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Hardware Compatibility	Product Line	IoT Modules	Series	EM8695	

Software Compatibility	All	Document Type	App Note	✓	Tech Note	

1 Introduction

This document is provided to Sierra Wireless distributors and clients. To request a new application/technical note, contact your regional Sierra Wireless Product Marketing Manager.

2 Scope

This document describes Qualcomm (QTI) Smart Transmit (ST), the ST certification workflow, and how to use the ST feature and associated tools to comply with SAR regulations.

3 ST Overview

EM8695 series modules introduce QTI's advanced ST feature for regulatory compliance, which replaces the legacy SAR backoff feature used in earlier Sierra Wireless modules.[1]

Important: *Integrators intending to use the Smart Transmit feature on the module may be required to obtain separate certifications (e.g., FCC, ISED, etc.) for either the module itself or the host platform in which the module is embedded.*

3.1 ST Exposure Methods

ST supports two exposure methods for managing a wireless device's target output power (P_{limit}), which is the output power requirement for SAR regulatory compliance:

- Time-averaged exposure — ST controls the wireless device's Tx power for all supported RAT/band combinations by dynamically adjusting instantaneous Tx power to achieve a target average power over a period of time (i.e., the "averaging window").

  Note that:
  - Average output power never exceeds the P_{limit}.
  - Instantaneous output power can exceed the P_{limit} and the wireless device's SAR design target (regulatory average SAR power limit), but the wireless device will cap the output power at its maximum transmit power limit (MTPL).

  Time-averaging allows the wireless device to maintain SAR regulatory compliance, while also achieving good user experience and network performance.
- Force Peak exposure — Instantaneous output power never exceeds the P_{limit}. (Note: This is the default exposure method used for a given band when ST has not been configured to use a specific exposure method for that band.)

1. Legacy SAR backoff via non-volatile memory items (and related AT commands, e.g., !SARBACKOFF) are no longer supported.

The ST exposure method, time-averaging window and SAR regulatory limit used for any given RAT/band combination are region-dependent and carrier-dependent.

Figure 1 displays the difference between the exposure methods. (For additional ST details, refer to *[3] Qualcomm Smart Transmit Feature for SDX35 (80-61400-14 Rev.AA).*)

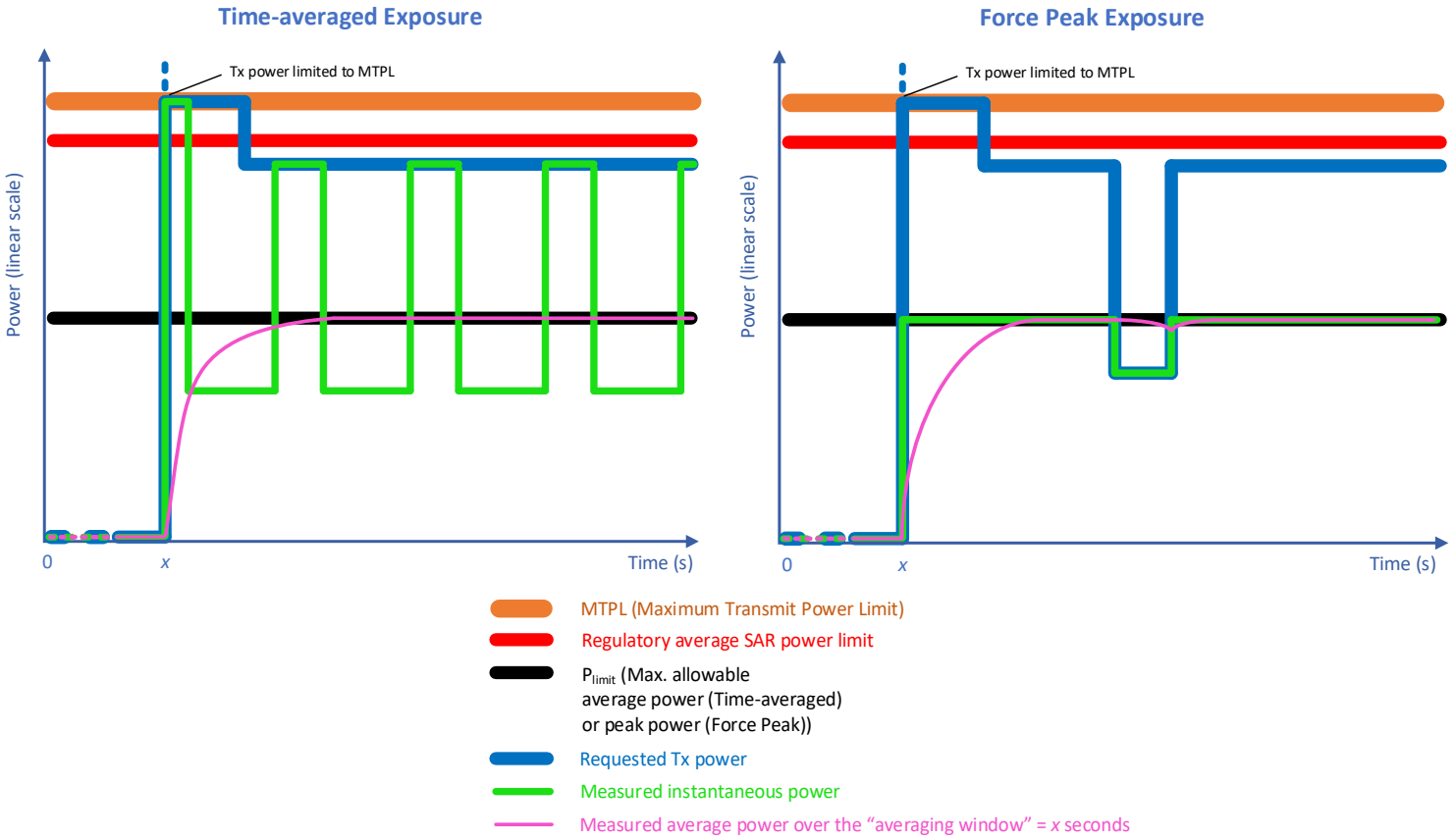


Figure 1: ST Exposure Methods (Idealized) Comparison — Time-averaged vs. Force Peak

3.2 ST Customization by Region and Mobile Country Code (MCC)

To configure a wireless device to use ST, Sierra Wireless provides a radio transmitter SAR (rtsar) configuration template file that the OEM must populate with P_{limit} values for all of the device's exposure conditions, and with the regional MCCs that use those limits:

- rtsar_sub6.xlsx — For use in all regions, including those subject to FCC regulation and those in other (non-FCC) regions in the rest of the world (ROW).

After the OEM populates the ST rtsar configuration template file, Sierra Wireless converts it to an EFS file (rtsar_config) that the OEM must load onto the module using EXTERNAL_STTool (Sierra Wireless' ST flash application, provided in to the OEM in 5.1 ST Certification Kickoff (Task #1)). ST settings automatically take effect on the next restart if ST initialization is successful.

For details, see 5.2 Evaluate SAR Exposure Scenarios, Assign DSIs, Specify SAR_design_target Values (Task#3) and 5.4 Populate ST rtsar Template File (Task #6).

4 ST Certification Workflow

The ST certification process involves the OEM, third-party labs (with SAR measurement and ST testing capabilities), and Sierra Wireless. (Note — Sierra Wireless does not recommend any specific third party labs.)

Figure 2 and Table 1 outline the ST certification procedure and brief descriptions of the actions taken for each task by the OEM, third-party lab or Sierra Wireless, and detailed descriptions of the OEM's tasks are included in 5 OEM Actions in the ST Certification Workflow.

Note: Figure 2 illustrates the workflow, and Table 1 adds additional context.

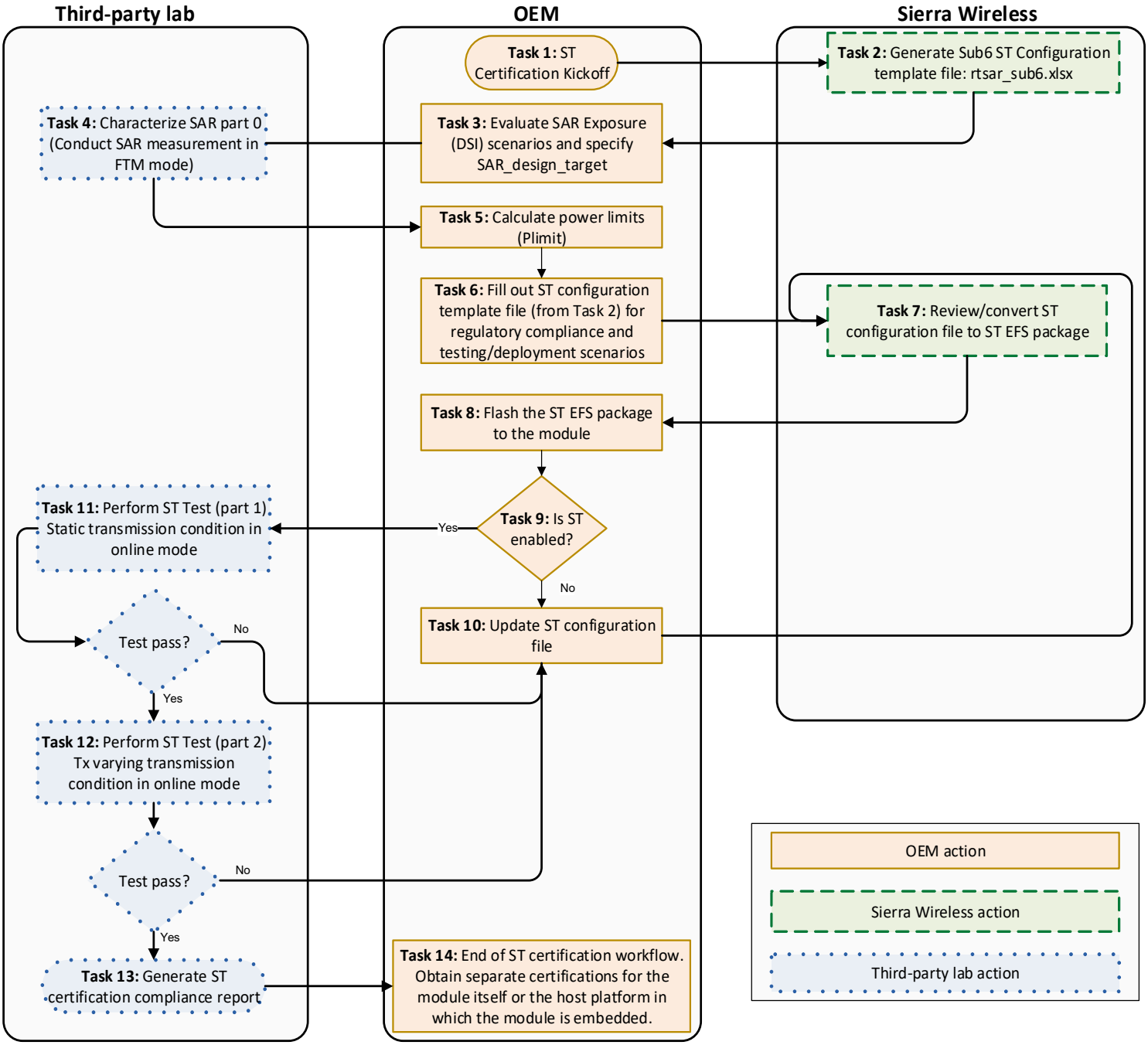


Figure 2: ST Certification Workflow for EM8695 modules

Table 1: ST Certification Workflow Actions — Inputs and Outputs

Task	Action	Responsible Party	Input	Action / Output
#1	ST certification kickoff (Section 5.1)	OEM	—	OEM requests an ST rtsar configuration template file from Sierra Wireless and provides the following information: ▪ Firmware version that will be used for ST certification ▪ OEM's Project ID
#2	Generate an ST rtsar configuration template file	Sierra Wireless	#1 output	Sierra Wireless produces and sends the ST rtsar configuration template file (rtsar_sub6.xlsx) and the STTool flash application to the OEM.
#3	Evaluate SAR exposure scenarios, assign DSI values, and specify SAR_design_target values (Section 5.2)	OEM	#2 output	OEM determines their SAR exposure scenarios, assigns DSI index values to the scenarios, calculates SAR_design_target values, and provides the details to the lab.
#4	Characterize SAR part 0 — Conduct SAR measurement in FTM mode	Third-party Lab	#3 output (i.e., DSI scenarios)	Lab measures max power and SAR values for every antenna/RAT/band/DSI combination, and provides a report to the OEM.
#5	Calculate power limit (Section 5.3)	OEM	#4 output	OEM calculates power limit values for every antenna/RAT/band/DSI combination.
#6	Fill out the ST rtsar configuration template file (Section 5.4)	OEM	#5 output	OEM completes the ST rtsar configuration template file with required details for regulatory compliance testing, and for development testing and commercial field deployments. OEM returns the completed rtsar configuration file to Sierra Wireless.
#7	Verify and convert the OEM's completed ST rtsar configuration file to a signed ST EFS file	Sierra Wireless	#6 output or #10 output	Sierra Wireless uses the OEM's completed ST rtsar configuration file to prepare an ST EFS file (rtsar_config), then sends it to the OEM. *Note: The ST EFS file is used for FCC and ROW regulatory compliance, and for FCC and ROW testing/deployment.*
#8	Flash the ST EFS file to the module (Section 5.5)	OEM	#7 output	OEM installs the ST EFS file on the module using the STTool flash application.
#9	Verify that ST is enabled (Section 5.6)	OEM	#8 output	OEM verifies that ST is enabled: ▪ If enabled, continue to Task #11. ▪ If not enabled, go to Task #10.
#10	Review the submitted ST rtsar configuration file for valid MCCs, DSIs, and P_{limit} values. Update the ST rtsar configuration file accordingly. (Section 5.7)	OEM	#9 test failure or #11 test failure or #12 test failure	OEM corrects the ST rtsar configuration file and resends it to Sierra Wireless with the same name that was used in Task #6.

Table 1: ST Certification Workflow Actions — Inputs and Outputs (Continued)

Task	Action	Responsible Party	Input	Action / Output
#11	Flash the ST EFS file to the module. Perform testing for regulatory compliance — ST Test (part 1) in static transmission condition in online mode.	Third-party Lab	#9 output	Lab performs static transmission testing using a test SIM with MCC=1, which forces the device to operate in Force Peak exposure mode. ▪ If the test passes, continue to Task #12. ▪ If the test fails, go back to Task #10.
#12	Perform testing for field use — ST Test (part 2) in Tx varying transmission condition in online mode	Third-party Lab	#11 test passes	Lab performs varying transmission testing using a SIM with a 'real' MCC (i.e., MCC != 1) that is configured in the template file to use time-averaging. ▪ If the test passes, continue to Task #13. ▪ If the test fails, go back to Task #10.
#13	Generate an ST certification compliance report	Third-party Lab	#12 test passes	Lab produces an ST certification compliance report and sends to the OEM.
#14	End of ST certification workflow	OEM	#13 report received	The module is now configured to use ST. **Important:** Integrators intending to use the Smart Transmit feature on the module may be required to obtain separate certifications (e.g., FCC, ISED, etc.) for either the module itself or the host platform in which the module is embedded.

4.1 Materials List

Table 2 describes the materials that OEMs require to engage in ST certification.

Table 2: Materials List

Tool or Test Equipment	Owner / Brand	Required for Task #	Remark
Callbox	CMW500, Anritsu MT8000A, or equivalent	#9 — Verify that ST is enabled	Populate template file with MCC 001.

5 OEM Actions in the ST Certification Workflow

This section describes actions the OEM must take for OEM-specific tasks in the ST certification workflow (Section 4).

Note — Actions performed by Sierra Wireless or third-party labs are summarized in Table 1.

5.1 ST Certification Kickoff (Task #1)

To begin the ST certification workflow for a wireless device, the OEM must:

1. Determine where the wireless device will be used:
   - Regions subject to FCC regulation (i.e., U.S.A.) — FCC ST certification is required for FCC SAR compliance.
   - Rest of World — ROW ST certification is required for ICNIRP SAR compliance.

2. Contact your Sierra Wireless customer support representative to request an ST rtsar configuration template file for the wireless device.

   Be prepared to:

   a. Optionally, indicate a project ID that will be assigned to the template file.

   b. Indicate the firmware version that will be used for ST certification.

   Based on the information you provide, Sierra Wireless performs Task #2 and provides the rtsar_sub6.xlsx file and the STTool flash application to the OEM. (Note: The STTool will be used later to upload files to the module — 5.5 Flash ST file to the Wireless Device (Task #8).)

5.2 Evaluate SAR Exposure Scenarios, Assign DSIs, Specify SAR_design_target Values (Task#3)

The OEM's wireless device must be SAR-characterized for all supported bands and Tx antenna paths. SAR characterization is evaluated at each surface of the wireless device for each SAR exposure scenario ("DSI scenario") — for example, "DSI 0" scenarios and "DSI 1" scenarios[1]

To prepare for SAR characterization, the OEM must:

1. As described in 5.2.1 Define DSI Scenarios, identify all exposure scenarios that apply to the wireless device, assign unique Device State Index (DSI) values to each scenario, and calculate the worst-case RF exposure values for each scenario — 1gSAR for FCC, and 10gSAR for ROW.

   (Note — The OEM will populate the ST rtsar configuration template file with these DSI values and related details.)

2. Calculate SAR design target values for both regulatory regions (FCC, ROW) — see 5.2.2 Specify FCC / ROW SAR Design Target Values.

3. Provide the exposure scenario details and the SAR design target values ($SAR_{design\_target\_FCC}$, $SAR_{design\_target\_ROW}$) to the lab — the lab performs Task #4 and provides a SAR characterization report to the OEM.

5.2.1 Define DSI Scenarios

1. Identify all SAR exposure scenarios that apply to the wireless device and assign unique DSI values to each scenario:
   - If the device does not support any sensors or other SAR detection mechanisms, use DSI value 0 to indicate there is only one exposure scenario (and that scenario is not distinguished).
   - Otherwise, assign unique DSI values from 0 (default) to 40 (maximum) to each exposure scenario.

Note: For example, the hypothetical wireless device described in this procedure (e.g., Figure 3, Worst Case 1gSAR Determination Based on SAR Scenario Detection Scheme, on page 9) has three defined exposure scenarios (DSI 0, DSI 1 and DSI 2).

1. SAR characterization reference materials: *[6] SAR Evaluation Procedures for Portable Devices With Wireless Router Capabilities (941225 D06 Hot Spot SAR v02r01), [5] RF Exposure Compliance with Smart Transmit (Sub-6) (80-PM669-8 Rev.A) section 3 Part 0: SAR Characterization*

2. Determine the worst-case RF exposure values for each DSI (1gSAR values for FCC, 10gSAR values for ROW).

   The example shown in Figure 3 represents a wireless device with three exposure scenarios — *DSI 0*, *DSI 1* and *DSI 2*. (Note: Examples shown in this document (unless otherwise indicated) refer to 1gSAR values (FCC).)

Number of scenarios distinguished[a]	Worst-case 1gSAR
All scenarios distinguished — The wireless device has proximity sensors or other SAR scenario detection mechanisms for each exposure scenario.	Worst-case 1gSAR for each DSI (individual exposure scenario) is that DSI's SAR value: • Worst-case 1gSAR[DSI_0] = $SAR_{DSI\ 0}$ • Worst-case 1gSAR[DSI_1] = $SAR_{DSI\ 1}$ • Worst-case 1gSAR[DSI_2] = $SAR_{DSI\ 2}$
No scenarios distinguished — The wireless device has no proximity sensors or other SAR scenario detection mechanisms.	All DSIs (individual exposure scenarios) use the same worst-case 1gSAR — the maximum of the 1gSAR values for all exposure scenarios: • Worst-case 1gSAR = max {$SAR_{DSI\ 0}$, $SAR_{DSI\ 1}$, $SAR_{DSI\ 2}$}
Some (not all) scenarios distinguished — The wireless device has proximity sensors or other SAR scenario detection mechanisms for some (but not all) exposure scenarios.	Worst-case 1gSAR for each DSI (individual exposure scenario) depends on whether the DSI is distinguished or not distinguished: • DSI is Distinguished = Yes — Worst-case 1gSAR is the DSI's SAR. • DSI is not Distinguished = No — Worst-case 1gSAR is the maximum of the 1gSAR values for all non-distinguished exposure scenarios.

a. 'Distinguished' scenarios are specific exposure scenarios that can be identified by the wireless device using proximity sensors or other SAR scenario detection mechanisms.

ST works with a single exposure scenario (DSI) at any time, using the power limit value (P_{limit}) recorded for the DSI / RAT / Band / Antenna combination, which is derived from the worst-case 1gSAR value associated with the current DSI (see 5.3 Calculate Power Limits (Task #5)).

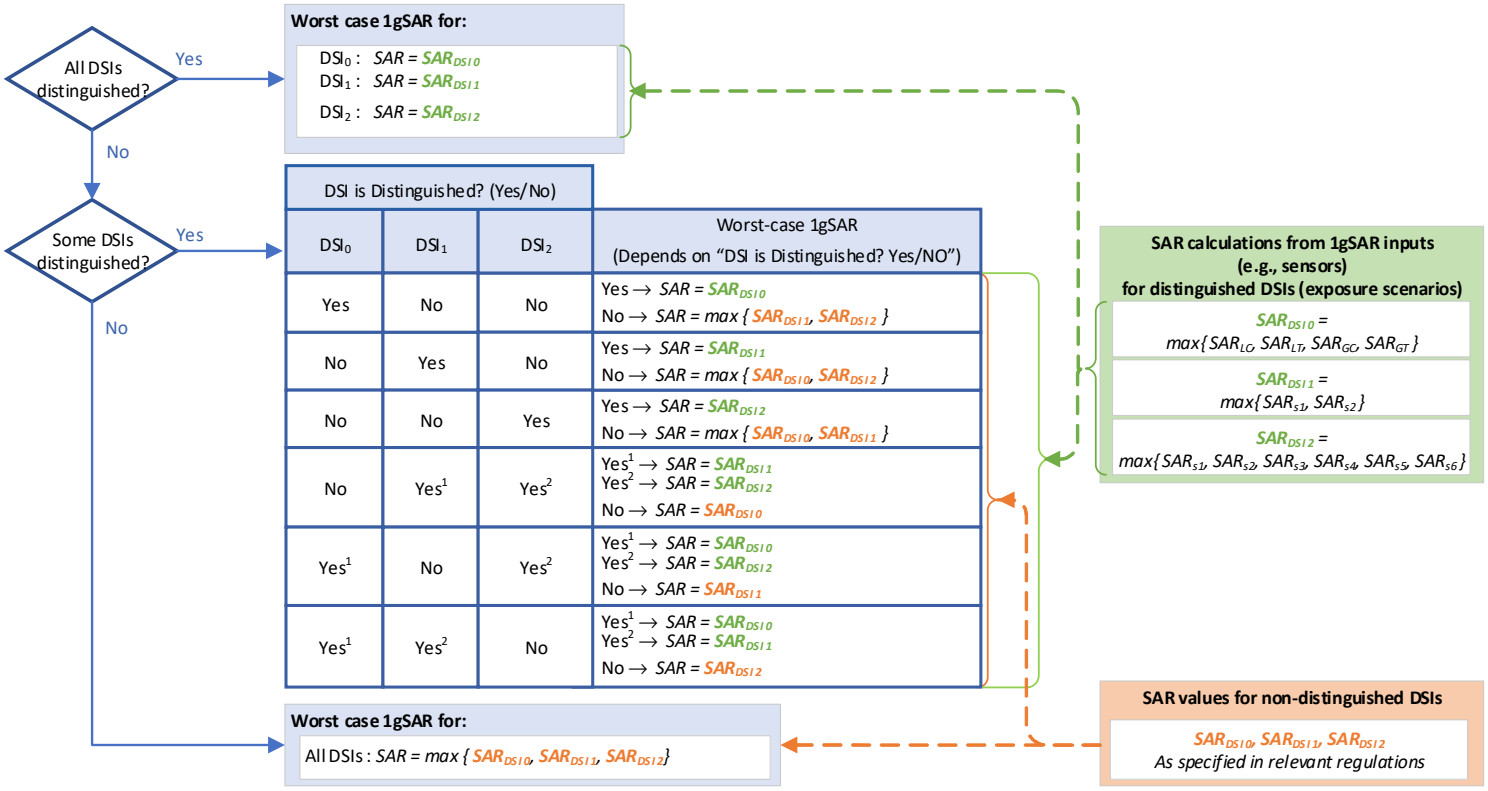


Figure 3: Worst Case 1gSAR Determination Based on SAR Scenario Detection Scheme

5.2.2 Specify FCC / ROW SAR Design Target Values

To enable the lab to perform SAR characterization, SAR design target values must be calculated for both regulatory regions — FCC (1gSAR limit) and ROW (10gSAR limit).

To calculate SAR design target values:

1. Use *(e.1)* to calculate the wireless device's total uncertainty from the EM8695 module uncertainty and the wireless device's base uncertainty:

$$Uncertainty_{total} = Uncertainty_{device} + Uncertainty_{module} \quad (e.1)$$

where:

- $Uncertainty_{module} = 1.5\,\text{dB}$ (EM8695 module uncertainty)
- $Uncertainty_{device} = (\text{TBD by OEM})\ \text{dB}$ (Base device uncertainty due to TxAGC uncertainties and device variance)

2. Use *(e.2)* as described in the following substeps to calculate SAR_{design_target} values for FCC and ROW from region-specific SAR regulatory limits and the device's total uncertainty:

$$SAR_{design\_target\_<Region>} < SAR_{regulatory\_limit\_<Region>} \times 10^{\frac{-Uncertainty_{total}}{10}} \quad (e.2)$$

where:

- $SAR_{regulatory\_limit\_FCC} = 1.6$ W/kg per 1g (FCC / ISED regulatory limit)
- $SAR_{regulatory\_limit\_ROW} = 2$ W/kg per 10g (ROW regulatory limit)

For example:

a. Calculate the FCC SAR design target value, assuming $Uncertainty_{total}$ = 1.5 dB, and round down to 1 decimal place:

$$SAR_{design\_target\_FCC} < SAR_{regulatory\_limit\_FCC} \times 10^{\frac{-Uncertainty_{total}}{10}}$$

$$SAR_{design\_target\_FCC} < 1.6 \times 10^{\frac{-1.5}{10}}$$

$$SAR_{design\_target\_FCC} < 1.1\,\text{W/kg per 1g} \quad \text{(rounded down from 1.133)}$$

b. Calculate the ROW SAR design target value, assuming $Uncertainty_{total}$ = 1.5 dB, and round down to 1 decimal place:

$$SAR_{design\_target\_ROW} < SAR_{regulatory\_limit\_ROW} \times 10^{\frac{-Uncertainty_{total}}{10}}$$

$$SAR_{design\_target\_ROW} < 2 \times 10^{\frac{-1.5}{10}}$$

$$SAR_{design\_target\_ROW} < 1.4\,\text{W/kg per 10g} \quad \text{(rounded down from 1.416)}$$

c. If the wireless device supports additional concurrent WLAN technologies that are not supported by ST (e.g., Bluetooth, Wi-Fi), reduce the calculated $SAR_{design\_target\_FCC}$ and $SAR_{design\_target\_ROW}$ values to account for the additional RF exposure.

$$SAR_{design\_target\_FCC} = SAR_{design\_Target\_FCC} - additionalRFexposure$$

$$SAR_{design\_target\_ROW} = SAR_{design\_Target\_ROW} - additionalRFexposure$$

3. If FCC and/or ROW certification is required for the wireless device, use *(e.3)* to calculate region-specific SAR design target extremity value(s) from the corresponding region-specific SAR regulatory limit for extremities and the device's total uncertainty:

$$SAR_{design\_target\_extremity\_<region>} = \frac{SAR_{design\_target\_<region>}}{SAR_{regulatory\_limit\_<region>}} \times SAR_{regulatory\_limit\_extremity\_<region>} \qquad (e.3)$$

where:

- $SAR_{regulatory\_limit\_extremity\_FCC}$ = 4 W/kg per 10g (FCC/ISED regulatory limit (extremity))
- $SAR_{regulatory\_limit\_extremity\_ROW}$ = 4 W/kg per 10g (ROW regulatory limit (extremity))

For example, using the $SAR_{design\_target\_FCC}$ and $SAR_{design\_target\_ROW}$ values calculated in step 2:

a. Calculate $SAR_{design\_target\_extremity\_FCC}$:

$$SAR_{design\_target\_extremity\_FCC} = \frac{SAR_{design\_target\_FCC}}{SAR_{regulatory\_limit\_FCC}} \times SAR_{regulatory\_limit\_extremity\_FCC}$$

$$SAR_{design\_target\_extremity\_FCC} = \frac{1.1}{1.6} \times 4$$

$$SAR_{design\_target\_extremity\_FCC} = 2.75\ \text{W/kg per 10g}$$

b. Calculate $SAR_{design\_target\_extremity\_ROW}$:

$$SAR_{design\_target\_extremity\_ROW} = \frac{SAR_{design\_target\_ROW}}{SAR_{regulatory\_limit\_ROW}} \times SAR_{regulatory\_limit\_extremity\_ROW}$$

$$SAR_{design\_target\_extremity\_ROW} = \frac{1.4}{2.0} \times 4$$

$$SAR_{design\_target\_extremity\_ROW} = 2.8\ \text{W/kg per 10g}$$

5.3 Calculate Power Limits (Task #5)

The SAR characterization report provided by the third-party lab (Task #4) should include measured power and measured SAR values for each DSI, at the maximum Tx power limit (MTPL) for each band/antenna path/device position/channel combination.

Note: If all of the following conditions are satisfied, HPUE (power class 2) is supported on HPUE-capable LTE bands (e.g., B41), otherwise power class 3 will be used:

- *The ST rtsar template file's Config tab has the power_class value = 2.*
- *TDD UL/DL frame configuration 1–5 is in use.*
- *Inter-band ULCA is not activated (HPUE band intra-contiguous ULCA is allowed).*
- *MTPL in SIB1 is > +23 dBm.*

Typical MTPL values are +23 dBm for non-HPUE LTE bands and +26 dBm for HPUE LTE bands. For band-specific MTPL values, refer to the Conducted Maximum Tx (Transmit) Power Tolerances table in [1] EM8695 Product Technical Specification (Doc# 41114813).

The OEM must use the lab report's measured power and measured SAR values to calculate power limit (P_{limit}) values for each DSI/band/antenna path combination at each device position and channel (low, middle, high).

To calculate the P_{limit} values for a specific DSI/band/antenna path combination:

1. Use *(e.4)* to calculate the P_{limit} values for each position/channel combination (see 5.3.1 Power Limit Calculation Example):

$$P_{limit} = MeasuredPower + 10 \times \log\left(\frac{SAR_{design\_target\_<region>}}{Measured\ SAR}\right) \quad (e.4)$$

   where:
   - $MeasuredPower$ — Refer to the lab report.
   - $MeasuredSAR$ — Refer to the lab report.
   - $SAR_{design\_target\_<region>}$ — Worst-case 1gSAR for the DSI as determined in 5.2.1 Define DSI Scenarios.

2. After calculating the P_{limit} values, enter the minimum P_{limit} value as the Tx power at Design Target for the DSI/band/antenna path combination in the ST rtsar configuration template file.
3. Go back to step 1 and repeat this procedure for the next DSI/band/antenna path combination.

5.3.1 Power Limit Calculation Example

Table 3 presents an excerpt of a lab report prepared for an example UE (User Equipment) device that has been FCC SAR-characterized for two positions — front and back.

The OEM uses *(e.4)* to calculate P_{limit} values for both positions for DSI 3 + LTE Band 5 at low, middle, and high channels.

For example, the first P_{limit} (DSI=3, LTE B5, Ant0, Position=Front, Channel=20450) in this example is 20.8 dBm (rounded down to 1 decimal place), calculated as follows:

$$P_{limit} = MeasuredPower + 10 \times \log\left(\frac{SAR_{design\_target\_FCC}}{Measured\ SAR}\right)$$

$$P_{limit} = 23.75 + 10 \times \log\left(\frac{1.1}{2.13}\right)$$

$$P_{limit} = 20.8\ \text{dB}$$

Table 3: Example — P_{limit} Calculation using Lab-provided SAR Characterization Report

DSI	Mode	RB / RB Offset	Ant#	Position	Channel	Freq (MHz)	Measured Power (dBm)	Measured SAR (W/kg)	$SAR_{design\_target\_FCC}$ (W/kg)	P_{limit} (dBm)[a] (Power level scaled at $SAR_{design\_target\_FCC}$)
									1 g	1 g
3	LTE Band 5 (10 MHz) QPSK	1/0	0	Front	20450	829	23.75	2.13	1.1	20.8
				Back				2.68		19.8
				Front	20525	836.5	23.73	2.93		19.4
				Back				3.70		18.4
				Front	20600	844	23.75	2.77		19.7
				Back				3.50		18.7
				Tx power at Design Target for LTE Band 5 for Ant#0 = min(P_{limit} for each combination above) →						**18.4**

a. P_{limit} values rounded down to 1 decimal place

5.4 Populate ST rtsar Template File (Task #6)

The OEM must populate the rtsar template file that was received from Sierra Wireless, then send it back to Sierra Wireless to convert into an ST EFS file:

1. Populate the rtsar template file:
   a. Populate the Config tab (section 5.4.1).
   b. Populate the mcc_list Tab (section 5.4.2).
   c. Populate the FCC_FR1_Limits and ICNIRP_FR1_Limits tabs (section 5.4.3).
   d. Optionally, review the Sub6 Antenna Groups tab (section 5.4.4).
2. Send the completed file to Sierra Wireless.
3. Sierra Wireless performs Task #7 and will contact the OEM to collect information needed to produce an ST EFS file. (Note — Only one ST EFS file is needed for regulatory compliance and for testing/field deployment.

   Use the following commands and save their responses to provide to Sierra when requested:

```
ATI
<response>
OK

AT!SKU?
<response>
OK

AT!RFCID?
<response>
OK
```

4. When the ST EFS file is ready, Sierra Wireless provides it to the OEM.

5.4.1 Config tab

This tab contains template file identification information and general configuration settings. (Note: Only the oem_id can be modified, as described in the procedure below. Do not change any other settings.)

	A	B
1	Global Config	
2	version	17
3	oem_id	1811939328
4	reserve_power_margin_db	0.0
5	power_class	2
6	voice_call_exp_mode	Time-Averaged

← oem_id is the only setting that can be modified.
Do not change any other values.

Figure 4: Config Tab Parameters

To populate the Config tab:

1. Update the oem_id (which embeds the OEM's Customer_ID, the host device's Project_ID, and the Project_ConfigFile_Version:

   (**Note:** The following steps use the oem_id example from Figure 4 above.)

   a. Convert the oem_id from decimal format to hexadecimal.

   b. Optionally, update the Project_ID, which is a unique value (0–0xFF (255)) assigned by the OEM for a new project.

   c. Add 1 to the Project_ConfigFile_Version, which is a unique value (0–0xFFFF (65535)) updated by the OEM for this version of the template being sent back to Sierra Wireless.

   (Note: If the Project_ID was updated, reset the Project_ConfigFile_Version to 0.)

Step 1:	(stored oem_id) Decimal	(working value) Hexadecimal
(a)	**1811939328**	6c000000 where: ▪ Byte3: 6c — Customer_ID assigned by Sierra Wireless **(Do not change)** ▪ Byte2: 00 — Project_ID (assigned by OEM) ▪ Bytes1-0: 0000 — Project_ConfigFile_Version (updated by OEM)
(b)	—	6c**03**0000 ← *Update Project_ID*
(c)	—	6c03**0001** ← *Update Project_ConfigFile_Version* *Note: This is **not** the 'version' field that is shown on row 2 of the of the template..*
(d)	**1812135937**	6c030001

   d. Convert the hexadecimal format oem_id back to decimal format and enter it in the oem_id field.

2. **Do not change** any other settings in the Config tab, unless instructed to do so by Sierra Wireless.

5.4.2 mcc_list Tab

This tab lists the preferred exposure methods (Time-averaged or Force Peak) and related fields for groups (MCC Lists) of carrier (network) MCCs.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	MCC List	Exposure Mode	Averaging Windows	SAR Limit	Smart Tx Gen	Note: Please list out the MCCs corresponding to each list in the same row									
2	Default MCC	Peak	FCC_timewindow	FCC_FR1_Limits	GEN1										
3	MCC List 1	Time-Averaged	FCC_timewindow	FCC_FR1_Limits	GEN1	310	311	312	313	314	315	316			
4	MCC List 2	Peak	FCC_timewindow	FCC_FR1_Limits	GEN1	1									
5	MCC List 3	Time-Averaged	ICNIRP1998_timewindow	ICNIRP1998_FR1_Limits	GEN1	302									
6	MCC List 4	Peak	ICNIRP1998_timewindow	ICNIRP1998_FR1_Limits	GEN1	202	204	206	208	212	214	216	219	222	226

Figure 5: mcc_list Tab Parameters

The tab includes a default set of MCC Lists with typical configurations for specific countries:

- Default MCC — Used automatically for any MCC that is not specifically linked to one of the "MCC List"s.

Important: *Do not delete the Default MCC.*

- MCC List 1 — USA
- MCC List 2 — Test MCC (1), for use by labs in Part 1 testing
- MCC List 3 — Canada
- MCC List 4 — Greece, Netherlands, Belgium, France, Monaco, Spain, Hungary, Croatia, Italy, Romania, Switzerland, Czech Republic, Slovakia, Austria, United Kingdom, Denmark, Sweden, Norway, Finland, Lithuania, Latvia, Estonia, Russia, Ukraine, Belarus, Poland, Germany, Gibraltar, Portugal, Luxembourg, Ireland, Iceland, Malta, Cyprus, Georgia, Bulgaria, Turkey, Faroe Islands, Greenland, Slovenia, Liechtenstein, Kazakhstan, India, India, United Arab Emirates, Israel, Japan, Japan, Kyrgyzstan, Japan, Japan, Hong Kong, China, China (Reserved code), Taiwan, Malaysia, Australia, Thailand, Singapore, New Zealand, Norfolk Island (Australia), New Caledonia (France), French Polynesia, Saint Pierre and Miquelon, Guadeloupe/French Guiana, Cayman Islands, British Virgin Islands, Bermuda, Montserrat, Curacao/Sint Maarten, Aruba, Turks and Caicos Islands, Reunion (France), Brazil, French Guiana

Important:

- Any MCC can appear in only one MCC List row — If the MCC is duplicated in more than one MCC List, ST will not work.
- If an MCC is not specified in any MCC List rows, the Default MCC list configuration is used.
- If a country has more than one MCC and the MCCs are assigned to different MCC Lists, each of the lists must have the same "Smart Tx Gen" value. For example, Indian MCCs (404, 405, 406) are included in MCC List 4. If MCC 405 is moved to a new list (e.g., "MCC List 6"), the new list must also use Smart Tx Gen = GEN1.)
- Modify only the values described in the procedure below. If any other values are modified, ST will not work correctly with the design.

To update the MCC Lists (e.g., add or update carrier MCCs in existing or new MCC Lists):

1. For the first carrier MCC to add or modify, determine which MCC List it should be in:
   - Existing or new MCC List — Used to group MCCs that use the same settings.
   - Default MCC — Used to group MCCs that will use the default setting behavior (i.e., apply FCC P_{limit} values for each RAT / band / antenna combination using the Force Peak Exposure method).

   Note: MCCs that are not included in any "MCC List #" automatically use the Default MCC.
2. If the MCC should use the default MCC configuration, make sure the MCC is not included in any "MCC List #" row, then go back to step 1 to process the next carrier MCC.

   Otherwise, continue to the next step.
3. Optionally, if the MCC's required configuration is used by an existing MCC List, add the carrier's MCC to the MCC List in the next available cell starting at column 'F', and then go back to step 1 to process the next carrier MCC.

   Otherwise, continue to the next step.
4. In the next empty row, add a new MCC List with the configuration required for the carrier MCC:
   a. In the MCC List field, enter "MCC List *n*" (e.g., "MCC List 6", "MCC List 7", etc.)
   b. In the Exposure Mode field, select the mode the carrier MCC supports:
      - "Time-Averaged"
      - "Peak"

      Note: The Exposure Mode (Force Peak or Time Averaged) can be overridden for specific RAT / band / antenna combinations by the "force peak" parameter in the FCC_FR1_Limits or ICNIRP_FR1_Limits tab (section 5.4.3).
   c. In the Averaging Windows field, select the appropriate averaging window method:
      - "FCC_timewindow"
      - "ICNIRP1998_timewindow"

d. In the SAR Limit field, select the limits type used by the carrier:
- "FCC_FR1_Limits" — Uses the SAR limits from the FCC_FR1_Limits tab.
- "ICNIRP1998_FR1_Limits" — Uses the SAR limits from the ICNIRP_FR1_Limits tab.

e. In the Smart Tx Gen field, select "GEN1".

f. Add the carrier's MCC in the next available cell starting at column 'F', and then go back to step 1 to process the next carrier MCC. When all carrier MCCs have been processed, continue to the next step.

5. Go back to step 1 to process the next carrier MCC.

6. **Important:** After all MCC's have been processed, review each MCC List and make sure that none of the MCCs are duplicated in another MCC List:
   - If an MCC appears in more than one MCC List, remove all duplicates. (ST will not work if any MCC appears in two or more MCC Lists.)
   - Reminder: If an MCC is not in any of the MCC Lists, the Default MCC list configuration is used for ST.

5.4.3 FCC_FR1_Limits and ICNIRP_FR1_Limits tabs

These tabs list all RATs/Bands supported by the customer design, and includes DSI details for each supported RAT/Band/Antenna combination. Separate tabs are used for FCC limits and ICNIRP limits.

	A	B	C	D	E	F	G	H	I	J	K
1		DSI	0			1			2		
2	Tech_Band	Antenna	force peak	4G/5G FR1 backoff for Wifi/BT (dB)	Tx power at Design Target (dBm)	force peak	4G/5G FR1 backoff for Wifi/BT (dB)	Tx power at Design Target (dBm)	force peak	4G/5G FR1 backoff for Wifi/BT (dB)	Tx power at Design Target (dBm)
3	LTE_B1	0			24			10			20
4	LTE_B106	0			24			10			20
5	LTE_B12	0			23.5			10			20
6	LTE_B13	0			23.5			10			20
7	LTE_B14	0			23.5			10			20
8	LTE_B17	0			23.5			10			20
9	LTE_B18	0			24			10			20
10	LTE_B19	0			24			10			20
11	LTE_B2	0			23.5			10			20
12	LTE_B20	0	x		24	x		10	x		20
13	LTE_B25	0			23.5			10			20
14	LTE_B26	0			23.5			10			20
15	LTE_B28	0	x		23.5	x		10	x		20
16	LTE_B3	0			24			10			20
17	LTE_B30	0	x		22	x		10	x		20
18	LTE_B34	0			23.5			10			20
19	LTE_B38	0			23.5			10			20
20	LTE_B39	0			24			10			20
21	LTE_B4	0			23.5			10			20
22	LTE_B40	0			24			10			20
23	LTE_B41	0			24			10			20
24	LTE_B42	0			23.5			10			20
25	LTE_B43	0			23.5			10			20

Figure 6: FCC_FR1_Limits/ICNIRP_FR1_Limits Tabs Parameters

Notes:

- The default rtsar template file defines two DSIs: DSI 0 (in yellow) and DSI 1 (in blue). (Note: The example in Figure 6 also includes a customer-defined DSI (DSI 2).)

  The default DSI 0 definition has Tx power at Design Target values with no backoff for all bands — power class 3 bands are set to 24 dBm and HPUE-capable (power class 2) bands are set to 26 dBm.

Important:

- Do not delete any rows (otherwise the deleted RAT/Band/Antenna path combinations will not work).

  If a band must be added or removed, submit a request to Sierra Wireless for review and to generate a new ST rtsar configuration template.

  Note that after passing certification, any changes made to band/antenna path combinations, Tx power at Design target (P_{limit}) values or force peak values void the certification, and new certification will be required.
- Modify only the values described in the procedure below. If any other values are modified, ST will not work correctly with the design.
- The same DSIs must be defined in both the FCC_FR1_Limits and ICNIRP_FR1_Limits tabs. (i.e., in the example shown, both Limits tabs require DSI 0, DSI 1, and DSI 2)

To populate the FCC_FR1_Limits and ICNIRP_FR1_Limits tabs:

1. Make sure each DSI scenario that was distinguished in 5.2.1 Define DSI Scenarios is included in both tabs as shown in Figure 6 (e.g., DSI 0, DSI 1, and DSI 2).

   If any DSIs must be added, then for each new DSI:

   a. Copy rows 1–2 from one DSI and paste them in the next available columns and assign a DSI number. (For example, if DSI 0, DSI 1, and DSI 2 are present and a new DSI has to be added, copy and paste DSI 2 rows 1–2 to the next columns.)

   b. In the DSI field, enter an available DSI value in the range 0–40.

   Note: If no DSI scenarios were distinguished, make sure only one DSI is shown, with the DSI value set to 0.

2. For each RAT/antenna path/band/DSI combination:

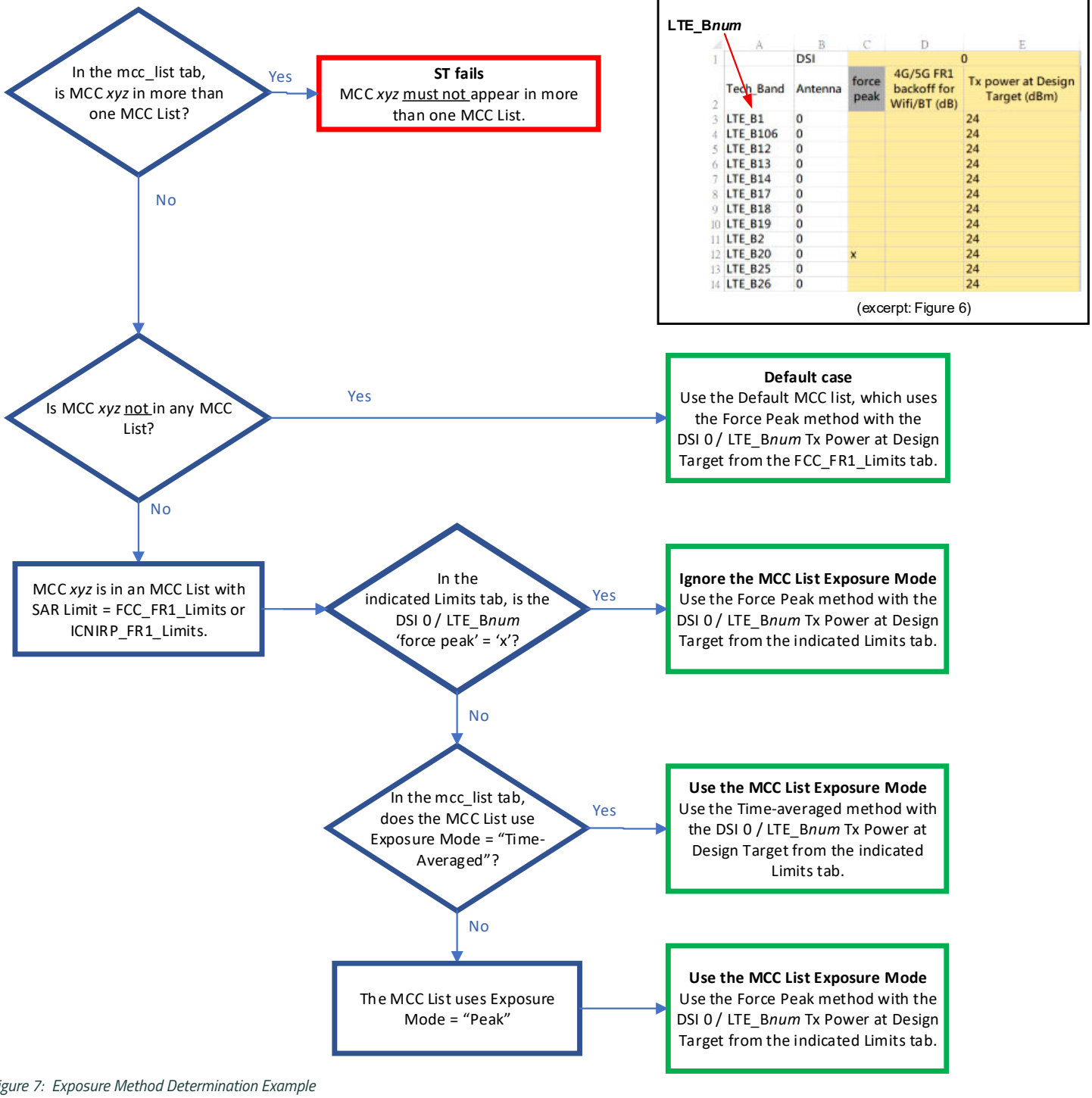
   a. In the force peak field, enter the exposure mode to use for the combination:
      - blank — The exposure mode will be selected for each network on which the wireless device operates, based on the mcc_list tab:
        - MCC is listed in an MCC List with Exposure Mode = "Time-Averaged" — Use the Time-averaged method.
        - MCC is listed in an MCC List with Exposure Mode = "Peak" — Use the Force Peak method.
        - MCC is not listed in any MCC List — Use the Default MCC list configuration.
      - x — Always use the Force Peak exposure mode for this combination. (This overrides the Exposure Mode assigned in the mcc_list tab.

        See Figure 7 for an example of how the exposure method is determined.

   b. Leave the 4G/5G FR1 backoff for Wifi/BT (dB) field blank.

   c. In the Tx power at Design target (dBm) field:
      - If the combination requires a SAR limit, enter the minimum P_{limit} value that was calculated for the combination in 5.3 Calculate Power Limits (Task #5),
        or
      - If the combination does not need a power limit and can operate up to the maximum power (i.e., no power backoff), enter 24 for power class 3 bands, or 26 for HPUE-capable (power class 2) bands
        or
      - If the combination requires power backoff to meet EIRP requirements (e.g., B48 combinations), enter an appropriate maximum value based on the antenna gain (e.g., 15 dBm) and set the force peak field to 'x'.

EXAMPLE: Exposure method determination for DSI=0, LTE_B*num* when MCC = *xyz*



LTE_B*num*

	DSI		0	
Tech_Band	Antenna	force peak	4G/5G FR1 backoff for Wifi/BT (dB)	Tx power at Design Target (dBm)
LTE_B1	0			24
LTE_B106	0			24
LTE_B12	0			24
LTE_B13	0			24
LTE_B14	0			24
LTE_B17	0			24
LTE_B18	0			24
LTE_B19	0			24
LTE_B2	0			24
LTE_B20	0	x		24
LTE_B25	0			24
LTE_B26	0			24

(excerpt: Figure 6)

Figure 7: Exposure Method Determination Example

5.4.4 Sub6 Antenna Groups tab

Important: ***Do not make any changes*** *to the antenna groups tab unless instructed to do so by Sierra Wireless. If any Antenna Groups are modified or added, you must make sure that all antennas in each group are mutually-exclusive, as detailed in [4] RF Exposure Compliance Test Report for FCC Equipment Authorization of QRD (80-W2112-4 Rev. YD).*

This tab allows specific antennas to be configured into different groups for specific exposure scenarios in both DSI 0 and DSI 1 exposure categories.

The default template file assigns the EM8695 module's antenna (0) to Antenna Group 0.

5.5 Flash ST file to the Wireless Device (Task #8)

After Sierra Wireless verifies the ST rtsar configuration file that was prepared in Task #6, the file is converted and sent back to the OEM as an ST EFS file (rtsar_config). The OEM must use the STTool through the DIAG port to upload the ST EFS file to the wireless device's EM8695 module.

(Note: The STTool was delivered with the original ST rtsar configuration template file — 5.1 ST Certification Kickoff (Task #1).)

To upload the ST EFS file to the module:

1. Enable the module's DIAG port:

```
AT!USBCOMP="DIAGENABLE",0x80
OK

AT!RESET
```

2. On the host device (after the module resets), run the EXTERNAL_STTool application:

```
C:\STTool>EXTERNAL_STTool.exe
EXTERNAL_STTool v1.0.0.0
Write files to EFS

writeSingleFile C:\STTool\ST_EFS_FILE\rtsar_config => "/nv/item_files/
mcs/lmtsmgr/sar/rtsar/rtsar_config"
[WRITE] Writing data . Done

Download success. 1 files write to EFS
rebootModule ...

Waiting device rebooting..........
```

5.6 Verify ST is Enabled (Task #9)

After installing an ST EFS file to the EM8695 module, confirm that ST is enabled:

1. Confirm the EFS file was properly flashed, and determine if the correct ST files have been used:
   a. Use the !STEFS command to display the names of the ST files that are currently installed:

```
AT!STEFS?
<st_file> <sha256_file>
OK

e.g.:

AT!STEFS?
rtsar_config    71C178A81FD1C72867916A5466A504B28749CA9F8567B09CC4062503EC6E3826

OK
```

   b. If the command returned a "File missing" message, the file did not flash successfully — the submitted rtsar file must be revised and resubmitted to Sierra Wireless to receive an updated ST EFS file. Go to 5.7 Update ST rtsar Configuration Template File (Task #10).

      Otherwise, continue to the next step.

   c. Compare the sha256 checksums returned by !STEFS? to the checksums provided by Sierra Wireless with the ST EFS file. If the checksums do not match, re-attempt the download if possible. If the checksums still do not match, contact your Sierra Wireless customer service representative.

2. Confirm that ST successfully initialized — Use the !STSTATUS command:

```
AT!STSTATUS?
ST_FW_version: <ST_Firmware_Version>
ST_Config_version: <ST Configuration Version>
ST_OEM_ID: <OEM ID> (OEM ID dec)
ST_Current_MCC: <Current MCC>
ST_MCC_Exposure_mode: <MCC exposure_Mode>
OK
```

   If the command returns output as shown above, ST has initialized successfully:

      i. If the <ST_Firmware_version> and <ST Configuration Version> match, continue to step 3.

      ii. Otherwise, contact your Sierra Wireless customer service representative to determine if a newer ST rtsar configuration template file is available and should be used.

   Otherwise, if an error message is returned (e.g. "ST unknown status", "ST configuration not present", etc.), ST did not initialize. Go to 5.7 Update ST rtsar Configuration Template File (Task #10) to revise the submitted ST rtsar configuration file and resubmit it to Sierra Wireless to receive an updated ST EFS file.

3. Manually test that ST is enabled:
   a. Connect the wireless device to a callbox.
   b. Initiate one data call from the callbox.
   c. Turn on the Tx measurement panel on the callbox and set the Tx power to the MTPL of the band used for the data call (typically +23 dBm for non-HPUE LTE bands, or +26 dBm for HPUE LTE bands).
   d. Set a valid DSI state (i.e., one that is listed in the rtsar file) — see 6 How to Select the DSI (Exposure Scenario) for Sub-6 ST.

e. Observe the Tx power limit changing with DSI state.

During this test, ensure there is data transmission from the wireless device to the network after the data call has been established. The expected Tx power behavior depends on whether the force peak option for the band and antenna path under test is disabled or enabled:

- Disabled — Tx power is expected to increase and decrease around the expected Tx power at Design Target value.
- Enabled — Tx power should never exceed the Tx power at Design Target value.

5.7 Update ST rtsar Configuration Template File (Task #10)

If 5.6 Verify ST is Enabled (Task #9) indicated there was a problem (i.e., ST did not flash successfully or did not initialize successfully), the submitted ST rtsar configuration file (or a new template from Sierra Wireless, if provided) must be revised and resubmitted to Sierra Wireless to receive an updated ST EFS file.

The most common errors that will prevent Sierra Wireless from building an ST EFS file and will require corrections to the template file are:

- An MCC is included in more than one MCC List in the "mcc_list" tab.
- No valid DSIs are populated (0–40)

To update the ST rtsar configuration file:

1. Review the file to identify and fix any errors/omissions (based on the requirements described in 5.4 Populate ST rtsar Template File (Task #6)).
2. Resubmit the corrected configuration file to Sierra Wireless for verification and conversion.

5.8 End of Certification Workflow (Task #14)

When the OEM has received an ST certification compliance report from the third-party lab, the ST certification workflow process is complete and the module is now configured to use ST.

Important: *Integrators intending to use the Smart Transmit feature on the module may be required to obtain separate certifications (e.g., FCC, ISED, etc.) for either the module itself or the host platform in which the module is embedded.*

6 How to Select the DSI (Exposure Scenario) for Sub-6 ST

To select the DSI (i.e., to select the exposure scenario) to use for ST, use an appropriate method (AT commands, SDK API, GPIO) as described in this section.

6.1 Set DSI via AT Command

To set the DSI using AT commands:

1. Enable access to password-protected AT commands:

```
AT!ENTERCND=<password>      ← The password is factory-configured and can be changed using !SETCND.
OK                            If the password is not known, contact Sierra Wireless for assistance.
```

2. Disable the DPR GPIO function if it is enabled (note — DPR GPIO is disabled by default):

```
AT!CUSTOM="GPIOSARENABLE",0
OK

AT!RESET
```

3. Set the DSI to select a desired exposure scenario (note — this setting does not persist across power cycles):

```
AT!SARSTATE=<dsi_index>
OK
```

Refer to *[2] EM8695 AT Command Reference (Doc# 41114815)* for AT command details.

6.2 Set DSI via SDK API

To set the DSI using an SDK API:

1. Disable the DPR GPIO function if it is enabled (note — DPR GPIO is disabled by default):

```
AT!CUSTOM="GPIOSARENABLE",0
OK

AT!RESET
```

2. Set the DSI to select a desired exposure scenario (note — this setting does not persist across power cycles) — Use the "pack_sar_SLQSSetRfSarState()" API.

6.3 Set DSI via GPIO

The DPR GPIO (pin 25) can be used to switch exposure scenarios between DSI 0 and DSI 1.

For example, consider a device with two distinguished exposure scenarios — DSI 0 (default configuration) and DSI 1 (a human body scenario — head, body, etc.):

- Because the default ST rtsar configuration template's DSI 0 configuration was used to build the ST EFS file, the Tx power at Design Target values for all bands are set to max Tx power (refer to "Conducted Maximum Tx Power Tolerances" table in *[1] EM8695 Product Technical Specification (Doc# 41114813)*).
- For this example, assume DSI 1 is configured with lower Tx power at Design Target values (i.e., SAR backoffs applied) for various bands.

In this case:

- The DPR GPIO can be used to switch from DSI 0 to DSI 1 (i.e., enabling SAR backoff) when the device's sensors (or other detection mechanisms) detect the human body scenario (DSI1).
- When the human body scenario is no longer detected, the DPR GPIO can be used to switch back to DSI 0 from DSI 1 (i.e., disabling SAR backoff).

To set the DSI with the DPR GPIO:

1. Enable access to password-protected AT commands:

```
AT!ENTERCND=<password>      ← The password is factory-configured and can be changed using !SETCND.
OK                            If the password is not known, contact Sierra Wireless for assistance.
```

2. Enable the DPR GPIO function if it is disabled:

```
AT!CUSTOM="GPIOSARENABLE",1
OK
```

3. Set the DPR pin mode:

```
AT!SARINTGPIOMODE=<0 or 1>
OK

AT!RESET
```

4. Pull DPR GPIO (pin 25) high or low to switch the DSI. The wireless device's EM8695 module's firmware monitors DPR GPIO and adjusts the RF Tx power appropriately, as detailed in Table 4 on page 22.

Table 4: Dynamic Power Selection of ST DSI

!SARINTGPIOMODE[a]	DPR Internal Pull	DPR Pin	ST State
0 (default)	Pull up	High[b]	No ST enabled or ST enabled with DSI 0
		Low	ST enabled with DSI 1
1	Pull down	Low	No ST enabled or ST enabled with DSI 0
		High	ST enabled with DSI 1

a. !SARINTGPIOMODE=1 inverts the DPR logic.
b. The host can implement an open collector drive for the DPR pin (if a 1.8V-compatible drive is not available).

7 References

Sierra Wireless

[1] EM8695 Product Technical Specification (Doc# 41114813)

[2] EM8695 AT Command Reference (Doc# 41114815)

Qualcomm Technologies, Inc.

[3] Qualcomm Smart Transmit Feature for SDX35 (80-61400-14 Rev.AA)

[4] RF Exposure Compliance Test Report for FCC Equipment Authorization of QRD (80-W2112-4 Rev. YD)

[5] RF Exposure Compliance with Smart Transmit (Sub-6) (80-PM669-8 Rev.A)

FCC

[6] SAR Evaluation Procedures for Portable Devices With Wireless Router Capabilities (941225 D06 Hot Spot SAR v02r01)

8 Glossary

Term	Definition
CW	Continuous Waveform
DRI	Device Range Index
DSI	Device State Index (Value corresponding to a specific usage scenario)
EFS	Qualcomm Embedded Files System (Latest version — EFS17)
FCC	Federal Communications Commission (FCC ST certification is the American standard smart transmit certification)

Term	Definition
FTM	Factory Test Mode
HPUE	High Power User Equipment
ICNIRP	International Commission on Non-Ionizing Radiation Protection
ISED	Innovation, Science, Economic Development Canada
MCC	Mobile Country Code
Module	Sierra Wireless EM8695 series module
MTPL	Maximum Tx Power Limit — The module's maximum (non-configurable) Tx power. Tx power will be limited to this value if the requested Tx power is higher.
PD	Power Density (W/m^2)
Plimit	Power Limit — The maximum power, in dBm, at which a given radio configuration reaches the SAR design target. The SAR design target is predetermined for the specific device and will be less than the regulatory SAR limit after accounting for all design-related tolerances.
QTI	Qualcomm Technologies, Inc.
RAT	Radio Access Technology
RF	Radio Frequency
ROW	Rest of World (ROW ST certification is the European standard smart transmit certification)
SAR	Specific Absorption Rate (W/kg)
SIB1	System Information Block #1
ST	Smart Transmit
Sub-6	3G/4G/5G-Sub6 Technology
ULCA	Uplink Carrier Aggregation
Wireless device	Host platform (i.e., chassis in which a module is installed)

9 Support

For direct clients: contact your Sierra Wireless FAE

For distributor clients: contact your distributor FAE

For distributors: contact your Sierra Wireless FAE

10 Document History

Revision number	Release date	Changes
1	July 2025	Creation
2	November 2025	Added Important notes for Integrators re: obtaining certifications for the module or host platform. Updated 4 ST Certification Workflow (added Task#14 — Figure 2, ST Certification Workflow for EM8695 modules, Table 1, ST Certification Workflow Actions — Inputs and Outputs) and added 5.8 End of Certification Workflow (Task #14).

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