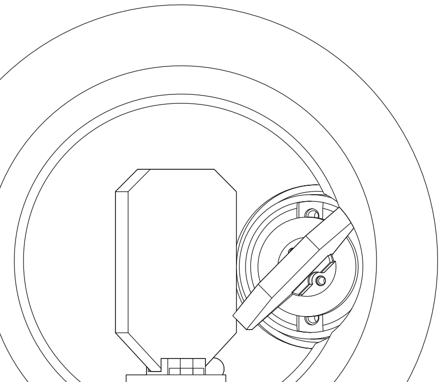
innovative scanner control

*SCAN*ahead is a tracking error free control technology for laser scan systems. By using *SCAN*ahead, mirror positioning is always executed with maximum acceleration.

The dynamic potential of your galvanometer scanner is thus utilized in the best possible way. The scan systems excelli*SCAN*, intelli*SCAN* IV and fiberSYS are equipped with *SCAN*ahead.

Application advantages

- High contour fidelity even for demanding scan jobs
- Faster process development thanks to universal tuning and automated delay setting
- Increase in productivity due to significantly shorter acceleration phases



SCANLAB
innovators for industry

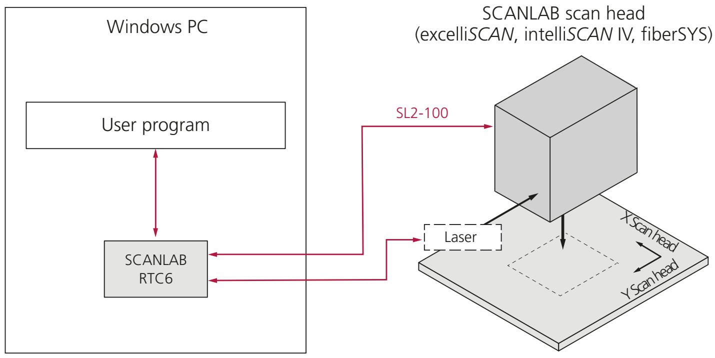
*SCAN*ahead

*SCAN*ahead is an innovative control technology for laser scan systems. Its use can significantly reduce process times in a variety of applications and considerably increase the precision of the laser spot positioning.

The figure on the right shows the main components of a laser scan system:

In your user program, you define the desired path that the laser spot should follow. The SCANLAB RTC6 control board translates your input into so-called microvectors and sends a time sequence of "mirror angle setpoint coordinates" to the control electronics in the scan head. This is done via the SL2-100 protocol at a rate of 100 kHz. In addition, the RTC6 also takes over the laser control, which can be done with a resolution of 64 MHz.

SCANLAB offers control technologies that are distinguished as follows: the conventional and the *SCAN*ahead-control.



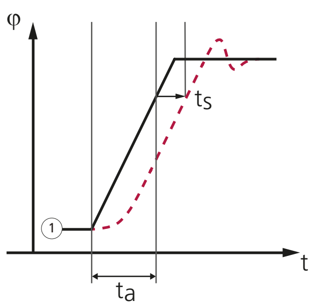
Tracking error free scan systems thanks to *SCAN*ahead technology

Conventional control

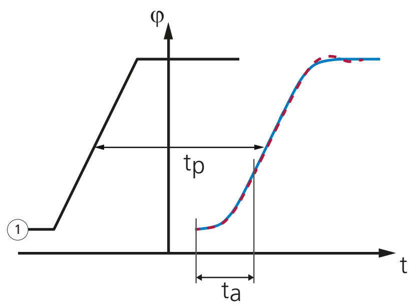
Conventional scanner control is a proven and cost-effective solution for many applications. However, laser scanning systems with conventional control have a tracking delay that can have a detrimental effect in some applications.

*SCAN*ahead control

A key component of the *SCAN*ahead technology is an intelligent status control system that allows the scanner mirror axes to always be accelerated with a maximum rate. This eliminates the tracking error. The calculations for the state control are done in real time, the movement execution is accordingly delayed by the preview time t_p, but is free of tracking error.



① = RTC control values
— = Set trajectory
··· = Actual trajectory
t_s = Tracking error
t_a = Acceleration time
t_p = Preview time

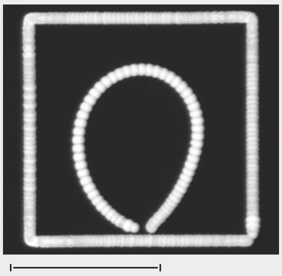


The linear behavior of conventional control means that the actual values of the scanner-galvanometer-mirror-angles (red) react with a delay to the RTC control values (black). This time delay is referred to as tracking error t_s.

The *SCAN*ahead technology translates the original target values of the mirror position (black) into a smoothed target value curve shifted by the preview time t_p (blue). The actual position values of the mirror (red) follow this smoothed set point curve almost perfectly.

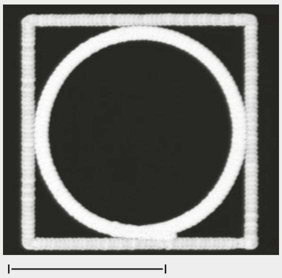
Example: Necking effect

Undesirable deviations in the laser spot position occur on curved paths due to the tracking error. This can occur, for example, when marking very small circles quickly.



150 µm   v = 2.8 m/s

Contour fidelity on curved tracks is significantly improved by the use of tracking error free *SCAN*ahead technology at high marking speeds.



150 µm   v = 2.8 m/s

Dynamic advantages thanks to *SCAN*ahead technology

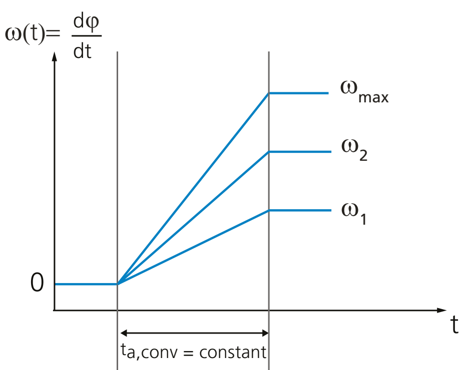
Conventional control

The acceleration times of conventional control are always constant. Consequently, the dynamic potential of the scanning system is not fully utilized in every application, especially if the application requires frequently changing speeds of the laser spot.

*SCAN*ahead control

By using *SCAN*ahead, the acceleration times are always minimized, regardless of the target speed. This leads to a significant increase in productivity if the marking pattern contains a large number of acceleration phases.

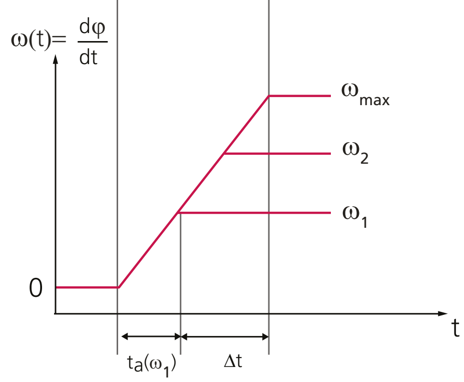
Comparison of the mirror velocity curves



Conventional control

The acceleration time $t_{a,conv}$ is always constant, regardless of the target speeds ω_1, ω_2 or ω_{max}.

The mirror acceleration, i.e. the gradient of the curves, depends on the target speeds.



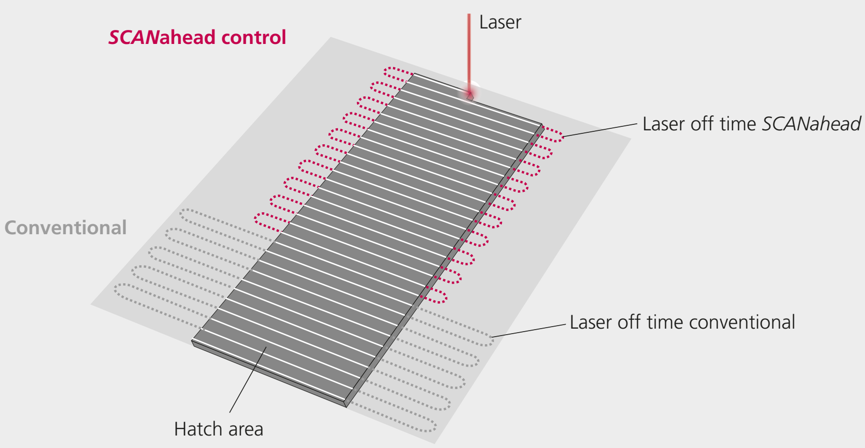
*SCAN*ahead control

Always runs at maximum possible acceleration. In applications in which the mirror speed is changed frequently, the acceleration times can be drastically reduced. The acceleration time from 0 to speed ω_1 is shown as an example: $t_a(\omega_1)$. This is reduced by Δt compared to the acceleration time with conventional control.

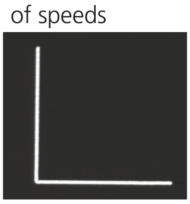
Example: Additive manufacturing

In additive manufacturing, two-dimensional structures are typically realized using bidirectional hatching. A large part of the process time in scanning systems with conventional control is required for the turnaround times for acceleration and deceleration processes.

Scan systems with *SCAN*ahead control significantly reduce these turnaround times and therefore contribute to a significant increase in productivity.



*SCAN*ahead control compared to conventional control

	Conventional control	*SCAN*ahead control
Dynamics	• Acceleration time t_a is constant • Dynamic potential of the galvanometer scanner not used efficiently at all times	• Scanner axis acceleration always at maximum • Fully utilized galvanometer scanner dynamics
Tracking error [t_s]	• Finite, constant tracking error • Limits precision of image field correction at high speeds • Typically optimized for a single application • Several different tunings necessary, only possible in digital scan systems	• No tracking error: $t_s = 0$ • Precise image field correction even at high speeds • Only one tuning needed. Optimum performance across all applications • A constant preview time t_p is used to determine the navigable trajectory
Use of delays	• Delays must be determined and set manually • Optimization of the delay settings by the user necessary	• Set by the auto-delay function of the RTC6
Example application: circles and arcs (circle v = 2.8 m/s)	• Necking effects (caused by the tracking error) • Adjustment of the circle diameter necessary  150 µm	• No necking effects, if the scanner dynamics are sufficient • Adjustment of the circle diameter not necessary  150 µm
Example application: 90° corners (corner v = 1 m/s)	• Tracking error can result in a significant corner rounding  300 µm	• Significantly smaller deviations during traversal of 90° corners at a wide range of speeds  300 µm

More information about *SCAN*ahead in the video:

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