

Further complexity reduction for eRedCap devices enabling SAW-less design

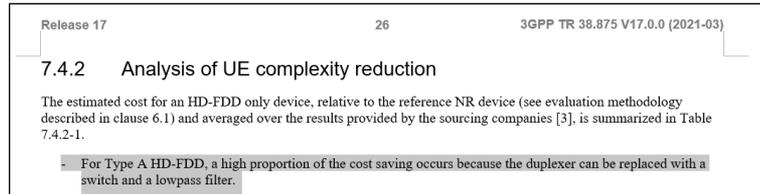
Sony, Nordic Semiconductor ASA, Semtech

Motivation

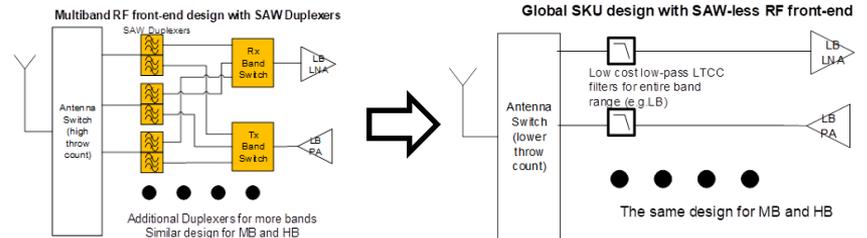
- From the device implementation viewpoint, the SAW-less design is one of the main options to **achieve hardware complexity reduction while enabling a single SKU (stock-keeping unit) design for global operation.**
 - According to TR 38.875 “*For Type A HD-FDD, a high proportion of the cost saving occurs because the duplexer can be replaced with a switch and a lowpass filter*”.
 - Removing the band specific SAW filters enables a single SKU design for global operation, simplifying device procurement, manufacturing and inventory management.
 - Removing the SAW filter reduces the insertion loss which improves the power efficiency, and likely also reduces the form factor of the devices.
- Further complexity reduction of eRedCap devices will also **facilitate further network deployments and ecosystem growth**
 - SAW-less design will allow significant complexity reduction of devices and thus more devices could be deployed to wider applications, bringing more clients and more service utilization of the network. Therefore, SAW-less design will facilitate the growth of the ecosystem.
 - More economical eRedCap devices will accelerate the network migration and market moving towards 5G technology and away from legacy alternatives that are available today e.g., CAT-1bis devices. This will unleash new use cases and verticals which benefits the whole industry including module makers and operators.
 - A single SKU design for global operation simplifies worldwide IoT device deployments for customers.
- RAN4 has already had some preliminary discussions to enable SAW-less implementation for eRedCap in Rel-18, but no conclusion was reached due to insufficient time. However, as concluded in RAN4#109, **RAN4 agreed to consider discussion on SAW-less design for eRedCap in Rel-19.**

Background

- Based on the 3GPP study in *TR 38.875 Study on support of reduced capability NR devices*, **the duplexer is a major cost contribution in the RF front-end for an NR FDD device.**
- Rel-17 RedCap enables HD-FDD operation in NR so that the duplexer can be omitted. However, to meet some RF requirements that have been defined for NR, **band-specific SAW filters are still needed for HD-FDD RedCap which dilute the intended cost saving benefit.**
- In Rel-18 eRedCap, the eRedCap UE with BW3/PR3+ PR1 is defined. **It is possible for such a device to meet most of the RF requirements without a SAW filter due to the limited RB length (only 25/12 RBs for 15 and 30 kHz SCS) for PUSCH**, with only a limited set of requirements (e.g., emission and blocking limits) in 38.101-1 as exceptions (see appendix).
- With this proposal, for a further complexity reduction for eRedCap in Rel-19, especially for HD-FDD, **we propose to resolve the barriers in 3GPP specs by specifying corresponding mechanism(s) to enable implementations without SAW filters (i.e. SAW-less).**
 - Note: Without SAW filters (i.e. SAW-less) does not imply “without filters”, since a few small and low-cost low-pass filters for harmonics rejection are still needed.



Conclusion for HD-FDD cost saving in TR 38.875



Proposal

- RAN4 to investigate the limiting factors in UE RF requirements in TS 38.101-1 (for example, band specific transmitter out of band emissions and receiver out of band blocking) to enable SAW-less designs in Rel-19 for PC3 HD-FDD eRedCap device with BW3/PR3+ PR1 (IE supportOfERedCap-r18 is present and IE eRedCapNotReducedBB-BW-r18 is NOT present).
- Based on the identified limiting factors, RAN4 to identify and specify the corresponding mechanism(s) to enable SAW-less eRedCap designs in Rel-19.
 - Note: public safety band protection shall be guaranteed.

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Appendix: Examples of limited factors in 38.101-1 for SAW-less implementation

- Noise for UE-coex in SAW-less design with small frequency offset
 - 3GPP requires Tx “noise” into the protected frequency bands to not exceed -50dBm/MHz – specified as “Spurious Emission for UE coexistence” under section 6.5.3.2 in TS 38.101-1
 - This requirement can’t be met for >5MHz channel BWs in SAW-less design due to strong PA non-linearity products falling into the protected bands –SAW filtering is necessary at such band scenarios.
 - This is a major SAW-less design challenge in 5G NR designs compared to LTE IoT using much narrower channel BWs (<1.4MHz)
 - For 5MHz PUSCH, the above requirement becomes more realistic for SAW-less design but still very challenging in some critical scenarios due to higher order IMD products falling into the protected Rx bands
 - **The worst case is n13 Tx noise → B14 Rx band (protected):** -9MHz offset from the edge of LOWEST channel BW, affected by IMD7. This offset is smaller than the minimum Foob limit (10MHz) that the UE-coex requirements are usually applied from.
 - Our measurements on a few existing PA types show spurious emission of -43 - -48dBm/MHz in this scenario → -45 - -50dBm at antenna – marginal/not sufficient to meet 3GPP spec.



- Additional blocking requirements for band n71 and 105
 - In-band Blocking (IBB) spec for 5G NR includes very challenging requirements for n71 (Case 3) and n105 (Case 5). Both specs are much harder than other IBB and OBB specs.

	n71 (Case3)	n105 (Case5)	IBB other bands (Case2)	OBB	
P_interferer	-15	-22	-44	-44 or -15	dBm
BW_interferer	5	5	5	CW	MHz
Offset_interferer	FDL_low - 12	FDL_low - 12	FDL_low/FDL_high +/-15	FDL_low/FDL_high +/-15 or FDL_low/FDL_high +/-85	MHz