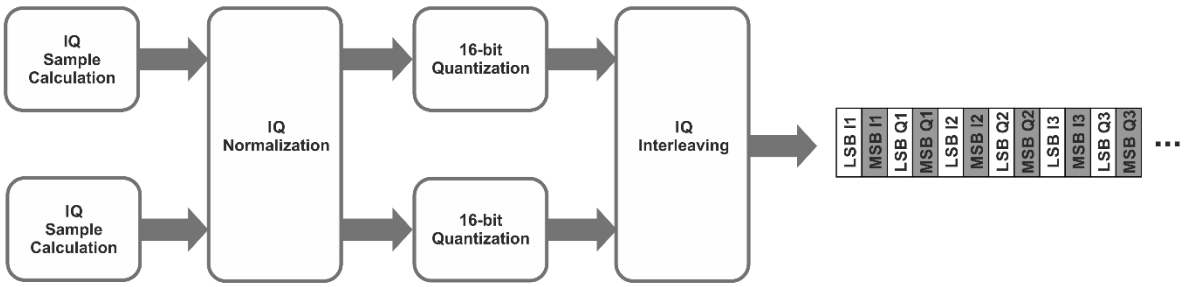

Figure 4.3: IQ waveform data must be stored properly for play-back. In the ONE mode, data must be arranged as a single segment with the I and Q samples interleaved.

The maximum overall data rate for this mode is 2.5GS/s (16-bit) so the maximum sample rate for each component would be 1.25GS/s (1.125GS/s for 9GS/s DAC conversion rate and 8x interpolation) and the resulting modulation BW would be slightly larger than 1.0 GHz.

The TWO mode is more complex, as two sets of IQ pairs must be transferred to a given channel. The resulting two sets of IQ pairs must be doubled interleaved to be downloaded to a single segment (fig. 4.4). The binary data to be sent to the segment must be properly formatted, so the transfer to the waveform memory is aligned with the DUC block requirements. This is the sequence of formatting actions to be carried out:

1. Arrange the 16-bit samples in the I1, Q1, Q2, I2 sequence
2. Split all the 16-bit samples in two bytes
3. For each group of four samples, take the MSB bytes following the interleaving sequence shown above (I1M, Q1M, Q2M, I2M)
4. You must perform the same operation for the LSB bytes (I1L, Q1L, Q2L, I2L)
5. Obtain the final waveform data by interleaving the MSB and LSB groups built in the previous steps (I1M, I1L, Q1M, Q1L, Q2M, Q2L, I2M, I2L)

As the overall data rate (5GBytes/s) stands here as well, the maximum sampling rate for each one of the IQ components is 625MS/s and modulation BW will be close to 600MHz. However, as interpolation factor depends on the ratio between the DAC sampling rate and the baseband interpolation ratio, and currently the maximum interpolation factor implemented in Proteus is 8x, the maximum DAC sampling rate supporting the two mode is 625 * 8 = 5,000MS/s = 5GS/s. Future product improvements will allow for higher interpolation factors (16x) so the TWO mode will be feasible up to the maximum DAC sampling rate (9GS/s).

Finally, the HALF mode uses half of one of the DUCs in each channel of a given pair, using just one of the DACs after adding the output of each block. In this case, waveform data is stored as two independent segments in the same DDR bank and segment assignment is done as a direct real only waveform to each participating channel. This is the formatting procedure:

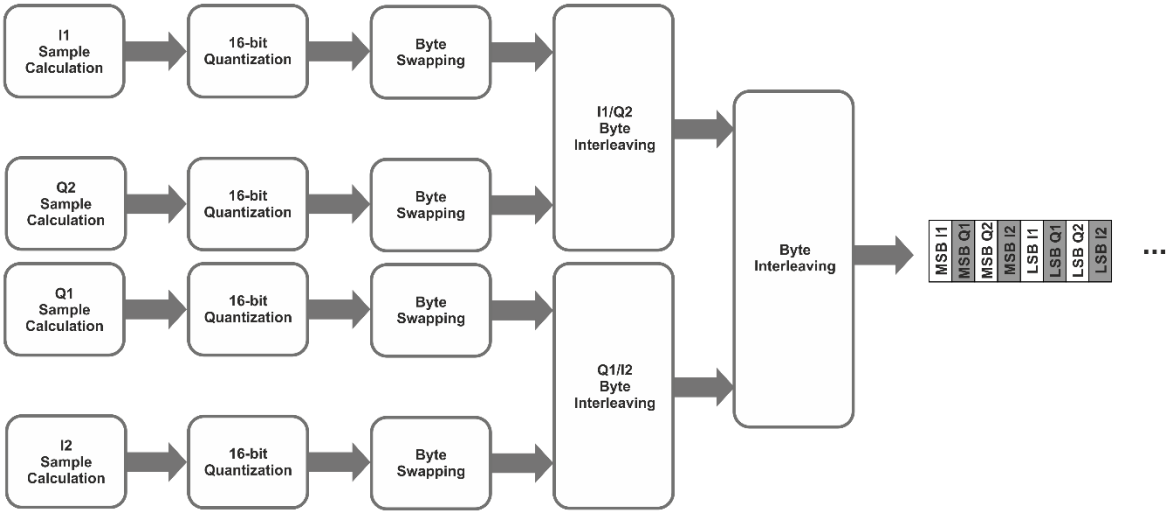

Figure 4.4: The TWO mode requires interleaving the IQ1 and IQ2 sample pairs together in such a way the DUC can use the data immediately and latency is minimized. Here, the dual-level interleaving process is shown.

1. Calculate I and Q waveforms
2. Joint normalization
3. Download I waveform to segment A
4. Download Q waveform to segment B
5. Segment size = I waveform size = Q waveform size
6. Select Segment A for target active channel (1 or 3)
7. Select Segment B for associated phantom channel (2 or 4)

NCO for each channel must be set to the same frequency and phase. When the mode is activated, the "phantom" channels will not output any signal, and the active channel will work exactly as it was in the ONE mode, although the I and Q quadrature modulated components come from different DUCs (each one using a different, but synchronized and coherent, NCO). The main advantage of this mode consists in increasing by a factor of 2 (up to 2.5GS/s) the sampling rate for each one of the components, so modulation BW goes beyond 2.3GHz. At a 9GS/s DAC sampling rate, and using the x4 interpolation factor, baseband sampling rate will be 2.25GS/s so modulation BW will go beyond 2GHz.

Resources & Contact

For more information on Microwave signal generation challenges and solutions, review the following resources:

- White Paper: Multi-Nyquist Zones Operation-Solution Note
- White Paper: Direct Generation/Acquisition of Microwave Signals
- White Paper: Effective Number of Bits for Arbitrary Waveform Generators
- White Paper: Multi-Tone Signal Generation with AWGs
- Solution Brief**:** Envelope Tracking – Solution Note
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