

The RFID Revolution Starts Now!

Sapphire DART Ultra Wideband Precision Asset Location System™

The promises of Radio Frequency Identification (RFID) have excited the imagination, yet until today there have been no viable solutions which can provide extensible, wide area coverage with 100% read rates and precision localization of assets and personnel. The wait is over -- the revolution starts now!



Multispectral Solutions, Inc. (MSSI), the industry leader in Ultra Wideband (UWB) technology, introduces its **Sapphire DART** solution for RFID and precision localization and tracking. Using MSSI's patented UWB technology, **Sapphire DART** is setting new industry standards for Real Time Location Systems (RTLS).

With read ranges in excess of 200 meters (650 feet), resolution and accuracies of better than 30 cm (1 foot), battery life-times in excess of 5 years, robust operation in severe multipath environments and micro-miniature tag sizes, **Sapphire DART** represents the ultimate state-of-the-art in RTLS.

This article provides a brief introduction to **Sapphire DART's** Ultra Wideband technology and its application to Radio Frequency Identification and Real Time Location.

What is Ultra Wideband (UWB)?

The term "ultra wideband" refers to the development, transmission and reception of extremely short duration bursts of radio frequency (RF) energy – typically ranging from a few hundred picoseconds (trillionths of a second) to a few nanoseconds (billionths of a second) in duration (see Figure 1).

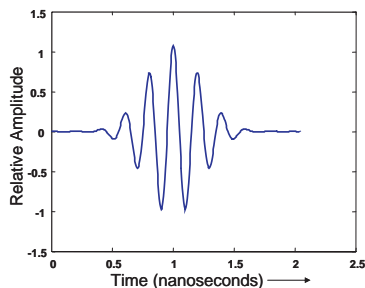


Figure 1. Typical UWB RF Pulse

As a consequence of these extremely short time durations, UWB waveforms have some rather unique properties. For example, with such short burst transmissions, the average transmit power is extremely small, resulting in huge savings in battery consumption. Since short time bursts correspond to a wide instantaneous bandwidth, this energy is spread over a broad range of frequencies resulting in a very low energy densities. This low energy translates into a low probability of interference to proximity systems and minimal RF health hazards, significant for both military and commercial applications.

Since the speed of light is approximately one foot per nanosecond, UWB pulses have spatial extents measured in inches, enabling extremely fine range resolution in UWB-based radar sensors. For communications, RFID and RTLS applications, this further translates into superb performance in multipath.

Multipath, or "multipath cancellation" occurs when a strong reflected wave – e.g., off of a wall, file cabinet, ceiling, vehicle, building, etc. – arrives partially or totally out of phase with the direct path signal, causing a reduced amplitude response at the receiver. With very short pulses, the direct path has essentially come and gone before the reflected path arrives and no cancellation occurs. Conventional spread spectrum signals (e.g., WiFi 802.11), on the other hand, experience significant waveform distortion and loss of signal strength (see Figure 2).

Another important feature of UWB is its circuit simplicity. Fig. 3 illustrates a spread spectrum RFID tag (top) and a **Sapphire DART** UWB tag (below). The UWB tag has only 25 components compared to over 150

for the spread spectrum based tag design.

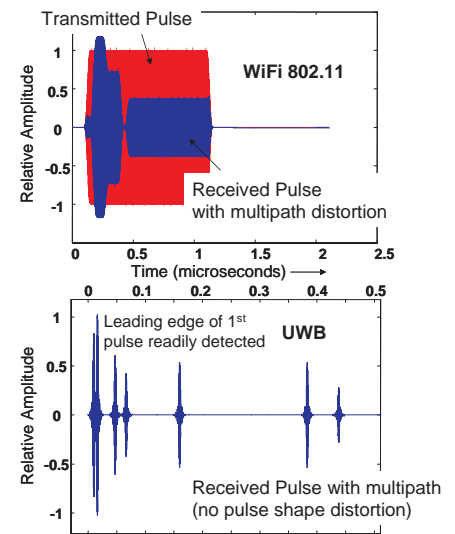


Figure 2. Multipath Effects on WiFi 802.11 (top) and Ultra Wideband (below)

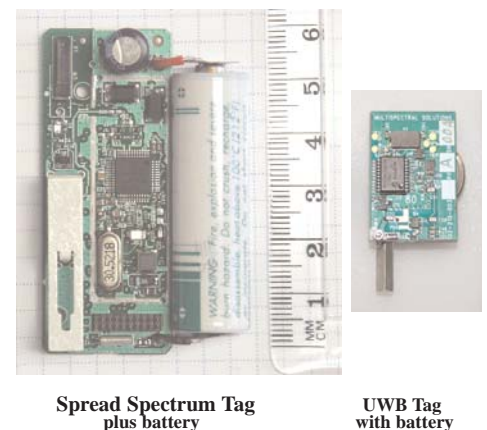


Figure 3. RFID/RTLS Tags Showing Size & Complexity Advantages of UWB



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Ultra wideband systems are approved for unlicensed use within the United States under FCC Part 15, specifically Subpart F and Part 15.250. **Sapphire DART** tags operate under Part 15.250 regulations, permitting both indoor and outdoor use. The FCC Part 15.250 band spans from 5.925-7.250 GHz. European regulators are currently considering the authorization of UWB-based RFID and RTLS systems within the 6.0-9.0 GHz, overlapping allocations within the U.S.

What are RFID and RTLS?

Radio Frequency Identification, or RFID, utilizes electromagnetically radiating or "RF" circuits to send data from an RFID "tag" to a remote tag receiver or "reader". The data stored on the tag is typically used for asset management, ranging from simple presence detection (e.g., "the tag is in this area") to the transmission of full item description or cargo manifest (e.g., container contents, etc.). RFID tags have been used on products, personnel and even animals. RFID systems are typically subdivided into "passive" and "active" technologies.

In passive RFID systems, the tag does not contain its own source of power or battery. Rather, the tag is "activated" by a burst of RF energy from a separate transmitter, typically contained within the tag reader. This RF burst energizes the circuitry within the passive tag to transmit its information. Passive tags can be made very inexpensively, literally consisting only of a small microwave diode or other device and antenna. However, this low cost comes at a high price - read ranges to the tag are very short, typically only a few feet. In many practical situations, passive tags simply cannot be seen through obstructions.

In active RFID systems, the tag contains its own source of power, typically in the form of a small Lithium cell. Because of this, active tags have significantly larger ranges than do passive devices, typically 100 feet or more. With their higher output power, these tags can also usually be read through obstacles, making them significantly more useful for inventory control. Unlike passive tags, however, active tags are significantly more complex and costly.

Real Time Location Systems (RTLS) are systems based upon the use of active RFID tag technology, and use the transmissions from the active tag as seen by several readers to accurately triangulate the position of the tag using amplitude, time-of-flight or differential time-of-flight information.

Sapphire DART is the State-of-the-Art in Active RFID and RTLS

Active RFID, and most recently, the use of active tags in location-based applications, have become of extreme interest for many clients because of the wide range of problems that can be solved with this unique combination of technologies. Unfortunately, active RFID tags have carried a high price tag (\$40 and more), are physically large, exhibit poor battery life expectancies, and have performed poorly in situations where multipath is a dominant issue -- e.g., most industrial and hospital applications.

Sapphire DART, with its unique use of MSSl's patented ultra wideband technology, has solved these issues, enabling end users to finally realize all of the benefits of active RFID and RTLS in demanding applications.

Sapphire DART provides:

- ✓ Tag read ranges in excess of 200 meters (650 feet) line-of-sight, and better than 50 meters (160 feet) through multiple obstructions
- ✓ Battery life expectancies of better than 4.5 years, even at one tag update per second!
- ✓ Real time location accuracies of better than 30 cm (12"), and better than 10 cm (4") with averaging
- ✓ Superb performance in multipath environments (see photos below of actual **Sapphire DART** installations)
- ✓ Microminiature tag sizes (e.g., 0.5 x 1.0 x 0.25 inches)
- ✓ Tags certified UL1604 for use in hazardous locations.

Sapphire DART

The State-of-the-Art in Active RFID and Real Time Location Systems

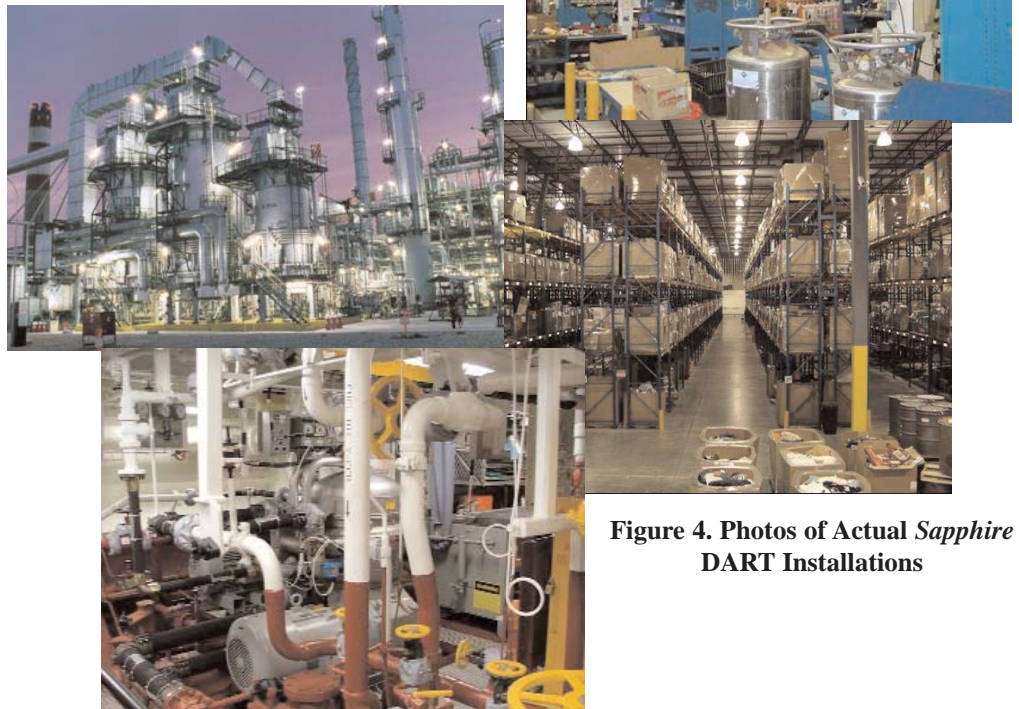


Figure 4. Photos of Actual **Sapphire DART** Installations