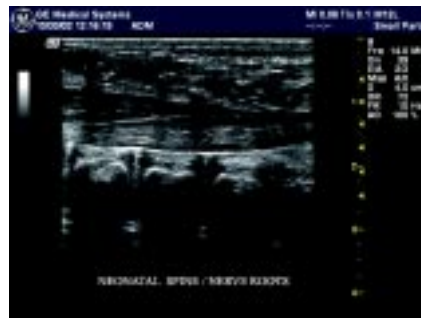


Multi-Level Codes deliver dramatic improvements in ultrasound resolution

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Executive Summary

Of all the recent advances developed to improve ultrasound image quality, perhaps none has been as significant as Code technology. Introduced by GE Medical Systems in 1998, this exciting technology employs bipolar coding of the ultrasound pulse sequence to enhance both resolution and signal-to-noise ratio.

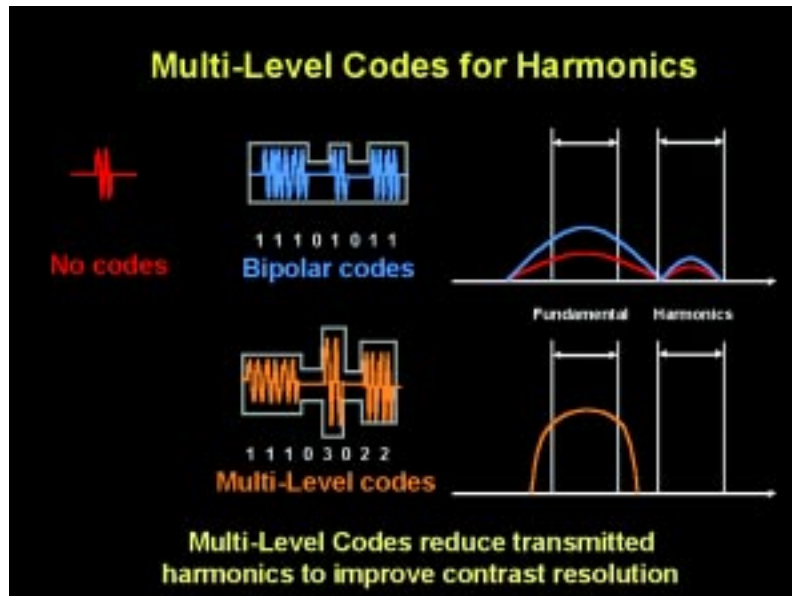
GE has now improved the performance levels of Code technology with the introduction of Multi-Level Code Technology. Available exclusively with the GE LOGIQ® 9 system, this new technology promises to further enhance resolution and signal-to-noise ratio (SNR) across a full range of ultrasound-imaging applications – including B-mode, harmonic, and contrast-enhanced imaging.

In recent years, ultrasound developers have made enormous investments in enhancing the state of the art in ultrasound imaging.

One recent advance has done just that: the development of Code technology, a key component of GE Medical Systems' Breakthrough in 1998. This technology digitally encodes the ultrasound signal to produce substantial improvements in both SNR and bandwidth control – and thereby delivers the sensitivity and contrast resolution needed to extract more diagnostic information than ever before.

These advantages have now been enhanced dramatically via the development of Multi-Level Codes™. Available exclusively with the GE LOGIQ 9 system, this capability has already demonstrated significant improvements in B-mode, harmonic and contrast-enhanced imaging alike.





How Code technology works

For years, Code technology has been used in the avionics industry to improve SNR without compromising resolution. More recently, a different type of code technology has been used in cell phones and in managing computer data. In fact, it is fundamental to today's most advanced information storage, transmission and retrieval strategies.

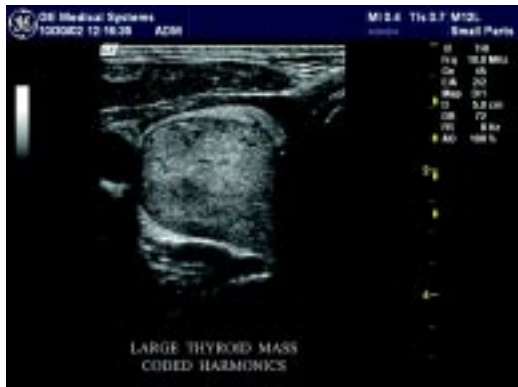
When applied to ultrasound, Code technology forms and transmits digitally encoded pulse sequences – pulse sequences which have been encoded with unique signatures that stay with them throughout the transmit and receive process.

When these specially encoded signals are returned from the body during the course of scanning, they pass through a programmable digital decoder for pulse-sequence decoding. This decoder is able to detect and amplify only the signals that bear the encoded signature, and to discard those that do not. As a result, even weak signals can be used to generate high-contrast images.

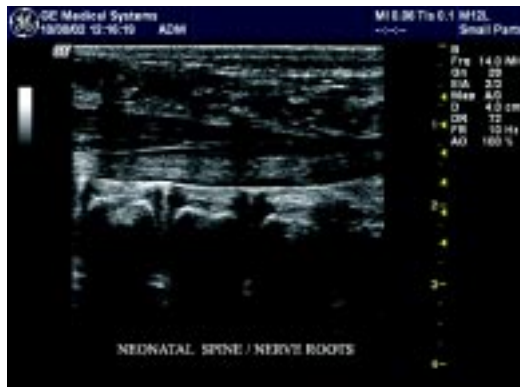
The results include wave shaping, which improves sensitivity without the conventional trade-offs between resolution and penetration /frame rate ... and optimization of both SNR and bandwidth.

A Multi-Level revolution in image quality

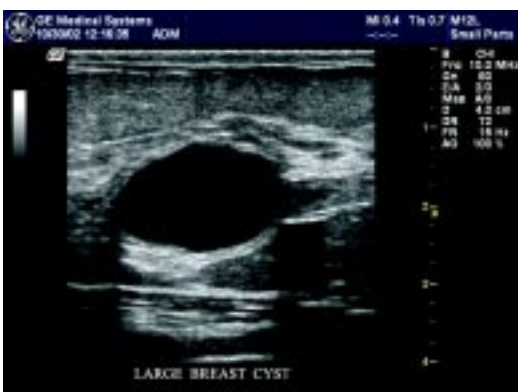
The original Digitally Encoded Ultrasound™ (DEU) technology introduced by GE Medical Systems in 1998 used bipolar coding of the ultrasound pulse sequence; each "signature" consisted of various combinations of 1 and 0, like an on/off switch. To this day, the bipolar coding used on the LOGIQ 7 and LOGIQ 9 systems represents a significant improvement over conventional ultrasound imaging in a full range of applications. It also makes possible an outstanding new diagnostic tool called B-flow™, which produces superior B-mode images for hemodynamic applications.



Multi-Level Codes in Coded Harmonic Imaging



Multi-Level Codes at 14 MHz



High Signal to Noise ratio with Coded Harmonic Imaging



Multi-Level Codes with LOGIQView

Summary

GE Medical Systems' Code technology boosts weaker high frequencies, helps achieve better penetration and helps eliminate unwanted signals from background reflections and system noise. Multi-Level Codes should therefore make it easier than ever before for physicians and sonographers to clearly resolve smaller structures, permitting earlier diagnosis of a broad range of pathologies.

On the LOGIQ 9, Multi-Level Codes take this technology to new levels of performance. It operates on precisely the same principle as its bipolar counterpart. The difference lies in the "resolution" of the encoding process and therefore in the level of control it maintains over shaping the ultrasound waveform. Instead of limiting the pulse-sequence signature to just 1's, 0's and -1, it applies up to 31 distinct levels, from -15 to 15, in effect functioning as a dimmer switch rather than an on/off switch.

Available exclusively on the LOGIQ 9 ultrasound system, this capability therefore gives the user far more precise control over transducer bandwidth, as well as higher SNR and improved penetration at higher imaging frequencies.

The results are marked improvements in axial resolution for fundamental imaging, and extraordinary enhancements in B-mode, Coded Harmonic Imaging™, and Coded Contrast Imaging™. As clinicians continue working with this new capability, GE expects feedback of increased performance in image quality, especially in resolving smaller structures.

Defining the parameters of ultrasound image quality

Axial resolution: The ability to resolve objects that lie one above the other, determined by transmit-pulse length or bandwidth. Depending on the patient's size, axial resolution is inversely proportional to transducer frequency.

Lateral resolution: The ability to resolve adjacent objects, determined by the finite size of the beam in the scan plane. This parameter is proportionately affected by frequency; the higher the frequency, the greater the lateral resolution.

Contrast resolution: The ability to distinguish between small anatomic structures with similar tissue characteristics. Out-of-plane slice thickness and interface characteristics are the major contributors to contrast resolution.

Signal-to-noise ratio (SNR): A measure of signal strength relative to background reflections, or noise – and a good predictor of contrast resolution. The absolute noise level and strength of an echo from a small object depend on a number of factors, including transducer frequency, bandwidth and efficiency; the body's inherent acoustic properties; scan path and distance; transducer/patient interface; and the object's location relative to the incident beam.



GE Medical Systems Ultrasound

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