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tech tips

Testing Drum Servos With The VC93 and Waveform Analyzer

This Tech Tip explains how to use the Sencore VC93 All Format VCR Analyzer and the Waveform Analyzer to troubleshoot VCR drum servo problems. The step-by-step procedures will help you quickly isolate drum servo problems down to the defective circuit or component. If you need additional information on how servos operate, ask for a copy of Tech Tip #176. If you are unfamiliar with how the VC93 Servo Analyzer Tests work, ask for Tech Tip #186.

Servo Functional Analyzing

The main difficulty in troubleshooting servo problems is to determine which servo loop is at fault. Defects in one servo loop can produce symptoms that may suggest a problem elsewhere. In addition, non-servo related problems can sometimes appear as a servo problem. Functional analyzing using the Sencore VC93 All Format VCR Analyzer and the Waveform Analyzer takes the guesswork out of servo analyzing.

Servo functional analyzing is a three step process:

1. Use the VC93 Servo Analyzer Tests to determine if the problem is servo related.
2. Use the same VC93 Servo Analyzer Tests to localize the problem to the defective drum or capstan servo section.
3. Use the Waveform Analyzer to check key signals to isolate the defective component or circuit within the servo section.

The first two steps of this three step servo functional analyzing process are covered in Tech Tip #186. The third step, as it pertains to drum servo troubleshooting will be covered in the remainder of this Tech Tip. Tech Tip #187 covers the the third step as it pertains to capstan servo troubleshooting.

Identifying Drum Servo Problems

The VC93 provides five Servo Analyzer Tests that quickly pinpoint drum and capstan servo problems. You should do all five Servo Analyzer Tests to ensure that you have narrowed the problem down to the most likely defect. See Tech Tip #186 on how to perform and interpret these tests.

There are four possible drum servo defect areas that the VC93 Servo Analyzer Tests identify:

I. **Reference Frequency Defects**
II. **Drum Phase Loop Defects**
III. **Drum Speed Loop Defects**
IV. **Mechanical Defects**

After you have tested the VCR with the VC93 and have determined the defect area, refer to the appropriate section in this Tech Tip to isolate the problem down to the specific component or circuit.

SERVOS LOCKED	CAPSTAN SPEED ERROR	CAPSTAN JITTER	DRUM SPEED ERROR	DRUM JITTER	MOST LIKELY DEFECT	DEFECT AREA
GOOD	GOOD	GOOD	GOOD	GOOD	NO SERVO DEFECTS*	
GOOD	GOOD	GOOD	GOOD	BAD	DRUM MECHANICAL	IV
GOOD	GOOD	GOOD	BAD	N/A	REFERENCE FREQUENCY	I
GOOD	GOOD	BAD	GOOD	GOOD	CAPSTAN MECHANICAL	
GOOD	BAD	N/A	GOOD	GOOD	REFERENCE FREQUENCY	
GOOD	BAD	N/A	BAD	N/A	REFERENCE FREQUENCY	I
GOOD	BAD	N/A	GOOD	BAD	REFERENCE FREQUENCY	I
BAD	GOOD	GOOD	GOOD	GOOD	CAPSTAN PHASE LOOP or DRUM PHASE LOOP	II, III
BAD	BAD	N/A	GOOD	GOOD	CAPSTAN SPEED LOOP or CAPSTAN MECHANICAL	
BAD	GOOD	BAD	GOOD	GOOD	CAPSTAN PHASE LOOP or CAPSTAN MECHANICAL	
BAD	GOOD	GOOD	BAD	N/A	DRUM SPEED LOOP or DRUM MECHANICAL	III, IV
BAD	GOOD	GOOD	GOOD	BAD	DRUM PHASE LOOP or DRUM MECHANICAL	II, IV
BAD	BAD	N/A	BAD	N/A	REFERENCE FREQUENCY	I
BAD	BAD	N/A	GOOD	BAD	REFERENCE FREQUENCY	I

*NOTE: A noise bar that occurs periodically at a rate of one minute or greater could be a capstan or drum phase problem.

Fig. 1: Several VC93 Servo Analyzer Test results point to a potential drum servo problem.

I. Locating Reference Frequency Defects

In the playback mode, the capstan and drum servos must lock to a reference 30 Hz (29.97Hz) signal. This reference signal is derived from a higher frequency master oscillator such as the 3.58 MHz oscillator used by the color circuits.

NOTE: Some VCRs and camcorders do not use the 3.58 MHz color oscillator for its servo reference source. Refer to the manufacturers' service literature for the specific frequency of the servo reference oscillator in these VCRs and camcorders.

In most cases, the reference divider circuits are located inside the servo IC and the final reference 30 Hz signal can not be directly measured. Instead, the master oscillator is the only signal available for testing. There are two essential parameters of the master oscillator that should be checked. They are its frequency and its amplitude. Use the Waveform Analyzer to quickly check both of these parameters.

The master oscillator must have sufficient amplitude to ensure that the count-down circuits in the servo IC will operate properly and generate the reference 30 Hz signal. Use the Waveform Analyzer to first check the amplitude of th e master oscillator signal. Simply connect the Channel A probe to the master oscillator test point and press the CHAN A VPP button. Read the digital display and compare the results to the level give in the manufacturers' service literature.

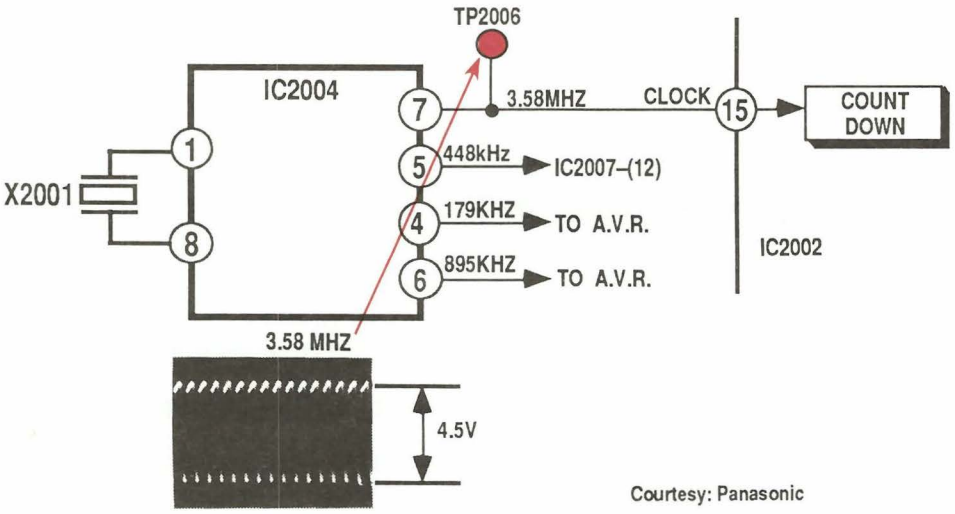

Fig. 2: Check the reference signal generator output for proper amplitude and frequency. If it is a 3.58 MHz color oscillator, the frequency should be within (+/- 100 Hz) of the correct frequency.

The master reference oscillator must also operate at the correct frequency to ensure that the servos operate correctly. In most VCRs, this signal is the 3.58 MHz color oscillator. Even an error as small as 100 Hz in the 3.58 MHz signal can cause problems in the servos and/or color circuits. Use the Waveform Analyzer to check the master oscillator frequency. Select the "CH A" position of the TRIGGER SOURCE switch, and the "Auto" position of the TRIGGER MODE switch. Leave the TRIGGER LEVEL control set to "0". Now press the CHAN A "FREQ" button for Channel A and read the digital display. The frequency should read between 3.57945 and 3.57965. If it is outside this range, suspect a bad crystal or digital oscillator stage.

II. Locating Drum Phase Loop Defects

The SERVOS LOCKED test is one of the key tests in identifying whether a servo phase loop problem exists. The SERVOS LOCKED test, done alone however, will not isolate a problem down to the drum phase loop. You need to perform the other four tests to determine if the problem, is in the drum phase loop or not. If the DRUM JITTER test also shows "bad" but the drum and capstan speed tests are good then the VC93 has conclusively proved that a drum phase loop problem exists.

Occasionally, you may test a VCR that reads "bad" on the SERVOS LOCKED test but "good" on all other tests. These test results occur when a marginal phase loop problem is not sufficiently bad for the other Servo Analyzer Tests to pick up. In this case, the problem is either the capstan or the drum phase loop. To troubleshoot a marginal type of phase loop problem like this, start by troubleshooting the capstan phase loop following the procedures given in Tech Tip #187. If all capstan phase loop tests are good, then troubleshoot the drum phase loop following the procedures given here.

There are several potential reasons why a drum phase loop fails to operate. They are:

1. Pulse Generator (PG) signal is missing or weak.
2. Drum servo IC is defective.
3. Low pass filter circuit is defective.

Troubleshooting of drum phase loop problems is best done in the following sequence:

1. Check the PG feedback signal:
Since a properly operating drum servo circuit needs a feedback signal to tell it where the drum is at any instant of time, this is the first signal to check. There are at least three types of PG pulses present in VCRs: a dual polarity pulse, a single polarity pulse, and a combined PG/FG pulse.

Some VCRs use two magnets located on opposite sides of the drum flywheel to produce the PG pulses. Each magnet is mounted with the opposite magnetic pole to the out-

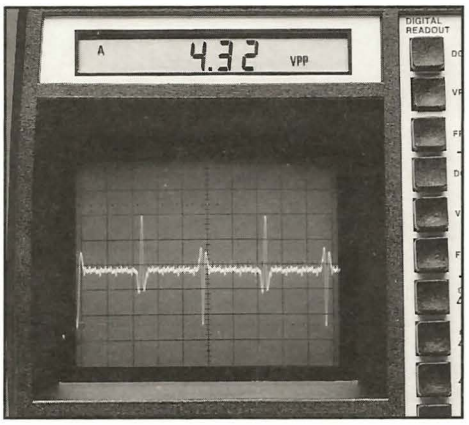

Fig. 3: The PG Pulse in some VCRs is of both a positive and a negative polarity.

side. A magnetic pickup, much like an audio playback head, responds to the magnetic field of each magnet and produces positive and negative polarity pulses. The order of the pulses determines which video head is associated with each magnet.

Other VCRs use a single magnet and a hall effect sensor to detect the position of the video drum. The PG pulse from the hall effect sensor is a single polarity pulse.

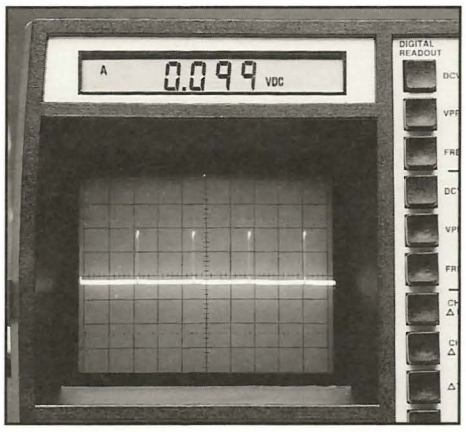

Fig. 4: VCRs that use the hall-effect sensors have a single polarity PG pulse.

Some late model VCRs combine the Pulse Generator (PG) signal with the Frequency Generator (FG) signal. These two signals are combined right at the sensor amplifiers and are fed simultaneously on the same data line. The PG pulse is sometimes at a higher amplitude than the FG pulses and is detected inside the servo IC with a level detection circuit. Other VCRs separate the pulses using filters.

NOTE: In VCRs using a combined PG/FG pulse, the servos in these VCRs can lock incorrectly if the drum PG pulse is missing, locking instead to the FG signal. Since the FG signal is of a higher frequency, the servos will lock to any one of the FG transitions. This produces a locked in picture with noise or a noise bar appearing in the picture. The VC93 SERVOS LOCKED test indicates the servos are locked. This is a correct diagnosis because the servo phase loops are actually locked, even though it is the incorrect one.

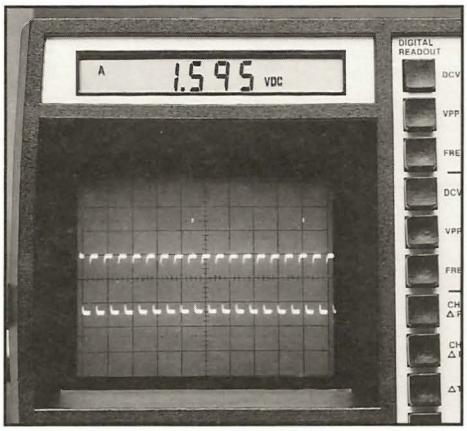

Fig. 5: Some VCRs combine the FG and PG pulse together. This is a typical example of a combined FG/PG pulse.

The best way to diagnose this problem is to stop and start the VCR several times while observing the position of the noise bar on the screen. Because the servos will lock to any FG transition, the noise bar will change position each time the VCR is placed into the PLAY mode. If you observe this symptom, check the combined FG/PG pulse for a missing PG pulse.

Irregardless of the type of PG pulse used in the VCR, the amplitude of the pulse must be sufficiently large to allow the servo circuits to use it. If the PG pulse is too small, erratic operation will result. You should check the amplitude of the PG pulse right at the PG input pin on the drum servo IC and compare it to the manufacturers service literature. In general, the signal should be large enough for a TTL or CMOS circuit to respond to it.

Use the SC61 to check the amplitude of the PG pulse. First, connect the Channel A probe to the PG input pin on the drum servo IC. Next, press the CHAN A VPP button. Read the results on the SC61 display and compare to the manufacturers service literature. If the signal is too small, troubleshoot the PG pickup device. If it is a hall effect type sensor, make sure that the bias voltage to the sensor is present.

2. Check the pulse width modulator (PWM) signal:

Most VCRs presently use pulse width modulators to create servo correction voltages. Use the SC61 to analyze the operation of the PWM circuits. Connect the SC61 to the drum phase PWM output pin, ahead of the low-pass filter. Adjust the TIMEBASE-FREQ control on the SC61 until you see two or three squarewave cycles.

The duty cycle of the PWM signal will constantly vary in a normally operating drum servo. Confirm normal servo correction by increasing the physical drag on the drum. You should see the duty cycle of the PWM signal change as it attempts to correct for the change in drag on the drum circuits.

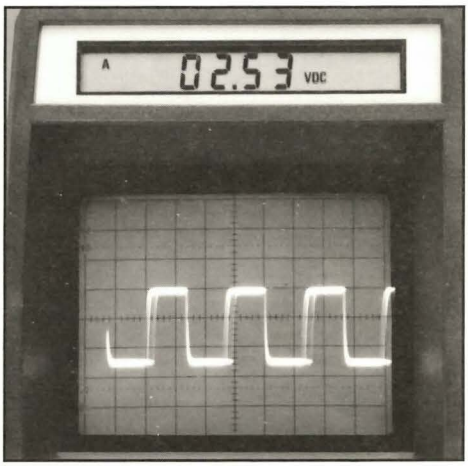

Fig. 6: The output of the pulse width modulator should vary slightly in duty cycle. Placing a light drag on the motor should change the duty cycle of the pulse.

With a defective drum servo, the PWM output will vary wildly, or remain steady. The steady condition will produce a squarewave with constant duty cycle, a narrow pulse, or a constant DC near the supply level or ground. If any of these conditions are observed and you have already confirmed that the drum phase servo is receiving a proper PG pulse reference signal, then the servo IC is defective and should be replaced.

3. Check the low pass filter circuit:

The output to the drum phase PWM must be filtered to supply a DC correction voltage for the motor control IC. A simple filter circuit is used to create this voltage. Move the Waveform Analyzer probe to the output of the low-pass filter circuit. Place the input coupling switch to DC, the VOLTS/DIVISION switch to .2, and the TIMEBASE-FREQ switch to 1msec. Again increase the physical drag on the drum and watch for up or down movement of the trace. If no movement is seen, or the DC voltage fluctuates wildly, then check the low pass filter. Filter capacitors in these circuits sometimes develop high ESR or open up, preventing proper filtering of the drum phase PWM signal.

III. Locating Drum Speed Loop Defects

If the VC93 DRUM SPEED ERROR test reads "bad", it indicates that the drum speed circuits are not functioning properly. There are several reasons why the drum speed circuits can fail. They are:

1. Frequency Generator (FG) signal is missing or weak.
2. Defective drum servo IC is defective.
3. Low-pass filter circuit is defective.

Troubleshoot a drum speed problem in the following sequence:

1. Check the FG feedback signal:

Since a properly operating drum speed circuit requires a feedback signal to monitor the speed of the drum, this is the first signal to check. If the FG signal is missing, the drum will either run at full speed or not run at all. Use the Waveform Analyzer to check for the presence of the drum FG signal.

The amplitude of the FG signal must be sufficiently large to allow the servo circuits to respond to it. If the FG pulse is too small, erratic operation will result. Use the Waveform Analyzer to check the amplitude of the FG pulse by first connecting the Channel A probe to the FG input pin on the drum servo IC. Next, press the CHAN A VPP button. Read the results on the digital display and compare to the manufacturers' service literature. If the signal is weak or not present, check the FG sensor. If the sensor is a hall-effect type, verify that the sensor is receiving its required DC power. If the DC power is present at the sensor, then replace the hall-effect sensor.

2. Check the pulse width modulator (PWM) signal:

Most VCRs use a pulse width modulator followed by a low-pass filter to create the speed error correction voltage. Use the Waveform Analyzer to check the operation of the PWM output by connecting the probe to the drum speed PWM output pin, ahead of the low-pass filter. Adjust the TIMEBASE-FREQ control on the Waveform Analyzer until you see two or three cycles of the FG pulse.

The duty cycle of the PWM signal will constantly vary in a normally operating drum servo. Confirm normal servo operation by increasing the physical drag on the drum. You should see the duty cycle of the PWM signal change as it attempts to correct for the drag on the drum.

With a defective drum servo, the PWM output will vary wildly, or remain steady. The steady condition will produce a squarewave with constant duty cycle, a narrow pulse, or a constant DC near the supply level or ground. If any of these conditions are observed and you have already confirmed that the drum speed servo is receiving a proper FG pulse and reference signal, then the servo IC is defective and should be replaced.

3. Check the low-pass filter circuit:

The output of the drum speed PWM must be filtered to supply a DC correction voltage to the motor driver IC. A simple filter circuit is used to create this voltage. Move the Waveform Analyzer probe to the output of the low-pass filter circuit. Place the input coupling switch to DC, the VOLTS/DIVISION switch to .2, and the TIMEBASE-FREQ switch to 1mSec. Adjust the VERTICAL POSITION control until the trace is in the center of the screen. Again, increase the physical drag on the drum and watch for up and down movement of the trace. If no change is seen, or the DC voltage fluctuates wildly, then check the filter. Filter capacitors used in this circuit sometimes exhibit high ESR, or open up, preventing proper filtering of the drum speed PWM signal.

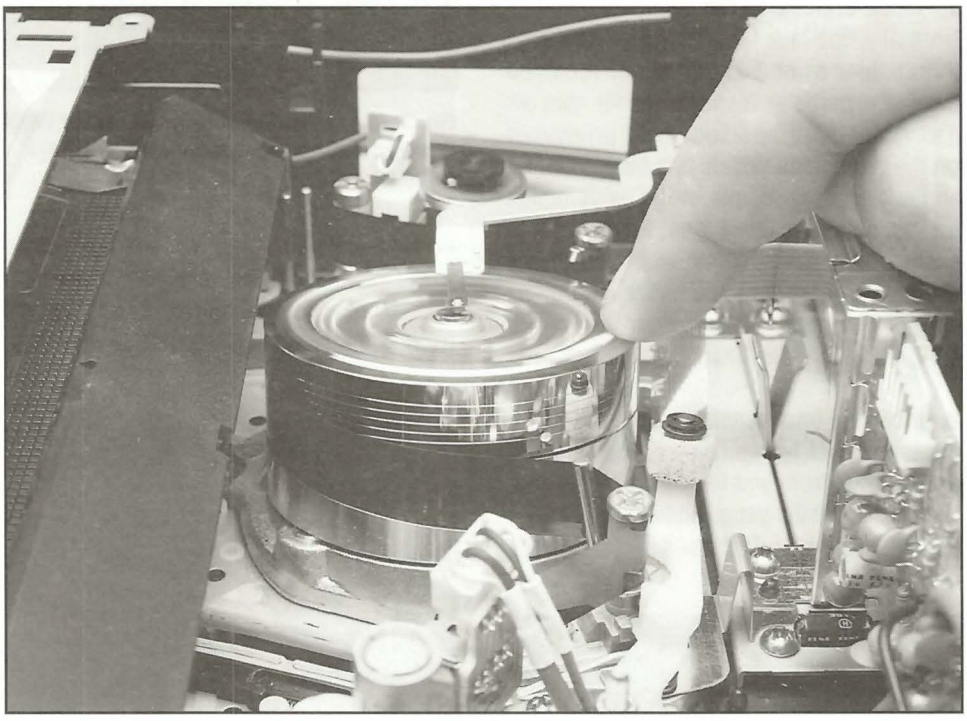

Fig. 7: Lightly touch the drum with your finger to place a slight drag on the drum. You should see a change in the signals and voltages in the servo circuit in response to this drag.

IV. Locating Mechanical Defects

Minor drum related mechanical problems are compensated for by the drum servo circuits. As these mechanical problems progressively get worse, a point is reached where the drum servos can no longer compensate for them. This produces erratic rotation of the drum resulting in poor picture quality.

Several mechanical related problems can cause erratic drum rotation:

1. Oxide buildup on the drum.
2. Incorrect back tension on the tape.
3. Defective motor or motor driver.

Troubleshooting of mechanical problems is most successfully done by carefully observing the operation of the key mechanical functions. Let's look at each of the potential mechanical problem areas identified.

1. Oxide buildup on the drum:
Normally, the tape rides off the drum on a thin cushion of air. The grooves on the video head are partially responsible for this air gap. A buildup of tape oxide in the grooves or on the drum itself upsets this cushion of air and excess drag results. If the oxide builds up in a small localized area, this results in excess drag during only a portion of the drum rotation. Check the entire circumference of the drum and clean any oxide off with a high quality video head cleaner.

2. Incorrect back tension on the tape:
Excessive back tension on the tape creates a drag on the drum just like an oxide buildup. Use a tape tension gauge and adjust the back tension to the manufacturer's specifications.

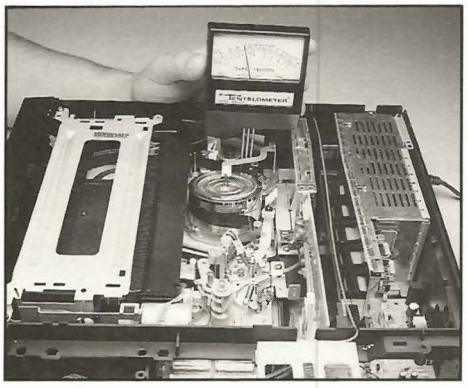

Fig. 8: Check the back tension on the supply reel using a tension gauge.

3. Defective motor or motor driver:
A bad bearing, defective motor winding or missing drive signal will cause erratic drum rotation. Use the Servo Sub Bias on the VC93 to inject a DC voltage into the motor driver control input. The way the motor responds to this voltage tells a lot about the operation of the motor and motor driver. Changing the Servo Sub Bias voltage should cause the motor to change speed. You will not be able to get the motor to run at its exact operating speed because the motor driver has extremely high gain. It is normal for variations of only a few tenths of a volt from the normal "zero correction" level to drastically change the motor speed. Careful control of the DC voltage should let you get the speed near normal. If the motor fails to turn, or it continues to turn too quickly or too slowly with a normal DC input, the problem is in the motor driver or the motor.

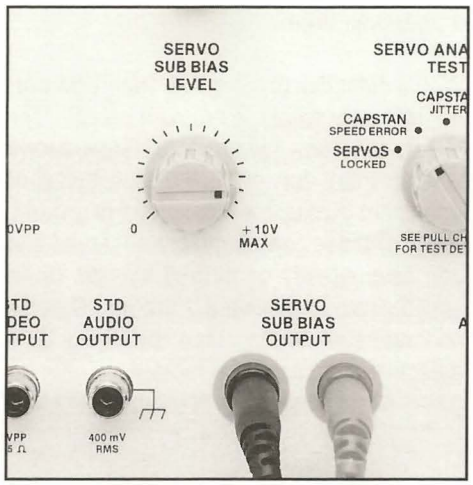

Fig. 9: Use Servo Sub Bias supply on the VC93 to supply a substitute control voltage for the servo motor IC.

If you suspect that the motor driver circuits are at fault, continue to feed the substitute DC voltage into the driver IC while you trace the two or three phase AC motor drive signals with your Waveform Analyzer. Confirm that each driving signal has the same waveshape, frequency, peak-to-peak level, and DC bias as the others. Observe the Waveform Analyzer's CRT and press the appropriate digital readout selector buttons one at a time. If one signal differs from the others, the driver circuits are at fault, or the motor has a bad winding. If the signals are all the same and the motor has a jerking motion, stop the VCR and manually turn the drum. Feel for any catching as you rotate the capstan. A sudden catch is an indication of a bad motor bearing.

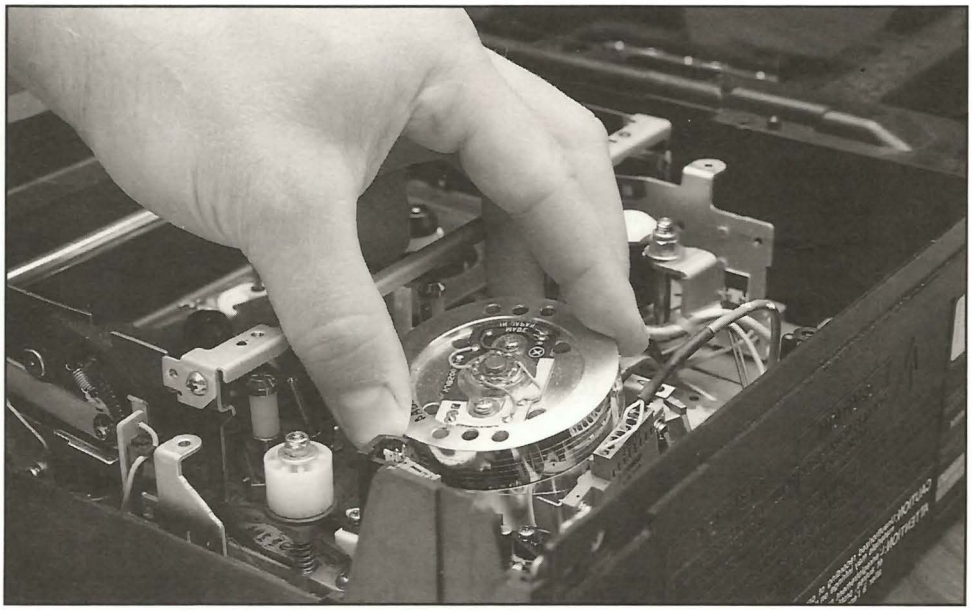

Fig. 10: Place a slight down pressure on the video drum as you turn it. Feel for a catch that is caused by a bad motor bearing.

NOTES

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