From December 2006 *High Frequency Electronics*

Achieving Connector Performance with Stacked Boards in Cell Phones

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Board-to-board connectors have a unique set of mechanical assembly and high frequency electrical performance issues

Multi-tasking has become a way of life in today's fast-paced world. We email while talking on the phone and attend conference calls in the carpool lane. Just as we have become multi-taskers, so have our gadgets. Very seldom is a cell phone just a cell phone these days—there are camera phones, PDA phones, MP3 player phones, and several all-in-one phones on the market and in development.

Increasing functionality beyond that of a regular cell phone requires more and more components within the phone—components that are smaller and more reliable than their predecessors. One of the most popular features in today's cell phones is the push-to-talk function.

Push-to-talk is a software technology for mobile phones that is designed to let you use your phone in real-time for direct one-to-one and one-to-many voice communication. The primary technologies behind push-to-talk are SIP (Session Initiation Protocol) and IP networks such as GPRS or WCDMA.

How Does Push-to-Talk Work?

Push-to-talk technology channels voice communication through a data network for always-on functionality. Mobile phones that are equipped with push-to-talk software and that have been subscribed to a mobile network's push-to-talk communication service can establish a telephone conference with one person or a group of people. Pushing a specific button on the mobile phone opens a voice channel to all selected participants whose phones will automatically play the caller's voice through the phone's loudspeaker. Push-to-talk allows only one participant to talk at a time, much like using a walkie-talkie.

The Traditional RF Connector Solution

Push-to-talk features require a second PC board that stacks above the main board in the mobile device and varies depending on the market for which it is designed. The traditional connector solutions for the main board in push-to-talk features are micro-miniature RF connectors such as MMCX and SSMB. However, these types of connectors do not produce any mechanical "float" due to the pin and socket inner contacts; plus the cost of the two connectors is relatively high, which drives up the cost of the final product.

Traditional two-connector RF solutions also present other challenges. Because mating is frequently an automated process, manufacturers often have difficulties with angular and offset misalignment of the connectors. Printed circuit board alignment during push-to-talk board manufacturing is often a highly guided process with tight tolerances and a number of guide pins for mating. A misalignment condition of as little as 0.010 in. can result in non-mating, a highly possible occurrence in most cell phone PC board assemblies. With phones, pagers, and other hand held devices becoming smaller and smaller, this misalignment cannot be countered by using larger connectors. RF connectors also require 360-degree shielding from a metal outer ground, which prevents further miniaturization of the components and end products. Yet another complication with two-connector assemblies is the possibility that a male pin may break in a female socket.

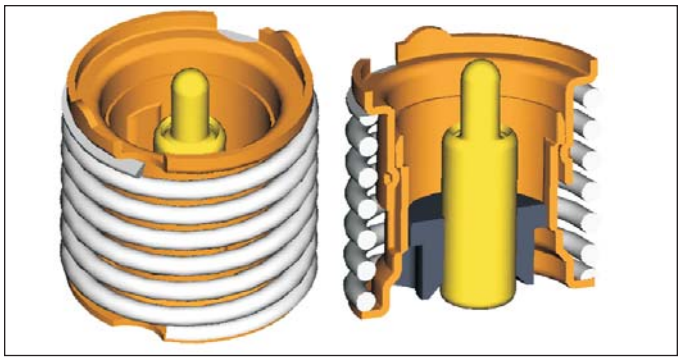

Figure 1 · The 4 mm board-to-board RF connector from ITT, Electronic Components offers a high degree of compliance on the height of the assembly, with an operating height of 3.5 to 4.5 mm.

	VSWR				
Sample	1 GHz	2 GHz	3 GHz	4 GHz	6 GHz
1	1.08	1.06	1.03	1.03	1.22
2	1.08	1.06	1.03	1.04	1.23
3	1.08	1.06	1.03	1.05	1.27
4	1.10	1.08	1.07	1.05	1.17
5	1.08	1.06	1.04	1.04	1.24

Figure 2 · RF performance of ITT's board-to-board connector.

New RF Connector Technology

In response to these challenges, cell phone manufacturers are exploring ways to preserve signal integrity, increase mating accuracy, lower costs, and further enable miniaturization. The answer has come in board-to-board connectors that not only provide offset and angular misalignment, but also eliminate the need for two connectors, reducing costs and parts needed by half.

The mechanical makeup of certain RF board-to-board connectors also provides a distinct advantage over traditional two-connector solutions. There are tolerance issues with the board itself that accompany the misalignment concern. For example, if two connectors are off by as little as 0.05 mm, they will not be able to mate.

However, one single RF board-to-board connector solution enables connector misalignment of up to 1.6 mm while still allowing mating. The connector design features a spring-loaded center pin and outer ground shell separated by a plastic insulator. The spring design of some connectors can present a challenge to the development engineers, as it is necessary to control the spring tension and keep contact resistance low while preventing the two inner bodies from binding together.

ITT, Electronic Components used the spring design for its RF connector, which connects the underside of one PC board to the top of the second circuit board needed in push-to-talk phones. The connector is reflow soldered to one PC board and sprung against the second, allowing easy disassembly of the PC board equipment. The pressure mount side is located against a target on the second PC board, allowing axial misalignment and a small degree of angular misalignment.

The spring design benefits RF testing applications as well as push-to-talk uses. Traditional connectors last an average of 500 mating cycles, while new single RF connectors can last up to 1,000 mating cycles. Furthermore, the simple punch connection simplifies the mating process, saving time and material costs for testing.

Some connectors, such as ITT's, also feature a unique connector surface on the ground shell. Traditional connector solutions mate two flat ground shell surfaces, which become susceptible to environmental contamination over the course of use. Designs with bumps, or "knuckles," on the connector interface produce a Hertz force of nearly 330,000 psi, further ensuring signal continuity with the connection. Some RF board-to-board connectors are capable of operating up to 6 GHz and 50 ohms, making them ideal for use in hand held devices.

Challenges Still Present

Despite all of the advantages, board-to-board connectors present some design challenges. For example, PC board spacing has to fall within certain height parameters since the connectors are usually designed for a specific height, requiring the connector to be tailored for each solution, including push-to-talk applications.

Design challenges are also present with RF board-to-board connectors, which need 0.3 mm of compression (movement) for the device to work properly. There is also the concern of the inner and outer body of the connector sliding around the metal spring, so it is necessary to ensure that the connector is free moving while still having at least a low amount of conductivity between the two parts.

While there are minor disadvantages to RF board-to-board connectors, the many performance advantages make them superior to traditional two connector solutions in push-to-talk applications. Not only do the connectors provide manufacturing benefits, but the reduced cost and improved sound quality allow end users to benefit as well. With their proven performance in communication equipment, RF board-to-board connectors are now being specified for applications in medical, test and measurement, and bar scanning equipment.

Author Information

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