

This Datasheet Applies to Monza™ Part No. IPJ_W_C_(A and C)

Features

- ☞ EPCglobal certified and ISO 18000-6C compliant, assuring robust performance and seamless interoperability.
- ☞ Dual antenna input maximizes range and provides for orientation indifference.
- ☞ High receptivity yields eight-meter read range, six-meter write range, and excellent tag performance—even when buried deep within a pallet of RF-absorbing material.
- ☞ Write rate of >15 tags/second enables rapid programming throughput.
- ☞ Extended temperature range (–40 °C to +65 °C) for reliable performance under harsh conditions.
- ☞ Patented interference rejection affords robust performance in noisy environments.
- ☞ Impinj’s field-rewritable NVM (optimized for RFID) with 96-bit EPC provides programming flexibility and 100,000-cycle/50-year retention reliability.
- ☞ Available preprogramming of customer EPCs at the wafer level delivers a fast, reliable, and cost-effective turnkey manufacturing solution.
- ☞ A key component of the Impinj GrandPrix™ Solution, Monza™ tag silicon is *RFID that just works™*.

Overview

An essential component of Impinj’s GrandPrix™ solution, Monza tag silicon is the industry’s first to be granted the EPCglobal™ Mark of Certification, guaranteeing standards compliance, interoperability, and the delivery of the many features empowered by UHF Gen 2, including superior tag throughput and conformance to global spectral regulations. The EPCglobal Gen 2 specification is the ultimate standard for automatic identification requirements ranging from items to cases to pallets—worldwide. For inventory control, unique item tracking, logistics, product integrity, security, and data accuracy, the use of Monza-powered tags yields unprecedented performance for supply chain visibility and confidence.

In addition, Monza establishes new benchmarks for range, readability, and high-speed field rewriteability. And in keeping with Impinj’s ground-breaking quality standards, Monza chips are 100% factory tested. Furthermore, Monza’s nonvolatile memory (NVM) features 100,000 cycle/50-year retention reliability.

Monza tag silicon benefits from Impinj’s innovative Self-Adaptive Silicon® core technology, which enables the creation of a true RFID system-on-a-chip integrating leading-edge analog, digital, and memory functions on a single die no larger than a grain of sand. It’s a significant Impinj advantage that yields major performance, sourcing, and cost improvements over competing products. More importantly, Monza is the best-performing tag silicon available, exhibiting outstanding receptivity, as well as ESD protection characteristics that are critical for ensuring inlay manufacturability at the highest assembly speeds.

Finally, Monza is supported by a family of innovative antenna designs that not only optimize tag performance for wide-ranging requirements and specific market applications, but also enable whole new categories of use.

RFID that just works™. Everywhere.

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1 Introduction

1.1 Scope

This datasheet defines the physical and logical specifications for Gen 2-certified Monza tag silicon, a reader-talks-first, radio frequency identification (RFID) component operating in the UHF frequency range.

1.2 Reference Documents

EPCglobal™ Generation-2 UHF RFID Protocol for Communications at 860 MHz – 960 MHz (Gen 2 Specification)

Note: This specification includes normative references, terms and definitions, symbols, abbreviated terms, and notation, the conventions of which were adopted in the drafting of this document.

Impinj Wafer Assembly Specification

Impinj Wafer Map Orientation

EPC™ Tag Data Specification

2 Functional Description

Described are the key functional blocks of the Monza tag silicon, as well as an overview of its operation within a typical application.

2.1 Monza Block Diagram

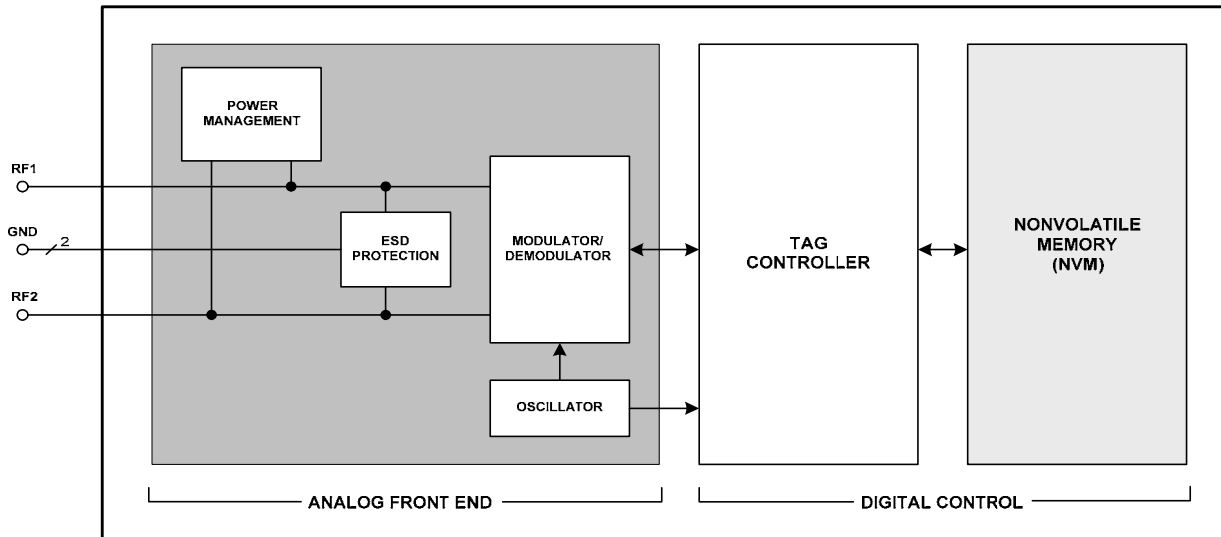


Figure 2-1 Block Diagram

2.2 Pad Descriptions

Monza tag silicon has four external pads available to the user: two antenna pads and two ground pads (the antenna ports are isolated while the ground pads are internally strapped together), as shown in Table 2-1 (see also Figure 2-2).

Table 2-1 Pad Descriptions

| External Signals | External Pad | Description |
|------------------|--------------|-----------------|
| RF1 | 1 | Antenna Input 1 |
| RF2 | 1 | Antenna Input 2 |
| GND | 1 | Ground |
| GND | 1 | Ground |

2.3 Dual Antenna Input

All interaction with Monza tag silicon, including generation of its internal power, air interface, negotiation sequences, and command execution, occurs via its two antenna ports and associated grounds.

The dual antenna inputs enable antenna diversity, which in turn minimizes a tag's orientation sensitivity, particularly when the two antennae are of different types (e.g., a combination of loop and dipole) or are otherwise oriented on different axis (X-Y). The dual antenna configuration also enables increased read and write ranges.

The two antenna inputs operate quasi-independently. The power management circuitry receives power from the electromagnetic field induced in the pair, and the demodulator exploits the independent antenna connections, combining the two demodulated antenna signals for processing on-chip.

Monza tag silicon may also be configured to operate using a single antenna port by simply connecting just one of the two inputs. The unused port may be connected to ground (to either, or both ground pads, as they are identical and connected on-chip) or allowed to float. With the exception of the use cases described in section 3.3, the two ports should not be connected to each other, as this will reduce power efficiency.

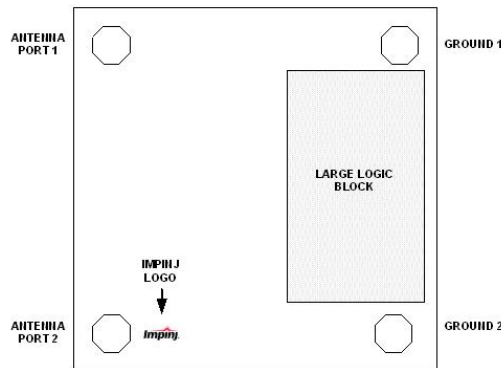


Figure 2-2 Monza die orientation

2.4 Power Management

The tag is activated by proximity to an active reader. When the tag enters a reader's RF field, the Power Management block converts the induced electromagnetic field to the DC voltage that powers the chip.

2.5 ESD Protection

To divert ESD energy, the ESD Protection block shunts charge from both positive and negative sources when a high voltage is presented across the inputs, thus protecting the chip from damage (see section 5.2).

2.6 Modulator/Demodulator

Monza tag silicon demodulates any of a reader's three possible modulation formats, DSB-ASK, SSB-ASK, or PR-ASK. The tag communicates to a reader via backscatter of the incident RF waveform by switching the reflection coefficient of its antenna pair between reflective and absorptive states. Backscattered data is encoded as either FM0 or Miller subcarrier modulation (with the reader commanding both the encoding choice and the data rate).

2.7 Tag Controller

The preceding sections detail the analog functions of power management and signal acquisition and transmission. In the Tag Controller block, we enter the digital domain. While it also performs a number of overhead duties, the heart of this block is the finite state machine logic that carries out the command sequences.

2.8 Nonvolatile Memory

Monza's embedded memory is based on Impinj's multiple-times-programmable (MTP), nonvolatile memory (NVM) cell technology, specifically optimized for exceptionally high performance in RFID applications. All programming overhead circuitry is integrated on-chip. Monza NVM provides 100,000 cycle endurance and 50-year data retention.

The NVM block is organized into two segments: (1) EPC Memory (up to 96 bits), and (2) Reserved Memory (which contains the Kill and Access passwords). TID Memory is ROM-based, and contains Impinj's manufacturer ID (000000000001) and the Monza model number.

3 Interface Characteristics

Described are the RF interface characteristics of both reader (Forward Link) and tag (Reverse Link).

3.1 Reader-to-Tag (Forward Link) Signal Characteristics

Table 3-1 Forward Link Signal Parameters

| Parameter | Minimum | Typical | Maximum | Units | Comments |
|-----------------------------------|------------------|-----------------------------|------------------|-------|--|
| RF Characteristics | | | | | |
| Carrier Frequency | 860 | | 960 | MHz | North America: 902–928 MHz Europe: 865–868 MHz |
| Read Sensitivity Limit | | -11.5 | | dBm | Input sensitivity is measured on a single RF input at 25 °C. Input sensitivity is specified for a R=>T link using DSB-ASK modulation with 90% modulation depth, Tari=6.25µs, PW=2.1µs, and a T=>R link operating at 160kbps with FM0 encoding. |
| Write Sensitivity Limit | | -7 | | | |
| Maximum RF Field Strength | | | +20 ¹ | dBm | |
| Modulation Characteristics | | | | | |
| Modulation | | DSB-ASK, SSB-ASK, or PR-ASK | | | Double and single sideband amplitude shift keying; phase-reversal amplitude shift keying |
| Data Encoding | | PIE | | | Pulse-interval encoding |
| Modulation Depth (A-B)/A | 80 | | 100 | % | |
| Ripple, Peak-to-Peak $M_h=M_l$ | | | 5 | % | Portion of A-B |
| Rise Time ($t_{r,10-90\%}$) | 0 | | 0.33Tari | sec | |
| Fall Time ($t_{f,10-90\%}$) | 0 | | 0.33Tari | sec | |
| Tari ² | 6.25 | | 25 | µs | Data 0 symbol period |
| PIE Symbol Ratio | 1.5:1 | | 2:1 | | Data 1 symbol duration relative to Data 0 |
| Duty Cycle | 48 | | 82.3 | % | Ratio of data symbol high time to total symbol time |
| Pulse Width | MAX(0.265Tari,2) | | 0.525Tari | µs | Pulse width defined as the low modulation time (50% amplitude) |

Note 1. Reader antenna power with tag sitting on antenna. Assumes tag has half-wave dipole antenna. While maximum radiated reader power is +36 dBm for both Read and Write operations, the maximum power the tag should receive is +20 dBm (see section 5.2).

Note 2. Values are nominal; they do not include reader clock frequency error.

3.2 Tag-to-Reader (Reverse Link) Backscatter

The tag transmits information on the tag-to-reader link by reflecting, or backscattering, part of the incident RF energy from the reader. Backscatter modulation is performed by modulating the input impedance of the tag, thereby modulating the reflection coefficient (denoted by Γ , or gamma) at the antenna-to-tag interface. The symbol $|\Delta\Gamma|$ (delta gamma) represents the magnitude of the change in reflection coefficient from the non-modulating (absorptive) to the modulating (reflective) state.

3.2.1 Modulation as Related to $|\Delta\Gamma|$

Figure 3-1 illustrates the measured magnitude of the difference between the two states of the reflection coefficient:

$$|\Delta\Gamma| = |\Gamma_{\text{mod_on}} - \Gamma_{\text{mod_off}}|$$

When a tag is transmitting information to a reader, the tag modulator switches its reflection coefficient between the two states, producing modulated (information-bearing) sidebands in the reflected signal. The amount of energy in the modulated sidebands is directly proportional to $|\Delta\Gamma|^2$. As such, $|\Delta\Gamma|$ plays a key role in any RF link budget. It should be noted that resistance and other nonlinear parasitic effects in the modulator impose practical limits on the range of $|\Delta\Gamma|$. Note also that as the incident power level increases, the magnitude of the reflection coefficient in the modulator off state is intentionally increased, thereby reflecting excess incident power as CW to prevent damage to the tag's analog front end.

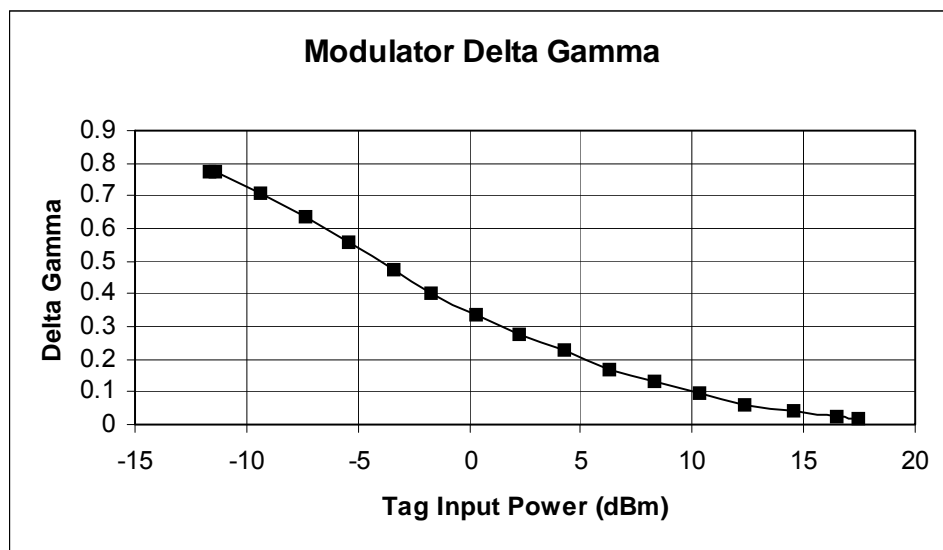


Figure 3-1 Measured tag delta gamma as a function of available input power

3.2.2 Radar Cross Section (RCS)

Tag RCS is the measure of the portion of the incident RF energy reflected isotropically back to a reader (a higher $|\Delta\Gamma|$ results in a larger RCS. But $|\Delta\Gamma|$ is not fixed; it changes with power). Figure 3-2 illustrates RCS as a function of $|\Delta\Gamma|$. RCS is given by:

$$\sigma_{bs} = \frac{P_{\text{received}}}{P_{\text{incident}}} \cdot 4\pi R^2$$

where σ_{bs} is the radar cross section; P_{incident} is the power incident on the tag, and P_{received} is the power at the antenna observing the tag's backscattered signal. Radar-cross section and $|\Delta\Gamma|$ are related by:

$$\sigma_{bs} = \frac{\lambda^2}{4\pi} \cdot G_{\text{Tag}}^2 \cdot |\Delta\Gamma|^2$$

where G_{Tag} is the gain of the tag antenna.

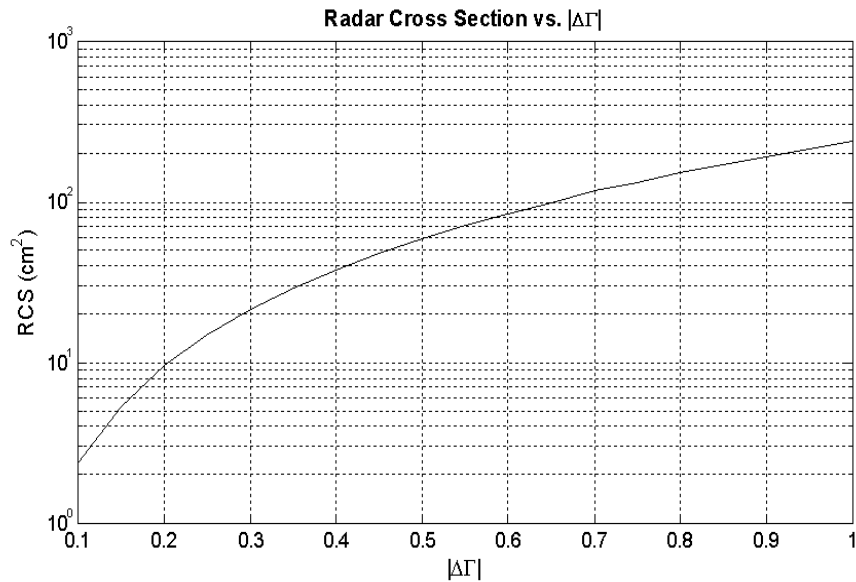


Figure 3-2 Tag Radar Cross Section (RCS) as a Function of $|\Delta\Gamma|$ (assumes half-wave dipole tag antenna and carrier frequency of 915 MHz)

If a tag is in close proximity to a reader, it will reflect a different amount of power than if the tag is at the limit of range. If the power level transmitted by the reader is known, and if the path loss to the tag is known, then one can determine $|\Delta\Gamma|$. At lower power levels (long range), a large $|\Delta\Gamma|$ is desired, as this increases the tag's RCS, and hence its read/write range. But at higher power levels, a lower level of reflection is preferred. As can be seen in Figure 3-1, as input power increases, $|\Delta\Gamma|$ decreases.

3.2.3 Reflection Coefficient as Function of Antenna Impedance

Complex backscatter strength

Figure 3-3 shows delta gamma at minimum sensitivity as a function of antenna impedance (showing change in backscatter strength as the antenna impedance is varied). Complex delta gamma relates to the power that a coherent receiver such as a reader would detect. The data shown is the aggregate of measured impedance and calculations. The contours show the magnitude of the change in reflection coefficient at the antenna/chip interface for modulating (backscattering) versus non-modulating (power absorbing) states. The polar plot field is the s_{11} of the tag antenna as measured from a 50 ohm system. The black-filled circle shows tag antenna design target.

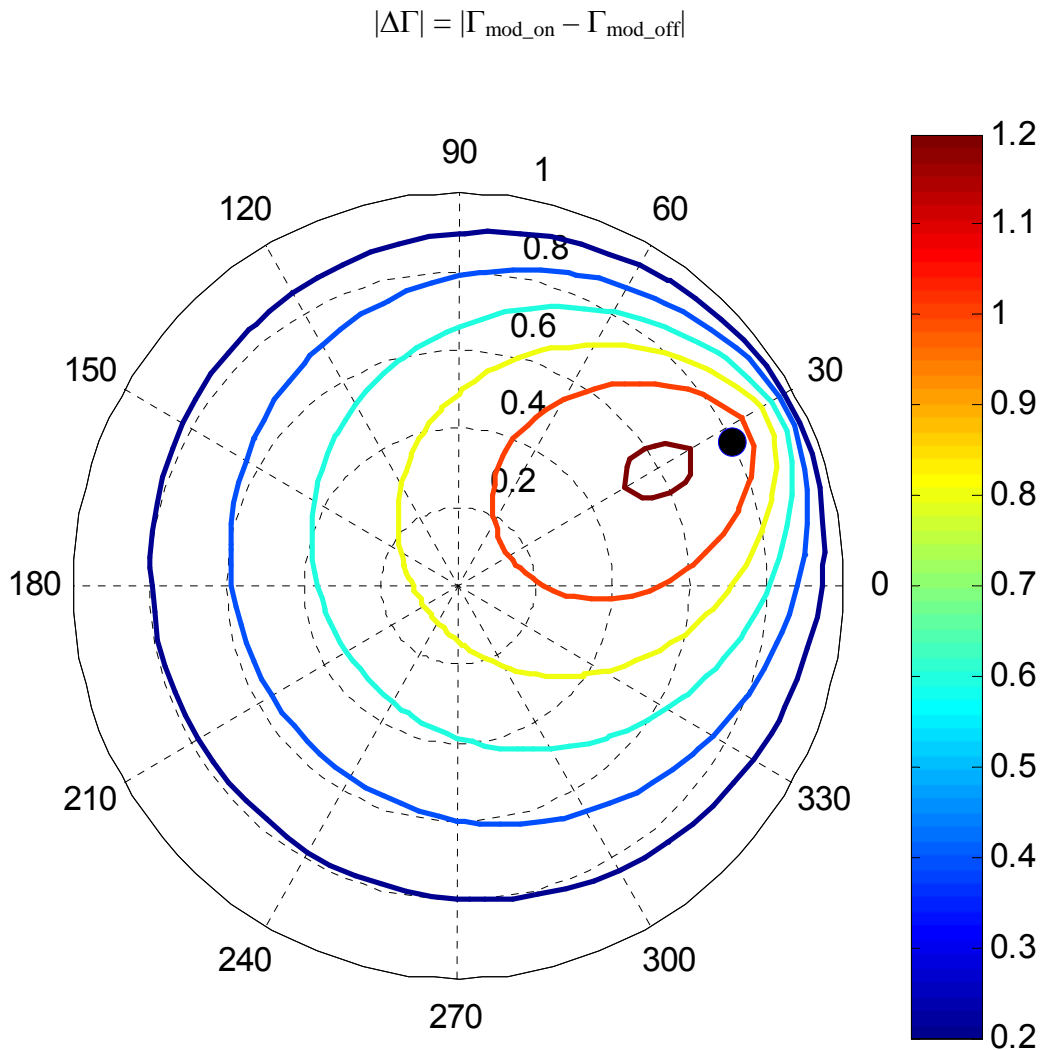


Figure 3-3 Tag reflection coefficient vs antenna impedance (total backscatter, magnitude of delta gamma)

Amplitude-modulated component of backscatter

The contours of Figure 3-4 show the change in reflection coefficient magnitudes at the antenna/chip interface for modulating (backscattering) versus non-modulating (power absorbing) states. The AM component of the backscatter relates to the power that monitoring or test equipment and other non-coherent receivers would detect. The polar plot field is the s_{11} of the tag antenna as measured from 50 ohm system. The black-filled circle shows tag antenna design target.

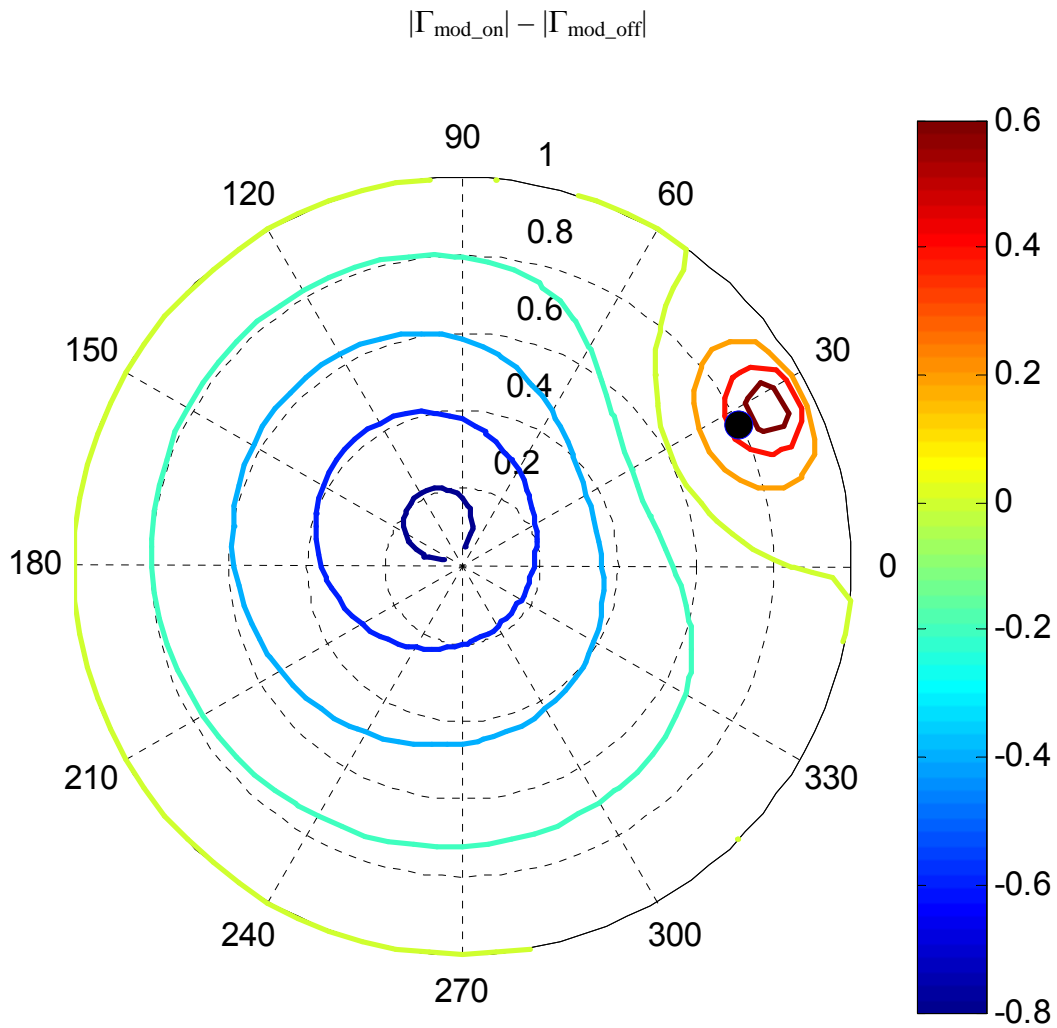


Figure 3-4 Amplitude-modulated component of backscatter

3.3 Making Connections

Impinj's patented rectifier technology (see 2.4, Power Management) is realized without the use of diodes. However, the bridge rectifier models shown in this section serve to illustrate the operating concepts, which are similar. The addition of a ground contact to this structure allows for three distinct antenna connection configurations, as follows:

- Single-ended
- Differential
- Shunt

Note that all three connection configurations use the same Monza tag silicon; there is no change to the chip, itself. These possibilities enable a tremendous amount of flexibility for the antenna designer to tailor a tag to a specific market application. For each of these configurations, Impinj recommends a target source impedance for best operation (see section 3.4). Details of the various configurations are described in the sections that follow.

3.3.1 Single-ended Connection

In this configuration, the signal is applied between one of the Monza antenna ports and ground. The single-ended connection is the generally recommended configuration, as it exhibits the most efficient operation (highest sensitivity) of the three possible configurations, particularly when both RF ports are connected in this fashion.

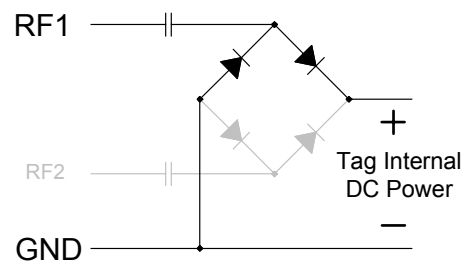


Figure 3-5 Rectifier model, single-ended configuration

The equivalent rectifier circuit for the single-ended configuration is shown in Figure 3-5, above (the portion of the circuit rendered in light gray is not electrically connected). Figure 3-6 shows an example of an antenna (Impinj Satellite™) designed for connection in this fashion.



Figure 3-6 Antenna designed for single-ended connection. Satellite antenna shown (L), with antenna trace connection detail (R). Note the diagonal pad contacts between RF1 and GND.

The single-ended configuration allows for a variety of possible chip/antenna connections, as shown in Figure 3-7, where the pad locations filled in black are those that are connected to the antenna traces. The dashed gray lines represent the electrical connections within the chip.

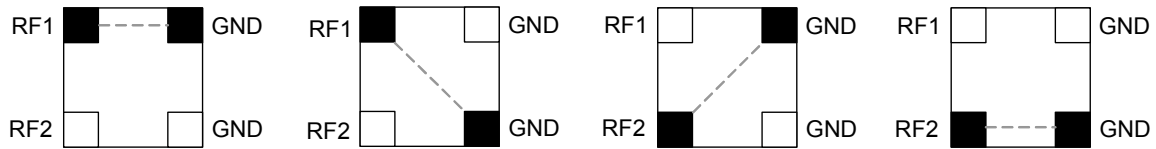


Figure 3-7 Chip/antenna connection possibilities for single-ended configuration

Note that Monza features two electrically isolated antenna (RF) ports. As such, a second antenna can be connected in the same single-ended manner, allowing, for example, the use of a dual dipole design, which provides for antenna diversity and enables greater orientation flexibility. The use of Monza’s dual antenna inputs also captures more radiated energy, which extends tag read/write range.

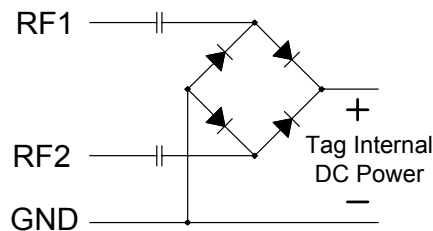


Figure 3-8 Rectifier model, dual single-ended configuration (e.g., dual dipole)



Figure 3-9 Two single-ended connections established for dual dipole antenna. Impinj Jumping Jack™ shown (L) with antenna trace detail (C) and corresponding chip/antenna connections (R).

3.3.2 Differential Connection

In this configuration, the signal is applied across the two antenna ports, with both ground pads left floating.

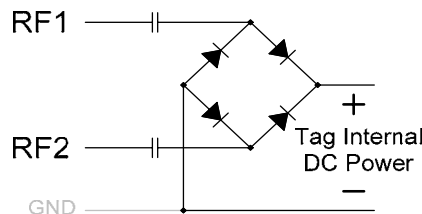


Figure 3-10 Rectifier model, differential configuration

Note that while both RF ports are connected in this configuration, it is intended for a single (dipole or loop) antenna. This arrangement represents a conventional application of a bridge rectifier, with signal applied across RF1 and RF2 (see Figure 3-10). However, the parasitic capacitance that would normally appear from RF1-to-GND and RF2-to-GND has substantially less effect in the differential configuration (RF1-to-RF2). The lower effective capacitance and higher impedance benefits antennas with higher resistivity, e.g., those manufactured using conductive ink processes; the smaller value of inductive susceptance enables a larger loop, which yields a more efficient antenna (see Figure 3-11).



Figure 3-11 Antenna designed for differential connection. Impinj Disc™ shown (L) with antenna trace detail (C) and corresponding chip/antenna connections (R)

3.3.3 Shunt Connection

In this configuration, the two RF ports are shorted together (see Figure 3-12).

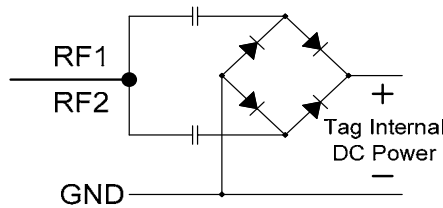


Figure 3-12 Rectifier model, shunt configuration

This scheme results in increased capacitance and greater sensitivity to low voltages, which benefits small loop and slot antennas (see Figure 3-13).



Figure 3-13 Small loop antenna (8 mm) designed for shunt connection. Impinj Button™ shown (L) with antenna trace detail (C) and corresponding chip/antenna connections (R)

3.4 Source Impedance

Table 3-2 shows the recommended antenna source impedances for Monza tag silicon across center frequencies of the primary regions of operation (North America, Europe, and Japan) for the three connection configurations.

Figure 3-14 shows the same data graphically, with -1 dB sensitivity loss contour for the single-ended configuration. While the Smith chart plots only the case of $F_c = 915$ MHz, the results of the other frequencies fall within the resolution of the recommended point shown (indicated by the triangle inside the contour boundary; for the other frequencies considered, there is negligible change in the size and shape of the contour, although there is a slight phase shift). Note that due to the nonlinear nature of the tag circuits, this antenna source impedance is *not* the complex conjugate of the tag input impedance. The recommended source impedance values were determined empirically. Note that the suggested antenna impedance design target is near the *center* of the inner contour. The resulting mismatch loss from the point of *maximum* power transfer will be negligible; more importantly, it will result in more robust tag performance overall. Note also that a compromise value can be chosen to cover all worldwide frequencies.

Table 3-2 Recommended Antenna Source Impedances

| Configuration | | Single-ended | Differential | Shunt |
|--|-----------------------------------|-----------------------|------------------------|------------------------|
| Typical Read Power Sensitivity | | -11.5 dBm | -10.2 dBm | -10.5 dBm |
| Voltage Sensitivity | | 190mV _{RMS} | 320mV _{RMS} | 180mV _{RMS} |
| Linearized Model of Tag + Mounting Capacitance | | 530 Ω 980fF | 1050 Ω 680fF | 380 Ω 1.87pF |
| Recommended Antenna Impedance at Minimum Sensitivity | 866 MHz (Europe) | 58 + j166 Ω | 66 + j254 Ω | 24 + j92 Ω |
| | 915 MHz (North America) | 52 + j158 Ω | 59 + j242 Ω | 21 + j88 Ω |
| | 956 MHz (Japan) | 48 + j153 Ω | 55 + j233 Ω | 20 + j84 Ω |

Notes to table:

1. The recommended values shown are typical. Adhesives used for mounting the chip to the antenna add capacitance beyond Monza's intrinsic capacitance (820 fF). Additional capacitance depends on adhesive properties and mounting parameters (values typically fall in the range of 150 fF to 250 fF).
2. Measurements reported herein were taken on mounted chips. As such, mounting capacitance is comprehended in these values.
3. Recommended source impedances were determined by load pull method.
4. Linearized tag model is the conjugate of the recommended source impedance, NOT the actual tag input impedance. This model is useful for calculating antenna mismatch.

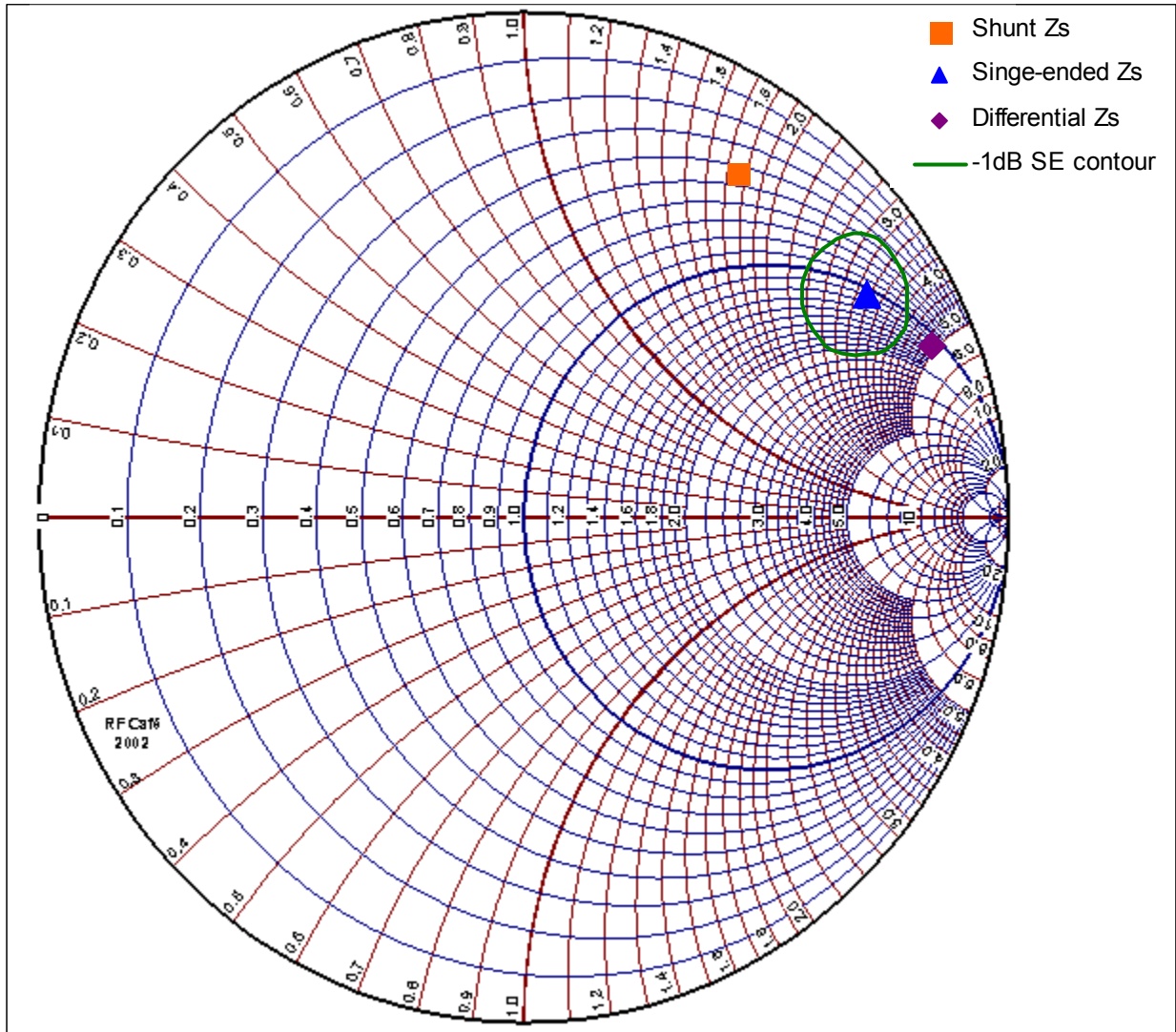


Figure 3-14 Recommended antenna source impedances for connection scenarios at 915 MHz

3.5 Reverse Link Signal Characteristics

Table 3-3 Reverse Link Signal Parameters

| Parameter | Minimum | Typical | Maximum | Units | Comments |
|---|---------|---|---------|---------------|--|
| Modulation Characteristics | | | | | |
| Modulation | | ASK | | | FET Modulator |
| Data Encoding | | Baseband FM0 or Miller Subcarrier | | | |
| Change in Modulator Reflection Coefficient $ \Delta\Gamma $ due to Modulation | | 0.8 | | | $ \Delta\Gamma = \Gamma_{\text{reflect}} - \Gamma_{\text{absorb}} $ (per read/write sensitivity, Table 3-1) |
| Duty Cycle | 45 | 50 | 55 | % | |
| Symbol Period ¹ | 1.5625 | | 25 | μs | Baseband FM0 |
| | 3.125 | | 200 | μs | Miller-modulated subcarrier |
| Miller Subcarrier Frequency ¹ | 40 | | 640 | kHz | |

Note 1. Values are nominal minimum and nominal maximum, and do not include frequency tolerance. Apply appropriate frequency tolerance to arrive at absolute durations and frequencies.

4 Tag Memory

4.1 Monza Memory Map

Figure 4-1 depicts both a physical and logical chip memory map. The memory comprises Reserved, EPC, and TID (which is ROM-based, and not user-writable) memory banks.

| MEM BANK # | MEM BANK NAME | MEM BANK BIT ADDRESS | BIT NUMBER | | | | | | | | | | | | | | | | |
|-----------------|----------------|----------------------------------|----------------------------|----|----|----|--------------|----|---|---|---|---|---|---|---|---|---|---|--|
| | | | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| 10 ₂ | TID (ROM) | 10 _h -1F _h | 0 | 0 | 0 | 1 | MODEL NUMBER | | | | | | | | | | | | |
| | | 00 _h -0F _h | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 01 ₂ | EPC (NVM) | 70 _h -7F _h | EPC[15:0] | | | | | | | | | | | | | | | | |
| | | 60 _h -6F _h | EPC[31:16] | | | | | | | | | | | | | | | | |
| | | 50 _h -5F _h | EPC[47:32] | | | | | | | | | | | | | | | | |
| | | 40 _h -4F _h | EPC[63:48] | | | | | | | | | | | | | | | | |
| | | 30 _h -3F _h | EPC[79:64] | | | | | | | | | | | | | | | | |
| | | 20 _h -2F _h | EPC[95:80] | | | | | | | | | | | | | | | | |
| | | 10 _h -1F _h | PROTOCOL-CONTROL BITS (PC) | | | | | | | | | | | | | | | | |
| | | 00 _h -0F _h | CRC-16 | | | | | | | | | | | | | | | | |
| 00 ₂ | RESERVED (NVM) | 30 _h -3F _h | ACCESS PASSWORD[15:0] | | | | | | | | | | | | | | | | |
| | | 20 _h -2F _h | ACCESS PASSWORD[31:16] | | | | | | | | | | | | | | | | |
| | | 10 _h -1F _h | KILL PASSWORD[15:0] | | | | | | | | | | | | | | | | |
| | | 00 _h -0F _h | KILL PASSWORD[31:16] | | | | | | | | | | | | | | | | |

Figure 4-1 Physical/Logical Memory Map

4.2 Logical vs. Physical Bit Identification

For purposes of distinguishing most significant from least significant bits, a logical representation is used in this datasheet where MSBs correspond to large bit numbers and LSBs to small bit numbers. For example, Bit 15 is the logical MSB of a memory row in the memory map. Bit 0 is the LSB. A multi-bit word represented by WORD[N:0] is interpreted as MSB first when read from left to right. This convention should not be confused with the physical bit address indicated by the rows and column addresses in the memory map; the physical bit address describes the addressing used to access the memory.

4.3 Memory Banks

Described in the following sections are the contents of the NVM and ROM memory, and the parameters for their associated bit settings.

4.3.1 Reserved Memory

Reserved Memory contains the *Access* and *Kill* passwords.

4.3.2 Passwords

1. Monza tags have a 32-bit Access Password and 32-bit Kill Password.
2. The default password for both Kill and Access is 00000000_h.

4.3.3 Access Password

The Access Password is a 32-bit value stored in Reserved Memory 20_h to 3F_h MSB first. The default value is all zeroes. Tags with a non-zero Access Password will require a reader to issue this password before transitioning to the secured state. A tag that does not implement an Access Password acts as though it had a zero-valued Access Password that is permanently read/write locked.

4.3.4 Kill Password

The Kill Password is a 32-bit value stored in Reserve Memory 00_h to 1F_h, MSB first. The default value is all zeroes. A reader shall use a tag's kill password once to kill the tag and render it silent thereafter. A tag will not execute a kill operation if its Kill Password is all zeroes. A tag that does not implement a Kill Password acts as though it had a zero-valued Kill Password that is permanently read/write locked.

4.3.5 Tag Identification (TID) Memory

The ROM-based Tag Identification memory contains Impinj-specific data. The Impinj MDID (Manufacturer Identifier) is 000000000001 (shown in Figure 4-1 as the lighter grey-shaded bits across both TID memory map rows). The Monza model number is shown in Figure 4-1 as the darker grey-shaded bits in TID memory row 10_h-1F_h. The non-shaded bit locations in TID row 00_h-0F_h store the EPCglobal™ Class ID (0xE2).

4.3.6 EPC Memory

EPC memory contains the 16 protocol-control bits (PC) at memory addresses 10_h to 1F_h, a CRC16 at memory addresses 00_h to 0F_h, and an EPC value beginning at address 20_h. A reader accesses EPC memory by setting MemBank = 01₂ in the appropriate command, and providing a memory address using the extensible-bit-vector (EBV) format. The PC, CRC16, and EPC are stored MSB first (i.e., the EPC's MSB is stored in location 20_h).

The EPC written at time of manufacture is as follows:

| Impinj Part Number | 96-Bit EPC Value Preprogrammed at Manufacture (hex) |
|--------------------|---|
| IPJ_W_R_(A or C) | 300833b2ddd901400000000 |

5 Absolute Maximum Ratings

Stresses beyond those listed in this section may cause permanent damage to the tag. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this datasheet is not guaranteed or implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

5.1 Temperature

Several different temperature ranges will apply over unique operating and survival conditions. Table 5-1 lists the ranges that will be referred to in this specification. Tag functional and performance requirements are met over the operating range, unless otherwise specified.

Table 5-1 Temperature parameters

| Parameter | Minimum | Typical | Maximum | Units | Comments |
|--------------------------------|---------|---------|---------|----------|---|
| Extended Operating Temperature | -40 | | +65 | °C | Default range for all functional and performance requirements |
| Storage Temperature | -40 | | +85 | °C | |
| Assembly Survival Temperature | | | +150 | °C | Applied for one minute |
| Temperature Rate of Change | | | 4 | °C / sec | During operation |

5.2 Input Damage Levels

The tag is guaranteed to survive the inputs specified in Table 5-2.

Table 5-2 ESD and input limits

| Parameter | Minimum | Typical | Maximum | Units | Comments |
|--|---------|---------|-----------------|-------|--|
| ESD | | | 2,000 | V | HBM (Human Body Model) |
| Reader antenna power with tag sitting on antenna | | | 36 ¹ | dBm | Tag has 10 cm half-wave dipole antenna |
| DC input voltage | | | ± 3.5 | volts | Applied across two pads |
| DC input current | | | ± 0.5 | mA | Into any input pad |

Note 1. Assumes tag has half-wave dipole antenna. While maximum radiated reader power is +36 dBm for both Read and Write operations, the maximum power the tag should receive is +20 dBm (see Table 3-1).

5.3 NVM Use Model

Tag memory will endure 100,000 write cycles and 50-year data retention.

6 Ordering Information

| Part Number | Form | Product | Processing Flow |
|-------------|-------|---------|---|
| IPJ_W_C_A | Wafer | Monza | Raw: non-bumped, non-thinned |
| IPJ_W_C_C | Wafer | Monza | Bumped, thinned (to 6 mils, or ~150 μm), and sawn |

Notices:

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