



Capstan Servo Controller 4840356

AMPEX UPGRADE ELECTRONICS

Owners Manual

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1. INTRODUCTION

Thank you for purchasing your new RTZ capstan servo controller electronics for Ampex studio recorders! All cards are hand built and individually tested 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.

2. DESCRIPTION

The RTZ capstan servo card is a direct replacement for Ampex AG-440C (with capstan servo option), MM1100 and MM1200 studio recorders. Additional support for the MM1200 constant tension upgrade kit is also provided. The RTZ servo card includes additional signals and control lines required by the original Ampex constant tension kit.

The new servo card also includes a capstan servo flutter error circuit and indicator LED. This circuit is very sensitive and gives visual indication of any flutter present in the capstan servo loop (bad bearings, etc.).

3. SPEED SELECT JUMPER CONFIGURATION

The new servo card supports all speeds offered by Ampex 440 and 1100/1200 series machines, including 1200 machines with constant tension kit upgrade. Jumper JP1 configures the HIGH and LOW tape speed pair settings for the machine. The jumpers on JP1 allow configuring the card for 30/15 IPS, 15/7.5 IPS, 7.5/3.75 IPS and other possible non-standard speed pair combinations.

The jumper block is divided into two sections; one for HIGH speed and the other for LOW speed. Each position selects the desired speed using the appropriate reference clock divider output.

Table 1 – JP1 Speed Pair Select Jumpers

IPS	30/15	15/7.5	7.5/3.75
AG-440	1-2 13-14	3-4 15-16	5-6 17-18
MM1200	3-4 15-16	5-6 17-18	7-8 19-20

Refer to Table 1 to select the desired speed pair combination and jumper configuration required for your machine.

Figure 1 below shows the jumper configuration for 15/30 IPS operation in a MM1200 or MM1100 series machine.

Figure 1 - Speed Select Jumpers



Note the AG-440 would require jumpers on 1 & 2 and 13 & 14 for 15/30 IPS. The 440 series machines have a smaller capstan (half) diameter than the 1200 series machines and thus require different jumper speed settings.

4. REFERENCE CLOCK OPTIONS

The servo logic requires a 9600 Hz master reference clock that determines the capstan motor and tape speed. The servo loop is a closed loop system with a phase comparator which compares the servo motor tachometer pulses against the master reference clock pulses and corrects the motor speed as needed in real time.

The RTZ capstan servo card contains a precision crystal reference oscillator and divider to achieve a very precise 9600 Hz crystal control oscillator on the board locally. Optionally, the card may be configured to use an external reference master clock if vari-speed operation is required. Normally, the master reference clock is routed to a rear panel accessory connector on the machine with a jumper plug that routes the master clock back into the machine (if no external reference is used). Figure 2 illustrates the master clock and routing out the PCB edge connector pins.

Normally, an external reference will not be used and JP3 should be configured for LOCAL use only. In this configuration, the master reference does not go to the rear accessory panel

connector and routes directly to the phase detector locally on the card. In this way, we avoid routing the master clock through extra wiring in the machine and avoid less chance of clock signal degradation or noise within the machine.

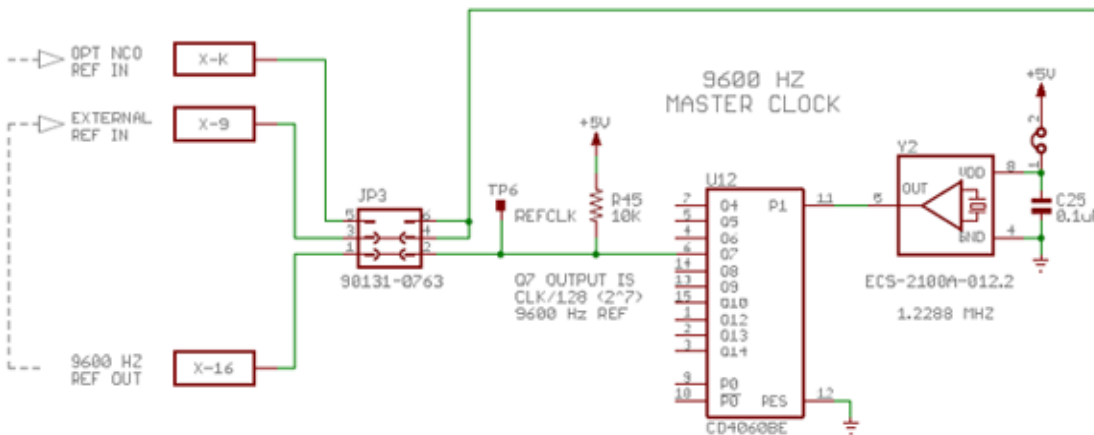
5. REFERENCE SOURCE JUMPER CONFIGURATION

The master reference clock can be configured to source from the local 9600Hz reference oscillator, an external accessory reference oscillator, or from an optional NCO reference source (numerically controlled oscillator). Jumper JP2 allows removing power to the local oscillator if a permanent external reference is ever required (e.g., external vari-speed or NCO reference).

Table 2 – JP3 Select Jumper

Reference Source	JP3 Configuration
Local (default)	2 & 4
External Ref	1 & 2
External NCO	6 & 5

Figure 2 - Reference Source Select



6. INSTALLATION AND CAPSTAN SERVO CARD ALIGNMENT

The servo card requires proper calibration upon initial installation in a machine. Once calibrated, the capstan servo card should not require periodic adjustment unless major service is required on the machine. Perform this adjustment procedure only when installing a new card or a change in critical capstan servo components makes it necessary.

First, configure the tape speed pair and reference source jumpers as described in sections 3 & 5. In most cases, the default local reference option should be used. Trimmer RV2 adjusts the duty cycle of the PWM signal and must be adjusted for 50% duty cycle. Trimmer potentiometer RV1 adjusts the capstan motor drive amp gain and must be adjusted for minimum jitter.

Perform the capstan servo card adjustment procedure as follows:

- 1) Connect an oscilloscope to TP2 to monitor the phase comparator PWM output signal while the machine is in play mode.
- 2) Thread tape on the machine and enter play mode. Observe the PWM signal on the scope and adjust the scope for proper level and triggering of the signal.
- 3) Adjust trimmer RV2 to achieve a 50% duty cycle as closely as possible. That is, the square wave should exhibit the same amount of on-time as off-time to form a perfect square wave pattern.
- 4) Adjust trimmer RV1 for minimum jitter of the PWM waveform. Jitter will appear as the square wave leading/trailing edges jumping around on the scope. Adjust RV1 to minimize jitter as much as possible and obtain a stable square wave pattern.

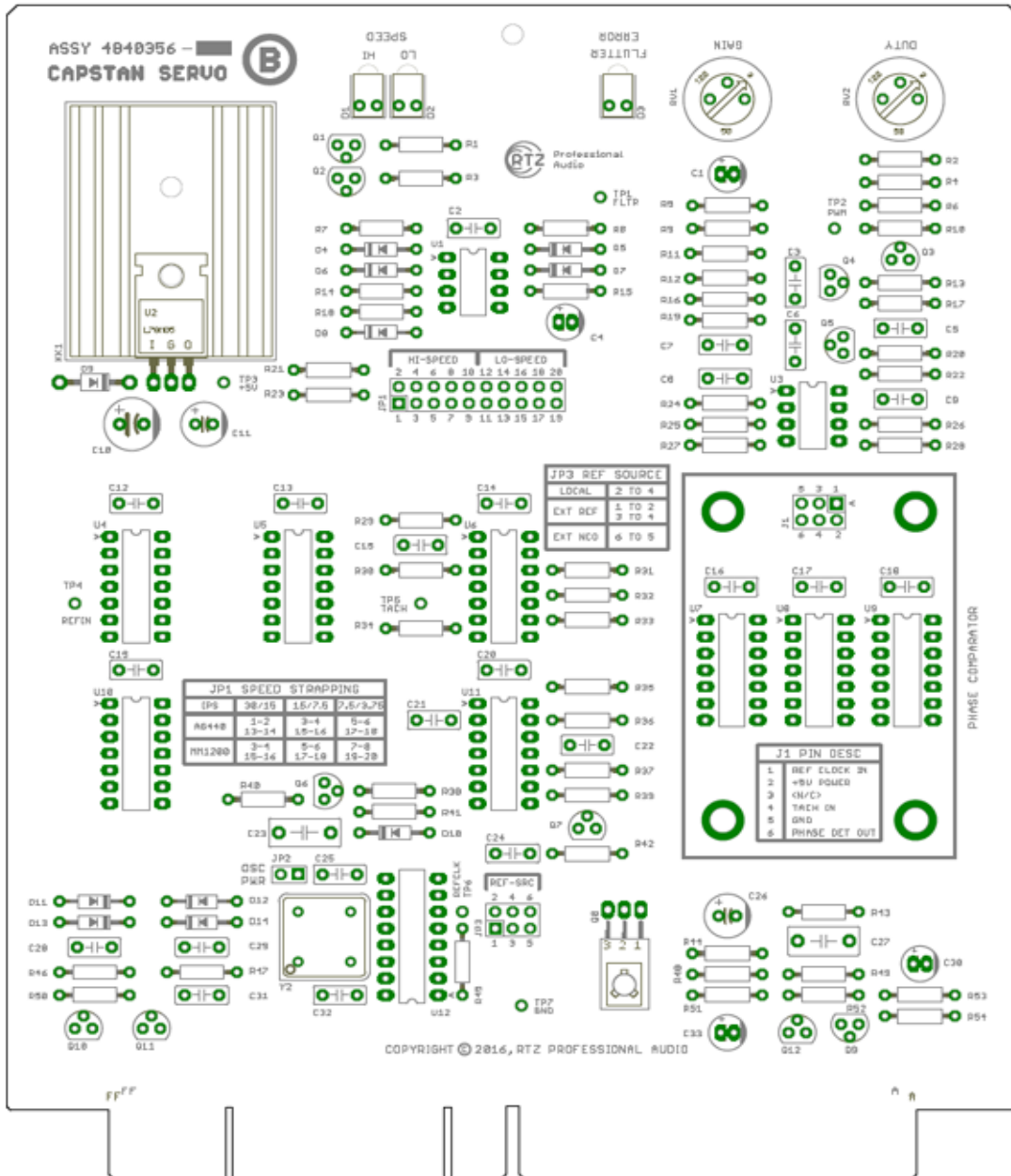
Once properly aligned, the PWM signal should be very stable with very little jitter present. If the PWM signal is not stable and has excessive jitter, then speed accuracy is affected and the speed will not be accurate. If you are unable to achieve stable operation, this might be due to problems with the motor tach, power supply, MDA output transistor or a problem with the capstan DC motor itself (bearings, etc).

Note the capstan flutter error LED will flicker slightly in normal operation as the servo loop corrects speed. The flutter detector circuit is very sensitive to variations in the drive signal. Although the LED will show some slight flicker, it should not be on constantly. If so, then check the PWM signal for jitter and duty cycle. Figure 3 below shows a typical waveform of the PWM output on test point TP2 when locked.

Figure 3 - PWM Output Signal at TP2



7. PCB COMPONENT LEGEND



8. BILL OF MATERIALS

Qty	Part Ref ID	Mfg Part#	Description
1	C1	ULD1H010MDD1TD	Aluminum Electrolytic Capacitors - Leaded 50V 1UF 20%
2	C30, C33	ULD1H2R2MDD1TD	Aluminum Electrolytic Capacitors - Leaded 50V 2.2UF 20%
1	C4	ULD1C470MDD1TD	Aluminum Electrolytic Capacitors - Leaded 16V 47UF 20%
2	C11, C26	ULD1C101MED1TD	Aluminum Electrolytic Capacitors - Leaded 16V 100UF 20%
1	C10	ULD1V101MPD1TD	Aluminum Electrolytic Capacitors - Leaded 35V 100UF 20%
1	C23	FKP3J004702B00KSSD	Film Capacitors 470pF 630V 10% PCM7.5
1	C27	MKP1J013302C00MSSD	Film Capacitors 3300pF 630V 20% PCM7.5
1	C5	MMK5222K50J01L4BULK	Film Capacitors 50volts 0.0022uF 10% LS 5mm
1	C7	MMK5562M50J01L4BULK	Film Capacitors 50volts 5600pF 20% LS 5mm
1	C22	MMK5682K50J01L4BULK	Film Capacitors 50volts 0.0068uF 10% LS 5mm
1	C6	MMK5563K100J01L4BULK	Film Capacitors 100volts 0.056uF 10% LS 5mm
1	C3	MMK5823M63J01L4BULK	Film Capacitors 63volts 0.082uF 20% LS 5mm
6	C15, C21, C24, C28, C29, C31	MMK5103K50J01L4BULK	Film Capacitors 50volts 0.01uF 10% LS 5mm
12	C2, C9, C12, C13, C14, C16, C17, C18, C19, C20, C25, C32	MMK5104K50J01L4BULK	Film Capacitors 50volts 0.1uF 10% LS 5mm
1	C8	MMK5224K63J01L4BULK	Film Capacitors 63volts 0.22uF 10%
1	R44	SFR2500001509FR500	Metal Film Resistors - Through Hole 400mW 15ohms 1%
1	R54	SFR2500003659FR500	Metal Film Resistors - Through Hole 400mW 36.5ohms 1%
3	R1, R3, R26	SFR2500004990FR500	Metal Film Resistors - Through Hole 400mW 499ohms 1%
1	R28	SFR2500002430FR500	Metal Film Resistors - Through Hole 400mW 243ohms 1%
1	R43	SFR2500003300JR500	Metal Film Resistors - Through Hole .4watt 330ohm 5%
1	R18	SFR2500004750FR500	Metal Film Resistors - Through Hole

			400mW 475ohms 1%
4	R20, R21, R23, R40	SFR2500001001FR500	Metal Film Resistors - Through Hole 400mW 1Kohms 1%
1	R42	SFR2500002211FR500	Metal Film Resistors - Through Hole 400mW 2.21Kohms 1%
5	R6, R29, R31, R33, R41	SFR2500003321FR500	Metal Film Resistors - Through Hole 400mW 3.32Kohms 1%
1	R2	SFR2500003921FR500	Metal Film Resistors - Through Hole 400mW 3.92Kohms 1%
2	R11, R39	SFR2500004701FR500	Metal Film Resistors - Through Hole 400mW 4.7Kohms 1%
3	R30, R32, R34	SFR2500005601FR500	Metal Film Resistors - Through Hole 400mW 5.6Kohms 1%
2	R25, R27	SFR2500006191FR500	Metal Film Resistors - Through Hole 400mW 6.19Kohms 1%
1	R35	SFR2500006811FR500	Metal Film Resistors - Through Hole 400mW 6.81Kohms 1%
6	R7, R8, R10, R12, R45, R53	SFR2500001002FR500	Metal Film Resistors - Through Hole 400mW 10Kohms 1%
1	R49	SFR2500001202FR500	Metal Film Resistors - Through Hole 400mW 12Kohms 1%
1	R51	SFR2500001502FR500	Metal Film Resistors - Through Hole 400mW 15Kohms 1%
1	R37	SFR2500002212FR500	Metal Film Resistors - Through Hole 400mW 22.1Kohms 1%
1	R9	SFR2500002432FR500	Metal Film Resistors - Through Hole 400mW 24.3Kohms 1%
1	R48	SFR2500002742FR500	Metal Film Resistors - Through Hole 400mW 27.4Kohms 1%
1	R24	SFR2500003902FR500	Metal Film Resistors - Through Hole 400mW 39Kohms 1%
1	R36	SFR2500004322FR500	Metal Film Resistors - Through Hole 400mW 43.2Kohms 1%
3	R22, R47, R50	SFR2500004702JA500	Metal Film Resistors - Through Hole 0.4watt 47Kohms 5%
4	R13, R16, R17, R19	SFR2500005112FR500	Metal Film Resistors - Through Hole 400mW 51.1Kohms 1%
1	R4	SFR2500007502FR500	Metal Film Resistors - Through Hole 400mW 75Kohms 1%
3	R38, R46, R52	SFR2500001003FR500	Metal Film Resistors - Through Hole 400mW 100Kohms 1%
2	R14, R15	SFR2500001583FR500	Metal Film Resistors - Through Hole 400mW 158Kohms 1%
1	R5	SFR2500001004JA500	Metal Film Resistors - Through Hole 0.4watt 1Mohms 5%

1	RV1	93PR100LF	Trimmer Resistors - Through Hole 1/2 inch 100 ohm
1	RV2	93PR500LF	Trimmer Resistors - Through Hole 1/2 inch 500 ohm
1	D1	H101CGD	LED Circuit Board Indicators LED Assmby Grn Single Level 565nm
1	D2	H101CYD	LED Circuit Board Indicators CBI Yellow 585nm Sing Level 3mm
1	D3	H101CRD	LED Circuit Board Indicators LED Assmby Red Single Level 655nm
10	D4, D5, D6, D7, D8, D10, D11, D12, D13, D14	1N914B	Diodes - General Purpose Power Switching 100V Io/200mA BULK
1	D9	1N4002	Rectifiers 100V/1a Rectifier General Purpose
9	Q1, Q2, Q3, Q4, Q6, Q7, Q9, Q10, Q11	2N3904BU	Bipolar Transistors - BJT NPN Transistor General Purpose
2	Q5, Q12	2N3906BU	Bipolar Transistors - BJT PNP Transistor General Purpose
1	Q8	2N5190G	Bipolar Transistors - BJT BIP NPN 4A 40V
1	U1	MC1458P	Operational Amplifiers - Op Amps Dual GP
1	U3	LM741CN/NOPB	Operational Amplifiers - Op Amps Op-Amp
1	U12	CD4060BE	Counter ICs 14-Bit Ripple
1	U10	SN74HC14N	Inverters Hex Schmitt-Trigger
1	U11	SN74LS122N	Monostable Multivibrator Retriggerable Mono
2	U4, U5	SN74LS73AN	Flip Flops Dual J-K Flip-Flops with Clear
1	U6	SN7438N	Logic Gates Quad 2-Input
1	U2	L78M05CV	Linear Voltage Regulators 5.0V 0.5A Positive
3	U7, U8, U9	NTE9950N	DTL R-S Flip Flop Pulse Triggered
1	Y2	ECS-2100A-012.2	OSC XO 1.2288MHZ HCMOS TTL PC
1	J1	960206-6202-AR	Headers & Wire Housings 6P STR SR BDMNT SKT 3.0MM TAIL/7.1MMBODY
1	JP1	90131-0770	Headers & Wire Housings 2.54MM CGRIDIII HDR 20P VERT DR SEL AU
1	JP2	90120-0762	Headers & Wire Housings 2.54MM CGRIDIII HDR 2P VERT SR SEL AU

1	JP3	90131-0763	Headers & Wire Housings 2.54MM CGRIDIII HDR 6P VERT DR SEL AU
1	KK1	7-340-2PP-BA	Heat Sinks BLK ANODIZED HEAT SINK
7	TP1, TP2, TP3, TP4, TP5, TP6, TP7	5000	Test Point Red Through Hole
4	PEM1, PEM2, PEM3, PEM4	SMTSO-256-4ET	SMTSO SMD Threaded Standoff (#2-56) Length 0.125 in.
5	BOM-ENTRY1	15-29-1025	Headers & Wire Housings SHUNT CLOSED TOP 2P
2	BOM-ENTRY18	53-77-9G	Thermal Interface Products THERMALSIL INSULATOR
2	BOM-ENTRY2	XR2A-0811-N	IC & Component Sockets Socket DIP Term 8P 7.62mm .25AuPlate
9	BOM-ENTRY3	XR2A-1411-N	IC & Component Sockets Socket DIP Term 14P 7.62mm .25AuPlate
1	BOM-ENTRY4	XR2A-1611-N	IC & Component Sockets Socket DIP Term 16P 7.62mm .25AuPlate