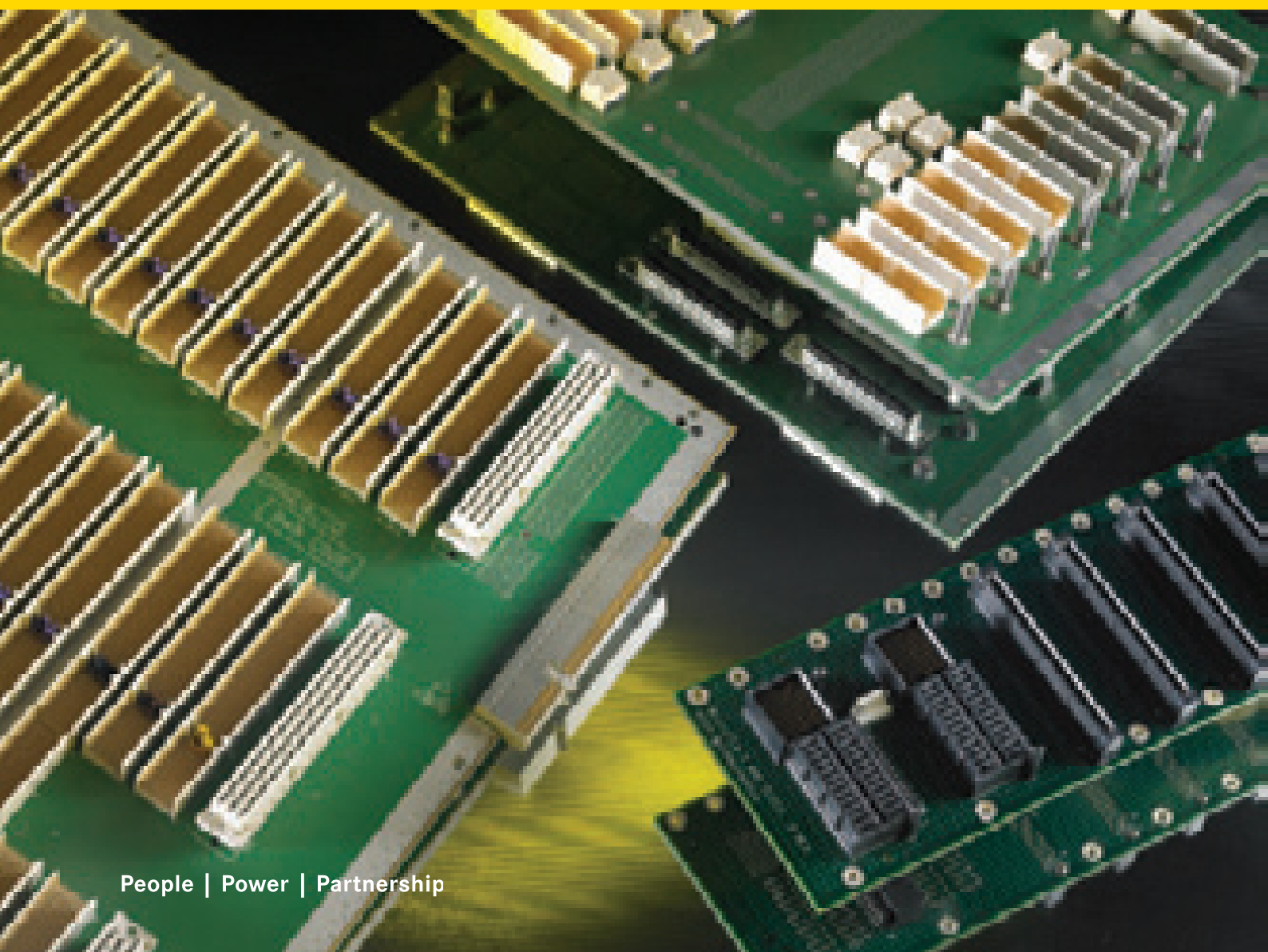




Pushing Performance

HARTING High Speed Backplanes



People | Power | Partnership

HARTING Technology Group

Competence in all areas of industrial manufacturing – tailored solutions for every type of industrial application – customer centers throughout the world: the transmission of energy, signals and data is at the core of HARTING Technology Group. HARTING offers outstanding development and manufacturing competence, especially in the areas of connection, transmission and network technology.

HARTING Technology not only provides components but also complete solutions, ranging from connection technology in the area of electrical and electronic industrial connectors, 3D-MID technology and network components through to printed board technology, sales systems as well as solutions for the automotive sector, tool construction and the construction of machines for special applications.

Customers of the HARTING Technology Group are at home in the automotive industry, rail engineering, medical technology, renewable energies, plant automation and the telecommunication sectors.

Solutions from the HARTING Triad – Installation Technology, Device connectivity and Smart Network Infrastructure – generate clear benefits in various applications across a broad range of markets.



Installation Technology

Han® connectors are the worldwide connector standard in industry. Han® connectors impress with their rugged design, convenient handling and modularity of data, signal and power connections. Worldwide.



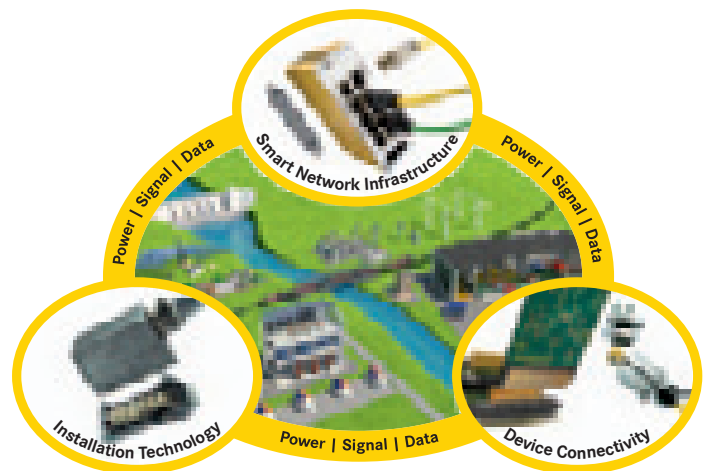
Device Connectivity

HARTING's *har-* Device Connectivity technology is a universal and innovative product portfolio of board connector and connection technology for devices in the IP 20 to IP 65 / IP 67 protection categories.



Smart Network Infrastructure

With its product series Ha-VIS, HARTING offers a consistent range of Ethernet network components and cabling products, which from the communication platform of convergent automation IT networks. Under Ha-VIS HARTING offers fully integrated RFID solutions.

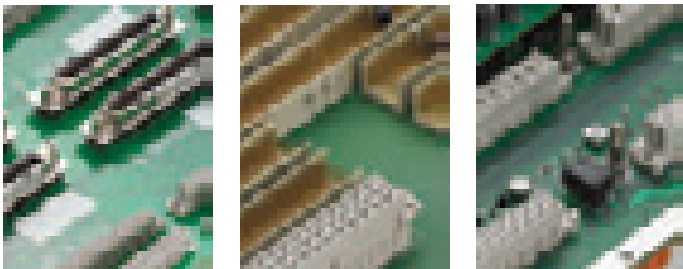


Pushing Performance

HARTING Integrated Solutions (HIS)

HARTING Integrated Solutions (HIS) is one of seven business units that make up the HARTING Technology Group. With 10 production plants and more than 400 engineers and scientists, we serve our customers from 32 subsidiaries around the world.

Through the innovative use of microstructures, metallurgy, printed circuit board technology, design simulation, and advanced production equipment, HARTING's HIS facilities provide complete backplane engineering and manufacturing services. This includes both standard and customized backplane solutions, each one being produced in fully integrated manufacturing plants. Prior to shipment, all products undergo comprehensive mechanical testing and electronic performance verification according to widely recognized industry standards and customer specifications.



Contents

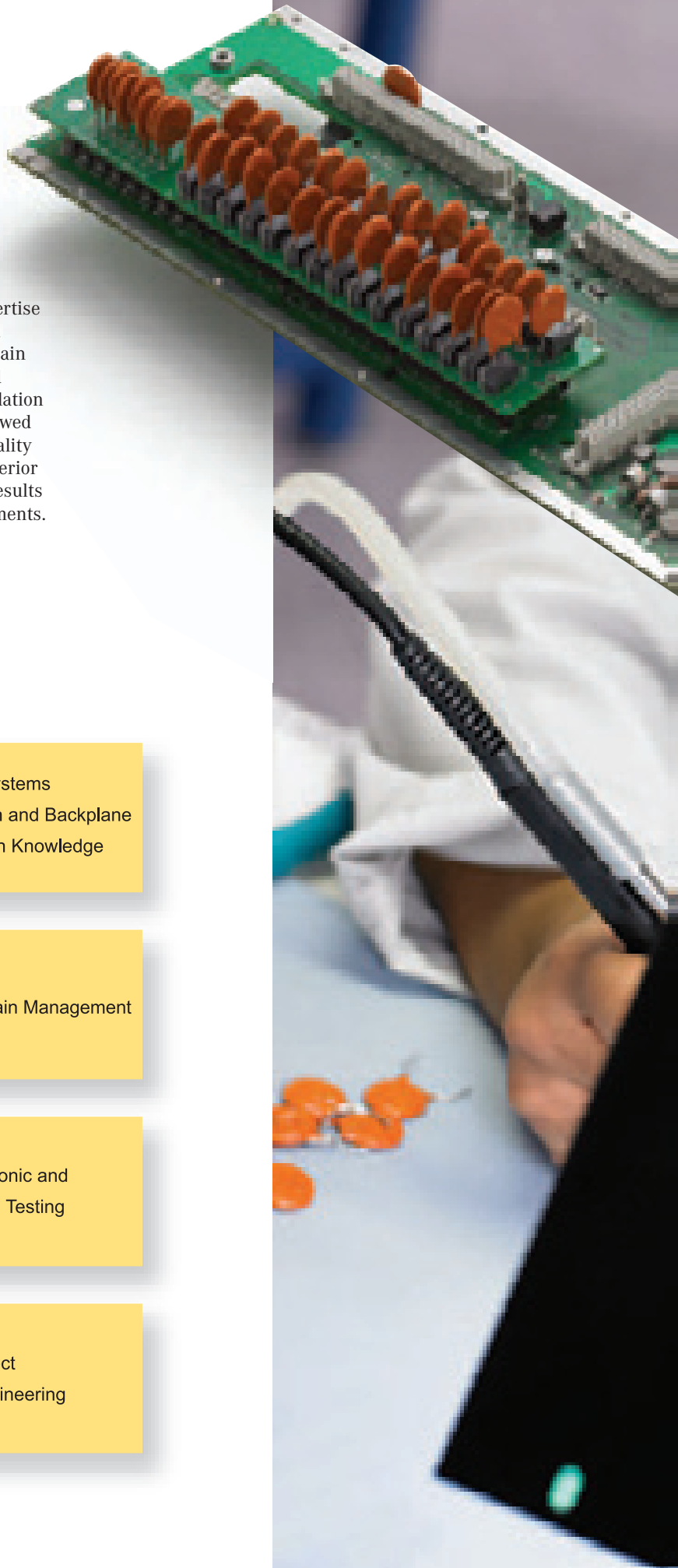
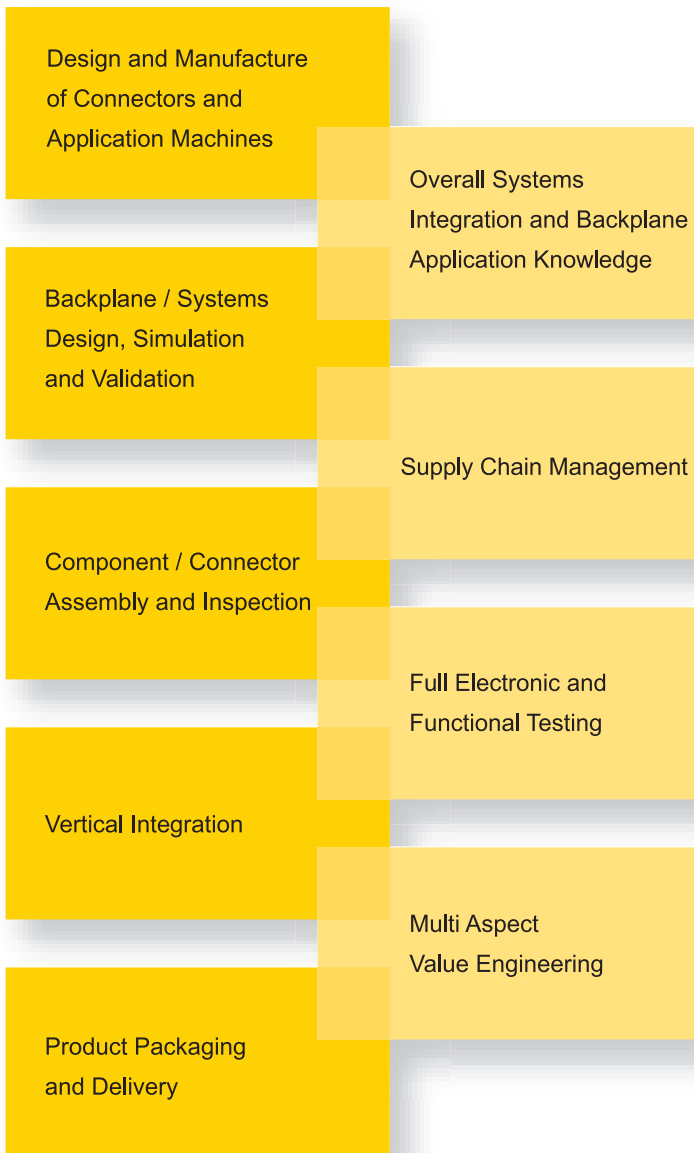
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HARTING Backplane Value Chain

The Value Chain of Services

Every backplane produced by HARTING benefits from HIS expertise in nine areas – shown as links in our value chain below. From interconnect design to manufactured assemblies, our value chain ensures that all HARTING Integrated Solutions backplanes and backplane systems will be of the highest quality. Design simulation and fast prototyping will quickly get your project started, followed by ensured delivery of the finished product. As part of our quality assurance program, sophisticated signal analysis ensures superior performance of high-speed backplanes, and superior design results in years of reliable service in demanding application environments.



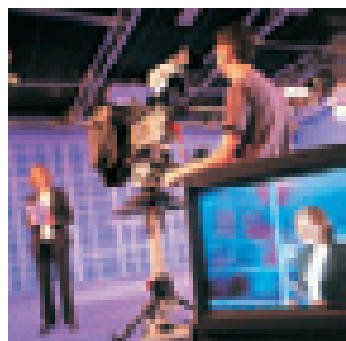


No detail is too small in the design, production, inspection and testing of HARTING Integrated Solutions backplanes.

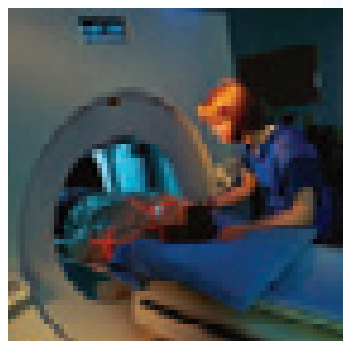
Markets Served



Telecommunications



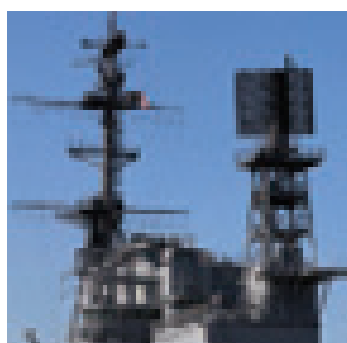
Broadcast



Medical



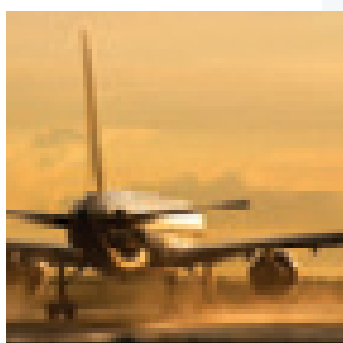
Embedding Computing



Military



Transportation



Aviation

High Data Rate Applications

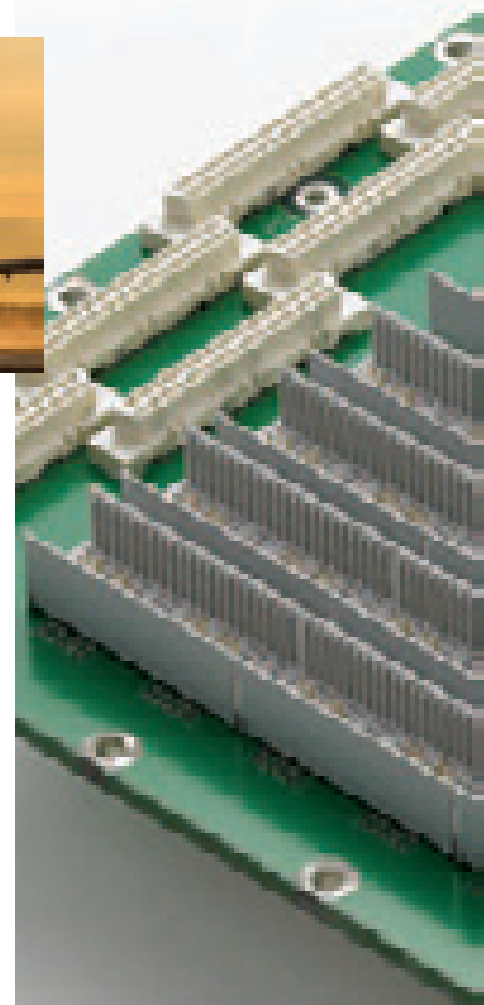
HARTING specializes in high-speed backplanes for applications requiring error-free transmission at high data rates. Along with embedded computing, this is a common thread in all the HARTING Integrated Solutions target markets. A few applications for our high-speed backplanes include:

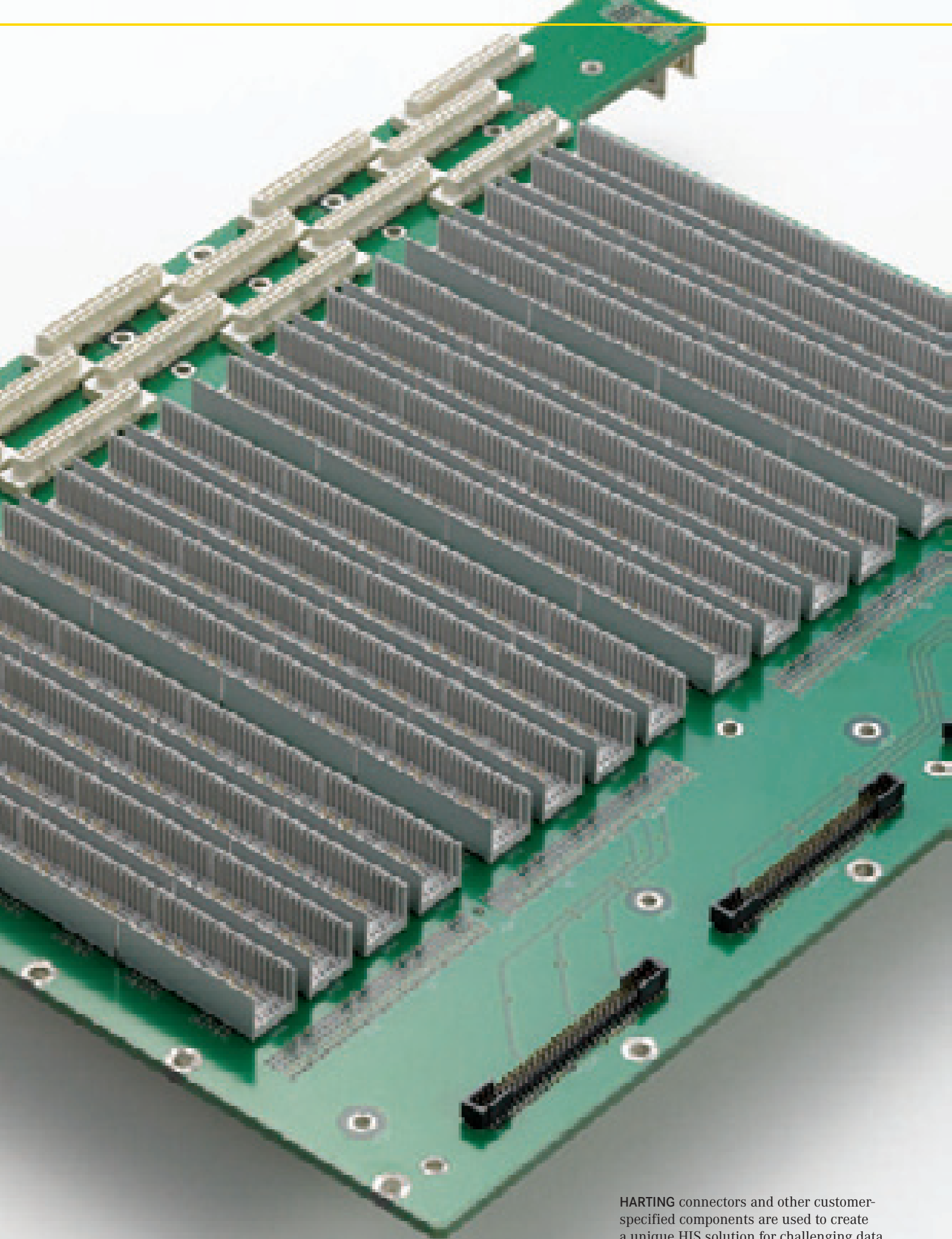
- SS7 switchgear for broadband telecommunications
- Backplanes carrying 180 simultaneous broadcast video channels
- Data processing in medical CAT scans and graphic imaging
- Military/aerospace radar image processing
- Automatic train control and safety systems for rail transportation
- Aircraft fly-by-wire data communications
- Embedded computing in these and many other applications

Essential HARTING Capabilities

HARTING Integrated Solutions' expertise—crucial in all our target markets—is the design and manufacture of backplanes to accommodate high-speed signals without excessive latency and distortion. Backplane engineering, manufacturing, and testing are key capabilities, as are these other areas of expertise:

- Design simulation to shorten product development time
- Manufacture of interconnects and installation machinery to meet specific customer needs
- Simplifying customer sourcing with our total integration services, including backplane, rack, power supply, wiring, and enclosure integration
- Careful control of our supply chain for end product quality assurance
- Complete mechanical, electrical and functional testing to ensure product performance
- Value engineering for cost effectiveness, design improvements, and production efficiency
- Full documentation of our entire engineering, manufacturing, and quality control systems to meet customer and end user requirements





HARTING connectors and other customer-specified components are used to create a unique HIS solution for challenging data processing applications.

Custom Backplane Products

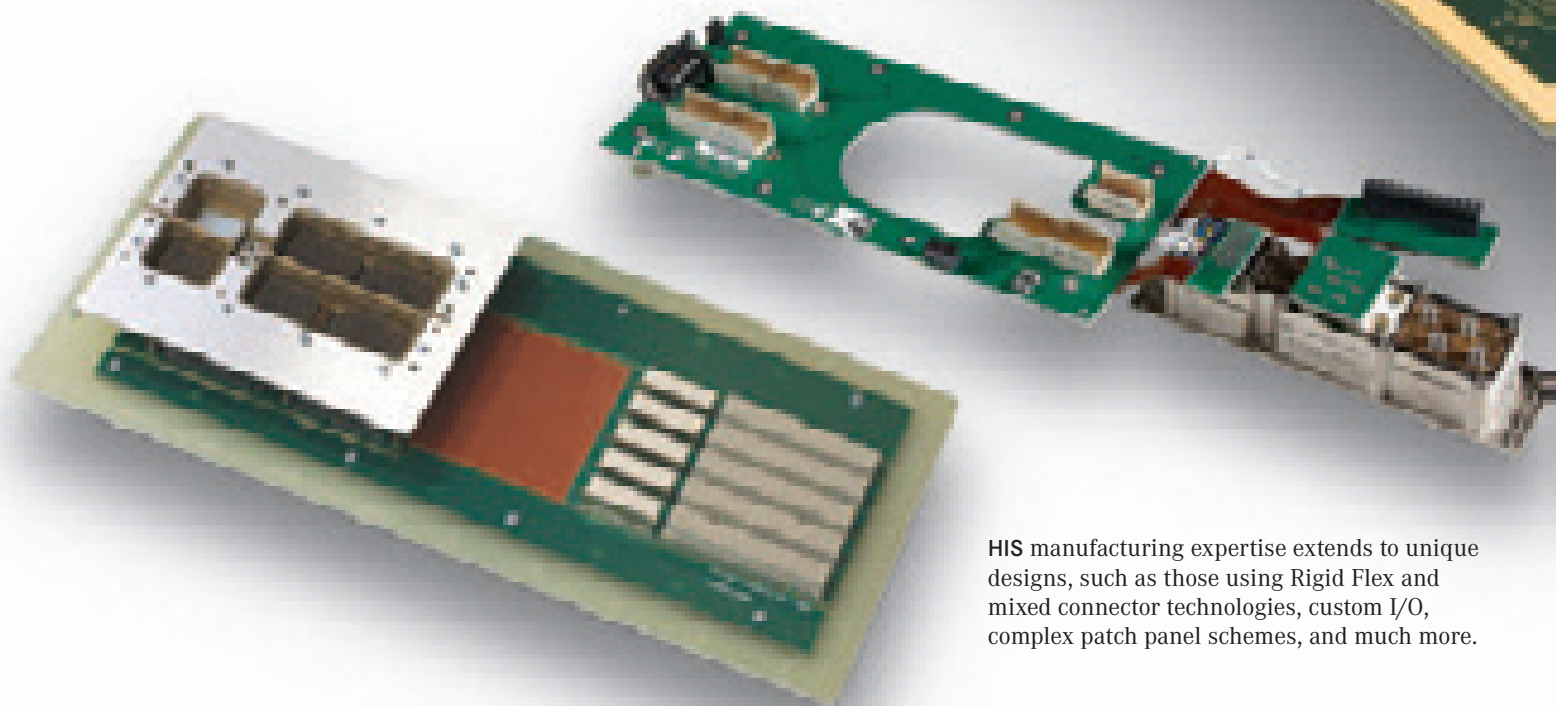
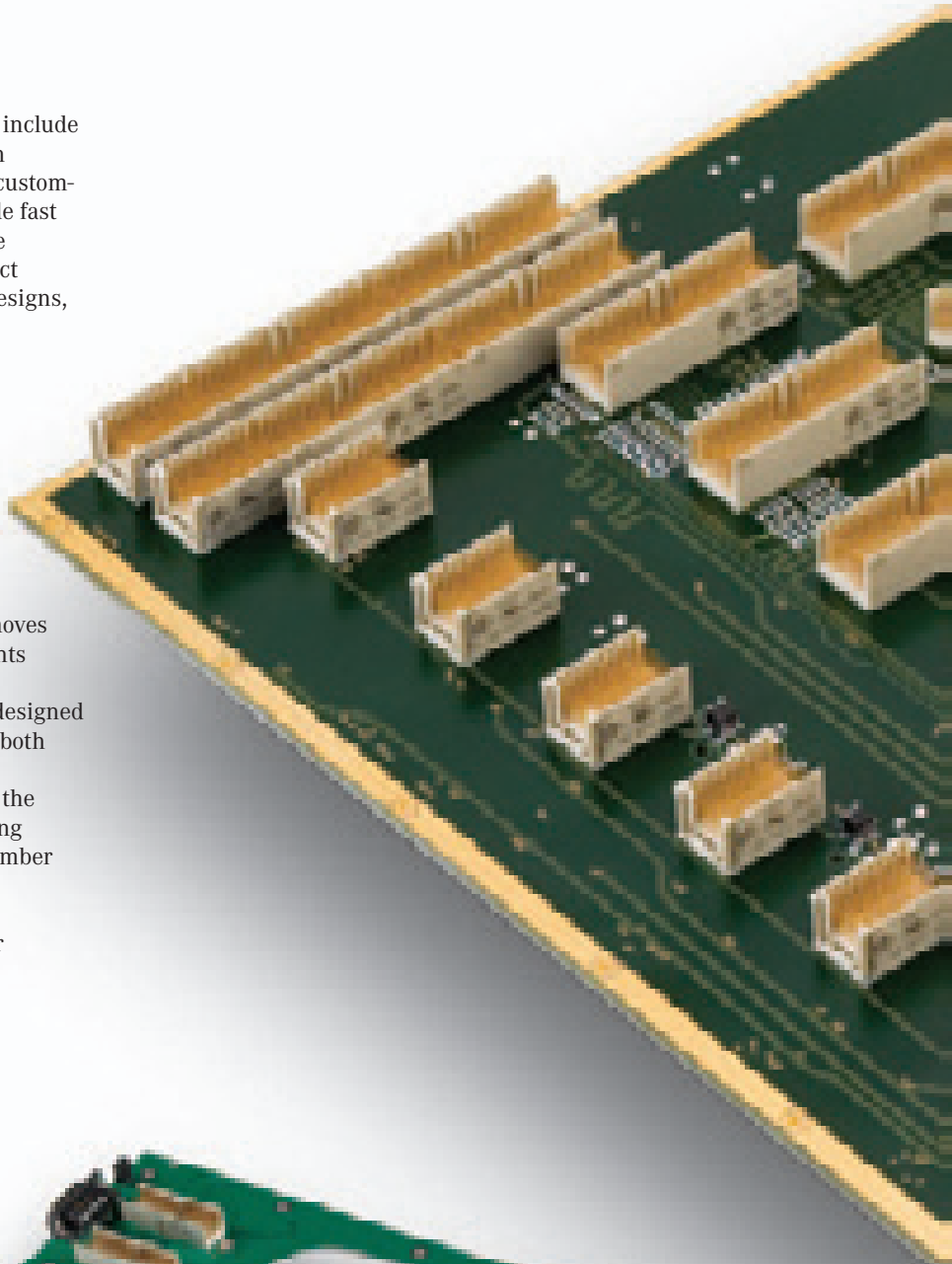
Full Service Engineering

HARTING Integrated Solutions backplane capabilities include a complete range of engineering expertise and design services to meet customer requirements for unique, custom-built products of any size or configuration. We provide fast engineering response to enquiries, supplying reliable PCB designs to customer specifications, for any project initiative – large or small. To support these unique designs, HIS resources include:

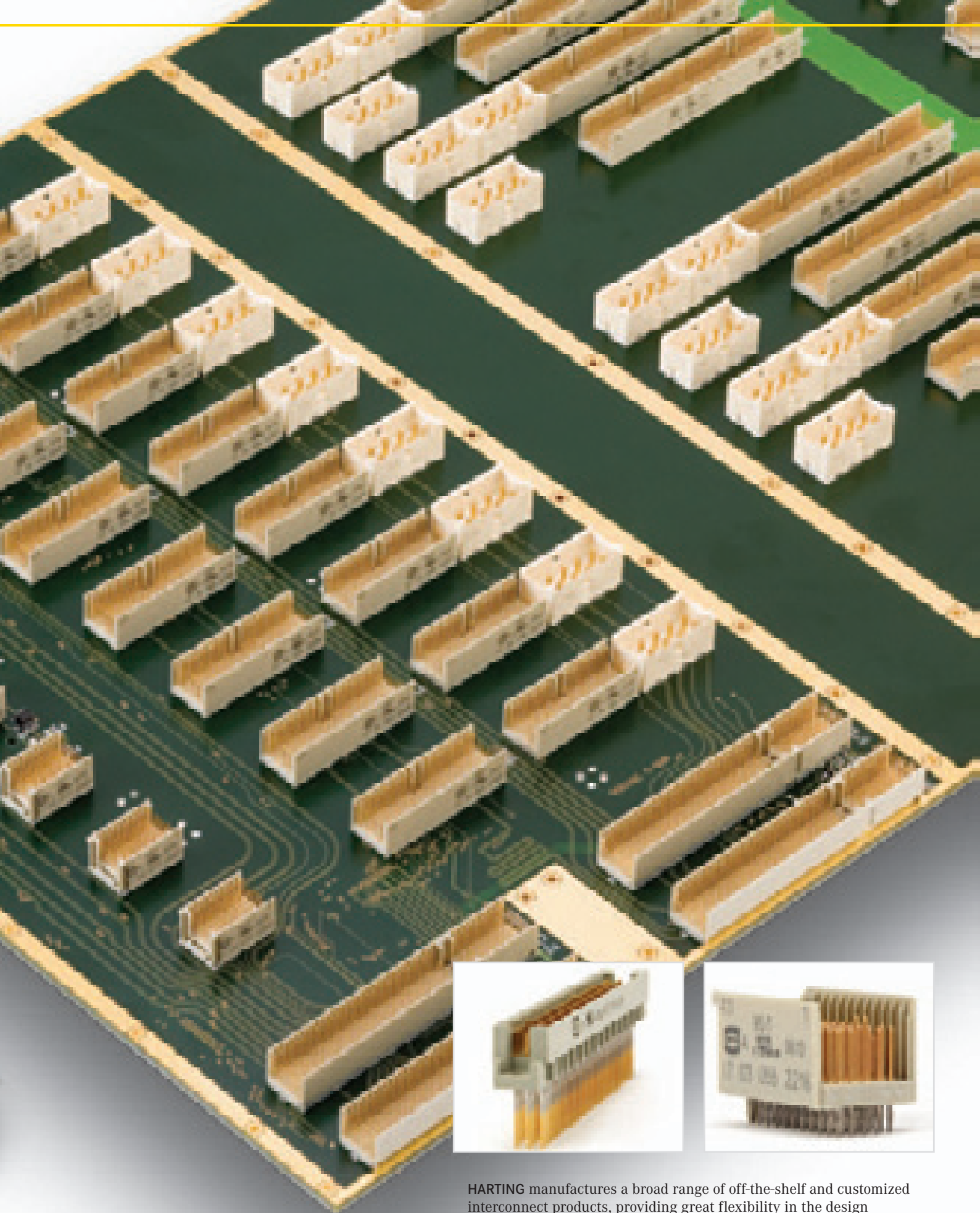
- Cadence Allegro design software
- A complete connector library
- Full differential pair capability
- SPICE and IBIS modeling
- Complete backplane simulation
- Time and frequency domain measurements
- EMC testing

Modern Manufacturing

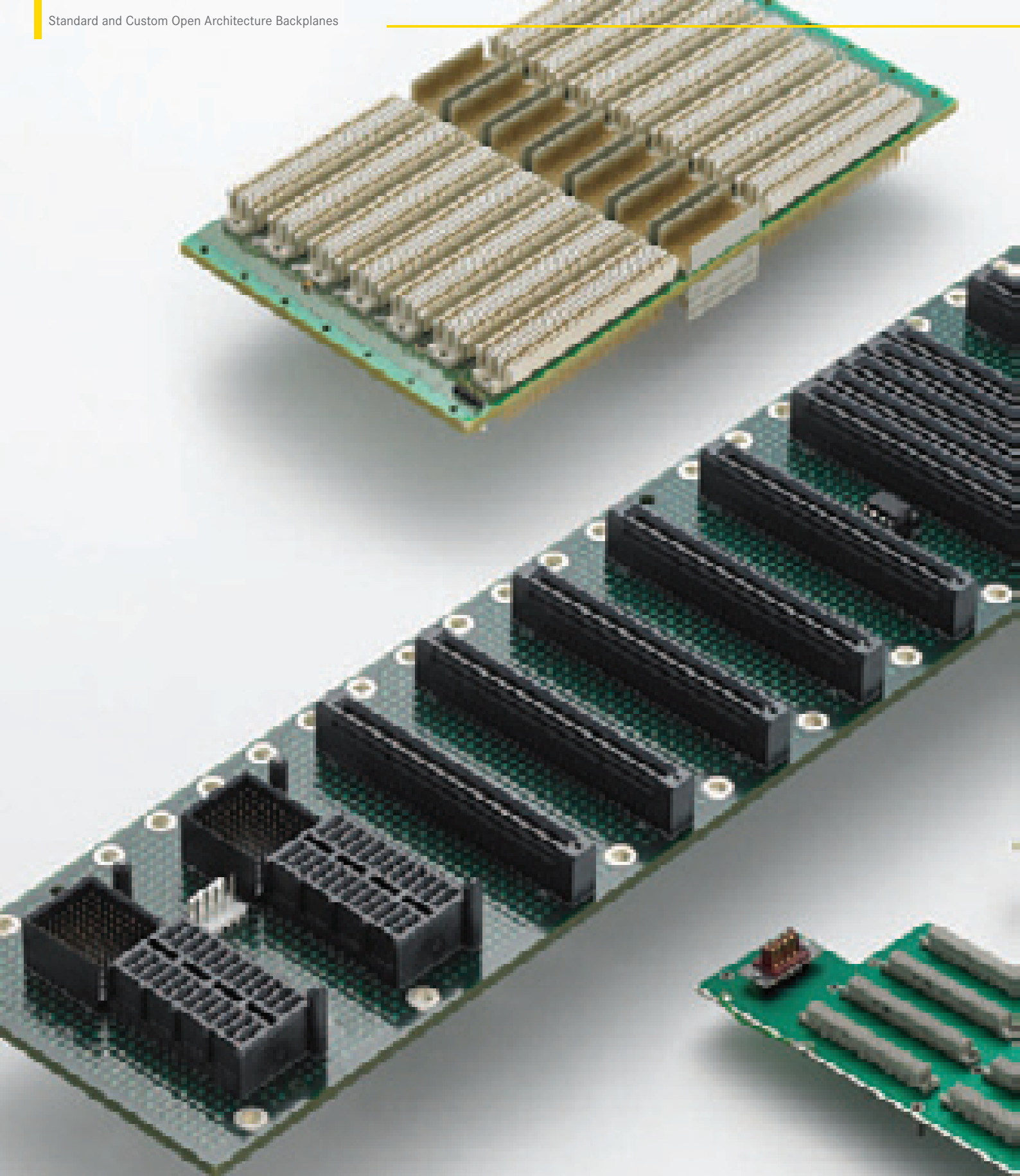
Following customer approval, the HIS board design moves to manufacturing. Modern facilities on three continents shorten supply lines to customers around the globe. Our equipment includes assembly lines specifically designed for large-scale backplanes. These lines can assemble both press-fit and surface-mount compatible connectors. Pin-in-hole intrusive reflow soldering can be done in the same operation with surface mounting. Wave soldering can also be used, even on backplanes with a large number of component and high layer counts (48+), which are traditionally difficult to handle. Expertise in these technologies is one reason HIS is the leading supplier of custom backplanes.



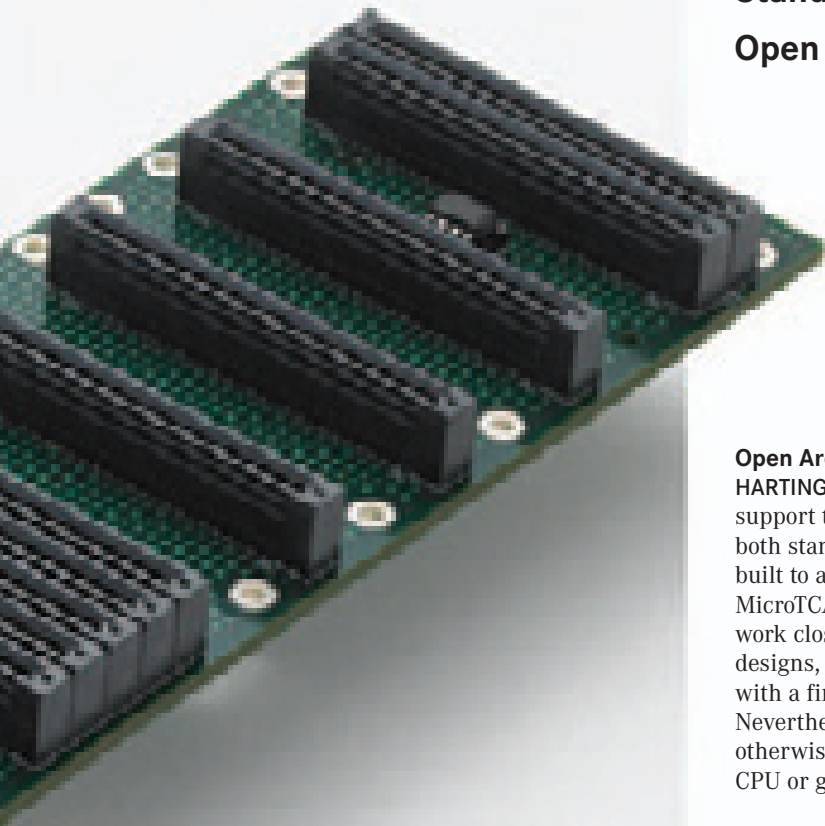
HIS manufacturing expertise extends to unique designs, such as those using Rigid Flex and mixed connector technologies, custom I/O, complex patch panel schemes, and much more.



HARTING manufactures a broad range of off-the-shelf and customized interconnect products, providing great flexibility in the design of custom backplanes. Specially designed press-fit machinery at HARTING Integrated Solutions manufacturing plants also allow unique connector configurations, such as staggered pin lengths to ensure proper grounding before power pins engage.



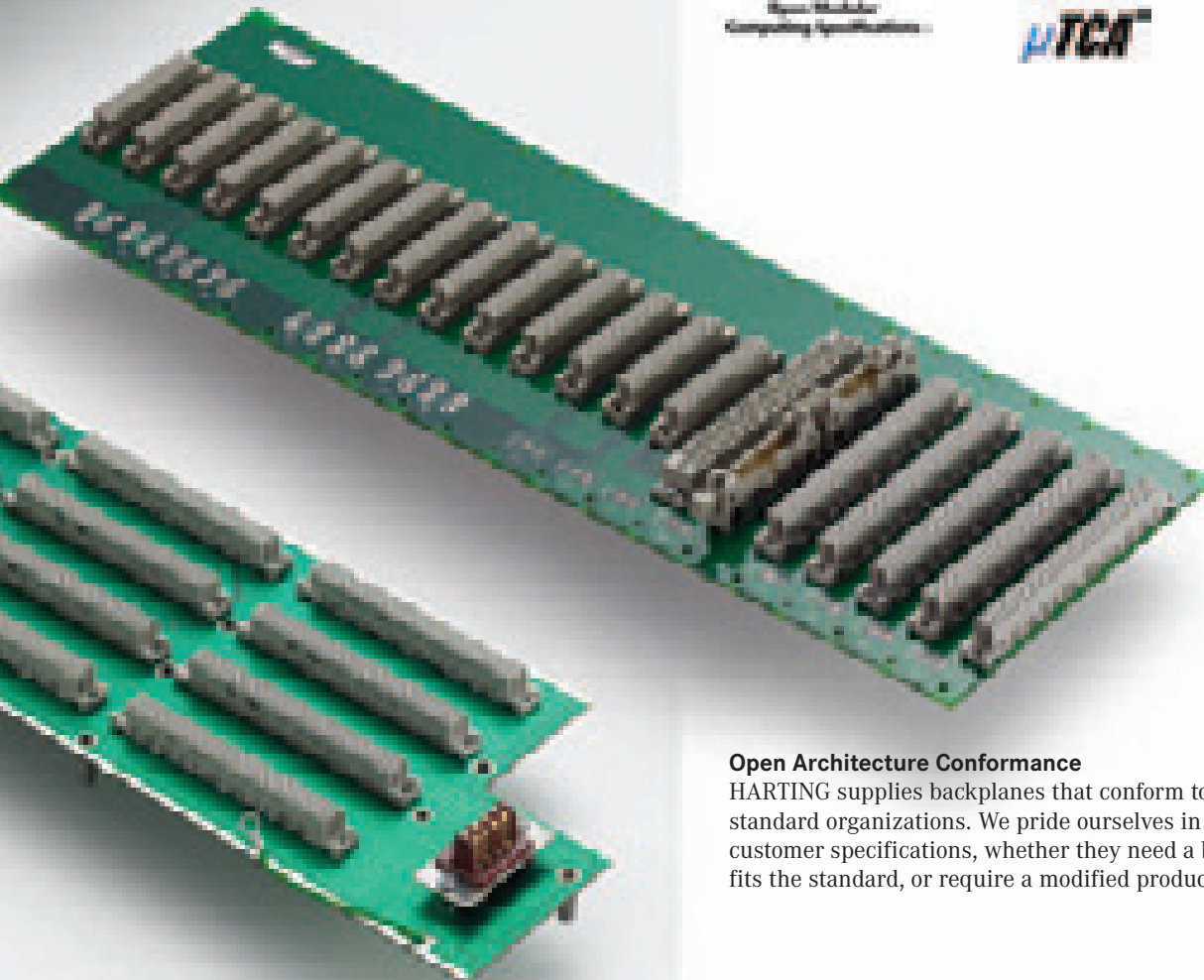
Engineering and manufacturing support the design and development of backplane architectures including AdvancedTCA[®], MicroTCA[™], CompactPCI, VME, VME64x, VXS, VPX and custom designs



Standard and Custom Open Architecture Backplanes

Open Architecture Support

HARTING Integrated Solutions' Engineering and Manufacturing support the design and development of open architecture backplanes – both standard and customized designs. These can be designed and built to any of the standard specifications, such as AdvancedTCA®, MicroTCA™, Compact PCI, VME, VME64x, VXS, VPX, etc. We also work closely with our customers in the modification of standard designs, such as adding extra power slots, or using connectors with a finer pitch, non-standard plating, and different I/O pin-outs. Nevertheless, we make sure these modified backplanes conform otherwise to the underlying standard so, for example, anyone's CPU or graphic board can be used.



Open Architecture Conformance

HARTING supplies backplanes that conform to many well-known standard organizations. We pride ourselves in being able to meet customer specifications, whether they need a backplane that exactly fits the standard, or require a modified product.

Design, Simulation and Modeling

HARTING Integrated Solutions provides engineering, design and product development services unique in our industry for the creation of high-speed, high-performance backplanes. The first step in our Advanced Design System is the use of Cadence Allegro software to design and generate a board model for simulation testing at up to 40GHz rates. This modeling in a 3D Field Solver Software includes the actual connectors that will be used, as their pins and other physical characteristics have a huge impact on performance. We also simulate board layers and traces within a circuit simulation tool to see how they impact the design.

Simulation / Modeling equipment

These models are tested with the most advanced measurement equipment available to check for impedance matching, signal loss, and distortion.

HARTING's instrumentation capabilities include:

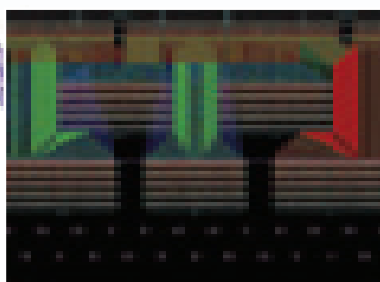
- Broadband Digitizing Oscilloscope with differential TDR Module
- Measurements with pulse rise times $\leq 28\text{ps}$ at the DUT (Device under Test)
- 4-Port PLTS (Physical Layer Test System) with comprehensive software for post-processing of S-Parameter Data into Time Domain (Bandwidth: 40GHz)
- 12.5Gbps BERT (Bit Error Rate Tester) with Pattern Generator for Eye Diagram Analysis
- Drill/Mill Plotter for PCB-Prototyping

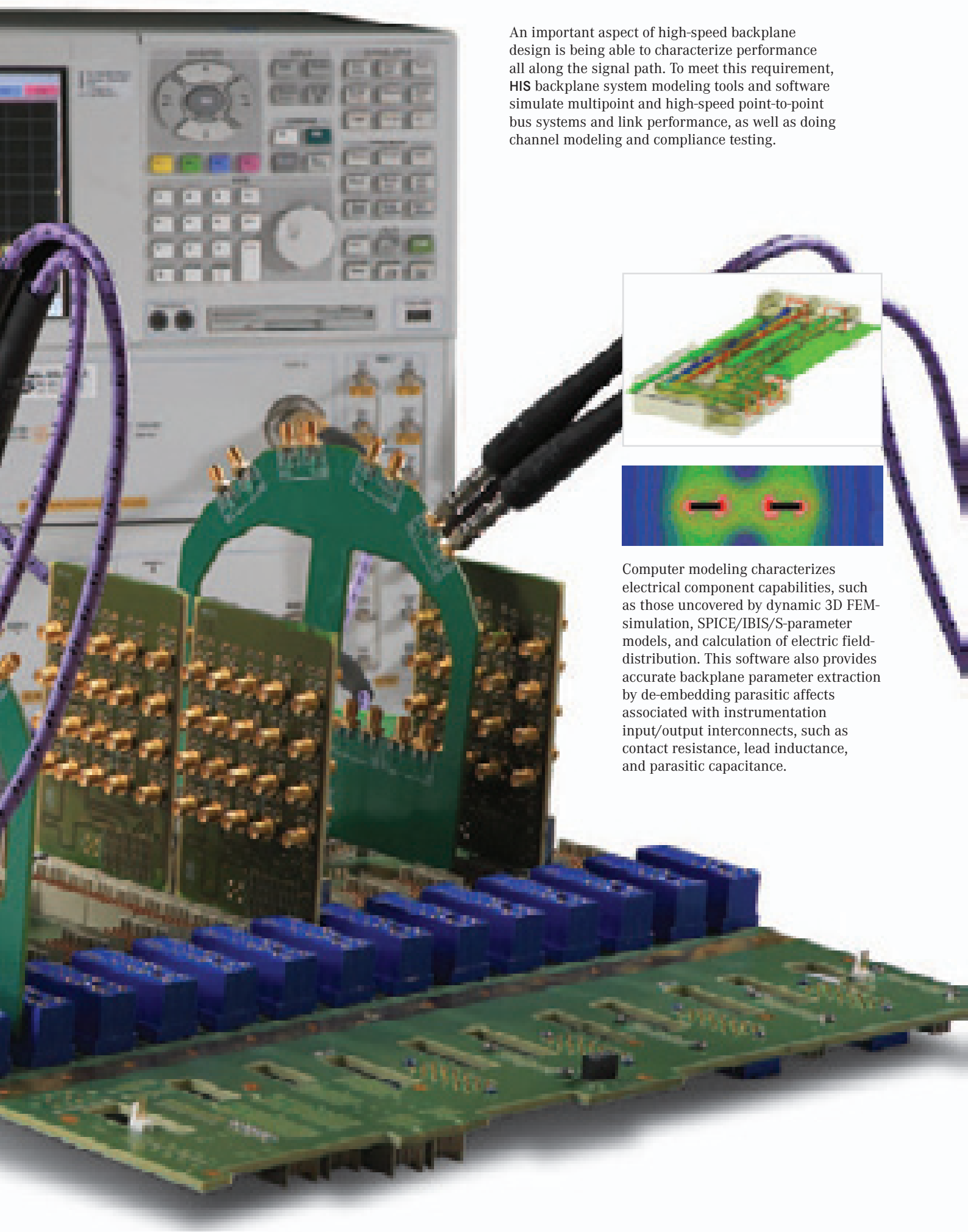
Software Library

HARTING's signal integrity instrumentation is supported by a large software library that supplies a wide range of physical layer modeling and simulation capabilities:

- SPICE, HSPICE Models
- 3D Simulation
- CST Microwave Studio
- HFSS (High Frequency Structure Simulator)
- Q3D Simulation
- PCB Layout-Software (Pads)
- Individual Test Card Design

cadence[®]





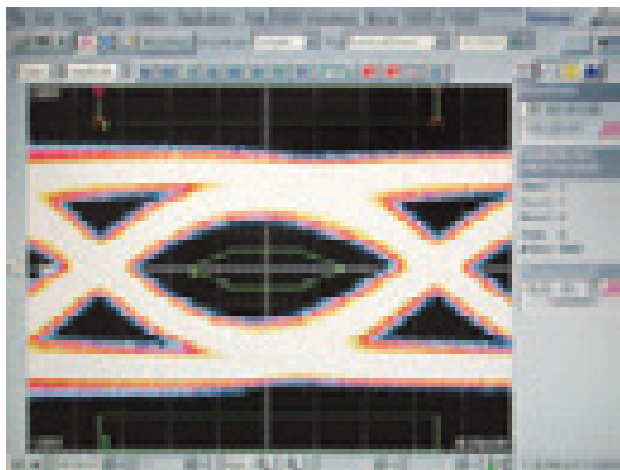
An important aspect of high-speed backplane design is being able to characterize performance all along the signal path. To meet this requirement, HIS backplane system modeling tools and software simulate multipoint and high-speed point-to-point bus systems and link performance, as well as doing channel modeling and compliance testing.

Computer modeling characterizes electrical component capabilities, such as those uncovered by dynamic 3D FEM-simulation, SPICE/IBIS/S-parameter models, and calculation of electric field-distribution. This software also provides accurate backplane parameter extraction by de-embedding parasitic affects associated with instrumentation input/output interconnects, such as contact resistance, lead inductance, and parasitic capacitance.

Measurement and Verifications

Corporate Technology Services

HARTING Integrated Solutions is supported by a Corporate Technology Services lab that supplies the full range of mechanical, electrical, environmental, and signal integrity testing. This lab is independently accredited by DAR according to the quality standards for DIN, EN, and ISO/IEC 17025 testing of electromechanical components and data transmission systems.



Eye Diagram of a
fiber optic receiver

Signal Integrity Verification

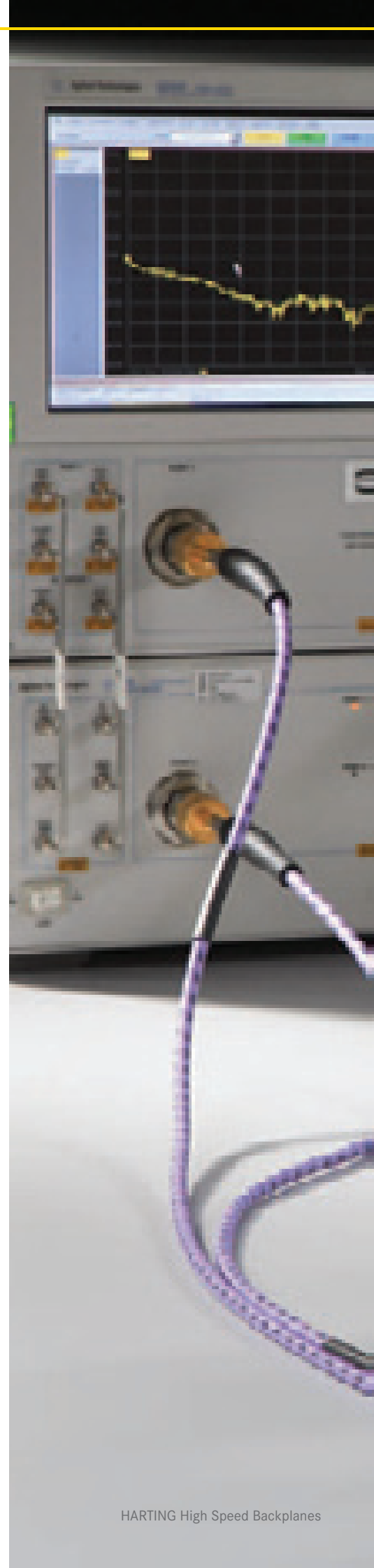
After development of test cards and prototype backplanes, HARTING conducts high frequency measurements on components and complete systems. Verification capabilities include:

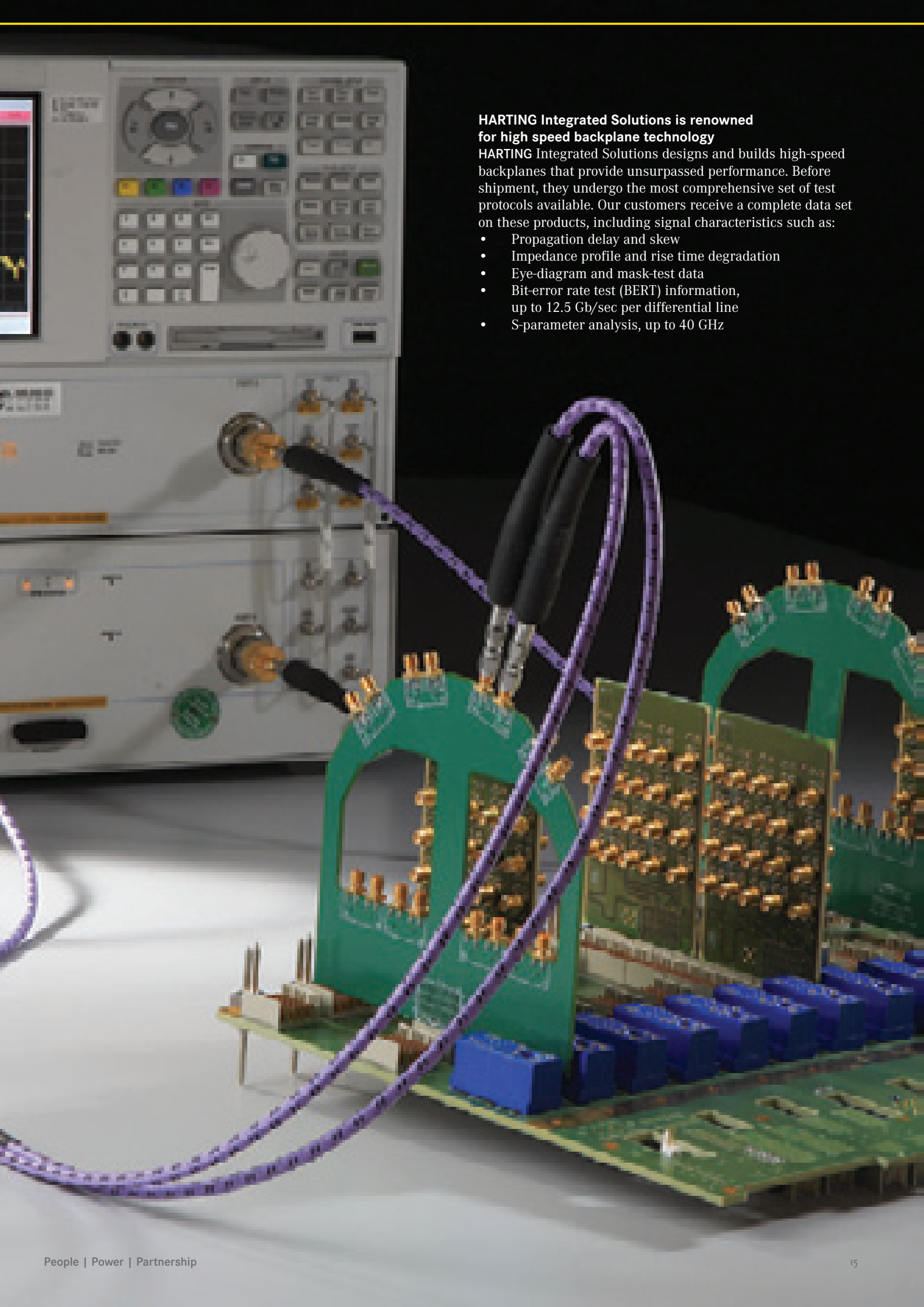
- Time and frequency domain characterization
- Characteristic impedance
- Reflection/standing wave ratio
- Pulse signal rise and fall times
- 4-Port S-parameter analysis
- Return loss, attenuation, crosstalk
- Eye-Diagram - compliance tests with chip vendor evaluation modules

Interconnect Characteristic Characterization

Environmental and other electromechanical test protocols determine a finished backplane's suitability for use in a wide range of applications. The HARTING test spectrum includes:

- Climate and environmental tests
- Electromechanical testing
 - Vibration and mechanical shock
 - Material analysis and microscopic examinations
 - Insertion and removal forces
- Electromagnetic compatibility (EMC)
 - Radiated and conducted





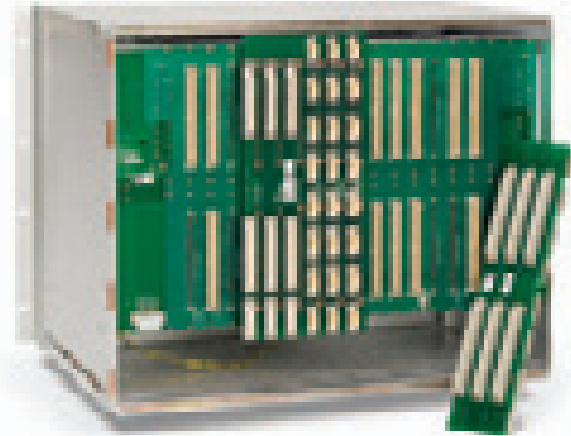
HARTING Integrated Solutions is renowned for high speed backplane technology

HARTING Integrated Solutions designs and builds high-speed backplanes that provide unsurpassed performance. Before shipment, they undergo the most comprehensive set of test protocols available. Our customers receive a complete data set on these products, including signal characteristics such as:

- Propagation delay and skew
- Impedance profile and rise time degradation
- Eye-diagram and mask-test data
- Bit-error rate test (BERT) information, up to 12.5 Gb/sec per differential line
- S-parameter analysis, up to 40 GHz

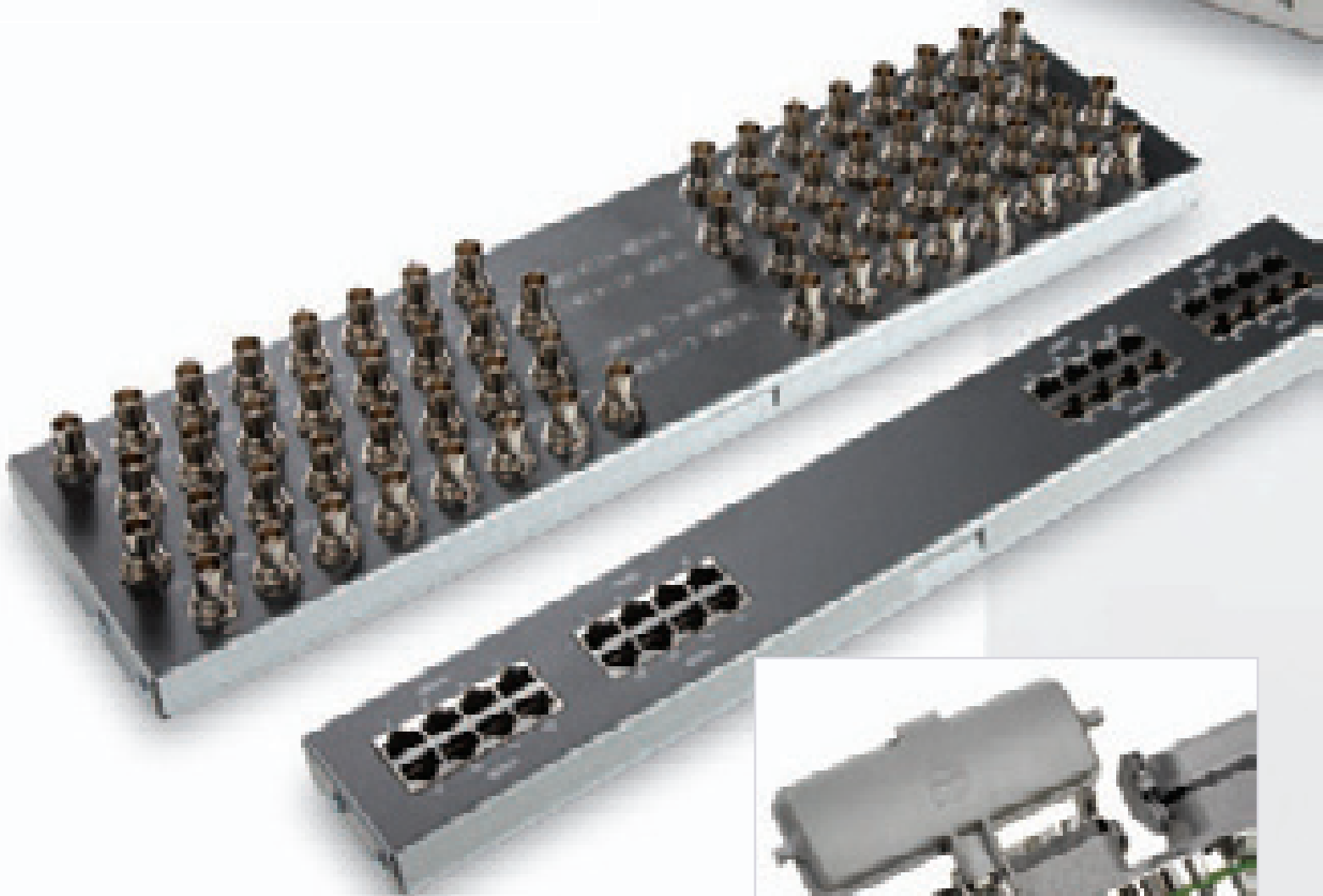
Special Value Added Products and Services

HARTING Integrated Solutions satisfies customers' needs for a supplier that can provide value added services in addition to our usual range of products. When requested by our customers, HIS selectively supplies special chassis, racks, and patch panels to complement the backplanes we manufacture.

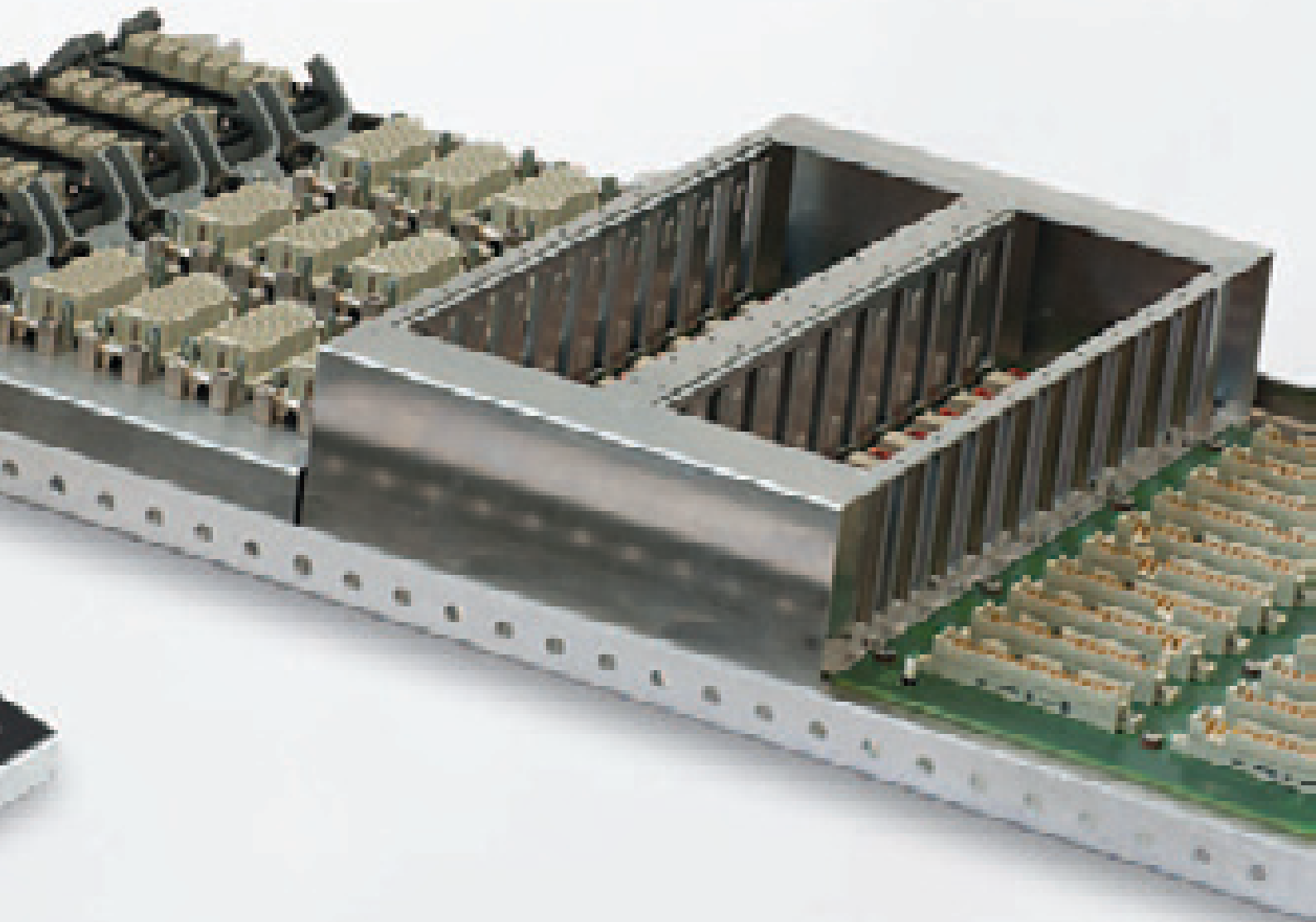


Select Chassis Assemblies

HIS capabilities include the design and manufacture of special chassis assemblies requested by our customers. These chassis are typically designed to satisfy the requirements for service in rugged industrial and military environments.



Select I/O panels, interconnect boards, patch panels, and custom cable assemblies are supplied by HIS upon request.



Integration and Project Management

HARTING makes it easy to do business with us, undertaking complete project management responsibility to the degree needed by our customers. This includes local support and coordination with our customers' engineers, and the services of a team of specialists at our global manufacturing plants, which includes designers, application engineers, and project managers. We are adept at managing all aspect of a project from start to finish, and coordinating activities across international boundaries. Whether you need only a backplane, or a uniquely designed and integrated system, HIS delivers on time and within budget.



Three identical ISO9000:2000 factories were built by **HARTING** to IPC 610, Class III standards to provide our global customers with uniform manufacturing capabilities. Repeatability in equipment, processes, procedures and controls means we can produce any of our products at the plant with the shortest supply line and best communications channel between **HARTING** Integrated Solutions and the customer.



Global Footprint

HARTING Integrated Solutions Global Footprint

- Clear focus on backplanes and backplane-based systems
- Common assembly and test equipment
- Transferable tooling
- Common manufacturing and quality standards
- Co-ordinated global management
- Global SAP business management system



HARTING facility in North Hampton, United Kingdom



HARTING facility in North America



HARTING facility in Zuhai, China

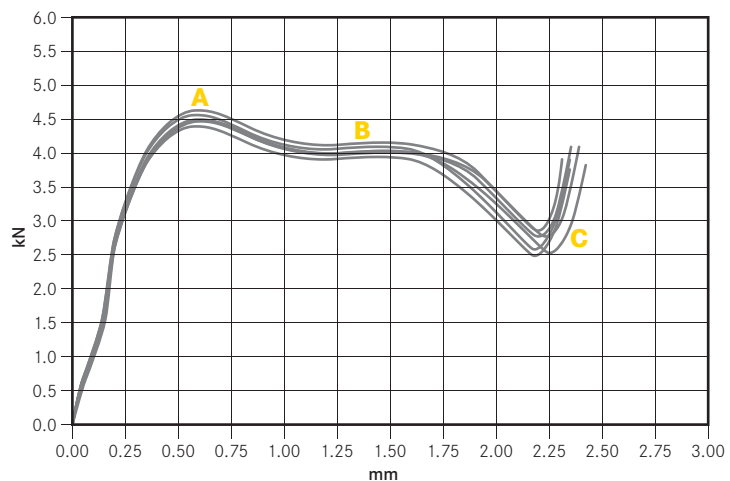


HARTING's modern surface mount machines and assembly lines are designed to handle large, thick backplanes - up to 745mm (29") x 610mm (24") x 10mm (0.4") thick. For maximum production efficiency, these machines are designed for fast set-up and changeover between different backplane assemblies.

Manufacturing Capabilities— Press-fit and Surface Mount



HARTING's automated presses for press-fit backplane components result in far more accurate and repeatable insertion compared to any manual method, even with conformal-coated boards. The result is higher reliability by reducing the chance of latent failures due to cracked barrels and temperature cycling.



Every connector insertion stroke on our presses is recorded for pin insertion depth and pressure. This can be observed on a graphical printout of the insertion cycle to verify the quality of press-fit joints. Three points are recorded:

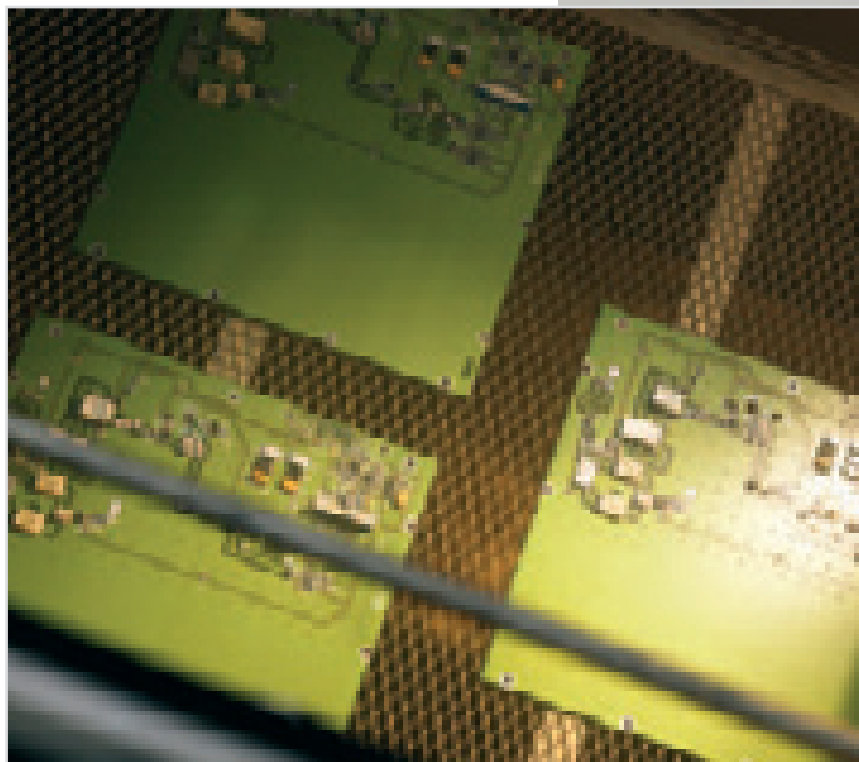
- Point A - Pin engagement in plated hole
- Point B - Pin pressing through plated hole
- Point C - Pressure reduction upon full insertion

Manufacturing Capabilities—Vapor Phase Reflow and Soldering

Vapor Phase Reflow Ensures Connection and Reliability

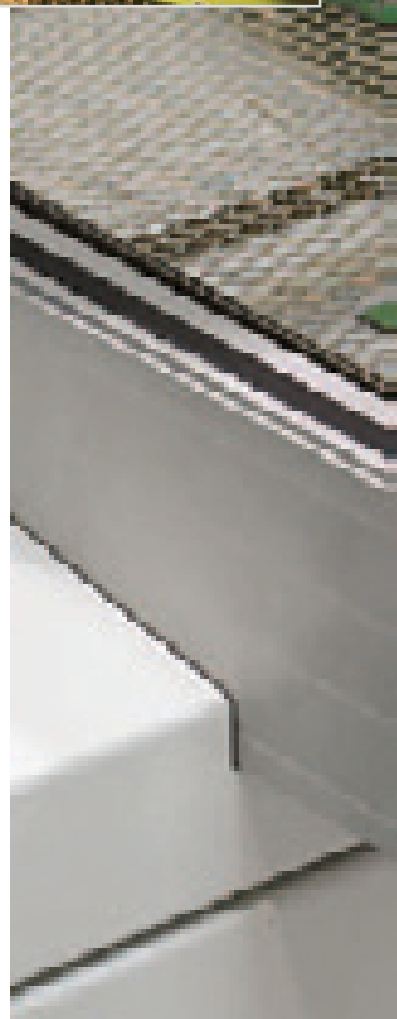
Vapor phase reflow is the preferred soldering method for backplane assembly, ensuring uniform control and a soldering profile that typically limits board temperatures to less than 230°C (lead-free solder pastes) for the shortest possible time.

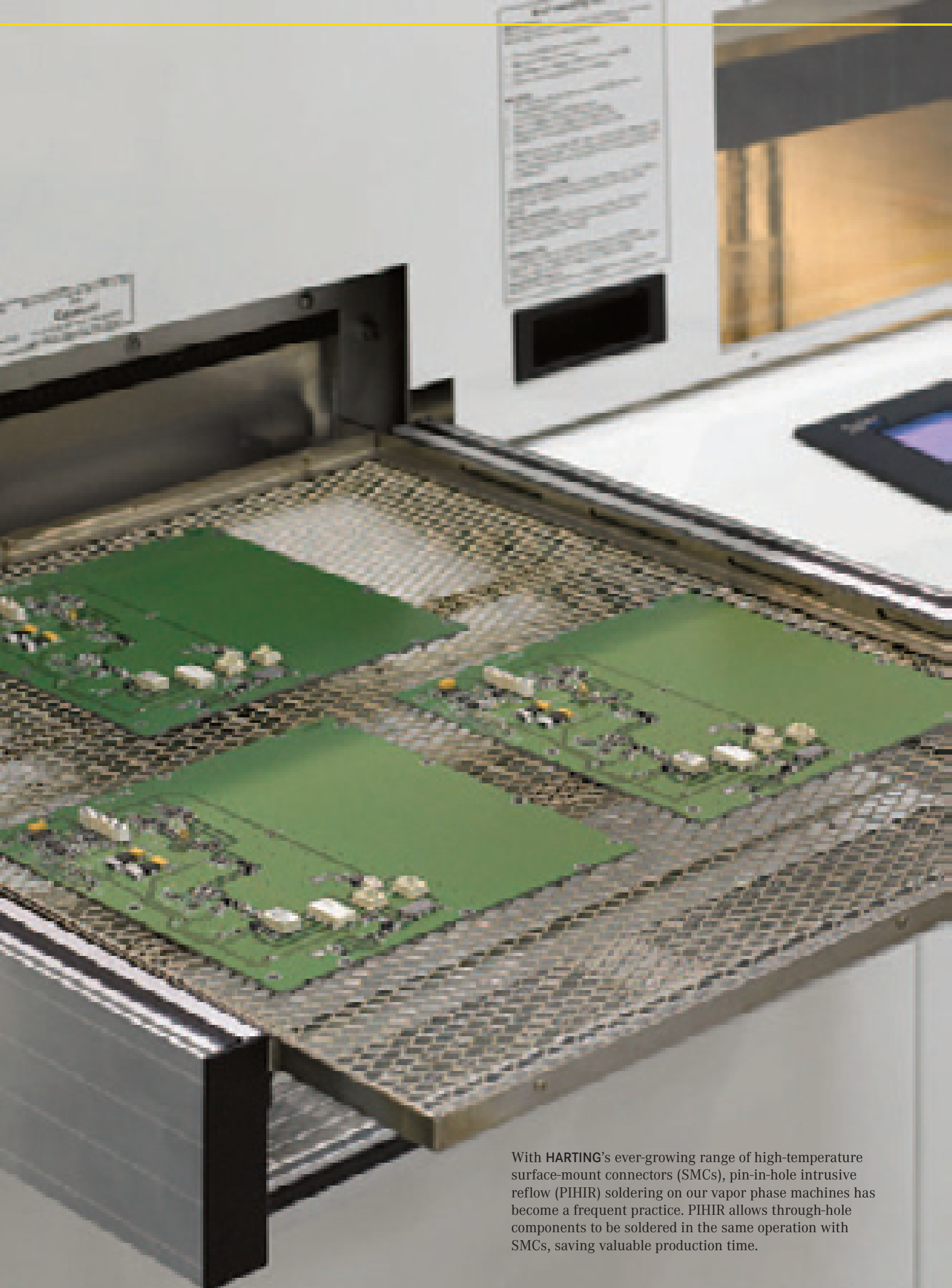
While protecting the board and components from damage, the vapor phase heat transfer coefficients to board solder pastes are up to ten times higher than convection reflow soldering. This provides the highest quality component connection and reliability, especially on large, thick backplane assemblies.



Wave Soldering

Wave soldering is carried out on computer-controlled Electrovert Astrapak machines. Uniform, reliable connections are assured by storing the ideal soldering profile for each board assembly in computer memory.





With HARTING's ever-growing range of high-temperature surface-mount connectors (SMCs), pin-in-hole intrusive reflow (PIHIR) soldering on our vapor phase machines has become a frequent practice. PIHIR allows through-hole components to be soldered in the same operation with SMCs, saving valuable production time.

All backplane assemblies are inspected at key stages of the production process. Automatic optical inspection machinery with color recognition is used to verify solder quality, along with proper location of components, their values and polarity orientation. This particular machine runs Auto Inspector software.



Manufacturing Capabilities—Assembly and Inspection



HARTING Integrated Solutions operates best-in-class production facilities with automated assembly and inspection equipment for the highest efficiency and backplane reliability. HIS assembly operations follow the IPC 610, Class III standards and a program of continuous improvement. A range of automated inspection equipment can accommodate backplanes up to 1.5m x 0.8m in size.



Assembly and Quality Inspection Process

Every custom assembly project is carefully planned, and each new product introduction is supervised by a team of experienced engineers and production operators. Process instruction sheets are compiled using step-by-step written and visual procedures to ensure continuity and quality of the build.

To maintain and improve assembler skills at the highest level, HIS retains an in-house staff of fully qualified IPC trainers. This part of our Continuous Improvement program is always looking for better ways to conduct operations, increase product performance, and ensure quality at the highest level. As a minimum, we make sure every aspect of your assembly meets the high standards of IPC 610, Class III.



Backplane Quality Assurance Testing



Automated RoBAT Tester

HARTING is one of a select number of companies in the world with RoBAT testers. There is one in every HARTING Integrated Solutions facility. The RoBAT performs fully automated optical and electrical inspections on both sides of a completed backplane. It is used for backplanes with high component counts and large pin fields. Electrical tests check for opens, shorts, proper continuity, and measures parasitic capacitance, which could cause signal distortion. Optical inspection with a 3D coordinate measuring system makes sure components are properly located, pins are straight, checks leading/lagging pin configurations, and ensures connectors are properly keyed.



Versatile, interchangeable test head modules on HARTING's automated RoBAT tester ensure full compatibility with different component and connector configurations. These images show some of the RoBAT's electrical test heads.

Top Left: A test head in place to the left of the optical inspection lens – ready to run a series of tests on the backplane mounted within the fixtureless framework to the right of the lens.

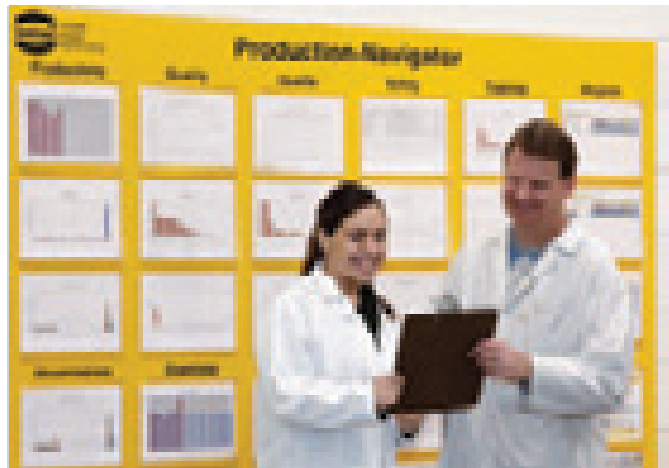


Below Left: Details of a test head's POGO pins that mate to the connectors under test.

Certified to ISO 9001:2000, and dedicated to The HARTING Way, our worldwide continuous improvement program to achieve business excellence is based on the EFQM model. Within HARTING Integrated Solutions, the Quality Assurance (QA) system provides crucial information that drives key aspects of the continuous improvement program.



QA Drives Continuous Improvement



The HIS Continuous Improvement team is constantly monitoring and improving processes throughout our facilities. The team uses six-sigma measurements and techniques to find ways of increasing efficiency, product reliability, customer service, and overall satisfaction in our business relationships.



The LINX intelligent test stations verify mechanical integrity between individual boards and backplane connectors, and are also used to check custom cable assemblies. This extensive test area with its large number of LINX units ensures a continuous flow of zero-defect products to our customers at all times



American Society for Quality



IRIS
Certification

ISO 9001:2015



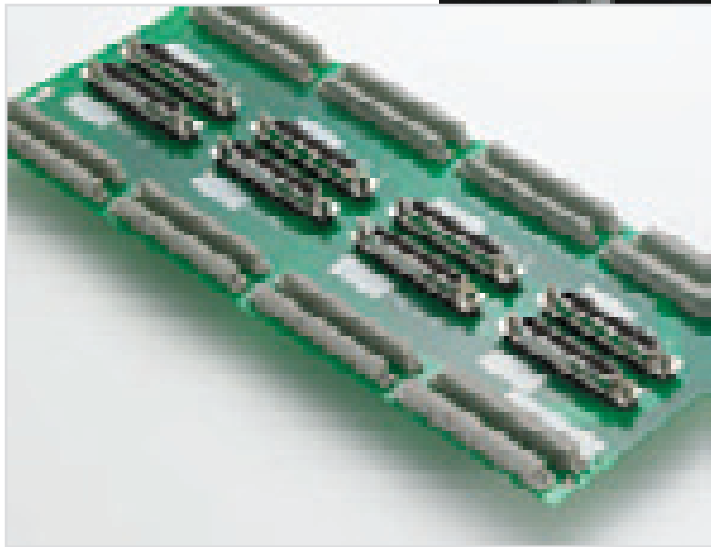
SCOPE

Preventing Open Loop Costs
Since 1988

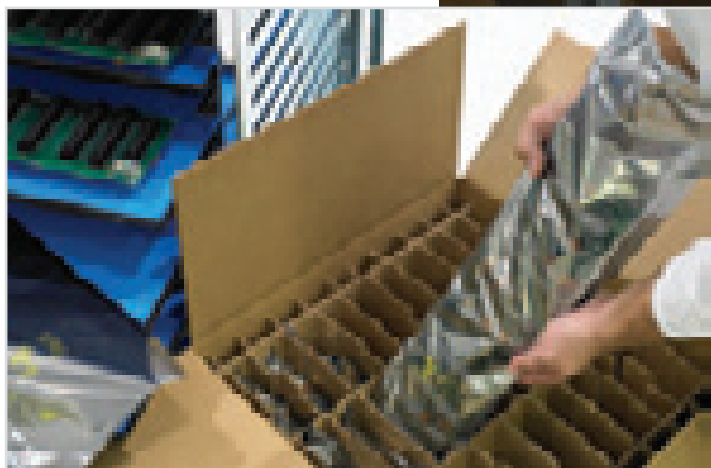


INVESTOR IN PEOPLE

Packaging and Logistics



HARTING Integrated Solutions uses SAP Business management systems to support all operations in its European, North American and Asian facilities. These systems are linked seamlessly with HARTING's other global operations, allowing us to utilize all company resources to fully support HIS customers. Material handling, product packaging, inventory control, and timely deliveries are integral parts of SAP-managed logistics.



At HIS we understand that offering a flexible packaging and shipping solution is just as important as the design of a quality product. Treating packaging as a separate engineering discipline allows us to create solutions that range from simple cost-effective, re-usable boxes to complex customized packages that protect overseas shipments.





LEGEND

- Sales organizations
- Production plants
- R&D

Sales Network—Worldwide

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