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tech tips

Troubleshooting VCR Servos

This Tech Tip explains how to use the Sencore VA62A Universal Video Analyzer, the SC61 Waveform Analyzer, and a test tape recorded with VA62A signals to identify the source of servo troubles. The step-by-step procedures use a combination of signal tracing and signal substitution to quickly identify the bad circuits. If you need background on how servos operate, ask for a copy of Tech Tip #176, which takes you through circuit operation.

Organized Troubleshooting Methods

The main difficulty in isolating servo problems is the way several feedback loops overlap each other. It's common to spend time troubleshooting one loop, and to learn later that the trouble was really in a different loop. To avoid this, follow these steps (each is covered in detail later):

1. Confirm a servo problem by analyzing the symptoms with a test tape.
2. Confirm the 3.58 MHz reference signal is correct with the SC61's digital measurements.
3. Confirm if the cylinder and capstan loops are locked to each other by comparing the head-PG and the control-track signals.
4. Separate problems in the capstan servo from those in the cylinder servo by testing the 30 Hz feedback signals to see which one is wrong.
5. Separate speed from phase loop problems with a combination of signal tracing and signal injection.
6. Narrow the problem to a particular component with signal tracing or component tests.

Confirming Servo Symptoms

Most servo defects cause picture tearing, and may also affect the linear (non-hi-fi) audio. Some servo troubles also blank the picture, hiding the symptom.

Picture tearing may take several forms. Sometimes, the picture is clear for a while, gradually turns to noise, and then gradually returns to normal. In other

Fig. 1: Servo problems usually cause the picture to tear, or to change between clear and snowy. If the tearing remains stationary, or if the picture stays snowy all the time, the servos are not a likely cause.

VCR Symptoms

Probably are servo related:

1. Linear (not Hi-Fi) audio is at wrong speed.
2. Linear audio is changing in pitch (warbling).
3. Picture alternates between clear and snowy at a regular rate.
4. A horizontal noise bar passes through the picture from time to time, either moving from top to bottom or bottom to top.
5. Picture noisy, and adjusting the tracking control has no effect

May or may not be servo related:

1. Jitter, or noise near picture top or bottom.
2. Screen is blank, or audio is muted.
3. Tape loads, but does not play.
4. Machine begins to move tape, but then shuts down.
5. VCR plays tapes it recorded okay, but will not play tapes recorded on another machine.

Probably not servo related:
(Probable cause shown for each)

1. Picture is always snowy or constantly noisy, but tracking control changes results. (Bad head signal)
2. Picture has a noise bar which remains in the same position on the screen. (Tape path)
3. Picture has a line running horizontally across the screen from left to right. (Scratched tape)
4. Color is intermittent (or missing) but black and white (luminance) signal is okay. (Bad color circuit or weak head signal)
5. Picture changes in brightness as tape plays; especially on copies of tapes. (Copy protection on copied tape)

Fig. 2: Relating each symptom to its likely cause prevents troubleshooting servo circuits when some other circuit is at fault.

Fig. 3: If the picture remains noisy all the time, the problem is likely not in the servos. This photograph shows the symptom caused by a bad head, head amplifier, or A/B head switching IC.

Fig. 4: A thin horizontal line at one location in the screen is not caused by a servo problem. The most likely problem is a physical scratch on the tape. If the suspect machine is scratching tapes, it will permanently place a line on every tape that passes through.

cases, a noise bar intermittently moves through the picture, either from top to bottom or from bottom to top. In still other cases, the picture jumps up and down, or noise appears at the top or bottom of the picture.

Servo symptoms can be even more confusing when they combine with problems in other circuits. Fig. 2 breaks the common symptoms down to their probable causes.

Testing the 3.58 MHz Reference Signal

If symptoms point to the possibility of a servo problem, follow a plan to isolate the specific problem. If the VCR lets you get to the 30 Hz reference signal, test it first. Most servo circuits, however, no longer bring this signal outside the main IC, so start with the 3.58 MHz signal feeding into the servos. Errors in this signal can produce a wide range of symptoms, including loss of color, poor horizontal sync, and incompatibility between tapes recorded in one VCR versus another.

The two essential parameters of the reference signal are its frequency and its amplitude. A quick check of waveshape with a scope is not adequate to confirm either.

The peak-to-peak amplitude must be large enough to trigger the later stages.

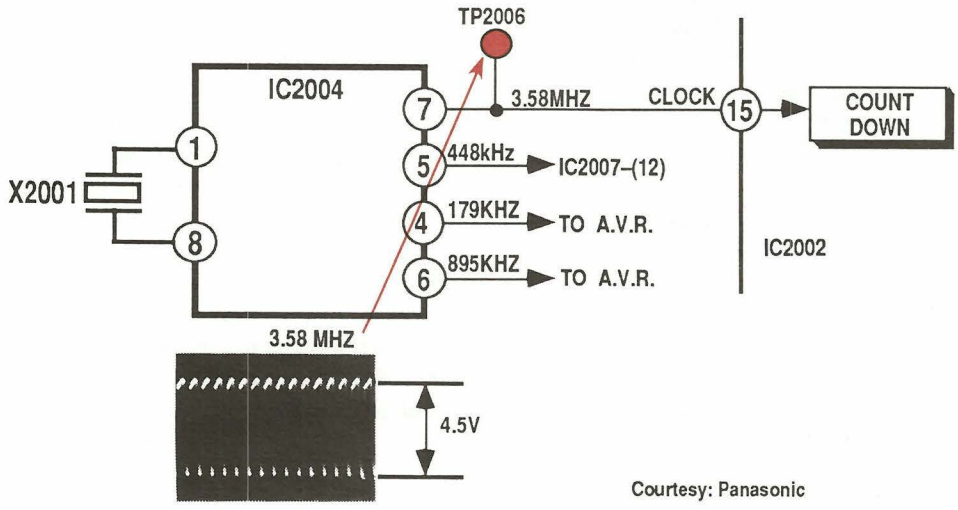


Fig. 5: The first step to effective troubleshooting is confirming the 3.58 MHz reference signal is correct. The signal should have a frequency of 3.57954 MHz (±100 Hz.) and a peak-to-peak amplitude close to the level shown on the VCR's schematic.

If the amplitude is low, the circuits may intermittently trigger on the signal, which leads to unreliable operation. Simply connect the SC61's Channel A probe to the test point, and press the "VPP" button to verify the correct signal amplitude.

The signal must operate at the correct frequency, since the color and sync frequencies of the played back video are affected by the servos. Even a 100 Hz error in the reference can change the color and the horizontal sync frequencies enough to cause problems.

To test the reference frequency, choose 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". Press the "FREQ" button for Channel A, and read the digital display.

The frequency should read between 3.57945 and 3.57965 MHz. If it is outside this range, suspect a bad crystal or digital oscillator stage.

Compare Cylinder and Capstan Feedback

Sometimes, a servo symptom directly indicates if a problem is in the capstan or cylinder (sometimes called head or drum) servo. For example, audio at the wrong speed shows the capstan is turning at the wrong rate. Or, you may notice that a cylinder motor is turning much too fast or slow by its sound.

But, many problems are more subtle. They could be caused by problems in either servo. For example, a defective capstan phase loop can cause intermittent picture tearing. The capstan's speed loop may operate the motor so close to normal that the tape's audio plays normally, which could lead you to troubleshoot the cylinder servo.

The easiest way to confirm if the servos are locked is to compare the two phase-correction feedback signals. If the servos are working, these two signals are locked to each other, indirectly through comparison to the internal 30 Hz reference signal. If they are locked, the problem is not really in the servos, so you should turn your attention elsewhere.

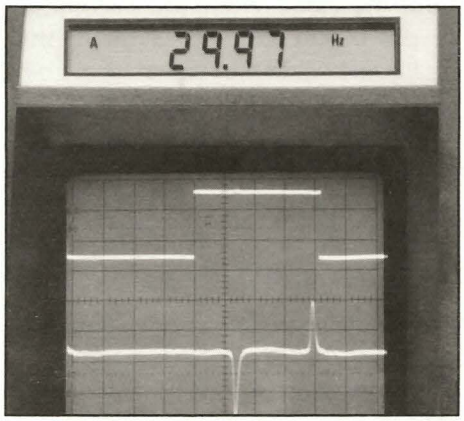


Fig. 6: Confirm that each servo is properly locked by comparing the 30 Hz head PG signal with the control track signal. If the signals drift past teach other, the servos are not locked.

The capstan feedback signal comes from the control-track head. The signal at the head itself is usually very small, so you may need to pick up the signal after an amplifier or multivibrator. If you do this, however, don't forget that the intervening stage may be the actual cause of the problem.

Connect channel A of your SC61 to the control head amplifier output. This should produce a 30 Hz pulse signal as the tape plays. Trigger the CRT from this signal.

The cylinder feedback comes from the PG generator on the head-motor assembly. Some VCR motors combine the PG and the FG signal into one output, with the PG signal represented by a pulse of higher amplitude or wider duty cycle. Since you are triggering the SC61 from the control track signal, you don't need to adjust the trigger circuits to separate the special PG signal from the FG signal. Just watch to see if the PG part of the signal stays locked to the control track feedback signal.

NOTE: Always use a "working" test tape, instead of an expensive alignment tape, for testing suspected servo problems, because some problems will ruin the test tape. Only use the alignment tape for a final check of compatibility after repairing all problems.

Place the SC61 into the dual-trace mode by pressing the "A&B" CRT Selector button. Position the CRT controls until both traces are on the screen. Trigger from Channel A, and carefully watch the Channel B trace. It should remain steady. If it moves in comparison with Channel A (either rapidly, or at a very slow rate) one of the servos is out of lock. If the two signals remain fixed, the servos are both working.

Remember that some servo problems cause the VCR to work correctly on one or more tape speeds, but not on others. If you suspect speed compatibility problems, use a test tape recorded with samples of each tape speed. Confirm that the servos properly switch from one tape speed to the next. If you recorded a test tape following the instructions in the VA62A manual, or in Sencore Tech Tip #107, the first tape segment tests the speed selection circuits.

Separate Cylinder from Capstan Problems

If the signals are not locked to each other, use the SC61's frequency function to determine which one is wrong. Each phase-correction feedback signal should measure 29.97 Hz, within 0.1 Hz. Press the frequency button for Channel A and read the frequency. If the frequency is in error, troubleshoot the capstan circuits.

If the control track signal has the correct frequency, measure the PG signal from the head assembly. If the deck uses a circuit which combines the PG and FG signal into one pulse train, switch the SC61 TRIGGER SOURCE switch to "CH B", and move the "TRIGGERMODE" switch to "Video". The video sync separators will make it easier to trigger directly from the larger PG signal, as you adjust the TRIGGER LEVEL control for stable triggering. This cleans up the composite signal, so that the internal

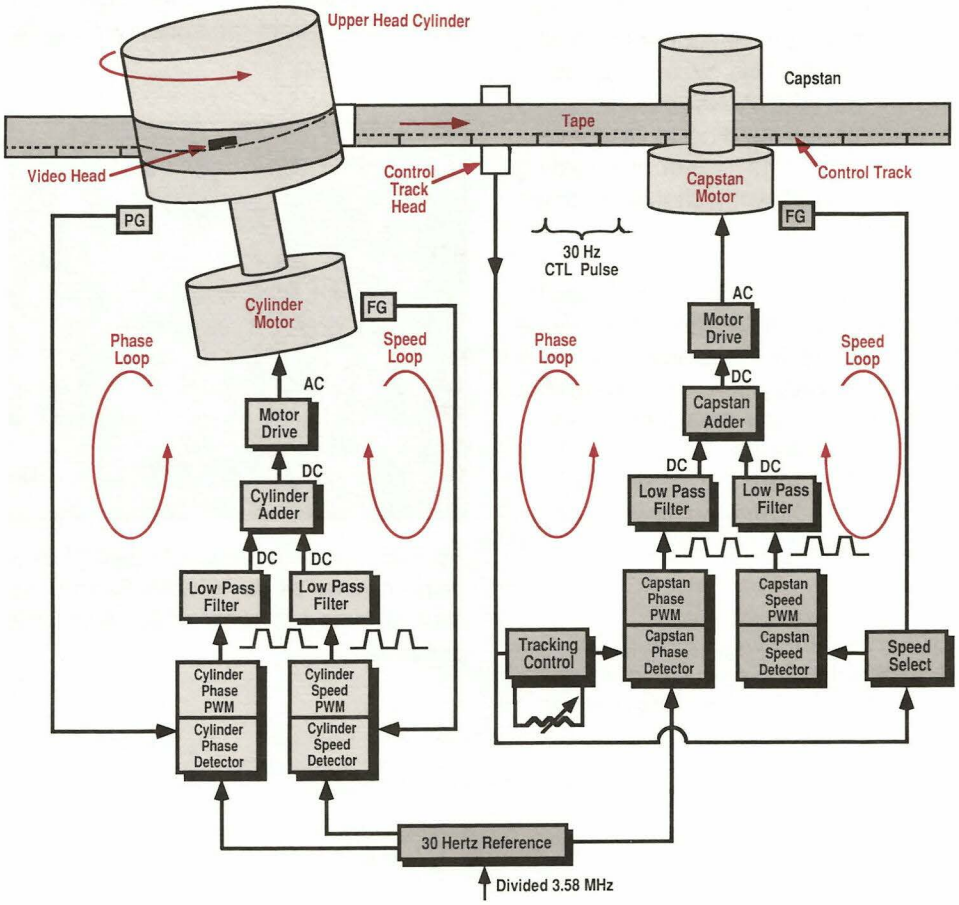
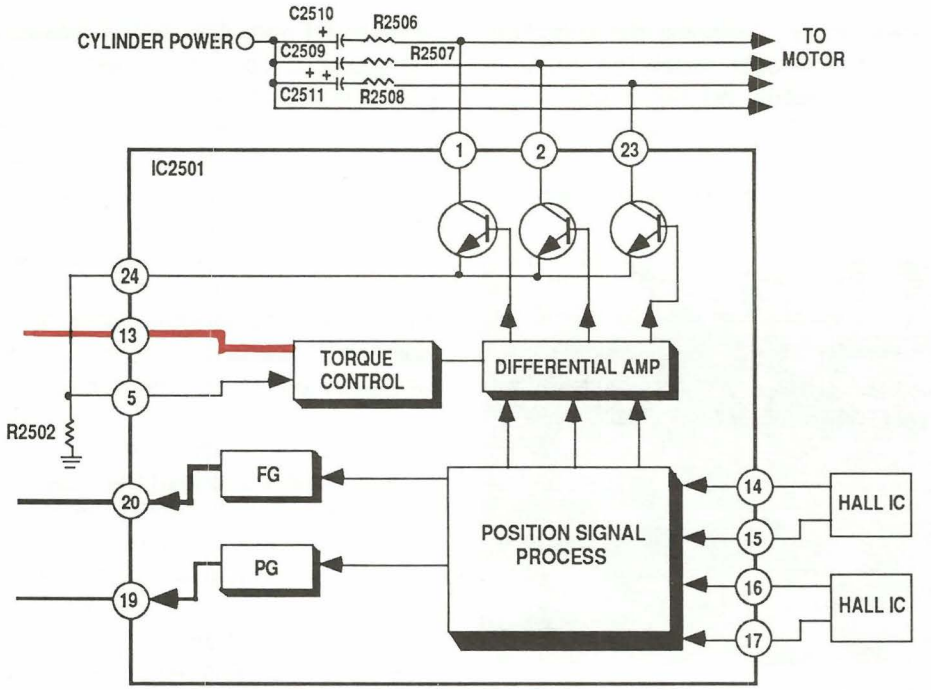


Fig. 7: Use this universal servo block diagram to identify the main test points on your schematic. Start by confirming the reference signal is correct, and then move to the "PG" feedback signals for each servo. If these check, move to the correction signals.



Courtesy: Panasonic

Fig. 8: Injecting substitute DC from the VA62A at the test point between the servo circuits and motor driver confirms whether the motor and its electrical driver circuits work correctly. You should be able to control the speed of the motor by varying the DC voltage.

frequency circuits measure only the PG portion of the signal, while ignoring the higher frequency FG signal.

Separate Phase from Speed Loops

The comparison of the 30 Hz feedback signals identifies whether problems are in the capstan or the cylinder circuits. If the defective signal is very close to the correct signal, the speed loop is most probably working, so troubleshoot the phase loop.

If the frequency is considerably out of tolerance, you cannot be certain which loop is defective, so the following steps are needed to confirm the problem.
The combination of signal injection and signal tracing works the best. Inject a DC voltage from your VA62A troubleshooting power supply into the testpoint which controls the motor speed. This is the test point **after** the circuit which mixes the correction voltages from the error detectors from the two loops.

By manually adjusting the voltage, youshould be able to control the motor's speed until it runs near the normal speed. (Sometimes, the motor will "fight" adjustment to the exact speed, since one of the servo loops may cause the voltage to change as you adjust the VA62A control to a voltage near the ideal level. The motor might jump between speeds above and below normal rates. This, however, indicates the motor and its driver are working correctly.) If you cannot get the motor to a speed near normal, suspect a problem in the motor or the motor driver.

Adjust the external DC until the motor runs as close as possible to its normal speed. Then, follow the Frequency Generator (FG) signal path in the defective servo. Measure the FG output directly, to confirm that it produces an output of the correct amplitude and frequency. Remember that the frequency will probably not be exact, since the external DC voltage only gets the motor close to the correct speed. But, the frequency should be close to the normal operating frequency.

For example, if the frequency is about half the normal FG output, though the motor is turning at a speed close to normal, you have confirmed a defective frequency generator. Often, the only solution for this problem is a new motor assembly.

If the FG signal appears normal, continue tracing the signal through the various stages back to the FG error detector. If the entire FG loop has normal signals, finish your test of the speed loop by connecting your SC61 probe to the error detector output. Carefully watch the test point for correction on the SC61's digital readout and CRT (set for DC coupling), as you vary the DC substitution voltage to change the speed of the motor.

If the error detector is working, you should see the output swing from its lowest to its highest output level as the motor changes speeds from below to above the normal rotational speed. If the error detector does not respond in this way, suspect that the error detector or the storage capacitor at its output to be the problem.

If the speed loop checks okay, the problem is most likely in the phase loop. Trace the signals from the phase-loop's PG source, through the error detector, just as you did in the speed loop. One important difference happens when you vary the speed of the motor manually. The phase loop will normally alternate between highest and lowest values, even if the motor is turning at nearly the correct speed, since the phase between the PG and the reference signals are random. If you see very small changes at the error detector output, check the components related to the error detector.

Special Notes On Pulse Width Modulators

When testing pulse-width-modulator (PWM) error detectors, watch for correction at the PWM output, ahead of the low-pass filter (LPF). Confirm normal correction by increasing the physical drag on the motor or a pulley to see if the PWM duty cycle changes in a normal fashion. Lightly touch a rotating part with your finger to cause a change.

When connected ahead of the VCR's LPF, the SC61's digital DC voltage readout shows the average DC level represented by the square wave, which is the same correction voltage at the LPF output. The SC61's CRT shows the actions of the modulated pulse.

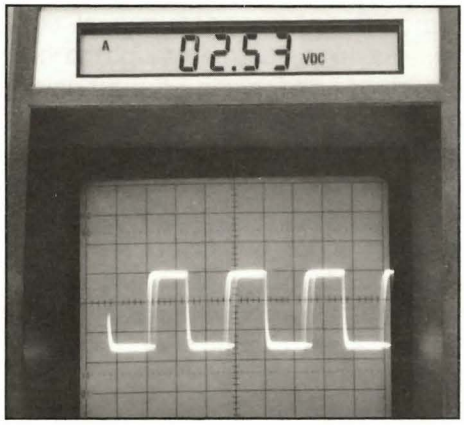


Fig. 9: When the pulse width modulator corrects for variations in tape motion, the output shows horizontal movement. Loading the motor, by lightly touching a pully with your finger, should change the pulse width .

With a servo defect, the PWM output will vary more than normal, or be too steady. The steady condition may produce a squarewave with constant duty cycle, a narrow pulse, or a constant DC near the supply level or ground.

Testing the Motor and Motor Driver

Servo problems are often caused by mechanical or electrical problems in the motor or its driver, which are after the

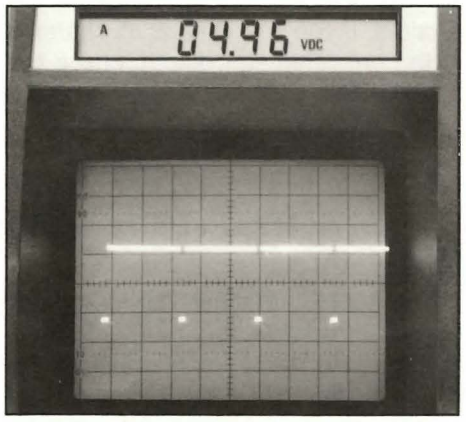


Fig. 10: Some servo problems will cause the PWM to go to maximum or minimum correction. If so, it may show pure DC, or a very narrow pulse, as shown here.

error detectors. If so, both loops will test normally as you move through the various test points, but servo errors remain. The way the motor responds to your substitute DC controlling signal tells a lot about the operation of the motor and motor driver. Changing the substitute DC value should cause the motor to change speeds, but the motor should turn smoothly at any speed.

You might not be able to get the motor

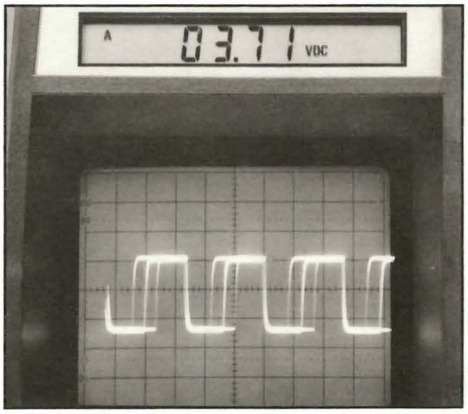


Fig. 11: Other problems may cause the PWM output to rapidly change from maximum to minimum pulse width. Injecting the VA62A signal should let you bring the correction under control, if the circuits after the injection point are working correctly.

to 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. The important thing is that careful control of the DC voltage should let you get the speed near normal. If the motor fails to turn, or if it continues to turn too quickly or too slowly with a normal DC input, the problem is in the driver or the motor.

If you think the motor driver circuits are at fault, continue to feed the substitute DC voltage into the driver, while you trace the two or three phase AC motor drive signals with your SC61. Confirm that each driving signal has the same waveshape, frequency, peak-to-peak level, and DC bias as the others by observing the CRT and by pressing the SC61 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.

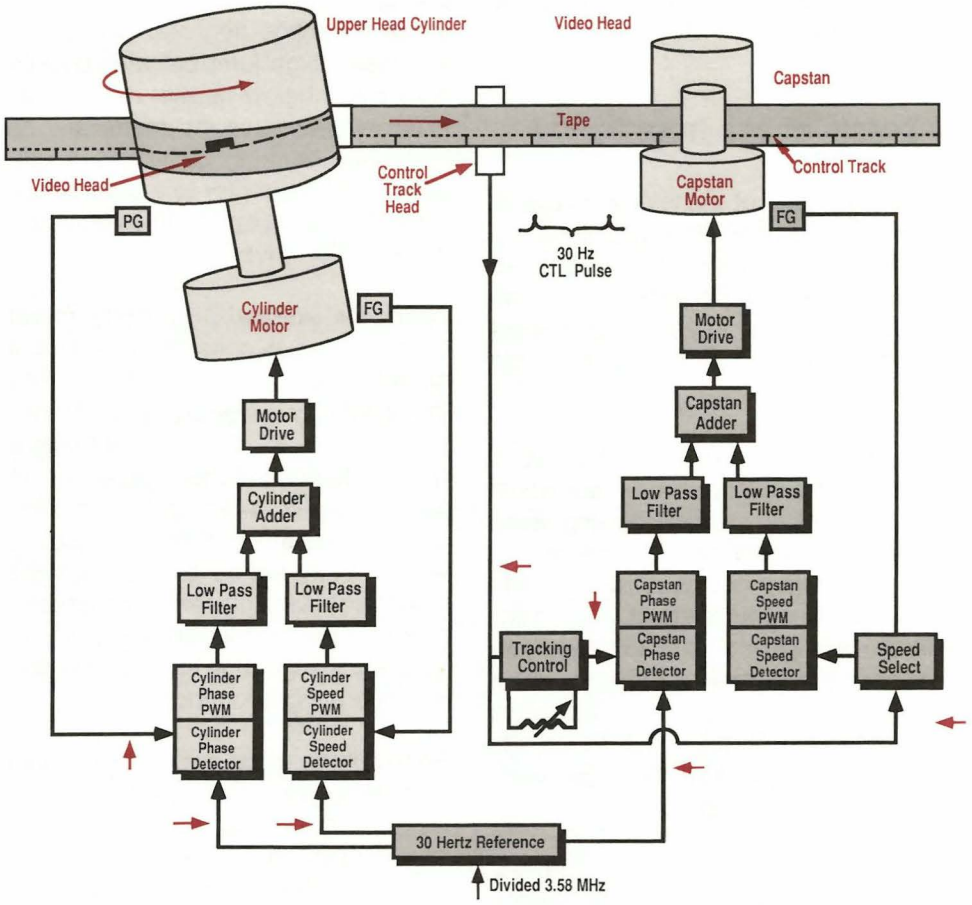


Fig. 12: The VA62A's 30 Hz Servo Drive signal will substitute for any of the 30 Hz signals in the VCR. Follow the procedures covered at the end of this Tech Tip to set the signals for the correct amplitude to safely inject into the low impedance servo stages.

Injecting the 30 Hz Servo Drive

The VA62A's 30 Hz Servo Drive lets you feed a controlled 30 Hz signal into any test point which normally uses a 30 Hz signal. As Fig. 12 shows, this includes signal paths for the control track signal, the master 30 Hz reference, and the PG signal returning from the head cylinder assembly.

The VA62A supplies this substitute signal differently than its other drive signals, because some servo integrated circuits will try to "sink" any current applied externally to their outputs. By comparison, most stages only act as a "source", and can be safely swamped by the VA62A drive signals. This difference calls for a different method of substituting signals than used for other VCR or TV circuits.

Unlike its other driver signals, the VA62A's 30 Hz drive output doesn't automatically "swamp" out the original circuit signal when you connect to a test point. Even with this circuit protection, however, the VA62A lets you inject servo signals without needing to disconnect circuit components to interrupt existing signals. This calls for a slightly modified procedure.

The procedure uses the digital peak-to-peak meter to monitor the signal level in the VCR circuit, before and after making the VA62A connection. This is possible because the meter measures the true signal level, whether it's coming from the VA62A or from the VCR servo circuit. Use the following procedure to inject the 30 Hz servo signals:

1. Before connecting to the circuit, set the VA62 "30 Hz Servo Drive" knob for zero output (fully counter-clockwise).
2. Move the DIGITAL METER switch to the "30 Hz Servo Drive" position.
3. Connect the black test lead to ground and the red test lead to the circuit test point.
4. Place the VCR into its "play" mode, and read the digital meter. If the VA62A shows a voltage reading near the normal signal level, a signal is present in the circuit. If the meter reads near zero, the normal circuit signal is missing.
5. Slowly increase the 30 HZ SERVO DRIVE control, while watching the peak-to-peak voltage on the VA62A digital meter.
6. Stop increasing the drive when the VA62A meter reads 1 to 2 volts higher than the voltage in step 4, or reads the normal peak to peak signal level if step 4 showed a voltage near zero. At this level, the VA62A safely replaces the circuit signal.

After using this procedure to find the correct signal level, you can safely disconnect and re-connect the drive lead to see what effect the substitute signal has on the circuit. When you disconnect the drive lead, the digital meter will usually show a higher signal level than when you have the lead connected. This is normal. **Do not re-adjust the signal level if you will re-connect the test lead to the same test point.** The signal will return to the pre-set level when you re-connect to the test point.

Fig. 13: The servos should respond to a phase-reversal as the VA62A's Servo Drive knob is moved to either of its two switch positions.

Before moving the 30 Hz drive lead to a different servo test point, return the servo drive control to zero and repeat steps 3 through 6 to ensure maximum circuit protection.

The easiest way to tell if the servo circuits are responding to the VA62A signal is to alternate the signal's phase, while the lead remains connected to the test point. Move the SERVO DRIVE control knob to its "in" and then its "out" position, which activates the phase-reversal switch. **(NOTE: Do not rotate the knob, which would change the amplitude. Only change the switch position.)** Each time you reverse the phase, the servos should momentarily change as they correct for the new signal. If they don't, the problem is after the signal injection point.

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