

Power Management Solutions for Aerospace and Defense Applications

Gabino Alonso, Director of Strategic Marketing for the Power by Linear Group

Introduction

Analog Devices' broad portfolio of antenna-to-bits solutions makes possible today's mission-critical and rugged advanced aircraft, space systems, and defense platforms. ADI components and high performance signal chain solutions are highly integrated to reduce size, weight, and power requirements. Optimal performance of high performance signal chain devices requires complementary low noise and high efficiency power management solutions.

Power by Linear[™] products for aerospace and defense power systems are designed, developed, and factory tested to meet or exceed the performance and reliability standards of ruggedized systems. The wide selection of products also features unique combinations of high power density, high efficiency, low EMI performance, and ease of use. ADI's power products portfolio is broken down into two main categories: power regulation and power monitor, control, and protection. This article highlights a few high reliability power management products that are ideal for next-generation aerospace and defense applications.

Product Availability

At ADI, products have a vintage, not an age. ADI Power by Linear products are available decades after release, and we believe obsolescence should be avoided. When it cannot be avoided, customers are notified two years in advance via a Product Discontinuance Notice in compliance with JESD48A. ADI continues to support the specialized needs of the ADEF market with exceptional long-term support of legacy products. For more information, please review our Product Life Cycle Information.

100% Factory Tested

Solutions for aerospace and defense power management demand reliability, even when subjected to harsh environmental conditions. ADI's Power by Linear portfolio continues to support the specific requirements of the ADEF power management market with industry-leading quality and reliability. LT, LTC, LTM, and LTP prefixed products are available in a variety of temperature grades, and to guarantee performance, all are 100% electrical tested at room temperature to data sheet electrical characteristics limits. Furthermore, data sheet electrical characteristics limits. Furthermore, data sheet electrical tested at hot and cold temperatures to data sheet electrical characteristics limits. Zero failures are allowed. Please refer to individual data sheets for specific details on temperature grades.

Regulated Output Voltage (Note 4)	$\begin{array}{l} V_{01T}=0.6V, \ 10mA \le I_{01T}\le 2.5A, \ 0.90V\le V_{1M}\le 1.05V\\ V_{01T}=1.0V, \ 10mA \le I_{01T}\le 2.5A, \ 1.3V\le V_{1N}\le 1.45V\\ V_{01T}=1.2V, \ 10mA \le I_{01T}\le 2.5A, \ 1.5V\le V_{1N}\le 1.65V\\ V_{01T}=1.5V, \ 10mA \le I_{01T}\le 2.5A, \ 1.8V\le V_{1N}\le 1.95V\\ V_{01T}=1.8V, \ 10mA \le I_{01T}\le 2.5A, \ 2.1V\le V_{1N}\le 2.25V\\ V_{01T}=2.5V, \ 10mA \le I_{01T}\le 2.5A, \ 2.8V\le V_{1N}\le 2.98V \end{array}$	•••••••••••••••••••••••••••••••••••••••	0.591 0.985 1.1850 1.4812 1.7775 2.4687	0.600 1.000 1.200 1.500 1.800 2.500	0.609 1.015 1.2150 1.5188 1.8225 2.5313	~~~~~
Regulated Output Voltage Margining	MARGA = 1.2V MARGA = 0V	:	9 -11	10 -10	11 -9	%
Line Regulation to V _{IN}	$\begin{array}{l} V_{OUT}=0.6V, \ \Delta V_{IN}=0.9V \ to \ 3.45V, \ V_{BIAS}=5.0V, \ I_{OUT}=10mA \\ V_{OUT}=1.2V, \ \Delta V_{IN}=1.5V \ to \ 3.45V, \ V_{BIAS}=5.0V, \ I_{OUT}=10mA \end{array}$	•		0.02	1 2	mV mV
Line Regulation to V _{BIAS}	$\begin{array}{l} V_{OUT}=0.6V, \ \Delta V_{BIAS}=2.375V \ to \ 5.25V, \ V_{IN}=0.9V, \ I_{OUT}=10 \text{mA} \\ V_{OUT}=1.2V, \ \Delta V_{BIAS}=2.4V \ to \ 5.25V, \ V_{IN}=1.5V, \ I_{OUT}=10 \text{mA} \end{array}$	•		0.2 0.2	1.5 3	mV mV
Load Regulation Agyr = 10mA to 2.5A (Note 5)	$V_{BIAS} = 2.375V, \ V_{IN} = 0.9V, \ V_{OUT} = 0.6V$			1.2	2.4 3.6	mV mV
	$V_{BIAS} = 2.375V, \ V_{IN} = 1.3V, \ V_{OUT} = 1.0V$			2	4	mV mV
	$V_{BIAS}=2.4V,V_{IN}=1.5V,V_{OUT}=1.2V$	•		1.3	2.5 3.7	mV mV
	V _{BIAS} = 3V, V _{IN} = 2.1V, V _{OUT} = 1.8V			1.9	3.7 5.6	mV mV
	$V_{BIAS} = 3.7V, V_{IN} = 2.8V, V_{OUT} = 2.5V$			2.6	5.1 7.7	mV mV
		_				

Figure 1. Sample electrical tested at hot and cold temperatures to data sheet electrical characteristics limits.

Military plastic grade, MP, is a commercial off-the-shelf (COTS) solution with guaranteed performance over the military temperature range. MP-grade devices are 100% electrical tested at hot and cold temperatures, and include additional inspections, tight in-process controls, temperature cycling to eliminate infant mortality failures, and enhanced reliability monitoring. Device options can be expanded by considering other temperature grades, such as high temperature automotive (H) and industrial (I). Filter for these temperature ranges in the analog.com parametric tables by clicking **Choose Parameters** and checking the **Temp Range Code** option.

Table 1. Aerospace and Defense Power ManagementProducts Temperature Grade

Select Temp Grades	Data Sheet Performance over Temperature*	Test at Room (25°C)	Cold and Hot Test Temperatures*	Sample Test at Hot	Sample Test at Cold
MP	-55°C to +125°C or +150°C	100%	-55°C and +125°C or +150°C	100%	100%
н	-40°C to +125°C or +150°C	100%	-40°C and +125°C or +150°C	100%	1000 per lot
1	-40°C to +85°C	100%	-40°C and +85°C	1000 per lot	1000 per lot

* or as specified in data sheet

ADI offers several linear regulator and switching regulator solutions for space qualified radiation tolerant (RT) power products. Additional information on these products can be found on the Space Technology Solutions page.





Figure 2. Power management tool suite.

Powerful Software Tools to Speed Up Designs

ADI offers complete power management tools to make designing power systems and circuits easier. Use LTpowerPlanner[®] for system-level power tree design, start with LTpowerCAD[®] to find solutions for and optimize supply designs, and use LTspice[®] for circuit simulations. For the ultimate in configuration, diagnostic, and debug tools for complex multi-rail systems, check out LTpowerPlay[®]. World-class power design tools are available for download at no cost.

µModule Regulators for High Efficiency Power in Tight Spaces

µModule^{*} regulators are exceptional, complete system-in-package power management solutions. The package includes controller ICs, power transistors, capacitors, compensation circuitry, and inductors. All products are tested in final package to data sheet electrical characteristics limits. Enhanced thermal performance and solution size are at the forefront of µModule design philosophy, keeping bulky mechanical and thermal mitigation at bay. High efficiency and low EMI are designed in, simplifying qualification and reducing design time. The µModule product family supports multiple topologies to include buck, boost, buck-boost, isolated, and inverting regulators. Many of the μ Module products are available in BGA with SnPb finish and distinguished by the package top mark (e0), while also complying with JEDEC standard J-STD-609. More BGA manufacturing guidelines for PCB assembly are available on our μ Module design and manufacturing resources page. To search for SnPb finish in additional product families, you can add and filter **Terminal Finish (PB)** on our website's parametric tables.



Figure 3. Package and thermal image of LTM4700 (BGA) stepping down 12 V to 1 V at 100 A with 200 LFM airflow and no heat sink.

26.6



Figure 4. Reduce EMI with dual-channel 4 A, 42 V, synchronous step-down Silent Switcher 2 technology with 6.2 µA quiescent current.

Reduce EMI with Silent Switcher Step-Down Regulators

The Power by Linear portfolio's exclusive Silent Switcher* regulators offer high efficiency at high switching frequencies while maintaining ultralow EMI emissions—easily passing CISPR 25 Class 5 peak EMI limits while operating at 2 MHz switching frequency and providing 95% efficiency. These no compromise, feature-rich switching regulators have a maximum input voltage range from 5.5 V to 65 V, provide 1.2 A to 20 A of output current, and have a programmable switching frequency from 200 kHz to 5 MHz. The second generation of this technology, Silent Switcher 2, adds internal bypass capacitors and an integrated substrate to further improve EMI. The integrated components make low EMI designs insensitive to PCB layout, simplifying design and production, and reducing performance risks. Silent Switcher µModule step-down regulators integrate the inductor, further minimizing design and production risks.

Ultralow Noise, High PSRR, Low Dropout Linear Regulators

Ultralow noise, ultrahigh PSRR low dropout (LDO) linear regulators are an important part of supplying well-regulated power to precision sensors, high speed and high resolution data converters, frequency synthesizers, and other noise sensitive devices. The Power by Linear family of positive and negative LDO regulators features products with ultralow output noise and ultrahigh power supply ripple rejection (PSRR). The LDO regulators cover a wide input voltage range, from 1.8 V to 20 V (-20 V to -1.8 V), and a wide output current range, from 200 mA to 500 mA.

Many Power by Linear LDO regulators can be easily paralleled to further reduce noise, increase output current, and spread heat over a wider area of the PCB. Additional features include programmable current limit and power good, and VIOC capability, which maximizes efficiency and system transient response when the LDO regulator is used with a switching regulator.

Table 2. High PSRR LDO Regulators with PSRR Greater than 70 dB

	LT3093	LT3094	LT3042	LT3045
Regulated Voltages	Negative	Negative	Positive	Positive
Output Current (mA)	200	500	200	500
Output Noise (10 Hz to 100 kHz) (µV)	0.8	0.8	0.8	0.8
Spot <u>No</u> ise at 10 kHz (nV/√Hz)	2.2	2	2	2
PSRR at 1 MHz (dB)	73	74	79	76
Programmable Current Limit	•	•	•	•
Programmable Power Good		•	•	•
VIOC Capability	•	•		-1 version
Parallelable	•	•	•	•
Fast Start-Up Capability	•	•	•	•

ADI also offers a broad line of high performance linear regulators, which includes hard-to-kill high voltage PNP linear regulators.

Surge Stoppers: Overvoltage and Overcurrent Protection

Front-end protection is especially important in tightly packed systems facing unpredictable inputs. Power by Linear surge stopper protection solutions cover the full range of surge and transient events documented in military and avionic standards, including ISO 7637-2, ISO 16750-2, MIL-STD-1275, and D0-160, without the use of bulky passive components—which do not guarantee power delivery, and can be permanently damaged when they shunt high energy to ground.



Figure 5. MIL-STD-1275D 100 V/500 ms surge stopper test using the DC2150A-C demo circuit.

By using a MOSFET to clamp the maximum output voltage to a user-programmed level, Power by Linear protection solutions feature precise ride-through operation on transient events, ensuring reliable operation instead of disconnection. Surge stoppers also add the ability to disconnect the output on extended faults, allowing programmable current limit and undervoltage lockout, and often provide reverse battery protection when back-to-back MOSFETs are used.

To extend output current capability and reduce power loss during high voltage transients and faults, switching surge stoppers achieve high efficiency operation while providing high reliability. For example, the LTC4366 and LT4363 high voltage surge stoppers can ease MIL-STD-1275D compliance.

ADI also offers a complete line of overvoltage and overcurrent protection solutions that includes products that disconnect on fault.

Conclusion

The broad Power by Linear portfolio of leading-edge solutions for next-generation aerospace and defense applications features high reliability, rugged products that meet long operating life and harsh environment standards. Visit our Aerospace and Defense site for easy access to relevant product and technical design information. Additional online resources include product data sheets, an enhanced product recommended (AQEC) part list, application notes, technical articles, LTspice demo circuits, design tools, and EngineerZone* forum. Local technical support experts are available to help you quickly turn design concepts into marketable, ruggedized solutions.

To stay up to date on the latest power products and solutions from ADI, register for our Power by Linear and Aerospace and Defense newsletters at analog.com/subscribe.

About the Author

Gabino Alonso is currently the director of strategic marketing for the Power by Linear Group. Prior to joining ADI, Gabino held various positions in marketing, engineering, operations, and education at Linear Technology, Texas Instruments, and California Polytechnic State University. He holds a Master of Science degree in electrical and computer engineering from University of California, Santa Barbara. He can be reached at gabino.alonso@analoq.com.

Engage with the ADI technology experts in our online support community. Ask your tough design questions, browse FAQs, or join a conversation.



Visit ez.analog.com



For regional headquarters, sales, and distributors or to contact customer service and technical support, visit analog.com/contact.

Ask our ADI technology experts tough questions, browse FAQs, or join a conversation at the EngineerZone Online Support Community. Visit ez.analog.com.

©2021 Analog Devices, Inc. All rights reserved. Trademarks and registered trademarks are the property of their respective owners.

TA22642-1/21