



DTC-1200

DIGITAL TRANSPORT CONTROLLER

AMPEX MM-1200 UPGRADE

Owner's Manual & 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.rtaudio.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 Instruments¹ 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 all open source and 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 its +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 REQUIRED WIRING MODIFICATIONS

Table 1 below describes the pinout of the MM-1200 transport controller 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 to the main system +5V power rail available on the timer./counter card edge connectors. Each modification is described in detail in the sections that follow.

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

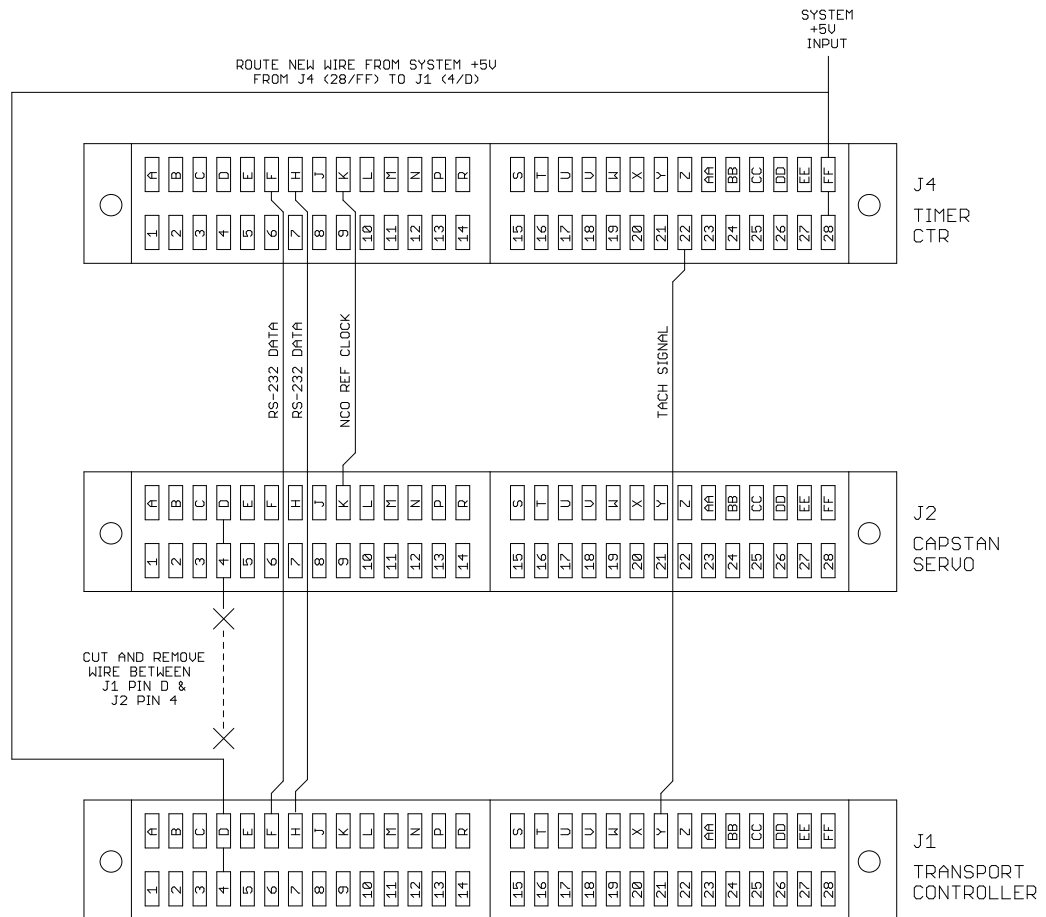
2.1 WIRING CHANGE MODIFICATIONS

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



2.2 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 connectors 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.

2.2.1 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 should now be powered from the main +5V system regulator instead.

2.3 ADD TACHOMETER 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 does not feed to the transport controller card in the original Ampex design. The new DTC-1200 requires this signal to monitor tape speed for play mode operation. We must add a wire between edge connectors J1 and J4 to route this tachometer signal to the new DTC-1200 transport controller card.

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 to transport controller card. Note there is already a wire on J4 pin 22 which feeds the tachometer signal out the rear panel accessory connector. Leave the wire already connected at pin 22 and attach the new jumper wire to pin 22.

2.3.1 EDGE CONNECTOR WIRING CHANGES

- 1) Route a wire from edge connector J4 pin 22 (search-to-cue timer/counter connector) over to edge connector J1 pin Y (transport controller card connector). Leave the existing wire on J4 pin 22 connected, we want to branch off this signal to the DTC-1200 card as well.
- 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.

2.4 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.

2.4.1 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.

2.5 ADD SERIAL TX/RX COMMUNICATIONS SIGNALS

The DTC-1200 has the ability to communicate with an optional STC-1200 search-to-cue timer/counter and auto-locator card via 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.

2.5.1 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.

3 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 brake hub mounting screws. Label each motor as TAKEUP or SUPPLY with a Sharpie pen when removing. Also, draw a small orientation alignment line as a guide during re-assembly.



STEP 2 – Clean brake hub face and center hole around shaft. The motor shaft end should sit recessed about $\frac{1}{2}$ " from the end of the brake hub face.



STEP 3 – Insert the magnet mount into brake hub so it sits flush against the brake hub face. The ½” center boss on the back side of the magnet holder should fit snugly into the end of brake hub hole.



STEP 4 – Insert stainless steel flat washers and Allen head screws from the top side. We will mount washers and lock nuts on the back side of the brake hub in the next step.



STEP 5 – Add washer and blue (medium) strength thread locker to screw ends. The screws will be just snug and thread locker is required to keep these from possibly falling loose.



STEP 6 – Tighten washers down snug, but DO NOT OVERTIGHTEN the screws to avoid warping or damaging the plastic magnet holder assembly. Excessive torque may bend and throw off the center axis alignment of the magnet as well.



STEP 7 – Spin the motor shaft and make sure the assembly has minimal runout (wobble). The motor should spin freely and the magnet holder should sit securely and flush against the brake hub.



STEP 8 – Now install the brake housing back on the motor in its original orientation using the index location we marked as a guide in Step 1.



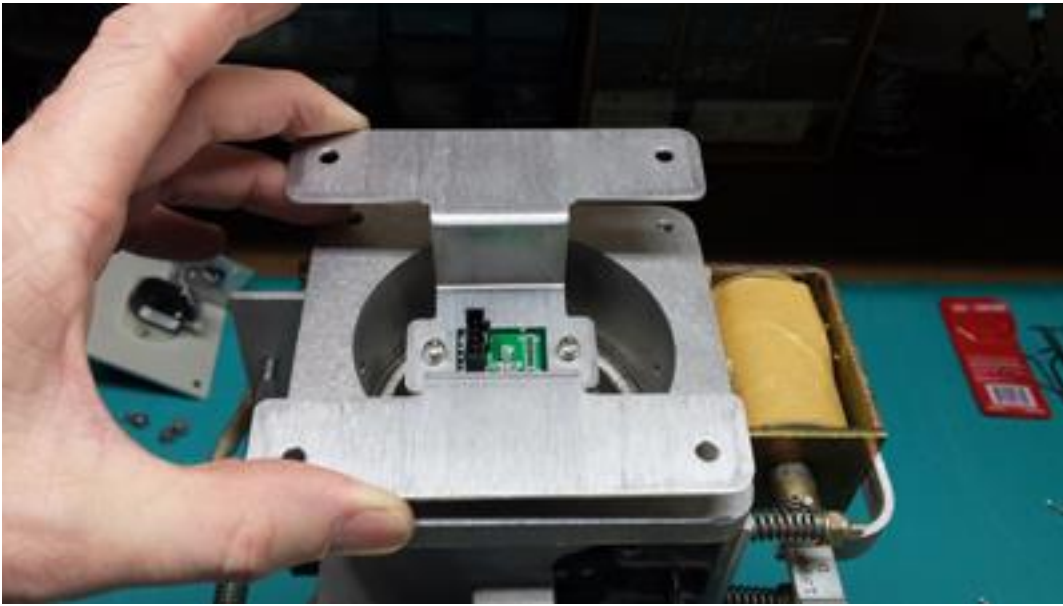
STEP 9 – Next, tighten the brake housing screws securely. Do not over tighten the screws, the heads should be snugged securely against the lock washers.



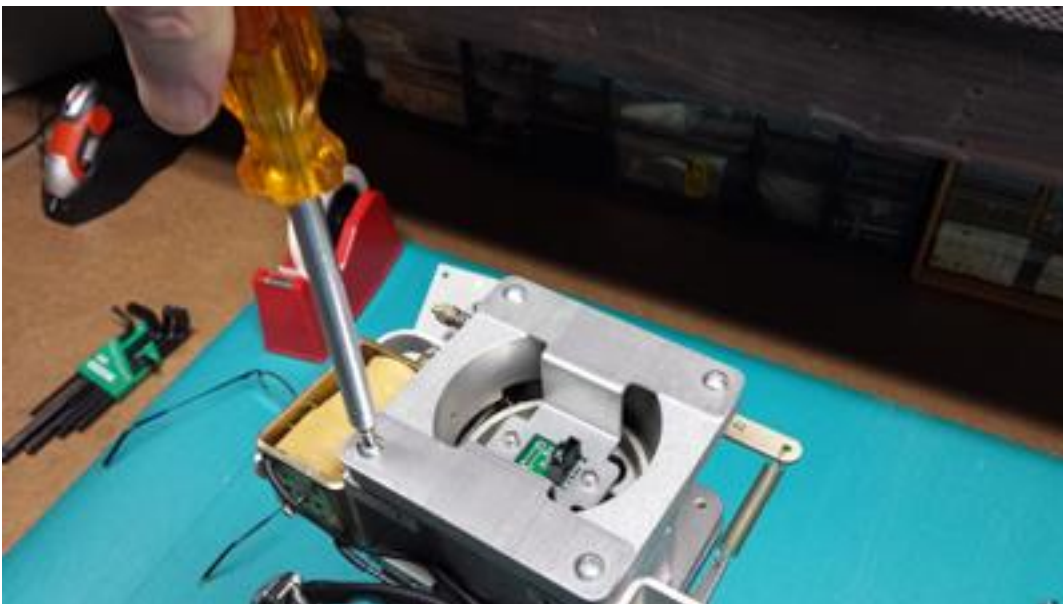
STEP 10 – Hold the brake solenoid release mechanism and spin the motor shaft to make sure it spins freely and the magnet spins true. If all looks good, we are now ready to install the mounting brackets with the quadrature encoders.



STEP 11 – Install the encoder bracket on the motor rear housing. Look through brake band hole and spin the shaft to make the magnet is not touching the encoder chip/board. The magnet should have around a 1/4 inch or so clearance to the encoder board & chip.



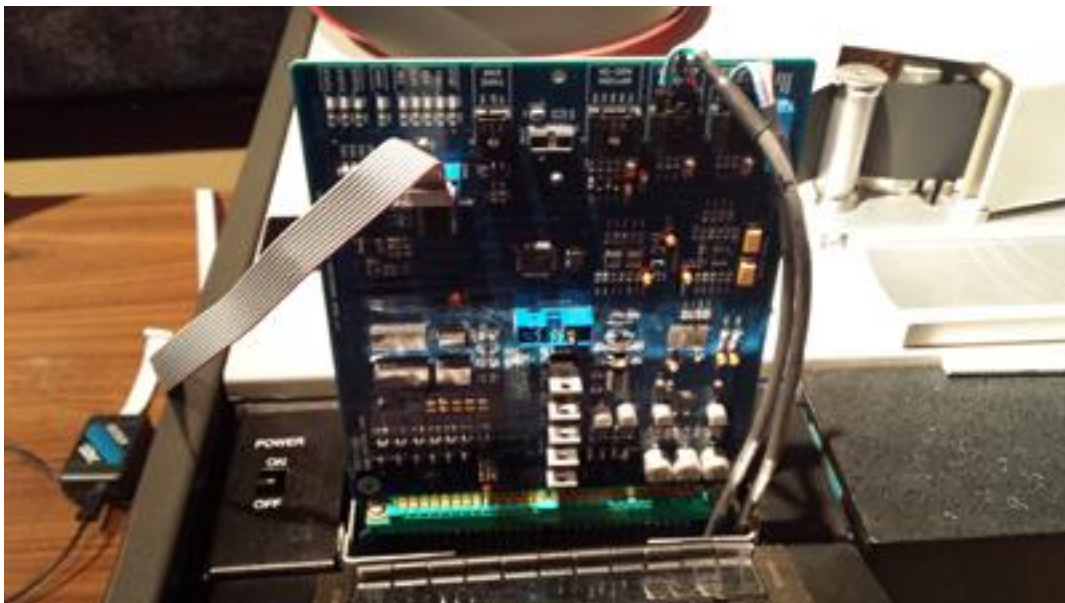
STEP 12 – Secure the encoder bracket with #10 screws.



STEP 13 – Add the encoder cable and secure it with a tie strap. Note that one end of the cable goes to DTC-1200 (with extra shield wire grounded) and the other plugs into the encoder board as shown. The cable ends should be labeled appropriately. Observe the orientation label on the wire when plugging in the cable connector. The motor is now ready to be installed back into the machine.



STEP 14 – Route the wires from the quadrature encoders through the machine to the front side of the transport control card cage. 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 connector J2 on the DTC-1200 board.



4 DTC-1200 TRANSPORT CARD INSTALLATION

The DTC-1200 digital transport controller card can be installed in the machine once the wiring changes and reel motor quadrature encoders have been installed. We recommend using an extender card if available for easy access during initial system power up and installation. The extender card will allow easier access to the tension sensor gain trimmer (R85 on revision C PCB's) and power status LED's.

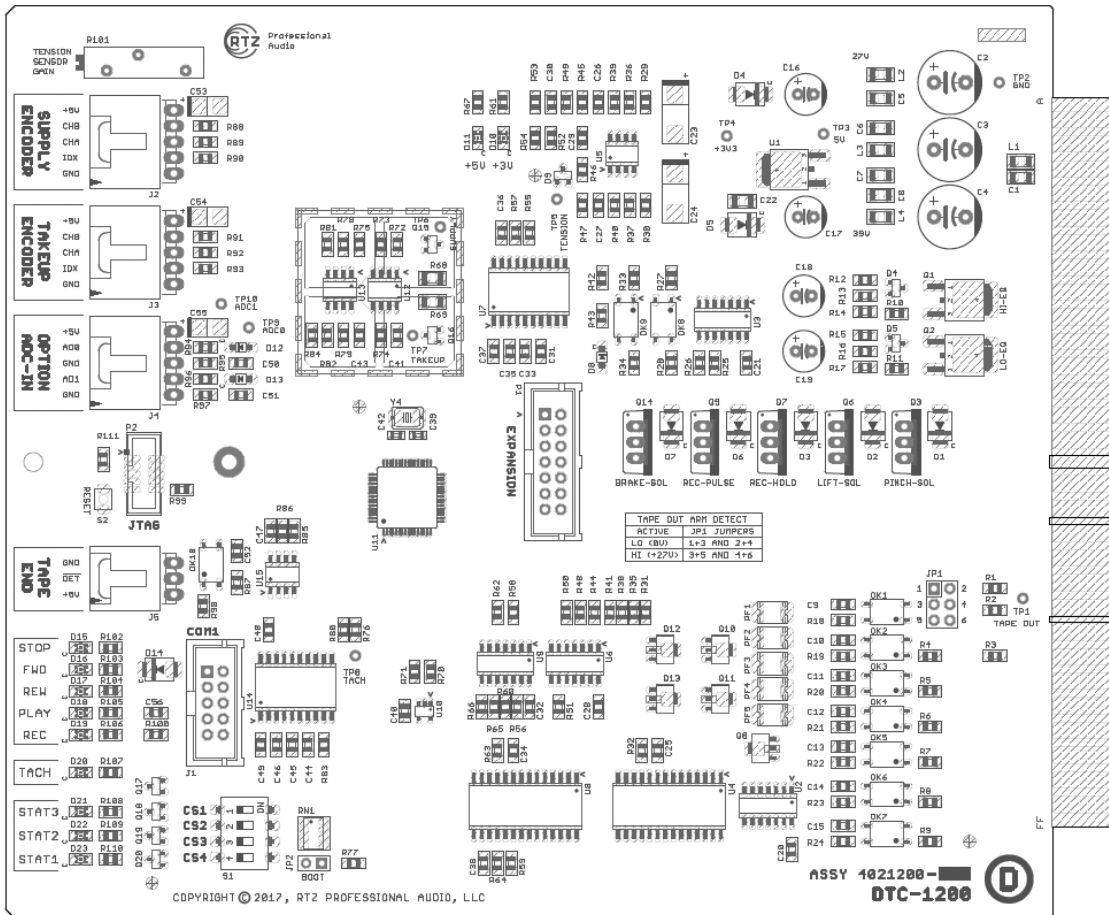
4.1 Initial 5V Power Check

First check 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 5.00V 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.

Figure 2 - DTC-1200 Controller PCB



4.2 Tape Out Detect Polarity Configuration

The tape out arm on the right hand side of the machine actuates a micro switch inside the machine when tape is present and loaded in the tape path. Apparently some machines have this wired as active high logic (+27V) or active low logic (ground) when the switch is activated.

The 6-pin jumper JP1 configures the tape detection for high or low logic. By default, the controller ships configured for active low logic. Refer to Figure 2 below for JP1 jumper configuration. Review the DTC-1200 schematics prior to changing these jumpers for additional information.

Table 2- Tape-Out Detect Polarity

TAPE OUT SENSE POLARITY	
ACTIVE	JP1 JUMPER CONFIG
HIGH (27V)	Jumper pins 3+5 and pins 4+6
LOW (GND)	Jumper Pins 1+3 and pins 2+4

Make sure to power down the machine and card before changing jumper JP1 configuration jumpers. Pay special attention to the jumper configuration and orientation as shown above and in the schematic.

4.3 Controller Configuration via TTY

The COM1 serial port provides TTY terminal access for all system configuration and diagnostics information. You will need a VT-100 terminal emulator program (we recommend the freeware program **TeraTerm**) and a computer with a DB9 style RS-232 serial port available.

Figure 3 – TTY Configuration Main Menu

```

COM1 - Tera Term VT
File Edit Setup Control Window Help
DTC-1200 Transport Controller - v2.01
MAIN MENU
30 IPS

SETTINGS                                SYSTEM
1 ) General                               10) Diagnostics
2 ) Tensions                              11) Monitor : 0
3 ) Stop Servo
4 ) Play Servo
5 ) Shuttle Servo

CONFIG
6 ) Load Config
7 ) Save Config
8 ) Default Config

TRANSPORT: <S>top <P>lay <R>ewind <F>orward

Option: _

```

Most modern motherboards still have a RS-232 header connector available on the motherboard that can be used by adding the appropriate break out cable to a DB-9 connector. Please consult with your computer motherboard vendor to locate or build a RS-232 breakout cable if needed. You might consider purchasing a PCI card RS-232 serial port adapter. Also, USB-to-RS232 serial port adapters are available for use with laptops and computers.

4.3.1 RS-232 Ribbon Cable

The DTC-1200 includes a ribbon cable with DB9 connector for the RS-232 connection to a PC. The ribbon cable header end plugs into J1 (COM1) on the DTC-1200 board. The DTC-1200 serial port is configured for baud rate 19200, no parity, 8 data bits, 1 stop bit (19200/N/8/1). No handshaking signaling lines are used (DTR, CTS, etc). The baud rate can be changed to 9600 by switching DIP switch #1 (CS1) to the ON position and resetting the CPU.

Connect the ribbon cable header end to J1 on the DTC-1200. Connect the DB9 connector end to a PC with serial port running **TeraTerm**. Press the enter key to refresh and the main configuration screen should appear as shown below in Figure 3 above.

4.4 Tape Tension Sensor Adjustment

The MM-1200 tape tension sensor arm (located on the supply reel side of the machine) contains an optical sensor that uses two photo cells and a light bulb to sense tape tension. Check that the light bulb in the tension sensor arm housing is fully illuminated with the machine powered up. The light bulb and photo cells must be in working order for use with the DTC-1200. The servo control loop monitors this tension sensor in real-time continuously. If the bulb does not light, replace the bulb and ensure that it illuminates properly when the machine is powered on. The tension sensor must work properly as the controller samples this value in the real-time servo loop to correct tape tension in the servo loop logic.

TTY Monitor mode 1 must be used to monitor the tension sensor A/D value. Navigate to the TTY main menu screen as shown in Figure 3 and select monitor mode menu item 11, then enter 1 to enable monitor mode 1. Monitor mode updates the screen every second as shown below in Figure 4 until the ESC key is pressed. The ESC key used exit any menu or to exit monitor modes.

4.5 Adjusting the Tension Gain Trimmer

Move the tension sensor arm by hand and note the **Tension Arm** reading as shown in Figure 4 under the **TAPE** heading screen section. Set the transport to halt mode (disengage right hand tape arm) and remove tape from the tape tension sensor arm. Make sure nothing is touching the tape tension sensor arm and adjust R85 until the **Tension Arm** value reads 400 as closely as possible. Push the tape tension arm by hand all the way forward and note the tension value should reach zero at the maximum forward limit position. Likewise the tension value should measure around 450 or higher when pulled back to the maximum travel limit.

Figure 4 - Monitor Mode 1 Screen

```

COM1 - Tera Term VT
File Edit Setup Control Window Help
MM-1200 Transport/Servo Controller - v2.01 MONITOR 1
SUPPLY < TAKEUP
DAC Level : 524 DAC Level : 489
Velocity : 0 Velocity : 0
RPM : 0 RPM : 0
Stop Null : 0 Stop Null : 0
Offset : 18 Offset : -18
PID_SERVO █
PID CV : 346
PID Error : 19
PID Debug : 320
Velocity : 0
TAPE
Tape Tach : 32
Offset Null : 18
Tension Arm : 306
<ESC> Key Exits...
    
```

(TO BE CONTINUED IN FUTURE DOCUMENT UPDATES)