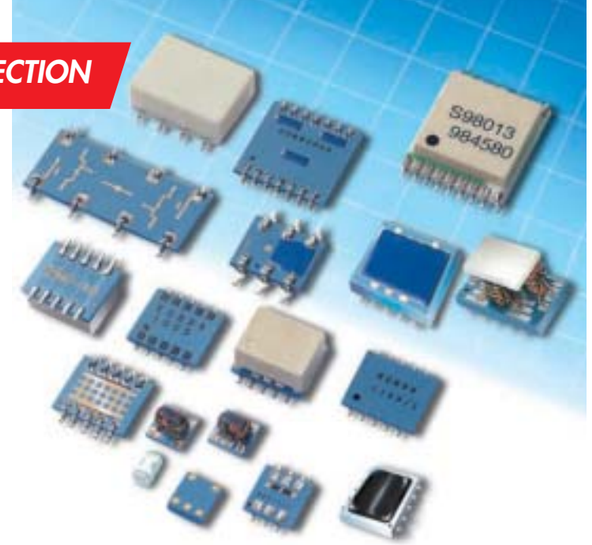


WHAT IS BLUE CELL™ LTCC TECHNOLOGY?

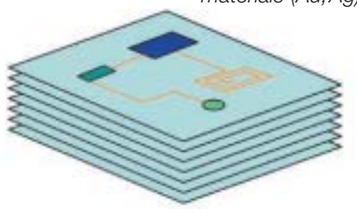
As the market increasingly demands smaller, high performance, cost effective products, designers turn to Blue Cell™ LTCC solutions for their microwave needs.

What Is LTCC?

***L**ow **T**emperature* → **<1000°C** — *Enables use of low-resistive materials (Au, Ag)*

***C**o-fired* → **Fired In A Single Run** — *Efficient*

***C**eramic* → **Ceramic Base** — *Excellent physical properties*



LTCC Multilayer RF Circuits

Blue Cell™ Low Temperature Co-fired Ceramic technology provides the means to produce multilayer circuits using multiple layers of ceramic substrate tape.

How Are LTCC Substrates Made?

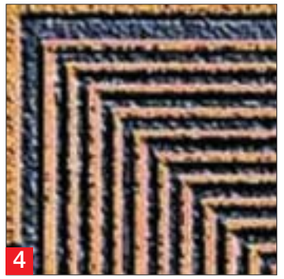

1


2

1 ***Preparation:*** *LTCC ceramic tapes are delivered on rolls or as sheets. The tapes are subsequently preconditioned in a furnace.*

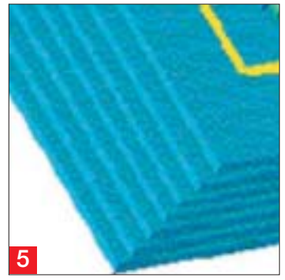
2 ***Via and Cavity Forming:*** *A laser is then used to cut the registration and via holes (>100um) out of the LTCC tape. Arbitrary shapes of cavities and windows can also be formed with the laser.*


3


4

3 ***Via Filling:*** *The via holes are filled with thick film pastes using the screen printing method. An accurate alignment of the stencil and tape can be achieved with an optical positioning system combined with the screen printer.*

4 ***High Resolution Lines:*** *For high frequency applications, an improved conductor resolution is preferred. Standard line width and spacing starts at 150um. By using a photoimageable paste, a 50um resolution can be achieved.*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5 ***Collating and Stacking:*** *The single tapes with filled vias and printed conductors are collated on a special tool and stacked to avoid slipping of the layers. The collating and stacking work is done manually with great care and accuracy.*

6 ***Lamination:*** *In this step, the lamination process is done at a typical temperature of 80°C and a pressure of 3000 psi.*


7


8

7 ***Co-firing:*** *The laminated LTCC stack is fired in a computer controlled furnace at a temperature of about 900°C. In this process, the LTCC will shrink up to 13% in X- and Y-direction, and up to 15% in Z-direction (thickness). Because firing takes place at low temperatures, low resistivity conductor materials such as silver and gold can be used on LTCC, instead of the molybdenum and tungsten materials typically used with high-temperature-cofired-ceramic (HTCC) processes.*

8 ***Post-processing:*** *A number of post-processing steps are available for LTCC prototype manufacturing, such as post-firing of conductors and resistors, surface mount technology and wire bonding, dicing, and singulation or sawing.*

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WHAT IS BLUE CELL™ LTCC TECHNOLOGY?

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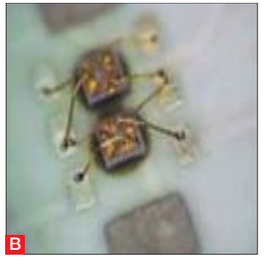
How Are LTCC Substrates Assembled?



A ***Die-Attach:*** *The semiconductor die is attached to the ceramic substrate using adhesive epoxy.*

B ***Wire-Bonding:*** *The semiconductor die is then electrically connected to the ceramic substrate through gold wires bonded by thermo-compression.*

C ***Glob-Top:*** *An epoxy glob-top is applied over each device on the ceramic substrate. This encapsulates the device to protect it.*

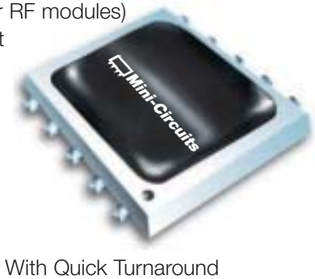
D ***Marking:*** *Ink marking on the glob-top of the device provides a means of identifying each product.*

E ***Testing:*** *Each device in the ceramic substrate is tested using an automated X-Y table. Any electrical rejects are inked during this process.*

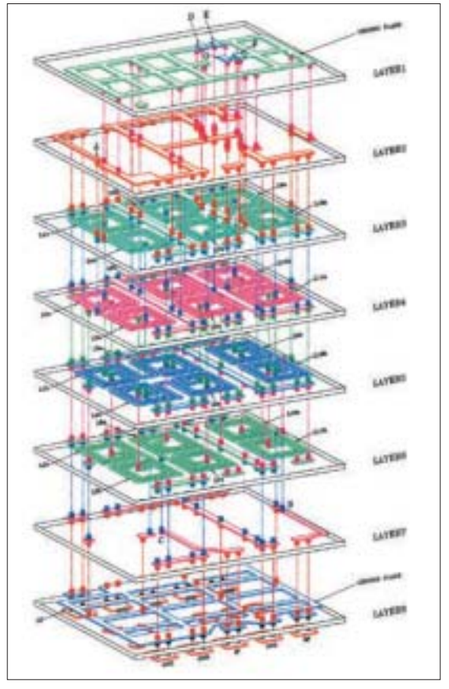
Since Blue Cell™ LTCC is a repeatable process, it can reliably produce large quantities of RF and microwave components measuring a fraction of the size of components fabricated with conventional substrate materials.

Benefits of the LTCC

- ☐ Size Reduction and Ruggedness
  - ✓ Integrated passive components
  - ✓ 3-D design (multi-layer RF modules)
  - ✓ Direct chip attachment
- ☐ High Performance and Reliability
  - ✓ High Q, low loss
  - ✓ Controlled impedance
  - ✓ Environmental stability
- ☐ High Repeatability
- ☐ Rapid Prototyping
- ☐ High Volume Production Capability With Quick Turnaround
- ☐ Very Low Cost



3-D "X-Ray View" of Typical Blue Cell™ LTCC Product



In order to practically and cost effectively apply Blue Cell™ technology, Mini-Circuits has developed a series of sophisticated three dimensional computer models using the latest electromagnetic (EM) simulation tools. These proven computer models allow Mini-Circuits to develop new and custom LTCC components quickly, economically, and reliably, with a high degree of first-pass design success.

Off-The-Shelf And Custom Designs

When special custom designs are required, Mini-Circuits sophisticated 3D EM simulation tools and state-of-the-art automated manufacturing facilities can quickly turn a customer's requirements into a finished product with extremely short lead times. Whether your application is telecommunications, microwave, cable, wireless, Bluetooth, industrial, commercial, or military, Mini-Circuits Blue Cell™ LTCC design team is anxious to work with you on your design challenges to develop the ideal Blue Cell™ product solution.

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WHAT IS BLUE CELL™ LTCC TECHNOLOGY?

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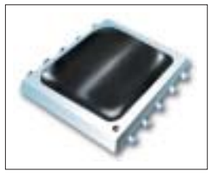
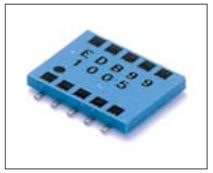
Current Blue Cell™ LTCC off-the-shelf product lines include:

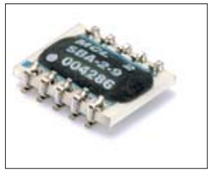


Frequency Mixers



Power Splitters/Combiners

Directional and Bi-Directional Couplers



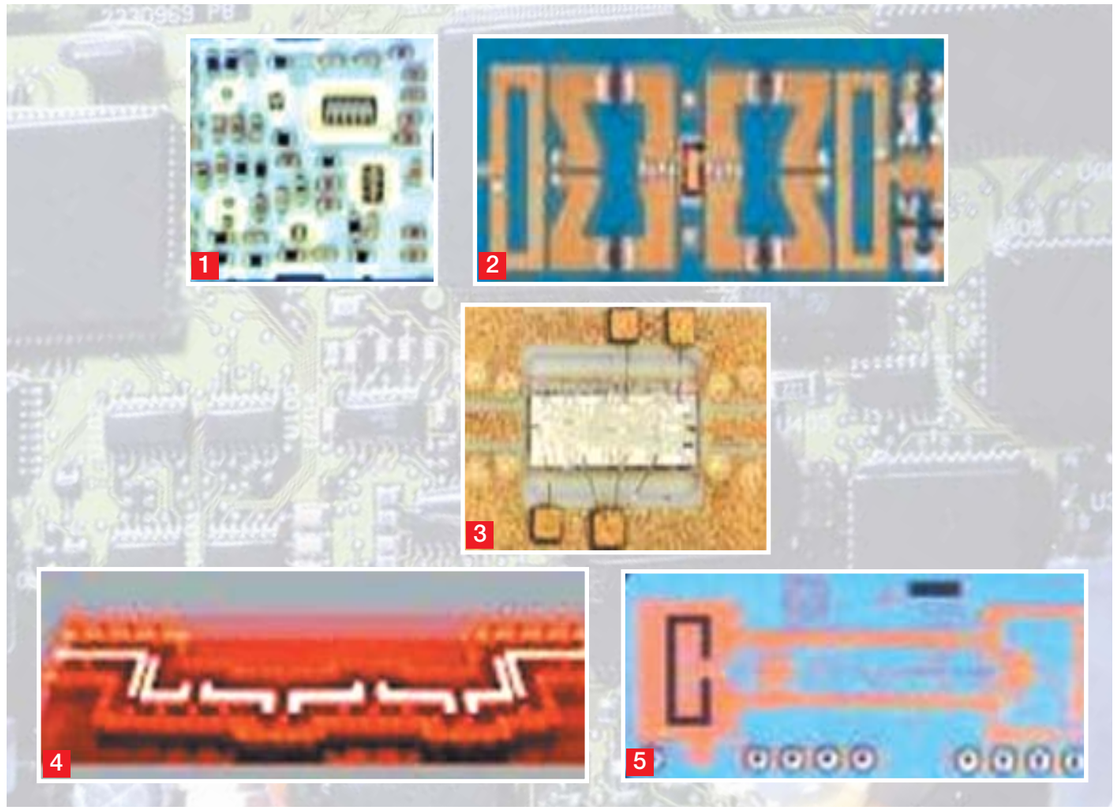
Frequency Doublers

Filters

RF Transformers

I&Q Modulators

LTCC Applications



1. ***Dual Band Amplifier***
2. ***Balanced Push-pull Amplifier***
3. ***Low Noise Amplifier***
4. ***Shielded Stripline Bandpass Filters***
5. ***Point-to-Point Transceiver Module***

Conclusion

Many wireless systems have already discovered the benefits of Mini-Circuits LTCC technology. Mini-Circuits Blue Cell™ LTCC technology can deliver extremely small package size, improved electrical performance, high reliability, excellent thermal stability, superb unit-to-unit repeatability, and low cost. These characteristics help system designers to substantially improve the quality of their products while cutting overall costs and dramatically reducing the time to market. Mini-Circuits Blue Cell™ products are protected by U.S. Patent numbers 5,534,830, 5,640,132, 5,640,134, and 5,640,699, with additional patents pending. More information about Blue Cell™ products is available on the Mini-Circuits web site at: www.minicircuits.com or by contacting Mini-Circuits.

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