ASSURED SPACE

PHASED ARRAY SOLUTIONS FEATURING THE CAPLINK ARRAY™

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Abstract

Modern satellite systems and spacecraft face ever-increasing demands for performance, size, weight, and cost. As a result, improved solutions are required. Assured Space has developed unique, high-performance, and reliable solutions to meet these demands. This paper describes some of the advantages of phased arrays for space missions and a few of the unique features of the Assured Space solution are given. As an example of our phased array solutions, a mini-specification is provided for a S-Band array (though other phased can be provided to 40GHz) and a few of the available options are listed. As will be shown, the Assured Space solution provides solutions to the challenges facing the satellite communications industry.

Introduction

A phased array on a satellite or other spacecraft is an advanced antenna system made up of numerous small elements that act together to form an antenna beam. The antenna beam can be steered electronically in the direction required by the system and can be used for a wide range of space-based missions such as:

Satellite Communication:
Phased arrays enable high-speed, reliable communication links between spacecraft and ground stations or other satellites, even while in motion.

Earth Observation:
Phased arrays provide high-resolution imaging and scanning capabilities, crucial for monitoring weather, ground targets, climate, and natural disasters.

Deep Space Exploration:
They facilitate long-range communication and data transmission with deep space probes, allowing for continuous contact with Earth.

Synthetic Aperture Radar (SAR):
Phased arrays are used in SAR systems for detailed surface mapping and terrain analysis from orbit, reconnaissance, surveillance, target detection, support of military operations, and strategic planning. Additionally, it can detect and monitor ground movements, and identify hidden structures or infrastructure, providing essential intelligence information.

Space Situational Awareness:
They help detect and track space debris, other satellites, and potential threats, enhancing the safety of spacecraft.

Inter-Satellite Links:
Phased arrays enable data relay between satellites, forming a network that increases the coverage and efficiency of satellite constellations.

Planetary Exploration:
Used on spacecraft orbiting other planets, phased arrays assist in radar imaging of planetary surfaces and terrain.

Navigation and Guidance:
They can support precise navigation and guidance for spacecraft, essential for accurate maneuvering and docking.

Scientific Research:
Phased arrays can be used in space-based telescopes and other instruments to study cosmic phenomena with high precision.

Weather Prediction:
Phased arrays on weather satellites improve the accuracy of meteorological data collection, enhancing global weather forecasting.

By precisely controlling the phase of the signal at each element in the phased array, the satellite can electronically steer its antenna beams without needing physical movement. This technology enables quick and accurate directional control, allowing the satellite to maintain connections with multiple ground stations or other satellites simultaneously. Phased arrays are essential for satellite applications, offering enhanced performance, reliability, and efficiency, especially in tasks like global communications, Earth observation, and deep space exploration.

Assured Space phased array technology transforms space communication, exploration, and observation.

Our phased arrays are the cutting-edge solution redefining what's possible in space. Whether launching a satellite, a deep-space probe, or a constellation of communication satellites, phased arrays **deliver unmatched performance, reliability, and efficiency.**

Since these **advanced antenna systems offer precise, instant beam steering without any moving parts,** your spacecraft can maintain constant, high-speed communication with Earth, even while maneuvering or orbiting far-off planets. Say goodbye to the limitations of traditional antennas and embrace the future with phased arrays— your gateway to seamless, multi-directional connectivity. But the benefits don't stop there.

Assured Space phased arrays are compact, lightweight, and highly versatile. They can be **tailored to meet the unique demands of any mission,** from high-resolution Earth observation to deep space exploration. Imagine capturing detailed SAR images of the Earth or maintaining a flawless communication network across a satellite constellation—all made possible by the power of phased arrays.

Assured Space Phased Array Specifications

Assured Space offers a wide range of phased array solutions in multiple frequency bands. Table 1 describes our S-Band phased array architecture with 70 elements in the uplink array and 70 elements in the downlink array. The number of elements in the array can be scaled to meet link budge requirements, mission goals, and spacecraft capabilities. The design includes integrated antenna elements, low-noise amplifiers, high power amplifiers, and phase shifters, variable gain amplifiers, and filters for full phased array capabilities. Single polarization with nulling capability to filter non-desired signals. For applications that require it, options exist for adaptive beam forming to reduce the effects for jamming signals.

Table 1. Mini-Spec Table for Phased Array Capabilities and Architecture

Parameter	Value	Comments
Array Antenna Elements	**16 to 2048 on Tx and Rx**	**Number of array elements is modular and scalable to system requirements.**
Frequency Range	**S, C, X, Ku, or Ka-Band**	**Our solutions cover the majority of customer requirements.**
Beam Steering Range	**±45°**	**In azimuth and elevation.**
Beam Switching Time	**1 ms to 1us**	**Depending upon EIRP and other parameters.**
Size	**0.25m2 to 10m2**	**Size can scale to spacecraft and mission needs.**
Mass	**5kg to 75kg**	**Depends on mission gain and/or EIRP requirements.**
Power	**30-40 W**	**Depends on required gain and EIRP.**

Available Options

Since each mission may have unique requirements and needs, the Assured Space phased array capability has multiple available options to extend functionality to meet your specific mission needs.

A few of the options are described below:

- **Integrated transponder**
- **High power space based phased arrays**
- **Radar waveform generator and signal processing**
- **Advanced adaptive beam forming for interference and jamming mitigation**
- **Multiple simultaneous receive beams**
- **Low-power and compact phased arrays**
- **TT&C solutions**
- **High-speed data transmission up to 3.5Gb/S (higher with appropriate ground equipment)**
- **Integrated software defined radio with connectivity to the bus computer**

CapLink Array™: A Versatile Phased Array Option

Assured Space is currently developing CapLink Array™, a next-generation phased array technology that leverages capacitive dipole elements in a novel configuration. At TRL 4, this proprietary technology offers significant performance potential across satellite communications and radar applications.

Below are examples of how CapLink Array™ features align with different mission needs:

Satellite Communication Systems

CapLink Array™ Features and Benefits

Features	Benefits
Controlled coupling between antenna elements	**Maintains antenna radiation mask over a wide field of view.**
Improved sidelobe performance over wide scan angles	**Maintains antenna ITU radiation mask over wide scan angles.**
Wide frequency bandwidth	**Provides multiple band coverage and wide range of use cases.**
Module subarray architecture	**Supports small or large phased array configurations.**
Flexible EIRP configurations	**Facilitates a wide range of link budgets and operational needs.**

CapLink Array™ Features and Benefits

Features	Benefits
Controlled coupling between antenna elements	**Reduces main beam distortions over a wide field of view.**
Improved sidelobe performance over wide scan angles	**Reduces errors in radar detection and jamming susceptibility.**
Wide frequency bandwidth	**Allows a diversity of waveforms supported.**
Module subarray architecture	**Supports small or large phased array configurations.**
Flexible EIRP configurations	**Enables performance for large and small targets.**

Conclusions

Assured Space phased arrays represent a transformative leap in technology, offering unparalleled advantages for a wide range of applications, particularly in the demanding environment of space. Their ability to steer beams electronically without mechanical parts enhances reliability, making them ideal for long-duration missions where maintenance is impossible. The compact and lightweight nature of phased arrays also reduces payload weight, crucial for lowering launch costs and maximizing efficiency.

Our phased arrays excel in providing high-resolution imaging, precise navigation, and robust communication links, whether for Earth observation, deep space exploration, or satellite communication networks. Their versatility allows for simultaneous multi-target tracking and communication, vastly improving operational capabilities and ensuring continuous connectivity across multiple platforms.

In an era where space missions are becoming increasingly complex and ambitious, the adaptability and precision of our phased arrays provide a critical edge. **They empower spacecraft with the ability to respond dynamically to changing conditions and mission requirements, ensuring that they not only meet but exceed their objectives.**

In summary, the benefits of phased array solutions from Assured Space are clear: **enhanced performance, greater reliability, and increased efficiency.** As the backbone of modern space technology, phased arrays from Assured Space are setting new standards for what can be achieved in the final frontier.