# MOJIX STAR

# User Manual

## MOJIX Corporation

## Space-Time-Array Reader


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# Table of Contents

# 1. Overview

The origin of Mojix's technology lies in deep space communication theory. By utilizing time, frequency *and* space dimensions in processing the received signal from the RFID tag, Mojix technology provides more than a 30dB increase in link budget when compared to existing RFID readers. The result is far greater accuracy in read reliability and up to 10 times improvement in read/write range. With this breakthrough radio performance, the Mojix STAR-1000 can be configured to achieve any degree of location accuracy for each RFID tag located in the *coverage* area.

In addition to the fundamental breakthrough in digital packet radio design and performance, the Mojix STAR-1000 platform has the ability to offer consistent read rates for nearly all types of goods using advanced signal processing techniques. The STAR-1000 can utilize Mojix's Channel Codes (MCC) which is an algorithm used to ensure and recover tag integrity. MCC solves the problem of reading tags impeded in line-of-sight from the receive antenna by neighboring objects, such as reading cases in the middle of a densely packed pallet. MCC seamlessly and reliably solves the problem of pallet integrity or electronic proof-of-delivery (ePOD). This encoding scheme is ameans by which each case on a pallet is tagged and uniquely identified and in the event that some set of those tags fail or are manipulated, then MCC provides a mechanism to re-build the tag code content.

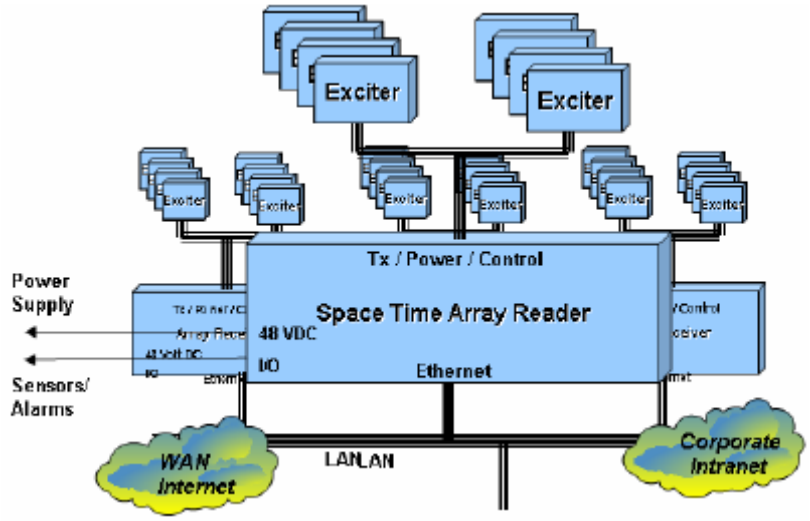



Figure 1

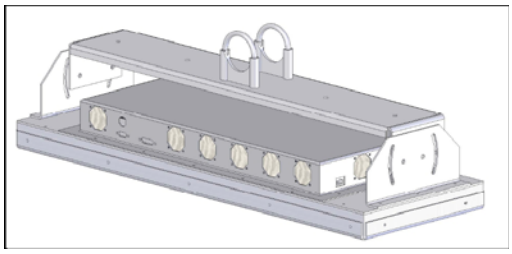
The Mojix family of products can be configured to transmit and receive across the UHF band [902 MHz to 928 MHz] and can operate in both the near and far fields which makes it possible for a single system to read tags at the pallet, carton or item level. The UHF, or ISM band as it is commonly referred to, is partially allocated for public use and is heavily utilized by many different devices and applications which makes operating in this spectrum especially challenging. Mojix provides both 'interference nulling' and 'interference excision' Interference nulling mitigates the interference in the space dimension by minimizing the impinging energy from

the unwanted direction of arrival of the interferer. Interference excision identifies the waveform class of the interferer and cancels the interference in frequency and time domain in the signal processing chain of the received signal.

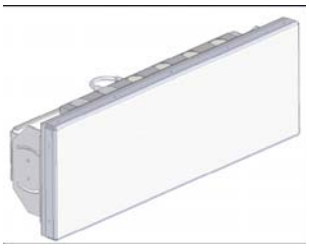
# 2. Air Interface Assembly

The AIA is powered directly by the 48 VDC power supply and the AIA in turn powers each Exciter. Each exciter is connected to the AIA by RJ-50 cable, commonly used in cable TV, and receives supply voltage, command and control signals, and baseband RF over this medium. The AIA is typically connected to the enterprise via the LAN or an optional WLAN.

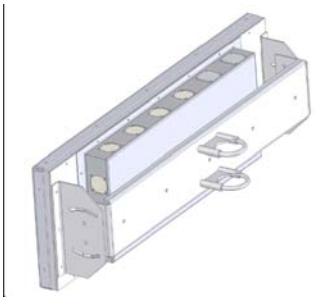
Each exciter, as depicted in Figure 3, creates and is associated with a single interrogation space, which is individually addressed and controlled by the AIA. Exciters are physically positioned according to business process needs to provide optimal performance in exciting Gen2 tags. The AIA is ordinarily positioned as an 'eye in the sky' with a vantage point to all Exciters in the system – this can be line of sight (LOS) or non-line of sight (NLOS) but always within the rated Rx range.



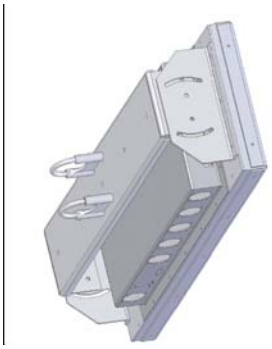
Rear View



Right View



Rear Right View



Bottom Left View

Figure 2

The STAR-1000 Air Interface Assembly contains a 1 x 4 array assembly, and digital and RF processing assemblies. The overall package dimension shown in Figure 5 is 30" x 10" x 10" (L x W x D). The AIA utilizes classical, fully active, phased array antennas for enabling the visibility into the space dimension. The smart array approach adopted by Mojix is based fully on digital processing techniques, thereby providing very high resolution for estimation of direction of arrival of the signal of interest (SOI), enabling the system to provide accurate location information on the tag position in the three dimensional Euclidean space. The STAR-1000 AIA signal processing platform is linked to a central, generic host computer, and controller via a standard Ethernet 10BaseT (RJ45)-connector. The controller can drive an arbitrary number of STAR-1000 systems

and will include interfaces to the enterprise middleware. The controller is not explicitly depicted in Figure 1 to emphasize the abstraction of the controller functionality in the WAN cloud. In a larger enterprise deployment, multiple STAR domains would exist in various locations and would require one or more controllers, which are generic, Linux based computer systems.

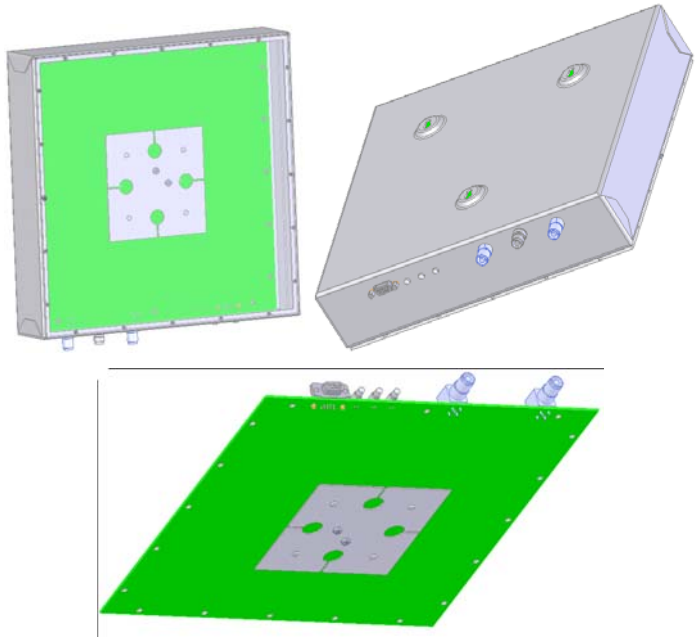


Figure 3

## 3. Technical Specifications

| | |
|---|---|
| Operating Frequency | UHF Band, 902-928 MHz, frequency hopping |
| Read Capacity | Up to 700 tags per second per interrogation space |
| Dimensions | AIA: 30 in. L x 10 in. W x 5.4 in. H, 11.81cm L x 3.94cm W x 2.13cm H<br>Exciter: 30 in. L x 10 in. W x 5.4 in. H, 11.81cm L x 3.94cm W x 2.13cm H |
| Weight | AIA: 37.4 kg / 17 lbs Exciter: 5.5 kg / 2.5 lbs |
| External I/O | DB-15 (8 Dry Relay Contacts – 4 in / 4 out) |
| Temperature | IEC 60068-2-1/2/14<br>Operating: 0° to +50° C (+32° to +122° F)<br>Storage: -20° to +70° C (-4° to +158° F) |
| Humidity | IEC 60068-30/56 5-95% non-condensing |
| Vibration | IEC 60068-2-6 |

| | |
|---|---|
| Power Supply | +24 VDC, 2 Amp |
| Power Consumption | 200 Watts operational, 100 Watts in standby |
| External Antenna Connectors | RJ6 BNC for Exciters (Remote Transmitters) |
| Wireless LAN | Optional 802.11a/b/g/n integrated module |
| WAN | 3rd Party solutions available for cellular, satellite or fiber |
| Indicators | LED's for Power, Standby and Transmit |
| Network Interface | Ethernet 10/100 Base-T, RJ-45 Interface |
| Logical Interface | • Full TCP-IP socket interface Version 4.0 and Version 6.0 (4thQFY07)<br>• SNMPv3 Client Version 3.0<br>• FTP / Telnet Version 2.0<br>• HTTP Version 1.3<br>• IPSec Version A.02.01.01<br>• SSL Version 2.0 |
| Application Programming Interface | Java VM Interface Version 1.5.0 |
| Compliance | Safety: UL60950-01<br>Regulatory: FCC Part 15 |
| Firmware Upgrade | Web-based and remote capable |
| RFID Reader Interface | Low Level Reader Protocol EPC Global Version 1.0 |
| Tag Protocols | EPC Gen2 |
| Synchronization | Network Time Protocol |
| IP Addressing | Static and Dynamic |
| Host Interface Protocols | XML |
| Warranty | 1 Year from date of shipment |
| Extended Warranty | Available |

# 4. System Architecture

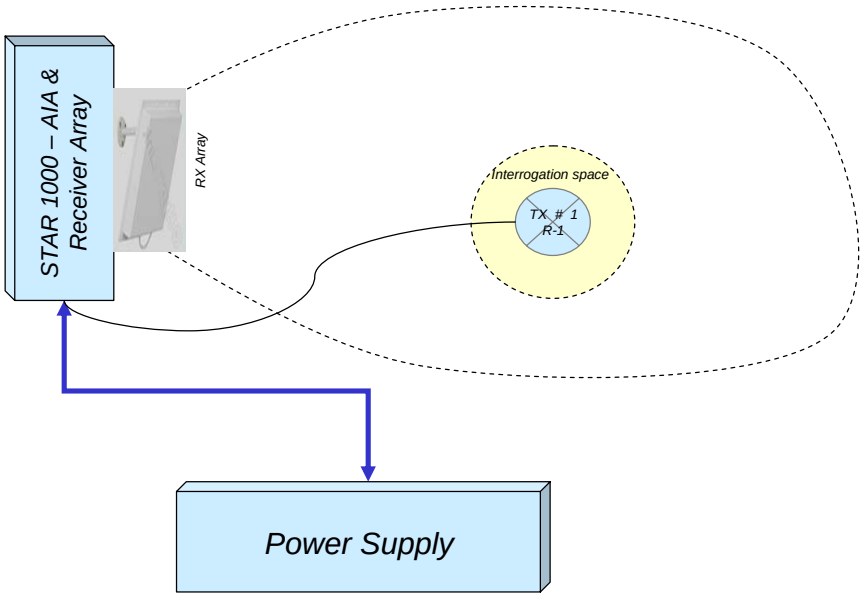



Figure 4

Figure 4 represents the overall system architecture with the AIA, exciters and Linux host for management, control, deployment, and business applications.

## 4.1. Top Level Architecture – AIA Hardware

Figure 5 represents the top level architecture of the AIA hardware.

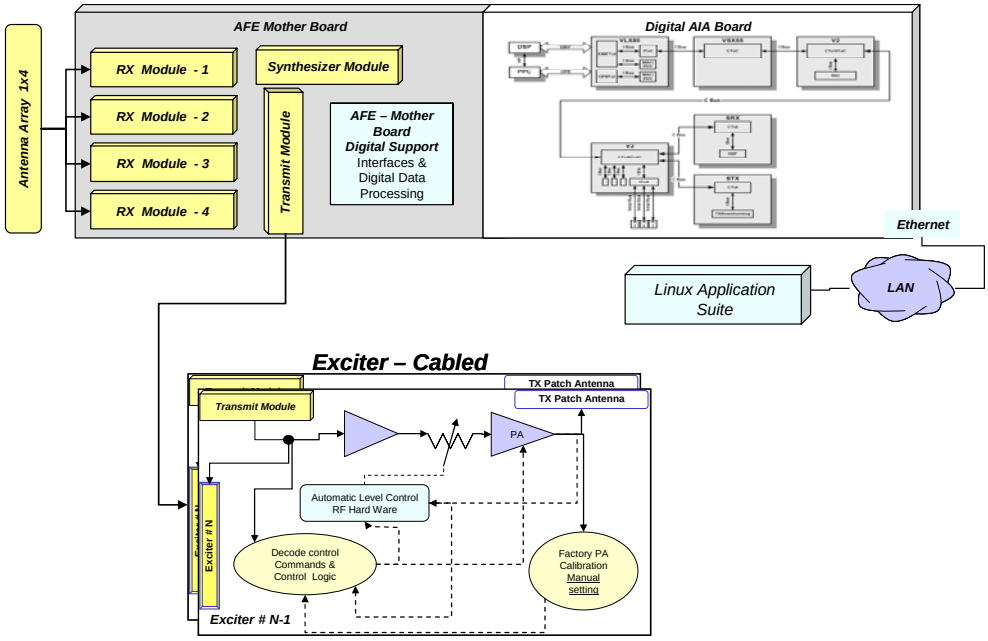
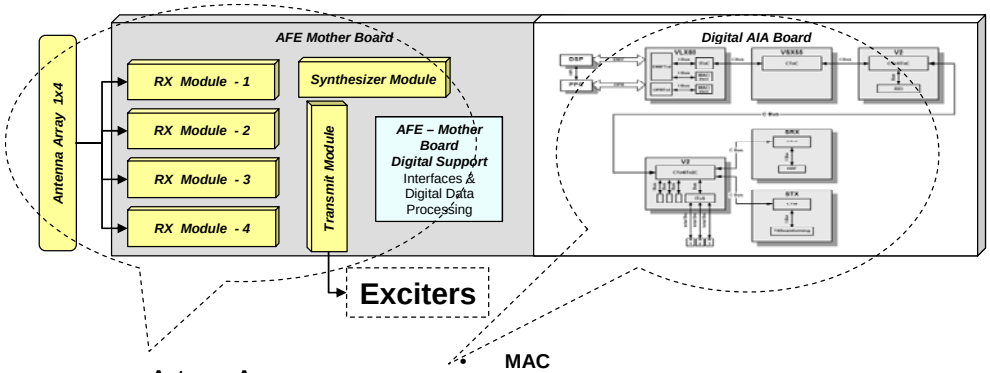



Figure 5

## 4.2. Hardware Architecture Components




- **Antenna Array**
- **Exciter interface**
- **Receive modules**
- **TX modules**
- **Synthesizer**
- **DACs**
- **ADCs**
- **Digital and Analog Filer**
- **Control logic**

- **MAC**
- **Digital Filters**
- **Preamble detect**
- **Decoders**
  - **MSNC**
  - **SISO**
- **Beam Forming**
- **Control logic**
- **External Interfaces**
- **Excite controls & management**

Figure 6

## 4.3. Algorithm & Configuration Control

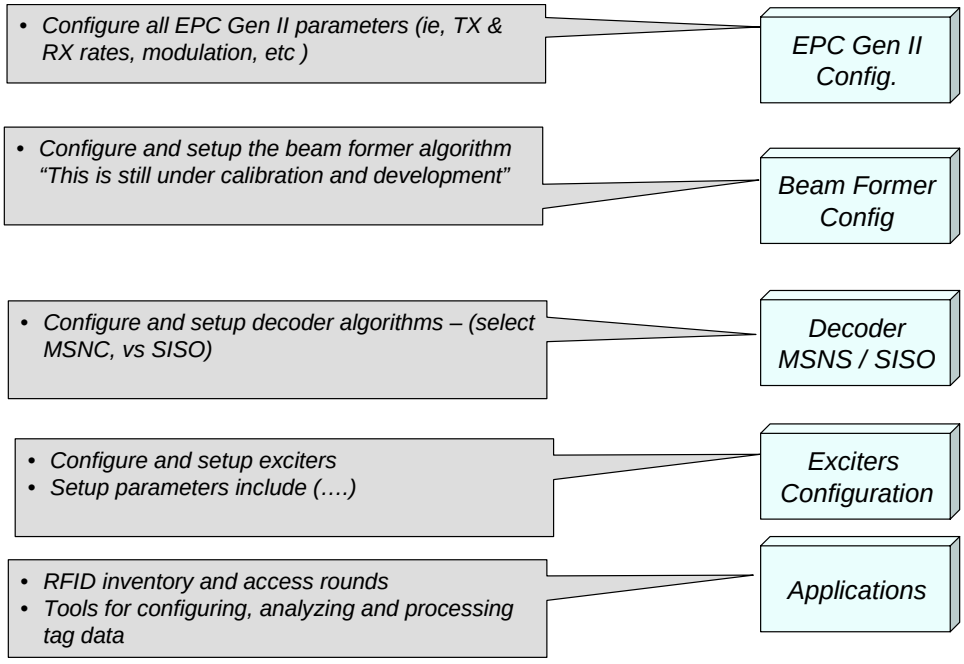



Figure 7

# 5. FCC Assertion

**INSTRUCTION TO THE USER**

This equipment has been tested and found to comply with the limits for a class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This equipment has been certified to comply with the limits for a class B computing device, pursuant to FCC Rules. In order to maintain compliance with FCC regulations, shielded cables must be used with this equipment. Operation with non-approved equipment or unshielded cables is likely to result in interference to radio and TV reception. The user is cautioned that changes and modifications made to the equipment without the approval of manufacturer could void the user's authority to operate this equipment.

CAUTION: To comply with FCC RF exposure compliance requirements, a separation distance of 20 cm must be maintained between the antenna of this device and all persons.