INTERPOINT MICROELECTRONICS CAPABILITIES

CRANE
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Electronics Group

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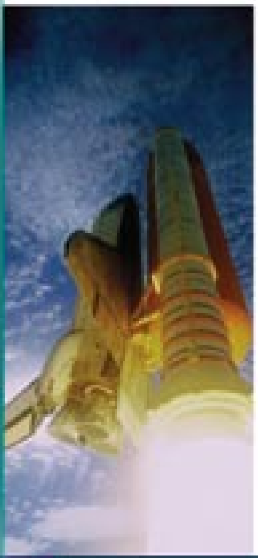

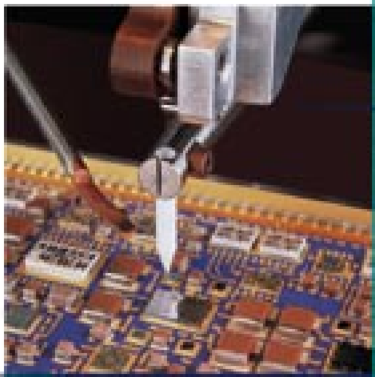

CRANE®
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Electronics Group

Interpoint's Microelectronics Capabilities

Interpoint is part of the Electronics Group of Crane Aerospace & Electronics.
Crane Aerospace & Electronics is a Crane Co. segment

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The Process

Product Development

Customer and Interpoint determine:

- Schematic – Performance, power, tolerances, thermal requirements
- Package – Input/output, mechanical constraints, size, materials, environmental, hermeticity
- Quality – Screening levels, qualification testing, source inspections
- Electrical test – Electrical parameters, test equipment, test fixtures, temperature range
- Program – End application, projected quantities, target pricing, schedule

Responsibility

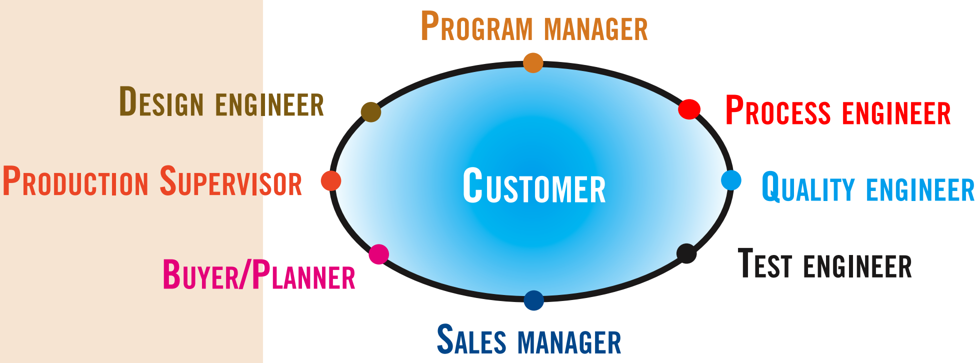
- Interpoint Design Engineer – provides electronic and/or mechanical design expertise to the customer focus team
- Interpoint Program Manager – ensures communication links are maintained and develops schedule to include the activities of both companies

Review and Production

Customer and Interpoint:

- Review product requirements
- Generate project plan
- Review critical design cost drivers
- Optimize design for cost reduction and manufacturability
- Complete electrical design review and validation
- Identify product review points
- Identify product acceptance criteria
- Verify that product meets specifications
- Implement transfer of new product to manufacturing
- Qualify product
- Submit to customer for approval of product
- Release product to production

Customer Focus Team

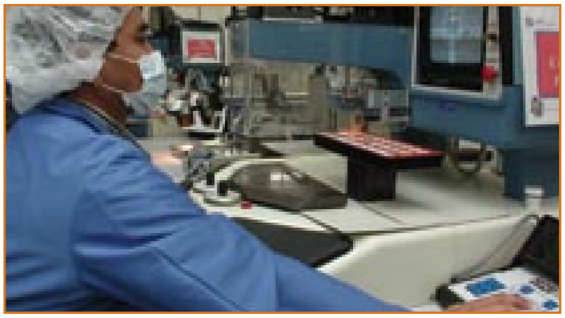


Radio Frequency (RF)

Interpoint has expanded its capabilities into the fast growing RF environment to include manufacturing of RF devices plus the design and fabrication of specialized test fixtures for complex RF measurements.

Production

Interpoint's RF production line has an experienced team using high-tech equipment for high-volume, quality, and reliability. Palomar automatic die-attach and wirebond machines complement the manual portion of the assembly line. Test fixtures and software designed by Interpoint engineers complete the line. The full line is housed in a clean-room to prevent contamination and to maintain an ESD safe environment.

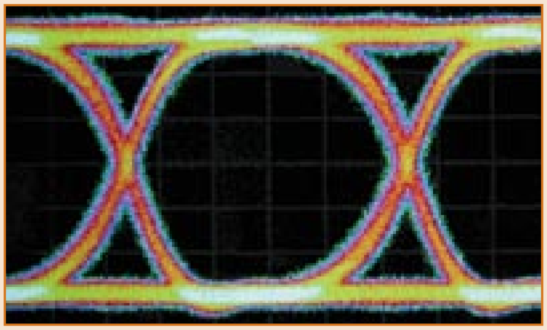


RF Production

Test

Interpoint has designed and fabricated specialized test fixtures for complex RF measurements. These test fixtures allow the measurement of all the test parameters mentioned below at a low temperature of -40C without condensation or icing on RF adaptors and connectors. Therefore the test data accuracy is retained as well as the performance of adaptors and connectors.

Eye Test Set-Up



Eye Test Waveform

Interpoint can perform RF/microwave testing from 50 kHz to 20 GHz. These test include:

- Gain
- VSWR's
- Isolation
- Ripple
- Group delay or phase response
- 1 dB compression points

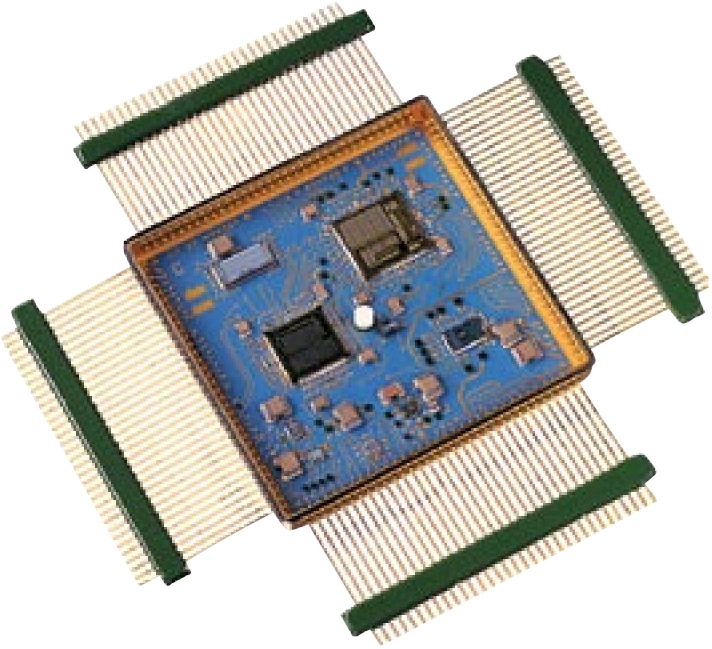
RF Device

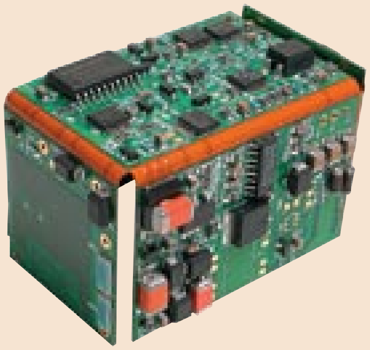
The innovative test fixtures integrated with the test software, which was also developed by Interpoint engineers, enables us to complete full RF electrical testing in five minutes for frequencies up to 10 GHz. Interpoint uses the following methodology for developing RF testing:

- Identify the parameters to be tested
- Identify the equipment needed for testing
- Separate DC testing from RF testing
- Separate power measurements from S-Parameter measurements
- Create proper daily calibration procedure for testing of RF/ microwave parameters
- Identify and define ATE requirements,
- Validate ATE results for minimum delta
- Provide test results on the network

Custom

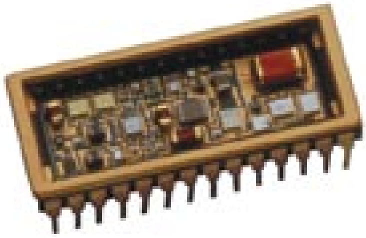
Interpoint custom microelectronics are used in a variety of applications including torpedoes, missiles, reconnaissance electronics, and avionic sensing equipment. Local bio-scientists are using our services to develop and fabricate the smallest possible fish tracking electronics to study fish migrating patterns. Interpoint continues to support emerging technology and applications for commercial use.

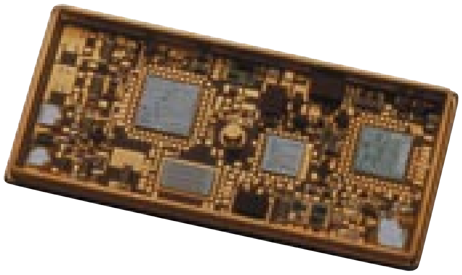




Medical

Interpoint's expertise in medical electronic miniaturization has been proven in device performance. We have co-developed and fabricated five evolutions of implantable defibrillators, several designs of implantable pacemakers, and the worlds best bionic ear.





Estimating the Size of Microelectronic Packaging

Technology Size Comparisons

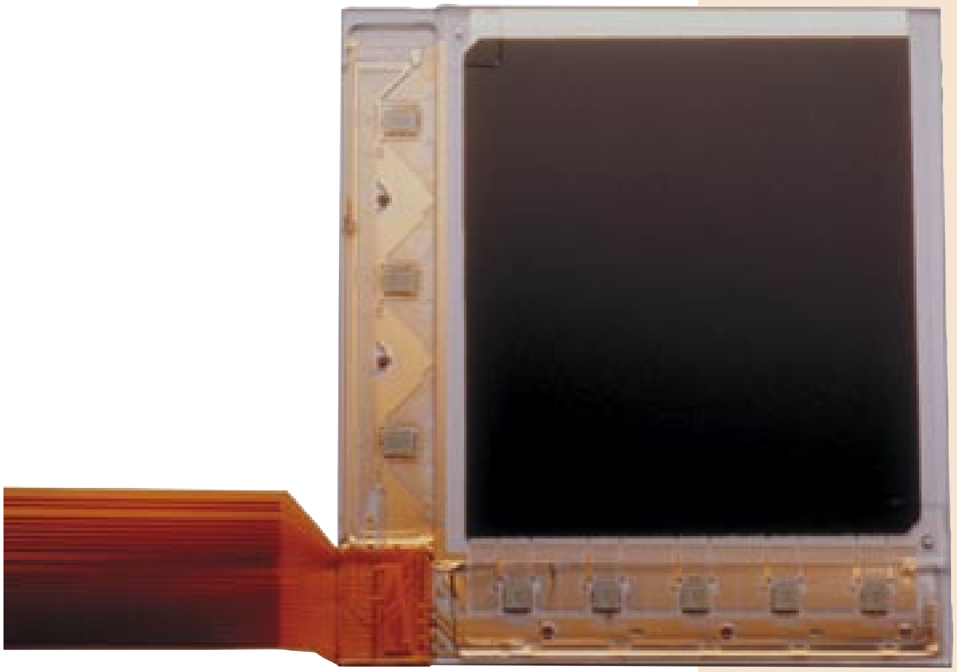
Relative Circuit Size	Manufacturing Technology	Substrate Material	Typical no. Layers	Typical Components	Printed Resistor Trim
	SMD on PCB	PCB	2 to 10	SMD	yes*
	SMD on Thick-Film	Thick-Film Ceramic	2 to 10	SMD, Printed Resistors	yes
	COB	PCB	2 to 5	Silicon Die, SMD	no**
	C&W on Thick-Film	Thick-Film Ceramic	2 to 10	Silicone Die, Printed Resistors, SMD, MMIC	yes
	C&W on Thin-Film	Thin-Film Ceramic	1 to 2	Silicone Die, Deposited Resistors, SMD	yes
	C&W on Co-Fired	Co-Fired Ceramic	3 to 20	Silicone Die, SMD, Gallium Arsenide die, MMIC	no**
	Flip Chip or BGA	PCB or Flex	2 to 10	Silicone Die, SMD	no**

The bar graph above compares the area required to build a circuit using different technologies. Ratios are typical only, varying with interconnect requirements, component size, and circuit type.

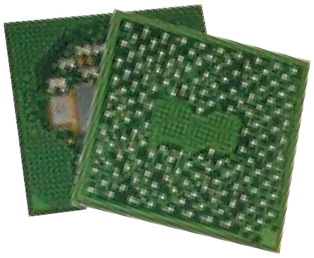
SMD: Surface Mount Devices
PCB: Printed Circuit Board
COB: Chip On Board
C&W: Chip & Wire

* limited tolerance

** thick-film ceramic boards may be added to provide trimmable resistors



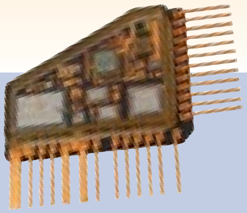
Estimating the Size of Microelectronic Packaging (continued)



Microelectronics Size Calculation

How small can your circuit be?
Use Interpoint's size calculation table to determine the size of your circuit as a thick-film hybrid using either chip & wire or solder-reflow components.
To use the table:

1. Multiply the size estimate for each component type by the number of similar components used in your circuit.
2. Total the individual estimates. This estimate can often be reduced by 10% to 20% through a careful layout.
3. Select a package that allows the substrate to fit between the package's pins or leads.



Component	Edge Size	Chip & Wire	Solder Reflow	Typical Specs
Diodes				
Small signal	0.020	0.005	0.010	200mA/100V
Rectifier/zener	0.040	0.010	0.010	1A/400V
Medium power	0.085	0.030	0.060	3A/1000V
Power SCR	0.250	0.120	0.560	45A/1200V
Transistors				
Small signal	0.020	0.008	0.020	100mA/100V
Low power	0.035	0.010	0.020	500mA/60V
Medium power	0.075	0.025	0.060	4A/40V
Power FET	0.250	0.120	0.560	30A/200V
Integrated Circuits				
8-pin	0.035	0.030	0.040	S08
14-pin	0.045	0.040	0.080	S014
16-pin	0.080	0.050	0.160	LCC
24-pin	0.100	0.070	0.240	LCC
44-pin	0.150	0.090	0.440	LCC
88-pin	0.225	0.140	0.800	LCC
120-pin	0.300	0.200	1.200	LCC
Resistors				
Chip, 2.0%	0.050x.040	0.010*	0.020	0.1w
Chip, 0.5%	0.080x.050	0.015*	0.030	0.1w
Chip, 2.0%	0.120x.050	0.015*	0.035	0.5w
Thin-film chip	0.030	0.010		0.1w
Capacitors				
47pF NPO/.01uF BX	0.050x.040	0.020	0.020	50V
1000pF NPO/.022uF BX	0.080x.050	0.030	0.030	50V
4700pF NPO/.15uF BX	0.120x.050	0.040	0.040	50V
.033uF NPO/.68uF BX	0.180x.250	0.060	0.060	50V
2.2uF Tantalum	0.200x.050	0.060	0.060	25V
22uF Tantalum	0.280x.150	0.080	0.080	25V

*Thick film

Package Types

Choosing microelectronic packaging techniques and materials depends on the end use of the product. Some aspects to consider when choosing a package type are:

- post processing
- environmental requirements
- maximum temperature exposure
- compatibility with cleaning solutions
- structural integrity
- use of encapsulant

Two main types of packaging are hermetically-sealed traditional metal packaging and those where the substrate becomes the package.

Traditional Metal Packaging

For over 30 years, Interpoint has offered high-reliability, high-density microelectronics in metal packaging. The package consists of gold plated Kovar – an iron-nickel-cobalt alloy – with glass or ceramic sealed connecting pins of various configurations (see Figure 1). Other metal packaging options include titanium, molybdenum, cold rolled steel, and metal matrix composites (such as aluminum-silicone-carbon and copper-tungsten). The hybrid assembly is hermetically sealed and may be screened to MIL-PRF-38534. These hybrids can operate at extreme temperatures and under high pressure. They can withstand an autoclave, corrosive environments, and other severe conditions.

Figure 1: Traditional Metal Packaging

Contemporary Co-Fired Ceramic Packages

Over the years, developments in commercial and medical applications have had a tremendous impact on hybrid assembly and packaging. In most cases this new packaging is lighter and smaller than traditional Kovar headers, yet just as reliable.

The co-fired ceramic packages (high temperature co-fired ceramic, HTCC, and low temperature co-fired ceramic, LTCC) consist of layers of green ceramic tape laced with conductive circuitry. The co-fired ceramic packages can be hermetically sealed using a brazed on ring-frame and a lid.

This type of package eliminates the need to produce a separate ceramic substrate, and provides over 35% weight reduction in comparison to a Kovar package. Co-fired ceramic packages are available in many different configurations. See Figure 2.

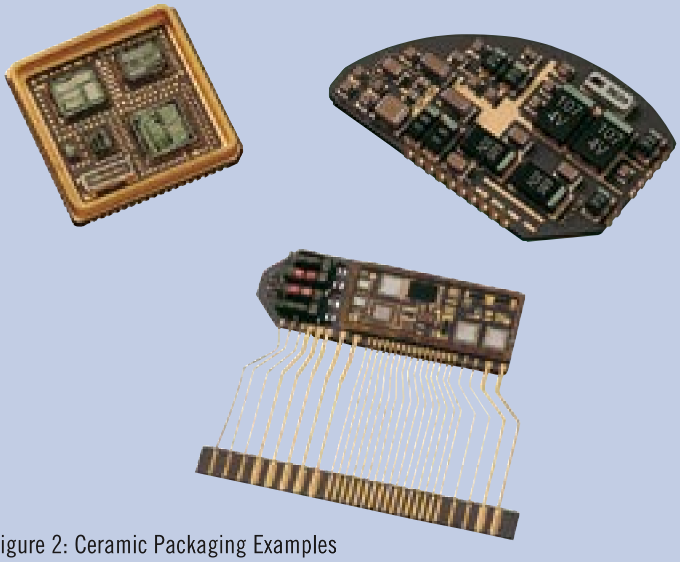


Figure 2: Ceramic Packaging Examples

Interpoint provides many different packaging options for applications where hermeticity is not a requirement including chip and wire, chip on board (COB), chip on flex (COF) and surface mount. The substrate itself becomes the ultimate package.

Chip and Wire

Chip and wire can be on thick-film, thin-film or co-fired ceramic for non-hermetic packaging. For protection from environmental and handling damage, wire bonded components can be encapsulated ("Glob-Top") using epoxy resins, silicone or UV curing material. See Figure 3.

Figure 3: Chip and Wire sealed with Glob Top on ceramic substrate

Chip on Board (COB)

Chip mounting on a ceramic substrate, PC board (FR4, polyester or polyimide) may use a combination of solder, conductive and non-conductive epoxy, and wirebonds. COB is desirable for low vertical profile applications. A double sided attach is often used. The wire-bonded components are usually covered with "Glob-Top" for environmental protection and handling damage. See Figure 4.

Figure 4: Glob Top wire-bonded components on organic substrate

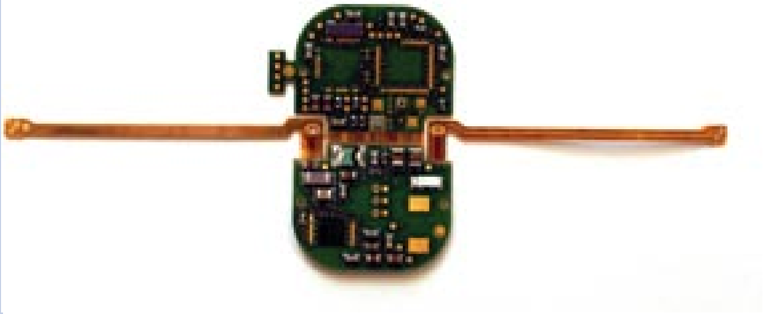
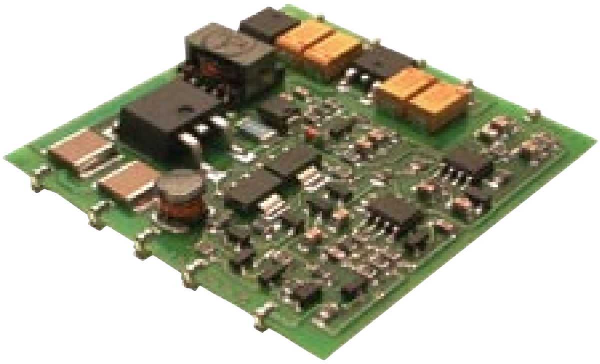


Figure 5: Chip on Flex

Chip on Flex (COF)

This technique is often used to further reduce the weight and size of the medical hybrid. To provide structural support and stability during wire bonding, FR4 or polyester stiffeners are used. The components are mounted using solder and/or epoxy compounds. The "Glob Top" is used for encapsulation of wire bonded components. See Figure 5.

Figure 6: Surface Mount



Surface Mount Technology (SMT)

This option is available for all designs. The Interpoint process uses surface mount assemblies with a typical trace/space width of 5-7 mils. See Figure 6.

Custom Packaging

Interpoint can customize packaging for unique applications. As an example, complete hybrid encapsulation for environmental protection and/or to prevent handling damage can be achieved by using plastic ring frames and silicone encapsulant. See Figure 9, 10 and 11.

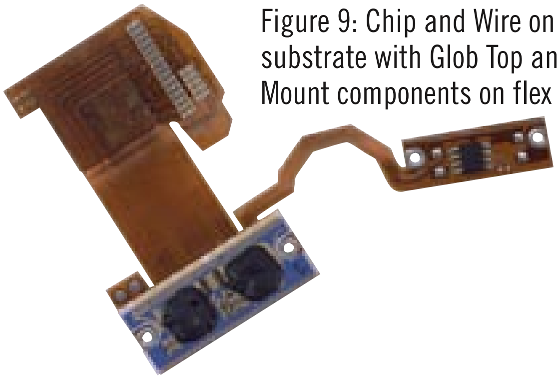


Figure 9: Chip and Wire on ceramic substrate with Glob Top and Surface Mount components on flex

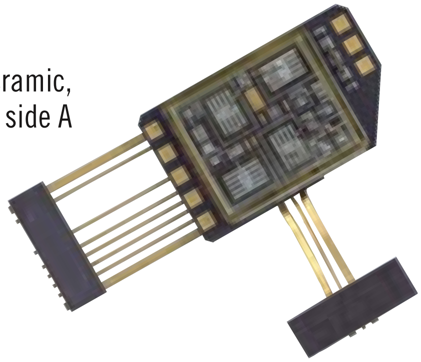


Figure 10: Co-fired Ceramic, Silicone Encapsulant, side A

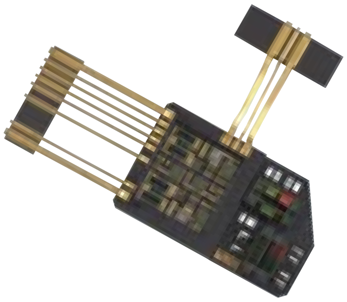


Figure 11: Co-fired Ceramic, Silicone Encapsulant, side B

Component Mounting Options

In pursuit of further size reduction, Interpoint offers customers the following component mounting approaches:

Double Sided Package

This approach is available for any of the packaging types described above. See Figure 12.

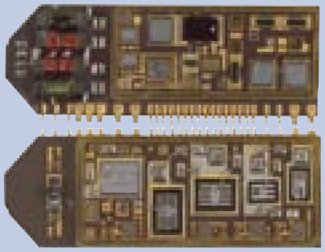


Figure 12: Two sided

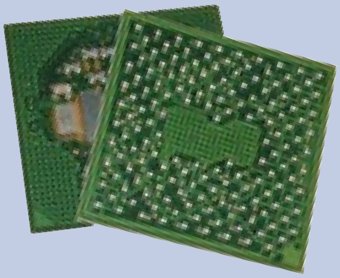
Flip Chip (Solder Bumped Chips)/Surface Mount (SMT)

This approach will provide reduction in size and cost of the assembly because no wire bonds are required for termination. To avoid future contamination and environmental damage, Interpoint uses underfill materials. X-Ray equipment is available on-site for bump alignment verification. See Figure 13.

Chip-Scale Packaging (CSP)

Interpoint is working with a variety of COB/SMT products and in the recent years developed the internal capability to produce BGA and mBGA interconnects on “organic” (“green”) boards, that will adhere to JEDEC standard. See Figure 13. Interpoint’s recent BGA product was built to the following specifications

- JEDEC BGA packaging on PCB with Flip Chip dice and SM components
- Flip Chip ASIC size 0.260”x0.260” with 195 balls (4 mil diameter)
- BGA bumps: 0.030” ball diameter with random spacing (0.100” horizontal; 0.071” diagonal pitch)



← Backside BGA is 0.030” ball size

Figure 13: Flip Chip and SM on organic board

Assembly Process Equipment

Interpoint's process engineering is our customer's resource for innovative ideas on materials, processes, and automated assembly operations. Extensive automation of our assembly process helps to ensure the repeatable quality of our products. Interpoint's statistical process control (SPC) provides continuous process monitoring. Automated equipment includes component attach, wire-bond, and device seal equipment.

Component Attach

Auto adhesive or solder dispense and die placement

The Palomar 2500 and 3500 have monthly capacities of 90,000 dice and 130,000 dice, respectively, per machine.

Figure 14: Palomar 3500 automatic die attach

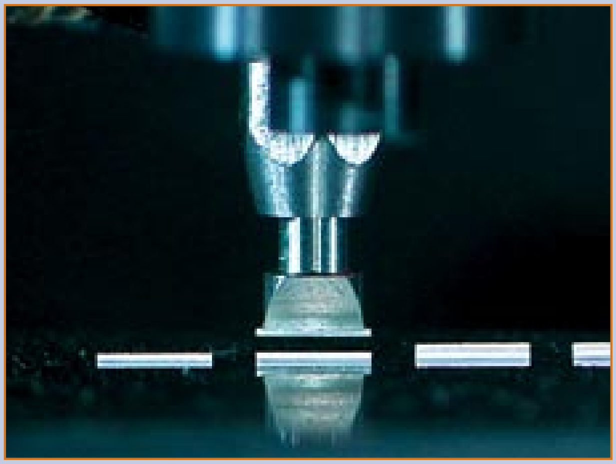


Figure 15: Palomar 3500 picking up a chip

Semi-automatic epoxy and solder attach

- Asymtek dispensing system for solder or adhesive
- Screen printing
- Skilled manual die attach and solder operators
- Solder reflow machines include BTU, Sikama, and Watkins Johnson with nitrogen or hydrogen gas

Wire Bonding

The Palomar 2460 provides high-speed, precision, automatic, one or two mill gold-ball, and stitch bonding for high pin count devices and complex multichip modules. It has a monthly capacity of 6,000,000+ one mil bonds, 1,000,000+ two mil bonds and can be used on any hybrid.

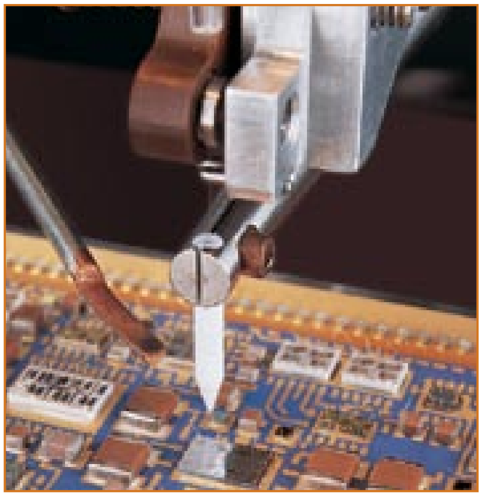


Figure 16: Palomar 2460 wired bonding detail

The Palomar 2470 provides high-speed, fine-gauge, automatic, aluminum wedge bonding, gold ribbon bonding, and gold wedge bonding of less than one mil wire. It has a monthly capacity of 6,000,000+ wire bonds.

Photos 14 through 17 courtesy of Palomar Technologies

The Orthodyne 360 provides heavy-gauge, automatic, aluminum wire bonding from 4 to 20 mils. It has a four-axis head allowing bonding in any direction for complex, high-density devices; programmable bonding and indexing parameters for bond quality and reliability; and a monthly capacity of 375,000+ 4 to 20 mil bonds. Heavy gauge aluminum wire is used to accommodate high current carrying requirements.

Device Seal

- Hermetic seam welders, SSEC 1000, 2100 and Benchmark SM 8000, are used for resistance welding batch processing with a monthly capacity of 10,000 sealing operations per machine
- Hermetic solder sealing with a monthly capacity of 8,500 sealing operations.
- Laser welder to hermetically seal RF/microwave aluminum and implantable titanium packages
- Encapsulation or glob-top using epoxy, silicone, urethanes, or UV-cured encapsulants.

Figure 17: Palomar 2470 automatic wire bonder

Mixed Technology Line

Interpoint's mixed technology line provides high-speed, high-volume precision assembly of surface mount components, flip chip, BGA, chip-on-flex, chip-on-board, and hybrids. The newest addition to the mixed technology line is the GSMx™ Linear Motor Platform from Universal Instruments. The GSMx is a fully automated assembly line with a throughput of 1500 to 4700 placements per hour, depending on the application.

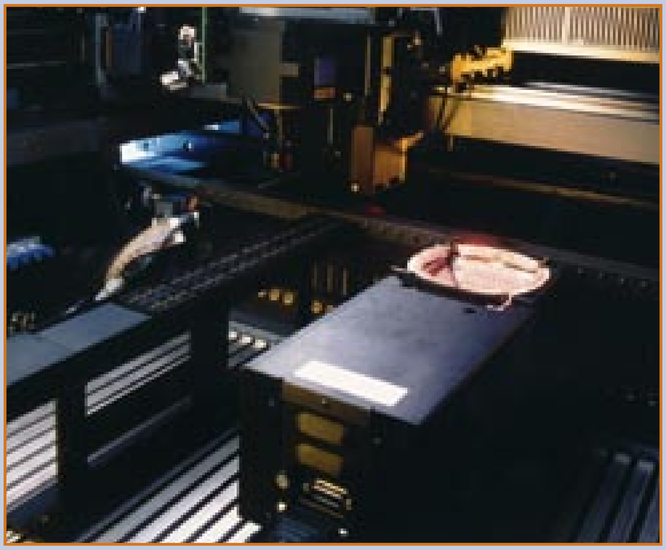


Figure 18: GSMx™ fully automated assembly line

Figure 18 photo courtesy of Universal Instruments Corporation

Certifications, Qualifications and Standards

- ISO 9001/AS9100 - Quality Systems. Model for quality assurance in design, development, production, installation, and servicing. All facilities are registered with BVQI.
- MIL-PRF-38534 - Hybrid Microcircuits, General Specifications for (Class H and K)
- QML-38534 - Qualified Manufacturer's List of Custom Hybrid Microcircuits
- ANSI-Z540 - Calibration Laboratories and Measuring and Test Equipment - General Requirements
- ISO 14644 - Cleanrooms and Controlled Environments
- ANSI/ESD S20.20 - Electrostatic Discharge Control Program
- MIL-STD-883 - Test Method Standard for Microcircuits
- ASQC-Z1.4 - Procedures, Sampling and Tables for Inspection by Attributes
- ANSI/IPC-A-600 - Acceptability of Printed Boards
- ANSI/IPC-A-610 - Acceptability of Electronic Assemblies

Quality Monitoring Techniques

Emphasis is placed on defect prevention, not detection.

Process trends plus X-bar and R-bar charts are used to establish, control, and verify process capability and product characteristics.

- X-bar charts are used to monitor the mean dimension of items produced by a process.
- R-bar charts are used to monitor the standard deviation

Acceptance sampling plan is based on ANSI/ASQC Z1.4 (1993)

- ANSI/ASQC Z1.4 (formerly MIL-STD-105E) is based on acceptance sampling usually in receiving/incoming inspection.
- Describes sampling procedures and tables for inspection by attributes.
- Acceptance sampling is a required part of the quality system as indicated by ISO 9001 and GMPs
- All sampling plans are periodically reviewed to ensure validity and all activities are documented.

Microelectronics Screening

- Component Lot Acceptance Testing (LAT)
- Element evaluated components
- Active and passive component element evaluation is conducted in accordance with MIL-PRF-38534 standards.
- Microcircuit and semiconductor die element evaluation may include element electrical, element visual, internal visual, temperature cycling, constant acceleration, interim electrical, burn-in, post burn-in electrical, final electrical, and scanning electron microscopy (SEM).
- Passive component element evaluation may include element visual, element electrical, temperature cycling, constant acceleration, voltage conditioning/aging, visual inspection, electrical, solderability, and wire bonding evaluation.
- Inspection per ANSI/IPC-A-600 and A-610
- Package testing includes leak test for glass seal evaluation (if applicable).
- Die shear (in process verification) using Dage die shear tester.
- Wire bond pull test (in process verification) using Dage wire bond pull tester.
- Internal Visual
- Temperature Cycling
- Constant Acceleration
- Burn-In
- Final Electrical Test: Interpoint offers many different testing options for your products including final electrical testing over temperature.
- Seal
- External Visual
- Traceability: Interpoint's computerized traceability system tracks components for all products and rapidly retrieves data for analysis. The components are tracked by work order and serial number to maintain complete end-item traceability.
- The end item life test is performed per customer requirements.
- Nicolet Imaging System (X-Ray) for in-process verification of solder joints, flip chip and mBGA attachment /alignment.

Test Development and Implementation

Interpoint designs, develops, and optimizes its test systems to accommodate customer requirements. Optimization of the circuit design, layout, and test requirements is available through component, assembly, and system-level testing. The testing is designed to provide reliable information while maintaining quick production cycle times.

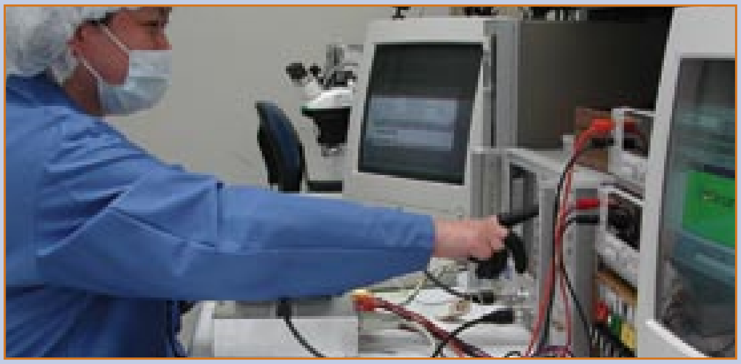
Interpoint Test Systems

- High speed digital
- Mixed-signal
- Power
- RF automated test system (up to 20 GHz)
- General purpose test rack
- Interpoint proprietary systems
- Customer supplied systems

Interpoint's drafting department, machine shop, and project engineering work together with the test engineering department to conduct mechanical design for test fixtures and burn-in boards. Our philosophy is to keep our designs simple and effective to maintain high volume production. The test equipment is specifically chosen for the types of tests to be performed from a selection of quality manufacturers.

Test Methodologies

Interpoint uses standard interface and test libraries for fast program development for manual, semi-automatic and fully automated test fixtures to provide the desired turnaround. Customer supplied test systems are quickly integrated, and we can suggest modifications that will improve production. These assets allow us to provide accurate and reliable test results for our customers.



Analytical Services

Interpoint's Development Team offers customers a variety of services, from co-development of the product – including electrical circuit analyses and layout for high density and miniaturization – to innovative packaging techniques. The following analytical tools are available to our customers:

In house

- FEA Modeling / Analysis
- P-SPICE Circuit Analysis
- Nicolet Imaging Systems Model NXR-20 X-RAY System ; 120 KeV ; 10-60 Watt; Magnification Capability - 230x screen; 45x geometric
- SEM / EDX (Hitachi S-2400 - SEM and Oxford QX-20 - EDX)
- Metallurgical Microscopes
- Cross Sectioning

Outsourced

- Sonoscan
- Auger
- FTIR
- Fein Focus

Interpoint

Interpoint is a business unit of the Electronics Group of Crane Aerospace & Electronics, a segment of Crane Co. We manufacture high-reliability microelectronic power conversion products and custom microelectronics for the telecom, medical, military, space, aerospace, industrial and commercial markets. Our power products are qualified to Class H (military products) and Class K (space products). Interpoint's custom medical hybrids are built to customer specifications and qualify to Class II and III requirements.

Our 35-year history of producing high reliability microelectronics has given us the experience and process base to supply highly competitive products to meet market demand. Our quality systems support the medical industry's specialized needs including custom qualification protocols and component traceability.

Interpoint was founded in 1969 as Integrated Circuits Incorporated (ICI) and was renamed "Interpoint" in 1989. Crane Co. acquired Interpoint in October 1996.

"North Building" on Interpoint's Redmond campus

CRANE®
AEROSPACE & ELECTRONICS
Electronics Group

Electronics Group

The Electronics Group is comprised of Advanced Integrated Systems Division (AISD), ELDEC, General Technology, Interpoint, Keltec, and STC Microwave Systems (formerly Signal Technology Corporation). The Electronics Group designs and manufactures high-density, high-reliability electronics for aerospace, space, military, medical, industrial, and commercial applications.

Crane Aerospace & Electronics

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