

## AWR1243 シングルチップ 77 および 79GHz FMCW トランシーバ

### 1 特長

- FMCW トランシーバ
  - PLL、トランスミッタ、レシーバ、ベースバンド、ADC を内蔵
  - 76~81GHz 帯で使用可能帯域幅 4GHz
  - 4 つの受信チャネル
  - 3 つの送信チャネル (2 つを同時に使用可能)
  - フラクショナル N PLL を使用した超高精度のチャープエンジン
  - TX 出力: 12dBm
  - RX ノイズ指数:
    - 14dB (76~77GHz)
    - 15dB (77~81GHz)
  - 1MHz での位相ノイズ:
    - -95dBc/Hz (76~77GHz)
    - -93dBc/Hz (77~81GHz)
- 較正および自己テストを内蔵
  - 内蔵ファームウェア (ROM)
  - プロセスおよび温度の自己較正システム
- ホスト・インターフェイス
  - SPI で外部プロセッサと通信可能な制御インターフェイス
  - MIPI D-PHY および CSI2 V1.1 で外部プロセッサと通信可能なデータ・インターフェイス
  - 割り込みによるフォルト通知
- 機能安全準拠
  - 機能安全アプリケーション向けに開発
  - ASIL-D までの ISO 26262 機能安全システム設計に役立つ資料を入手可能
  - ASIL-B までのハードウェア安全度
  - 安全関連認証
    - TUV SUD により ISO 26262 認証済み (ASIL B まで)
- AEC-Q100 認定済み
- デバイスの高度な機能
  - ホスト・プロセッサの関与を必要としない自己監視機能を内蔵
  - 複素ベースバンド・アーキテクチャ
  - 干渉検出機能を内蔵
- パワー・マネージメント
  - 内蔵 LDO ネットワークにより PSRR の向上を実現
  - I/O は 3.3V/1.8V のデュアル電圧に対応
- クロック・ソース
  - 40MHz の外部駆動クロック (方形波 / 正弦波) をサポート
  - 負荷コンデンサ付きの 40MHz 水晶振動子接続をサポート
- ハードウェア設計が簡単
  - 組み立てが簡単で低コストの PCB を設計できる 0.65mm ピッチ、161 ピン、10.4mm × 10.4mm のフリップチップ BGA パッケージ
  - 小型ソリューション・サイズ
- 動作条件
  - 接合部温度範囲: -40°C ~ 125°C



## 2 アプリケーション

- 距離、速度、角度測定向け車載用センサ
- ハイウェイでの自動運転

- 自動緊急ブレーキ
- アダプティブ・クルーズ・コントロール

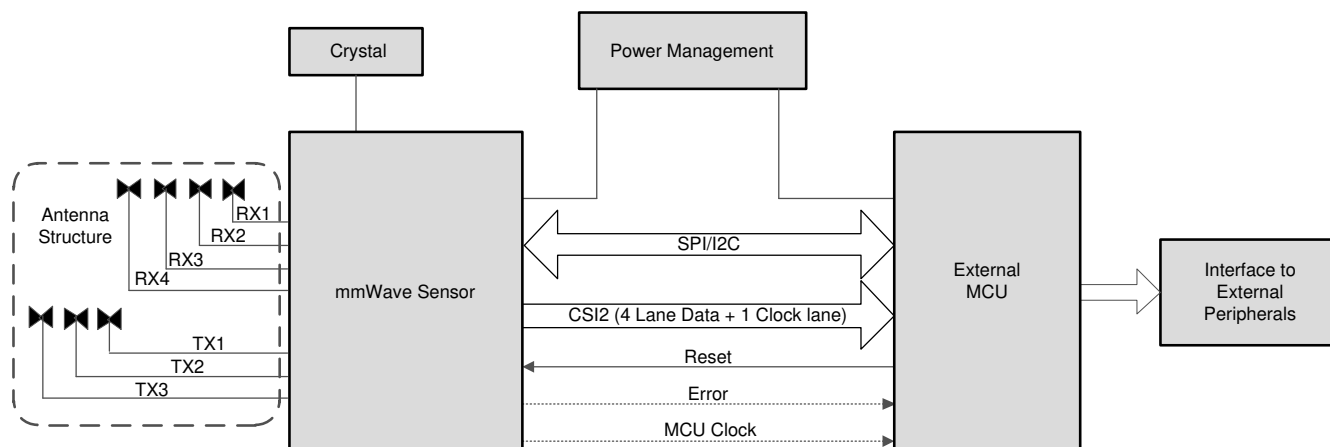


図 2-1. 車載用アプリケーション向け自律レーダー・センサ

## 3 概要

AWR1243 は、76～81GHz 帯で動作可能な統合型シングルチップ FMCW トランシーバです。超小型のフォームファクタで、かつてないレベルの統合を実現しています。AWR1243 は、低消費電力で自己監視機能を備えた超高精度の車載用レーダー・システムに最適なソリューションです。

AWR1243 デバイスは、76～81GHz 帯車載用レーダー・センサの実装を簡単にする自己完結型 FMCW トランシーバ・シングルチップ・ソリューションです。TI の低消費電力 45nm RFCMOS プロセスで製造され、PLL および A/D コンバータを内蔵する 3TX/4RX システムのモノリシック実装を実現しています。プログラミング・モデルを変更するだけで、さまざまなセンサ (短距離、中距離、長距離) を実装でき、マルチモード・センサの実装においては動的再構成にも対応します。また本デバイスは、TI のリファレンス・デザイン、ソフトウェア・ドライバ、構成例、API ガイド、ユーザー・マニュアルを含む完全なプラットフォーム・ソリューションとして提供しています。

### 製品情報

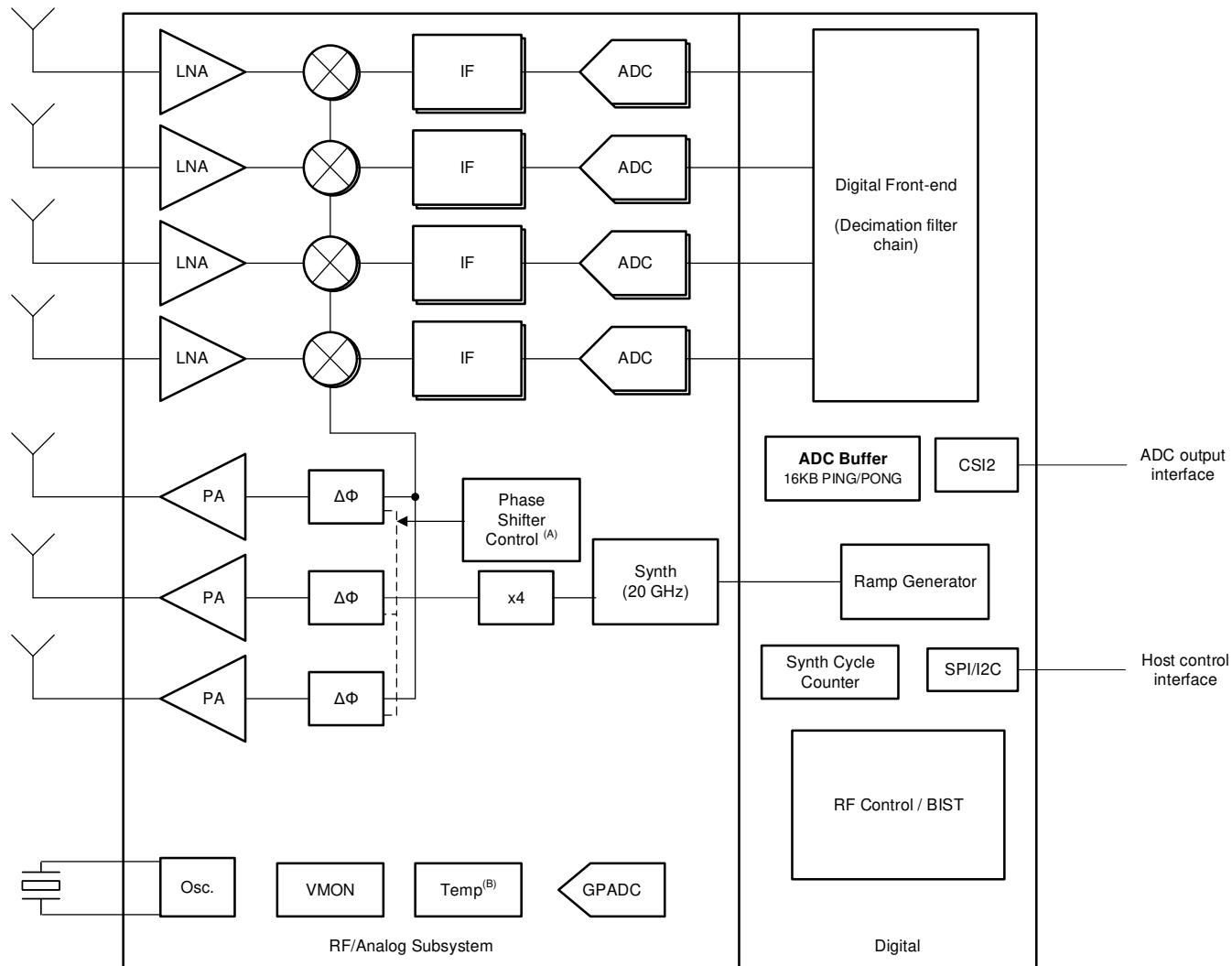
| 部品番号 <sup>(2)</sup> | パッケージ <sup>(1)</sup> | 本体サイズ           | トレイ / テープ・アンド・リール |
|---------------------|----------------------|-----------------|-------------------|
| AWR1243FBIGABLQ1    | FCBGA (161)          | 10.4mm × 10.4mm | トレイ               |
| AWR1243FBIGABLRQ1   |                      |                 | テープ・アンド・リール       |

(1) 詳細については、[セクション 13](#)、「メカニカル、パッケージ、および注文情報」を参照してください。

(2) 詳細については、[セクション 12.1](#)「デバイスの命名規則」を参照してください。

## 4 Functional Block Diagram

4-1 shows the functional block diagram of the device.



A. Phase Shift Control:

- 0° / 180° BPM for AWR1243

B. Internal temperature sensor accuracy is  $\pm 7^\circ\text{C}$ .

**4-1. Functional Block Diagram**

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## 5 Revision History

### Changes from May 1, 2020 to December 8, 2021 (from Revision C (May 2020) to Revision D (December 2021))

|                                                                                                                                                                                                                                                          | Page |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| • グローバル:機能安全準拠および関連する認証資料を反映して更新.....                                                                                                                                                                                                                    | 1    |
| • グローバル:「A2D」を「ADC」に置き換え、マスタ・サブシステムおよびマスタ R4F をメイン・サブシステムおよびメイン R4F に変更、マスタ / スレーブの用語をより包括的な言葉遣いに移行.....                                                                                                                                                 | 1    |
| • (特長):ミリ波センサ固有の動作温度範囲について説明.....                                                                                                                                                                                                                        | 1    |
| • (アプリケーション):図を修正し、アプリケーションのリンクを更新.....                                                                                                                                                                                                                  | 2    |
| • (製品情報): 量産開始前の注文可能型番 (XA1243FPBGABL) を表および関連する特長から削除.....                                                                                                                                                                                              | 2    |
| • Updated/Changed <i>Functional Block Diagram</i> to remove XA1243FPBGABL OPN specific features.....                                                                                                                                                     | 3    |
| • (Device Comparison) : Removed a row on Functionality-Safety compliance and instead added a table-note for this and LVDS Interface; modified the existing table-note on simultaneous TX operation; Additional information on Device security added..... | 6    |
| • (Device Comparison) : Updated/Changed RF Specification Receiver from "Max real sampling rate (Msps)" to "Max real/complex 2x sampling rate (Msps)"; and "Max complex sampling rate (Msps)" to "Max complex 1x sampling rate (Msps)".....               | 6    |
| • (Signal Descriptions): Removed XA1243FPBGABL OPN specific pin functions; updated descriptions for CLKP and CLKM pins for Reference Oscillator.....                                                                                                     | 12   |
| • (Absolute Maximum Ratings): Added entries for externally supplied power on the RF inputs (TX and RX) and a table-note for the signal level applied on TX.....                                                                                          | 16   |
| • (Power Supply Specifications): Updated/Changed footnote in 表 8-1 .....                                                                                                                                                                                 | 18   |
| • (Maximum Current Rating at Power Terminals): Updated footnotes section to add estimation assumption for VIOIN rail.....                                                                                                                                | 19   |
| • (Average Power Consumption at Power Terminals): Removed 3TX, 4RX power numbers since only 2TX are operational simultaneously in the device.....                                                                                                        | 19   |
| • (RF Specification): Updated/Changed RF Specification Receiver from "A2D sampling rate (complex)" to "ADC sampling rate (complex 1x)"; and "A2D sampling rate (real)" to "ADC sampling rate (real/complex 2x)".....                                     | 20   |
| • (RF Specification): Updated/Changed the table to remove XA1243FPBGABL specific features.....                                                                                                                                                           | 20   |
| • (Synchronized Frame Triggering): Updated the maximum pulse width to 4ns.....                                                                                                                                                                           | 22   |
| • (Clock Specifications): Updated/Changed 表 8-6 to reflect correct device operating temperature range.....                                                                                                                                               | 24   |
| • (Table. External Clock Mode Specifications): Revised frequency tolerance specs from +/-50 to +/-100 ppm.....                                                                                                                                           | 24   |
| • (Switching Characteristics for Output Timing versus Load Capacitance): Updated/Modified the table to remove Slew Rate = 1 condition; removed a footnote.....                                                                                           | 30   |
| • 図 9-1: Updated the figure to remove XA1243FPBGABL OPN specific features. ....                                                                                                                                                                          | 33   |
| • (Monitoring and Diagnostic Mechanisms): Added a new section.....                                                                                                                                                                                       | 39   |
| • (Reference Schematics) : Added weblinks to AWR1243 EVM documentation collateral .....                                                                                                                                                                  | 43   |
| • (Device Nomenclature):Updated/changed Device Nomenclature .....                                                                                                                                                                                        | 44   |

## 6 Device Comparison

| FUNCTION                                              | AWR1243 <sup>(1)</sup>                                                        | AWR1443 | AWR1642 | AWR1843          |
|-------------------------------------------------------|-------------------------------------------------------------------------------|---------|---------|------------------|
| Number of receivers                                   | 4                                                                             | 4       | 4       | 4                |
| Number of transmitters                                | 3                                                                             | 3       | 2       | 3                |
| On-chip memory                                        | —                                                                             | 576KB   | 1.5MB   | 2MB              |
| Max I/F (Intermediate Frequency) (MHz)                | 15                                                                            | 5       | 5       | 10               |
| Max real/complex 2x sampling rate (Msps)              | 37.5                                                                          | 12.5    | 12.5    | 25               |
| Max complex 1x sampling rate (Msps)                   | 18.75                                                                         | 6.25    | 6.25    | 12.5             |
| Device Security <sup>(2)</sup>                        | —                                                                             | —       | Yes     | Yes              |
| <b>Processor</b>                                      |                                                                               |         |         |                  |
| MCU (R4F)                                             | —                                                                             | Yes     | Yes     | Yes              |
| DSP (C674x)                                           | —                                                                             | —       | Yes     | Yes              |
| <b>Peripherals</b>                                    |                                                                               |         |         |                  |
| Serial Peripheral Interface (SPI) ports               | 1                                                                             | 1       | 2       | 2                |
| Quad Serial Peripheral Interface (QSPI)               | —                                                                             | Yes     | Yes     | Yes              |
| Inter-Integrated Circuit (I <sup>2</sup> C) interface | —                                                                             | 1       | 1       | 1                |
| Controller Area Network (DCAN) interface              | —                                                                             | Yes     | Yes     | Yes              |
| CAN-FD                                                | —                                                                             | —       | Yes     | Yes              |
| Trace                                                 | —                                                                             | —       | Yes     | Yes              |
| PWM                                                   | —                                                                             | —       | Yes     | Yes              |
| Hardware In Loop (HIL/DMM)                            | —                                                                             | —       | Yes     | Yes              |
| GPADC                                                 | —                                                                             | Yes     | Yes     | Yes              |
| LVDS/Debug <sup>(3)</sup>                             | Yes                                                                           | Yes     | Yes     | Yes              |
| CSI2                                                  | Yes                                                                           | —       | —       | —                |
| Hardware accelerator                                  | —                                                                             | Yes     | —       | Yes              |
| 1-V bypass mode                                       | Yes                                                                           | Yes     | Yes     | Yes              |
| Cascade (20-GHz sync)                                 | —                                                                             | —       | —       | —                |
| JTAG                                                  | —                                                                             | Yes     | Yes     | Yes              |
| Number of Tx that can be simultaneously used          | 2                                                                             | 2       | 2       | 3 <sup>(4)</sup> |
| Per chirp configurable Tx phase shifter               | —                                                                             | —       | —       | Yes              |
| Product status <sup>(5)</sup>                         | PRODUCT PREVIEW (PP),<br>ADVANCE INFORMATION (AI),<br>or PRODUCTION DATA (PD) | PD      | PD      | PD               |

- (1) Developed for Functional Safety applications, the device supports hardware integrity upto ASIL-B. Refer to the related documentation for more details.
- (2) Device security features including Secure Boot and Customer Programmable Keys are available in select devices for only select part variants as indicated by the Device Type identifier in Section 3, Device Information table.
- (3) The LVDS interface is not a production interface and is only used for debug.
- (4) 3 Tx Simultaneous operation is supported only in AWR1843 with 1V LDO bypass and PA LDO disable mode. In this mode 1V supply needs to be fed on the VOUT PA pin. Rest of the other devices only support simultaneous operation of 2 Transmitters.
- (5) PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

## 6.1 Related Products

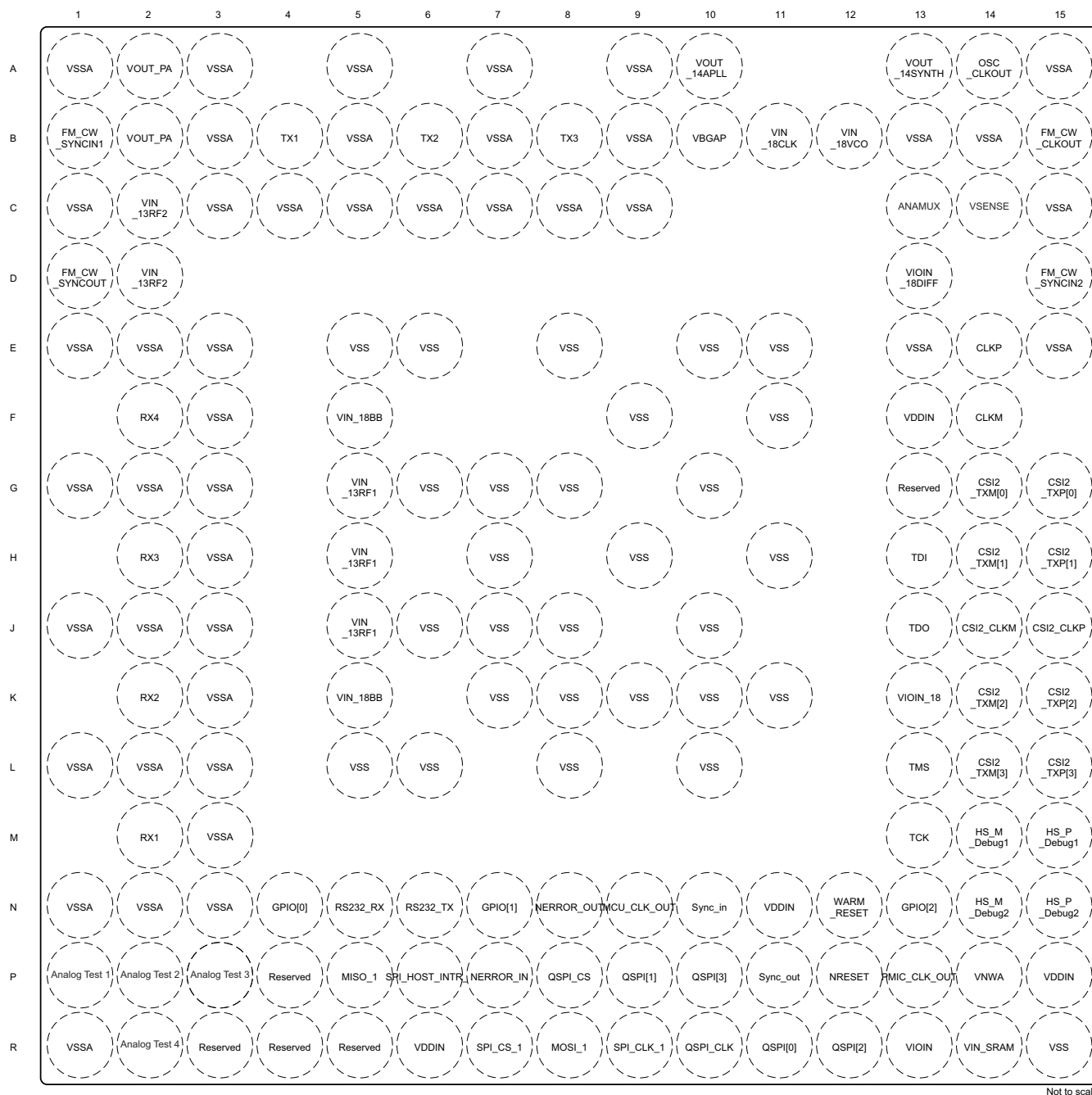
For information about other devices in this family of products or related products see the links that follow.

- |                                       |                                                                                                                                                                                                                                                                                                                                                                                  |
|---------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>mmWave Sensors</b>                 | TI's mmWave sensors rapidly and accurately sense range, angle and velocity with less power using the smallest footprint mmWave sensor portfolio for automotive applications.                                                                                                                                                                                                     |
| <b>Automotive mmWave Sensors</b>      | TI's automotive mmWave sensor portfolio offers high-performance radar front end to ultra-high resolution, small and low-power single-chip radar solutions. TI's scalable sensor portfolio enables design and development of ADAS system solution for every performance, application and sensor configuration ranging from comfort functions to safety functions in all vehicles. |
| <b>Companion Products for AWR1243</b> | Review products that are frequently purchased or used in conjunction with this product.                                                                                                                                                                                                                                                                                          |

## 7 Terminal Configuration and Functions

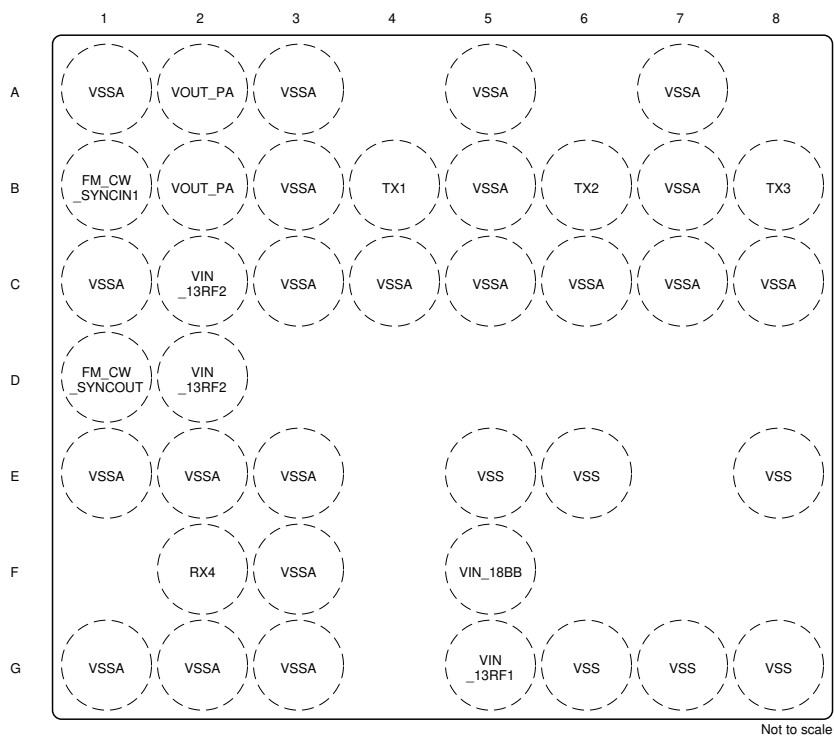
### 7.1 Pin Diagram

Figure 7-1 shows the pin locations for the 161-pin FCBGA package. Figures 7-2, 7-3, 7-4, and 7-5 show the same pins, but split into four quadrants.



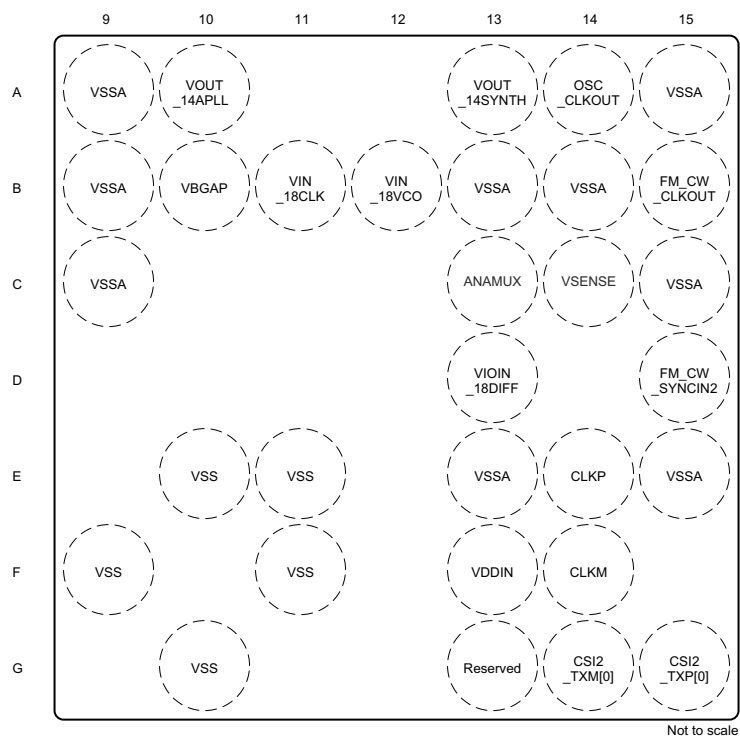
Not to scale

Figure 7-1. Pin Diagram



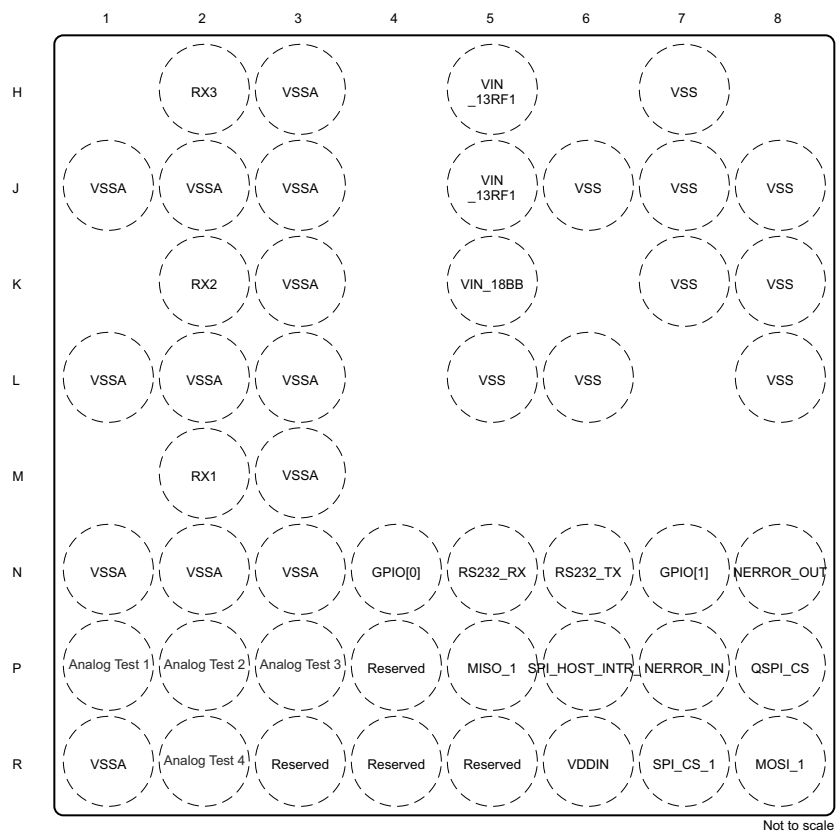
|   |   |
|---|---|
| 1 | 2 |
| 3 | 4 |

## 7-2. Top Left Quadrant



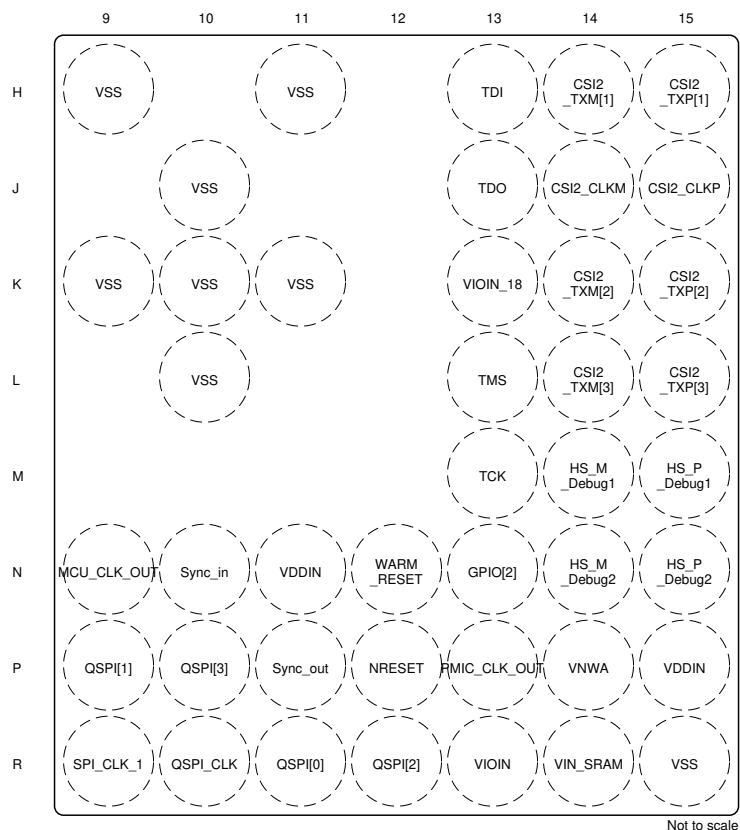
|   |   |
|---|---|
| 1 | 2 |
| 3 | 4 |

## 7-3. Top Right Quadrant



|   |   |
|---|---|
| 1 | 2 |
| 3 | 4 |

**7-4. Bottom Left Quadrant**



Not to scale

|   |   |
|---|---|
| 1 | 2 |
| 3 | 4 |

**7-5. Bottom Right Quadrant**

## 7.2 Signal Descriptions

セクション 7.2.1 lists the pins by function and describes that function.

### 注

All IO pins of the device (except NERROR\_IN, NERROR\_OUT, and WARM\_RESET) are non-failsafe; hence, care needs to be taken that they are not driven externally without the VIO supply being present to the device.

### 7.2.1 Signal Descriptions

| FUNCTION               | SIGNAL NAME   | PIN NUMBER | PIN TYPE | DEFAULT PULL STATUS <sup>(1)</sup> | DESCRIPTION                                                                                                             |
|------------------------|---------------|------------|----------|------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| Transmitters           | TX1           | B4         | O        | —                                  | Single-ended transmitter1 o/p                                                                                           |
|                        | TX2           | B6         | O        | —                                  | Single-ended transmitter2 o/p                                                                                           |
|                        | TX3           | B8         | O        | —                                  | Single-ended transmitter3 o/p                                                                                           |
| Receivers              | RX1           | M2         | I        | —                                  | Single-ended receiver1 i/p                                                                                              |
|                        | RX2           | K2         | I        | —                                  | Single-ended receiver2 i/p                                                                                              |
|                        | RX3           | H2         | I        | —                                  | Single-ended receiver3 i/p                                                                                              |
|                        | RX4           | F2         | I        | —                                  | Single-ended receiver4 i/p                                                                                              |
| CSI2 TX                | CSI2_TXP[0]   | G15        | O        | —                                  | Differential data Out – Lane 0 (for CSI and LVDS debug interface)                                                       |
|                        | CSI2_TXM[0]   | G14        | O        | —                                  |                                                                                                                         |
|                        | CSI2_CLKP     | J15        | O        | —                                  | Differential clock Out (for CSI and LVDS debug interface)                                                               |
|                        | CSI2_CLKM     | J14        | O        | —                                  |                                                                                                                         |
|                        | CSI2_TXP[1]   | H15        | O        | —                                  | Differential data Out – Lane 1 (for CSI and LVDS debug interface)                                                       |
|                        | CSI2_TXM[1]   | H14        | O        | —                                  |                                                                                                                         |
|                        | CSI2_TXP[2]   | K15        | O        | —                                  | Differential data Out – Lane 2 (for CSI and LVDS debug interface)                                                       |
|                        | CSI2_TXM[2]   | K14        | O        | —                                  |                                                                                                                         |
|                        | CSI2_TXP[3]   | L15        | O        | —                                  | Differential data Out – Lane 3 (for CSI and LVDS debug interface)                                                       |
|                        | CSI2_TXM[3]   | L14        | O        | —                                  |                                                                                                                         |
|                        | HS_DEBUG1_P   | M15        | O        | —                                  | Differential debug port 1 (for LVDS debug interface)                                                                    |
|                        | HS_DEBUG1_M   | M14        | O        | —                                  |                                                                                                                         |
|                        | HS_DEBUG2_P   | N15        | O        | —                                  | Differential debug port 2 (for LVDS debug interface)                                                                    |
|                        | HS_DEBUG2_M   | N14        | O        | —                                  |                                                                                                                         |
| Reserved Space         | FM_CW_CLKOUT  | B15        | O        | —                                  | Reserved Signal. Not applicable in AWR1243.                                                                             |
|                        | FM_CW_SYNCOUT | D1         |          |                                    |                                                                                                                         |
|                        | FM_CW_SYNCIN1 | B1         | I        | —                                  | Reserved Signal. Not applicable in AWR1243.                                                                             |
|                        | FM_CW_SYNCIN2 | D15        |          |                                    |                                                                                                                         |
| Reference clock        | OSC_CLKOUT    | A14        | O        | —                                  | Reference clock output from clocking subsystem after cleanup PLL. Can be used by peripheral chip in multichip cascading |
| System synchronization | SYNC_OUT      | P11        | O        | Pull Down                          | Low-frequency frame synchronization signal output. Can be used by peripheral chip in multichip cascading                |
|                        | SYNC_IN       | N10        | I        | Pull Down                          | Low-frequency frame synchronization signal input. This signal could also be used as a hardware trigger for frame start  |

| FUNCTION                                                          | SIGNAL NAME               | PIN NUMBER     | PIN TYPE | DEFAULT PULL STATUS <sup>(1)</sup> | DESCRIPTION                                                                                                                                                                                                                                                                                                                                |
|-------------------------------------------------------------------|---------------------------|----------------|----------|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SPI control interface from external MCU (default peripheral mode) | SPI_CS_1                  | R7             | I        | Pull Up                            | SPI chip select                                                                                                                                                                                                                                                                                                                            |
|                                                                   | SPI_CLK_1                 | R9             | I        | Pull Down                          | SPI clock                                                                                                                                                                                                                                                                                                                                  |
|                                                                   | MOSI_1                    | R8             | I        | Pull Up                            | SPI data input                                                                                                                                                                                                                                                                                                                             |
|                                                                   | MISO_1                    | P5             | O        | Pull Up                            | SPI data output                                                                                                                                                                                                                                                                                                                            |
|                                                                   | SPI_HOST_INTR_1           | P6             | O        | Pull Down                          | SPI interrupt to host                                                                                                                                                                                                                                                                                                                      |
|                                                                   | RESERVED                  | R3, R4, R5, P4 |          | —                                  |                                                                                                                                                                                                                                                                                                                                            |
| Reset                                                             | NRESET                    | P12            | I        | —                                  | Power on reset for chip. Active low                                                                                                                                                                                                                                                                                                        |
|                                                                   | WARM_RESET <sup>(2)</sup> | N12            | IO       | Open Drain                         | Open-drain fail-safe warm reset signal. Can be driven from PMIC for diagnostic or can be used as status signal that the device is going through reset.                                                                                                                                                                                     |
| Sense on Power                                                    | SOP2                      | P13            | I        | —                                  | The SOP pins are driven externally (weak drive) and the AWR device senses the state of these pins during bootup to decide the bootup mode. After boot the same pins have other functionality.<br>[SOP2 SOP1 SOP0] = [0 0 1] → Functional SPI mode<br>[SOP2 SOP1 SOP0] = [1 0 1] → Flashing mode<br>[SOP2 SOP1 SOP0] = [0 1 1] → debug mode |
|                                                                   | SOP1                      | P11            | I        |                                    |                                                                                                                                                                                                                                                                                                                                            |
|                                                                   | SOP0                      | J13            | I        |                                    |                                                                                                                                                                                                                                                                                                                                            |
| Safety                                                            | NERROR_OUT                | N8             | O        | Open Drain                         | Open-drain fail-safe output signal. Connected to PMIC/Processor/MCU to indicate that some severe criticality fault has happened. Recovery would be through reset.                                                                                                                                                                          |
|                                                                   | NERROR_IN                 | P7             | I        | Open Drain                         | Fail-safe input to the device. Error output from any other device can be concentrated in the error signaling monitor module inside the device and appropriate action can be taken by firmware                                                                                                                                              |
| JTAG                                                              | TMS                       | L13            | I        | Pull Up                            | JTAG port for TI internal development                                                                                                                                                                                                                                                                                                      |
|                                                                   | TCK                       | M13            | I        | Pull Down                          |                                                                                                                                                                                                                                                                                                                                            |
|                                                                   | TDI                       | H13            | I        | Pull Up                            |                                                                                                                                                                                                                                                                                                                                            |
|                                                                   | TDO                       | J13            | O        | —                                  |                                                                                                                                                                                                                                                                                                                                            |
| Reference oscillator                                              | CLKP                      | E14            | I        | —                                  | In XTAL mode: Input for the reference crystal<br>In External clock mode: Single ended input reference clock port                                                                                                                                                                                                                           |
|                                                                   | CLKM                      | F14            | O        | —                                  | In XTAL mode: Feedback drive for the reference crystal<br>In External clock mode: Connect this port to ground                                                                                                                                                                                                                              |
| Band-gap voltage                                                  | VBGAP                     | B10            | O        | —                                  |                                                                                                                                                                                                                                                                                                                                            |

| FUNCTION                   | SIGNAL NAME  | PIN NUMBER                                                                                                                             | PIN TYPE | DEFAULT PULL STATUS <sup>(1)</sup> | DESCRIPTION                                                                                                                                                                                                          |
|----------------------------|--------------|----------------------------------------------------------------------------------------------------------------------------------------|----------|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Power supply               | VDDIN        | F13,N11,P15,R6                                                                                                                         | POW      | —                                  | 1.2-V digital power supply                                                                                                                                                                                           |
|                            | VIN_SRAM     | R14                                                                                                                                    | POW      | —                                  | 1.2-V power rail for internal SRAM                                                                                                                                                                                   |
|                            | VNWA         | P14                                                                                                                                    | POW      | —                                  | 1.2-V power rail for SRAM array back bias                                                                                                                                                                            |
|                            | VIOIN        | R13                                                                                                                                    | POW      | —                                  | I/O supply (3.3-V or 1.8-V): All CMOS I/Os would operate on this supply.                                                                                                                                             |
|                            | VIOIN_18     | K13                                                                                                                                    | POW      | —                                  | 1.8-V supply for CMOS IO                                                                                                                                                                                             |
|                            | VIN_18CLK    | B11                                                                                                                                    | POW      | —                                  | 1.8-V supply for clock module                                                                                                                                                                                        |
|                            | VIOIN_18DIFF | D13                                                                                                                                    | POW      | —                                  | 1.8-V supply for CSI2 port                                                                                                                                                                                           |
|                            | Reserved     | G13                                                                                                                                    | POW      | —                                  | No connect                                                                                                                                                                                                           |
|                            | VIN_13RF1    | G5,J5,H5                                                                                                                               | POW      | —                                  | 1.3-V Analog and RF supply,VIN_13RF1 and VIN_13RF2 could be shorted on the board                                                                                                                                     |
|                            | VIN_13RF2    | C2,D2                                                                                                                                  | POW      | —                                  |                                                                                                                                                                                                                      |
|                            | VIN_18BB     | K5,F5                                                                                                                                  | POW      | —                                  | 1.8-V Analog baseband power supply                                                                                                                                                                                   |
|                            | VIN_18VCO    | B12                                                                                                                                    | POW      | —                                  | 1.8-V RF VCO supply                                                                                                                                                                                                  |
|                            | VSS          | E5,E6,E8,E10,E11,F9,F11,G6,G7,G8,G10,H7,H9,H11,J6,J7,J8,J10,K7,K8,K9,K10,K11,L5,L6,L8,L10,R15                                          | GND      | —                                  | Digital ground                                                                                                                                                                                                       |
|                            | VSSA         | A1,A3,A5,A7,A9,A15,B3,B5,B7,B9,B13,B14,C1,C3,C4,C5,C6,C7,C8,C9,C15,E1,E2,E3,E13,E15,F3,G1,G2,G3,H3,J1,J2,J3,K3,L1,L2,L3,M3,N1,N2,N3,R1 | GND      | —                                  | Analog ground                                                                                                                                                                                                        |
| Internal LDO output/inputs | VOUT_14APLL  | A10                                                                                                                                    | O        | —                                  |                                                                                                                                                                                                                      |
|                            | VOUT_14SYNTH | A13                                                                                                                                    | O        | —                                  |                                                                                                                                                                                                                      |
|                            | VOUT_PA      | A2,B2                                                                                                                                  | IO       | —                                  | When internal PA LDO is used this pin provides the output voltage of the LDO. When the internal PA LDO is bypassed and disabled 1V supply should be fed on this pin. This is mandatory in 3TX simultaneous use case. |
| External clock out         | PMIC_CLK_OUT | P13                                                                                                                                    | O        | —                                  | Dithered clock input to PMIC                                                                                                                                                                                         |
|                            | MCU_CLK_OUT  | N9                                                                                                                                     | O        | —                                  | Programmable clock given out to external MCU or the processor                                                                                                                                                        |
| General-purpose I/Os       | GPIO[0]      | N4                                                                                                                                     | IO       | Pull Down                          | General-purpose IO                                                                                                                                                                                                   |
|                            | GPIO[1]      | N7                                                                                                                                     | IO       | Pull Down                          | General-purpose IO                                                                                                                                                                                                   |
|                            | GPIO[2]      | N13                                                                                                                                    | IO       | Pull Down                          | General-purpose IO                                                                                                                                                                                                   |

| FUNCTION                                                                                                | SIGNAL NAME  | PIN NUMBER | PIN TYPE | DEFAULT PULL STATUS <sup>(1)</sup> | DESCRIPTION                                                                                      |
|---------------------------------------------------------------------------------------------------------|--------------|------------|----------|------------------------------------|--------------------------------------------------------------------------------------------------|
| QSPI for Serial Flash                                                                                   | QSPI_CS      | P8         | O        | Pull Up                            | Chip-select output from the device. Device is a controller connected to serial flash peripheral. |
|                                                                                                         | QSPI_CLK     | R10        | O        | Pull Down                          | Clock output from the device. Device is a controller connected to serial flash peripheral.       |
|                                                                                                         | QSPI[0]      | R11        | IO       | Pull Down                          | Data IN/OUT                                                                                      |
|                                                                                                         | QSPI[1]      | P9         | IO       | Pull Down                          | Data IN/OUT                                                                                      |
|                                                                                                         | QSPI[2]      | R12        | IO       | Pull Up                            | Data IN/OUT                                                                                      |
|                                                                                                         | QSPI[3]      | P10        | IO       | Pull Up                            | Data IN/OUT                                                                                      |
| Flash programming and RS232 UART                                                                        | RS232_TX     | N6         | O        | Pull Down                          | UART pins for programming external flash                                                         |
|                                                                                                         | RS232_RX     | N5         | I        | Pull Up                            |                                                                                                  |
| Test and Debug output for preproduction phase. Can be pinned out on production hardware for field debug | Analog Test1 | P1         | IO       | —                                  | Internal test signal                                                                             |
|                                                                                                         | Analog Test2 | P2         | IO       | —                                  | Internal test signal                                                                             |
|                                                                                                         | Analog Test3 | P3         | IO       | —                                  | Internal test signal                                                                             |
|                                                                                                         | Analog Test4 | R2         | IO       | —                                  | Internal test signal                                                                             |
|                                                                                                         | ANAMUX       | C13        | IO       | —                                  | Internal test signal                                                                             |
|                                                                                                         | VSENSE       | C14        | IO       | —                                  | Internal test signal                                                                             |

(1) Status of PULL structures associated with the IO after device POWER UP.

(2) For the AWR1243 WARM\_RESET can be used as an output only pin for status indication.

## 8 Specifications

### 8.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)

| PARAMETERS <sup>(1) (2)</sup>  |                                                                                                                                                                                                                         | MIN   | MAX                                    | UNIT |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|----------------------------------------|------|
| VDDIN                          | 1.2 V digital power supply                                                                                                                                                                                              | –0.5  | 1.4                                    | V    |
| VIN_SRAM                       | 1.2 V power rail for internal SRAM                                                                                                                                                                                      | –0.5  | 1.4                                    | V    |
| VNWA                           | 1.2 V power rail for SRAM array back bias                                                                                                                                                                               | –0.5  | 1.4                                    | V    |
| VIOIN                          | I/O supply (3.3 V or 1.8 V): All CMOS I/Os would operate on this supply.                                                                                                                                                | –0.5  | 3.8                                    | V    |
| VIOIN_18                       | 1.8 V supply for CMOS IO                                                                                                                                                                                                | –0.5  | 2                                      | V    |
| VIN_18CLK                      | 1.8 V supply for clock module                                                                                                                                                                                           | –0.5  | 2                                      | V    |
| VIOIN_18DIFF                   | 1.8 V supply for CSI2 port                                                                                                                                                                                              | –0.5  | 2                                      | V    |
| VIN_13RF1                      | 1.3 V Analog and RF supply, VIN_13RF1 and VIN_13RF2 could be shorted on the board.                                                                                                                                      | –0.5  | 1.45                                   | V    |
| VIN_13RF2                      |                                                                                                                                                                                                                         |       |                                        |      |
| VIN_13RF1                      | 1-V Internal LDO bypass mode. Device supports mode where external Power Management block can supply 1 V on VIN_13RF1 and VIN_13RF2 rails. In this configuration, the internal LDO of the device would be kept bypassed. | –0.5  | 1.4                                    | V    |
| VIN_13RF2                      |                                                                                                                                                                                                                         |       |                                        |      |
| VIN_18BB                       | 1.8-V Analog baseband power supply                                                                                                                                                                                      | –0.5  | 2                                      | V    |
| VIN_18VCO supply               | 1.8-V RF VCO supply                                                                                                                                                                                                     | –0.5  | 2                                      | V    |
| RX1-4                          | Externally applied power on RF inputs                                                                                                                                                                                   |       | 10                                     | dBm  |
| TX1-3                          | Externally applied power on RF outputs <sup>(3)</sup>                                                                                                                                                                   |       | 10                                     | dBm  |
| Input and output voltage range | Dual-voltage LVCMOS inputs, 3.3 V or 1.8 V (Steady State)                                                                                                                                                               | –0.3V | VIOIN + 0.3                            | V    |
|                                | Dual-voltage LVCMOS inputs, operated at 3.3 V/1.8 V (Transient Overshoot/Undershoot) or external oscillator input                                                                                                       |       | VIOIN + 20% up to 20% of signal period |      |
| CLKP, CLKM                     | Input ports for reference crystal                                                                                                                                                                                       | –0.5  | 2                                      | V    |
| Clamp current                  | Input or Output Voltages 0.3 V above or below their respective power rails. Limit clamp current that flows through the internal diode protection cells of the I/O.                                                      | –20   | 20                                     | mA   |
| T <sub>J</sub>                 | Operating junction temperature range                                                                                                                                                                                    | –40   | 125                                    | °C   |
| T <sub>STG</sub>               | Storage temperature range after soldered onto PC board                                                                                                                                                                  | –55   | 150                                    | °C   |

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

(2) All voltage values are with respect to V<sub>SS</sub>, unless otherwise noted.

(3) This value is for an externally applied signal level on the TX. Additionally, a reflection coefficient up to Gamma = 1 can be applied on the TX output.

### 8.2 ESD Ratings

|                                            |                                                         |                | VALUE | UNIT |
|--------------------------------------------|---------------------------------------------------------|----------------|-------|------|
| V <sub>(ESD)</sub> Electrostatic discharge | Human-body model (HBM), per AEC Q100-002 <sup>(1)</sup> |                | ±2000 | V    |
|                                            | Charged-device model (CDM), per AEC Q100-011            | All other pins | ±500  |      |
|                                            |                                                         | Corner pins    | ±750  |      |

(1) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

### 8.3 Power-On Hours (POH)

| JUNCTION TEMPERATURE (T <sub>J</sub> )<br>(1) (2) | OPERATING CONDITION | NOMINAL CVDD VOLTAGE (V) | POWER-ON HOURS [POH] (HOURS) |
|---------------------------------------------------|---------------------|--------------------------|------------------------------|
| –40°C                                             | 100% duty cycle     | 1.2                      | 600 (6%)                     |
| 75°C                                              |                     |                          | 2000 (20%)                   |
| 95°C                                              |                     |                          | 6500 (65%)                   |
| 125°C                                             |                     |                          | 900 (9%)                     |

- (1) This information is provided solely for your convenience and does not extend or modify the warranty provided under TI's standard terms and conditions for TI semiconductor products.
- (2) The specified POH are applicable with max Tx output power settings using the default firmware gain tables. The specified POH would not be applicable, if the Tx gain table is overwritten using an API.

### 8.4 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

|                                             |                                                                                   | MIN         | NOM | MAX       | UNIT   |
|---------------------------------------------|-----------------------------------------------------------------------------------|-------------|-----|-----------|--------|
| VDDIN                                       | 1.2 V digital power supply                                                        | 1.14        | 1.2 | 1.32      | V      |
| VIN_SRAM                                    | 1.2 V power rail for internal SRAM                                                | 1.14        | 1.2 | 1.32      | V      |
| VNWA                                        | 1.2 V power rail for SRAM array back bias                                         | 1.14        | 1.2 | 1.32      | V      |
| VIOIN                                       | I/O supply (3.3 V or 1.8 V):<br>All CMOS I/Os would operate on this supply.       | 3.135       | 3.3 | 3.465     | V      |
|                                             |                                                                                   | 1.71        | 1.8 | 1.89      | V      |
| VIOIN_18                                    | 1.8 V supply for CMOS IO                                                          | 1.71        | 1.8 | 1.9       | V      |
| VIN_18CLK                                   | 1.8 V supply for clock module                                                     | 1.71        | 1.8 | 1.9       | V      |
| VIOIN_18DIFF                                | 1.8 V supply for CSI2 port                                                        | 1.71        | 1.8 | 1.9       | V      |
| VIN_13RF1                                   | 1.3 V Analog and RF supply. VIN_13RF1 and VIN_13RF2 could be shorted on the board | 1.23        | 1.3 | 1.36      | V      |
| VIN_13RF2                                   |                                                                                   |             |     |           |        |
| VIN_13RF1<br>(1-V Internal LDO bypass mode) |                                                                                   | 0.95        | 1   | 1.05      | V      |
| VIN_13RF2<br>(1-V Internal LDO bypass mode) |                                                                                   |             |     |           |        |
| VIN18BB                                     | 1.8-V Analog baseband power supply                                                | 1.71        | 1.8 | 1.9       | V      |
| VIN_18VCO                                   | 1.8V RF VCO supply                                                                | 1.71        | 1.8 | 1.9       | V      |
| V <sub>IH</sub>                             | Voltage Input High (1.8 V mode)                                                   | 1.17        |     |           | V      |
|                                             | Voltage Input High (3.3 V mode)                                                   | 2.25        |     |           |        |
| V <sub>IL</sub>                             | Voltage Input Low (1.8 V mode)                                                    |             |     | 0.3*VIOIN | V      |
|                                             | Voltage Input Low (3.3 V mode)                                                    |             |     | 0.62      |        |
| V <sub>OH</sub>                             | High-level output threshold (I <sub>OH</sub> = 6 mA)                              | VIOIN – 450 |     |           | mV     |
| V <sub>OL</sub>                             | Low-level output threshold (I <sub>OL</sub> = 6 mA)                               |             |     |           | 450 mV |
| NRESET<br>SOP[2:0]                          | V <sub>IL</sub> (1.8V Mode)                                                       |             |     | 0.2       | V      |
|                                             | V <sub>IH</sub> (1.8V Mode)                                                       | 0.96        |     |           |        |
|                                             | V <sub>IL</sub> (3.3V Mode)                                                       |             |     | 0.3       |        |
|                                             | V <sub>IH</sub> (3.3V Mode)                                                       | 1.57        |     |           |        |

## 8.5 Power Supply Specifications

表 8-1 describes the four rails from an external power supply block of the AWR1243 device.

**表 8-1. Power Supply Rails Characteristics**

| SUPPLY                                                    | DEVICE BLOCKS POWERED FROM THE SUPPLY                                         | RELEVANT IOS IN THE DEVICE                                                                              |
|-----------------------------------------------------------|-------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| 1.8 V                                                     | Synthesizer and APLL VCOs, crystal oscillator, IF Amplifier stages, ADC, CSI2 | Input: VIN_18VCO, VIN18CLK, VIN_18BB, VIOIN_18DIFF, VIOIN_18IO<br>LDO Output: VOUT_14SYNTH, VOUT_14APLL |
| 1.3 V (or 1 V in internal LDO bypass mode) <sup>(1)</sup> | Power Amplifier, Low Noise Amplifier, Mixers and LO Distribution              | Input: VIN_13RF2, VIN_13RF1<br>LDO Output: VOUT_PA                                                      |
| 3.3 V (or 1.8 V for 1.8 V I/O mode)                       | Digital I/Os                                                                  | Input VIOIN                                                                                             |
| 1.2 V                                                     | Core Digital and SRAMs                                                        | Input: VDDIN, VIN_SRAM                                                                                  |

(1) The device only supports simultaneous operation of 2 transmitters. In the 1-V LDO bypass mode, 1V supply needs to be fed on the VOUT PA pin.

The 1.3-V (1.0 V) and 1.8-V power supply ripple specifications mentioned in 表 8-2 are defined to meet a target spur level of  $-105$  dBc (RF Pin =  $-15$  dBm) at the RX. The spur and ripple levels have a dB-to-dB relationship, for example, a 1-dB increase in supply ripple leads to a  $\sim 1$  dB increase in spur level. Values quoted are rms levels for a sinusoidal input applied at the specified frequency.

**表 8-2. Ripple Specifications**

| FREQUENCY (kHz) | RF RAIL                                                       |                                      | VCO/IF RAIL                          |
|-----------------|---------------------------------------------------------------|--------------------------------------|--------------------------------------|
|                 | 1.0 V (INTERNAL LDO BYPASS)<br>( $\mu\text{V}_{\text{RMS}}$ ) | 1.3 V ( $\mu\text{V}_{\text{RMS}}$ ) | 1.8 V ( $\mu\text{V}_{\text{RMS}}$ ) |
| 137.5           | 7                                                             | 648                                  | 83                                   |
| 275             | 5                                                             | 76                                   | 21                                   |
| 550             | 3                                                             | 22                                   | 11                                   |
| 1100            | 2                                                             | 4                                    | 6                                    |
| 2200            | 11                                                            | 82                                   | 13                                   |
| 4400            | 13                                                            | 93                                   | 19                                   |
| 6600            | 22                                                            | 117                                  | 29                                   |

## 8.6 Power Consumption Summary

表 8-3 和 表 8-4 summarize the power consumption at the power terminals.

**表 8-3. Maximum Current Ratings at Power Terminals**

| PARAMETER                          | SUPPLY NAME                                            | DESCRIPTION                                                                     | MIN | TYP | MAX  | UNIT |
|------------------------------------|--------------------------------------------------------|---------------------------------------------------------------------------------|-----|-----|------|------|
| Current consumption <sup>(1)</sup> | VDDIN, VIN_SRAM, VNWA                                  | Total current drawn by all nodes driven by 1.2V rail                            |     |     | 500  | mA   |
|                                    | VIN_13RF1, VIN_13RF2                                   | Total current drawn by all nodes driven by 1.3V (or 1V in LDO Bypass mode) rail |     |     | 2000 |      |
|                                    | VIOIN_18, VIN_18CLK, VIOIN_18DIFF, VIN_18BB, VIN_18VCO | Total current drawn by all nodes driven by 1.8V rail                            |     |     | 850  |      |
|                                    | VIOIN                                                  | Total current drawn by all nodes driven by 3.3V rail <sup>(2)</sup>             |     | 50  |      |      |

(1) The specified current values are at typical supply voltage level.

(2) The exact VIOIN current depends on the peripherals used and their frequency of operation.

**表 8-4. Average Power Consumption at Power Terminals**

| PARAMETER                 | CONDITION                       |          | DESCRIPTION                                                                                                                                                 | MIN | TYP  | MAX | UNIT |
|---------------------------|---------------------------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|-----|------|
| Average power consumption | 1.0-V internal LDO bypass mode  | 1TX, 4RX | Sampling: 16.66 MSps complex Transceiver, 40-ms frame time, 512 chirps, 512 samples/chirp, 8.5-μs interchirp time (50% duty cycle)<br>Data Port: MIPI-CSI-2 |     | 1.62 |     | W    |
|                           |                                 | 2TX, 4RX |                                                                                                                                                             |     | 1.79 |     |      |
|                           | 1.3-V internal LDO enabled mode | 1TX, 4RX |                                                                                                                                                             |     | 1.80 |     |      |
|                           |                                 | 2TX, 4RX |                                                                                                                                                             |     | 2.01 |     |      |

## 8.7 RF Specification

over recommended operating conditions and with run time calibrations enabled (unless otherwise noted)

| PARAMETER       |                                                     |                                                                | MIN | TYP  | MAX   | UNIT   |
|-----------------|-----------------------------------------------------|----------------------------------------------------------------|-----|------|-------|--------|
| Receiver        | Noise figure                                        | 76 to 77 GHz (VCO1)                                            |     | 14   |       | dB     |
|                 |                                                     | 77 to 81 GHz (VCO2)                                            |     | 15   |       |        |
|                 | 1-dB compression point (Out Of Band) <sup>(1)</sup> |                                                                |     | –8   |       | dBm    |
|                 | Maximum gain                                        |                                                                |     | 48   |       | dB     |
|                 | Gain range                                          |                                                                |     | 24   |       | dB     |
|                 | Gain step size                                      |                                                                |     | 2    |       | dB     |
|                 | Image Rejection Ratio (IMRR)                        |                                                                |     | 30   |       | dB     |
|                 | IF bandwidth <sup>(2)</sup>                         |                                                                |     |      | 15    | MHz    |
|                 | ADC sampling rate (real/complex 2x)                 |                                                                |     |      | 37.5  | Msp/s  |
|                 | ADC sampling rate (complex 1x)                      |                                                                |     |      | 18.75 | Msp/s  |
|                 | ADC resolution                                      |                                                                |     | 12   |       | Bits   |
|                 | Return loss (S11)                                   |                                                                |     | <–10 |       | dB     |
|                 | Gain mismatch variation (over temperature)          |                                                                |     | ±0.5 |       | dB     |
|                 | Phase mismatch variation (over temperature)         |                                                                |     | ±3   |       | °      |
|                 | In-band IIP2                                        | RX gain = 30dB<br>IF = 1.5, 2 MHz at<br>–12 dBFS               |     | 16   |       | dBm    |
|                 | Out-of-band IIP2                                    | RX gain = 24dB<br>IF = 10 kHz at –10dBm,<br>1.9 MHz at –30 dBm |     | 24   |       | dBm    |
| Transmitter     | Idle Channel Spurs                                  |                                                                |     | –90  |       | dBFS   |
|                 | Output power                                        |                                                                |     | 12   |       | dBm    |
| Clock subsystem | Amplitude noise                                     |                                                                |     | –145 |       | dBc/Hz |
|                 | Frequency range                                     |                                                                | 76  |      | 81    | GHz    |
|                 | Ramp rate                                           |                                                                |     |      | 100   | MHz/μs |
|                 | Phase noise at 1-MHz offset                         | 76 to 77 GHz (VCO1)                                            |     | –95  |       | dBc/Hz |
|                 |                                                     | 77 to 81 GHz (VCO2)                                            |     | –93  |       |        |

(1) 1-dB Compression Point (Out Of Band) is measured by feed a Continuous wave Tone (10 kHz) well below the lowest HPF cut-off frequency.

(2) The analog IF stages include high-pass filtering, with two independently configurable first-order high-pass corner frequencies. The set of available HPF corners is summarized as follows:

Available HPF Corner Frequencies (kHz)

HPF1

175, 235, 350, 700

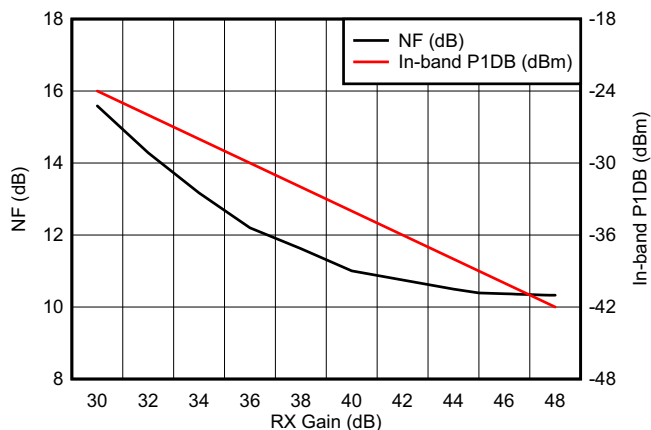
HPF2

350, 700, 1400, 2800

The filtering performed by the digital baseband chain is targeted to provide:

- Less than ±0.5 dB pass-band ripple/droop, and
- Better than 60 dB anti-aliasing attenuation for any frequency that can alias back into the pass-band.

✎ 8-1 shows variations of noise figure and in-band P1dB parameters with respect to receiver gain programmed.



**8-1. Noise Figure, In-band P1dB vs Receiver Gain**

## 8.8 Thermal Resistance Characteristics for FCBGA Package [ABL0161]

| THERMAL METRICS <sup>(1)</sup> |                         | °C/W <sup>(2) (3)</sup> |
|--------------------------------|-------------------------|-------------------------|
| R <sub>ΘJC</sub>               | Junction-to-case        | 5                       |
| R <sub>ΘJB</sub>               | Junction-to-board       | 5.9                     |
| R <sub>ΘJA</sub>               | Junction-to-free air    | 21.6                    |
| R <sub>ΘJMA</sub>              | Junction-to-moving air  | 15.3 <sup>(4)</sup>     |
| Ψ <sub>iJT</sub>               | Junction-to-package top | 0.69                    |
| Ψ <sub>iJB</sub>               | Junction-to-board       | 5.8                     |

(1) For more information about traditional and new thermal metrics, see [Semiconductor and IC Package Thermal Metrics](#).

(2) °C/W = degrees Celsius per watt.

(3) These values are based on a JEDEC-defined 2S2P system (with the exception of the Theta JC [R<sub>ΘJC</sub>] value, which is based on a JEDEC-defined 1S0P system) and will change based on environment as well as application. For more information, see these EIA/JEDEC standards:

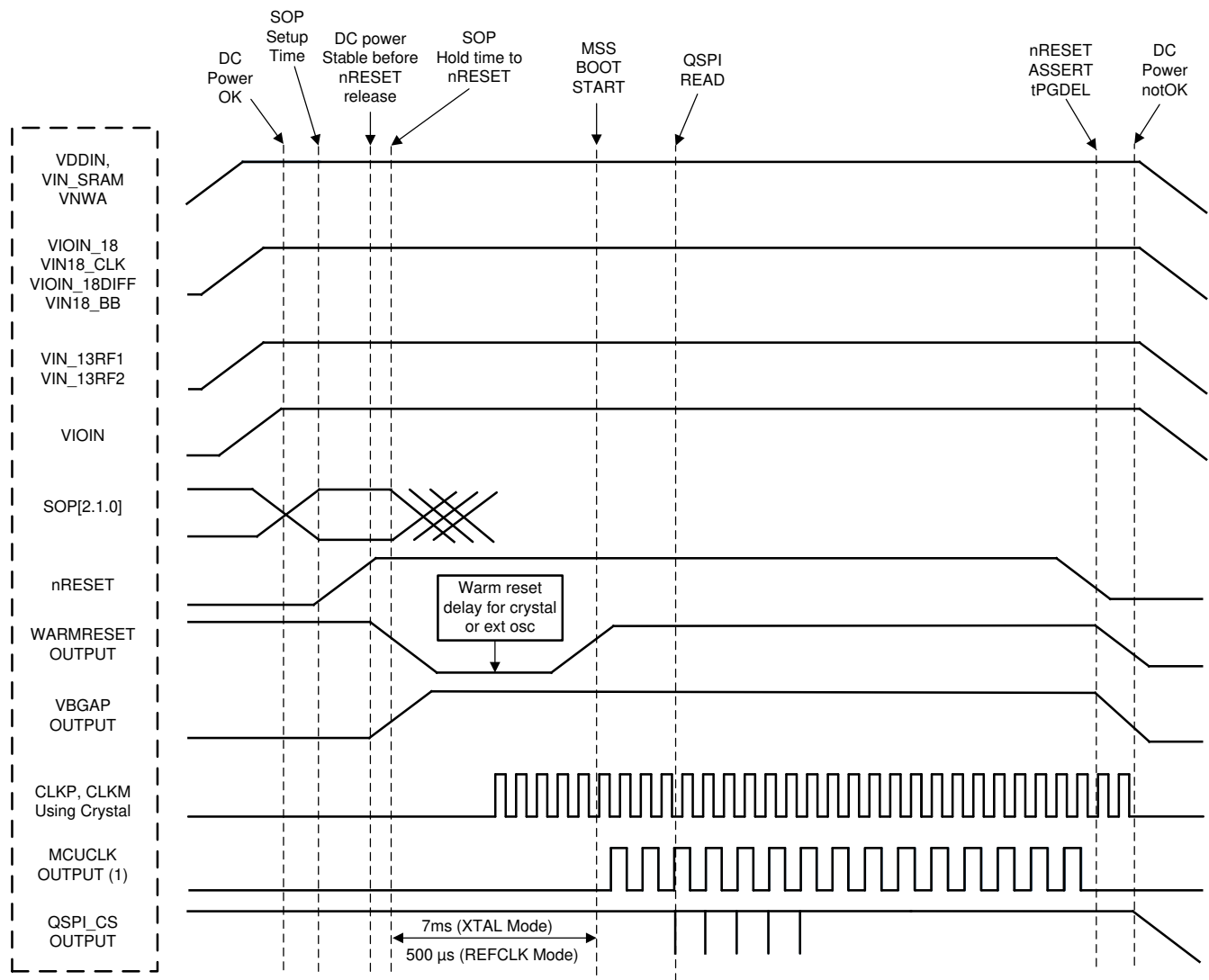
- JESD51-2, *Integrated Circuits Thermal Test Method Environmental Conditions - Natural Convection (Still Air)*
- JESD51-3, *Low Effective Thermal Conductivity Test Board for Leaded Surface Mount Packages*
- JESD51-7, *High Effective Thermal Conductivity Test Board for Leaded Surface Mount Packages*
- JESD51-9, *Test Boards for Area Array Surface Mount Package Thermal Measurements*

(4) Air flow = 1 m/s

## 8.9 Timing and Switching Characteristics

### 8.9.1 Power Supply Sequencing and Reset Timing

The AWR1243 device expects all external voltage rails and SOP lines to be stable before reset is deasserted. [8-2](#) describes the device wake-up sequence.



**8-2. Device Wake-up Sequence**

### 8.9.2 Synchronized Frame Triggering

The AWR1243 device supports a hardware based mechanism to trigger radar frames. An external host can pulse the SYNC\_IN signal to start radar frames. The typical time difference between the rising edge of the external pulse and the frame transmission on air (Tlag) is about 160 ns. There is also an additional programmable delay that the user can set to control the frame start time.

The periodicity of the external SYNC\_IN pulse should be always greater than the programmed frame periodic in the frame configurations in all instances.

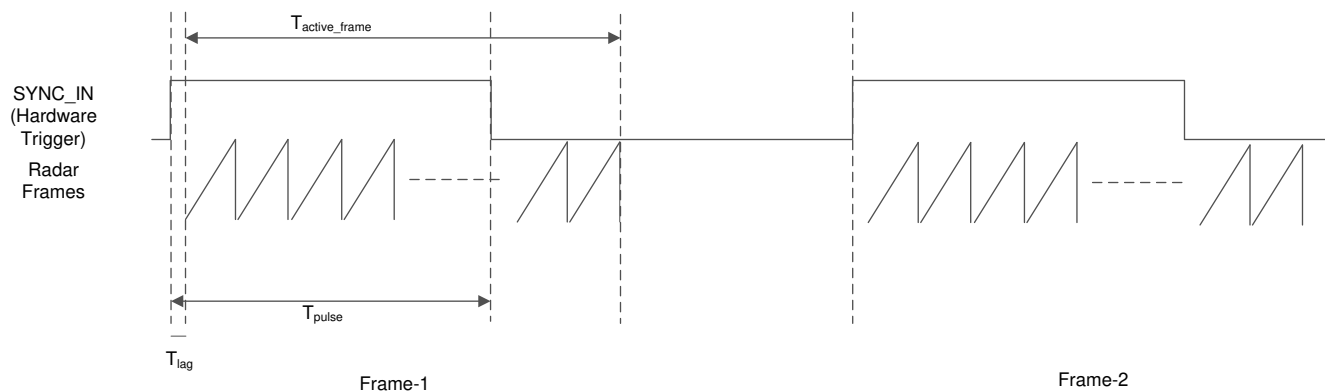


图 8-3. Sync In Hardware Trigger

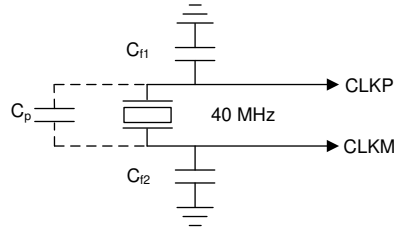
表 8-5. Frame Trigger Timing

| PARAMETER           | DESCRIPTION           | MIN          | MAX  | UNIT |
|---------------------|-----------------------|--------------|------|------|
| $T_{active\_frame}$ | Active frame duration | User defined |      | ns   |
| $T_{pulse}$         |                       | 25           | 4000 |      |

### 8.9.3 Input Clocks and Oscillators

#### 8.9.3.1 Clock Specifications

An external crystal is connected to the device pins. [Figure 8-4](#) shows the crystal implementation.



**Figure 8-4. Crystal Implementation**

#### 注

The load capacitors,  $C_{f1}$  and  $C_{f2}$  in [Figure 8-4](#), should be chosen such that [Equation 1](#) is satisfied.  $C_L$  in the equation is the load specified by the crystal manufacturer. All discrete components used to implement the oscillator circuit should be placed as close as possible to the associated oscillator CLKP and CLKM pins. Note that  $C_{f1}$  and  $C_{f2}$  include the parasitic capacitances due to PCB routing.

$$C_L = C_{f1} \times \frac{C_{f2}}{C_{f1} + C_{f2}} + C_P \quad (1)$$

[Table 8-6](#) lists the electrical characteristics of the clock crystal.

**Table 8-6. Crystal Electrical Characteristics (Oscillator Mode)**

| NAME                | DESCRIPTION                                    | MIN  | TYP | MAX | UNIT               |
|---------------------|------------------------------------------------|------|-----|-----|--------------------|
| $f_P$               | Parallel resonance crystal frequency           |      | 40  |     | MHz                |
| $C_L$               | Crystal load capacitance                       | 5    | 8   | 12  | pF                 |
| ESR                 | Crystal ESR                                    |      |     | 50  | $\Omega$           |
| Temperature range   | Expected temperature range of operation        | -40  |     | 125 | $^{\circ}\text{C}$ |
| Frequency tolerance | Crystal frequency tolerance <sup>(1) (2)</sup> | -200 |     | 200 | ppm                |
| Drive level         |                                                |      | 50  | 200 | $\mu\text{W}$      |

(1) The crystal manufacturer's specification must satisfy this requirement.

(2) Includes initial tolerance of the crystal, drift over temperature, aging and frequency pulling due to incorrect load capacitance.

In the case where an external clock is used as the clock resource, the signal is fed to the CLKP pin only; CLKM is grounded. The phase noise requirement is very important when a 40-MHz clock is fed externally. [Table 8-7](#) lists the electrical characteristics of the external clock signal.

**表 8-7. External Clock Mode Specifications**

| PARAMETER                                                                                                     |                            | SPECIFICATION |     |      | UNIT    |
|---------------------------------------------------------------------------------------------------------------|----------------------------|---------------|-----|------|---------|
|                                                                                                               |                            | MIN           | TYP | MAX  |         |
| Input Clock:<br>External AC-coupled sine wave or DC-<br>coupled square wave<br>Phase Noise referred to 40 MHz | Frequency                  |               | 40  |      | MHz     |
|                                                                                                               | AC-Amplitude               | 700           |     | 1200 | mV (pp) |
|                                                                                                               | DC- $t_{\text{rise/fall}}$ |               |     | 10   | ns      |
|                                                                                                               | Phase Noise at 1 kHz       |               |     | -132 | dBc/Hz  |
|                                                                                                               | Phase Noise at 10 kHz      |               |     | -143 | dBc/Hz  |
|                                                                                                               | Phase Noise at 100 kHz     |               |     | -152 | dBc/Hz  |
|                                                                                                               | Phase Noise at 1 MHz       |               |     | -153 | dBc/Hz  |
|                                                                                                               | Duty Cycle                 | 35            |     | 65   | %       |
|                                                                                                               | Freq Tolerance             | -100          |     | 100  | ppm     |

## 8.9.4 Multibuffered / Standard Serial Peripheral Interface (MibSPI)

### 8.9.4.1 Peripheral Description

The SPI uses a MibSPI Protocol by TI.

The MibSPI/SPI is a high-speed synchronous serial input/output port that allows a serial bit stream to be shifted into and out of the device at a programmed bit-transfer rate. The MibSPI/SPI is normally used for communication between the microcontroller and external peripherals or another microcontroller.

セクション 8.9.4.1.2 and セクション 8.9.4.1.3 assume the operating conditions stated in セクション 8.9.4.1.1. セクション 8.9.4.1.2, セクション 8.9.4.1.3, and 図 8-5 describe the timing and switching characteristics of the MibSPI.

#### 8.9.4.1.1 SPI Timing Conditions

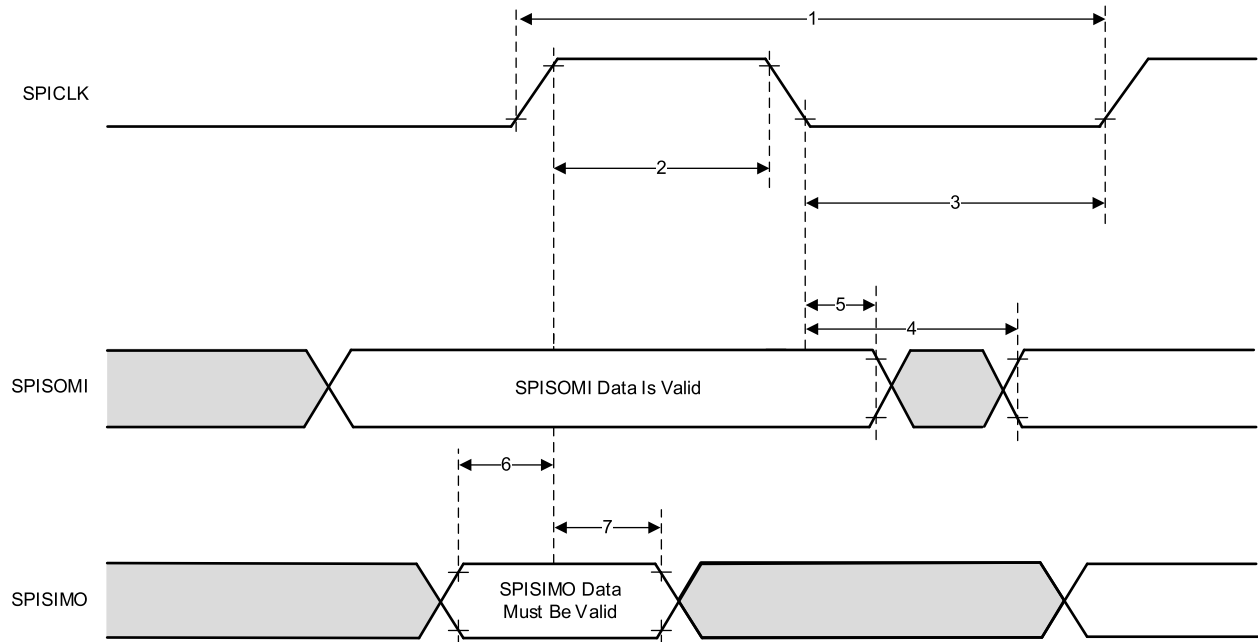
|                                    | MIN | TYP | MAX | UNIT |
|------------------------------------|-----|-----|-----|------|
| Input Conditions                   |     |     |     |      |
| $t_R$ Input rise time              | 1   |     | 3   | ns   |
| $t_F$ Input fall time              | 1   |     | 3   | ns   |
| Output Conditions                  |     |     |     |      |
| $C_{LOAD}$ Output load capacitance | 2   |     | 15  | pF   |

#### 8.9.4.1.2 SPI Peripheral Mode Switching Parameters (SPICLK = input, SPISIMO = input, and SPISOMI = output)

| NO. | PARAMETER           |                                                | MIN | TYP | MAX | UNIT |
|-----|---------------------|------------------------------------------------|-----|-----|-----|------|
| 1   | $t_{c(SPC)}S$       | Cycle time, SPICLK                             | 25  |     |     | ns   |
| 2   | $t_{w(SPCH)}S$      | Pulse duration, SPICLK high                    | 10  |     |     | ns   |
| 3   | $t_{w(SPCL)}S$      | Pulse duration, SPICLK low                     | 10  |     |     | ns   |
| 4   | $t_{d(SPCL-SOMI)}S$ | Delay time, SPISOMI valid after SPICLK low     |     |     | 10  | ns   |
| 5   | $t_{h(SPCL-SOMI)}S$ | Hold time, SPISOMI data valid after SPICLK low | 2   |     |     | ns   |

#### 8.9.4.1.3 SPI Peripheral Mode Timing Requirements (SPICLK = input, SPISIMO = input, and SPISOMI = output)

| NO. |                      |                                                 | MIN | TYP | MAX | UNIT |
|-----|----------------------|-------------------------------------------------|-----|-----|-----|------|
| 6   | $t_{su(SIMO-SPCH)}S$ | Setup time, SPISIMO before SPICLK high          | 3   |     |     | ns   |
| 7   | $t_{h(SPCH-SIMO)}S$  | Hold time, SPISIMO data valid after SPICLK high | 1   |     |     | ns   |

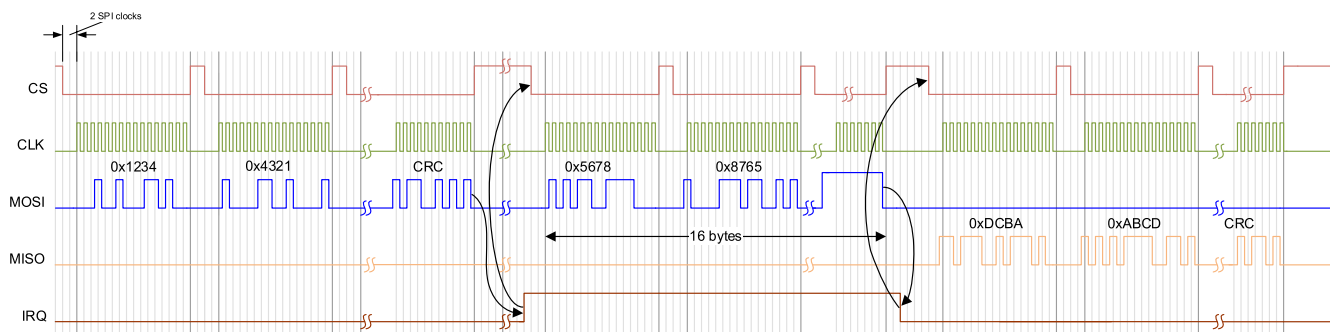


**图 8-5. SPI Peripheral Mode External Timing**

### 8.9.4.2 Typical Interface Protocol Diagram (Peripheral Mode)

1. Host should ensure that there is a delay of at least two SPI clocks between CS going low and start of SPI clock.
2. Host should ensure that CS is toggled for every 16 bits of transfer through SPI.

✎ 8-6 shows the SPI communication timing of the typical interface protocol.



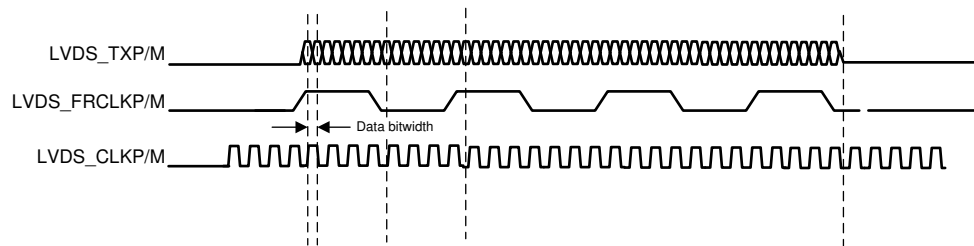
✎ 8-6. SPI Communication

### 8.9.5 LVDS Interface Configuration

The AWR1243 supports seven differential LVDS IOs/Lanes to support debug where raw ADC data could be extracted. The lane configuration supported is four Data lanes (LVDS\_TXP/M), one Bit Clock lane (LVDS\_CLKP/M) one Frame clock lane (LVDS\_FRCLKP/M). The LVDS interface supports the following data rates:

- 900 Mbps (450 MHz DDR Clock)
- 600 Mbps (300 MHz DDR Clock)
- 450 Mbps (225 MHz DDR Clock)
- 400 Mbps (200 MHz DDR Clock)
- 300 Mbps (150 MHz DDR Clock)
- 225 Mbps (112.5 MHz DDR Clock)
- 150 Mbps (75 MHz DDR Clock)

Note that the bit clock is in DDR format and hence the numbers of toggles in the clock is equivalent to data.

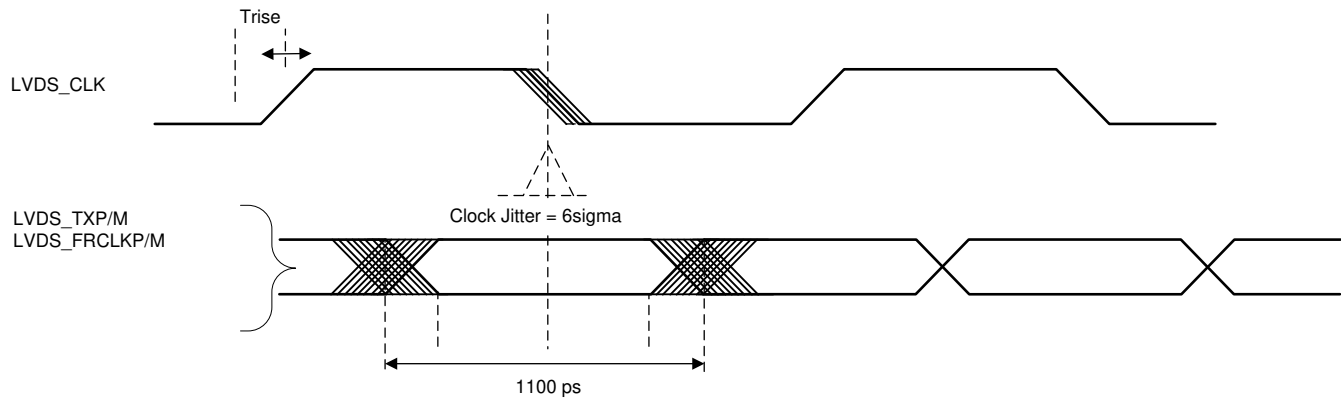


**8-7. LVDS Interface Lane Configuration And Relative Timings**

#### 8.9.5.1 LVDS Interface Timings

**表 8-8. LVDS Electrical Characteristics**

| PARAMETER                   | TEST CONDITIONS                                                                       | MIN  | TYP | MAX  | UNIT |
|-----------------------------|---------------------------------------------------------------------------------------|------|-----|------|------|
| Duty Cycle Requirements     | max 1 pF lumped capacitive load on LVDS lanes                                         | 48%  |     | 52%  |      |
| Output Differential Voltage | peak-to-peak single-ended with 100 $\Omega$ resistive load between differential pairs | 250  |     | 450  | mV   |
| Output Offset Voltage       |                                                                                       | 1125 |     | 1275 | mV   |
| Trise and Tfall             | 20%-80%, 900 Mbps                                                                     |      | 330 |      | ps   |
| Jitter (pk-pk)              | 900 Mbps                                                                              |      | 80  |      | ps   |



**図 8-8. Timing Parameters**

### 8.9.6 General-Purpose Input/Output

セクション 8.9.6.1 lists the switching characteristics of output timing relative to load capacitance.

#### 8.9.6.1 Switching Characteristics for Output Timing versus Load Capacitance ( $C_L$ )

| PARAMETER <sup>(1)</sup> |               | TEST CONDITIONS       | VIOIN = 1.8V | VIOIN = 3.3V | UNIT |
|--------------------------|---------------|-----------------------|--------------|--------------|------|
| $t_r$                    | Max rise time | $C_L = 20 \text{ pF}$ | 2.8          | 3.0          | ns   |
|                          |               | $C_L = 50 \text{ pF}$ | 6.4          | 6.9          |      |
|                          |               | $C_L = 75 \text{ pF}$ | 9.4          | 10.2         |      |
| $t_f$                    | Max fall time | $C_L = 20 \text{ pF}$ | 2.8          | 2.8          | ns   |
|                          |               | $C_L = 50 \text{ pF}$ | 6.4          | 6.6          |      |
|                          |               | $C_L = 75 \text{ pF}$ | 9.4          | 9.8          |      |

(1) The rise/fall time is measured as the time taken by the signal to transition from 10% and 90% of VIOIN voltage.

## 8.9.7 Camera Serial Interface (CSI)

The CSI is a MIPI D-PHY compliant interface for connecting this device to a camera receiver module. This interface is made of four differential lanes; each lane is configurable for carrying data or clock. The polarity of each wire of a lane is also configurable. セクション 8.9.7.1, 図 8-9, 図 8-10, and 図 8-11 describe the clock and data timing of the CSI. The clock is always ON once the CSI IP is enabled. Hence it remains in HS mode.

### 8.9.7.1 CSI Switching Characteristics

over operating free-air temperature range (unless otherwise noted)

| PARAMETER                                        |                                                                                                                                                  |                       | MIN                     | TYP | MAX            | UNIT        |
|--------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-------------------------|-----|----------------|-------------|
| HPTX                                             |                                                                                                                                                  |                       |                         |     |                |             |
| HSTX <sub>DBR</sub>                              | Data bit rate                                                                                                                                    | (1/2/4 data lane PHY) | 150                     |     | 600            | Mbps        |
| f <sub>CLK</sub>                                 | DDR clock frequency                                                                                                                              | (1/2/4 data lane PHY) | 75                      |     | 300            | MHz         |
| Δ <sub>VCMTX(LF)</sub>                           | Common-level variation                                                                                                                           |                       | –50                     |     | 50             | mV          |
| t <sub>R</sub> and t <sub>F</sub>                | 20% to 80% rise time and fall time                                                                                                               |                       |                         |     | 0.3            | UI          |
| LPTX DRIVER                                      |                                                                                                                                                  |                       |                         |     |                |             |
| t <sub>EOT</sub>                                 | Time from start of THS-TRAIL period to start of LP-11 state                                                                                      |                       |                         |     | 105 + 12*UI    | ns          |
| DATA-CLOCK Timing Specification                  |                                                                                                                                                  |                       |                         |     |                |             |
| UINOM                                            | Nominal Unit Interval                                                                                                                            |                       | 1.67                    |     | 13.33          | ns          |
| UIINST,MIN                                       | Minimum instantaneous Unit Interval                                                                                                              |                       | 1.131                   |     |                | ns          |
| TSKEW[TX]                                        | Data to clock skew measured at transmitter                                                                                                       |                       | –0.15                   |     | 0.15           | UIINST, MIN |
| CSI2 TIMING SPECIFICATION                        |                                                                                                                                                  |                       |                         |     |                |             |
| T <sub>CLK-PRE</sub>                             | Time that the HS clock shall be driven by the transmitter before any associated data lane beginning the transition from LP to HS mode.           |                       | 8                       |     |                | ns          |
| T <sub>CLK-PREPARE</sub>                         | Time that the transmitter drives the clock lane LP-00 line state immediately before the HS-0 line state starting the HS transmission.            |                       | 38                      |     | 95             | ns          |
| T <sub>CLK-PREPARE</sub> + T <sub>CLK-ZERO</sub> | T <sub>CLK-PREPARE</sub> + time that the transmitter drives the HS-0 state before starting the clock.                                            |                       | 300                     |     |                | ns          |
| T <sub>EOT</sub>                                 | Transmitted time interval from the start of T <sub>HS-TRAIL</sub> or T <sub>CLKTRAIL</sub> to the start of the LP-11 state following a HS burst. |                       |                         |     | 105 ns + 12*UI | ns          |
| T <sub>HS-PREPARE</sub>                          | Time that the transmitter drives the data lane LP-00 line state immediately before the HS-0 line state starting the HS transmission              |                       | 40 + 4*UI               |     | 85 + 6*UI      | ns          |
| T <sub>HS-PREPARE</sub> + T <sub>HS-ZERO</sub>   | T <sub>HS-PREPARE</sub> + time that the transmitter drives the HS-0 state prior to transmitting the Sync sequence.                               |                       | 145 ns + 10*UI          |     |                | ns          |
| T <sub>HS-EXIT</sub>                             | Time that the transmitter drives LP-11 following a HS burst.                                                                                     |                       | 100                     |     |                | ns          |
| T <sub>HS-TRAIL</sub>                            | Time that the transmitter drives the flipped differential state after last payload data bit of a HS transmission burst                           |                       | max(8*UI, 60 ns + 4*UI) |     |                | ns          |
| T <sub>LPX</sub>                                 | TXXXransmitted length of any low-power state period                                                                                              |                       | 50                      |     |                | ns          |

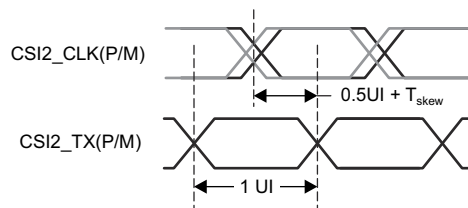
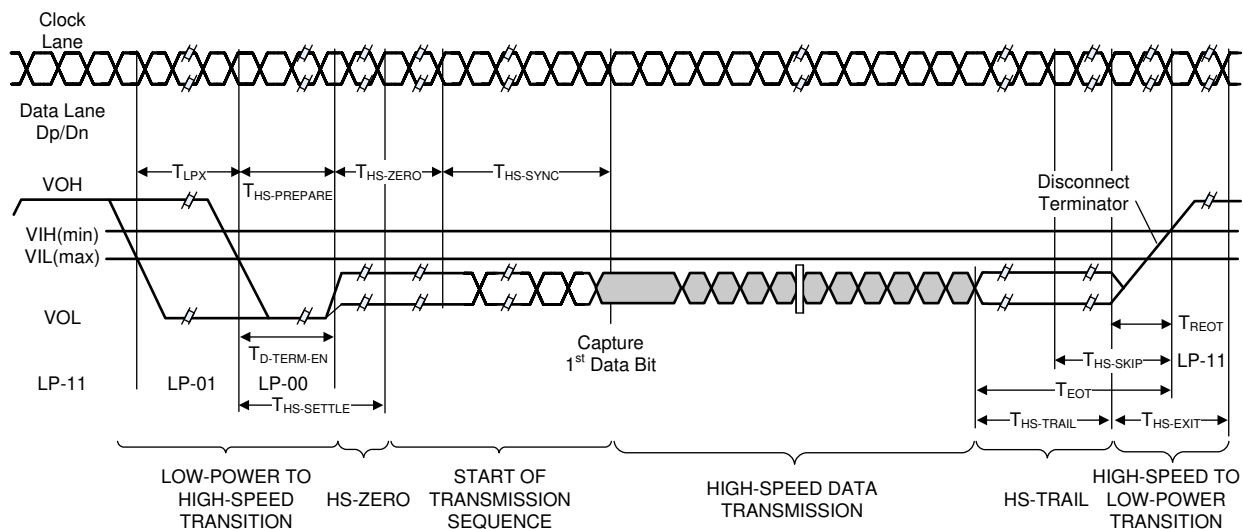
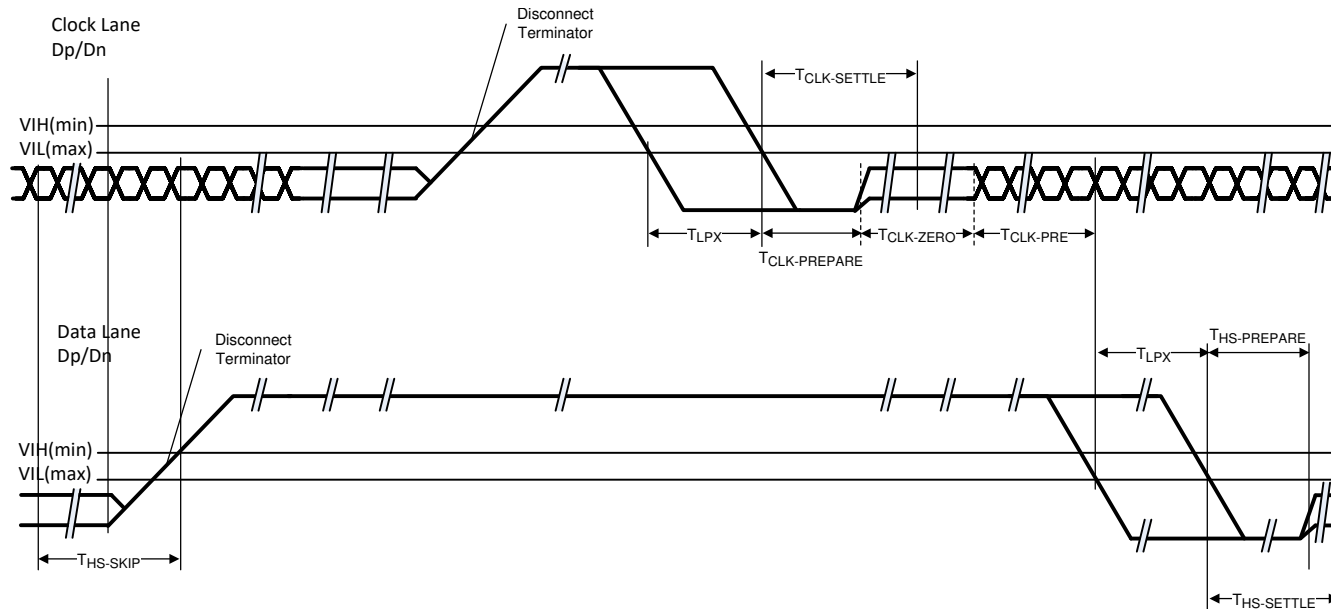


図 8-9. Clock and Data Timing in HS Transmission



**8-10. High-Speed Data Transmission Burst**



A. The HS to LP transition of the CLK does not actually take place since the CLK is always ON in HS mode.

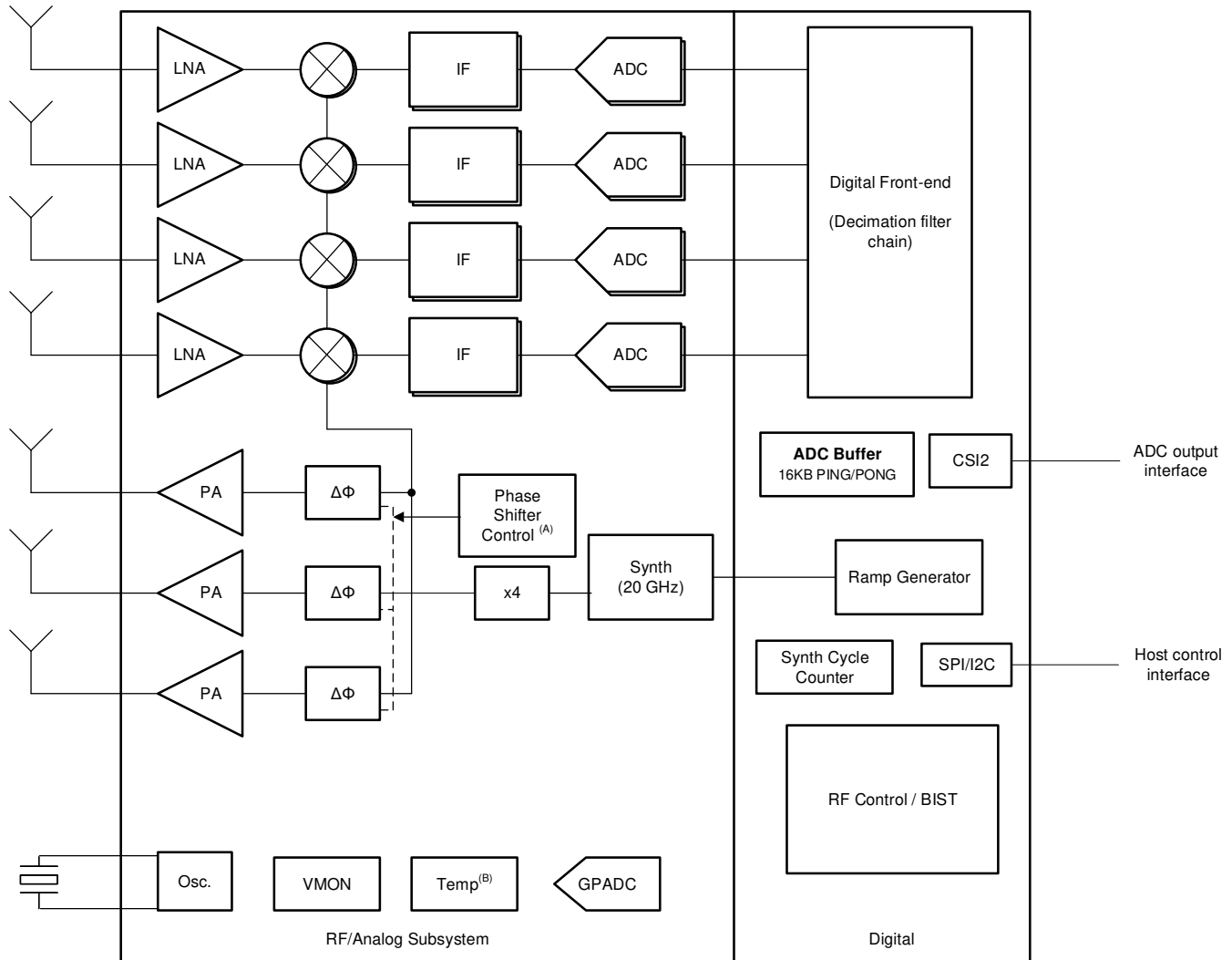
**8-11. Switching the Clock Lane Between Clock Transmission and Low-Power Mode**

## 9 Detailed Description

### 9.1 Overview

The AWR1243 device is a single-chip highly integrated 77-GHz transceiver and front end that includes three transmit and four receive chains. The device can be used in long-range automotive radar applications such as automatic emergency braking and automatic adaptive cruise control. The AWR1243 has extremely small form factor and provides ultra-high resolution with very low power consumption. This device, when used with the TDA3X or TD2X, offers higher levels of performance and flexibility through a programmable digital signal processor (DSP); thus addressing the standard short-, mid-, and long-range automotive radar applications.

### 9.2 Functional Block Diagram



A. Phase Shift Control:

- 0° / 180° BPM for AWR1243

B. Internal temperature sensor accuracy is  $\pm 7^\circ\text{C}$ .

**9-1. Functional Block Diagram**

## 9.3 Subsystems

### 9.3.1 RF and Analog Subsystem

The RF and analog subsystem includes the RF and analog circuitry – namely, the synthesizer, PA, LNA, mixer, IF, and ADC. This subsystem also includes the crystal oscillator and temperature sensors. The three transmit channels can be operated simultaneously for transmit beamforming purpose as required; whereas the four receive channels can all be operated simultaneously.

Please note that AWR1243 device supports simultaneous operation of 2 transmitters only.

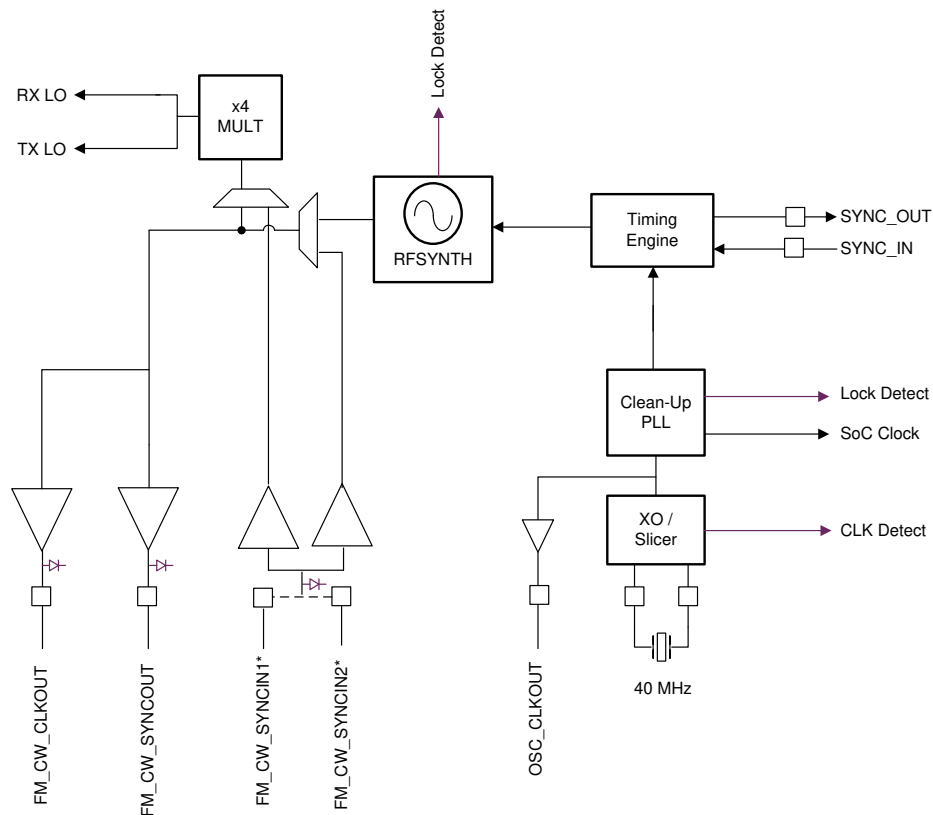
### 9.3.1.1 Clock Subsystem

The AWR1243 clock subsystem generates 76 to 81 GHz from an input reference of 40-MHz crystal. It has a built-in oscillator circuit followed by a clean-up PLL and a RF synthesizer circuit. The output of the RF synthesizer is then processed by an X4 multiplier to create the required frequency in the 76 to 81 GHz spectrum. The RF synthesizer output is modulated by the timing engine block to create the required waveforms for effective sensor operation.

The output of the RF synthesizer is available at the device pin boundary for multichip cascaded configuration. The clean-up PLL also provides a reference clock for the host processor after system wakeup.

The clock subsystem also has built-in mechanisms for detecting the presence of a crystal and monitoring the quality of the generated clock.

☒ 9-2 describes the clock subsystem.



\* These pins are 20GHz LO input pins. Connect LO to one pin while grounding the other pin.

☒ 9-2. Clock Subsystem

### 9.3.1.2 Transmit Subsystem

The AWR1243 transmit subsystem consists of three parallel transmit chains, each with independent phase and amplitude control. A maximum of two transmit chains can be operational at the same time, however all three chains can be operated together in a time-multiplexed fashion. The device supports binary phase modulation for MIMO radar and interference mitigation.

Each transmit chain can deliver a maximum of 12 dBm at the antenna port on the PCB. The transmit chains also support programmable backoff for system optimization.

Figure 9-3 describes the transmit subsystem.

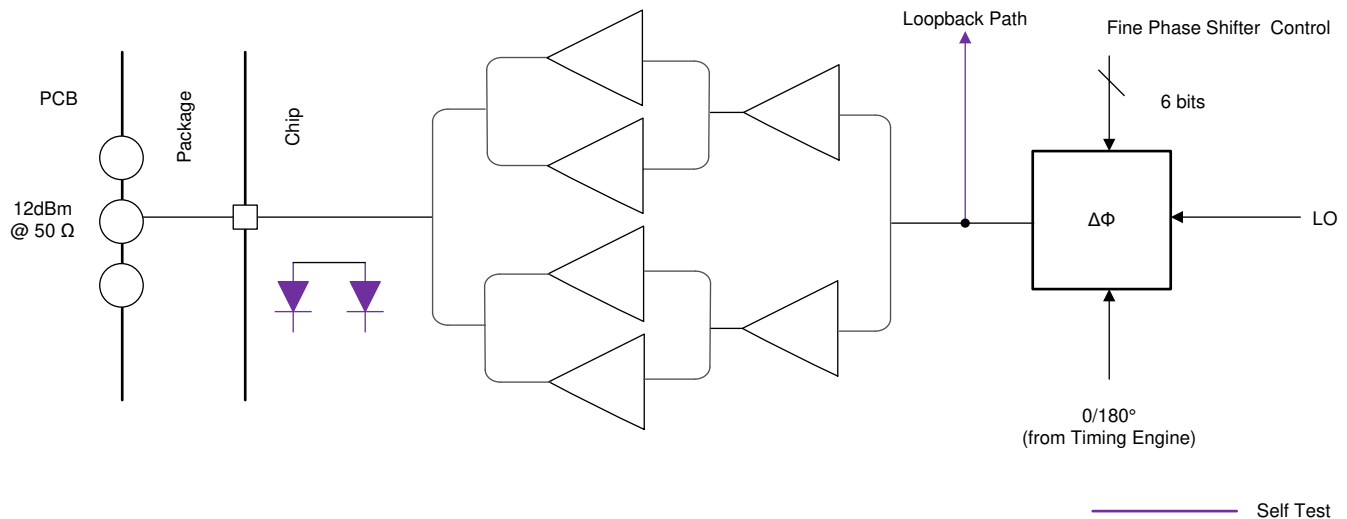


Figure 9-3. Transmit Subsystem (Per Channel)

### 9.3.1.3 Receive Subsystem

The AWR1243 receive subsystem consists of four parallel channels. A single receive channel consists of an LNA, mixer, IF filtering, ADC conversion, and decimation. All four receive channels can be operational at the same time an individual power-down option is also available for system optimization.

Unlike conventional real-only receivers, the AWR1243 device supports a complex baseband architecture, which uses quadrature mixer and dual IF and ADC chains to provide complex I and Q outputs for each receiver channel. The AWR1243 is targeted for fast chirp systems. The band-pass IF chain has configurable lower cutoff frequencies above 175 kHz and can support bandwidths up to 15 MHz.

Figure 9-4 describes the receive subsystem.

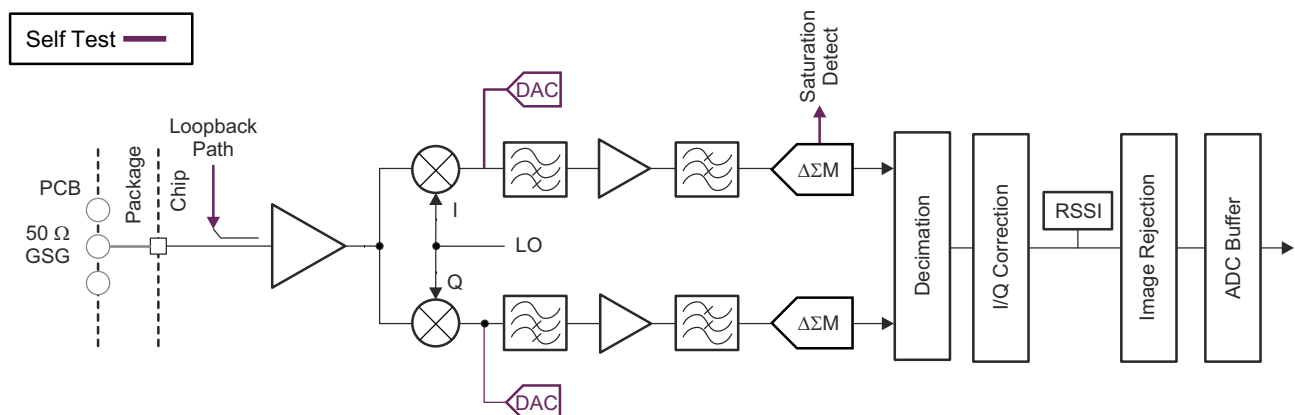


Figure 9-4. Receive Subsystem (Per Channel)

### 9.3.2 Host Interface

The AWR1243 device communicates with the host radar processor over the following main interfaces:

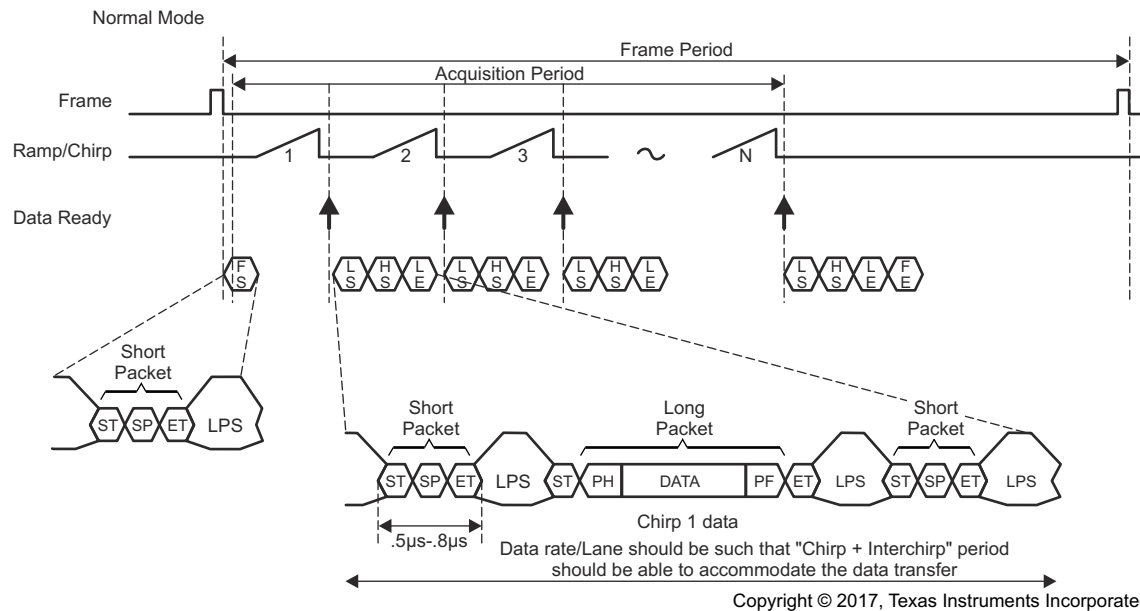
- Reference Clock – Reference clock available for host processor after device wakeup
- Control – 4-port standard SPI (peripheral) for host control along with HOST INTR pin for async events.. All radio control commands (and response) flow through this interface.
- Data – High-speed serial port following the MIPI CSI2 format. Four data and one clock lane (all differential). Data from different receive channels can be multiplexed on a single data lane to optimize board routing. This is a unidirectional interface used for data transfer only.
- Reset – Active-low reset for device wakeup from host
- Out-of-band interrupt
- Error – Used for notifying the host in case the radio controller detects a fault

## 9.4 Other Subsystems

### 9.4.1 ADC Data Format Over CSI2 Interface

The AWR1243 device uses MIPI D-PHY / CSI2-based format to transfer the raw ADC samples to the external MCU. This is shown in [Figure 9-5](#).

- Supports four data lanes
- CSI-2 data rate scalable from 150 Mbps to 600 Mbps per lane
- Virtual channel based
- CRC generation



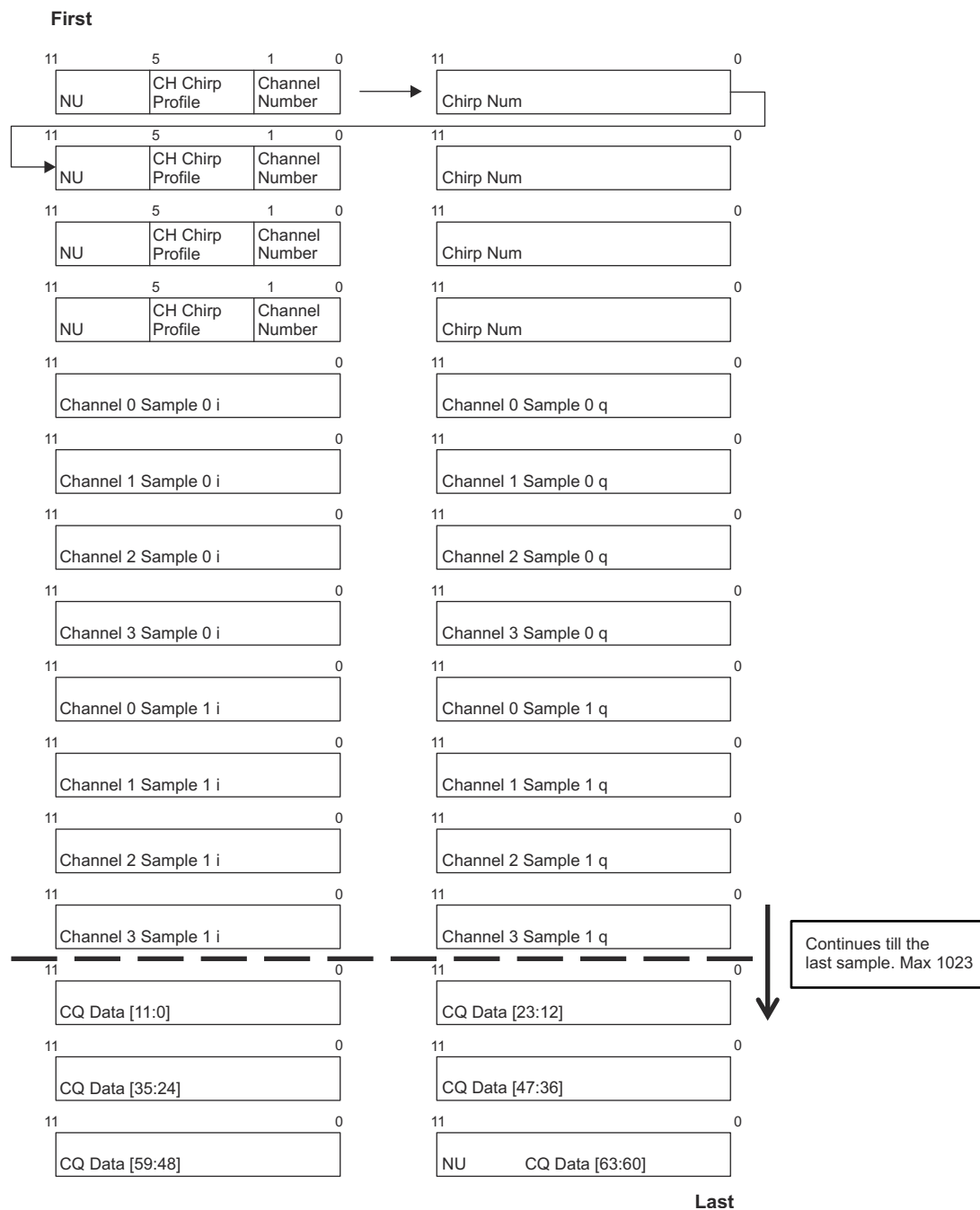
Frame Start – CSI2 VSYNC Start Short Packet  
Line Start – CSI2 HSYNC Start Short Packet  
Line End – CSI2 HSYNC End Short Packet  
Frame End – CSI2 VSYNC End Short Packet

**Figure 9-5. CSI-2 Transmission Format**

The data payload is constructed with the following three types of information:

- Chirp profile information
- The actual chirp number
- ADC data corresponding to chirps of all four channels
  - Interleaved fashion
- Chirp quality data (configurable)

The payload is then split across the four physical data lanes and transmitted to the receiving D-PHY. The data packet packing format is shown in [Figure 9-6](#)



**Figure 9-6. Data Packet Packing Format for 12-Bit Complex Configuration**

## 10 Monitoring and Diagnostics

### 10.1 Monitoring and Diagnostic Mechanisms

Below is the list given for the main monitoring and diagnostic mechanisms available in the AWR1243.

MSS R4F is the processor used for running TI's Functional Firmware stored in the ROM that helps in the execution of the API calls issued by the host processor (It is not a customer programmable core).

**表 10-1. Monitoring and Diagnostic Mechanisms for AWR1243**

| S No | Feature                                             | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------|-----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Boot time LBIST For MSS R4F Core and associated VIM | AWR1243 architecture supports hardware logic BIST (LBIST) engine self-test Controller (STC). This logic is used to provide a very high diagnostic coverage (>90%) on the MSS R4F CPU core and Vectored Interrupt Module (VIM) at a transistor level. LBIST for the CPU and VIM are triggered by the bootloader.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 2    | Boot time PBIST for MSS R4F TCM Memories            | MSS R4F has three Tightly coupled Memories (TCM) memories TCMA, TCMB0 and TCMB1. AWR1243 architecture supports a hardware programmable memory BIST (PBIST) engine. This logic is used to provide a very high diagnostic coverage (March-13n) on the implemented MSS R4F TCMs at a transistor level. PBIST for TCM memories is triggered by Bootloader at the boot time . CPU stays there in while loop and does not proceed further if a fault is identified.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 3    | End to End ECC for MSS R4F TCM Memories             | TCMs diagnostic is supported by Single error correction double error detection (SECEDED) ECC diagnostic. An 8-bit code word is used to store the ECC data as calculated over the 64-bit data bus. ECC evaluation is done by the ECC control logic inside the CPU. This scheme provides end-to-end diagnostics on the transmissions between CPU and TCM. CPU is configured to have predetermined response (Ignore or Abort generation) to single and double bit error conditions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 4    | MSS R4F TCM bit multiplexing                        | Logical TCM word and its associated ECC code is split and stored in two physical SRAM banks. This scheme provides an inherent diagnostic mechanism for address decode failures in the physical SRAM banks. Faults in the bank addressing are detected by the CPU as an ECC fault. Further, bit multiplexing scheme implemented such that the bits accessed to generate a logical (CPU) word are not physically adjacent. This scheme helps to reduce the probability of physical multi-bit faults resulting in logical multi-bit faults; rather they manifest as multiple single bit faults. As the SECEDED TCM ECC can correct a single bit fault in a logical word, this scheme improves the usefulness of the TCM ECC diagnostic.                                                                                                                                                                                                                                                                                                                                                    |
| 5    | Clock Monitor                                       | AWR1243 architecture supports Three Digital Clock Comparators (DCCs) and an internal RCOSC. Dual functionality is provided by these modules – Clock detection and Clock Monitoring.<br>DCCint is used to check the availability/range of Reference clock at boot otherwise the device is moved into limp mode (Device still boots but on 10MHz RCOSC clock source. This provides debug capability). DCCint is only used by boot loader during boot time. It is disabled once the APLL is enabled and locked.<br>DCC1 is dedicated for APLL lock detection monitoring, comparing the APLL output divided version with the Reference input clock of the device. Initially (before configuring APLL), DCC1 is used by bootloader to identify the precise frequency of reference input clock against the internal RCOSC clock source. Failure detection for DCC1 would cause the device to go into limp mode.<br>Clock Compare module (CCC) module is used to compare the APLL divided down frequency with reference clock (XTAL). Failure detection is indicated by the nERROR OUT signal. |
| 6    | RTI/WD for MSS R4F                                  | Internal watchdog is enabled by the bootloader in a windowed watchdog (DWWD) mode.. Watchdog expiry issues an internal warm reset and nERROR OUT signal to the host.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 7    | MPU for MSS R4F                                     | Cortex-R4F CPU includes an MPU. The MPU logic can be used to provide spatial separation of software tasks in the device memory. Cortex-R4F MPU supports 12 regions. It is expected that the operating system controls the MPU and changes the MPU settings based on the needs of each task. A violation of a configured memory protection policy results in a CPU abort.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 8    | PBIST for Peripheral interface SRAMs - SPI, I2C     | AWR1243 architecture supports a hardware programmable memory BIST (PBIST) engine for Peripheral SRAMs as well. PBIST for peripheral SRAM memories is triggered by the bootloader. The PBIST tests are destructive to memory contents, and as such are typically run only at boot time. . Any fault detected by the PBIST results in an error indicated in PBIST and boot status response message.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

**表 10-1. Monitoring and Diagnostic Mechanisms for AWR1243 (continued)**

| S No | Feature                                                   | Description                                                                                                                                                                                                                                                                                                                                                                                     |
|------|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9    | ECC for Peripheral interface SRAMs – SPI, I2C             | Peripheral interface SRAMs diagnostic is supported by Single error correction double error detection (SECDED) ECC diagnostic. When a single or double bit error is detected the error is indicated by nERROR (double bit error) or via SPI message (single bit error).                                                                                                                          |
| 10   | Cyclic Redundancy Check – Main SS                         | Cyclic Redundancy Check (CRC) module is available for the Main SS. The firmware uses this feature for data transfer checks in mailbox and SPI communication.                                                                                                                                                                                                                                    |
| 11   | MPU for DMAs                                              | AWR1243 architecture supports MPUs on Main SS DMAs. The firmware uses this for stack protection.                                                                                                                                                                                                                                                                                                |
| 12   | Boot time LBIST For BIST R4F Core and associated VIM      | AWR1243 architecture supports hardware logic BIST (LBIST) even for BIST R4F core and associated VIM module. This logic provides very high diagnostic coverage (>90%) on the BIST R4F CPU core and VIM. This is triggered by MSS R4F boot loader at boot time and it does not proceed further if the fault is detected.                                                                          |
| 13   | Boot time PBIST for BIST R4F TCM Memories                 | AWR1243 architecture supports a hardware programmable memory BIST (PBIST) engine for BIST R4F TCMs which provide a very high diagnostic coverage (March-13n) on the BIST R4F TCMs. PBIST is triggered at the power up of the BIST R4F.                                                                                                                                                          |
| 14   | End to End ECC for BIST R4F TCM Memories                  | BIST R4F TCMs diagnostic is supported by Single error correction double error detection (SECDED) ECC diagnostic. Single bit error is communicated to the BIST R4FCPU while double bit error is communicated to MSS R4F as an interrupt which sends a async event to the host.                                                                                                                   |
| 15   | BIST R4F TCM bit multiplexing                             | Logical TCM word and its associated ECC code is split and stored in two physical SRAM banks. This scheme provides an inherent diagnostic mechanism for address decode failures in the physical SRAM banks and helps to reduce the probability of physical multi-bit faults resulting in logical multi-bit faults.                                                                               |
| 16   | Temperature Sensors                                       | AWR1243 architecture supports various temperature sensors all across the device (next to power hungry modules such as PAs, DSP etc) which is monitored during the inter-frame period. <sup>(1)</sup>                                                                                                                                                                                            |
| 17   | Tx Power Monitors                                         | AWR1243 architecture supports power detectors at the Tx output. <sup>(2)</sup>                                                                                                                                                                                                                                                                                                                  |
| 18   | Error Signaling Error Output                              | When a diagnostic detects a fault, the error must be indicated. The AWR1243 architecture provides aggregation of fault indication from internal monitoring/diagnostic mechanisms using nERROR signaling or async event over SPI interface.                                                                                                                                                      |
| 19   | Synthesizer (Chirp) frequency monitor                     | Monitors Synthesizer's frequency ramp by counting (divided-down) clock cycles and comparing to ideal frequency ramp. Excess frequency errors above a certain threshold, if any, are detected and reported.                                                                                                                                                                                      |
| 20   | Ball break detection for TX ports (TX Ball break monitor) | AWR1243 architecture supports a ball break detection mechanism based on Impedance measurement at the TX output(s) to detect and report any large deviations that can indicate a ball break. Monitoring is done by TI's code running on BIST R4F and failure is reported to the host. It is completely up to customer SW to decide on the appropriate action based on the message from BIST R4F. |
| 21   | RX loopback test                                          | Built-in TX to RX loopback to enable detection of failures in the RX path(s), including Gain, inter-RX balance, etc.                                                                                                                                                                                                                                                                            |
| 22   | IF loopback test                                          | Built-in IF (square wave) test tone input to monitor IF filter's frequency response and detect failure.                                                                                                                                                                                                                                                                                         |
| 23   | RX saturation detect                                      | Provision to detect ADC saturation due to excessive incoming signal level and/or interference.                                                                                                                                                                                                                                                                                                  |

(1) Monitoring is done by the TI's code running on BIST R4F. There are two modes in which it could be configured to report the temperature sensed via API by customer application.

- Report the temperature sensed after every N frames
- Report the condition once the temperature crosses programmed threshold.

It is completely up to customer SW to decide on the appropriate action based on the message from BIST R4F via Mailbox.

(2) Monitoring is done by the TI's code running on BIST R4F.

There are two modes in which it could be configured to report the detected output power via API by customer application.

- Report the power detected after every N frames
- Report the condition once the output power degrades by more than configured threshold from the configured.

It is completely up to customer SW to decide on the appropriate action based on the message from BIST R4F.

---

注

Refer to the Device Safety Manual or other relevant collaterals for more details on applicability of all diagnostics mechanisms. For certification details, refer to the device product folder.

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## 11 Applications, Implementation, and Layout

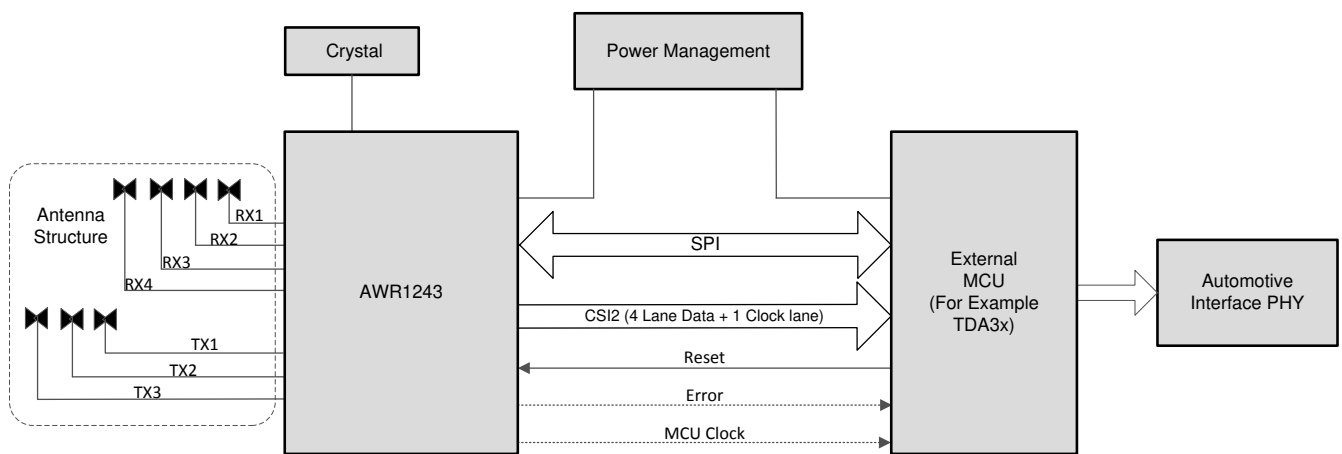
注

Information in the following Applications section is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

### 11.1 Application Information

A typical application addresses the standard short-, mid-, long-range, and high-performance imaging radar applications with this radar front end and external programmable MCU. [Figure 11-1](#) shows a short-, medium-, or long-range radar application.

### 11.2 Short-, Medium-, and Long-Range Radar



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**Figure 11-1. Short-, Medium-, and Long-Range Radar**

### 11.3 Reference Schematic

The reference schematic and power supply information can be found in the [AWR1243 EVM Documentation](#).

Listed for convenience are: Design Files, Schematics, Layouts, and Stack up for PCB.

- [Altium AWR1243 EVM Design Files](#)
- [AWR1243 EVM Schematic Drawing, Assembly Drawing, and Bill of Materials](#)

## 12 Device and Documentation Support

TI offers an extensive line of development tools. Tools and software to evaluate the performance of the device, generate code, and develop solutions follow.

### 12.1 Device Nomenclature

To designate the stages in the product development cycle, TI assigns prefixes to the part numbers of all microprocessors (MPUs) and support tools. Each device has one of three prefixes: X, P, or null (no prefix) (for example, *AWR1243*). Texas Instruments recommends two of three possible prefix designators for its support tools: TMDX and TMDS. These prefixes represent evolutionary stages of product development from engineering prototypes (TMDX) through fully qualified production devices and tools (TMDS).

Device development evolutionary flow:

- X** Experimental device that is not necessarily representative of the final device's electrical specifications and may not use production assembly flow.
- P** Prototype device that is not necessarily the final silicon die and may not necessarily meet final electrical specifications.
- null** Production version of the silicon die that is fully qualified.

Support tool development evolutionary flow:

- TMDX** Development-support product that has not yet completed Texas Instruments internal qualification testing.
- TMDS** Fully-qualified development-support product.

X and P devices and TMDX development-support tools are shipped against the following disclaimer:

"Developmental product is intended for internal evaluation purposes."

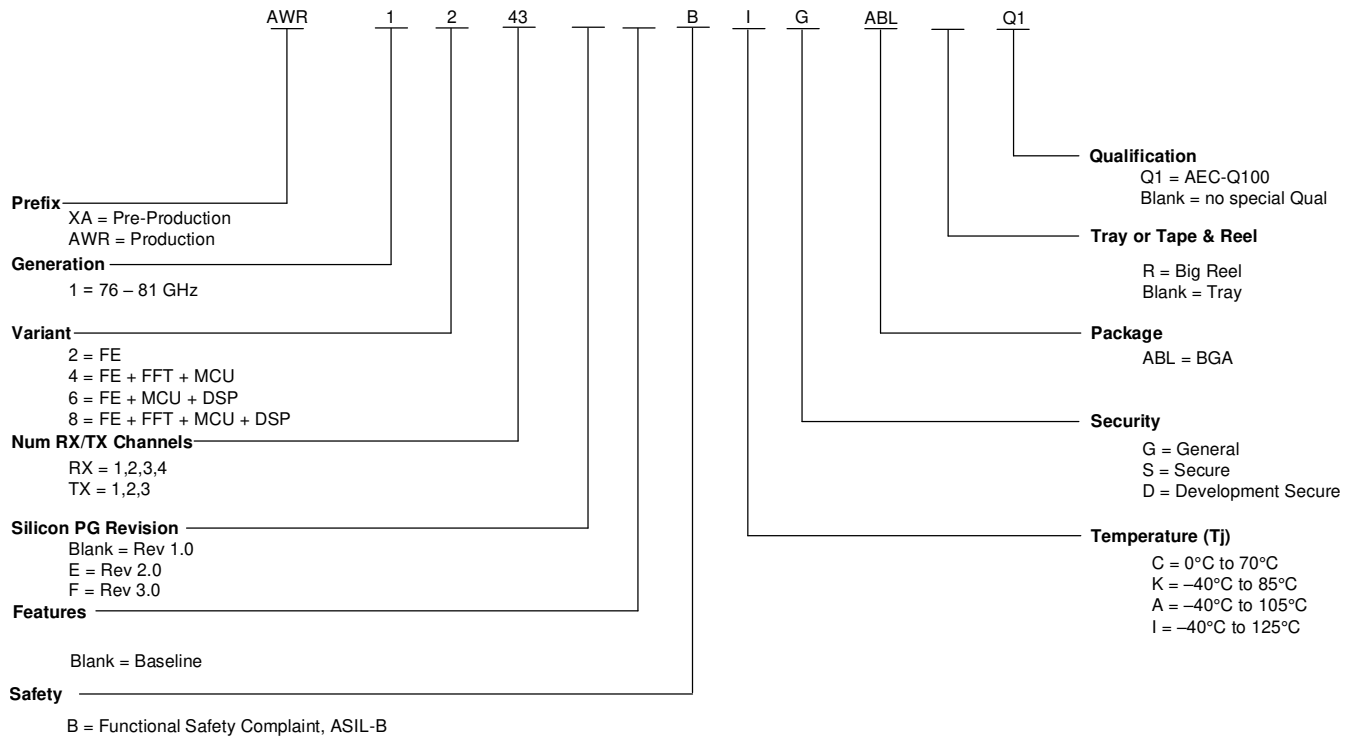
Production devices and TMDS development-support tools have been characterized fully, and the quality and reliability of the device have been demonstrated fully. TI's standard warranty applies.

Predictions show that prototype devices (X or P) have a greater failure rate than the standard production devices. Texas Instruments recommends that these devices not be used in any production system because their expected end-use failure rate still is undefined. Only qualified production devices are to be used.

TI device nomenclature also includes a suffix with the device family name. This suffix indicates the package type (for example, ABL0161 ALB0161), the temperature range (for example, blank is the default commercial temperature range). [Figure 12-1](#) provides a legend for reading the complete device name for any *AWR1243* device.

For orderable part numbers of *AWR1243* devices in the ABL0161 package types, see the Package Option Addendum of this document, the TI website ([www.ti.com](http://www.ti.com)), or contact your TI sales representative.

For additional description of the device nomenclature markings on the die, see the [AWR1243 Device Errata](#).



## 12-1. Device Nomenclature

## 12.2 Tools and Software

### Development Tools

[AWR1243 cascade application note](#)

Describes TI's cascaded mmWave radar system.

### Models

[AWR1243 BSDL model](#)

Boundary scan database of testable input and output pins for IEEE 1149.1 of the specific device.

[AWR1x43 IBIS model](#)

IO buffer information model for the IO buffers of the device. For simulation on a circuit board, see IBIS Open Forum.

[AWR1243 checklist for schematic review, layout review, bringup/wakeup](#)

A set of steps in spreadsheet form to select system functions and pinmux options. Specific EVM schematic and layout notes to apply to customer engineering. A bringup checklist is suggested for customers.

## 12.3 Documentation Support

To receive notification of documentation updates, navigate to the device product folder on [ti.com](https://www.ti.com). Click on *Subscribe to updates* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

The current documentation that describes the DSP, related peripherals, and other technical collateral follows.

### Errata

[AWR1243 device errata](#) Describes known advisories, limitations, and cautions on silicon and provides workarounds.

## 12.4 サポート・リソース

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## 12.5 Trademarks

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## 12.6 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

## 12.7 Glossary

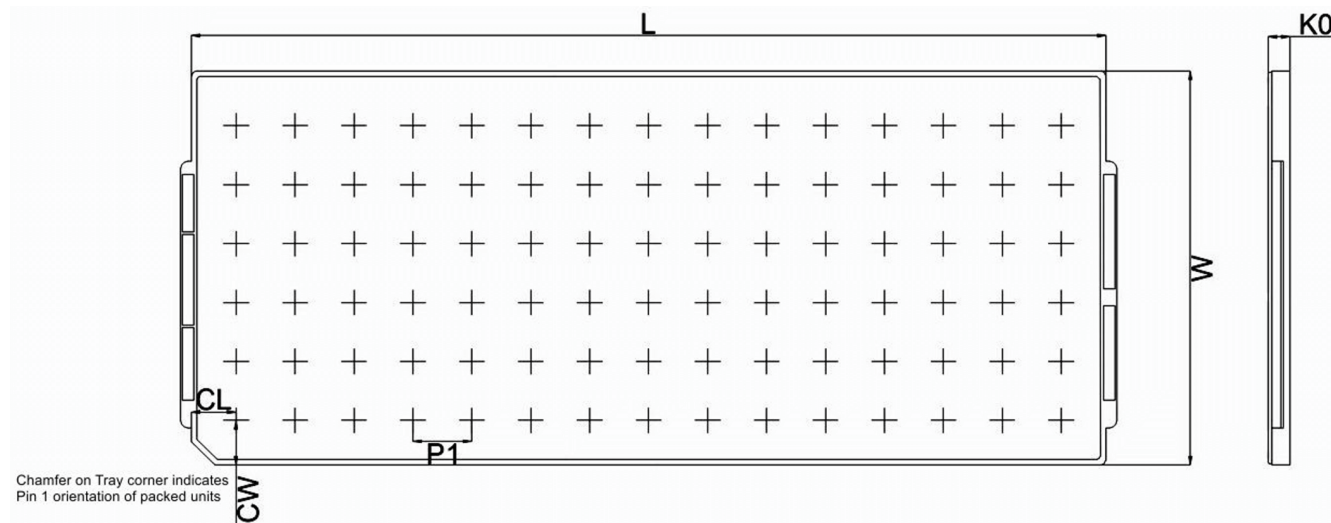
[TI Glossary](#) This glossary lists and explains terms, acronyms, and definitions.

## 13 Mechanical, Packaging, and Orderable Information

### 13.1 Packaging Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

### 13.2 Tray Information for



## PACKAGING INFORMATION

| Orderable part number             | Status<br>(1) | Material type<br>(2) | Package   Pins    | Package qty   Carrier   | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6)              |
|-----------------------------------|---------------|----------------------|-------------------|-------------------------|-------------|--------------------------------------|-----------------------------------|--------------|----------------------------------|
| <a href="#">AWR1243FBIGABLQ1</a>  | Active        | Production           | FCCSP (ABL)   161 | 176   JEDEC TRAY (10+1) | -           | Call TI                              | Level-3-260C-168 HR               | -40 to 125   | AWR1243<br>IG<br>964FC           |
| AWR1243FBIGABLQ1.B                | Active        | Production           | FCCSP (ABL)   161 | 176   JEDEC TRAY (10+1) | -           | Call TI                              | Level-3-260C-168 HR               | -40 to 125   | AWR1243<br>IG<br>964FC           |
| <a href="#">AWR1243FBIGABLRQ1</a> | Active        | Production           | FCCSP (ABL)   161 | 1000   LARGE T&R        | -           | Call TI                              | Level-3-260C-168 HR               | -40 to 125   | AWR1243<br>IG<br>964FC<br>ABL G1 |
| AWR1243FBIGABLRQ1.B               | Active        | Production           | FCCSP (ABL)   161 | 1000   LARGE T&R        | -           | Call TI                              | Level-3-260C-168 HR               | -40 to 125   | AWR1243<br>IG<br>964FC<br>ABL G1 |

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "-" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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## GENERIC PACKAGE VIEW

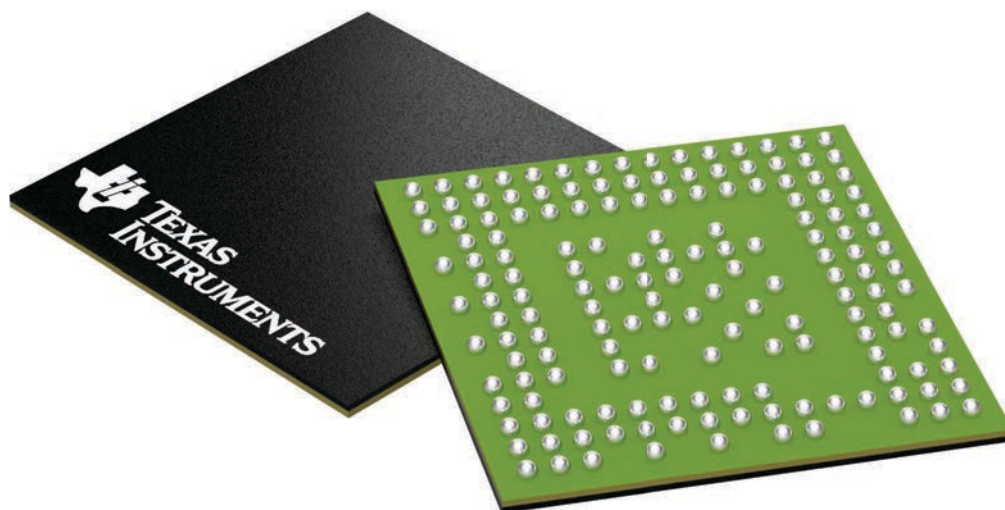
**ABL 161**

**FCBGA - 1.17 mm max height**

10.4 x 10.4, 0.65 mm pitch

PLASTIC BALL GRID ARRAY

This image is a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.



4225978/A

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