Mechanism Products & Engineering Germany

Who are we?

We are a team of approximately 30 engineers specializing in space mechanisms, covering the entire lifecycle from design and analysis to verification and operation. Our multidisciplinary mechanism team combines expertise in computer science, electronics, mechanical and electrical engineering. We also offer strong heritage in hardware-related activities, including assembly, functional verification, and in-orbit support. Additionally, we provide a full portfolio of project management services for handling complex projects.

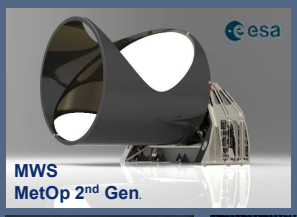
Situated in Friedrichshafen, Germany, on the shores of Lake Constance, we benefit from a robust mechanism network with activities in France, the UK and Spain. Furthermore, we leverage Airbus' extensive expertise in space engineering.

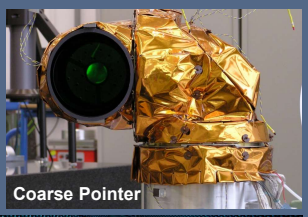
What do we do?

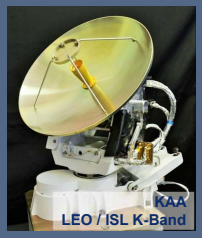
We cover the complete product life cycle from early studies to in-orbit operational support, from breadboarding to flight models and small series productions. Our portfolio includes fully qualified products and comprehensive engineering support, ranging from feasibility studies to launch and operational support.

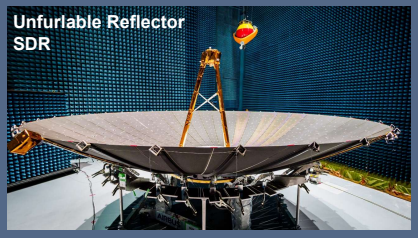
We offer a wide range of space mechanisms. These can be developed from scratch, satisfying any kind of customer requirements. A broad basis of heritage products is available.

We are well experienced in complex individual developments for science missions and exploration. Nevertheless we are also targeting standard products for small series as well as for constellations. Our goal is to provide customized solutions tailored to customer needs, whether the focus is on high-end performance or cost-effective design approaches.









Long heritage

At our site in Friedrichshafen, Airbus Defence and Space has been contributing to space missions since 1962, originally known as Dornier. Our department was established about 50 years ago, providing a wealth of heritage and expertise.

The department has delivered more than 20 deployment and trimming mechanisms, which range from non-ITAR hold-down and release mechanisms to opening-closing mechanisms using shape memory alloys.

More than 40 Antenna Pointing Mechanism units have been flown, providing 2-axis movement in LEO, MEO & GEO, supporting both X- and Ka-bands.

For earth observation purpose more than 17 products are in-orbit, providing high performance even after exceeding their required lifetime.

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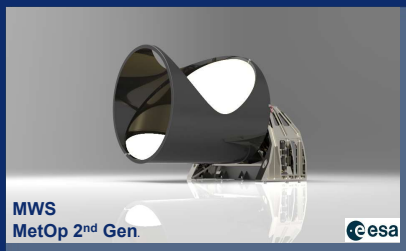
AIRBUS

Mechanism Products
Main Product Lines


MWS
MetOp 2nd Gen.


MWI – Export


ICI
MetOp 2nd Gen.


MWHS – Export

EARTH OBSERVATION

More than 25 Scanning Mechanisms have been delivered to various customers, the department successfully contributes to RF and Optical Instruments.

Contributions in ESA funded projects like MetOp 2nd Generation Scanners for MWI, ICI, MWS and Instrument METImage has built a cutting-edge expertise within the Centre of Excellence.

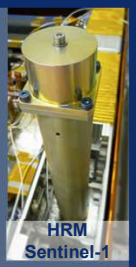
Export projects have enabled the creation of a product line, benefiting from batch orders and standardization, in order to offer high performance at reduced costs.

DEPLOYMENT

With options for 3 and 5 meter diameter, the Unfurlable Reflector deploys itself in orbit. Its lightweight CFRP structure is composed by individual panels, easily exchangeable and maintainable prior launch.

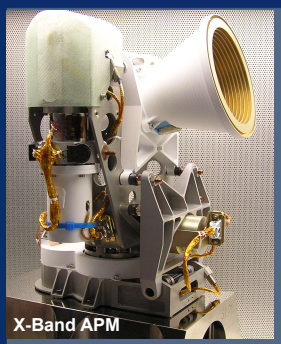
The department has delivered more than 20 deployment and trimming mechanisms, which range from non-ITAR Hold-Down and Release Mechanisms to Opening-closing mechanisms using Shape Memory Alloys.


SDR
Unfurlable Reflector

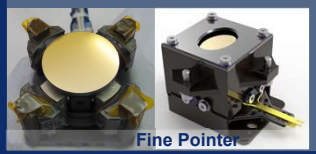

HRM
Sentinel-1


SDR
Unfurlable Reflector


2CIR
Calibration Mechanism


X-Band APM


Coarse Pointer


Fine Pointer

CPA70

COMMUNICATIONS

More than 30 Antenna Pointing Mechanism units have been flown, providing 2-axis movement in LEO, MEO & GEO, supporting both X and Ka bands.

The Fine Steering Mechanisms have been developed for laser communication terminals, and the coarse pointers enable inter-satellite links.

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AIRBUS

Centre of Excellence
MECHANISMS

Earth Observation Mechanisms

RF EARTH OBSERVATION

On ESA funded projects like MetOp 2nd Generation Satellites & Copernicus CIMR Mission as well as on export missions, our mechanisms are a performance enabler in the RF Scanning Instruments onboard.

Continuous Scanning

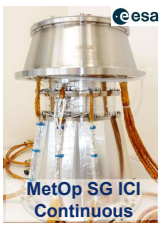
- Rotation of large RF Instruments up to 160kg
- Bearing off-load device for launch guarantees long in-orbit lifetime
- Power and data transfer via Roll Ring
- Actuation via redundant BLDC Motor
- Position feedback via Optical Encoder
- Designed for long-term storage applications (>20 years)
- Qualified for up to 230 million revolutions

Discontinuous Scanning

- Rotation of large reflectors up to D35x50cm
- Highly agile drive profile
- Actuation via redundant BLDC Motor
- Position feedback via Optical Encoder
- CFRP Reflector with qualified coating
- Designed for long-term storage applications (>20 years)


Export – MWI Continuous


CIMR Continuous


MetOp SG ICI Continuous


Export – Double Scanner Discontinuous


MetOp SG MWS Discontinuous

System	Heritage	Envelope [cm]	Scanning Accuracy [µrad]	Velocity [deg/s]	Frequency [GHz]	Power [W]	Mass [kg]
Continuos	MetOp SG MWI & ICI , Copernicus CIMR (ESA funded projects) & several export missions	D30 x 50	10	180 – 270		25 – 40	20 – 30
Discontinuos	MetOp SG MWS, multiple export missions	D35 x 50	–	75 – 150	23 – 230	25 – 35	16 – 20

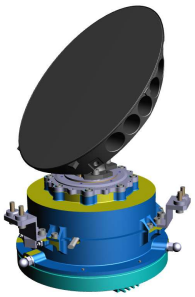
OPTICAL EARTH OBSERVATION

In the frame of MetOp 2nd Generation, the department was developing two mechanisms for the METimage Instrument, with the following characteristics:

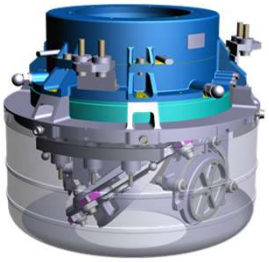
- High accuracy across-track scanning and de-rotation for image stabilization
- Highly dynamic operational profile (optimized for Earth view scanning duration)
- Also available with hollow shaft, optimized w.r.t. stray light
- Actuation via redundant BLDC Motor
- Position feedback via Optical Encoder
- Developed from heritage scanner missions
- Electronically synchronized mechanisms

System	Heritage	Envelope [cm]	Accuracy [µrad]	Velocity [deg/s]	Wavelength [nm]	Mass [kg]
Scanner / Derotator	Several Export missions, Bepi Colombo ADM	D21 x 34 D30 x 20	< 50	160	443 – 13,345	8

Scanner METimage



Derotator METimage



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AIRBUS

Centre of Excellence
MECHANISMS

Communications Mechanisms

RF COMMUNICATIONS

The department counts with ample experience in Antenna Pointing Mechanisms for different orbit applications. Some design characteristics include:

- Independent 2-axis movement (full Azimuth rotation, variable Elevation)
- Geared stepper motor drive
- Contactless Rotary Joints for RF signal transfer
- Slip Ring for electrical signal transfer
- Qualified control electronics (developed also at Airbus Friedrichshafen)
- Built-in Launch Lock

The New Generation Mechanism for RF Communications is now under development, using a standard drive with adaptable RF Path and Antenna.

XAS
Moon X-Band

XAAE
LEO X-Band

KAA
LEO / ISL K-Band

Application	Product & Heritage	Moving Envelope [cm]	Accuracy [deg]	Velocity [deg/s]	Accel. [deg/s2]	Movement Range	Antenna Gain [dBi]	Freq. [GHz]	Mass [kg]
LEO X-Band	XAA (4 units in-orbit, 6 more FMs delivered)	D40 x 60	< 0.5	< 10	< 5	Full Hemispheric	18	8 – 8.4	< 8
	XAAE (4 units in-orbit)	D95 x 82	< 0.5	< 10	< 10	Full Hemispheric	25	8 – 8.4	< 12.5
LEO Ka-Band	KAA (1 unit in orbit)	D70 x 72	< 0.3	< 10	< 10	Hemispheric	31	25.5 – 27	< 9
GEO (gimbal)	Skynet, SatcomBW, DFH-3 (total >20y acc. flight heritage)	40 x 40 x 15	< 0.05	< 5	< 5	+/- 13 deg	< 22kg dishes	Dish design	< 5.5
Exploration X-Band	XAS (Moon Mission, under development)	D90 x 85	< 0.2	< 3	< 5	Full Hemispheric	32	8.45 – 8.5	< 15

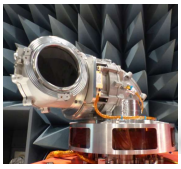
OPTICAL COMMUNICATIONS

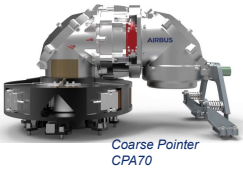
Coarse Pointer

- Independent 2-axis movement
- Application for Laser Terminals and Inter-Satellite Links
- Direct drive with BLDC motor and Optical Encoder
- Built-in Launch Lock

Fine Pointer

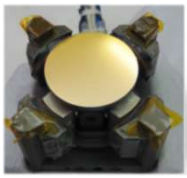
- Cardan 2-axis Gimbal pointed mirror
- Suspended by flexural pivots
- Actuation via four Spherical Linear motors
- Position feedback by Eddy Current sensors





Coarse Pointer
CPA70

System	Heritage	Envelope [cm]	Accuracy [µrad]	Velocity [rad/s]	Accel. [rad/s2]	Rotation Range	Mass [kg]
Coarse Pointer	TerraSar, NFire (18y acc. flight heritage)	35 x 35	125	-	-	Unlimited	15.5
Fine Pointer	TerraSar, Nfire, Alphasat (21y acc. flight)	8 x 5.7 x 4.7	< 100	5	10,000	+/- 3 deg	0.25



FSM - Fine Steering Mirror

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Centre of Excellence
MECHANISMS

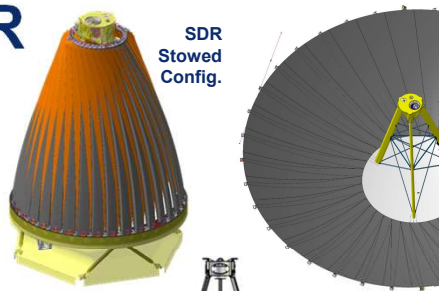
Deployable Mechanisms

UNFURLABLE REFLECTOR

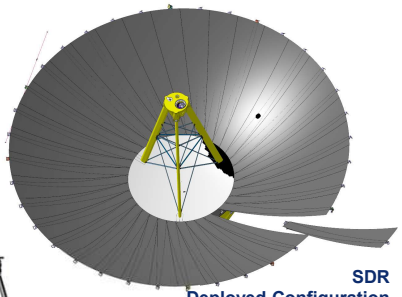
The Unfurlable Reflector product allows the launch of a 5-meter diameter CFRP reflector in a stowed configuration of 1.6-meter diameter, with the following characteristics:

- Very compact design with high contour accuracy
- Scalable design with 3-meter and 5-meter diameter
- Individual CFRP panels avoiding mechanical and thermal cross-couplings
- Fully cold redundant release and damping system
- Easy repair and maintenance of damaged panels (in 2 working days)
- Spring-driven deployment (no electric motorization)
- Different Reflector configurations (Apex-fed, Cassegrain, Gregorian…)
- Surface reflectivity >97% of Aluminium
- Photogrametry Inspection for end-to-end reflector alignment

The current use of the Unfurlable Reflector is Earth Observation, in SAR instruments, and Communications, for MEO data downlink.



SDR Stowed Config.



SDR Deployed Configuration

SDR 3-meter & 5-meter Versions

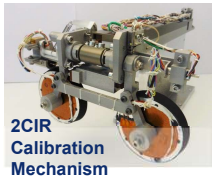
System	Heritage	Deployed [m]	Stowed [m]	Contour Acc. RMS [mm]	1st Eigenfrequency Stowed/Deployed [Hz]	Deployment Time [s]	Frequnecy [GHz]	Contour Symm. Parab. [mm]	Mass [kg]
3-meter	Development model produced in 2003	D3 x 1.4	D1.1 x 1.4	0.6	28 / > 12	5 – 10	X – Ku	F = 1100	< 20
5-meter	Fully qualified, one unit operating in-orbit	D5 x 2.1	D1.6 x 2.1	< 0.6	26 / > 4	20 – 30	8 – 12	F = 1800	< 70

HRM & DEPLOYMENT

Apart from unfurlable reflectors, the department offers a wide range of mechanisms to deploy antenna booms, solar arrays, instrument baffles and calibration mechanisms. The 2CIR Calibration Mechanism opens and closes 2 covers with Shape Memory Alloy technology. The covers act as calibration targets for the optical instrument.

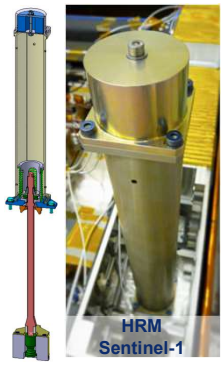
Furthermore, Antenna Deployment Hinges based on springs have been successfully flown. With a self-locking capability, they act as a Hold-Down mechanism too.

In addition, a Hold-Down and Release Mechanism with non-ITAR technology was developed for Sentinel 1. Using NEA as release device, it has a load capacity of 30kN. The shock is absorbed by a honeycomb damper. Already 24 units are in orbit, with 24 more to be flown in the next batch.



2CIR Calibration Mechanism

Deployment Hinges



HRM Sentinel-1

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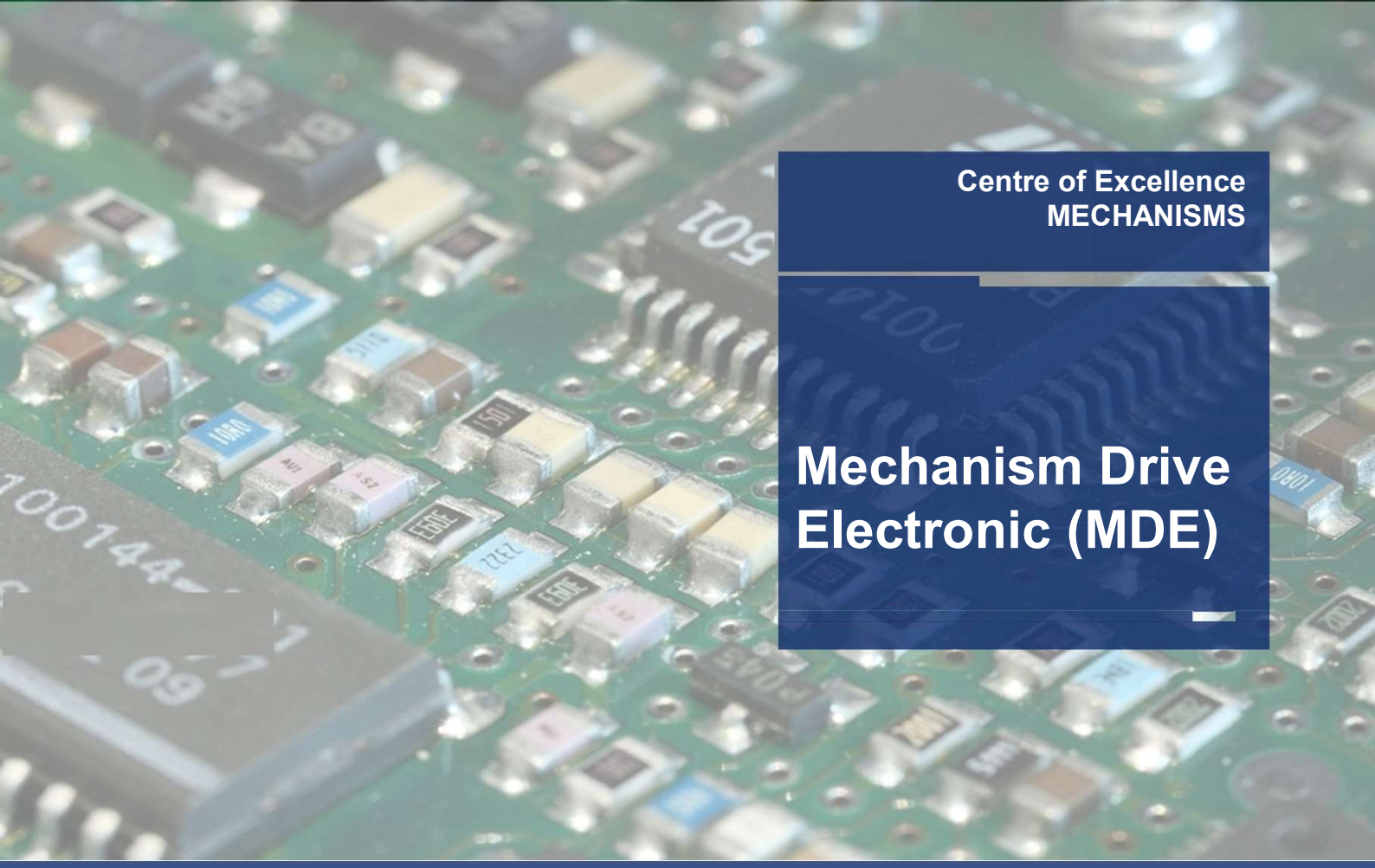


Centre of Excellence
MECHANISMS

Mechanism Drive Electronic (MDE)

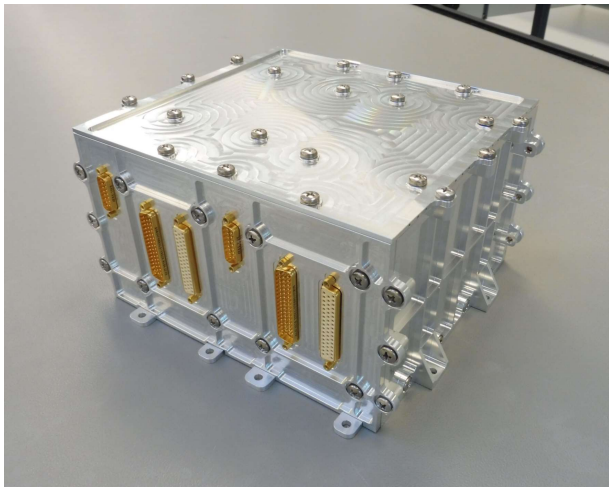
Mechanism Drive Electronics

Heritage and Know-how over several Decades

Significant expertise in the design, manufacturing, and verification of Mechanism Drive Electronics for a wide range of applications, including:

- Stepper Motor Control for Antenna Pointing, Solar Array Drive, and Mass Trim
- Brushless-DC Motor operation in high-accuracy Microwave, Instrument-Scan and APC equipment
- Voice-coil type Motor control in Fine Steering Mechanisms

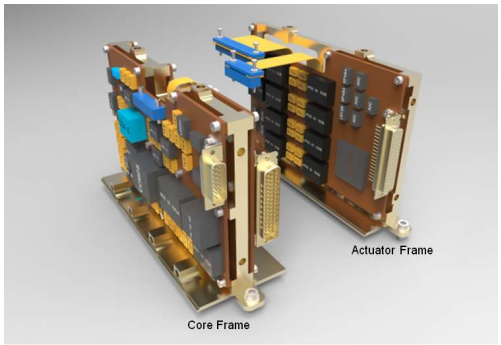
Well-established supply chain for all types of Mechanism Drive and Control Electronics, providing end-to-end service from specification and procurement to verification at the electronics and assembly levels.



MDE Supply Chain Management

Well-known and continuously monitored supply chain for all kinds of Mechanism Drive & Control Electronics, providing end-to-end service, including:

- MDE specification:
  - Detailed requirements definition
  - Inclusion of higher level GDIR and Applicable Documents
- Management of mechanism/electronics interfaces:
  - Interface design and specification
  - Compatibility testing and validation
- Control and review of development, integration, and verification phases:
  - Project planning and scheduling
  - Progress tracking and reporting
- Integration into mechanism equipment and combined test sequences:
  - System-level testing and validation
  - Performance and environmental testing



Flexible MDE next-generation study under GSTP

International Partnership

- Task- and competence sharing
- Equipment competence in TSEMC2, Design and MAIV with partners

Flexible MDE architecture to minimize NREC effort and Flight Model lead time:

- Standardized Core Modules: Utilizing standardized components to reduce development time and costs.
- Flexible adaptation of specific actuator-/sensor-modules: Customizable actuator and sensor modules to meet specific project requirements.
- Flexible Interface configuration: Adaptable interfaces to accommodate various system needs.
- Operational Modes and Control Loops in Software by standard
- Option to avoid software and implement full FPGA control.

Control of BLDC (3-phases) as well as Stepper (2 coils) motors

Support several data interface protocols to CU (RS422, MIL-BUS, Spacewire)

High scalability w.r.t. number of actuators and redundancy

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AIRBUS

Centre of Excellence
MECHANISMS

Verification Services

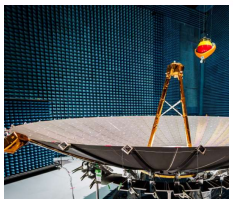
VERIFICATION SERVICES

End-to-end System Verification & Qualification

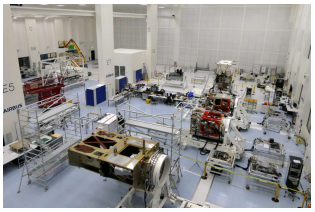
Airbus Defence and Space provides end-to-end functional and environmental verification services for mechatronic systems as well as for mechatronic components:

- On-site Vibration, Shock, Thermal Vacuum, RF, EMC testing, electrical and mechanical I/F verification
- Mechanisms Life testing with HIL in thermal vacuum environment
- Functional tests with HIL, bearing and drive characterization, emitted micro-vibrations measurements and more
- State-of-the-art Cleanroom Facilities (ISO-8 and ISO-5) in our new Integrated Technology Center for hardware integration and testing
- Heritage of several qualification and FM acceptance test campaigns (e.g. MetOp Scan Mechanisms, SDR Deployable reflector)


Functional Verification


RF PAMS


Vibration and Shock

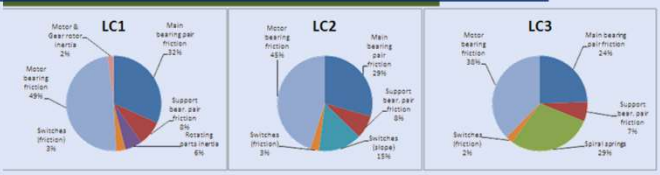


	Test	Detail	Capability
Environmental Verification	**Vibration and Shock**	Shakers: 5kN – 111kN, sine, 3-3000Hz, 100 – 220g, 500 – 862kg, 3 axes Shock: up to 3000g SRS (2-10kHz) for 15kg, 10000g SRS (6-8kHz) for 2kg	Head expander 1.12 x 1.12 m Slip Table 1.2x1.2 m
	Thermal Vacuum	TBS 1400: <1E-5 hPa, -70°C to +130°C, feed- throughs Other chambers available upon request	Test volume 0.9 x 1.38 x 0.98 m
	EMC	MIL-STD-461/462, static magnetic field measurements, EMI, symmetric & asymmetric signal transmission parameters	Shielded measuring room: 6.5 x 4.8 x 2.3m Anechoic Chamber: 5.2 x 5.2 x 2.3 m
	RF	Direct RF measurement of large antennas/reflectors, sampling of radiation pattern on irregular surface using a standard crane as near-filed scanner	L-, X-, and Ka- Band antennas
Functional Verification	**Balancing**	Static and dynamic unbalances through torque and force measurements	Unbalances < 0.1 N / < 0.1Nm ; Low velocity balancing
	Bearing Run-out Characterization	Synchronous & asynchronous run-out (wobble)	Noise floor 1-2 micro-rad
	Electrical Checks	Insulation, bonding isolation, resistance / continuity, inductance and capacitance	Adjustable measurements frequency, bonding in mOhm, insulation in MOhm
	Micro-vibration	Exported Forces and Torques, FFT (PSD, ASD) of time-domain data	Noise floor 1mNm
	Motor Characterization	Torque constant, power measurements, back-EMF constant	
	Photogrammetry	10k measurement points	Object size: 16mm – 10m Accuracy: 0.03mm + 0.01mm/m
	Strain Gauges	Installation and operation, 24bit - 50000µm/m or 10000µm/m	Full / Half / Single Bridge Setups up to 8 Ch
	Resistance Measurements	High-frequent (to 25kHz) dynamic resistance measurements of Power /Data Transfer Devices	Up to 30 channels, accuracy 0.5 -10mOhm
	Torque Measurements	Bearing characterization, resistive torques over temperature Velocity & position depending torques evaluation (FFT)	Noise floor 1-10mNm
	Life Testing	Proof of mechanisms functionality & EOL performance in thermal vacuum conditions. Regular functional checks and status monitoring	Accelerated or nominal speed typically 1-3 years

AIRBUS

Centre of Excellence
MECHANISMS

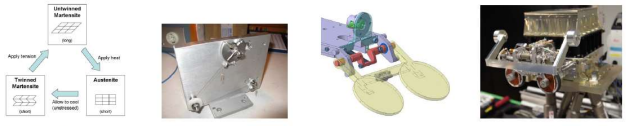
Engineering Services



DESIGN AND DEVELOPMENT

Airbus Defence and Space provides the complete portfolio for the design and development of mechanisms for space applications and ground applications in demanding environments, such as vacuum or high radiation. Our portfolio includes:

- 3D design and drawing preparation, from initial draft to manufacturing/interface/measurement drawings
- Design trade-offs, involving all relevant engineering disciplines and making use of our extensive product and engineering heritage
- Selection of mechanism components, such as bearings, motors or sensors
- Design of features and complex structures, such as mirror mounts, isostatic mounts, thin structures, large deployable structures or redundancy concepts for demanding applications
- Coverage of all mechanisms-related disciplines, including structural/thermal aspects, kinematics, mechatronics, tribology



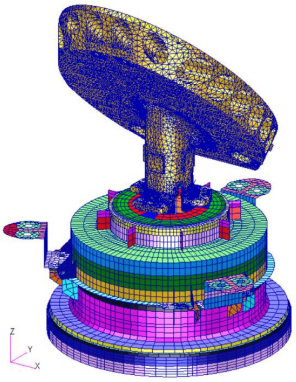
Selection of technology | Feasibility on BB Level | Design of Calibration Unit | Production and Test

From Design Concept to Flight Hardware

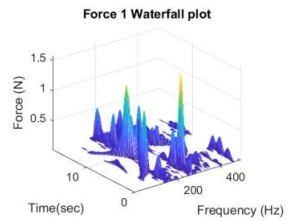
SYSTEMS ENGINEERING

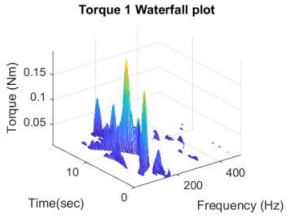
Airbus Defence and Space is able to provide systems engineering for the entire life cycle of mechanism products. Activities typically performed by our systems engineers are:

- Generation of project-specific end-to-end development and verification processes
- Requirements breakdown and consolidation
- Generation of technical specifications on all levels
- Design and process optimization for risk mitigation, cost saving, schedule optimization
- Supplier management
- Failure investigation and root-cause analysis



FEM Modelling





Exported Forces

ANALYSIS AND SIMULATION

Airbus Defence and Space is able to provide engineering services for all disciplines involved in mechanisms design and development. Airbus engineers from the different disciplines work closely together in our internal projects as well as in engineering service work packages provided to external customers.

Mechanism simulation and analysis

- Performance prediction with guaranteed confidence
- Closed-loop control system design and simulation with hardware in-the-loop
- Robust performance and stability analysis of closed-loop control systems
- Exported torque spectrum (micro-vibration) prediction
- Multi-body and -actuator modelling, simulation and design model derivation
- Dynamic simulation, using state-space models

Bearings and tribology

- Conceptual design, bearing & lubricant selection
- Bearing calculation according to ISO 76 and ISO 281, incl. consideration of thermo-elastic effects
- Bearing lifetime prediction

Torque and power budget assessments

Assessment of torque and power budgets for all types of mechanisms and mechatronic sub-systems, such as single-axis or multi-axis BLDC-driven mechanisms, stepper motor mechanisms or spring actuators

Pointing analysis and budgets

- High accuracy statistical analysis of performance and knowledge errors
- Pointing analysis in line with ESA's Pointing Error Engineering Handbook
- Line-of-Sight and ground path uncertainty cone analysis

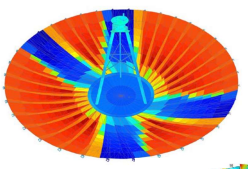
Dynamic and kinematic deployment analyses

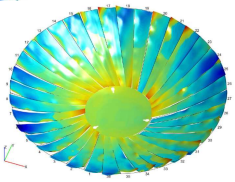
- Simulation of rigid and flexible body kinematics
- Modelling of non-linear problems (e.g. contact or friction) based on empirical test data.
- Robustness & sensitivity analysis

Fuel Sloshing Analysis

- Tightly coupled dynamics analysis with CFD-in-the-loop
- Derivation of simplified fuel sloshing models for performance campaigns and controller design

Thermal Analysis & TED





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