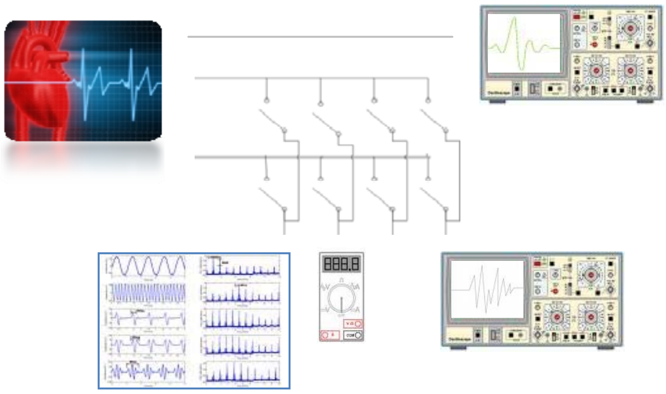

Signal Switching for Medical Device Manufacturing

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Maintaining signal integrity is critical in medical device testing and characterization. The signal's shape, as well as its frequency, amplitude and other electrical parameters must be preserved for accurate measurement and evaluation.

A major medical device manufacturer designed a test system to verify performance of their product, a pacemaker with defibrillator. Since proper operation can make the difference between life and death, the customer selected very high performance test instrumentation, including a state-of-the-art arbitrary waveform generator (ARB) to simulate the wide range of medical conditions. However, as is often the case, little attention was paid to the signal switching system between the test instruments and the device under test (DUT). Since an average heart beats around 70 times per minute (bpm) and a pacemaker with defibrillator only puts out a moderate amplitude voltage signal, the customer selected a low cost signal switching system with about 5 MHz of signal bandwidth. The 5 MHz signal bandwidth was thought to be more than adequate given the heart rate of only 70 bpm.

Even though the heart rate is low, the heart beat itself has very fast rise times.

There are technical Issues that come into play when switching signals. Not only is the fundamental frequency component of the signal important to bandwidth, but the shape of the signal is important as well. A narrow time pulse is comprised of a wide range of frequencies. Narrow pulses and pulses with fast rise and fall times will have frequency components many multiples of the fundamental frequency. And although the voltage from the pacemaker with defibrillator may have moderate amplitude, the simulated electrical signals of the heart are in the low millivolt range.

The unfortunate result of these issues is that the test systems may be unable to pass their intended test signals to the DUT and they may receive unexpected response signals from the DUT. The test system designers face a difficult situation. They either have to redesign the signal switching system or discard it and start over. A good rule of thumb is that bandwidth (BW) of the signal due to its shape is given by the formula $BW = 0.35/t_r$, where t_r is the rise time of the signal. The rise time of the example pacemaker with defibrillator signal of approximately 20 ns requires a bandwidth of at least 17 MHz to preserve the integrity of the signal shape. In this example, the 5 MHz bandwidth of the signal switching was inadequate, and a new switching solution with wider bandwidth was required.

In addition, low-level signals (e.g. millivolts) are susceptible to being interfered with by comparable or higher-level signals if not properly shielded and isolated. A higher performance switching solution is designed with good shielding and isolation to prevent any external noise and interference from degrading the signal quality and causing measurement errors.

Giga-tronics ASCOR understands that separated ground planes and ground returns paths and controlled impedance signal paths are essential for the best shielding and isolation performance. We carefully engineer the separate chassis, digital and signal grounds. Unlike many competitors, Giga-tronics uses more costly, but higher performance, multi-layer boards to route different signal types on different layers. As a result, our signal switches are able to be used in environments with more potential interferers present.

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