ScannerMAX Saturn 5B scanning various size steps

This is a test of the ScannerMAX Saturn 5B scanner with the standard ScannerMAX 5mm mirror set. A customer approached us with a “step and hold” application and asked us how quickly we could perform 12-degree mechanical (24-degrees optical) steps with a 5mm beam. Their goal was to accomplish the 12-degree mechanical step within in “0.5 milliseconds”

The Saturn 5B is available with three different coil configurations: “standard”, -46S, and 74S. The Saturn 5B-46S is optimized for small-angle / high frequency applications. The Saturn 5B-74S is optimized for wide-angle imaging applications. The “standard” version offers the best all-around performance, and was chosen for this application.

The standard ScannerMAX mirror set for 5mm is capable of projecting a variety of beams sizes and shapes to 5mm “square” at various mirror-surface-limited angles. A 4mm round beam can be projected as much as 70 degrees vertical. A 5mm beam can be projected through 60 optical degrees horizontal and 40 degrees vertical. Thus, if the application does not require this wide scan angle, then faster step times can be accomplished using a smaller mirror set.

For convenience and for low heat dissipation by the servo driver, the Mach-DSP uses a single-ended power amplifier – not an H-bridge as is the case for some competitors. Nevertheless, performance is roughly within the customer’s expectations for this application. In any event, work is being done on an H-bridge power amplifier add-on for the Mach-DSP, which will provide faster step times for all applications.

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 use a scale factor of 2 mechanical degrees per division, thus optical scan angle is double that shown in the traces). The blue trace shows Position Error, having a scale factor of 0.1 degrees per division, and is being used to highlight step time. And finally, the green trace shows the voltage applied to the galvanometer coil. This shows that, for a 12-degree mechanical step, voltage on the coil calls for maximum acceleration of the scanner (given the available power supply voltage, which is +/-24V for this set of tests.)

For all of the testing, we drove the input command signal using the built-in function generator, which is capable of generating sine and square waveforms with any desired frequency and amplitude.

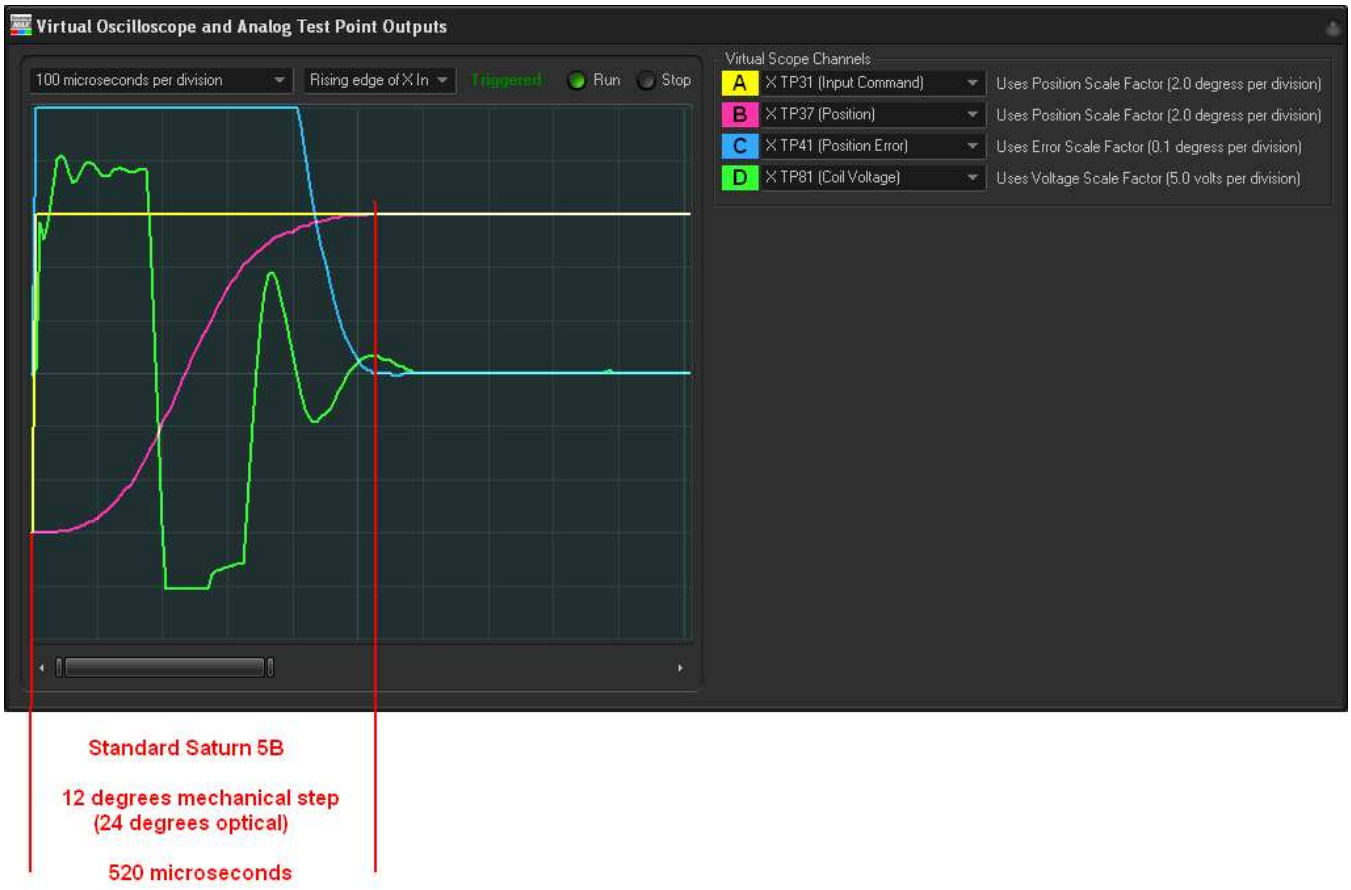
The Mach-DSP servo driver has the capability of storing multiple scanner “tunings”. These tunings can be activated virtually instantly, using either the PC-based software, or external TTL lines. This allows applications to choose the most optimal tuning for the particular job being performed.

Below we illustrate two tunings. The first tuning shown is our “30K tuning”, which provides 2.5kHz closed-loop small-signal bandwidth. The second tuning shown is our “60K tuning”, which provides 5kHz closed-loop small-signal bandwidth.

Command, Position, Error, and Coil Voltage for a 12-degree mechanical step

The screen shot below is from the built-in oscilloscope. It shows that it takes 520 microseconds to perform a 12-degree mechanical (24-degrees optical) step, using the “60K” tuning.

The green trace shows that maximum acceleration and maximum deceleration are called for. (The slight wavering in the beginning of the green trace is notch-filter action, to keep the galvo under control and keep the motion pure.)



Various size steps with "30K tuning" and "60K tuning" with Saturn 5B

Mechanical angle	Optical angle	Step time with 30K tuning	Step time with 60K tuning
0.1°	0.2°	250 μS	150 μS
0.5°	1°	300 μS	180 μS
1°	2°	300 μS	225 μS
2°	4°	325 μS	300 μS
3°	6°	350 μS	340 μS
4°	8°	375 μS	370 μS
5°	10°	400 μS	400 μS
6°	12°	410 μS	415 μS
7°	14°	425 μS	430 μS
8°	16°	450 μS	450 μS
9°	18°	460 μS	480 μS
10°	20°	490 μS	500 μS
11°	22°	500 μS	510 μS
12°	24°	520 μS	520 μS
13°	26°	540 μS	530 μS
14°	28°	560 μS	550 μS
15°	30°	570 μS	580 μS
16°	32°	585 μS	600 μS
17°	34°	600 μS	610 μS
18°	36°	610 μS	620 μS
19°	38°	620 μS	640 μS
20°	40°	635 μS	660 μS
21°	42°	640 μS	675 μS
22°	44°	650 μS	690 μS
23°	46°	660 μS	700 μS
24°	48°	670 μS	710 μS
25°	50°	690 μS	725 μS
26°	52°	700 μS	735 μS
27°	54°	710 μS	750 μS
28°	56°	720 μS	775 μS
29°	58°	730 μS	790 μS
30°	60°	740 μS	800 μS

You will note that for step sizes smaller than 5 degrees mechanical, the "60K" tuning has faster step times – in fact, twice as fast for very small steps. For step sizes from around 5 degrees to 15 degrees mechanical, the step time for both tunings is virtually identical. For very large step sizes, the "30K" tuning is actually faster. This is common, because when tuning optimizes small steps, often times larger steps are sacrificed.

Conclusions

The Saturn 5B with standard coil configuration, using the standard ScannerMAX 5mm mirror set, driving by the standard Mach-DSP servo driver using +/-24V power supply is able to perform a 12-degree mechanical (24-degree optical) step in 520 microseconds. The customer's goal was "0.5 milliseconds". If the customer is using milliseconds, and does not care about the next higher digit in precision, then this configuration can meet their needs. Moreover, the customer inquired about a 12-degree maximum optical scan angle, and thus with a custom mirror set designed for the smaller scan angle, certainly 500 microseconds or even less would be possible.

If faster step times are desired, more voltage must be supplied to the galvo coils. The present configuration of the Mach-DSP servo driver only provides a peak coil voltage of around 20 volts with the +/-24V power supplies. Future versions of the Mach-DSP will double this drive voltage using an H-bridge output, thus achieving the shorter step times. That configuration should be available in Q4 of 2018.