# AFE79xx: RX DSA Gain/Phase Calibration

**Texas Instruments**

**High Speed Data Converters**

**June 03, 2019**

# RX DSA – Gain/Phase Calibration

- The RX DSA Gain/Phase Calibration has two modes of operation.
  1. Gain/Phase Calibration Mode
  2. Calibration Packet Load Mode

- Gain/Phase Calibration Mode: The calibration mode operation is performed once for each device, as part of factory calibration.
  - During the calibration mode, test tones are injected to enable the device to estimate the gain and phase error as a function of the RX DSA gain steps.
  - The gain/phase parameters are computed for the RX DSAs in each band of each of the 4 receivers.
  - The estimated gain/phase parameters are to be read by the host and stored in a non-volatile memory.

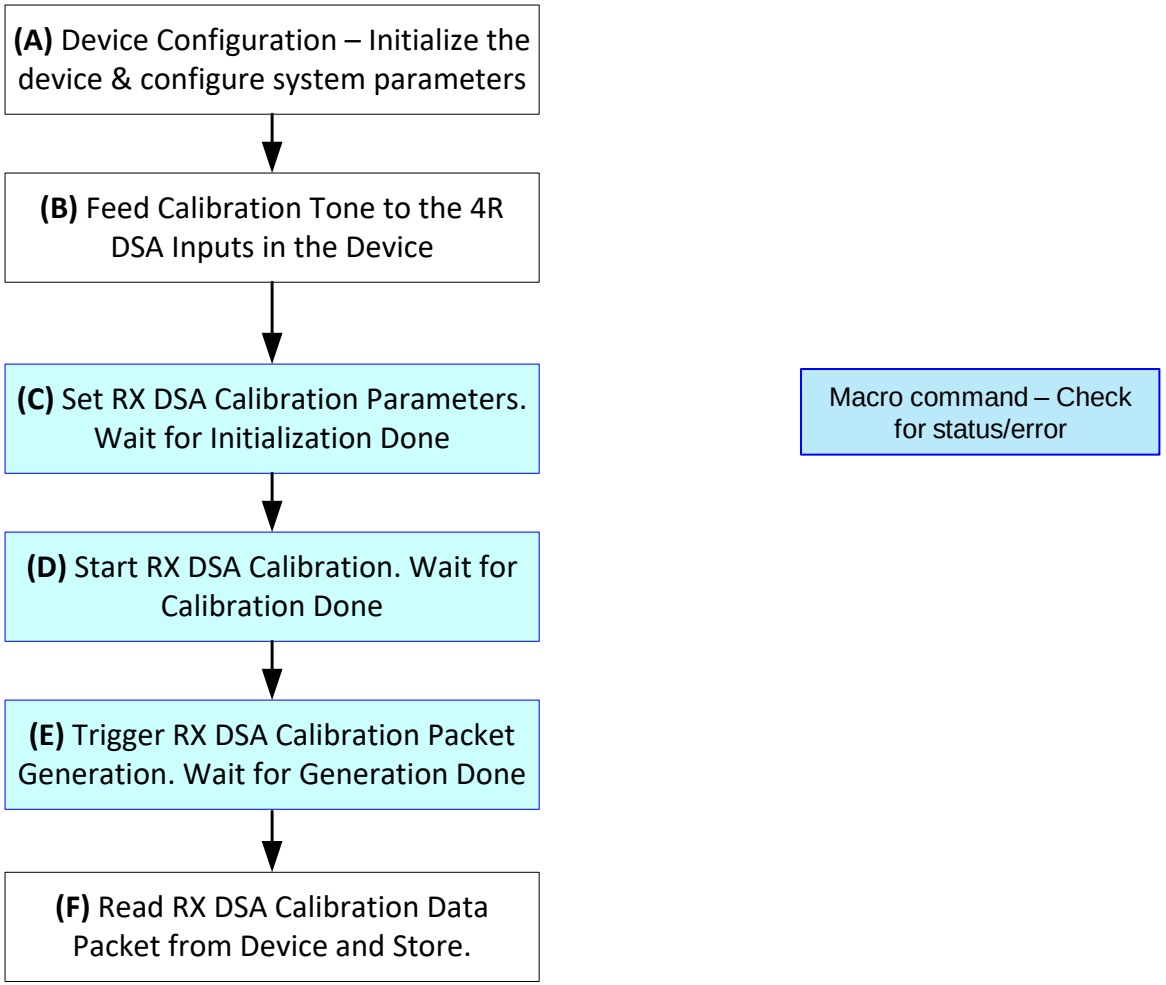
- Calibration Packet Load Mode: The calibration packet load mode operation is performed once during every power up.
  - During the calibration packet load mode, the gain/phase parameters stored by the host in a non-volatile memory are configured in to the device.
  - The configured parameters are used, internally in the device, to compensate for gain/phase errors as the RX DSA gain steps are changed during normal operation.

# RX DSA – Calibration Mode

- Requirement on the Test Tone:
  - The tone frequency should be selected to be in the desired band of operation, i.e., should be within about ±40% of interface rate (e.g., ±100 MHz for 245.76 MSPS).
  - The input tone frequency should be offset from the band-center-frequency by an integer multiple of $f_{int}/256$, where "$f_{int}$" is the interface rate.
  - The tone level at the input of the device should nominally be around -16 (?) dBm.
  - One test tone should be injected in each band of interest.
  - The test tone can be simultaneously injected to all the receivers with the same band of interest.
    - For instance, if the receiver frequency in the two sets of 2R (in a 4T4R) would be configured to the same frequency band, then the same test tone can be simultaneously injected to all 4R.
- Calibration Mode Configuration
  - The specific frequency band of interest for the DSA and the decimation factor (e.g., interface rate) need to be used during the calibration mode.
  - After calibration, the gain/phase error parameters are expected to hold only for the frequency band of interest.

# RX DSA – Calibration Flowchart (1)

- The RX DSA calibration mode flowchart is illustrated.
  - Additional details on the states of the flowchart are provided in the following slides.



# RX DSA – Calibration Flowchart (2)

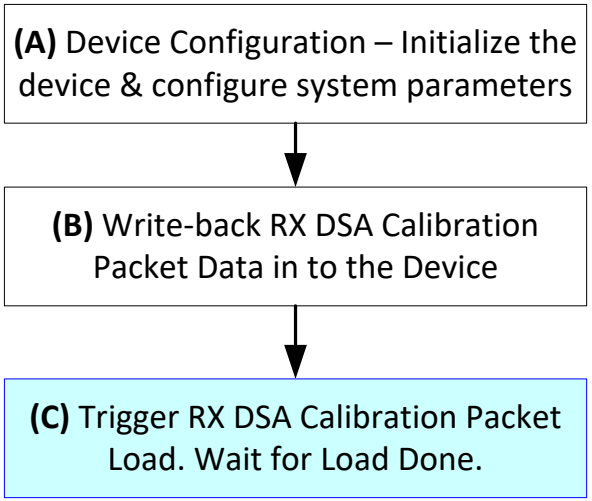
- State A: The device is brought out of reset by setting the appropriate SPI registers. The device needs to be configured in to the appropriate state with the desired system parameters (Band Center Frequencies, interface rate, etc.)
- State B: The calibration tone corresponding to desired frequency band is to be fed to all the 4R inputs in the device.
- State C: The initialization parameters for RX DSA calibration needs to be programmed.
  - An SPI register bit indicating initialization done event needs to be monitored. If the 'Initialization_Done bit' is 1, then proceed to State D.
- State D: The appropriate set of SPI registers corresponding to the RX DSA calibration macro needs to be programmed to start the RX DSA calibration procedure.
  - An SPI register bit indicating calibration done event needs to be monitored. If the 'Calibration_Done bit' is 1, then record the 'Error_Status'.
  - Take appropriate action based on the 'Error_Status' (e.g., Signal power too low, Tone frequency incorrect, etc.) and then repeat the step to start RX DSA calibration (State D).
  - Otherwise, proceed to State E.

# RX DSA – Calibration Flowchart (3)

- State E: Program appropriate SPI registers to trigger the generation of the RX DSA gain/phase calibration packet.
  - An SPI register bit indicating packet generation done event needs to be monitored. If the Generation_Done bit is 1, then record the 'Error_Status'.
  - In case the 'Error_Status' indicates an error, then exit to an "Error State" and record error status indicators. If no error, then proceed to State F.

- State F: Read the RX DSA calibration data packet from the device and store it in non-volatile memory.
  - The size of the calibration data packet (in bytes) can be read from an SPI status register, 'Calibration Packet Size'.

# RX DSA – Calibration Packet Load Mode




- State A: The device is brought out of reset by setting the appropriate SPI digital registers. The device needs to be configured in to the appropriate state with the desired system parameters (Band center frequency, interface rate, etc.)
- State B: Write-back the RX DSA calibration data, stored in a non-volatile memory, in to the device.
- State C: Trigger (by SPI writes) load of RX DSA gain/phase calibration packet.
  - An SPI register bit indicating packet load done event needs to be monitored. If the Load_Done bit is 1, then record the 'Error_Status'.
  - In case the 'Error_Status' indicates a packet error, then exit to an "Error State" and record error status indicators. If no error, then calibration packet load mode is complete.

# RX DSA – Calibration Data Packet Size

- RX DSA Calibration Packet: The size of the data packet that needs to be stored for the RX DSA calibration, is ~1500 bytes for 4 RX channels, with each programmed to be in dual band mode.
  - The data packet size is ~1000 bytes for single band mode of operation.