ScannerMAX Saturn 5B-46S scanning 650Hz and 1325Hz at small scan angles

This is a test of the ScannerMAX Saturn 5B-46S scanner with our standard 6mm Y mirror. This particular Y mirror has the capability of scanning a 6mm beam over a 50-degree optical angle.

Based on the customer request, this testing is being done at 4 optical degrees, and 7 optical degrees peak to peak. Since this is much smaller than the 50-degrees that the standard mirror set is capable of, it means that beams larger than 7 mm could be reflected by this mirror set.

The Saturn 5B is available in several coil configurations, including “-46S”, “-74S” and “Standard”. The difference is the number of turns and diameter of wire used in the stator. The “–46S” version has the lowest coil impedance (only 0.9 ohms and less than 100uH) so it provides the best dynamic performance for this kind of application.

The Saturn 5B scanner was driven with ScannerMAX Mach-DSP servo driver having +/-24V rails. This servo driver is capable of driving two scanners (dual axis driver) and it is in a compact package. HOWEVER, for convenience and for low heat dissipation by the servo driver, it is designed to have a single-ended power amplifier. This means that the power amplifier can only deliver approximately +/-21 volts to the galvo coils.

This is in contrast to servo drivers that have an H-bridge output which can nearly double this amount of drive voltage. However, such servo drivers are physically much larger, and also dissipate four times as much heat.

According to our testing, we are able to accomplish the desired 650Hz and 1325Hz both at 4 optical degrees and 7 optical degrees as requested by the client. For this particular application the limitation was not scan frequency, scan angle or even temperature, but rather the limitation is one of “scan efficiency” or perhaps better known as “flyback time” or “retrace time”.

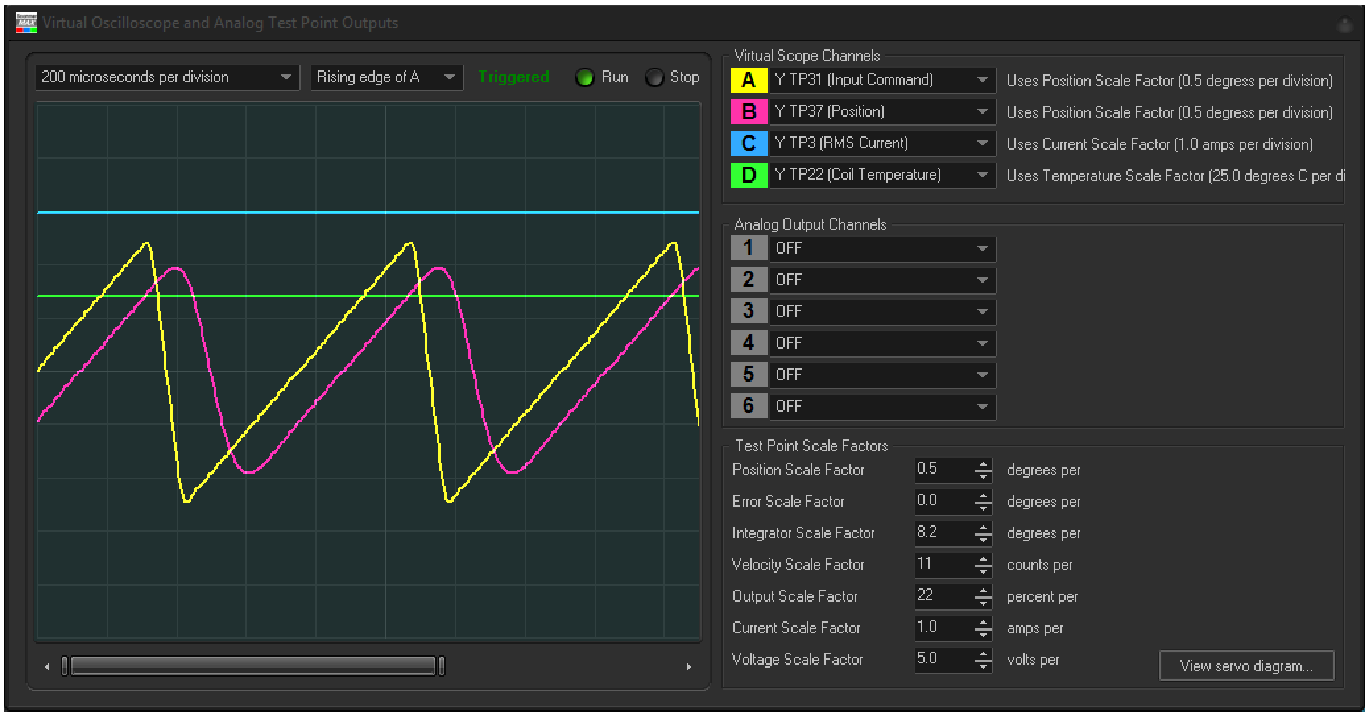
The Mach DSP has a built-in oscilloscope function. This comes in handy as it can be used to measure virtually any quantity of the overall scanning system. For example, the screen shot below shows four separate channels being measured. The yellow trace shows “Input command”. The pink trace shows “Position”. (Both Input and Position are in mechanical degrees, thus, optical scan angle is double that shown in the traces). The blue trace shows the RMS current being driven into the scanner. The green trace shows the coil temperature.

For all of the testing, we drove the input command signal using a function generator capable of generating ramp waveforms with any desired frequency and “symmetry”. You will notice that the input command signal has higher amplitude than the position signal. This is common, since all servo drivers act like low-pass filters and have some “rolloff”. The rolloff could be adjusted if desired.

1325Hz at 4 degrees optical

The scope screen shot below shows the results of 1325Hz (roughly 755 microsecond period) sawtooth waveform. Here the input command signal waveform has 12 percent symmetry (12 percent of 755 microseconds is roughly 90 microseconds). Clearly the position signal (pink trace) has a longer retrace than 90 microseconds. Based on the fact that the scope is showing 200 microseconds per horizontal division, we estimate retrace time is 220 microseconds or so.

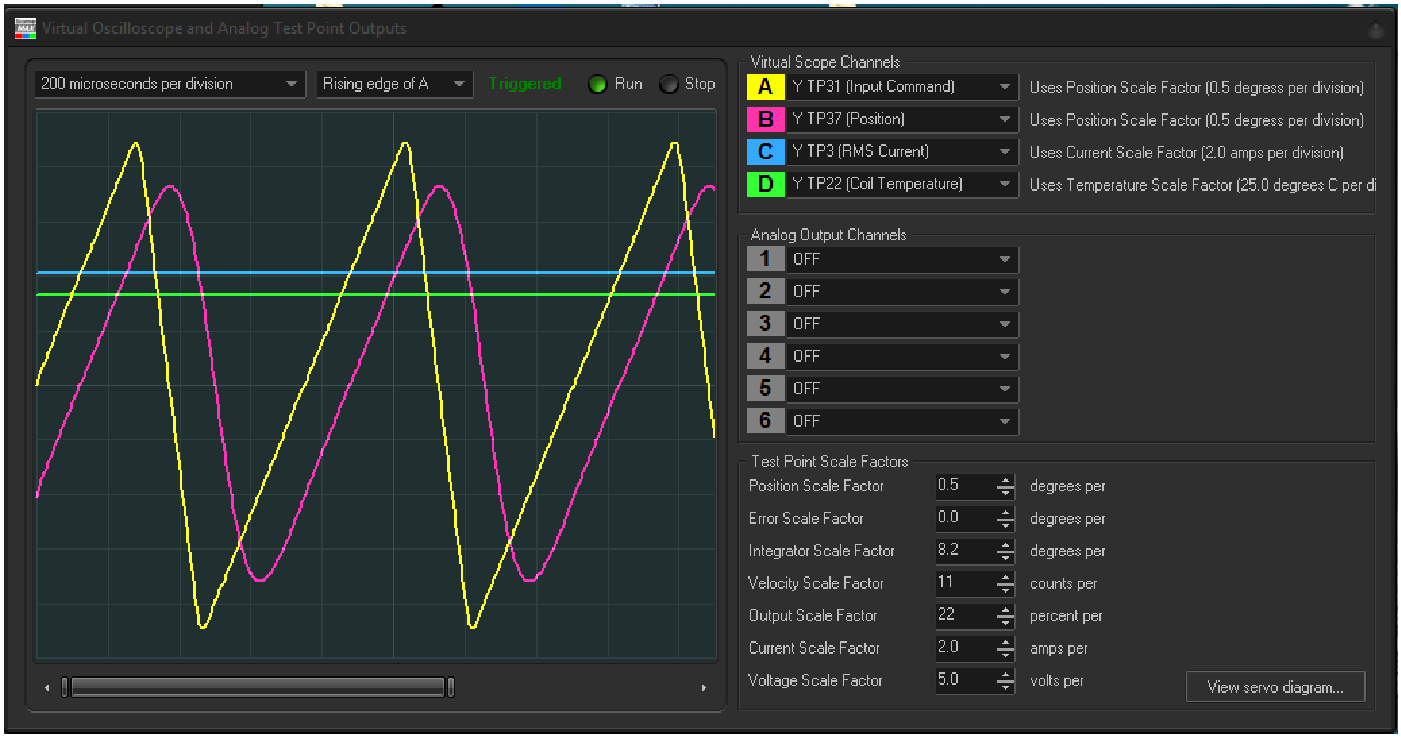
In any event, you can see the waveform below. Around 535 microseconds is spent in the “trace” portion of the waveform, and around 220 microseconds is spent in the “retrace” portion.



The oscilloscope shows that the RMS current being driven into the scanner is almost 3 amps and coil temperature is only around 35 degrees. Note that at this current, the scanner will be dissipating 9 watts of heat, which is certainly manageable. Power required from the power supply is around 1.8 amps from each of the +24V and –24V supply rails.

1325Hz at 7 degrees optical

Below you will see another scope screen shot, but this time we increased the amplitude to a bit more than 3.5 degrees mechanical peak to peak (a bit more than 7 degrees optical). This shows the fastest flyback time that we are able to currently accomplish using the Saturn 5B-46S, given the +/-24V power supply and present Mach DSP power amplifier configuration. In this case we set the function generator for 1325Hz, but for 23% symmetry. Therefore – from the function generator perspective, the retrace portion of the waveform takes 174 microseconds. Nevertheless it is clear that the position signal retrace takes longer, albeit not much longer than it was above – certainly well under 250 microseconds.



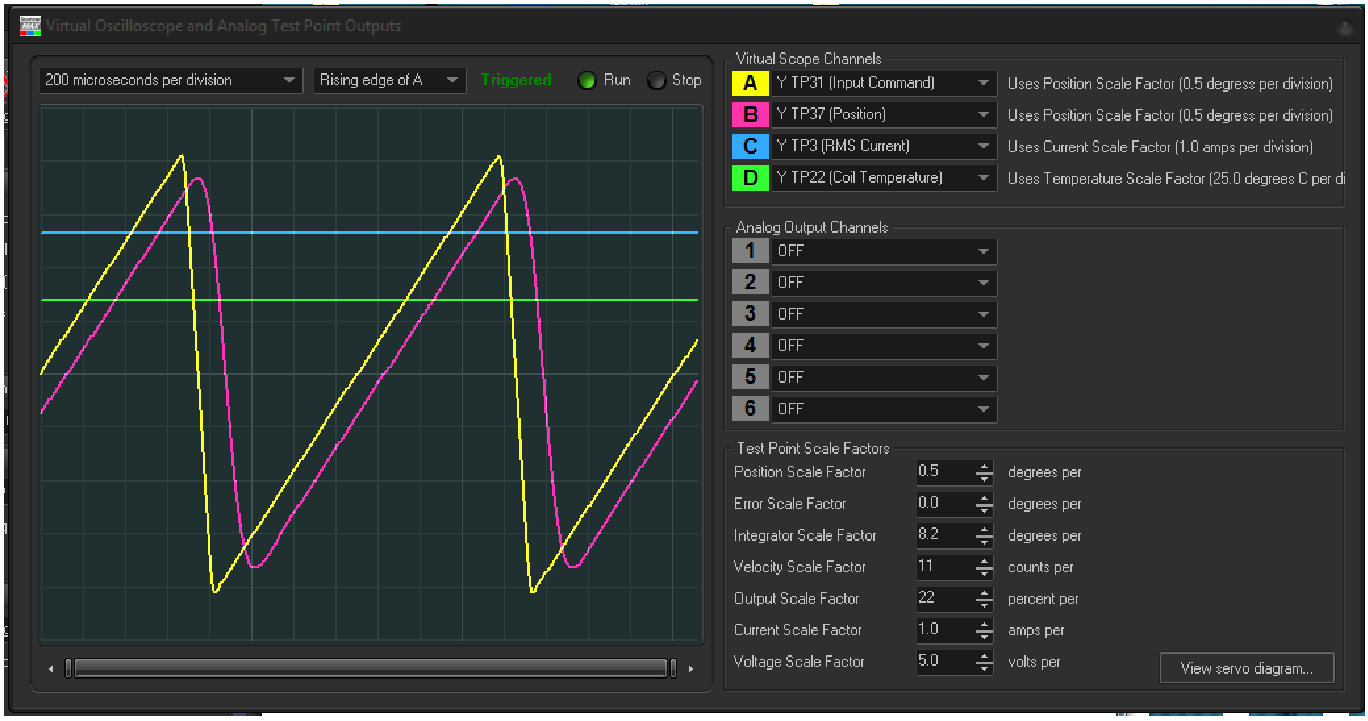
In this case we see that the RMS current being driven into the scanner is just above 4 amps, and coil temperature is still around 35C (assuming the scanner body is 30C). The scanner will be dissipating 16 watts, and power required from the power supply is around 2.25 amps per rail.

The heat was still quite manageable. For the testing, we had the scanner only in its X-Y mount, but did not have the X-Y mount bolted down to a chassis. Likewise the servo driver was sitting on a bench. Both became noticeably warm to the touch, but still worked with no problem.

650Hz at 7 degrees optical

Below you will see another scope screen shot. This time the testing was done at 650Hz (a bit more than 1.5 millisecond period). The function generator was set for 9% symmetry (140 microseconds), although the “retrace” time of the actual position signal appears to take approximately 225 microseconds or so.

In this case the “trace” portion of the wave takes approximately 1300 microseconds, while the “retrace” portion takes approximately 225 microseconds.



In this case, the coil current is 2.7 amps RMS and coil temperature is around 32 degrees C. The scanner will be dissipating 7.3 watts, and power required from the power supply is around 1.5 amps per rail.

Conclusions

It is clear that heat will not be a problem for this application, given the waveforms above. Retrace time is respectable, and can be reduced somewhat further with the use of +/-30V power supply rail voltages. Because of the low coil resistance and inductance, the servo driver will need to be heat sinked very well to conduct generated heat to the laser equipment chassis.

The scanner and mirror configuration used for this testing (Saturn 5B-46S with 6mm / 50-degree mirrors) was one that we happened to have handy for a quick test based on an informal customer inquiry. A customized mirror set that is designed for this small scan angle would deliver better performance than the standard mirror set used during this test.