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

The DTC-1200 uses 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.

Quadrature encoders on both of the AC reel torque motors provide tachometer and direction information to the DTC-1200. 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.

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.

1.3 CONSTANT TAKEUP TENSION KIT REMOVAL

If your machine has been retrofitted with the original Ampex constant tension controller kit, this board must be removed along with all of its associated wiring.

The telltale signs that you have this kit installed are an LED under the transport card cover over to the right of the transport cards, and a circuit board mounted behind the meter panel, visible when the panel is pulled forward.

See the separate Ampex Tension Kit Removal document for complete details of what to remove.

[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, some folks advise not to stand the motor up on the reel hold down, instead to 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. The photos in this document were taken before this advice was imparted!

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. Be careful not to put excessive strain on the wires to the edge connectors. The low numbered pins are especially vulnerable.

The first few pages of the Ampex Tension Kit Removal document cover this in more detail, with photos.

3 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, M, P and Y are new signals from the other cards. The +5V power input on pins 4 and D from the capstan servo card +5V regulator will be replaced with a feed from the main system +5V power rail. 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**	**RS232 TX TO STC-1200**
12	LO SPEED DISABLE	N	LO SPEED SELECT
13	HI SPEED SELECT	**P**	**RS232 RX FROM STC-1200**
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

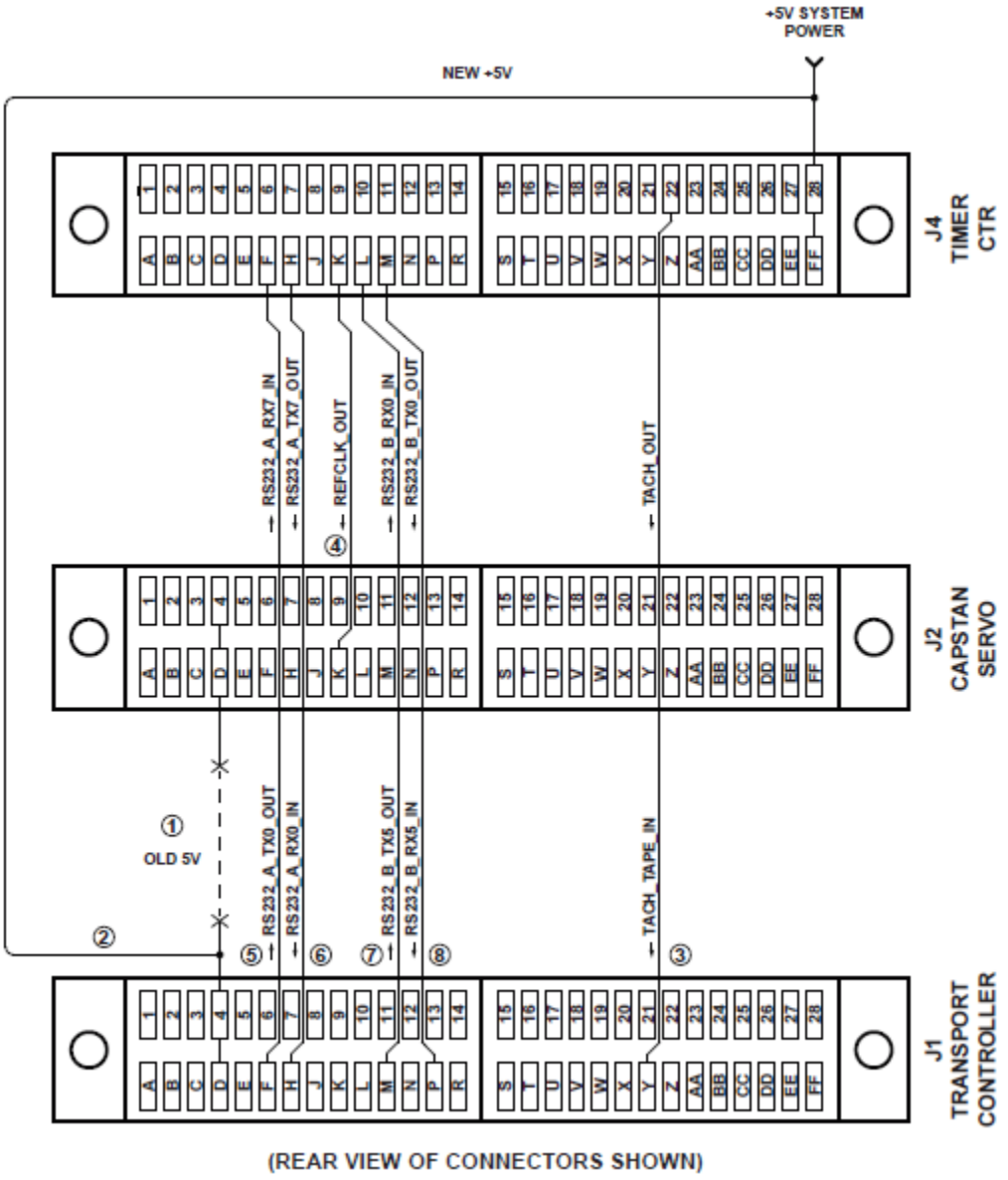
3.1 WIRING CHANGE MODIFICATIONS

Before doing any changes, it is important to check the accuracy of the 5V supply, since if it is over 5.1V damage may occur to chips on the controller board.
There is no dedicated 5V test point, so use the extender card in the STC slot (the one furthest from the front of the machine) to check the voltage at pins FF/28 and adjust if necessary.

You must complete 2.2 CARD CAGE ACCESS first.

The diagram below illustrates the transport controller card cage connectors and wiring changes. Keep it handy while making the changes. For convenience it shows the view from underneath the card cage.

Figure 1 – Required Wiring Change Modifications



3.1.1 EDGE CONNECTOR WIRING CHANGES

This table details all wiring changes required for the DTC-1200. While making wiring modifications it makes sense to also add future support for the STC-1200, so these are listed too.

Change transport controller 5V power source (required for DTC)	
Purpose	In the original Ampex design the +5V power to the transport controller is provided by a zener diode regulator located on the capstan servo card. 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 must be moved to the main system 5V regulator instead
Step 1	Cut and remove wire between J1 pin 4/D and J2 pin 4/D.
Step 2	Add a wire from J4 pin 28/FF to J1 pin 4/D.

Add tachometer signal from tape roller (required for DTC)	
Purpose	The MM-1200 generates a tape roller tachometer signal for the search-to-cue timer/counter card. This modification additionally routes the signal to the transport controller.
Step 3	Add another wire to J4 pin 22 that will feed over to J1 pin Y. 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.

Add NCO reference clock signal (required for STC)	
Purpose	This supports the STC-1200 timer/counter/cue card with NCO (numerically controlled oscillator) reference daughter card option. 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. The STC-1200 owner's manual contains complete instructions using the NCO reference card option.
Step 4	Route a wire from J4 pin K over to J2 pin K.

Add serial TX/RX communications signals (required for STC)	
Purpose	The DTC-1200 communicates with an optional STC-1200 search-to-cue timer/counter and auto-locater card via four high-speed RS-232 serial links. This allows full duplex bi-directional high-speed communications links between the two cards for the STC-1200 auto-locator.
Step 5	Route a wire from J1 pin F to J4 pin F.
Step 6	Route a wire from J1 pin H to J4 pin H.
Step 7	Route a wire from J1 pin M to J4 pin L. *Note: this step is new in revision 7 of this document.*
Step 8	Route a wire from J1 pin P to J4 pin M. *Note: this step is new in revision 7 of this document.*

Verification	
Check wiring changes	With the machine powered down and no transport cards installed, refer to figure 1 and use an ohmmeter to check for continuity between the respective pins for all 7 new connections, and for no continuity between the respective pins for the old +5V feed.
5V supply reminder	Did you remember to check the accuracy of the 5V supply? If you haven't done so, see the beginning of this section.
Check tachometer signal	Power up the machine with all transport cards installed and slowly roll the counter roller by hand while monitoring the TACH LED on the DTC-1200 card. The LED should blink with each tach pulse.

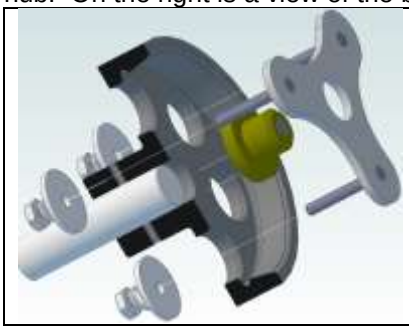
4 QUADRATURE ENCODER INSTALLATION

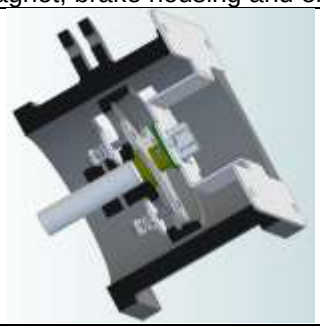
You must install quadrature encoders on both of the AC reel torque motors in the MM1200 before the DTC-1200 can be used. These encoders provide tachometer and direction information to the new controller for each reel motor. The servo loop firmware samples the tachometer and direction information in real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

4.1 OVERVIEW

The magnet is attached to the brake hub so it spins with the motor. The quadrature encoder is attached to the brake housing.

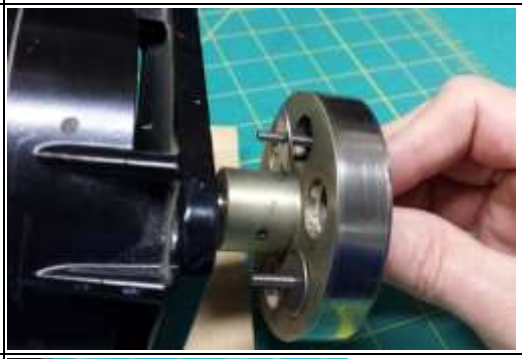
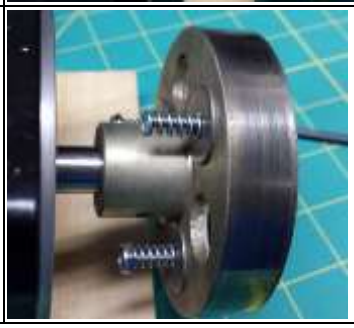
On the left is an exploded view of the magnet and its spanner bracket showing how it fits onto the brake hub. On the right is a view of the brake hub, magnet, brake housing and encoder after installation.

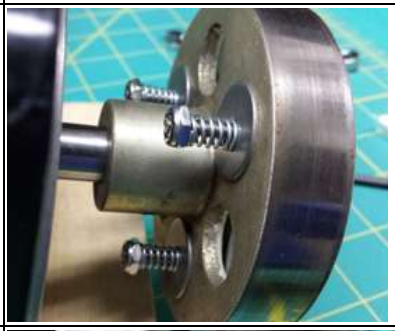


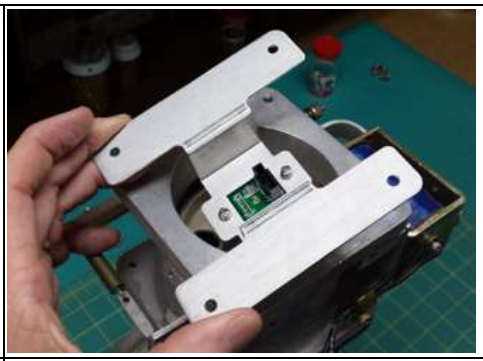
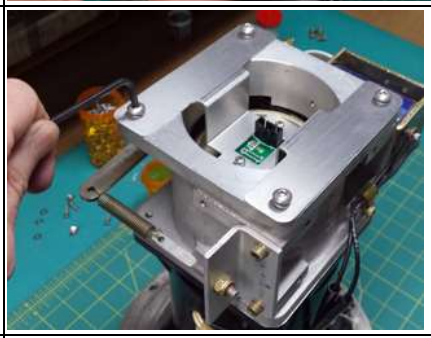
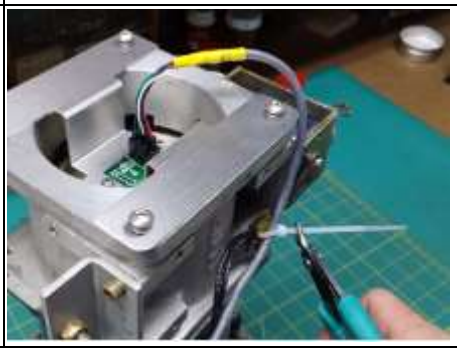
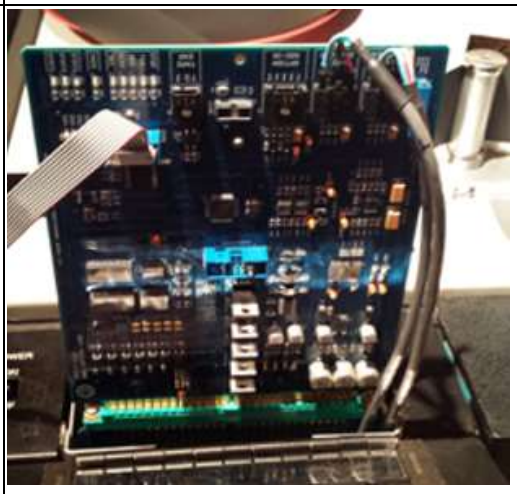


4.2 STEP BY STEP INSTRUCTIONS

STEP 1 – Remove reel motors from machine and remove the brake hub mounting screws. Draw a small orientation alignment line as a guide during re-assembly of the machine. If doing them both at the same time, label each motor as TAKEUP or SUPPLY with a marker pen when removing.	
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 – 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 (which are on the opposite side to their respective motors, ie. the takeup connector is on the left and the supply connector is on the right). 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.	

This 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.

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.