ScannerMAX Saturn 9B scanning ramp waves 200Hz through 900Hz at 20 degrees

This is a test of the ScannerMAX Saturn 9B scanner with our standard 8mm X-Y mirror set. This particular Y mirror has the capability of scanning a 8mm beam over a 40-degree optical angle on both X and Y axis. Moreover, this particular mirror set uses the same inertia for both X- and Y-axis mirrors. Therefore the results below would be identical for X or Y axis.

Based on the customer request, this testing is being done at 20 optical degrees peak to peak. Since this angle is half of what this 40-degree standard mirror set is capable of, it means that beams larger than 8 mm could be reflected by this mirror set at this angle. Alternatively, a different mirror set could be used, optimized for the smaller scan angle, in which case less electrical power would be needed, and less heat would be generated by the scanner and servo drivers.

The Saturn 9B is available in several coil configurations, including “-46S”, “-56S” and “Standard”. The difference is the number of turns and diameter of wire used in the stator. This test is being done using the “Standard” coil, and for this scan angle and range of frequencies, it is the overall best choice.

The Saturn 9B 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.

The Mach-DSP servo driver has accompanying Application Software that runs on a Windows-based PC. The software is capable of monitoring all parameters of the scanner during operation. The software also includes 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 “velocity” (first derivative of position). The green trace shows the coil voltage.

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.

The customer will be using triangle-waves some of the time, and sawtooth-waves at other times. We tested the system with sawtooth-waves ranging from 200Hz to 600Hz. The “symmetry” (as it is defined in function generator vernacular) was varied to provide the overall best results. In the tests performed below you should note that as frequency increases, “symmetry” also increases.

Example: 500Hz, 25% symmetry, 20 degrees optical peak-to-peak

The scope screen shot below shows the results with a 500Hz (2000 microsecond period) sawtooth waveform. Here the input command signal waveform has 25 percent symmetry (25 percent of 2000 microseconds is roughly 500 microseconds). Clearly the position signal (pink trace) has a longer retrace than 500 microseconds. Based on the fact that the scope is showing 500 microseconds per horizontal division, we estimate retrace time is 900 microseconds.

In any event, you can see the waveform below. Around 1100 microseconds is spent in the "trace" portion of the waveform, and around 900 microseconds is spent in the "retrace" portion.

The blue trace of the oscilloscope shows the velocity of the scanner. When the velocity is "flat" (non-changing), this demonstrates that the mirror is traveling at a constant speed, which is highly desirable for imaging applications. During retrace, the mirror speed reaches 22,500 degrees per second, which is equivalent to 393 radians per second.

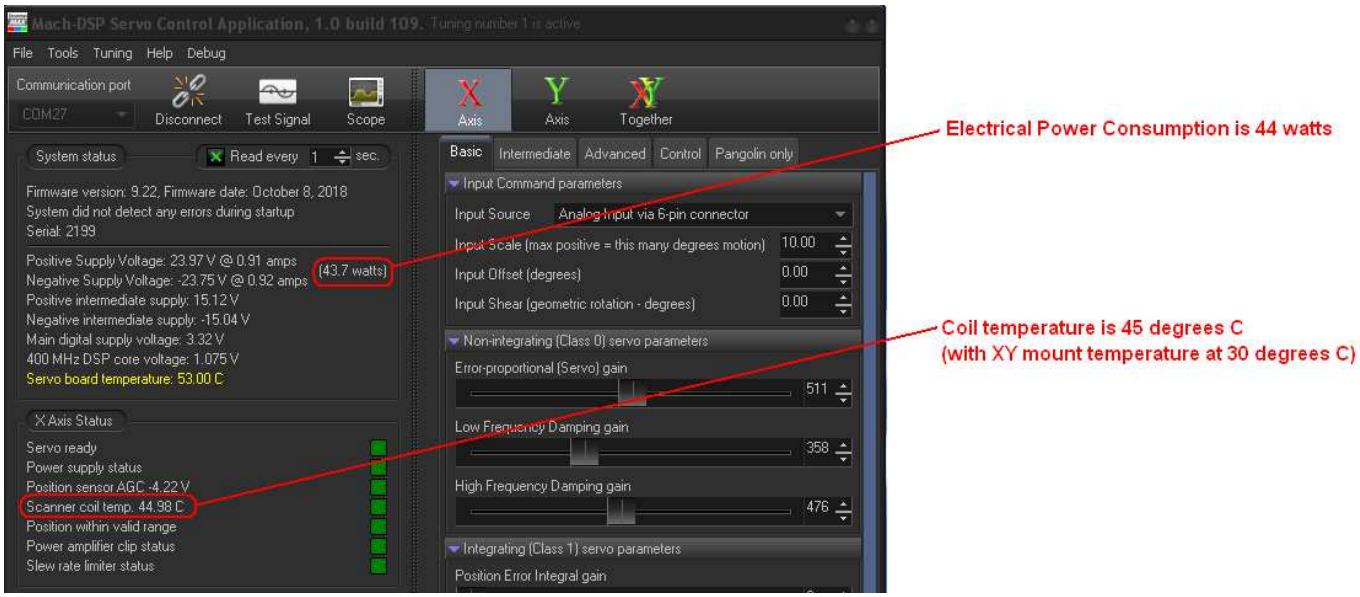
The green trace of the oscilloscope shows that the peak voltage reaches +/-20 volts.

Electrical Power Consumption and Coil Temperature

The Mach-DSP PC Application also allows for the monitoring of electrical voltage and current (and resulting electrical power) as well as the coil temperature, and various other system-health-related parameters.

Below you can see that – with the 500Hz sawtooth signal input as shown above, the electrical power consumption is 44 watts and coil temperature reaches around 45 degrees C.

During the testing the X-Y mount was maintained at 30 degrees C.



Sawtooth-wave Tests

Table showing Frequency, Symmetry, and various heat / power consumption parameters.

Freq (Hertz)	Symmetry (Percent)	Coil Current (Amps RMS)	Coil Temperature (Degrees Celsius)	Heat in the coil (thermal watts)	Heat at the servo driver (thermal watts)	Electrical Power (electrical watts)
200	8	1.6	34.75	7	9	22
300	16	1.7	35	7	11	25
400	18	2.4	41	12	16	36
500	25	2.8	45	17	20	44
600	30	3.3	51	22	20	54

Triangle-wave Tests

Note that the table uses the same layout, and that the symmetry is always 50 percent.

Freq (Hertz)	Symmetry (Percent)	Coil Current (Amps RMS)	Coil Temperature (Degrees Celsius)	Heat in the coil (thermal watts)	Heat at the servo driver (thermal watts)	Electrical Power (electrical watts)
500	50	2.0	38	8	18	35
600	50	2.8	43	16	22	48
700	50	3.6	55	25	26	62
800	50	4.4	68	39	32	65
900	50	5.5	92	59	40	106

Conclusions

The ScannerMAX Saturn 9B using our standard mirror set configured for driving 8mm beams through a 40-degree angle can clearly meet the customer's demands. Electrical power consumption and heat generated by both the servo driver and scanner are easily manageable.

A customized mirror set that is designed for the smaller scan angle would deliver better performance than the standard mirror set used during this test.