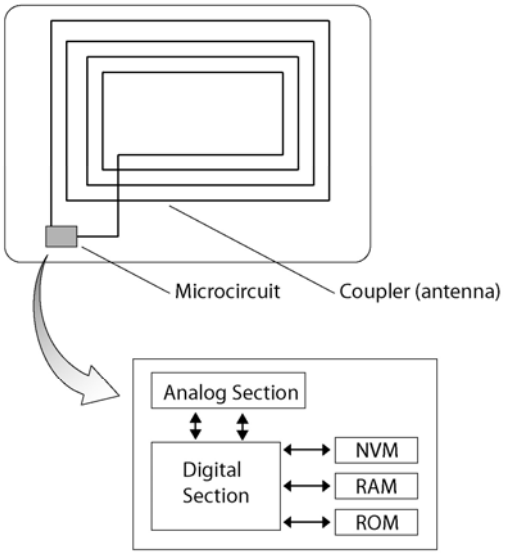
ID*entity* 5100 Operational Description

The IDentity 5100 UHF Reader is a member of the Sirit family of Radio Frequency Identification (RFID) products. RFID is a wireless data acquisition method used to remotely retrieve product data such as part number, date-of-manufacture, quantity, version, and other information. All RFID systems are comprised of the following components:

- Transponders (tags) attached to a product
- Reader/Interrogator to write and read tag data
- Reader/Interrogator Antenna

Transponders (Tags)

The transponder or tag is the data-carrying device attached to the product or container and can come in any shape or size. The most common are the “credit card” tags used for security access and the larger plastic, anti-theft tags used by retailers. Whatever the size or application, each tag always consists of a coupler (antenna element) and a microcircuit. Tags operate in read/write mode. In other words, data can be rewritten to the tag as well as read from the tag.



The tag communicates with the reader across the air-interface. This interface is defined by its carrier frequency, bit data rate, encoding method and other parameters.

Tags are typically referred to as either active or passive devices depending on the power source. Active tags contain an internal battery and have longer read ranges but a limited operation life.

Low frequency passive tags do not have an internal battery and are powered by inductive or capacitance coupling when the tag is in the RF field of the reader. These tags typically have shorter read ranges, but have substantially longer operational lives.

UHF tags, like those used with the IDentity 5100, use reflected electromagnetic backscatter coupling. These tags operate in the 864-955 MHz range and typically have longer read ranges.

When a UHF tag passes through the RF field, the tag is energized by the reader's time-varying, electromagnetic RF wave. This signal is called the carrier signal. When the RF field passes through the antenna, an AC voltage is generated. This voltage is rectified to supply power to the tag's microcircuit. As the microcircuit loads and unloads the tag's antenna terminals, the information in the tag is transmitted back to the reader. This modulation scheme is referred to as Amplitude Shift Keying (ASK) or On-Off Keying (OOK).

IDentity 5100 Reader

The IDentity 5100 operates in the 902 MHz to 928 MHz UHF ISM band. The 5100 supports ISO 18000-6B, Ucode 1.19, and EPCglobal Generation 2 (ISO 18000-6C). The reader supports single, multiple, and dense reader modes and may integrate into most UHF installations including dock door portals, conveyor systems, access control, and many others. The 5100 provides interface options including RS-232 serial, Ethernet, and digital I/O to support most domestic and international RFID applications.

The IDentity 5100 is equipped with two RFID antenna ports: One port dedicated to the integrated patch antenna and the second is for an optional external antenna. The 2 TX/RX ports are multiplexed, i.e. only one port is active at any given time. Conducted output power is user-adjustable up to 2 Watts maximum for FCC Part 90 Licensed operation, but is further restricted to a 1 watt maximum output for FCC Part 15 operation. In addition to flexibility in power level, the transmitter has been optimized to handle the demanding requirements of dense reader modes. These optimizations include the use of phase reversal keying and substantial filtering to reduce out-of-band emissions to well below industry standards.

The reader contains a transmitter section, receiver section, synthesizer section and modem. The transmitter section contains a digital/analog converter, I/Q modulator, filtering, power amplifier and the coupling circuit. The receiver section contains amplifiers, I/Q demodulator, filtering and analog/digital converter. The synthesizer section contains a voltage-controlled oscillator and phase-locked loop. The modem includes the microprocessor, DSP, FPGA and input/output communication interfaces.

The reader transmits an 902-928 MHz signal to one of the antennas. This RF field can range from 6 inches to 30 feet depending on the power and frequency. The RF field generated by the reader performs the following:

- Energize the tag antenna to provide power to the integrated circuit
- Provide a synchronized clock source for the tag
- Act as a carrier for returned tag data

The reader can be configured to constantly generate the RF carrier, but in many applications, to minimize radio interference, the reader's transmitter is idle until an event triggers the reader to begin transmission. While the RF carrier is transmitted, the reader is monitoring the return signal for modulation indicating the presence of a tag.

When a tag enters the RF field, the antenna is energized and the tag starts to divide down the carrier, demodulate commands from the reader, and begins to clock data to the output transistor. The output transistor shunts the antenna element causing momentary fluctuations in the carrier amplitude. The reader detects this amplitude-modulated data and decodes the resulting bit stream into the actual tag data. The decoding scheme depends on the specific tag protocol.

Frequency Hopping Mechanism

Frequency set

The reader can be configured to operate in one of four frequency band sets, as shown in the table below.

Frequency Band Set	Frequency Range (MHz, inclusive)	Channel Spacing (kHz)	Number of Channels
FCC_A	902.3 – 912.1	200	50
FCC_B	910.1 – 919.9	200	50
FCC_C	917.9 – 927.7	200	50
FCC_DENSE	902.75 – 927.25	500	50

Channel Randomization mode

The reader hops from one frequency to another at times as described in the "Timing Considerations" subsection below.

The entire frequency list is shuffled using a pseudo-random number generator. The frequencies in the pseudorandom shuffled list are then used in sequence; only when the last frequency has been used, the list is reshuffled. No frequency is ever repeated until the entire list has been used. The Identity 5100 hopping sequence is generated as follows:

1. The set of 50 channels is shuffled in random order into a pseudorandom frequency hopping table.
2. Each channel is transmitted in the order set by step 1 for equal, fixed periods of time
3. When the last channel is completed from the set, return to step 1 and repeat.

This reshuffling algorithm guarantees each channel is used equally. By construction each channel will be used 1/50 = 0.02 = 0.4 seconds / 20 seconds, which satisfies the average occupancy limit.

Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified. When the Identity 5100 is presented with a continuous data stream, each packet transmitted by the device will be sent on the next channel in the pseudo-random list. When a continuous data stream is presented, the Identity 5100 adheres to the 0.4 second dwell time limit for each 20 second window requirement. The Identity 5100 is programmed using a pseudo-random shuffle mode that utilizes all the channels equally. The entire frequency channel list is shuffled using a pseudo-random number generator. The frequencies in the shuffled list are then used in sequence; when the last frequency has been used, the list is reshuffled. No frequency is ever repeated until the entire list has been used.

Timing considerations

In compliance with FCC Part 15 regulations, the reader never stays on one frequency for more than 400 ms. There are several mechanisms at work to enforce the 400 ms cutoff. First, as the reader performs tag inventories, from time to time it will check to see how much time is remaining from the 400 ms allotment for a given frequency. If there is less than 100 ms remaining, the reader will hop to the next frequency. Second, in some cases, if more than one antenna is in use, the reader will change frequencies when an antenna change is performed; these antenna changes typically occur many times within any 400 ms time period. Finally, a hardware timer in the reader is dedicated to tracking the 400 ms dwell time. Should a frequency continue to be used for 400 ms, because none of the above conditions caused it to be changed, the timer will force a frequency change at the 400 ms mark.

Incorporation of Intelligence FCC Part 15.247(h)

The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

By design and construction, the Identity 5100 does not attempt to recognize other users or interferers within this spectrum band for any type of coordination purposes.