



**Gearbox
Shifting Robot
GSR**

Gearbox Shifting Robot GSR

for Shifting and Testing of Automotive Gearboxes

Applications

- Engaging and disengaging of gears in automobile shift gearboxes (automation of driveline and noise test benches)
- Use in test benches for End-of-Line, endurance test and quality measuring
- Measurement & appraisal of shifting, synchronisation and detent forces for quality control
- Complex testing tasks like measurement of gear positions and detent forces, measurement of axial and transverse play, force controlled scanning of boundary contour
- Testing of mechatronics components of modern gearbox generations (neutral/gear position sensors for start-stop-automatic)

Customer's Benefit

- Automatic test procedure and objective appraisal
- Manual or automatic adaption of shifting shafts without backlash
- Effective quality assurance by high testing accuracy
- „Sensitive“ force/position control (automatic teaching of gear positions)
- Availability for a wide range of gear shifting shafts and gearbox types
- Easy to integrate into existing test bench environments
- Extensive test step library

Special Features

The Gearbox Shifting Robot GSR is a modularly built product line which is available in different variants and stages of extension. The complete version is characterized by following features:

- Manual teach-in with hand terminal or fully automatic searching of gear positions by force sensor based control strategies
- Safe and robust operation by force limitation, surveillance of gear positions and shifting retrail in case of engaging failure
- Gearbox version specific parametrization of shifting velocity, shifting force and gearshift topology

- Configurability of test scope (library of different test steps, administration of gear basic schedules, e gear number and set point positions)
- Easy to integrate into existing test bench environments (supported interfaces for commands, information of status, online-indicated values and test results: Profibus DP, Ethernet TCP/UDP Sockets, CAN, RS232)
- High dynamics and position quality associated with compact design and small constructed space

Compared to the coupling to gearshift lever the direct adaption to gear shifting-shafts offers the advantage of a higher measurement accuracy due to avoiding the elasticities. The automated clamping device guarantees a force-fit linkage without backlash from Gearbox Shifting Robot to shifting shafts.

The use of long-term available standard components leads to a high protection of the investment (Siemens IPC, BoschRexroth Drives, HBM Force Measurement Instrumentation).

The control system is based on a multiaxis robot control system with hybrid force/position control which was engineered at the Fraunhofer-Institute for Production Systems and Design (IPK Berlin). The control system allows:

- Force/position controlled measurement of gear position and boundary contour
- Force controlled tests of synchronization
- Generating any geometries of trajectories by successive linear, circular and fly-by motion sets

IBS Test Systems further developed this control system to the **flexible test bench control FPS** with following functions:

- Use of internal programmer or connection to external programmer
- Gearbox version list and parametrization of test steps, test conditions and limit values of quality features
- Connection to guidance system and SAP system
- Archiving of test results and measured row data (sampling time to parametrize min. 1 ms)
- Integration of identification systems (1D/2D-Scanner, MobyU)

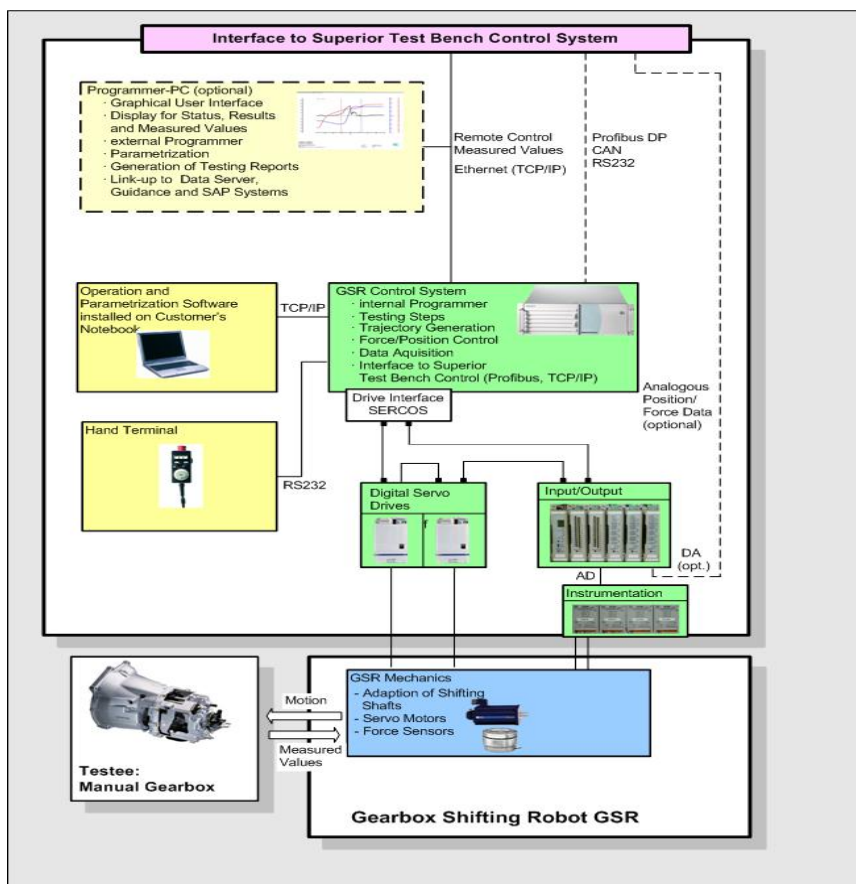
Description of System

The basic system consists of following components:

- Mechanics (manual adaption, four joint kinematics for misalignment compensation, servo drives with high resolution angle transmitter)
- Software (system control and basic test steps)
- Control cabinet (power electronics, measurement instrumentation and industrial PC with real-time operating system)

Following options are available:

- Fully automatic adaption of gear shifting shafts
- Force measurement instrumentation
- Clutch and throttle actuators
- Programmer-PC with graphical user interface, information of status and online indicated values, programmer functionality and connection to data server, guidance system and SAP system



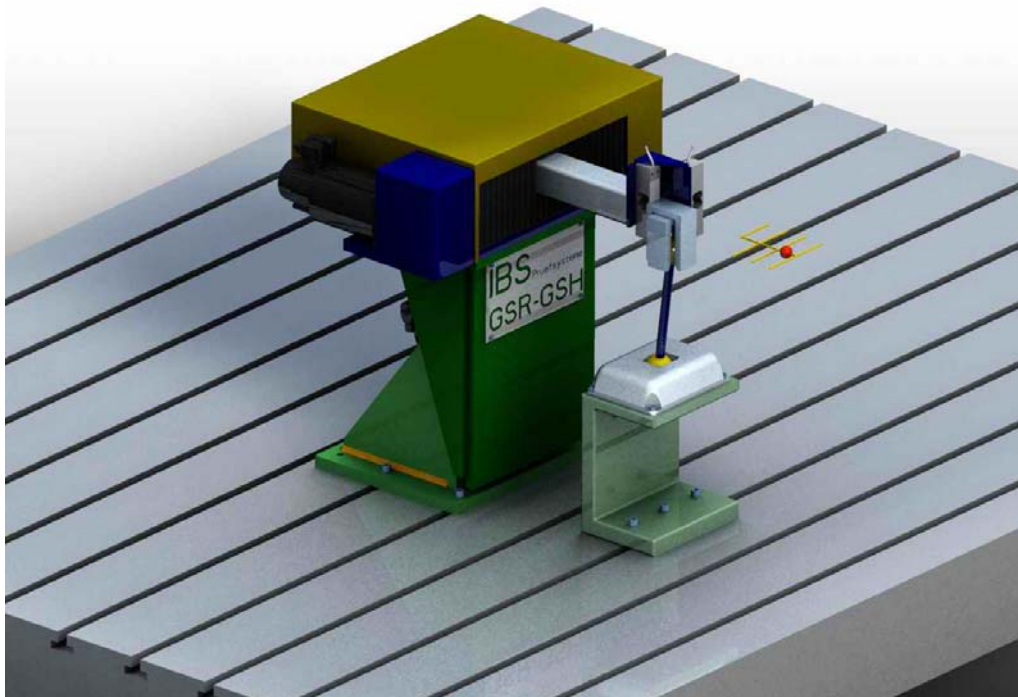
Mechanics

The mechanics is characterized by following features:

- Easy to integrate into test bench environment sby compact design with small constructed space (width 390mm x length 290mm x depth 500mm)
- High precision of position measurement by use of standard machine tools servo drives with Sine Cosine angular measuring system
- Compensation of misalignments (<4mm, <3 degree) by use of special four joint kinematics

Due to the modular design following options of coupling to different gearshifts/gear shift lever are available:

GSR-GSH	Adaption to shift knob by X-Y-(Z)-compound slide rest
GSR-ZSW	Direct adaption to the central gear shifting shaft
GSR-GWS	Direct adaption to separated gearing and shifting shafts
GSR-GWSB	Direct adaption to separated gearing and shifting shafts with force transmission by bowden cable (Flexball)
GSR-GSHB	Adaption to shift knob by bowden cable and X-Y-compound slide rest

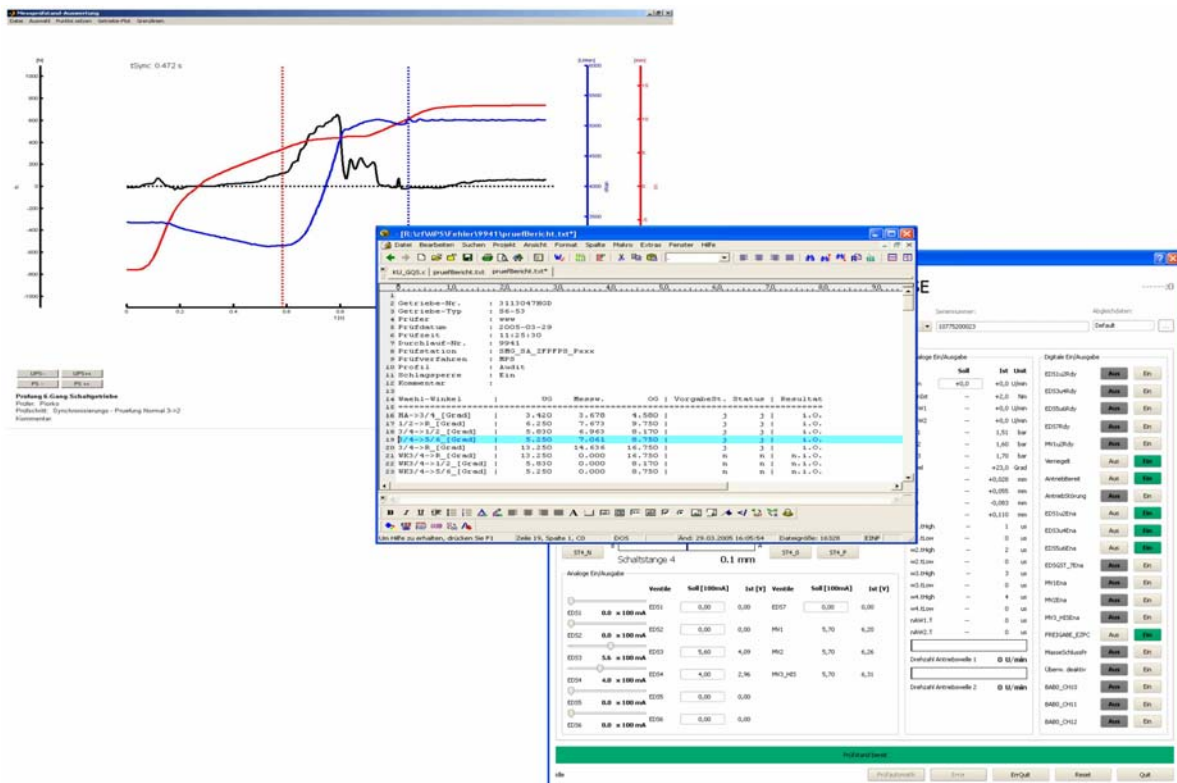


GSR-GSH: Adaption to Shift Knob by X-Y-(Z) Compound Slide Rest

Control software

The software system of real-time control consists of following components:

- Real-time operating system VxWorks
- System software with basic functions
 - Run-time system
 - Driver unit for servo drivelines, measurement instrumentation, peripheral equipment and identification systems (1D/2D-Scanner, MobyU)
 - Generation of ramps and rotational speed/torque control for gearbox drive sided and output sided E-machinery
 - User programm system for administration of test steps
 - Communication to superimposed test bench control systems (SPS, PC-based programmer)
 - Commands, status / failure, test parameters, quality features/test results
 - Supported Interface: Profibus DP, TCP/IP, CAN, RS232)
 - Online transfer of measured raw data (cycle time 1ms) analoguous, TCP/IP or Profibus DP
 - Data transfer of measured raw data with FTP-Client/Server (for



- Basic/advanced test steps
 - Data reduction and creation of quality features

- Appraisal and delivery of test results and measured raw data
- Library with prototype test steps and basic functions for efficient programming of new test steps

The option programmer-PC includes following components:

- Siemens industrial PC with Windows XP Professional (installation of user software to customer PC on demand)
- Graphical user interface
- Programmer system with gearbox version lists and test step specific parametrization system
- Online display of measurements and test results
- Creation of test reports and filing on Windows-Remote-drives
- Connection to data base, guidance and SAP systems of customers

Test Steps

With regard to the test software following extension stages are available:

- **SW-GS gear shifting**
 - Engaging and disengaging of all gears
 - Repeat after ineffective engaging of gear

Force measurement instrumentation not required as the force/position control is realized via the torque interface of the drivelines

- **SW-BP basic test steps** (as gear shifting with following additional test steps)
 - Automatic teaching of gear positions
 - Shift and gearing forces
 - Synchronisation forces and times
 - Synchronisation signal for noise measurement system

Force measurement instrumentation required

- **SW-FP advanced test steps** (as SW-BP with following additional test steps)
 - Axial play and transverse play
 - Testing of avoidance of gear alley
 - Gear jumping, shifting blocker, servo effect
 - Force/position controlled measuring of the boundary contour in gear alleys with diagonal contact motion in corners of galley
 - Testing of neutral and gear position sensors

Force measurement instrumentation required

- **SW-AP application-specific test steps according to customer's specifications**

Control cabinet

The control cabinet includes following components:

- Design of cabinet (Rittal) available in the variants
 - TS8 600x600x2000 or 600x600x1200
 - PC cabinet system (600x600x1600)
 - Manufacturing according to customer's specifications
- Fan cooling (optional air conditioner)
- Servo drives with set point communication 1ms cycle time by SERCOS Interface (BoschRexroth) or Profibus DP (Siemens)
- HBM force measurement instrumentation
- Control computer Siemens RackPC, Core 2 Duall, T7400, 2,16 Ghz
- Programmer-PC Siemens RackPC (optional)

Technical Specifications

	GSR-ZSW		GSR-GSH
Shifting Direction	Reference Central Shift Shaft	Reference Gear Shift Lever virtual Lever Length 225mm, Ratio 1:4,5	Actuation of Gear Shift Lever by GSR-GSH-Kinematics
Transl. Range	±75mm	±330mm	±150mm
Max. Speed	±1,0m/s	±4,5m/s	±1,6m/s
Transl. Resolution	0,005mm	0,022mm	0,005mm
Max. Force	±1500N	±330N	±500N
Force Resolution	0,061N	0,016N	0,02N
Gearing Direction			
Angular Range	±20Grad	±20Grad	±150mm
Max. Speed	±1000Grad/s	±1000Grad/s	±1,6m/s
Angular Resolution	0,01Grad	0,01Grad	0,005mm
Max. Torque	±60Nm	±60Nm	±500N
Torque Resolution	0,0073Nm	0,0073Nm	0,02N

Power Supply	3 x 400V / 50Hz Power Input 4kW
Temperature Range	0°C bis 45°C

Services

We offer following services:

- Setting-up operation at the test bench manufacturer and customer
- Integration into existing test benches
- Implementation of customized test steps
- Constructive adjustments / changes according to customer's specifications
- Long-term maintenance and delivery of spare parts

Furthermore, we deliver driveline systems with rotational speed/torque regulated E-machines for testing of manual shift, automatic and double clutch gears.

Contact

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