Technical White Paper

AFE7950-SP Usage in Satellite Communications

Zoe Aboab
Bhavesh Rathod

High Speed Data Converters
Wireless Infrastructure

ABSTRACT

Satellite communication (SATCOM) systems require multiband agility, high throughput, and radiation-hardened reliability within strict power and size constraints. This paper introduces the AFE7950-SP, a space-qualified 4T4R2F RF transceiver offering broadband coverage, advanced digital features, and low power operation. The goal is to give system architects, payload engineers, and designers a clear, unbiased view of what the AFE7950 can and cannot do in satellite communications.

Specifically, the document presents flexible architectures across various SATCOM use cases—like repeaters, phased arrays, and multiband systems—while outlining key limitations (for example, bandwidth, frequency gaps, and power trade-offs) to help designers assess the AFE7950 and plan development aligned with mission needs.

Table of Contents

Trademarks

All trademarks are the property of their respective owners.

1 Introduction

1.1 Overview of Modern Satellite Communication Systems

Satellite communications (SATCOM) have evolved from narrow-band, low-data-rate links used primarily for telemetry, tracking, and command (TT&C) into broadband, high-throughput networks that support broadband internet, high-definition video, machine-to-machine telemetry, and emerging constellations for IoT connectivity. Contemporary SATCOM payloads operate across multiple frequency bands: the L-band, S-band, C-band, X-band, Ku-band, Ka-band, and V-band. These bands employ sophisticated modulation and coding schemes (for example, QPSK, 8PSK, 16QAM, LDPC, and ACM) and integrate adaptive beamforming and frequency-reuse techniques to maximize spectral efficiency.

Key trends shaping SATCOM architectures include:

- Multiband, multimode operation
  - Platforms must switch quickly between bands and support fast frequency hopping while staying phase coherent
- Higher throughput demands
  - User terminals and hub stations require data rates from megabits-per-second up to multigigabit-per-second links
- Tight power budgets
  - Satellite payloads are constrained by limited available power, especially on SmallSat and CubeSat platforms
- Robustness in harsh environments
  - Radiation, temperature extremes, and mechanical vibrations demand components with high reliability and built-in fault tolerance

These drivers push RF front-end designers to look for highly integrated, low-power, and wide-bandwidth options that can be programmed to meet a variety of mission profiles without excessive redesign.

Table 1-1. Specific Requirements for SATCOM

Requirement	Typical Specifications	Significance to SATCOM
Bandwidth	100MHz – 2.4GHz per channel (depending on mode of operation)	Supports high-order modulation and throughput-enhancing techniques such as carrier aggregation
Linearity and EVM	Depends on modulation scheme	Essential for high-order QAM and PSK constellations and for avoiding inter-modulation in dense frequency-reuse scenarios
Temperature range	–40°C to +110°C (space-qualified)	Provides reliable performance from launch through on-orbit thermal cycling
Radiation tolerance	Total ionizing dose (TID) = 100krad(Si)	Prevents functional degradation over the mission lifetime
Form factor and integration	17mm × 17mm	Reduces board space, weight, and BOM complexity, especially critical for SmallSat platforms
Programmability	RF tuning, adjustable gain and duplexing control through SPI	Allows a single hardware design to support multiple bands and mission updates post-launch

Meeting all these criteria simultaneously is non-trivial; SATCOMs require radio frequency (RF) front ends that combine high-performance analog blocks, digital features, and a compact, power-aware architecture.

1.2 Presentation of the AFE7950 as an Integrated RF Design

The Texas Instruments' AFE7950 is a four-transmit, four-receive, two feedback channels (4T-4R-2F) RF transceiver designed specifically for wide-frequency-range satellite and aerospace applications. The key architectural features of the transceiver that align with the SATCOM requirements listed in Table 1-1 include:

- A broadband front end that supports continuous frequency coverage, enabling operation across Ku-band, Ka-band, and lower-band satellite windows without redesign
  - Transmitter (TX): 600MHz to 12GHz
  - Receiver (RX): 5MHz to 12GHz

- An on-chip automatic gain control (AGC) block that controls digital step attenuators (DSAs) to maintain input power levels on RX
- Multiple GPIOs to control digital features such as power amplifier protection (PAP) and numerically-controlled oscillator (NCO) hopping
- Typical power consumption of approximately 7.5 watts for full duplex operation, with power-down modes that reduce consumption to less than 1 watt
- Radiation hardness assurance (RHA) verified through testing for single event latch-up (SEL) up to 70MeV·cm^2/mg and total ionizing dose (TID) up to 100krad(Si)
- Implemented in a 0.8mm pitch, 17mm × 17m BGA package

Collectively, these attributes make the AFE7950 a single-chip, multiband RF front end that can reduce the size of the bill of materials (BOM), board area, and development time while still delivering the performance envelope required for SATCOM payloads.

2 Technical Advantages of AFE7950 for SATCOM Applications

2.1 Spectral Flexibility and Agility

The AFE7950 is a high-performance, multichannel transceiver that consolidates four RF-sampling digital audio converter (DAC) transmitter paths, four RF-sampling analog-to-digital converter (ADC) receiver paths, and two RF-sampling ADC feedback paths on one die.

Each receiver (RX) channel incorporates a digital step attenuator (DSA), followed by a 3-GSPS, non-interleaved, RF-sampling ADC. Every channel also includes an analog peak-power detector, several digital power detector blocks for external or internal autonomous AGC control, and an RF-overload detector for device reliability protection. The ADC output feeds a flexible single-band or dual-band digital down converter (DDC) that reduces the sample rate to the bands of interest.

The feedback (FB) chains are often used as the observation paths of the power amplifier (PA) outputs for an external linearization DPD engine, but can also be used as additional receivers. The FB ADCs are identical to the RX ADCs.

Each transmitter (TX) channel features a single-band or dual-band digital up-converter (DUC) that can drive 12 GSPS RF-sampling DACs, followed by a DSA block.

In single-band DUC or DDC mode, each up-conversion chain and down-conversion chain integrates 16 independent numerically-controlled oscillators (NCOs), enabling rapid switching between RF frequencies while preserving the phase of any idle NCO. In dual-band DUC or DDC mode, each chain provides two NCOs, allowing rapid switching between two RF frequencies with the same phase-coherent behavior.

2.1.1 Wide Frequency Range (600MHz - 12GHz)

The 12 GSPS direct RF-samplings of the AFE7950 cover the L-band, S-band, C-band, and X-band without the need for external mixers, making the device highly adaptable for diverse applications. Up to the X-band, the device operates as a true RF-sampling option. For higher frequencies, the device seamlessly supports heterodyne architecture, particularly, in the Ku-band, where the 8GHz capability enables efficient frequency planning.

2.1.2 Configurable Bandwidth

The AFE7950 device has a configurable bandwidth that supports two modes: single DDC mode and dual DDC mode. These bandwidth settings are programmable and can be chosen from the wide range available, making AFE7950 scalable and flexible.

In single-band DDC mode, the ADC front-end digital decimation block can be programmed for 100MHz to a maximum instantaneous bandwidth of 1200MHz.

In dual DDC mode, the device can support 2400MHz of aggregate bandwidth while preserving independent NCO control per channel.

2.1.3 Significance of Frequency Hopping for SATCOM

Frequency hopping enables anti-jamming, spectrum sharing, and link-layer agility that benefit satellite communications.

Fast NCO reprogramming enables pseudo-random or adaptive hopping sequences that can be updated in-flight with minimal overhead. Additionally, the ability to maintain phase coherence across frequency hops permits seamless handover between frequency-diverse beams without retraining the demodulator.

Table 2-1 lists features of the AFE7950 device that support frequency hopping.

Table 2-1. Support for Frequency Hopping in AFE7950

Parameter	Specification	Operational Impact
NCO count	Two per channel in dual DDC mode and 16 NCOs in single DDC mode	Enable user to configure device to cover multiple bands through the 16 independently configurable NCOs
Phase-coherent NCO hopping	Retains NCO phase across hops	Enables phase-coherent frequency hopping on uplink and downlink using SPI or GPIO
Dual DDC mode	Two digital mixers per channel	Allows user to configure two decimation factors and two NCOs per DDC or DUC chain for the same wide band signal independently
GPIO-based hop trigger	Dedicated HOP pin (edge-triggered)	Helps achieve deterministic hop scheduling without CPU intervention

2.1.4 JESD204B and JESD204C Flexibility

AFE7950 is compatible with both JESD204B and JESD204C. AFE7950 supports 8b/10b and 64b/66b encoding schemes, making the device compatible with most FPGAs and ASICs. The device supports several additional features per JEDEC standards.

2.1.4.1 Subclass 1 Synchronization

The AFE7950 implements JESD204B and JESD204C subclass 1, providing deterministic latency and a SYSREF-aligned frame start across multiple devices. Multi-device synchronization is achieved with a single shared SYSREF pulse, making sure that every AFE7950 in a phased-array transceiver samples the RF front end simultaneously. Multi-device synchronization is a prerequisite for coherent beam forming and MIMO techniques used in high-capacity SATCOM.

2.1.4.2 Lane Reduction for Power Savings

The AFE7950 device supports multiple LMFS settings. This is especially valuable for satellite payloads where every watt of saved power translates into an increased payload margin or longer mission life. Any combination of lane 1, lane 2, lane 3, and lane 4 can be configured for the JESD data transmission.

2.1.4.3 Recommended JESD Encoding

8b/10b mode has low latency and high robustness. Select this mode for control-plane data or when operations in radiation-prone environment demand stronger error detection.

64b/66b mode has high throughput and lower overhead. Select the 64b/66b mode for bulk IQ-sample streaming; 64b/66b mode achieves approximately 93% line efficiency versus 80% line efficiency for 8b/10b mode. The internal framing logic of the AFE950 automatically inserts the required alignment characters and the device can switch encoding on a per-link basis. Switching encoding allows a mixed-mode data path, such as low latency control on one lane and high throughput samples on the remaining lanes.

2.2 Advantages for SATCOM System Design

Deterministic latency simplifies timing budget calculations for on-board digital back ends and ground segment timing alignment.

Power-aware lane scaling enables designers to trade raw data rates for power savings when the link budget permits a reduced sample rate, such as during low traffic periods.

Encoding choice provides a knob to balance robustness against radiation-induced bit flips (favoring 8b/10b encoding) and spectral efficiency (favoring 64b/66b encoding) without hardware redesign.

2.3 Radiation Tolerance

The AFE7950-SP is a space qualified RF-sampling transceiver designed specifically for space applications. The radiation tolerance of AFE7950-SP has been validated through a series of standardized tests to maintain reliable performance in the harsh environments of low Earth orbits (LEO), medium Earth orbits (MEO), and geostationary orbits (GEO).

2.3.1 AFE7950-SP: Space-Qualified Version

To see how well the AFE7950-SP handles strong radiation, the device was tested through exposure to high levels of radiation over time.

2.3.1.1 Total Ionizing Dose (TID)

The device was exposed to a high total ionizing dose (TID) rate of 120 rad(Si)/s using a Co-60 gamma source at Texas Instruments' CLAB facility in Dallas, Texas. A total of 25 devices were irradiated across five dose levels: 3, 10, 30, 50, and 100 krad(Si). Post-irradiation electrical testing confirmed that all devices remained within the datasheet specifications, with no functional degradation observed even at the maximum tested dose of 100krad(Si). This testing demonstrates the robustness of the device against long-term exposure to space radiation.

Figure 2-1 shows the performance of the AFE7950-SP device in radiation exposure testing. See also AFE7950-SP TID Radiation Report.

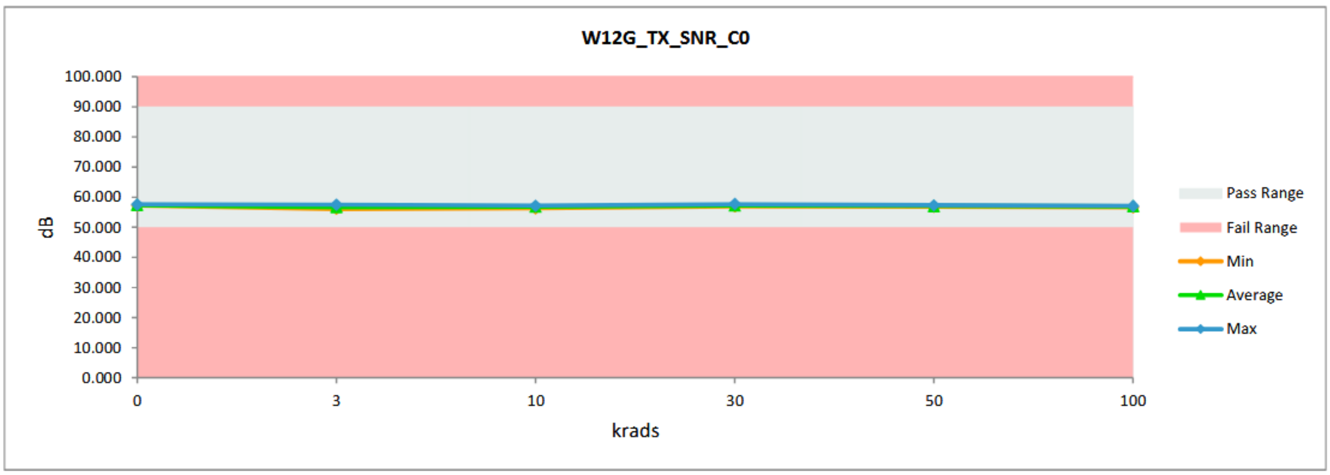

Figure 2-1. AFE7950-SP Performance

2.3.1.2 Single Event Latch-Up (SEL)

In addition to TID, the AFE7950-SP was evaluated for single event latch-up (SEL) immunity. The device is immune up to 70MeV·cm^2/mg, at a junction temperature of 125℃, with no latch-up events recorded across all tested samples. This level of immunity is critical for verifying uninterrupted operation in space, where high-energy particles are prevalent.

2.3.1.3 Single Event Functional Interrupt (SEFI)

SEFI robustness is a key concern for the AFE7950-SP. A SEFI requires power cycling and reprogramming to recover. To measure SEFIs, the beam runs for a set time based on flux (typically five minutes at 1E2). After each interval, the beam pauses and the device restores to the original state. If RX channel 1 SNR returns to the 100dB noise floor, testing continues; if not, the device is reconfigured after power cycling. The accumulated fluence is then used to calculate the SEFI cross section for the given LET.

Table 2-2. SEFI Runs

Flux (ions·cm^2/s)	Ion	LET (MeV·cm²/mg)	Time	Fluence	SEFI?
1.00×10^4	Ar	9.75	25 sec	2.45×10^5	No
1.00×10^4			50 sec	4.88×10^5	No
1.00×10^4			75 sec	7.15×10^5	No
1.00×10^4			100 sec	9.53×10^5	Yes
1.00×10^2	Cu	24.54	5 min	4.43×10^4	No
1.00×10^2			10 min	8.79×10^4	No
1.00×10^2			15 min	1.28×10^5	No
1.00×10^2			20 min	1.71×10^5	No
1.00×10^2			25 min	2.16×10^5	No
1.00×10^2			30 min	2.56×10^5	No
1.00×10^2			35 min	3.00×10^5	Yes
1.00×10^2	Ag	57.73	5 min	3.92×10^4	No
1.00×10^2			20 min	1.60×10^5	No
1.00×10^2			25 min	2.00×10^5	No
1.00×10^2			30 min	2.39×10^5	Yes

Table 2-3. SET Event Rate Calculations of SEFIs for Worst-Week LEO and GEO Orbits

Orbit Type	Onset LET_{EFF} (MeV-cm^2/mg)	σSAT (cm^2)	Event Rate (/day)	Event Rate (FIT)	MTBE (Years)
LEO (ISS)	1	2.33×10^{-5}	9.48×10^{-5}	3.95×10^3	2.89×10^1
GEO			8.29×10^{-4}	3.45×10^3	3.30

2.3.1.4 Radiation Lot Acceptance Testing

For consistent radiation performance across production lots, radiation lot acceptance testing (RLAT) is also implemented. For each wafer lot, five representative units are subjected to exposure up to 100krad(Si).

2.3.1.5 Outgassing ASTM E595 Compliance

The AFE7950-SP complies with the ASTM E595 standards for low outgassing. Outgassing tests were performed on five units in a vacuum below 5 × 10-5Torr for 24 hours at 125℃ . Materials were screened using total mass loss (TML) ≤ 1% and collected condensable material (CVCM) ≤ 0.1% thresholds.

Table 2-4. Outgas Test Results

Sample	Material	TML 1%	CVCM < 0.1%
AFE7950ALKSHP	Underfill	PASS	PASS
AFE7950ALKSHP	Substrate	PASS	PASS
AFE7950ALKSHP	TIM	PASS	PASS

This compliance minimizes the risk of contaminating sensitive optical or thermal surfaces within spacecraft, enhancing mission longevity and performance. Indeed, materials used in the AFE7950-SP are compliant.

2.3.2 Benefits for SATCOM

The radiation tolerance of the AFE7950-SP translates directly into reliability for satellite communication systems. The device remains operational even under intense cosmic radiation since the device is immune to SEL, which eliminates the need for complex latch-up protection circuitry. This is particularly advantageous for LEO, MEO, and GEO missions, where exposure to high-energy particles is a constant concern.

Moreover, the device continues to perform reliably even after being exposed to radiation, which helps maintain a strong signal of high quality and stabilizes the operation of the system. The combination of high RF performance (up to a 12GHz operation with 12 GSPS DACs and three GSPS ADCs) and space-grade reliability makes the AFE7950-SP a compelling choice for:

- Satellite communication

- Phased array antennas
- Beamforming systems
- High-throughput satellite links

2.4 Power Consumption Optimization

The AFE7950-SP has been designed with a flexible power architecture that allows engineers to optimize energy usage according to mission requirements. Power consumption varies significantly depending on:

- Number of active channels
- JESD interface configuration
- Digital processing settings (for example, interpolation or decimation)

2.4.1 Power Mode Configuration

2.4.1.1 Rx Only Mode

In this mode, only the four ADCs are enabled while all DACs remain on standby in TDD mode. Under these conditions, the device consumes approximately 4.85W.

2.4.1.1.1 Use Case of Rx Mode

This configuration is typically used for narrowband monitoring or low-data-rate telemetry applications where energy efficiency is critical.

2.4.1.1.2 Benefits of Rx Mode

In Rx mode, the JESD lanes are minimized. Operating at lower power modes can reduce thermal stress and contribute to long term reliability in harsh environments.

Table 2-5. Electrical Characteristics in Rx Mode

Typical values at T_A = +25°C, full temperature range is $T_{A,MIN}$ = -40°C to $T_{J,MAX}$ = +110°C; TX Input Rate = 491.52MSPS, f_{DAC} = 8847.36MSPS interleave mode; f_{ADC} = 2949.12MSPS; nominal power supplies; 1 tone at -1 dBFS; DSA Attenuation =0dB; SerDes rate = 24.33Gbps; unless otherwise noted.

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{VDD1P8}	Group 3A: VDD1P8FB + VDD1P8RX + VDD1P8TX	Mode 7b: TDD 4R (TX in Standby) TX 9G and FB 3G -16bit: 368.64M; DSA = 6dB, , non-interleave mode, Standby RX 3G : 368.64M. 16 bit Serdes: 25gbps) -> 2 lanes for Rx/FB (lane shared) and 2lanes for Tx		789.5		mA
	Group 3B: VDD1P8FBCLK + VDD1P8RXCLK + VDD1P8TXDAC+ VDD1P8GPIO + VDDA1P8			471.3		mA
	Group 3C: VDD1P8PLL + VDD1P8PLLVCO			73.4		mA
I_{VDD1P2}	Group 2A: VDD1P2FB + VDD1P2RX			599.3		mA
	Group 2B: VDD1P2TXCLK + VDD1P2TXENC			169.6		mA
	Group 2C: VDD1P2FBCML + VDD1P2RXCML + VDD1P2PLLCLKREF			39.1		mA
I_{VDD0P9}	Group 1A: DVDD0P9 + VDDT0P9			1645.3		mA
P_{diss}	Power Dissipation			4851.9		mW

2.4.1.2 Typical Operation Mode

This configuration, operating in TDD mode with a 4T4R1FB setup, offers a balanced compromise between performance and power efficiency with a total power dissipation of 7.62W. While moderately scaled in terms of sampling rates and JESD204 throughput, the mode remains highly capable for SATCOM applications:

- Supports wideband transmission at 8GHz (X-band)
- Provides robust data delivery through high speed JESD204 links
- Enables real-time monitoring and adaptive calibration through feedback channel
- Benefits systems that prioritize uplink (for example, airborne or mobile terminals) through TDD structure
- Designed for platforms with tight thermal and energy constraints

Table 2-6. Electrical Characteristics of Typical Operation Mode

Typical values at T_A = +25°C, full temperature range is $T_{A,MIN}$ = -40°C to $T_{J,MAX}$ = +110°C; TX Input Rate = 491.52MSPS, f_{DAC} = 8847.36MSPS interleave mode; f_{ADC} = 2949.12MSPS; nominal power supplies; 1 tone at -1 dBFS; DSA Attenuation =0dB; SerDes rate = 24.33Gbps; unless otherwise noted.

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{VDD1P8}	Group 3A: VDD1P8FB + VDD1P8RX + VDD1P8TX	Mode 7b: TDD 4R (TX in Standby)TX 9G and FB 3G - 16bit: 368.64M; DSA = 6dB, non-interleave mode, Standby RX 3G : 368.64M. 16 bitSerdes: 25gbps) → 2 lanes for Rx/FB (lane shared) and 2 lanes for Tx		789.5		mA
	Group 3B: VDD1P8FBCLK + VDD1P8RXCLK + VDD1P8TXDAC + VDD1P8GPIO + VDDA1P8			471.3		mA
	Group 3C: VDD1P8PLL + VDD1P8PLLVCO			73.4		mA
I_{VDD1P2}	Group 2A: VDD1P2FB + VDD1P2RX			599.3		mA
	Group 2B: VDD1P2TXCLK + VDD1P2TXENC			169.6		mA
	Group 2C: VDD1P2FBCML + VDD1P2RXCML + VDD1P2PLLCLKREF			39.1		mA
I_{VDD0P9}	Group 1A: DVDD0P9 + VDDT0P9			1645.3		mA
P_{diss}	Power Dissipation			4851.9		mW

2.4.1.3 4T4R FDD Mode

4T4R FDD mode has all four ADCs and all four DACs enabled, operating at full sampling rates of 3 GSPS and 12 GSPS, respectively. In this configuration, the device reaches a peak consumption of approximately 10.640W.

Additional features of this mode include:

- Sustains a high data rate through a fully populated JESD interface (eight lanes for the transmit and four for the receive)
- Internal digital processing blocks operate at full capacity to handle interpolation and decimation for bandwidth shaping

Table 2-7. Electrical Characteristics of 4T4R FDD Mode

Typical values at T_A = +25°C, full temperature range is $T_{A,MIN}$ = -40°C to $T_{J,MAX}$ = +110°C; TX Input Rate = 491.52MSPS, f_{DAC} = 8847.36MSPS interleave mode; f_{ADC} = 2949.12MSPS; nominal power supplies; 1 tone at -1 dBFS; DSA Attenuation =0dB; SerDes rate = 24.33Gbps; unless otherwise noted.

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{VDD1P8}	Group 3A: VDD1P8FB + VDD1P8RX + VDD1P8TX	Mode 11d: FDD 4T4RSingle Band: 8x Int, RX uses FBTX/FB/RX Rate = 1474.56Msps f_{DAC} = 11796.48MSPS f_{ADC} = 2949.12MSPS f_{TX} = f_{RX} = 8GHz 64/66 coding, 24.33Gbps TX: 8-8-2-1, FB/RX: 4-4-4-2		1260		mA
	Group 3B: VDD1P8FBCLK + VDD1P8RXCLK + VDD1P8TXDAC + VDD1P8GPIO + VDDA1P8			940		mA
	Group 3C: VDD1P8PLL + VDD1P8PLLVCO			73		mA
I_{VDD1P2}	Group 2A: VDD1P2FB + VDD1P2RX			630		mA
	Group 2B: VDD1P2TXCLK + VDD1P2TXENC			1480		mA
	Group 2C: VDD1P2FBCML + VDD1P2RXCML + VDD1P2PLLCLKREF			78		mA
I_{VDD0P9}	Group 1A: DVDD0P9 + VDDT0P9			4200		mA
P_{diss}	Power Dissipation			10640		mW

2.4.1.3.1 4T4R FDD Mode Use Case

This configuration is recommended for high-throughput SATCOM payloads where multiple beams or wideband channels are active simultaneously.

2.4.2 Power-Saving Strategies

The AFE7950-SP offers several methods to optimize power usage.

2.4.2.1 Low Power Operation Mode

2.4.2.1.1 Standby Mode

Standby mode disables data converters but keeps the clocking and JESD interfaces active. During idle slots, the corresponding chains can be placed in standby to save power while remaining ready for fast switching. This method allows the system to maintain synchronization and resume operation almost instantly without needing to re-lock PLLs or reinitialize JESD links.

Some features of standby mode include:

- Wake-up time: less than 2µs
- Control: configured through SPI, activated through GPIO
- Use case: appropriate for TDD-based SATCOM systems with alternating Tx and Rx slots
- Benefit: maintains synchronization and allows near-instant recovery without re-locking PLLs or reinitializing JESD links

2.4.2.1.2 Sleep Mode

Sleep mode reduces power consumption even further compared to standby mode. However, sleep mode also requires a long wake-up time because JESD links are completely shut down and must be re-established.

Some features of sleep mode include:

- Wake-up time: longer than standby mode due to reinitialization requirements
- Control: managed through SPI or SLEEP GPIO pin
- Use case: designed for long, idle periods in energy-constrained systems when full operation is not needed

Table 2-8. Electrical Characteristics of Sleep Mode

Typical values at T_A = +25°C, full temperature range is $T_{A,MIN}$ = -40°C to $T_{J,MAX}$ = +110°C; TX Input Rate = 491.52MSPS, f_{DAC} = 8847.36MSPS interleave mode; f_{ADC} = 2949.12MSPS; nominal power supplies; 1 tone at -1 dBFS; DSA Attenuation =0dB; SerDes rate = 24.33Gbps; unless otherwise noted.

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{VDD1P8}	Group 3A: VDD1P8FB + VDD1P8RX + VDD1P8TX	Mode 8: same configuration as mode 7, Sleep Mode. SLEEP pin is pull high.		20.3		mA
	Group 3B: VDD1P8FBCLK + VDD1P8RXCLK + VDD1P8TXDAC + VDD1P8GPIO + VDDA1P8			292.8		mA
	Group 3C: VDD1P8PLL + VDD1P8PLLVCO			12.6		mA
I_{VDD1P2}	Group 2A: VDD1P2FB + VDD1P2RX			4.6		mA
	Group 2B: VDD1P2TXCLK + VDD1P2TXENC			54.3		mA
	Group 2C: VDD1P2FBCML + VDD1P2RXCML + VDD1P2PLLCLKREF			15.3		mA
I_{VDD0P9}	Group 1A: DVDD0P9 + VDDT0P9			313.1		mA
P_{diss}	Power Dissipation			956.8		mW

2.4.3 Benefits of Sleep and Standby Mode for SATCOM

The trade-off between sleep mode and standby mode is clear. Standby mode offers fast recovery at slightly higher power, while sleep provides maximum energy savings at the cost of slower wakeup. For SATCOM, both modes are valuable for enabling energy efficiency, thermal management, quick recovery, and flexible control.

The AFE7950-SP provides a wide operational envelope, enabling designers to balance performance and power efficiency through careful configuration of active channels, JESD lane allocation, and digital processing parameters.

3 Conclusion

In conclusion, the AFE7950 combines spectral flexibility, radiation robustness, and power efficiency in a single, highly integrated design. The proven radiation tolerance of the device maintains reliability in harsh space environments. The wide frequency coverage, advanced JESD204B and JESD204C features, and dynamic configuration options of the device allow designers to improve performance for diverse mission profiles while minimizing size, weight, and power.

An SEP version of the AFE7950 is in development, further enhancing the scalability and capability of the device to support multiple mission profiles, such as LEO missions. Looking ahead, multiple AFE configurations can usher in advanced phased-array and multiple-input multiple-output (MIMO) systems, enabling higher capacities and more resilient satellite links. These capabilities make the AFE7950 a versatile and future-ready choice for the next generation of SATCOM platforms.

4 References

- Agoro, Yusuf (July 2020). How to Achieve Frequency Hopping With the AFE79xx, Texas Instruments' application report.
- Guibord, Matt (April 2015). JESD204B Multi-Device Synchronization: Breaking Down the Requirements, Texas Instruments' analog design journal
- Iyer, Srinivasan and Murphy, Srinivas (May 2023). AFE79xx as a Single Chip Wideband Repeater Solution, Texas Instruments' application note.
- Texas Instruments, AFE7950-SP Production Flow and Reliability Report, radiation report.
- Texas Instruments, AFE7950-SP Total Ionizing Dose (TID) Radiation Report, radiation report.
- Texas Instruments, AFE7950-x 4T6R RF Sampling AFE with 12GSPS DACs and 3GSPS ADCs, datasheet.