Overview

The Speedway™ reader, a key element of Impinj’s GrandPrix™ RFID system solution, is the first high-performance reader designed from the ground up (not merely upgraded) to support the EPCglobal Gen 2 standard in its entirety. That includes the horsepower to accommodate 640 kbps tag-to-reader data rates, robust performance in dense-reader environments, the flexibility to read at the case, pallet, or item level, and more. Combined with an extensible architecture that supports seamless integration of field-upgradeable, third party application software, the Speedway reader is the most adaptable reader solution available today.

Speedway’s unparalleled flexibility is essential to fully exploit the power of the Gen 2 protocol, which allows an unlimited number of reader transmit and receive modes, each of which might generate a different combination of unique reader-to-tag command rate, tag-to-reader backscatter rate, modulation format, and backscatter type. What’s more, the Gen 2 protocol allows a range of settable parameters (such as the choice of inventory round management parameters) that have an equally strong impact on throughput and overall reader performance. Speedway automatically self-configures all of these parameters for optimal performance, cutting through the technical details and delivering unsurpassed tag inventory rate and reliability. Speedway also senses the presence of other readers within range and self-configures to maintain the performance level of the overall reader network, reducing its impact on neighboring readers. It does all of this without requiring cumbersome network synchronization.

Finally, the ease and convenience of Speedway’s duplexed single-antenna operation no longer means compromising on performance; Speedway’s high-performance noise-canceling design effectively renders cumbersome dual-antenna systems (with separate transmit and receive antennas at each port) obsolete.

It all adds up to RFID that just works™
Speedway provides a platform for seamless integration with third-party application software. Speedway provides the radio performance you need, then allows you to choose the application software you want, providing an RFID solution that supports a wide range of end-user requirements. Speedway is delivered with the Linux operating system, and is configured with the powerful Speedway modem API. To ensure that your system can grow with increasing demands, Speedway’s software architecture supports remote software/firmware upgrade, self-test, and measurable performance metrics. Three essential elements of the Speedway reader’s software suite include:

**Modem API:** Speedway’s onboard API provides a flexible modem interface for third-party application software to leverage all of the features of the Gen 2 protocol, including read, write, lock, and kill with low command latency.

**End Users:** Although the Speedway API is transparent to end users who interact with the third-party application software that runs on the API, these same end users can rest assured that it leverages all of Impinj’s deep expertise with Gen 2. Simply put, the Speedway API allows end users to harness the power of Gen 2.

**Application Software Developers:** The Speedway API’s functionality allows not only the ability to inventory tags, but also to access and read, write, lock, and kill them. Importantly, it deals effectively with the latency issues associated with these Gen 2 functions.

**Operating System with SDK:** The Speedway reader’s operating system is Montavista Linux (Kernel 2.4), bundled with a software development kit (SDK) that includes:

- Drivers and setup for all peripherals and network, serial, and GPIO interfaces
- Firmware upgrade agent via TCP/IP
- Reader self-test and diagnostics
- NTP support
- SNMP v2 with MIB2
- Speedway-specific MIB

**Application Software:** Speedway can be configured with custom end-user application software, or with software developed by Impinj’s application software partners to yield a powerful enterprise system. The functionality that typically resides with the application software includes:

- Real-time tag data filtering and smoothing, including time-stamping when tags enter or exit the field
- Tag data buffering and reporting in a format selected by the end user
- Real-time, ruled-based tag processing that allows autonomous tag access operations (read, write, lock, kill) on matching tags without requiring network data exchange
- On-board diagnostics that identify and report reader alarms or failures (these functions are in addition to reader management data available via the SNMP interface)
- Event triggering and trigger management via multiple GPIO interfaces

To ensure maximum performance, Speedway incorporates two processors—one dedicated to modem functions and the second to run the application software. Speedway’s dual-processor architecture ensures that third-party application and network interfacing does not impact time-critical modem operations, and vice versa.

The application processor is a 266 MHz Intel IXP420, configured as follows:

- 64 Mbyte SDRAM operating at 133 MHz
- 64 Mbyte Flash memory
- 8-bit parallel interface to the modem processor
- Real-time clock
**Interfaces**

Speedway includes a full array of network, service, and general-purpose control interfaces, including:

- **Network Communications:**
  - 10/100BASE-T Ethernet (RJ45 connector)
  - Configurable to use fixed IP address or DHCP
  - An optional 802.11B module can be installed at time of manufacture

- **Management / Service:**
  - RS-232 for local login (DB9 connector)
  - Built-in HTTP web server
  - Usage indicators including LEDs for power, antenna selection, and status

- **Trigger / Control Actuator Management:**
  - RS-232 interface to control external devices (DB25 connector)
  - 4 input and 8 output GPIOs to sense external triggers and control actuators (DB25 connector)

**Antennas**

Speedway has four antenna ports, each of which uses a single, duplexed antenna (i.e., a single antenna for transmit and receive) per port.

- **Connectors:** Reverse-gender TNC
- **Protection:** No damage from open or short
- **Port Termination:** Not required

**Power**

Speedway uses an external power converter to convert 110–250V AC to DC power:

- **Reader power interface:** 12–36 V DC input
- **Power connector:** Positive locking type

**Physical Dimensions & Environmental**

Speedway is designed to operate continuously in industrial environments.

- **Dimensions:** 22.7 × 32.4 × 5.7 cm (8.95 in × 12.75 in × 2.25 in)
- **Weight:** 2.7 kg (6 lbs)
- **Mounting:** Horizontal or vertical orientation, with mounting tabs
- **Environmental:**
  - Operating temperature: −20 to 55 °C
  - Storage temperature: −20 to 85 °C
  - Environmental sealing: Per IEC 529 IP54
  - Humidity: 5-95% relative, non-condensing
Speedway™ Reader Architecture

Per the plots shown below, Speedway’s outstanding frequency domain performance (left) comes without compromise to its time-domain performance (right).
# Speedway Reader Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transmit</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LO and tuning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tuning range</td>
<td>902</td>
<td>928</td>
<td>MHz</td>
<td>FCC 15.247</td>
<td>Tuning range 902-928 MHz for FCC 15.247</td>
</tr>
<tr>
<td>Tuning step size</td>
<td>250</td>
<td>500</td>
<td>kHz</td>
<td>Self-configuring</td>
<td>Tuning step size 250-500 kHz</td>
</tr>
<tr>
<td>Tuning frequency accuracy</td>
<td>−10</td>
<td>10</td>
<td>ppm</td>
<td></td>
<td>Tuning frequency accuracy with ±10 ppm accuracy.</td>
</tr>
<tr>
<td>RF Power</td>
<td>30</td>
<td>dBm</td>
<td></td>
<td></td>
<td>RF Power measured at antenna connector</td>
</tr>
<tr>
<td>Attenuation range</td>
<td>0</td>
<td>15</td>
<td>dB</td>
<td></td>
<td>Attenuation range 0-15 dB</td>
</tr>
<tr>
<td>Attenuation step size</td>
<td>0.25</td>
<td>dB</td>
<td></td>
<td></td>
<td>Attenuation step size 0.25 dB</td>
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<tr>
<td>Modulation depth</td>
<td>80</td>
<td>100</td>
<td>%</td>
<td></td>
<td>Modulation depth 80-100%</td>
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<tr>
<td><strong>Receive</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receive sensitivity</td>
<td>−77</td>
<td>dBm</td>
<td>160 kbps FM0, BER=10⁻³</td>
<td>Receive sensitivity −77 dBm for 160 kbps FM0, BER=10⁻³</td>
<td></td>
</tr>
<tr>
<td>Input power</td>
<td>30</td>
<td>dBm</td>
<td></td>
<td></td>
<td>Input power measured at antenna connector</td>
</tr>
<tr>
<td>Reader spacing</td>
<td>3</td>
<td>m</td>
<td></td>
<td></td>
<td>Reader spacing 3 m Boresight-to-boresight (note a)</td>
</tr>
<tr>
<td><strong>Physical parameters</strong></td>
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<td></td>
<td></td>
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<tr>
<td>Supply voltage</td>
<td>12</td>
<td>24</td>
<td>36</td>
<td>VDC</td>
<td>Supply voltage 12-24-36 VDC via external power converter</td>
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<tr>
<td>Power consumption</td>
<td>25</td>
<td>W</td>
<td></td>
<td></td>
<td>Power consumption 25 W</td>
</tr>
<tr>
<td>Boot time</td>
<td>50</td>
<td>s</td>
<td></td>
<td></td>
<td>Boot time 50 s Boot-up at 23 °C</td>
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<tr>
<td><strong>Survivability</strong></td>
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<td></td>
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<tr>
<td>ESD protection</td>
<td>4</td>
<td>kV</td>
<td></td>
<td>HBM, any input</td>
<td>ESD protection 4 kV HBM, any input</td>
</tr>
<tr>
<td>Forced DC voltage</td>
<td>−5</td>
<td>+5</td>
<td>V</td>
<td>Any RF port</td>
<td>Forced DC voltage −5-5 V for any RF port</td>
</tr>
<tr>
<td>Forced DC current</td>
<td>50</td>
<td>mA</td>
<td></td>
<td>Any pin; DC source must observe forced DC voltage limits</td>
<td>Forced DC current 50 mA for any pin; DC source must observe forced DC voltage limits</td>
</tr>
</tbody>
</table>

a. This parameter is specified for Gen 2 dense-interrogator operation only. Usable reader spacing may be limited by tag demodulator desensitization rather than by reader sensitivity or adjacent-channel interference rejection.
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