TECH BRIEF

COTS Modular Microwave Amplifiers for NewSpace Missions

ERZIA

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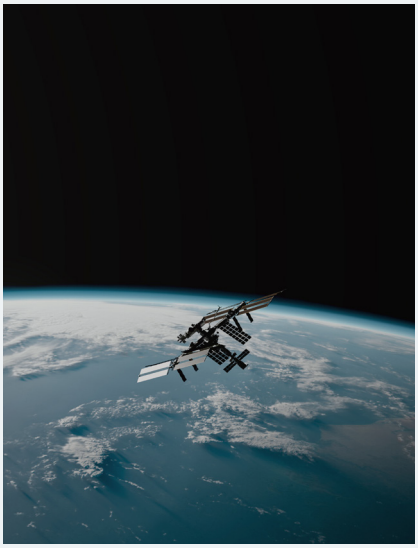
Introduction



NewSpace refers to the emergence of a private space industry heavily focused on quicker delivery times and optimized costs. With a new approach to the design and manufacturing of space-based systems, platforms, and payloads, NewSpace can reduce the amount of analysis and design iterations, eliminate overheads and bureaucracy, use industrial techniques like serial production, and maximize the use of Components of the Shelf (COTS) instead of developing/qualifying every single part. NewSpace opens up the space segment to new applications by allowing the entry of private entities willing to create new business models with smaller and cheaper platforms. Due to their (generally) smaller size and limited lifetime, satellites enable more risk-taking when it comes to reducing costs and manufacturing times, including the use of COTS that where originally designed for other applications (e.g. Automotive grade parts).

ERZIA is supporting this emerging market with RF & Microwave products based on both COTS and custom units with optimized approaches.

In this paper, we review the main technical points that make a COTS Microwave Modular Amplifier suitable for NewSpace missions, and take a closer look at the changes or modifications that might be recommended, depending on the type of mission. We also include a summary of ERZIA COTS used in NewSpace missions.

GENERAL CONSIDERATIONS FOR RF & MICROWAVE AMPLIFIERS

The ERZIA catalog and custom amplifier products are all, by default, designed and manufactured for highly demanding applications like defence or aeronautics, delivering very high performance and reliability in rugged environmental conditions.

All modules are assembled in an IPC-certified line and specific environmental stress screening is applied to 100% of assembled modules before they are shipped to the customer. Product flow, from design conception to final packaging, is managed under UNE:EN 9100 and ISO 9001 certified processes.

All units are also rated by design to the following environmental specifications (MIL-STD-810F):

- **Operating Temperature: -40ºC to +80ºC**
- **Storage Temperature: -55ºC to +125ºC**
- **Vibration: 8g rm**
- **Shock: 20g, 11ms saw-tooth**
- **Acceleration: 15g**

As these metrics show, the products are ideally positioned to meet the environmental requirements of a wide range of NewSpace applications.

Even if the toughest vibration or temperature requirements are needed, a dedicated test can be planned after ananalysis. In most cases, the device will align with customer expectations.

In regard to other environmental requirements, like thermal vacuum, we leverage our experience in traditional space projects to assess the need for special measures, such venting holes (typical approach, with minimum cost), or to use the modules sealed as they usually are.

Finally, one of the biggest environmental variables that the applications must account for is the exposure to the radiation in space.

Most of the units manufactured by ERZIA are composed of two different sections: the RF/Microwave section and the DC section, each with a different radiation influence. Passive electronic components, like capacitors and resistors, can usually be neglected as they are radiation hardened up to 200 - 300 krad, which is more than enough for NewSpace applications and most space missions — including hardware for long-term ones (10-15 years). The difference to be studied is the response of semiconductor devices to the radiation environment, which depends on the active section design and the semiconductor type.

RF SECTION

The RF products manufactured by ERZIA are mainly using semiconductor devices based on GaAs and GaN. These are wide bandgap technologies considered rad hard up to 300 krad (as per ECSS-Q-ST-60-15C). Therefore, most of ERZIA RF designs can be used as-is for NewSpace applications without further radiation validation. In any case, a radiation analysis and/or tests might be recommended for missions with very high radiation demands.

DC/LOW FREQUENCY SECTION

The DC/Low frequency section of our designs normally includes DC/DC converters to generate —from a single input voltage coming from the satellite bus —all requested voltages (positive and negatives) that the semiconductor stages require. This section also includes protection circuitry to ensure the correct bias sequence and, in some complex units, a microcontroller to compensate for the aging of GaN semiconductors. All these semiconductors (regulators, converters, logical gates, Op Amps, etc...) are based in Silicon (Si). Silicon is usually sensitive to radiation in both TID and SEE, and should be carefully analysed when sending a unit to space.

Several approaches are possible to mitigate this dynamic:

- **Use as-is:** Even when using Silicon commercial components, a standard DC section can survive in space for short periods of time, depending on the spacecraft orbit, shielding, radiation environment, mission lifetime, etc.. This is something the end user needs to consider. Also, a radiation test can be performed at the module or component level to determine the radiation dose that every design can handle. This approach brings significant cost and timing advantages, since a COTS component is directly used.
- **Remove DC section:** Another fast and cost-efficient option is to remove the DC section from the module. In this case, the platform shall supply the requested voltages (usually one or two positive values and a negative one).
- **Upgrade DC section (I):** This can require additionaldesign time and will consequently cost more than the "as-is" option. However, the figures will be reasonable if the Silicon components of the DC section are replaced by components with known rad-hard or space equivalents. The use of commercial versions of space qualified components can help avoid long lead times and reduce the cost of extensive screenings at the component level. This option still means the design itself has some degree of radiation hardness Aside from the cost-saving benefits, it's a good fit for missions with a relatively small exposure to radiation.
- **Upgrade DC section (II):** With this option, specific rad-hard components are selected for the DC section. Although it will increase the budget and extend the timeline, it is still far from full space-qualified approach. However the upgrade delivers the most security for projects in need of a serious level of radiation compatibility while maintaining budgets and timelines withincertain limits. This solution may needthe supply of external positive voltages with certain regulation, but internal signal conditioning is done to ensure critical voltages stabilization, cleaning and sequencing.

The different options are summarized in **Table 1**, showing the differences on budget and delivery times.

Table 1: *How various upgrade strategies to the DC Section will effect cost and delivery times.*

RF Section	DC Section	Budget	Delivery Time
Use as is	**Use as is** Commercial Si components	$	⧗
	Remove DC section	$	⧗
	Upgrade DC section (I) Commercial Si components with rad-hard equivalent	$ $ $	⧗ ⧗ ⧗
	Upgrade DC section (II) Rad-hard components	$ $ $ $ $	⧗ ⧗ ⧗ ⧗

DOCUMENTATION AND OTHERS

There is a whole universe of options when choosing between COTS and full Space Qualified modules. A COTS unit is, by default, delivered with a complete electrical test report at three temperatures, a 7-cycle screening performed, and a Certificate of Conformance. We have presented the most general modifications in the previous sections, but there is a raft of specific tests, analyses, reports, screenings, and even manufacturing quality (from IPC to ECSS) that can be applied to every project, depending on the final application budget, timeline, lifetime, and strategy.

The more options are added, the lower the risk becomes. That, in turn, brings a higher budget and longer delivery time. Each customer must determine what items are essential for their applications.

Some of the most requested options are:

Tests:

- **Radiation tests at the component or module level**
- **Thermal-vacuum test at the module level**
- **Shock tests**
- **EMC/EMI/ESD**
- **Dedicated qualification to a certain environmental level**

Analysis Documents:

- **FMECA**
- **Radiation assessment**
- **Reliability analysis**
- **Worst Case Analysis**
- **Derating**
- **Thermal Analysis**
- **Tailored electrical test**
- **Screening at the component level**

Manufacturing:

- **IPC**
- **ECCS or equivalent**

EXAMPLES

Table 2 represents a non-exhaustive list of RF amplifiers and modules delivered by ERZIA for NewSpace applications.

Device		P/N	RF Section	DC Section	Additional Tests and analysis
	COTS LNA	ERZ-LNA-1250-1700-3-3	As-is	As-is	None
	COTS LNA	ERZ-LNA-2600-4000-50-2.5	As-is	As-is	None
	COTS HPA	ERZ-HPA-0900-1400-34	As-is	As-is	None
	COTS HPA	ERZ-HPA-1700-2400-34	As-is	As-is	None
	COTS HPA	ERZ-HPA-0200-2000-37	As-is	As-is	None
	COTS HPA	ERZ-HPA-0600-1800-40-E	As-is	As-is	None
	Modified COTS LNA	ERZ-LNA-0270-0310-30-0.5	As-is	removed	None
	Modified COTS LNA	ERZ-LNA-0100-4000-45-5	As-is	removed	None
	Custom made Integrated Microwave Assembly	Front end TX/RX X-Band	As-is	Upgrade DC section (II)	Doc Package including FMCA, etc.
	Modified COTS LNA	ERZ-LNA-0714-0723-40-1	As is	Upgrade DC section (II)	None

Table 2: *RF & Microwave amplifiers examples from ERZIA used in NewSpace*

It's worth noting that the majority of recent customers use the COTS as is, including RF and DC sections, indicating a clear preference for short timelines and optimized budgets to complex analyses and tests.

Conclusion

ERZIA supports the space industry with RF amplifiers and modules following a NewSpace approach. The main conclusions are:

- The RF section of most of COTS and customized COTS from the ERZIA catalog can be used as is.
- For the DC section, there are several strategies depending on the mission characteristics.
- Additional documentation and analysis can always be added to a COTS ERZIA product depending on its final use.
- Successful COTS use cases for NewSpace applications show most customers prefer to have minor or no modifications to existing COTS solutions.

NEXT STEPS

How can we help to take you further? Please contact our sales team for all your amplifier needs. We'd be delighted to discuss your best options to meet your highest performance requirements and take up as little space and weight as possible. sales@erzia.com.

ERZIA catalog of High Power Amplifiers:
erzia.com/products/hpa

ERZIA catalog of Low Noise Amplifiers:
erzia.com/products/lna

ERZIA designs and builds rugged, high-performing, and reliable amplifiers. If you do not find what you are looking for in the catalog, please ask us at sales@erzia.com.