lower than 3 ounces at the head for cassette tape, it is necessary to disconnect the fast wind holdback resistor when in play mode. On duplicator transports the Play-Rewind-Fast forward mode selector may be used to break this holdback circuit.

IV. OPERATIONAL AND FUNCTIONAL DESCRIPTION

4.1 TENTROL Operation

There are no operating controls or procedures required when using TENTROL. Once adjusted, TENTROL will control the Record/Play mode tape tension to the desired tension-tape pack characteristics determined during the adjustment procedure. The holdback reel size switch will have no affect on the play holdback tension when operating in the Run position. It will still be active in fast wind. It also reduces the Tentrol start torque in the small reel position. Variations in line voltage and temperature will have some effect upon absolute tension, but will have only minor effect on tension consistency throughout a reel. A ±10% variation in line voltage will normally produce less than ½ ounce change in tension with nominal tensions of 6 ounces or less. At higher tension the absolute tension will become proportional to the line voltage change. The largest variable in maintaining constant holdback tension at the head input is the wrap around the reel idler tape guide. If there is any sticktion in the tape guide arm, the arm can choose various wrap angles for the same pack diameter, causing a tension change at the head input. This effect is only noticable with low nominal tensions, and is normally less than ½-ounce. If the sticktion should be severe, disassemble and clean the reel idler assembly.

TENTROL will only maintain constant tension when the tape speed is constant. If the transport is operated in a variable speed mode, the tension will be inversely proportional to the tape speed such that a 20% increase in speed will result in a 20% reduction in tension. If speed changes in excess of 20% are anticipated, two options are available. One is to bypass TENTROL by removing the nine-pin cable from the Control Module and installing the Dummy Plug in the cable connector. The other method is to change the

RUN-SETUP switch to the Setup position. This will operate the transport in a constant torque mode regardless of tape speed or pack diameter. The torque desired can be adjusted with the Start Torque control, R23.

4.2 Functional Description

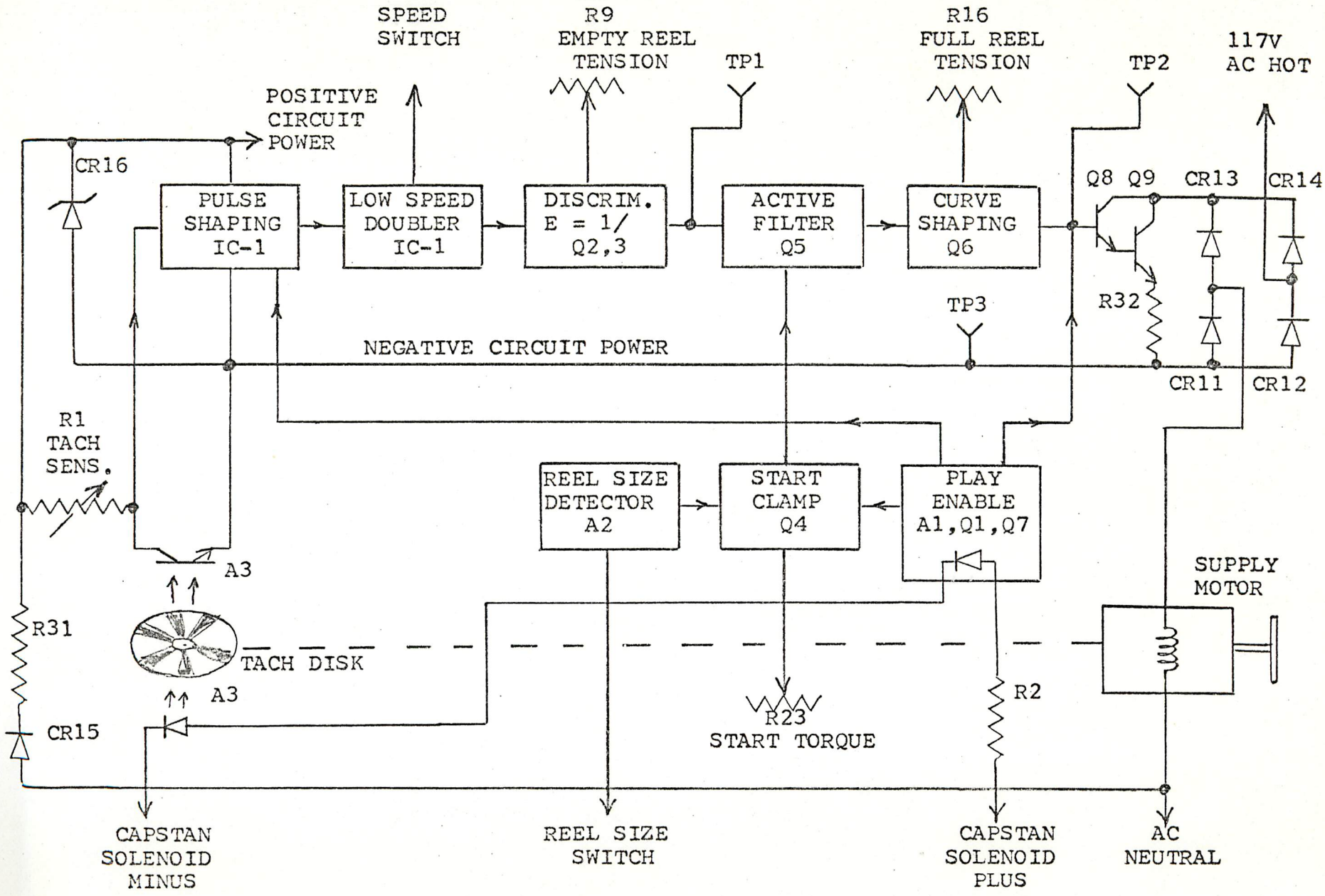
The TENTROL tension control system operates on the principle that the rotational velocity of the reel is inversely proportional to the diameter of the tape pack when the tape is traveling at a constant linear velocity. The reel velocity information is converted to a voltage which controls the power of the reel motor so that the motor torque is proportional to the reel pack diameter. Thus doubling the pack diameter will double the motor torque to produce a constant tension in the tape. Since TENTROL is an open-loop control system, there is no possibility of instability. The torque may be adjusted to produce constant tension for holdback applications, or a compromise between constant tension and constant torque for takeup applications.

Referring to the block diagram at the end of this section, the power for the control circuitry is obtained from the AC power line through CR15, R31, CR16, and CR12. The power amplifier Q8 and Q9 is held off by the play enable circuit and will only be activated when power is applied to the capstan solenoid. The power for the motor is obtained from the AC power line through the diode-bridge/transistor-power amplifier.

R1 controls the sensitivity of the photocell in the tachometer assembly to produce a square waveform from the rotating tach disc. Pulses are then formed and fed to the discriminator. In low tape speed operation, the tachometer frequency is doubled so that the pulse frequency at a given pack diameter is the same at both tape speeds. The discriminator produces a sawtooth waveform whose volt-

age is inversely proportional to the reel velocity. When the tape is started, the output of the discriminator is clamped to a selectable voltage to produce an initial starting torque adjustable from zero to full motor torque. The initial starting torque will smoothly change to constant tension in approximately four seconds. Selection of the small reel position of the holdback reel size switch will reduce the starting torque but have no effect on the control-tension. In the Setup position of the RUN-SETUP switch, the adjusted starting torque is applied to the motor regardless of pack diameter. This is used for measuring start torque and for making tension adjustments with a spring scale. The Setup position of the switch may also be used to change the operating mode from constant tension to constant torque, as previously described.

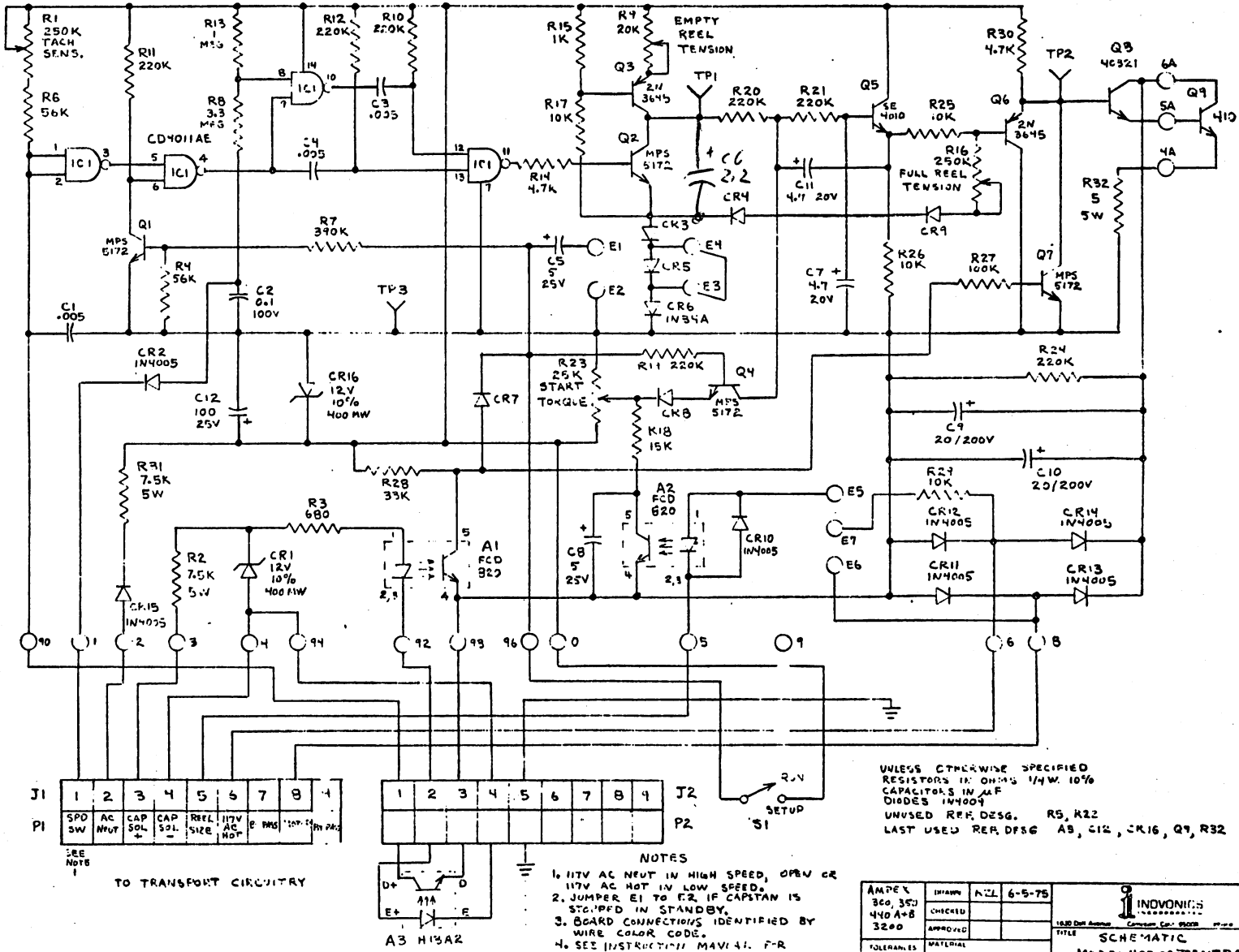
The sawtooth wave is filtered to remove the carrier frequency, and passed through an adjustable curve-shaping circuit which allows close matching of tension requirements to the motor torque characteristics. The empty reel tension control adjusts the gain of the discriminator and is used to adjust tension for the various speed pairs. The full reel tension control adjusts the degree of curve shaping to match the motor characteristics. The output of the curve shaping circuit is fed to the base of the power amplifier to control the AC voltage applied to the motor.


SPEED SWITCH
R9 EMPTY REEL TENSION
TP1
R16 FULL REEL TENSION
TP2
117V AC HOT
POSITIVE CIRCUIT POWER
CR16
PULSE SHAPING IC-1
LOW SPEED DOUBLER IC-1
DISCRIM. E = 1/ Q2,3
ACTIVE FILTER Q5
CURVE SHAPING Q6
Q8 Q9
CR13
CR14
R32
TP3
NEGATIVE CIRCUIT POWER
CR11
CR12
R1 TACH SENS.
A3
REEL SIZE DETECTOR A2
START CLAMP Q4
PLAY ENABLE A1,Q1,Q7
SUPPLY MOTOR
R31
TACH DISK
A3
R23 START TORQUE
R2
CR15
CAPSTAN SOLENOID MINUS
REEL SIZE SWITCH
CAPSTAN SOLENOID PLUS
AC NEUTRAL

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
	129500	PC BOARD ASS'Y (Schematic 130500)		
A1,2	1307	Optical Coupler	Fairchild	FCD 820
C1,3,4	1064	Capacitor, .005 uF 500V Ceramic	Sprague	5GA D50
C2	0867	" 0.1 uF 100V Mylar	Sprague	225P10491
C5,8	0901	" 5 uF 25V Electrolytic	Sprague	TE 1202
C6	1053	" 2.2 uF 20V Tantalum	Matsuo	DTSA12002225M
C7,11	1054	" 4.7 uF 20V Tantalum	Matsuo	DTSA22002475M
C9,10	0916	" 20 uF 200V Electrolytic	Sprague	TE 1442.1
C12	0907	" 100 uF 25V Electrolytic	Sprague	TE 1211
CR1,16	1105	Diode, Zener 12V 400mw 10%		1N5242
CR2,10-15	1125	Diode, Silicon, 600V 1A		1N4005
CR3-5,7-9	1100	Diode, Silicon		1N4009
CR6	1106	Diode, Germanium		1N34A or 1N270
IC1	1306	Integrated Circuit, C-MOS	RCA	CD4011AE
Q1,2,4,7	1219	Transistor, NPN, MPS5172	Motorola	
Q3,6	1205	" PNP, 2N3645	National	
Q5	1210	" NPN, SE4010	Fairchild	
Q8	1216	" NPN, 40321	RCA	
R1,16	0570	Resistor, Variable, 250K	CTS	X201R254B
R2,31	0675	" 5W 10% 7.5K		
R3	0159	" ¼W 10% 680 ohm		

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
R4,6	0182	Resistor ¼W 10% 56K		
R7	0192	" " 390K		
R8	0203	" " 3.3 Meg		
R9	0511	" Variable, 20K	Beckman/Hel	89PR20K
R10-12,19-21, 24	0189	" ¼W 10% 220K		
R13	0197	" " 1 Meg		
R14,30	0169	" " 4.7K		
R15	0161	" " 1K		
R17,25,26,29	0173	" " 10K		
R18	0175	" " 15K		
R23	0569	" Variable, 25K	CTS	X201R253B
R27	0185	" ¼W 10% 100K		
R28	0179	" " 33K		
R32	0674	" 5W 10% 5 ohm		
TP1,2,3	1772	Test Point	H.H.Smith	325-102 Red
	129600	CONTROL MODULE ASS'Y (Schematic 130500)		
J1	1675	Connector, 9-pin female shell	Molex	03-06-2091
	1677	Pin, female	Molex	02-06-1103
J2	1676	Connector, 9-pin male shell	Molex	03-06-1091
	1678	Pin, male	Molex	02-06-2103
Q9	1217	Transistor NPN, POwer	RCA	410
	2603	Insulating Cap for Q9	Jermyn	A22-2003

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
S1	1816	Switch, SPDT Slide	H.H.Smith	516
	121800	PHOTOCELL ASSY (Schematic 130500)		
A3	1308	Optical Coupler	GE	H13A2
P2	1675	Connector, 9-pin female shell	Molex	03-06-1091
	1677	Pin, female	Molex	02-06-1103
	121900	NINE PIN CABLE ASS'Y		
P1	1676	Connector 9-pin, male shell	Molex	03-06-1091
	1678	Pin, male	Molex	02-06-2103
	130000	DUMMY PLUG ASS'Y		
	1675	Connector, 9-pin female shell	Molex	03-06-2091
	1677	Pin, female	Molex	02-06-1103
	122100	TACH DISK ASS'Y (Standard, for .718" drum hub dia.)		
	122101	TACH DISK ASS'Y (Special for .750" drum hub dia.)		
	122200	Tachometer Disk		
	120600	Hub (.718" drum hub)		
	120601	Hub (.750" drum hub)		



UNLESS OTHERWISE SPECIFIED
RESISTORS IN OHMS 1/4 W. 10%
CAPACITORS IN μF
DIODES IN4004
UNUSED REF. DESG. R5, R22
LAST USED REF. DESG. A3, C12, CR16, Q9, R32

NOTES
1. 117V AC NEUT IN HIGH SPEED, OPEN OR 117V AC HOT IN LOW SPEED.
2. JUMPER E1 TO E2 IF CAPSTAN IS STRIPPED IN STANDBY.
3. BOARD CONNECTIONS IDENTIFIED BY WIRE COLOR CODE.
4. SEE INSTRUCTION MANUAL FOR JUMPER INFORMATION

AMPEX 350, 351, 440 A+B, 3200	DRAWN	M.L.	6-5-75
	CHECKED		
	APPROVED		
TOLERANCES	MATERIAL		
FINISH			

INDIVONICS
TITLE: SCHEMATIC MODEL 405-00 TENTROL
PAGE OF
DRG NO 130500