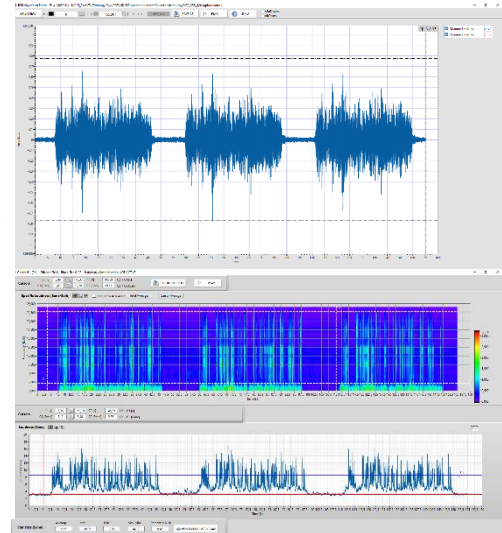


2D Tribo-Acoustics Test System



MB DYNAMICS
Sound & Vibration Testing Technology



Analysis of friction, friction noise, stick-slip, abrasion, wear and material damping based on highly dynamic, real relative motions and normal forces

The 2D Tribo-Acoustic test bench enables testing of a wide range of material pairings and components with real, highly dynamic relative motions and normal forces to analyze friction, friction noise, stick-slip, material damping and abrasion and wear. The precise reproduction of real dynamic load conditions provides more reliable predictions of the stick-slip risk occurring in practice and allows a more precise analysis of abrasion and wear. The completely friction-free design and extremely low operating noise of the actuators enable direct measurement of the frictional forces and accelerations occurring at the contact surfaces without influencing the test by additional leaf spring elements or friction in drive and guide elements. Stick-slip tests based on specified RANDOM excitation profiles (PSDs, e.g. in accordance with GMW 16321) and tests with constant relative speeds and normal forces (e.g. VDA 230-206, FORD CETP01.05) are possible as well. For tests in accordance with VDA 230-206, standardised sample holders with leaf springs are also available. As an option, tests can also be carried out with the addition of oils, lubricants, greases, various liquids or pastes as well as dirt and dust.

Features & Benefits:

- Highly dynamic simulation of relative motions, forces and accelerations in 2 axes
- Freely definable motion profiles
- Extremely quiet, frictionless actuators, no influence on the measurement data
- Recording of accelerations, forces, position, temperature and humidity
- Interchangeable sample holders with and without leaf spring
- Standard-compliant testing in accordance with VDA 230-206 including RPN calculation
- Measurement of static and dynamic friction
- Measurement & evaluation of friction noise
- Fully automatic execution of predefined test cycles
- Suitable for use in a climatic chamber in a temperature range from -40°C to +80°C

Typical Applications:

- Analysis and evaluation of the stick-slip risk of various material pairings and surfaces according to various test specifications
- Measurement of friction forces and friction coefficients
- Analysis of the emitted friction noise with acoustic and psychoacoustic analyses
- Aging, abrasion and wear tests
- Analysis of the damping properties

Options / Accessories:

- Standardised leaf spring and specimen holder for tests in accordance with VDA 230-206
- Testing of friction, abrasion and wear of various material combinations with added oils, lubricants, greases, various liquids or pastes as well as dirt and dust

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Frictionless motion & extremely low operating noise

The two air bearing, friction-free guided axes of the quiet electrodynamic drives enable high-resolution, direct measurement of the friction and normal forces actually occurring at the contact surface of the two materials. Any influence on the dynamic behavior of the test specimens and distortion of the measured frictional forces by coupled leaf springs and superimposed frictional forces in the guides of the moving axes is therefore eliminated. The extremely low operating noise enables the analysis and objective metrological evaluation of the recorded friction noise and superimposed disturbing impulses caused by stick-slip using acoustic and psychoacoustic analyses.

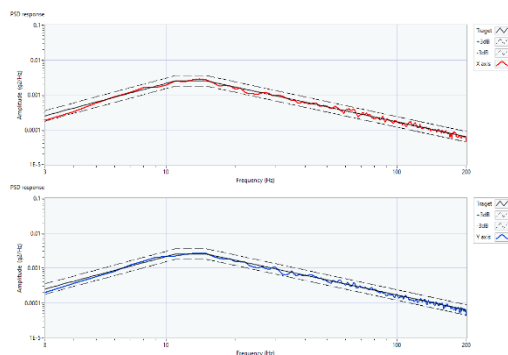


Figure 2: Multi-axis control system enables excitation based on predefined power density spectra (PSDs)

Measurement of accelerations, forces, displacements & noises

The integrated data acquisition system enables the measurement and logging of acceleration, force and position in both axes. Temperature and humidity of the contact area are also monitored. The measurement channels are configured and calibrated directly in the user interface of the test bench software. Configurable high-pass, low-pass and band-pass filters optimize the signal-to-noise ratio and thus further increase the resolution of the measurement signals. Force, acceleration and microphone data can be saved in various standard formats for further signal analyses and evaluation. A precision measuring microphone can be used to record and analyze the friction noise and stick-slip noises emitted from the material sample.

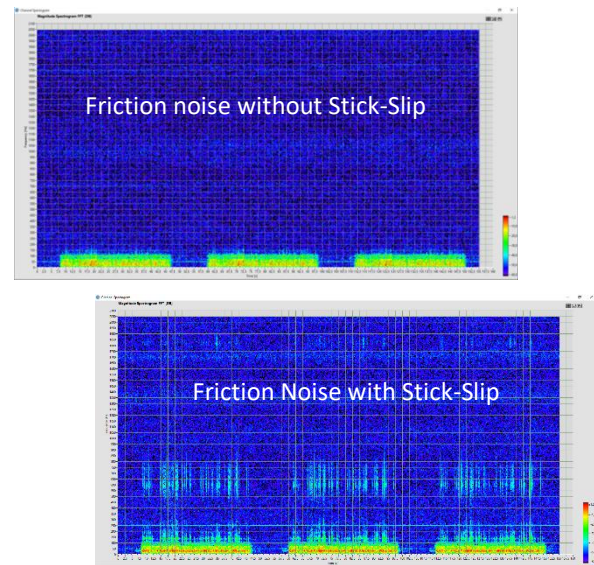


Figure 1: Time Varying Loudness spectra of a material pair without stick-slip and a material pair with stick-slip.

Reproducible, highly dynamic simulation of real load scenarios

The integrated closed-loop multi-axis vibration control system enables reproducible simulation of real accelerations, relative motions and forces. Recorded time signal data can be quickly and easily transferred to the TIME-HISTORY controller. The RANDOM excitation mode enables endurance tests based on definable power density spectra (PSDs) for testing abrasion and wear.

X-ACHSE						
Ch 0	Position [mm]	1000	mV	TP: 50Hz [Butt-10]	4096	KALIBRIERUNG
Ch 1	Acceleration [g]	475.9	mV/g	TP: 400Hz [Butt-10]	4096	KALIBRIERUNG
Ch 2	Force [N]	22.92	mV/N	TP: 100Hz [Butt-10]	4096	KALIBRIERUNG

Y-ACHSE						
Ch 3	Position [mm]	1000	mV	TP: 50Hz [Butt-10]	4096	KALIBRIERUNG
Ch 4	Acceleration [g]	482.26	mV/g	TP: 400Hz [Butt-10]	4096	KALIBRIERUNG
Ch 5	Force [N]	45.17	mV/N	TP: 100Hz [Butt-10]	4096	KALIBRIERUNG

ALLGEMEIN						
Ch 6	Temperatur [°C]	82.31	mV/°C	Off	32	KALIBRIERUNG
Ch 7	Feuchte [%]	100.71	mV/%	Off	32	KALIBRIERUNG
Ch 8	Y-Abstand [mm]	1000	mV	Off	32	KALIBRIERUNG
Ch 9	Sound Pressure [Pa]	48.42	mV/Pa	BP: 200Hz - 20000Hz [Butt-10]	51200	KALIBRIERUNG

Figure 3: Configuration, scaling and calibration of the input channels

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Profile editor for easy creation of sine & ramp profiles

An integrated profile editor enables the definition of sinusoidal and ramp-shaped motion profiles. The start and stop position, frequency, amplitude, phasing, duration of the ramp, number of cycles and dwell time at a fixed position are defined directly in the profile editor.



Figure 4: Definition of a ramp-shaped motion profile

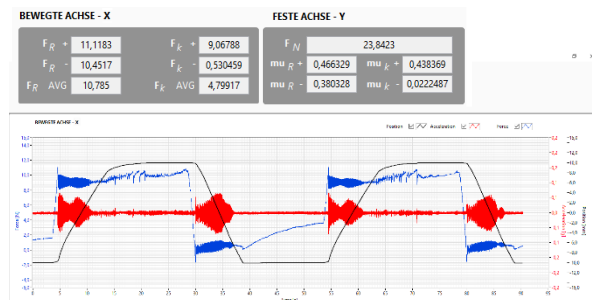


Figure 5: Calculation of averaged friction coefficients by separate averaging for both directions of movement, material sample shows clear stick-slip

Statistics & objective key figures for friction noise & stick-slip

The evaluation software enables the calculation of statistical parameters for the measured force, acceleration, sound level and loudness curves. Friction Noise Indicator (FNI) and Stick-Slip Indicator (SSI) allow the differentiation and separate evaluation of friction and sliding noise as well as superimposed, impulsive noise caused by stick-slip. Level curves and signal statistics are saved with the raw data and are available for further analyses in external data analysis programs.

Measurement of static and dynamic friction and calculation of friction coefficients

Ramp-shaped excitation signals with definable amplitude and velocity enable the targeted analysis of friction forces at different velocities, compression and normal forces. The resulting friction forces and friction values are measured over a user-defined number of cycles and calculated separately for each direction of movement.

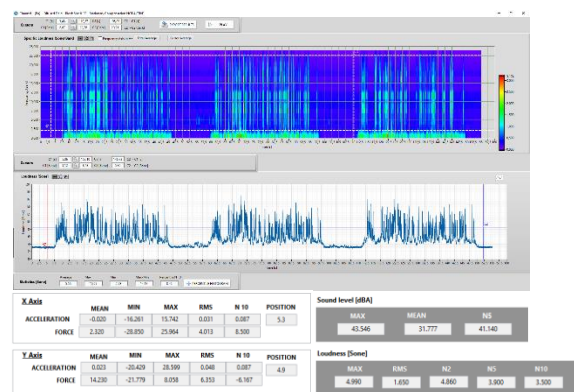


Figure 6: Analysis of friction noise and stick-slip noise including calculation of statistical parameters

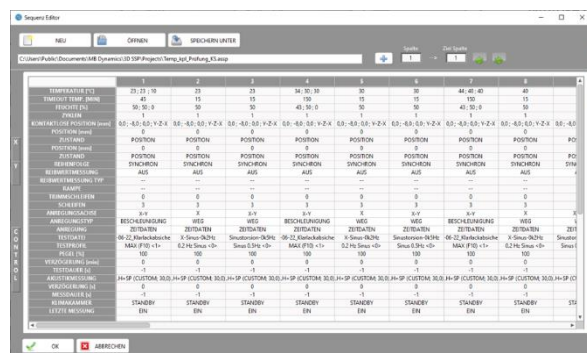


Figure 7: Definition of complete test sequences including the specification of excitation signals for x- and y-axis

Fully automatic execution of predefined test sequences

The integrated automatic mode enables the definition and fully automated execution of predefined test cycles. The position of the axes, the excitation signals to be used, dwell times at a specified position as well as the test and measurement duration can be defined, executed fully automatically and saved in various test steps. If the test stand is integrated into a climate chamber, the climate chamber can also be controlled as an option.

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Testing of stick-slip risk in accordance with VDA 230-206

To analyse the stick-slip risk of various material pairings in accordance with VDA 230-206, an optional probe attachment with integrated leaf spring and standard-compliant sample holders in semi-circular and flat designs is available. The leaf spring and specimen holder are quickly and easily mounted to the y-axis linear guide using four screws. The parameters required by the standard, such as maximum acceleration g_{max} , pulse rate, coefficient of static friction, coefficient of dynamic friction and risk priority number (RPN), are calculated and displayed in the measurement software.

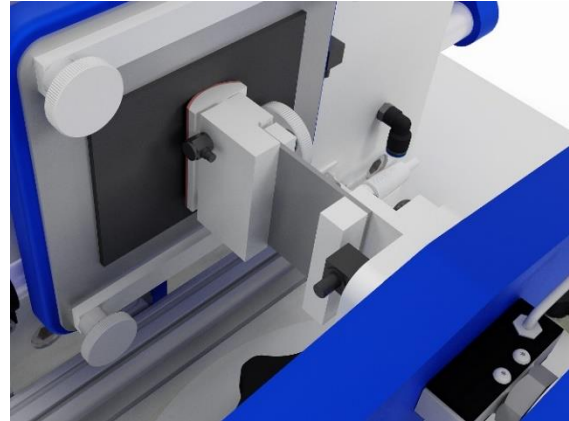


Figure 8: Sample holder with leaf spring and integrated sensors for testing in accordance with VDA 230-206

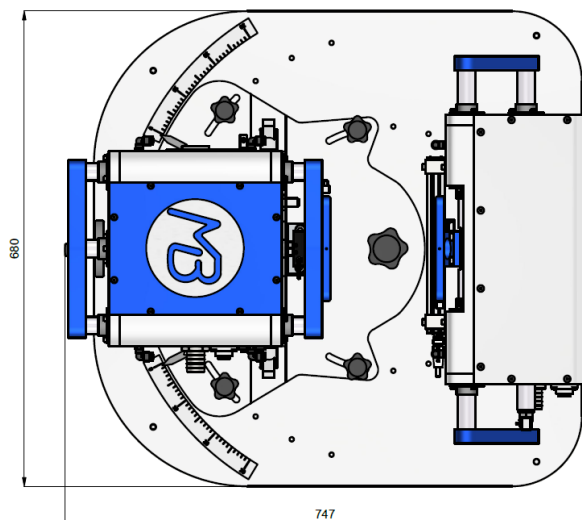
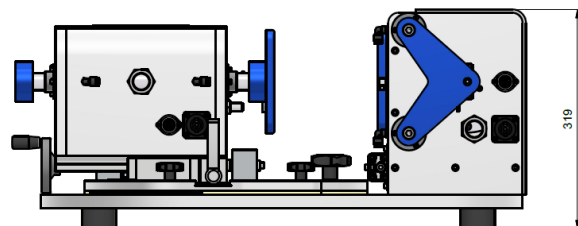


Figure 9: Plug-in connections for all supply lines directly at the test bench enable easy relocation and integration of the test bench into a climate chamber

Integration in climate chamber for testing from -40°C to +80°C

The complete test stand is designed to operate in a climatic chamber at temperatures from -40°C to +80°C. Plug-in connections directly on the test stand facilitate the connection of the required supply lines and allow the test stand to be easily relocated and integrated into a climate chamber. Temperature and humidity are measured directly in the area of the specimens by an integrated sensor. The control of the climatic chamber can be integrated into the 2D Tribo-Acoustic test stand control via a suitable interface. This enables the fully automated execution of measurements under different climatic conditions.

Dimensions and weight



Weight: approx. 110kg

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Technical Data:

2D Tribo-Acoustics Test System		
	x-axis	y-axis
Max. displacement	75mm pk-pk	25mm pk-pk
Locking of individual axes	Yes, mechanical	Yes, mechanical
Adjustable overpressing / position	Yes, position controlled or locked	Yes, position controlled or locked
Max. velocity	1m/s	1m/s
Max. stat. preload force	200N	200N
Max. dyn. excitation force	300N peak	300N peak
Frequency range	DC-500Hz	DC-500Hz
Maximum payload	2kg	2kg
Types of excitation	User-defined ramp & sine signals, Definable Random PSD spectra, Time History Replication	User-defined ramp & sine signals, Definable Random PSD spectra, Time History Replication
Controlled variables	Position or acceleration, Force control available as an option	Position or acceleration, Force control available as an option
Overtravel protection	Yes	Yes
Overtemp protection	Yes	Yes
Operating Noise *		
Noise Rating Curve (NR)	NR18, typical	NR18, typical
Sound Pressure Level **	<25dB(A)	<25dB(A)
Time Varying Loudness ***	<0,2 Sone	<0,2 Sone
Data acquisition	8-simultaneously sampled inputs, 24-bit AD converter, sampling rates up to 256000 samples/second per channel	
Measured quantities	Position, acceleration, force	Position, acceleration, force
Other measured variables	Temperature and humidity in the area of material samples	
Analyses Force/Acceleration/Position	Level over time, mean value, min and max value, rms N10, N50 and N90 percentile level	
Acoustic analyses	Sound Pressure Level [dB(A)], level over time, mean value & max. value Time Varying Loudness, level over time, N10, N50 & N90 percentile level	
Indicators friction	Coefficient of static friction, coefficient of sliding friction	
Indicators VDA 230-206	max. acceleration, pulse count/pulse rate & Risk Priority Number (RPN)	
Indicators friction noise	FNI (Friction Noise Indicator), SSI (Stick-Slip Indicator)	
Data formats	TDMS-, WAV- and CSV-format.	
Dimensions (W*H*D)	approx. 680mm*319mm*747mm	
Weight	approx. 111kg	
Mains connection	3 phases, 220-240VAC @50-60Hz, secured with 16A circuit breaker	
Compressed air supply	Filtered, oil-free compressed air, 6 bar@100 liters/min	

* Measured at 70cm from the shaker when excited with a typical Squeak & Rattle test profile in the frequency range from 5Hz to 100Hz with an averaged acceleration level of 0.3gRMS

With simultaneous operation of both axes, the resulting noise level can increase by up to 6dB(A).

** A-weighted Sound Pressure Level, FAST (125ms), 100Hz to 20kHz

*** N10 Percentile Level, loudness according to DIN45631/A1, measured in accordance with GMW14011