BENEFITS AND TECHNIQUES FOR INCREASED POWER EFFICIENCY IN MODERN TELEMETRY TRANSMITTERS

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ABSTRACT

With recent developments in telemetry transmitter technologies, significantly greater DC to RF power efficiencies can be achieved. These new high efficiency transmitter designs may impact overall system design trade-offs by reducing the system size and weight requirements for batteries, heat sinks, and cabling. Furthermore, these fully DC isolated, next generation ARTM Tier 0, I and II enabled devices offer unique options to the platform designer in EMI/EMC control and system design. Advanced manufacturing techniques coupled with adaptive microprocessor control promises enhanced functionality, improved performance and reduced unit costs.

The paper presents the performance of a new, high efficiency, telemetry transmitter topology and the possible system benefits involved with the application of this advanced transmitter technology within modern and legacy telemetry platforms. Specific sub-assembly circuit design techniques will be discussed and compared with prior design approaches.

KEYWORDS

Transmitter, PCM/FM, SOQPSK, Efficient

INTRODUCTION

It has long been the desire of system designer for more efficient transmitter designs. Recent transmitter technology advances have enabled higher DC to RF efficient transmitters. Higher efficiency yields less power consumption, heat generation, reduced system weight, and longer battery life. Along with higher efficiency, greater flexibility can be given to system designers in terms of power control and EMI/EMC design. L-3 TE has developed a new line of highly efficient transmitters that provides increased flexibility for system designers.

This paper details L-3 ST3000 and ST4000 transmitter architecture, compares power consumption with prior design approaches, describes benefits of power control and EMI/EMC flexibility.

LEGACY ARCHITECTURE

Previous transmitter architectures consisted of an exciter, RF pallet, and linear regulator power supply. With this topology, transmitter packaging was minimized, however power consumption suffered due to inefficient voltage regulation techniques. Legacy transmitter designs are basically constant current input devices. When the input DC voltage is above the nominal input level transmitter power consumption increases and when voltage is below nominal power consumption decreases. Typical internal support voltages of 5V and 12V were also linearly regulated from the prime 28V. Power not converted to RF was directly dissipated into heat. These linear regulator's inefficiencies drove system designers to include large heat sinks to remove wasted power from the transmitter, significantly increasing platform size and weight. Many transmitter architectures have been conceived and implemented in and attempt to ameliorate this critical system power consumption problem. This problem has also become more severe for the telemetry transmitter designer as analog and digital components have shifted from, relatively high, 5V supply voltages to 3.3V, 2.5V, 1.8V and 1.2V technologies. Use of linear regulator technologies also limited the choice of suitable RF power devices to those optimized for use below the minimum input DC voltage.

These legacy architectures also limited the ability of system designers to select reference grounds since linear regulation was typically implemented with a common chassis and primary ground. System designers that wished to isolate the ground references often used isolation plates, floating internal circuitry or a separate isolated DC supply. The anodized metal isolation plates were susceptible to damage that would degrade its isolation properties. These plates also caused an additional mechanical thermal interface that increased transmitter base plate temperatures reducing reliability. Separated DC supplies added increased system complexity, cabling, size, and weight. Independently isolated status and control / communication lines were rarely achieved.

These transmitter designs also provided fixed output RF power levels. Each transmitter were designed for a defined output power reducing flexibility and requiring multiple internal designs and qualifications.

ST3000 AND ST4000 ARCHITECTURE

The ST3000 and ST4000 unique internal architecture uses a proprietary technology to achieve high efficiencies and provide the system designer unprecedented flexibility. The ST3000 is an ARTM Tier 0 (PCM/FM) transmitter and the ST4000 transmitter is capable of supporting ARTM Tier 0 (PCM/FM), I (SOQPSK) and II (multi-h CPM) modulations.

The basic building block assemblies of ST3000 and ST4000 transmitters are: a RF exciter/ modulator, a RF power amplifier and a miniaturized integrated isolated switching power supply. The RF power amplifier and the switching power supply sections are common to both products. Modulation techniques are dependent on the style of exciter selected.

The inclusion of this high density, high reliability switchmode supply in a standard 2 by 3 inch footprint, enables several major design advantages:

Flexibility

The integrated isolated switching power supply accepts input prime power from +22VDC to greater than +34V DC and efficiently generates all required internal voltages. These internal voltages may be selected by the transmitter designer to enable the use of any suitable internal semiconductor device regardless of its input voltage requirements without sacrificing efficiency. This feature is particularly useful in supplying VDD voltages that are either much higher than the prime input voltage – i.e. HPA devices, or voltages much lower than the prime input voltage – i.e. FPGA devices.

Power Control

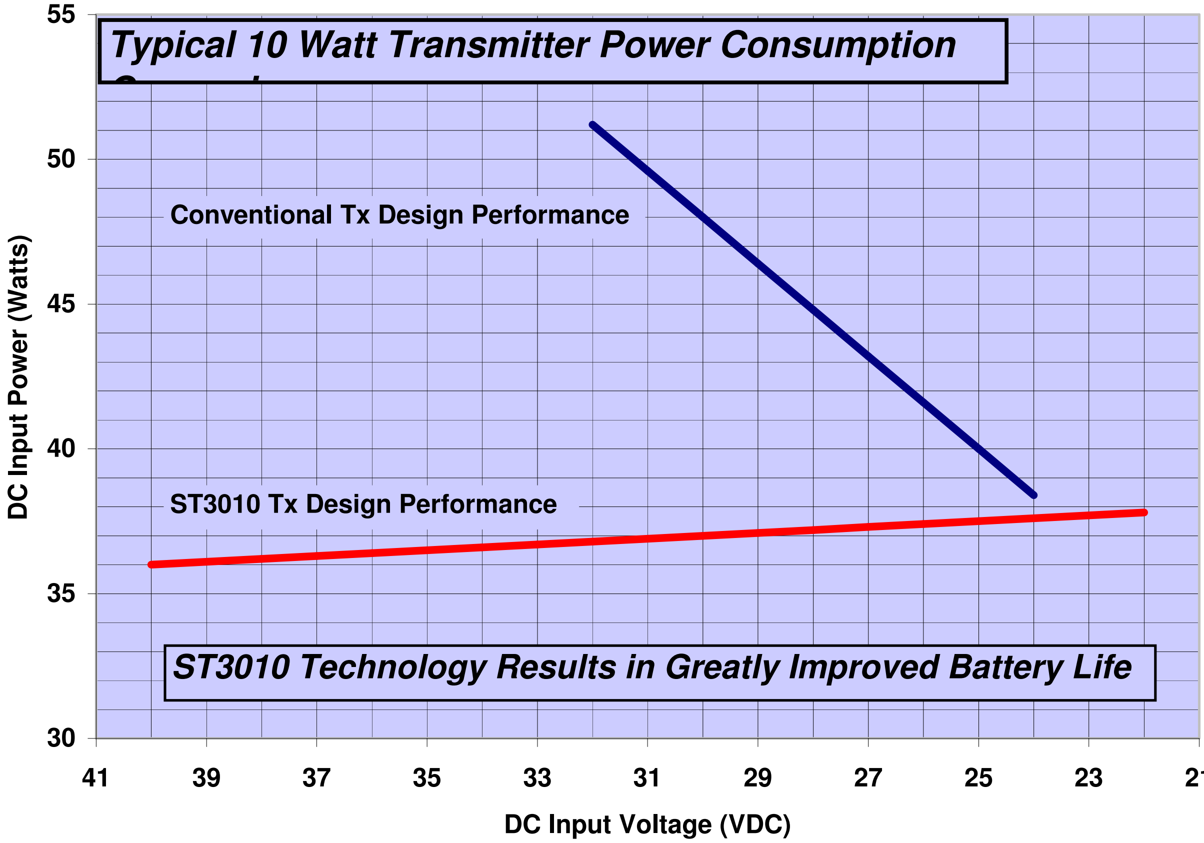
The ST3000 and ST4000 transmitters also feature adjustable output power control from 2-watts to 10-watts in 0.5dB steps or can be factory set to a desired level. This adjustable power control gives system designers the ability to use one transmitter to cover 2-watt to 10-watt needs while eliminating the need for separate qualifications. This approach can also reduce procurement lead times by consolidating transmitter variations to a single part number. Another application of this power adjustment can also be used to adaptively change RF output levels dependent on operational / environmental conditions during live use, reducing or increasing RF output power versus range or location. The internal switchmode power supply again assists in maintaining peak efficiency at all output powers by adjusting internal supply and bias voltages depending on programmed RF output requirements.

Isolation / EMI

Due to the use of the switching power supply and discrete opto-isolators, both the ST3000 and ST4000 transmitters are completely DC isolated from chassis ground. Communication through separate, isolated RS232 or RS422 can be referenced to primary return, chassis ground, or fully isolated. An isolated modulation return can also be provided. If isolation is not desired, the transmitter can easily be internally configured to provide common ground. These grounding options give the telemetry system designer total flexibility when considering the EMI/EMC/ TEMPEST performance of the platform of interest.

Power Consumption

Lastly, the power consumption profile of this new line of telemetry transmitters differs dramatically from legacy designs. As seen in the figure below, the ST3010's power consumption remains essentially constant regardless of the input voltage. The conventional transmitter design dissipates large amounts when the input voltage source is high and only approaches the ST3010's efficiencies at low DC input levels. Furthermore, the switching supply allows for greater input voltage range since there are no linear regulator drop out limitations.



So, what are the thermal effects of this power savings?

–ST810 transmitter is constant current at 2.7amps typ.

- *At 34Vin power to heat is 91.8watt-10wattsRF = 81.8watts typ*
- *At 28Vin power to heat is 75.6watt-10wattsRF = 65.6watts typ*
- *At 24Vin power to heat is 64.8watt-10wattsRF = 54.8watts typ*

–ST3010 is constant power.

- *At 34Vin current is 1.1amps. Power to heat is 37.4watts-10WRF=27.4watts typ*
- *At 28Vin current is 1.3amps. Power to heat is 36.4watts-10WRF=26.4watts typ*
- *At 24Vin current is 1.6amps. Power to heat is 38.4watts-10WRF= 28.4watts typ*

-ST3010 thermal saving

- *At 34Vin; 81.8watts - 27.4watts = 54.4watts*
- *At 28Vin; 65.6watts - 26.4watts = 39.2watts*
- *At 24Vin; 54.8watts - 28.4watts = 26.4watts*

CONCLUSION

By using advance design architecture the ST3000 and ST4000 transmitters are clearly more efficient than legacy products. Increased efficiency provides the system designer with greater overall system performance by reducing total system volume, weight, power and battery requirements. These reductions may also result in longer operational durations, increased flight distances and increased standby capabilities. The ST3000 and ST4000 increase system design flexibility by providing configurable grounding schemes.

BIOGRAPHIES

Mr. Horcher has been with L3 Communication - Telemetry East for 20 years and now holds the position of senior RF engineer. He earned a BS in Electrical Engineering from Trenton State College. He has designed various transmitters for military telemetry applications including the first airborne FQPSK telemetry transmitter. He also has spent 3 years at Ericsson Microelectronics where he designed predistorted linear power amplifiers for use in WCDMA and TD-SCDMA cellular system.

Mr. Bozarth has been with L3 Communications –Telemetry East for 2 years and now holds the position as Product Development Manager for RF and Encryption products. He earned MS in Electrical Engineering from Steven's University and a BS in Electrical Engineering from NJIT. His team's primary focus is on design, development, and support of transmitters, receivers, and encryption products

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