According to Liboff the therapeutic value of a given pulsed signal is highly dependent on how rapidly the rise time and fall time happen. (Rosch 2004) This signal characteristic cannot be underemphasized, and is perhaps the most important thing to note in our discussion about the 4 key parameters of an electromagnetic signal. The abrupt fall time represents a high peak voltage value that is responsible for ion displacement in the body. Greater ion displacement exerts a stronger biological effect. Note that, within the low-to-mid frequency ranges of therapeutic application, the signal shape may be as important, if not more important, than the intensity or field strength of the electromagnetic pulsation being used. In the same treatise just cited, Liboff stated: "It is important to remember that there is no such thing as a little or a lot of magnetic field." While this author may disagree with this statement, particularly at higher ranges of field intensity, the point is this: the shape of the electromagnetic signal is something to which very close attention needs to be paid.
Both the sawtooth signal shape and the square waveform have rise and fall times that are far more abrupt than a simple sine waveform. Again, the more abrupt the rise and fall time, the greater the biological effect. Clinicians and health technicians using this form of energy medicine must have a proper understanding of the relationship between signal shape and bioelectromagnetic interaction so they can knowledgeably evaluate signals emitted by various devices. Signal shape, frequency and amplitudes are all important variables in the use of electromagnetic impulses for health benefit.

The sawtooth waveform

The most well-known signal shape is the sawtooth waveform introduced by Bassett in 1974. (Bassett 1974c/15) Dr. Bassett observed that changes in the electromagnetic signal induce an electrical current within the treated tissue, with maximum current being induced

when the signal changes most abruptly, namely when it falls from its peak value to its lowest value (fall time). The piezoelectric current induced within bone accelerated the bone healing. As a result of Bassett's work, this waveform has been FDA approved in the United States since 1979 for the treatment of non-union fractures and to aid in spinal fusion operations.
iMRS device has 3 applicators: a full body mat, a local pad applicator, and a small probe applicator. The signal shape delivered by the mat is a sawtooth waveform.
This waveform is a composite of a large number of harmonic sine waves in the low-frequency range. The sawtooth pulse of the iMRS systems supplies its basic signal at a frequency of 64 Hz, which is the frequency of the natural heartbeat. Unlike simple sine waves or static, externally worn magnets, the sawtooth electromagnetic signal changes continuously, producing constant induction of electromagnetism into the body's tissues, maximizing ion displacement and preventing cellular membrane fatigue. This means that the cell membrane remains responsive to the signals, maximizing the beneficial effects of electromagnetic stimulation.

The problem of signal specificity
If our knowledge were perfect, rather than progressive, it would be possible to know exactly what waveform works best for each of the body's tissues and organ systems, for each disease or condition, and for virtually any level of desired enhancement to one's health. As suggested above, there are many existing as well as new and developing diagnostic techniques to gain insight into the current health status of the human body, including standard blood chemistries and blood analysis, imaging studies (such as MRI, CT scan, bone scans and x-rays), functional MRI, Electro-Interstitial Scanning (EIS) for pH analysis of many internal organ systems (LD Technologies, Miami, Florida), nutritional analysis, scanning of the biofield using polycontrast imaging photography, variable heart rate

monitoring, pulse monitoring (such as used in acupuncture and Traditional Chinese Medicine), live blood cell analysis, infrared thermography, electrodiagnostic testing (such as electrocardiography (EKG), electromyography (EMG) and nerve conduction velocity (NCV), electroencephalography(EEG), and many others. Much of the data from these types of biophysical feedback mechanisms have already begun to be incorporated into some uses of pulsed magnetic field therapy, usually at a higher expense to the patient or end user, but in many cases well worth it. However, much of the claims of superiority of waveform touted by device manufacturers are based on incomplete information at best. Some devices, such as the MRS 2000+ designo® MED deliver a wide variety of time-varying impulses (Figure 7) and amplitudes to ensure that a broad spectrum of electromagnetic energy is delivered to the cell membrane. It is believed, though not yet thoroughly proven, that cell membrane receptors selectively respond to signal shapes (and frequencies) that they need to derive optimum health – much like a tree in a drought that will naturally respond to water applied to its root system. The philosophy of MediConsult GmbH, the manufacturer of the iMRS, is to target the known "biological windows" we have mentioned above and will discuss further below.

The 4 Programs of the iMRS Whole Body Mat, and the Main Frequencies Used

The frequency bands utilizing the unique sawtooth signal shape are composites of a large number of electromagnetic signals in the extremely low frequency (ELF) range. The basic signal frequency is 64 Hz and each pulsation requires 5.25 milliseconds (ms) to deliver. The main frequencies used in daily application are shown below:

Program 1 (morning: 5 am to 10 am)

The basic sawtooth signal is delivered as follows: one "packet" of sawtooth stimulation (comprised of 4 pulsations lasting 5.45 ms each) is followed by a 45 ms pause. Thirty of these 4-pulse packets are delivered as one "pallet" of stimulus, followed by a 1320 ms pause. This means that there are 66 ms (4 x 5.25 ms + 45 ms = 66 ms) required to deliver the pallet of pulsations. Since a reasonable estimate of the maximum frequency (in Hz) of pulsations is the inverse of the time involved, the carrier frequency of Program 1 = 1/**66 ms** (x 1000) = **15.15 Hz**. This cycle of bioelectromagnetic signaling of every cell within the field is continued for 8, 16 or 24 minutes, depending on the session time setting used. Every 2 minutes during this signaling the polarity is reversed to prevent cellular fatigue or accommodation to the signal. The intention of this is to maximize the biological effect.

Program 2 (mid-morning to mid-afternoon: 10 am to 3 pm)

The basic sawtooth signal shape is delivered at 64 Hz, 4 times, followed by a 31.5 ms pause. (4 x 5.25 + 31.5 = 52.5 ms. 1/52.5 (x 1000) = 19.04 Hz) These 4-pulse packets are delivered **30**4 times, followed by a 24.3 ms pause. (3 x 52.5 ms + 24.3 ms = 181.8 ms. 1/181.8 (x 1000) = 5.5 Hz carrier frequency.) Both of these processes are repeated 20 times, followed by a 1364 ms pause. (20 x 181.8 ms + 1364 ms = 5000 ms. 1/5000 ms (x 1000) = 0.2 Hz)

Program 3 (mid-afternoon to evening: 3 pm to 8 pm)

The basic sawtooth signal shape is delivered at 64 Hz, 5 times, followed by a 36.75 ms pause (5 x 5.25 ms + 36.75 ms = 63 ms. 1/63 ms (x 1000) = 15.87 Hz) These 5-pulse packets are delivered 4 times followed by an 81 ms pause (4 x 63 ms + 81 ms = 333 ms. 1/333 ms (x 1000) = 3 Hz) Both of these processes are repeated 20 times followed by

a 3340 ms pause (20 x 333 ms + 3340 ms = 10,000 ms. 1/10,000 ms (x 1000) = 0.1 Hz)

Program 4 (night: 8 pm to 5 am)

The basic sawtooth waveform is repeated 5 times followed by a 50.75 ms pause (5 x 5.25 ms + 50.75 ms = 77 ms. 1/77 ms (x 1000) = 12.99 Hz) These 5-pulse packets are delivered in pallets of 12, followed by a 1076 ms pause (12 x 77 ms + 1076 ms = 2000. 1/2000 ms (x 1000) = 0.5 Hz) Both of these processes are repeated 3 times followed by a 4000 ms pause (3 x 2000 ms + 4000 ms = 10,000 ms. 1/10,000 ms (x 1000) = 0.1 Hz)

One Program for the Local Pad and Probe Applicators of the iMRS®

The local Pad and Probe applicators are capable of higher flux densities and are versatile in how they are applied externally to the body. There is no need for a Chinese Organ Clock for this application. A square waveform is used. Once the Pad or Probe applicator is selected, the indicator light for the other programs utilizing the whole body mat will switch off automatically. The basic 5.25 ms signal is again used with the local applicators (although now in a square signal shape) and this signal is repeated 5 times followed by a brief 36.75 ms pause. (5 x 5.25 ms + 36.75 ms = 63 ms. 1/63 ms (x 1000) = 15.87 Hz) These packets are delivered in pallets of 4, followed by an 81 ms pause (4 x 63 ms + 81 ms = 333 ms. 1/333 ms (x 1000) = 3 Hz) Both of these processes are repeated 20 times, followed by a 3340 ms pause (20 x 333 ms + 3340 ms = 10,000 ms. 1/10,000 ms (x 1000) = 0.1 Hz)