CIRCUITS HIC
Quality Across the Board

Circuits, LLC

Company Overview

2014

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Company Overview

- Founded in 2008
- Exclusively flex and rigid flex
  - Small to medium production
  - Serving defense, medical and industrial markets
- Hand-picked industry professionals
  - Senior Staff with 200+ years combined industry experience
  - Design, material and process experts fully accessible to customers
- ISO-9000, ITAR and UL certifications
- Small business classification
- Privately held, debt free
- D&B Class 1 Credit Score
  - 1R3 Rating
- Made in the USA

PITTSBURGH BUSINESS TIMES
2011 & 2012 MANUFACTURER OF THE YEAR FINALIST

ISO 9001:2008
PRI Registrar
Registered Firm

IPC Member

iMAPS

ITAR Compliant International Traffic in Arms Regulations

Pittsburgh Technology Council

D&B

UL

SBCA Best of Business 2009

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Flexible PCB Benefits

- Flex Properties
  - Heat dissipation, shock and vibration resistant
  - Electrical characteristics: predictable and controllable (impedance, cross-talk, noise)
  - Versatile shape enables 3-dimensional configurations
- Weight and Size
  - Allows dramatic reduction of electronics package size and weight (up to 75% compared to rigid and round wire configurations)
- Cost effective
  - Designed to eliminate board to board interconnects or board to wire connections (the most common failure points in electronic assemblies)
  - Easier to install or replace (removes human-error associated with point to point wire assemblies)
- Durability
  - Bend & straighten up to 500 million times without a failure
  - Unmatched performance for applications with repetitive motion
  - Polyimide is known for its dimensional stability, dielectric strength and high heat resistance

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Flex & Rigid-Flex Applications

Defense and Aerospace

- Replacing many wire harnesses for ruggedized applications, flexible circuit boards are able to survive hostile environments.
- Weight reduction paired with increased reliability.
- Field serviceability

Medical

- Dramatic reduction of overall electronics package size.
- Weight reduction enables handheld and portable devices.
- Resistance to chemically aggressive environments enables implantable devices.

Industrial Controls

- With the ability to bend and straighten millions of times without a failure, flex circuits provide un-matched performance for applications with repetitive motion.
- Durability and reliability in aggressive environments.

Consumer Electronics

- Weight reduction is key for hand-held devices, personal computing, GPS, cell phones.
- Stability of materials for high volume manufacturing.

Circuits' Facilities

30,000 sq. ft. facility designed *specifically* for manufacturing highly reliable flexible PCBs

- Class 1000 Clean Room central to operations, equipped with independent air-handling units, HEPA air filtration system, interlocking pass-through unit and UV light protection
- Open, highly efficient, work-flow designed to minimize transport and handling
- Custom-engineered equipment built to handle thin core materials
- Electroless copper and full panel electroplating using chemistry tuned for flexible substrates
- Two UV laser driller/routers
- High speed, fine pitch flying probe test
- Complete in-house cross section and failure analysis lab

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Clean Manufacturing

- Solar Energy –chemical rinses are heated with thermal solar power
  - Panels heat 10 gallons water per minute to 70°F with 3 ½ hours average sunlight per day
  - Warm rinse water reduces chemical bleed from one bath to next eliminating organic contaminates

- Facility outfitted with exhaust and fume scrubbers
  - Reduces any pollutants leaving the manufacturing area
- Water treatment – ion exchange technology to remove metallic and chemical contaminants
  - Eliminates the generation of hazardous wastes
  - Reclamation/recycle of valuable materials
- Efficient and environmentally-friendly process choices
  - ENIG (cleanest, most reliable, assembly-friendly lead-free finish)
  - Plasma etch – clean smear removal and etchback
  - Cobra Bond™ - inner layer adhesion promotion

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- ISO9001:2008 Certified
- ITAR Certified
- UL 94v.0 Class 1 & Class 2 flex
- MIL-PRF-31032: targeted for 2014
- AS9100 to follow MIL Spec qualification

In-house SEM/EDAX

- SPC throughout manufacturing
- Cross-section analysis
- Controlled impedance TDR Testing
- Fixtureless flying probe 100% netlist test
  - Continuity and isolation testing
  - No witness marks left on SMT pads
- Comprehensive final inspection procedures

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Capabilities - Overview

Flex and Rigid-Flex PCBs	
Flex Materials	DuPont Pyralux AC, AP, FR and LF
Rigid Materials	FR4 & Polyimide
Copper Weight	¼ oz to 3 oz
Core Thickness Min	. 5 mils
Board Thickness	2 – 125 mils
Layer Count Max	16
Max board Size	22”x16”
Lead Time	3 to 10(*) business days
Specifications	IPC-6013(*), MIL-PRF-31032
Trace/Space	3/3 mils
Via Structure	Through, Blind, Buried, Microvias
Hole Sizes	2-250 mils
Surface Finish	ENIG (*), HAL, Hard and Soft Gold, Immersion Silver, OSP
Surface Coatings	Coverlay Pyralux LF(*) and FR, LPI
Special Processes	Controlled Impedance, flying leads

* Denotes standard processes

Standard lead time is 10-days for single & double sided flex using stock stack-ups. Accelerated deliveries are available for time-critical projects

Designing Flex and Rigid-Flex Seminars

- 90-minute presentation
- Design for Manufacturability
- Best Practices
- Arrays, Stack-ups
- Cost Drivers

Available at the Customer Site, or combined with a Facility Tour at Circuits

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Why Circuits?

1. Flex and Rigid-Flex Focus – We do 1 thing better than anyone else, purpose built facility, defect-free philosophy
2. 200 years experience – share our knowledge with our customers to design using best practices and cost-effective layouts, very strong upfront engineering support
3. Competitive – shorter standard lead times, aggressive pricing in our market space

Shorten customer time to market – eliminating multiple revision cycles, close the gap between OEMs and CMs

Saves Cost – build it right the first time, repeatable cost-effective designs

Good Experience, Eliminate frustration – We are responsive and accessible, cooperative process throughout the product lifecycle

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Pricing in 24-hours or less
Full Engineering Support and DRC
10-day Standard Lead Time*

www.qualityacrossttheboard.com

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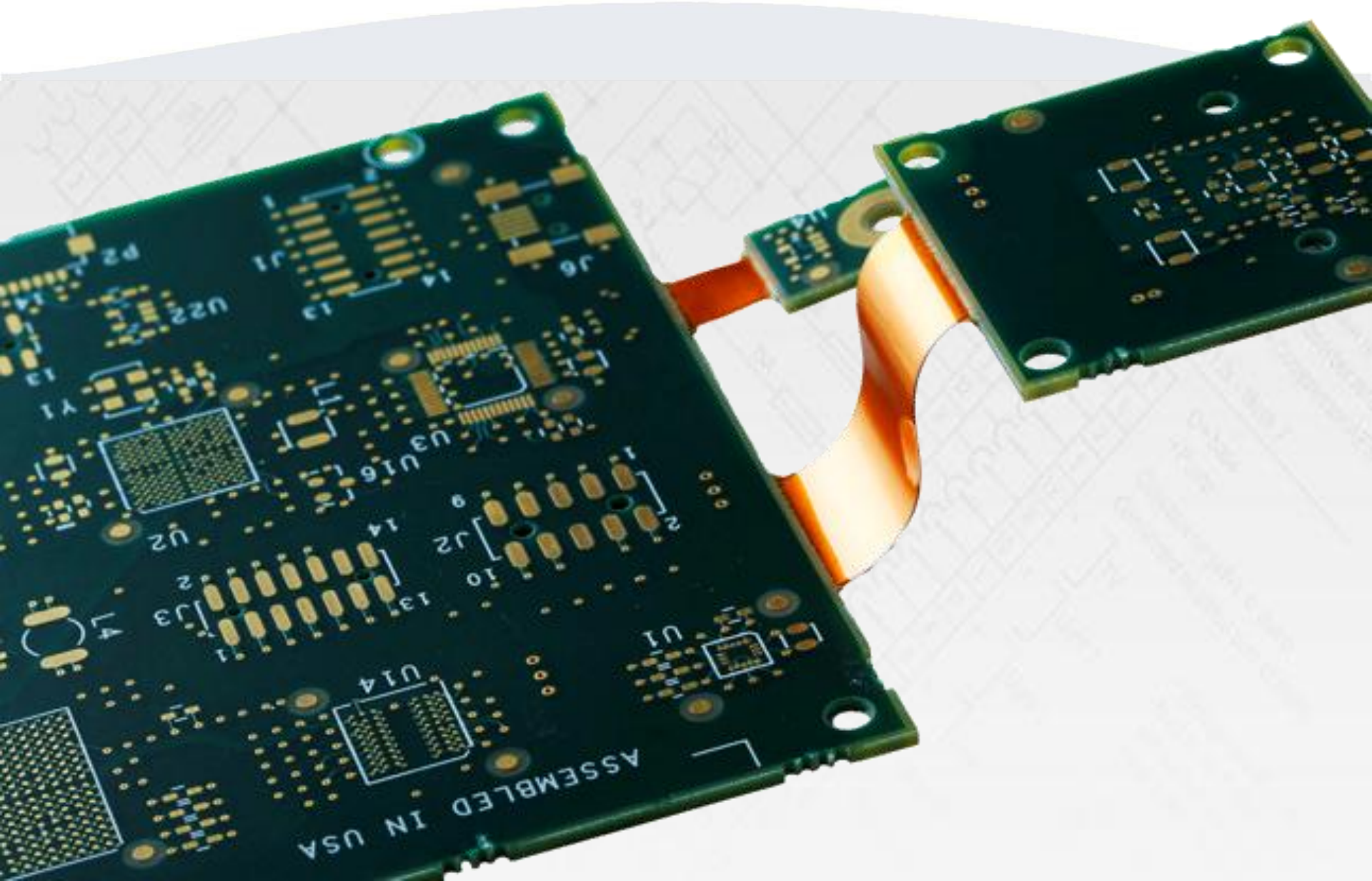
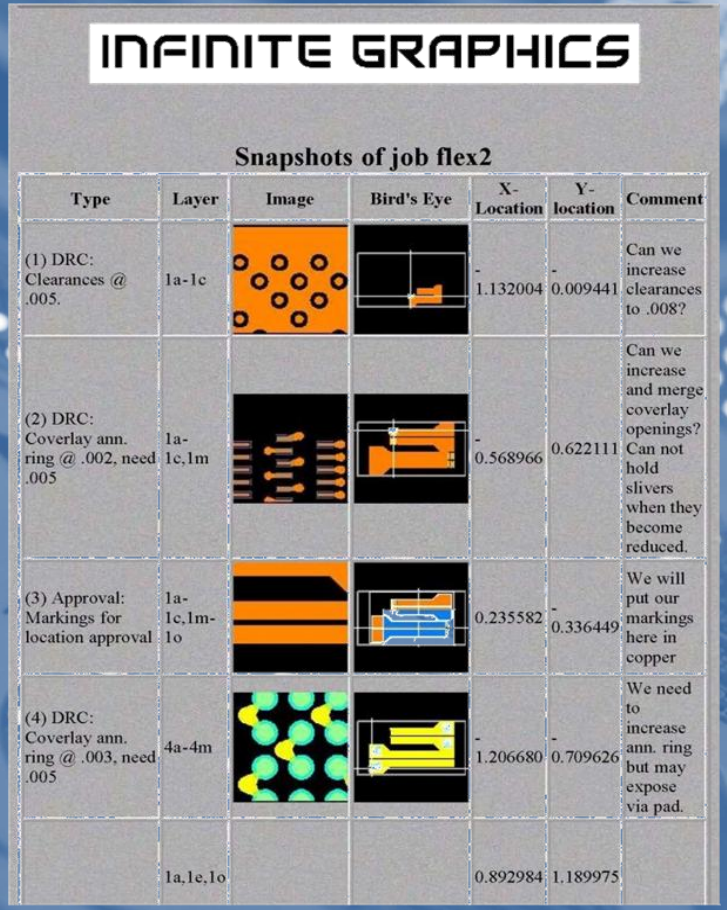
Manufacturing



CAM

- Data Integrity
  - Netlist extracted from “as received” gerber is compared to customer supplied netlist
  - Electrical test netlist extracted
- Design Rule Check
  - Comprehensive DRC to resolve any potential manufacturability issues and suggested areas of improvement for increased yields or cost savings
  - All alterations made by Circuits require customer approval
- Manufacturing Tools
  - Full panel optimization for individual pieces or assembly
  - Conformance coupons added
  - Master output files created for imaging, drill, laser, test and routing



INFINITE GRAPHICS

Snapshots of job flex2

Type	Layer	Image	Bird's Eye	X-Location	Y-location	Comment
(1) DRC: Clearances @ .005.	1a-1c			-1.132004	-0.009441	Can we increase clearances to .008?
(2) DRC: Coverlay ann. ring @ .002, need .005	1a-1c,1m			-0.568966	0.622111	Can we increase and merge coverlay openings? Can not hold slivers when they become reduced.
(3) Approval: Markings for location approval	1a-1c,1m-1o			0.235582	-0.336449	We will put our markings here in copper
(4) DRC: Coverlay ann. ring @ .003, need .005	4a-4m			-1.206680	-0.709626	We need to increase ann. ring but may expose via pad.
	1a,1e,1o			0.892984	1.189975	

Sample DRC feedback report

Imaging

- Photoplotting
  - Crescent 30 Photoplotter integrated with upfront CAM software
  - .25 mil resolution
- Printer
  - Point source printer, 25 X 30 exposure area
  - Self-contained air conditioner and multiple drawer processing unit

- Imaging-intensive processing
  - 16’ X 20’ modular Class 1000 Clean Room
  - Rigorous quality control regimen and safeguards in place
  - State-of-the-art imaging equipment

Chemical

- Superior technology, best practices and attention to detail
- PTH-electroplating
  - Low deposit electroless followed by full-panel electroplating ensures the best hole plating characteristics
- Standard Electroless Nickel Immersion Gold (ENIG)

- Custom-engineered DES conveyorized process line
  - Eliminates handling between processes when ultra fine substrates are most vulnerable
- Plasma etch-back
  - 16 chamber, 5 gas equipment offers a wide variety of processing
- Cobra-Bond™ inner layer adhesion promotion system for the manufacture of rigid-flex (black oxide alternative)

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Mechanical

- Lamination Press
  - Programmable Vac-Q-Lam
  - Pressure uniformity and temperature ramp up/ramp down capabilities
- Mechanical Drilling and Routing
  - Uniline 2000 turns 80K RPM for routing and 125K RPM drilling
  - EX200
  - Continuous laser inspection of bit quality and hit count
  - Fully integrated with upfront CAM operations
- Laser Drill and Route
  - ESI 5150 laser (1 mil precision laser)
  - Microvias, tight radii and critical dimension features
  - Variable depth