DTC-1200

DIGITAL TRANSPORT CONTROLLER

AMPEX MM-1200 UPGRADE

Installation Guide

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1 INTRODUCTION

Thank you for purchasing your new DTC-1200 digital transport controller for Ampex MM-1200 studio recorders! All controller cards are tested individually prior to shipping. Before installing the card, please read this document thoroughly and retain it for future reference. Additional copies of this manual are available upon request or may be downloaded from our website at http://www.rtzaudio.com.

All items are carefully packed to endure the rigors of shipping and handling. However, please inspect all contents and packaging immediately upon receipt. Please report any problems to us immediately. In the event of damage, retain all shipping and packaging materials for shipper damage claims inspection.

1.1 DESCRIPTION

The DTC-1200 is a digital servo loop and transport logic controller designed around the latest 32-bit advanced ARM microprocessor technology. The DTC-1200 controller uses a Tiva TM4C123AE6PM 32-bit M4 ARM processor by Texas Instruments[1] that is designed for use in advanced motion control system applications. A precision dual 12-bit DAC was also added to allow fine torque control of both reel motors under microprocessor servo loop control.

The transport controller firmware runs under Texas Instruments TI-RTOS operating system. TI-RTOS brings true multi-threaded real-time programming power to ARM embedded systems. The controller source code is written entirely in the standard C programming language. A transport servo loop task runs at highest priority and manages all tape transport servo and user mode handling.

1.2 OVERVIEW

Several wiring and mechanical modifications are required to use the DTC-1200 transport controller in the MM-1200. Please read this manual completely and perform all necessary modifications prior to installing the DTC-1200 card in your machine. Failure to perform the required modifications will result in improper operation and/or possible damage to the DC-1200 card and/or your machine.

The DTC-1200 requires tachometer pulses from the tape timer/counter roller assembly. This tape roller tachometer data provides tape speed information to the microcontroller's real-time operating system as tape moves across the transport. The new controller relies on tape speed information for proper operation and servo loop control. The DTC-1200 controller will not function correctly without this tape speed tachometer data.

The original Ampex transport controller sources it's +5V power from a crude Zener diode regulator on the capstan servo card. The original controller was mostly powered from +15V logic and the +5V it did use required very little current. However, the new DTC-1200 controller requires around 200mA current and this is far more than the Zener regulator can provide without major overheating.

Luckily, the main system +5V power rail is available on the timer/counter card edge connector. Originally this 1.5A capable +5V supply was used mainly to power the remote tape counter display. Now we will dedicate the main system +5V regulator for use by the RTZ DTC-1200 transport controller and the STC-1200 timer/counter/locator card.

Another pair of spare connector pins on the transport controller edge connector and the timer/counter edge connector are wired together so the DTC-1200 and STC-1200 cards can communicate to each other via a high-speed RS-232 serial bus. These new signal wires between the edge connectors are simply passive connections between the two edge connectors.

[1] Texas Instruments is a legal trademark of Texas Instruments Corporation.

2 INSTALLATION TIPS

The following tips may help with installation and modifications required to install the DTC-1200 controller. In general, all systems need to be in proper working order for the transport controller to function properly. Please refer to the Ampex MM-1200 owner's manual for additional maintenance and adjustment procedures.

2.1 BRAKE MAINTENANCE

When removing and reinstalling the brake housings the brake solenoid should be pushed in and held in place using string, wire or a cable tie so the brake band is free from the brake hub. With the brake band engaged, reinstalling the housing is difficult and damage to the brake band lining may occur. A thorough cleaning of the brake system should be done at this time. Remove all dust and a wipe down with alcohol on the hub and inside of the housing. A business card or card stock soaked in alcohol can be used to clean the space between brake band and the housing. Gunk in that space can prevent the band from expanding fully when the brakes are off and brake rub can result. The brake lining should be wiped dry- solvents or water may disturb the lining. Emery cloth can be used if the surface needs smoothing.

The brake solenoid plunger and tube should be cleaned and lubed at this time. The snap ring on the plunger linkage needs to be removed to free the pin. Mark the plunger stop bracket position and remove it to free the plunger. The plunger and tube should be cleaned with alcohol to remove the dried grease and gunk buildup. Be very careful to not damage the rubber o ring on the end of the plunger. This ring should be wiped lightly once with alcohol and quickly dried. The plunger can be lubed with a light weight bearing grease but silicone "fader grease" is best. The silicone grease will protect the o ring as well. Only a very small amount of grease should be used. The solenoid should have a moderately damped action when reassembled but not totally free movement.

When working on the motor assembly it is advised to not stand the motor up on the reel hold down. Lay the motor on its side being careful not to pinch the solenoid wires. Standing the motor up on the reel hold-down risks damage to the motor bearings, hold down assembly and shaft. On their sides, the assemblies are easy to work on and the shaft spins freely.

2.2 CARD CAGE ACCESS

The card cage mods require the meter panel to be lowered. Unbolt the four slide bushings being careful to note how they are assembled to aid in re-assembly. Use wire, string or long cable ties going from the bushing holes on the brackets to the bushing holes on the panel to suspend the panel at 90 degrees facing down and away from the card cage being careful to not put undue stress on the wiring. The remote and remote shelf need to be removed as well as the power switch bracket and spacer to the right of the cage.

Remove the left side panel from the machine to gain access and remove the card cage. Multi-pin connector J5 (the connector nearest the cage) must disconnected from the rear and the panel mount connector dismounted by squeezing the retainers from the rear and pushing it out to free the harness so the bottom of the cage can be easily accessed.

Remove the card cage cover door and the power switch bracket/assembly. You'll need to reach inside the left side of the machine to access the screws hold the card cage and other fasteners. Be careful not to drop any screws or nuts inside the machine. You may need to remove clamps holding the wiring harness to the frame for more flexibility. Remove the card cage screws and carefully rotate the cage around till you can access the connectors pins and wiring.

3 REQUIRED WIRING MODIFICATIONS

Table 1 below describes the pinout of the MM-1200 transport controller edge connector J1 in the machine. Note that bold red text indicates the edge connector pins that require modifications or wiring changes. Note that pins F, H and Y are new signals from the other cards. The +5V power input on pins 4 and D will be changed from the capstan servo card +5V regulator and moved to the main system +5V power rail available on the timer/counter card edge connectors. Each modification is described in detail in the following sections.

Table 1 – J1 Transport Controller Edge Connector Pinout

Pin	Description	Pin	Description
1	+39V	A	+39V
2	+27V	B	+27V
3	+15V	C	+15V
4	**+5V**	**D**	**+5V**
5	TAPE SELECT (0=2")	E	HI EQ ENABLE
6	TENSION SENSOR	**F**	**RS232 TX TO STC-1200**
7	SUPPLY ERROR SIGNAL	**H**	**RS232 RX FROM STC-1200**
8	TENSION SENSOR	J	---
9	LOW EQ ENABLE	K	REC INDICATOR
10	PLAY INDICATOR	L	CAPSTAN SERVO ENABLE
11	HI SPEED DISABLE	M	----
12	LO SPEED DISABLE	N	LO SPEED SELECT
13	HI SPEED SELECT	P	---
14	GND	R	GND
15	GND	S	GND
16	PINCH ROLLER SOLENOID	T	----
17	---	U	TAPE LIFTER SOLENOID
18	REC PULSE	V	REC HOLD
19	BRAKE SOLENOID	W	TAPE OUT SWITCH
20	LIFT DEFEAT BUTTON	X	MOTION SENSE (0=FWD)
21	REC BUTTON	**Y**	**TACH IN FROM TMR/CTR CARD**
22	REC BUTTON	Z	FWD BUTTON
23	STOP BUTTON	AA	FWD BUTTON
24	STOP BUTTON	BB	MOTION SENSE (0=REW)
25	REW BUTTON	CC	REW BUTTON
26	PLAY BUTTON	DD	STOP INDICATOR
27	PLAY BUTTON	EE	FWD INDICATOR
28	TAKEUP ERROR SIGNAL	FF	REW INDICATOR

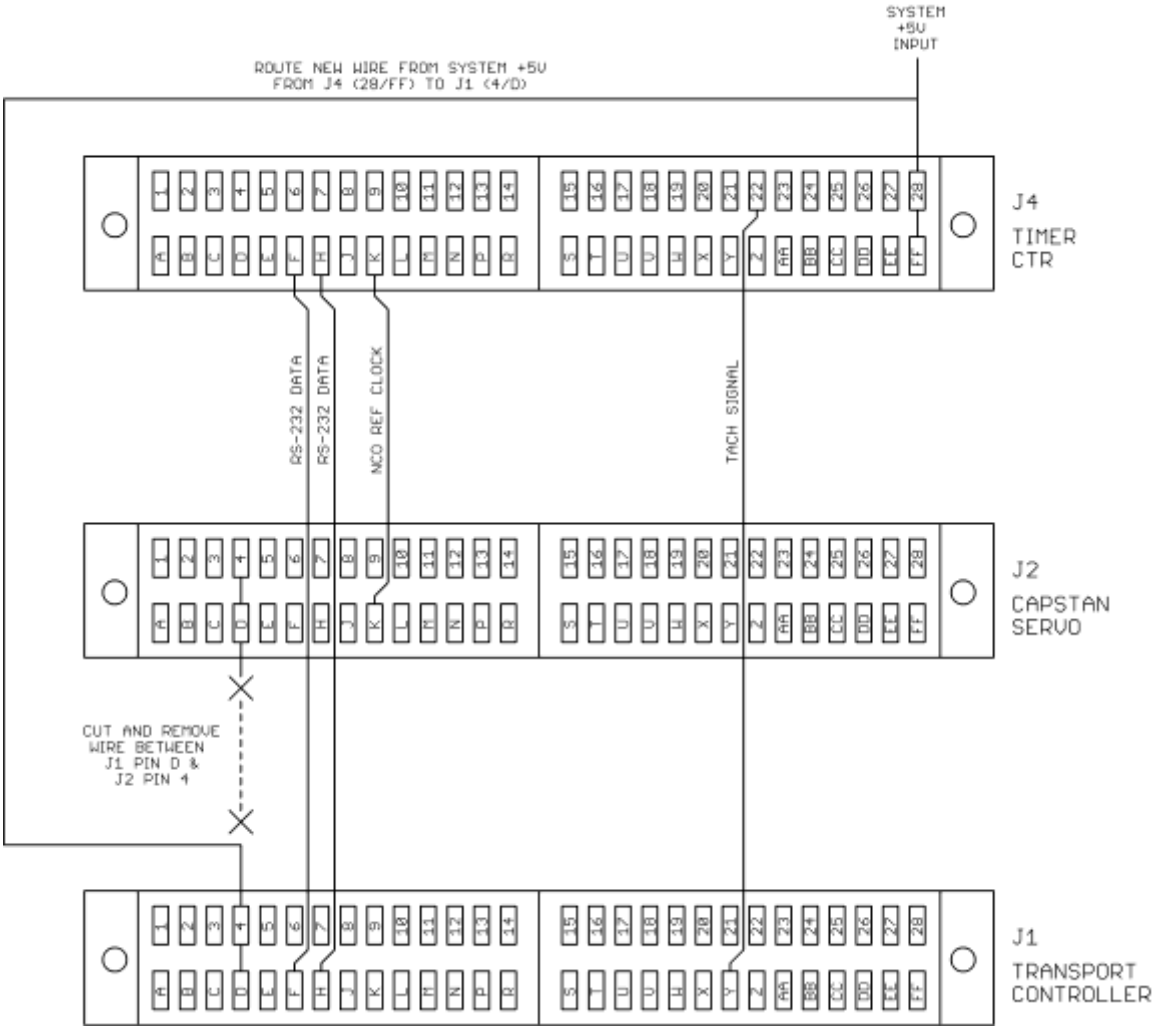
3.1 WIRING CHANGE MODIFICATIONS

The diagram below illustrates the transport controller card cage connectors and wiring changes. The RS-232, TACH and NCO REF signal wires are added to unused pins of the existing edge connectors. The +5V power change requires removing the wire between J1 pins 4/D and J2 pins 4/D.

You must route a new +5V power wire from J1 pins 4/D over to J4 pins 28/FF. Figure 1 below illustrates the wiring changes as viewed looking down into the card cage from the top of the machine.

You will need to remove the entire card cage assembly to gain access to the edge connectors on the underside. This can be done by removing the left side panel from the machine and reaching inside to access mounting and cable harness holder screws.

Figure 1 – Required Wiring Change Modifications



(REAR VIEW OF CONNECTORS SHOWN)

3.2 CHANGE TRANSPORT CONTROLLER CARD +5V POWER SOURCE

The +5V power to the transport controller card slot J1 is currently provided by a zener diode regulator located on the capstan servo card in the original Ampex design. This crude regulator does not have enough current capability to drive the DTC-1200 without overheating. The new transport controller card draws around 220mA current in normal operation.

The 5V wiring to J1 must be moved to the main system 5V regulator instead. The 1200 card cage connector slots are ordered front to back, with J1 being in the first slot closest to the front face of the machine as listed below.

J4 = Search/Timer/Counter Card (rear cage slot)
J2 = Capstan Servo Card (middle cage slot)
J1 = Transport Controller Card (front cage slot)

The following steps describes the +5V wiring changes. Afterward, the transport controller card will then receive+5V power from main system +5V supply rather than the Zener regulator on the capstan servo card.

3.2.1 EDGE CONNECTOR WIRING CHANGES

1) Before making any wiring changes, confirm the +5V voltages at J1 pins 4/D and J4 pins 28/FF with a voltmeter and then power down the machine.

2) Disconnect the +5V wire at edge connector J2 pins 4/D (capstan servo card connector) and move this wire to J4 pins 28/FF (search-to-cue edge connector) instead.

3) Remove the capstan servo card, temporarily power up the machine and verify that transport controller edge connector J1 pins 4/D have system +5V available.

This completes the +5V power source modifications. The transport controller card slot connector should now be provided +5V from the main system +5V regulator instead.

3.3 ADD TACHOMTER SIGNAL FROM TAPE ROLLER

The MM-1200 generates a tape roller tachometer signal on J4 pin 22 of the search-to-cue timer/counter card. Unfortunately, this signal is not routed to the transport controller card slot in the original Ampex card cage design. The DTC-1200 requires this tachometer signal in order to monitor tape path speed. We must add a wire between edge connectors J1 and J4 to route the tape roller tachometer signal to the DTC-1200's microprocessor.

J4 = Search/Timer/Counter Card (rear cage slot)
J2 = Capstan Servo Card (middle cage slot)
J1 = Transport Controller Card (front cage slot)

The following steps describe adding a wire to feed the tape roller tachometer signal from the timer/counter card (J4) to the transport controller card (J1). Note there is already a wire on J4 pin 22 which feeds the tachometer signal out the rear panel accessory connector also. Leave the wire already connected at pin 22 and attach the new jumper wire to pin 22 also.

3.3.1 EDGE CONNECTOR WIRING CHANGES

1) Add another wire to edge connector J4 pin 22 (search-to-cue timer/counter connector) that will feed over to edge connector J1 pin Y (transport controller card connector). Remote the heat shrink but leave the existing wire on J4 pin 22 connected, we want to add a wire that branches from this tach signal to the DTC-1200 card.

2) Temporarily power up the machine and very slowly roll the tape roller by hand on the machine while monitoring the TACH LED on the DTC-1200 card. The LED should blink with each tach pulse.

This completes the tape roller tachometer wiring modifications. Confirm that the tape roller tachometer signal is present with a scope via TP5 on the DTC-1200 board. The DTC-1200 card also has a TACH LED that pulses when the tape roller moves for visual indication. PLAY mode will not function correctly without this tachometer signal on the DTC-1200. The servo loop software monitors tape speed via this pulse stream when PLAY mode initiates. The controller adjusts torque in real-time as tape comes up to speed in PLAY mode based on this tachometer signal.

3.4 ADD NCO REFERENCE CLOCK SIGNAL (OPTIONAL)

We suggest an additional modification to support the STC-1200 timer/counter/cue card with NCO (numerically controlled oscillator) reference daughter card option. Although not required for DTC-1200 use, it makes sense to add future support for the STC-1200 this while making wiring modifications. The NCO generates a master 9600 Hz reference clock signal and must be routed to the RTZ capstan servo board to control tape speed via software.

J4 = Search/Timer/Counter Card (rear cage slot)
J2 = Capstan Servo Card (middle cage slot)
J1 = Transport Controller Card (front cage slot)

This modification simply involves adding a jumper wires between pins J4 pin K and J2 pin K. The following steps describe which pins to jumper the wire between.

3.4.1 EDGE CONNECTOR WIRING CHANGES

1) Route a wire from edge connector J4 pin K (search-to-cue timer/counter connector) over to edge connector J2 pin K (capstan servo card connector).

This completes the NCO reference signal modifications. Refer to the STC-1200 owner's manual for complete instructions using the NCO reference card option.

3.5 ADD SERIAL TX/RX COMMUNICATIONS SIGNALS

The DTC-1200 communicates with an optional STC-1200 search-to-cue timer/counter and auto-locater card via high speed RS-232. This allows high speed asynchronous communications between the two cards for future support of the STC-1200 auto-locator and wired remote controller.

J4 = Search/Timer/Counter Card (rear cage slot)
J2 = Capstan Servo Card (middle cage slot)
J1 = Transport Controller Card (front cage slot)

This modification simply involves add two jumper wires between pins F & H on both edge connectors J1 and J4. The following steps describe which pins to jumper wires between.

3.5.1 EDGE CONNECTOR WIRING CHANGES

1) Route a wire from edge connector J1 pin F (transport controller card connector) to J4 pin F (search to cue card connector). The DTC-1200 transmits serial data to the STC-1200 over this signal connection.

2) Route a wire from edge connector J1 pin H (transport controller card connector) to J4 pin H (search to cue card connector). The DTC-1200 receives serial data from the STC-1200 over this signal connection.

This completes the wiring changes required to the transport control card chassis. Verify the pins F on J1 and J4 are connected properly with an ohmmeter. Also verify that pins H on J1 and J4 are connected. This section completes all wiring changes required by the DTC-1200 digital transport controller.

ORIGINAL AMPEX CONSTANT TENSION KIT

If your machine is retrofitted with the original Ampex constant tension controller kit, this board is no longer needed and must be removed along with all of its associated wiring. The DTC-1200 provides servo loop and constant tension control of both reel motors and the Ampex tension kit is no longer needed.

4 STEP BY STEP QUADRATURE ENCODER INSTALLATION

You must install quadrature encoders on both of the AC reel torque motors in the MM1200 before the DTC-1200 can be used. These encoders provide tachometer and direction information to the new controller for each reel motor. The servo loop firmware samples the tachometer and direction information in real time and adjusts the tape tension for all transport servo modes of operation.

STEP 1 – Remove reel motors from machine and remove the brake hub mounting screws. Lable each motor as TAKEUP or SUPPLY with a marker pen when removing. Also, draw a small orientation alignment line as a guide during re-assembly of the machine.

STEP 2 – Locate the magnet spindle, spanner bracket, springs washers and lock nuts from the kit.

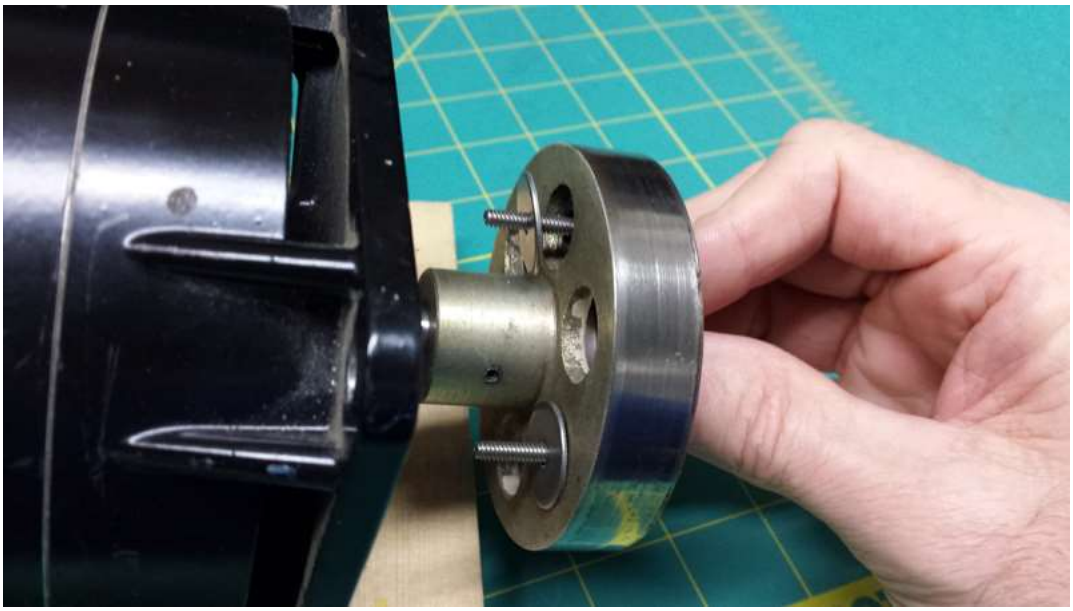
STEP 3 – The magnet spindle is held into the brake hub so it sits flush against the brake hub face. The ½" center boss on the back side of the magnet spindle should fit snugly into the end of the brake hub with the body of the spindle sitting flush against the brake up face.

STEP 4 – Insert the magnet spindle boss end into the brake hub. The boss should fit snug in the hole. If the fit is too tight, use some 400-grit silicon carbide sand paper to smooth the hole in the brake hub.

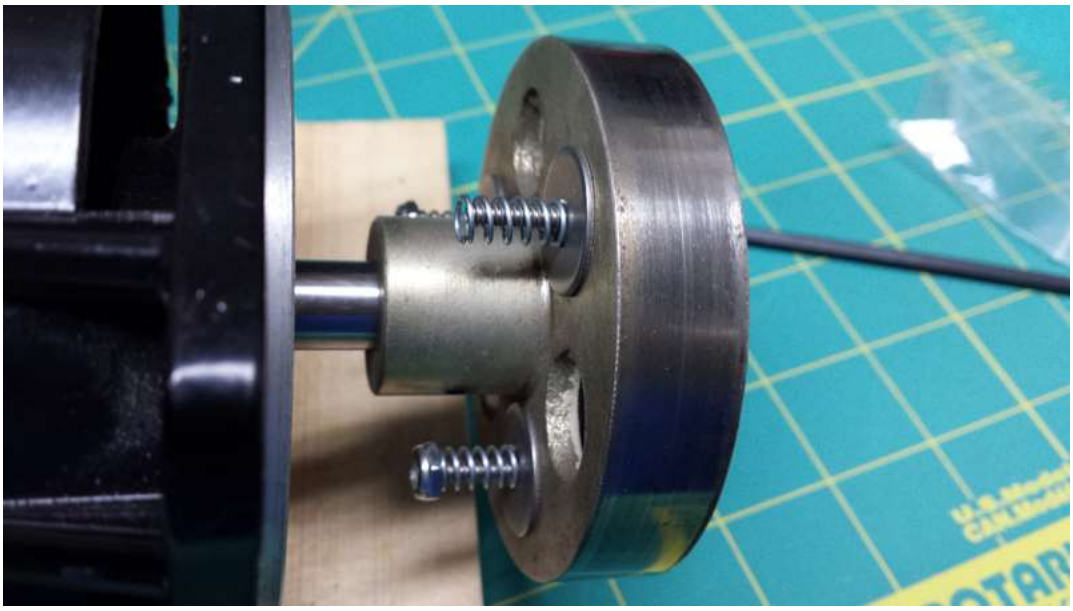
STEP 5 – Add the spanner bracket over the magnet spindle with the studs and rubber bumpers passing through three of the brake hub cutout holes.

STEP 6 – The spanner should rest on the magnet spindle face and serves as a clamp to hold the spindle firmly. Hold the spanner in place by hand while laying the motor back over on its side.

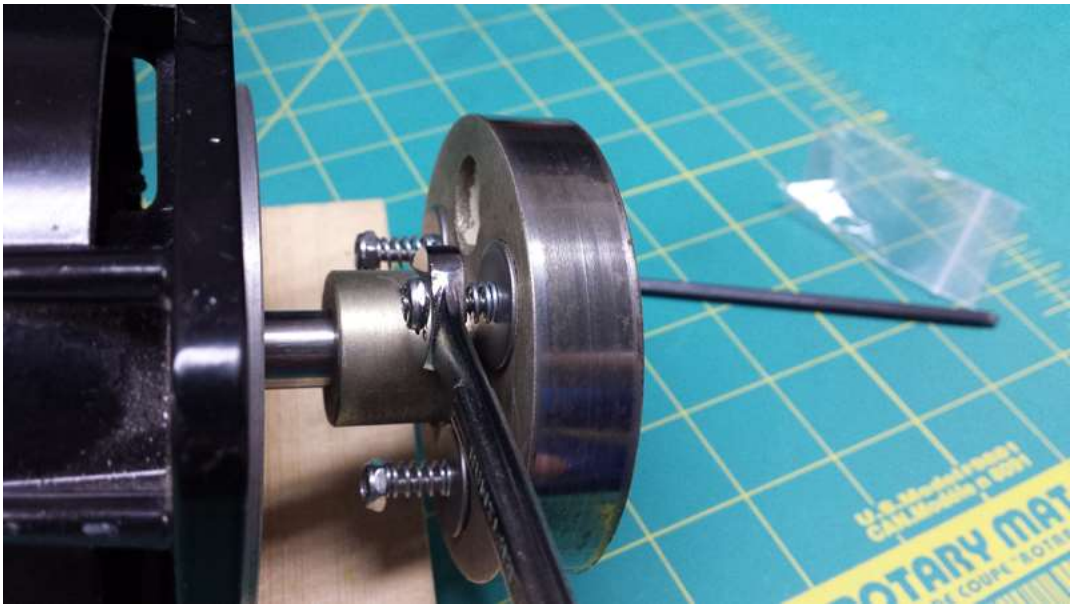
STEP 7 – Add the large diameter washers on the back side of the brake hub while holding the spindle and spanner in place by hand.



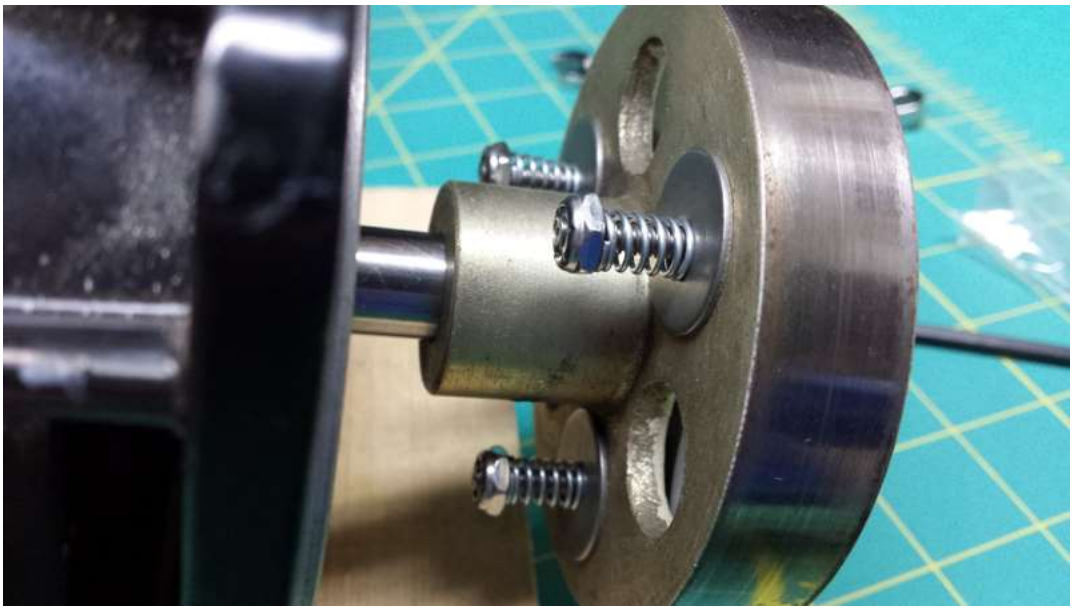
STEP 8 – Add a spring to each of the threaded studs on the back sides of the washers and finger tighten the lock nuts just enough to hold the assembly in place.



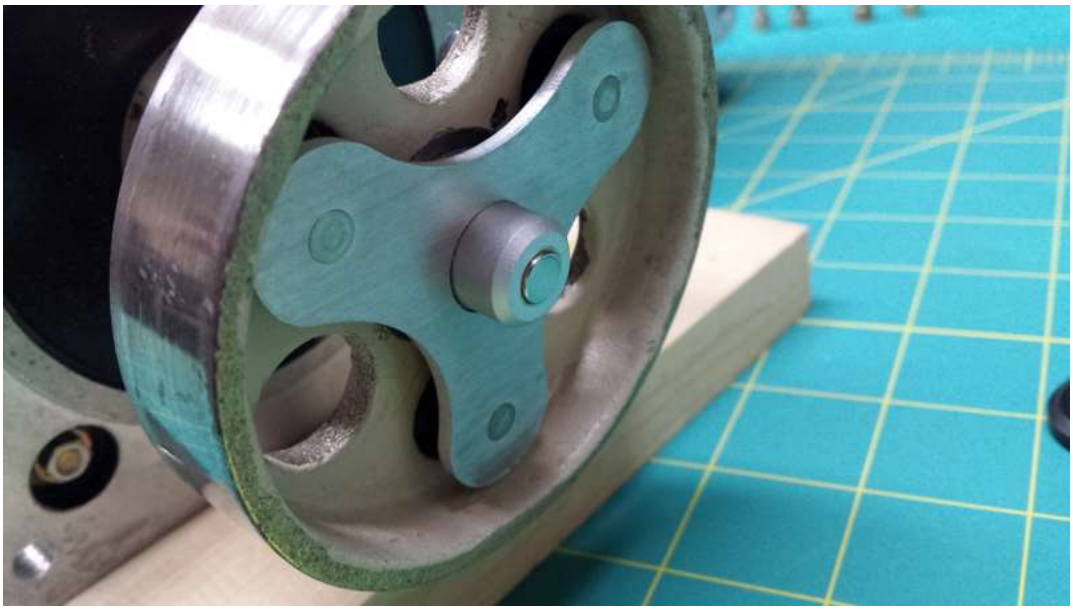
STEP 9 – Next, tighten the lock nuts with a wrench till the threads just exit the back side of the nylon lock washer. Do not over tighten the screws, the nylon thread locks will hold the screws firmly in place.



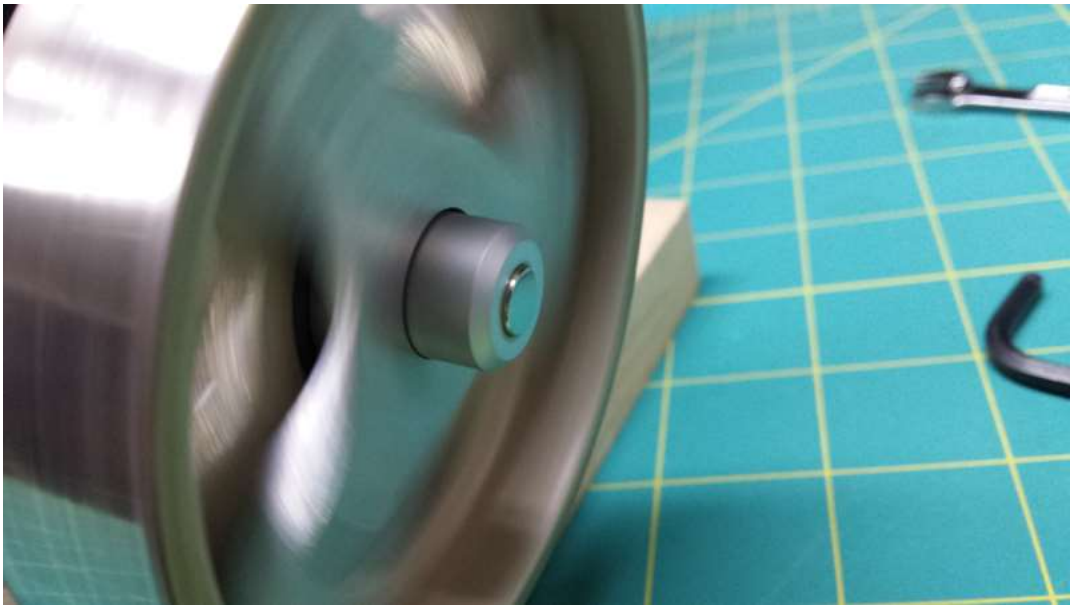
STEP 10 – The threads should just protrude from the back side of the lock nuts. You may also add some LokTite to the threads if desired. DO NOT OVER TIGHTEN THE NUTS AND COMPRESS THE SPRINGS TOO TIGHTLY.



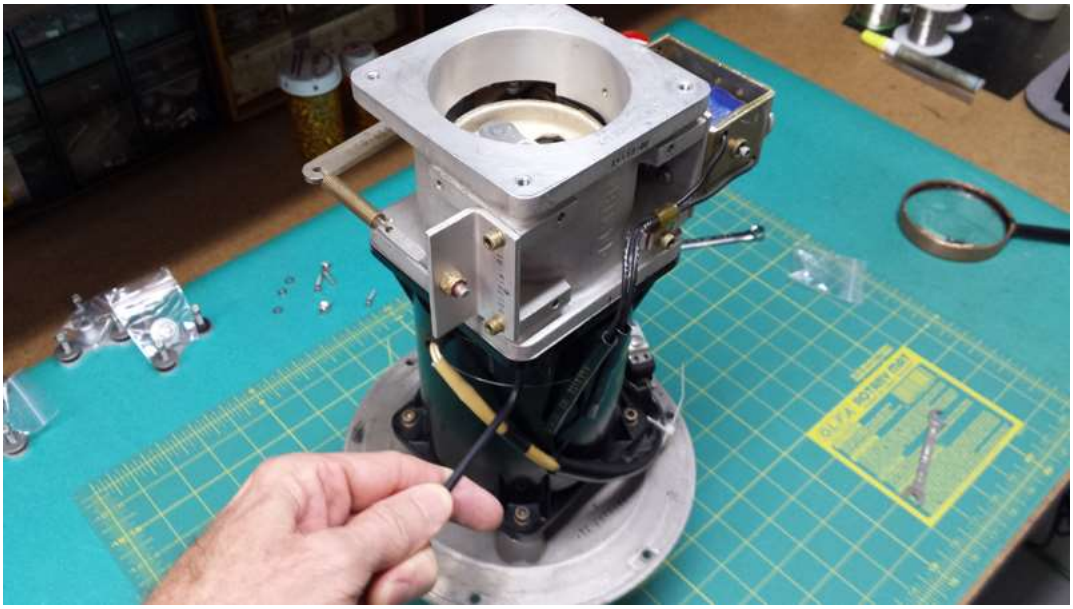
STEP 11 – Inspect the spanner and magnet spindle to make sure it's held firmly in place. Align the spanner so the threads and washers are centered in hole. It should be tight enough you can move it by hand, but not loose such that it could move from motion of the motor. You may tighten the nuts a little if more pressure is desired, but do not over tighten to avoid bending the aluminum spanner plate.



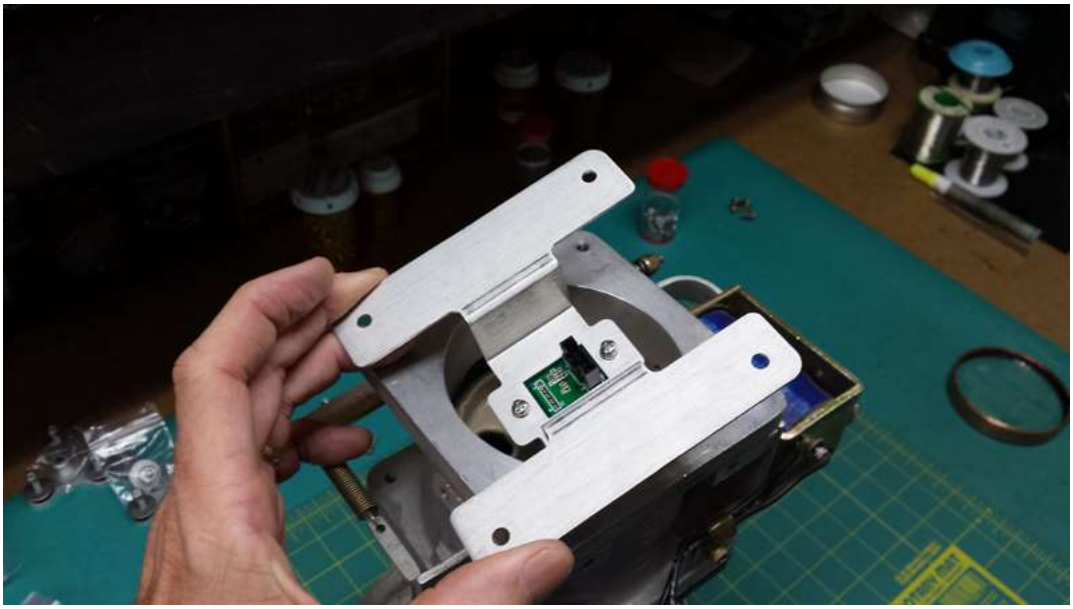
STEP 12 – Hold the brake solenoid mechanism on the motor to release the brake and spin the motor brake hub by hand. The magnet must spin true without wobble or excessive run out.



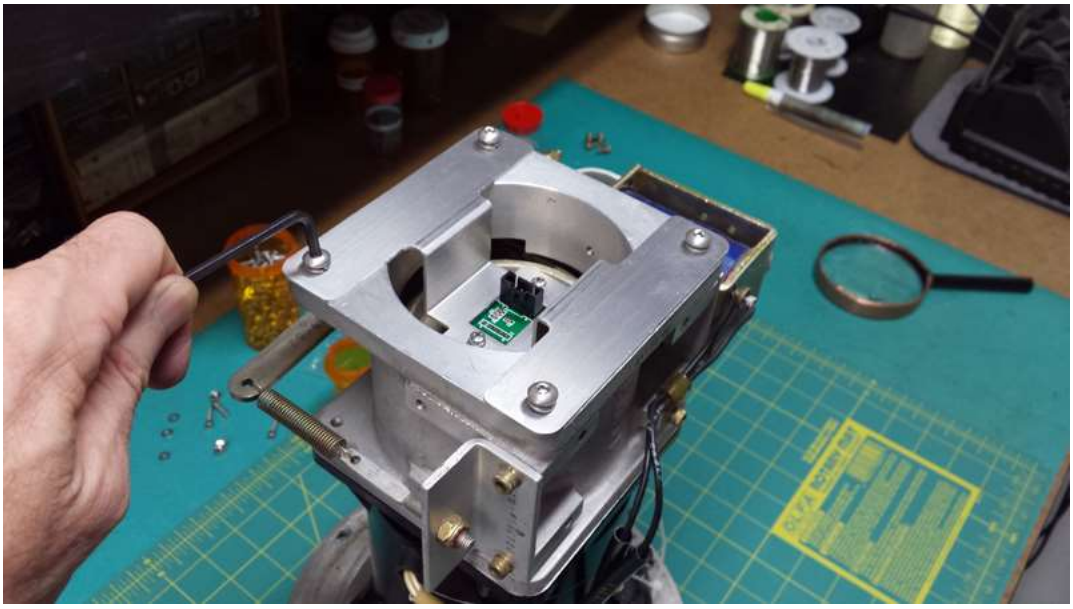
STEP 13 – Reinstall the brake hub housing and secure the Allen screws holding the brake housing.



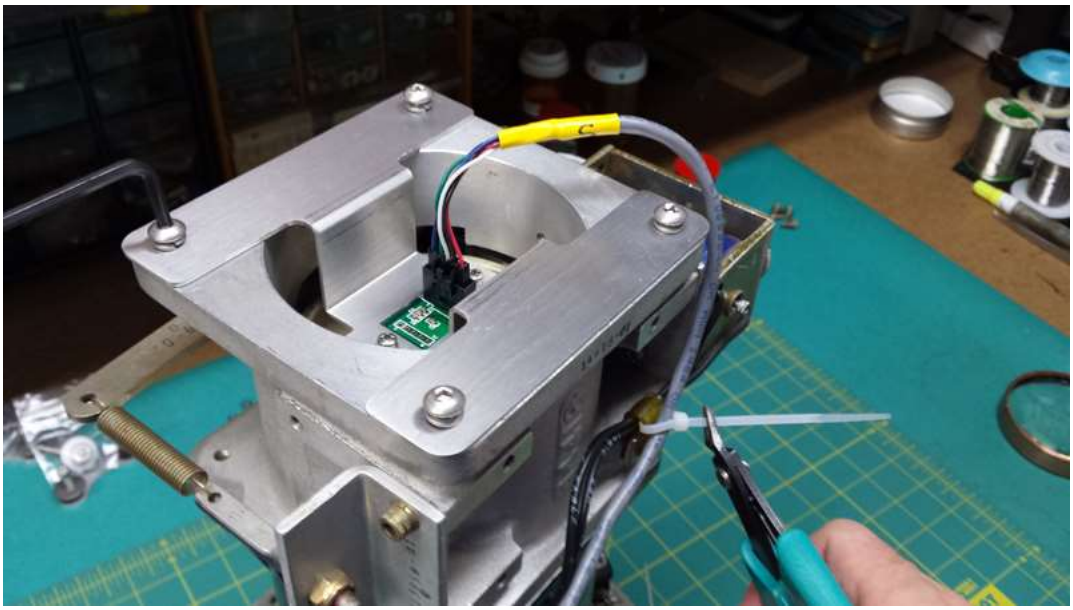
STEP 14 – Now add the magnetic quadrature encoder assembly on the back side of the brake housing.



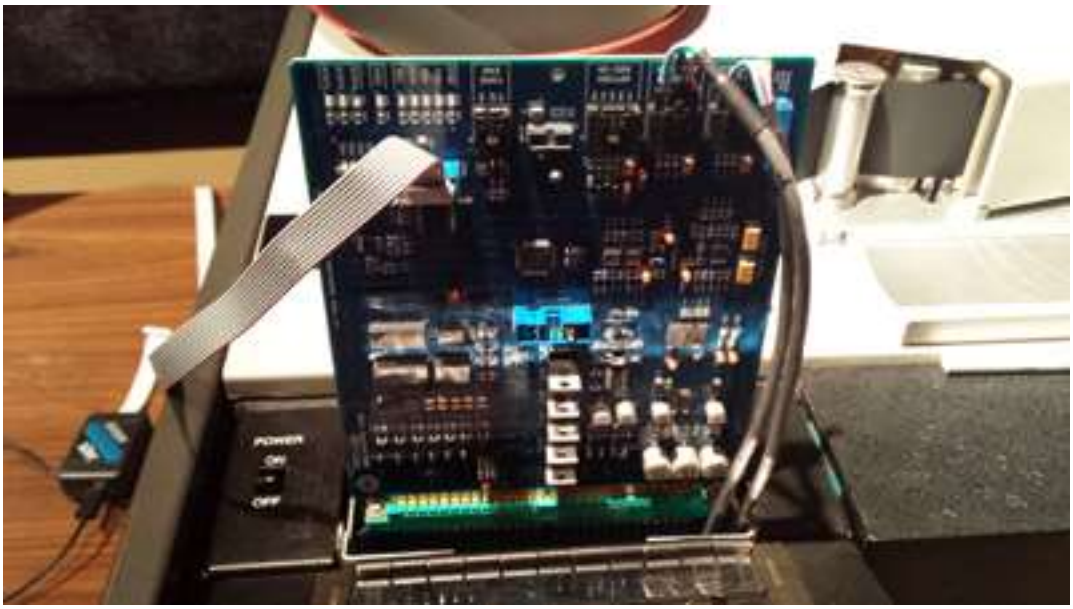
STEP 15 – Secure the encoder bracket with the lock washers and Allen screws provided. The screws should be tightened snug, but do not over tighten.



STEP 16 – Next connect one end of the encoder cable to the encoder and secure the cable to the motor housing with a tie strap. Note the cables are marked TAKEUP and SUPPLY and should be installed on the correct motor for each. The motors are now ready to be installed back into the machine.



STEP 17 – Route the cables from the motor quadrature encoders through the machine to the front side of the transport control card cage when installing the motors. Note the TAKEUP and SUPPLY reel encoders must be plugged into the correct connectors as labeled on the DTC-1200 board. Make sure the TAKEUP encoder cable connector is plugged into the TAKEUP encoder connector J3. Likewise, the SUPPLY encoder should be plugged into the SUPPLY connector J2 on the DTC-1200 board.



The completes the encoder and wiring modification to the machine!

5 MODIFICATIONS COMPLETE

All hardware modifications should now be complete and the machine can be reassembled. Double check that all the wiring changes are correct as described in Section 3.1. Confirm that 5V system power is available on pins 4/D of J1 before installing the DTC-1200 into the machine. Since we've redirected the 5V power to connector J1, we must confirm that 5V power is correct and available on these pins.

Remove any tapes/reels from the tape machine and power up the machine with no transport control card installed. Measure and check that 5.00V power is correct on pins 4/D of edge connector J1. If the 5.00V voltage is off, refer the Ampex MM1200 service manual for the machine's 5V regulator adjustments.

It's important that make sure that the 5V supply is not over 5.1V or damage may occur to chips on the controller board. Note that the reels motors will run at full speed when the machine is powered up with no transport controller card installed in the machine.

5.1 INSTALL THE DTC-1200 CARD

Now install the DTC-1200 card into the machine on an extender card if available. Power up the machine with no tape installed and verify the power LED's on the DTC card are lit and good.

You are now ready to connect the RS-232 serial port to the DTC card to configure tensions and settings on the controller. Please proceed to the **DTC-1200 Owner's Manual** for initial configuration and testing of the controller. This completes the modifications to the Ampex MM-1200 required to use the DTC-1200 digital transport controller system.