



Application Note

IMPINJ MONZA 5 TO MONZA R6-P TRANSITION GUIDELINES AND BENEFITS

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1 INTRODUCTION

Impinj will stop production of the Impinj Monza® 5 RAIN™ RFID endpoint IC on December 31, 2020. This decision is intended to better match the supply of Impinj Monza 5 ICs with the natural drop in demand for a product that has been in the market since 2011, as most Monza 5 customers have moved to the more advanced Monza R6-P tag chip.

For the needs of most Impinj Monza 5 customers, Impinj recommends converting existing solutions with Monza 5 tags to Monza R6-P tags, which boast a richer feature set for those applications. There are some exceptions in which the end user may gain more value from a different Impinj Monza 6 family endpoint IC, but for most scenarios, Monza R6-P is the best replacement option for Monza 5.

Impinj Monza 6 family chips deliver enhanced features, better read sensitivity and other performance improvements over the Monza 5. They are also mutually RF compatible; Impinj Monza 6 tag chips can be used on any of the tag antenna designs in the reference design library, providing current Monza 5 users multiple options for replacement tags in their applications.

This application note is a technical guide outlining the considerations for end users transitioning from Impinj Monza 5 to Monza R6-P. End customers should work closely with the inlay manufacturers to determine the best strategy for transitioning from Impinj Monza 5 tags to Monza R6-P tags.

1.1 Reference Documents

Impinj Monza 5 Tag Chip Datasheet (<https://support.impinj.com/hc/en-us/articles/202756948-Monza-5-Tag-Chip-Datasheet>).

Impinj Monza R6-P Tag Chip Monza R6-P Product Brief / Datasheet (<https://support.impinj.com/hc/en-us/articles/204793258-Monza-R6-P-Product-Brief-Datasheet>).

Impinj Monza 5 Wafer Specification (<https://support.impinj.com/hc/en-us/articles/202756708-Monza-5-Wafer-Specification>).

Impinj Monza R6-A/B/P Wafer Specification (<https://support.impinj.com/hc/en-us/articles/360000719819-Monza-R6-A-B-P-Wafer-Specification>).

Process Guideline: Fast Curing Die Attach Process for RFID Assembly Machines, DELO/Impinj/Muehlbauer (Available on request. Contact support@impinj.com).

2 IMPINJ MONZA R6-P COMPARISON TO MONZA 5

The Impinj Monza R6-P tag chip is part of the sixth generation of Monza endpoint technology. The Impinj Monza 6 tag chip family has superior read sensitivity to Monza 5 as well as built-in advanced features that improve IC functionality, performance, and quality. Impinj Monza 6 family tag chips vary in their specifications and features to best match the needs of users. For most Impinj Monza 5 users, Monza R6-P is the best replacement tag chip option because it can match the data and memory specifications of Monza 5. Table 2-1 is a feature and performance comparison between Impinj Monza R6-P and Monza 5. For an additional comparison between Impinj Monza R6-P and other Monza 6 family tag chips, see the *Impinj Monza R6-P Product Brief* referenced in section 1.1.

Table 2-1 Comparison Between Impinj Monza R6-P and Monza 5

FEATURE	IMPINJ MONZA 5	IMPINJ MONZA R6-P
EPC	128 bits	96 or 128 bits*
User Memory	32 bits	64 or 32 bits*
Read Sensitivity	-20 dBm	-22.1 dBm
Write Sensitivity	-16 dBm	-17.3 dBm
Write Speed	3.4 ms per 32 bits	1.6 ms per 32 bits
UMI Bit Setting	0	1
Bonding Pads	Bumps (Ni / Au)	Enduro™ (Ti / NiV / Cu)
Access Password	Yes	Yes
Kill Password	Yes	Yes
Short-Range Mode	No	Yes
AutoTune™ RF Tuning	No	Yes
Integra™ Memory Diagnostics	No	Yes
TagFocus™ Mode	Yes	Yes
FastID™ Mode	Yes	Yes
R _p Port Parameter	1.8 kΩ	1.2 kΩ
C _p + C _{mount} Port Parameter	1.07 pF	1.44 pF
Pre-Serialization (EPC)	No	Yes
Self-Serialization (TID)	Yes	Yes
Diced Physical Size	464 μm x 464 μm	442 μm x 464 μm
Wafer Size	200 mm	200 mm
Packaged IC Option	No	Yes

* Max User Memory Profile or Default Memory Profile; see Section 2.1.1

2.1 EPC and User Memory

Like the Impinj Monza 5, Monza R6-P can hold a 128-bit EPC and 32 bits of User Memory in its default memory profile. Impinj Monza R6-P can support all EPC encoding standards requiring up to 128 bits of EPC memory and 32 bits of User Memory. This includes encoding standards using the Application Family Identifier (AFI) bits, in the Protocol Control bits (EPC word 1).

2.1.1 Max User Memory Mode

Unlike Impinj Monza 5, Monza R6-P has the additional option of a “max user memory mode”. This will transform 32 bits of the Impinj Monza R6-P’s EPC data space into added User Memory space if desired, for a 96-bit EPC and 64 bits of User Memory.

2.1.2 User Memory Indicator (UMI) Bit

Impinj Monza R6-P is configured in accordance with the latest version of the Gen2 specification, which requires that its User Memory Indicator (UMI) bit be set to 1 (default EPC word: 3400_h) to indicate the presence of User Memory.

Impinj Monza 5 was designed in accordance with a previous version of the Gen2 specification in which implementing the user memory bit was *optional*, which is why its UMI bit setting is 0 (default EPC word: 3000_h).

Modern encoding systems are typically designed to encode tags regardless of the User Memory Indicator (UMI) bit value found in the protocol control word. Still, some encoding systems are unable to properly process tag chips with a UMI bit set to 1. These systems are out of date and should be upgraded in order to handle current generation tags, designed to comply with the latest version of the Gen2 specification.

End users who are transitioning from Impinj Monza 5 should consult their tag encoding partners to determine whether their system can handle tag chips with a UMI bit setting of 1. If not, we recommend updating the encoding system to one which can handle both UMI bit settings. Contact Impinj customer support (support.impinj.com) if you are concerned about the UMI bit configuration.

2.2 Performance Overview

Like other Impinj Monza 6 family tags, Monza R6-P has improved tag sensitivity over Monza 5. The read sensitivity of the Impinj Monza R6-P is -22.1 dBm, as opposed to -20 dBm for Monza 5. The write sensitivity of the Impinj Monza R6-P is -17.3 dBm as opposed to -16 dBm for Monza 5. (Note: A lower tag sensitivity is better.) Furthermore, Impinj Monza R6-P has double the write speed over Monza 5.

Better tag sensitivity means that the user can read Impinj Monza R6-P tags at a lower power, or at a greater distance. It also means that Impinj Monza R6-P can potentially maintain performance with a smaller form factor tag.

2.3 Endpoint Features

Impinj Monza R6-P can implement all the endpoint features of Monza 5, including Access/Kill passwords, TagFocus, FastID and TID self-serialization. Impinj Monza R6-P can also implement several additional features unavailable in Monza 5, listed below:

- **Short-Range Mode:** Option that reduces the IC’s read range to less than 1/10 of its normal range to enhance privacy
- **AutoTune™ RF Tuning:** Allows Impinj Monza R6-P inlays to maintain higher performance on a greater range of tagged items and materials
- **EPC Pre-Serialization:** Impinj Monza R6-P ICs ship from the factory with a unique pre-serialized EPC value based on the unique TID (Tag Identifier). This enables additional verification downstream, known as pre-serialization verification. In some use cases, the pre-serialized EPC can eliminate the need for subsequent EPC encoding.
- **Integra™ Memory Diagnostics:** A suite of memory integrity technologies to check for tag damage and ensure tag quality

- **TID Parity Check** validates tags against bit flips, such as those that may be caused by physical damage to the tag chip
- **MarginRead** verifies that the memory is strongly written and tests for data retention issues
- **Memory Self-Check** automatically tests memory integrity whenever the tag inventoried. If the test does not pass, the tag responds with a zero-length EPC to prevent invalid data from being sent to the reader.

2.4 Physical Specifications

While the wafer dimensions are the same size (200mm), the Impinj Monza R6-P die is slightly smaller than Monza 5. Impinj Monza R6-P is also offered in a packaged IC option for PCB surface mount assembly if desired, unlike Monza 5.

Impinj Monza R6-P comes with Enduro™ bonding pads, which make inlay manufacturing less sensitive to die-attach pressures. Enduro pads cover the underlying circuit area with a consistent parasitic mounting capacitance that eliminates die positioning mounting capacitance variability. This increases consistency in tag manufacturing, improving inlay quality and yield.

Figure 1 details the Impinj Monza 5 tag chip with bumped attach points. Figure 2 details the Impinj Monza R6-P tag chip with Enduro bonding pads.

Figure 1: Impinj Monza 5 Dimensions (µm)

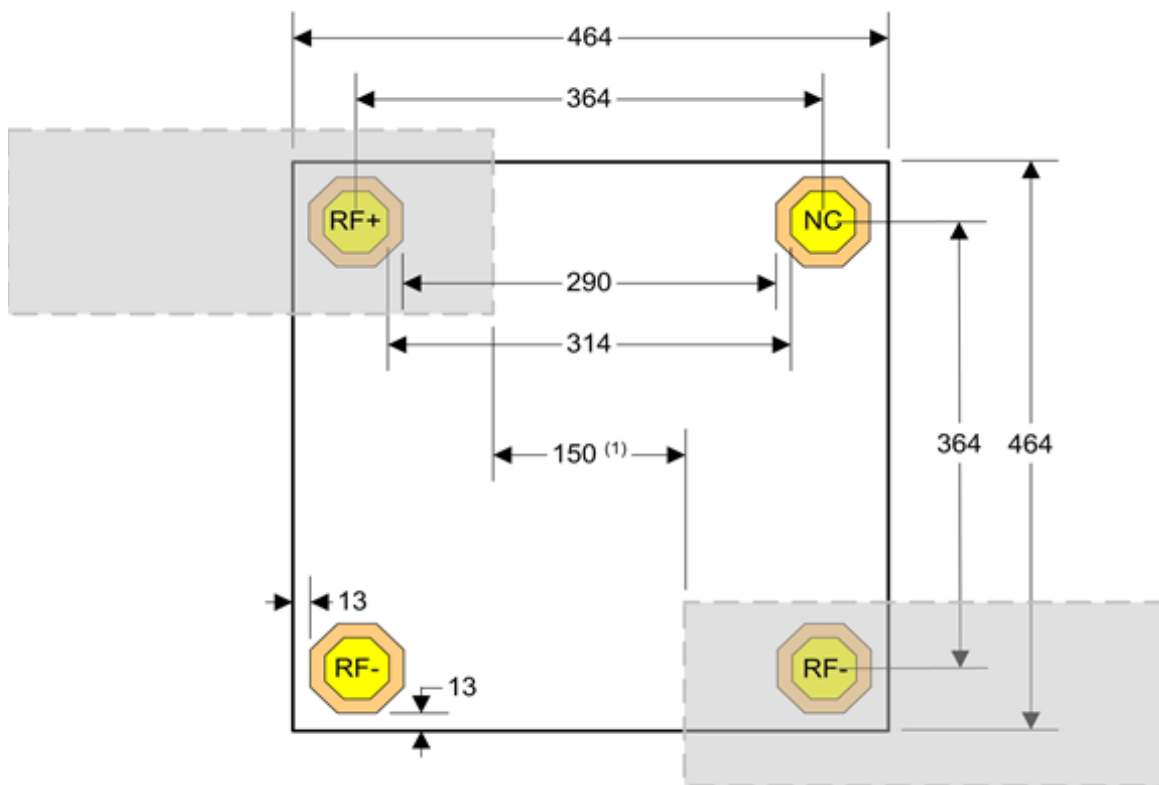
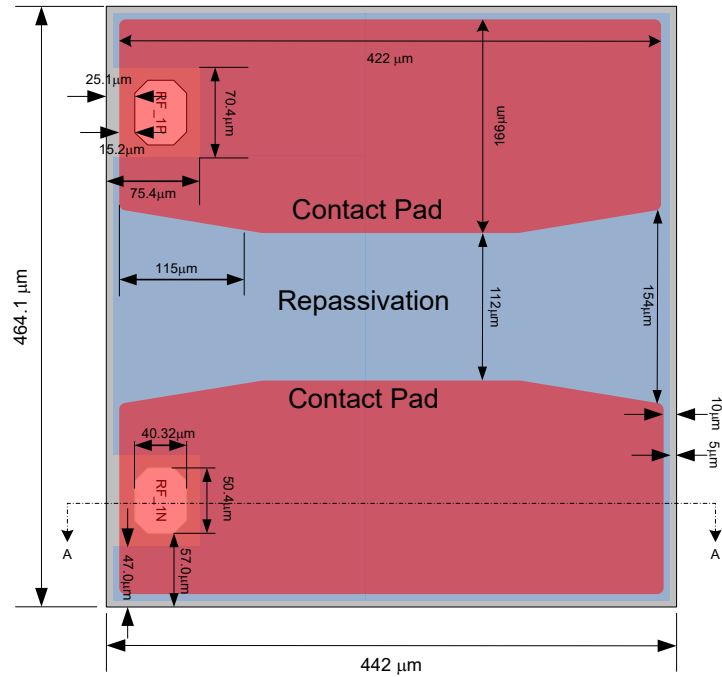


Figure 2: Impinj Monza R6-P Dimensions (with Enduro pads)



3 ANTENNA DESIGN CONSIDERATIONS

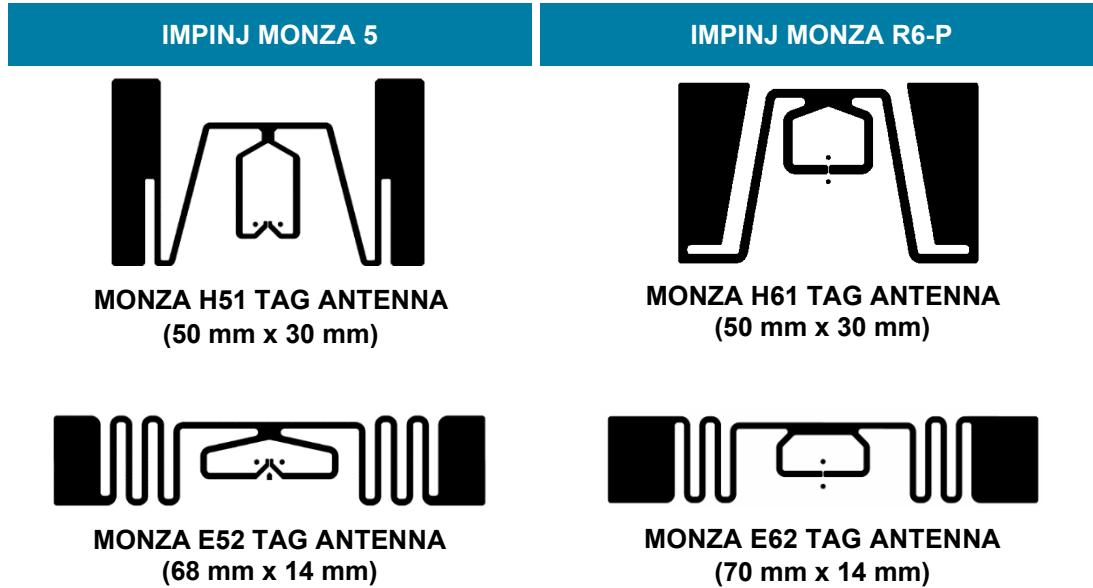
Impinj Monza R6-P is compatible with a larger selection of tag antenna designs, so end users will generally be able to find applicable tags for their use case. End users transitioning from Impinj Monza 5 should consult their inlay partner to see if there is a comparable Monza R6-P tag that they can use for their use case. If not, the following section outlines key technical differences between Impinj Monza 5 and Monza R6-P to help determine if a new antenna design is required.

3.1 Tag Antenna Reference Design Transition

Most Impinj Monza 5 tag antenna reference designs have Monza R6-P equivalents. Impinj Monza R6-P reference designs are available for all common inlay sizes (e.g., 70 mm, 50 mm). Several reference designs are also available in uncommon sizes or for specific applications.

Table 3-1 shows example reference designs for two very common form factors. Numerous reference designs are available at the Impinj support portal¹ with a signed antenna agreement, including the completed documentation for the examples below. Contact Impinj customer support (support.impinj.com) if you require further assistance in migrating to an Impinj Monza R6-P inlay design.

Table 3-1 Impinj Monza 5 and Monza R6-P Reference Design Examples



3.2 Impedance Difference

The impedance model has not changed from Impinj Monza 5 to Monza R6-P. However, the values are different (shown in Table 3-2), so the tag antenna must be optimized differently. Some of the differences are described here.

Table 3-2 Impinj Monza 5 and Monza R6-P Impedance Values

IMPINJ MONZA 5		IMPINJ MONZA R6-P	
$C_p + C_{mount}$	1.07 pF	$C_p + C_{mount}$	1.44 pF
R_p	1.8 k Ω	R_p	1.2 k Ω

3.2.1 R_p Difference

The chip resistance (R_p) caused by energy absorption and conversion at the RF circuits is lower for Impinj Monza R6-P than Monza 5. The lower R_p value typically means higher coupling should be used to optimally match the antenna impedance. This also improves backscatter signal strength.

3.2.2 C_p Difference

The intrinsic chip capacitance (C_p) is higher for Impinj Monza R6-P than Monza 5. The higher C_p value means a lower inductance value is required to tune the antenna towards the same resonant frequency. The lower inductance leads to a smaller inductor loop for Impinj Monza R6-P tag antennas compared to Monza 5.

3.3 AutoTune™ RF Tuning

Impinj Monza 6 family chips have the AutoTune adaptive tuning feature. AutoTune enables chips to automatically adjust their C_p values to determine the optimum capacitance for the target application. Tag

antennas designed with Impinj Monza R6-P will perform well on a wider variety of materials compared to Monza 5 tag antennas of the same size.

3.4 Improved Sensitivity

Impinj Monza R6-P has improved forward link sensitivity over Monza 5. An antenna built with Impinj Monza R6-P should result in greater overall tag sensitivity and increased read range over a Monza 5 design of the same size.

3.5 Impinj Monza R6-P Assembly Benefits Over Monza 5

Impinj Monza R6-P has numerous assembly benefits for inlay manufacturing over Monza 5. It enables higher speed assembly, lower manufacturing variability, and more durable inlays.

The large contact area of Impinj Monza R6-P Enduro pads ensures that the typical inlay assembly process disperses its pressure over a wide surface on the die. This design provides a better spread of anisotropic conductive paste (ACP) when attaching the die to an antenna, requiring less ACP and reducing assembly cost. The flat Enduro pad design is more mechanically robust and less likely to crack when stressed in printing, assembly, and converting machines. The larger surface area of the Enduro pads also creates a more stable connection to the antenna and reduces the potential for degradation from environmental factors like humidity.

By contrast, Impinj Monza 5 concentrates that same pressure on four small bump surfaces, narrowing the spread of ACP and creating focal points for pressure where mechanical processes could potentially damage the die. As a result, Impinj Monza R6-P consistently boasts a better (i.e. lower) contact resistance connection on average and greatly reduced variation. In addition to its superior assembly tolerances, Impinj Monza R6-P can also achieve the highest assembly rates possible today as the Enduro pads are compatible with a fast-curing ACP (see Section 3.6).

In summary, the manufacturability benefits of Impinj Monza R6-P over Monza 5 are as follows:

- Higher assembly rates
 - Enduro pads are compatible with fast-curing ACP
 - Improved assembly tolerances
- Better low-resistance connection
- Reduced assembly variability due to Enduro pad design, leading to more consistent performance
- Better reliability with increased contact area, supported by temperature-humidity tests (THT) and other reliability testing
- Greater durability to handle mechanical stressors, such as high-tension rollers and cusp print heads

Table 3-3 Impinj Monza 5 and Monza R6-P Assembly Quality Assurance Testing

ASSEMBLY TESTS	IMPINJ MONZA 5	IMPINJ MONZA R6-P	COMPARISON
Contact Resistance	GOOD	EXCELLENT	2-3 times lower for Enduro
Sheer	EXCELLENT	EXCELLENT	Comparable performance
Temperature-Humidity Test (THT)	GOOD	EXCELLENT	NO fails with Enduro
Temperature-Cycling Test (TCT)	GOOD	EXCELLENT	NO fails with Enduro
Bend	EXCELLENT	EXCELLENT	Comparable performance
Printer Test (24,000 TESTS)	GOOD	EXCELLENT	NO fails with Enduro

For more information on the assembly benefits of Enduro-based inlays, refer to the Enduro Technology White Paper on the Impinj Support website².

3.6 Impinj Monza R6-P Assembly Support

Impinj Monza R6-P is supported by the leading inlay manufacturing machines in the industry, with multiple assembly recipes available.

Muehlbauer-owned manufacturing recipes can apply the most commonly used ACPs to Impinj Monza R6-P, including DELO AC268. The copper-based Impinj Monza R6-P chips are also compatible with the DELO MONOPOX AC6545, a fast-curing ACP that can facilitate the highest possible assembly rates. Using DELO MONOPOX AC6545, the Muehlbauer Direct Die Attach (DDA) machine can assemble upwards of 40,000 units per hour (UPH) of Impinj Monza R6-P-based inlays.

4 EXTERNAL REFERENCES

¹ Support Link: *Impinj Monza Reference Design Documents & Downloads* (<https://support.impinj.com/hc/en-us/sections/200454558-Monza-Reference-Design-Documents-Downloads>) – Note: These documents are restricted and require access permission from Impinj.

² Support Link: *Enduro Technology White Paper* (<https://support.impinj.com/hc/en-us/articles/202334166-Enduro-Technology-White-Paper>)

5 NOTICES

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